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INCENDIARY PROJECTILE

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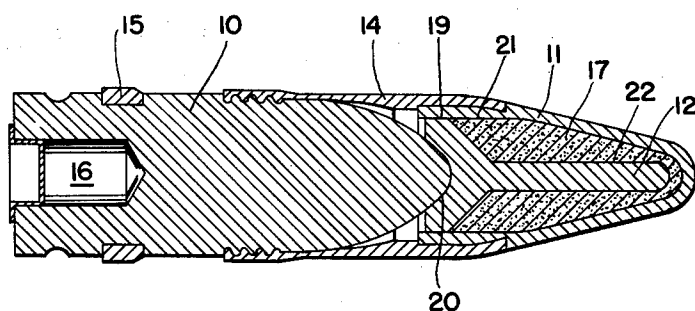


FIG. 1.

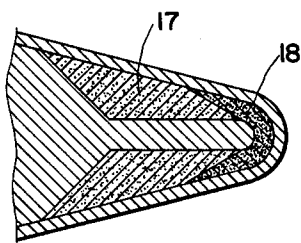


FIG. 2.

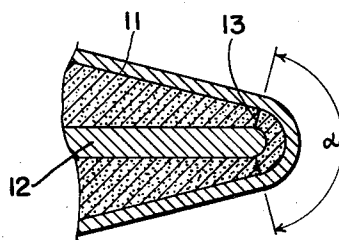


FIG. 3.

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2,900,914

INCENDIARY PROJECTILE

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7 Claims. (Cl. 102—90)

(Granted under Title 35, U.S. Code (1952), sec. 266)

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

This invention is a continuation-in-part of my copending patent application, Serial No. 585,131, filed May 15, 1956 (abandoned as of March 26, 1958), and relates to incendiary projectiles, and more particularly toward enhancing the uniformity of sensitivity and performance of incendiary projectiles at long ranges.

An armor piercing incendiary projectile is designed to penetrate a target, and in doing so, to ignite the incendiary material in the projectile. Thereafter, to have the burning incendiary material adhere to the bullet when it strikes the target in back of an outer protective shield, then setting fire to or exploding the protected materiel.

Incendiary projectiles, in the past, have functioned by having the outer jacket split open and allow the incendiary mixture to burn upon reaction with the air. More recently, incendiary mixes have been used which ignite upon impact of the projectile with the target. That is, the impact causes crystal shear of the incendiary mix explosive particles, that is, the generation of heat brought about by shear forces acting on the crystals of the incendiary mix, creating friction and releasing heat sufficient to ignite the solid fuel in the mix. The idea behind this arrangement devolved from the primer mixes, which functioned upon impact from a firing pin. However, where the primer mixes needed only $\frac{1}{10}$ or less ft. lbs. of impact to result in ignition, this would not be safe to handle in an incendiary projectile, as it would function if dropped or if it balloted in a worn gun tube. To use incendiary mixes which were drop and bore safe required less sensitive mixes, and construction which utilized some means of obtaining crystal shear to generate the heat for ignition, which resulted in lack of uniformity of functioning and sensitivity.

In the past, there were two general ways of achieving what was then considered an efficient projectile. One way was to provide a hollow penetrator, filling it with incendiary mix, and loading it right to the nose of the projectile. The nose was then thinned to increase sensitivity to impact or another more sensitive mixture was inserted at the front of the main column of incendiary. Difficulties with this design were in its lack of uniformity of sensitivity, not being drop or bore safe when sensitive mixes are used in the nose; and being unable, due to the hollow penetrator, to defeat the heavier aircraft armor in use in recent years, and the inefficient use of the incendiary mixture. The applicant has found that increasing the column of incendiary mixture does not increase efficiency.

The other way of achieving an efficient projectile was to work on the penetrating angle. That is, to incorporate a solid penetrator, and then have either a sensitive mix in front, or reduce the space between the penetrator and the nose, and thin out the nose section of the projectile so that functioning will occur by preferential failure of the nose resulting in a pinching of the explosive compo-

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nent of the mix to achieve the release of heat to ignite the solid fuel. This arrangement did not prove uniform in functioning at long ranges due to low impact forces and high angles of obliquity due to variation in column of mix compressed. Also when increasing the sensitivity, the distance between the penetrator and jacket is reduced, thereby substantially reducing the volume of incendiary in the nose of the projectile.

As a result of this, the greatest problem encountered was sensitivity at long ranges. At long ranges the projectile has decelerated, and the impact force at the target correspondingly reduced. The projectile must still be capable of penetrating as much as .150 inch of laminar Duralumin; the incendiary material must still ignite; and remain burning until after the primary, protected target is contacted.

