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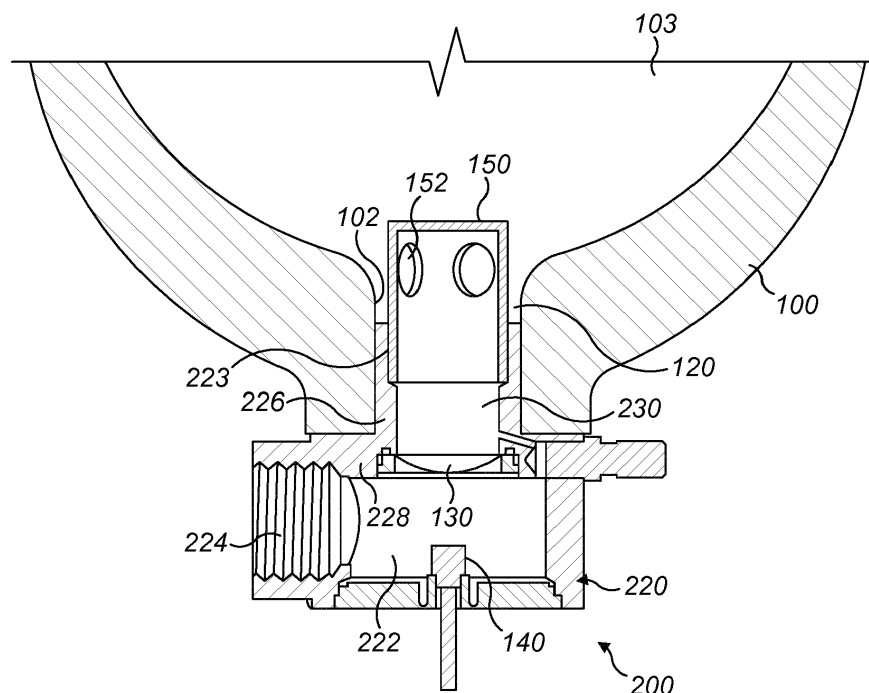
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(54) **FIRE SUPPRESSANT APPARATUS**

(57) There is provided an apparatus comprising:
 a container 100 for holding a fire suppressant;
 a valve sealing said container 100 and comprising a diaphragm 130 configured to perforate so as to release fire suppressant from said container 100, wherein said fire

suppressant exerts a force on said diaphragm 130 in use;
 a pyrotechnic charge 140 for perforating said diaphragm 130;
 a device 150 configured to reduce the force exerted by said fire suppressant on said diaphragm 130 in use.

**FIG. 2A****EP 3 072 556 A1**

Description

[0001] The present disclosure generally relates to an apparatus comprising a container for holding fire suppressant, and a valve for sealing a container holding a fire suppressant powder.

BACKGROUND

[0002] Fire suppressant, in particular powder fire suppressant, is typically held in a pressurised container until such time that it is required to be deployed into an environment. A valve may be placed at an outlet of the container to prevent premature deployment of the suppressant, which valve may be activated by use of a pyrotechnic charge as discussed below. An example of such a container and valve arrangement is shown in Figs. 1A-1C.

[0003] Fig. 1A shows a container 10 for holding a fire suppressant at a raised pressure, and a valve 20 for controlling the release of the fire suppressant into an environment (not shown).

[0004] Fig. 1B shows a cross-section of the container 10 and valve 20 through line A-A in Fig. 1. The operative orientation of the container is such that the valve 20 is located at the bottom of the container in use. Thus, it can be seen that in operation the fire suppressant 1 is held within the container and rests on the valve 20 due to gravity.

[0005] Fig. 1C shows a close up of the valve 20 (indicated at "B" in Fig. 1 B) which comprises a hollow valve body 22 that is located inside an outlet 12 of the container 10. A rupturable diaphragm 30 is located within the valve body 22 and acts to seal the container 10 to prevent pressurised fire suppressant from escaping prematurely.

[0006] A pyrotechnic charge 40 is located inside the valve 20 and below the diaphragm 30. Upon actuation of the pyrotechnic charge 40 a shockwave or localised blast is directed onto the centre of the diaphragm 30. This shockwave causes flexure of the diaphragm 30 inwards towards the fire suppressant 1. This causes mechanical weakening of the diaphragm 30 causing the diaphragm 30 to rupture or perforate (e.g. burst open, tear) and open outwards away from the fire suppressant 1.

