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(54) **Title:** A LIQUID STORAGE DEVICE III

(57) **Abstract:** The disclosed invention relates generally to a liquid storage device, more particularly to a liquid storage device adapted to permit a substance to be selectively added to a liquid and an associated method of selectively adding a substance to a liquid. The invention has been primarily developed for use in water bottles that allow the selective addition of powdered vitamin supplements and will be described hereunder with reference to this application. However, the invention is not limited to this particular application and is also suited for use in storage of numerous other liquids and the selective addition of numerous other substances, as will be explained in this document.



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A LIQUID STORAGE DEVICE III

Field of the Invention

The present invention relates generally to a liquid storage device, more particularly to a liquid storage device adapted to permit a substance to be selectively added to a liquid and an associated method of selectively adding a substance to a liquid.

The invention has been primarily developed for use in water bottles that allow the selective addition of powdered vitamin supplements and will be described hereinafter with reference to this application. However, the invention is not limited to this particular application and is also suited for use in storage of numerous other liquids and the selective addition of numerous other substances, as will be exemplified below.

Background of the Invention

The consumption of bottled water is very popular. Further, the consumption of bottled water, and other drinks, with vitamins or other substances included therein is also very popular.

A disadvantage of these known 'premixed' drinks is that the efficacy of the vitamins, or other added substances, can be compromised as a result of their storage in a suspended state in the water or other liquid.

One approach to address this disadvantage are bottles that are sold without liquid therein, but that have a powdered supplement occupying a minor part of their total volume. The user then adds water to the bottle and mixes it with the supplement just prior to consumption, for example after exercising. A disadvantage of this approach is that the user must have access to a supply of drinkable water prior to consumption. This is not practical, or even possible, in many situations, particularly running, hiking and the like.

Object of the Invention

It is an object of the present invention to substantially overcome or at least ameliorate one or more of the above prior art deficiencies.

Summary of the Invention

Accordingly, in a first aspect, the present invention provides a liquid storage device including:

a liquid reservoir;

a substance reservoir, the substance reservoir being connectable to the liquid reservoir for handling as a single item without causing liquid transmission between the substance reservoir and the liquid reservoir; and

manually operable means to selectively allow liquid transmission between the substance reservoir and the liquid reservoir.

The manually operable means preferably includes valve and/or seal means associated with one or both of the substance reservoir and the liquid reservoir. In one form, the manually operable means is preferably operable by twisting or turning the substance reservoir, or an associated housing, relative to the liquid reservoir. In another form, the manually operable means is preferably operable by deforming the liquid reservoir.

The liquid reservoir is preferably accessible, for receiving or releasing fluid, whilst connected to the liquid reservoir without causing liquid transmission between the substance reservoir and the liquid reservoir. In one form, the liquid reservoir includes an opening, most preferably closed by a cap or lid, that is remote the substance reservoir. In another form, the liquid reservoir includes an opening, most preferably a tube closed by a cap or lid, that passes through the substance reservoir. In yet another form, the substance reservoir includes a passage or duct in fluid communication with an opening in the liquid reservoir.

The substance reservoir preferably includes at least one frangible part adapted for cutting or rupturing by at least one cutter in the liquid reservoir, in response to relative movement between the liquid reservoir and the cutter. More preferably, the substance reservoir preferably includes two opposed frangible parts adapted for cutting or rupturing by two opposed cutters in the liquid reservoir, in response to relative movement between the liquid reservoir and the cutters. The substance reservoir is preferably adapted for insertion into the liquid reservoir in a first position, in which the cutter(s) are remote the frangible part(s), and movable to a second position, in which the cutter(s) are adjacent the frangible part(s). More preferably, the substance reservoir is rotatable about its longitudinal axis between the first and second positions. The substance reservoir preferably includes one or more recesses extending longitudinally along the substance reservoir, in which the cutter(s) travel whilst in the first position.

The frangible part(s) is/are preferably foil seal(s), most preferably foil seal(s) extending longitudinally along the substance reservoir.

The cutter(s) is/are preferably associated, most preferably forming part of, a cap part connectable to the liquid reservoir. The liquid reservoir and cap part preferably

include corresponding engagement formations, most preferably at least one protuberance near each end of the liquid reservoir and at least one groove in the cap part, to limit the relative movement between the liquid reservoir and the cap part. The cap part is also preferably grooved to allow relative axial rotation between the liquid reservoir and the cap part when either end of the liquid reservoir is substantially adjacent the cap part. The liquid reservoir preferably includes a tab, most preferably, adjacent an end thereof to facilitate manual gripping of the liquid reservoir.

In a second aspect, the present invention provides a liquid storage device including:

a liquid reservoir having at least one first opening;
a substance reservoir having at least one first opening, closed by a seal; and
a joiner adapted for engagement with the liquid reservoir and the substance reservoir, the joiner including a cutter adapted to rupture said seal during engagement of the substance reservoir with the joiner;

wherein the liquid reservoir is selectively movable relative to the substance reservoir between a first position preventing liquid transmission between the at least one first opening of the liquid reservoir and the at least one first opening of the substance reservoir and a second position permitting liquid transmission between the at least one first opening of the liquid reservoir and the at least one first opening of the substance reservoir.

The liquid reservoir preferably includes at least one second opening, the at least one second opening being closable by a lid. The liquid reservoir at least one first opening and at least one second opening are preferably on opposed ends of the liquid reservoir. The liquid reservoir preferably has two first openings and one said second opening.

In a third aspect, the present invention provides a liquid storage device including:
a liquid reservoir;
a substance reservoir having at least one opening that is closed by a seal; and
a joiner adapted: for engagement with the liquid reservoir and the substance reservoir; to rupture said seal during said engagement with the substance reservoir; and selectively prevent or allow liquid transmission between the liquid reservoir and the substance reservoir.

The liquid reservoir preferably has two said first openings on end and one second opening on its other end. The substance reservoir preferably has one said first opening. The substance reservoir first opening is preferably adjacent a threaded cylindrical part,

which threaded cylindrical part is adapted to engage a corresponding threaded cylindrical recess on the joiner.

The joiner preferably includes at least one, most preferably four, teeth adapted to rupture the seal during engagement, most preferably screwing engagement, of the
5 substance reservoir with the joiner. The teeth are preferably adjacent the threaded cylindrical recess.

The liquid reservoir and the joiner preferably include corresponding formations adapted to, once the liquid reservoir and the joiner have been screwed together, selectively allow or prevent relative rotation between the liquid reservoir and the joiner.
10 More preferably, relative rotation is prevented by the formations abutting one another in a natural state and relative rotation is allowed by the formations clearing one another in a deformed state. The joiner is preferably adapted such that manual squeezing, most preferably of opposed sides thereof, moves the formations out of engagement to allow the relative rotation.

15 The device preferably includes a seal, most preferably an elastomeric seal, between the liquid reservoir and the joiner. The seal is preferably fixed to the liquid reservoir. The seal preferably includes one or more, preferably two, openings corresponding to the first openings in the liquid reservoir.

The substance reservoir preferably includes means to enable releasable
20 connection to a like substance reservoir, most preferably in the form of corresponding threaded cylindrical parts and recesses on its opposed ends respectively.

In a fourth aspect, the present invention provides a method of selectively adding a substance to a liquid, the method including the steps of:

adding liquid to a liquid reservoir having at least one first opening and at least
25 one second opening, the at least one second opening being closable by a lid;

adding a substance to a substance reservoir having at least one first opening;

closing the at least one first opening of the substance reservoir with a seal;

connecting the substance reservoir to a cutter which is adapted to pierce said seal
during the connection to the cutter or the substance reservoir; and

30 moving the liquid reservoir relative to the substance reservoir from a first position preventing liquid transmission between the at least one first opening of the liquid reservoir and the at least one first opening of the substance reservoir and a second position permitting liquid transmission between the at least one first opening of the liquid reservoir and the at least one first opening of the substance reservoir.

The method preferably also includes rotating the liquid reservoir relative to the substance reservoir between the first and second positions.

In a fifth aspect, the present invention provides a method of selectively adding a substance to a liquid, the method including the steps of:

- 5 adding liquid to a liquid reservoir;
- adding a substance additive to a substance reservoir having at least one opening;
- sealing the substance reservoir at least one opening;
- connecting the liquid reservoir to the substance reservoir;
- rupturing the seal whilst maintaining the connection of liquid reservoir to the
- 10 substance reservoir; and
- opening a liquid transmission path between the liquid reservoir and the substance reservoir whilst maintaining the connection of liquid reservoir to the substance reservoir.

The method preferably includes rupturing the seal during connection of the liquid reservoir to the substance reservoir.

- 15 The method preferably includes connecting the liquid reservoir to the substance reservoir via a joiner.

In a sixth aspect, the present invention provides a liquid storage device including:

- a liquid reservoir having at least one first opening;
- 20 a substance reservoir adapted for introduction into the liquid reservoir via the at least one first opening;
- means adapted for rupturing the substance reservoir,
- wherein the rupturing means is activatable from the exterior of the liquid storage device.

- 25 The rupturing means is preferably manually activatable from the exterior of the liquid storage device.

The device preferably includes a lid adapted for closing the at least one first opening. The lid preferably includes a flow selectable drinking nozzle therein. The lid preferably also includes a member adapted for rupturing the substance reservoir that is

- 30 connected to an externally operable flange, most preferably an annular flange around the nozzle.

The device preferably includes a carrier adapted for introduction into the liquid reservoir via the at least one first opening and able to receive the substance reservoir therein. The carrier preferably has a series of holes therein. The carrier preferably has a

flange on one end adapted for mounting to the liquid reservoir, most preferably retained by the lid.

In a seventh aspect, the present invention provides a liquid storage device including:

5 a flexible liquid reservoir defining an interior; and

a substance reservoir, within the interior of the liquid reservoir, formed of a weaker material than that of the liquid reservoir;

wherein the substance reservoir is adapted for rupturing in preference to the liquid reservoir in response to deformation of the liquid reservoir.

10 The substance reservoir is preferably adapted for rupturing in preference to the liquid reservoir in response to manual deformation of the liquid reservoir.

The substance reservoir is preferably also flexible, and most preferably mounted to, or forming part of, the base of the liquid reservoir. The substance reservoir is preferably formed from a material that has a lower burst or tear strength than that of the liquid reservoir. The substance reservoir preferably includes regions of weakness.

15 In an eighth aspect, the present invention provides a liquid storage device including:

a liquid reservoir having at least one first opening;

20 a substance reservoir within the liquid reservoir, or adapted for introduction into the liquid reservoir via the at least one first opening, the substance reservoir having at least one second opening;

means adapted for closing the substance reservoir at least one second opening; and

means adapted for opening the substance reservoir,

25 wherein said rupturing means is activatable from the exterior of the liquid storage device.

The means adapted for closing the substance reservoir at least one second opening is preferably a lid. The means adapted for opening the substance reservoir is preferably a pull-cord that is attached to the lid and of a length that reaches exterior of the liquid storage device.

30 In a ninth aspect, the present invention provides a liquid storage device including:

a liquid reservoir having an open interior, a threaded part and a cutter;

a substance reservoir having a closed interior;

a corresponding threaded part, associated with the substance reservoir, and adapted for threaded engagement liquid reservoir threaded part; and

a device adapted to selectively restrict the extent of positioning of the liquid reservoir relative to the substance reservoir,

5 wherein, with the restricting device positioned between the liquid reservoir and the substance reservoir, the relative positioning of the liquid reservoir and the substance reservoir is restricted to prevent the cutter from rupturing the substance reservoir to thereby prevent liquid transmission between the liquid reservoir interior and the substance reservoir interior and, with the restricting device removed from between the liquid
10 reservoir and the substance reservoir, the liquid reservoir and the substance reservoir can be positioned relative to the substance reservoir to cause the cutter to rupture the substance reservoir to thereby permit liquid transmission between the liquid reservoir interior and the opened substance reservoir interior.

In one form, the device preferably also includes a housing adapted to contain the
15 substance reservoir, and said corresponding threaded preferably part forms part of the housing. The liquid reservoir and the housing preferably have male and female threaded parts respectively. The restricting device is preferably a removable peripheral band between the male and female threaded parts. The substance reservoir preferably has a passage, duct or tube therethrough that is in fluid communication with the interior of the
20 liquid reservoir. The distal end of the passage, duct or tube is preferably in fluid communication with an opening in the housing. The housing opening preferably being closed by a removable, most preferably screw threaded, cap or lid.

In another form, said corresponding threaded preferably part forms part of the substance reservoir. The liquid reservoir and the substance reservoir preferably have
25 male and female threaded parts respectively. The restricting device is preferably a removable peripheral band between the male and female threaded parts. The substance reservoir preferably has a passage, duct or tube therethrough that is in fluid communication with the interior of the liquid reservoir. The distal end of the passage, duct or tube is preferably closed by a removable, most preferably screw threaded, cap or
30 lid.

Brief Description of the Drawings

Preferred embodiments of the invention will now be described, by way of examples only, with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of a first embodiment of a liquid storage device;

Fig. 2 is a perspective view of the device shown in Fig. 1 after release of a tamper indicating seal associated with the lid of the device;

Fig. 3 is a partially exploded view of the device shown in Fig. 1;

Fig. 4 is a perspective view of a pair of nested substance reservoirs for use with the device shown in Fig. 1;

Fig. 5 is a fully exploded view of the device shown in Fig. 1, with the lid removed;

Fig. 6 is an underside perspective view of the liquid reservoir of the device shown in Fig. 1;

Fig. 7 is a perspective view of the seal used in the device shown in Fig. 1;

Fig. 8 is a perspective view upper of a cutter used in the device of Fig. 1;

Fig. 9 is an underside perspective view of the cutter shown in Fig. 8;

Fig. 10 is an upper perspective view of the cutter shown in Fig. 8 and a substance reservoir used in the device of Fig. 1;

Fig. 11 is a lower perspective view of the cutter and substance reservoir shown in Fig. 10;

Fig. 12 is a perspective view of the device shown in Fig. 1 with the liquid reservoir and the substance reservoir in a position preventing liquid transmission therebetween;

Fig. 13 is a perspective view of the device shown in Fig. 1 with the liquid reservoir and the substance reservoir in a position permitting liquid transmission therebetween;

Fig. 14 is a partial cross sectional view of the device shown in Fig. 12;

Fig. 15 is a partial cross sectional view of the device shown in Fig. 13;

Fig. 16 is a side view of a second embodiment of a water storage device;

Fig. 17 is an exploded side view of the device shown in Fig. 16;

Fig. 18 is a cross sectional view of the device shown in Fig. 16;

Fig. 19 is a side view of the substance reservoir and a means to rupture the substance reservoir used in the device of Fig. 16;

Fig. 20 is an exploded perspective view of a third embodiment of a liquid storage device;

Fig. 21 is a side view of a fourth embodiment of a liquid storage device according to the invention;

Fig. 22 is a front view of the device shown in Fig. 21;

Fig. 23 is an underside view of the device shown in Fig. 21;

Fig. 24 is a perspective view of the device shown in Fig. 21;

Fig. 25 is a cross sectional side view of the device shown in Fig. 21;

Fig. 26 is a cross sectional side view of a fifth embodiment of a liquid storage device;

5 Fig. 27 is a perspective view of the device shown in Fig. 26;

Fig. 28 is a partial detailed view of the lid region of the device shown in Fig. 26;

Fig. 29 is a cross sectional view of a sixth embodiment of a liquid storage device with the liquid reservoir and the substance reservoir in a position preventing liquid transmission therebetween;

10 Fig. 30 is a cross sectional view of the liquid storage device shown in Fig. 29 with the liquid reservoir and the substance reservoir in a position permitting liquid transmission therebetween;

Fig. 31 is an underside perspective view of a substance reservoir used in the device shown in Figs. 29 and 30;

15 Fig. 32 is a top view of a seventh embodiment of a liquid storage device;

Fig. 33 is a side view of the device shown in Fig. 32;

Fig. 34 is a perspective view of the device shown in Fig. 32;

Fig. 35 is a perspective view of the device shown in Fig. 32 with the lid on;

20 Fig. 36 is a perspective view of the device shown in Fig. 32 with the lid removed;

Figs. 37a to 37e are sequential perspective views of the device shown in Fig. 32 showing a transition from a configuration (Fig. 37a) preventing liquid transmission between the liquid reservoir and the substance reservoir and a configuration (Fig. 37e) permitting liquid transmission between the liquid reservoir and the substance reservoir;

25 Figs. 38a to 38g are partial sequential perspective views of the device shown in Fig. 32 showing a transition from a configuration (Fig. 38a) preventing liquid transmission between the liquid reservoir and the substance reservoir and a configuration (Fig. 38g) permitting liquid transmission between the liquid reservoir and the substance reservoir;

30 Fig. 39 is a side view of a neck component of the device shown in Fig. 32;

Fig. 40 is a lower perspective view of the neck component shown in Fig. 39;

Fig. 41 is a lower perspective view of an internal neck component of the device shown in Fig. 32 with seals in place;

Fig. 42 is an upper perspective view of the internal component shown in Fig. 41;

Fig. 43 is a lower perspective view of the internal neck component shown in Fig. 41 with seals removed; and

Fig. 44 is an upper perspective view of the internal component shown in Fig. 43.

