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(54) **MORTAR BOMB**

(57) According to an aspect of the invention, there is provided a mortar bomb, comprising: a main body; a nose; a tail extending from the main body, away from the nose; an obturating ring groove for accommodating, in

use, an obturating ring, the ring groove being located in the main body; wherein a maximum diameter of the main body is upstream of the ring groove, toward the nose.

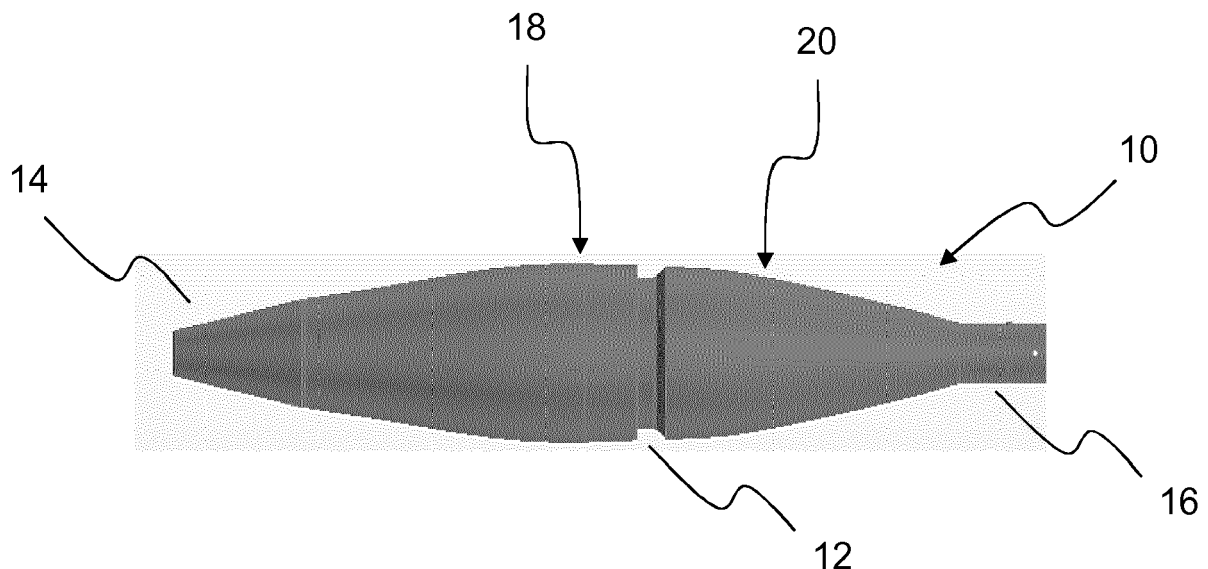


FIG. 6

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Description

[0001] The present invention relates to a mortar bomb.

[0002] When a mortar bomb is fired, people and objects in the vicinity of the firing location are subjected to blast overpressure effects. This can be detrimental or even damaging to the surrounding people or objects. It might be possible to at least partially shield one or more parts of the people or objects from the overpressure effects. For example shields, goggles or ear defenders might be used to protect people. However, this approach requires the use of additional high-specification equipment or procedures, which needs to be employed each time the mortar bomb is fired, which can add to operational cost and complexity. Higher overpressure effects might be disadvantageous even with such protection being employed.

[0003] It is therefore an example aim of example embodiments of the present invention to at least partially solve, avoid, or overcome one or more problems of the prior art, whether identified herein or elsewhere, or to at least provide a viable alternative to existing apparatus or methods.

[0004] According to an aspect of the invention, there is provided a mortar bomb, comprising: a main body; a nose; a tail extending from the main body, away from the nose; an obturating ring groove for accommodating, in use, an obturating ring, the obturating ring groove being located in the main body; wherein a maximum diameter of the main body is upstream of the obturating ring groove, toward the nose.

[0005] The maximum diameter of the main body may be located upstream of the obturating ring groove by a distance of substantially 0.3 to 0.4 times a calibre of the mortar bomb.

[0006] The maximum diameter of the main body may be located upstream of an edge of the obturating ring groove closest to the nose, by a distance of 0.3 to 0.4 times a calibre of the mortar bomb.

[0007] A difference in diameter between the maximum diameter of the main body, and a diameter at the ring groove, may be 0.01 to 0.015 times a calibre of the mortar bomb.

[0008] The diameter at the obturating ring groove may be the diameter at the greatest radial extent of the obturating ring groove.

[0009] Immediately downstream of the ring groove, toward the tail, a profile of the main body may initially extend substantially axially with respect to a longitudinal axis of the mortar bomb.

[0010] Downstream of the ring groove, immediately adjacent to the tail, a profile of the main body may be curved to meet and blend with a profile of the tail.

[0011] The profile of the tail immediately adjacent to the main body may extend substantially axially with respect to a longitudinal axis of the mortar bomb.

[0012] Downstream of the ring groove, a gradient of the main body profile, substantially in-between the ring

groove and the tail, may be greater than a gradient of a substantially straight line theoretically extending between the ring groove and the tail.

[0013] Downstream of the ring groove, a gradient of the main body profile, substantially at a mid-point between the ring groove and the tail, is greater than a gradient of a substantially straight line theoretically extending between the ring groove and the tail.

[0014] According to another aspect of the invention, there is provided a mortar bomb main body, comprising: an obturating ring groove for accommodating, in use, an obturating ring; wherein a maximum diameter of the main body is upstream of the ring groove.