[0007] Once the diaphragm 30 is perforated a pressure differential is created between the interior of the container 10 and the external environment. This causes the fire suppressant to expel out through the outlet 12 and valve 20 and into the environment to perform its fire suppressing function.

[0008] The present disclosure is aimed at improving the ability of the diaphragm to open to ensure that the fire suppressant can be deployed.

SUMMARY

[0009] In accordance with an aspect of the disclosure, there is provided an apparatus comprising:

a container for holding a fire suppressant;
a valve sealing the container and comprising a diaphragm configured to perforate so as to release fire suppressant from the container, wherein the fire suppressant exerts a force on the diaphragm in use;
a pyrotechnic charge for perforating the diaphragm;
a device configured to reduce the force exerted by the fire suppressant on the diaphragm in use.

[0010] The apparatus may further comprise a fire suppressant powder within the container.

[0011] The device may comprise a cap that is optionally positioned over the diaphragm, wherein the cap optionally comprises apertures or holes to allow fire suppressant powder to pass through upon perforation of the diaphragm.

[0012] The apertures or holes may be located on a side of the cap.

[0013] The cap may comprise a top or covering portion, and the top or covering portion of the cap may be solid or non-apertured.

[0014] The container may be a bottle or cylinder shape, and may comprise a chamber portion and a narrowed neck portion. The cap may extend from the neck portion into the chamber portion, and the apertures or holes may open into the chamber portion.

[0015] The device may be configured to support a portion of the fire suppressant powder held within the container.

[0016] The device may be configured to reduce the weight of the fire suppressant acting on the diaphragm in use.

[0017] The container may be pressurised.

[0018] The apparatus may further comprise means for creating a pressure differential across the diaphragm and/or barrier after perforation of the diaphragm.

[0019] The diaphragm may comprise a metal disc. The metal disc may comprise lines of weakness to aid perforation thereof by the pyrotechnic charge. The diaphragm may be of the "non-fragmenting" type, in that it may be configured to flex, weaken and perforate, due to the directed shockwave. The diaphragm may comprise portions that are configured to open along the lines of weakness, for example petals. The diaphragm and/or lines of weakness and/or portions of the diaphragm may be configured to open towards the pyrotechnic charge. The diaphragm is optionally configured to perforate or open as described above due to the combined effect of the combustion products of the pyrotechnic charge, as well as the storage pressure of the fire suppressant.

[0020] In accordance with an aspect of the invention, there is provided a method of using the apparatus as described above, the method comprising:

loading fire suppressant into the container;
pressurising the container;
perforating the diaphragm using a pyrotechnic charge so as to cause the pressurised fire suppressant

sant to be released from the container.

[0021] In accordance with an aspect, there is provided a valve for sealing a container holding a fire suppressant powder, the valve comprising:

a passage extending between a valve inlet and a valve outlet, wherein in use fire suppressant flows into the valve inlet from the container, and then through the passage to the valve outlet;
a diaphragm within the passage and a pyrotechnic charge adjacent to the diaphragm;
wherein the diaphragm is configured to initially prevent flow of fire suppressant through the passage, and to perforate upon activation of the pyrotechnic charge so as to allow flow of fire suppressant through the passage, and wherein, in use, fire suppressant exerts a force on the diaphragm;
a device located at the valve inlet, wherein the device is configured to reduce the force exerted by the fire suppressant on the diaphragm in use.

[0022] The device may comprise a cap that is positioned over the diaphragm, wherein the cap comprises apertures or holes to allow fire suppressant powder to pass through upon perforation of the diaphragm.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Various embodiments will now be described, by way of example only, and with reference to the accompanying drawings in which:

Figs. 1A-1C show a conventional container for holding fire suppressant; and
Figs. 2A and 2B show a container for holding fire suppressant and associated device, in accordance with the present disclosure;
Figs. 3A-3B show the forces exerted by fire suppressant in a conventional apparatus, and an apparatus according to the disclosure.

DETAILED DESCRIPTION

[0024] An embodiment of the present disclosure will now be described with reference to Figs. 2A and 2B, which show an apparatus including a container 100 and a valve 200.