Detailed Description of the Preferred Embodiments

5 Figures 1 to 15 show a first embodiment of a liquid storage device 40. As best shown in Fig. 1, the device 40 includes a liquid reservoir 42 and a substance reservoir 44 connected by a joiner 46. The device 40 also has a screw on lid 48. The liquid reservoir 42, substance reservoir 44 and lid 48 are all formed from a relatively rigid plastics material such as Polypropylene, PET, Polyethylene or Styrene. The joiner 46 is produced
10 from a flexible elastomeric material or elastomer such as Silicon or Polyethylene. The volume of the liquid reservoir 42 is approximately 1 litre. The volume of the substance reservoir 44 is approximately 100ml. However, in other embodiments, these volumes will be application specific with the volume of the liquid reservoir ranging from approximately 100ml to 1 litre and the volume of the substance reservoir ranging from
15 approximately 10ml to 100ml.

The device 40 has a square cross sectional shape. However, the device 40 can also be produced in many alternate shapes, for example round.

The lid 48 includes a tab 50 which is initially received within a corresponding recess 52 in the liquid reservoir 42. When the tab 50 is in the position shown in Fig. 1,
20 the tab 50 prevents the lid 48 from being removed from the liquid reservoir 42. The tab 50 must be bent outwardly, as shown in Fig. 2, in order for the lid 48 to be removed and, by doing so provides an indication of non-tampering.

As best shown in Fig. 3, the substance reservoir 44 has a circular first opening 54 that is closed by a seal 56 which is produced from foil film, Polyethylene film, Teflon,
25 coated paper or other like frangible membranes. The opening 54 is positioned at the distal end of a male threaded cylindrical part 58. As can be seen in Fig. 11, the underside of the substance reservoir 44 has a corresponding female threaded cylindrical recess 60 (threads not shown) adapted for engagement with the threaded part 58. This allows a number of substance reservoirs 44 to be connected together for convenient carrying, as
30 exemplified by Fig. 4. It should be noted that connecting the substance reservoirs 44 to each other in this way does not cause any rupturing of the seal 56.

Fig. 5 shows the liquid reservoir 42 with the lid 48 removed. The liquid reservoir 42 has a conventional threaded necked opening 62.

The Figs. 5 to 8, show a cup shaped seal 64 with two openings 66 therein. The seal 64 is produced from a flexible elastomeric material, such as silicon or polyethylene. As best shown in Fig. 6, the seal 64 is attached to a corresponding cylindrical extension 68 in the underside of the liquid reservoir 42 by plastic welding.

5 The exterior of the extension 68 includes a pair of stops 70, whose purpose shall be described in more detail below. The base of the liquid reservoir 42 within the extension 68 includes a pair of diametrically opposed openings 71, whose purpose shall also be described in more detail below. The distal end of the seal 64 and the extension 68 is received within an annular recess 72 in the joiner 46. The annular recess 72 surrounds a

10 cup shaped part 74 that has a pair of diametrically opposed openings 76 therein. The joiner 46 also has a pair of tabs 78, four struts 80 and two extensions 82, whose purpose shall be described in more detail below.

As shown in Fig. 8, when the sides 46a of the joiner 46 are inwardly squeezed in the direction of arrows 84, the adjacent sides 46b are caused to bow outwardly as indicated by arrows 86. The purpose of which will also be explained below.

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As best shown in Figs. 9 to 11, the underside of the seal 64 has four teeth 88 and an internally threaded surface 89 (threads not shown) which is adapted to engage with the externally threaded part 58 of the substance reservoir 44. Further, as the substance reservoir 44 is screwed into engagement with the joiner 46, the teeth 88 rupture the foil

20 seal 56.

The use of the device 40 will now be described with reference to Figs. 12 to 15. The device 40 can be marketed with or without a liquid being supplied in the liquid reservoir 42. If the latter, then a user will firstly add liquid (eg. water) to the liquid reservoir 42, via the opening 62. The joiner 46 is attached to the liquid reservoir 42. The

25 user then selects a substance reservoir 44 that has a desired substance therein (eg. vitamin supplements). The user then screws the substance reservoir onto the joiner 46 and, as previously described, this causes the teeth 88 to rupture the seal 56. As the joiner 46 is connected to both the liquid reservoir 42 and the substance reservoir 44, both reservoirs can then be conveniently carried as a single item, in a similar manner to existing bottles.

30 Further, additional substance reservoirs 44 can be attached to the underside of the substance reservoir 44 connected to the liquid reservoir 42 for convenient carrying whilst maintaining their seals 56 in tact, and thus also maintaining the integrity, freshness and sterilisation of the substances therein.

When the liquid reservoir 42 and substance reservoir 44 are in the relative position shown in Fig. 12 and Fig. 14, the openings 71 in the bottom of the liquid

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reservoir 42, which corresponds to the openings 66 in the seal 64, are 90° out of alignment with the openings 76 in the joiner 46. As a result, the seal 64 prevents liquid transmission between the liquid reservoir 42 and the substance reservoir 44. The liquid reservoir 42 can thus be used as a conventional bottle in this position. Further, in this position, the tabs 78 abut against the stops 70 and prevent unintentional relative rotation between the liquid reservoir 42 and the substance reservoir 44.

However, when the opposed sides of the joiner 46 are pushed together, as indicated by arrows 84, the adjacent sides expand and cause the tabs 78 to disengage from the stops 70 and thereby allow the substance reservoir 44 to be rotated relative to the liquid reservoir 42 by approximately 90°, as indicated by arrows in Fig. 13. In this position, as shown in Figs. 13 and 15, the corresponding openings 71 and 66 in the liquid reservoir 42 and the seal 64 respectively, are aligned with the openings 76 in the joiner 46. Liquid transmission can then occur between the liquid reservoir 42 and the substance reservoir 44 through the aligned openings. Accordingly, by shaking the device 40, the liquid L in the liquid reservoir 42 can be mixed with the substance S in the substance reservoir 44 to freshly mix the sterile substance S with the liquid L.

For example, immediately after a workout a user can mix, then consume water that has been freshly mixed with a vitamin supplement of their choosing therein. This alleviates the previously discussed disadvantages associated with vitamins stored in a liquid suspended state.

Figs. 16 to 19 show a second embodiment of liquid storage device 100. The device 100 includes a liquid reservoir, in the form of bottle 102, which has a conventional screw threaded neck 104 defining an opening to the interior of the bottle 102. The device 100 also includes a screw type lid 106 with a conventional up/down flow selectable drinking nozzle 108. The nozzle 108 is of the common type used in many water and other drink bottles and, when pulled up (ie. away from the bottle), allows liquid flow from the bottle interior to the user and, when pushed down (ie. towards the bottle), prevents liquid flow from the bottle interior. The bottle 102, lid 106 and valve 108 are produced from a relatively rigid plastics material.

As best shown in Fig. 17, the device 100 also includes a substance reservoir 110, for vitamin supplements and the like. The reservoir 110 is formed from an easily rupturable plastics material. The reservoir 110 is received within a generally cylindrical carrier 112 that has a series of openings 114 therein. The carrier also has a flange 116 at its open end which, as best shown in Fig. 18, is adapted to locate against the distal end of

the bottle neck 104. The lid 106 fixes the carrier 112 in relation to the bottle 102 by clamping the flange 116 against the bottle neck 104.

The lid 106 also includes a means to rupture the substance reservoir in the form of member 118, of cross shaped cross sectional area, which is connected to an annular
5 flange 120 positioned around the nozzle 108.

The use of the device 100 will now be described with reference to Fig. 18. Water, or other liquid, is firstly added to the bottle 102. To assemble the device 100, a user then selects a substance reservoir 110 that has a desired substance therein and inserts it into the carrier 112. The carrier 112 is then inserted into the bottle 102 via the neck 104
10 and secured in place by screwing the cap 106 to the neck 104. Alternatively, the substance reservoir 110 can be inserted into the carrier 112 prior to the carrier 122 being inserted into the bottle 102.

In this configuration, the device 100 can be used as a regular bottle with liquid able to be withdrawn through the nozzle 108. However, when the user depresses the
15 flange 120 relative to the bottle 102, the member 118 is pushed into rupturing the substance reservoir 110, the contents S of which can then be mixed with the liquid L in the bottle 102, via the openings 114, by shaking.

As with the first embodiment, this allows the user to consume a liquid (eg. water) that has been freshly mixed with a substance (eg. vitamin supplement) stored in a
20 sealed environment.

Fig. 20 is an exploded view of a third embodiment of the liquid storage device 140, which aside from the shape is similar to the device 100 described with reference to Figs. 17 to 19. The device 140 is constructed and functions in a similar manner to that of the device 100 and like features between the two embodiments have been indicated with
25 like reference numerals.

Figs. 21 to 25 show a fourth embodiment of a liquid storage device 160 formed from a flexible material or elastomer such as Silicon or Polyethylene. As best shown in Fig. 25, the device 160 includes a liquid reservoir 161 with a base 162. A substance reservoir 164 is mounted to the base 162. The base 162 also forms one wall of the
30 substance reservoir 164. The liquid reservoir has a liquid L therein and the substance reservoir 164 has a substance S therein.

The substance reservoir 164 is formed from Styrene which is a weaker material than that of the flexible reservoir 162. As an example, the substance reservoir can have a lower tear or burst strength than that of the liquid reservoir material. Alternatively,
35 regions of weakness can be included in the material of the substance reservoir material.

When the liquid reservoir 162 is deformed, for example by manual squashing of its exterior, the liquid reservoir 164 will rupture in preference to (ie. prior to) the liquid reservoir 162. As with earlier described embodiments, this allows a user to delay mixing the liquid L in the liquid reservoir 162 with the substance S in the substance reservoir 164 until immediately prior to consumption in order to preserve the freshness of same.

The liquid reservoir 162 also includes an opening 170 for a straw 172, as is well known in the art.

Fig. 26 shows a fifth embodiment of liquid storage device 180. The device 180 includes a liquid reservoir 182 and a substance reservoir 184. The liquid reservoir has a lid 185 and a liquid L therein. The substance reservoir 184 has a substance S therein. Desired substances are added to the substance reservoir 184 via a resealable aperture (not shown) on the underside of the substance reservoir 184.

The substance reservoir 184 has an opening 186 is closed by a lid 190 attached to a pull-cord 192, which is accessed from the exterior of the device 180. The pull cord 192 terminates in a fitting 194 that forms part of a neck 196 for the liquid reservoir 182.

In use, a user fills the liquid reservoir 182 with water or other liquid L which can be consumed or carried in a manner similar to a traditional bottle. However, by pulling the cord 192, the lid 190 can be removed from the substance reservoir 184 thereby enabling its contents S to be mixed with the liquid L and, as with earlier embodiments, consumed whilst in a fresh state.

Figs. 29 to 31 shows a sixth embodiment of a liquid storage device 200. The device 200 has a liquid reservoir 202 with a cylindrical opening 204 to its interior. The liquid reservoir 202 also has a male threaded part 206 and a cutter, in the form of edge 208.

The device 200 also has a substantially Donut-shaped substance reservoir 210 with a passage or duct 212 therethrough. One end of the substance reservoir has a line of peripheral line of weakness 210a. The substance reservoir 210 is retained by, and moves with, a housing 214 that has a female threaded part 216 adapted for threaded engagement with the liquid reservoir male threaded part 206.

The liquid reservoir 202, the substance reservoir 210 and the housing 214 are all preferably formed from a relatively rigid plastics material.

The device 200 also includes a peripheral band 218 which is adapted to selectively restrict the extent of threaded connection between the liquid reservoir 202 and the housing 214, and thus the substance reservoir 210 therein. The band 218 is releasably

connected to the housing 214, for example by clipping, so it can be easily manually removed when desired.

As shown in Fig. 29, when the band 218 is positioned between the liquid reservoir 202 and the housing 214, the liquid reservoir 202 and the housing 214 can only be
5 connected to the extent shown where the cutter edge 208 does not contact the substance reservoir 210. As a result, liquid transmission between the contents L of the liquid reservoir 202 and the contents S of the substance reservoir 210 is prevented.

However, as shown in Fig. 30, when the band 218 is removed, the liquid reservoir 202 and the housing 214 can be connected to an extent where the cutter edge
10 208 ruptures the weakness line 210a in the substance reservoir 210 to permit mixing of the contents L and S.

The duct 212 in the substance reservoir 210 is in fluid communication with the interior of the liquid reservoir 202. The distal end of the housing 214 has a threaded opening 214a which is closed by a screw threaded cap or lid 222. When the lid 222 is
15 removed, the duct 212 allows the contents L to be consumed and/or refreshed without rupturing the substance reservoir 210.

The substance reservoir 210 can be replaced in, or inserted into, the housing 214 when the liquid reservoir 202 and the housing 214 are screwed apart to separate themselves from one other. The band 218 is then clipped therebetween to prevent mixing
20 of the liquid L and the substance S until desired.

In a variation of the device 200 (not shown), the substance reservoir and the housing are integrally formed. In this variation, the band is releasably connected to the substance reservoir, for example by perforations, so it can be easily manually removed when desired.

25 Figs. 32 to 44 show a seventh embodiment of a liquid storage device 240. The device 240 has a liquid reservoir 242 and a lid or cap 244. As best shown in Figs. 35 and 36, the cap 244 can be screwed onto, and unscrewed from, a cap part 246 which itself can be screwed onto, and unscrewed from, a neck 248 provided on the liquid reservoir 242. The cap part 246 is best shown in Figs. 39 and 40 and includes a threaded neck for
30 engaging the cap 244, and openings 252 which allow liquid to flow therethrough from the interior of the liquid reservoir 242 to the cap part 246 and so to a user. The cap part 246 also includes a pair of cutters 254 and an arrangement of internal grooves 256, the function of which shall be described below.

The device 240 also includes a substance reservoir 260, which is best shown in Figs. 41 to 44. The substance reservoir 260 is elongate and hollow and includes a pair of opposed frangible foil seals 262 sealing longitudinal openings 264. A pair of opposed longitudinal recesses 266 are oriented at 90 degrees to the seals/openings 262/264. The liquid reservoir 260 also includes an arrangement of protuberances or detents 268 and a tab 270 with a finger hole 272 therein, the function of which shall also be described in more detail below.

The use of the device 240 will now be described with reference to sequential Figs. 36a to 37e and 38a to 38g. The device 240 is supplied with or without a liquid contained therein and with one or more substance reservoirs 260 having a substance retained therein by the seals 262. If the latter, then a user will firstly add liquid (eg. water) to the liquid reservoir 242. The user then inserts a substance reservoir 260 into the liquid reservoir 242 until it reaches the position shown in Fig. 37a. The substance reservoir 260 is retained in this position due the detents 268 adjacent the upper end of the substance reservoir 260 engaging the groove arrangement 256 in the cap part 246. The cap 244 can then be added to the liquid reservoir 240. As per earlier embodiments, both the liquid and substance reservoirs 242 and 260 can then be conveniently carried as a single item, in a similar manner to existing bottles. Further, the openings 252 in the cap part 246 allow the (unmixed) contents of the liquid reservoir 242 to be consumed, without requiring removal or opening of the substance reservoir 260, by simply removing the cap 244.

When the user chooses to mix the contents in the liquid and substance reservoirs 242 and 260, the cap 244 is removed and the pull tab 270 is gripped to draw the substance reservoir 260 relatively outwardly in relation to the liquid reservoir 242, as shown in Fig. 37b. The detents 268 on the lower end of the liquid reservoir 260 engage with the grooves 256 when the liquid reservoir 260 has been removed sufficiently to enable it to be twisted 90 degrees, as shown in Fig. 37c. The user then reinserts the substance reservoir 260 into the liquid reservoir 242, as shown in Fig. 37d, until it reaches the position shown in Fig. 37e. During this reinsertion process, the cutters 254 cut and remove the seals 262 and gather them within the cap part 246. The sequence of movements described with reference Figs. 37a to 37e is shown in greater detail in sequential Figs. 38a to 38g with the liquid reservoir 242 omitted for clarity purposes.

