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

(19) **World Intellectual Property Organization**
International Bureau

(43) **International Publication Date**
18 November 2010 (18.11.2010)

PCT

(10) **International Publication Number**
WO 2010/131042 A1

(51) **International Patent Classification**:
B05B 11/00 (2006.01)

(21) **International Application Number**:
PCT/GB2010/050780

(22) **International Filing Date**:
13 May 2010 (13.05.2010)

(25) **Filing Language**: English

(26) **Publication Language**: English

(30) **Priority Data**:

0908239.7	14 May 2009 (14.05.2009)	GB
0911194.9	29 June 2009 (29.06.2009)	GB
0922580.6	23 December 2009 (23.12.2009)	GB
1006152.1	14 April 2010 (14.04.2010)	GB

(71) **Applicant** *(for all designated States except US)*: **LEAF-GREEN LIMITED** [GB/GB]; 35 Fairfield Rise, Wollaston, Stourbridge, West Midlands DY8 3PQ (GB).

(72) **Inventor; and**
(75) **Inventor/Applicant** *(for US only)*: **LAIDLER, Keith** [GB/GB]; 35 Fairfield Rise, Wollaston, Stourbridge, West Midlands DY8 3PQ (GB).

(74) **Agent**: **CHURCH, Simon**; Charles House, 148/9 Great Charles Street, West Midlands, Birmingham, West Midlands B3 3HT (GB).

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

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

Published:

— *with international search report (Art. 21(3))*

(54) **Title**: A PRECOMPRESSION VALVE AND FLUID DEVICE COMPRISING SUCH A VALVE

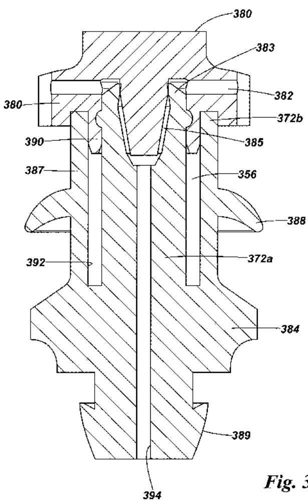


Fig. 38

(57) **Abstract**: A precompression valve has a body(314) defining a fluid inlet, a fluid outlet and a fluid passage (373) from the inlet to the outlet. A resiliently deformable valve member (372) is located in the passage. The valve member has a resiliently deformable body (372a) smaller than the bore and a resiliently deformable sealing skirt (388) mounted to part of the body to engage with a sealing surface of the passage to prevent fluid flowing through the passage when the body portion and sealing skirt are both in initial resiliently biased configurations. The valve member body (372a) deforms when subjected to a force causing the sealing skirt (388) deform or move to open a flow path through the valve. During at least part of the deformation of the body, the sealing skirt (388) is deformed and held in the sealing position by the pressure of the fluid acting upon it. The valve is arranged so that when a minimum fluid pressure level is reached, the sealing skirt (388) is moved sufficiently to open a fluid flow path through the valve. As the pressure differential across the sealing skirt equalises, it is then able to at least partially reform to its original shape increasing the area of the fluid flow path.

WO 2010/131042 A1

A Precompression Valve and Fluid Device Comprising Such a Valve

The present invention relates to one way valves and especially precompression valves and particularly when used in manually actuated pump type fluid dispensers including trigger sprayers and dispensers.

Manually actuated pump type fluid dispensers are commonly used to provide a means by which fluids can be dispensed from a non-pressurised container. Typically, dispensers of this kind have a pump arrangement which is located above the container when in use. The pump includes a pump chamber connected with the container by means of an inlet having an inlet valve and with a dispensing outlet via an outlet valve. To actuate the dispenser, a user manually applies a force to an actuator to reduce the volume of the pump chamber and pressurise the fluid inside. Once the pressure in the chamber reaches a pre-determined value, the outlet valve opens and the fluid is expelled through the outlet. When the user removes the actuating force, the volume of the chamber increases and the pressure in the chamber falls. This closes the outlet valve and draws a further charge of fluid up into the chamber through the inlet. A range of fluids can be dispensed this way this way including pastes, gels, liquid foams and liquids. In certain applications, the fluid is dispensed in the form of an atomised spray, in which case the outlet will comprise an atomising nozzle. The actuator may be push button or cap, though in some applications the actuator arrangement includes a trigger that can be pulled by a user's fingers.

A large number of commercial products are presented to consumers in a manual pump type dispenser, including, for example, tooth paste, antiperspirant, de-odorant, perfumes, air fresheners, antiseptics, paints, insecticides, polish, hair care products, pharmaceuticals, shaving gels and foams, water and lubricants.

There are a number of drawbacks associated with conventional pump-action dispensers. Firstly, many of the conventional devices tend to be extremely complex in design and typically comprise numerous different component parts. In some designs there are between 8 and 10 individual components, with 10 to 14 individual components being used in dispensers having a trigger actuator. As a consequence, these devices can be costly to manufacture due to the amount of material required to form the individual components and the assembly processes involved. Secondly, many of the conventional devices tend to be bulky (which again increases the raw material costs) and a proportion of this bulk is invariably disposed inside the container to which the device is attached. This creates a drawback in that the nozzle device takes up a proportion of the internal volume of the container, which can be a particular problem in small containers where the available space inside the container is limited. Finally, the size of the pump is also dictated to certain extent by the size of the container to which it is attached. Thus, the size of the pump is usually restricted in small containers, and especially small containers with narrow necks, and this limits the amount of pressure that can be generated by the pump as well as the volume of fluid that can be dispensed, and, for this reason, can be detrimental to the performance of the device.

Many dispensers and especially spray dispensers or triggers use a precompression valve which is a one way valve that allows liquor or fluid to pass downstream but doesn't allow any fluid past upstream. Usually the valve is preset to give way at a certain pressure such as 4 bars and it shouldn't open before then and should snap shut quickly after use. Current valves tend to allow some fluid past below the set pressure as they partially open and once they are open they normally only open a minimum amount that allows the fluid past but obstructs the flow. Many of the products which are supplied in a manual pump action dispenser are high volume products that are very cost sensitive and there is constant pressure on the manufactures of dispensers to reduce manufacturing costs without adversely affecting the performance of the dispenser.

There is a desire for a manually actuated pump dispenser which is:

simpler in design;

utilises fewer components; and

is easy to operate and functions effectively.

There is also a desire for a precompression valve which overcomes or at least mitigates the problems of the known precompression valves.

In particular, there is desire for a precompression valve which opens quickly when the fluid on the inlet side of the valve reaches a predetermined value.

There is a further desire for a precompression valve in which backpressure generated in a fluid on the downstream side of the valve after it opens assists in holding the valve open.

In accordance with a first aspect of the invention, there is provided a valve having a body, a fluid inlet, a fluid outlet and a bore defined in the body and which forms at least part of a fluid passage from the inlet to the outlet, the valve further compromising a resiliently deformable valve member having a resiliently deformable body that is smaller than the bore and a resiliently deformable sealing skirt mounted to part of the body that engages with a sealing region of the inner surface of the bore to form a seal that in their initially biased configuration in a valve closed position close the valve bore to prevent fluid flowing through the bore, and in a valve open position do not close the valve bore and a fluid flow path through the bore is established, characterised in that the valve is configured such that when force is applied to the body or the resiliently deformable valve member at least part of the body of the resiliently deformable valve member is deformed causing the sealing skirt to also deform but to be still held in the sealing position on the bore by the pressure of the fluid acting upon it until a minimum fluid pressure level is reached when the sealing skirt comes away from the valve bore allowing the fluid to pass it and enabling the sealing skirt to at least partially reform to its original shape increasing the gap between the sealing skirt and the valve bore.

In one embodiment, the action of the resiliently deformable valve member body being deformed causes at least part of the sealing skirt to deform to maintain the seal with the sealing region of the inner surface of the bore preventing fluid flow in the bore and where further compression of the body causes the sealing skirt to come away from the sealing region of the inner surface of the bore enabling fluid flow in the bore and where that fluid flow enables the sealing skirt to at least partially reform to its non deformed condition thus increasing the gap between the sealing skirt and the sealing region of the inner surface of the bore.

The valve may be a one way valve allowing fluid to pass from upstream to downstream of it. The resiliently deformable valve member body may have a further sealing skirt upstream of the first sealing skirt, the upstream skirt preventing the flow of fluid from downstream to upstream of the valve.

The valve may be a two way valve allowing the fluid to pass from upstream to downstream and from downstream to upstream of it.

The resiliently deformable valve member body may have two or more sealing skirts.

The upstream fluid may be a liquor or a liquor and air and the downstream fluid may be a liquor or air or a mixture of both.

The upstream fluid may be a paste or a paste and air and the downstream fluid may be a paste or air or a mixture of both.

The deformable body of the resiliently deformable valve member may be configured to compress at an angle away from the flow of the fluid and the angle may be greater than 50 degrees.

The sealing skirt may be annular and circular. The sealing skirt may have a finer and more deformable sealing skirt around its edge. The outer sealing skirt may extend at an angle to the main sealing skirt.

The sealing skirt may comprise part of a downstream wall of a pump chamber in a fluid dispenser.

There may be one or more protrusions on the resiliently deformable valve member body downstream of the sealing skirt to prevent the skirt from flipping partially or becoming totally inverted when the valve is open and being unable to return to its original position.

There may be one or more protrusions on the sealing skirt of the resiliently deformable valve member body and downstream of the sealing skirt to prevent the skirt from flipping partially or totally inverted when the valve is open and being unable to return to its original position.

There may be one or more protrusions on the wall of the bore defined in the body and downstream of the sealing skirt to prevent the skirt from flipping partially or totally inverted when the valve is open and being unable to return to its original position.

There may be one or more protrusions or ribs on the wall of the bore defined in the body and downstream of the sealing skirt that act upon part of the sealing skirt and inboard of the sealing edge of it as the body of the resiliently deformable valve member body is deformed pushing part of the sealing skirt upstream and away from part of the bore wall and breaking the seal and opening the valve.

There may be one or more protrusions or ribs on the resiliently deformable valve member body or the sealing skirt and downstream of the sealing skirt and inboard of the sealing edge of the sealing skirt act upon part of the bore defined in the body as the body of the resiliently deformable valve member body is deformed pushing part of the sealing skirt upstream and away from part of the bore wall and breaking the seal and opening the valve.

There may be one or more protrusions or ribs on the resiliently deformable valve member body or the sealing skirt and downstream of the sealing skirt and inboard of the sealing edge of the sealing skirt act upon a ledge on part of the bore defined in the body as the body of the resiliently deformable valve member body is deformed pushing part of the sealing skirt upstream and away from part of the bore wall and breaking the seal and opening the valve.

Part of the deformable body of the resiliently deformable valve member may be hollow or contain closed cell bubbles.

Part of the body of the resiliently deformable valve member may also form part of a swirl chamber in a fluid device.

At least part of the resiliently deformable valve member body may be proximal to an outlet orifice of the body of the valve. The orifice may be a spray orifice.

The valve may be configured to open only when the fluid pressure acting upon the upstream side of the sealing skirt and/or valve member is at or above a predetermined minimum value.

The valve may be configured to open only when the fluid pressure acting upon the sealing skirt and/or valve member is at or above a predetermined minimum value and the deformable body of the resiliently deformable valve member deforms to a limited amount prior to the valve opening.

The valve may be configured to open only when the fluid pressure acting upon the sealing skirt and/or the valve member is at or above a predetermined minimum value and the sealing skirt of the resiliently deformable valve member deforms to a limited amount prior to the valve opening.

The valve may be a non drip valve.

The valve may be an air release valve.

In accordance with a second aspect of the invention, there is provided a precompression valve, the valve comprising a body defining a fluid passage having an inlet end and an outlet end and a sealing surface within the passage, and a valve member located in the passage, the valve member having a resiliently deformable body portion dimensioned so that a flow path is defined between the body portion and a surface of the fluid passage along which a fluid can flow when the valve is open, the valve member further comprising a seal portion projecting from the body portion, the seal portion being resiliently deformable relative to the body portion, the seal portion contacting the sealing surface to prevent fluid flowing along the passage from the inlet end to the outlet end when both the body portion and the seal portion are in initial resiliently biased configurations, in which deformation of the body portion of the valve member under the application of a force from its initially biased configuration to a deformed configuration causes the seal portion to move relative to the sealing surface to open a flow path through the valve, the seal portion being resiliently deformable from its initial resiliently biased configuration to a deformed configuration under the pressure of a fluid acting on an upstream side of the of the sealing portion to maintain contact with the sealing surface to close the flow path during an initial phase of the deformation of the body portion from its initially resilient configuration to its deformed configuration.

The valve may be configured so that the seal portion recovers from the deformed configuration towards its initial resilient biased configuration once the flow path has opened and the pressure differential across the seal portion is insufficient to overcome the inherent resilience of the seal portion.

The valve may be configured such that in use, movement of the seal portion from the deformed configuration toward its initial resiliently biased configuration increases flow area past the seal.