[0015] For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic Figures in which:

Figure 1 schematically depicts an existing mortar bomb;

Figure 2 schematically depicts an outline of the modular of Figure 1;

Figure 3 schematically depicts an air pressure profile around an outline of the mortar bomb of Figures 1 and 2;

Figures 4 and 5 schematically depict properties of a maximum diameter of the mortar bomb of Figures 1 and 2 in standard and outline views, respectively;

Figures 6 and 7 schematically depict profiles of a main body of a mortar bomb according to an example embodiment, in standard and outline views, respectively;

Figures 8 and 9 schematically depict principles associated with a maximum diameter of the main body of the mortar bomb of Figures 6 and 7 in standard and outline views, respectively;

Figure 10 schematically depicts a comparison between an existing main body profile downstream of an obturating ring groove of a mortar bomb, and an exemplary embodiment profile downstream of such an obturating ring groove;

Figure 11 schematically depicts more detail of the comparison of Figure 10, immediately adjacent to the ring groove of the mortar bomb;

Figure 12 schematically depicts more detail of the comparison of Figure 10, immediately adjacent to the tail of the mortar bomb;

Figure 13 schematically depicts an air pressure profile about the main body of the mortar bomb accord-

ing to an example embodiment; and

Figure 14 schematically depicts a side-by-side comparison of the pressure profiles of Figure 3 and Figure 13.

[0016] As discussed above, overpressure effects at the firing location of a mortar can have a negative effect on the people or objects in the vicinity of the firing location. It is desirable to avoid having to use additional equipment or procedures during the firing in order to limit or avoid the effects of the overpressure, or to at least reduce the need or level of such equipment or procedures. In general, reduction in overpressure makes it easier to operate the firing of the mortar bomb, or to work in the environment of such firing.

[0017] A relatively straightforward way of reducing the overpressure effects is to simply reduce the overpressure, by way of reducing the charge that is required to fire the mortar bomb. However, and of course, without other modifications, reducing the charge would reduce the firing range of the mortar bomb. So, if this reduction in charge for firing the mortar bomb is to be realised in practice, a given or typical mortar bomb fired from the location will, ideally, need to somehow maintain its firing range, even through the firing charge is reduced.

[0018] According to example embodiments, it has been realised that a mortar bomb can be re-designed or re-shaped to have reduced drag, thereby allowing the (i.e. a typical) mortar bomb to travel further (i.e. have a longer range) when used with the same charge, or to have the same range as a typical or standard (that is, not re-designed as described herein) mortar bomb when fired with a reduced charge. Overall, then, overpressure effects are reduced, for given firing range, when compared with an existing mortar bomb fired over that same range.

[0019] An existing mortar bomb, and associated problems, will be described initially. An improved mortar bomb, according to example embodiments, will then be described.

[0020] Figure 1 shows an existing mortar bomb (2). This same mortar bomb is shown in Figure 2, with an outline view for clarity, so that the profile of the mortar bomb (2) can be more readily seen.

[0021] Figure 3 shows a pressure profile about the mortar bomb (2) during flight. Increased regions of air pressure are shown in darker shading. It can be seen that at the high speeds typical due in the trajectory of a mortar bomb, significant air pressure shock (3) is located at or immediately adjacent to an obturating ring groove (4) of the mortar bomb (2). The obturating ring groove (4) is used to accommodate an obturating ring during firing of the mortar bomb. This shock (3), and its location at the obturating ring groove (4), significantly adds to the drag on the mortar bomb (2).

[0022] Figures 4 and 5 schematically depict a region of the existing mortar bomb, around the obturating ring

groove (4), in standard and outline views respectively. These Figures show that the main body of the mortar bomb has a diameter (6) which is at a maximum (8) at the location of the ring groove (4). The significance of this feature, relative to example embodiments, will be discussed in further detail below.

[0023] Figures 6 and 7 schematically depict a main-body of a mortar bomb (10) according to an example embodiment. As with all, typical mortar bombs, the mortar bomb (10) of Figure 6 has an obturating ring groove (12) for accommodating, in use, an obturating ring. Upstream of that ring groove (12), at one end of the mortar bomb (10) is a nose (14) of the mortar bomb (10). At an opposite end of the main body, remote from the nose (14), is a tail (16) of the mortar bomb (10). Although not shown in the Figures, the tail (16) typically defines, is, or is attached to, one or more fins for stabilising the mortar bomb (10) during flight.

[0024] The nose (14) of the mortar bomb (10) might be, or comprise (e.g. house) a fuze. The nose (14) might be attached or attachable to, or part of, the main body of the mortar bomb (10). That is, the nose (14) and main body may not be formed integrally with one another.

[0025] In accordance with example embodiments, regions upstream (18) of the ring groove (12), toward the nose (14), and downstream (20) of the ring groove (12), toward the tail (16) have been re-designed or re-shaped to reduce drag.

[0026] Figures 8 and 9 schematically depict principles associated with a maximum diameter of a mortar bomb according to an example embodiment, in standard and outline views respectively. As discussed previously with respect to existing mortar bombs, the mortar bomb according to example embodiments will, of course, have a diameter (22) which will reach a maximum (24). What is different, however, with the mortar bomb according to an example embodiment, is that the maximum diameter (24) does not occur (i.e. is not located) at the obturating ring groove (12), but is instead located upstream of the obturating ring groove (12), towards the nose of the mortar bomb.

[0027] The difference in profile of the main body with respect to the location of the maximum diameter (24) of the mortar bomb is subtle but extremely important. It has been found that this subtle but fundamental change in the profile of the mortar bomb has a significant effect on the air pressure profile in the vicinity of the mortar bomb during its trajectory. In particular, it has been found that the air pressure shock is moved upstream of the ring groove (12), significantly reducing air pressure drag. While the shock is indeed moved upstream, the fact that the shock is allowed to form on a continuous body geometry, rather than the sudden change associated with the groove (12), is what causes the reduction in drag to be so pronounced.