The removal of the seals 262 thereby allows the contents of the liquid reservoir 242 and the substance reservoir 260 to be mixed and the mixed contents to be consumed.

Figs 50 to 54 show an eighth embodiment of a liquid storage device 280. The device 280 has a liquid reservoir 282, a lid 284, a cap part 292 and a substance reservoir 288.

As best shown in fig 51, the lid 284 can be screwed onto, and unscrewed from, a cap part 292 which itself can be screwed onto, and unscrewed from, a neck 286 provided on the liquid reservoir 282.

The cap part 292 is best shown in fig 52. The cap part 292 has a larger section with an internal thread 294A, and a smaller section with an external thread 294B, and is designed to engage or screw onto the neck 286 via the internal thread 294A, and to the lid 284 via the external thread 294B. Both threads 294A and 294B have opposing threads. That is to say, both threaded sections of the cap part 292 have opposite directional threads so that when the lid 284 is opened by the user, the cap part 292 does not unscrew together with the lid 284.

The lid 284 includes a threaded section 296, and a second section 298. The threaded section 296 is used to screw onto, and unscrew from, the cap part 292. The second section 298 is tubular and hollow or solid and includes a flange 300 at its outer edge. The flange 300 is larger in diameter than the second section 298, and includes an angular edge detail. The flange 300 is designed to engage onto the substance reservoir 288, which is best shown in figs 51 to 53. The substance reservoir 288 is elongate and hollow and includes a flange 290. The flange 290 is larger in diameter than the substance reservoir 288, and is designed to engage onto the second section 298 in the lid 284 via a groove just below the internal edge of the flange 290. The flange 290 is also designed to be larger than the middle section of the cap part 292 so that the substance reservoir cannot move past the middle section of the cap part 292.

The use of the device 280 will now be described with reference to sequential fig 52. The device is supplied with or without a liquid contained therein and with one or more substance reservoirs 288 having a substance retained therein. In the case of the latter, the user will firstly add liquid (e.g. water) to the liquid reservoir 282. The user then inserts the substance reservoir 288 back into the liquid reservoir 282. As per earlier embodiments, both the liquid and substance reservoirs 282 and 288 can be carried conveniently as a single item, in a similar manner to existing bottles.

When the user chooses to mix the contents in the liquid and substance reservoirs 282 and 288, the lid 284 is turned anticlockwise, and in so doing, the lid 284 pulls away from the cap part 292 and dislodges from the substance reservoir 288. Once dislodged, the Substance reservoir 288 drops into the liquid reservoir 282. The user then screws the lid 284 back onto the cap 292 and shakes the device 280 to allow the substance within the substance reservoir 288 to come in contact and mix with the liquid within the liquid reservoir 282.

As with earlier embodiments, this allows the user to consume a liquid that has been freshly mixed with a substance stored in a sealed environment.

In a variation of the device best shown in fig 54, the second section 298 is not moulded as part of the lid 284, but is a separate lid 302 which is attached to the substance reservoir 288 via the flange 300 in an identical manner to the attachment of the other version, and it is further attached to the lid 284 via flange 304. The lid 284 has a flange 306 which allows the interlocking of the lid 302 to the lid 284.

As described above, the devices 40, 100, 140, 160, 180, 200, 240 and 280 allow the user to carry a liquid from a known safe source, together with a substance from a known (eg. Sterilized) source, and conveniently mix the two just prior to consumption so as to preserve the freshness, and thus the efficacy, of the substance.

Although the invention has been described with reference to water and powdered vitamin supplements it will be appreciated by a person skilled in the art that the invention is not limited to this combination and is equally suitable for many other liquid/supplement combinations as listed in the table below.

<u>Liquid</u>	<u>Substance</u>
<u>Water</u>	<u>Powdered vitamins</u>
<u>Milk</u>	<u>Flavoured powders (eg. Chocolate, strawberries, drinks, pancakes, vitamins, medicines)</u>
<u>Fruit juice</u>	<u>Vitamins</u>
<u>Mixers (eg. Coke, Lemonade)</u>	<u>Alcohol</u>
<u>Water</u>	<u>Medicines</u>
<u>Medicines</u>	<u>Medicines</u>
<u>Water</u>	<u>Flavours</u>
<u>Water</u>	<u>Carbonating substances</u>

Further, a person skilled in the art will also appreciate that the invention may be embodied in many other forms.

CLAIMS

CLAIM No.1

The present invention provides a liquid storage device including:

- a liquid reservoir;
- a substance reservoir, the substance reservoir being connectable to the liquid reservoir for handling a single item without causing liquid transmission between the substance reservoir and the liquid reservoir; and
- manually operable means to selectively allow liquid transmission between the substance reservoir and the liquid reservoir.

The manually operable means preferably includes valve and/or seal means associated with one or both of the substance reservoir and the liquid reservoir. In one form, the manually operable means is preferably operable by twisting or turning the substance reservoir, or an associated housing, relative to the liquid reservoir. In another form, the manually operable means is preferably operable by deforming the liquid reservoir.

The liquid reservoir is preferably accessible, for receiving or releasing fluid, whilst connected to the liquid reservoir without causing liquid transmission between the substance reservoir and the liquid reservoir. In one form, the liquid reservoir includes an opening, most preferably closed by a cap or lid, that is remote the substance reservoir. In another form, the liquid reservoir includes an opening, most preferably a tube closed by a cap or lid, that passes through the substance reservoir. In yet another form, the substance reservoir includes a passage or duct in fluid communication with an opening in the liquid reservoir.

The substance reservoir preferably includes at least one frangible part adapted for cutting or rupturing by at least once cutter in the liquid reservoir, in response to relative movement between the liquid reservoir and the cutter. More preferably, the substance reservoir preferably includes two opposed frangible parts adapted for cutting or rupturing by two opposed cutters in the liquid reservoir, in response to relative movement between the liquid reservoir and the cutters. The substance reservoir is preferably adapted for insertion into the liquid reservoir in a first position, in which the cutters(s) are remote the frangible part(s), and moveable to a second position, in which the cutters(s) are adjacent the frangible part(s). More preferably, the substance reservoir is rotatable about its longitudinal axis between the first and second positions. The substance reservoir preferably includes one or more recesses extending longitudinally along the substance reservoir, in which the cutter(s) travel whilst in the first position.

The frangible part(s) is/are preferably foil seal(s), most preferably foil seal(s) extending longitudinally along the substance reservoir.

The cutter(s) is/are preferably associated, most preferably forming part of, a cap part connectable to the liquid reservoir. The liquid reservoir and cap part preferably include corresponding engagement formations, most preferably at least one protuberance near each end of the liquid reservoir and at least one groove in the cap part, to limit the relative movement between the liquid reservoir and the cap part. The cap part is also preferably

grooved to allow relative axial rotation between the liquid reservoir and the cap part when either end of liquid reservoir is substantially adjacent the cap part. The liquid reservoir preferably includes a tab, most preferably, adjacent an end thereof to facilitate manual gripping of the liquid reservoir.

CLAIM No. 2

The present invention provides a liquid storage device including:

- a liquid reservoir having at least one first opening,
- a substance reservoir having at least one first opening, closed by a seal; and
- a joiner adapted for engagement with the liquid reservoir and the substance reservoir, the joiner including a cutter adapted to rupture said seal during engagement of the substance reservoir with the joiner;

wherein the liquid reservoir is selectively movable relative to the substance reservoir between a first position preventing liquid transmission between the at least one first opening of the liquid reservoir and the at least one first opening of the substance reservoir and a second position permitting liquid transmission between the at least one first opening of the liquid reservoir and the at least one first opening of the substance reservoir.

The liquid reservoir preferably includes at least one second opening, the at least one second opening being closable by a lid. The liquid reservoir at least one first opening and at least one second opening are preferably on opposed ends of the liquid reservoir. The liquid reservoir preferably has two first openings and one said second opening.

CLAIM No. 3

The present invention provides a liquid storage device including:

- a liquid reservoir;
- a substance reservoir having at least one opening that is closed by a seal; and
- a joiner adapted: for engagement with the liquid reservoir and the substance reservoir, to rupture said seal during said engagement with the substance reservoir; and selectively prevent or allow liquid transmission between the liquid reservoir and the substance reservoir.

The liquid reservoir preferably has two said first openings on end and one second opening on its other end. The substance reservoir preferably has one said first opening. The substance reservoir first opening is preferably adjacent a threaded cylindrical part, which threaded cylindrical part is adapted to engage a corresponding threaded cylindrical recess on the joiner.

The joiner preferably includes at least one, most preferably four, teeth adapted to rupture the seal during engagement, most preferably screwing engagement, of the substance reservoir with the joiner. The teeth are preferably adjacent the threaded cylindrical recess.

The liquid reservoir and the joiner preferably include corresponding formations adapted to, once the liquid reservoir and the joiner have been screwed together,

selectively allow or prevent relative rotation between the liquid reservoir and the joiner. More preferably, relative rotation is prevented by the formations abutting one another in a natural state and relative rotation is allowed by the formations clearing one another in a deformed state. The joiner is preferably adapted such that manual squeezing, most preferably of opposed sides thereof, moves the formations out of engagement to allow the relative rotation.

The device preferably includes a seal, most preferably an elastomeric seal, between the liquid reservoir and the joiner. The seal is preferably fixed to the liquid reservoir. The seal preferably includes one or more, preferably two, openings corresponding to the first openings in the liquid reservoir.

The substance reservoir preferably includes means to enable releasable connection to a like substance reservoir, most preferably in the form of corresponding threaded cylindrical parts and recesses on its opposed ends respectively.

CLAIM No. 4

The present invention provides a method of selectively adding a substance to a liquid, the method including the steps of:

- adding liquid to a liquid reservoir having at least one first opening and at least one second opening, the at least one second opening being closable by a lid;

- adding a substance to a substance reservoir having at least one first opening;

- closing the at least one first opening of the substance reservoir with a seal;

- connecting the substance reservoir to a cutter which is adapted to pierce said seal during the connection to the cutter or the substance reservoir; and

- moving the liquid reservoir relative to the substance reservoir from a first position preventing liquid transmission between the at least one first opening of the liquid reservoir and the at least one first opening of the substance reservoir and a second position permitting liquid transmission between the at least one first opening of the liquid reservoir and the at least one first opening of the substance reservoir.

The method preferably also includes rotating the liquid reservoir relative to the substance reservoir between the first and second positions.

CLAIM No. 5

The present invention provides a method of selectively adding a substance to a liquid, the method including the steps of:

- adding liquid to a liquid reservoir;

- adding a substance additive to a substance reservoir having at least one opening;

- sealing the substance reservoir at least one opening;

- connecting the liquid reservoir to the substance reservoir;

- rupturing the seal whilst maintaining the connection of liquid reservoir to the substance reservoir; and

- opening a liquid transmission path between the liquid reservoir and the substance reservoir whilst maintaining the connection of liquid reservoir to the substance reservoir.

The method preferably includes rupturing the seal during connection of the liquid reservoir to the substance reservoir.

The method preferably includes connecting the liquid reservoir to the substance reservoir via a joiner.

CLAIM No. 6

The present invention provides a liquid storage device including:

- a liquid reservoir having at least one first opening;
- a substance reservoir adapted for introduction into the liquid reservoir via the at least one first opening;
- means adapted for rupturing the substance reservoir;
- wherein the rupturing means is activatable from the exterior of the liquid storage device.

The rupturing means is preferably manually activatable from the exterior of the liquid storage device.

The device preferably includes a lid adapted for closing the at least one first opening. The lid preferably includes a flow selectable drinking nozzle therein. The lid preferably also includes a member adapted for rupturing the substance reservoir that is connected to an extremely operable flange, most preferably an annular flange around the nozzle.

The device preferably includes a carrier adapted for introduction into the liquid reservoir via the at least one first opening and able to receive the substance reservoir therein. The carrier preferably has a series of holes therein. The carrier preferably has a flange on one end adapted for mounting to the liquid reservoir, most preferably retained by the lid.

CLAIM No. 7

The present invention provides a liquid storage device including:

- a flexible liquid reservoir defining an interior; and
- a substance reservoir, within the interior of the liquid reservoir, formed of a weaker material than that of the liquid reservoir;
- wherein the substance reservoir is adapted for rupturing in preference to the liquid reservoir in response to deformation of the liquid reservoir.

The substance reservoir is preferably adapted for rupturing in preference to the liquid reservoir in response to manual deformation of the liquid reservoir.

The substance reservoir is preferably also flexible, and most preferably mounted to, or forming part of, the base of the liquid reservoir. The substance reservoir is preferably formed from a material that has a lower burst or tear strength than that of the liquid reservoir. The substance reservoir preferably includes regions of weakness.

CLAIM No. 8

The present invention provides a liquid storage device including:

a liquid reservoir having at least one first opening;
 a substance reservoir within the liquid reservoir, or adapted for introduction into the liquid reservoir via the at least one first opening, the substance reservoir having at least one second opening;
 means adapted for closing the substance reservoir at least one second opening;
 and
 means adapted for opening the substance reservoir,
 wherein said rupturing means is activatable from the exterior of the liquid storage device.

The means adapted for closing the substance reservoir at least one second opening is preferably a lid. The means adapted for opening the substance reservoir is preferably a pull-cord that is attached to the lid and of a length that reaches exterior of the liquid storage device.

CLAIM No. 9

The present invention provides a liquid storage device including:

a liquid reservoir having an open interior, a threaded part and a cutter;
 a substance reservoir having a closed interior;
 a corresponding threaded part, associated with the substance reservoir, and adapted for threaded engagement liquid reservoir threaded part; and
 a device adapted to selectively restrict the extend of positioning of the liquid reservoir relative to the substance reservoir,
 wherein, with the restricting device positioned between the liquid reservoir and the substance reservoir, the relative positioning of the liquid reservoir and the substance reservoir is restricted to prevent the cutter from rupturing the substance reservoir to thereby prevent liquid transmission between the liquid reservoir interior and the substance reservoir interior and, with the restricting device removed from between the liquid reservoir and the substance reservoir, the liquid reservoir and the substance reservoir can be positioned relative to the substance reservoir to cause the cutter to rupture the substance reservoir to thereby permit liquid transmission between the liquid reservoir interior and the opened substance reservoir interior.

CLAIM No. 10

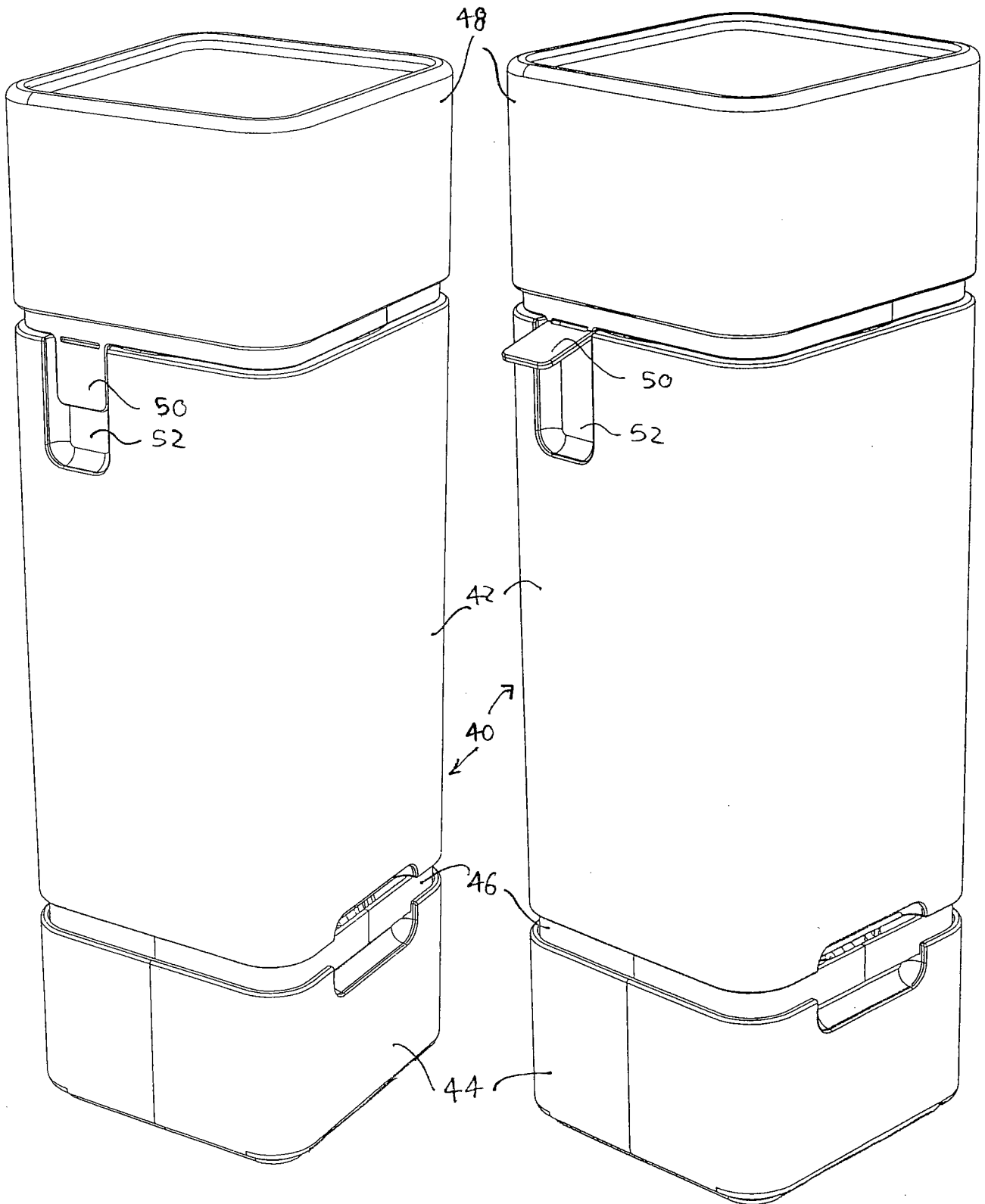
In one form, the device preferably also includes a housing adapted to contain the substance reservoir, and said corresponding threaded preferably part forms part of the housing. The liquid reservoir and the housing preferably have male and female threaded parts respectively. The restricting device is preferably a removable peripheral band between the male and the female threaded parts. The substance reservoir preferably has a passage, duct or tube therethrough that is in fluid communication with the interior of the liquid reservoir. The distal end of the passage, duct or tube is preferably in fluid communication with an opening in the housing. The housing opening preferably being closed by a removable, most preferably screw threaded, cap or lid.

