



- (51) International Patent Classification:
F42B 12/62 (2006.01) *F42B 12/58* (2006.01)
- (21) International Application Number:
PCT/SE2018/050973
- (22) International Filing Date:
26 September 2018 (26.09.2018)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
1700293-2 28 November 2017 (28.11.2017) SE
- (71) Applicant: **BAE SYSTEMS BOFORS AB** [SE/SE]; N/A,
691 80 Karlskoga (SE).
- (72) Inventors: **THUMAN, Christer**; Storängsvägen 10, 691
47 Karlskoga (SE). **HEICHE, Ulf**; Skolgatan 31, 69141
Karlskoga (SE). **VESA, Reijo**; Älvhyttan 528, 713 92 Gyt-
torp (SE).

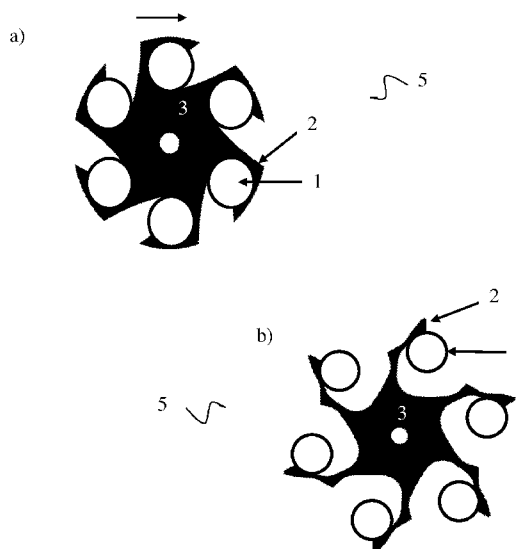
(74) Agent: **NOBELI BUSINESS SUPPORT AB**; Hyttåsvä-
gen 10, SE69180 Karlskoga (SE).

(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,
KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

(54) Title: DEVICE AND METHOD FOR COUNTERACTING CONTACT-IMPACT EVENTS OF ELONGATED SUB-PROJEC-
TILES

Fig. 2



(57) Abstract: The present invention provides a holding device (5) and method for decreasing the contact-impact event on sub-projectiles (1) when fired from a barrel, cylinder, carrier shell or the like. The holding device (5) comprises a core (3) and at least two legs (2) that at least partially enclose at least one sub-projectile (1) each. When a projectile is fired from a barrel or the like the sub-projectiles load the legs (2) of the device (5) which are deformed and open up and release the sub-projectiles (1) in a controlled manner without tumbling which leads them to hit and penetrate their target with the short-side. The present invention further provides a holding device (5) comprising sub-projectiles (1) and a projectile comprising the holding device (5).

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

DEVICE AND METHOD FOR COUNTERACTING CONTACT-IMPACT EVENTS OF ELONGATED SUB-PROJECTILES

TECHNICAL FIELD

The present invention relates to the field of spin stabilized projectiles containing a releasable
5 payload. More particularly the invention relates to a device for counteracting contact-impact events upon firing of a projectile leading to improved effect/penetration of the sub-projectiles to the target.

BACKGROUND

When elongated sub-projectiles (rods, flechettes, sub-munitions etc.) are fired out of a barrel, separated from a carrier shell or cylinder, the sub-projectiles rotate either relative to a stationary
10 barrel, or the barrel, carrier shell or cylinder rotates together with the sub-projectiles. The sub-projectiles are affected by the centrifugal forces which give rise to a tumbling motion when the centre of gravity of the projectiles/sub-projectiles pass the muzzle of the barrel/cylinder, or are released from a carrier shell, (see Fig. 1). The tumbling motion means that the projectiles/sub-projectiles tumbles uncontrollably and many meet their target wide-sided, which results in poorer
15 impact and penetration.

US 3,656,433 provides a method for reducing shot dispersion by using a viscoelastic matrix utilized to hold flechettes or other types of small missiles or shots in a unitary projectile form until the unit are released from the gun barrel and until it has substantially passed through the blast region area.

