

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
21 September 2006 (21.09.2006)

PCT

(10) International Publication Number
WO 2006/096944 A1

(51) International Patent Classification:
F42B 12/34 (2006.01)

(21) International Application Number:
PCT/BR2005/000035

(22) International Filing Date: 17 March 2005 (17.03.2005)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant (for all designated States except US):
CBC COMPANHIA BRASILEIRA DE CARTUCHOS [BR/BR]; Avenida Humberto de Campos, 3220, CEP-9426-900 Ribeirão Pires-SP (BR).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **MARTINI FILHO, Laudemiro** [BR/BR]; Av. Humberto de Campos 3.220, Guapituba, 09426-900 Ribeirão Pires - SP (BR).

(74) Agent: **ESTHER ARRUDA, Luciana**; Nomina Propriedade intelectual, Al.Joaquim Eugenio de Lima, 881, cj.405, CEP-Jardim Paulista, São Paulo, SP (BR).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

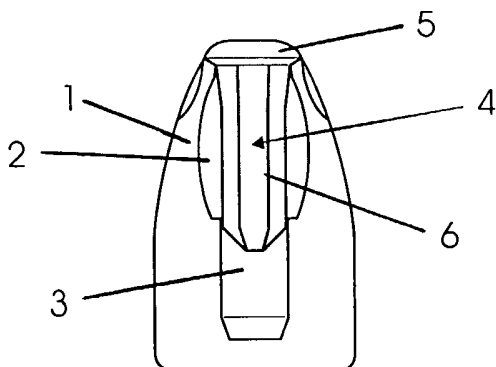
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: EXPANSION PROJECTILE FOR FIREARMS



(57) Abstract: The projectile of the present invention combines the advantages of both the solid and hollow point designs, featuring the initial ballistics of a solid projectile and the terminal (target) ballistic effects of a hollow-point projectile, without the risk of collecting undesired foreign matter into the cavity in the unfired configuration and also eliminating the possible feeding problems from the magazine to the barrel chamber by a simple manufacturing process. A plunger (4) is initially positioned in the expansion chamber (2) of a projectile. Upon sinking into the projectile body (1) no part of the plunger head (5) touches the internal surface of the expansion chamber (2) except for the bottom of such chamber (2) so that the plunger (4) has no active role in the expansion of the projectile upon impact.

WO 2006/096944 A1

Expansion projectile for firearms

Background of the Invention

It is well known that projectiles, especially those
5 used in police work and personal defense, must feature a high
capability for stopping an attacker at once, without traversing the
target and thus risking injuring innocent people. That is particularly
important when the use of said ammunition is considered under extreme
situations, such as that involving life risk for the police officer,
10 an innocent pedestrian, etc.

Therefore projectiles used in police operations must
be able to pass through tactical obstacles that offer protection to
the criminal, such as vehicle doors and windscreen. However, the same
projectile must do so without altering its original trajectory, lest
15 there is serious risk of injury to bystanders that were not the
intended target of police action.

Another fundamental aspect of projectile performance
is that it must not fragment upon hitting any target. This restriction
is related to the already addressed risk of projectile fragments
20 injuring innocent people or damaging property which was not the
original target of police action, especially in public spaces of urban
environment.

DESCRIPTION OF RELATED ART

A recent, updated example of hollow-point projectile
25 design can be found on PCT/BR04/000006, "LEAD-FREE MONOBLOC EXPANSION
PROJECTILE AND MANUFACTURING PROCESS" filed by the same Applicant,
which describes a solid monobloc projectile with a cavity on the
longitudinal axis which is opened towards the fore end of the
projectile. Said hollow-point projectile, which features a plurality
30 of regularly spaced grooves distributed over the external front face,
opens up upon hitting a soft target, creating a flower-shaped element
which is much more effective in transferring energy to the target than
are standard solid profile projectiles. This higher energy transfer
fosters a higher stopping power, and the cavity design also tends to
35 avoid fragmentation of the projectile upon hitting both hard and soft
targets.

Nevertheless, the idea of a hollow-pointed projectile features some inconveniences. First of all, there is the aerodynamic inconvenience of placing an open cavity at the front end of the projectile, which entails ballistic problems such as trajectory instability generated by the pattern of the air vortex created ahead of the projectile.

