US 20030205580A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2003/0205580 A1**

Yahav (43) **Pub. Date: Nov. 6, 2003**

(54) **SPRAY DISPENSER**

(76) Inventor: **Shimon Yahav**, Rehovot (IL)

Correspondence Address:
LADAS & PARRY
26 WEST 61ST STREET
NEW YORK, NY 10023 (US)

(21) Appl. No.: **10/181,876**

(22) PCT Filed: **Jan. 24, 2001**

(86) PCT No.: **PCT/IL01/00068**

(30) **Foreign Application Priority Data**

Jan. 25, 2000 (IL) 134219

Publication Classification

(51) **Int. Cl.**[7] **B67B 7/00**

(52) **U.S. Cl.** **222/1**

(57) **ABSTRACT**

This invention is an apparatus (**10**) for spraying contents of a spray container (**16**), including a dispenser body (**12**) sealingly attachable to the container containing a fluid (**18**), a fluid outlet (**20**) formed in the dispenser body and a deformable element (**56**) generally freely (**51**) supported around a perimeter thereof in the dispenser body, the deformable element having a first orientation (FIG. **1**A) when in a reference temperature range and reversibly deforming to a second orientation (FIG. **1**B) when out of the reference temperature range, wherein in the first orientation the deformable element is operative to block passage of the fluid from the container and in the second orientation of the deformable element is operative to allow a passage of the fluid from the container. A method of dispensing a fluid from a container is also disclosed.

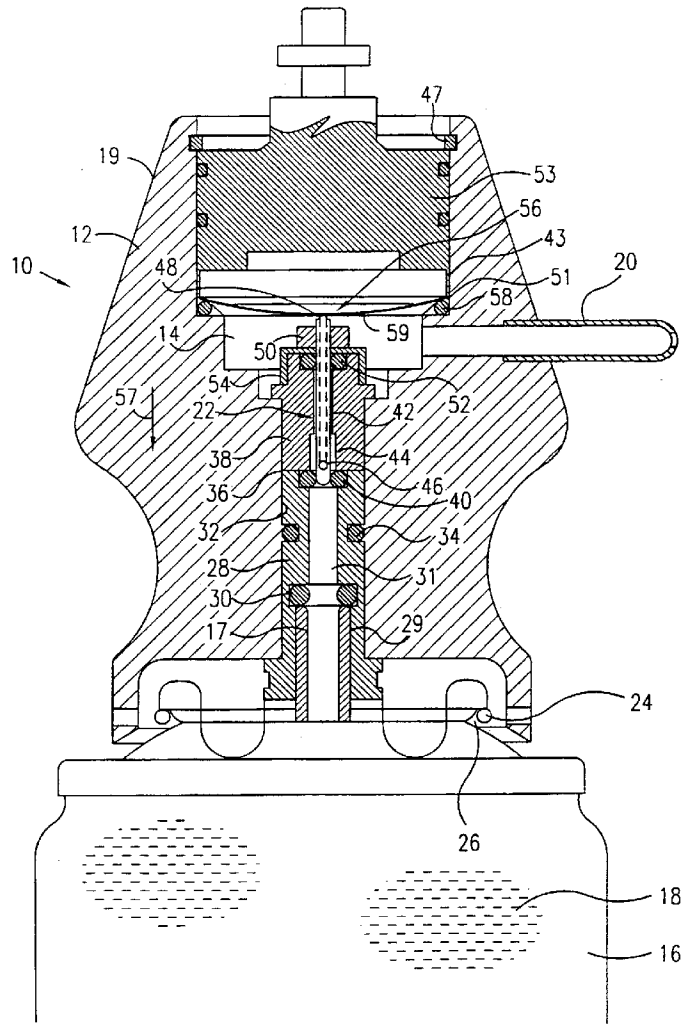

FIG. 1A

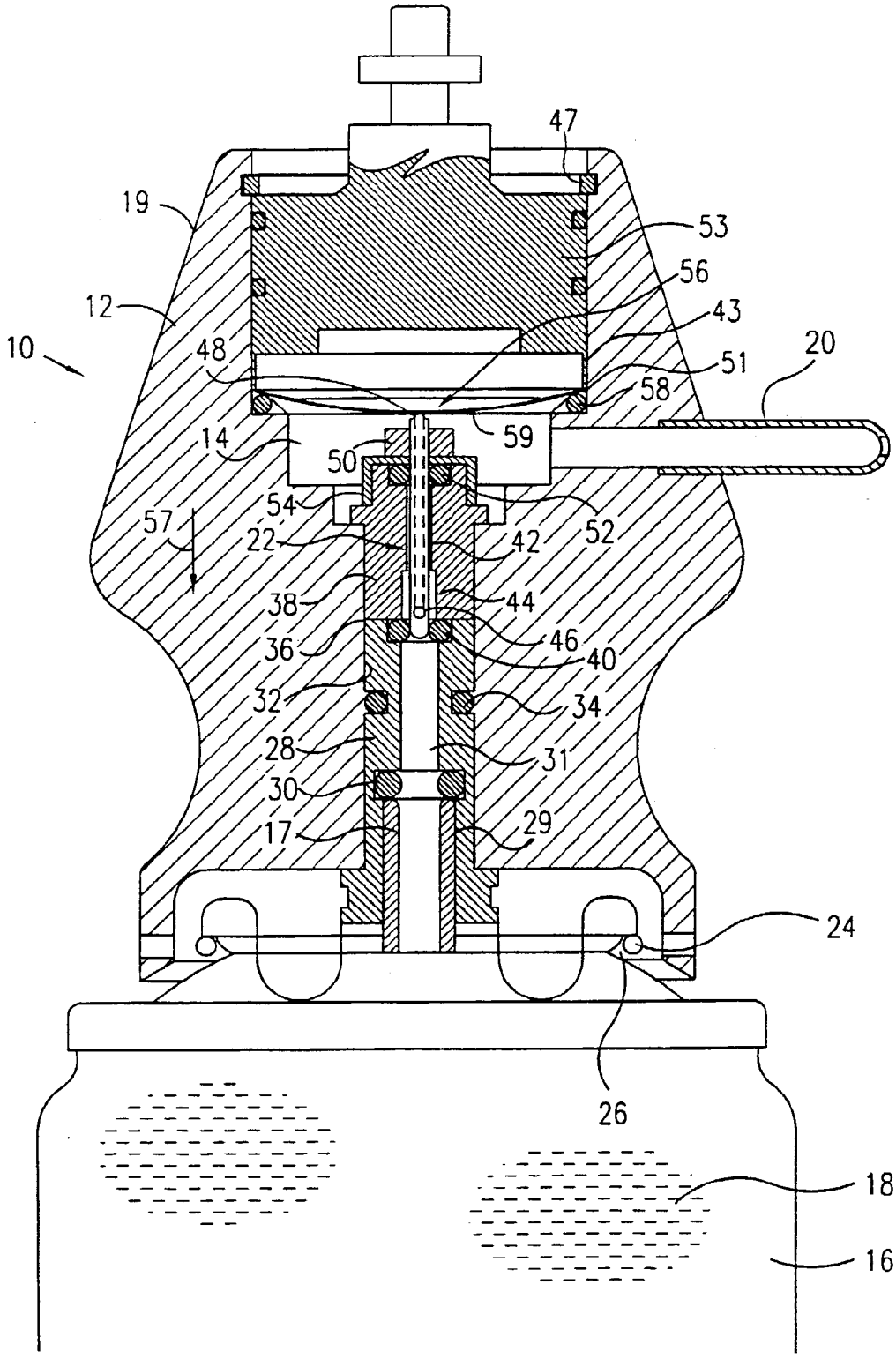
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FIG. 1B

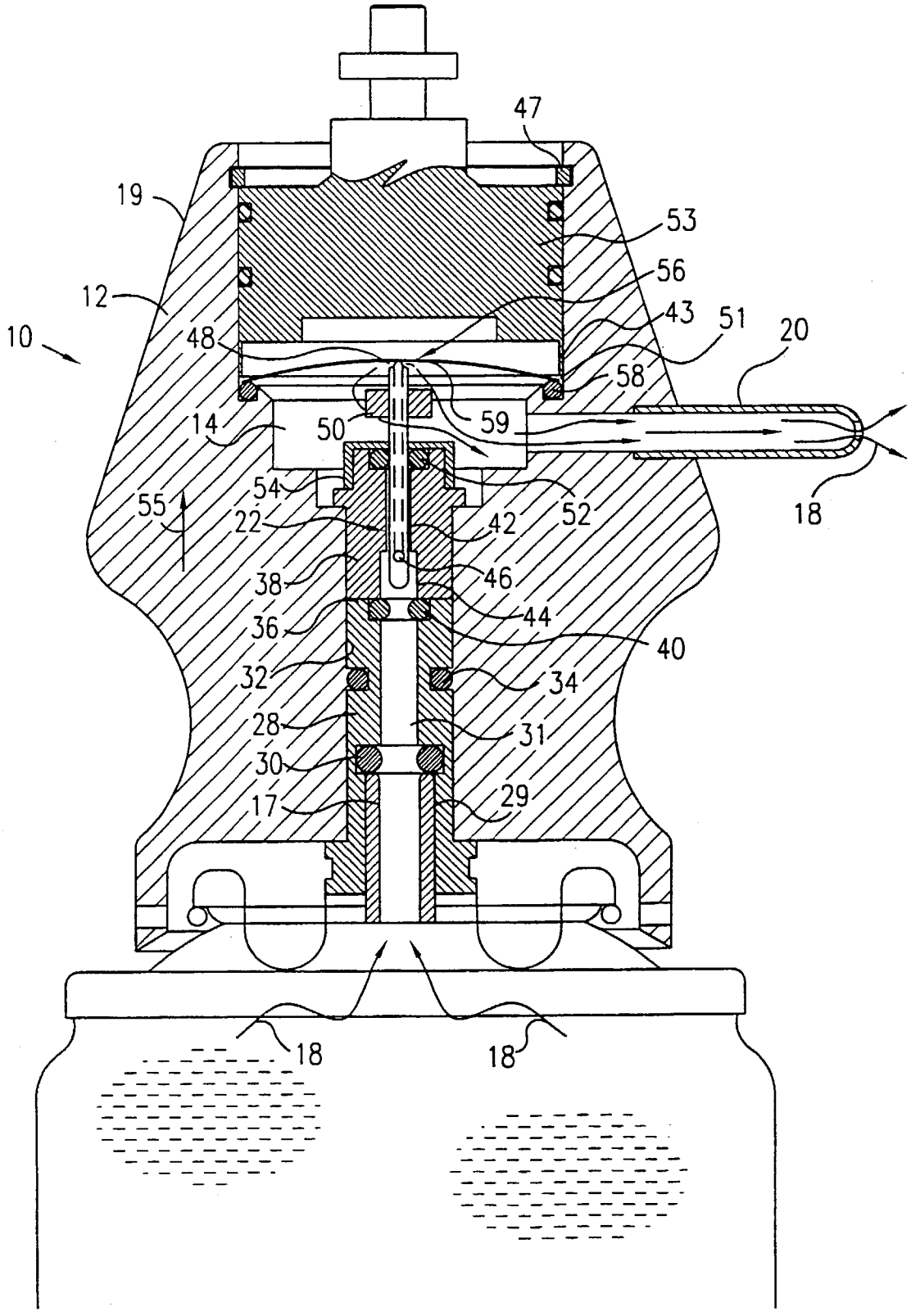
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FIG. 2A

