

(19)



(11)

EP 3 467 427 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.04.2019 Bulletin 2019/15

(51) Int Cl.:
F42B 12/78 (2006.01) **F42B 14/02** (2006.01)
F41A 21/18 (2006.01)

(21) Application number: **17275156.2**

(22) Date of filing: **03.10.2017**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR
 Designated Extension States:
BA ME
 Designated Validation States:
MA MD

(72) Inventor: **The designation of the inventor has not yet been filed**

(74) Representative: **BAE SYSTEMS plc**
Group IP Department
Farnborough Aerospace Centre
Farnborough
Hampshire GU14 6YU (GB)

(71) Applicant: **BAE SYSTEMS plc**
London SW1Y 5AD (GB)

(54) ENHANCED PERFORMANCE AMMUNITION

(57) This invention relates to a combination of a gun having a rifled barrel and a round of enhanced performance ammunition, and to a projectile for use in the combination. The invention is especially, but not exclusively related to an improved form of projectile for small arms ammunition. There is provided a projectile with a nominal calibre, for use in a rifled barrel, the projectile comprising: a monolithic body, said monolithic body comprising

a. an ogival portion forming the front of the monolithic body; said ogival portion at a point of intersection abuts with

b. an elongate cylindrical core, said elongate cylindrical core comprising at least three bands located circumferentially thereon, said bands protruding radially outward therefrom; and said elongate cylindrical core abuts

c. a boat tailed portion, forming the rear of the monolithic body,

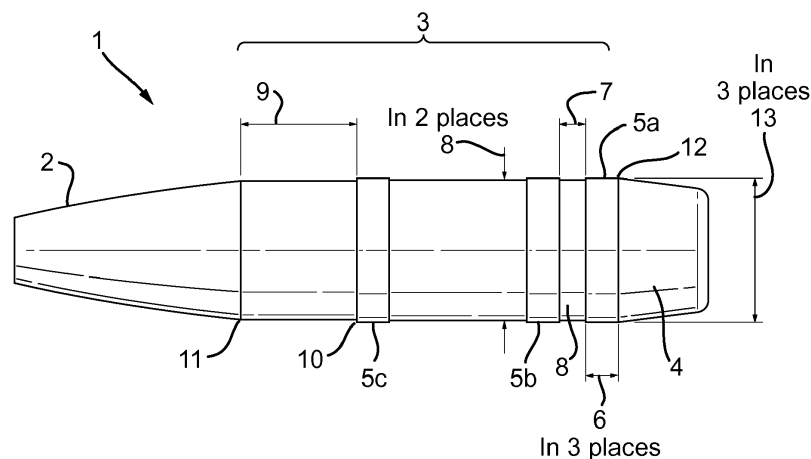
wherein a first band is located at the point where the elongate cylindrical core abuts the boat tail section,

wherein a third band is located rearwardly, from the point of intersection, at a distance in the range of from 80% to 120% of said nominal calibre,

wherein a second band is located between the first and third bands on said elongate cylindrical core;

wherein the monolithic body is formed from a metal having a Vickers Hardness of at least 550HV,

wherein a deformable jacket or coating, surrounds the monolithic body, which defines an outer diameter of said projectile

Fig. 1

Description

[0001] This invention relates to a combination of a gun having a rifled barrel and a round of enhanced performance ammunition, and to a projectile for use in the combination. The invention is especially, but not exclusively related to an improved form of projectile for small arms ammunition.

[0002] When a projectile is fired from a rifled barrel, the projectile must deform as it travels along the barrel so that material forming part of the projectile is forced into the spaces between the lands that form the rifling. This process is called engraving, and causes a spin to be imparted to the projectile by virtue of the twist of the rifling.

[0003] The deformation of the projectile, its travel along the barrel effectively as a force fit to the rifling, the high linear acceleration imparted by the gun propellant on firing, and the consequent high rate of angular acceleration and associated force acting between rifling and projectile all contribute to substantial wear on the barrel.

[0004] If this wear rate can be reduced, substantial benefits follow, including increased barrel life, higher muzzle velocity and hence increased accuracy and lethality.