Another ballistic inconvenience of the hollow-pointed profile is the loss of energy through attrition, which reduces the amount of energy actually transferred to the target upon hitting.

The feeding mechanism from the magazine to the barrel chamber also tends to yield a higher percent of jams when handling hollow-pointed ammunition than would be the case with regular-shaped, standard ammunition.

The storage and loading of the ammunition raises issues for hollow-pointed projectiles, which could collect dust and other external particles in the open cavity, possibly compromising the performance of the ammunition when fired.

There is also a more subtle, subjective and yet important political factor affecting the manufacturing and usage of hollow-point projectiles, which have been much maligned over the years by its labeling as cruel and, to some extent, it's former association with the intentional use of contaminants in the projectile and fragmentation that would add to its lethal power.

Another example of the state of the art can be found in PCT/EP01/01868 "REDUCED CONTAMINANT DEFORMABLE BULLET, PREFERABLY FOR SMALL ARMS", in the name of Knapworst et al. This patent addresses the inconveniences of an exposed hollow-point projectile by covering the open end of the projectile's cavity with a plastic element with the general shape of a nail. The nail head lies exposed at the very tip of the projectile, and preserves the regular external shape of the projectile right up to the impact moment, and then acts as a pusher to split the cavity wall open. The patent names this plastic, nail-shaped element a plunger. The movement of said plastic plunger from the very tip of the projectile towards the rear of the projectile is oriented by the previous alignment and partial insertion of the plunger shank with a purpose-designed axial shaft that receives the plunger shank

when the shank moves rearwards upon hitting the target, the plunger sinking into the rear body of the projectile.

Among the fundamental design features of the Knapworst patent projectile are the use of the plastic plunger conical head to force the projectile wall open upon impact (there are no external slits to foster the opening of the projectile wall into a flower shape) and the precise machining of the shapes of both the plunger shank and the corresponding projectile shaft that receives it upon impact.

Knapworst's patent design, although solving many of the already addressed inconveniences of open-cavity projectiles, presents some inconveniences of its own. The precision of machining and use of annealing become critical for the performance of the projectile, because the slightest geometrical or dimensional imperfection might cause problems such as irregular expansion of the cavity, breakage of the plunger, etc. Therefore, production costs are higher in view of the requirement of a comparatively strict manufacturing process control.

The lack of external slits keeps the projectile wall from tearing itself into various pieces, and in fact the fired projectiles show preserved continuity of the wall perimeter, with little radial expansion if compared to the flower-shaped pattern obtained with the use of external slits. Less expansion allows for less energy transmission and thus less stopping power.

The use of a cylindrical shape for both the plunger shank and its receiving axial shaft is not conducive to the exhaustion of the volume of air that fills the projectile shaft of the unfired ammunition. Upon impact, the plunger's round cross-section blocks the shaft completely, leaving no gap for the air to escape. That raises a pneumatic resistance, which could compromise the symmetrical expansion and general performance of the projectile.

The chamfering of a section of the circular cross-section of the plunger shaft is supposed to alleviate the problem, but the fact that the exhaust area is small and its geometric disposition is not axially symmetrical suggest the need of a better solution for the exhaust of the shaft air.

SUMMARY OF THE INVENTION

The projectile of the present invention combines the advantages of both the solid and hollow point designs, featuring the initial ballistics of a solid projectile and the terminal (target) ballistic effects of a hollow-point projectile, without the risk of collecting undesired foreign matter into the cavity in the unfired configuration and also eliminating the possible feeding problems from the magazine to the barrel chamber. That is achieved with comparably simple manufacturing process control, with major reduction of precision requirements at no risk to the performance of the projectile.

One object of the present invention is to disclose a projectile that easily and quickly deforms upon expansion when penetrating soft targets.

Another object of the present invention is to ensure the proper sinking of the plunger into the projectile body, so that after the initial impact the cavity in the front face of the projectile is completely exposed and brings about the desired terminal (target) ballistic effects.

Another object of the present invention is to avoid any sort of fragmentation of the projectile, so as to avoid unintended damage to targets other than the one intentionally fired upon.

All of the objects disclosed above are to be achieved without increasing too much the manufacturing costs of the projectile, so as to keep the final price of the product in the reach of most police forces around the world.

