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(71) Applicant: **Hartmann, Marc**
Chippendale, New South Wales 2008 (AU)

(72) Inventor: **Hartmann, Marc**
Chippendale, New South Wales 2008 (AU)

(74) Representative: **Glawe, Delfs, Moll**
Partnerschaft mbB von
Patent- und Rechtsanwälten
Rothenbaumchaussee 58
20148 Hamburg (DE)

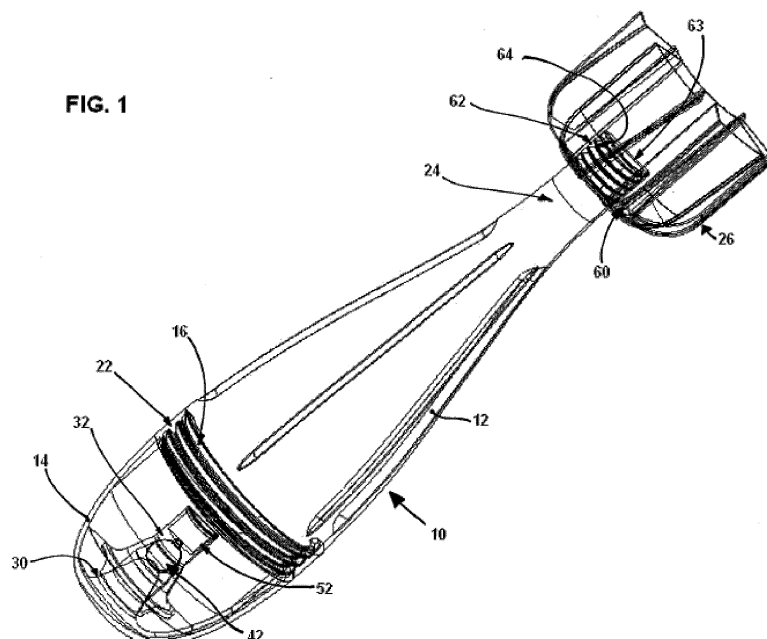
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(54) **APPARATUS FOR RELEASING FLUID TO THE ATMOSPHERE**

(57) An apparatus (10) for releasing a fluid to the atmosphere comprises a housing (12) for the fluid. The housing can comprise a biodegradable polymer, or a polymer that has been adapted to biodegrade. The polymer can also comprise a component that is reflective to infrared radiation so as to prevent melting of the housing polymer *during immersion in or whilst in proximity to flame*. The apparatus further comprises a mechanism (30, 32, 42, 50, 56, 58) for causing the fluid to be released to the

atmosphere from the housing. The mechanism can be housed in a second housing (14) that is detachably mounted to the first housing to define a housing unit. Further, a restraint mechanism (34) can be provided for regulating when the fluid is to be released from the housing to the atmosphere. The restraint mechanism can be deactivated once a certain force of apparatus impact with a surface has been reached.

FIG. 1



Description

Technical Field

[0001] Disclosed is an improved apparatus for releasing a fluid to the atmosphere, typically by dispersing the fluid from a height above or at a surface (e.g. the ground). The fluid can, for example, be of a type that extinguishes fires (eg. water) or can be a chemical for release such as a herbicide, defoliant, pesticide, insecticide etc. The apparatus can atomise the fluid in the vicinity of e.g. a fire, crop etc.

Background Art

[0002] Fire extinguisher devices that are dropped from a height onto a fire front are known. For example, WO 2004/03347 discloses a fire extinguisher that can be dropped from a helicopter and that comprises a container for extinguishing fluid and a blasting charge for rupturing the container and dispersing the extinguishing fluid. RU 2146544 discloses an aerial bomb that can also be dropped from a helicopter and which explodes at the fire front to deliver a fire-fighting substance to the fire.

[0003] A reference herein to a prior art document is not an admission that the document forms a part of the common general knowledge of a person of ordinary skill in the art in Australia or in any other country.

Summary of the Disclosure

[0004] In a first aspect there is provided an apparatus for releasing a fluid to the atmosphere, the apparatus comprising:

- a first housing for the fluid;
- a second housing detachably mountable to the first housing to define a housing unit, the second housing being adapted for causing the fluid to be released to the atmosphere from the housing unit.

[0005] The detachable mounting of the first and second housings allows each to be manufactured separately (including fluid filling in the first housing), and stored and transported separately. It also allows the apparatus to be assembled on or close to site. This can also improve safety and handling of the apparatus. For example, the apparatus may only be able to release fluid to the atmosphere when the first and second housings are attached. For safety reasons, these may not be attached to one another until necessary.

[0006] The first housing for the fluid can be elongate, and one end of the first housing can comprise a generally flat portion so as to enable the first housing to separately stand on a surface. This can allow for easy fluid filling and storage. Further, an opposing end of the first housing can be openable to enable the fluid to be introduced

therein.

[0007] The first housing may comprise rupture lines or points that are located to provide a pre-weakened structure to the housing, thus facilitating release of fluid to the atmosphere.

[0008] The apparatus may further comprise a device that can be mounted to the first housing to close the fluid opening to the first housing. The rupture lines/point in the first housing may be adapted such that a force/pressure required to cause them to fail is less than that required to force the device of its mounting to the first housing.

[0009] In a second aspect there is provided an apparatus for releasing a fluid to the atmosphere, the apparatus comprising:

- an elongate housing for the fluid, the housing being adapted to spin about a longitudinal axis thereof as it falls through the atmosphere; and
- a mechanism for causing the fluid to be released to the atmosphere from the housing.

[0010] The spinning of the housing about its longitudinal axis as it falls through the atmosphere can enhance the capacity of the apparatus to be directed towards a target, and can also enhance (or ensure) surface impact at e.g. a nose of the housing. In this regard, the housing can comprise a nose and an opposing tail, and the adaptation of the housing to spin can comprise a device that is associated with the tail to induce the spinning about the housing's longitudinal axis.

[0011] In one form the device can comprise an end cap having a narrower forward end mountable to the tail, and a wider trailing end. The device can further comprise one or more recessed passageways in its outer surface moving from its forward to trailing ends, and through each of which air flows as the housing falls through the atmosphere so as to induce the spinning about the housing's longitudinal axis. For example, in relation to the longitudinal axis, the one or more passageways can each have a curve moving from the device's forward to trailing ends so as to induce the spinning.

[0012] The housing's centre of gravity may lie towards the nose, relative to the tail, such that the apparatus falls through the atmosphere nose first.

[0013] The apparatus of the second aspect can otherwise be as defined in the first aspect.

[0014] In a third aspect there is provided an apparatus for releasing a fluid to the atmosphere, the apparatus comprising:

- a polymer housing for the fluid;
- a mechanism for causing an explosion to rupture the housing whereby the fluid is released to the atmosphere from the housing;

wherein the polymer comprises a component that is re-

flective to infrared radiation so as to prevent melting of the housing polymer *during immersion in or whilst in proximity to flame*.

Such flame may be *generated by the explosion or it can be present in the local environ (e.g. during a bushfire, building fire, etc.)*. The component can thus preserve the plastic (e.g. during deployment and to allow for subsequent biodegradation or clean-up).

[0015] The component can coat or be incorporated into the polymer. For example, metallic coatings, layers and films can be applied to the polymer that are reflective to infrared radiation, such as metallic coatings, layers and films of e.g. zinc or aluminium, or a coating incorporating copper phthalocyanine.

[0016] The term "incorporated into" in relation to the component is intended to include component dyes or pigments in the polymer that are reflective to infrared radiation such as copper phthalocyanine dye, or titanium dioxide (rutile), red iron oxide and thin leafing aluminium flake pigments. Fire retardant paints and polymer additives can also be employed that reflect the thermal IR radiation emitted by fire. Such additives can reflect adverse electromagnetic energy and slow the spread of fire. The term also includes layers of polymer films whereby one of the layers (e.g. the in-use outer layer) is particularly reflective or scattering to infrared radiation.

[0017] The component is particularly suitable to be employed with the polymer adapted to biodegrade of the first aspect, whereby that polymer can be protected against melting by the component, thus enhancing or maintaining its capacity to later biodegrade.

[0018] In a fourth aspect there is provided a housing for a projectile. The housing has a generally cylindrical outer surface that comprises one or more circumferential grooves extending at least partway around the housing.

