(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 March 2012 (22.03.2012)

PCT

(10) International Publication Number
WO 2012/035038 A2

(51) International Patent Classification: Not classified

(21) International Application Number: PCT/EP2011/065891

(22) International Filing Date: 13 September 2011 (13.09.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
12/880,719 13 September 2010 (13.09.2010) US

(71) Applicant *(for all designated States except US)*: **POWERS PRODUCTS III, LLC** [US/US]; 2 Powers Lane, Brewster, New York 10509 (US).

(71) Applicant *(for VC only)*: **POWERS FASTENERS EUROPE BV** [NL/NL]; Westrak 208, NL-1771 SV Wieringerwerf (NL).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **GAUDRON, Paul** [US/US]; 305 Beaver Pond Road, Harrington, Delaware 19952 (US).

(74) Agent: **BALDWIN, Mark**; 40 Bowling Green Lane, London EC1R 0NE (GB).

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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published**:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

**(54) Title**: GAS CARTRIDGE

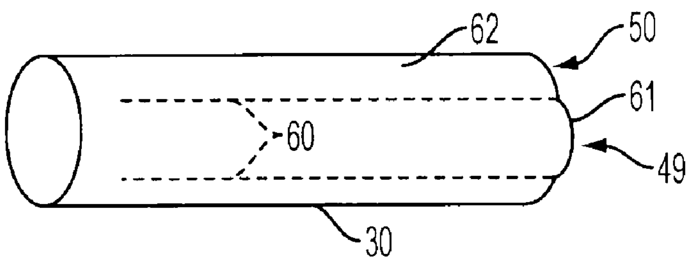


FIG. 6

**(57) Abstract**: A method of forming an inner can of a gas cartridge including securing inner can material and pre-stressing the material such that flexion thereof during gas cartridge use is distributed.

WO 2012/035038 A2

# GAS CARTRIDGE

## BACKGROUND OF THE INVENTION

The invention relates to gas cartridges.

Typically, a setting tool for striking a fastener includes a gas cartridge provided with an outer vessel (outer can), a gas charge vessel (inner bag) and an inner space formed between the two vessels. Liquefied fuel inside the gas charge vessel is ejected when a valve is opened by a combination of the effects of exposing the liquefied fuel to atmospheric conditions and a compressing force applied thereto by compression gas at high pressure, which is charged into the inner space.

The outer vessel is generally rigid and provides support to the gas charge vessel, which is operationally disposed in an interior of the outer vessel. The gas charge vessel includes a valve and is made of relatively thin aluminium or similar materials so as to be easily deformable as the liquefied fuel is ejected.

A result of the gas charge vessel being formed of such thinly formed materials is that, when the gas charge vessel is deformed, the deformation proceeds freely and often non-uniformly. This non-uniform deformation can lead to extreme deformation at particular sections of the gas charge vessel and relatively little deformation at others. For example, the opening portion of the gas charge vessel may experience minor deformation whereas the central portions of the gas charge vessel may be nearly entirely crushed. In such a case, a wrinkle or a fold in the gas charge vessel material may be formed and eventually may lead to a crack or a pin hole being produced.

When a crack or a pin hole is produced at the gas charge vessel, the compression gas is permitted to enter the gas charge vessel and its pressure is reduced. Similarly, the liquefied fuel may leak from the gas charge vessel. In each case, the gas charge vessel may be insufficiently compressed and the liquefied fuel may be undesirably mixed with the compression gas or lost from the gas charge vessel. When the valve is subsequently opened, the entire quantity of the liquefied fuel may not be ejected. This represents a degraded operation of the setting tool and may constitute an economic loss.

Summary of the Invention

The invention provides a method of forming an inner can of a gas cartridge is provided and includes securing inner can material and pre-stressing the material such that flexion thereof during gas cartridge use is distributed.

The invention also includes a gas cartridge comprising an inner can, which is charged with fluid that is selectively ejectable toward a gas cartridge exterior, and which includes inner can material that is deformable as fluid ejection and thermal cycling of the fluid proceed and a flexion distribution feature to distribute flexion of the inner can material associated with deformation thereof among inner can sections.