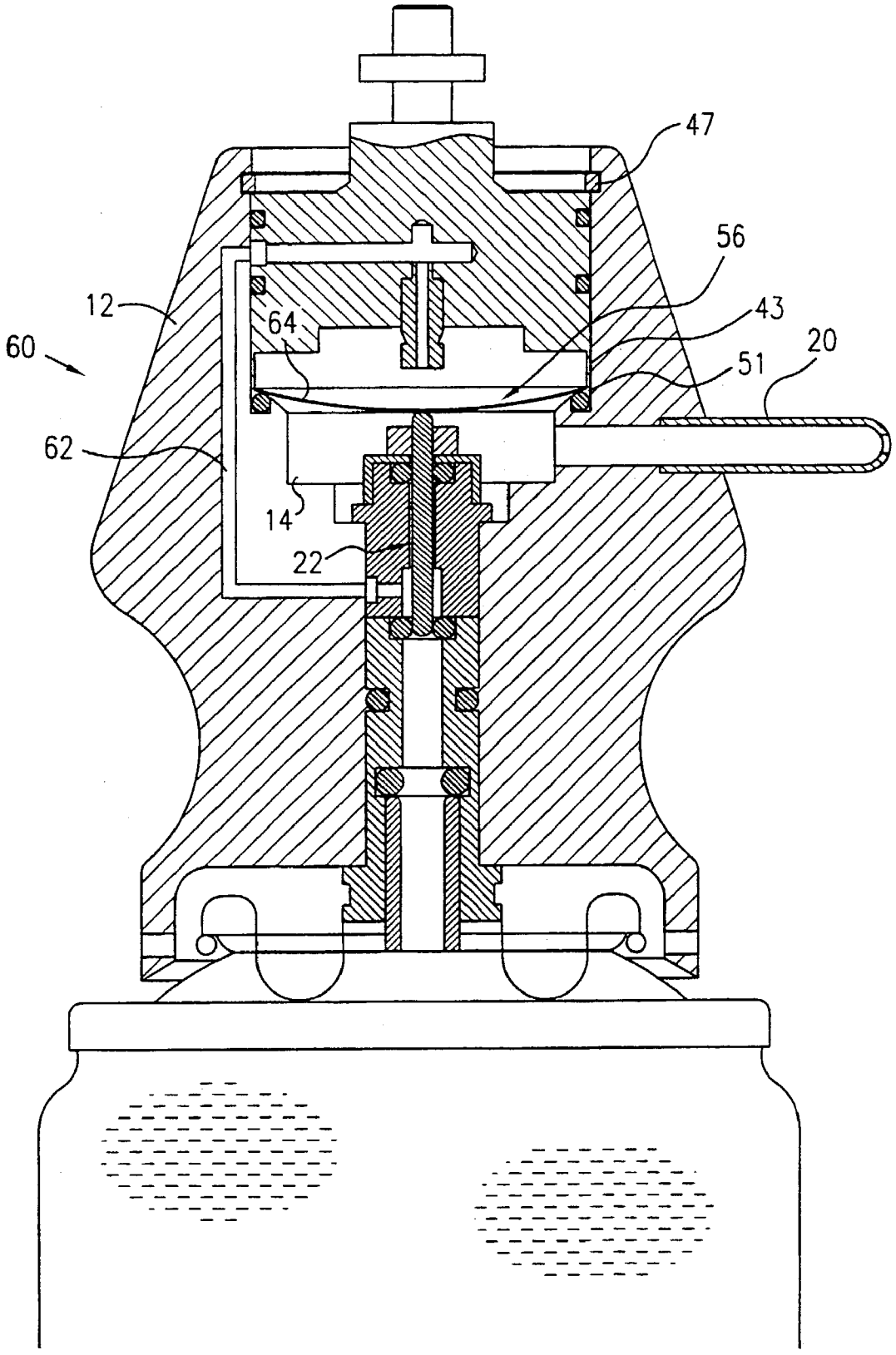

FIG. 2B

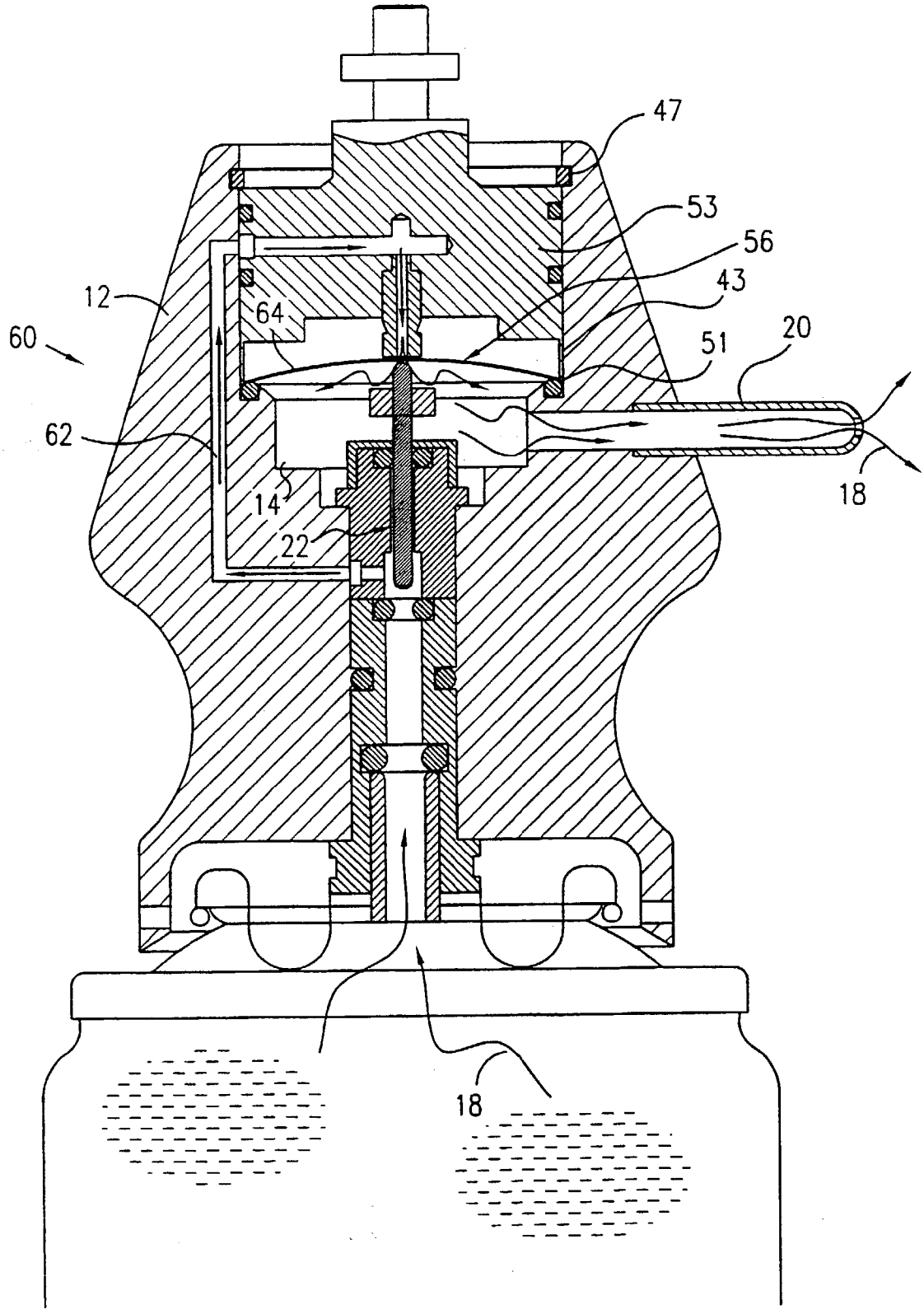

FIG. 3A

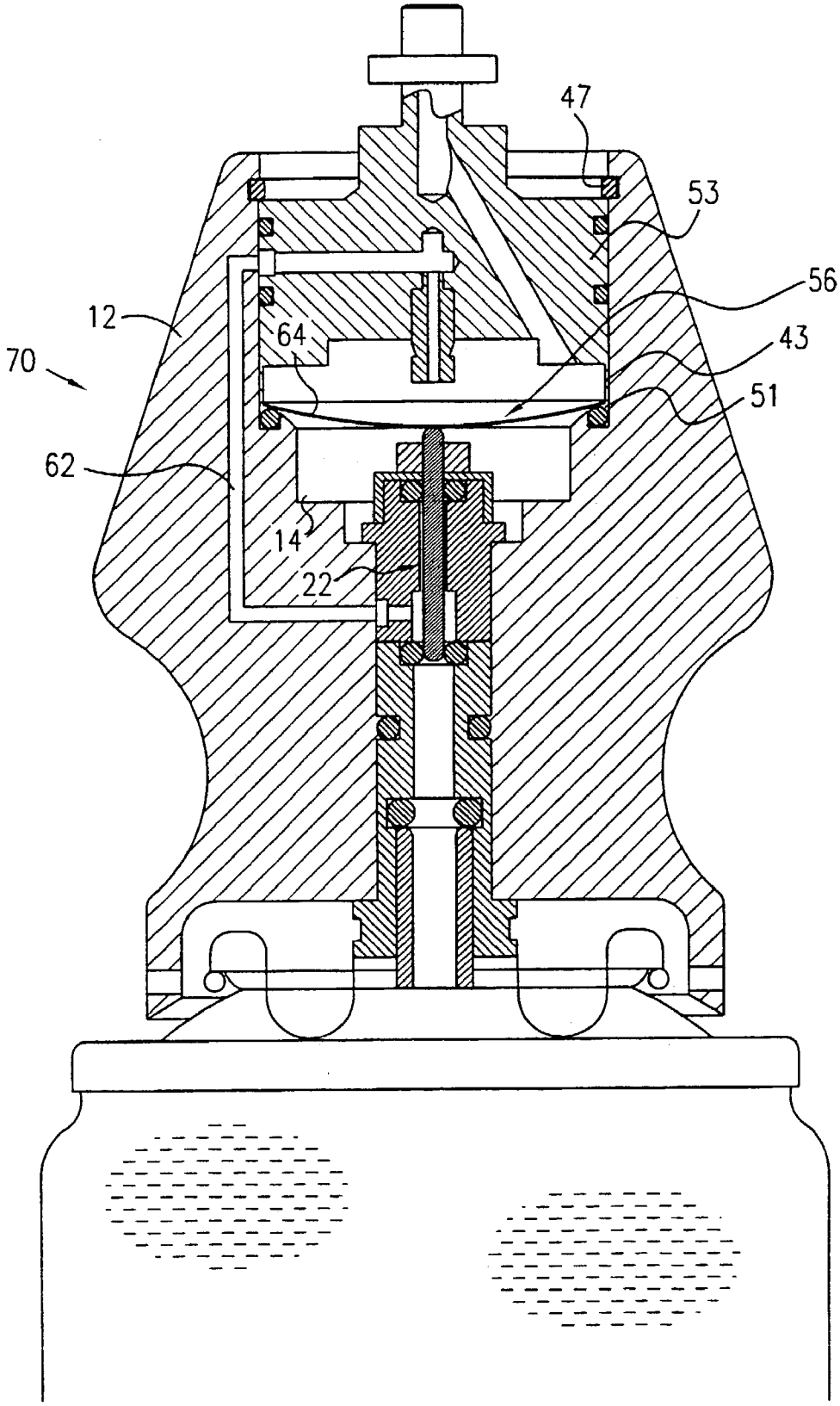

FIG. 3B

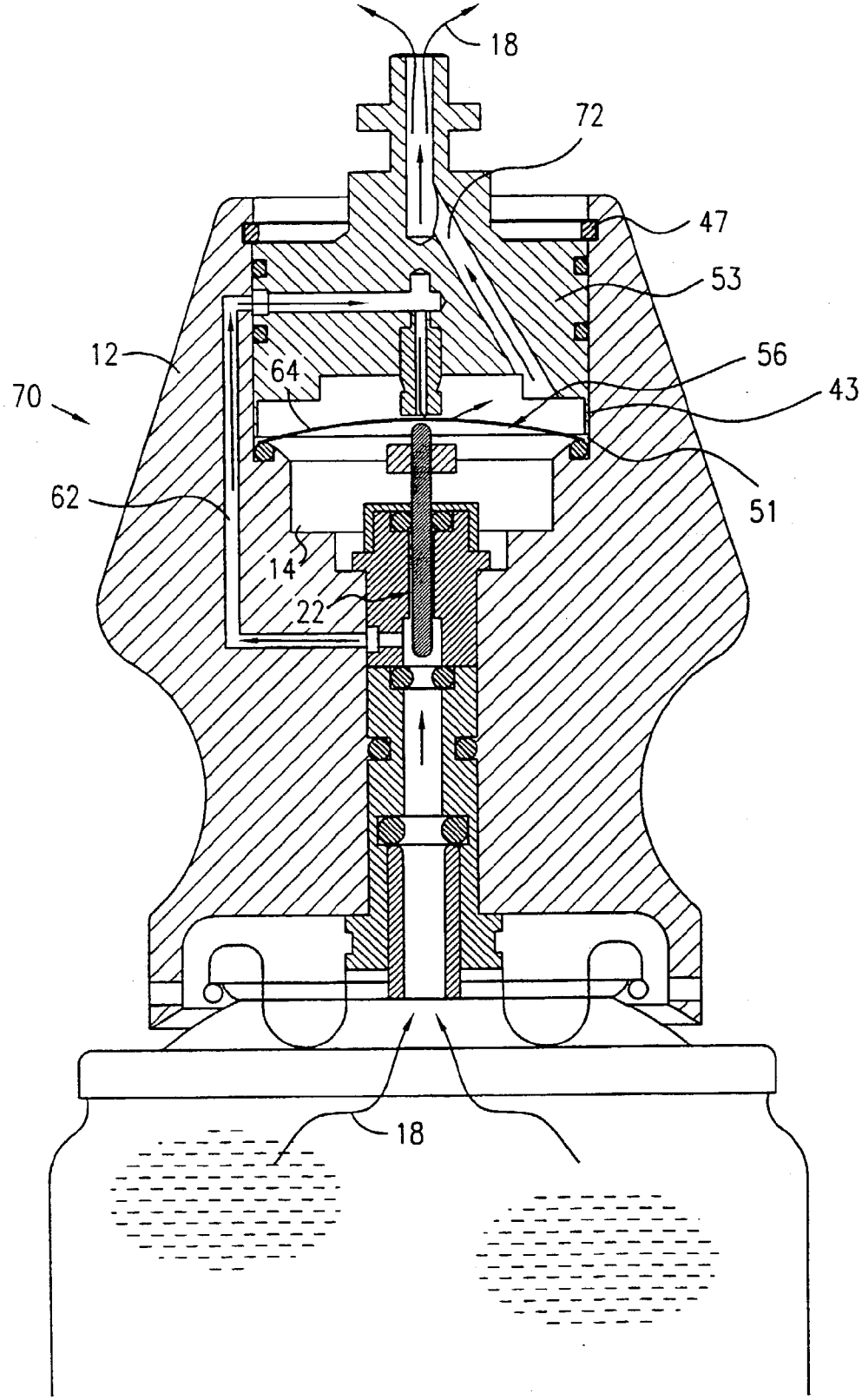

FIG. 4A