US 5,817,969 discloses a method to avoid contact-impact event of the payload, i.e., sub-projectiles,
20 when the payload is released from a carrier shell, i.e., the payload chamber opens essentially along a casing line from the bottom to the top (cap) and the sub-projectiles are released from the carrier shell when the shell opens up, thereby avoiding contact-impact events. The construction is complex and heavy; the aim is also to fill the casing with maximum number of sub-projectiles for improved hit rate, i.e., quantity.

25 In view of the background there is a need of developing a device that allows the sub-projectiles to leave the barrel, carrier shell or the like with decreased interference of the centrifugal forces leading to decreased tumbling of the sub-projectiles thereby obtaining increased effect/penetration.

SUMMARY

A first object of the present invention is to provide a device that decreases and/or counter-acts the tumbling effect of projectiles/sub-projectiles fired from a barrel, cylinder, carrier shell or the like.

5 This object is obtained by providing a holding device as defined in present claim 1. The holding device counteracts the contact-impact event on sub-projectiles when they are fired from a barrel, cylinder, carrier shell or the like.

The holding device comprises a core having at least two legs. The legs enclose at least partially at least one sub-projectile each.

10 In one embodiment the number of legs is in the range of two to twelve. In yet another embodiment the number of legs is in the range of two to six. The number and design of the legs varies and depends on the type of projectile to be used. The number and the design of the legs depend on the type of sub-projectiles to be enclosed.

15 Generally, the holding device comprises a core from where at least two legs are protruding. The legs are protruding from the core in a circular symmetric manner and evenly distributed around the core. If two legs are utilized they are separated by 180 degrees, three legs 120 degrees, four legs 90 degree, etc.

The holding device may for example be made of plastics. In another embodiment it may be made of aluminium. In yet another embodiment the holding device may be made of magnesium. A holding device made of steel, preferably soft steel, is also provided.

20 The holding device may in another embodiment be made of a combination of material.

The holding device of the present invention may be manufactured by molding, but other processes known by the art is also possible.

In one embodiment of the holding device each leg can enclose up to 5 sub-projectiles.

25 The holding device may in one embodiment be enclosed by a cover. A cover may surround the holding device, e.g., surrounding the outside on the legs. In another embodiment a cover can be used for preventing the sub-projectiles from falling out from the holding device, e.g., as top or bottom cover. The holder may also be used in combination with a payload container.

Another object of the present invention is to provide the holding device, as described above, comprising sub-projectiles. The sub-projectiles may be of any suitable kind.

A payload container comprising a holding device of the present invention and sub-projectiles can be arranged in a projectile, preferably in the payload chamber of a carrier shell.

- 5 Yet another object of the present invention is to provide a projectile comprising said holding device comprising sub-projectiles as described above. In one example the projectile is a dividable projectile, comprising a payload chamber, a time fuze and a separation charge arranged behind the payload chamber for separating the payload chamber from the projectile in the forward direction of the projectile.
- 10 Yet another object of the present invention is to provide a process for decreasing the tumbling effect when firing projectiles/sub-projectiles from a barrel, cylinder, carrier shell or the like. The tumbling effect of a sub-projectile is counteracted or decreased when the holding device described above is used. A leg of the holding device encloses at least partly a sub-projectile. The rotation implies that the sub-projectile loads the leg which is deformed and opens up, which results in that the sub-
- 15 projectile is released outside the muzzle or opening without tumbling, i.e., in a controlled manner.

The present invention also provides a process for adapting a commercial projectile for firing sub-projectiles without or decreased contact-impact events when passing a barrel/cylinder, carrier shell or the like. The process comprises the steps of

- arranging sub-projectiles in a holding device as defined above and present claim 1,
- 20 - firing the projectile, and
- releasing the sub-projectiles from the barrel/cylinder, carrier shell or the like thereby loading the legs of the device which are deformed and opens up and releasing the sub-projectiles in a controlled manner without tumbling which leads them to hit and penetrate their target with the short-side.

- 25 The loading of the sub-projectiles is due to the centrifugal forces and the rotation that implies that the sub-projectiles load the legs.