The invention also includes a gas cartridge comprising an outer can, a cap, including a selectively actuatable valve, to enclose an interior of the outer can, an inner can disposed within the outer can interior, which is charged with fluid ejectable toward a gas cartridge exterior upon selective actuation of the valve, the inner can being deformable as fluid ejection and thermal cycling of the fluid proceed and a flexion distribution feature to distribute flexion associated with inner can deformation among inner can sections

The invention also includes a gas cartridge comprising an outer can, a cap, including a selectively actuatable valve, to enclose an interior of the outer can and an inner can, which is charged with fluid, and which is disposed within the outer can interior to define a space charged with compression gas to encourage ejection of the fluid from the inner can toward a gas cartridge exterior upon selective actuation of the valve, the inner can including inner can material that is deformable as fluid ejection and thermal cycling of the fluid proceed with flexion associated with the deformation being distributed among multiple inner can sections.

The invention also includes an inner fuel container to be installed in an outer can of a setting tool gas cartridge to hold a fuel for a setting tool, said inner fuel container comprising a wall that is deformable in response to changes in the fuel held therein and said wall comprising a plurality of spaced apart deformation facilitating zones provided to facilitate distribution of said deformation of the inner fuel container.

The invention also includes a method of manufacturing a setting tool gas cartridge comprising forming an inner fuel container to be installed in a setting tool gas cartridge, said forming comprising providing a wall of said inner fuel container with a plurality of spaced apart deformation facilitating zones to distribute deformation of said inner fuel container in response to changes in a fuel contained therein.

Brief Description of the Drawings

In order that the invention may be well understood, some embodiments thereof, which are given by way of example only, will now be described with reference to the drawings in which:

FIG. 1 is a perspective view of a gas cartridge;

FIG. 2 is an exploded perspective view of the gas cartridge of FIG.1;

FIGS. 3A, 3B and 3C illustrate possible flexion of inner can material in a prior art structure;

FIG. 4 is a schematic sectional view of inner can material according to embodiments;

FIG. 5 is a schematic sectional view of various inner can materials according to embodiments;

FIG. 6 is a side view of an inner can according to embodiments; and

FIG. 7 is a schematic diagram of a method of forming an inner can of a gas cartridge.

Detailed Description of the Illustrated Embodiments

Referring to FIGS. 1 and 2, a gas cartridge 10 that may be used with a setting tool comprises an outer can 15 having a peripheral wall 16 that is formed to define an outer can interior 17 and a cap 20. The cap 20 includes a selectively actuatable valve 21 and is attachable to a normally open end of the outer can 15 to enclose the outer can interior 17. The other end of the outer can 15 is capped or otherwise closed as well.

The gas cartridge 10 further includes an inner can 30, which is formed of inner can material 31 that is shaped to define an inner can interior 32. The inner can interior 32 may be charged with fluid, such as liquefied fuel, gas or similar fluids. Where the fluid is liquefied fuel, the liquefied fuel may, in some cases, be selected so that it vaporizes upon exposure to atmospheric conditions such that it can be ejected at high speed and/or high pressure. In this way, the gas cartridge 10 may be employed as a component of a setting tool in which the liquefied fuel vapour is able to be ejected for use with a targeted fastening element.

The inner can 30 may be disposed within the outer can interior 17 and supported by at least the cap 20 and, in some but not all cases, the peripheral wall 16 or structures coupled thereto. With the inner can 30 supported by the cap 20, the selectively actuatable valve 21 may define a pathway 35 extending from the inner can interior 32 to a gas cartridge exterior 33 (i.e., proximate to a targeted fastening element) when the selectively actuatable valve 21 is actuated and thereby opened.

Further, with the inner can 30 disposed within the outer can interior 17, the inner can 30 defines a space 34 between an exterior surface of the inner can material 31 and an interior surface of the peripheral wall 16. The space 34 may be charged with compression gas that exerts pressure on the inner can 30 that compresses the inner can 30 and encourages ejection of the fluid from the inner can interior 32 toward the gas cartridge exterior 33 upon the selective actuation of the selectively actuatable valve 21. Thus, if the pressure of the compression gas is high enough, it may not be necessary for the liquefied fuel to be vaporized upon exposure to atmospheric conditions since the pressure of the compression gas may be sufficient to eject the fluid from the inner can interior 32 at high enough velocity to accomplish a given application.