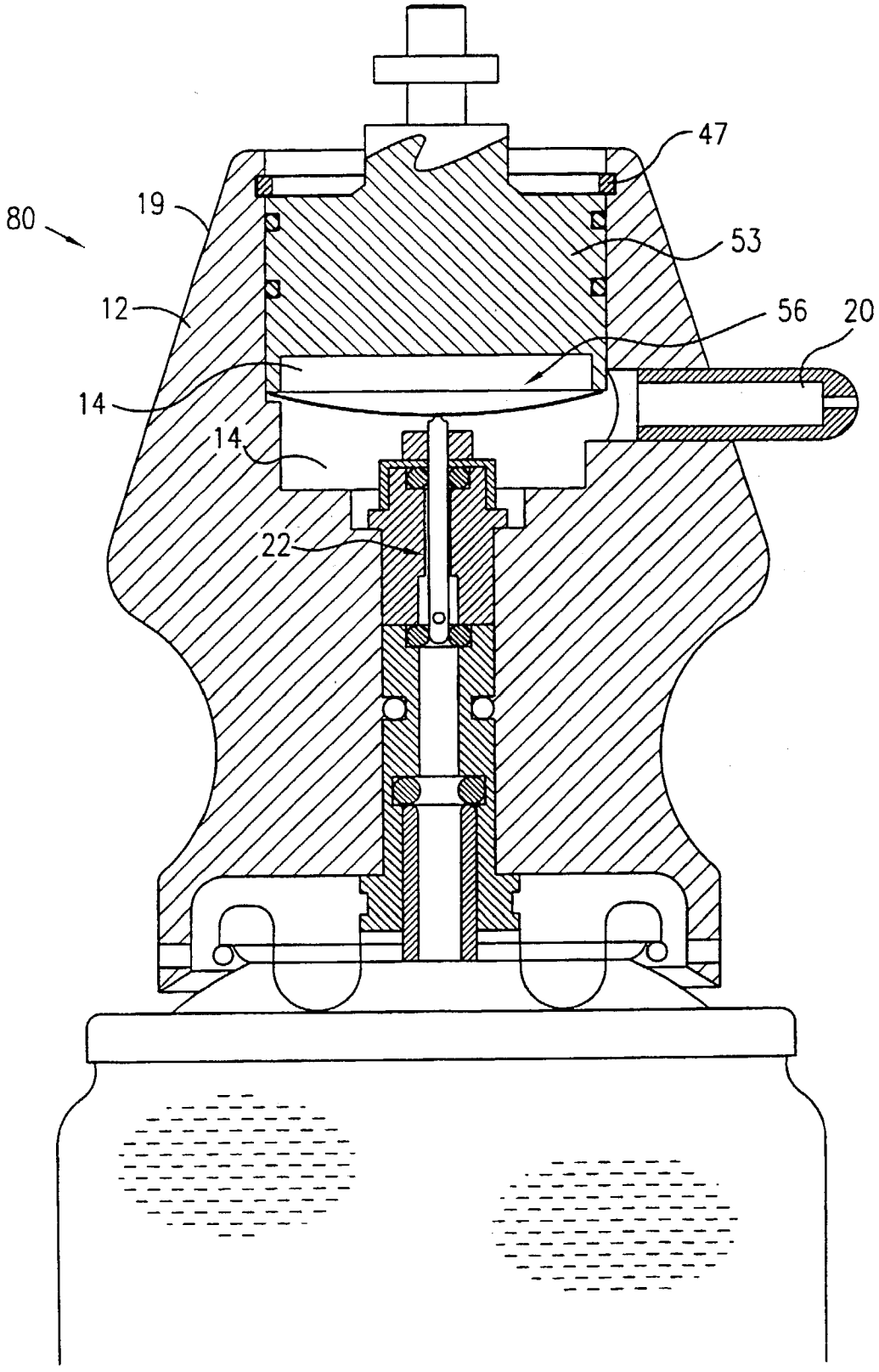

FIG. 4B

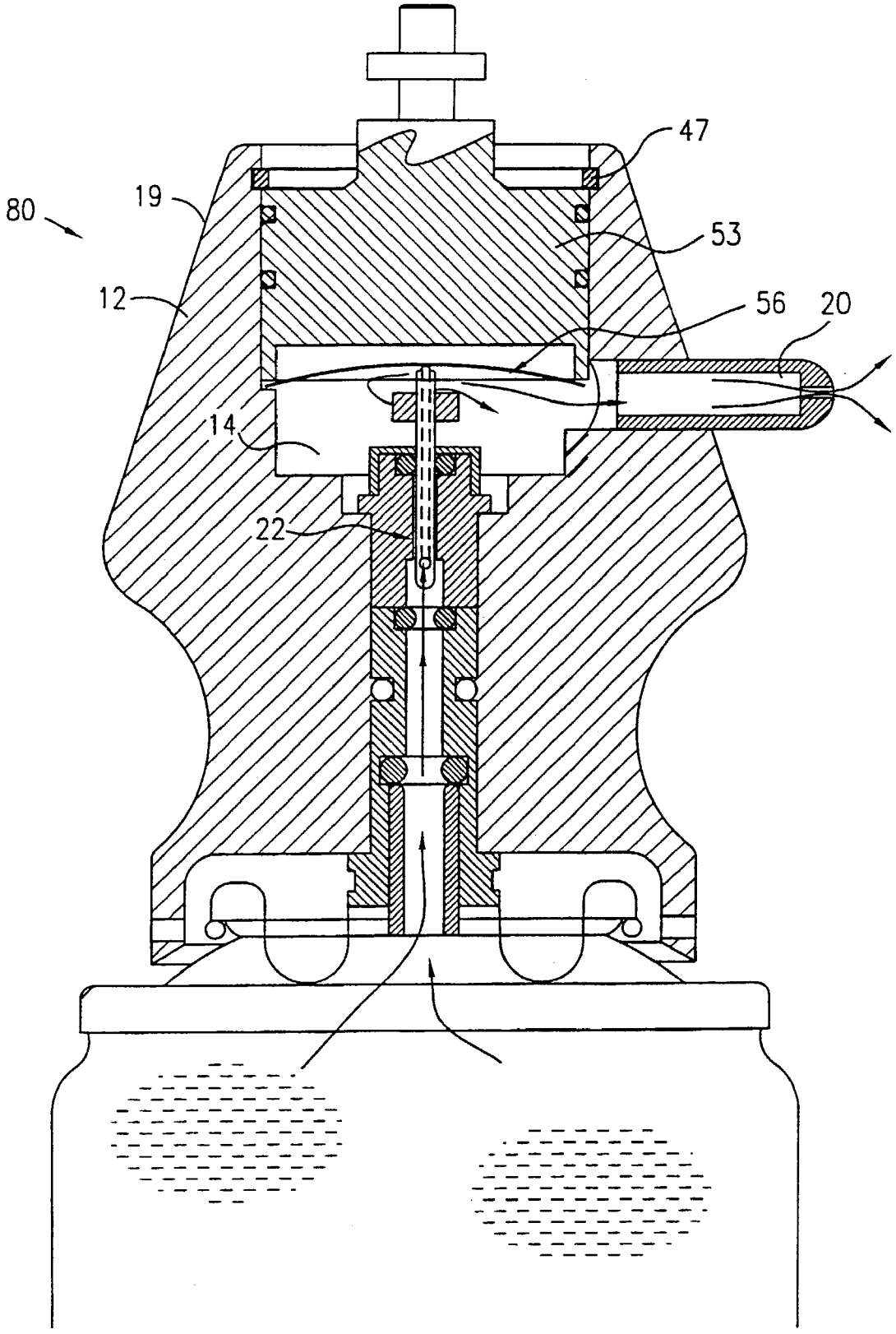

FIG. 5

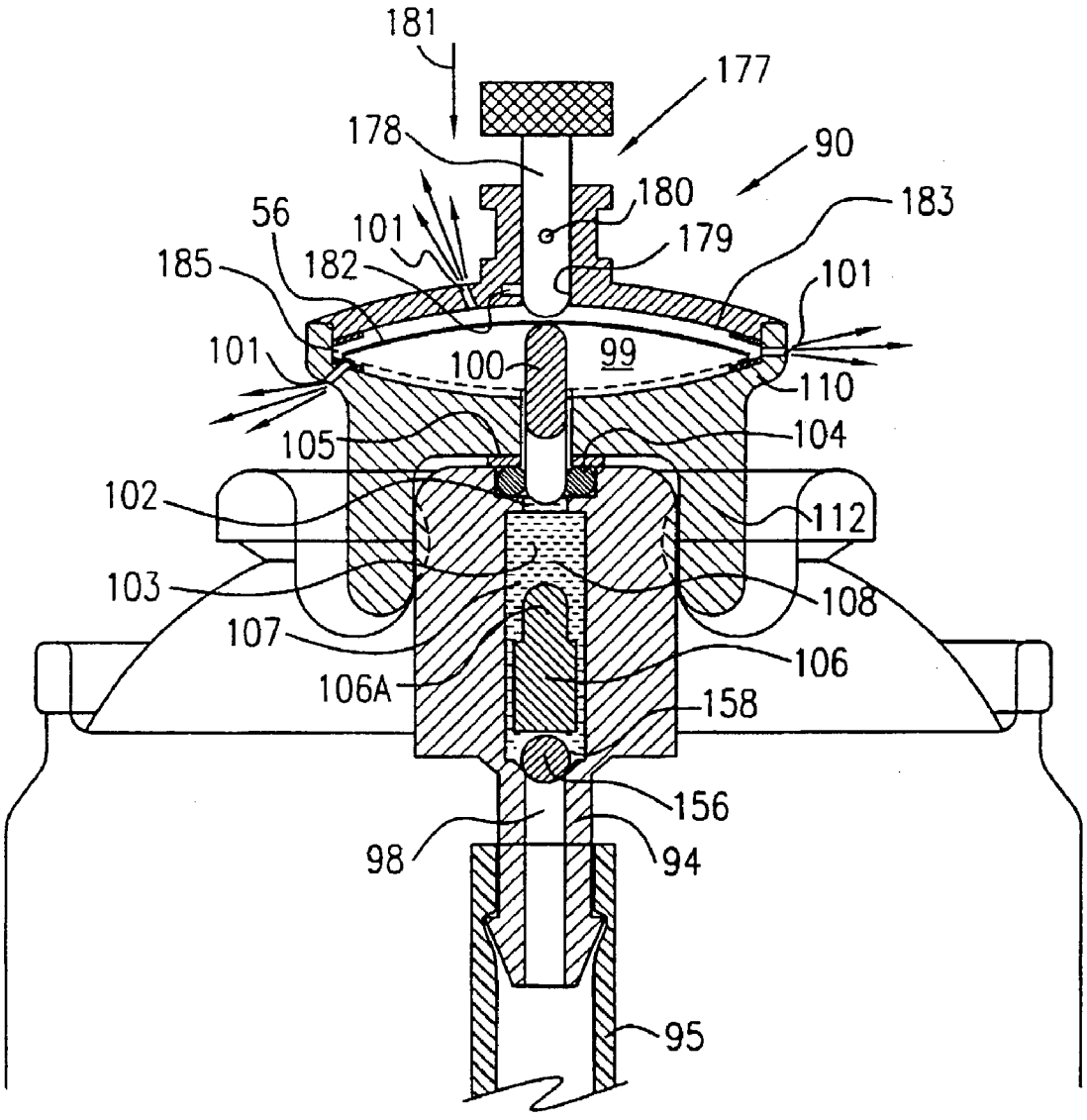
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FIG. 6A