[0028] It would appear that moving the maximum diameter upstream of the ring groove does, in general, result in a reduction in drag (at least to a certain extent). It

has, however, been found that this effect is even more pronounced and even optimised when the location of the maximum diameter of the main body of the mortar bomb is located upstream of the obturating ring groove by distance of substantially 0.3 to $0.4 \times a$ (typical) calibre of the mortar bomb, and more particularly when the maximum diameter is 0.3 to $0.4 \times a$ (typical) calibre of the mortar bomb upstream of an edge of the obturating ring groove that is closest to the nose of the mortar bomb.

[0029] Of course, in existing mortar bombs, the maximum diameter of the main body is at the same location as the obturating ring groove. In contrast, in example embodiments, the diameter at or of the obturating ring groove will be different to the maximum diameter of the main body of the mortar bomb. The exact differences between these obturating ring groove diameters and maximum diameters will vary depending on the overall profile of the mortar bomb, to achieve a reduction in drag. However, it has been found that drag reduction might be optimised when a difference in diameter between the maximum diameter of the main body, and a diameter at the obturating ring groove, is 0.01 to $0.015 \times a$ (typical) calibre of the mortar bomb. This is found to be particularly the case when this comparison is implemented when the diameter at the obturating ring groove is a diameter at the greatest radial extent of the ring groove (i.e. the diameter of the mortar bomb at the peak of the groove, as opposed to the trough).

[0030] Re-designing or re-shaping the profile of the mortar bomb upstream of the ring groove as discussed above has been found to lead to a reduction in drag. However, the rear section of the mortar bomb according to example embodiments, downstream of the ring groove and towards the tail of the mortar bomb, can also be re-designed or re-shaped to reduce or further reduce drag.

[0031] Figure 10 shows a comparison between profiles, downstream of the ring grooves (4, 12) of an existing profile (26), and a profile according to an example embodiment (28). In general terms, Figure 10 shows that the downstream or rear section of example embodiments has been altered to have a generally shallower gradient extending away and down from the ring groove (12), towards the tail (16). This is to the extent that a gradient of the main body profile, substantially in-between the ring groove (12) and the tail (16) (i.e. substantially at and/or around a mid-point (29) between the ring groove (12) and the tail (16)) is greater than a gradient of a substantially straight line theoretically extending between the ring groove and the most upstream section of the tail. The rear profile of an existing mortar bomb, downstream of the ring groove (4) typically extends in such a linear manner

[0032] Figure 11 shows an exploded view of Figure 10 that focuses on the vicinity of the ring groove (4, 12). Compared with the more linearly extending profile of the existing mortar bomb (26), it can be seen that the profile of the main body of example embodiments (28), downstream of the ring groove (12) and immediately adjacent

to the ring groove (12), extends substantially axially with respect to a longitudinal axis of the mortar bomb. This same Figure also shows how the existing profile gradient (26) is more linear, and has a far steeper gradient, immediately extending away from the ring groove (4), than the shallower gradient of the profile (28) of example embodiments that extends from the ring groove (12). This example embodiment profile (28) feature, again, reduces drag.

[0033] Figure 12 shows an exploded view of the comparison of Figure 10, but now in the vicinity of where the main body of the mortar bomb meets the tail (16) of the mortar bomb. It can be seen that the profile (26) of the existing mortar bomb extends substantially linearly towards and into angled adjoinment with the tail (16). The tail (16), as is typical, extends substantially axially in respect to the longitudinal axis of the mortar bomb. In stark contrast with the existing profile (26), it can be seen that a gradient of the main body profile (28) of example embodiments is curved to meet and blend with the profile of the tail. This example embodiment profile (28) feature, again, reduces drag.

[0034] Each of the changes in profile discussed in Figures 10 to 12 have been found to contribute to reduce drag by encouraging boundary layer adhesion along the full length of the main body downstream of the ring groove. In combination, then, each of these changes leads to an even more significant reduction in drag. A key aspect is that the gradient of the bomb profile before and after the obturating ring groove is as similar as possible, to reduce drag. This is made much easier by not having the obturating ring groove at the maximum diameter.

[0035] Figure 13 shows the pressure profile surrounding the mortar bomb (10) of example embodiments, during a flight trajectory of the mortar bomb (10). It can be seen that the highest pressure region, or shock (30), is no longer located at the location of the obturating ring groove (12), but has moved upstream of the obturating ring (12) towards the nose of the mortar bomb (10). In particular, the shock (30) will still be located at or near the largest diameter of the main body, but in accordance with example embodiments, this largest diameter is away from, not at, the location of the ring groove (12). Overall, drag is significantly reduced. The changes to the profile downstream of the ring groove (12) work synergistically with this change in location of maximum diameter, to reduce drag even further.

[0036] Figure 14 is included simply to easily show the comparison of the pressure profiles with the existing mortar bomb (2) and the re-shaped or re-designed mortar bomb (10) according to example embodiments. Again, it can be seen that drag is significantly reduced with the mortar bomb (10) of example embodiments, as discussed above. The shock (3, 30), in particular, is significantly reduced in accordance with example embodiments (30).

[0037] It has been found that the most significant factor

in the reduction of drag is the change of the location of the largest diameter of the main body of the mortar bomb, as discussed above. Changes to the shape of the mortar bomb downstream of the ring groove are perhaps less significant, but nevertheless also reduce drag. The changes downstream of the obturating ring groove might be used to reduce drag in isolation (i.e. separately to or independent of changes upstream of the groove), but it has been found in simulations that the changes upstream and downstream of the ring groove work in a synergistic manner to achieve a more significant reduction in overall drag of the mortar bomb. That is, while the changes can reduce drag in isolation, the combined effects are greater than simply the addition of individual contributions.

[0038] It has been found that the above principles are consistently advantageous for mortar bombs of different calibres, for example 51mm, 74mm, 75mm, 81mm, and 120mm, and in particular those in the range of 74-81 mm. The above principles also appear to extend to sub-calibre mortar bombs, where the mortar bomb has a main body diameter, or main diameter in general, which is inferior (less than) an internal diameter of the barrel or tube from which the mortar bomb is, or is to be, fired.