The inner can material 31 is relatively thin walled and made of, for example aluminium, tin, a similar metallic material or an alloy thereof, such that the inner can 30 is relatively easily deformed by the compression gas charged into the space 34 as fluid ejection from the inner can interior 32 proceeds and/or as thermal cycling of the fluid or the compression gas proceeds. Flexion of the inner can material 31, which is associated with the deformation of the inner can 30, is distributed among multiple sections of the inner can 30 by a flexion distribution feature as described below.

FIGS 3A, 3B and 3C show how flexion of the inner can material 31 can occur in a prior art structure as a volume of the fluid charged in the inner can interior 32 decreases. As shown in FIG. 3A, this initial level may represent a case in which the volume of the inner can interior 34 is entirely filled with fluid such that the inner can material 31 is in tension. Upon a decrease in the volume of the fluid, as shown in FIG. 3B, the inner can material 31 is deformed and exhibits a dent or recess 40 caused. As shown in FIG. 3C, as the volume continues to decrease, a possibility exists that the resulting continued deformation will cause the recess 40 to eventually form a fold 41, which may lead to generation of a pinhole in the inner can 30 that will inhibit full ejection of the fluid and a corresponding product failure or economic loss.

With the flexion distribution feature of the embodiments, flexion of the inner can material 31, which is associated with the deformation of the inner can 30, is distributed among multiple inner can sections, so that the eventual formation of such folds 41 may be avoided or at least substantially reduced. Also, as described below, this distribution of the flexion of the inner can material 31 may be dependent or independent of support providable by the outer can 15. That is, with reference to FIG. 4, the flexion of the inner can material 31 may be distributed among the multiple sections of the inner can 30 in accordance with the inner can 30 and/or the inner can material 31 being formed with flexion distributing structures.

As shown in FIG. 4, the flexion distribution feature may be provided by the inner can material 31 having differing thicknesses at various locations. For example, the inner can material 31 may be formed to have a first thickness, $T_1$, at first ones 49 of the multiple sections and a second thickness, $T_2$, which is for example thinner than the first thickness, $T_1$, at second ones 50 of the multiple sections. As such, the inner can 30 has throat sections 51 at borders between the first and second ones 49, 50 of the multiple sections that may serve as local stress points. The inner can 30 may be formed such that these local stress points are distributed at various locations of the inner can 30 such that, as inner can 30 deformation proceeds, the flexion of the inner can material 31 can be distributed to these local stress points as opposed to single locations where a fold 41 and/or an eventual pinhole may form.

As shown in FIG. 5, the flexion distribution feature may be provided by the inner can material 31 including various materials having different mechanical properties at various locations. For example, the inner can material 31 may include at the first ones 49 of the multiple sections a first material 52 and, at the second ones 50 of the multiple locations, a second material 53, which has at least one mechanical property that is different from that of the first material 52. For example, the second material 53 may mate with the first material 52 at sealing sections 54 and be more compliant, or flexible, than the first material 52.

As shown in FIG. 6, the flexion distribution feature may be provided by the inner can 30 being formed with seams 60 that delimit borders of exemplary first and second portions 61, 62 at first and second ones 49, 50 of the multiple sections, respectively. These borders are formed such that the inner can 30, when fully charged with fluid, has a shape that may be regular or irregular. That is, in the example of FIG. 6, first and second portions 61 and 62 are substantially tubular and extend laterally in different directions. In this way, as deformation of the inner can 30 or thermal cycling proceeds, the first and second portions 61 and 62 will tend to deform in different directions such that developing stresses can be distributed in a similar manner as described above. It is understood that the example of FIG. 6 is not limiting and that other shapes both regular and irregular are possible.

The flexion distribution feature may be provided by the inner can 30 further including skeletal supports that are disposed at the inner can interior and/or exterior. In both cases, the skeletal supports may be formed to support the inner can 30 as deformation of the inner can 30 proceeds. The skeletal supports may each include elastic elements and/or may be coupled to the outer can 15 via coupling elements to further increase support of the inner can 30. The skeletal supports may also be movable relative to the cap 20 as the fluid ejection and the thermal cycling proceed.

In accordance with further embodiments of the invention, it is understood that the examples shown in FIGS. 4-6 are non-limiting and that other formations of the inner can 30 and types of inner can material 31 are possible. It is further understood that the various embodiments described herein and made possible by similar embodiments may be combined with one another.

