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CH-A- 470 648
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DE-C- 737 734
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Description

This invention relates to an explosive small arms projectile, that is a projectile filled with an explosive charge.

In this specification, the subject of the invention will be referred to as a "projectile", although strictly speaking a bullet or missile is a projectile only while in flight. The term "projectile" is, however, commonly used to denote the bullet or missile while at rest or whilst in flight, and will be so used in the specification.

Such projectiles are used mainly in combating crime, particularly international terrorism, where, on an aircraft, for instance, an explosive projectile may be used to take out a target from within a group of innocent bystanders. Complete penetration of the target may result in harm to the bystanders and it is therefore an object of explosive projectiles to eliminate or at least minimize, total penetration of the target while maximizing the shock from the projectile within the target.

The objective of the inclusion of high explosives (taken to include primary explosives such as Mercury Fulminate or Lead Azide, and secondary explosives such as pentaerythritol tetranitrate (PETN) or mannitol hexanitrate) in small arms projectiles may be conceived of primarily as enhancing the shocking effect of the projectile in the target and the prevention of the projectile's penetration to any point beyond the intended objective where the projectile may cause unintended injury or damage.

Known small arms projectiles are commonly constructed with a jacket of a relatively light weight yet strong material such as steel and gilding metal, and a core of a relatively heavy material which may be partly filled with explosive.

The jacket of a conventional explosive small arms projectile is typically of a wear-resistant material such as steel which is gilded or clad with gilding metal, the steel providing mechanical strength to withstand the pressures and high temperatures resulting from burning propellants and the gilding metal being provided for the purpose of reducing friction. On known explosive small arms projectiles, the steel jacket is normally thin and largely non-structural, the functions thereof being containment of the lead core more than maintaining the integrity of the projectile on impact. This results in limited penetration of a target with the result that light armour is often sufficient to prevent penetration. Limited penetration of the target should be distinguished from eliminating or minimising total penetration of the target. In order to maximize the shock from the projectile within the target as mentioned above, it is necessary, firstly, to penetrate the target whereafter, ideally, the total energy of the projectile should be expended within the target. If, however, the projectile penetrates the target completely or totally, in other words, if the projectile passes through the target, the energy of

the projectile remaining after passage thereof through the target, is effectively wasted.

In prior art small arms explosive projectiles, the explosive is normally carried within a narrow central bore formed in the lead core. The explosive may comprise a simple explosive train of an impact sensitive primary explosive, such as, for example, lead azide, or a more complicated version comprising three stages: a first stage constituted by an impact sensitive mechanism; an initiating or primary explosive such as, for example, mercury fulminate as second stage; terminating in a third state of a secondary high explosive such as PETN. Some designs have employed, as the high explosive, a poly-basic glycerol trinitrate/pyrocellulose smokeless propellant powder which is a combustible solid and an explosive, and which 'burns to detonation', but without optimal explosive utilization.

The deficiencies in the effect of prior art explosive small arms projectiles lie in failure to effect and maintain optimal required ballistic rotational stabilisation, owing to limitations of conventional explosive projectile mass and mass distribution, thus leading to deficiencies in long range performance and accuracy; deficiencies in penetration owing to diminished mass; and perhaps most significantly, deficiencies in the propagation of the secondary high explosive shock wave within the necessarily narrow (5 mm diameter (3/16") in a .38 caliber projectile) conventional explosive column. This last deficiency results from the relatively restricted diameter of the explosive which is constrained to function in a high velocity rotational mode within a lead sheath of low strength which is subject to plastic deformation on impact. An efficient 3-stage .38 caliber projectile containing a 5 mm diameter PETN explosive column initiated in flight may suffer non-detonation of 10—14% of its PETN column when detonation occurs within an airfilled space.

French Patent No. 1,212,390—Levine—relates to a "perforating core" for an armour piercing projectile, bullet or projectile the material of which is a metal with a specific gravity in excess of 17, such as sintered tungsten or uranium 238 residue. The primary concern of the inventor is the hardening of the penetrator which is obtained by mechanical, chemical or thermal treatment of the projectile or penetrator structure or by forming a layered structure by heating powders of different compositions once or successively. A specific example is given of a body of sintered tungsten and an ogive of sintered tungsten carbide which are spot or compression welded and maintained under pressure until cooled. They are then annealed or heat treated at a lower temperature. The primary purpose of the use of high density metal is to increase the penetrating strength of the projectile.