[0025] The container 100 is of the type used to hold a fire suppressant (not shown) in its interior, optionally in powder form, and is largely cylindrical, forming a bottle-shape with an outlet 120 provided at a lower end of the container 100. The container 100 comprises a neck portion 102 and a chamber portion 103. The chamber portion 103 has a maximum diameter that is relatively large when compared to the diameter of the neck portion 102, and forms the main body of the container 100 for holding most of the fire suppressant. The neck portion 102 and the

outlet 120 are of a smaller diameter.

[0026] The interior of the container is pressurised, for example using nitrogen gas. The valve 200 is inserted into the outlet 120 so as to plug or seal the container 100 and prevent pressurised fire suppressant held within the container from being released prematurely. Other shapes of container may be used, and the disclosure is not limited to cylindrical containers such as the one shown.

[0027] The valve 200 comprises a valve body 220 that is hollow and forms a passage 222 for fire suppressant to transfer from the interior of the container 100 to the environment. The passage 222 extends from a valve inlet 223 to a valve outlet 224. The valve inlet 223 and a neck 226 of the valve body 220 fit within the outlet 120 of the container 100, and a shoulder portion 228 of the valve body 220 rests on an exterior surface of the container 100. The valve inlet 223 and neck 226 are sealed against the walls of the neck portion 102 and outlet 120 of the container 100. Any suitable sealing method may be used.

[0028] The apparatus includes a rupturable diaphragm 130 that is positioned within the passage 222 of the valve body 220. The diaphragm 130 is sealed against the interior walls of the passage 222 and valve body 220 so as to prevent the fire suppressant from being released through said passage 222.

[0029] A pyrotechnic charge 140 is provided and arranged such that, upon activation of the charge, a percussive shockwave is directed onto the diaphragm 130 by the rapid release of gas and heat generated by the pyrotechnic charge 140. This causes the diaphragm 130 to flex, weaken and perforate (or burst, fail, tear etc.). Due in part to the pressure differential across the diaphragm 130 when the container 100 is pressurised, the diaphragm 130 perforates outwards away from the chamber portion 103 and fire suppressant.

[0030] This mechanism is different from, say, an explosive charge that uses fragments of hot metal to perforate a diaphragm, although such charge is not excluded from the broadest aspects of this disclosure.

[0031] After perforation of the diaphragm 130, fire suppressant transfers from the interior of the container 100 to the environment via passage 222. This is due, in part, to the fire suppressant being held under pressure within the container 100. That is, rupturing the diaphragm 130 results in a pressure differential between the interior of the container 100 and the passage 222 or external environment.

[0032] The diaphragm 130 is typically made of metal, for example stainless steel or nickel. The diaphragm 130 may be scored across its surface to promote failure of the diaphragm 130 along predefined score lines. The score lines may form a star pattern on the surface of the diaphragm 130, causing the diaphragm 130 to petal open along the predefined score lines.

[0033] As shown in Fig. 2A the diaphragm 130 is hemispherical and the tip of the hemisphere points towards the pyrotechnic charge 140, and away from the container

100 and chamber portion 103.

[0034] It has been recognised that the weight of fire suppressant acting on the diaphragm in conventional arrangements (see Figs. 1A-1 C) can prevent the proper opening of the diaphragm upon activation of the pyrotechnic charge. The weight of the fire suppressant, for example a fire suppressant powder, resting on a diaphragm may act as a mechanical damper and absorb some of the energy delivered by the pyrotechnic charge that would otherwise act to rupture the diaphragm. The fire suppressant may also act as a thermal damper, absorbing some of the heat released from the charge.

[0035] In accordance with the disclosure, the apparatus includes a device 150 configured to reduce the force exerted by said fire suppressant on the diaphragm 130 in use. This mitigates the damping effect of the fire suppressant and improves the ability of the diaphragm 130 to perforate upon activation of the pyrotechnic charge 140. The device 150 is of a construction that allows the fire suppressant to be released from the container 100 and/or chamber upon perforation of the diaphragm 130.

[0036] In the embodiment of Figs. 2A and 2B, a tubular cap 150 is placed over the diaphragm 130 that covers, or at least partially covers the diaphragm 130. A cavity 230 is formed by the space underneath the cap 150 and above the diaphragm 130. The cap 150 comprises apertures or holes 152 to allow fire suppressant to pass through and fill the cavity 230 prior to perforation of said diaphragm 130, and then to pass through and expel from the chamber upon perforation of the diaphragm 130. In this manner, the cap 150 optionally does not prevent or hinder the release of fire suppressant held within the chamber portion 103 of the container 100 into an external environment after perforation of the diaphragm 130.