[0039] Overall, it is perhaps counter-intuitive to completely redesign the profile of a mortar bomb in order to reduce its drag, in order to reduce the effects of over-pressure on people or objects around a firing location of such a mortar bomb. Similarly, it is perhaps counter-intuitive to completely redesign the profile of a mortar bomb in order to reduce its drag, to make it easier to operate the firing of the mortar bomb, or to make it easier to work in the environment of such firing. In contrast, a more typical approach might be to simply increase or maintain existing safety equipment or procedures around that firing location, for example high specification goggles, ear defenders, or shielding. From another perspective, an alternative solution would be to reduce the firing, sacrificing range.

[0040] Of course, the invention has further benefits, in that if a given charge for firing a mortar is not reduced, the mortar described above will have an increased range. Also, it will be appreciated that the mortar as described above can be used with existing firing apparatus. That is, the firing apparatus does not have to be re-designed or otherwise modified to accommodate the firing of the new mortar bomb discussed above, while still enjoying the described benefits.

[0041] The invention relates generally to a mortar bomb. However, the invention relates perhaps most specifically to a main body of such a mortar bomb. So, the main body as described above could be used with, and attached to, existing noses or even tails.

[0042] For the avoidance of any doubt, an "obturating ring" as used herein is typically a ring of relatively soft material designed to obturate under pressure to form a seal. Obturating rings are often found in artillery and other ballistics applications. The "ring groove" described herein is typically continuous around a circumference of the

mortar bomb, but in some examples could be substantially continuous, or discontinuous (e.g. comprise one or more interruptions), such that the "obturating ring groove" is a groove that generally extends around the circumference of the mortar bomb in a ring-like manner. Changes in the diameter of the main body, or changes in location of the maximum diameter of the main body, may be such that an existing obturating ring (suitable for a non-modified/re-designed main body/mortar bomb) may still be suitably used. However, a different obturating ring can be used (e.g. one with a different inner and/or outer diameter) if changes in the diameter of the main body, or changes in location of the maximum diameter of the main body, are such that the existing obturating ring does not function as intended.

[0043] Although a few preferred embodiments have been shown and described, it will be appreciated by those skilled in the art that various changes and modifications might be made without departing from the scope of the invention, as defined in the appended claims.

[0044] Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0045] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0046] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0047] The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A mortar bomb, comprising:

- a main body;
- a nose;
- a tail extending from the main body, away from the nose;
- an obturating ring groove for accommodating, in use, an obturating ring, the obturating ring

groove being located in the main body;
wherein a maximum diameter of the main body
is upstream of the ring groove, toward the nose.

in use, an obturating ring;
wherein a maximum diameter of the main body
is upstream of the ring groove.

2. The mortar bomb of claim 1, wherein the maximum diameter of the main body is located upstream of the ring groove by a distance of substantially 0.3 to 0.4 times a calibre of the mortar bomb. 5
3. The mortar bomb of claim 1 or claim 2, wherein the maximum diameter of the main body is located upstream of an edge of the ring groove closest to the nose, by a distance of 0.3 to 0.4 times a calibre of the mortar bomb. 10
4. The mortar bomb of any preceding claim, wherein a difference in diameter between the maximum diameter of the main body, and a diameter at the ring groove, is 0.01 to 0.015 times a calibre of the mortar bomb. 15 20
5. The mortar bomb of claim 4, wherein the diameter at the ring groove is the diameter at the greatest radial extent of the ring groove. 25
6. The mortar bomb of any preceding claim, wherein immediately downstream of the ring groove, toward the tail, a profile of the main body initially extends substantially axially with respect to a longitudinal axis of the mortar bomb. 30
7. The mortar bomb of any preceding claim, wherein downstream of the ring groove, immediately adjacent to the tail, a profile of the main body is curved to meet and blend with a profile of the tail. 35
8. The mortar bomb of claim 7, wherein the profile of the tail immediately adjacent to the main body extends substantially axially with respect to a longitudinal axis of the mortar bomb. 40
9. The mortar bomb of any preceding claim, wherein downstream of the ring groove, a gradient of the main body profile, substantially in-between the ring groove and the tail, is greater than a gradient of a substantially straight line theoretically extending between the ring groove and the tail. 45
10. The mortar bomb of any preceding claim, wherein downstream of the ring groove, a gradient of the main body profile, substantially at a mid-point between the ring groove and the tail, is greater than a gradient of a substantially straight line theoretically extending between the ring groove and the tail. 50 55
11. A mortar bomb main body, comprising:

an obturating ring groove for accommodating,

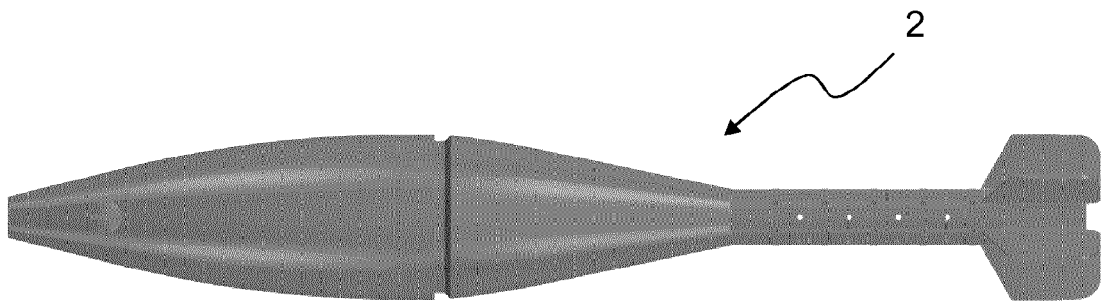


FIG. 1



FIG. 2

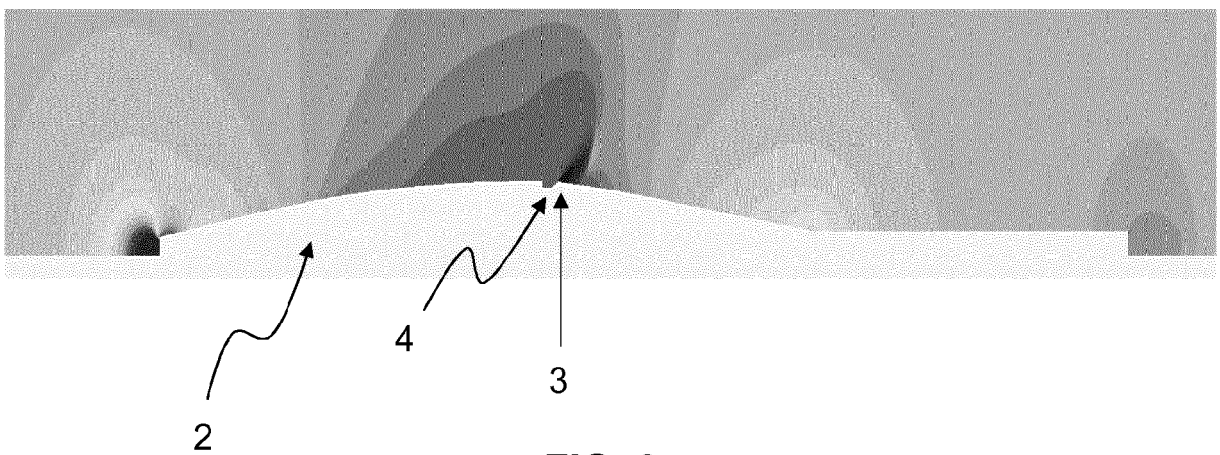


FIG. 3

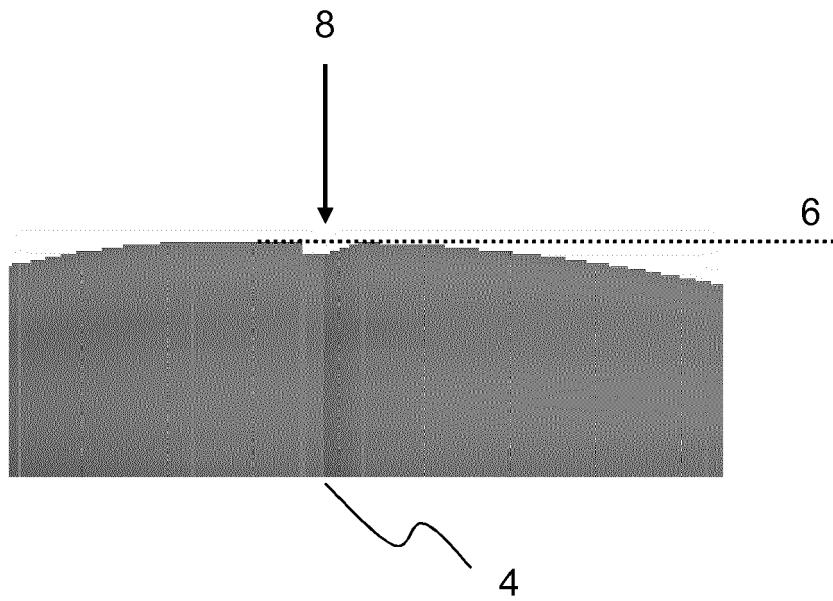


FIG. 4

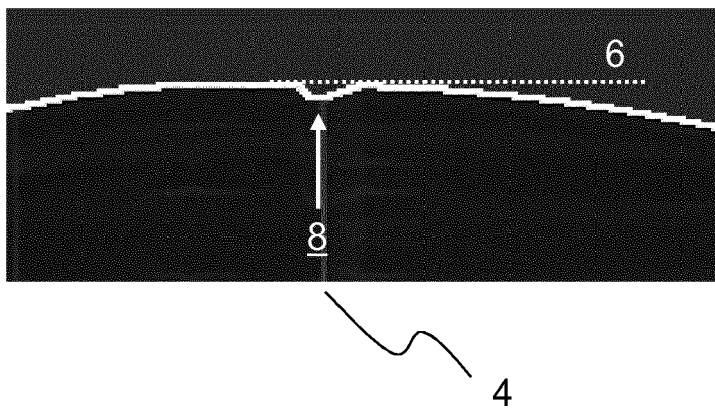