German Patent No. 737 734—Rheinmetall Borsig AG—relates to steel alloys for armour piercing projectiles which find particular application to smaller calibers of projectiles. The

specification and the claims mention the addition to the alloy of a small percentage (up to 1%) of one or more heavy metals such as molybdenum, vanadium, titanium, tantalum or beryllium. The primary purpose of the invention, once again, is to increase the penetrating power of the projectile which is solid.

It is an object of this invention to provide an explosive small arms projectile with the mass thereof re-distributed to the periphery so as to be subject to investment with a higher rotational stabilizing energy than was possible with prior art projectiles, resulting in improved accuracy upon chosen targets at an increased range as well as an increase in penetrational power, and more particularly resulting in the in-flight ballistic rotational stabilizing force and energy of the projectile being improved with respect to known high explosive projectiles of similar total mass and configuration.

It is a further object of this invention to provide an explosive small arms projectile in which the explosive column diameter is increased as a means of reducing explosive non-utilisation. It should be kept in mind that, with explosive projectiles, substantially all of the energy of the projectile will be transferred to the target in virtually every case, keeping in mind that explosive non-utilisation is manifested both as non-detonation and inefficient propagation of the secondary high explosive shock wave within the explosive column. The latter may result in a delay in detonation to the extent that a part of the detonation occurs after passage of the projectile through the target with a resultant wastage of total projectile energy. Upon detonation, the projectile jacket is exploded and often fragmented. This results in a rapid velocity loss due to increase friction within the target and often also to the diversion of the material of fragments of the material within the target. An increase in explosive efficiency, therefore, contributes towards the retention of the material of the projectile and the maximisation of the shock from the projectile, within the target.

In a preferred embodiment the invention provides an explosive small arms projectile, the explosive containing envelope of which shows an increase in tensile and inertial characteristics over the conventional lead or copper or steel jacketed lead projectiles which, once again, improves the penetrational power of the projectile.

In accordance with the present invention, an explosive small arms projectile comprises a jacket of metal or an aggregate and an explosive charge located therein, the jacket defining a cavity for the explosive charge and the material of the jacket having a specific gravity greater than 13, characterised in that the material of the jacket occupies a minor proportion of the total volume of the projectile, and accounts for a major proportion of the total mass of the projectile, the major proportion of the total volume of the projectile being occupied by the cavity for the explosive charge.

The mass of the projectile is thus largely

concentrated in the jacket which, to this end, is relatively thick.

The jacket is of metal or an aggregate. By "aggregate" is included alloys, mixtures or compounds of metals.

Preferably, the metal or aggregate of the jacket is tantalum or a tantalum/tungsten alloy, the densities of which approximate 16.6 to 16.9 g.cm⁻³, or includes tantalum or a tantalum/tungsten alloy as a principal component, the object being to provide a projectile the jacket of which has a mass equal to the entire conventional explosive or other projectile.

Alternatively, the metal or aggregate of the jacket may be chosen from amongst the elements hafnium, uranium, rhenium, osmium, platinum, iridium or gold, or alloys, mixtures or compounds of the said elements, which alloys, mixtures or compounds may include tantalum or tungsten or both.

As with prior art projectiles the projectiles of the invention may be coated or gilded or, alternatively, the jacket may be metal-plated or metal clad on one or both sides.

The invention is further described with reference to the accompanying drawings in which:

Figure 1 is a section through a prior art explosive projectile; and

Figure 2 is a section through an explosive projectile according to the invention.

The projectile 10 shown in Figure 1 comprises a relatively thin steel jacket 12 with gilding metal 14 and 16 plated on both the inside and outside thereof. The projectile 10 is provided with a lead core 18 formed with a central bore 20 which serves as a receptacle for the explosive.

The explosive may be loaded in any one of a number of ways, but for the sake of clarity is shown as comprising a charge of explosive powder 22, a commercially available small arms percussion primer 24 and a closure of resin 26.

