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(54) **Loading method of an explosive device with controlled destructive capacity and corresponding explosive device**

(57) Method of loading an explosive device (4), used as an aerial bomb, comprising the steps of preparing a device body (8) which defines an inner cavity (12) and having, at opposite ends in a main axial direction (X-X), a bullet (14) and a closing cap (16), performing a partial filling of the cavity (12) of the device body (8) by means of an inert filler material (28) up to a predetermined level, performing a partial filling of the cavity (12) with an explosive charge (32) according to a predefined quantity, applying an encapsulating meniscus (36) between mutually facing surfaces (28', 32') of the inert filler material (28) and of the explosive charge (32) so as to prevent any contact between the explosive charge (32) and the inert filler material (28), - applying at least one firing fuse (40) positioned so as to guarantee the triggering of the explosive charge (32). The present invention also relates to an explosive device obtained using the loading method described.

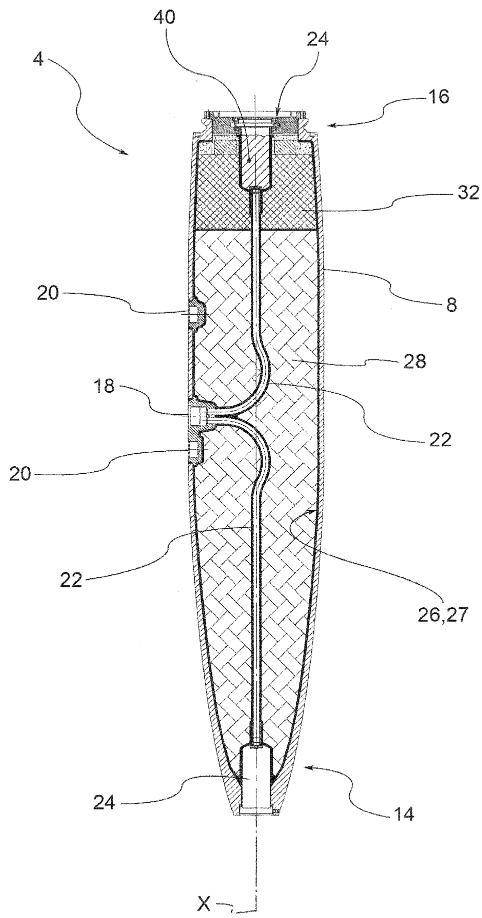

FIG.1

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Description

FIELD OF APPLICATION

[0001] The present invention relates to a loading method of an explosive device having a controlled destructive capacity and the relative explosive device.

STATE OF THE ART

[0002] As is known, current war scenarios require weapons characterised by extreme precision in hitting the targets and an effectively calibrated destructive capacity. In particular, the reduction of collateral damage, i.e. damage to people (civilians, allied troops nearby), to structures adjacent to a predefined target is a primary operating need.

[0003] Today's bombs, despite the accuracy of the relative targeting and guidance systems are unable to circumscribe the collateral effects spoken of, having been designed for different purposes.

PRESENTATION OF THE INVENTION

[0004] In the context of aerial bombs, in order to achieve these objectives in terms of collateral damage, it would be possible to have bombs of various sizes, containing different amounts of explosive. On the other hand, the qualification of a new bomb, especially with regard to the technical and safety studies and tests for interfacing with a given aircraft, guidance and firing fuse system, takes a long time and considerable financial resources.

[0005] The need is therefore felt to resolve the drawbacks and limitations mentioned with reference to the prior art.

[0006] This requirement is satisfied by a loading method of an explosive device according to claim 1 and by an explosive device according to claim 12.

DESCRIPTION OF THE DRAWINGS

[0007] Further characteristics and advantages of the present invention will be more clearly comprehensible from the description given below of its preferred and non-limiting embodiments, wherein:

figure 1 shows a cross-section view of an explosive device according to one embodiment of the present invention;

figures 2-7 represent cross-section views of subsequent steps of loading the explosive device in figure 1.

The elements or parts of elements common to the embodiments described below will be indicated using the same reference numerals.

DETAILED DESCRIPTION

[0008] With reference to the aforementioned figures, reference numeral 4 globally denotes a schematic overall view of an explosive device, such as an aerial bomb, according to the present invention.

[0009] The explosive device 4 comprises a bomb body 8 which defines a cavity 12 and having, at opposite axial ends, in a main axial direction X-X, a bullet 14 and a closing cap 16.

[0010] The bomb body 8 is preferably fitted with an armament well 18 and attachments 20 to a vector, typically an aircraft. The armament well 18 is usually connected by means of ducts or pipes 22 to one or more firing-fuse holders 24, in a known manner. When the bomb is fitted with the firing-fuse or the sensors, cables are made to pass inside said ducts or pipes 22.

[0011] Preferably, at an inner side wall 26 of the bomb body 8 which defines said cavity 12, a sealing layer 27 is applied. Said sealing layer 27 comprises for example, a first application of asphalt paint, to which a subsequent tar coating is applied.

[0012] Advantageously, the cavity 12 is at least partially filled by means of an inert filler material 28 up to a predetermined level, in other words, it is possible to predetermine the quantity of inert filler material with which fill at least partially the cavity 12.

[0013] It is possible to use various inert materials; preferably polymeric materials in liquid or semi-solid form are used which, once cross-linked, give a consistency similar to a hard rubber.