The present invention can be better understood by analyzing the specification text along with the attached set of Figures, in which:

Fig. 1 is a side view illustrating the general external shape of an unfired projectile according to the present invention, with slits (a) and in the alternative configuration without slits (b);

Fig. 2 is a longitudinal cross-section view illustrating an unfired projectile according to the present invention;

Fig. 3 is a longitudinal cross-section view illustrating a projectile according to the present invention in its

fired configuration, after it has hit the target, with slits (a) and in the alternative configuration without slits (b);

Fig. 4 is a perspective view illustrating a projectile according to the present invention in its fired configuration, after it has hit the target, with slits (a) and in the alternative configuration without slits (b);

Fig. 5 is a longitudinal cross-section view illustrating an unfired projectile according to the state of the art;

Fig. 6 is a longitudinal cross-section view illustrating a projectile according to the state of the art in its fired configuration, after it has hit the target;

Fig. 7 is a perspective view illustrating a projectile according to the state of the art in its fired configuration, after it has hit the target.

The present invention eliminates the inconveniences found in the state of the art by the use of a specific configuration that comprises two pieces:

- a deformable, cylindrical projectile body (1) with a front part tapering towards the front end. This cylindrical projectile features an internal cavity opened towards the front end, being said cavity composed of an expansion chamber (2) and a cylindrical shaft extension (3) which is continuously connected with it and is positioned right behind, both cavities featuring radial symmetry regarding the longitudinal axis of the projectile, being the shape of said expansion chamber preferably identical to that described in PCT/BR04/000006, "LEAD-FREE MONOBLOC EXPANSION PROJECTILE AND MANUFACTURING PROCESS" filed by the same Applicant, and

- a plunger (4) with the general shape of a nail, with a head (5) and a shank (6), also featuring radial symmetry regarding the longitudinal axis of the projectile.

The full axial length of the shank (6) of the plunger (4) is such that, in the unfired configuration, a length preferably between 5 and 25% of the shank's total extension lies inserted into the forward portion of the shaft (3). That keeps the plunger (4) firmly in place in the unfired configuration and serves the purpose of initial orientation of the sinking movement upon impact.

The external shape of the head (5) of the plunger (4) is such that the projectile presents in its unfired configuration an uninterrupted aerodynamic profile that is preserved after firing until the moment of impact. The cross-section of the shank (6) of the
5 plunger (4) is preferably that of a regular polyhedron with 3 to 8 sides, with contact between the elements occurring at the tips of the polyhedral figure, thus leaving a certain amount of free section between the shank (6) and the cylindrical shaft (3). This is important to facilitate the exhaustion of the air trapped inside the cylindrical
10 shaft (3) and suddenly pressurized by the sinking of the shank (6) into it upon impact.

The maximum cross section radius of the shank (6) is slightly bigger than the nominal cross-section radius of the cylindrical shaft (3), with the penetration of the shank (6) into the
15 shaft (3) being allowed by deformation of the plastic material of the plunger (4) under the force of the projectile impact. This serves the purpose of hindering the separation between the projectile body (1) and the plunger (4) after impact, achieving a press-fit between them.

As stated before, one of the objects of the present
20 invention is to disclose a projectile that easily and quickly deforms upon expansion when penetrating soft targets. That is preferably achieved by following the same cavity design guidelines described in PCT/BR04/000006, "LEAD-FREE MONOBLOC EXPANSION PROJECTILE AND
25 MANUFACTURING PROCESS" filed by the same Applicant, including the preferential use of external slits around the open face of the specially designed cavity to foster the forming of a flower-shape element after impact. Alternatively, it is possible to produce the projectile of the present invention without the external slits, but then the expansion after impact is reduced and so is the energy
30 transfer, consequently reducing the stopping power of the projectile.

The ideal design is such that the energy transfer to the targeted body should be performed by the whole projectile. In the event of accidental separation between the projectile body (1) and the plunger (4), part of the energy will inevitably end up transferred to
35 the plunger, in a direct proportion to its mass. Therefore it is advisable to make the plunger (4) mass much smaller than that of the projectile body (1), so that in the event of an accidental separation,

the smallest possible amount of energy is transferred to the "stray" plunger (4). In the present invention, the mass of the plunger (4) is no more than 5% of the total mass of the projectile in its unfired configuration.