FIG. 5

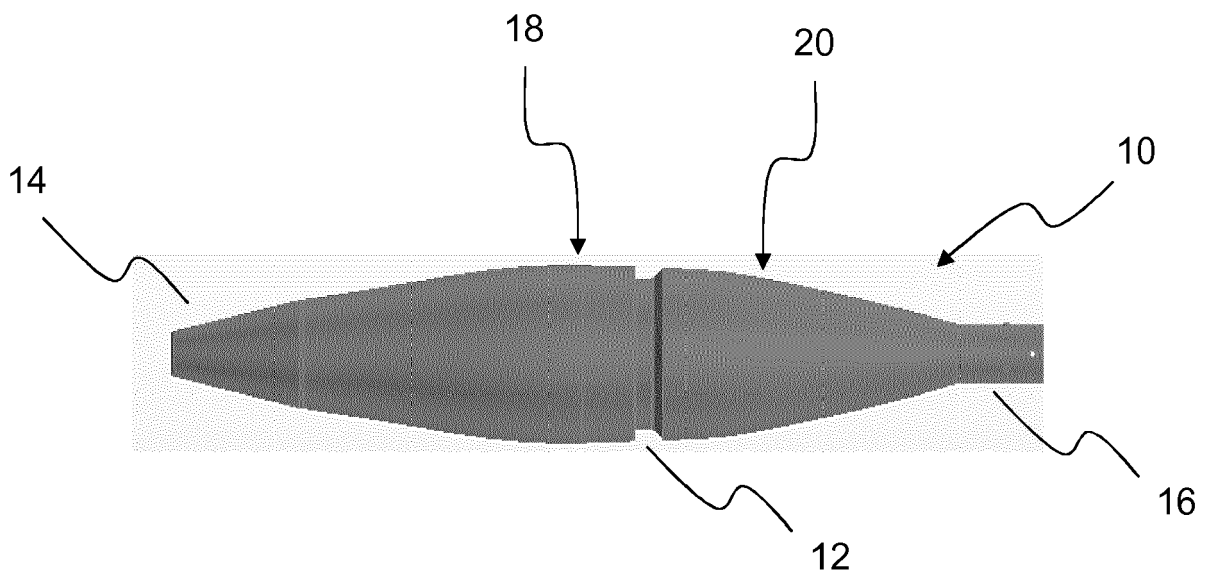


FIG. 6

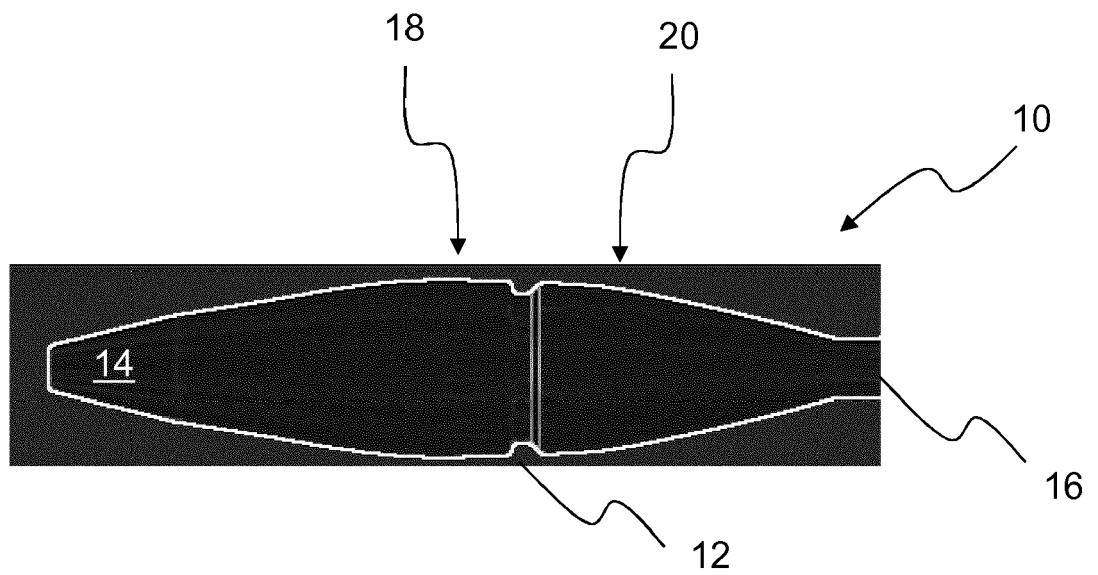


FIG. 7

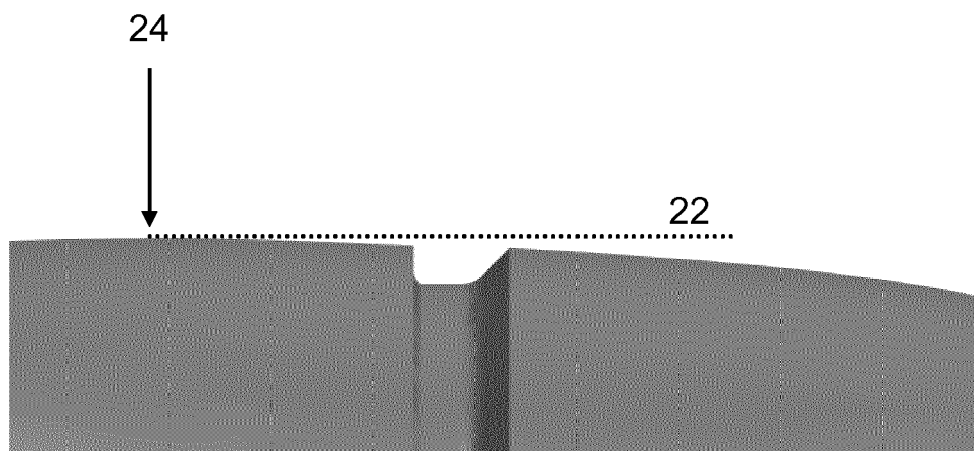


FIG. 8

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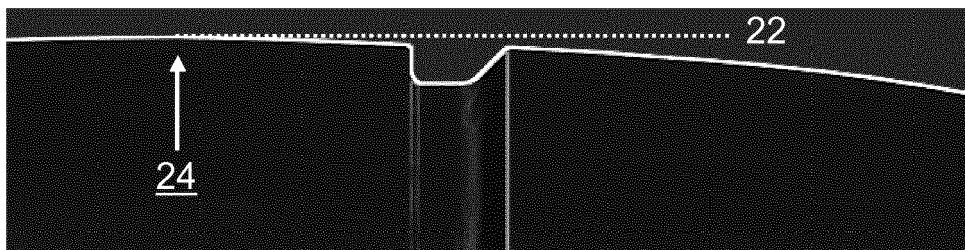