With reference to FIG. 7 and, in accordance with further aspects, a method of forming the inner can 30 of the gas cartridge 10 is provided and includes securing the material to be formed into the inner can 30 in, for example, a holder 100 and pre-stressing the material at for example multiple locations such that flexion thereof during gas cartridge 10 use is distributed among multiple inner can sections associated with the exemplary multiple locations. Prior to the pre-stressing operation or following the per-stressing, the material may be formed into a substantially cylindrical shape, as shown in FIG. 2. That is, the pre-stressing may occur with the material already formed into the inner can 30 shape or prior to such shaping. As an example, the material may be pre-stressed while in sheet form or only a partial cylindrical form or after being formed into an otherwise completed inner can.

The multiple locations may extend linearly or substantially linearly parallel to a longitudinal axis of the substantially cylindrical shape whether the pre-stressing occurs before or after the forming of the inner can 30 material into the substantially cylindrical shape. As such, the flexion distributed among the multiple inner can sections associated with the multiple locations will tend to occur along or in parallel with these longitudinally extending lines, which may be uniformly or non uniformly circumferentially distributed ($\alpha_1 = \alpha_2 = \alpha_3$ or $\alpha_1 \neq \alpha_2 \neq \alpha_3$) and parallel with or transverse from one another.

The pre-stressing may be achieved by the application of pressure to the inner can 30 material at the multiple locations and/or the placing of the material in tension at the multiple locations. For example, as shown in FIG. 7, pressurizing forces $F_{PS1-3}$, which may be substantially equal or non-equal, can be applied to the inner can 30 material at the multiple locations before or after formation of the inner can 30 material into the substantially cylindrical shape.

The embodiments provide an inner container for a gas cartridge that has a plurality of spaced apart deformation facilitating zones that facilitate deformation of the container in response to changes in the content of the container. The inner container can be a fuel container for a gas cartridge used to provide fuel for a setting tool. The inner container comprises a wall that is deformable so that as the fuel expands and contracts due to changes in temperature the container can deform accordingly and similarly the container can deform as the fuel is used up and the volume of fuel contained reduces. The spaced apart deformation facilitating zones ensure that the deformation of the can is distributed about the container thereby preventing or at least substantially reducing the formation of folds such as the fold 41 shown in FIG. 3C.

The inner container may be tubular body made of aluminium. The tubular body may be formed by a reverse extrusion process. The deformation facilitating zones may be formed during the extrusion process. Alternatively, the deformation facilitating zones may be formed following extrusion. For example, following extrusion of the tubular body, a mandrel or other support may be inserted into the body and a plurality of elements pressed against an outer wall of the body to form the deformation facilitating zones. The deformation facilitating zones may take the form of indents, for example creases, defined in the wall. The deformation facilitating zones may comprise sections of reduced thickness of the wall produced by localised pressing and/or stretching of the wall material. The deformation facilitating zones may comprises zones of relative weakness in the container wall.

The inner container may made a shipped separately for installation in an outer can. Similarly, the completed gas cartridge may be manufactured and shipped empty to filler for filling with fuel and propellant/compression gas. Those skilled in the art will be familiar with the techniques used to fill gas cartridges and so no detailed description of that will be given here.

The inner container may take the form of a can or a bag.

It is to be understood that the disclosure in the Background to the Invention (including any potential prior art) is not to be taken as an admission of the common general knowledge.

It is recognised that the terms "comprise", "comprises" and "comprising" may, under varying jurisdictions, be attributed with an exclusive or an inclusive meaning. For the purpose of this specification, and unless otherwise noted, these terms are intended to have an inclusive meaning - ie they are to be taken to mean an inclusion of just the listed components that the use directly references and also the inclusion of other non-specified components or elements.

While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

CLAIMS:

1. A method of forming an inner can of a gas cartridge, comprising:
securing an inner can material; and
pre-stressing the material such that flexion thereof during gas cartridge use is distributed.

2. The method according to claim 1, further comprising forming the material into a substantially cylindrical shape.

3. The method according to claim 2, wherein the pre-stressing is performed at multiple locations, each of which extends substantially parallel to a longitudinal axis of the substantially cylindrical shape.

4. The method according to claim 1, 2 or 3, wherein the securing comprises securing the material in a holder.

5. The method according to any one of the preceding claims, wherein the pre-stressing comprises at least one or more of applying pressure to the material and placing the material in tension.