[0019] The housing may comprise two grooves that are arranged so as to be parallel and spaced apart along the housing from one another.

[0020] The grooves may be spaced equidistantly along the housing from, and on opposite sides of, the centre of mass of the apparatus when containing the fluid to be released.

[0021] The grooves may have a generally semi-circular cross section.

[0022] Each of the one or more grooves may be formed so as to correspond to a launch rail for launching the projectile from a vehicle. The grooves may facilitate the rolling of the projectile along the launch rail. When the grooves are spaced equidistantly from the centre of mass, the apparatus may be balanced when being launched.

[0023] The projectile may be an apparatus for releasing fluid to the atmosphere. In this respect, the housing may be able to release the fluid to the atmosphere.

[0024] The housing may be caused to rupture by an explosion that is initiated by the housing impacting a surface. The grooves may facilitate collapse of the housing upon impact with the surface. Such collapse of the hous-

ing may be desirable as it can prevent (or reduce the occurrence of) the housing rupturing prior to, for example, detonation of the projectile. Thus, the grooves may provide two functions (i.e. facilitating collapse of the housing and rolling along launch rails).

[0025] In a fifth aspect there is provided an apparatus for releasing a fluid to the atmosphere, the apparatus comprising a housing having an outer surface that is generally cylindrical about a longitudinal axis, the surface comprising a plurality of longitudinally extending recesses.

[0026] The recesses may be arranged so as to be generally parallel to one another and spaced around the housing.

[0027] The recesses may be spaced equidistantly right around the housing.

[0028] Each recess may have a generally semi-circular cross section.

[0029] The opposing ends of each recess may be rounded.

[0030] The apparatus may further comprise a mechanism for causing the fluid to be released to the atmosphere from the housing. The housing may be caused to rupture by an explosion (or deflagration) that is initiated by the apparatus impacting a surface. The recesses may facilitate radial expansion of the housing upon impact with the surface. That the housing is able to expand upon impact may prevent it from rupturing due to the impact. Thus, rupture of the housing may be delayed until explosion of the apparatus. The radial expansion may also increase the volume of the housing (e.g. holding the fluid) and may cause the fluid to be optimally arranged around a device (e.g. burster charge) causing the explosion. This optimal arrangement of the fluid may minimise the droplet size of the fluid (i.e. when the fluid is a liquid) and maximise dispersal of the fluid. Minimal droplet size may be desired, for example, when the apparatus is used to disperse water into a fire to extinguish the fire.

[0031] The apparatus of the fifth aspect can otherwise be as defined in the aspects described above.

[0032] In a sixth aspect there is provided a detonator for an adiabatic fuse. The detonator comprises a body formed of a pyrotechnic composition and a passage extending partway through the body. The detonator further comprises a second passage extending partway through the body so as to define a separator between it and the first passage. Upon ignition of the adiabatic fuse, gas in the first passage is caused to be heated, thereby causing the body and the separator to burn, such that burning material is ejected from the second passage.

[0033] Such an arrangement may allow for reliable ignition by maximising the surface area of the detonator that is exposed to the heated gas. The use of a pyrotechnic composition may allow the detonator to be used for a variety of applications, including applications that are non-military related. For example, some countries may have laws or regulations making it difficult to use primary explosives (rather than a pyrotechnic composition) in

non-military applications. The pyrotechnic composition may be in pressed power form.

[0034] The separator may be comprised of a part of the body. Thus, the separator and body may be formed of the same pyrotechnic composition.

[0035] The body may be cylindrical. This may ensure even burning of the body in a radial direction.

[0036] Each passage may be circular in cross section. Again this may facilitate even burning of the body in a radial direction.

[0037] Each passage may be tapered inwardly from its open end. This may facilitate manufacture of the detonator when formed of pressed material. For example, if the passages are formed by way of projections used on a press, then the tapered shape of the projections may facilitate removal of the projections without damaging the pressed detonator.

[0038] The second passage may be arranged such that the burning material is ejected into a burster charge. Thus, the burning material may cause the burster charge to ignite and explode. In this respect, the detonator may essentially be an intermediary between the hot gas of the adiabatic fuse and explosion of the burster charge. The separator may ensure that the cavity of the adiabatic fuse (i.e. containing the gas) is sealed, thereby facilitating the heating of the gas when the adiabatic fuse is e.g. impacted (to reduce the volume and increase the pressure).

[0039] The thickness of the septum may be optimised to minimise the initiation time, or alternatively can be optimised to delay ignition of the burster charge.

[0040] The detonator of the sixth aspect may form a part of, or be used with, any one of the apparatuses described above.

[0041] In a seventh aspect there is provided a projectile. The projectile comprises a housing, a cone extending inwardly from the housing, and a detonator mechanism comprising an impact surface. The impact surface is shaped so as to correspond to the distal end of the cone to guide the distal end of the cone. Impact of the housing against a surface causes the cone to move towards and collide with the impact surface of the detonator mechanism thereby causing the detonator to detonate. The relationship between the cone and the detonator mechanism may ensure that the detonator mechanism is always impacted by the cone at the impact surface. In other words, even if the projectile does not impact a surface directly square on (i.e. as may be intended), the cone is guided so as to impact the impact surface (i.e. rather than impacting another area of the detonation mechanism).

[0042] The detonator mechanism may comprise a gas reservoir and the impact surface may be a portion of a wall of the gas reservoir.

[0043] The distal end of the cone and the impact surface may be hemispherical.

[0044] The projectile may be in the form of a fluid releasing apparatus as set forth in any one of the aspects above.

[0045] Also disclosed herein is an apparatus for releasing a fluid to the atmosphere, the apparatus comprising:

- a housing for the fluid;
- a mechanism for causing the fluid to be released to the atmosphere from the housing;

wherein the housing comprises a biodegradable polymer, or a polymer that has been adapted to biodegrade.

[0046] The employment of a biodegradable polymer (or a polymer adapted to biodegrade) in the housing enables the apparatus to be used in the open environment (e.g. in the fighting of bushfires) without itself representing a pollutant. Typically the bulk, if not all, components of the apparatus are adapted to biodegrade.

[0047] The polymer that is adapted to biodegrade may comprise an additive that promotes biodegradation and is itself biodegradable. The polymer can comprise a polyolefin such as polyethylene or polypropylene, and the additive can be in the form of a filler such as an inorganic carbonate, a synthetic carbonate, nepheline syenite, talc, magnesium hydroxide, aluminium trihydrate, diatomaceous earth, mica, natural or synthetic silicas and calcined clays or mixtures thereof. The additive may also be a metal carboxylate, inclusive of a large number of metals, such as cerium, cobalt, iron, and magnesium, an aliphatic poly hydroxy-carboxyl acid and/or calcium oxide.

[0048] Also disclosed herein is an apparatus for releasing a fluid to the atmosphere, the apparatus comprising:

- a housing for the fluid; and
- a restraint mechanism adapted for regulating when the fluid is to be released from the housing to the atmosphere, whereby the restraint mechanism is deactivated once a certain force of apparatus impact with a surface has been reached.

[0049] The restraint mechanism can thus allow for certain apparatus impact with a surface (i.e. to accommodate inadvertent apparatus dropping from a low height, such as may occur during transportation or installation).

[0050] In one form the housing comprises an element positioned adjacent to a location where the housing is adapted to impact at the surface such that the element is caused to be urged inwardly of the apparatus to effect the fluid release, and the restraint mechanism further comprises a member for restricting element movement until the certain force of apparatus impact with the surface is reached.

[0051] The element may have a piston-like form and may be adapted at surface impact to be urged inwardly towards an explosive charge positioned within the apparatus to detonate the same. The resultant explosion can then cause the housing to rupture and release the fluid.

[0052] The member can be ring-like to surround the piston-like element and only to allow its passage there-

through and towards the explosive charge when the apparatus impact with the surface produces the certain force. In this regard, the movement of the element through the member at the certain force can be enabled only by the member deforming or breaking.

[0053] In one example, the certain force may be reached only above e.g. a certain apparatus deployment (or drop) height of say 20 metres.

[0054] The fluid as set forth in the aspects above can be of a type that extinguishes fires (e.g. water, or other fire retardant liquid or powder) or can be a chemical for release such as a herbicide, defoliant, pesticide, insecticide etc. The term "fluid" is thus to be interpreted broadly to include liquids, flowable solids such as powders and slurries, and also atomisable solids.

