United States Patent [19]

Dillinger et al.

[11] **3,754,507**

[45] **Aug. 28, 1973**

[54] **PENETRATOR PROJECTILE**

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[22] Filed: **May 30, 1972**

[21] Appl. No.: **257,559**

[52] **U.S. Cl.** **102/52,** 102/DIG. 5

[51] **Int. Cl.** **F42b 11/14,** F42b 13/04

[58] **Field of Search** 102/49.3, 49.7, 52, 102/DIG. 5; 149/42

[56] **References Cited**

UNITED STATES PATENTS

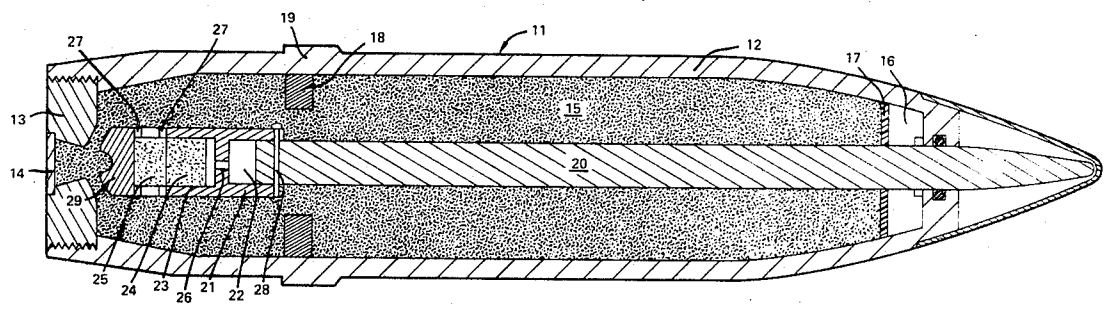
3,277,825	10/1966	Maillard	102/52
3,097,602	7/1963	Turner	102/DIG. 5
3,399,088	8/1968	Christian et al.	149/42
3,302,570	2/1967	Marquardt	102/52
2,419,414	4/1947	Mohaupt	102/52 X
982,402	1/1911	Wells	102/52 X
36,686	10/1862	Callender	102/52 X

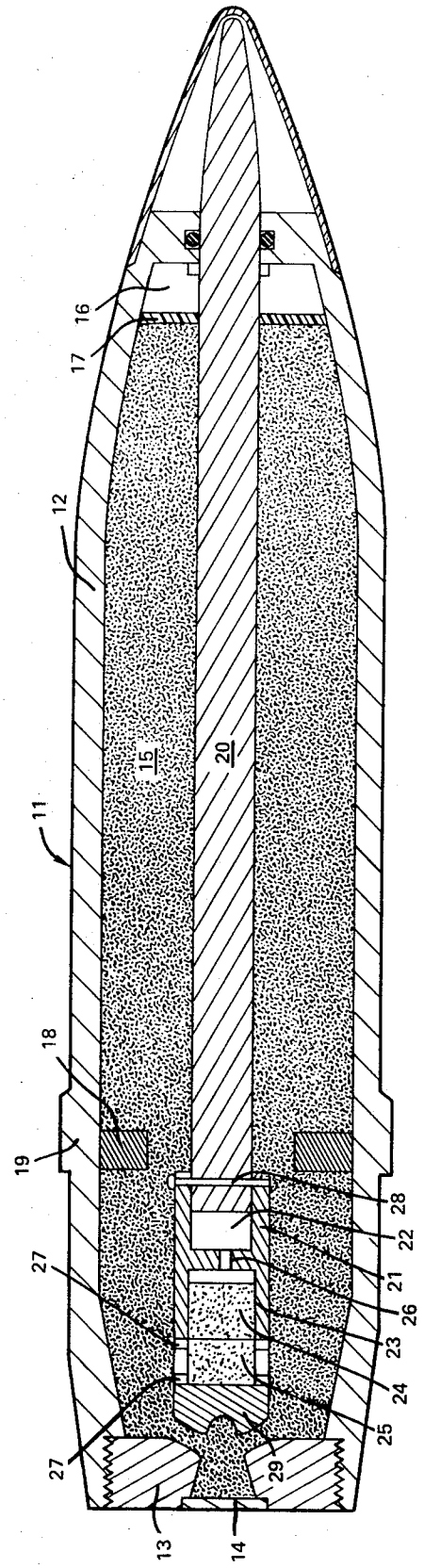
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[57] **ABSTRACT**

A projectile in which a combination of interior elements, including a penetrator, a pyrotechnic delay column and an ignition charge are utilized to ignite a viscous uncured propellant after the projectile has been fired. The thus ignited propellant increases the velocity and effectiveness of the projectile.