As already explained, the purpose of the jacket is to withstand the pressures and high temperatures resulting from the burning propellants and to withstand the frictional forces between the lands and grooves of the barrel, of the firing weapon and the accelerating projectile. The lead core 18 functions to increase the mass of the projectile whereby the momentum of the projectile may be increased. The primer 24 is intended to detonate the explosive 22 on impact, but it will be appreciated that the projectile 10 will have penetrated the target to a certain extent by the time detonation occurs due to the velocity of the projectile.

The projectile shown in the drawing is enlarged for clarity and in a .38 caliber projectile the central bore 20 will have a diameter of 5 mm. A .38 caliber projectile containing a three-stage explosive column in which detonation is initiated in flight has been found to suffer non-detonation of 10-14% of its explosive column when detonation occurs within an air-filled space. The reason for this is that the conventional explosive

projectile can sacrifice only a limited proportion of its total volume to explosive content in order to retain the mass thereof thus leading to an explosive column of relatively narrow diameter, in which the explosive shock wave front is propagated inefficiently particularly under the high velocity rotational condition of actual use.

As has also been mentioned, the thin steel jacket 12 performs a containment function more than anything else and possesses sufficient mechanical strength merely to withstand the frictional forces existing between the projectile and the lands and grooves of the barrel during firing. The jacket is not possessed of the mechanical strength required to maintain optimal integrity of the projectile when the projectile penetrates the target.

The disadvantages of the projectile 10 described above are therefore firstly, the sacrifice of a significant proportion of the mass, as much as 20% of the leaden mass, to accommodate a certain amount of explosive, secondly, the use of a narrow diameter explosive column, thirdly, the relatively limited tensile strength and unsatisfactory inertial characteristics of the jacket or envelope and fourthly, the unsatisfactory mass distribution thereof resulting in relatively low rotational stabilising energy values compared to the projectile of the present invention. It will be seen that, in a conventional small arms explosive projectile as described above, a compromise must be struck between the core mass which is normally represented by the amount of lead in the core and the diameter of the explosive column. It is not possible, with conventional small arms explosive projectiles, to combine both the attributes of high mass and a large amount of explosive or at least an explosive column of a larger diameter.

A solution of these deficiencies may be found in the projectile 100 of the invention which is shown in Figure 2. The projectile 100 comprises a jacket 102 of a Tantalum/Tungsten alloy (TaW) although other metals of suitably high specific gravity may be used. Because of the high specific gravity of the jacket 102 no internal high density core is required and the whole of the internal space can be filled with explosive. A three-stage explosive column is shown comprising a commercially available small arms percussion primer 104, a

lead azide primary explosive layer 106, a secondary high explosive layer of PETN 108, and a sealing cap of resin 110.

The eventual mass of the projectile 100 is arranged to be at least equivalent to that of the projectile 10 described above. In projectiles of equivalent mass the provision of the heavy metal jacket 102 may not remedy entirely the mass lost in providing the projectile 10 with the explosive core, but the diminished mass is at least distributed more efficiently so as to render the mass of the projectile susceptible to investment with a higher level of rotational stabilizing energy than is possible with the projectile 10.

It will be immediately evident that the explosive column has been increased in volume by approximately 250% whereby explosive non-utilization is reduced from the 10—40% non-utilization of the prior art projectiles to a point such that it is not readily detectable and is assumed to be significantly below 1% if not effectively complete.

The tensile and inertial characteristics of the Tantalum/Tungsten alloy jacket 102 are increased with respect to the prior art jackets to a point potentially approximating the tensile characteristics of steel or alloy steel and with an improved inertial characteristic approximating 46% in excess of a lead envelope (calculated on a density basis of 16.6 g.cm^{-3} for TaW and 11.4 g.cm^{-3} for Pb so that $(16.6/11.4) - 1 = 0.46$).

In addition the projectile mass is efficiently redistributed away from the rotational axis of the projectile and closer to its periphery in contact with the bore of the weapon so as to equal and exceed, in flight, the ballistic rotational stabilizing force and energy present in conventional small arms high explosive projectiles of similar total mass and configuration. This re-distribution and increased rotational stabilizing force provides for improved accuracy at longer range.

These results can be confirmed by a rough comparison, based on calculation, of the projectile of the invention with a prior art explosive projectile with reference to two long-standing American military service weapons, namely, the US Model 1911 .45 ACP (Colt Automatic Pistol), firing a 230 grain (14.9g) projectile and the (30-06) US Caliber 30 (M1A2 Ball) rifle firing a 150 grain (9.7g) projectile.