[0055] Similarly, the mechanism for causing the fluid to be released to the atmosphere from the housing may be adapted to cause the fluid to atomise at release. In this regard, the mechanism of the aspects described above may be adapted to cause an explosion internally of the apparatus that in turn causes both housing rupture and the fluid atomisation at release.

[0056] The apparatus of any one of the aspects as set forth above may optimally have the form of a bomb (or missile) so that it can be targeted in use.

Brief Description of the Drawings

[0057] Notwithstanding any other forms which may fall within the scope of the fluid releasing apparatus as defined in the Summary, a number of specific apparatus embodiments will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a schematic cross-section (in perspective) through a fluid releasing apparatus according to a first embodiment;

Figure 2 shows a detail of a nose of the apparatus cross-section of Figure 1;

Figure 3 shows in side view a cross-sectional detail of the apparatus nose of Figure 2;

Figure 4 shows a detail (in perspective) of a tail of the apparatus of Figure 1;

Figure 5 shows (in perspective) the separated tail portion of the apparatus of Figure 1;

Figure 6 shows a casing for a projectile; and

Figures 7A and 7B show a perspective view and a section view respectively of a detonator.

Detailed Description of Specific Embodiments

[0058] Referring now to Figures 1 to 5, an apparatus for releasing a fluid to the atmosphere is shown in the form of a bomb (or missile) 10. The bomb is shaped to optimise its targeting in use. The bomb comprises a housing for both the fluid and an explosive device, with the housing assuming the form of a two-part casing that comprises a first elongate casing portion 12 for the fluid, and a second shorter casing cap (or nose cone) 14 that is detachably mountable to an end of the first casing portion to define a casing unit. When so mounted, the second casing portion 14 surrounds and encloses both the explosive device and a mechanism for activating the explosive device. The explosive device is such as to cause the fluid to be released to the atmosphere from the casing unit, as described below.

[0059] The first elongate casing portion 12 can be provided with **rupture lines or points that are located to provide a pre-weakened structure to the casing, thus facilitating** release of fluid to the atmosphere (i.e. by facilitating casing rupture during explosion of the explosive device). The **rupture lines or points** can run parallel to the bomb's longitudinal axis. The **rupture lines or points** can also allow the bomb to rupture in a predictable fashion (i.e. to increase the likelihood that the dispersal/atomisation of the fluid will follow a predictable or pre-determined pattern).

[0060] The detachable mounting of the first and second casing portions 12, 14 allows each to be manufactured separately, and allows for easy fluid filling in the first casing (as described below). It also allows for each casing portion to be stored and transported separately, and for bomb assembly to occur at or close to a usage site. This can improve both the safety and handling of the bomb.

[0061] As best shown in Figure 3, the detachable mounting of the first and second casing portions is facilitated by an external threaded region 16 that is located in a rebate 18 that is inset from a closed (explosives) end 20 of the first casing portion 12. An internal threaded region 22 located at and within an open end of the second casing portion 14 then mates with the external threaded region 16 such that, when fully mounted, a substantial proportion (or length) of the second casing portion surrounds the closed (explosives) end 20 of the first casing portion 12. This provides for increased hoop strength at this part of the bomb, so that the explosive device preferentially ruptures the bomb away from this part (i.e. preferentially ruptures at a remainder of the first casing portion 12).

[0062] The detachable mounting of the first and second casing portions can be facilitated by another detachable mechanism such as a bayonet coupling, snap- or interference-fitting arrangement etc.

[0063] The closed (explosives) end 20 of the first casing portion 12 is generally flat to enable the casing portion to separately stand on a surface. This can allow for easy fluid filling at an opposite tail end 24 of the first casing

portion 12 (i.e. before a tail cap 26 is screw mounted thereto, as described below). For example, filling can take place at a standard bottling plant operation. This generally flat end can also facilitate storage of the unfilled or filled casing portion 12 (i.e. when separated from the second casing portion 14).

[0064] Again, as best shown in Figures 2 & 3, the second casing portion 14 can comprise an element in the form of a piston 30 that is formed integrally with the casing to extend internally thereof (i.e. within the confines of the bomb). The piston is located on an inside of the casing portion 14 that is adjacent to where the bomb is adapted to impact at a surface. This has the result of forcing the piston inwardly of the bomb at impact, as described below. Also, by forming the piston to lie within the confines of the second casing portion 14 an optimal (e.g. curved aerodynamic) profile can be provided at a nose of the bomb, and yet the piston can still activate the bomb.

[0065] When the first and second casing portions 12, 14 are mounted together the piston 30 extends into the closed (explosives) end 20 of the first casing portion 12. In this regard, the piston interacts with a restraint mechanism that restrains piston movement to prevent inadvertent fluid release from the bomb to the atmosphere. Further, the restraint mechanism is deactivated only once a certain force of bomb impact with a surface has been reached. The restraint mechanism can thus allow the bomb to accommodate inadvertent bomb dropping from a low height (e.g. during transportation or installation).

[0066] A tube-like cartridge 32 having a ring-like flared end 34 is mounted into the closed (explosives) end 20 of the first casing portion 12 as shown. The flared end 34 surrounds a passage into the cartridge 32. The restraint mechanism can be defined as an inner tapered surface 36 of the ring-like flared end 34 that is adapted to surround and interfere with the piston 30 when the first and second casing portions 12, 14 are mounted together.

[0067] Also, when the first and second casing portions 12, 14 are mounted together, the piston 30 can actually hold the cartridge 32 in place in the closed end 20 (i.e. so that the cartridge does not require separate fixing to the closed end).

[0068] In this regard, the taper on the inner surface 36 interacts with an opposite taper on the piston (see arrow I in Figure 3) and this configuration thus only allows further advancement of the piston into the passage when bomb impact with a surface (e.g. the ground) produces a certain (i.e. sufficiently high) reactive force. In fact, the movement of the piston through the ring-like flared end 34 can occur only by the flared end deforming or breaking. This deformation or breakage is facilitated by a series of windows 37 formed through and around the wall of cartridge 32.

[0069] The ring-like flared end 34 can thus be provided with a breaking strain (tensile failure) such that it will not deform or break if the bomb is dropped or impacted moderately in handling or transport, but will do so if subjected to the forces associated with a drop from an aircraft. In

one example, a safety threshold can be imposed whereby the reactive force is reached only when the bomb is dropped above a height of say 20 metres.

[0070] As the piston is caused to move further into the passage of cartridge 32 its free end 38 moves against a deformable external wall 40 (e.g. formed of an elastomer) of an enclosed gas reservoir 42 located at a base 44 of the cartridge passage. An opposing wall 46 of the gas reservoir 42 comprises a needle-like valve 48 that extends into a thin capillary conduit 50, itself extending through the base 44. In one embodiment the volumetric dimension ratio of the gas reservoir 42 to the conduit 50 is not less than 8/1, to achieve a high gas pressure in conduit 50.

[0071] The piston 30 is conical with a hemispherical distal end (i.e. the end being oriented towards the interior of the casing). The external wall 40 of the gas reservoir 42 comprises a corresponding hemispherical socket for receipt of the distal end of the piston 30. Such an arrangement means that if the apparatus hits a surface off centre (e.g. at an angle of 0 to 30°), the conical piston is constrained by the socket such that it seats within the socket and fully compresses the gas reservoir 42. A skilled person would understand that such a feature could be used in other forms of projectile configured to rupture or explode upon impact with a surface.

[0072] Located within cartridge 32 on an opposite side of the base 44 is an explosive device 52. The explosive device is sealed in this end of the cartridge by a biodegradable and water-soluble plastic plug 54 (e.g. formed of a starch-based plastic). The explosive device 52 comprises a first explosive material 56 into which the capillary conduit 50 continues to extend, with the material 56 being of a type that is detonatable by the pressurised gas. A second explosive material 58 (i.e. propellant charge or burster charge) surrounds the first explosive material and is adapted to deflagrate when the first explosive material detonates.

[0073] Thus, at surface impact, the sudden movement of the piston end 38 against reservoir wall 40 forces gas under pressure from the reservoir, through the conduit 50 and into the material 56 to detonate the same. The resultant explosion of material 58 blows off the plug 54 and is propagated into the fluid in first casing portion 12 to cause it at least to rupture and release the fluid from the bomb. This rupturing can be facilitated by rupture lines or point as described below. The arrangement depicted provides a reliable form of an adiabatic fuse.