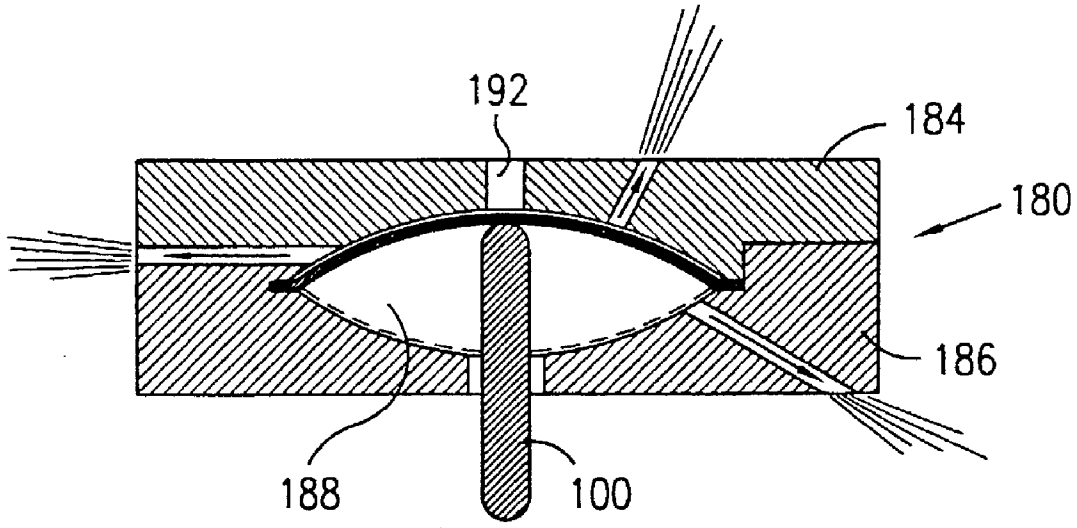


FIG. 6B

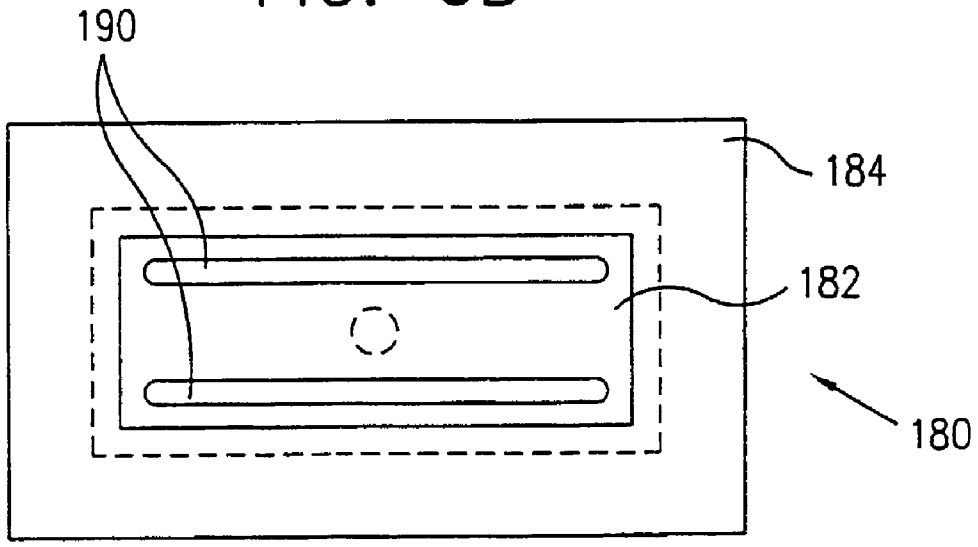


FIG. 6C

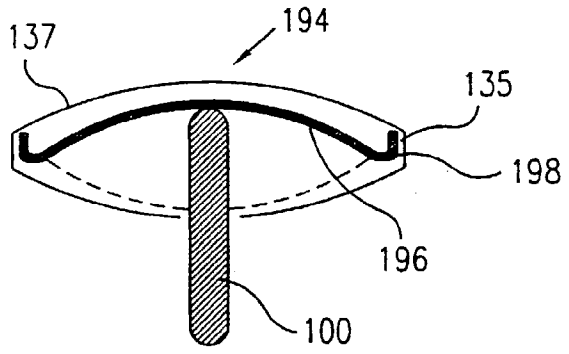


FIG. 6D

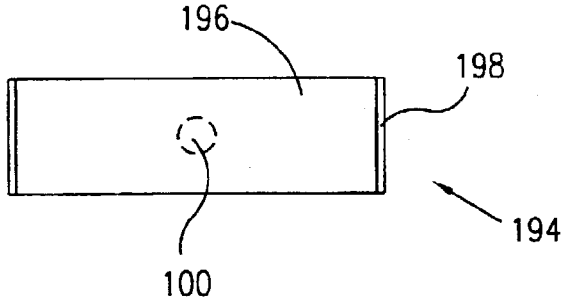


FIG. 6E

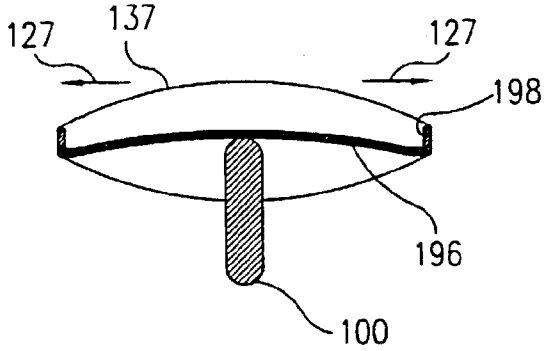


FIG. 6F

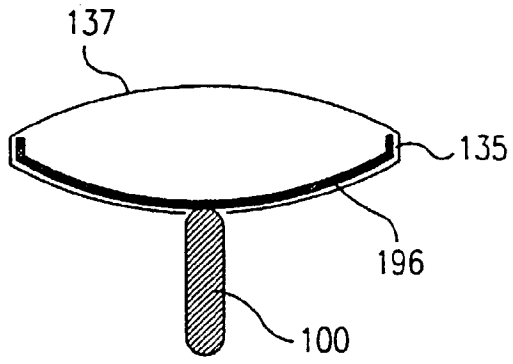


FIG. 7A

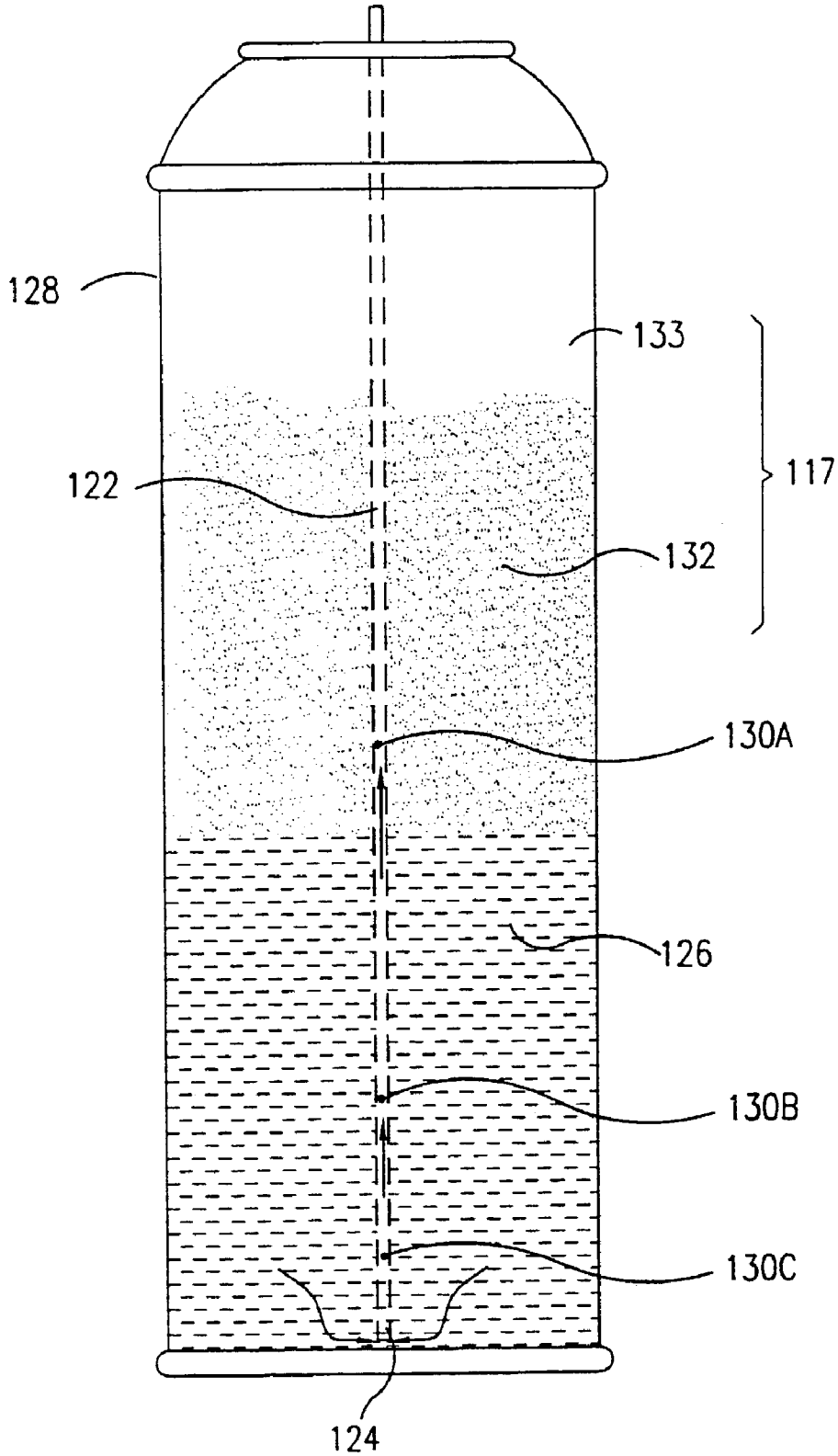


FIG. 7B

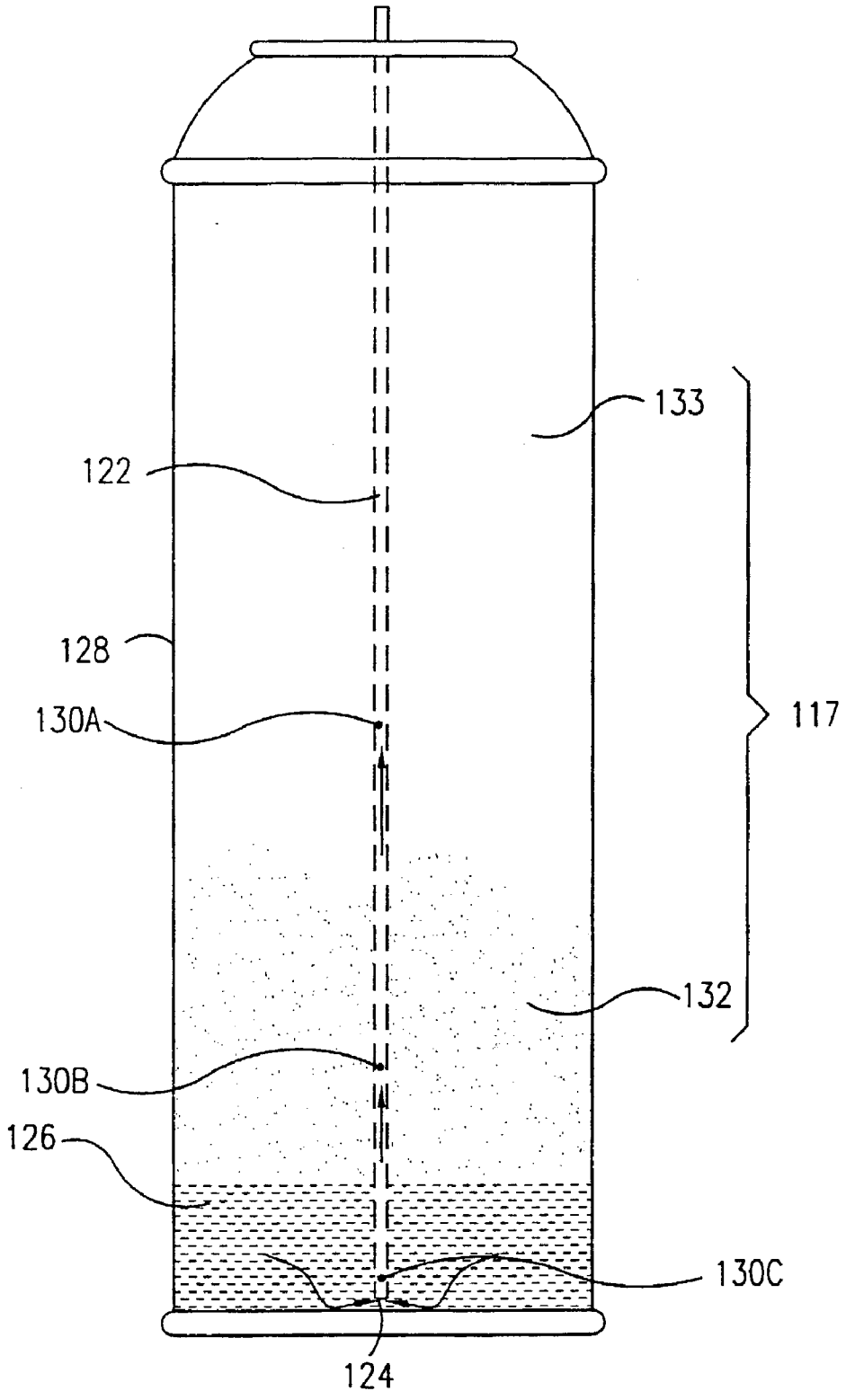


FIG. 7C

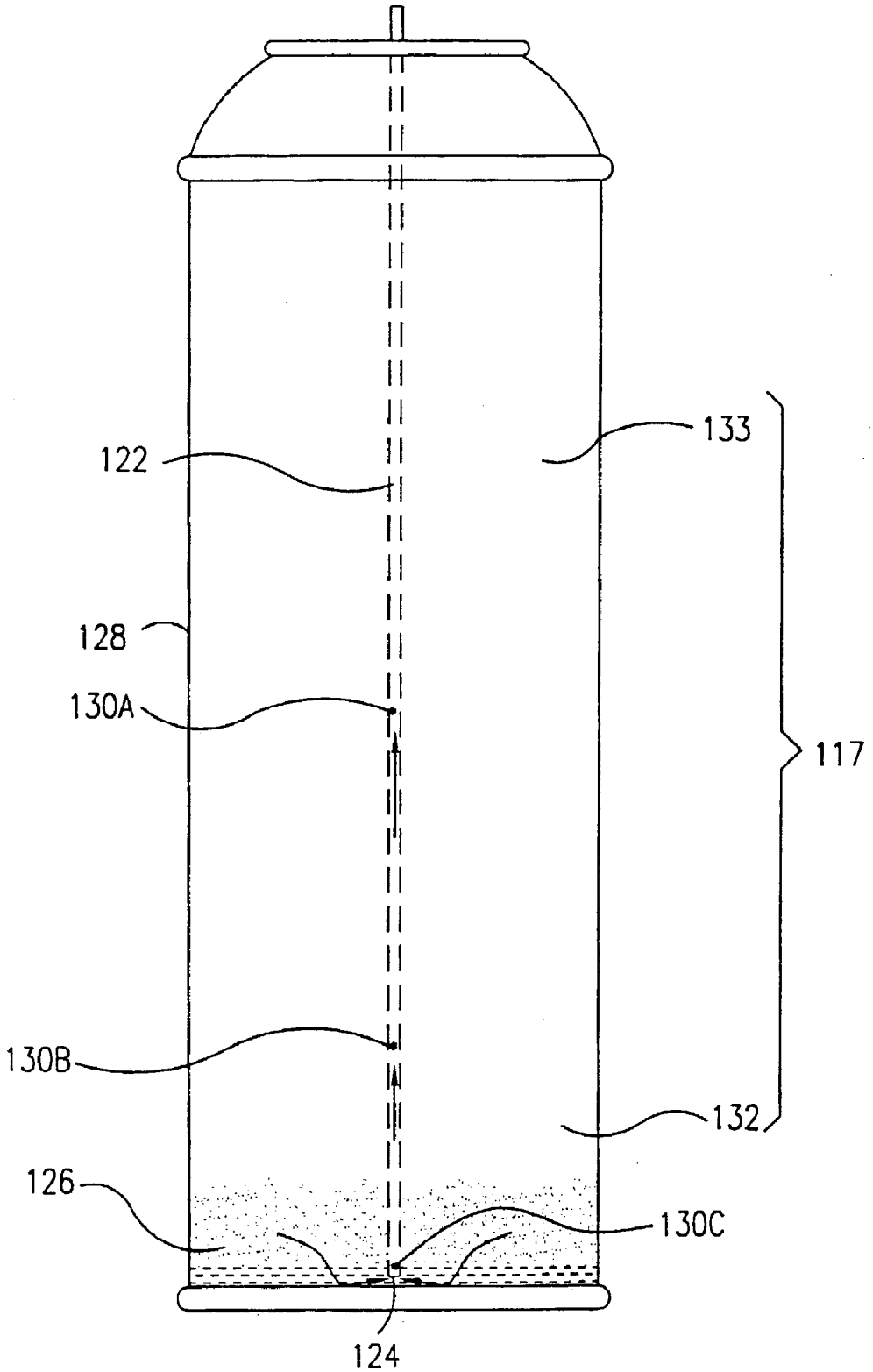
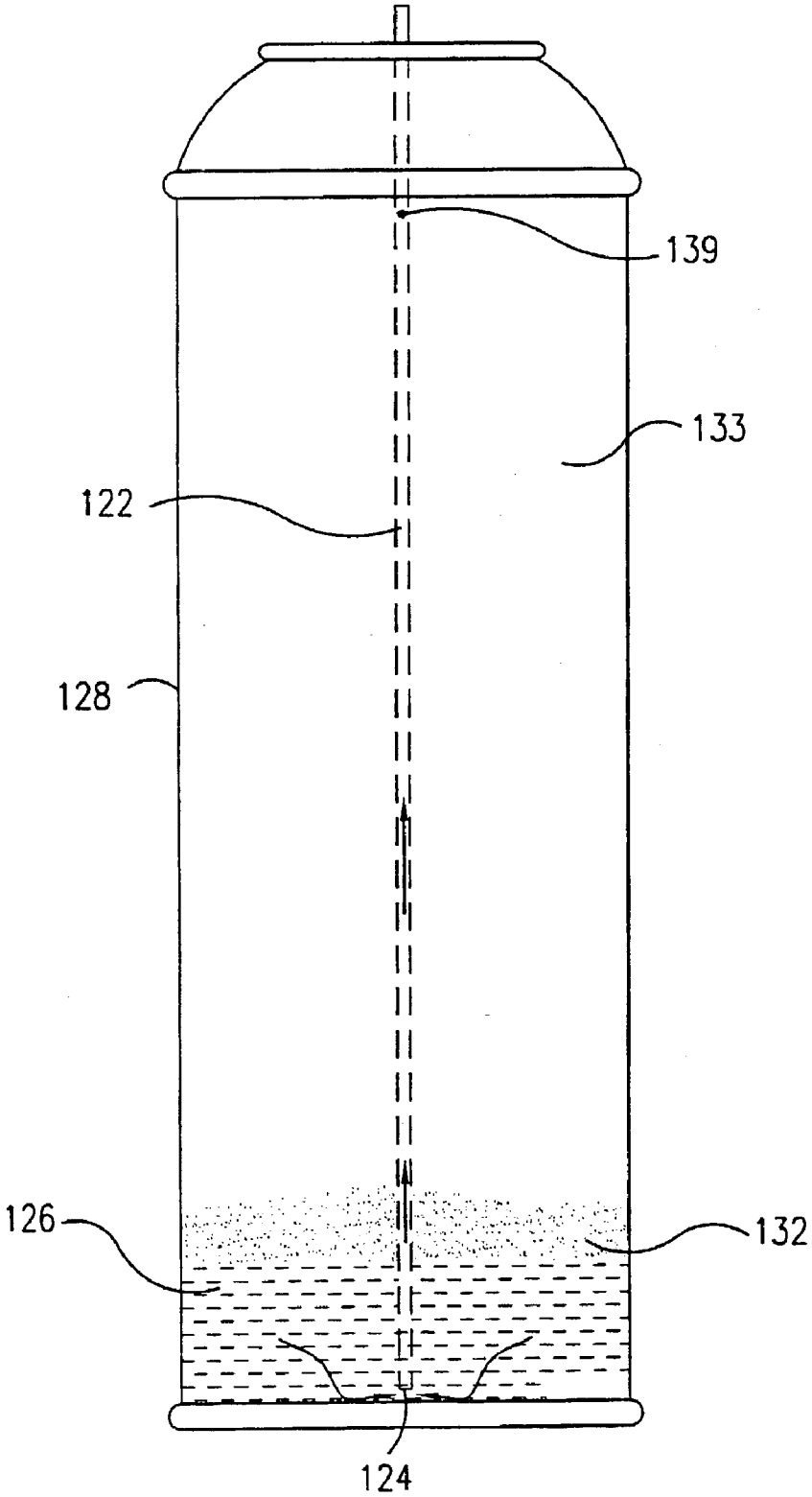


FIG. 7D



SPRAY DISPENSER

FIELD OF THE INVENTION

[0001] The present invention relates generally to the field of spray dispensers and particularly to a spray dispenser which operates by means of a novel deformable element.