[0037] A lower portion 154 of said cap 150 is threaded onto the neck 226 of the valve body 220. The lower portion 154 is therefore sealed against the walls of the outlet portion 120 of the container 100 with the valve body 226. The cap comprises an upper portion 156 that extends from the neck portion 102 of the container and into the chamber portion 103 of the container 100. The apertures or holes 152 are located in the upper portion 156 and this allows fire suppressant powder to fill the cavity 230 and pass through from the chamber portion 103, and subsequently expel from the container 100 as described above.

[0038] The cap 150 of the embodiment of Figs. 2A and 2B reduces the force exerted by the fire suppressant on the diaphragm 130. This is due to the cap 150 supporting at least a portion of the fire suppressant. This is explained further with reference to Figs. 3A and 3B.

[0039] Fig. 3A shows a schematic of the conventional container 10 of Figs. 1A-1C, which does not have a device configured to reduce the force exerted by said fire suppressant on the diaphragm 30.

[0040] As will be appreciated, the weight of fire suppressant particles will be transferred under gravity to surrounding fire suppressant particles. The weight of the fire suppressant particles will ultimately be transferred to ei-

ther the diaphragm 30, or the bottom curved portion 11 of the chamber. The proportion of weight that is supported by the diaphragm 30 is determined by the shear angle ϕ of the fire suppressant, which is affected by, for example, frictional and cohesive forces acting on the particles of the fire suppressant.

[0041] This is shown in Fig. 3A, where the shaded area 5 represents the fire suppressant that contributes to the weight acting on the diaphragm (assuming the chamber is full). As can be seen, with the exception of the unshaded areas 6, substantially all of the fire suppressant in the chamber acts on the diaphragm 30 due to gravity.

[0042] Fig. 3B shows a schematic of the container 100 of the embodiment of Fig. 2A. In this case the cap 150 is present as described above and this optionally supports a portion of the fire suppressant. The introduction of the cap 150 restricts the weight transferred to the diaphragm 130 to fire suppressant located between a first shear angle ϕ and a second shear angle θ , thereby reducing the weight of fire suppressant transferred to the diaphragm. In the case of Fig. 3B, only two shaded areas 8 of fire suppressant in the chamber portion 103 contribute to the weight acting on the diaphragm 130. The weight of the fire suppressant in the unshaded area 7 above the cap 150 acts on the cap 150, and not the diaphragm 130 in use.

[0043] Thus, it can be seen that the cap 150 dramatically reduces the force exerted by the fire suppressant on the diaphragm 130.

[0044] When the diaphragm 130 is perforated the fire suppressant flows under a different regime, since it is being forced out by a pressure differential between the interior of the container 100 and the external environment. Therefore the shear angle restriction described above no longer applies, allowing fire suppressant to freely exit the container 100 through the cap 150 and valve 200.

[0045] Although the present disclosure has been described with reference to the embodiments described above, it will be understood by those skilled in the art that various changes in form and detail may be made.

Claims

1. An apparatus comprising:

- a container (100) for holding a fire suppressant;
- a valve (200) sealing said container (100) and comprising a diaphragm (130) configured to perforate so as to release fire suppressant from said container (100), wherein said fire suppressant exerts a force on said diaphragm (130) in use;
- a pyrotechnic charge (140) for perforating said diaphragm (130);
- a device (150) configured to reduce the force exerted by said fire suppressant on said diaphragm (130) in use.