FIG. 9

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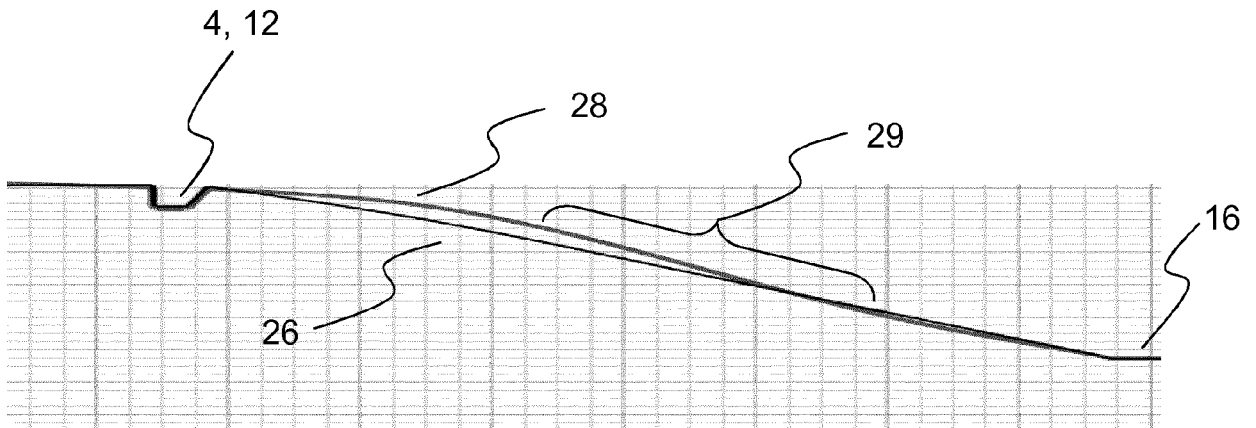