6. A gas cartridge, comprising:
an inner can charged with fluid that is selectively ejectable toward a gas cartridge exterior, said inner being made of an inner can material that is deformable as fluid ejection and thermal cycling of the fluid proceed and comprising first inner can sections and second inner can sections; and
a flexion distribution feature to distribute flexion of the inner can material associated with deformation thereof among said first inner can sections.

7. The gas cartridge according to claim 6, wherein the flexion distribution feature comprises the inner can material having a first thickness at said first the inner can

sections and a second thickness, which is different from the first thickness, at said second inner can sections.

8. The gas cartridge according to claim 7, wherein the second thickness is thinner than the first thickness.

9. The gas cartridge according to claim 6, 7 or 8, wherein the flexion distribution feature comprises the inner can material comprising a first material at said first inner can sections and a second material, which has a different mechanical property than the first material, at said second inner can sections.

10. The gas cartridge according to claim 9, wherein the second material is more compliant than the first material.

11. The gas cartridge according to any one of claims 6 to 10, wherein the flexion distribution feature comprises seams.

12. The gas cartridge according to claim 11, wherein the seams delimit borders of said first and second inner can sections.

13. The gas cartridge according to claim 12, wherein said first and second inner can sections are deformable in different directions.

14. The gas cartridge according to claim 12 or 13, wherein the seams constrain the inner can to assume an irregular shape.

15. The gas cartridge according to any one of claims 6 to 14, further comprising:
an outer can; and
a cap, including a selectively actuatable valve, to close an end of the outer can.

.

16. The gas cartridge according to claim 15, further comprising compression gas charged in a space defined between the outer and inner cans to encourage the fluid ejection.

17. The gas cartridge according to claim 15 or 16, wherein the inner can is supported within the outer can interior by the cap, and, when selectively actuated, the valve defines a pathway from an inner can interior to the gas cartridge exterior.

18. The gas cartridge according to any one of claims 6 to 17, wherein the fluid comprises liquefied fuel.

19. The gas cartridge according to any one of claims 6 to 18, wherein distribution of the flexion is independent of inner can support providable by the outer can.

20. An inner fuel container to be installed in an outer can of a setting tool gas cartridge to hold a fuel for a setting tool, said inner fuel container comprising a wall that is deformable in response to changes in the fuel held therein and said wall comprising a plurality of spaced apart deformation facilitating zones provided to facilitate distribution of said deformation of the inner fuel container.

21. An inner fuel container as claimed in claim 20, wherein said deformation facilitating zones extend in a lengthways direction of the inner fuel container.

22. An inner fuel container as claimed in claim 20 or 21, wherein said deformation facilitating zones comprise indents defined in said wall.

23. An inner fuel container as claimed in claim 20, 21 or 22, wherein said deformation facilitating zones are defined by sections of reduced thickness of said wall.

24. An inner fuel container as claimed in any one of claims 20 to 23, comprising at least three said deformation facilitating zones.

25. A setting tool gas cartridge comprising an outer can, an inner fuel container as claimed in any one of claims 20 to 24 housed in said outer can and a valve operable to permit release of a fuel from said inner fuel container.

26. A setting tool gas cartridge as claimed in any one of claims 20 to 25, further comprising a fuel contained in said inner fuel container and a compression gas contained in a space defined between said inner fuel container and said outer can.

27. A method of manufacturing a setting tool gas cartridge comprising forming an inner fuel container to be installed in a setting tool gas cartridge, said forming comprising providing a wall of said inner fuel container with a plurality of spaced apart deformation facilitating zones to distribute deformation of said inner fuel container in response to changes in a fuel contained therein.

28. A method as claimed in claim 27, comprising providing said deformation facilitating zones by pressing said wall.

29. A method as claimed in claim 27, comprising providing said deformation facilitating zones by indenting said wall.

30. A method as claimed in claim 27, 28 or 29, wherein said deformation facilitating zones extend in a lengthways direction of said inner fuel container.

31. A method as claimed in any one of claims 27 to 30, comprising forming said inner fuel container by reverse extrusion.

32. A method as claimed in claim 31, comprising providing said deformation facilitating zones subsequent to reverse extruding said inner fuel container.