The body portion may be deformable in response to the pressure of a fluid acting on the body portion upstream of the seal portion prior to the valve opening.

The body portion may be deformable in response to the pressure of a fluid acting on the body portion upstream and downstream of the seal portion when the valve is open.

The precompression valve in accordance with the second aspect may be the same as the valve in accordance with the first aspect, the bore forming part of the fluid passage and the sealing skirt forming the seal portion. The valve in accordance with the second aspect may include any of the optional features of the valve in accordance with the first aspect as set out above.

In accordance with a third aspect of the invention, there is provided a precompression outlet valve for use in a manual pump and trigger actuated dispenser for controlling the flow of a fluid from a pump of the dispenser to a final outlet of the dispenser, the valve being configured to open when the fluid flowing from the pump chamber reaches a certain set pressure, the valve being configured in such away that the forces on the valve act in a direction substantially angled away from the line of flow of the fluids causing the valve to be deformed or moved away from the line of flow in such a manner that a fluid backpressure force caused by the outlet hole also helps to move or deform the valve in a similar direction.

In accordance with a fourth aspect of the invention, there is provided a fluid device comprising a valve in accordance with any one of the first to third aspects of the invention, in which the body of the valve is an integral part of the body of the device.

The body of the device may be an outlet of a squeezy bottle or tube or flexible sachet or bag or any flexible container that delivers a bolus of liquor or paste past the resiliently deformable valve member when deformed.

The body of the device may be an outlet of a squeezy bottle or tube or flexible sachet or bag or any flexible container that delivers a spray of liquor when deformed.

The body of the device may be a squeezy bottle or tube or flexible sachet or bag or any flexible container that delivers a bolus of liquor or paste past the resiliently deformable valve member when deformed.

The body of the device may be an outlet nozzle, in particular for a liquid dispenser.

Methods of operating or using the a valve in accordance with any one of the first to third aspects of the invention or the device of the fourth aspect of the invention may be claimed.

Further aspects and features of the invention will be understood from the following description of a number of embodiments of the invention, which are provided by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of first embodiment of a dispenser in accordance with the invention, shown prior to actuation;

Figure 2 is a view similar to that of Figure 1 but showing the dispenser in mid-actuation with a cap portion depressed;

Figure 3 is an exploded view of the dispenser of Figure 1;

Figure 4 is a cross-sectional view through part of the dispenser of Figure 1 but showing an alternative outlet incorporating a spray nozzle;

Figure 5 is a cross-sectional view though a cap forming part of the dispenser of Figure 4;

Figure 6 is a cross-sectional view similar to that of Figure 4 showing a modified form of the dispenser of Figure 1 prior to actuation;

Figure 7 is a view similar to that of Figure 6 but showing the dispenser in mid-actuation;

Figure 8 is a perspective view of a further embodiment of a dispenser in accordance with the invention;

Figure 9 is a view similar to that of Figure 8 but showing the cap after insertion of a flexible insert;

Figure 10 is a view similar to that of Figure 4 of a further alternative embodiment of a dispenser in accordance with the invention;

Figure 11 is a view similar to that of Figure 4, showing a further embodiment of a dispenser in accordance with the invention during a recovery phase with an inlet valve open;

Figure 12 is view similar to that of Figure 4 of a yet further alternative embodiment of a dispenser in accordance with the invention;

Figure 13 is view similar to that of Figure 4 of a still further alternative embodiment of a dispenser in accordance with the invention;

Figures 14a and 14b are longitudinal and lateral cross sectional views respectively through a modified filter plug suitable for use in a dispenser in accordance with the invention;

Figures 15a and 15b are longitudinal and lateral cross sectional views respectively through a further modified filter plug suitable for use in a dispenser in accordance with the invention;

Figure 16a is a longitudinal cross sectional view through an outlet arrangement for a dispenser in accordance with the invention adapted to produce foam;

Figure 16b is a lateral cross sectional view through and end wall of the outlet arrangement of Figure 16a taken on line X-X;

Figure 17 is a longitudinal cross sectional view through a further embodiment of an outlet arrangement for a dispenser in accordance with the invention adapted to produce foam;

Figure 18 is a longitudinal cross sectional view through a yet further embodiment of an outlet arrangement for a dispenser in accordance with the invention adapted to produce foam;

Figure 19a is a longitudinal cross sectional view through a flood jet arrangement for use in an outlet passage of a dispenser in accordance with the invention;

Figure 19b is an end view of the flood jet arrangement of Figure 19a, taken in the direction of arrow Y;

Figure 20 is view similar to that of Figure 4 of a yet further alternative embodiment of a dispenser in accordance with the invention;

Figure 21 is a cross sectional view through a modified insert for use in a dispenser in accordance with the invention;

Figures 22a to 22c are a series of cross sectional views through an outlet valve arrangement for use in a dispenser in accordance with the invention illustrating movement of the valve as it opens during actuation of the dispenser;

Figure 23 is view similar to that of Figure 4 of a yet further alternative embodiment of a dispenser in accordance with the invention;

Figure 24 is a cross sectional view through a modified insert for use in a dispenser in accordance with the invention;

Figure 25 is a cross sectional view through a further modified insert for use in a dispenser in accordance with the invention;

Figure 26 is a cross sectional view through a still further modified insert for use in a dispenser in accordance with the invention;

Figure 27 is a perspective view of a further embodiment of a dispenser in accordance with the invention, part of an actuator cap being cut away to show details of a modified twist lock arrangement;

Figure 28 is a longitudinal cross sectional view through part of the dispenser of Figure 27;

Figure 29 is view similar to that of Figure 4 of a yet further alternative embodiment of a dispenser in accordance with the invention;

Figure 30 is a view similar to that of Figure 4 showing a further embodiment of a dispenser in accordance with the invention including a trigger actuator;

Figure 31 is a cross sectional view similar to that of Figure 4 showing a further embodiment of a dispenser in accordance with the invention including a trigger actuator;

Figure 32 is a cross sectional view through part of the dispenser of Figure 31 taken on line Z-Z;

Figure 33 is a view similar to that of Figure 31 but showing the dispenser in mid-actuation with the insert full deformed; and

Figure 34 is a cross sectional view similar to that of Figure 4 showing a further embodiment of a dispenser in accordance with the invention.

Figure 35 is a perspective view of a further embodiment of a dispenser where part of an actuator cap being cut away to show details of a modified input valve;

Figure 36 is a cross sectional view of the central part of a device similar to that of Figure 31 showing an integral side valve in the central component of the dispenser in accordance with the invention including a trigger actuator;

Figure 37 is a cross sectional view similar to that of Figure 31 showing a further embodiment of a dispenser in accordance with the invention including a trigger actuator including new valves;

Figure 38 is a cross sectional view of the precompression valve shown in figure 37.

Figure 39 shows the precompression valve in the trigger dispenser;

Figure 40 shows an integral precompression valve on the underside of the top part of a split dome pump usually actuated by a trigger handle;

Figure 41 shows the top of the base part of the pump shown in figure 40 including the tube for the precompression valve;

Figure 42 shows another version of the precompression valve of figures 40 and 41 on the same device including the integral precompression valve;

Figure 43 shows the underside of the top part of the device shown in figure 42 with the integral precompression valve;

Figure 44 shows the underside of the top part of the device shown in figure 42 with another version of the integral precompression valve;

Figure 45 shows the top of the base part of the device in figure 44 including the recess for the precompression valve;

Figure 46 shows the precompression valve used as a non drip valve.

Figure 47 shows another view of figure 46;

Figure 48 shows a cross sectional view of part of a device using a version of the precompression valve;

Figure 49 shows a cross sectional view of part of a device using a version of the precompression valve and

Figure 50 shows a cross sectional view of another version of the non drip valve of figure 46.

Dispensers in accordance with the invention can be manufactured using any suitable apparatus and methods but can be at least partly manufactured in a convenient and economical manner using the various moulding apparatus and methods described in the applicant's co pending patent applications Nos. PCT/GB2006/002751 (published as WO2007/010286) and PCT/ GB2008/002558. The reader should refer to these and related patent applications for a full description of the apparatus and methods.

Figures 1 to 7 show a first embodiment of a manually actuated pump dispenser 110 in accordance with the invention. The dispenser 110 comprises three component parts, a container 112, an actuating cap 114 and an insert 116, at least parts of which are resiliently flexible.

The container has a main body 118 for receiving a fluid to be dispensed and an open neck region 120 which forms a first or base part of the dispenser pump. The cap 114 is mounted to the neck region 120 and forms a second or upper part of the dispenser pump. The insert 116 is mounted between the cap 114 and the neck region 120 to define a main or first pump chamber 122 and, in this embodiment, a second pump chamber 123.

The container 112 and cap 114 are preferably formed from a polymeric material such as polyethylene, polythene or the like using injection and/or blow moulding techniques as will be discussed in more detail later. The insert 116 may also be formed by injection moulding from a polymeric material. Typically, the insert 116 is made from a material which once moulded remains resiliently flexible such as TPV, TPE, PP, silicon or the like. However, the flexible insert could also be manufactured using bi-injection techniques so as to have a core or framework of a more rigid material onto which the flexible portions are over moulded. This would provide for additional strength. The cap 114 and at least the neck 120 of the container are typically formed from a material which is substantially rigid once moulded, or at least substantially rigid when compared with the flexible portions of the insert 116. The main body 118 of the container may also be substantially rigid after moulding or it may be flexible.

The neck region 120 of the container 112 is substantially annular in shape and has a ridge 124 extending around its outer surface and which separates an upper portion 120a of the neck from a lower portion 120b. The upper portion 120a has a slightly smaller outer diameter than the lower portion 120b. Two diametrically opposed grooves 126, only one of which can be seen, extend longitudinally through the ridge 124 and into the lower portion 120b. Two pairs of stops 128, 130 project radially outwardly from the outer surface of the upper region 120a adjacent the ridge 124. A first pair of stops 128 are positioned adjacent each of the grooves 126, whilst the other pair of stops 130 are aligned at approximately 90 degrees to the first pair in a circumferential direction.

The upper edge of the neck 120 has flange 132 which angles inwardly to support the flexible insert 116 as will be described in more detail below. A small opening 134 extends through the wall of the neck to provide an air inlet to the container as will also be described in more detail below.

The cap 114 has an annular main body portion 136 which is received over the neck region 120 of the container. An inwardly directed flange 138 is formed at the lower edge of the main body for cooperation with the ridge 124 on the neck of the container to prevent the cap 114 from being accidentally removed from the neck 120 after fitting. The arrangement is such that the cap 114 can be pushed onto the neck 120 so that the flange 138 passes over the ridge 124 to engage with the lower surface of the ridge. In normal use, upward movement of the cap 114 relative to the neck 120 is limited by contact between the flange 138 and the ridge 124 to an upper rest position as shown in Figure 1.

A pair of diametrically opposed, longitudinal locking tabs 140 project radially inwardly from the inner surface of the main body portion 136 of the cap. A lower edge 142 of the tabs 140 is arranged to be positioned just above the upper surface of the annular ridge 124 on the neck 120 when the cap 114 is in its upper rest position as shown in Figure 1. In this position, the cap 114 can be twisted between a locked position in which the tabs 140 abut the second pair of stops 130 on the neck and an unlocked position in which the tabs 140 abut the first pair of stops 128. When the cap 114 is in the locked position, it is prevented from being depressed as the tabs 140 contact the upper surface of the ridge 124 on the neck. However, when the cap 114 is in the unlocked position the tabs 140 are aligned with the grooves 126 and the cap 114 can be depressed to the position shown in Figure 2, with the tabs 140 entering and sliding along the grooves 126. This provides a simple twist locking mechanism that enables a user to lock the dispenser 10 against accidental actuation. Any other suitable means of locking the cap against accidental actuation can be used.

An outlet 144 is formed at an upper region of the cap 114. In the embodiment as shown in Figures 1 to 3, the outlet is in the form of an elongate spout having an oval cross section shape with a large internal outlet passage 146 suitable for dispensing a paste, gel or foam. In contrast, the outlet 144’ shown in Figures 4 to 7 incorporates an “atomizing” nozzle suitable for dispensing a liquid as an atomised spray or fine mist. It will be appreciated by those skilled in the art that the outlet 144 can be modified in numerous ways depending on the application and the type fluid to be dispensed. For example, in the present embodiments the outlet 144, 114’ is directed generally perpendicular to the longitudinal axis of the container 112 so as to extend horizontally when the dispenser is in an upright position. However, the outlet 144, 114’ could be arranged to extend parallel to the longitudinal axis of the container so as to project upwards when the dispenser is positioned upright or indeed at any desired angle.

Where the outlet 144’is in the form of a spray nozzle, a swirl chamber or other arrangement may be provided just prior to the final outlet orifice to encourage the fluid to spin about the axis of the orifice in a manner known in the art.