The holding device is preferably arranged in a payload chamber of a projectile.

In general, the holding device of the present invention can be arranged in any suitable commercial projectile, thereby providing a projectile that does not suffer from contact-impact events upon firing the projectile from a barrel or the like.

BRIEF DESCRIPTION OF DRAWINGS

The invention is now described, by way of example, with reference to the accompanying drawings, in which:

- 5 Fig. 1: Shows a schematic side-view demonstrating the contact-impact event at a muzzle of fired sub-projectiles causing the tumbling effect.
- Fig. 2a-c: Shows a cross-section of a holding device and the arrangement of sub-projectiles (a), the release of the sub-projectiles in a controlled manner (b), and how the sub-projectiles are leaving the holding device (c).
- 10 Figs. 3a-c Show cross-sections of different embodiments of the holding device, wherein the sub-projectiles are at different distance from the centre of the device (a), several layers of sub-projectiles are partially enclosed by legs (b), and a plurality of sub-projectiles at least partly surrounded by a common supporting leg (c).
- Figs. 4a-b Illustrates the dispersion pattern of the sub-projectiles obtained when using the holding device of the present invention (a) compared to prior art (b).
- 15 Fig. 5 Shows a schematic side-view of a projectile comprising a plurality of holding devices of the present invention.

DETAILED DESCRIPTION

Before the invention is disclosed and described in detail, it is to be understood that this invention is not limited to particular materials or configurations disclosed herein as such configurations and materials may vary. It is also to be understood that the terminology employed herein is used for the purpose of describing particular embodiments only and is not intended to be limiting since the scope of the present invention is limited only by the appended claims.

20

The present invention will now be described in more detail with reference to the accompanying figures, in which different embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein.

25

In context of the present invention the term *sub-projectile* means a small weapon or device that is part of a larger warhead and separates from it prior to impact, e.g., rods, flechettes, or arrow-like

darts, i.e., not only munitions of various kinds, but all kinds of payloads, from which a specific continued flight on a determined flight path is expected after its release.

In context of the present invention the term *contact-impact events* means the event when the projectile/sub-projectile is fired/released from a barrel, carrier shell, cylinder or the like and pass the muzzle-edge resulting in disturbances and tumbling of the sub-projectile.

In context of the present invention the term *holding device* defines devices that at least partly enclose and arrange sub-projectiles.

When a sub-projectile is emerging from a muzzle or opening of a barrel or being separated forward from a carrier shell or a cylinder, the sub-projectiles will rotate either in relation to a stationary barrel, or the barrel or carrier shell rotates together with the sub projectiles. Due to the rotation, the sub-projectiles are influenced by the centrifugal force (F , Fig. 1) which gives rise to a tumbling motion when the centre of gravity of the sub-projectile is outside the muzzle or opening of the barrel/cylinder/carrier shell. The uncontrolled tumbling of the sub-projectiles results in that they hit their target with the broad-side (i.e., contact-impact event) which leads to less effect/penetration.

An ideal solution would be that the sub-projectiles are released from the barrel/cylinder, or carrier shell without tumbling.

Fig. 2a shows an example of a holding device 5 with the purpose to overcome the problems caused by the centrifugal forces described above.

The holding device 5 comprises a core 3 with protruding legs 2 arranged to it. The core 3 and legs 2 can be manufactured in one piece, or the legs 2 may be arranged to the core 3 in a separate step.

In some embodiments the centre of the core 3 it is a bore for arrangement of a continuous detonator wire, for example a shock tube or an electric wire.

The legs 2 are in this embodiment six, but in other embodiments the number may vary between 2-50 depending on the type of carrier shell, holder or purpose. Usually, the number of legs is in the range of 2-50, or 2-25, 2-12 2-6, 2-4 or only 2.

The legs 2 are in this embodiment at least partially enclosing the sub-projectiles 1, and in this example there is one sub-projectile 1 enclosed per leg 2.