[0014] In particular, the use of inert materials in a liquid or semi-liquid state permits optimum coverage of the cavity 12 to be achieved; in fact, the force of gravity helps to level the inert charge 28, positioning the free surface of the liquid always parallel to the ground and optimally filling every crevice of the cavity; moreover the inert material 28 in liquid phase is able to adhere around the inner components of the cavity 12 filling them completely and avoiding the formation of voids.

[0015] Moreover, the cavity 12 is at least partially filled with an explosive charge 32 according to a predefined quantity; in other words the mass of the explosive charge 32 to equip the explosive device 4 with can be established. This way, as described further below, it is possible to predefine the destructive capacity of the explosive device 4 and thus limit at will, the collateral effects depending on the chosen objective.

[0016] As a result, the amount of explosive loaded in the bomb body can substantially be varied at will in order to determine a different destructive effect. The amount of explosive also determines how the bomb body 8 fragments, determining the number, size, weight and distance of body fragments originating during the explosion.

[0017] As explosive charges polymer-based explosives with specific mechanical characteristics are preferably used, in that once cross-linked they acquire a consistency similar to that of a hard rubber.

[0018] The presence of the sealing layer 27 is advantageous in that it prevents both the inert charge 28 and the explosive charge 32 from coming directly into contact with the inner side wall 26 of the bomb body 8 defining said cavity 12. This avoids oxidation/corrosion phenomena on the inner side wall 26 and, above all, helps to isolate both the inert charge 28 and the explosive charge 32 from the bomb body 8.

[0019] Advantageously, mutually facing free surfaces 28', 32' respectively of the inert filler material 28 and of the explosive charge 32 are separated by the interposition of an encapsulating meniscus 36, so as to prevent any contact between the explosive charge 32 and the inert filler material 28.

[0020] In particular, the encapsulating meniscus 36 is flexible so as to adapt to the mechanical deformation and thermal expansion of the explosive charge 32 due to accelerations and temperature variations respectively. In other words, during use, the explosive charge 32 is subject to continuous deformation due both to accelerations during transport and due to thermal changes. Thanks to the flexibility of the encapsulating meniscus 36 such deformations of the explosive charge 32 are supported by the encapsulating meniscus which is able to deform according to the geometrical variations of the explosive charge 32, ensuring that the latter is always properly encapsulated in all conditions. Moreover, the deformability of the encapsulating meniscus 36 prevents the explosive charge 32 from being subjected locally to excessive tensions on account of the aforementioned thermal and mechanical stresses.

[0021] Preferably, the material of the encapsulating meniscus 36 is a rubbery inert material, compatible with the explosive charge 32.

[0022] According to one embodiment, the material of the encapsulating meniscus 36 is the same as that of the sealing layer 27.

[0023] Preferably, the material of the encapsulating meniscus 36 is a polyurethane.

[0024] In particular, the encapsulating meniscus 36 has the function of adhering to the free surface of the explosive charge 32 so as to seal said charge and follow the volumetric variations and/or displacements of the mass of explosive charge 32 following mechanical and thermal stresses.

[0025] According to one embodiment, the inert filler material 28 is placed on the side of the bullet 14 and the explosive charge 32 is placed on the side of the closing cap 16.

[0026] Preferably, the inert filler material 28 and the explosive charge 32 have similar specific weights; for example, the difference between the specific weights of the inert filler material 28 and of the explosive charge 32 is less than 10%. Preferably said difference between the specific weights of the inert filler material 28 and of the explosive charge 32 is less than 4%.

[0027] Preferably, the inert filler material 28 and the explosive charge 32 have similar stiffness; for example, the difference between the stiffness of inert filler material 28 and of the explosive charge 32, measured in relation to the explosive charge 32, is less than 60%.

[0028] It is to be noted that in the solutions of the prior art such difference between the stiffness of the inert filler material 28 and of the explosive charge 32, measured in relation to the explosive charge 32 is at least an order of magnitude, and can also be of several orders of magnitude.

[0029] Preferably, the inert filler material 28 and the explosive charge 32 have similar impedances, where a material's impedance is defined as the product of the density (and thus the specific weight) of the material and the propagation speed of sound inside it.

[0030] Preferably, the impedances of the inert filler material 28 and the explosive charge 32 differ at most by 40%, this difference being measured relative to the impedance of the explosive charge 32.

[0031] It is to be noted that in the solutions of the prior art such difference between the impedances of the inert filler material 28 and of the explosive charge 32 is at least an order of magnitude, and can also be of several orders of magnitude.

[0032] It is to be noted that the impedance characterises the transmission of the shock wave in the material determining the speed transmitted to the bomb body 8 and thus the size and speed of the fragments of the latter at the time of the explosion. Thanks to the similarity in the impedance values of the inert filler material 28 and the explosive charge 32 the shock wave is less altered in the passage between the explosive 32 and inert material 28 and thus the correct and desired fragmentation of the bomb body 8 and speed of the relative fragments is achieved.

[0033] The explosive device 4 further comprises at least one firing fuse 40 positioned so as to guarantee the triggering of the explosive charge 32, in the known manner.

[0034] The loading of an explosive device according to the present invention will now be described

[0035] For the purposes of the present invention, the steps described below need not be executed in the exact order in which they are presented and described.

[0036] In particular, the bomb body 8 defining the inner cavity 12 which extends in the main axial direction X-X, between the bullet 14 and the closing cap 16, is prepared.