[0074] In an alternative embodiment, at surface impact, the piston 30 can be forced against a percussion cap located in the cartridge 32 adjacent to an explosive charge, to in turn detonate the explosive charge. This latter arrangement thus provides a form of percussion fuse.

[0075] In either case, the explosive device is typically adapted to cause fluid held in the first casing portion 12 to atomise at release, as the casing ruptures. This atomisation of the fluid increases its surface area, making it

more effective as a fire extinguishing agent, or as a herbicide, defoliant, pesticide, insecticide etc.

[0076] By locating the explosive device etc. such that is surrounded by the second casing portion 14 (i.e. by the nose cone) the bomb's centre of gravity lies towards the nose, relative to the tail, such that the bomb then falls through the atmosphere nose first (i.e. centre of mass forward of the bomb's aerodynamic centre).

[0077] Referring particularly to Figures 4 and 5, the spin-inducing tail cap 26 will now be described in greater detail. The cap causes the bomb to spin (rotate) about its longitudinal axis as it falls through the atmosphere (i.e. when in free-stream). This spinning can enhance the capacity of the bomb to be directed towards a target (e.g. a fire front, crop etc.) and can also ensure that the bomb impacts a surface at its nose.

[0078] In this regard, the cap 26 is screw mounted to the tail end 24 of the first casing portion 12. The cap 26 has a relatively narrow forward end 60 having an internally threaded central sleeve 62 that is screw mountable to an external thread 64 on the tail end 24 (Figure 1). After filling the first casing portion with fluid through the tail end 24, a base 63 of the sleeve closes (i.e. seals) the tail end 24. The base 63 is typically of a water impermeable plastic.

[0079] A series of fin-like structures 66 extend out and back from the forward end to a wider trailing end 68 of the cap. The fin structures 66 define a series of recessed passageways 70 in an external part of the cap, moving from its forward to trailing ends, and through each of which air flows as the bomb falls through the atmosphere. In relation to the bomb's longitudinal axis, each passageway 70 is curved moving from the device's forward to trailing ends so as to induce the bomb spinning about its longitudinal axis.

[0080] The overall shape of the tail cap 26 also renders it less likely to snare branches, twigs and foliage etc. on the way through e.g. a tree canopy. This is because the cap's volume is generally closed to such intrusions by the downward-facing surfaces of the fin structures 66.

[0081] The rupture lines/points in the first elongate casing portion 12 (as mentioned above) are typically designed so that the force or pressure required to cause them to fail is less than that required to force the tail cap 26 off its thread

[0082] The bomb's component parts, such as the first and second casing portions 12, 14, as well as the tail cap 26, cartridge 32 and gas reservoir 42, can each be formed from a biodegradable polymer, or a polymer that has been adapted to biodegrade. This enables the bomb to be used in the open environment (e.g. in the fighting of bushfires) without itself representing a pollutant. Typically all components of the bomb are adapted to biodegrade.

[0083] The polymer can additionally comprise a component that is reflective to infrared radiation. This component can prevent melting of the polymer *during immersion in or whilst in proximity to flame*. Such flame may be generated by the explosion and/or may be present in the

local environ in which the bomb is used (e.g. during a bushfire). The component can thus preserve the plastic during deployment and during subsequent biodegradation or clean-up.

[0084] The fluid can be a liquid, a flowable solid (such as a powder or slurry), an atomisable solid etc. The fluid can be employed in extinguishing fires, or can be another chemical for release such as a herbicide, defoliant, pesticide, insecticide etc.

[0085] The polymer can comprise a polyolefin such as polyethylene or polypropylene, and the additive that promotes biodegradation can be in the form of a filler such as an inorganic carbonate, a synthetic carbonate, nepheline syenite, talc, magnesium hydroxide, aluminium trihydrate, diatomaceous earth, mica, natural or synthetic silicas and calcined clays or mixtures thereof. The additive may also be a metal carboxylate, inclusive of a large number of metals, such as cerium, cobalt, iron, and magnesium, an aliphatic poly hydroxy-carboxyl acid and/or calcium oxide.

[0086] Insofar as IR reflection is concerned, the important spectral ranges for fire control are typically about 1 to about 8 μm or, for cool smoky fires, about 2 μm to about 16 μm . The component added to the polymer can thus desirably reflect adverse electromagnetic energy in such ranges and thus slow or retard the spread of fire.

[0087] The IR component can be a metallic or polymeric coating, layer or film applied to a main polymer that is reflective to infrared radiation. Such a coating, layer or film may comprise zinc or aluminium, a coating incorporating or comprising a metal phthalocyanine such as copper phthalocyanine etc. The component may alternatively be a dye or pigment introduced into the polymer that is reflective to infrared radiation. A specific such dye is copper phthalocyanine. Specific IR reflective pigments include titanium dioxide (rutile) and red iron oxide pigments with diameters of about 1 μm to about 2 μm , and thin leafing aluminium flake pigments.

[0088] A fire retardant paint or polymer additive can also be employed that reflects the thermal IR radiation emitted by fire in the 1 to 20 micrometer (μm) wavelength range. Usually the emissivity that results from the use of the component is less than or equal to 0.15.

[0089] The explosive device can comprise a low-explosive material, that is also of a nature to biodegrade, and that can be neutralised by contact with water. Examples of low-explosive materials include black powder, smokeless powder, etc.

[0090] The bomb typically has a length to diameter aspect ratio when fully assembled of 4/1 or greater. This optimises its targeting/trajectory.

[0091] The bomb is typically sized to hold a liquid fluid in the 10-30L range. The bomb's total weight typically does not exceed 30 kg as, above this, the vessel must be handled mechanically or by two individuals.

[0092] Once the bomb 10 has been assembled as shown, and filled with a fluid to be dispersed, it is dropped from an aerial platform (plane, helicopter etc.), hovering

or in forward flight, in such a way as to strike the ground amidst a fire, narcotic base-crop plantation or similar target.

[0093] The bomb initially falls with its longitudinal axis approximately parallel with the earth's surface, before assuming a nose down attitude as it falls.

[0094] The relative velocity of the free-stream air acts on the tail cap causing the bomb to spin about its longitudinal axis, thus producing a directionally stabilizing effect. A ring comprising a series of vanes may alternatively or additionally be provided to induce spinning of the bomb. If contact with foliage, tree canopy, etc., occurs the nose-cone protects the vessel from damage, and the bomb penetrates any tree or foliage cover and strikes the ground in a nose down attitude.

[0095] At this point the reaction force resulting from the impact forces the piston against the ring-like flared end inner surface, producing a high hoop strain and causing the flared end to rupture. This allows the piston free end to deform (compress) the gas reservoir in the cartridge, and cause a compression of the gas (e.g. air) within the reservoir. The gas is forced into the capillary conduit in the first explosive material, and is adiabatically heated to a temperature sufficient to ignite the material (detonation).

[0096] The energy released causes a subsequent deflagration of the second explosive material (propellant charge). The deflagration of this charge material produces a pressure that is transmitted to the closed end of the first casing, which in turn causes the casing to compress, and to rupture vertically. Further, as the vessel is compressed, the fluid is displaced through the ruptures and is projected into the target area in a semi-hemispherical pattern.

[0097] Where the fluid is water, a defoliant, a herbicide or a fire retardant, it is atomised by the combination of impact and the deflagration of the dispersal charge. In the event that the target is a fire, and the fluid dispersed is water or a water/fire retardant mix, the atomisation of the fluid will cause the evaporation of the contents, thereby removing a considerable amount of energy from the fire. This energy absorption is expected to be in the order of 200,000 kW for 10 kg of water released by the bomb.

[0098] Referring now to Figure 6, the housing (referred to here as a casing 72) has similar features to the first casing 12 shown in Figures 1 to 3 and is generally cylindrical with a generally cylindrical outer surface 74. However, this embodiment differs from that shown in previous Figures in that the outer surface 74 comprises two circumferential grooves in the form of runnels 76 that extend right around the casing 72. The runnels 76 are parallel and spaced apart from one another along the casing 72 and, in particular, are spaced so as to be equidistant from, and either side of, the centre of mass of the projectile in use (i.e. when assembled, and including equipment, explosives, fluid, etc.) In use, the runnels 76 may allow the projectile to be launched from a vehicle (e.g. a plane) by rolling it down launch rails located in or on the vehicle.