5 The reliance on the apparently fragile flower-shape pattern of the projectile to transfer energy to the target might suggest fragmentation is an issue. There might be some misgivings regarding the possibility of one of the "petals" of the hollow-point projectile coming off (such as by tearing) and thus separating from the
10 bulk of the projectile inside the target, which would amount to fragmentation. Nevertheless, there is in fact a proportion between the amount of energy imparted to the projectile upon firing (which is the superior limit of the energy of the projectile upon hitting the target), the mechanical resistance of the projectile material and the
15 maximum extent of the "tearing" of the "petals" in the projectile at the very end of its deformation. Those skilled in the art will realize that a simple series of tests will indicate, for each caliber and type of ammunition, the ideal number, depth and length of the projectile slits in order to obtain the desired "flower-shaped" pattern and yet
20 avoid any risk of fragmentation due to excessive "flowering".

 In the present invention, the sequence of events from firing to final disposition of the projectile is as follows: The projectile is fired, follows its external ballistic path and eventually hits its target. Upon impact, the plunger (4) is forced
25 inside by the pressure of the target against the external surface of the plunger head (5), which drives the whole plunger (4) towards the rear part of the projectile body (1). When the plunger (4) sinks into the projectile body (1), it leaves behind and thus exposes the expansion chamber (2), which is penetrated and filled up by target
30 material. It is important to observe that the force that actually expands the expansion chamber (2) is the one caused by penetration of target material into it. In the configuration that features external slits, these provoke the splitting of the front-end perimeter of the projectile body (1) during expansion and generate the flower-shape
35 element associated with optimal energy transfer. In the alternative configuration without the external slits, the expansion chamber (2)

expands without breaking the circular perimeter of the projectile body (1) front end.

Another important aspect of the present invention is that upon sinking into the projectile body (1), no part of the plunger (4) head (5) touches the internal surface of the expansion chamber (2) except for the bottom of said chamber at the end of the course of the sinking movement, so that the plunger (4) has no active role in the expansion of the projectile upon impact.

The projectile body (1) material is preferably from the copper class or a copper alloy.

The material of the plunger (4) is preferably polyamide or polyethylene. This plastic material is resistant to breakage and yet somewhat flexible in view of the forces applied to the plunger (4). Alternatively, metallic powder can be added in the casting of the plunger (4) in order to make it magnetically traceable into the target after firing.

MANUFACTURING PROCESS

The manufacturing process includes the following sequence that is generally similar to the sequence described in PCT/BR04/000006, "LEAD-FREE MONOBLOC EXPANSION PROJECTILE AND MANUFACTURING PROCESS" filed by the same Applicant:

obtaining a cylinder of soft material preferably from the copper class or copper alloy, by cutting a wire;

forming the cavity in one or more operations, by cold forming, being the cylindrical shaft (3) formed in the same operation of cold forming with the expansion chamber (2) or alternatively in a separate operation of cold forming, or alternatively by drilling. The cylindrical shaft (3) is placed right behind the expansion chamber (2) and is continuously connected to it;

forming the forward part of the piece obtained, in a die, also forming the slits (if required for the ammunition being manufactured) in the same operation, and

annealing, polishing and cleaning the formed projectile.

All these operations are well known by those skilled in the art of ammunition manufacture.

There is a last step added to the manufacturing process of the projectile according to the present invention, and that is a final calibration step. The basic approach of the manufacturing process according to the present invention eliminates the need for
5 strict, repetitive and costly manufacturing process controls. Nevertheless, the possibility of major geometric and/or dimensional inconsistencies must be accounted for, and that is the reason for including this final calibration step. All manufactured projectiles are checked against a perfectly symmetrical model, and in case the
10 calibration step detects geometric or dimensional inconsistencies, the specific unit is automatically resized so as to conform to the manufacturing standards. That ensures, among other aspects, that no part of the plunger (4) head (5) touches the internal surface of the expansion chamber (2) when the plunger (4) sinks into the projectile
15 body (1). Said calibration step helps prevent undesired developments such as breakage of the plunger (4) upon impact, which is also aided by the fact that the plastic used to manufacture the plunger (4) is resistant to breakage and yet somewhat flexible in view of the forces applied to it.