As can be seen best in Figures 4 to 7, the upper surface of the cap 114 includes an inwardly projecting collar 148. The collar 148 has first radially inner annular wall

150 which is connected at an outer or upper end to a second, radially outer annular wall 152 so as to provide an annular channel 154 between the two annular walls. The inner or lower end of the second annular wall is connected with the main body portion 136 whilst the inner or lower end of the inner annular wall 150 is connected to a central button 156 by means of a frusto-conical portion 158. A groove 160 is formed around the inner surface of the cap 114 at the junction between the outer annular wall 152 and the main body 136.

As mentioned previously, the outlet 144' as shown in Figures 4 to 7 comprises a nozzle configured to generate an atomised spray of liquid. The outlet 144' includes a short annular spout 162, a generally circular projection 164 located centrally within the spout and an end cap or spray insert 166 which locates within the spout about the projection. The insert 166 is a tight fit in the spout 162 but its inner surface is spaced from the outer surface of the projection to form outlet flow passages for the fluid. An end wall 168 of the insert has at least one small orifice or nozzle 170 through which the fluid is expelled as a spray. In an alternative arrangement which is not shown, the circular projection 164 may be omitted and the outlet nozzle formed by means of an insert mounted to the spout or other opening in the cap.

In the present embodiment, the dispenser 110 has two pump chambers, a first pump chamber 122 for pumping a liquid from the container and a secondary chamber 123 for delivering air to the outlet nozzle to mix with the liquid. A first opening 172 fluidly connects the interior of the outlet spout 162 with the annular space 154 between the first and second annular walls 150, 152 which form part of an outlet flow path for the liquid from the first pump chamber 122. A second opening 174 fluidly connects the interior of the outlet spout 162 with the secondary pump chamber 123 to enable air from the secondary pump chamber to enter the outlet and mix with the liquid. The end face 164a of the projection and/or the inner surface of the end wall 168 of the insert may be shaped so as to form a swirl or vortex chamber in which the liquid and air are directed so as to rotate about the axis of the outlet orifice 170 in a manner known in the art. The air and the liquid may be kept separate in the outlet prior to entering the swirl chamber. This could be achieved for example by forming grooves and/or recesses on the inner surface of the insert 166 and/or the outer surface of the projection 164 to form separate flow paths for the liquid and air.

The spray insert 166 may be moulded in the same tool as the cap 114 and is connected with the cap by means of a flexible lanyard 166a as shown in Figure 5. This arrangement assists in assembly of the dispenser as the cap 114 and insert 166 are held together to effectively form a single component part.

The insert 116 has a central core 176 and a central bore 178 which extends longitudinally through the core. An inner or lower end of the bore 178 has a region of increased diameter 178a which is adapted sit on an upper end region of a dip tube 180. The dip tube 180 extends towards the bottom of the container 112 to enable the contents of the container to be dispensed in a known manner. A small ridge 178b is provided on the surface of the enlarged diameter portion 178a. The ridge 178b contacts the outer surface of the dip tube 180 to form a point contact seal similar to that of an O-ring.

In the present embodiment, the dip tube 180 is formed integrally with the container. A lower end of the dip tube has an opening through which fluid can flow into a central bore 182. Although not shown in the drawings, the bottom of the container angles downwardly towards the centre of the container where the lower end of the dip tube is positioned. This arrangement ensures that substantially all the fluid in the container can be dispensed when the dispenser is positioned upright. Although it can be convenient to form the dip tube 180 as an integral part of the container, it will be appreciated that the dip tube could be a separate component in the known manner or it could be formed as an integral part of the insert.

The insert 116 is shaped like a double bell or hour-glass. A first upper bell-like portion or diaphragm member 184 contacts the interior surface of the cap 114 to define the first pump chamber 122. A second lower bell-like portion or diaphragm member 186 extends outwardly from the main core to contact and seal with the neck region 120 of the container. The lower diaphragm member 186 also seals with the interior of the main body 136 of the cap to define the secondary pump chamber 123 between the upper 184 and lower diaphragms 186 within the cap 114.

The upper diaphragm 184 includes a frusto-conical region 184a projecting upwardly and outwardly from the core 176 towards the inner surface of the main body portion 136 of the cap. A tubular region 184b extends from an upper end of the frusto-conical region 184a to contact the outer surface of the inner annular wall 150 of the collar 148. A semi-circular seal 184c is formed about the outer surface of the first diaphragm at the junction between the frusto-conical region 184a and the tubular region 184b. The seal 184c engages and seals in the groove 160. The tubular region 184b is resiliently biased into engagement with the outer surface of the inner annular wall 150 to form a seal separating the first pump chamber 122 from the outlet 144. The tubular region 184b acts as a flexible ring valve member to control the release of liquid from the first chamber 122.

The flexible insert also forms a one-way inlet valve 185 for controlling the flow of liquid into the first pump chamber 122 from the dip tube. The valve 185 can be of any suitable form and could comprise a flap valve or a duck valve for example.

The lower diaphragm 186 has a shoulder portion 186a which projects radially outwardly towards the neck 120 of the container 112 and a downwardly extending skirt 186b which extends into and seals with the inside of the neck region 120. A frusto-conical outer surface of the lower diaphragm 186 rests on the flange 132 of the neck region whilst an angled projection 186c on the skirt engages in an undercut below the flange 132. This secures the flexible insert 116 to the neck region 120 of the container. A further frusto-conical extension 186d of the skirt engages with the inner surface of neck 120 to form a point seal. The extension, contacts the neck at a point below air inlet 134 and acts as a valve to admit air into the container. If the pressure in the container falls below atmospheric as the contents are used up, the extension 186d is deflected away from the surface of the neck to allow atmospheric air to enter the container. At all other times, the extension 186d contacts the neck to form a seal preventing liquid from escaping through the air inlet 134 and the neck itself.

The lower diaphragm has a further frusto-conical extension 186e which extends upwardly to contact and seal with the inner surface of the main body portion 136 of the cap 114 to define the secondary pump chamber 123 between the upper and lower diaphragms 184, 186 and the cap 114. The further frusto-conical extension 186e is flexible and acts as a one way ring valve to admit atmospheric air into the secondary chamber after each actuation of the dispenser.

Operation of the dispenser 110 will now be described with reference in particular to Figures 6 and 7. The dispenser as shown in Figures 6 and 7 has a modified flexible insert 116 in which the inlet valve 185 for the first pump chamber is in the form of a duck-bill or fart type valve 185. This type of inlet valve 185 comprises a tube with a closed end having a slit 185a. When the pressure in the first pump chamber 122 falls as the flexible insert 116 recovers following each actuation, the slit 185a is opened to allow liquid to be drawn into the chamber. In a further modification, the flexible insert 116 is held in the neck region 120 of the container by a series of fins 188 instead of having a projection 186a which engages in an undercut. Eliminating the undercut in the neck 120 of the container makes it easier to mould. Other then these differences, the dispenser 110 shown in Figures 6 and 7 is constructed and operates in the same manner as the dispenser shown in Figures 1 to 5.

Assuming that the first pump chamber 122 and the secondary pump chamber 123 are fully primed with liquid and air respectively, the user initiates actuation of the dispenser by turning the cap to the unlocked position and depressing it. As the cap 114 is depressed, the conical region 184a of the upper diaphragm 184 of the flexible insert is deflected the downwardly and the volumes of the first pump chamber 122 and the secondary pump chamber are reduced. This results in an increase in the pressure of the liquid in the first pump chamber 122 and the air in the secondary pump chamber 123. Since liquid is incompressible, there will only be small change in the volume of the first pump chamber 122 initially with the conical region 184a deflecting downwardly to reduce the volume of the secondary pump chamber 123.

The increasing pressure of the liquid in the first pump chamber 122 acts on the inlet valve 185 to ensure it remains closed and on the tubular region 184b of the upper diaphragm 184. Once the pressure in the first chamber 122 has reached a predetermined level, the tubular region 184b is biased away from the inner annular wall 150 of the collar 148 so that the liquid flows under pressure into the annular channel 154 between the inner and outer annular walls 150, 152 of the collar and through the opening 172 into the outlet 144. The tubular region 184b thus acts as a pre-compression outlet valve ensuring that the liquid only flows from the first pump chamber 122 to the outlet 144 when it has reached a desired operating pressure suitable for producing a desired spray quality. The pressure at which the outlet precompression valve 184b opens is determined by the nature of the material used to form the flexible insert 116 and the thickness of the tubular region 184b. By selecting a suitable material and thickness, a designer can determine an appropriate opening pressure for the valve for any particular application.

At the same time, the increasing pressure of the air in the secondary chamber 123 acts on the further frusto-conical extension 186e of the lower diaphragm pushing it firmly onto the wall of the main body portion 136 of cap 114 to form a tight seal. As shown in Figure 6, the opening 174 connecting the secondary chamber 123 to the outlet 144 is normally closed by a portion of flexible insert 190 which acts as a pre-compression outlet valve member for the secondary pump chamber 123 in a manner similar to that of the tubular region 184b described above. Thus the portion of the flexible insert 190 closing the opening 174 is moved to admit air into the outlet 144 once the pressure of the air reaches a predetermined value. The outlet valves for the first and secondary chambers 122, 123 may be arranged to open at the same pre-determined pressure or at different pressures. For example, the air may be admitted into the outlet slightly earlier than the liquid.

Once the outlet valves for the pump chambers have opened, as shown in Figure 7, the user continues to depress the cap 114 further reducing the volume of the chambers so that the liquid and air continue to flow through the outlet where they are mixed prior to exiting through the outlet orifice 170 as an atomised spray. Once the cap has been fully depressed or when the user stops pressing the cap114, the pressure in the pump chambers 122, 123 falls and the outlet valves 184b, 190 close.

When the user removes the actuation force from the cap 114, the resilience of the insert 116 (the upper diaphragm 184 in particular) biases the cap 114 back towards the rest position. As the cap 114 is moved back towards its rest position, the volumes of the first and secondary chambers 122, 123 increase and the pressure in the chambers falls creating a partial vacuum. Once the pressure in the first pump chamber 122 has fallen to a predetermined value, the inlet valve 185 opens and a fresh charge of liquid is drawn into the chamber. A fresh charge of air is also admitted as the reduced pressure in the secondary pump chamber 123 allows atmospheric air to push the further frusto-conical extension 186e of the lower diaphragm away from the wall of the cap 114. By the time the cap 114 has fully recovered to its rest position, both the first and secondary pump chambers are fully charged ready for a further actuation. The user can then either depress the cap 114 again to dispense further liquid or twist the cap to the locked position for storage.

The insert 116, and in particular the upper diaphragm 184, can be strengthened by adding reinforcing ribs or struts to increase the spring force with which the cap 114 is biased back to the rest position. Figure 7 illustrates the dispenser 110 as the cap 114 reaches its fully depressed position. The tubular region 184b of the insert is shown deflected away from the inner annular wall 150 of the collar 148 to open a flow path from the first pump chamber 122 to the outlet 144. The flexible insert portion 190 has also been deflected to open a flow path through the second opening 174 from the secondary pump chamber to the outlet 144. It should be noted that the dispenser is designed to minimise the dead space in the pump chambers 122, 123 when the cap 114 is fully depressed. Thus the upper diaphragm 184 conforms closely to the shape of the collar 148 and overlies the angled surfaces of the lower diaphragm 184.

Dispensers in accordance with the invention can be manufactured using any suitable methods and apparatus. However, the container 116 and cap 114 can be cost effectively manufactured using the vertically stacked injection/blow moulding apparatus and methods described in the applicant's above referenced co-pending applications Nos. PCT/GB2006/002751 (published as WO2007/010286) and PCT/GB2008/002558, with a preform for the container being injection moulded in an upper station 12 and blown in a lower station 14. The neck region 120 of the container may be moulded in the upper station 12 or in the lower station 14 during the blow moulding phase. In some instances, part of the neck will be moulded in the upper station whilst additional features are added in the lower station. The cap 114 can also be injection moulded in the lower station 114 with suitable impressions in a split mould. Where the outlet 144 includes a spray nozzle insert 166, this can also be moulded in the lower station together with the cap. The flexible insert 116 will usually be manufactured in a separate injection moulding machine and assembled to the dispenser. As illustrated in Figure 3, the insert is first assembled to the cap 114 which is then pushed on to the neck region 120 of the container and fully depressed so that the flexible insert 116 engages in the neck 120. The dispenser can then be primed.

In order to reduce the tooling space required, the mould for the cap 114 will usually be positioned above a shoulder region of the blow moulding cavity for the container 112. This enables the number of units that can be produced in a single tool to be maximised. In many applications, the main body 118 of the container will be larger than that shown in the drawings and may have a non-circular (e.g. oval or elliptical) shape in horizontal cross section so that it is wider when viewed from the front or rear than from the sides. In this case there will be sufficient room for the whole of the mould for cap 114 to be positioned above the blow mould cavity for the container but even where the container is small or circular, the mould for the cap can be positioned minimise the overall footprint of the moulds for the container and cap.