[0037] Preferably, the loading steps are carried out holding the bomb body 8 in a vertical position, i.e. so as to present the main axial direction X-X perpendicular to a support surface of the explosive device 4.

[0038] In other words, the loading is performed level with the bomb body 8 positioned vertically.

[0039] A step of coating the inner side wall 26 of the device body 8 which defines the cavity 12, with a layer of sealant 27 (figure 2) is then performed.

[0040] The partial filling of the cavity 12 of the bomb body 8 with an inert filler material 28 up to a predetermined chosen level (figures 3-4) then takes place.

[0041] The inert filler material must reproduce the inertial characteristics of the explosive (same density) but also the same characteristics of stiffness and impedance.

[0042] Preferably, the inert filler material 28 is placed on the side of the bullet 14 and the explosive charge 32 is placed on the side of the closing cap 16.

[0043] According to one embodiment, the loading step may take place in several stages, i.e. through a deposition of a first portion of inert material 28a (figure 3) followed by the deposition of a second portion of inert material 28b (figure 4); in other words, successive depositions are made of the inert material in the liquid phase. For example, the loading of the second portion of inert material is performed following the complete solidification of the first portion 28a.

[0044] The loading with inert filler material 28 is performed up to a certain level, determined according to the amount of residual volume that is to be left for the loading of explosive.

[0045] An encapsulating meniscus 36 is then applied to the free surface 28' of the portion of inert material 28 (figure 5).

[0046] In the case of starting with the loading of the explosive substance, then the application of the encapsulating meniscus 36 will be made initially on the free surface of 32' of the explosive charge 32 already deposited and cross-linked.

[0047] The partial filling of the cavity 12 with an explosive charge 32 according to a predetermined level (figure 6) follows; this way the explosive charge superposes the encapsulating meniscus 36 which is incorporated between the mutually opposite respective free surfaces 28', 32' of the inert material 28 and of the explosive charge 32.

[0048] Such meniscus thus prevents any contact between the explosive charge 32 and inert filler material 28.

[0049] Moreover, as seen, said encapsulating meniscus 36 flexible so as to adapt to the mechanical deformation and thermal expansion of the explosive charge 32 due to accelerations and temperature variations respectively, This way, thanks to the flexibility of the encapsulating meniscus 36, such deformations of the explosive charge 32 are supported by the encapsulating meniscus which can deform according to the geometrical variations of the explosive charge 32 ensuring that the latter is always properly encapsulated in all conditions. Moreover, the deformability of the encapsulating meniscus 36 prevents the explosive charge 32 from being subjected locally to excessive tensions on account of the aforementioned thermal and mechanical stresses.

[0050] The closing cap 16 is then closed, applying in advance at least one firing fuse 40 in contact with the explosive charge 32.

[0051] The loading of the explosive charge 32 is conducted reaching the customary level of loading for a standard bomb. This ensures that the firing fuse 40 located in the rear holder 24 is interfaced with the explosive in the same way thus guaranteeing the same reliability for the triggering.

[0052] Preferably between the closing cap 16 and the explosive charge at least one felt disc 44 is inserted which prevents direct contact between the explosive charge 32 and the closing cap 16.

[0053] The felt 44 guarantees an space containing air to allow the expansion of the explosive. For example, over the felt 44 a layer of sealant called thermosetting is applied which fills all the spaces sealing both the explosive charge 32 and said felt 44; the felt 44 is not in contact with the closing cap 16.

[0054] As may be appreciated from the description, the present invention makes it possible to overcome the drawbacks mentioned of the prior art.

[0055] In particular, the bomb body according to the present invention is not changed: the bomb has all the geometric and interface characteristics of a standard bomb loaded with explosive inside, while presenting a variable explosive charge according to the specific requirements as needed.

[0056] This simplifies the interfacing process with the aircraft, the guidance and tail control kits, firing fuses already in service for this bomb, allowing the extension of existing certificates and approvals.

[0057] The same bomb body can be loaded with different percentages of inert material and explosive, making it possible to vary the destructive effect of the bomb and making it possible to destroy several targets and to minimise collateral damage.

[0058] As seen, the materials chosen for the inert charge and for the explosive charge are mechanically compatible with each other, so as to have the same physical and mechanical characteristics, the same inertial and vibratory and thus ballistic behaviour as a bomb fully loaded with an explosive substance.

[0059] In particular, as seen, the inert filler material and the explosive charge have similar specific weights and similar stiffness: this way they have similar mechanical, inertial and vibratory behaviour

[0060] In addition, the inert filler material and the explosive charge have similar impedances, where a material's impedance is defined as the product of the density (and thus the specific weight) of the material and the propagation speed of sound inside it. As seen the impedance characterises the transmission of the shock wave in the material determining the speed transmitted to the bomb body and thus the size and speed of the fragments of the latter at the time of the explosion. Thanks to the similarity in the impedance values of the inert filler material and the explosive charge the shock wave is less altered in the passage between the explosive and inert material and thus the correct and desired fragmentation of the bomb body and speed of the relative fragments is achieved.

[0061] The loading of explosive also complies with the load levels used in a bomb loaded with explosive only, ensuring the correct functioning of the rear triggering fuse.

[0062] The rearward placement of the explosive charge, i.e. on the side of the closing cap, on the other hand limits the number of fragments of the bomb body following the explosion and on the other concentrates the distribution of said fragments; consequently the placement in the tail of the explosive charge is used to control the falling range of bomb body fragments, in order to have a further limitation and control of collateral damage.