When sub-projectiles 1 are released from a barrel/cylinder, carrier shell or the like, the device is deformed due to the centrifugal forces and the rotation implies that the sub-projectiles 1 load the

legs 2 which are deformed and opens up (Fig. 2b). The sub-projectiles 1 are then released in a controlled manner (Fig. 2c) and will not tumble which leads them to hit and penetrate their target with the short-side, as desired.

5 The holding device 5 may for example be made of plastics, aluminium, magnesium, or steel, or a combination of said materials. The core 3 and the legs 2 can be made of different materials. The holding device (5) may be manufactured by molding.

Figs. 3a-c show different examples of embodiments of a holding device 5 and its arrangement of legs 2 and sub-projectiles 1.

10 In the embodiment of Fig. 3a the distance of the sub-projectiles 1 to the centre of the core 3 is varied.

The embodiment shown in Fig. 3b has several layers of sub-projectiles 1 enclosed by a leg 2 which is divided into two legs 2 or more.

15 The embodiment in Fig. 3c shows an example of a more closed design. The holding device 5 comprises different compartments separated by the legs 2, and each compartment comprises a plurality of sub-projectiles 1. Three sub-projectiles 1 are in this example enclosed by one leg 2.

The number of legs 2 and/or sub-projectiles 1 is scalable and is not intended to be limiting.

In the embodiments shown here the legs 2 enclose the sub-projectiles 1 from the left, but other embodiments are also possible.

20 Generally, the holding device 5 comprises a core 3 from where at least two legs 2 are protruding. The legs 2 are protruding from the core in a circular symmetric manner and evenly distributed around the core. If two legs 2 are utilized they are separated by 180 degrees, three legs 120 degrees, four legs 90 degree, etc.

25 Fig. 4 illustrates the effect of using the present invention, i.e., the holding device 5, when pluralities of sub-projectiles are fired from a barrel/cylinder, a carrier shell or the like. In Fig. 4a the sub-projectiles are released from the holding device 5 and hit the target with the short-side (arrow). In Fig. 4b are the sub-projectiles released without using the holding device 5 of the present invention, and it is clearly shown that the sub-projectiles tumble and hit the target with the broad-side (arrow) which is less penetrating and effective.

Clockwise as shown in Fig. 2a provides best result.

Fig. 5 shows a cross-view of an example of a projectile 10 suitable for comprising the holding device 5 of the present invention. The projectile 10 comprises a front projectile body 20 and a rear projectile body 30, and a belt 40. The front 20 and the rear projectile body 30 are joined by means of for example a threaded connection, shrink connection and/or press-fit connection. The rear projectile body 30 comprises a separation charge 50 and a pyrotechnic primer device 60 for initiating the separation charge 50. The primer device 60 is arranged in front of the separation charge 50 behind a drive plate 70 adjacent to the rear end of a payload chamber 80 and the front projectile body 20. The separation charge 50 may consist of a propellant charge of conventional type, for example a propellant charge comprising a smokeless nitrocellulose propellant, or in an alternative embodiment a composite propellant.

The payload chamber 80 arranged in the front projectile body 20 comprises at least one holding device 5 comprising sub-projectiles 1. A time fuze comprising an activation unit for activating the primer device 60 is arranged in the nose part 100 of the front projectile body 20, in front of the payload chamber 80. The nose part 100 is fitted to the front projectile body 20 by a second drive plate 110 and by for example shear pins 90, which are designed to rupture under the effect of the pressure on the separation of the payload chamber 80 from the projectile 10. In an alternative embodiment a continuous detonator wire 120, for example a shock tube, is arranged between the pyrotechnic primer device 60 and the front part 20 for separating the nose part (fuze) 100 from the projectile 10.

The holding device 5 of the present invention is intended to be used in commercially available projectiles. The holding device 5 is manufactured separately, and suitable sub-projectiles 1 are inserted into the holding device. At least one holding device 5 comprising sub-projectiles is thereafter arranged in a suitable projectile/carrier.

Sub-projectiles suitable for the holding device of the present invention are for example small calibre e.g. 12 gauge shotgun: rods, flechettes, medium calibre e.g. 40 mm, 57 mm: rods, flechettes, armor-piercing wolfram carbide projectiles and large calibre e.g. 120 mm, 155 mm sub-munitions, flechettes, rods.