In the present embodiment, the cap 114 is moulded with a flexible lanyard 192 connecting it to the container 112. This is advantageous as it minimises the assembly process and reduces the overall number of separate parts that must be produced and controlled. However, the lanyard could be omitted. The lanyard is flexible to allow the cap 114 to be fitted to the container 112 and to allow the cap 114 to fall vertically upside down adjacent the container to make it easy to assemble the insert. The cap 114 and lanyard 192 can be arranged so that the cap rests on a shoulder or side wall of the container when the insert 116 is assembled.

Figures 8 and 9 show a modified dispenser 210 in which the lanyard 192 is adapted to twist. This arrangement is beneficial as it enables the cap 114 to be moulded horizontally, as shown in Figure 8, with the underside being made in one part of a split mould tool and the topside in the other part of the tool. In this configuration the outlet spout 144 extends vertically and can be formed using retractable pins. As shown in Figure 9, when the container 112 and cap 114 are removed from the mould, the lanyard twists to enable the cap 114 to fall upside down adjacent the container. The lanyard 192 is formed with a series of openings 193 at different angles to allow the twisting to occur. The lanyard 192 in this and all embodiments can be manufactured with frangible links to the cap 114 and container 112 so that it can be easily removed after the cap 114 has been assembled to the container 112 or on first use of the dispenser.

Whilst it is advantageous for the cap to be moulded together with the container and connected by a lanyard, it will be appreciated that the cap could be moulded separately from the container. In many applications it will be desirable to produce the cap 114 in a different colour to the container 112.

The dispensers, 110, 210 as described above can be modified in a variety of ways. For, example, whereas in the embodiments described liquid is pumped via the first chamber 122 and air is pumped via the secondary chamber 123, this arrangement can be reversed and the liquid arranged to be pumped through the secondary chamber, with the first chamber 122 adapted to pump air. This may require the insert to be modified to provide and flow path from the dip tube to the secondary chamber 123 with an inlet valve. The design would also have to be modified to enable air to be admitted into the first chamber 122 during the recovery phase. Where there is no requirement to mix air with the liquid in the outlet nozzle 144, the secondary pump chamber 123 can be omitted. In this case the lower diaphragm 186 need not be provided with the further frusto-conical extension 186e and the second opening 174 into the outlet 144 can also be omitted. Alternatively liquid can be dispensed through both the first and secondary pump chambers. If the same liquid is dispensed through the two chambers, this would enable a given dispenser to deliver a greater volume of liquid on each actuation without increasing the stroke. This may require the insert to be modified to fluidly connect the dip tube to both the first and secondary changes via an inlet valve. Alternatively, the dispenser could be modified to enable different liquids to be dispensed through the two pump chambers by fluidly connecting each chamber to a different liquid supply. For example, the container 112 can be divided into two by means of an internal wall with a dip tube 180 extending into each part. In this configuration, the insert 116 would be modified so as to fluidly connect one dip tube to the first pump chamber 122 and the other to the secondary pump chamber 123 and to form an inlet valve for each dip tube. Where the dispenser has two chambers to dispense two liquids they can be mixed in the nozzle or they can be directed through separate outlets to be mixed in the air externally of the dispenser nozzle.

Figures 10 and 11 illustrate embodiments of a dispenser 310, 410 having only a single pump chamber 122. The flexible insert 116 in this embodiment is similar to that described above in relation to Figures 6 and 7 in that it is held in the neck region 120 of the container by a series of fins 188 and the inlet valve 185 to the pump is in the form of a duck or fart valve. Because this embodiment does not have a secondary pump chamber, the further frusto-conical extension 186e of the flexible insert 116 is omitted.

A further modified embodiment of the dispenser 510 is illustrated in Figure 12. This embodiment is similar to that described above in relation to Figures 6 and 7 and comprises a duck or fart type inlet valve 185 to the first pump chamber 122. A further modification involves the method of attaching the upper diaphragm portion 184 to the cap 114. Rather than having a semi-circular seal 184c engaging in a groove 160 as in previous embodiments, the upper diaphragm portion 184 has region of increased thickness 184d at the junction between the frusto-conical region 184a and the tubular portion 184b which extends between and is held in recesses between the inner and outer annular walls 150, 152 of the cap. Openings 194 are provided through the inner wall 150 through which the liquid can flow into the annular channel 154 between the inner and outer walls. The tubular region 184b of the insert functions as an outlet valve and is resiliently biased into contact with the inner annular wall 150 to close the flow path through the openings. When the pump dispenser is actuated, the increasing pressure of the fluid in the first chamber acts on the inner surface of the tubular region 184b. When the pressure of the fluid reaches a pre-determined value, it deflects the tubular region 184b away from the inner annular wall to allow fluid to pass from the first pump chamber into the channel 154 and the outlet.

Dispensers in accordance with the invention can be adapted for use as dosing dispensers by varying the size the pump chamber or chambers to control the discharge or dose of liquid dispensed on each actuation. Dosing dispensers can have many applications including dispensing of pharmaceuticals. A dosing dispenser may include a second chamber for mixing air with the liquid or dispensing two liquids. The volume of the second chamber can also be fixed to provide a dual dispensing pump.

Whilst is its preferred that the inlet and outlet valves for the pump chamber or chambers comprise resiliently flexible valve members formed integrally as part of the insert 116, alternative valve arrangements can be used. For example any of the valves could be replaced by a valve insert, which may comprise a ball type valve for example.

The outlet 144 of the dispenser can be modified in a variety of ways depending on the type of fluid being dispensed. Where the fluid is to be dispensed as a foam, for example, a filter mesh can be incorporated into the outlet. Figure 13 illustrates an embodiment of a dispenser 610 which is adapted to dispense a mixture of air and a liquid product as a foam.

The dispenser 610 in Figure 13 is similar to the dispenser 110 described above with reference to Figures 1 to 7 and comprises an insert 116 which defines a first pump chamber 122 for dispensing a liquid product from a container and a secondary pump chamber 123 for dispensing air to be mixed with the liquid product in the outlet 144. In this embodiment, the outlet 144 comprises an elongate spout having a large diameter outlet passage 146 surrounding an atomizing or spray outlet 145 through which the liquid product is sprayed into the passage 146 from the first pump chamber 122. The air from the secondary chamber 122 is introduced directly into the outlet passage 146 from the secondary pump chamber though an air outlet passage 174 where it mixes with the liquid product to produce a foam. Means for refining the foam can be included in the outlet passage 146. This might include one or more mesh filter screens as is well known in the art. However, in the present embodiment, a plug 210 of open celled foam or another suitable three dimensional mesh structure is located in the outlet passage 146. For convenience, the plug 210 may be held in an insert 212 which locates in an outer end of the outlet passage 146 as shown or it may be located directly in the outlet passage.

The dispenser 610 as shown in Figure 13 is otherwise constructed and operated in a similar way to the dispenser 110 in Figures 1 to 7 described above. The main differences being the way in which the upper diaphragm 184 is located within the cap 114 and the air release arrangements.

In the present embodiment, the upper diaphragm 114 of the flexible insert has a flange 184d which is received in the annular gap 154 between two spaced annular walls 150, 152 which project inwardly from the upper surface of the cap 114. The inner annular wall 150 and the flange 184d have inter-engaging formations 184e, 150a which lock the flange 184d in position. An outer lip seal 184f engages with inner surface of the side wall of the cap to define together with the lower diaphragm 186 and the side wall of the cap 114 the secondary air chamber 123. Part 184g of the lip seal 184f adjacent the air outlet passage 174 acts as an outlet valve for the secondary chamber and can be deflected inwardly away from the wall to allow air to enter the air outlet passage 174 when the dispenser is actuated. The lower diaphragm has a seal 186e which engages the wall of the cap to seal the lower end of the secondary chamber. As with the embodiment shown in Figures 1 to 7 and described above, the seal 186e acts as a one way valve to admit atmospheric air into the secondary chamber 123 when the cap 114 recovers to the rest position after each actuation.

A second lip seal 184h on the upper diaphragm 184 engages with an upper surface of the cap 114 to define the first liquid pump chamber 122 between the upper diaphragm 184 and the upper surface of the cap. At least part 184i of the second lip seal 184h adjacent the liquid outlet passage 172 acts as a pre-compression valve to control the release of liquid from the first pump chamber 122 when the pump is actuated. When the cap 114 is depressed, the pressure of the liquid in the first pump chamber 122 is increased. The increasing pressure of the liquid in the first pump chamber acts on the second lip seal 184h causing at least the portion 184i to deflect away from the cap to allow the liquid to enter the passage 172 when the pressure of the liquid reaches a predetermined desired value. In this embodiment, the inlet valve for the first pump chamber 185 is in the form of a duck bill or fart type valve.

Although the liquid in the first pump chamber is incompressible, in practice there will usually be a small quantity of air in the chamber as a result of the dead space left when the insert 116 is fully deformed. The presence of some air in the first chamber enables the insert to deform slightly compressing the second chamber 123 and pressurising the air inside by a limited amount. However, the pressure of the air in the secondary chamber 123 will not be raised significantly before the outlet valve for the liquid chamber 122 opens. Consequently, air from the air chamber 123 will be delivered to the outlet passage at a pressure which is only slightly above atmospheric and the outlet valve 184g for the air chamber can be configured to open at the same time as or just before or just after the outlet valve 184i.

Typically the dispenser 610 will deliver the air and liquid at a ratio in the range of 6:1 to 10:1 by volume. If necessary, the volume of the air chamber 123 can be increased by making the diameter of the cap larger than is shown and the cap may have a diameter which is significantly larger than that of the neck region 120.

In some circumstances, it may be desirable to raise the pressure of the air in the air chamber 123 above atmospheric. In this case, the dispenser can be modified to enable the volume of the air chamber 123 to be reduced before the liquid chamber outlet valve 184i opens. This can be achieved in a number of ways. For example a balloon or other compressible body containing a gas may be located within the liquid chamber. When the dispenser is actuated, the balloon or body will compress initially to allow the cap to move relative to the neck 120 so that the volume of the air chamber is reduced and the air pressure increased before the pressure of the liquid in the first chamber 122 is raised.

In the present embodiment, there is no opening 134 through the neck 120 to admit air into the container. Rather a small air passage (not shown) is provided between the flexible insert 116 and the inner surface of the neck through which air can be admitted into the container. The passage may be open all the time or the insert may be configured so that a passage is formed when the pressure in the container is below atmospheric. This arrangement can be adopted in any of the embodiments described in the application instead of the air hole 134.

In the present embodiment, a central region 156 of the upper surface of the cap 114 is indented and shaped like a dome. This is to reduce the amount of dead space in the first chamber 122 as the upper diaphragm 184 of the insert enters and conforms closely to the shape of the domed region when the cap 114 is fully depressed.

The use of a plug 210 of open celled foam in the outlet passage 146 is a convenient way of refining the foam but is not always as effective as a series of separate screens, in which foam is re-formed after passing through one screen and is then passed through another screen to be further refined. This is particularly true where the fluid is of a higher viscosity. Figures 14a to 15b illustrate modified plugs 210', 210'' which each have two enlarged cavities or gaps 214 spaced along its length. The gaps 214 are positioned so that they extend across at least a central third region of the cross sectional area of the plugs through which a majority of the liquid/foam passing through the plug will flow. The gaps 214 divide the pug in to separate portions along its length and act like the spaces between screens so that foam is formed in each of the gaps which is then further refined as it is pushed through the following section of the plug. In the plug 210' as shown in Figures14a and 14b, the two gaps extend from opposite sides of the plug across the central region. In the plug 214'' shown in Figures 15a and 15b, gaps are formed so as to extend only across a central region through which the majority of the foam will pass. The number and shape of the gaps 214 can be varied to suite the application. The modified plugs 210', 210'' are inexpensive to manufacture and can be easily inserted into the outlet passage but have been found to highly effective.

The modified plugs 210', 210'' are not limited to use with dispensers in accordance with the invention but could be adopted for use with any suitable foam dispensers. Accordingly, patent protection may be sort for this concept independently of any other inventive concept and/or any of the embodiments disclosed in this application.

A good alternative to the foam plug is to use one or more meshes and this is commonly used with foamers with 2 meshes in series being ideal. The problem as always is cost. Our solution is to use an insert pushed into the spout that uses one mesh that is bent in a shape like a V or a U shape or similar that causes the liquor to pass through the mesh twice. The mesh can be moulded or attached to a plastic frame that ensures it stays in place and the liquor cannot get around the mesh.