2. An apparatus as claimed in claim 1, further comprising a fire suppressant powder within said container (100).
3. An apparatus as claimed in claim 1 or 2, wherein said device (150) comprises a cap (150) that is positioned over said diaphragm (130), wherein said cap (150) comprises apertures or holes (152) to allow fire suppressant powder to pass through upon perforation of said diaphragm (130). 5
4. An apparatus as claimed in claim 3, wherein said apertures or holes (152) are located on a side of said cap (150). 10
5. An apparatus as claimed in claim 3 or 4, wherein a top of said cap (150) is solid or non-apertured. 15
6. An apparatus as claimed in claim 3, 4 or 5, wherein said container (100) is a bottle or cylinder shape, and comprises a chamber portion (103) and a narrowed neck portion (102), wherein said cap (150) extends from said neck portion (102) into said chamber portion (103), and said apertures or holes (152) open into said chamber portion (103). 20
7. An apparatus as claimed in any preceding claim, wherein said device (150) is configured to support a portion of said fire suppressant powder held within said container (100). 25
8. An apparatus as claimed in any preceding claim, wherein said device (150) is configured to reduce the weight of said fire suppressant acting on said diaphragm (130) in use. 30
9. An apparatus as claimed in any preceding claim, wherein said container (100) is pressurised.
10. An apparatus as claimed in any preceding claim, further comprising means for creating a pressure differential across said diaphragm (130) after perforation of said diaphragm (130). 35
11. An apparatus as claimed in any preceding claim, wherein said diaphragm (130) comprises a metal disc. 40
12. An apparatus as claimed in claim 11, wherein said metal disc comprises lines of weakness to aid perforation thereof by said pyrotechnic charge (140). 45
13. A method of using the apparatus as claimed in any preceding claim, said method comprising: 50
 - loading fire suppressant into said container (100);
 - pressurising said container (100);
- perforating said diaphragm (130) using said pyrotechnic charge (140) so as to cause said pressurised fire suppressant to be released from said container (100).
14. A valve for sealing a container holding a fire suppressant powder, said valve comprising:
 - a passage (222) extending between a valve inlet (223) and a valve outlet (224), wherein in use fire suppressant flows into said valve inlet (223) from said container (100), and then through said passage (222) to said valve outlet (224);
 - a diaphragm (130) within said passage (222) and a pyrotechnic charge (140) adjacent to said diaphragm (130);
 - wherein said diaphragm (130) is configured to initially prevent flow of fire suppressant through said passage (222), and to perforate upon activation of said pyrotechnic charge (140) so as to allow flow of fire suppressant through said passage (222), and wherein, in use, fire suppressant exerts a force on said diaphragm (130);
 - a device (150) located at said valve inlet (223), wherein said device (150) is configured to reduce the force exerted by said fire suppressant on said diaphragm (130) in use.
15. A valve as claimed in claim 14, wherein said device (150) comprises a cap (150) that covers said diaphragm (130), wherein said cap (150) comprises apertures or holes (152) to allow fire suppressant powder to pass through upon perforation of said diaphragm (130). 55

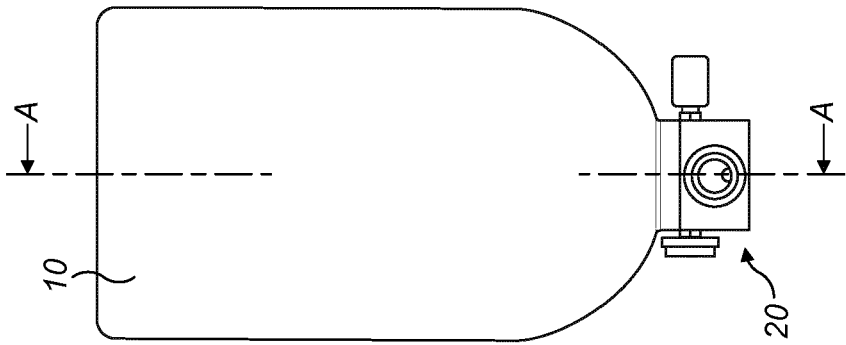


FIG. 1A
(Prior Art)

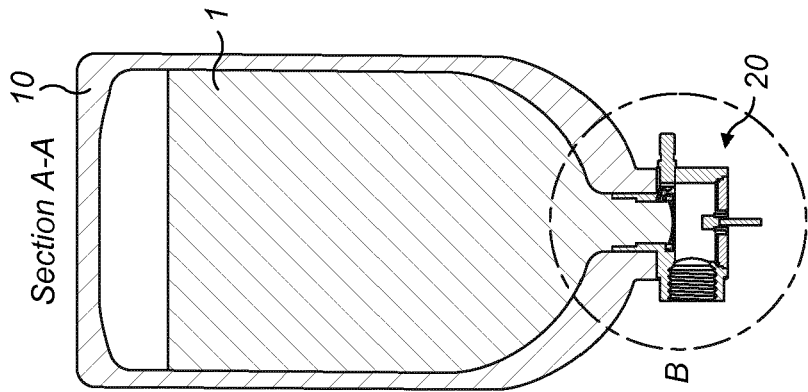


FIG. 1B
(Prior Art)