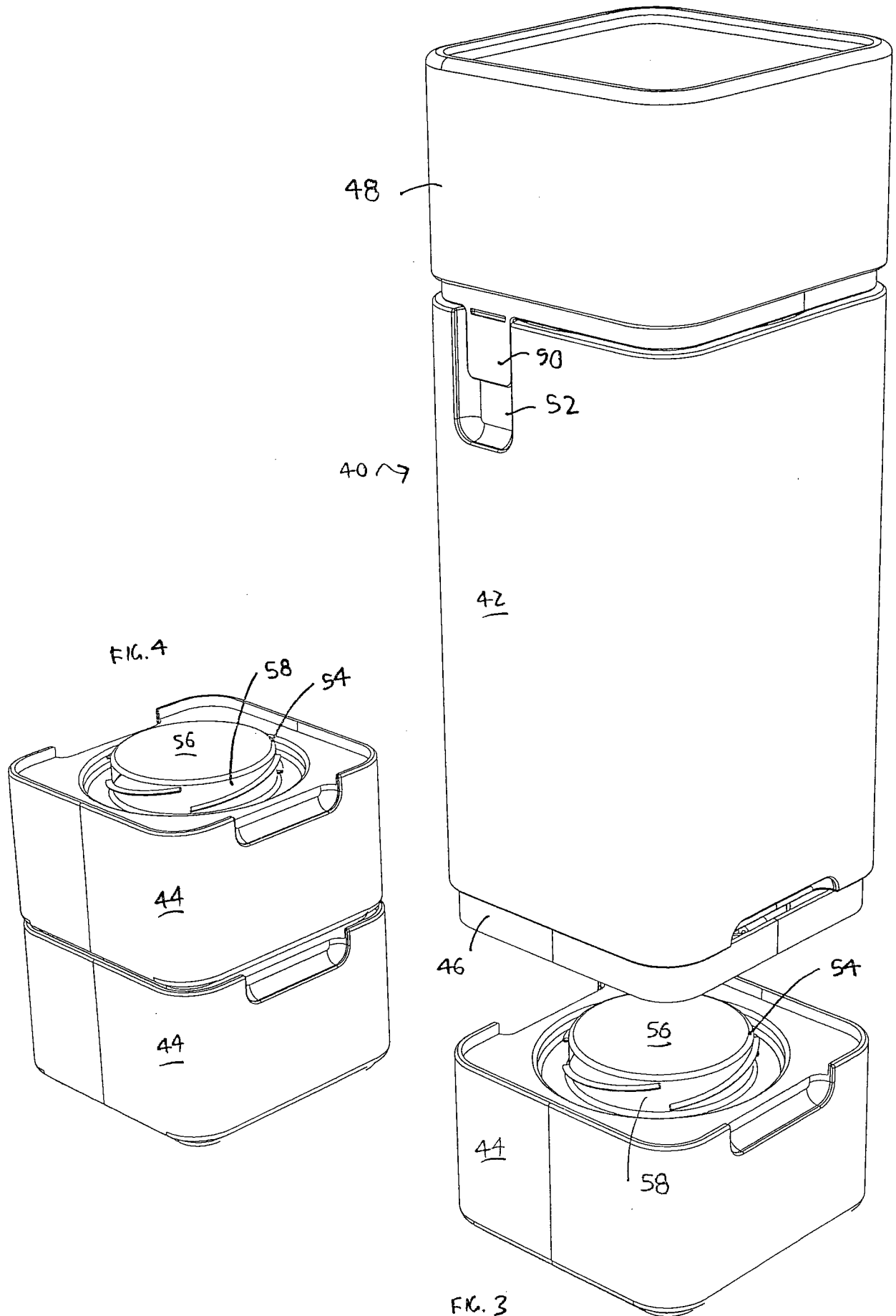
CLAIM No. 11

In another form, said corresponding threaded preferably part forms part of the substance reservoir. The liquid reservoir and the substance reservoir preferably have male and female threaded parts respectively. The restricting device is preferably a removable peripheral band between the male and female threaded parts. The substance reservoir preferably has a passage, duct or tube therethrough that is in fluid communication with the interior of the liquid reservoir. The distal end of the passage, duct or tube is preferably closed by a removable, most preferably screw threaded, cap or lid.

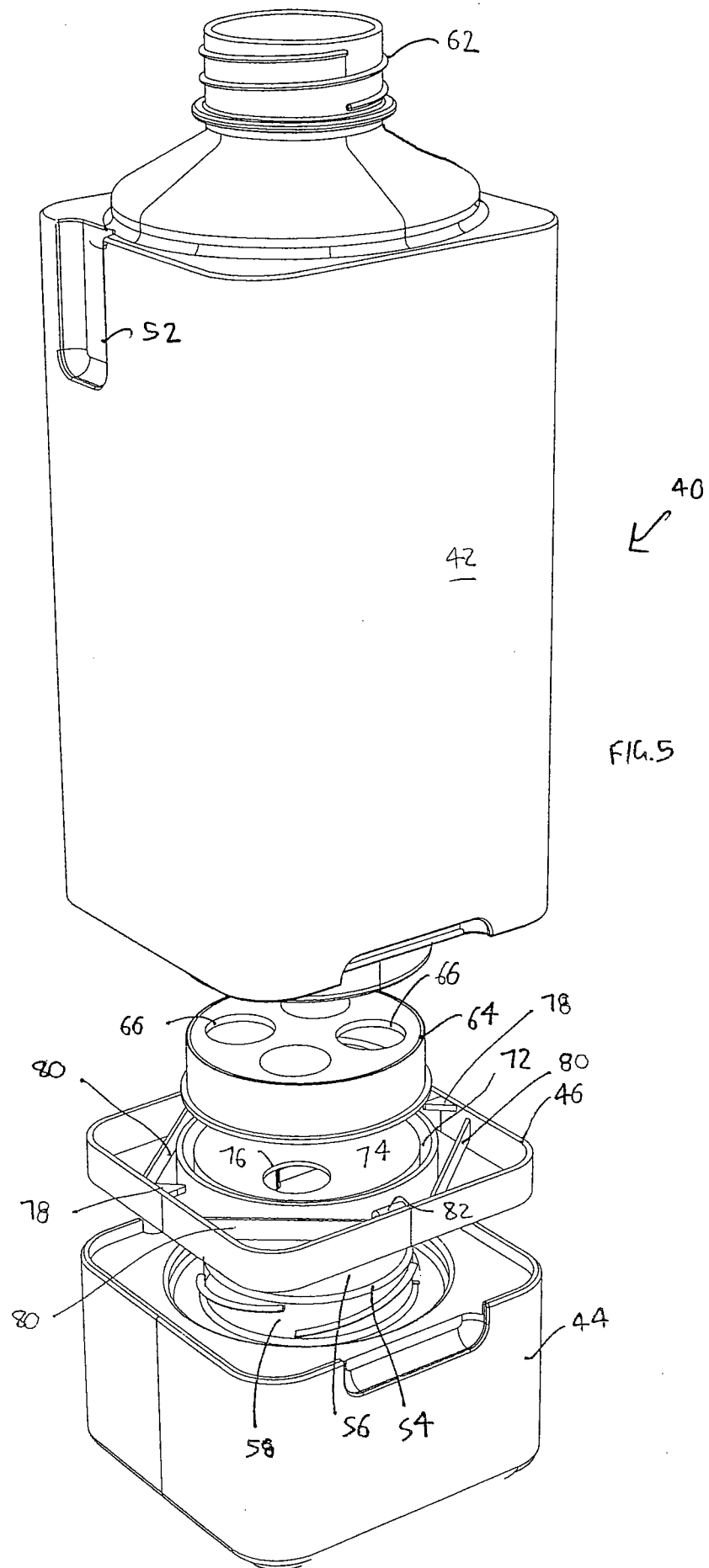
FIG. 1

FIG. 2

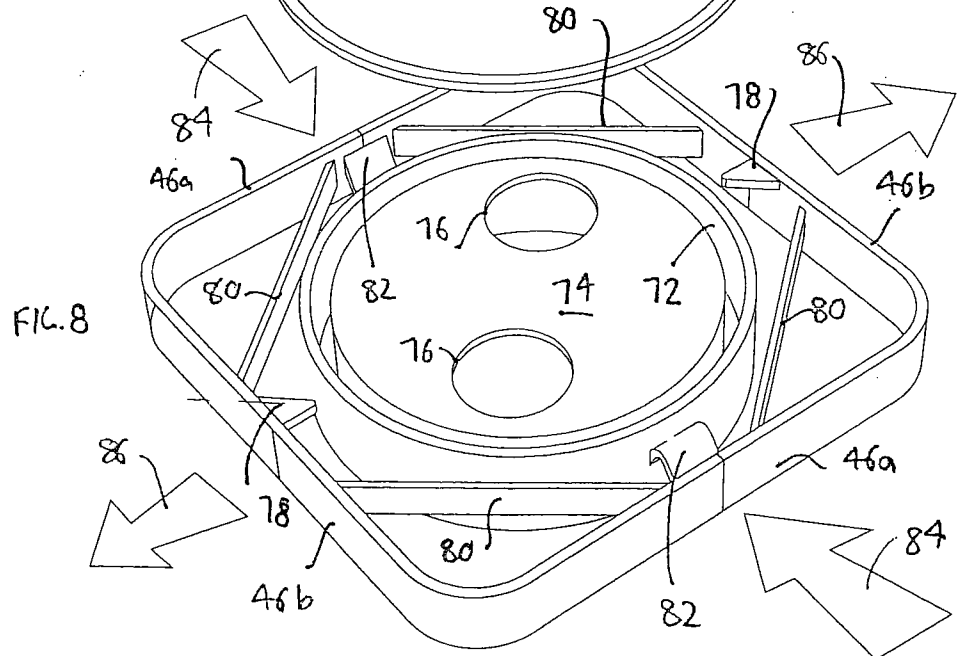
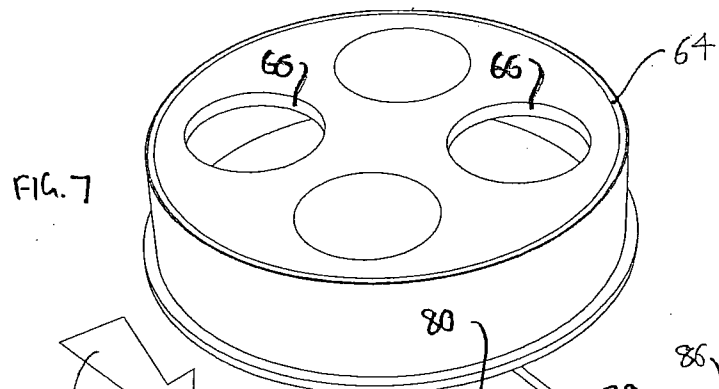
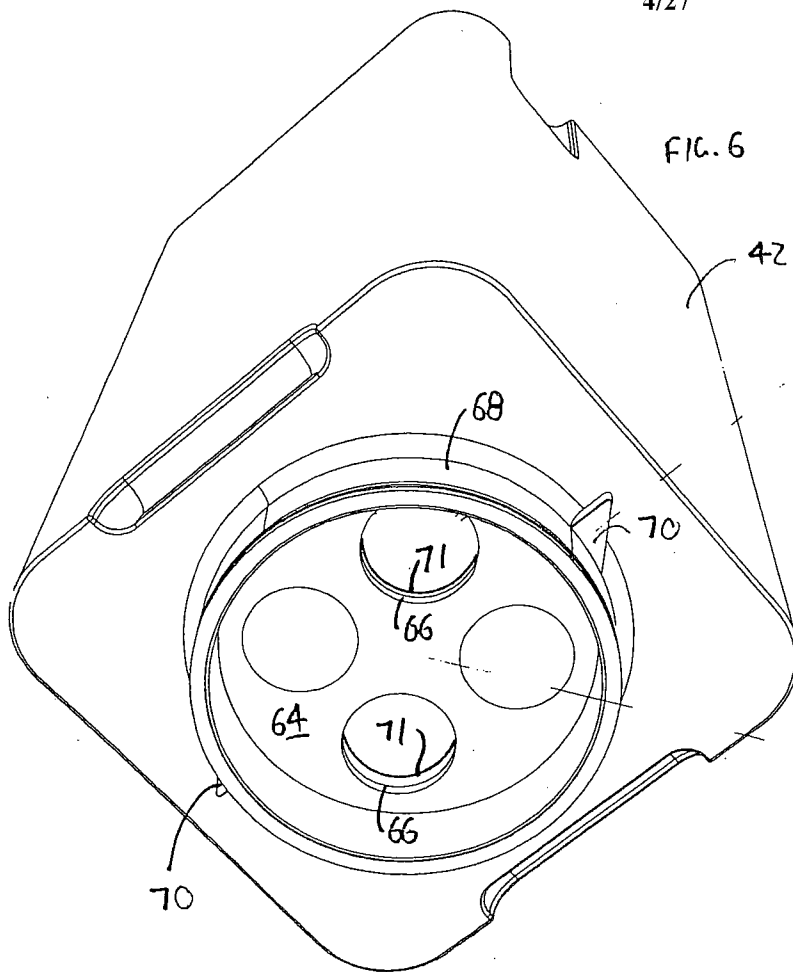