In this respect, the positioning of the runnels 76 corresponds to the launch rails and runnels have semi-circular cross-sections to facilitate smooth rolling of the casing 72 on the launch rails. The use of launch rails and corresponding runnels 76 may, for example, allow many projectiles to be launched in an efficient and effective manner from an aircraft or other vehicle.

[0099] The outer surface 74 further comprises a plurality of longitudinally extending recesses in the form of flutes 78, which extend between the runnels 76. The flutes 78 are arranged such that they are parallel to one another and are spaced evenly right around the casing 72. Each flute 78 has a semi-circular cross-section and is rounded at each opposing end. The roundness of the flutes 78 may facilitate the radial expansion, and may also simplify manufacture of the housing. As set forth above, the flutes 78 allow the housing 72 to expand radially (i.e. increasing volume of the housing) upon impact with a surface. When used, for example, as part of a fluid releasing apparatus as shown in Figures 1 to 5, the flutes 72 may prevent the casing 72 from rupturing prior to detonation of the explosive device (i.e. by allowing the radial expansion). The deformation of the casing 72 (i.e. radial expansion) may also allow the fluid to be arranged around the explosive device, such that upon explosion of the device the droplet size of the fluid is minimised (i.e. it may facilitate atomisation of the fluid).

[0100] As is the case with the casing 12 shown in Figures 1 to 3, the casing 72 in Figure 6 comprises threaded portions at either end for engagement with e.g. nose cone and tail components. When the casing 72 is used in an apparatus for releasing fluid, it may house an explosive device and fuse, and the nose cone may house a structural member for setting off the explosive device (via the fuse) upon impact of the nose with a surface.

[0101] Referring now to Figures 7A and 7B, the detonator 80 comprises a body 82 in the form of a pressed pellet of pyrotechnic composition. The body 82 is cylindrical in form and has a first passage 84 extending partway therethrough. The detonator further comprises a second passage 86 extending partway through the body so as to define a separator 88 between it and the first passage 84. When the detonator is used with an adiabatic fuse, and upon ignition of the adiabatic fuse, gas in the first passage 86 is heated, which causes the body 82 and the separator 88 (both being formed of the pyrotechnic composition) to burn. Once the separator 88 burns at least partway through, burning material is ejected from the second passage 86. Although not shown, a burster charge can be positioned at the end of the second passage 86 and the ejected burning material can ignite the burster charge, causing it to deflagrate. The presence of the second passage 86 means that, as the burning material is ejected through this passage 86, the walls of the passage 86 are in turn caused to burn. This may increase the reliability of the detonator 80.

[0102] The detonator can essentially act as an intermediary between the adiabatic fuse and the burster

charge. For example, the first passage 84 may form part of a gas reservoir of the adiabatic fuse, the separator 88 forming a portion of the wall of the gas reservoir. The burster charge may be formed of powder that is too loosely packed to provide this function (i.e. because it would not have the strength to form part of the wall of the gas reservoir). In use, an impact causes the volume of the gas reservoir to decrease, and the pressure and temperature of the gas to increase to cause the pyrotechnic material to burn. Thus, the separator 88 may be configured such that it does not fail under the increasing pressure, such that the pressure is able to increase to a point at which the temperature is high enough to cause the pyrotechnic material to burn.

[0103] The first and second passages 84, 86 are circular in cross section and aligned along the central axis of the body 82, which may ensure even burning of the body 82. The passages 84, 86 are also tapered along their lengths. This facilitates manufacture of the detonator 82 using a press. The tapered passages 84, 86 are produced using tapered projections that can be removed more easily after the pressing process (i.e. without causing damage to the body 80).

[0104] In the illustrated embodiment the separator 88 is thin, which means that there is minimal delay between the impact on the adiabatic fuse and the explosion of the burster charge. However, the thickness of the separator 88 can be altered if a delay is desired. For example, in forested areas, where the projectile may initially impact a tree, the detonation may be delayed (by using an appropriately designed detonator) to ensure that the projectile detonates once on the ground (rather than in the forest canopy).

[0105] Whilst a number of embodiments of the apparatus have been described, it will be appreciated that the apparatus can be embodied in many other forms.

[0106] For example, the runnels are illustrated as extending right around the housing, however in other embodiments the runnels may only extend partway around the housing. In this respect, the apparatus may be configured to only complete a half roll when being launched along launch rails.

[0107] The number of runnels and flutes may be changed depending on the requirements of the housing. For example, in some forms only one runnel may be required (e.g. around the centre of the housing).

[0108] In the claims which follow and in the preceding description, except where the context requires otherwise due to express language or necessary implication, the word "comprise" or variations such as "comprises" or "comprising" is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments.

Claims

1. A housing for a projectile, the housing having a generally cylindrical outer surface, the surface comprising one or more circumferential grooves extending at least partway around the housing.
2. A housing as claimed in claim 1 comprising two grooves that are arranged so as to be parallel and spaced apart along the housing from one another, the grooves optionally being spaced equidistantly along the housing from, and on opposite sides of, the centre of mass of the apparatus when containing the fluid to be released.
3. A housing as claimed in any one of the preceding claims wherein the groove has a generally semi-circular cross section and the grooves are optionally formed so as to correspond to a launch rail for launching the projectile from a vehicle, to facilitate the rolling of the projectile along the launch rail.
4. A housing as claimed in any one of the preceding claims wherein the projectile is an apparatus for releasing fluid to the atmosphere, the housing able to release the fluid to the atmosphere and wherein the housing is caused to rupture by an explosion that is initiated by the housing impacting a surface, the grooves facilitating collapse of the housing upon impact with the surface.
5. An apparatus for releasing a fluid to the atmosphere, the apparatus comprising a housing having an outer surface that is generally cylindrical about a longitudinal axis, the surface comprising a plurality of longitudinally extending recesses.
6. An apparatus as claimed in claim 5 wherein the recesses are arranged so as to be generally parallel to one another and spaced around the housing, the recesses optionally being spaced equidistantly right around the housing.
7. An apparatus as claimed in claim 5 or 6 wherein each recess has a generally semi-circular cross section.
8. An apparatus as claimed in any one of claims 5 to 7 wherein opposing ends of each recess are rounded.
9. An apparatus as claimed in any one of claims 5 to 8 further comprising a mechanism for causing the fluid to be released to the atmosphere from the housing and wherein the housing is caused to rupture by an explosion that is initiated by the apparatus impacting a surface, the recesses facilitating radial expansion of the housing upon impact with the surface.
10. A detonator for an adiabatic fuse, the detonator com-

prising:

a body formed of a pyrotechnic composition;
 a passage extending partway through the body;
 and
 a second passage extending partway through
 the body so as to define a separator between it
 and the first passage;
 whereby, upon ignition of the adiabatic fuse, gas
 in the first passage is caused to be heated, there-
 by causing the body and the separator to burn,
 such that burning material is ejected from the
 second passage.

11. A detonator as claimed in claim 10 wherein the sep-
 arator is comprised of a part of the body.

12. A detonator as claimed in claim 10 or 11 wherein
 each passage is tapered inwardly from its open end.

13. A detonator as claimed in any one of claims 10 to 12
 wherein the second passage is arranged such that
 the burning material is ejected into a burster charge.

14. A projectile comprising:

a housing;
 a cone extending inwardly from the housing; and
 a detonator mechanism comprising an impact
 surface, the impact surface shaped so as to cor-
 respond to the distal end of the cone to guide
 the distal end of the cone;
 wherein impact of the housing against a surface
 causes the cone to move towards and collide
 with the impact surface of the detonator mech-
 anism thereby causing the detonator to deto-
 nate.

15. A projectile as claimed in claim 14 wherein the det-
 onator mechanism comprises a gas reservoir and
 the impact surface is a portion of a wall of the gas
 reservoir.