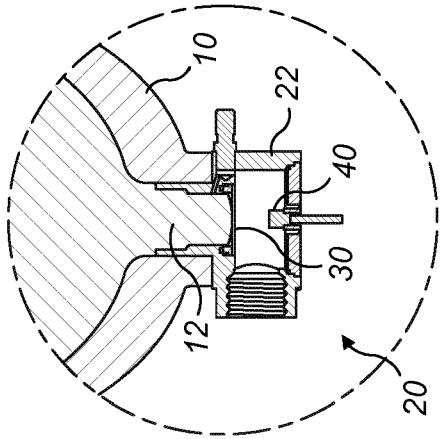


FIG. 1C
(Prior Art)

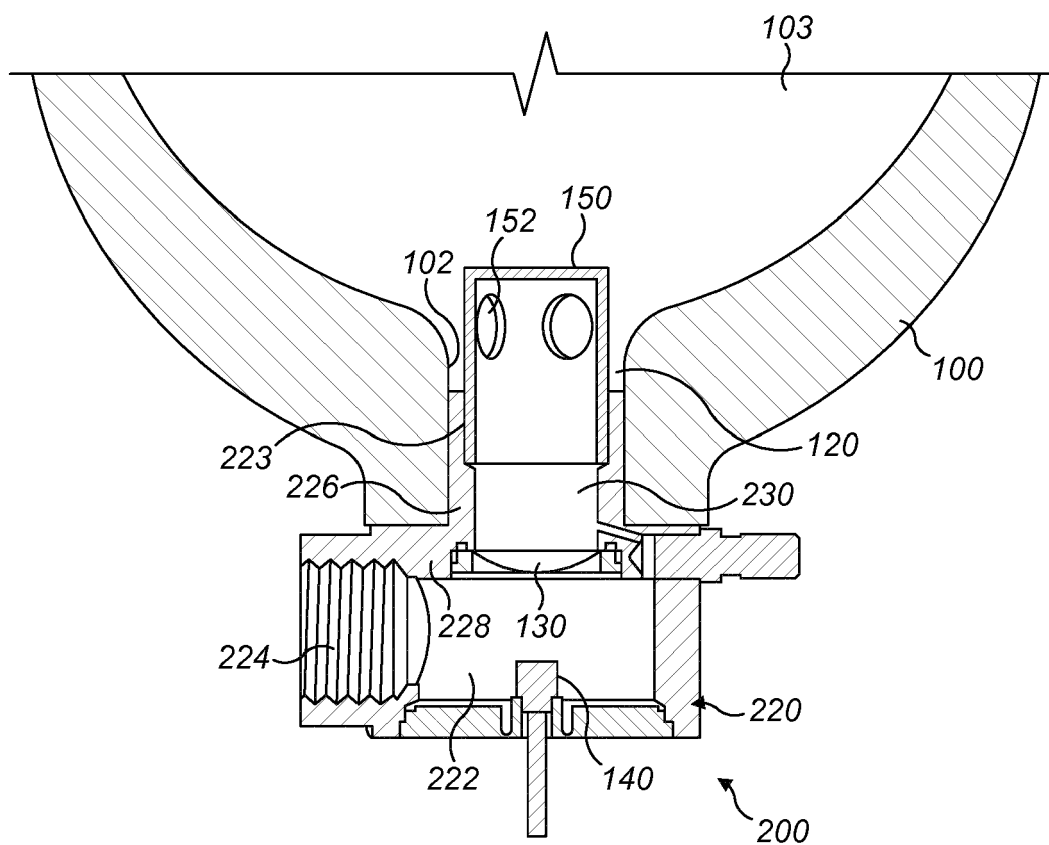


FIG. 2A

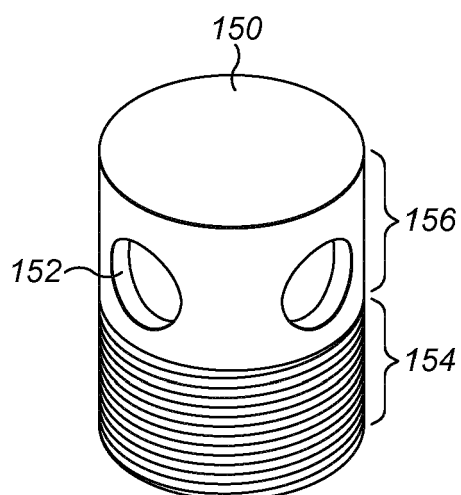


FIG. 2B

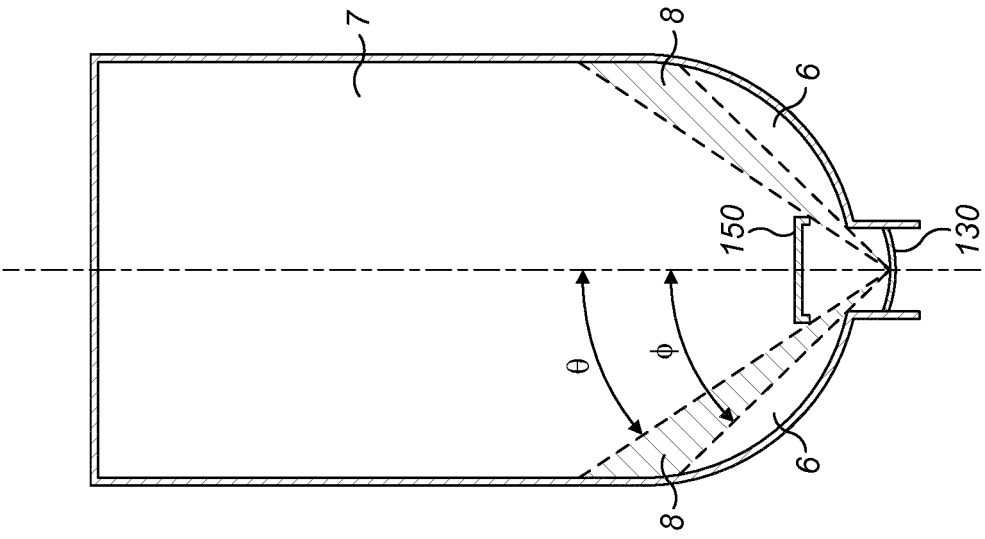


FIG. 3B

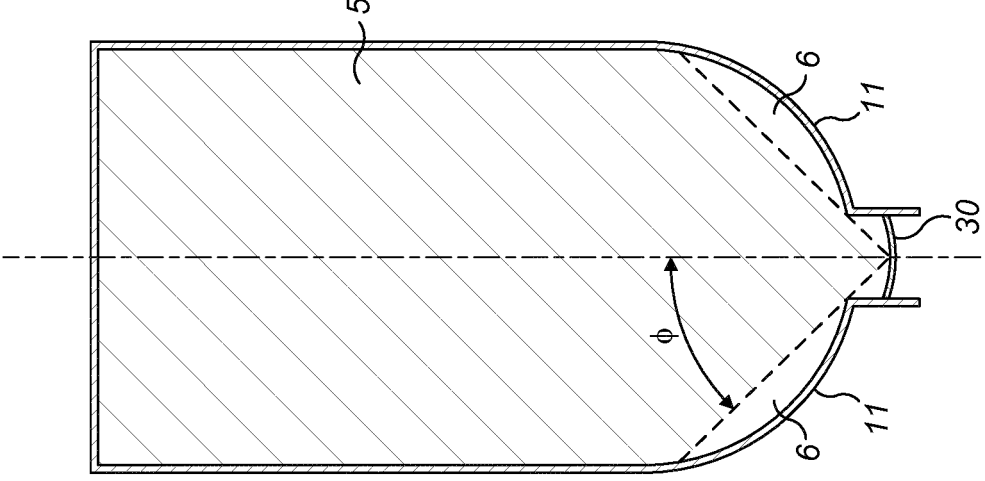


FIG. 3A

(Prior Art)



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Application Number
EP 16 15 2108

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Place of search The Hague		Date of completion of the search 1 July 2016	Examiner Horrix, Doerte
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The members are as contained in the European Patent Office EDP file on
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