20

INDUSTRIAL APPLICABILITY

The manufacturing process of the projectile of the present invention is a clear indication of the invention's industrial applicability. Those skilled in the art will realize that the description of one or more preferential incorporations of the present
25 invention does not limit its scope of application, which is in fact limited only by the claims attached herein.

WHAT IS CLAIMED IS:

1. An expansion projectile for firearms, comprising two pieces, being the first piece a deformable, cylindrical projectile body (1) with a front part tapering towards the front end, a set of regularly spaced slits placed at the front end of the projectile and an internal cavity opened towards said front end, composed of an expansion chamber (2) connected to a cylindrical shaft extension (3) and being the second piece a plunger (4), preferably made of polyamide or polyethylene, with the general shape of a nail with a head (5) and a shank (6), with all elements featuring radial symmetry regarding the longitudinal axis of the projectile, being the plunger (4) initially positioned so that the external face of the head (5) lies exposed at the very front tip of the projectile and the shank (6) lies inserted into the expansion chamber (2) characterized by the fact that upon sinking into the projectile body (1), no part of the plunger (4) head (5) touches the internal surface of the expansion chamber (2) except for the bottom of said chamber at the end of the course of the sinking movement, so that the plunger (4) has no active role in the expansion of the projectile upon impact.

2. An expansion projectile for firearms, according to claim 1, characterized by the fact that the full axial length of the plunger (4) is such that, in the unfired configuration, a length preferably between 5 and 25% of the plunger total extension lies inserted into the forward portion of the shaft (3).

3. An expansion projectile for firearms, according to claim 1 or 2, in which the external shape of the head (5) of the plunger (4) is such that the projectile presents an uninterrupted aerodynamic profile in its unfired configuration which is preserved after firing until the moment of impact, characterized by the fact that the cross-section of the shank (6) of the plunger (4) is preferably that of a regular polyhedron with 3 to 8 sides, featuring axial symmetry regarding the longitudinal axis of the projectile, with contact between the pieces occurring at the tips of the polyhedral figure, thus leaving a certain amount of free section between the shank (6) and the cylindrical shaft (3).

4. An expansion projectile for firearms, according to any of the previous claims, in which the projectile presents an cavity

opened towards the front end after the plunger (4) sinks into the projectile upon impact, characterized by the fact that the maximum cross section radius of the shank (6) is slightly bigger than the nominal cross-section radius of the cylindrical shaft (3), with the penetration
5 of the shank (6) into the shaft (3) being allowed by deformation of the material of the plunger (4) under the force of the projectile impact.

5. An expansion projectile for firearms, according to any of the preceding claims, characterized by the fact that alternatively there are no regularly spaced slits placed at the front end of the
10 projectile.

6. An expansion projectile for firearms, according to any of the preceding claims, characterized by the fact that the mass of the plunger (4) is no more than 5% of the total mass of the projectile in its unfired configuration.

15 7. Manufacturing process for the projectile according to any of the previous claims, characterized by the fact that said process includes the forming of the cylindrical shaft extension (3) placed right behind the expansion chamber (2) and continuously connected to it, as well as a final calibration step against a perfectly symmetrical model.