33. A method as claimed in any one of claims 27 to 32, comprising installing said inner fuel container in an outer can and providing a valve operable to release a fuel from said inner fuel container.

34. A method as claimed in claim 33, comprising providing a said fuel in said inner fuel container.

35. A method as claimed in claim 34, comprising providing a compression gas in a space defined between said inner fuel container and said outer can.

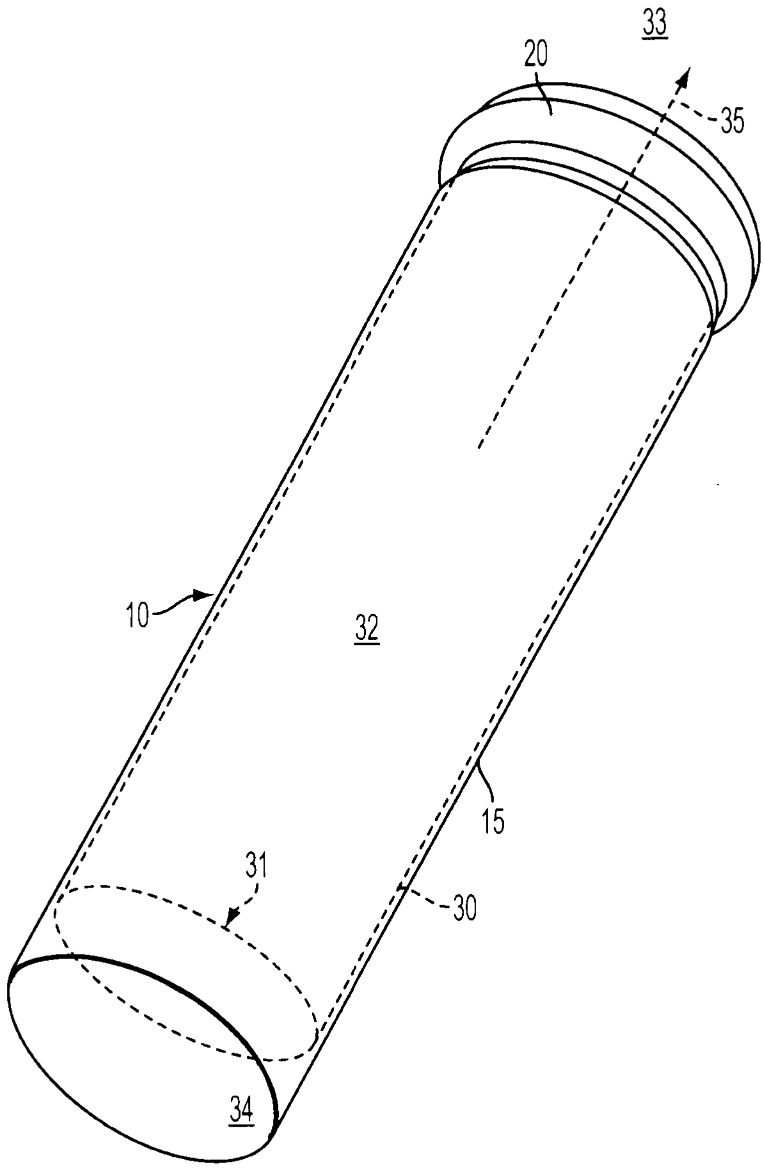


FIG. 1

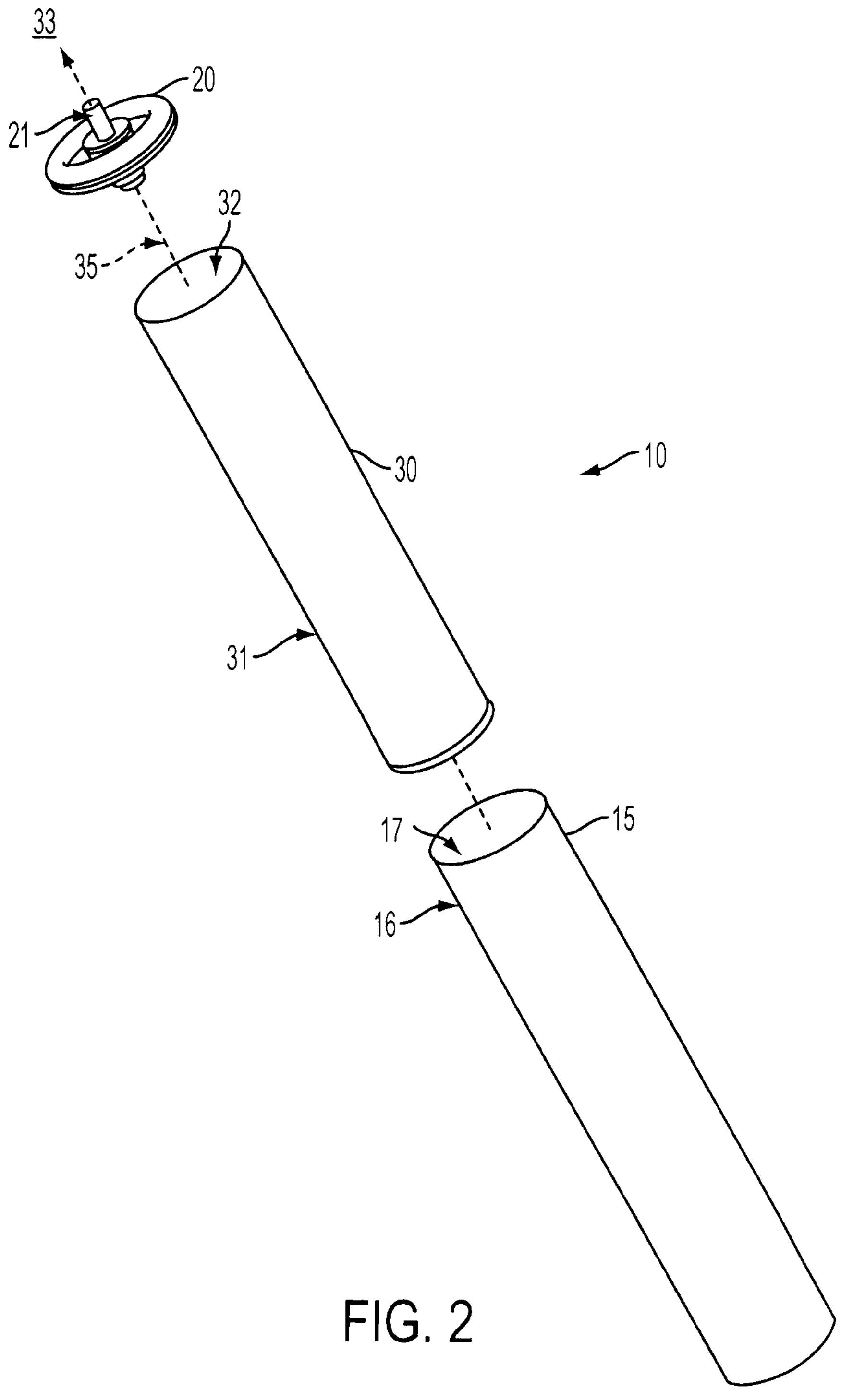