[0005] For this reason, low friction, soft, readily deformable materials are normally selected for small arms bullet. This was originally achieved by the use of solid lead bullets but these have now been almost universally replaced by a bullet comprising of a gilding metal jacket and lead core.

[0006] In order to improve bullet penetrative performance and/or to have a lead free bullet, it is necessary to use other materials such as for example steel. However, steel is not readily deformable, and when a solid steel core is used it can cause unacceptable barrel wear. On the other hand, hardness is a very desirable characteristic for the bullet material, in order to minimise nose tip ablation during penetration of hardened targets such as, for example, titanium/kevlar body armour.

[0007] In seeking to overcome these problems whilst striving to improve penetrative performance, it has been common practice to make a small arms bullet from a steel tip used in combination with a rearwardly located lead core enclosed in a gilding metal jacket. This provides the advantage of cheap construction, but still provides for a substantial amount of lead. The problem here is that when the projectile strikes a target at an oblique angle, the steel tip and lead core follow different trajectories, thus the penetrative performance improvement is limited.

[0008] According to the present invention there is provided a projectile with a nominal calibre, for use in a rifled barrel, the projectile comprising: a monolithic body, said monolithic body comprising

- a. an ogival portion forming the front of the monolithic body; said ogival portion at a point of intersection abuts with
- b. an elongate cylindrical core, said elongate cylindrical core comprising at least three bands located circumferentially thereon, said bands protruding radially outward therefrom; and said elongate cylindrical core abuts
- c. a boat tailed portion, forming the rear of the monolithic body,

wherein a first band is located at the point where the elongate cylindrical core abuts the boat tail section, wherein a third band is located rearwardly, from the point of intersection, at a distance in the range of from 80% to 120% of said nominal calibre,

wherein a second band is located between the first and third bands on said elongate cylindrical core; wherein the monolithic body is formed from a metal having a Vickers Hardness of at least 550HV, wherein a deformable jacket or coating, surrounds the monolithic body, which defines an outer diameter of said projectile.

[0009] The at least three bands may each have a width in the range of from 17% to 23% of the nominal calibre of the projectile. For a 5.56mm round, the nominal width of the band is in the highly preferred range of from 0.85 to 1.15mm, preferably 0.95mm to 1.05mm, preferably nominally 1mm. Preferably all three bands have substantially the same width.

[0010] The at least three bands, in a preferred arrangement may protrude above the elongate cylindrical core at a height in the range of from 0.5% to 4% of the nominal calibre of the projectile, more preferably in the range of from 1.5% to 2.5% of the nominal calibre. The bands have a leading edge towards the ogival section and a rear edge, located towards the boat tail section.

[0011] The third band is located rearwardly of the ogival section, at a distance from the point of intersection, in the range of from 80% to 120%, more preferably, 85% to 100%, more preferably 85% to 95% of the nominal calibre of the projectile. The distance is measured from the leading edge of the third band to the point of intersection. Preferably the distance from the leading edge of the third band to the point of intersection is less than the nominal calibre of the munition. The elongate cylindrical core has substantially parallel sides, and the point of intersection is the point where the sides of the elongate cylindrical core are substantially first parallel.

[0012] The second band is located between the first and third bands. In a preferred arrangement the second band is proximate to the first band towards the rear of the monolithic body, preferably at a distance from the third band in the range of from 17% to 23% of the nominal calibre of the projectile, most preferably for a 5.56mm round the distance

between the second band and third band is substantially a width of a band.

[0013] The material selected for the projectile monolithic body will depend partly upon the function which the projectile is to perform, but in the case of enhanced performance ammunition may be greater than a Vickers Hardness of 550 HV, more preferably greater than 570 HV.

[0014] The projectile body may be made from any material which has a high Vickers Hardness, such as metals, ceramics, carbides, and borides. The metals may be selected from steel, tungsten, alloys of tungsten. Carbides may be selected from tungsten carbide. Preferably hardened steel.

[0015] The deformable jacket or coating, surrounds the monolithic body, which defines an outer diameter of said projectile.