According to this invention, for the first time, a projectile is made which has a high degree of sensitivity and uniformity of functioning at long ranges, can successfully penetrate the target for which it is designed 90% of the time, is drop safe from a distance of 40 feet, bore safe in a worn tube at extreme temperatures, incorporates a maximum amount of incendiary mixture without reducing sensitivity, and which can be easily adjusted in sensitivity for the desired target.

These new results are achieved by employing the primer functioning principle. That is, by realizing that both incendiary projectiles and primers function essentially the same, by including in the projectile all the components found in a weapon system, designing the components so that they may be assembled in a unique way such that the projectile is uniformly sensitive to impact over a wide angle of impacts and striking velocities, at the same time incorporating the maximum amount of incendiary mix, while still maintaining safety requirements. Since primer composition is too sensitive, the projectile was designed to function with both the standard incendiary mix and with a special preliminary igniting mix which is more sensitive than the usual incendiary mixes. The nose of the projectile forms the housing for the mix, while the anvil performs the function of the firing pin. The shape of the forward portion of the anvil and the inner surface of the nose are such that the distance between them is constant over a wide angle, thus allowing for uniform crush-up in this area, resulting in uniform sensitivity. The T shape allows for the maximum amount of mix.

The specific nature of the invention as well as its advantages will be seen by referring to the drawings.

Fig. 1 is an axial sectional view of the projectile assembly;

Fig. 2 shows another preferred loading of the nose section; and

Fig. 3 shows the essence of the invention, the manner by which uniformity of functioning and sensitivity is achieved and maintained.

In Fig. 1 is shown the entire projectile assembly, where 10 is the penetrator, 15 is the projectile rotating band and 16 is the tracer cavity. An adapter 14 is assembled to the projectile body, and presents a threaded or interference fit for the nose 11. The incendiary mix 17 is located around the anvil 12 which is positioned by its outer surface 19 being in close contact with the inner surface 21 of the nose.

The nose is loaded with incendiary mixture in stages by using a former having a shape like that of the front end 22 of the anvil 12. Sufficient mix is put in to form the controlled space 13, and then successive loads until the entire mixture is in the nose. The anvil 12 is then inserted and the nose screwed or pressed into the adapter. The mixture compacts until the nose is seated against

the adapter by the action of the nose of the penetrator pressing against the anvil at 20.

Fig. 1 shows an assembly using the usual 50-50 incendiary mixture. That is 50 parts by weight of barium nitrate, and 50 parts by weight of a 50/50 alloy of magnesium-aluminum, in the usual powdered form.

In Fig. 2 is shown a preferred loading to further increase the efficiency and sensitivity of the projectile at long ranges. The loading of the nose is achieved in stages for the convenience of the loader. The first stage, or charge is a special mixture consisting of 49 parts by weight of 50/50 alloy of magnesium-aluminum, 49 parts by weight of potassium perchlorate, and 2 parts by weight of calcium resinate. Although 1-2 grains of this mixture in the tip would be sufficient, more is used so that it fills the area 18, when the assembly is made.

Fig. 3 shows the essence of the invention. The anvil is shaped as is the inside of the nose, so that the distance 13 is uniform over a large angle (α). The angle is made as large as possible so that the projectile functioning will be uniform over a wide range of impact angles. The distance can be made larger or smaller by shortening the anvil and reducing the diameter of the elongated portion 12.

This invention then employs the age-old primer principle to function an incendiary projectile. It has been found that varying the incendiary composition to achieve sensitivity does not solve the problem of functioning uniformly at long ranges. However, by proper control of tolerances and manufacture of this invention, the space between the anvil and the nose can be kept within a very small tolerance. For instance, on the 20 mm. armor piercing-incendiary projectile, the space 13 is .030 inch, held to a tolerance of as small as $\pm .0015$ inch. This achieves the uniformity of functioning of 90% or better against designated targets, while still passing the 40 ft. drop safety test.

The target to be defeated, and the impact velocities being known, with this invention the space 13 can be determined to obtain a highly efficient projectile incorporating a maximum amount of incendiary mixture, insuring maximum uniformity of performance while at the same time insuring drop and bore safety. For example, those skilled in the art know that a standardized 20 mm. AP-I projectile now in use has a length of about 2.9 inches and incorporates a space 13 of .030 inch, or about 1% of the total length, and an incendiary mix of 68 grains (by weight) consisting of 17 grains by weight of the more sensitive mix (potassium perchlorate, calcium resinate, magnesium-aluminum) and 51 grains by weight of the less sensitive 50-50 mixture, discussed above.