In summary, the invention provides a holding device 5 for decreasing or eliminating contact-impact events that occur when sub-projectiles are released from a barrel, cylinder or a carrier shell. Advantages of the present invention are among other things: reduced or eliminated tumbling leading to improved penetration into and effect on the target; the size of the fins and the

stabilization distance can be reduced of aerodynamic stabilized sub-projectiles; the sub-projectiles are fixed in a carrier shell when it is fired and before separation.

PATENT CLAIMS

1. A holding device (5) for counteracting the contact-impact event on elongated sub-projectiles (1) when fired from a barrel, cylinder, carrier shell or the like, wherein the holding device (5) comprises a core (3) comprising at least two legs (2) for at least partially enclose at least one elongated sub-projectile (1) each, wherein the device (5) is deformed due to the centrifugal forces and the sub-projectiles (1) are released in a controlled manner.
2. The holding device (5) according to claim 1, wherein the number of legs (2) are in the range of 2 to 12.
3. The holding device (5) according to claim 1 or 2, wherein the holding device (5) is made of plastics, aluminium, magnesium, or steel.
4. The holding device (5) according to any of claims 1-3, wherein the holding device (5) is molded.
5. The holding device (5) according to any of claims 1-4, wherein the legs (2) can enclose up to 5 sub-projectiles (1) each.
6. The holding device (5) according to any of claims 1-5 enclosed by a cover.
7. The holding device (5) according to any of claims 1-6 comprising sub-projectiles (1).
8. A projectile (10) comprising a holding device (5) according to any of claims 1-7.
9. A process for counteracting the contact impact event of a sub-projectile (1) fired from a barrel, cylinder, carrier shell or the like, wherein said process comprises the following steps:
 - arranging sub-projectiles (1) in a holding device (5) according to any of claims 1-7,
 - firing the barrel, cylinder, carrier shell or the like, and
 - releasing the sub-projectiles (1) from the barrel/cylinder, carrier shell or the like that load the legs of the device (5) which deforms and opens up due to the centrifugal forces wherein the sub-projectiles (1) are released in a controlled manner.
10. A process for adapting a commercial projectile for firing sub-projectiles (1) without or decreased contact-impact events when passing a barrel/cylinder, carrier shell or the like,

by arranging the holding device (5) comprising the elongated sub-projectiles (1) according to any of claims 1-7 in a projectile (10) according to claim 8.