20

1 / 2

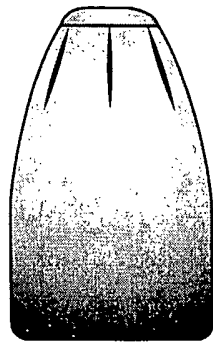


Fig. 1 a

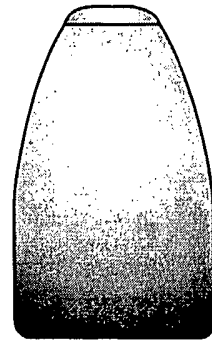


Fig. 1 b

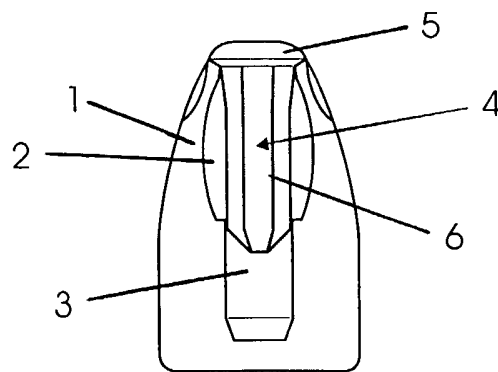


Fig. 2

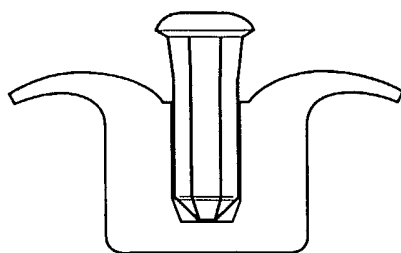


Fig. 3 a

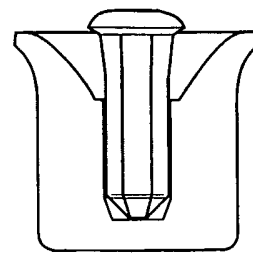


Fig. 3 b

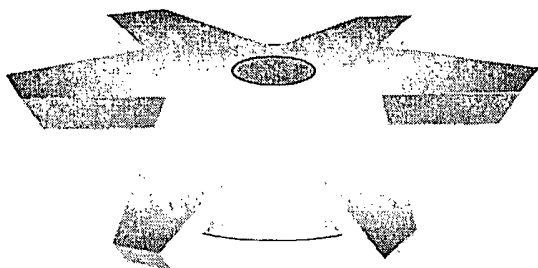


Fig. 4 a

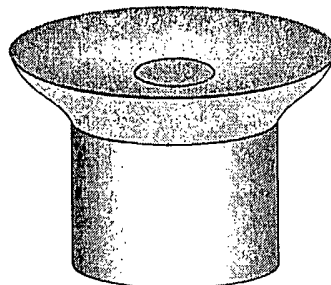


Fig. 4 b

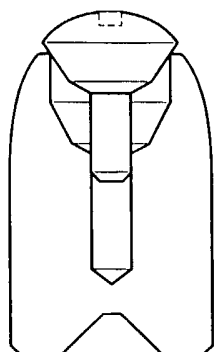


Fig. 5
STATE OF THE ART.

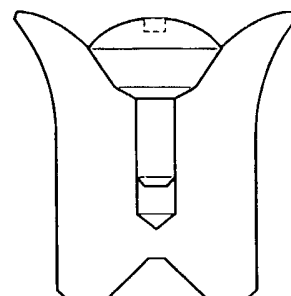


Fig. 6
STATE OF THE ART.

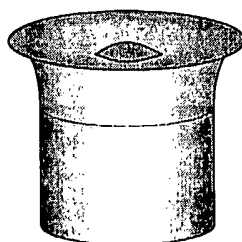


Fig. 7
STATE OF THE ART.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/BR 2005/000035

A. CLASSIFICATION OF SUBJECT MATTER

IPC⁷: F42B 12/34

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC⁷: F42B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 1 394 498 A2 (FIOCCHI MUNIZIONI SPA) 3 March 2004 (03.03.2004) <i>figure 1, claims.</i>	1, 2, 5-7
	--	
Y	DE 103 17 404 A1 (RUAG AMMOTEC GMBH) 13 November 2003 (13.11.2003) <i>figure 2, abstract.</i>	1, 2, 5-7
	--	
A	EP 1 355 119 A1 (NAMMO LAPUA OY) 22 October 2003 (22.10.2003) <i>figure 1.</i>	1, 7

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

30 November 2005 (30.11.2005)

Date of mailing of the international search report

20 December 2005 (20.12.2005)

Name and mailing address of the ISA/ AT

Austrian Patent Office
Dresdner Straße 87, A-1200 Vienna

Facsimile No. +43 / 1 / 534 24 / 535

Authorized officer

PFAHLER A.

Telephone No. +43 / 1 / 534 24 / 412

INTERNATIONAL SEARCH REPORT

Information on patent family members

PCT/BR 2005/000035

Patent document cited in search report			Publication date	Patent family member(s)			Publication date
DE	A1	10317404	2003-11-13	US	A1	2005241523	2005-11-03
				WO	A1	03093758	2003-11-13
				EP	A1	1502074	2005-02-02
				CA	A1	2485067	2003-11-13
				AU	A1	2003233202	2003-11-17
EP	A1	1355119	2003-10-22	US	A1	2004003747	2004-01-08
				FI	A	20021196	2003-10-16
				FI	U1	5551U	2002-10-17
EP	A2	1394498	2004-03-03	none			