[0016] The coating may be an electrodeposited coating, however the deposition techniques are designed to provide a metal which closely aligns to the monolithic body, and therefore removes the small cavities which exist between the ogival portion and the leading edge of the third band when a jacket is used. The advantage of the deposited coating is that it provides better transfer of spin from the outer metal coating to the monolithic body.

[0017] The deformable jacket may typically be a gilding metal jacket, typically copper or alloys thereof. The jacket may comprise, a metal jacket, formed from an extrudable outer sheath which is pressed through a series of dies, and forms around the monolithic body. In a highly preferred arrangement the jacket is located over the monolithic body, such that there are cavities created between the jacket and the monolithic body. The jacket may touch the monolithic body at the point of intersection and the leading edge of the third band, thereby creating a cavity under the jacket. Further there is a cavity created between the jacket and the monolithic body as there is only contact at the rear edge of the first band and the leading edge of the second band. There is a yet further cavity created between the jacket and the monolithic body as there is only contact at the rear edge of the second band and the leading edge of the third band.

[0018] The outer diameter of said projectile is substantially equal to an internal diameter of the barrel defined by the lands, and wherein during firing of the projectile the lands of the rifling in the barrel deform the deformable jacket or coating into the grooves defined between the at least three bands on the elongate cylindrical core of the body, and between the point of intersection and the leading edge of the third band.

[0019] Upon firing, deformation of the jacket is designed to provide the projectile with an interference fit with the rifling lands rifling so as to provide effective obturation by restricting or preventing the escape of propellant gases past the projectile via the rifling grooves.

[0020] According to a further aspect of the invention there is provided a combination of a gun having a rifled barrel and a round of ammunition as defined herein, the rifling of the barrel comprising rifling grooves which are separated by lands extending helically along a length of the barrel; the projectile having an outer diameter substantially equal to or less than an internal diameter of the barrel defined by the lands, and wherein during firing of the projectile the deformable jacket is deformed by the lands of the barrel into the grooves formed between the at least three bands and point of intersection on the elongate core.

[0021] The combination provides an arrangement such that wherein upon firing deformation of the jacket or coating provides the projectile with an interference fit with the rifling lands rifling so as to provide effective obturation by restricting or preventing the escape of propellant gases past the projectile via the rifling grooves.

[0022] Normally, the projectile will also have an ogival nose portion of the body forward of said substantially elongate cylindrical core, although other forms are possible.

[0023] The body of the projectile (i.e. excluding the deformable jacket) should have a diameter which is not greater than that defined by the rifling lands. The deformable jacket or deposited coating, of the projectile has an outer diameter which is designed so that upon firing of the projectile the rifling lands engage the deformable jacket which is designed to deform into the groove air gaps between said at least three bands and the point of intersection. The engagement of the deformable jacket with the rifling lands induces spin in the projectile due to the twist of the rifling. This deformation gives the projectile an interference fit with the rifling so as also to provide effective obturation by restricting or preventing the escape of propellant gases past the projectile via the rifling grooves. The length and precise diameter of the projectile is designed to provide the best fit.

[0024] Regard must also be taken to ensure that the force required to effect the deformation of the jacket material and to propel the projectile along the barrel is not excessive, and therefore the diameter of the monolithic body may not be greater than that of the rifling lands. This force is substantially reduced by the presence of the air gaps between the at least three bands and the deformable jacket, and between the point of intersection and the leading edge of the third band, to deform into said groove air gaps during the passage of the monolithic body along the barrel.

[0025] In high volume conditions, steel is a suitable material, as it is inexpensive and can be readily formed into the desired shape, eg. by a cold-forming process.

Results

[0026] The enhanced performance round according to the invention was compared to a NATO standard round, the

EP 3 467 427 A1

SS109 bullet as employed in 5.56mm Ball (NATO) ammo. The rounds were fired using the same propellant and from the same length barrel on a test rig.

EP* round according to the invention

[0027] Hardened steel core 570HV, nominal 5.56mm calibre. Distance from point of intersection to leading edge of third band 4.85mm. Band height 0.125mm, distance between second band and first band 1.0mm, mass of monolithic body 2.3g.