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Weapon	Projectile/Mass in grain (gram)	Muzzle Velocity in fps. (m.s ⁻¹)	Muzzle Energy in foot pounds force (Joule)
.45 ACP	Conventional bullet 230 (14.9)	900 (274.3)	412 (558.6)
.45 ACP	Prior art explosive bullet 172.5 (11.2)	1200 (365.8)	1035 (1403.2)
US Cal. 30 M1	Conventional bullet 150 (9.7)	2850 (868.7)	2700 (3 660.7)
.45 ACP	Ta or TaW alloy explosive bullet 172.5 (11.2)	1200 (365.8)	4000 (5423.2)
Winchester Magnum (.458")	Conventional bullet 400 (25.9)	2400 (731.5)	5160 (6 995.9)

From the above table, it may be seen that, whereas the conventional small arms explosive projectile is bracketed, in terms of muzzle energy, between the conventional non-explosive bullet as fired from a pistol and a conventional non-explosive bullet as fired from a rifle, an explosive pistol bullet according to the present invention is bracketed between a conventional non-explosive projectile as fired from a rifle and a conventional non-explosive projectile as fired from a big game-hunting rifle. It will, however, be appreciated that the present invention provides, in a highly manoeuvrable .45 Calibre hand-gun, muzzle energies 50% in excess of those provided by a heavy service rifle such as the US Caliber .30 M1, and nearly ten times that of the non-explosive .45 Caliber ACP Projectile when both are compared by firing from an identical .45 Caliber Automatic Pistol.

The term "muzzle energy" is used here to denote the maximum theoretical energy the projectile can deliver to the target. In instances where a non-explosive projectile is retained in the target, thereby communicating the total energy thereof to the target, the energy expended in the target will, discounting frictional and gravitational energy loss, be more or less equal to the energy of the projectile at the muzzle of the weapon. If the projectile penetrates the target, substantially less of the energy of the projectile will be communicated to the target depending on the nature of the penetration; with explosive projectiles, however, the projectile will, in virtually every case, transfer all of its energy to the target.

In the prior art, explosive projectile 10 shown in Figure 1, any increase in jacket thickness will have to be made at the expense of a decrease in the core mass leading inevitably to a decrease in the total projectile mass. In the projectile 100 of the present invention, the jacket 102 can, within certain limits, be increased to any desired thickness to increase the tensile and mass charac-

teristics of the jacket according to specific requirements, for instance, to increase the penetrational ability of the projectile. In this manner, within the space limited small arms context, the twin functions of energy absorption by a heavy mass and the jacket features of mechanical, structural and tensile strength, are condensed into a single entity. In the past, the energy absorbing heavy mass was provided by the lead core and structural integrity was provided, to a limited extent, by the steel or copper jacket. The improved stability achieved by the projectile of the present application, provides increased accuracy and this combined with the greater structural strength of the jacket provides for better penetration of light armour.

While the projectile of the present invention is described above with specific reference to a hand gun projectile, it is evidently adaptable to the entire range of small arms projectiles, the term "small arms" being taken to indicate any weapon whether mounted or not, which is portable.

Claims

1. An explosive small arms projectile (100) comprising a jacket (102) of metal or an aggregate and an explosive charge (104, 106, 108) located therein, the jacket (102) defining a cavity for the explosive charge (104, 106, 108) and the material of the jacket (102) having a specific gravity greater than 13, characterised in that the material of the jacket (102) occupies a minor proportion of the total volume of the projectile (100), and accounts for a major proportion of the total mass of the projectile (100), the major proportion of the total volume of the projectile (100) being occupied by the cavity for the explosive charge (104, 106, 108).

2. A projectile according to claim 1, characterised in that the metal or aggregate of the jacket is tantalum or a tantalum/tungsten alloy or

includes tantalum or a tantalum/tungsten alloy as principal component.

3. A projectile according to claim 1, characterised in that the metal or aggregate of the jacket is chosen from amongst the elements hafnium, uranium, rhenium, osmium, platinum, iridium or gold, or alloys, mixtures or compounds of the said elements, which alloys, mixtures or compounds may include tantalum or tungsten or both.