BACKGROUND OF THE INVENTION

[0002] Certain products such as insecticides and air fresheners are commonly supplied in pressurized containers. The contents of the container are usually dispensed to the atmosphere by pressing down on a valve at the top of the container. The contents of the container are consequently emitted through a channel in the valve.

[0003] In many cases it is desired that the contents of the container be automatically dispensed periodically. Many automatic dispensers are known in the art.

[0004] A first type of automatic dispenser includes dispensers with mechanical means, such as an arm, which periodically presses the valve of the container. Such dispensers are described, for example, in U.S. Pat. Nos. 4,184,612, 3,739,944, 3,543,122, 3,768,732, 5,038,972 and 3,018,056. However, these dispensers cannot accurately control the output of the container, since the valve and the contact of the dispenser with the valve are not accurately controlled by the dispenser. Also these dispensers are generally not portable and are fit for use only with containers of a specific size. The valves are also susceptible to failure because of valve sticking, resulting in complete discharge of the contents of the container within a short period.

[0005] Another type of automatic dispenser employs a solenoid, which is periodically energized in order to emit a burst of the contents of the container. Such dispensers are described, for example, in U.S. Pat. Nos. 4,415,797, 3,351,240 and 3,187,949. These dispensers require substantial electrical power, and are dependent on gravity and/or the fluid pressure in the container for successful operation.

[0006] A third type of automatic dispenser is described, for example, in U.S. Pat. No. 5,447,273. In this automatic dispenser the pneumatic pressure of the container is used to operate a timing device causing the contents of the container to be periodically dispensed. However, the ability to control the dispensation intervals is complicated and limited due to the pneumatic characteristic of the timing device. Other US patents that describe pneumatic or spring-actuated dispensers include U.S. Pat. Nos. 2,719,432, 3,589,562, 3,658,209, 3,722,749, 4,077,542, 4,469,255, 5,025,962 and 5,364,028.

[0007] A fourth type of automatic dispenser is described in PCT patent application PCT/IL98/00618, assigned to the present assignee, the disclosure of which is incorporated herein by reference. This type of automatic spray dispenser allows accurate control of the amount of discharged material, and allows flexibility in setting the frequency of dispensation. The dispenser has an open state in which fluid is discharged from a can or container, and a closed state in which the fluid is not emitted. A motor is provided which changes the state of the dispenser between the open and closed states. This is preferably accomplished by means of a flexible lever which is coupled to a threaded shaft which is attached to the motor. The lever is normally in a closed state. The motor rotates the shaft, thereby flexing the lever from the closed state to the open state and vice versa, depending on the direction of rotation.

[0008] A fifth type of automatic dispenser utilizes a bimetallic spring connected to a valve to control dispensing the contents of a spray container. In this dispenser, the bimetallic spring starts, for example, at room temperature, wherein the valve is open for dispensing the contents out of the container. As the contents of the container flow outwards, they thermally contact the bimetallic spring, thereby cooling the spring. Due to its lower temperature, the spring contracts and closes the valve, thereby stopping dispensing the contents from the container. Eventually the bimetallic spring is warmed by the environment back to a temperature sufficient for the spring to re-expand to its original position, thereby opening the valve and once again dispensing a portion of the contents.

[0009] One example of such a bimetallic mechanism includes U.S. Pat. No. 4,361,013 to Skeele. Skeele is not a spray dispenser, but rather a box for cooling items stored therein. Skeele employs coil or leaf types of bimetallic springs.

[0010] A Japanese inventor, Taisho Iketani, patented a number of bimetallic spray devices. His earliest, U.S. Pat. No. 3,360,165, utilizes bimetallic springs similar to those of Skeele for spray-dispensing contents from a container. However, Iketani quickly discovered that such springs are not suitable for spray-dispensing, because they lack the requisite snap action for spraying contents from a container.

[0011] Iketani improved the bimetallic spray dispenser in U.S. Pat. No. 3,419,189, which utilizes a bimetallic disc, shaped like a Belleville washer, clamped around its periphery. However, while the disc does provide the requisite snap action for spraying the contents, nevertheless the bimetallic disc does not operate properly when clamped around its periphery.

[0012] In his next patent, U.S. Pat. No. 3,596,800, Iketani describes the abovementioned problem in col. 3, lines 35-43: "The conventional mechanism for supporting a disc-shaped bimetal has been disadvantageous in that slight misalignment of the bimetal or small variation in its size may result in an accidental reversing movement of the bimetal depending upon the clamping forces exerted on its periphery and therefore it is almost impossible to obtain a uniform finished product. Such a problem becomes more serious because the valve mechanism of this type is extremely small." Iketani proposed to solve the problem by clamping not around the entire periphery but rather at a number of discrete points around the periphery.

[0013] In a divisional of U.S. Pat. No. 3,596,800, U.S. Pat. No. 3,685,693, Iketani utilized the same type of discrete clamping, and added a manual override for spraying without the bimetal disc.

[0014] In U.S. Pat. No. 3,684,133, Iketani added two more features to the bimetal mechanism. First, Iketani sandwiched the disc between portions of a spongy material inwards of the clamped periphery. The purpose of the spongy material is to absorb a volatile liquid, such as methyl alcohol, mixed with the pressurized contents of the spray container, so as to enhance cooling of the bimetallic disc and accelerate snapping of the disc. Second, Iketani attached an actuating rod to the bimetal disc. However, neither of these features provided reliable snapping action.

[0015] Thus, even with the discrete clamping of the bimetallic disc, these bimetallic spray dispensers have not had reliable performance and apparently have never had any commercial success.

SUMMARY OF THE INVENTION

[0016] It is an object of the present invention to provide an automatic bimetallic spray dispenser with an extremely simple and inexpensive construction that significantly improves upon the prior art devices. In accordance with one embodiment of the present invention, in contradistinction to Iketani, a bimetallic disc is employed that is freely supported around its perimeter. This surprisingly solves the problem of the prior art, namely, the disc-shaped bimetal does not have the disadvantage of being sensitive to slight misalignments or variations in size, and does not accidentally reverse its movement.

[0017] In accordance with another embodiment of the present invention, again in contradistinction to Iketani a generally rectangular bimetallic element is employed that can either be freely supported, clamped all around its perimeter or clamped only at its short ends. This once again surprisingly solves the abovementioned problem of the prior art. Unlike the circular disc, the rectangular bimetallic element is not sensitive to slight misalignments or variations in size, and does not accidentally reverse its movement under the influence of all-around clamping.

[0018] Another object of the present invention is to provide a novel safety valve that prevents undesirable overspraying of the contents of a spray container.

[0019] Yet another object of the present invention is to provide a novel, internal feed tube for a spray container that enables spraying contents of the container without shaking the contents.

[0020] There is thus provided in accordance with a preferred embodiment of the present invention apparatus for spraying contents of a spray container, including a dispenser body sealingly attachable to a container containing a fluid, a fluid outlet formed in the dispenser body, and a deformable element generally freely supported around a perimeter thereof in the dispenser body, the deformable element having a first orientation when in a reference temperature range and reversibly deforming to a second orientation when out of the reference temperature range, wherein in the first orientation the deformable element is operative to block passage of the fluid from the container and in the second orientation the deformable element is operative to allow passage of the fluid from the container. The deformable element may be generally circular or rectangular.

[0021] In accordance with a preferred embodiment of the present invention, in the second position, the fluid flows towards and contacts the deformable element, wherein heat is transferred between the fluid and the deformable element so as to bring the deformable element into the reference temperature range, such that the deformable element deforms from the second orientation to the first orientation. The fluid may contact the deformable element either on a surface of the deformable element which faces the container, or which does not face the container, or both.

[0022] Further in accordance with a preferred embodiment of the present invention a plunger is arranged for sliding motion in the dispenser body between a first position and a second position. The plunger is preferably attached to the deformable element.

[0023] In accordance with a preferred embodiment of the present invention the deformable element includes a bimetallic element. Alternatively, the deformable element may be a shape memory alloy element.

[0024] Further in accordance with a preferred embodiment of the present invention the dispenser body includes thermal insulation for thermally insulating the deformable element from an outside environment.

[0025] Still further in accordance with a preferred embodiment of the present invention the dispenser body is formed with an expansion chamber, and when the deformable element is in the second orientation, the fluid flows into the expansion chamber and expands therein. The expansion chamber may be positioned on one side or both sides of the deformable element.

[0026] Additionally in accordance with a preferred embodiment of the present invention a safety spray valve is in fluid communication with the fluid outlet which is operative to substantially prevent flow of the fluid through the fluid outlet.

[0027] In accordance with a preferred embodiment of the present invention the safety spray valve includes a stopper slidingly disposed in a bore formed in the dispenser body, the bore allowing fluid to flow from a container to the fluid outlet, wherein the stopper is adapted to slide towards an end of the bore, and be substantially sealingly retained thereat, by a force of pressurized contents of the container.

[0028] Further in accordance with a preferred embodiment of the present invention the safety spray valve includes a one-way valve that substantially prevents matter from flowing in a direction from the deformable element back into the container.

[0029] Still further in accordance with a preferred embodiment of the present invention the one-way valve includes a ball disposed in a bore formed in the dispenser body, the ball not interfering with flow of fluid from the container towards the deformable element, but substantially preventing flow of fluid backwards towards the container.

[0030] Additionally in accordance with a preferred embodiment of the present invention the spray valve is in fluid communication with contents of a spray container, the contents including a first substance, and a second substance which includes at least one of a liquid portion and a gaseous portion, the spray valve further including a tube with a lower open end in fluid communication with the first substance, the tube being formed with at least one side aperture in fluid communication with the second substance.

[0031] In accordance with a preferred embodiment of the present invention the at least one side aperture is in fluid communication with the liquid portion. Alternatively, the at least one side aperture is in fluid communication with the gaseous portion.

[0032] Further in accordance with a preferred embodiment of the present invention when the spray valve dispenses the contents, an internal pressure of the container forces the first substance into the open end, and as the first substance rises

in the tube, the second substance can enter the at least one side aperture and mix with the first substance, prior to the contents being sprayed.

[0033] There is also provided in accordance with a preferred embodiment of the present invention apparatus for spraying contents of a spray container, including a dispenser body sealingly attachable to a container containing a fluid, an expansion chamber formed in the dispenser body, a fluid outlet formed in the dispenser body, and a generally rectangular deformable element disposed in the expansion chamber, the deformable element having a first orientation when in a reference temperature range and reversibly deforming to a second orientation when out of the reference temperature range, wherein in the first orientation the deformable element is operative to block passage of the fluid from the container and in the second orientation the deformable element is operative to allow passage of the fluid from the container, and when the deformable element is in the second orientation, the fluid flows into the expansion chamber and expands therein.

[0034] In accordance with a preferred embodiment of the present invention the deformable element is generally freely supported in the expansion chamber in the first orientation, wherein as the deformable element snaps from the first orientation to the second orientation, ends of the deformable element move and abut against inner surfaces of the expansion chamber, the ends of the deformable element being separated by a gap from the inner surfaces of the expansion chamber and freely supported in the expansion chamber when the deformable element has snapped to the second orientation.

[0035] Alternatively, two ends of the deformable element are clamped in the expansion chamber. Still alternatively, the deformable element is clamped generally around its perimeter in the expansion chamber.

[0036] There is also provided in accordance with a preferred embodiment of the present invention apparatus for spraying contents of a spray container, including a dispenser body sealingly attachable to a container containing a fluid, a fluid outlet formed in the dispenser body, a spray nozzle in fluid communication with the dispenser body operative to spray the fluid from the container, and a safety valve operative to substantially prevent flow of the fluid through the spray nozzle even if the spray nozzle malfunctions.

[0037] There is also provided in accordance with a preferred embodiment of the present invention apparatus for spraying contents of a spray container, the contents including a first substance, and a second substance which includes at least one of a liquid portion and a gaseous portion, the apparatus including a tube with a lower open end in fluid communication with the first substance, the tube being formed with at least one side aperture in fluid communication with the second substance. The first substance may be generally in a fluid or solid state in the container.

[0038] In accordance with a preferred embodiment of the present invention the tube is formed with a plurality of the side apertures, wherein one of the side apertures is in fluid communication with at least one of the liquid portion and the gaseous portion.

[0039] Further in accordance with a preferred embodiment of the present invention one of the side apertures has a size different than another of the side apertures.

[0040] There is also in accordance with a preferred embodiment of the present invention a method of dispensing a fluid from a container, including providing a container containing a fluid, attaching a spray valve to the container, the spray valve including a dispenser body sealingly attachable to a container containing a fluid, a fluid outlet formed in the dispenser body, a deformable element generally freely supported around a perimeter thereof in the dispenser body, the deformable element having a first orientation when in a reference temperature range and reversibly deforming to a second orientation when out of the reference temperature range, wherein in the first orientation the deformable element is operative to block passage of the fluid from the container and in the second orientation the deformable element is operative to allow passage of the fluid from the container, and placing the container with the spray valve attached thereto in an environment whose temperature is out of the reference temperature range, such that heat transfer between the deformable element and the environment brings the deformable element out of the reference temperature range after a period of time, whereupon the deformable element deforms to the second orientation, and the fluid flows from the container into the dispenser body and is dispensed out of the fluid outlet.

[0041] In accordance with a preferred embodiment of the present invention the method further includes transferring heat between the fluid and the deformable element when the deformable element is in the second orientation so as to bring the deformable element into the reference temperature range, such that the deformable element deforms from the second orientation to the first orientation, thereby preventing the fluid from exiting the dispenser body.