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4/27



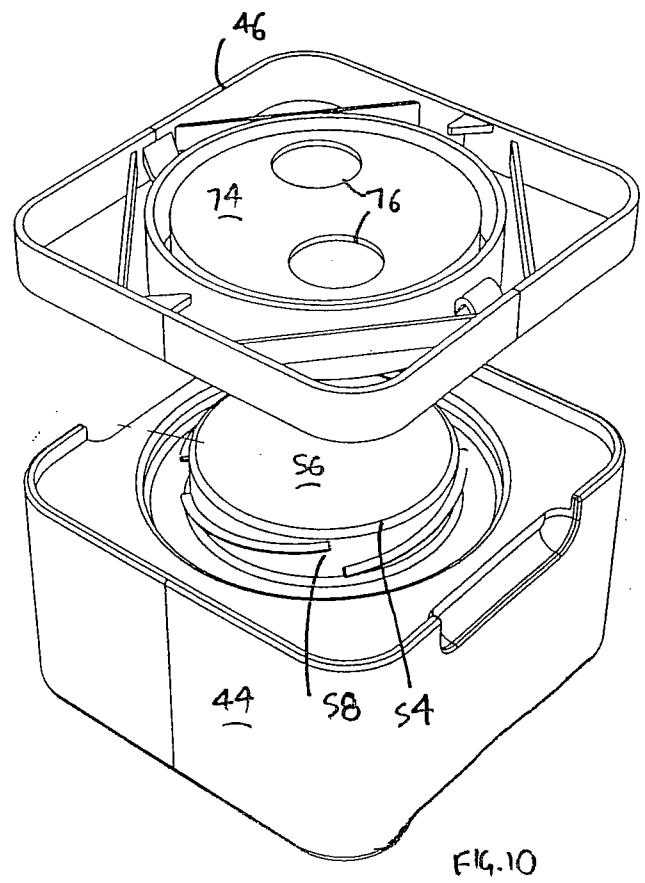
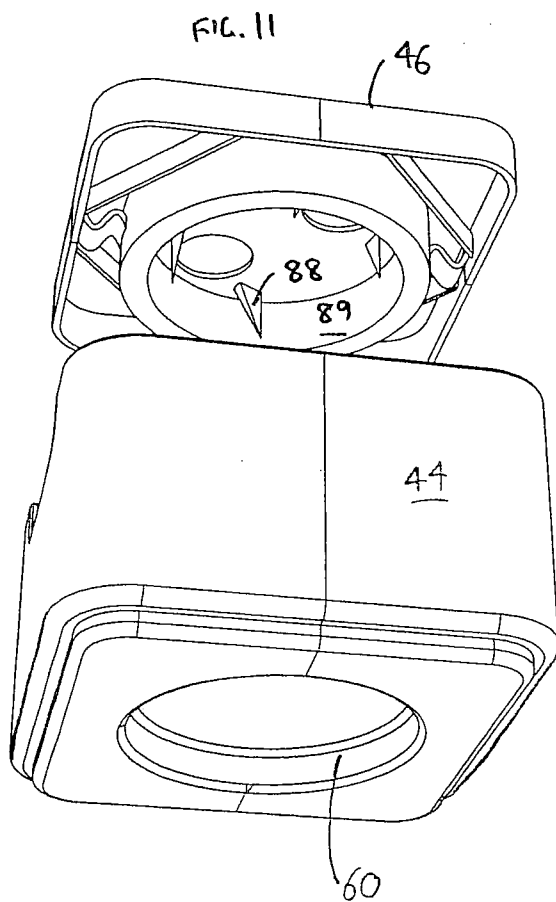
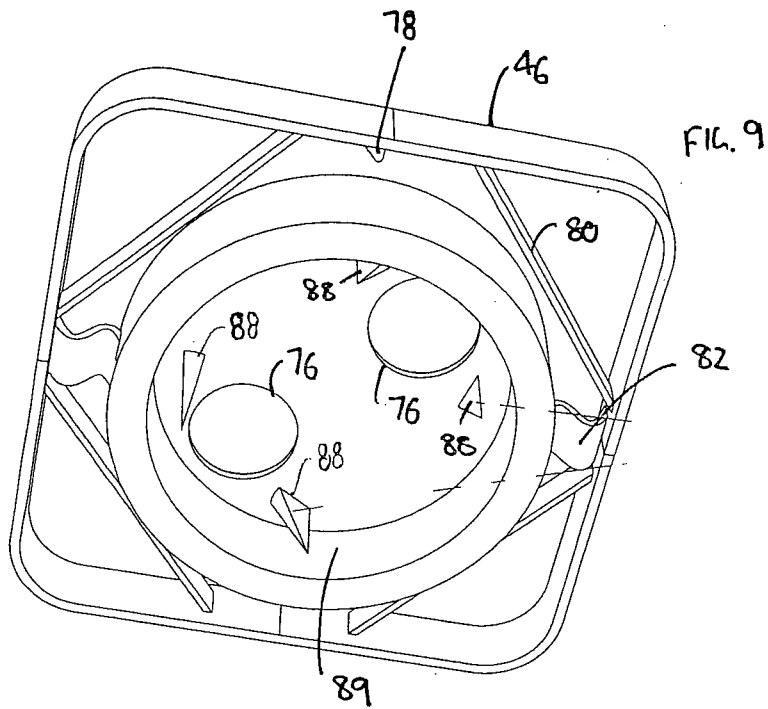
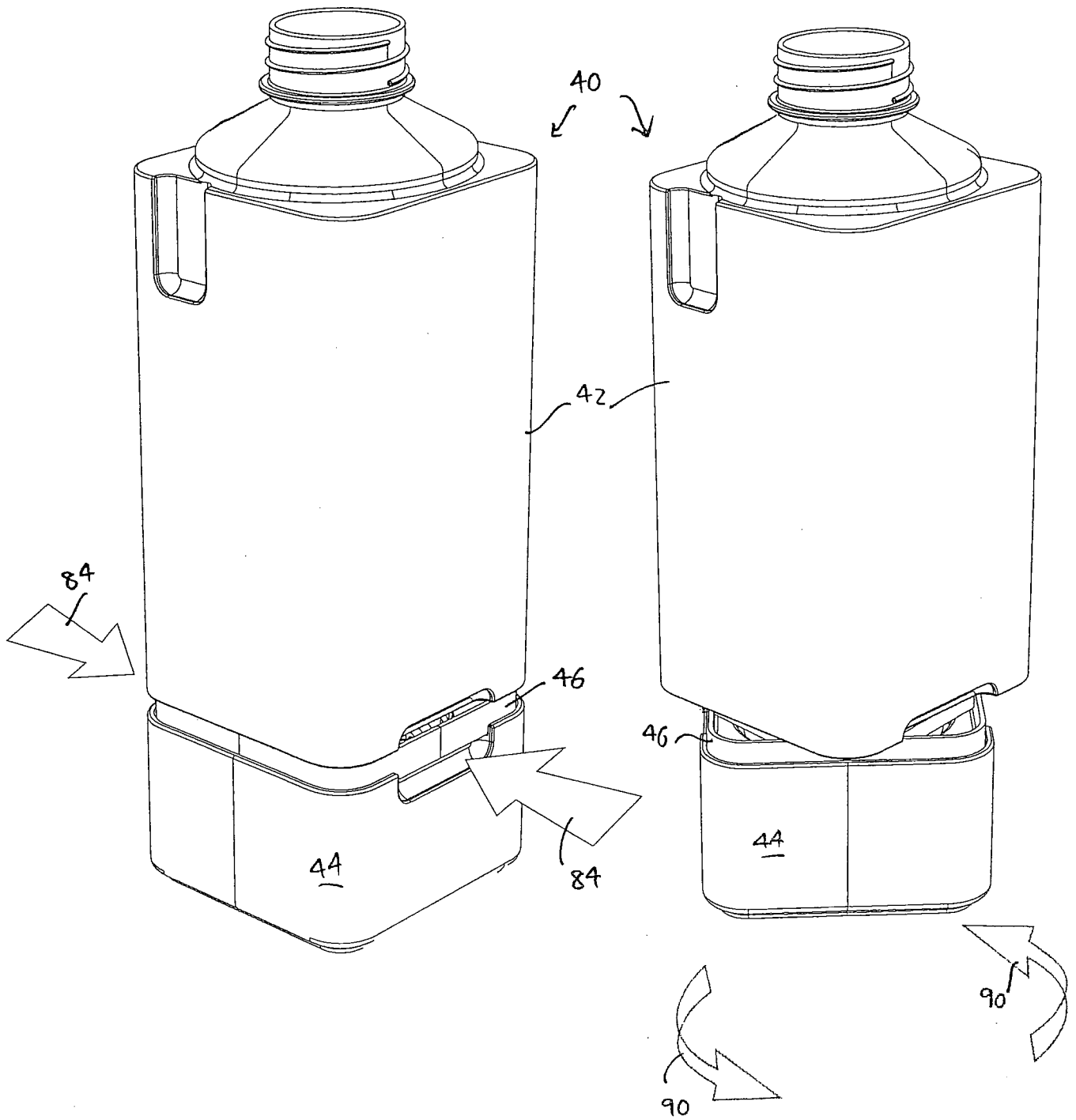


FIG. 12

FIG. 13



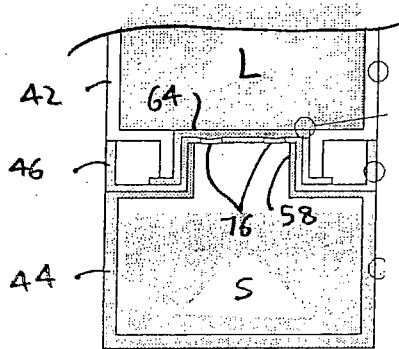


FIG. 14

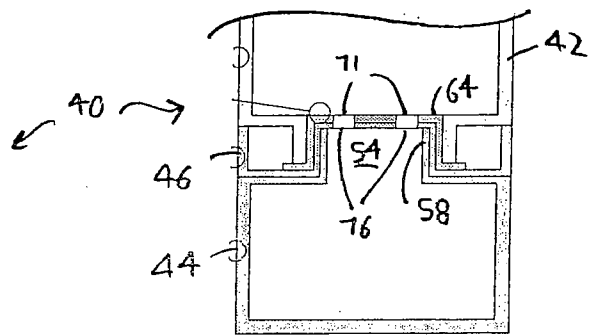


FIG. 15

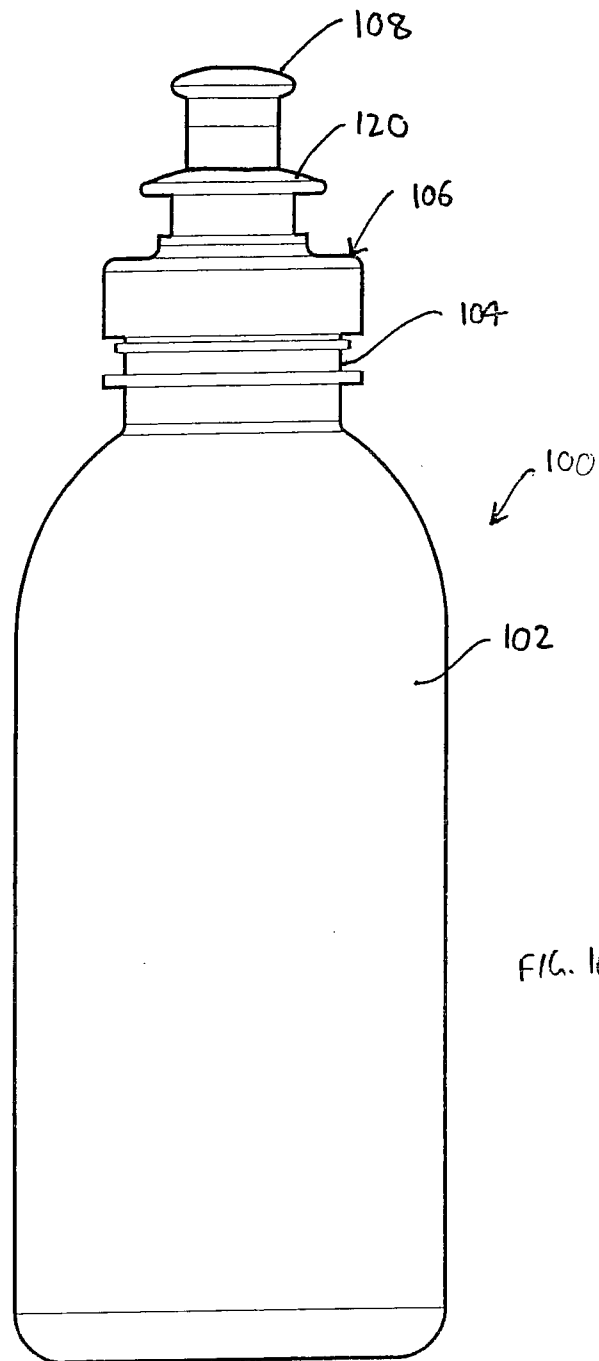
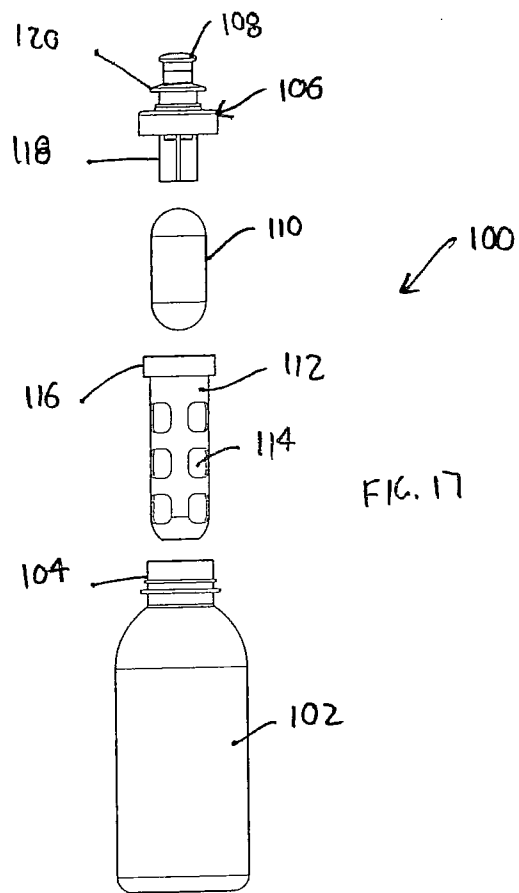
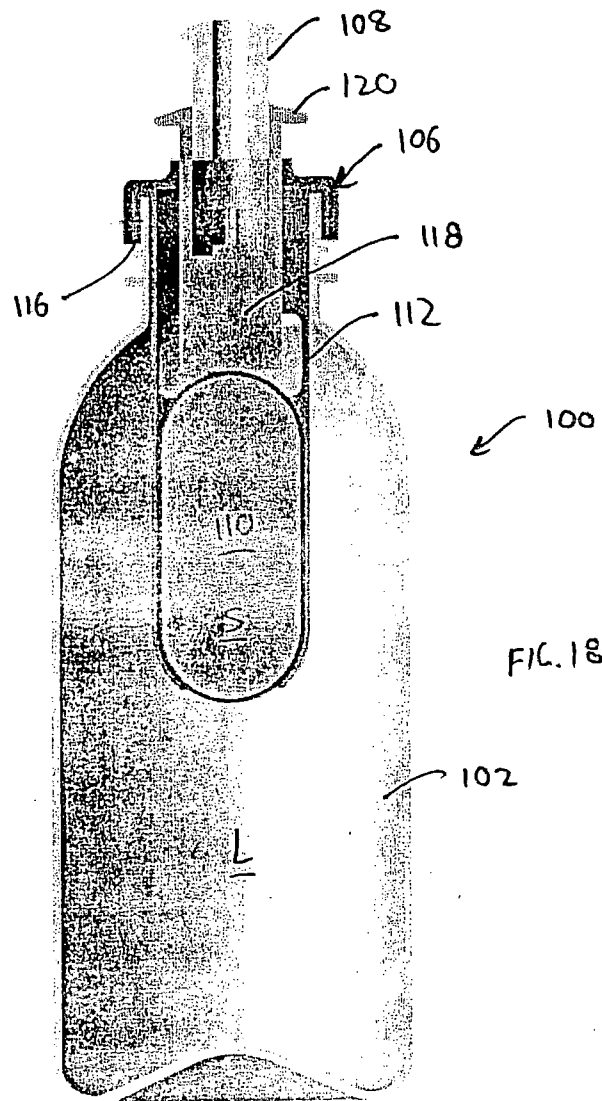
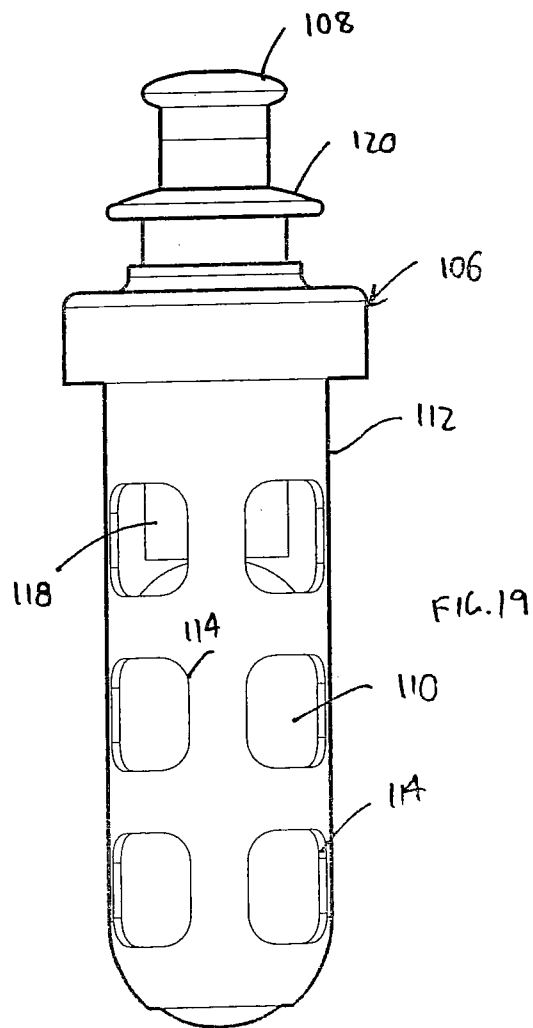