3 Claims, 1 Drawing Figure




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PENETRATOR PROJECTILE

BACKGROUND OF THE INVENTION

1. Field of the Invention.

This invention relates to penetrator projectiles. More particularly, this invention relates to penetrator projectiles of the type in which propellant is utilized to increase the projectile velocity.

2. Description of the Prior Art.

Penetrator projectiles, i.e., projectiles which contain penetrators for armor piercing purposes and the like are known. It is also known that the velocity and thus the effectiveness of such projectiles can be increased by utilizing propellants within the projectiles. However, in the prior art solid propellants which ignite almost instantaneously upon firing of the projectiles in which they are contained have generally been used.

The use of solid propellants which are ignited instantaneously upon firing of the projectile has several drawbacks. Firstly, it is well known that solid propellants are susceptible to cracking upon being subjected to high axial acceleration and the like and that cracks which develop in solid propellants often lead to explosions when the propellant is ignited. Secondly, enough solid propellant to be of great significance can not be incorporated into small projectiles. Thirdly, when the propellant is ignited almost unstantaneously as the projectile is fired, added thrust is obtained only during the first moments of the projectile's flight and not later when it could be better utilized. For these and other reasons, research leading to the present invention was conducted.

SUMMARY OF THE INVENTION

The present invention provides a rocket assisted penetrator projectile in which uncured propellant is used in lieu of solid propellant and in which the propellant is ignited at a predetermined time well after the projectile has been fired. The propellant is ignited by a combination of events which include:

1. compression and heating of air in an adiabatic compression chamber by the penetrator when the projectile is fired;

2. actuation of a pyrotechnic delay column by the heated air from the adiabatic compression chamber;

3. actuation of an ignition charge by the pyrotechnic delay column; and

4. ignition of the propellant by the ignition charge.

The use of uncured propellant precludes the possibility of propellant cracking under the high axial accelerations encountered when the projectile is fired from a gun. Also, the present invention permits the use of a greater amount of propellant in a projectile of a given caliber than was possible in the prior art. Further, this invention provides for ignition of the propellant at a predetermined time after the projectile has been fired.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE is a cross sectional view of a penetrator projectile according to this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Going first to the drawing in which like numerals are used to indicate like parts, the single FIGURE is a cross sectional view of a penetrator projectile **11** according to this invention prior to firing. The projectile is made to fit into and be fired from a cartridge (not shown) which may be of any convenient size such that it will fit into an existing gun. For example, projectiles for guns having calibers in the range of from about 20 mm to about 50 mm may be conveniently manufactured.

The projectile **11** comprises a hollow projectile housing **12** closed at its rear by nozzle **13** and nozzle closure **14.** It is preferred that the nozzle throat be of ablative material of a type commonly used in rockets.

Loaded within the projectile housing is propellant **15.** In practicing this invention, the propellant is an uncured propellant mix of the type ordinarily used to fabricate solid rocket propellant grains with the exception that no curing agent is added. That is, the propellant contains oxidizer particles such as NH_4ClO_4 or the like, fuel particles such as Al or the like and binder material such as hydrozy or carboxy terminated polybutadiene or the like but no curing agent such as toluene diisocyanate which would form cross-links between polymeric chains of binder material and cause the binder to set. Thus the propellant may be described as a viscous suspension of oxidizer and fuel particles in a matrix of uncured binder material. A forward ullage void **16** is insured by means of a frangible or deformable diaphragm **17** which may be fabricated of plastic, rubber or the like and fastened in place by means of a suitable adhesive.

Rotating band support **18** provides support for a rotating band **19** which interacts with rifling in the barrel of a gun from which the projectile is fired to impart spin. The rotating band support may be either a washer like article located in the indicated position or a washer like article with a plurality of projections extending inwardly and resting on penetrator **20.**

The penetrator **20** extends longitudinally from the forward end of the projectile towards the rear of the projectile and the aft end of the penetrator, along with tubular housing **21** and a partition **30** dividing the tubular housing describes an adiabatic compression chamber **22.** The penetrator is retained in fixed position with respect to tubular housing **21** by means of a shear pin **28** or other form of retaining device.