[0042] Further in accordance with a preferred embodiment of the present invention the method includes controlling dispensing of the fluid by one of the following steps: selecting a desired size of the spray nozzle, selecting a desired size of the fluid outlet, constructing the deformable element of a bimetallic material with selected thermal properties and physical dimensions, directing the fluid to flow on a surface of the deformable element which faces the container, when the deformable element is in the second position, directing the fluid to flow on a surface of the deformable element which does not face the container, when the deformable element is in the second position, directing the fluid to flow both on a surface of the deformable element which faces the container and on a surface of the deformable element which does not face the container, when the deformable element is in the second position, selecting desired physical properties of the fluid, selecting desired thermal properties of the fluid, selecting desired a pressure of the fluid, or thermally insulating the dispenser body from an outside environment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0043] The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

[0044] **FIGS. 1A and 1B** are simplified pictorial illustrations of a spray valve constructed and operative in accordance with a preferred embodiment of the present invention, in respective closed and open configurations, wherein a fluid flows against a lower surface of a deformable element and exits as a fluid spray from a side outlet;

[0045] **FIGS. 2A and 2B** are simplified pictorial illustrations of a spray valve constructed and operative in accordance with another preferred embodiment of the present invention, in respective closed and open configurations, wherein the fluid flows against an upper surface of the deformable element and exits as a fluid spray from a side outlet;

[0046] **FIGS. 3A and 3B** are simplified pictorial illustrations of a spray valve constructed and operative in accordance with yet another preferred embodiment of the present invention, in respective closed and open configurations, wherein the fluid flows against an upper surface of the deformable element and exits as a fluid spray from an upper outlet;

[0047] **FIGS. 4A and 4B** are simplified pictorial illustrations of a spray valve constructed and operative in accordance with another preferred embodiment of the present invention, in respective closed and open configurations, wherein the fluid flows against both lower and upper surfaces of the deformable element and exits as a fluid spray from a side outlet;

[0048] **FIG. 5** is a simplified sectional illustration of a safety spray valve constructed and operative in accordance with a preferred embodiment of the present invention;

[0049] **FIGS. 6A and 6B** are simplified sectional and top-view illustrations, respectively, of a spray valve constructed and operative in accordance with still another preferred embodiment of the present invention, which employs a generally rectangular deformable element clamped around its perimeter;

[0050] **FIGS. 6C and 6D** are simplified sectional and top-view illustrations, respectively, of a spray valve constructed and operative in accordance with yet another preferred embodiment of the present invention, which employs a generally rectangular deformable element clamped at its short ends;

[0051] **FIGS. 6E and 6F** are simplified sectional illustrations of the spray valve of **FIGS. 6C and 6D**, respectively during and after the deformable element reversing its position;

[0052] **FIGS. 7A, 7B** and 7C are simplified pictorial illustrations of a spray valve constructed and operative in accordance with still another preferred embodiment of the present invention, in respective full, partially full and nearly empty configurations, wherein contents of a spray container can be sprayed without shaking the container; and

[0053] **FIG. 7D** is a simplified illustration of the spray valve of FIGS. 7A-7C, with an upper aperture formed in a feed tube, in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0054] Reference is now made to **FIGS. 1A and 1B** which illustrate a spray valve **10** constructed and operative in accordance with a preferred embodiment of the present invention.

[0055] Spray valve **10** preferably includes a dispenser body **12** with an expansion chamber **14** formed therein. Dispenser body **12** may be sealingly connected to a container **16** containing a fluid **18**, such as by means of an elastic metal ring **24** which tightly fits into a groove **26** formed at a bottom end of dispenser body **12**, in the same or similar manner as described in PCT patent application PCT/IL98/00618. Fluid **18** may be any kind of fluid, suitable for storing in container **16** (under pressure or not), such as, but not limited to, odorants, pesticides, fungicides, foodstuffs, paint, repellents, and the like. Container **16** may be any kind of pressurized or non-pressurized container used in any of the applications described in PCT patent application PCT/IL98/00618. Container has a nozzle **17** extending therefrom (**FIG. 1A**).

[0056] Dispenser body **12** may include thermal insulation **19**, such as a plastic liner (single or multiple layers of insulation), or such as being constructed like a vacuum flask or with an insulating air pocket, for example.

[0057] A fluid outlet **20** is preferably formed in dispenser body **12** and is in fluid communication with expansion chamber **14**. In the embodiment of **FIGS. 1A and 1B**, fluid outlet **20** is located on a side of dispenser body **12**.

[0058] A plunger **22** is preferably arranged for sliding motion in dispenser body **12** between a first position (the position shown in **FIG. 1A**) and a second position (the position shown in **FIG. 1B**). Plunger **22** can be brought into fluid communication with the fluid **18** contained in container **16** in a variety of manners. In the illustrated embodiment, an adapter **28** is provided formed with a lower aperture **29** which snugly fits over nozzle **17** of container **16**. Different adapters **28** with differently sized apertures **29** may be provided for connection with any size nozzle **17**. An O-ring **30** may be provided for sealing the fluid connection between adapter **28** and container nozzle **17**. Adapter **28** is formed with a longitudinal bore **31**.

[0059] Adapter **28** fits in a bore **32** formed in dispenser body **12**. Another O-ring **34** may be provided for fluidly sealing adapter **28** with respect to bore **32**. An upper portion **36** of adapter **28** abuts against a guide member **38**. Preferably a third O-ring **40** is provided to seal the fluid connection between adapter **28** and guide member **38**. Guide member **38** is formed with a bore **42** in which slides plunger **22**. A lower portion of guide member **38** is formed with a counterbore **44** which extends from bore **42**.

[0060] In accordance with one preferred embodiment of the present invention, plunger **22** is constructed as a hollow needle with a hole **46** formed in a lower portion thereof and a hole **48** formed at an upper end thereof (the hollow being shown in dashed lines in **FIG. 1A**). Alternatively, plunger **22** may be formed as a non-hollow needle A stop **50** may be affixed to the upper end of plunger **22** which limits the downward travel (in the sense of **FIG. 1A**) of plunger **22**. In the case of a hollow-needle plunger **22**, an O-ring **52** and O-ring cover **54** may be provided for fluidly sealing the upper end of plunger **22** with guide member **38** and stop **50**. In the case of a non-hollow plunger **22**, stop **50**, O-ring **52** and O-ring cover **54** are preferably omitted.

[0061] The skilled artisan will appreciate that the foregoing description of plunger **22** and the various seals is just one example of countless other configurations of constructing and sealing plunger **22**, and that any configuration of plunger **22** is within the scope of the present invention.

[0062] A deformable element **56** is preferably mounted just above expansion chamber **14** in dispenser body **12**. Deformable element **56** may have any shape, such as circular, rectangular or square, for example. In the case of a circular, disc-shaped element, deformable element **56** is not clamped around its periphery, as in the Iketani devices described in the background. Instead, deformable element **56** is preferably freely supported around its periphery. In the embodiment illustrated in **FIGS. 1A and 1B**, a plug **53** preferably snugly fits in dispenser body **12** and is preferably fastened thereto with a retaining ring **47**. The periphery of deformable element **56** is placed, but not clamped, between a lower extension **43** of plug **53** and an O-ring **58**. As deformable element **56** bends downwards or upwards (in the sense of **FIG. 1A**), deformable element **56** merely rests on or slightly squeezes O-ring **58**, but there is generally no clamping force on deformable element **56**. The purpose of O-ring **58** is to seal the expansion chamber **14** which is situated below deformable element **56** in the embodiment of **FIGS. 1A and 1B**. (In another embodiment, shown in **FIG. 5**, the expansion chamber is on both sides of the deformable element, and there is no need for an O-ring.) Thus deformable element **56** is free to snap from one position to another without any clamping forces. Unlike the prior art, namely, deformable element **56** does not have the disadvantage of being sensitive to slight misalignments or variations in size, and does not accidentally reverse its movement.

[0063] There is preferably a gap **51** that extends radially between the peripheral edge of deformable element **56** and the inner perimeter of expansion chamber **14**. Gap **51** ensures that there are no radially-directed stresses acting upon deformable element **56**. In the case of a non-hollow plunger **22** that is attached to deformable element **56**, gap **51** enables plunger **22** to self-center relative to stop **50** and O-ring **52** without any radially-directed forces acting upon deformable element **56**. The presence of gap **51** relaxes manufacturing tolerances and thus brings down the cost of manufacturing spray valve **10**.

[0064] Deformable element **56** may be formed with one or more holes in its central portion or any other portion thereof. The upper end of plunger **22** preferably abuts against a surface **59** of deformable element **56**. Alternatively, in the case of plunger **22** being constructed as a non-hollow needle, plunger **22** is preferably attached to deformable element **56**, such as by means of spot welding, for example.

[0065] In a most preferred embodiment, deformable element **56** is constructed of a bimetallic material, i.e., two dissimilar metals welded or otherwise joined together, the two metals having different temperature coefficients of expansion. Due to the different thermal properties of the two metals, deformable element **56** has a first orientation when in a reference temperature range and reversibly deforms to a second orientation when out of the reference temperature range.

[0066] For example, in the illustrated embodiment, deformable element **56** is in the first orientation shown in **FIG. 1A**. In this first orientation, surface **59** of deformable element **56** has a generally convex shape when viewed from the upper tip of plunger **22**. Deformable element **56** applies a force against plunger **22** generally in the direction of an arrow **57** so as to prevent plunger **22** from sliding from the first position of **FIG. 1A** to the second position of **FIG. 1B**. In the first position, fluid **18** can flow from container **16** into longitudinal bore **31** of adapter **28**, but O-ring **40** substantially prevents fluid **18** from flowing into counterbore **44** of guide member **38**. Thus, in the first orientation, deformable element **56** prevents fluid **18** from being dispensed through outlet **20**. Deformable element **56** remains in the first orientation as long as it is in the reference temperature range. For example, as long as deformable element **56** is below −20° C., it will remain in the first orientation. (As is well known in the art, commercially available bimetallic elements can be supplied for any desired temperature range.)

[0067] If deformable element **56** is out of the reference temperature range, then deformable element **56** deforms to the second orientation shown in **FIG. 1B**. In this second orientation, surface **59** of deformable element **56** has a generally concave shape when viewed from the upper tip of plunger **22**. The deformation of deformable element **56** permits plunger **22** to slide generally in the direction of an arrow **55** (opposite to the direction of arrow **57** shown in **FIG. 1A**) to the second position shown in **FIG. 1B**. In the second position, fluid **18** flows into counterbore **44** of guide member **38**. In the case of a hollow plunger **22**, fluid **18** then flows into hole **46** through plunger **22** and out of upper hole **48** into expansion chamber **14**. In the case of a non-hollow plunger **22**, fluid **18** flows from counterbore **44** into the space between plunger **22** and bore **42** up into expansion chamber **14**. Fluid **18** then expands in expansion chamber **14** and exits outlet **20** as a spray. Deformable element **56** remains in the second orientation as long as it is out of the reference temperature range. For example, as long as deformable element **56** is at a temperature equal to or greater than −20° C., it will remain in the second orientation, and fluid **18** will continue to be dispensed from outlet **20**.

[0068] The temperature of deformable element **56** is determined by heat transfer between fluid **18** and deformable element **56** and by heat transfer between deformable element **56** and the environment outside of dispenser body **12**, as is now described.

[0069] Operation of spray valve **10** commences by placing container **16** with spray valve **10** attached thereto in an environment whose temperature is out of the reference temperature range. For example, container **16** is placed in a room whose ambient temperature is greater than −20° C. Heat transfer (by conduction through the walls of dispenser body **12**, and convection and radiation to the room environment) between deformable element **56** and the environment eventually brings deformable element **56** out of the reference temperature range after a period of time. In other words, in the above example, the heat transfer eventually warms deformable element **56** from a temperature below −20° C. to a temperature greater than or equal to −20° C., whereupon deformable element **56** deforms to the second orientation, plunger **22** slides to the second position, fluid **18** flows from container **16** to expansion chamber **14** and expands to a fluid spray that exits from fluid outlet **20**, as described hereinabove.

[0070] While plunger **22** is in the second position, fluid **18** contacts deformable element **56** and thereby eventually brings deformable element **56** back into the reference temperature range. In other words, in the above example, heat transfer between fluid **18** and deformable element **56** cools deformable element **56** from a temperature greater than or

equal to −20° C. to a temperature below −20° C., such that deformable element **56** deforms from the second orientation back to the first orientation and plunger **22** slides back to the first position, thereby preventing fluid **18** from exiting dispenser body **12**.

[**0071**] Eventually heat transfer between deformable element **56** and the environment once again brings deformable element **56** out of the reference temperature range, and the operating cycle repeats itself.

[**0072**] Thus spray valve **10** cyclically dispenses fluid **18** from container **16**. Various factors affect the frequency and time duration of dispensation, amount of fluid dispensed, the operative reference temperature range, and time for deformable element **56** to deform between the two orientations. These factors include, inter alia:

[**0073**] a. Size of plunger **22** and any holes thereof (**46**, **48**) through which fluid **18** flows.

[**0074**] b. Size of outlet **20**.

[**0075**] c. Type of bimetallic material (or shape memory alloy, as described below) from which deformable element **56** is constructed, as well as the size and thickness of deformable element **56**. The type of material affects the time for deformable element **56** to deform between the two orientations, temperature behavior of deformable element **56**, and force applied against plunger **22**.

[**0076**] d. Whether fluid **18** flows on surface **59** of deformable element **56** or on an opposite surface thereof (as is described hereinbelow). If fluid **18** flows on surface **59**, then the fluid pressure of fluid **18** retards the deformation of deformable element **56** from the second to the first orientation. Conversely, if fluid **18** flows on a side opposite to surface **59**, then the fluid pressure of fluid **18** aids in pushing deformable element **56** from the second to the first orientation.

[**0077**] e. The physical and thermal properties of fluid **18**, as well as its pressure.

[**0078**] f. More than one deformable element **56** may be used. For example, two or more deformable elements **56** may be stacked together and used as one composite deformable element. The number of deformable elements **56** governs the force that the deformable elements apply against plunger **22**. An assortment of deformable elements **56** may be provided with different thermal characteristics, mechanical properties or physical dimensions, in order to cover a wide range of applications.

[**0079**] g. Size of expansion chamber **14**.

[**0080**] h. Thermal properties of thermal insulation **19**.

[**0081**] It is noted that in the above example, deformable element **56** is warmed by the environment in order to dispense fluid **18**, and is cooled by fluid **18** in order to stop dispensing fluid **18**. It is appreciated that the present invention can also be carried out for dispensing fluids which are hotter than the environment. In such a case, deformable element **56** is cooled by the environment in order to dispense fluid **18**, and is warmed by fluid **18** in order to stop dispensing fluid **18**.

[**0082**] An alternative material for constructing deformable element **56** is a shape memory alloy, such as a nickel titanium alloy Shape memory alloys have the ability to return to a predetermined shape upon heating via a phase transformation between austenitic and martensitic structures.

[**0083**] Reference is now made to **FIGS. 2A and 2B** which illustrate a spray valve **60** constructed and operative in accordance with another preferred embodiment of the present invention, in respective closed and open configurations. Spray valve **60** is substantially constructed the same as spray valve **10**, with like elements being designated by like numerals. Spray valve **60** differs from spray valve **10** in that spray valve **60** includes a channel **62** which directs flow of fluid **18** against a surface **64** of deformable element **56** opposite surface **59**. Fluid **18** still exits as a fluid spray from side outlet **20**. As mentioned above, since fluid **18** flows on surface **64** opposite to surface **59**, the fluid pressure of fluid **18** aids in pushing deformable element **56** from the second to the first orientation.

[**0084**] Reference is now made to **FIGS. 3A and 3B** which illustrate a spray valve **70** constructed and operative in accordance with yet another preferred embodiment of the present invention, in respective closed and open configurations. Spray valve **70** is substantially constructed the same as spray valve **60**, with like elements being designated by like numerals. Spray valve **70** differs from spray valve **60** in that spray valve **70** includes a channel **72** which directs flow of fluid **18** from surface **64** of deformable element **56** to an upper outlet **74**, from which fluid **18** exits as a spray.