Fig. 1

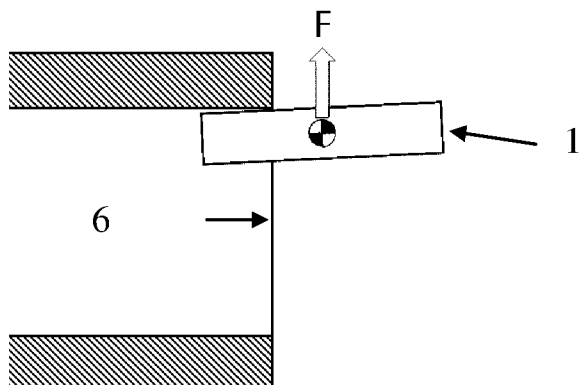
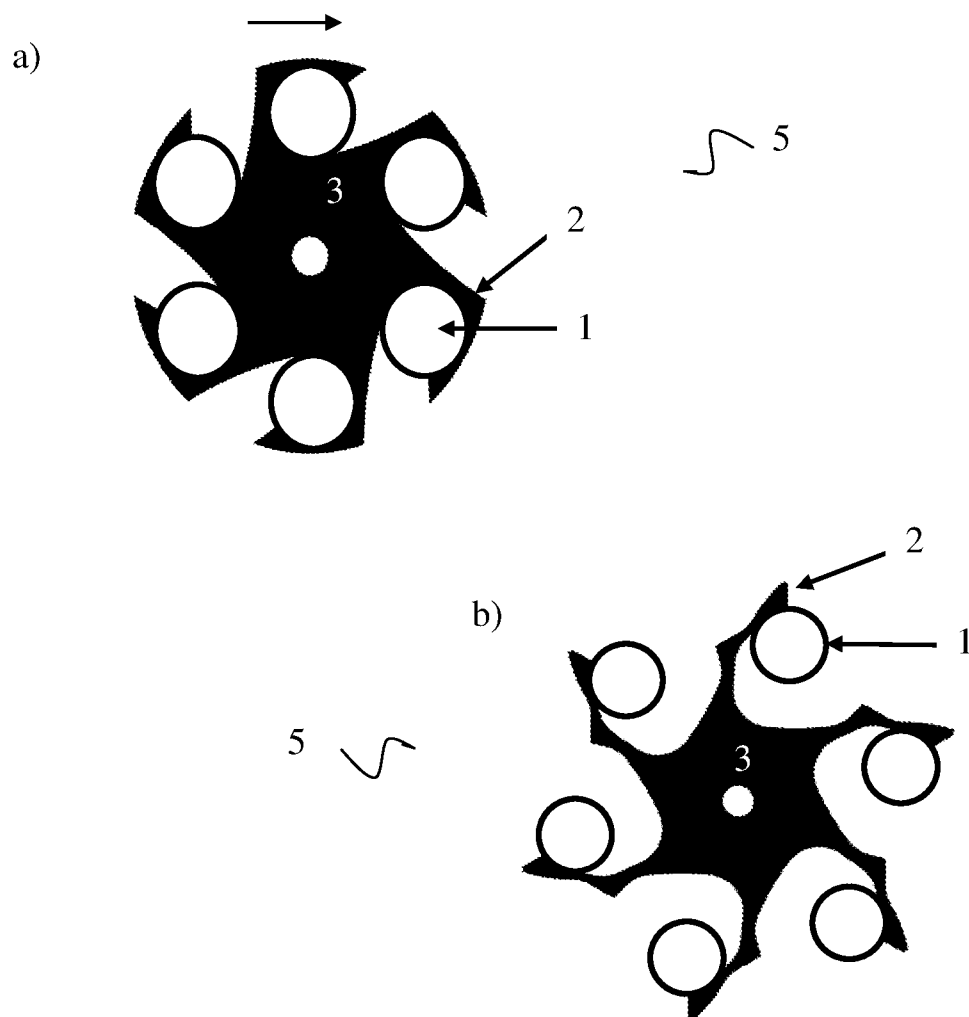