The nose should be made of a reasonably soft material, such as an aluminum-zinc casting. The anvil should be sufficiently stiff to first allow crush-up of the nose in order to achieve crystal shear of the mixture in front of it but of a material sufficiently less hard than the penetrator so that it does not impede penetration.

The sensitivity should generally fall within the range of 5-12 ft. lbs.

The object of this invention is to present the combination of an incendiary and armor piercing projectile whereby the maximum amount of incendiary mixture is incorporated for increasing behind the plate effect while at the same time maintaining a high degree of sensitivity over a large range of impact angles and still not impeding the penetrating ability of the projectile.

I claim:

1. An armor piercing incendiary projectile of the type using crystal shear to ignite the incendiary mixture, having a solid penetrator and circumferential band of soft material for imparting spin to the projectile, the combination therewith of the improvement for increasing the uniformity of sensitivity and functioning at long ranges and over a wide range of impact angles, said improve-

ment comprising a nose of softer metal than said penetrator, an adapter secured to said penetrator for mounting said nose, an elongated anvil having a radially extended rear portion mounted slidably inside said adapter, in contact with said penetrator, and a forward extending portion having substantially the same contour as the inner surface of said nose such that the distance between said anvil and the inner surface of said nose is constant over a wide angle, said distance being controlled to a close tolerance by preloading the nose with incendiary mixture prior to assembly and by the length of said anvil such that the incendiary mix will ignite by crystal shear upon impact with the target but will still be safe to handle, said anvil being of sufficiently hard material to withstand crush-up of said nose, but not so hard as to impede the penetrator, the entire space around said anvil and between said anvil and said nose being loaded with incendiary mixture.

2. A projectile according to claim 1 in which at least the portion between the anvil and the nose which is kept at a substantially constant distance, is loaded with a more sensitive incendiary mixture than the remaining volume of mixture.

3. A projectile according to claim 2 in which the more sensitive mixture consists essentially of 49 parts by weight of potassium perchlorate, 49 parts by weight of 50/50 alloy of powdered magnesium-aluminum and 2 parts by weight calcium resinate, the remaining portion of the filler being a mixture of 50 parts by weight barium nitrate and 50 parts by weight of a 50/50 alloy of powdered magnesium-aluminum.

4. A projectile according to claim 3 in which the distance is adjusted to yield a minimum impact sensitivity of 5 to 12 foot pounds.

5. A 20 mm. armor piercing incendiary projectile comprising a solid penetrator having a circumferential band of soft material for imparting spin to the projectile, a nose of softer metal than said penetrator, an adapter secured to said penetrator for mounting said nose, an elongated anvil having a radially extended rear portion mounted slidably inside said adapter in contact with said penetrator, and a forward extending portion having substantially the same contour as the inner surface of said nose such that a distance of .03 inch is maintained between said anvil and the inner surface of said nose within a close tolerance and over a wide angle, said distance being controlled by preloading the nose with an incendiary mix subject to ignition by crystal shear, said mix consisting essentially of 50 parts by weight of barium nitrate and 50 parts by weight of a 50/50 alloy of powdered magnesium-aluminum, and by controlling the length of said anvil, said anvil being of sufficiently hard material to withstand crush-up of said nose but not so hard as to impede the penetrator, substantially the entire space between said anvil and the inner surface of said nose being filled with said incendiary mixture.

6. A projectile according to claim 5 containing about 68 grains by weight of incendiary mixture.

7. A 20 mm. armor piercing incendiary projectile comprising a solid penetrator having a circumferential band of soft material for imparting spin to the projectile, a nose of softer metal than said penetrator, an adapter secured to said penetrator for mounting said nose, and an elongated anvil having a radially extended rear portion mounted slidably inside said adapter in contact with said penetrator, a forward extending portion of said anvil having substantially the same contour as the inner surface of said nose such that a distance of 0.3 inch is maintained between said anvil and the inner surface of said nose within a close tolerance and over a wide angle, said distance being controlled by preloading the nose with an incendiary filler subject to ignition by crystal shear, said filler consisting of two mixtures, a first mixture consisting of 49 parts by weight of potassium perchlorate, 49 parts by weight of 50/50 alloy of powdered mag-

nesium-aluminum and 2 parts by weight of calcium resinate, used as a preliminary igniter to achieve a minimum impact sensitivity of 5-12 foot pounds, and a second mixture consisting of 50 parts by weight of barium nitrate and 50 parts by weight of a 50/50 alloy of powdered magnesium-aluminum, and by controlling the length of said anvil, said anvil being of sufficiently hard material to withstand crush-up of said nose but not so hard as to impede the penetrator, the entire space between said anvil and the inner surface of said nose being filled with said incendiary filler.

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