Table 1

Target	Increase in range at which target can be defeated by EP* over std SS109
3.5mm Steel (NATO plate)	46%
8mm Steel	31%
5mm Armour Plate	140%
Simulated Protected Light Truck	SS109 - no capability; EP* - short range capability

[0028] It is clear from the data in table 1 that the improvements in target defeat, without comprise of accuracy, provide a significant improvement on a conventional NATO round, when fired under the same test conditions.

[0029] The use of a monolithic body, with a high Vickers Hardness provides improved penetration and defeat, the use of narrow ranges of locations of the at least three bands and point of intersection, provides the outer jacket the ability to deform into the grooves located between the said at least three bands and point of intersection; to ensure both a gas tight seal and sufficient thickness to prevent the rifling bands impinging on the monolithic body

[0030] The invention is particularly but not exclusively applicable to small arms weapons systems, having a nominal calibre of 20mm or less, such as for example, 12.7mm, 9mm or less, such as 7.62mm, 5.56mm and 4.6mm.

[0031] The invention will now be described by way of example only with reference to the accompanying drawings, of which:-

Figure 1 shows a diagrammatic representation of a monolithic body incorporating at least three bands; and

Figures 2 and 2a show the projectile shown in Figure 1, with a jacket thereon

Figure 3 shows, in section, the monolithic body and part of the cartridge case located in the chamber of a gun having a rifled barrel and ready for firing.

[0032] As shown in Figure 1, a small arms monolithic body 1 comprising an elongate cylindrical core 3, an ogival portion 2, and a rearwardly located boat tailed portion 4.

[0033] Along the length of the elongate cylindrical core 3, are located at least three bands (5a, 5b and 5c), between which are created grooves 8.

[0034] The ogival portion 2 abuts the elongate cylindrical core 3, at the point of intersection 11. The point of intersection 11 is the point where the elongate cylindrical core has substantially parallel sides. The third band 5c, is located rearwardly, from the point of intersection 11, at a distance 9 in the range of from 80% to 120% of said nominal calibre. The distance 9 is nominally taken from the leading edge 10 to the point of intersection 11.

[0035] The boat tail section 4 abuts the elongate cylindrical core 3, at the rear edge 12 of the first band 5a.

[0036] The second band 5b is located between the first band 5a and third band 5c. The gap 7 between the first band 5a and second band 5b, is preferably less than the gap between the second band 5b and the third band 5c, more preferably the gap 7 is substantially the same as one width of a band 6.

[0037] The bands are preferably all the same width 6, and protrude radially outwards a height 13. Preferably the at least three bands are uniform in their width and height.

[0038] The monolithic body 1 is of elongate form and may preferably be cold formed from steel having a Vickers Hardness of at least 550, more preferably 570HV. It can subsequently be given a heat treatment to provide the desired hardness or other physical properties.

[0039] Because of the substantial hardness of the monolithic body material, the projectile is highly effective at penetration of targets such as titanium/kevlar body armour. Moreover, the hardness also serves to minimise ablation of the projectile tip profile, thus further contributing to its effectiveness in target penetration.

[0040] Figure 2 show the projectile 20 which comprises the monolithic body 21 (as exemplified in Fig 1), with a jacket

22, located thereon. The leading edge 125c of the third band 25c (see figure 2a) and the point of intersection 29 form two contact points, such that when the jacket is applied it forms a cavity 28c. Further the at least three bands 25a, 25b and 25c, provide grooves 28b and 28c, such that when the jacket 22 is compressed when it impacts on the rifling of the barrel (fig 3), the copper jacket 22 deforms into the grooves 28a, 28b and 28c. The jacket 22 has a thickness 24, selected to provide the desired outer diameter for the nominal calibre of the gun form which it is to be fired.

[0041] When the monolithic body 21 and deformable jacket 22 passes from the gun chamber into the rifled part of the barrel, by virtue of its outer diameter 26, the jacket 22 is deformed by the lands of a rifled barrel into the corresponding groove air gaps 28a, 28b and 28c corresponding to the at least three band 25a, 25b, 25c and point of intersection 29. The outer diameter 26 of the jacket material 22 should be substantially equal to the diameter of any rifling grooves (not shown).