Fig. 2



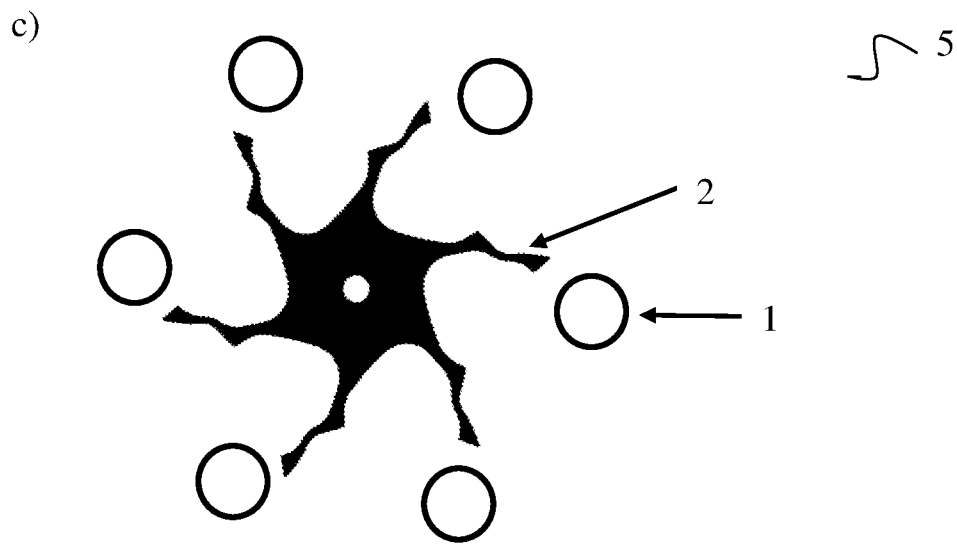
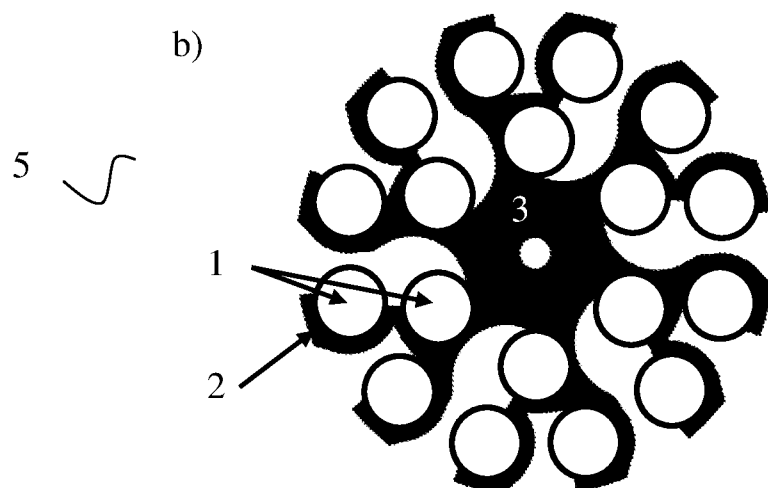
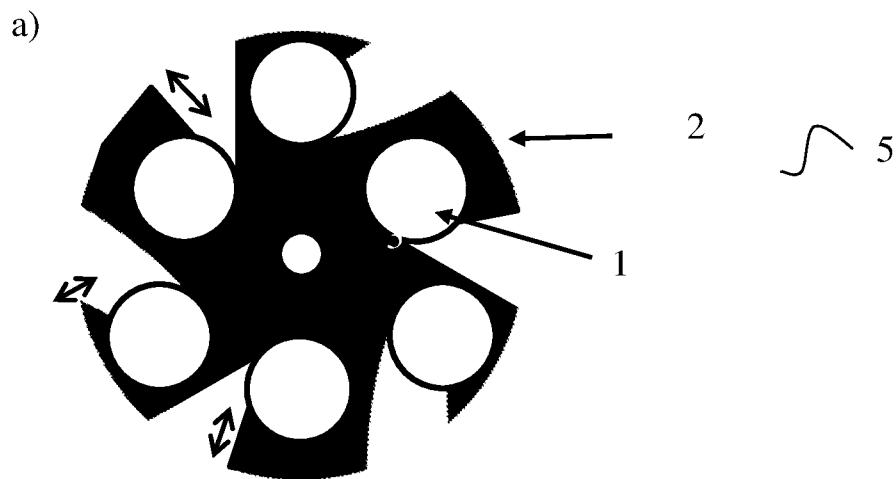


Fig. 3



c)

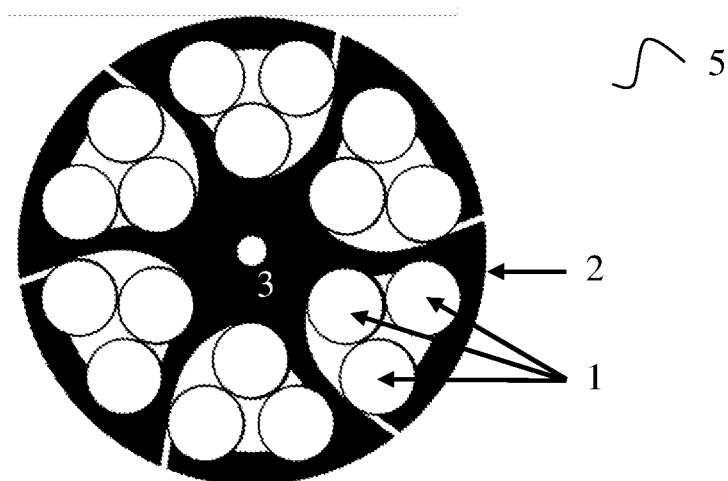
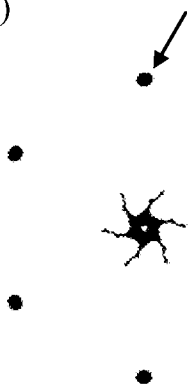