In known foam dispensers, liquid is introduced into a foaming chamber though simple holes which produce jets. This has been found to produce only low quality foam. In present embodiment, the dispenser 610 is configured so that the liquid is sprayed into the passage 146 through a nozzle 145 onto the foam plug 210. Air is introduced separately into the passage 146 where it mixes with the liquid to produce a foam. The region of the passage 146 between the nozzle 145 and the plug 210 can be considered an expansion or foaming chamber. Because the air is mixed with the liquid downstream of the nozzle 145 where the pressure of the liquid is reduced, the air does not have to be raised to the same pressure in the secondary chamber as the liquid in the first pump chamber. This helps to keep the activation force required to operate the dispenser low. In one embodiment, the spray nozzle 145 is configured to produce a cone spray and is be preceded by a swirl or vortex chamber. However, in some applications where the liquid is viscous and/or where there is insufficient distance between the nozzle and the screen or plug filter, a conical spray may not be formed and the liquid will jet through the nozzle adversely affecting the quality of the foam produced and may, in certain circumstances, prevent any foaming from taking place. In order to address this problem, it has been found that good quality foam can be produced by using one or more fan jets to produce a fan shaped spray rather than a cone shaped spray. This has been found to effect with viscous fluids or in other circumstances where a cone shaped spray could not be formed. The fan jet nozzle may be in the form of an elongate or eye-shaped orifice.

In a further alternative arrangement, a flood jet nozzle is used to create a sheet of liquid in the expansion chamber or passage 146 rather than a spray. This has also been found to be effect in producing high quality sprays, in particular with viscous liquids. Figures 16a and 16b illustrate one embodiment of a flood jet nozzle which is being used in combination with a modified plug 210' of expanded foam. In this embodiment, the liquid is introduced into the foaming chamber 216 in the outlet passage 146 through a lateral opening 218 in the passageway and is directed on to a curved ramp 220 which turns the direction of movement of liquid through an angle so that it is directed on to the plug 210'. The ramp 220 may turn the liquid through an angle of approximately 90° but the angle could be anywhere between 60° and 120°. This creates a fan shaped sheet of liquid, which in the present embodiment is aligned substantially vertically when the dispenser is upright. The ramp 220 may have side walls to prevent the fan spreading and could be formed as a groove in the end wall region 222. The width of the ramp is selected as appropriate for any particular application. The lateral opening 218 and the ramp 220 are positioned substantially centrally along a diameter of the circular end wall 222. Air is introduced into the chamber 216 through a series of orifices 224 in an axial direction through the end wall 222 of the passage to mix with the liquid but the air can be introduced in any direction and in any suitable position. The surface of the ramp 220 may be smooth or it may be shaped or textured, as illustrated at 226 in Figure 17, to break up the fan of liquid. In a further alternative the ramp 220 could be constructed so that it moves when the liquid impacts on it to break up the fan. The dispenser outlet could be provided with more than one liquid inlet 218 and ramp 220. A further alternative embodiment is illustrated in Figure 18 in which the liquid is introduced into the chamber 216 though an inlet passage 228 which is aligned axially with the passage 146 and the ramp 220 is arranged to direct the fan on to a side wall of the passage 146 so that it is deflected off the wall onto the plug 210'.

The above embodiments all produce a fan shaped sheet of liquid. Figures 19a and 19b illustrate an embodiment in which the flood jet nozzle 145' is arranged to produce a conical sheet of liquid. In this embodiment, the liquid flow passage 172 from the pump chamber has conically divergent outlet region 248 through which the liquid flows into the outlet passage 146 of the dispenser. A flow divider 250 is suspended centrally within the conically divergent outlet region 248 by means of three links 252. The flow divider has a conical region 254 which locates within the divergent outlet region 248 so that the outer surface of the conical region 254 is spaced from the surface of the passage to define an annular frusto-conical passage 256 about the divider through which the liquid flows to enter the outlet passage 146. The outer end of the flow divider is hemispherical in this embodiment but can be any suitable shape. The liquid flowing through the annular frusto-conical passage 256 about the divider passes through the gaps between the links 252 to form a generally conical sheet of liquid in the outlet passage 146 which is directed on to a plug 210, 210', 201'', which can be of any of the types described above. The plug 210 can be replaced by any other suitable screen or filter for refining the foam. Air is introduced separately into the passage 146 to mix with the liquid by any suitable means including any of those described above in relation to Figures 16 to 18. This arrangement differs from a cone spray nozzle as the liquid is not formed into a spray as it passes through the jet nozzle put forms a conical sheet of liquid. This has been found to be particularly effective at producing good quality foams with viscous liquids which are unsuitable for producing a conical spray in the outlet of a foam dispenser of the types used to dispense consumer products.

A problem with flood jet nozzles is that they produce a very wide angle of 120 degrees upwards and this is often too wide inside the actuator for foam production as it makes too much of the spray hit the side of the chamber rather than the mesh or foam pad and this produces an inferior foam. The flood jets like shown in figure 17 at 226 are open sided because if you put sides there they cause the curved area to fill with liquor and this ruins the spray. Our answer for some of the applications is to add sides that are angled or curved forwards so the ends of the spray are deflected forwards at the mesh. They can also be shaped so they cause part of the spray to deflect up or down as well so more of the mesh or filter plug is struck. The spray isn't as consistent as normal but it is acceptable for producing a good foam quality. Very thin sheets of plastic can also be added to the top and side edges of the nozzle where the last contact is made between the nozzle and the liquor and these are made to move by the liquor acting upon them and this causes the spray to also move and to hit much more of the surface of the mesh improving the foam quality. This can be done in practice by making the plastic very thin in these places.

Flood jet nozzles which produce a sheet of liquid rather than a spray or a simple circular jet can be advantageously used in any suitable type of foam dispenser and their use is not limited to the embodiments disclosed in the present application. Accordingly, patent protection for this concept may be sought independently of any other inventive concepts disclosed and/or claimed in this application.

A particular problem with foam dispenser is the tendency for material left in the outlet passage to continue to foam for a period after each actuation. This can lead to a bead of foam forming at the outlet or with the residue being expelled when the dispenser is next used, neither of which is desirable. It has been found that this problem can be overcome or reduced by drawing some or all of the residue back into the liquid pump chamber together with some air from the outlet passage. To achieve this, the outlet valve from the liquid dispenser is configured so that it does not fully seal the outlet of the liquid chamber, at least during an initial part of the recovery phase, so that the residue is drawn back into the chamber as it recovers. The amount of residue and air drawn into the chamber in this way is small in comparison with the total liquid which drawn into the liquid chamber through the inlet. This arrangement can advantageously be used in any suitable type of foam dispenser and its use is not limited to the embodiments disclosed in the present application. Accordingly, patent protection for this concept may be sought independently of any other inventive concepts disclosed and/or claimed in this application.

For various reasons, many liquid products are now being supplied in a concentrated form that has low water content. This can be desirable as the overall volume of liquid supplied is reduced which enables smaller containers to be used reducing packaging, storage and transport costs and waste. A problem with this approach is that the concentrated liquids are difficult to foam. Adding water to the liquids prior to dispensing improves the quality of the foam that can be produced but is impractical with conventional dispensers. Figure 20 illustrates a further embodiment of a dispenser 710 which is adapted to provide a solution to this problem.

The dispenser 710 as shown in Figure 20 is essentially the same as the dispenser 610 in Figure 13 and comprises an actuator cap 114, a flexible insert 116 and a base 112. In this embodiment, the base is in the form of an adaptor having a screw thread for attachment to the neck of a container. The insert 116 defines a first liquid pump chamber 122 between itself and a wall 258 of the cap and an inlet valve 185 through which a concentrated liquid product can be introduced into the chamber from the container. A dip tube will normally be mounted to the insert as with previous embodiments but is omitted from Figure 20. An outlet passage 172 connects the liquid chamber 122 with a nozzle 145 and the main outlet passage 146 of the dispenser in which a modified plug 210' is located. A lip seal 184h on the upper diaphragm 184 of the insert controls the flow of liquid from the chamber 122 to the outlet passage in a manner similar to that described above in relation to the previous embodiments. An air chamber 123 is defined between a side wall of the cap 114 and the upper and lower diaphragms 184, 186 and is connected with the outlet passage 146 by means of a further passage 174 and an outlet valve 184g. As so far described, the dispenser 710 in Figure 20 is essentially the same as and operates in a similar manner to the foam dispenser 610 shown in Figure 13. However, the dispenser 710 in Figure 20 differs from the earlier embodiments in that it is provided with a refillable fluid reservoir 260 which is defined in an upper region of the cap above the wall 258. A removable closure 262 is mounted to the cap 114 to close the reservoir. The closure is a clip fit on the cap and can be removed to enable the reservoir to be filled with water.

A fluid passage 264 is formed through the wall 258 to fluidly connect the reservoir 260 with the liquid pump chamber. A resiliently flexible one way valve member 266 is mounted to the wall 258 and is configured to allow water to be drawn from the reservoir into the liquid chamber through the passage 264 when the pressure in the chamber falls below atmospheric during the recovery phase. The valve 266 closes the passage 264 to prevent liquid flowing from the chamber 122 into the reservoir 260 when the liquid in the chamber is pressurised during the delivery phase of actuation. This allows an amount of water to be drawn into the liquid chamber 122 to mix with and dilute the liquid product drawn from the container as the chamber 122 recovers after each actuation. The ratio of liquid product to water drawn into the chamber 122 is determined by the relative cross section areas of inlets 185, 264 into to the chamber 122 from the container and the reservoir and will be selected as appropriate to the application. Typically in a foam dispenser a ratio in the region of 3:1 of product to water is expected but the ratio could be anything up to 1:1 or in some cases more water may be introduced than liquid product. The reservoir 260 will normally be relatively small and will require re-filling by the user before the container is emptied. This is simply done by removing the closure 262 and filling the reservoir from a tap. This helps to keep the overall size of the dispenser small enabling all the benefits of smaller packaging to be maintained. Alternatively, where re-fill containers of product are supplied for use with a dispenser pump, the reservoir could be dimensioned so that a single filling is sufficient to last for the life of each re-fill. If a further alternative arrangement, the reservoir could be dimensioned to last for the life of the container and can be filled and permanently sealed prior to supply to a user.

In some applications it will be preferable that the water is not introduced into the same pump chamber as the liquid product. In this case an additional pump chamber can be used to pump the water, which is mixed with the liquid product in the outlet. The water and product may be mixed prior to the nozzle 145 or in an expansion chamber downstream of the nozzle. Where there is no requirement for air to be mixed with the liquid, the dispenser can be modified so that one of the first and secondary chambers 122, 123 pumps the water, whilst the other pumps the liquid product.

Whilst the provision of a water reservoir for diluting a concentrated liquid product is particularly beneficial in foam dispensers, it could also have application in other types of manual pump dispensers, including spray dispensers, and in aerosol type dispensers. It should also be noted that the provision of a water reservoir for diluting a concentrated liquid can advantageously be applied in any suitable type of dispenser and its use is not limited to the embodiments disclosed in the present application. Accordingly, patent protection for this concept may be sought independently of any other inventive concepts disclosed and/or claimed in this application.

Figure 21 illustrates a yet further embodiment of a dispenser 810 in accordance with the invention. The dispenser shown in this embodiment can be adapted for use as a foam, spray or any other type of dispenser.

The dispenser 810 shown in Figure 21 is very similar to the dispenser 610 shown in Figure 13 and only certain key differences or features will be described. The container is omitted from Figure 21 which shows only the actuator cap 114 and the insert 116.

An important aspect of the design of dispensers in accordance with the invention is the requirement to hold the upper diaphragm 184 in position within the actuator cap 114. In this embodiment, the upper diaphragm 114 has an upwardly (as shown) directed flange 184d which is received in an annular groove 154 defined between two spaced annular walls 150, 152. The flange 184d is provided with a number of downwardly directed ridges 268 which engage with the walls 150, 152. The flange 184d and the ridges 268 are resiliently flexible and are configured to enable the flange to be easily inserted into the recess 154 but to resist the flange 184d being pulled out of the recess. This provides a simple method of locating the upper diaphragm 184 in the cap which is easy to manufacture and assemble.

Another important aspect of the dispenser is the outlet valve arrangement for the liquid pump chamber 122. In many pump action dispensers it is desirable that the liquid to be dispensed is only released from the pump chamber when it has a reached a pre-determined pressure above atmospheric. This particularly important in spray dispensers where the liquid needs to be forced through the nozzle at a sufficiently high pressure that a good quality spray is produced. If the outlet valve from the liquid pump chamber opens too early at the beginning of the delivery stoke when the pressure of the liquid in the pump chamber is below an optimum operating pressure, the liquid may initially splutter as it passes through the nozzle rather than forming a spray. It is also important that the outlet valve close quickly and cleanly as the pressure of the liquid drops of towards the end of the delivery stroke. In the previous embodiments, the outlet valve for the liquid pump chamber has been provided by means of a resiliently flexible annular or tubular seal portion 184b of the insert which abuts a wall of the cap to close off the flow passage from the chamber 122 to the outlet. The seal portion is resiliently biased into contact with the wall and the pressure of the fluid in the pump chamber acts on the seal portion to deflect it way from the wall and the seal portion is configured so that it moves to open the outlet when the pressure in the chamber reaches a pre-determine value above atmospheric for the application. In the previous embodiments, the seal portion 184b has been arranged to make surface to surface contact with the wall. Whilst the arrangement works well, it has been found that a more reliable operation of the vale is achieved if the seal portion 184b makes contact with the wall along a line which is close to the free end of the seal portion.