FIG. 10

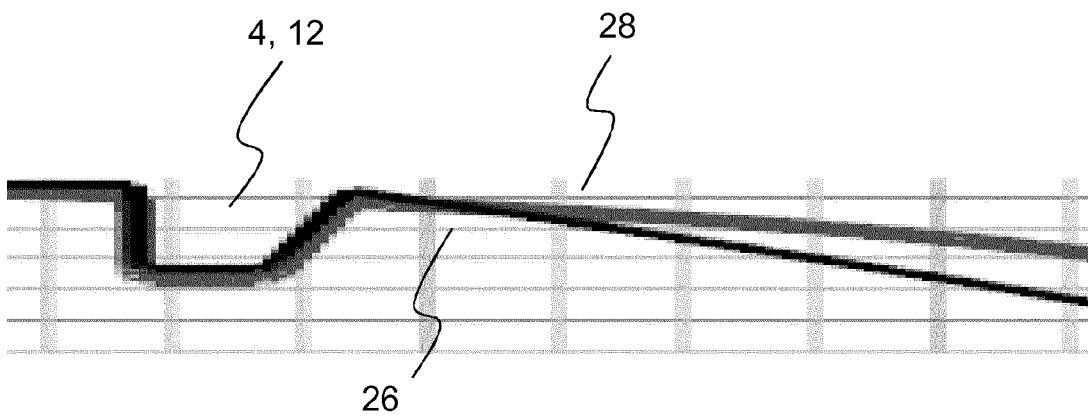


FIG. 11

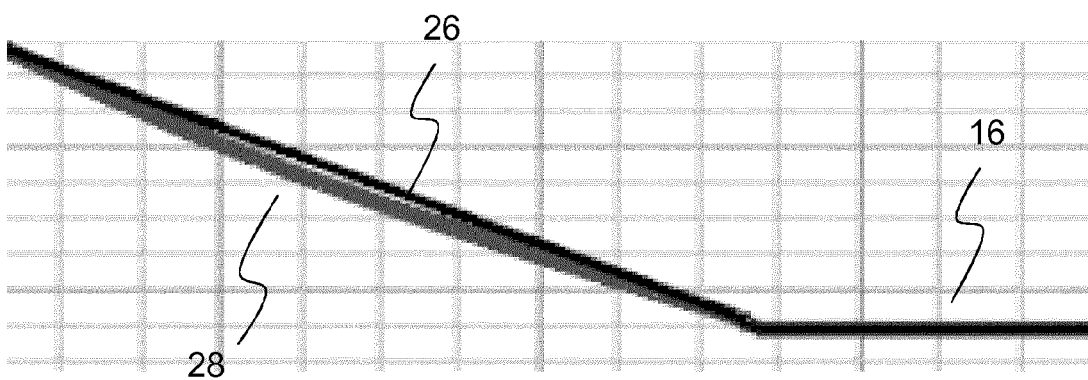


FIG. 12

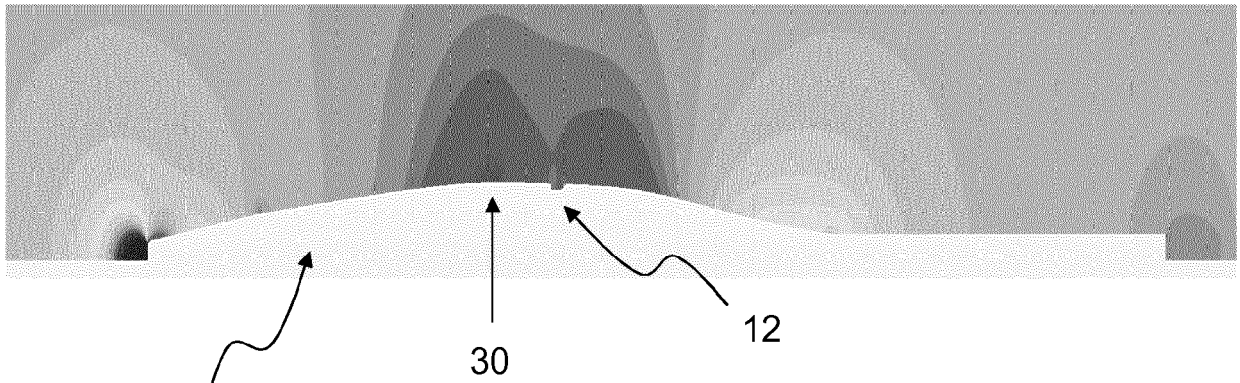


FIG. 13

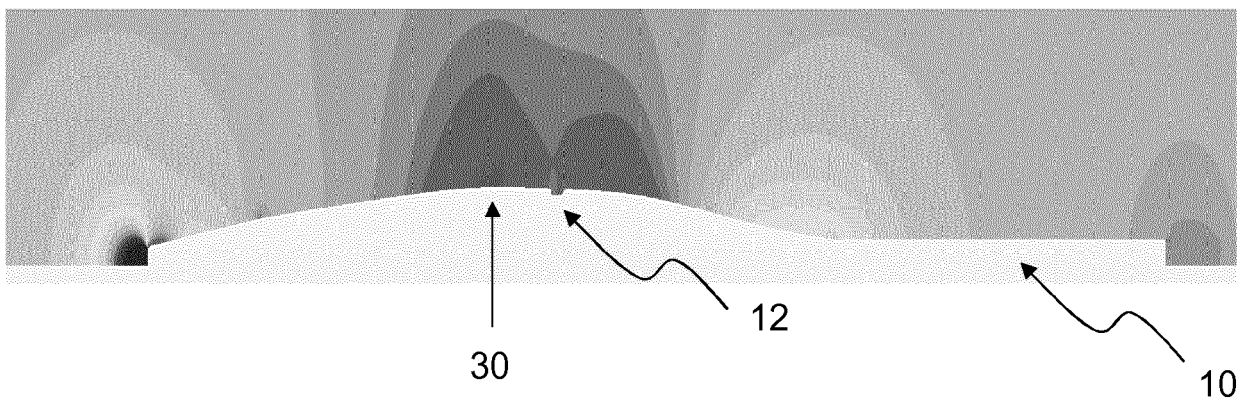
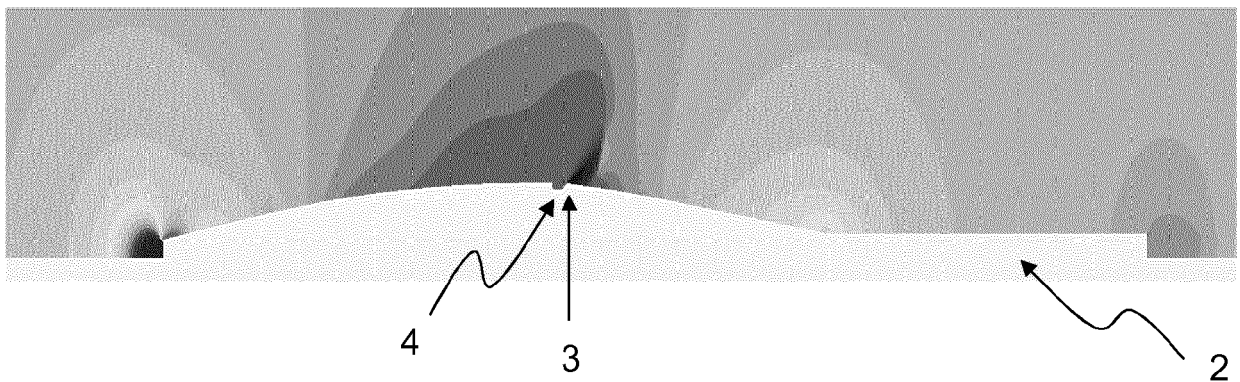


FIG. 14



EUROPEAN SEARCH REPORT

Application Number
EP 17 15 2022

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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	FR 774 170 A (MAURICE) 3 December 1934 (1934-12-03) * pages 1-2 * * figures 1-3 *	1-11	INV. F42B30/10
X	US 3 023 704 A (JOHN DAWSON PHILIP ET AL) 6 March 1962 (1962-03-06) * column 2, lines 27-62 * * figures 1-3 *	1-11	
X	GB 933 114 A (HOTCHKISS BRANDT) 8 August 1963 (1963-08-08) * page 2, lines 96-105 * * figures 1-2 *	1-11	
X	US 2 315 145 A (JEAN WAUTERS) 30 March 1943 (1943-03-30) * page 2, lines 42-45 * * figure 1 *	1-11	
X	US 4 413 567 A (FROSTIG AMOS [IL]) 8 November 1983 (1983-11-08) * abstract * * column 3, lines 33-35 * * figures 1-2 *	1-11	TECHNICAL FIELDS SEARCHED (IPC) F42B F41F
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 2 June 2017	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			

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 774170 A	03-12-1934	NONE	
US 3023704 A	06-03-1962	NONE	
GB 933114 A	08-08-1963	BE 605184 A1	16-10-1961
		CH 369683 A	31-05-1963
		DE 1148161 B	02-05-1963
		ES 269007 A1	01-01-1962
		FI 48304 B	30-04-1974
		FR 79793 E	25-01-1963
		FR 1270551 A	01-09-1961
		GB 933114 A	08-08-1963
		NL 266519 A	02-06-2017
		NL 6709693 A	25-09-1967
		US 3143074 A	04-08-1964
US 2315145 A	30-03-1943	BE 435707 A	02-06-2017
		CH 214639 A	15-05-1941
		FR 859381 A	17-12-1940
		GB 538712 A	14-08-1941
		NL 52634 C	02-06-2017
		US 2315145 A	30-03-1943
US 4413567 A	08-11-1983	BE 885108 A1	05-03-1981
		DE 2936408 A1	19-03-1981
		DK 378180 A	09-03-1981
		FI 802792 A	09-03-1981
		GB 2058303 A	08-04-1981
		IL 60972 A	29-06-1984
		NL 8004899 A	10-03-1981
		NO 147159 A	02-06-2017
		NO 802630 A	09-03-1981
		SE 442444 B	23-12-1985
		US 4413567 A	08-11-1983