[0042] The presence of the grooves 28a, 28b, 28c facilitates the necessary deformation of the jacket 22, thus enabling the rifle engraving to take place with a substantially reduced axial force. The fact that the jacket material can deform into the grooves contributes considerably to a dramatic reduction in the axial force required for engraving to occur.

[0043] Preferably the monolithic body 21, is covered by a jacket, which is extruded over the monolithic body, and creates a cavity 26.

[0044] Therefore, despite the hardness of the monolithic body, barrel wear from this factor is minimised.

[0045] It will be evident to the skilled addressee that all of these factors reducing the engraving force will also result in reduced barrel wear, higher muzzle velocity, and hence increased lethality and accuracy.

[0046] The optimum design parameters for the projectile according to the invention can be determined by those skilled in the art, based on the teaching contained herein.

[0047] The invention is particularly but not exclusively applicable to small arms ammunition. In one particular example, the invention has been successfully applied to 5.56mm gun and ammunition.

[0048] As shown in Figure 3, in use the round of ammunition comprising the assembled primed and filled cartridge case 33, together with a projectile 31 are fired from a gun having a rifled barrel 34, in the conventional manner, i.e. by chambering the round within the gun chamber 35, and arranging for the primer cap (not shown) to be struck by a firing pin.

[0049] When the monolithic body 21 and associated jacket 22 passes from the gun chamber into the rifled part of the barrel, by virtue of its greater diameter, the monolithic body becomes engraved by the rifling 37. The diameter of the monolithic body 21 and associated jacket 22 should preferably be substantially equal to or less than the diameter of the rifling grooves 38, while the grooves 32 (which are formed between the bands 25(a-c) and point of intersection, can have substantially the same diameter as the barrel diameter.

[0050] The presence of the grooves 32 facilitates the necessary deformation of the jacket 22, thus enabling the engraving to take place with a substantially reduced axial force. The fact that the jacket 22 can deform into the grooves 32 contributes considerably to a dramatic reduction in the axial force required for engraving to occur.

[0051] The jacket 22 is of a malleable material which can be copper or a copper alloy and could additionally comprise an outer layer of a low-friction material such as molybdenum disulphide. This jacket 22 is of a thickness greater than the depth of the rifling grooves, and is of a relatively softer material than that of the monolithic body 21, it can also engrave more readily, and thus contribute for this reason also to a reduction in the engraving force required. Because the jacket 22 is thicker than the depth of rifling, engraving can take place entirely within the coating so that the hard metal of the monolithic body 21 is kept substantially out of contact with the material forming the rifling of the gun barrel. Therefore, despite the hardness of the material forming the main part of the monolithic body 21, barrel wear from this factor is minimised.

Claims

1. A projectile with a nominal calibre, for use in a rifled barrel, the projectile comprising: a monolithic body, said monolithic body comprising

- a. an ogival portion forming the front of the monolithic body; said ogival portion at a point of intersection abuts with
- b. an elongate cylindrical core, said elongate cylindrical core comprising at least three bands located circumferentially thereon, said bands protruding radially outward therefrom; and said elongate cylindrical core abuts
- c. a boat tailed portion, forming the rear of the monolithic body,

wherein a first band is located at the point where the elongate cylindrical core abuts the boat tail section,

wherein a third band is located rearwardly, from the point of intersection, at a distance in the range of from 80% to 120% of said nominal calibre,

wherein a second band is located between the first and third bands on said elongate cylindrical core;

wherein the monolithic body is formed from a metal having a Vickers Hardness of at least 550HV,

wherein a deformable jacket or coating, surrounds the monolithic body, which defines an outer diameter of said projectile.