In the embodiment shown in Figure 21, the main, and in this case the liquid chamber, 122 is defined between the upper diaphragm 184 and a conical projection 270 on the inner surface of the upper part of the cap 114. The projection 270 is located inside and spaced from the inner annular wall 150 so that an annular outlet channel 272 is formed about the projection which is in fluid connection with the outlet of the dispenser by means of a fluid passage 172. Openings 194 are provided though an edge of the projection through which liquid can flow from the chamber 122 into the annular outlet channel 272 and hence into the outlet passage 172. The flow of liquid through the openings 194 is controlled by a resiliently flexible annular seal member 184b of the insert which locates in the channel 272 so that in its initial resiliently biased configuration a free end of the seal member contacts the outer surface of the projection at a position above the openings 194. With the seal member in contact with the projection, the flow path through the openings 194 into the channel is closed. When the dispenser is actuated to compress the chamber 122, the liquid pressure in the chamber acts on the inner surface of the seal member 184b tending to deform the seal member outwardly against its inherent resilience. The seal member 184b is configured so that it is only deflected far enough to open a flow path when the pressure of the liquid in the chamber 122 reaches a pre-determined value.

As discussed above, it can be advantageous if the seal member only contacts the surface on which it seals at or close to its free end. In the present embodiment, this is facilitated by the angled outer surface of the conical projection 270. However, this could also be achieved by angling the seal member 184b only or by angling both the surface and the seal member. The effectiveness of the seal is further enhanced by providing a resiliently compressible enlargement or ring 274 at the free end of the seal member. The ring 274 acts like an o-ring seal making line contact with the outer surface of the projection. This facilitates quick and clean opening and closing of the valve. In addition, the compressibility of the ring 274 enables the seal member to deflect outwardly over a limited range before the seal is broken. This enables the seal member 184b to be configured to open at a set pressure more reliably than with a surface to surface contact. This principle will be described with reference to Figures 22a – 22c which show a similarly constructed seal member 184b which is used to control the flow of a liquid though an outlet 276 from a pimp chamber 122 into an outlet passage 172.

Figure 22a shows the seal member 184b in its initial resiliently biased condition when the fluid pressure in the chamber 122 as at atmospheric. In this condition, the ring 274 is biased into contact with a wall 278 of the cap and the flow path through the outlet 276 to the passageway 172 is closed. The ring 274 in this state is compressed. In Figure 22b, the liquid in the chamber is pressurised but is below the optimum operating pressure at which the seal member 184b is configured to open. The fluid pressure acting on the seal member 184b has deflected part of the seal member away from the wall but the ring 274 is partially expanded from its initially compressed condition so that it remains in contact with the wall to close the flow path. Figure 22c shows the seal in an open position after the liquid in the chamber 122 has reached the pre-determined operating pressure. The seal member is deflected sufficiently that the ring is lifted of the wall 278 to open a flow path through the outlet 276 into the passage 172. Because the ring 274 enables the seal member 184b to move by a limited amount before the valve opens, it facilitates configuration of the valve to reliably open and close at the pre-determined pressure.

It is preferred that the enlargement 272 has a curved profile which contacts the wall 278 so that it acts like an o-ring to provide a point or line contact between the seal and the wall but this is not essential.

This seal arrangement can be adopted in many different types of dispenser and is not limited to use in the embodiments disclosed in the present application.

Accordingly, patent protection for these seal arrangements may be sought independently of any other inventive concepts disclosed and/or claimed in this application.

Many pump dispenser outlets include a spout 144 which projects from the main body of the actuator cap 114 or body. In dispensers that require various features to be incorporated in the outlet, the spout may be longer than is ideally desired. This is particularly the case for foam dispensers in which a spray nozzle and a filter arrangement such as the plug 210 or mesh screens have to be accommodated in the outlet passage. The presence of a projecting spout increases the tool space required to produce an actuator cap, which adds considerably to the costs of manufacture. In the field of mass produced dispensers, cost is of paramount importance. Figure 23 illustrates a further embodiment 910 of a dispenser in which this problem is addressed.

The dispenser 910 in Figure 23 is essentially the same as the dispenser 810 as shown in Figure 21 except that the outlet passage 146 is located within the main body of the cap 114 above the first pump chamber 122 and the insert. The outlet passage 146 is fed from the first chamber 122 by a fluid flow passage 172 which enters the outlet passage through the rear end. An air flow passage also connects the secondary chamber 123 to the outlet passage 146 but is not shown in the drawings. Where the dispenser 910 is for use in a foam dispenser, a plug filter 210, 210', 210'' or other filter arrangement can be located in the outlet passage 146 and the liquid introduced into the passage 146 by means of a spray or flood jet nozzle as discussed in relation to the embodiment shown in Figure 20.

In the dispenser 910 as shown in Figure 23, the entire outlet passage is located with the diametrical extent of the main body portion of the cap so that no projecting spout is required. This is ideal as it means that the tooling space required to mould the cap is kept to a minimum. However, in some cases it may only be possible to accommodate part of the outlet passage in the cap above the pump chambers so that a small spout will be required. This is still advantageous as the length of the spout is reduced, thus reducing the required tooling space. Nevertheless, it is preferred that at least 75% or more preferably 85% of the outlet passage 146 is located within the main body of the cap (that is to say within the diametrical extent of the cap).

The concept of locating all or the majority of the outlet passage 146 within the diametrical extent of the main body of the cap 114 in order to eliminate the need for a spout or to reduce the length of the spout can be applied to the design of any pump action or aerosol dispenser and is not limited to use with the embodiments disclosed in this application. Accordingly, patent protection for the arrangement may be sought independently of any other inventive concepts disclosed and/or claimed in this application.

Where dispensers in accordance with the invention are arranged to dispense two liquids, it may be desirable in some cases to keep the liquids separate so that they are only mixed when they leave the final outlet or near the outlet end of the outlet passage. This can be achieved by dividing the outlet passage 146 in two parts by means of a dividing wall and feeding the liquids from the two chambers in to the different parts or by providing two separate outlet passage for each liquid. The divided parts or the two outlet passages may be arranged one on top of the other or side by side. The divided or dual outlet passage could be formed in a spout or mainly located above the pump chambers within the diametrical extent of the cap as discussed above in relation to Figure 23.

In the previously described embodiments, the insert 116 as been designed for use with a dip tube formed integrally with the container or which is a separate component. Figure 24 illustrates how the insert 116 can be modified to incorporate an integral dip tube 180. This is advantageous as it means the insert and dip tube can be moulded together as a single integral component reducing manufacturing and assembly costs.

The insert 116 can also be modified to incorporate other features. In the embodiment shown in Figure 25, rather than a dip tube 180, the insert includes an integral flexible bag 280 which can be filled with a liquid to be dispensed. In use, the bag is located within an outer container. An air bleed will allow atmospheric air to enter the container around the bag so that the bag collapses as liquid is drawn in the pump chamber 122. This arrangement is advantageous as it prevents liquid from leaking out between the container and the insert.

Figure 26 shows an insert for use with a dispenser configured to dispense two different fluids. The insert 116 has an integral dip tube 180 which fluidly connects with the first pump chamber 122. The dip tube is surrounded by an integral flexible bag 280. As shown, the lower end of the bag is opened and in use the insert is inverted and the bag filled with a first liquid. The free end of the bag 280 is then sealed about the dip tube 180. The insert 116 is then located in a container which holds a second liquid. The second liquid is drawn into the first pump chamber 122 through the dip tube 180 whilst the first liquid is drawn from the bag into the secondary chamber 123 through a flow passage and one way valve which are not shown in the drawing. In this embodiment, the free end of the dip tube 180 is closed and a small slit is provided through with liquid enters the dip tube from the container. This enables a volume of liquid to be retained within the dip tube so that the dispenser can be actuated when inverted. The dip tube can be made larger than standard so that it can hold a sufficient volume of liquid for several actuations. This type of dip tube can be used in any of the embodiments disclosed.

As discussed previously, the insert 116 can be moulded from a material which remains resiliently flexible such as TPV, TPE, PP, silicon or the like or it can be manufactured from a combination of rigid and flexible materials using bi-injection moulding techniques. In the latter case, an integral dip tube could be formed from a rigid material and a flexible bag formed from a combination of flexible and rigid materials. For example, the side walls of the bag could be produced from a flexible material and the end from a rigid material. A bag or dip tube can also be shaped to improve its flexibility by being pleated or the like. Where more than one liquid is to be dispensed from a container, two or more integral dip tubes can be provided on an insert.

The insert 116 in the embodiments described above is a simple push fit in the neck 120 of the container 112. This arrangement is easy to manufacture and assemble. However, one potential drawback of this arrangement is the possibility of the insert pulling out of the neck if the dispenser is mistreated or subject to reduced or negative ambient pressure. Another problem is the need to prevent liquid leaking out between the insert and neck whilst allowing air to enter the container to prevent it collapsing as the liquid in the container is used up. These issues arise not only in respect of the insert 116 but apply to any pump dispenser arrangement which is a push fit in the neck of a container.

One method of preventing the insert or other push fit pump from being drawn out of the neck of a container is to use a collar which is mounted by means of a screw thread, or other suitable arrangement, on to the neck of the container to hold the insert 116 or other push fit pump in place. Where a twist lock arrangement is required to prevent unintentional actuation of the dispenser, corresponding formations for the twist lock can be provided on the collar and the actuator cap. Whilst a collar is effective in holding an insert or pump in position it does not specifically address the issue of preventing leakage whilst allowing air to enter the container and it requires the use of an additional component.

Figures 27 and 28 illustrate a further embodiment of a dispenser 1010 which has a modified twist lock arrangement designed to overcome the above mentioned potential problems.

In the dispenser 1010, the container 112 has a neck region 120 which includes a smaller diameter flange 282 projecting from the free end of the neck with an overhanging external lip 284 at the end of the flange. The lower diaphragm 186 of the insert 116 has an additional portion 286 that locates over collar and engages under the lip. A small ridge 288 extends about an outer diameter of the lower diaphragm. The side wall of the cap has a thickened lower section 289 and a ramp 290 between a thinner upper section 291 and the thickened lower section.

The free end of the side wall of the cap has an inwardly directed flange 138 which engages over a pair of spaced, generally circumferentially extending ridge formations 124 on the outer surface of the neck to prevent the cap from being separated from the container. The cap 114 is sufficiently flexible that the flange 138 can be pushed over the ridge formations 124 on assembly. Corresponding stops (not shown) on the neck 120 and cap 114 enable the cap to be rotated between a locked position and an unlocked position. In the locked position, further corresponding stops (not shown) on the neck and cap prevent the cap from being depressed to actuate the dispenser whereas in the unlocked position, the cap can be fully depressed. The ridge formations 124 on the neck are angled slightly so that the actuator cap 114 is moved axially in a downward direction relative to the neck 120 when it is moved to the unlocked position from the locked position.

When the cap 114 is in the upper locked position, the ridge 288 on the lower diaphragm is located opposite the lower thickened 289 region of the cap and the insert is pressed into contact with the lip to form an air and liquid tight seal. The flexible insert 116 is also firmly clamped in position in the container.

When the cap is moved to the unlocked position, it rotates the insert but also moves downwardly relative to the insert so that ridge 288 is located adjacent the ramp 290 or the thinner part of the cap wall 291. In this position, the flexible insert is no longer clamped to the lip 284 and air is able to pass along a channel 292 in the thicker wall section 289 of the cap and between the insert and the lip 284 as indicated by the arrow A in Figure 28 to enter the container 112. A seal 186d on the insert contacts an inner surface of the container neck to prevent liquid from passing out but allows air to pass inwardly.

Figure 28 shows the dispenser with the cap 114 in the locked position but the arrow A is included to show the flow path which is created when the cap is moved to the unlocked position.

The modified twist lock arrangement solves the problems of holding the insert 116 in position and preventing leakage without requiring the use of an additional component. This arrangement can be adopted for any suitable dispenser having a push fit pump arrangement and patent protection for this concept may be sought independently of any other inventive concepts disclosed and/or claimed in this application.

In all the embodiments described above, the cap 114 can be formed integrally with to the container but this is not essential and the container and cap can be formed separately. However, in certain applications it may be desirable to provide a pump dispenser separately from the container. Many advantages of the dispenser in accordance with the invention can still be achieved in this way. The insert 116 and cap 114 can be adapted to be mounted to a separate container having a suitably adapted neck region. Alternatively, an adaptor can be provided to enable the cap and insert to be mounted to a container having a standard neck region. In this case, the adaptor will form the base part 112 of the dispenser pump and will be comprise suitable means for mounting to the neck region of the container such as a screw thread or other twist fit arrangement, for example.

Figure 29 illustrates an embodiment of a dispenser 1110 in which the actuator cap 114 is mounted to an adaptor 291 having a screw thread 291a for mounting to a container.