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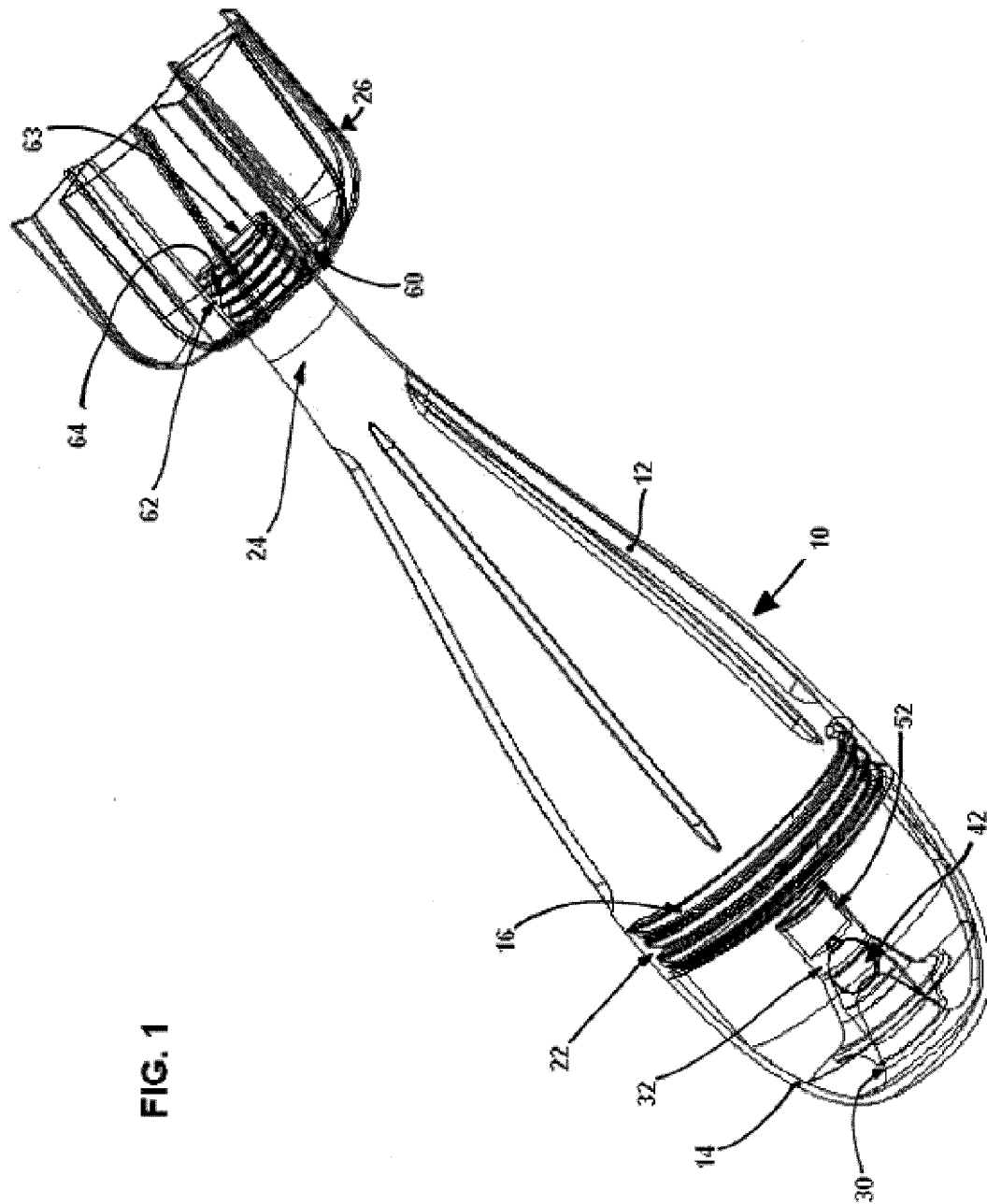


FIG. 1

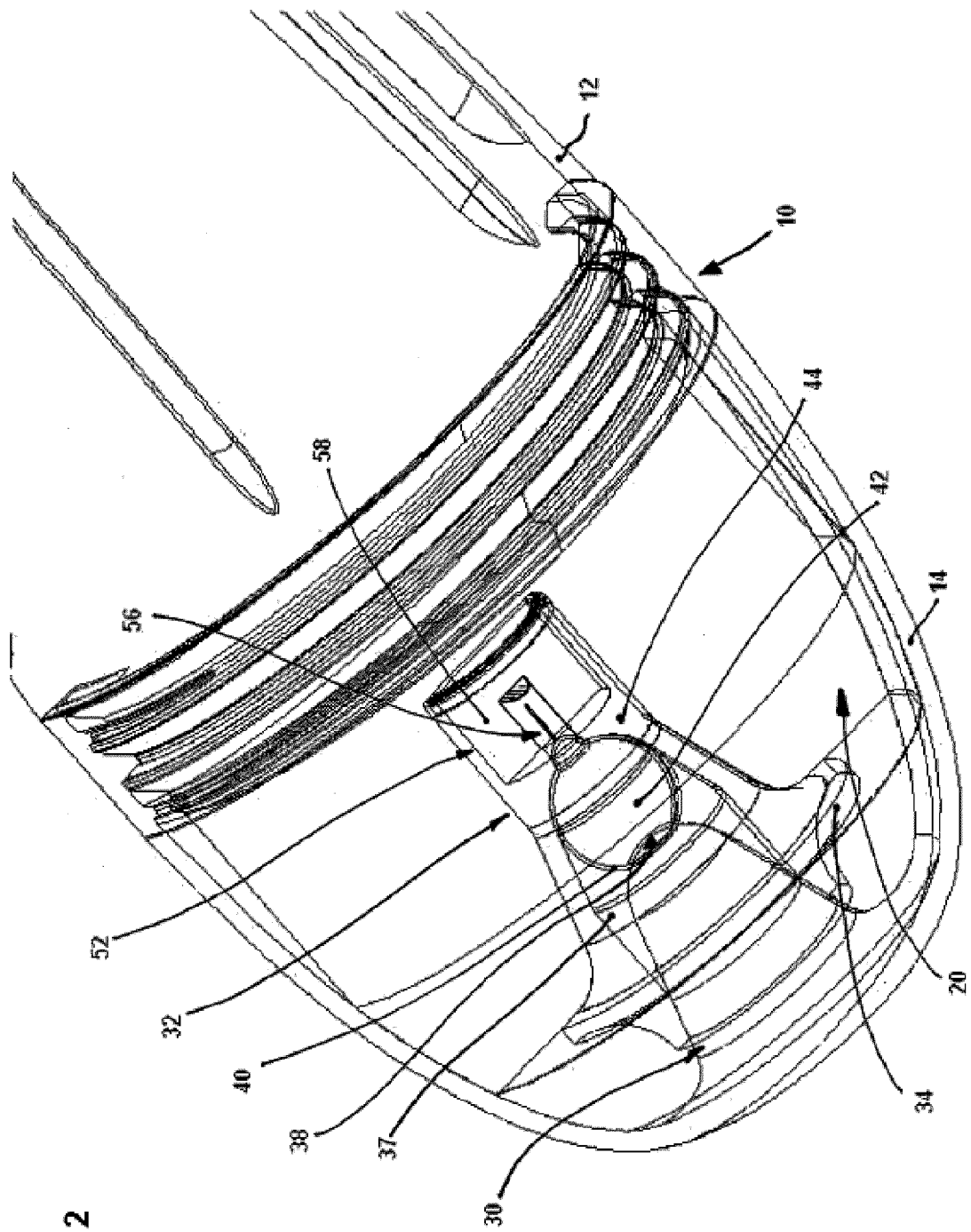
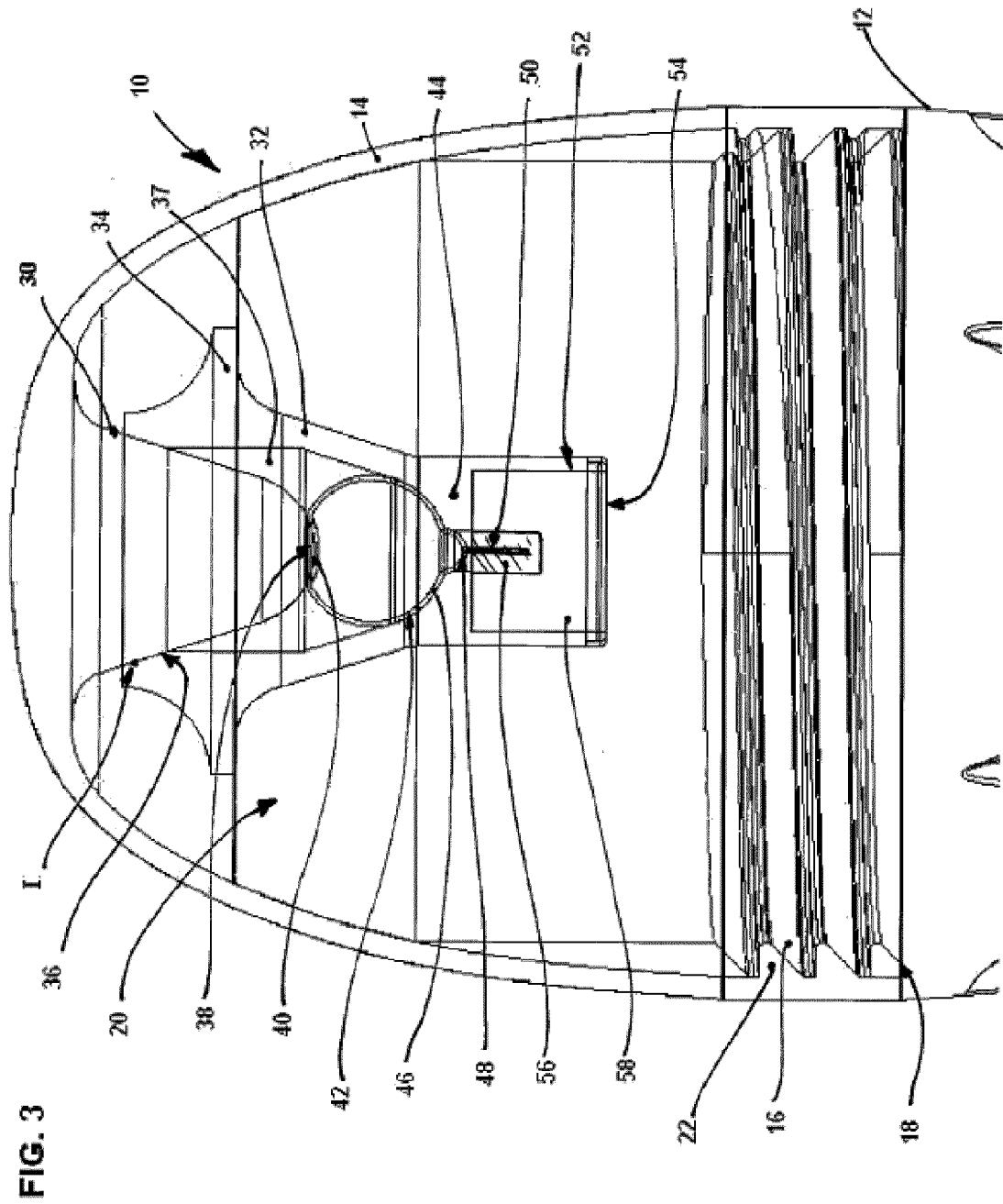