[0063] The explosive charge is advantageously encapsulated both on the inner side wall of the bomb body and at the separation meniscus from the charge of inert material.

[0064] This way the explosive charge is always covered and encapsulated as well as separated by a layer of sealant which protects it from moisture and corrosion. The action of the explosive charge remains unchanged over time, even after long periods of storage/stowage.

[0065] In addition, the meniscus is able to slide axially with the explosive charge, on the bitumen or waterproof paint covering the inner lateral surface of the bomb body. This aspect is a further advantage given that the masses of the inert charge and the explosive charge inevitably present differences of thermal expansion; this way the meniscus, sliding on the interior paint, is able to 'follow' the displacement of the explosive charge so as to always guarantee a perfect sealing of the explosive charge and thus its integrity and reliability over time.

[0066] In particular, the encapsulating meniscus meniscus is flexible so as to adapt to the mechanical deformation and thermal expansion of the explosive charge due to accelerations and temperature variations respectively,

[0067] A person skilled in the art may make numerous modifications and variations to the loading methods and bomb bodies described above so as to satisfy contingent and specific requirements while remaining within the sphere of protection of the invention as defined by the following claims.

Claims

1. Method of loading an explosive device (4), used as an aerial bomb, comprising the steps of:

   - preparing a device body (8) which defines an inner cavity (12) and having, at opposite ends in a main axial direction (X-X), a bullet (14) and a closing cap (16),
   - performing a partial filling of the cavity (12) of the device body (8) by means of an inert filler material (28) up to a predetermined level,
   - performing a partial filling of the cavity (12) with an explosive charge (32) according to a predefined quantity,
   - applying an encapsulating meniscus (36) between mutually facing surfaces (28', 32') of the inert filler material (28) and of the explosive charge (32) so as to prevent any contact between the explosive charge (32) and the inert filler material (28), wherein said encapsulating meniscus (36) is flexible so as to adapt to the mechanical deformation and thermal expansion of the explosive charge (32) due to accelerations and temperature variations respectively,
   - applying at least one firing fuse (40) positioned so as to guarantee the triggering of the explosive charge (32).
   - applying, to an inner side wall (26) of the device body (8) which defines said cavity (12), a layer of sealant (27).

2. Loading method (4) according to claim 1, wherein said sealing layer (27) comprises an asphaltic paint and a tar coating.

3. Loading method (4) according to any of the previous claims, wherein the material of the encapsulating meniscus (36) is the same as that of the sealing layer (27).

4. Loading method (4) according to any of the previous claims, wherein the material of the encapsulating meniscus (36) is a polyurethane.

5. Loading method (4) according to any of the previous claims, wherein the inert filler material (28) is placed on the side of the bullet (14) and the explosive charge (32) is placed on the side of the closing cap (16).

6. Loading method (8) according to any of the previous claims, wherein the loading provides for a first step of filling the device body (8) with the inert filler material (28), the application of the encapsulating meniscus (36) to the filled free surface (28') of the inert filler material (28) and the subsequent loading of the explosive charge (32) in direct contact with the encapsulating meniscus (36).

7. Loading method (8) according to any of the previous claims, wherein said loading takes place with the device body (8) placed in a vertical position, so as to present the main axial direction (X-X) perpendicular to a support plane of the explosive device (4) and wherein the filling step of the inert filler material (28) takes place by means of successive deposits of the inert material in the liquid phase.

8. Loading method (8) according to any of the previous claims, wherein the inert filler material (28) and the explosive substance (32) have specific weights which differ by a deviation of less than 10%.

9. Loading method (8) according to any of the previous claims, wherein the inert filler material (28) and the explosive substance (32) have specific weights

which differ by a deviation of less than 4%.

10. Loading method (8) according to any of the previous claims, wherein the inert filler material (28) and the explosive substance (32) have specific respective stiffness which differ by a deviation of less than 60%, said deviation being measured in relation to the explosive substance (32).

11. Loading method (8) according to any of the previous claims, wherein the inert filler material (28) and the explosive substance (32) have respective impedances which differ by a deviation of less than 40%, said deviation being measured in relation to the impedance of the explosive substance (32) wherein the impedance of a material is taken to mean the product of the density of the material and the speed of propagation of sound inside it.

12. Explosive device (4) comprising a device body (8) which defines a cavity (12) and having, at opposite axial ends, in a main axial direction (X-X), a bullet (14) and a closing cap (16),

- the cavity (12) being at least partially filled by means of an inert filler material (28) up to a predetermined level,
- the cavity (12) being at least partially filled with an explosive charge (32) according to a predefined quantity,
- wherein mutually facing surfaces (28', 32') of the inert filler material (28) and of the explosive charge (32) are separated by the interposition of an encapsulating meniscus (36), so as to prevent any contact between the explosive charge (32) and the inert filler material (28), wherein said encapsulating meniscus (36) meniscus is flexible so as to adapt to the mechanical deformation and thermal expansion of the explosive charge (32) due to accelerations and temperature variations respectively,
- the device (4) comprising at least one firing fuse (40) positioned so as to guarantee the triggering of the explosive charge (32).
- wherein, at an inner side wall (26) of the device body (8) which defines said cavity (12), a sealing layer (27) is applied.

13. Explosive device (4) according to claim 12, wherein the inert filler material (28) is placed on the side of the bullet (14) and the explosive charge (32) is placed on the side of the closing cap (16).