In some applications where there is no requirement to mix air with the liquid being dispensed it is possible to use both the first and second chambers to dispense the same liquid. This has the advantage of increasing the volume of liquid dispensed with each actuation. This can be done by providing separate inlets and outlets for each of the chambers as discussed previously. However, in this embodiment shown in Figure 29, an alternative arrangement is used which requires only a single inlet and outlet for both chambers. This is achieved by use of a modified insert 116 which has openings 184j fluidly connecting the first and second chambers 122, 123. During the recovery phase after each actuation, liquid is drawn into the first chamber 122 through the inlet 185 is the usually way but the liquid flows through the openings 184j into the second chamber so that both chambers are filled. When the cap is depressed to actuate the dispenser, both chambers are compressed and the liquid flows from both chambers to the outlet.

Dispensers in accordance with the invention can be modified to incorporate a trigger actuator. This can be achieved by adding hinge formations to the neck region 120 of the container and providing a separate trigger actuator which is assembled to the hinge formations and which fits over the cap 114. The actuator may have an opening through which the outlet 144 projects.

Alternatively, the cap 114 can be modified to incorporate an integral trigger actuator as illustrated in Figure 30. In this embodiment, the dispenser 1210 includes one or more hook like portions 196 moulded onto one side of the neck region 120 of the container. The cap 114 is provided with corresponding rod sections 198 which engage in the hooks 196 to form a hinge about which the cap 114 pivots. The cap 114 has a trigger portion 200 which can be gripped by a user to actuate the dispenser. In the embodiment shown in Figure 30, the dispenser has only a single pump chamber which is formed between the upper diaphragm portion 184 of the insert and the collar 148 of the cap. However, any of the embodiments described in the present application can be modified to incorporate a trigger actuator, including the dispensers with two pump chambers.

Figures 31 to 33 illustrate an alternative embodiment of a dispenser 1310 in accordance with the invention which is adapted to incorporate a trigger actuator.

The dispenser 1310 comprises a container 300 having an open neck region 302, a dispenser cap 304 mounted to the container and an insert 306. The dispenser cap comprises a body having a cylindrical chamber portion 308, an outlet spout portion 310 and a neck engaging portion 312. The neck engaging portion is adapted to be a push fit on the open neck region 302 of the container and has an annular abutment 314 which engages in a groove 316 formed in the outer surface of the neck region to hold the cap firmly on the container.

The flexible insert 306 has a resiliently flexible upper diaphragm 184 which defines a first pump chamber 122 between itself and a domed upper wall 318 of the cap within the cylindrical chamber portion 308. A second, lower diaphragm or flange 186 of the insert seals against the side wall 320 of the cylindrical portion 308 of the cap to define a second chamber 123 between the side wall and the upper and lower diaphragms 184, 186. The insert 306 also includes a tubular portion 322 which connects the upper and lower diaphragms with a flexible cover 324 which mounts over and closes the open end of the neck of the container.

The cover 324 is in the form of a flexible inverted dome and has a flange 326 on its outer diameter which locates over the rim of the neck and is received in a recess 328 in the neck engaging portion of the cap so as to close and seal the neck region. A leak valve arrangement (not shown) is provided to enable air to enter the container as the liquid in the container is used up, to prevent the container from collapsing. The tubular portion 322 extends from a position above the lower diaphragm 186 into a central region of the cover 324 where it is in fluid communication which a dip tube 182 which extends into the container. The dip tube 182 may be a separate component or it may be formed integrally with the insert or integrally with the container.

The insert 306 is formed from a combination of flexible and rigid materials using bi-injection moulding techniques. The tubular portion 322 is formed from a substantially rigid material. An annular disc 330 of rigid material also projects outwardly from the tubular portion to provide a base for the lower diaphragm 186 and an actuation surface for contact by a trigger actuator 332. A first region of flexible material is over moulded on to an upper region of the tubular portion to define the upper and lower diaphragms 184, 186. The flexible material also forms a seal 334 for the lower diaphragm and various valve members for the chambers as will be described below. A further region of flexible material is over moulded on to the lower end of the tubular portion to define the cover 324.

At an upper end of the tubular portion 322, part of side wall is omitted and an inlet 336 into the second chamber 123 is formed through the flexible material as shown in Figure 30. The inlet 336 is in the form of a slit which opens to admit liquid into the second chamber 123 when the pressure in the second chamber is below atmospheric but which is closed when the pressure in the chamber is above atmospheric so as to act as a one way inlet valve. Liquid can be drawn into the second chamber 123 from the container through the dip tube 182, the tubular portion 322 and the inlet 336.

The upper diaphragm 184 is held in position adjacent an upper end of the cylindrical chamber portion 308 by means of a flange 184d which locates in an annular recess or groove 154 in the cap, in a manner similar to the diaphragm 184 in the embodiment described above in relation to Figure 21. The upper diaphragm also comprises an annular flexible valve member 184g which forms a ring valve to control the release of liquid from the second chamber 123 into an outlet passage 174. The valve member may be constructed in the manner described above in relation to the embodiment shown in Figure 21.

An air inlet 338 for the first chamber 122 is provided in the upper wall 318. A resiliently flexible valve member 184j formed as an integral part of the upper diaphragm is positioned over the inner opening of the inlet 338 and acts as a one-way valve to admit air into the chamber when the pressure inside falls below atmospheric and to close the inlet when the dispenser is actuated and the pressure inside increases.

The dispenser 1310 is configured to produce a spray and the outlet includes a spray nozzle insert 340 with an atomising nozzle 342 which is mounted at the end of the outlet sprout 310. An air outlet passage 172 from the first chamber 122 passes through the centre of the outlet spout 310. A second insert 344 is located within the first insert 340 and forms an outlet for the air passage 172 to direct centrally into a swirl chamber 346 which is defined between the two inserts. The flow passage 174 from the second chamber 123 passes through the spout and is arranged to direct the liquid into the swirl chamber from the side. The liquid may be directed into the swirl chamber through a flood jet such as that shown in Figures 16a and 16b.

The trigger actuator 322 is pivotally mounted to the cap and comprises a trigger portion 348 and a curved actuating arm 350 that engages with the rigid disc 330 of the lower diaphragm 186. In use the trigger portion 348 is pulled towards the container and the main body of the dispenser, as shown in Figure 33. This movement results in the curved actuating arm 350 pushing on the lower diaphragm 186 to move the insert 306 upwardly (as shown) relative the cap 304 to compress the first and second chambers, and so dispense a charge of liquid. The movement of the insert 306 is accommodated by the flexibility of the cover. When the trigger is released, resilience in the upper diaphragm 184 and/or the cover biases the insert back to the rest position as shown in Figure 30. The curved actuator arm may be bifurcated so as to contact the lower diaphragm 186 on either side of the tubular portion.

As can be seen in Figure 33, when the insert 306 is moved to its uppermost position, the upper diaphragm 184 conforms closely to the profile of the domed wall 318 so that very little dead space remains in the first chamber 122. The upper diaphragm also encases an upper region of the tubular portion so that very little dead space is left in the second chamber 123.

Mixing air with a liquid in a dispenser helps to improve the quality of the spray produced, particularly at the start and end of the spray cycle during which the pressure of the liquid flowing through the outlet nozzle is building up and falling away. It can also be useful to configure the dispenser so that air begins to flow from the air chamber through the nozzle before the liquid flow commences at the start of the spray cycle and that air continues to flow after the liquid has stopped at the end of the spray cycle.

Most prior art dispensers which incorporate an air chamber mix the air with the liquid at a substantially constant ratio throughout the spray cycle. This requires the air to be pressurised to the same pressure as the liquid during the whole of the spray cycle, including periods during the spray cycle when the pressure of the liquid passing through the outlet is at its peak. It also requires a relatively high volume of air meaning that a large air chamber is required. Because of these drawbacks and the additional manufacturing costs involved, air/liquid dispensers have not generally been adopted for mass market dispensers despite the known advantages of mixing air with liquid in terms of the quality of spray produced. However, the applicant has found that dispensers in accordance with the invention can be modified so that a higher ratio of air to liquid is delivered at the outlet nozzle during the initial and end phases of the spray cycle, where the air is most effective at improving the quality of the spray, and a reduced ratio of air to liquid delivered during the remainder of the spray cycle. This reduces the volume of air required which means that a smaller air chamber can be used. In many cases, air will only be delivered from the air chamber to the nozzle during the initial and end phases of the spray cycle where the pressure of liquid is less than its peak value so that the air in the air chamber does not have to be raised to the peak pressure of the liquid.

In order for the dispenser 1310 to deliver air to the nozzle before the liquid flow commences, it is necessary for the air chamber to be compressed before the outlet valve for the liquid chamber opens. However, because liquid is incompressible, this is not possible where one of the chambers is full of liquid. To overcome this problem in the present embodiment, a quantity of air is drawn into the second chamber 123 through the outlet nozzle during the recovery phase. A small bleed hole (not shown but typically in the order of 0.1mm in diameter) is provided in the ring valve 184b through which the air can be admitted into the second chamber 123 from the nozzle as the insert recovers after each actuation. Typically, about 20% of the volume of the second chamber is taken up by air and the remainder by liquid drawn from the container but this can be varied as required.

The presence of air in the second chamber 123 enables the volume of second chamber to be reduced slightly before the outlet valve 184B opens. This in turn enables the insert 306 to move upwardly so that the volume of the first chamber is reduced and air begins to flow from the first chamber to the dispenser outlet 342. There is no outlet valve in the first chamber so that the air is delivered from the first chamber at a relatively low pressure which may be only just above atmospheric. Once the outlet valve 184b of the second chamber 123 opens, a mixture of air and liquid will flow along the passageway 174 to the swirl chamber 345 where it mixes with the air from the first chamber. Once the pressure of the liquid/air mix from the second chamber 123 in the passage 174 and the swirl chamber 345 rises, the flow of air from the first chamber is reduced so that over the main phase of the spray cycle, the majority of the air in the mixture passing through the nozzle 142 comes from the second chamber and the ratio of air to liquid in this phase is reduced. Towards the end of the spray cycle after the outlet valve 184b of the second chamber has closed, the pressure of the liquid/air mixture from the second chamber in the passage 174 and the swirl chamber 345 falls and air will again begin to flow from the first chamber 122 into the swirl chamber 345 where it mixes with the liquid/air mixture from the second chamber to improve the quality of the spray at the end of the cycle. The flow of air from the first chamber 122 at this stage also helps to draw all the liquid out of the outlet passage 174 of the second chamber. The dispenser is arranged so that air continues to flow from the first chamber for a short while after the flow of liquid has stopped to ensure all the liquid is dispensed and to clear our the nozzle 342.

In an alternative arrangement, a one way outlet valve (not shown) can be provided at the swirl chamber end of the outlet passage 172 from the air chamber. The air outlet valve is arranged to open at a lower pressure than the outlet valve of the liquid/air chamber 122 so that the air begins to flow before the liquid/air mix at the beginning of the spray cycle. Once the outlet valve of the second chamber opens, the pressure of the liquid/air mix from the second chamber flowing into the swirl chamber will act on the outside of the valve so as to close the air outlet passage once the pressure of the liquid/air mix increases beyond the pressure of the air in the first chamber. This will take place shortly after the spray cycle has begun. The valve will remain shut until the pressure of the liquid/air mixture from the second chamber falls below that of the air in the air chamber towards the end of the spray cycle. The air outlet valve will then re-open to allow air to flow from the air chamber 122 during the end phase of the spray cycle and for a short period after the flow of liquid through the nozzle has stopped.

By arranging the dispenser so that a higher ratio of air to liquid is delivered to the nozzle at the beginning and end of the spray cycle than during the remainder of the spray cycle, the quality of the spray can be maintained throughout using a lower volume of air than with previous known dispensers and the air need only be raised to a lower pressure which may be just above atmospheric. This means that a smaller volume air chamber can be used and the actuation forces can be kept low. By careful design of the flow rates of the liquid and air, it is possible to configure the dispenser so that it is able to deliver a continuous spray lasting anywhere from 2 to 10 seconds each time the trigger is actuated.

A continuous spray is enabled in part by having a smaller than usual spray orifice to restrict the flow rate of the liquid being dispensed in combination with the addition of air, particularly at the beginning and end of the spray cycle, to ensure that the a good quality spray is produced. The presence of a pre-compression outlet valve from the liquid pump chamber or chambers is also advantageous as this ensures that spraying is commenced when the pressure of the liquid is sufficiently high to create a good quality spray. Ideally the pre-compression valve should be located close to the outlet nozzle to prevent liquid from continuing to flow from the outlet passage when the pressure of the liquid falls. To this end, a pre-compression outlet valve may be located in the outlet passage from the pump chamber to the spray nozzle close to the nozzle. The valve will be configured to only open to allow liquid to be dispensed when the pressure of the liquid at the valve is above a minimum pre-determined value to generate a spray in the particular application.

In some cases it may be desirable to have a mixture of air/liquid in both the chambers 122, 123 or the air could be pumped from the second chamber 123 and a liquid or liquid/air mixture pumped from the first chamber 122.