FIG. 16







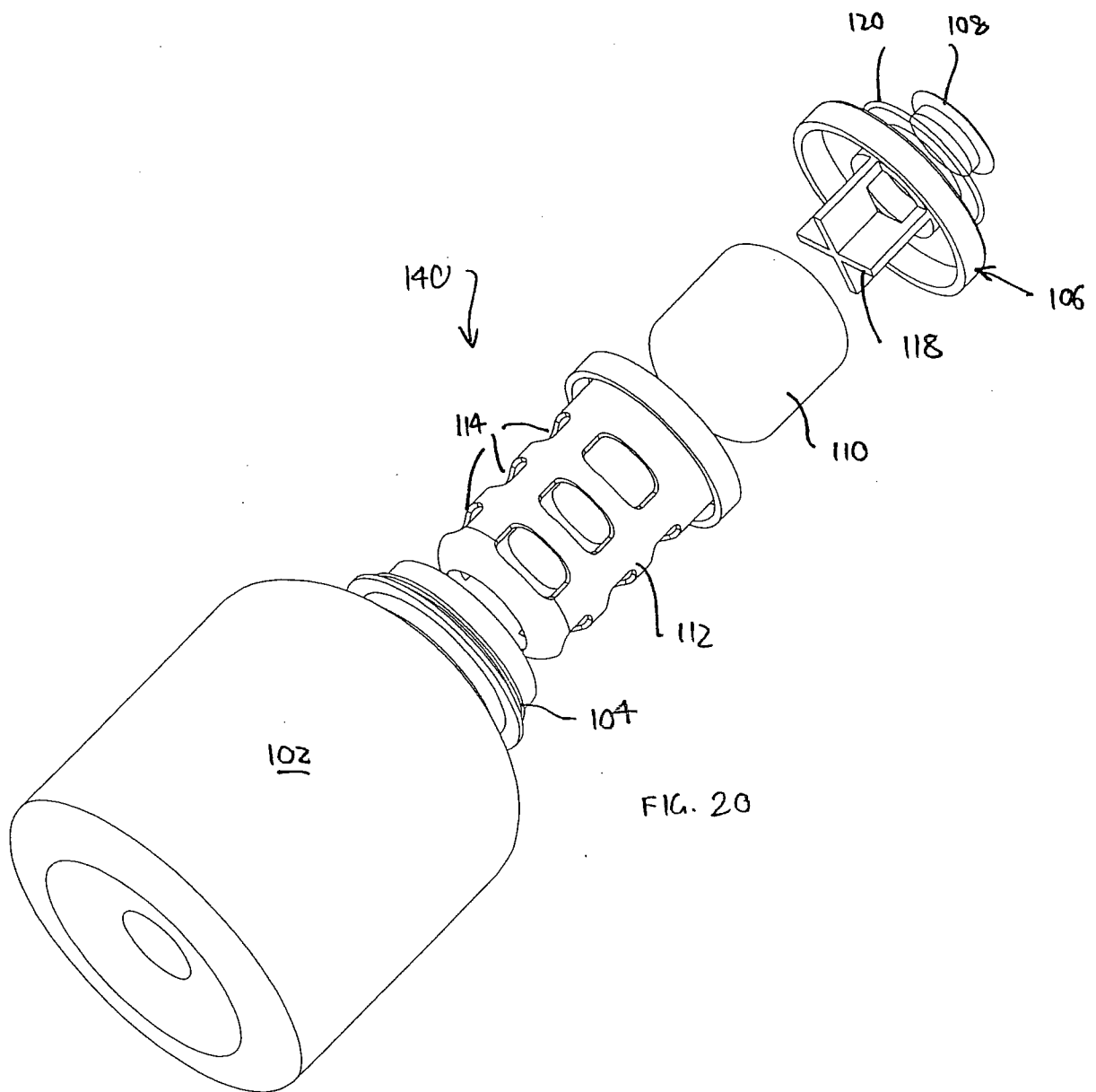


FIG. 20

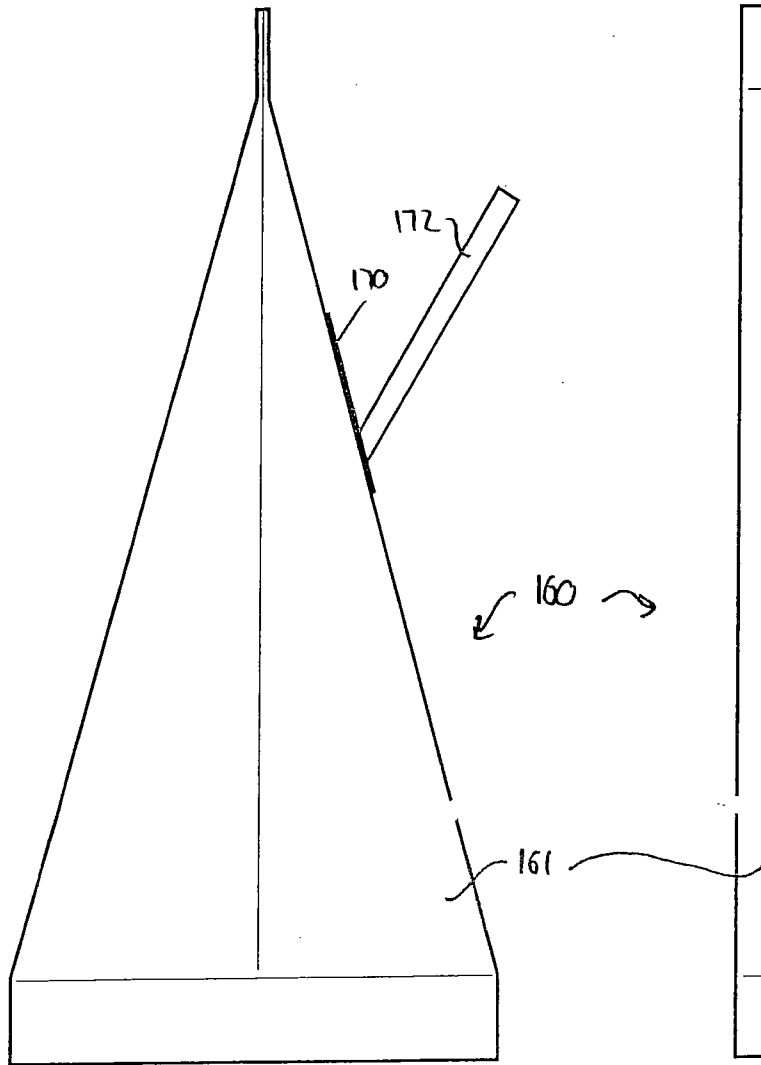


FIG. 21

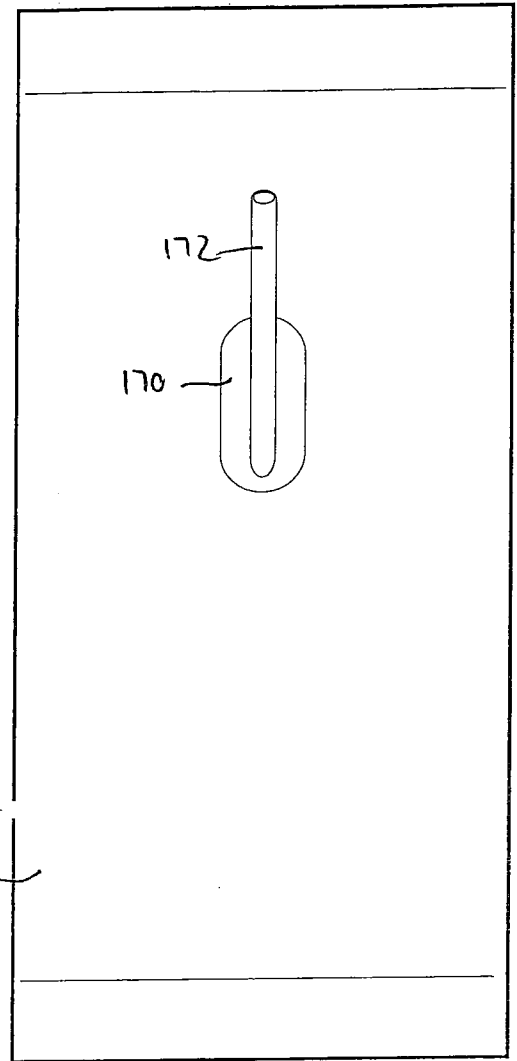


FIG. 22

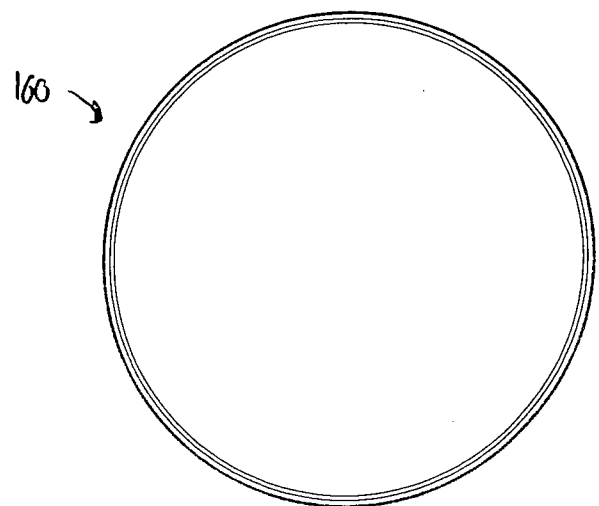


FIG. 23

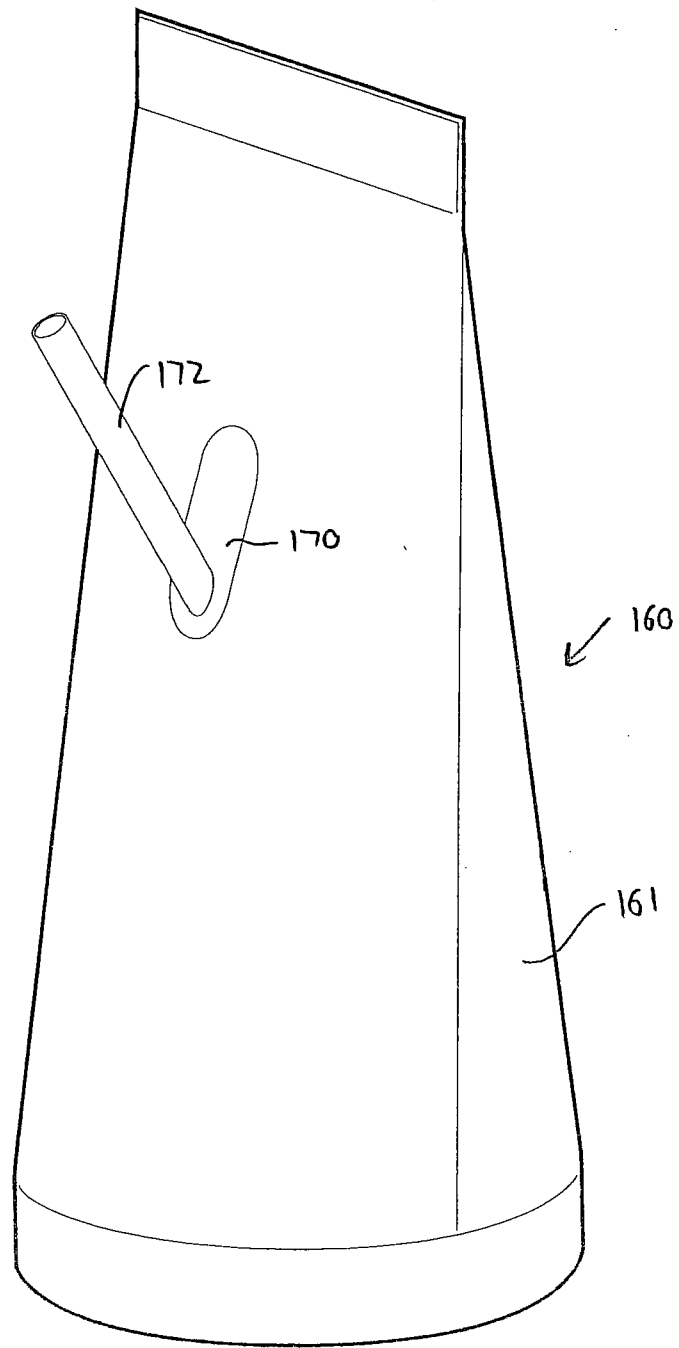


FIG. 24

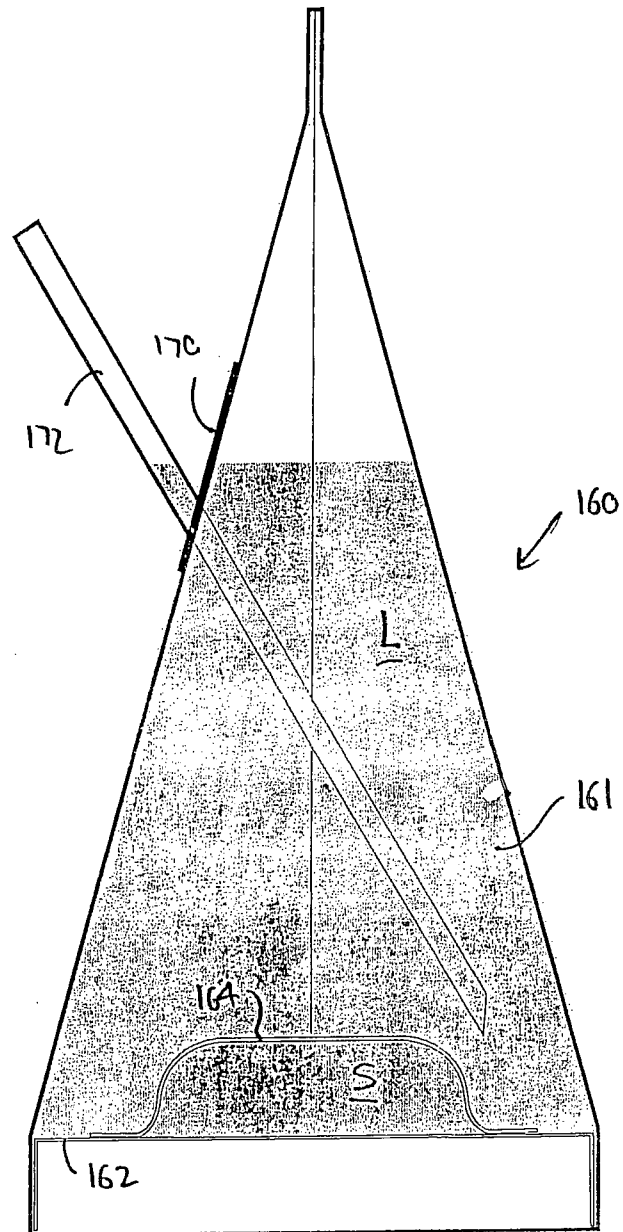


FIG. 25

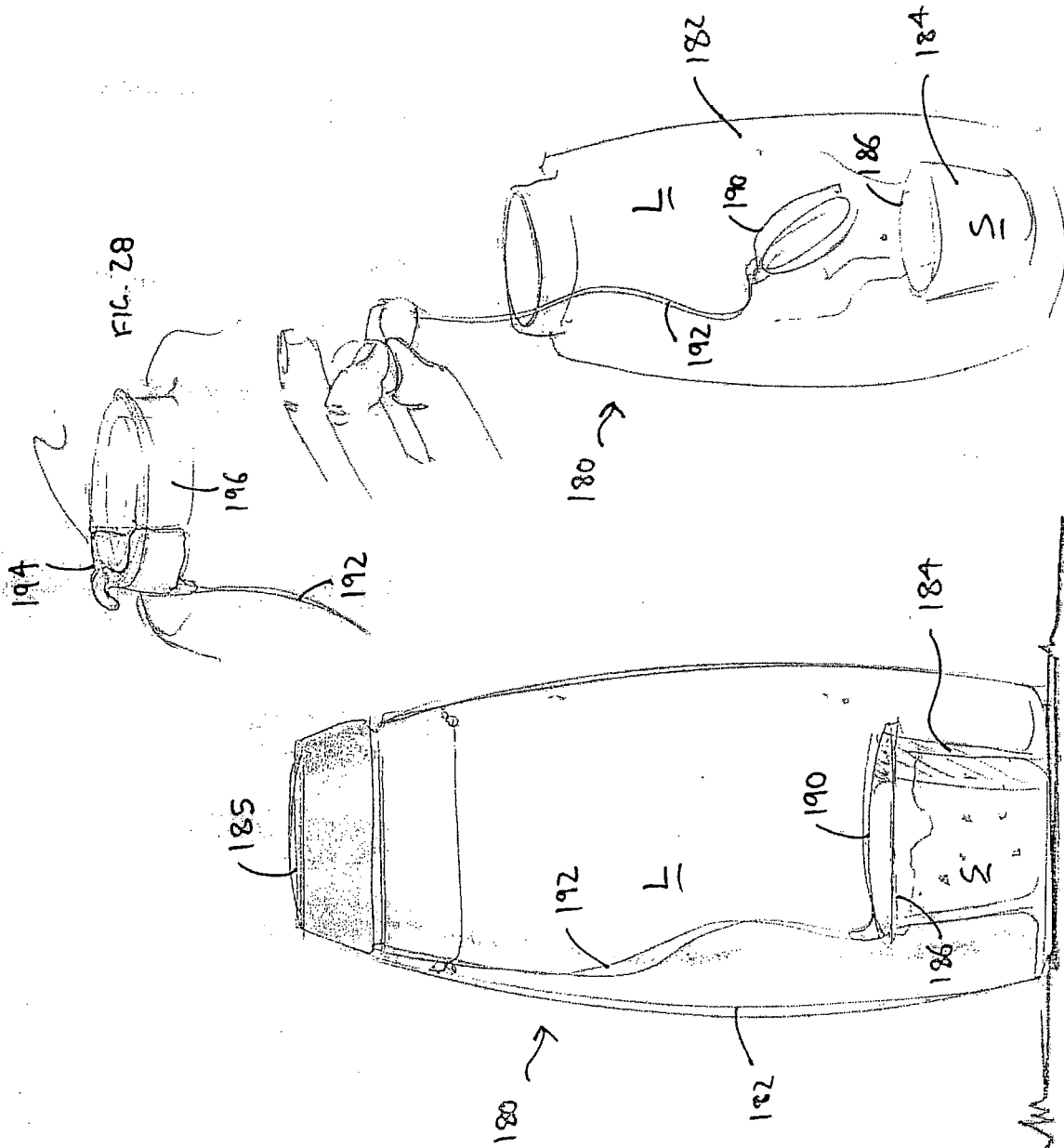