[**0085**] Reference is now made to **FIGS. 4A and 4B** which illustrate a spray valve **80** constructed and operative in accordance with yet another preferred embodiment of the present invention, in respective closed and open configurations. Spray valve **80** is substantially constructed the same as spray valve **10** or **60**, with like elements being designated by like numerals. Spray valve **80** differs from spray valve **10** or **60** in that in spray valve **80**, deformable element **56** is arranged with respect to expansion chamber **14** such that expansion chamber **14** extends around deformable element **56** by means of a bypass **82**. In this manner, in the second orientation, fluid **18** flows against both lower and upper surfaces **59** and **64** of deformable element **56**. The fluid **18** can exit from either a side outlet (as shown in **FIGS. 4A and 4B**) or as an upper outlet (as in the embodiment of **FIGS. 3A and 3B**).

[**0086**] It is noted that aerosol cans contain a pressurized liquid which is dispensed as droplets or as a mist or gas. However, aerosol cans cannot generally dispense a fluid which has already changed to gas inside the can. In the present invention, the presence of expansion chamber **14** permits dispensing fluid **18** even if fluid **18** has already changed to a gaseous state.

[**0087**] It is be appreciated that many other arrangements of the internal components of spray valves **10**, **60**, **70** and **80** are possible within the scope of the present invention.

[**0088**] Reference is now made to **FIG. 5** which illustrates a valve **90** constructed and operative in accordance with a preferred embodiment of the present invention. Valve **90** can be employed in any kind of aerosol spray system, including the above described embodiments of the present invention, and is particularly useful in systems which spray a predetermined amount of substance or where a safety valve is

required. Valve **90** can be integrated with or replace the existing valve of the spray system.

[**0089**] Valve **90** preferably includes a lower body **92** with a narrow extension **94**. Extension **94** is adapted to be fluid connected with a feed tube **95** through which contents of a container **96** can flow. Feed tube **95** is preferably the feed tube shown and described hereinbelow with reference to FIGS. **7**A-**7**D, but alternatively any other kind of feed tube may be used. Body **92** and extension **94** are preferably formed with a central bore **98** which extends into a counterbore **107**. In the position shown in **FIG. 5, a** stopper **106** is disposed at the bottom of counterbore **107**, thereby defining a volume **108** between stopper **106** and an upper end **102** of counterbore **107**. A clearance preferably exists between the outer perimeter of stopper **106** and the inner perimeter of counterbore **107**, such that a portion of the contents of container **96** can flow from container **96** around stopper **106** and fill volume **108**.

[**0090**] An expansion chamber **99** is preferably formed in an inner volume of an upper body **110**, which preferably has a lower extension **112** that snaps fixedly on lower body **92**. A soft elastomeric (e.g., rubber) washer **105** may be placed between upper and lower bodies **110** and **92**. Alternatively, lower and upper bodies **92** and **110** may be constructed as one unitary body, in which case there is no need for washer **105**. Deformable element **56** is disposed in expansion chamber **99**. A plunger **100** is preferably attached to deformable element **56**, such as by means of spot welding, for example. Plunger **100**, preferably non-hollow, is arranged to slide from an upper position shown in solid lines in **FIG. 5** to a lower position shown in dashed lines. In the lower position, plunger **100** preferably sealingly slides into an O-ring **104** affixed at the upper end **102** of counterbore **107**.

[**0091**] In accordance with a preferred embodiment of the present invention, expansion chamber **99** has a shape that conforms to the limits of the deformed orientations of deformable element **56**. Expansion chamber **99** preferably is formed with a hole **99**A, through which passes plunger **100**. The conformal shape of expansion chamber **99** has several advantages:

[**0092**] a. The shape of expansion chamber **99** permits placing a spray outlet **101** at any angle or orientation in expansion chamber **99**, thereby enabling spraying contents of a container in any direction.

[**0093**] b. Any number of spray outlets **101** of any combination of size and shape may be employed, through which the contents are sprayed essentially simultaneously. By controlling the number, size and shape of the outlets **101**, one can substantially prevent excess pressure build-up in expansion chamber **99**.

[**0094**] c. Because of the shape of expansion chamber **99**, the fluid contents of the container flow both over and under deformable element **56** generally at the same time.

[**0095**] d. The conformal shape of expansion chamber **99** has a small volume, thereby permitting spraying small dosages of the contents of the spray container.

[**0096**] e. The shape also prevents accumulation of any leftover matter that did not completely exit the expansion chamber **99** during the previous spraying. Any leftover matter flows along the bottom of expansion chamber **99**, drains through hole **99**A and is sprayed during the next spraying.

[**0097**] f. The size of expansion chamber **99** determines the quantity of fluid **103** that can be sprayed, and the amount of liquid droplets of fluid **103** that will be sprayed as opposed to gaseous matter. The larger the chamber, the more room there is for fluid **103** to expand, and consequently less liquid droplets will be sprayed. Conversely, the smaller the chamber, the more liquid droplets will be sprayed. The maximum quantity of substance which can be sprayed at a time is about equal to volume **108**. However, it is preferable not to spray more than volume **108** at a time, so that stopper **106** will not become lodged in end **102** of bore **98**.

[**0098**] Operation of valve **90** is now described. Initially, a quantity of fluid **103** has flowed from container **96** through tube **95** and bore **98** into volume **108**. When deformable element **56** is in the upward (solid line) position of **FIG. 5**, the internal pressure of the contents of container **96** push upwards (in the sense of **FIG. 5**) against stopper **106** and force some of the fluid **103** upwards from volume **108** through hole **99**A into expansion chamber **99**. Fluid **103** expands in expansion chamber **99** and exits as a spray through spray outlet or outlets **101**. Fluid **103** flows around the ends of deformable element **56**, such that fluid **103** cools both sides of deformable element **56**. Once deformable element **56** has sufficiently cooled, it snaps to the lower (dashed line) position shown in **FIG. 5**. Plunger **100** slides into O-ring **104** and seals the upper end **102** of counterbore **107**. Stopper **106** drops back down by gravity to the bottom of counterbore **107** and a fresh portion of the contents of container **96** flows upwards past stopper **106** and re-fills volume **108**. The re-filled volume **108** is now ready for the next spray.

[**0099**] Optionally, valve **90** may be configured to be a one-way valve, i.e., a valve that prevents matter from flowing back into container **96**. This may be accomplished by placing a small, preferably elastic, ball **156** below stopper **106**. Ball **156** can become lodged in a chamfered portion **158** formed in bore **98** at the throat of lower extension **94**. Ball **156** does not interfere with flow of fluid **103** from container **96** towards deformable element **56** and chamber **99**, but does substantially prevent flow of fluid backwards towards container **96**.

[**0100**] Once again, it is to be emphasized that deformable element **56** is free to snap from one position to another without any clamping forces. This is because deformable element **56** is not clamped, but rather freely supported. There is preferably an up-and-down gap **183** (in the sense of **FIG. 5**) and a radial gap **185** between deformable element **56** and the inner surfaces of expansion chamber **99**. Radial gap **185** ensures that there are no radially-directed stresses acting upon deformable element **56**, and enables plunger **100** to self-center relative to O-ring **104** without any radially-directed forces acting upon deformable element **56**. The presence of gaps **183** and **185** relaxes manufacturing tolerances and brings down manufacturing costs.

[**0101**] Generally only about half or less of the fluid **103** in volume **108** is sprayed at a time. Various factors affect the frequency and time duration of dispensation, amount of fluid dispensed, the operative reference temperature range, and time for deformable element **56** to deform between the two orientations, as described hereinabove.

[0102] If any malfunction occurs and plunger **100** does not close properly, the internal pressure of the contents of container **96** will continue to force stopper **106** upwards towards upper end **102** of bore **98** such that stopper **106** will become lodged in end **102** of bore **98**, thereby substantially sealing upper end **102** of bore **98** and preventing further spraying of the contents. It is noted that in **FIG. 5** stopper **106** is illustrated as having an upper protrusion **106**A which abuts against upper end **102**. However, it is appreciated that stopper **106** could be flat and still seal against end **102**, because the internal pressure of the contents of container **96** will maintain an upward force against stopper **106**.

[0103] Thus, stopper **106** acts as a safety valve which prevents undesirable overspraying of the contents. Stopper **106** can prevent leaking or overspraying due to a variety of malfunctions. For example, malfunctions can possibly occur due to: knocks or blows to the container **96**, dropping the container, a gas leak, or the fluid inside the container being spent. In all cases stopper **106** will act as a safety valve because the internal pressure will maintain stopper **106** sealed against end **102**. In addition, if spraying is performed with the container in a horizontal or inverted position, stopper **106** will also substantially prevent spraying, because the internal pressure will again maintain stopper **106** sealed against end **102**.

[0104] In accordance with a preferred embodiment of the present invention, an on-off switch **177** can be provided next to deformable element **56**. On-off switch **177** may be simply constructed, for example, as a stem **178** that slides in a bore **179** formed in an upper portion of upper body **110**. A pin **180** preferably protrudes from a side of stem **178**. Stem **178** can be pushed against deformable element **56** in the direction of an arrow **181** in **FIG. 5**, whereupon stem **178** can be turned approximately a quarter-turn so that pin **180** is received in a groove **182** formed in the upper portion of upper body **110**. Once on-off switch **177** is pushed against deformable element **56**, deformable element **56** cannot snap to the upper position of **FIG. 5**, and valve **90** is thus switched off Conversely, the valve is turned on by removing pin **180** from groove **182**.

[0105] On-off switch **177** can act as a manual reset for the stopper **106** as well. The action of pushing on-off switch **177** downwards (in the sense of **FIG. 5**), without quarter-turning stem **178**, dislodges stopper **106** from the upper end **102** of counterbore **107** It is appreciated that other on-off switches may also be employed.

[0106] It is noted that the embodiment of **FIG. 5** is distinguished, inter alia, by its simple construction—deformable element **56**, lower and upper bodies **92** and **110**, plunger **100**, expansion chamber **99**, stopper **106** and O-ring **104** (and optionally washer **105**, ball **1** and on-off switch **177**). The contents of the container flow directly to deformable element **56** without any need for extraneous structure as in Iketani, for example.

[0107] The fluid contents can be directed to flow from underneath deformable element **56** as shown and described hereinabove with reference to **FIGS. 1A and 1B**, or above deformable element **56** as shown and described hereinabove with reference to **FIGS. 2A and 2B**. In other words, one can construct valve **90** such that the flow of the contents helps deformable element **56** snap back to the closed position (i.e., flow from underneath deformable element **56**). Alternatively, one can construct valve **90** such that the flow of the contents retards deformable element **56** from snapping back to the closed position (i.e., flow from above deformable element **56**). As another alternative, deformable element **56** can be formed with one or more holes through which the contents can be sprayed. The contents can also flow around deformable element **56**.

[0108] In the case of the fluid contents being directed to flow from underneath deformable element **56**, the upward flow of the contents applies an upward force upon plunger **100**. This force aids in snapping deformable element **56** to the spray orientation, and shortens the time between sprayings. The smaller the cross-sectional area of plunger **100**, the smaller the force of the contents, and the longer time between sprayings. This upward force can cause deformable element **56** to snap to the spray orientation before deformable element **56** has actually reached the temperature normally required for snapping (i.e., actuation temperature). This allows using a deformable element with a slightly higher actuation temperature, which generally means cost savings, because the price of bimetallic discs generally decreases with higher actuation temperatures.

[0109] Reference is now made to **FIGS. 6A and 6B** which illustrate a spray valve **180** constructed and operative in accordance with still another preferred embodiment of the present invention. Spray valve **180** is constructed generally similarly to valve **90**, with like elements being designated by like numerals. Spray valve **180** employs a generally rectangular deformable element **182** either freely supported and placed between two halves **184** and **186** of an expansion chamber **188**, or alternatively, clamped around its perimeter by the two halves **184** and **186**, or further alternatively, clamped at only two ends thereof. It is generally the central area of deformable element **182** which snaps from one position to another.

[0110] A hole is preferably formed in the bottom of half **186** for plunger **100** to pass therethrough and for draining any leftover matter from previous sprayings. Deformable element **182** is preferably formed with one or more generally rectangular apertures **190**, through which matter can be sprayed. The matter can exit expansion chamber **188** through an upper spray outlet **192**, for example. Valve **180** operates in the same manner as the other valves of the present invention, described hereinabove. It is appreciated that any abovementioned variations in construction, such as number and position of spray outlets, for example, can be incorporated in valve **180** as well. Unlike circular bimetallic elements, the rectangular deformable element (bimetallic or shape memory) is not sensitive to slight misalignments or variations in size, and does not accidentally reverse its movement under the influence of all-around clamping.

[0111] Reference is now made to FIGS. **6C-6F** which illustrate a spray valve **194** constructed and operative in accordance with yet another preferred embodiment of the present invention. Spray valve **194** is constructed generally similarly to valve **180**, with like elements being designated by like numerals. Spray valve **194** employs a generally rectangular deformable element **196** with short ends **198** which may be bent. Deformable element **196** is preferably freely supported in an expansion chamber **137**. There is preferably a gap **135** between short ends **198** and an inner surface of expansion chamber **137**.

[0112] In **FIG. 6**C, deformable element **196** is bent upwards, in the sense of the figure. As deformable element **196** starts to snap downwards, the short ends **198** move outwards in the direction of arrows **127** and abut against inner surfaces of expansion chamber **137**, as seen in **FIG. 6E**. Once deformable element **196** snaps downwards to the position shown in **FIG. 6**F, there is again a gap **135** between short ends **198** and an inner surface of expansion chamber **137**.

[0113] Many aerosol cans contain liquid and gaseous contents which must be shaken before spraying in order to mix these contents properly. Unfortunately, sometimes users forget to shake the contents, and in some spraying systems, it is inconvenient or impossible (such as in automatic spray dispensers) to shake the contents before each spray. The present invention enables spraying such contents without any need for shaking as is now described.

[0114] Reference is now made to **FIGS. 7A, 7B** and 7C which illustrate a tube **122** useful for spray apparatus, constructed and operative in accordance with a preferred embodiment of the present invention. Tube **122** preferably has a lower open end **124** in fluid communication with contents of a spray container **128**. Lower open end **124** may be at the tip of tube **122**, or alternatively may be on a side wall of tube **122**. Lower open end **124** may be weighted, if desired, so that open end **124** gravitates towards the lowest part of container **128**, irrespective of the angle at which container **128** is positioned.