2. A projectile according to claim 1 wherein said bands protrude above the elongate cylindrical core a height in the range of from 0.5% and 4% of the nominal calibre of the projectile.
3. A projectile according to claim 1 or claim 2 wherein the projectile monolithic body is made from one of steel, tungsten, alloys of tungsten, or tungsten carbide.
4. A projectile according to any one of the preceding claims wherein the third band is located at a distance from the point of intersection, in the range of from 85% to 95% of the nominal calibre of the projectile.
5. A projectile according to any one of the preceding claims, wherein the at least three bands have a width in the range of from 17% to 23% of the nominal calibre of the projectile.
6. A projectile as claimed in any one of the preceding claims, wherein the second band is located a distance from the third band in the range of from 17% to 23% of the nominal calibre of the projectile.
7. A projectile as claimed in any one of the preceding claims, wherein said outer diameter of said projectile is substantially equal to an internal diameter of the barrel defined by a land of the rifling in the barrel, and wherein during firing of the projectile the lands of the rifling in the barrel deform the deformable jacket or coating into the grooves defined between the at least three bands and point of intersection on the elongate cylindrical core of the monolithic body.
8. A projectile as claimed in claim 7, wherein upon firing deformation of the jacket is designed to provide the projectile with an interference fit with the rifling lands so as to provide effective obturation by restricting or preventing the escape of propellant gases past the projectile via the rifling grooves.
9. A combination of a gun having a rifled barrel and a round of ammunition as defined in any one of the preceding claims; the rifling of the barrel comprising rifling grooves which are separated by lands extending helically along a length of the barrel; the projectile having an outer diameter substantially equal to or less than an internal diameter of the barrel defined by the lands, and wherein during firing of the projectile the deformable jacket is deformed by the lands of the barrel into the grooves formed between the at least three bands and the point of intersection on the elongate core.
10. A combination according to claim 9, wherein upon firing deformation of the jacket provides the projectile with an interference fit with the rifling lands so as to provide effective obturation by restricting or preventing the escape of propellant gases past the projectile via the rifling grooves.