Patentansprüche

1. Ein Explosivgeschoß (100) für Handfeuerwaffen, umfassend einen Mantel (102) aus Metall oder einem Aggregat und eine darin untergebrachte Explosivladung, wobei der Mantel (102) einen Hohlraum für die Explosivladung (104, 106, 108) begrenzt und das Material des Mantels (102) eine spezifische Schwere von mehr als 13 aufweist, dadurch gekennzeichnet, daß das Material des Mantels (102) einen kleineren Teil des Gesamtvolumens des Geschosses (100) einnimmt und zu der Gesamtmasse des Geschosses (100) einen größeren Teil beiträgt, wobei der größere Teil des Gesamtvolumens des Geschosses (100) von dem Hohlraum für die Explosivladung (104, 106, 108) eingenommen wird.

2. Ein Geschoß nach Anspruch 1, dadurch gekennzeichnet, daß das Metall oder Aggregat des Mantels Tantal oder eine Tantal-Wolfram-Legierung ist oder Tantal oder eine Tantal-Wolfram-Legierung als Hauptkomponente enthält.

3. Ein Geschoß nach Anspruch 1, dadurch gekennzeichnet, daß das Metall oder Aggregat des Mantels aus den Elementen Hafnium, Uran, Rhenium, Osmium, Platin, Iridium oder Gold

ausgewählt ist, oder Legierungen, Gemischen oder Zusammensetzungen dieser Elemente, welche Legierungen, Gemische oder Zusammensetzungen Tantal oder Wolfram oder beide enthalten können.

Revendications

1. Un projectile du type explosif pour arme légère (100) comprenant une enveloppe (102) faite de métal ou d'un agrégat et une charge explosive (104, 106, 108) située à l'intérieur, l'enveloppe (102) constituant le logement de la charge explosive (104, 106, 108) et le matériau de l'enveloppe (102) ayant une densité supérieure à 13, caractérisé en ce que le matériau de l'enveloppe (102) occupe une partie minime du volume total du projectile (100) et constitue la plus grande partie de la masse totale du projectile (100), la plus grande partie du volume total du projectile (100) étant occupée par le logement de la charge explosive (104, 106, 108).

2. Un projectile selon la revendication 1, caractérisé en ce que le métal ou l'agrégat constituant l'enveloppe est du tantale ou un alliage tantale/tungstène ou comprend comme principal composant du tantale ou un alliage tantale/tungstène.

3. Un projectile selon la revendication 1, caractérisé en ce que le métal ou l'agrégat constituant l'enveloppe est choisi parmi les éléments hafnium, uranium, rhénium, osmium, platine, iridium ou or, ou des alliages, mélanges ou composés desdits éléments, lesquels alliages, mélanges ou composés peuvent comprendre du tantale ou du tungstène ou les deux.

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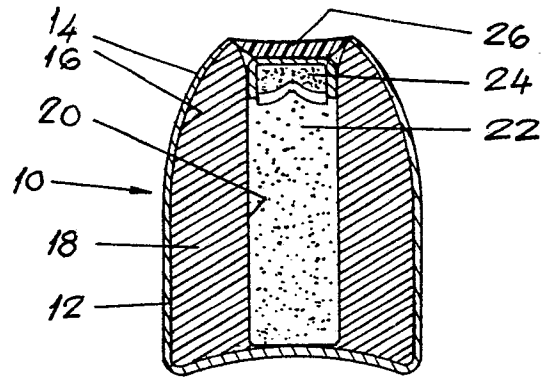


Fig 1

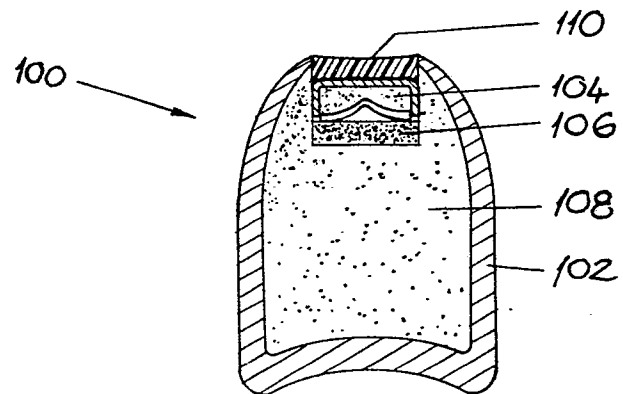


Fig 2