[0115] Spray container **128** may be any kind of spray container of the present invention or of the art, and the upper end of tube **122** may be connected to any kind of spray nozzle (not shown) of the present invention or of the art, including the safety valve of **FIG. 5**. The contents of container **128** preferably include a first substance **126**, which generally remains in a fluid (liquid or gaseous) state in container **128**, and a second substance **117** which preferably comprises a liquid portion **132** and a gaseous portion **133**. Gaseous portion **133** maintains a generally constant pressure on liquid portion **132** and first substance **126**. It is this pressure which pushes the contents of container **128** out through tube **122** for spraying, as will be described hereinbelow. In many spraying applications, it is preferable that the first substance **126** and liquid portion **132** be mixed prior to being sprayed. Tube **122** mixes the two substances **126** and **117** as is described hereinbelow.

[0116] It is noted that the present invention is also applicable for spraying fine, solid particles as well. Thus, first substance **126** can also comprise a solid material, such as a sprayable powder. Second substance **117** does not necessarily have to include both a liquid portion **132** and a gaseous portion **133**, but rather can be either liquid alone or gas alone.

[0117] Tube **122** is preferably formed with one or more side apertures of any size or shape. In the illustrated embodiment, there are three apertures, designated **130**A, **130**B and **130**C, although it is appreciated that any number of apertures may be formed in tube **122**. (Tube **122** may alternatively or additionally be provided with one or more gas intake apertures **139** to perform functions described further hereinbelow with reference to **FIG. 7D**.) **FIG. 7A** shows spray container **128** filled with liquid portion **132** above first substance **126**, and gaseous portion **133** above liquid portion **132**. It is seen that liquid portion **132** is in fluid communication with the upper aperture **130**A. When the spray nozzle is opened for spraying, the internal pressure of container **128**, i.e., the downward pressure supplied by gaseous portion **133**, forces the first substance **126** into the open end **124**. As first substance **126** rises in tube **122**, liquid portion **132** can enter the upper aperture **130**A and mix with first substance **126** as it flows upwards in tube **122**. In this manner, the two substances are mixed prior to being sprayed, without any need for shaking the contents of container **128**.

[0118] In **FIGS. 7B and 7C**, a sufficient amount of the contents have been sprayed such that spray container **128** is now partially full or nearly empty, respectively. Liquid portion **132** is now in fluid communication with the middle aperture **130**B or lower aperture **130**C, respectively. Once again, when the spray nozzle is opened for spraying, the downward pressure supplied by gaseous portion **133** forces first substance **126** into the open end **124**. As first substance **126** rises in tube **122**, liquid portion **132** can enter the middle or lower aperture **130**B or **130**C, respectively, and mix with first substance **126** as it flows upwards in tube **122**. The two substances are mixed prior to being sprayed, without any need for shaking the contents of container **128**.

[0119] It is noted that in **FIG. 7**B, gaseous portion **133** enters the upper aperture **130**A and mixes with first substance **126** and liquid portion **132**. In **FIG. 7**C, gaseous portion **133** enters the upper and middle apertures **130**A and **130**B and mixes with first substance **126** and liquid portion **132**. In each case, the added ingredient of gaseous portion **133** slightly changes the proportion of first substance to the second substance. Although the change in proportion is generally negligible, nevertheless it can be minimized by varying the relative sizes of the lower, middle and upper apertures **130**A, **130**B and **130**C. In general, the amount of gaseous portion **133** which enters tube **122** and mixes with first substance **126** and liquid portion **132**, is mostly a function of the inner diameter of tube **122** and the sizes of apertures **130**, rather than the number of apertures **130**.

[0120] In summary, it is possible to have small, although for most applications negligible, differences in the ratio of first substance to second substance as the contents are emptied from container **128**. The factors which affect the mixing ratio of first substance **126** and liquid portion **132** include, inter alia, initial ratio of first to second substance, properties of first and second substances **126** and **117**, the amount of gaseous portion **133** left as the contents of container **128** are emptied, diameter, shape or size of the side apertures **130** and their relative position to each other, internal pressure of the container, and the spray time, i.e., the amount of time the contents are sprayed.

[0121] Optionally, as shown in **FIG. 7**D, tube **122** may have one or more apertures **139** formed at an upper end thereof which are in fluid communication with gaseous portion **133** at all times, and are not in fluid communication with first substance **126** nor liquid portion **132**. In this manner, each time the contents of container **128** are sprayed, first substance **126** flows up through tube **122** and mixes only with gaseous portion **133**, thereby maintaining a constant ratio of the mixture of first substance **126** and second substance **117** (in the form of gaseous portion **133**), no matter whether the container **128** is full or not.

[0122] It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of the features described hereinabove as well as modifications and variations thereof which would occur to a person of skill in the art upon reading the foregoing description and which are not in the prior art.

What is claimed is:

1. Apparatus for spraying contents of a spray container, comprising:

a dispenser body sealingly attachable to a container containing a fluid;

a fluid outlet formed in said dispenser body; and

a deformable element generally freely supported around a perimeter thereof in said dispenser body, said deformable element having a first orientation when in a reference temperature range and reversibly deforming to a second orientation when out of said reference temperature range, wherein in said first orientation said deformable element is operative to block passage of the fluid from the container and in said second orientation said deformable element is operative to allow passage of the fluid from the container.

2. Apparatus according to claim 1 wherein said deformable element is generally circular.

3. Apparatus according to claim 1 wherein said deformable element is generally rectangular.

4. Apparatus according to claim 1 further comprising a container containing a fluid, said dispenser body being sealingly attached to said container.

5. Apparatus according to claim 4 wherein in said second position said fluid flows towards and contacts said deformable element, wherein heat is transferred between said fluid and said deformable element so as to bring said deformable element into said reference temperature range, such that said deformable element deforms from said second orientation to said first orientation.

6. Apparatus according to claim 4 wherein said fluid contacts said deformable element on a surface of said deformable element which faces said container.

7. Apparatus according to claim 3 wherein said fluid contacts said deformable element on a surface of said deformable element which does not face said container.

8. Apparatus according to claim 3 wherein said fluid contacts said deformable element both on a surface of said deformable element which faces said container and on a surface of said deformable element which does not face said container.

9. Apparatus according to claim 1 and further comprising a plunger arranged for sliding motion in said dispenser body between a first position and a second position.

10. Apparatus according to claim 1 wherein said plunger is attached to said deformable element.

11. Apparatus according to claim 1 wherein said deformable element comprises a bimetallic element.

12. Apparatus according to claim 1 wherein said deformable element comprises a shape memory alloy element.

13. Apparatus according to claim 1 wherein said dispenser body comprises thermal insulation for thermally insulating said deformable element from an outside environment.

14. Apparatus according to claim 1 wherein said dispenser body is formed with an expansion chamber, and when said deformable element is in said second orientation, said fluid flows into said expansion chamber and expands therein.

15. Apparatus according to claim 14 wherein said expansion chamber is positioned on one side of said deformable element.

16. Apparatus according to claim 14 wherein said expansion chamber is positioned on two sides of said deformable element.

17. Apparatus according to claim 1 and further comprising a safety spray valve in fluid communication with said fluid outlet which is operative to substantially prevent flow of said fluid through said fluid outlet.

18. Apparatus according to claim 17 wherein said safety spray valve comprises a stopper slidingly disposed in a bore formed in said dispenser body, said bore allowing fluid to flow from a container to said fluid outlet, wherein said stopper is adapted to slide towards an end of said bore, and be substantially sealingly retained thereat, by a force of pressurized contents of the container.

19. Apparatus according to claim 17 wherein said safety spray valve comprises a one-way valve that substantially prevents matter from flowing in a direction from said deformable element back into the container.

20. Apparatus according to claim 19 wherein said one-way valve comprises a ball disposed in a bore formed in said dispenser body, said ball not interfering with flow of fluid from the container towards said deformable element, but substantially preventing flow of fluid backwards towards the container.

21. Apparatus according to any of the preceding claims wherein said spray valve is in fluid communication with contents of a spray container, said contents comprising a first substance, and a second substance which comprises at least one of a liquid portion and a gaseous portion, said spray valve further comprising a tube with a lower open end in fluid communication with said first substance, said tube being formed with at least one side aperture in fluid communication with said second substance.

22. Apparatus according to claim 21 wherein said at least one side aperture is in fluid communication with said liquid portion.

23. Apparatus according to claim 21 wherein said at least one side aperture is in fluid communication with said gaseous portion.

24. Apparatus according to any of claims **21-23** wherein when said spray valve dispenses said contents, an internal pressure of said container forces said first substance into said open end, and as said first substance rises in said tube, said second substance can enter said at least one side aperture and mix with said first substance, prior to said contents being sprayed.

25. Apparatus for spraying contents of a spray container, comprising:

a dispenser body sealingly attachable to a container containing a fluid;

an expansion chamber formed in said dispenser body;

a fluid outlet formed in said dispenser body; and

a generally rectangular deformable element disposed in said expansion chamber, said deformable element having a first orientation when in a reference temperature

range and reversibly deforming to a second orientation when out of said reference temperature range, wherein in said first orientation said deformable element is operative to block passage of the fluid from the container and in said second orientation said deformable element is operative to allow passage of the fluid from the container, and when said deformable element is in said second orientation, said fluid flows into said expansion chamber and expands therein.

26. Apparatus according to claim 25 wherein said deformable element is generally freely supported in said expansion chamber in said first orientation, wherein as said deformable element snaps from said first orientation to said second orientation, ends of said deformable element move and abut against inner surfaces of said expansion chamber, said ends of said deformable element being separated by a gap from the inner surfaces of said expansion chamber and freely supported in said expansion chamber when said deformable element has snapped to said second orientation.

27. Apparatus according to claim 25 wherein two ends of said deformable element are clamped in said expansion chamber.

28. Apparatus according to claim 25 wherein said deformable element is clamped generally around its perimeter in said expansion chamber.

29. Apparatus according to claim 25 wherein said deformable element comprises a bimetallic element.

30. Apparatus according to claim 25 wherein said deformable element comprises a shape memory alloy element.

31. Apparatus for spraying contents of a spray container, comprising:

a dispenser body sealingly attachable to a container containing a fluid;

a fluid outlet formed in said dispenser body;

a spray nozzle in fluid communication with said dispenser body operative to spray said fluid from the container; and

a safety valve operative to substantially prevent flow of said fluid through said spray nozzle even if said spray nozzle malfunctions.

32. Apparatus according to claim 31 wherein said safety spray valve comprises a stopper slidingly disposed in a bore formed in said dispenser body, said bore allowing fluid to flow from a container to said fluid outlet, wherein said stopper is adapted to slide towards an end of said bore, and be substantially sealingly retained thereat, by a force of pressurized contents of the container.

33. Apparatus according to claim 31 wherein said safety spray valve comprises a one-way valve that substantially prevents matter from flowing in a direction from said deformable element back into the container.

34. Apparatus according to claim 33 wherein said one-way valve comprises a ball disposed in a bore formed in said dispenser body, said ball not interfering with flow of fluid from the container towards said deformable element, but substantially preventing flow of fluid backwards towards the container.

35. Apparatus according to any of claims **31-34** wherein said spray valve is in fluid communication with contents of a spray container, said contents comprising a first substance, and a second substance which comprises at least one of a liquid portion and a gaseous portion, said spray valve further comprising a tube with a lower open end in fluid communication with said first substance, said tube being formed with at least one side aperture in fluid communication with said second substance.

36. Apparatus according to claim 35 wherein said at least one side aperture is in fluid communication with said liquid portion.

37. Apparatus according to claim 35 wherein said at least one side aperture is in fluid communication with said gaseous portion.

38. Apparatus according to any of claims **35-37** wherein when said spray valve dispenses said contents, an internal pressure of said container forces said first substance into said open end, and as said first substance rises in said tube, said second substance can enter said at least one side aperture and mix with said first substance, prior to said contents being sprayed.

39. Apparatus for spraying contents of a spray container, said contents comprising a first substance, and a second substance which comprises at least one of a liquid portion and a gaseous portion, said apparatus comprising:

a tube with a lower open end in fluid communication with said first substance, said tube being formed with at least one side aperture in fluid communication with said second substance.

40. Apparatus according to claim 39 wherein said first substance is generally in a fluid state in said container.

41. Apparatus according to claim 39 wherein said first substance is generally in a solid state in said container.

42. Apparatus according to claim 39 wherein said tube is formed with a plurality of said side apertures, wherein one of said side apertures is in fluid communication with at least one of said liquid portion and said gaseous portion.

43. Apparatus according to claim 42 wherein one of said side apertures has a size different than another of said side apertures.

44. A method of dispensing a fluid from a container, comprising:

providing a container containing a fluid;

attaching a spray valve to said container, said spray valve comprising:

a dispenser body sealingly attachable to a container containing a fluid;

a fluid outlet formed in said dispenser body;

a deformable element generally freely supported around a perimeter thereof in said dispenser body, said deformable element having a first orientation when in a reference temperature range and reversibly deforming to a second orientation when out of said reference temperature range, wherein in said first orientation said deformable element is operative to block passage of the fluid from the container and in said second orientation said deformable element is operative to allow passage of the fluid from the container; and

placing said container with said spray valve attached thereto in an environment whose temperature is out of said reference temperature range, such that heat transfer between said deformable element and the environment brings said deformable element out of said reference temperature range after a period of time,

whereupon said deformable element deforms to said second orientation, and said fluid flows from said container into said dispenser body and is dispensed out of said fluid outlet.

45. The method according to claim 44 further comprising transferring heat between said fluid and said deformable element when said deformable element is in said second orientation so as to bring said deformable element into said reference temperature range, such that said deformable element deforms from said second orientation to said first orientation, thereby preventing said fluid from exiting said dispenser body.

46. The method according to claim 44 or claim 45 further comprising controlling dispensing of the fluid by selecting a desired size of said spray nozzle.

47. The method according to claim 44 or claim 45 further comprising controlling dispensing of the fluid by selecting a desired size of said fluid outlet.

48. The method according to claim 44 or claim 45 further comprising controlling dispensing of the fluid by constructing said deformable element of a bimetallic material with selected thermal properties and physical dimensions.

49. The method according to claim 44 or claim 45 further comprising controlling dispensing of the fluid by directing said fluid to flow on a surface of said deformable element which faces said container, when said deformable element is in said second position.

50. The method according to claim 44 or claim 45 further comprising controlling dispensing of the fluid by directing said fluid to flow on a surface of said deformable element which does not face said container, when said deformable element is in said second position.

51. The method according to claim 44 or claim 45 further comprising controlling dispensing of the fluid by directing said fluid to flow both on a surface of said deformable element which faces said container and on a surface of said deformable element which does not face said container, when said deformable element is in said second position.

52. The method according to claim 44 or claim 45 further comprising controlling dispensing of the fluid by selecting desired physical properties of said fluid.

53. The method according to claim 44 or claim 45 further comprising controlling dispensing of the fluid by selecting desired thermal properties of said fluid.

54. The method according to claim 44 or claim 45 further comprising controlling dispensing of the fluid by selecting desired a pressure of said fluid.

55. The method according to claim 44 or claim 45 further comprising controlling dispensing of the fluid by thermally insulating said dispenser body from an outside environment.

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