Fig. 1

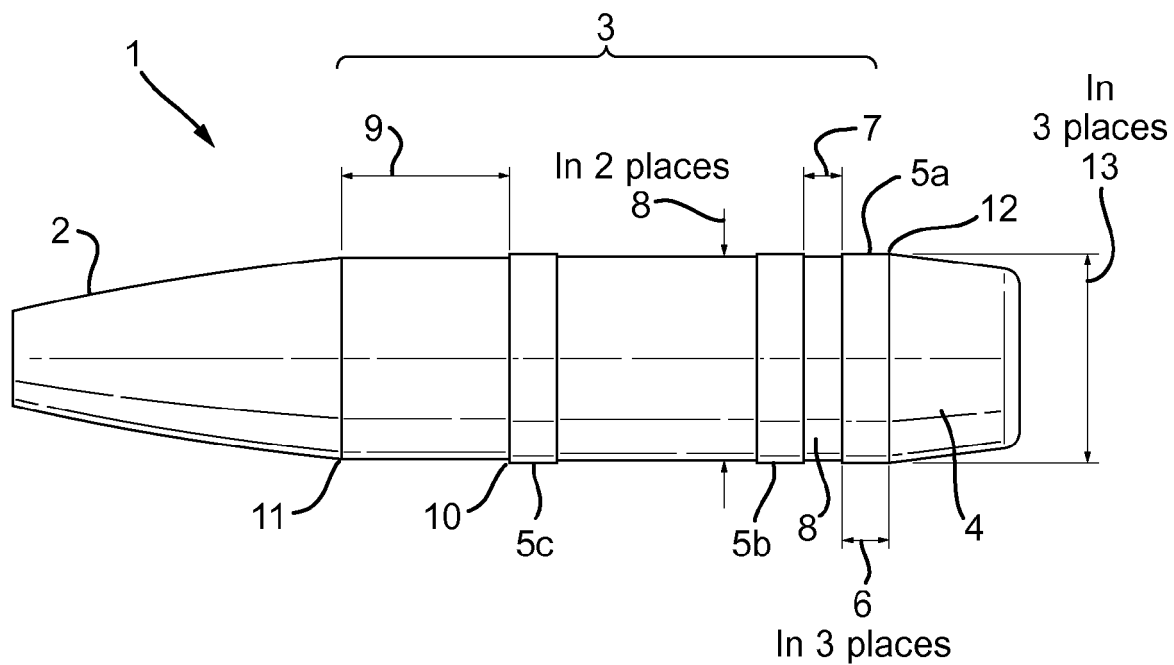


Fig. 2

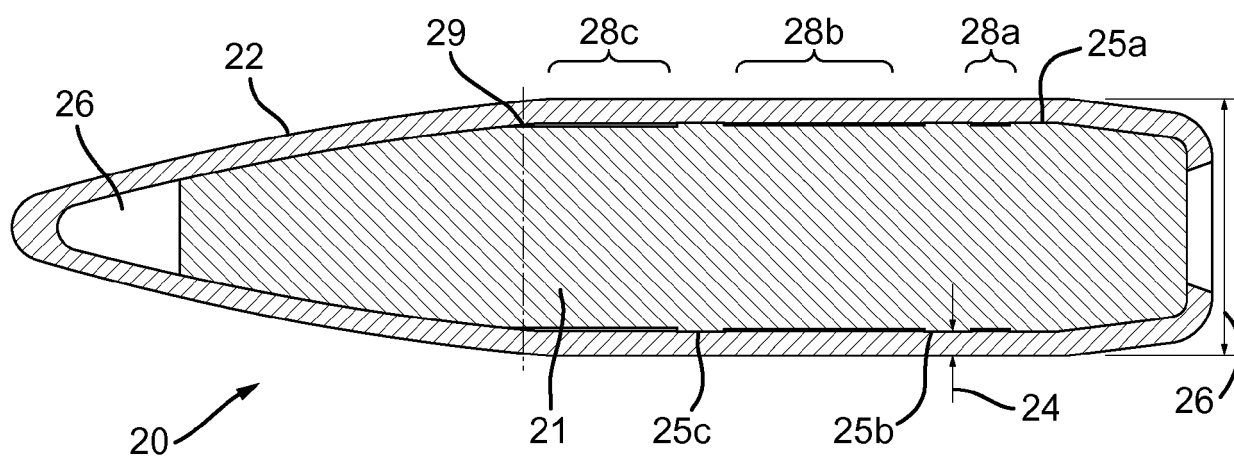


Fig. 2a

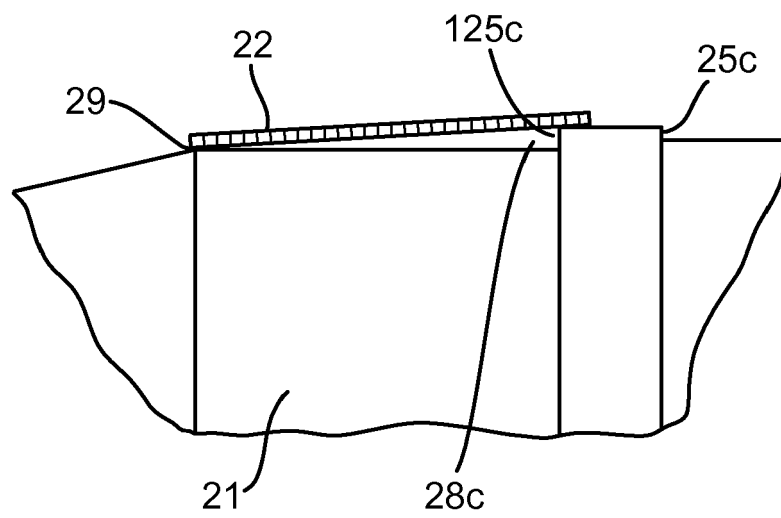
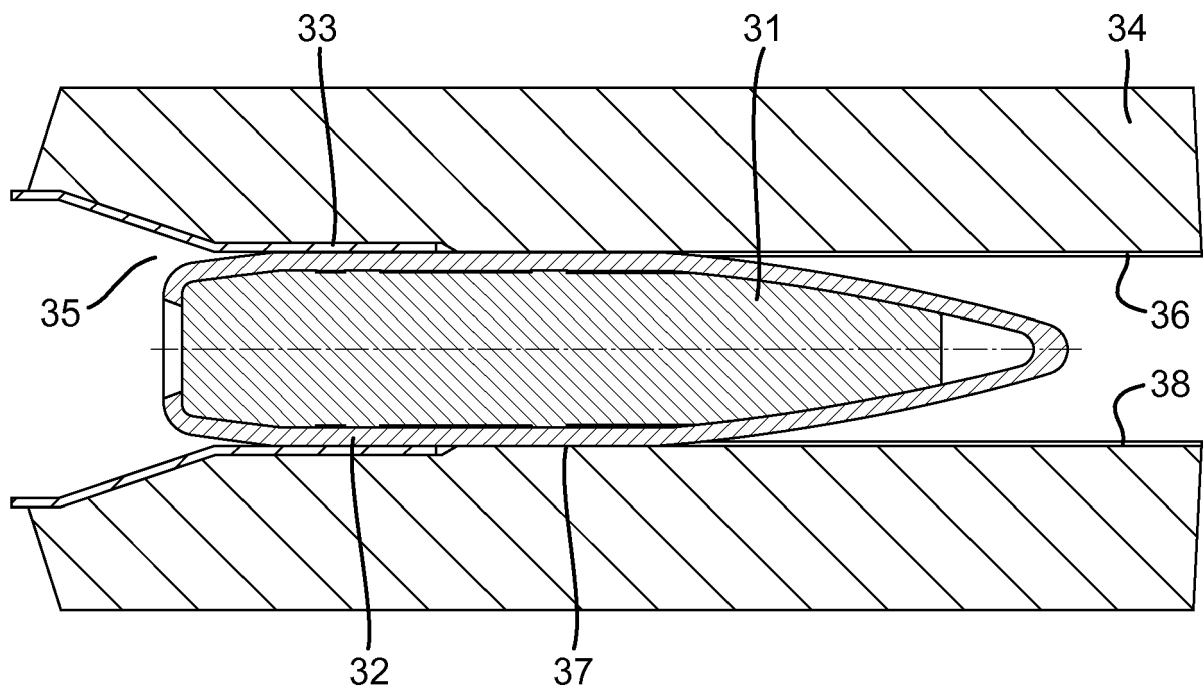


Fig. 3





EUROPEAN SEARCH REPORT

Application Number
EP 17 27 5156

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2015/059282 A1 (RUAG AMMOTEC GMBH [DE]) 30 April 2015 (2015-04-30) * abstract * * page 3, line 17 - page 7, line 3 * * figure 2 *	1-10	INV. F42B12/78 F42B14/02 F41A21/18
X	US 2016/153757 A1 (MAHNKE JOSHUA [US]) 2 June 2016 (2016-06-02) * paragraphs [0077] - [0079] * * figure 3 *	1-10	
A	US 5 686 693 A (JAKOBSSON BO [SE]) 11 November 1997 (1997-11-11)	1-10	
A	DE 295 16 889 U1 (BOFORS CARL GUSTAF AB [SE]) 25 January 1996 (1996-01-25)	1-10	
A	WO 2007/022612 A1 (SNC TECHNOLOGIES INC [CA]; MACDOUGALL JOHN [CA]) 1 March 2007 (2007-03-01)	1-10	
			TECHNICAL FIELDS SEARCHED (IPC)
			F42B F41A
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 9 February 2018	Examiner Menier, Renan
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 27 5156

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-02-2018

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2015059282 A1	30-04-2015	AU 2014338927 A1	09-06-2016
		CA 2928157 A1	30-04-2015
		DE 102014015674 A1	30-04-2015
		EP 3060875 A1	31-08-2016
		JP 2016538517 A	08-12-2016
		KR 20160087386 A	21-07-2016
		US 2016252332 A1	01-09-2016
		WO 2015059282 A1	30-04-2015

US 2016153757 A1	02-06-2016	EP 3137843 A2	08-03-2017
		US 2016153757 A1	02-06-2016
		US 2017314900 A1	02-11-2017

US 5686693 A	11-11-1997	NONE	

DE 29516889 U1	25-01-1996	NONE	

WO 2007022612 A1	01-03-2007	NONE	