FIG. 2



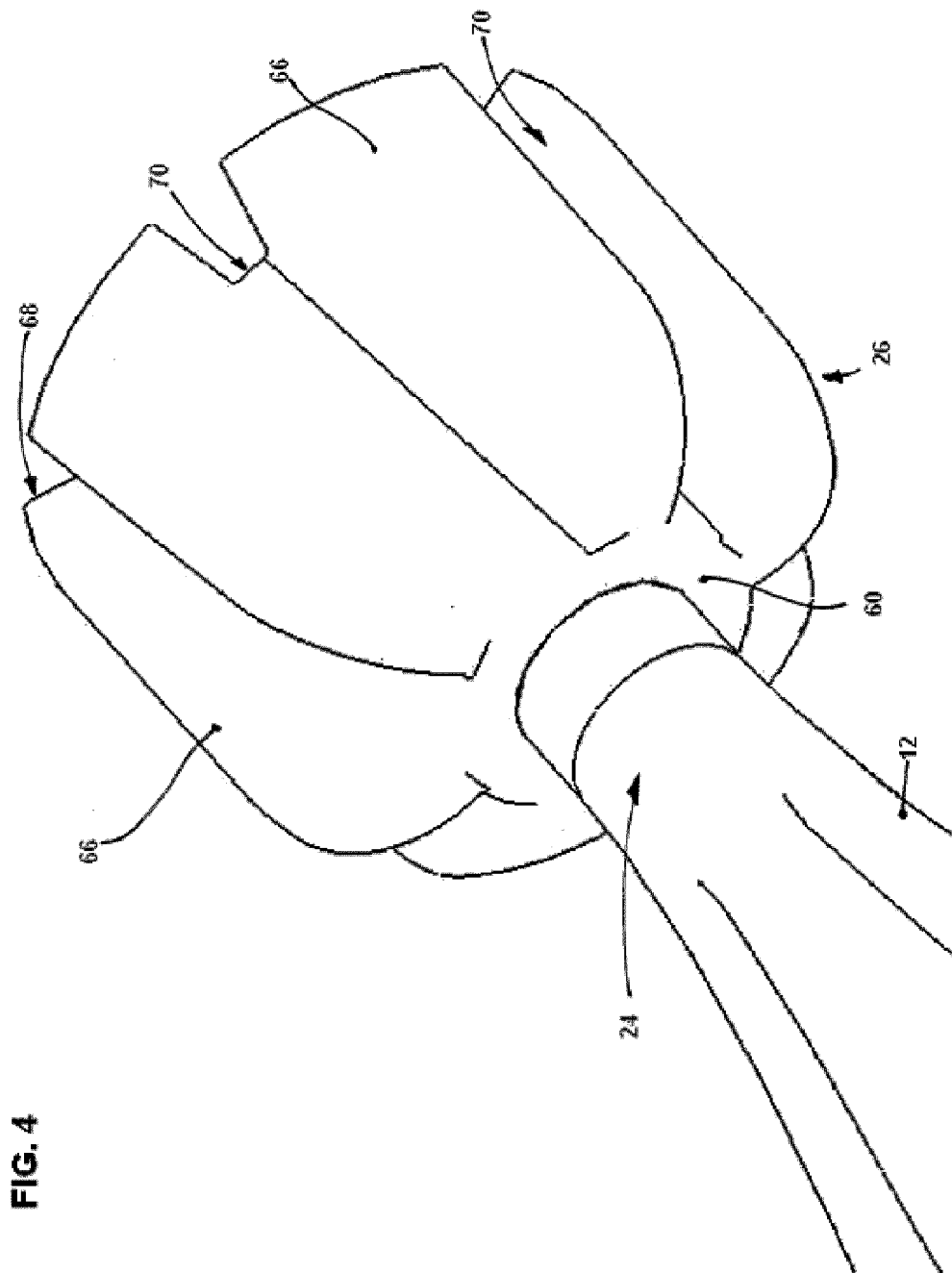


FIG. 4

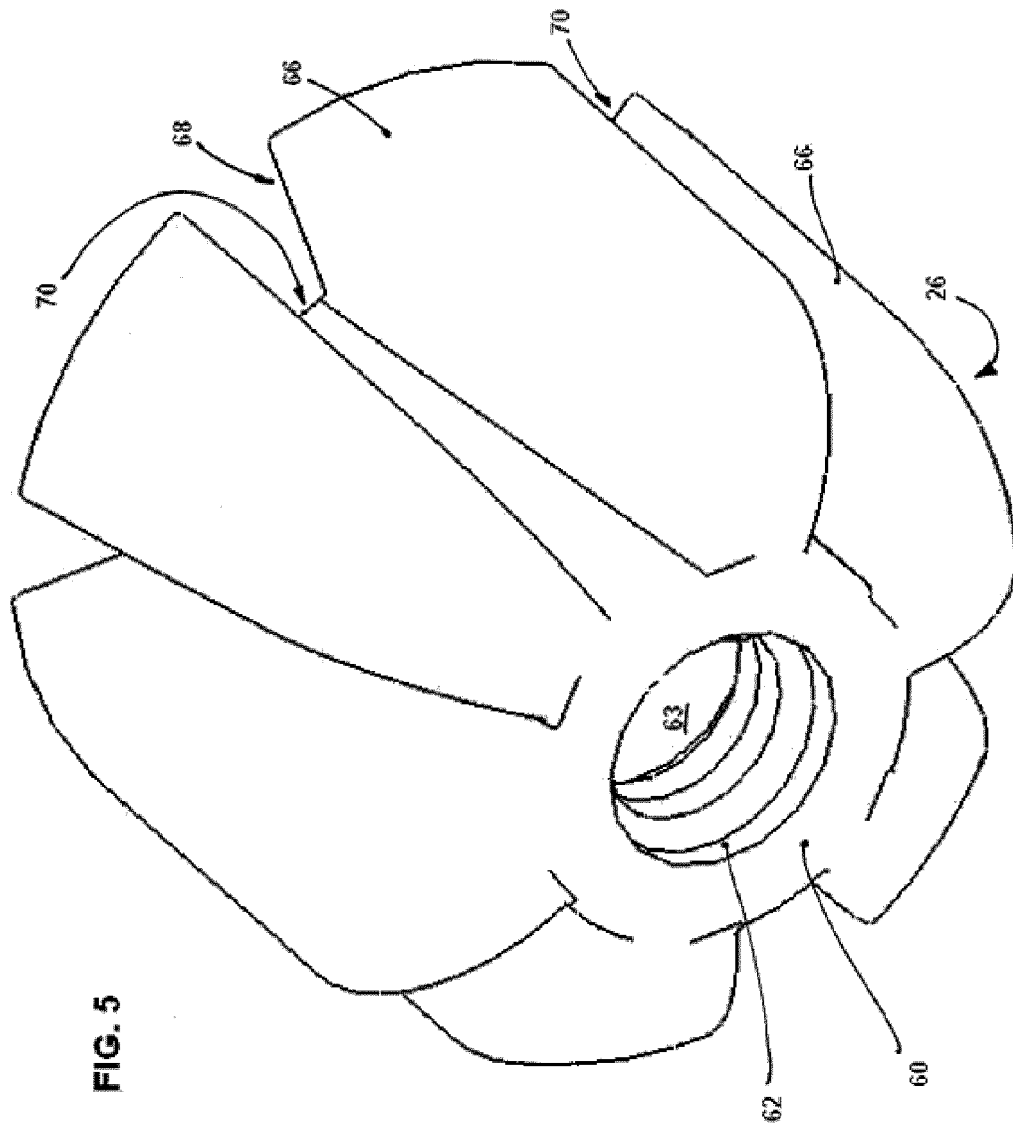
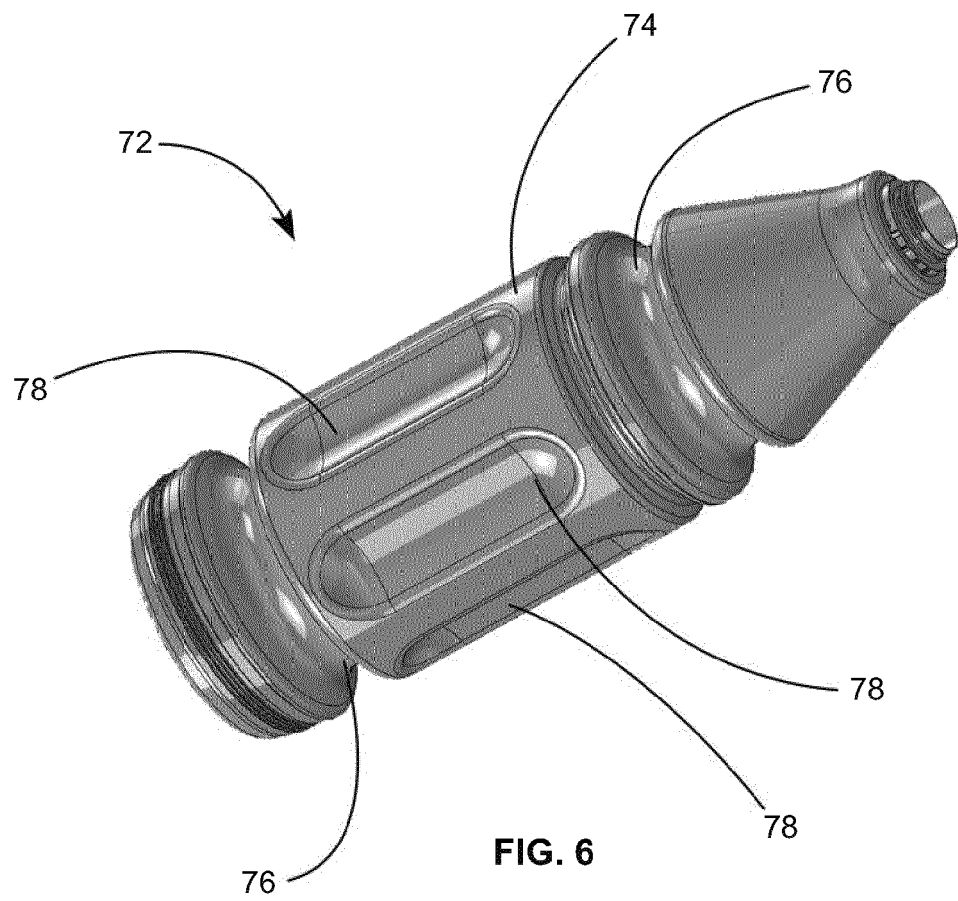


FIG. 5