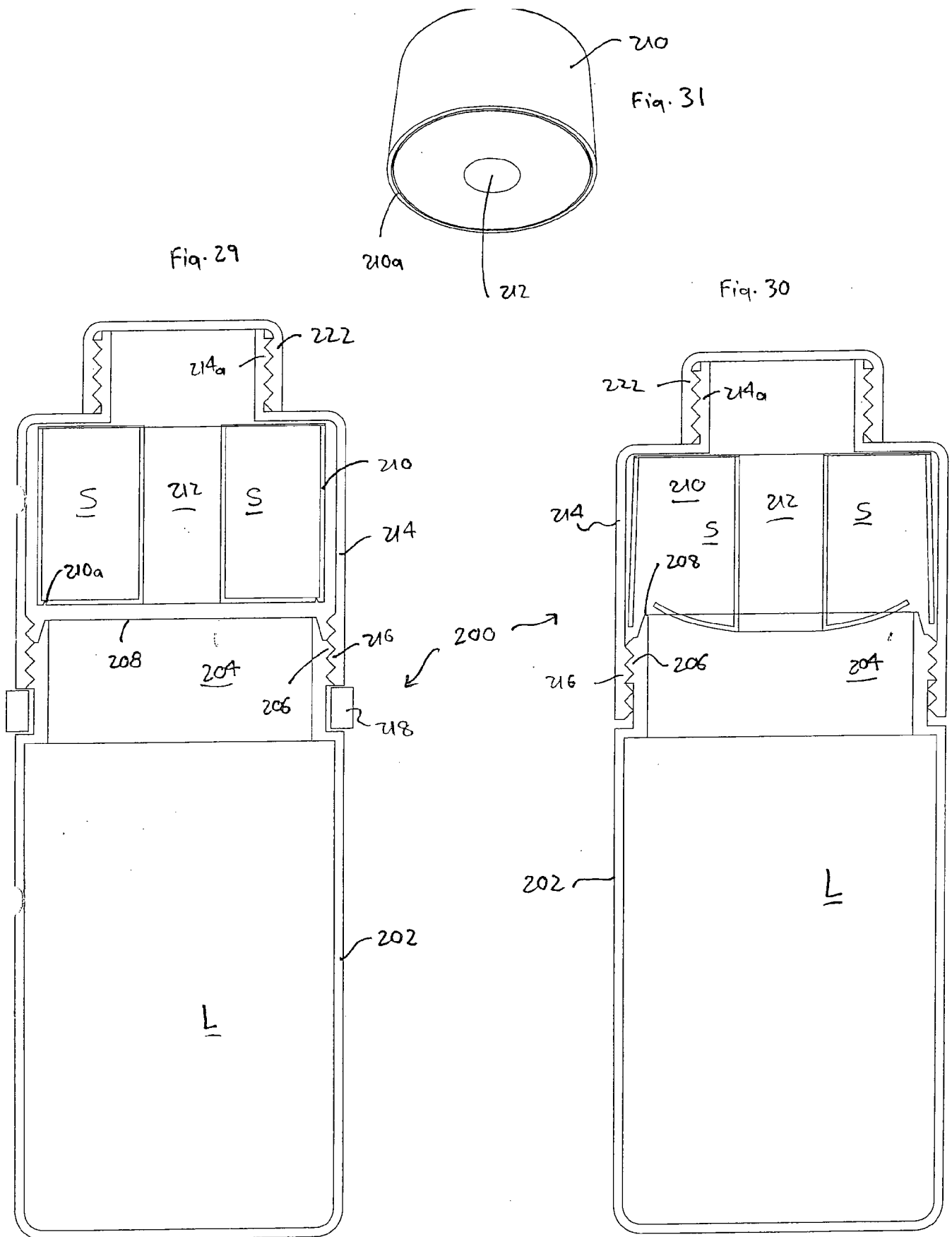


FIG. 27

FIG. 26



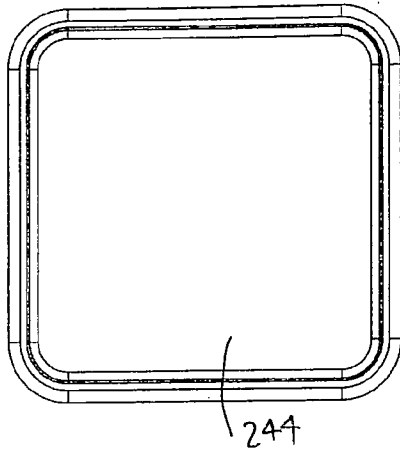


FIG. 32

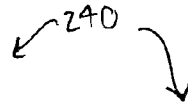


FIG. 34

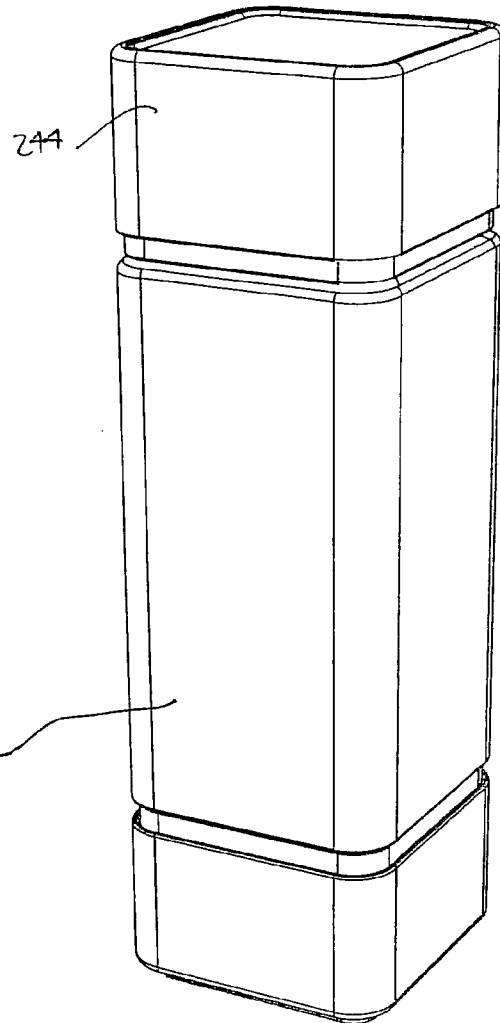
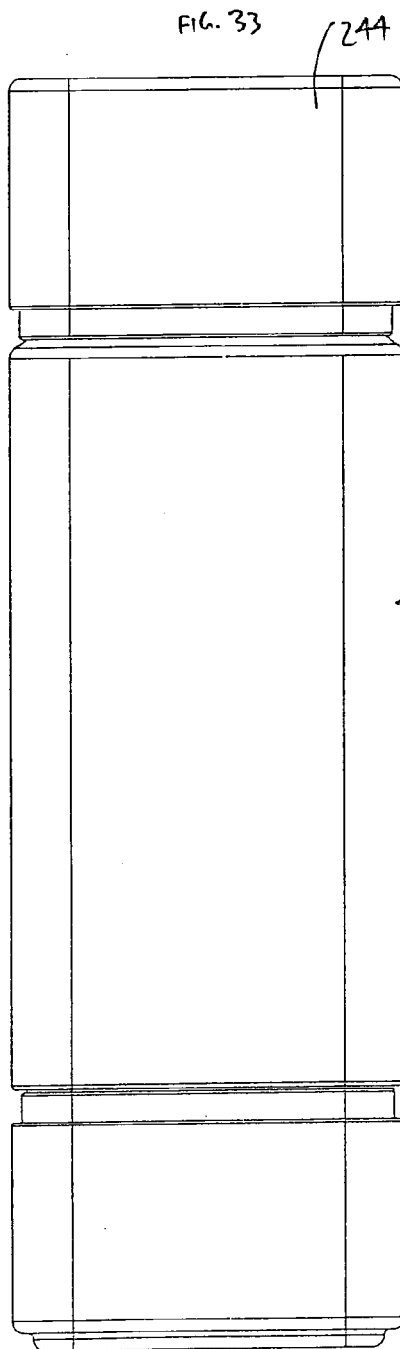
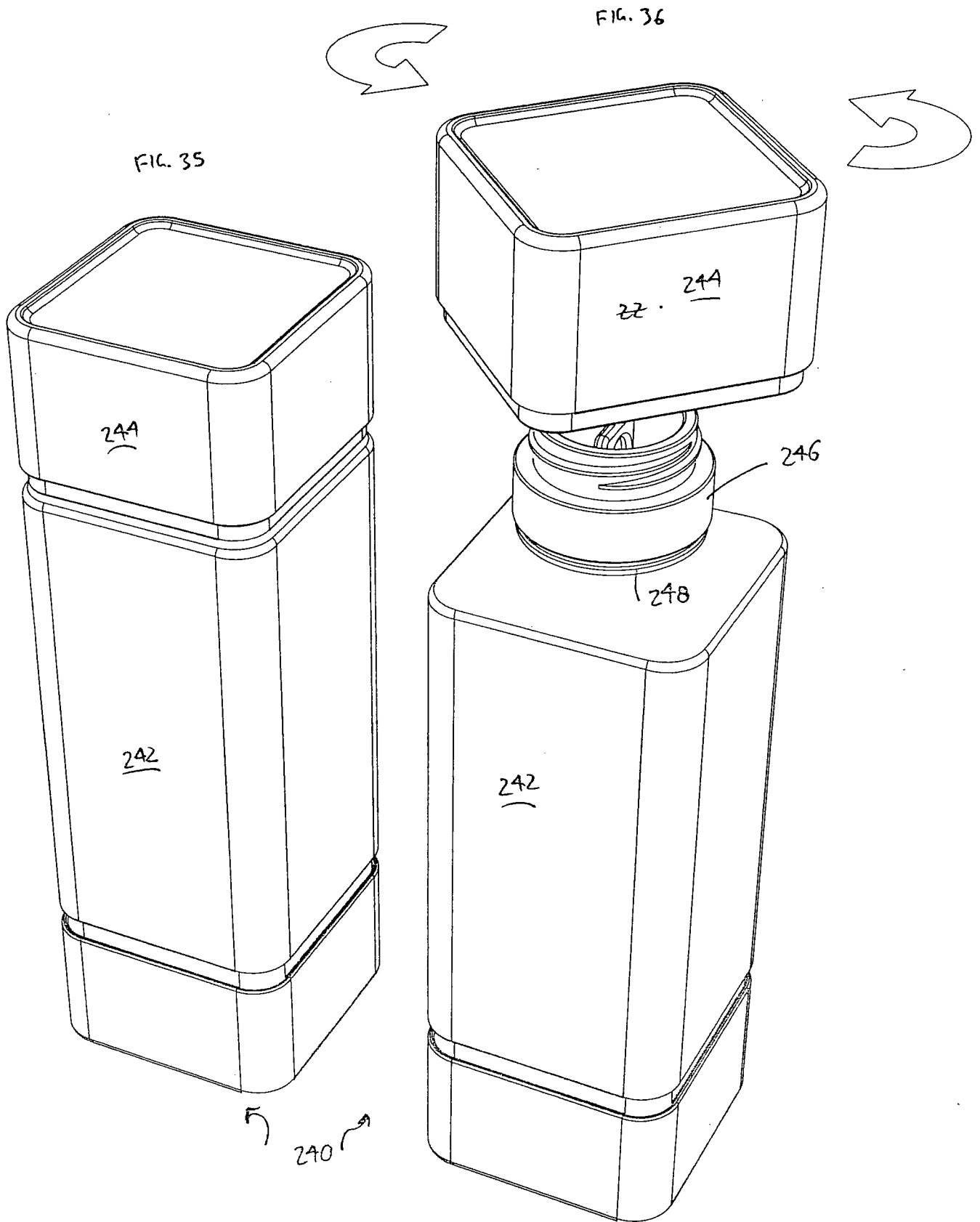
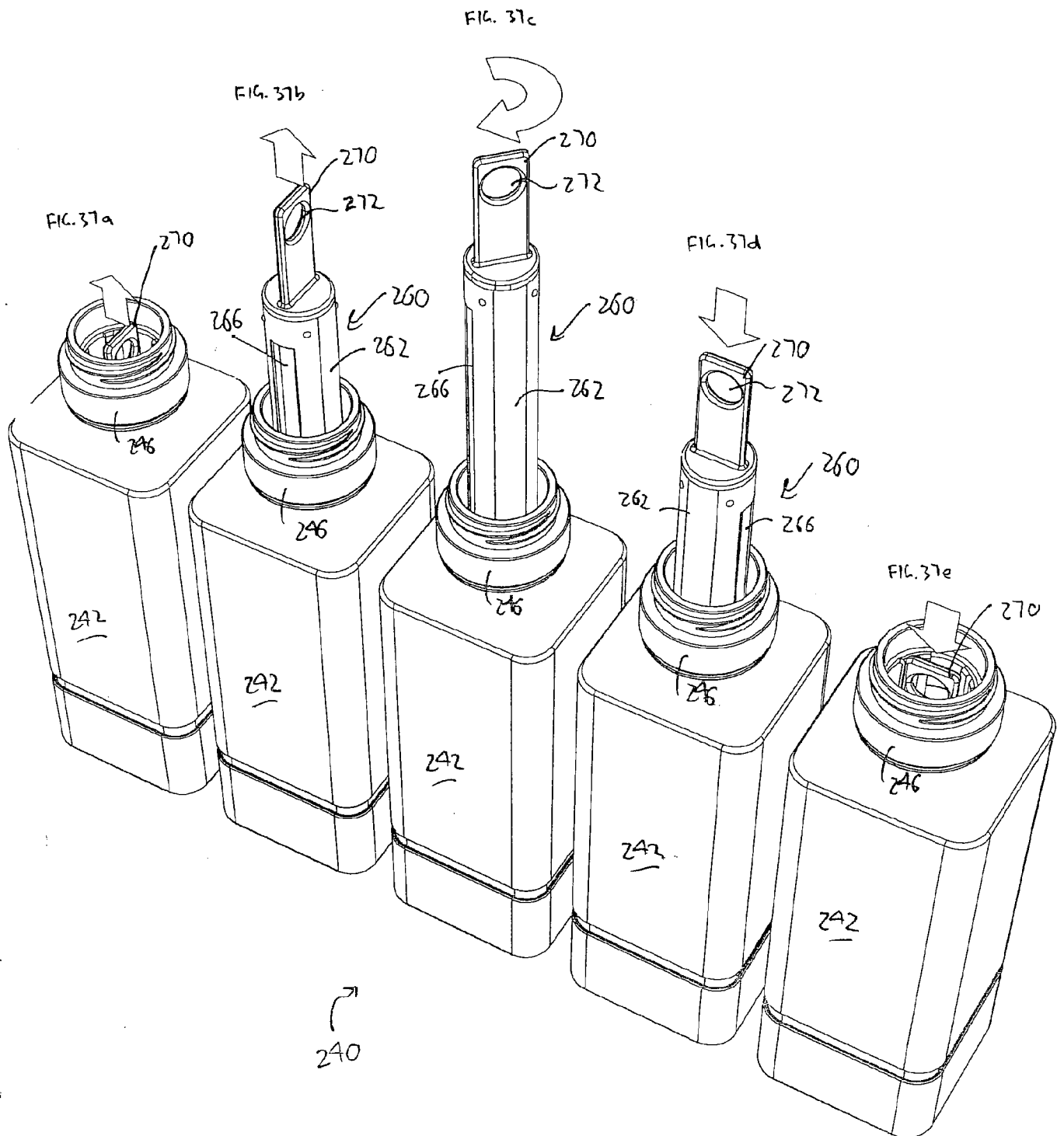
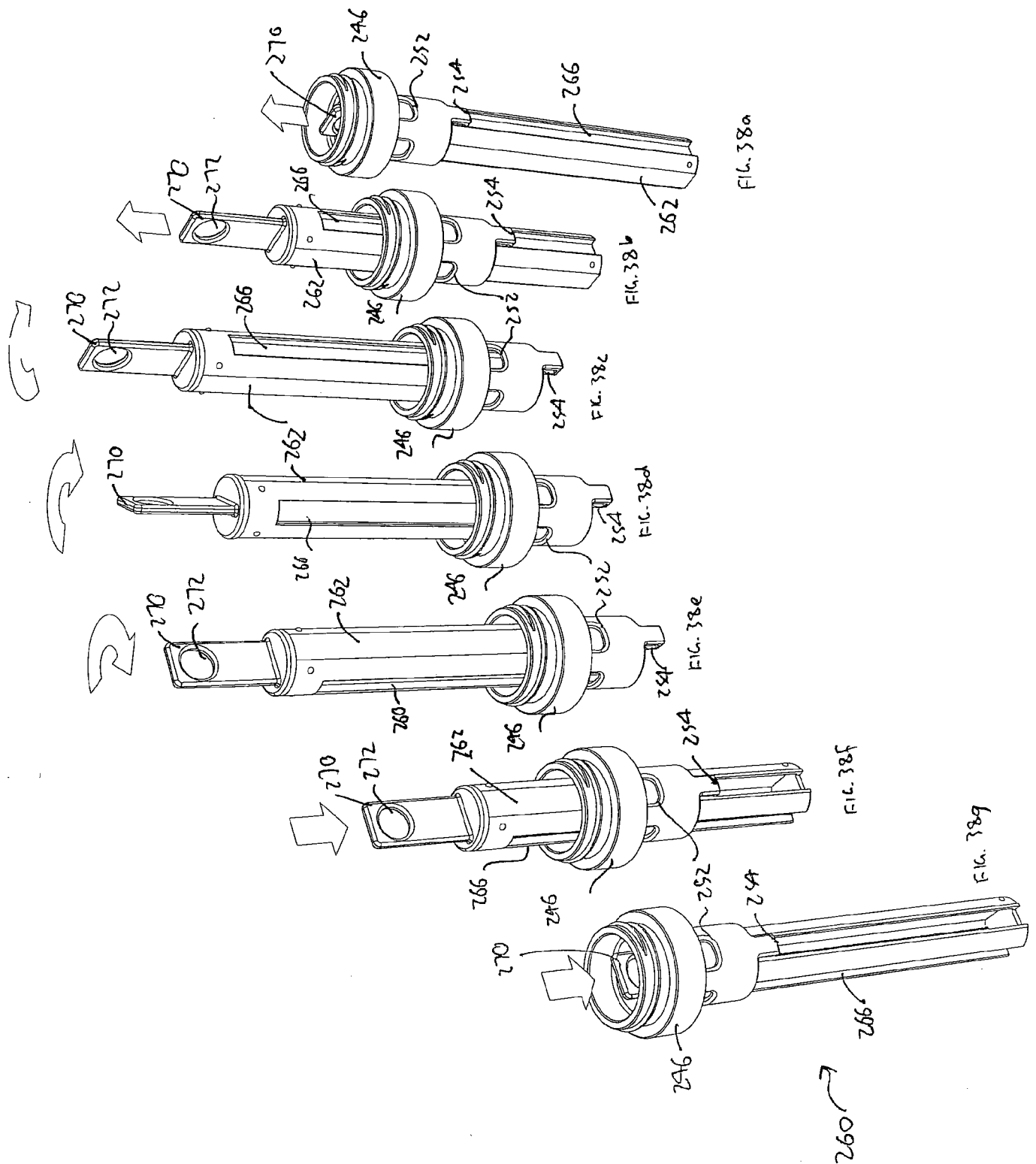