FIG. 2

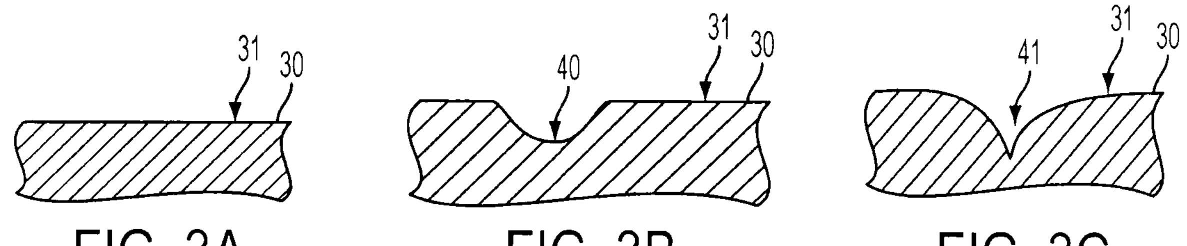


FIG. 3A FIG. 3B FIG. 3C

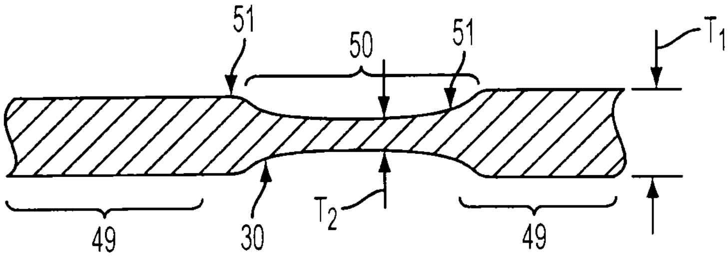


FIG. 4

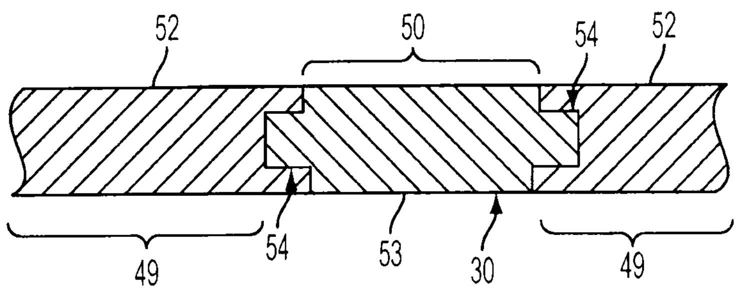


FIG. 5

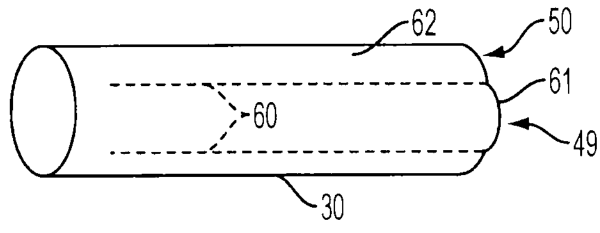


FIG. 6

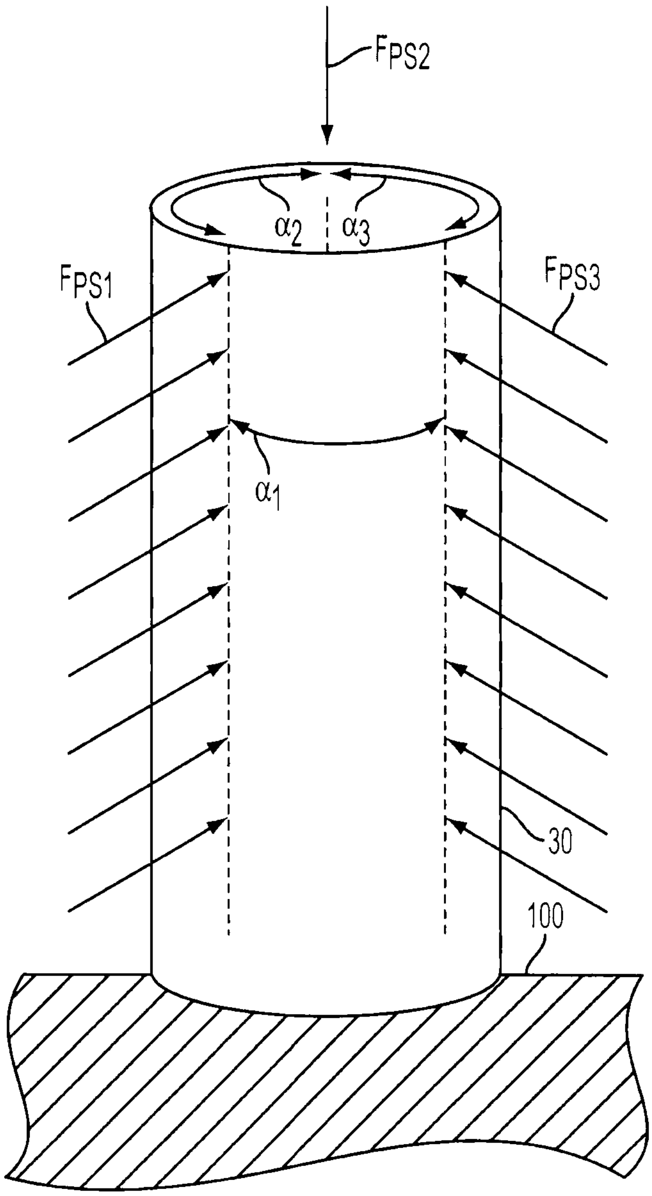


FIG. 7