14. Device (4) according to claims from 12 to 13, wherein the inert filler material (28) and the explosive substance (32) have specific weights which differ by a deviation of less than 10%.

15. Device (4) according to any of the claims from 12 to 14, wherein the inert filler material (28) and the explosive substance (32) have specific respective stiffness which differ by a deviation of less than 60%, said deviation being measured in relation to the explosive substance (32).

16. Device (4) according to any of the claims from 12 to 15, wherein the inert filler material (28) and the explosive substance (32) have respective impedances which differ by a deviation of less than 40%, said deviation being measured in relation to the explosive substance (32) wherein the impedance of a material is taken to mean the product of the density of the material and the speed of propagation of sound inside it.

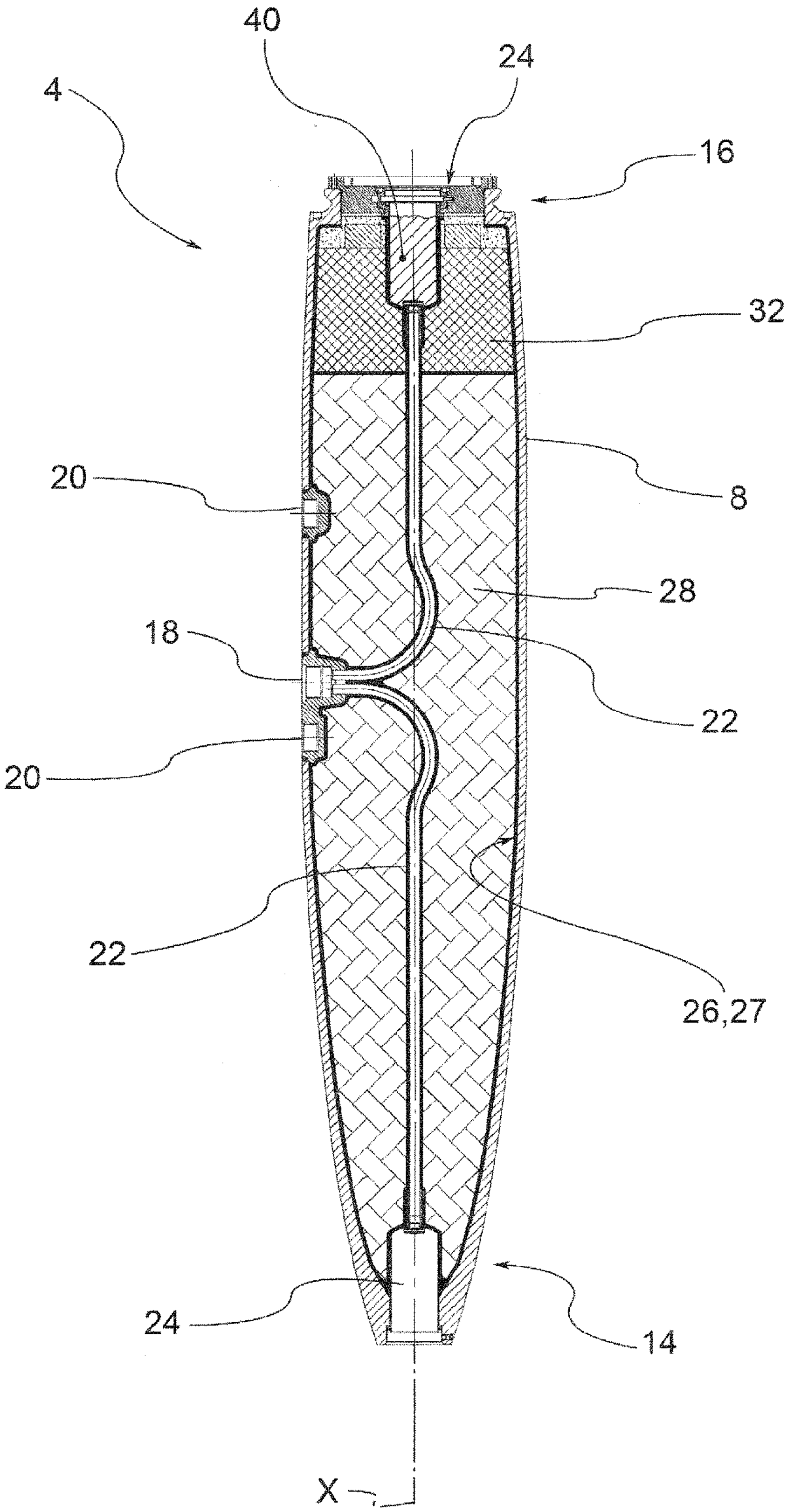

FIG.1

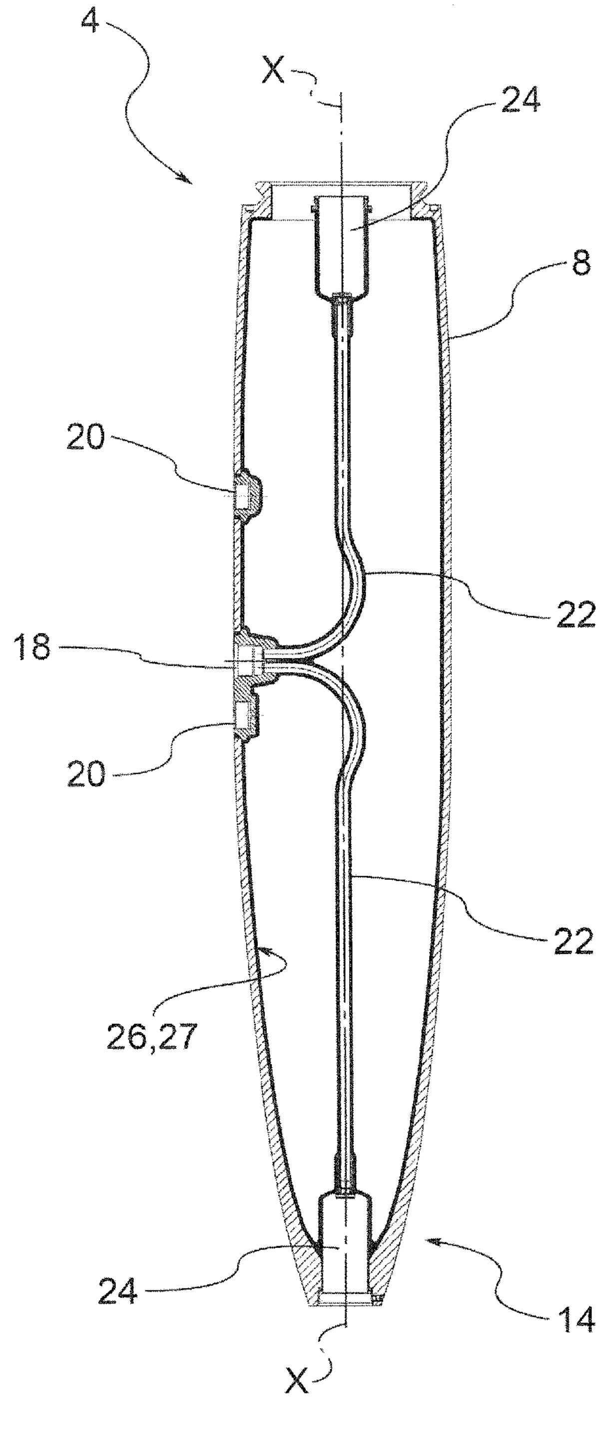

FIG.2

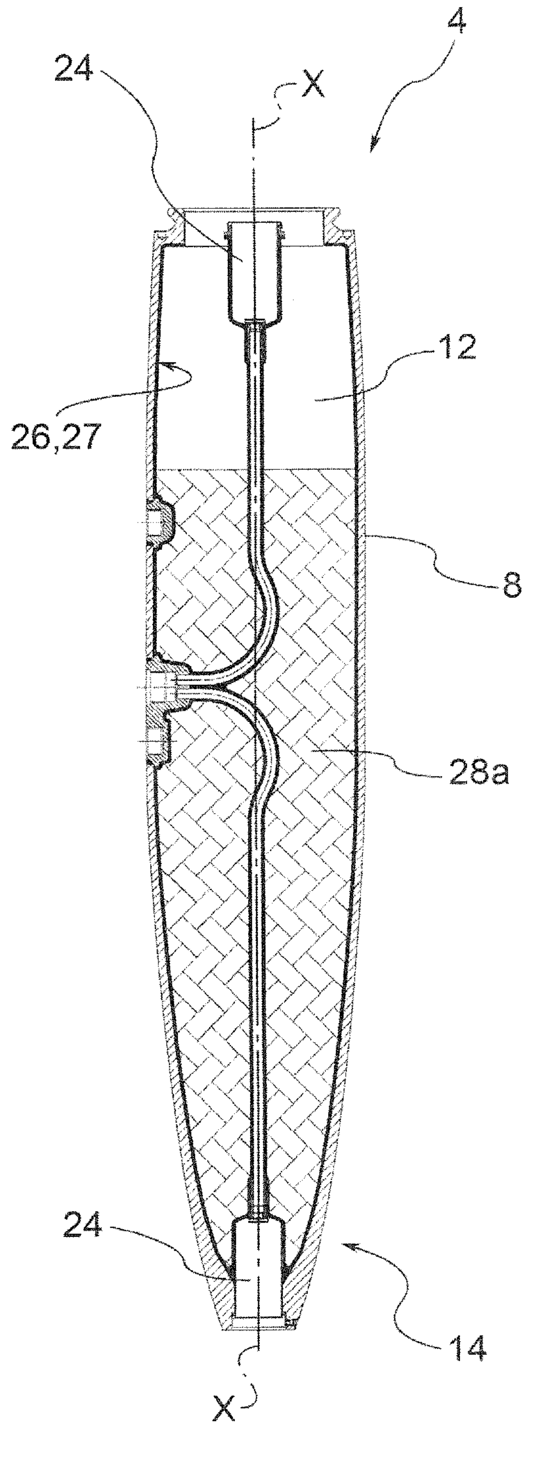

FIG.3

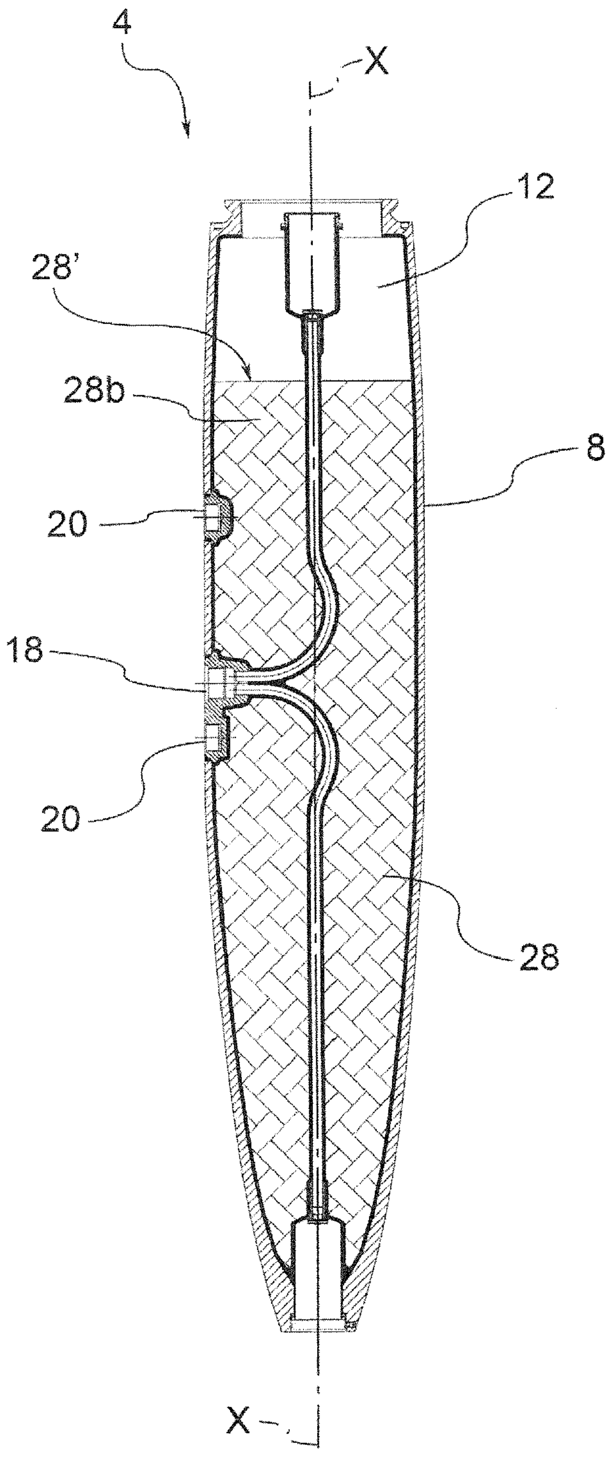

FIG.4

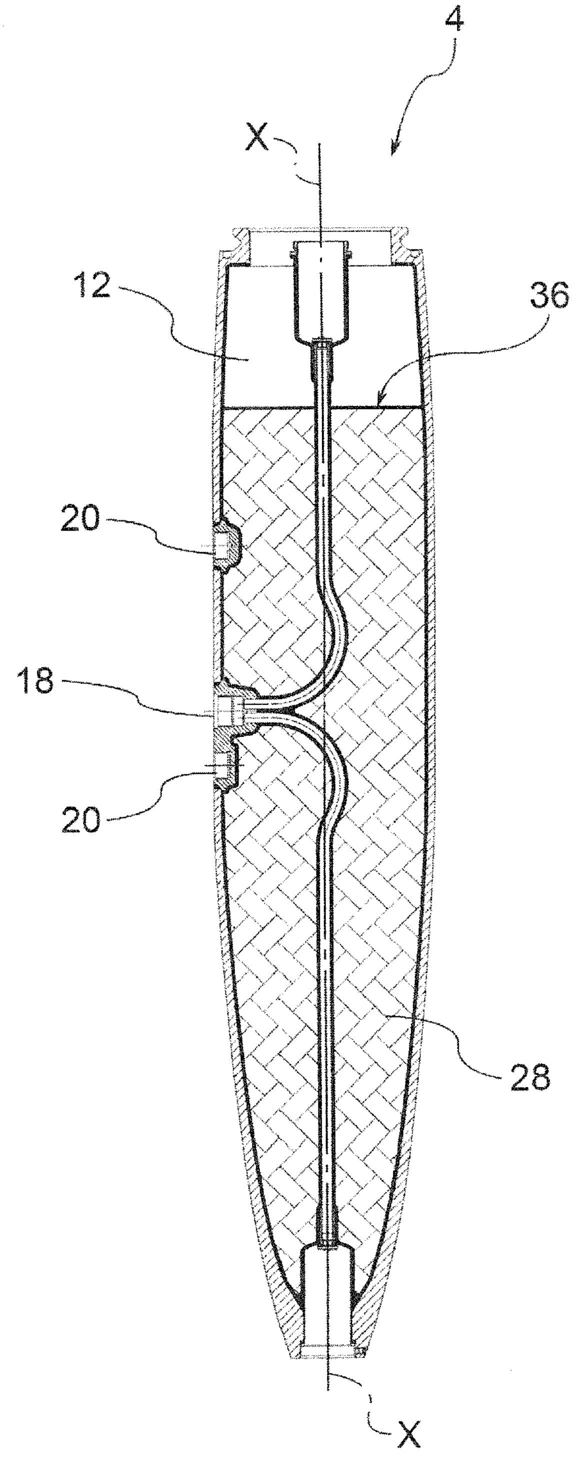

FIG.5