Fig. 4

a)



b)

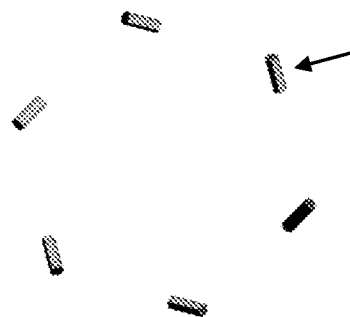
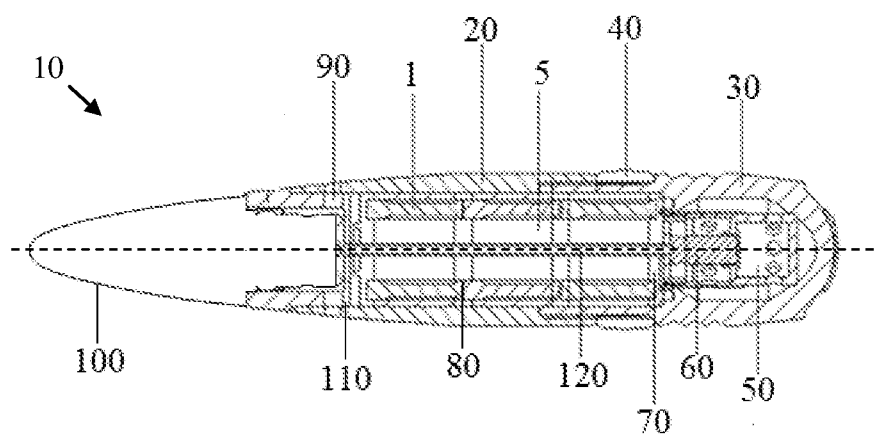


Fig. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2018/050973

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: F42B

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4264045 A1 (CAMPBELL ROBERT J), 28 April 1981 (1981-04-28); abstract; column 4, line 25 - line 47; figures 1-9,10A,17; claim 10 --	1-10
A	US 4770101 A1 (ROBERTSON WILLIAM J ET AL), 13 September 1988 (1988-09-13); abstract; column 3, line 4 - line 21; figures --	1-10
A	US 3656433 A1 (THRAILKILL ARTHUR E ET AL), 18 April 1972 (1972-04-18); abstract; column 2, line 20 - line 42; figures 1,2; claim 1 --	1-10

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 13-12-2018	Date of mailing of the international search report 13-12-2018
Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Erik Dahlblom Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2018/050973

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5817969 A1 (ETTMUELLER PETER), 6 October 1998 (1998-10-06); abstract; column 9, line 8 - column 10, line 11; figures 1-3 -- -----	1-10

Continuation of: second sheet

International Patent Classification (IPC)

F42B 12/62 (2006.01)

F42B 12/58 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2018/050973

US	4264045 A1	28/04/1981	NONE		
US	4770101 A1	13/09/1988	CA	1266202 A	27/02/1990
			DE	3784578 D1	15/04/1993
			DK	163892 B	13/04/1992
			DK	288587 A	06/12/1987
			EP	0255214 B1	10/03/1993
			JP	63259400 A	26/10/1988
			NO	872348 A	07/12/1987
			NO	165815 C	10/04/1991
US	3656433 A1	18/04/1972	CA	937101 A	20/11/1973
US	5817969 A1	06/10/1998	CA	2179373 A1	10/11/1997
			DE	59603070 D1	21/10/1999
			EP	0806623 B1	15/09/1999
			ES	2140761 T3	01/03/2000
			JP	2825153 B2	18/11/1998
			JP	09303997 A	28/11/1997
			NO	308049 B1	10/07/2000
			NO	962567 A	10/11/1997
			SG	82562 A1	21/08/2001
			US	5864086 A	26/01/1999