The adiabatic compression chamber **22** is connected by opening **26** through partition **30** to chamber **23** within the tubular housing which contains a pyrotechnic delay column **24** and an ignition charge **25** in contact with one another. The pyrotechnic delay column and ignition charge may be of any materials commonly used in the manufacture of such articles.

A plurality of lateral openings **27** through tubular housing **21** lead from the area of the ignition charge to the propellant **15.** Tubular housing **21** is closed at the rear by closure **29.**

When a projectile built as shown in the drawing and containing uncured propellant of the type described above is fired from a cartridge case contained in a rifled gun barrel, several related events occur.

Firstly, spin is imparted to the projectile by interaction of the rotating band **19** with the barrel rifling. This spin causes the viscous uncured propellant to be forced outwardly toward the projectile housing **12.** The force is sufficient to cause the diaphragm **17** to rupture or deform which, in turn, permits the propellant to have access to space provided by ullage void **16.** The extra space plus continued spin permits a central core to be formed in the propellant. The thus formed central core

surrounds the penetrator **20** and tubular housing **21** and acts in a manner similar to a core in a solid propellant grain. That is, the propellant can be ignited in the core and will burn outwardly towards the projectile housing in a manner similar to that in which a cored solid propellant grain would burn.

As the projectile is fired, inertia causes the penetrator **20** to be forced toward the rear of the projectile severing shear pin **28** and compressing air in adiabatic compression chamber **22.** The compression causes the air to heat and hot air passes through opening **26** actuating pyrotechnic delay column **24.** The pyrotechnic delay column burns, from the front toward the rear, for a predetermined amount of time depending upon its length and upon the material from which it is fabricated until the flame actuates ignition charge **25.** Flames jetting out of openings **27** from ignition charge **25,** in turn, ignite the now cored propellant.

Once the propellant is ignited, pressure begins to build up within the projectile. When the pressure is sufficiently built up, nozzle closure **14** is blown out of nozzle **13** and the escaping gases propel the projectile in a manner similar to that in which a rocket is propelled.

In the practice of this invention, a wide variety of choices exist insofar as the length and material of the pyrotechnic delay column and material of the ignition charge are concerned. Also, a wide variety of choices exist insofar as the material of the propellant is concerned. The propellant should have the property wherein solid oxidizer and fuel particles remain suspended in the binder material and do not settle out upon storage of a propellant filled projectile.

This invention is advantageous in that ignition of the propellant does not occur instantaneously upon firing of the projectile but is delayed until late in the flight of the projectile when the maximum benefit can be derived from it. Also, the use of uncured propellant permits more propellant to be loaded into a given amount of space than is possible with solid propellant. Further, uncured propellant does not develop flaws when it is subjected to high stresses and the like and can thus be stored indefinitely without inspection.

It will be apparent to the reader that if desired the nose end of the projectile could contain a small warhead or the like to further increase effectiveness insofar as penetration of armor is concerned.

We claim:

1. A projectile comprising:

a. a hollow projectile housing closed at its aft end by a nozzle and nozzle closure, said projectile housing having at least one rotating band around its outer periphery;

b. a penetrator and a tubular housing centrally and longitudinally located within the projectile housing with the forward end of the penetrator at the foward end of the projectile housing and the aft end of the penetrator resting in the foward end of the tubular housing and describing an adiabatic compression chamber therewith, the aft end of said tubular housing being closed;

c. a pyrotechnic delay column located within the tubular housing in a position where heated air from the adiabatic compression chamber can contact it;

d. an ignition charge located within the tubular housing to the rear of and in contact with the pyrotechnic delay column;

e. a plurality of lateral openings in the tubular housing leading from the area in which the ignition charge is located to the exterior of the tubular housing; and

f. a propellant mix comprising oxidizer particles and fuel particles suspended in uncured binder material surrounding said penetrator and tubular housing within the projectile housing.

2. A projectile according to claim **1** in which said propellant comprises NH_{4ClO4} particles and Al particles suspended in a binder material selected from uncured carboxy terminated polybutadiene and uncured hydroxy terminated polybutadiene.

3. A projectile according to claim **1** in which said nozzle is ablative.

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