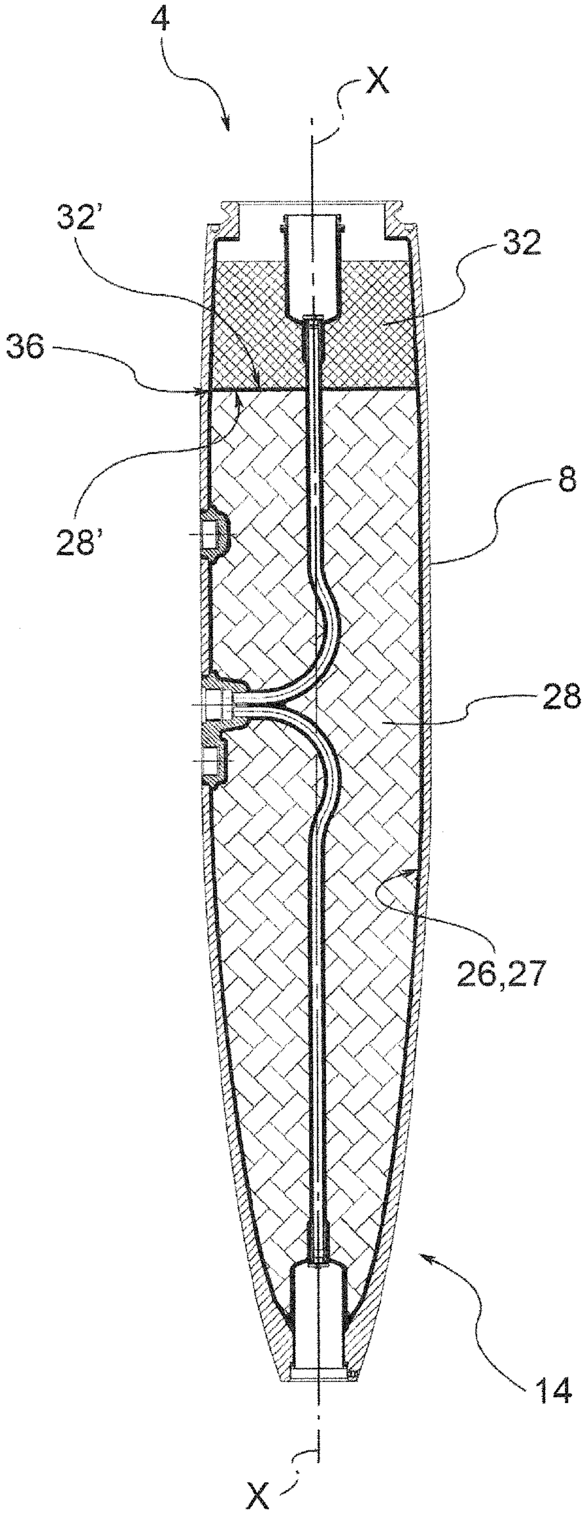

FIG.6

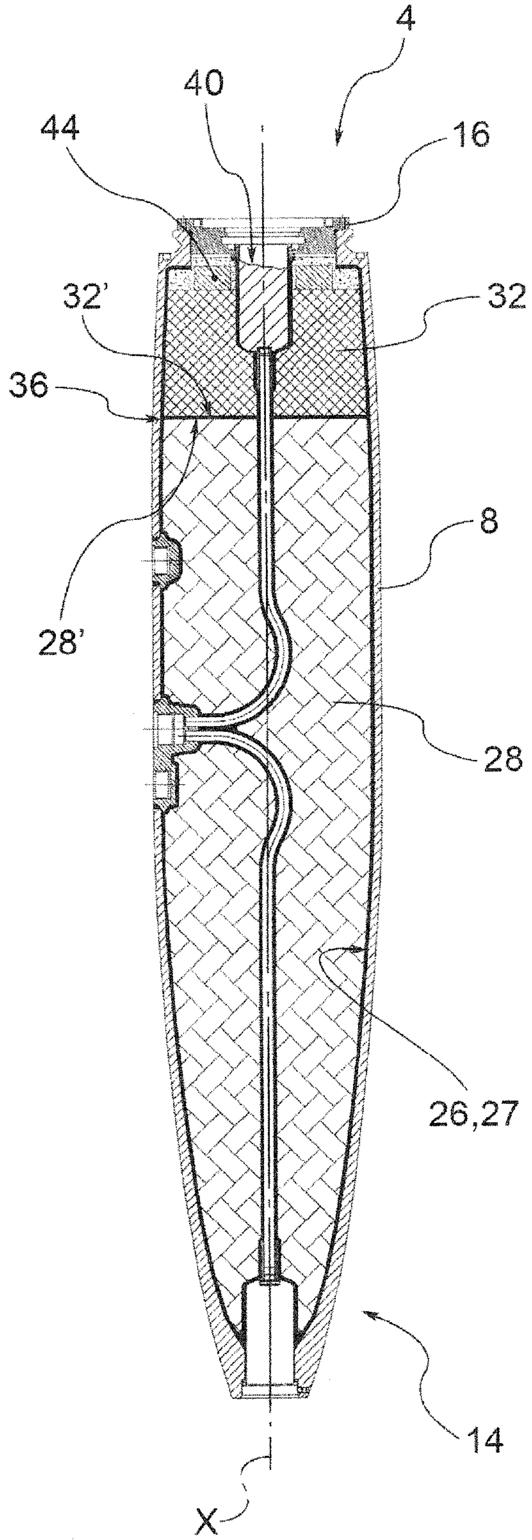

FIG.7

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EUROPEAN SEARCH REPORT

Application Number
EP 14 18 8995

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	5 February 2015	Gex-Collet, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 14 18 8995

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