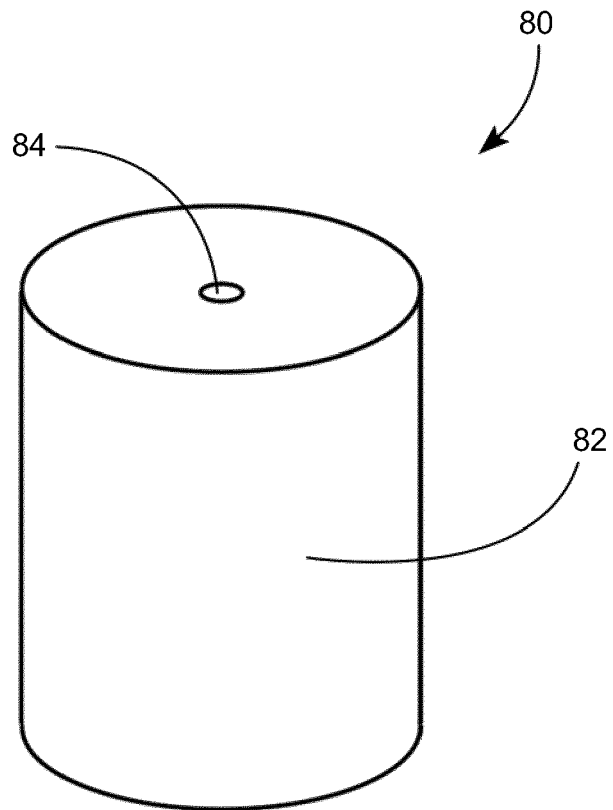


FIG 7A

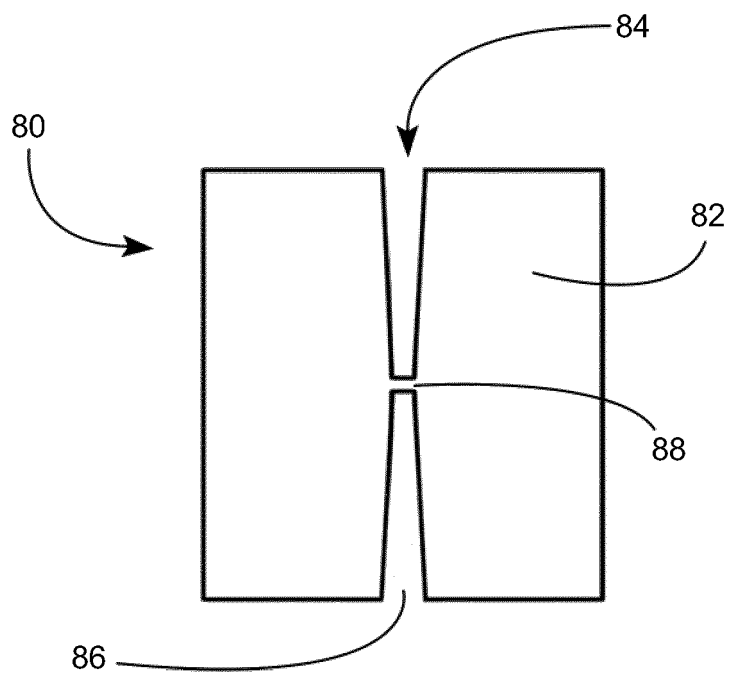


FIG 7B

REFERENCES CITED IN THE DESCRIPTION

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