FIG. 33









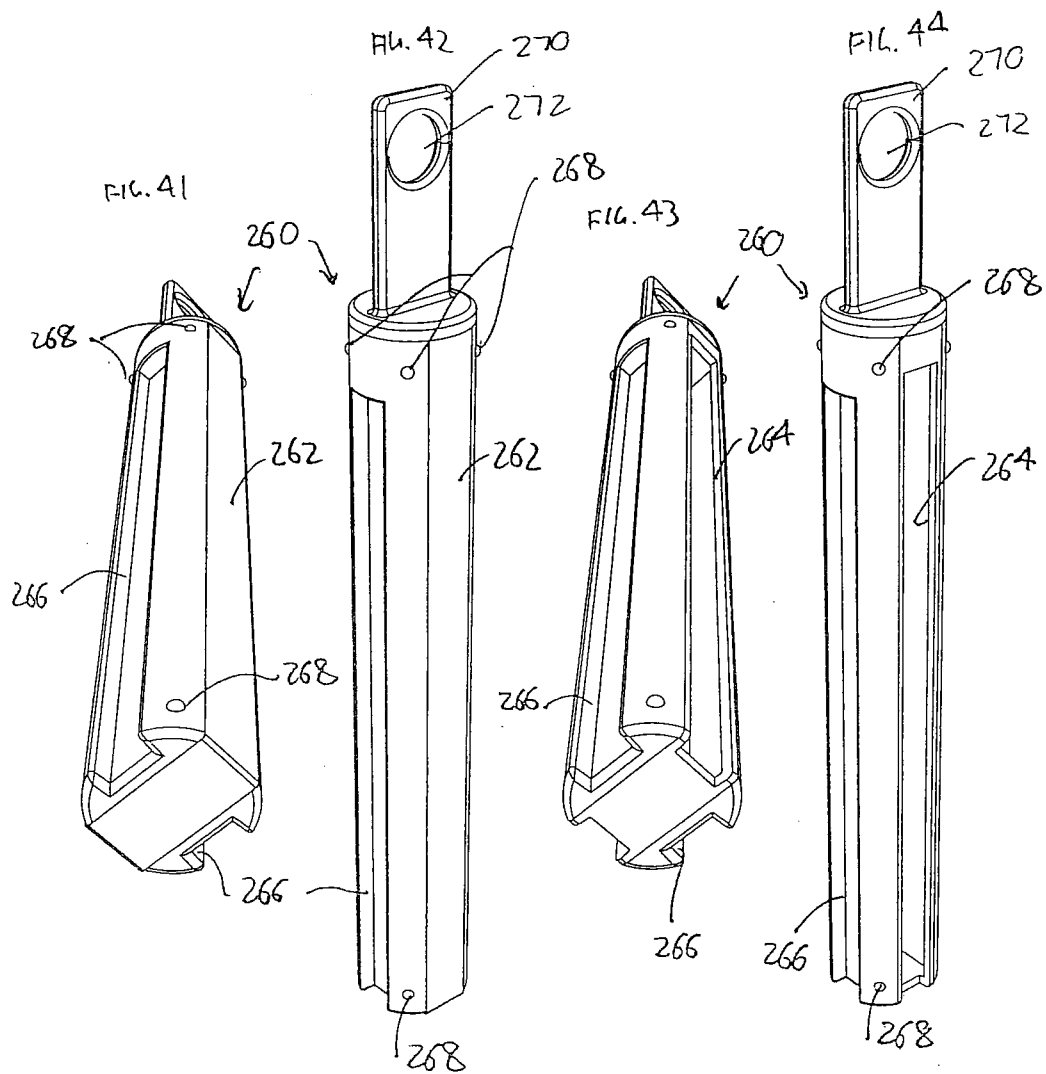
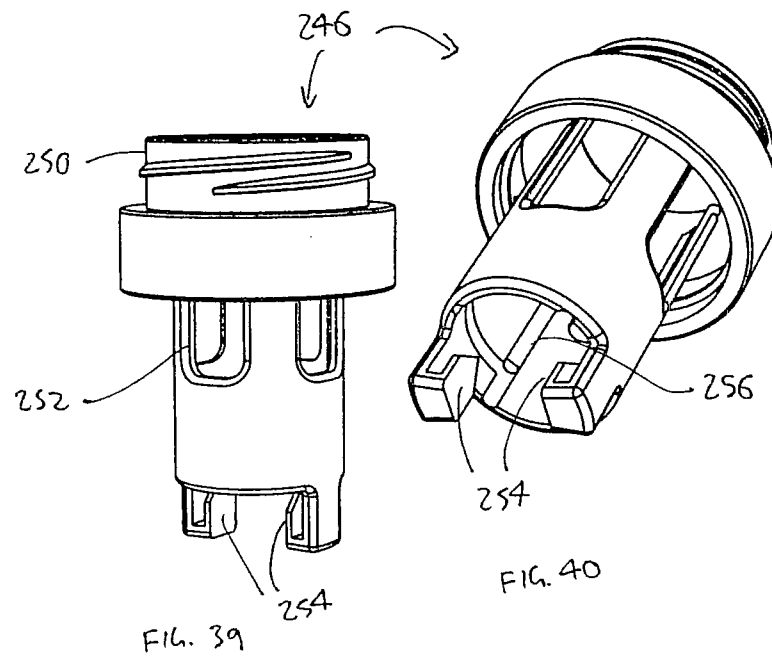


FIG 50

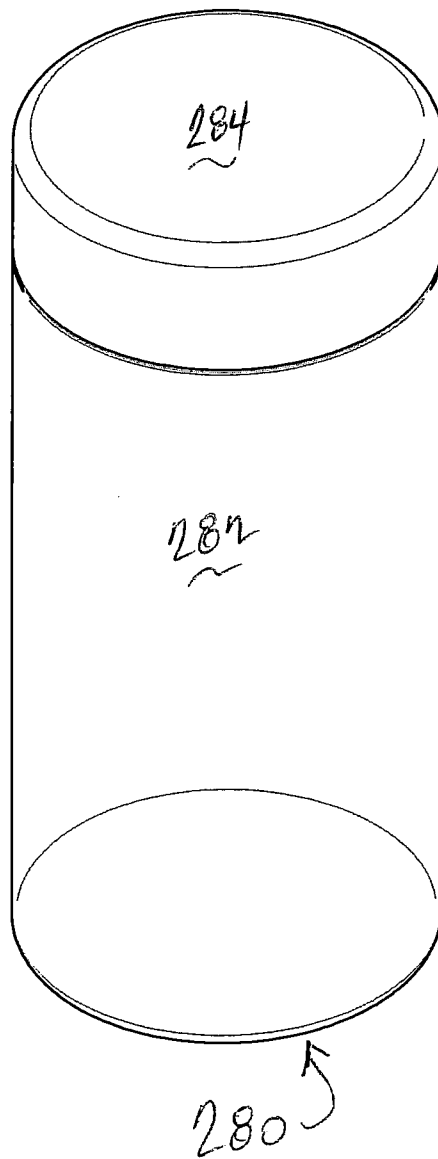


FIG 51

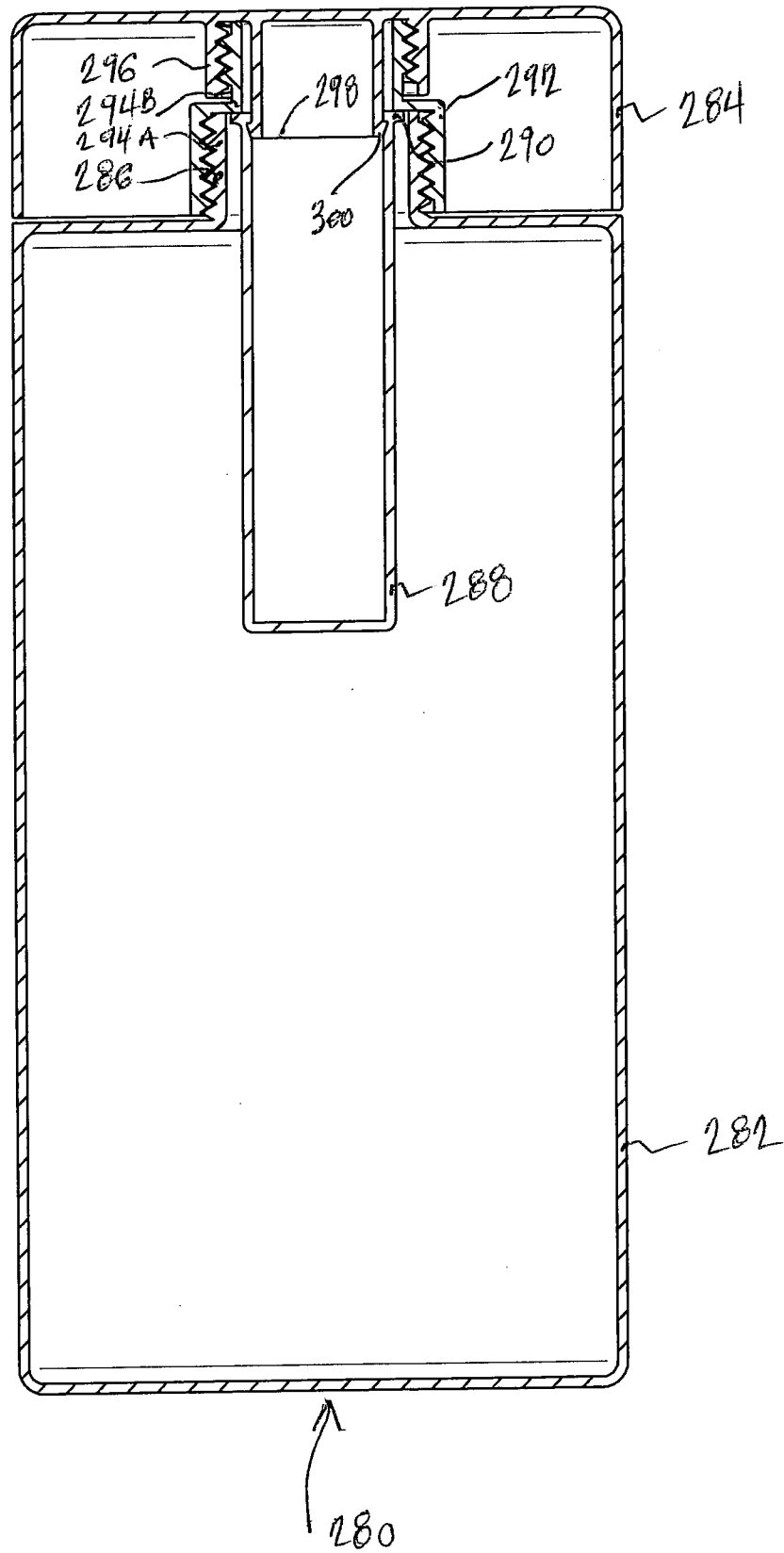


FIG 52