Figure 34 illustrates an alternative embodiment of a dispenser 1410 which is configured to deliver a higher ratio of air to liquid during the initial and end phases of the spray cycle. The dispenser 1410 is of the type having a movable actuator cap 114 and is configured so that air is pumped from the second or outer chamber 123 and liquid is dispensed from the first or central upper, chamber 122. As noted previously, some air will also be present in the first liquid pump chamber because of the dead space in the chamber 122 which cannot be eliminated altogether. The presence of air in the first chamber 122 allows the insert 116 to deform slightly when the dispenser is actuated before the outlet valve from the first chamber opens so that the air in the second chamber is pressurised to a limited extent. In some cases, the dispenser can be modified to draw air into the first, liquid chamber when the insert recovers or other means may be used to enable the volume of the second chamber to be reduced before the liquid outlet valve opens.

The flow of liquid from the first chamber 122 is controlled by a ring valve 184b, which opens to admit liquid from the first chamber into an upper annular channel 154 from where it can flow along passages 172 into a swirl chamber 345 and through an outlet nozzle 342. The flow of air from the second chamber 123 is controlled by a ring valve 184g which admits air from the second chamber into a lower annular channel 350 from which it can also flow via suitable passageways into the swirl chamber 345. The upper and lower annular channels are fluidly connected so that liquid from the first chamber is also able to enter the lower annular channel when the outlet valve 184b of the first chamber 122 is open. The outlet valve 184g from the air chamber is configured to open at a lower pressure above ambient than the outlet valve 184b of the liquid chamber.

During actuation when the cap 114 is depressed, the outlet valve 184b of the air chamber 123 will open before the outlet valve 184b of the liquid chamber so that air initially flows through the outlet nozzle. Once the outlet valve 184b of the liquid chamber 122 opens, liquid will being to flow through the outlet to mix with the air from the second chamber in the swirl chamber. During this initial phase of the spray cycle, the pressure of the liquid flowing through outlet increases until it becomes higher than that of the air flowing from the air chamber and some liquid will flow into the lower annular chamber where it acts on and closes the outlet valve 184g of the second chamber. The air outlet valve 184b remains closed until near the end of the spray cycle when the pressure of the liquid in the outlet passageway falls below that of the air in the air chamber 123. The air outlet valve then re-opens so that air again flows through the outlet passageways to the nozzle 342 helping to drive all the remaining liquid in the outlet passageways through the outlet nozzle.

The valve arrangement shown in Figure 34 can be adopted in a trigger actuated dispenser such as that shown in Figures 31 to 33 if desired or in any of the embodiments disclosed that have two pump chambers.

Rather then providing a mixture of air and liquid in at least one of the chambers, other arrangements can be used to enable the air chamber to be compressed before the outlet valve of the liquid chamber opens. For example, a compressible body can be located in the liquid chamber. Alternatively, the insert could be modified to have a compressible region to allow the air chamber to be compressed before the liquid chamber outlet valve is opened.

Dispensers in accordance with the invention are simple in construction and therefore relatively cheap to manufacture and yet highly effective. With all the flexible valve members for inlet and outlet valves of the or each chamber being formed integrally with the flexible insert, the dispenser comprises only three separate component parts, the cap, the base part (which may also comprises the container, and the insert. Where the cap and the base part are moulded together and interconnected by a lanyard, the dispenser will comprise only two separate component parts.

The flexible insert is a key element of the dispenser as it serves not only to define the pump chamber or chambers but also acts as a return spring. When the insert 116 is deformed, the core 176 is driven up into the upper diaphragm 184 which folds down about the core and, in some cases, a tapered region of the lower diaphragm. This helps to support the upper diaphragm and to stabilise the movement. Because the upper diaphragm is supported by the core, and in some cases the lower diaphragm, there is little or no lateral movement which prevents the actuator from wobbling when depressed. Deformation of the curved or angled resiliently deformable upper diaphragm 184 creates a restoring force tending to bias the insert back to its initial, resiliently biased rest position. The upper diaphragm 184 can be arranged so as to resist deformation until a certain actuation force is applied and to then deform relatively quickly giving a positive feel to the actuation for the user. The upper diaphragm 184 also recovers quickly once the actuation force is removed. It should also be noted that the upper diaphragm does not rely on co-operation with any rigid guide surfaces to generate a restoring force or to stabilize the movement and so is not subject to wear as a result of rubbing as may be the case with some known rolling diaphragm arrangements.

As has been noted previously, the insert and the cap are shaped to minimise the dead space in the chamber or chambers when the inserted is fully deformed at the end of the spray cycle. Thus the upper diaphragm is curved or angled to conform closely to the shape of an upper wall defining part of the first chamber 122, the upper wall being correspondingly shaped. In some cases, the upper wall may have a recess to accommodate part of the inlet valve. The upper diaphragm 184 is also shaped so as to fold down around the core of the insert and/or to overlie angled surfaces of the lower diaphragm 186 to minimise the dead space on the second chamber 123 when present.

In addition, the same basic design can be modified to provide a range of pumps. Thus the same cap 114 and base parts 112 can be used to form a single chamber pump or a dual chamber pump by using a modified flexible insert 116. The outlet 144, 144'of the cap can be moulded by means of an insert in the mould tool which is interchangeable so that the same basic tool can be used to produce cap actuators 114 having different outlet arrangements, e.g. spray nozzle, foam dispenser etc. In addition, a range of pump sizes can be produced by modifying the insert 116 and actuator cap 114. Alternatively, the discharge volume of the dispenser can be changed by providing cooperating stops on the cap 114 and the base part 112 to limit the range of movement of the cap 114 relative to the base part 112 to less than its potential maximum range of movement. The position of the stops can be varied to provide range of pumps having different discharge volumes but using the same basic cap 114, base part 112 and insert 116. The stops can be produced by means of inserts on the mould tool thus enabling a range of pumps to be manufactured using the same basic tooling. All of this enables a new pump range to be brought to market with significantly reduced tooling costs when compared to the prior art in which separate tooling is required for each pump size and type.

A new valve arrangement shown in fig 35 seeks to overcome the limitations of the duck bill valve. The problem with duck bill valves is that they aren't reliable enough and you are limited in the type of materials that can be used with silicone being the preferred material because of its properties but its price makes it difficult to justify with inexpensive products. They often fail because they tend to gape open especially if the flexible material absorbs some of the liquor and expands and products with particulates in them can cause them to stay partially open. The fundamental problem being that there is never a closing force on the valve other than from the liquor acting upon it.

Our solution is to have a post 351made in the top of the actuator 114 that goes down inside a hole in the flexible part 116 and to have an expandable neck 352 around the hole 353 shaped like a tapered cone. When the device is actuated the increased pressure in the chamber forces the neck to close on the post sealing the liquor inside the chamber. On the return stroke, the pressure in the chamber reduces pulling the neck away from the post and draws the liquor inside the chamber. Many types of flexible material can be used and each time it is activated the post moves inside the neck clearing away any debris. Unlike the duck bill valve the flexible neck always exerts some pressure against the post so there is always a seal. The post 354 is shown as solid but it could just as easily be hollowed out from the top of the actuator and solid at the bottom. The wall of 352 is shown as being indented or bent inwards like the sides of a volcano but in most applications they will be shaped as bent outwards as it has been found that this causes the forces to put more of a sealing force between the neck and post.

Because the neck needs to form a seal around the post and a seal usually works better with point contact then they may have an annular raised rim 354 or half O ring shape on it near to or at the end. The seal part may be shaped with a neck shaped so it is angled up towards the post so the pressure in the chamber on the compression stroke increases the sealing force and the negative pressure on the return stroke reduces the sealing force.

This valve could be used on any type of pump or trigger and it could also work as an outlet valve.

The inside top of the actuator can be shaped so that when the pump is pushed all of the way down, there is little or no space between the top and flexible part and this produces an accurate and consistent does each time as well as ensuring that once primed there is little or no air in the pump chamber. In this case the top of the actuator has an annular shaped protrusion 356 that corresponds to the space between the valve and the outside part of the flexible part of the valve at 355.

A new inlet valve shown in drawing 36 is used to make an integral one way valve for the lower chamber 123. For many applications it is desirable to have liquor in the lower chamber and so we need a one way input valve 365 there that allows the liquor in and prevents it returning. This is easy if an additional part such as a ball valve is used but is much more difficult otherwise. Our solution is to add a hinged section 362 inside the chamber just above the input hole 361. In its normal position a flap 363 seals the input hole and exerts some pressure on it. When the pump is activated the liquor inside the chamber 123 puts additional pressure on the flap sealing it further. On the return stroke the flap is sucked upwards by the vacuum force and this enables liquor to be drawn into the chamber through a hole at 366. The clever part is making the valve in an open position and then initially folding it inwards so it locks in place at 364. Any similar arrangement could be used on any pump or trigger.

The flap could be any protrusion sealing a hole or another protrusion such as a plug in a hole arrangement. The key is to manufacture it in one position and then to fold it over and lock it into another position.

In figure 36 the valve is part of the flexible component 367 which is supported by a rigid component 368 and the hole 361 is made in the rigid component. The easiest way to make this is to bi-inject the part and that includes the entire internal arrangement or part of it. But the valve could be made from one material only instead.

Many pumps and triggers use precompression valves to enable the fluids to build up a certain pressure before being delivered and this is usually for sprays or foams but can be for dispensers. The problem is that these precompression valves take out a lot of energy from the system and the gains you make with the spray quality can be lost by the effort needed. They work by blocking off the outlet channel leading to the spray orifice and being pretensioned in position so that they won't move until a certain pressure has been reached. Or at least, they won't allow the fluid to escape until the pressure has been reached. Higher pressures produces finer droplets and better formed sprays so ideally the pressure would be over 8 bars but this requires a high actuation force so the precompression pressure is normally set between 3 – 6 bars as a compromise. Dispensers and foamers may be as low as 0.2 bars but 1 bar would be more normal.

Another problem is that the precompression valves rarely open instantly at the required pressure and tend to partly unblock the channel before clearing it completely and this means that the initial momentum of the liquor may be less than the rest and initially the droplets can be larger and the form of the spray is poorer and often jets. Also, towards the end of the actuation the known precompression vlaves tend to also partially block the outlet giving the same problem.

The main problem though is that the known precompression valve exerts a force against the direction of flow of the liquor to block the passageway and this in turn causes an increase in the action force required to activate the device. With large spray orifices over 1 mm diameter and with a short spray duration of under 0.3 secs this is easily overcome by compromising on the precompression pressure. But smaller orifices and especially below 0.3 mm diameter cause a back pressure as the liquor cannot all escape quickly enough and this backpressure builds up in the spray cycle adding to the actuation force required as it is in the same line of flow. This becomes a major problem with continuous sprays and especially when fine sprays are needed. The backpressure can easily build up to 4 – 8 bars pressure and even higher so if you set the precompression pressure to 5 bars then the total pressure required to keep the valve open peaks at 9 – 13 bars and the required actuation force is way too high. Yet the minimum precompression pressure needed is often at least 4 bars or the initial spray is unsatisfactory. The problem is even greater when you want to discharge a high volume especially as a continuous spray as you already have a high actuation force needed to discharge a high volume and then an additional one is needed for the precompression valve and back pressure. This is because you are limited on the practical distance that you can move a pump or trigger so to increase the volume you have to increase the volume of liquor moved per mm movement. This means that in something like a cylindrical pump you need a larger diameter plunger and the actuation force is proportional to the diameter so it is correspondingly higher.

Some pumps and triggers don't use a precompression valve because of cost and the problems mentioned above but the spray from these is rarely satisfactory as every time you stop and start the device the spray is poor. With a dispenser adapted to provided a continuous spray people can use a lot of effort or a small amount pushing down the actuator or pulling a handle and this produces a very variable pressure at the spray orifice and hence a very variable spray quality.

Our solution to the problem is to develop a unique precompression valve that uses the backpressure to keep the valve open so that little or no more effort is required than the initial opening force. Yet when the actuation force is discontinued, the precompression valve shuts off the valve as normal with no reduction in its performance.

Figure 37 shows a further embodiment of a trigger actuated dispenser incorporating the side valve 365 of figure 36 and a novel precompression valve arrangement in accordance with the present invention. The final spray part 370 is shown in Figure 37 as being fixed inside a holder 371 but would normally be constructed as a single part like the spray nozzle insert 340 of figure 31 and held in by friction.

The precompression valve comprises a stepped bore 378 in the body of the nozzle in which a resiliently deformable valve member 372 is located. The valve member has a central main body 372a which is resiliently deformable. In this case the body 372a is resiliently compressible in a radial direction but in other forms of deformation can be used. The main body has a smaller diameter than the bore so that fluid can flow between the body and the surface of the bore 378. The valve member 372 is located in the bore by means of a base region 389 locates in a smaller diameter portion of the stepped bore and a ring portion 384 which surrounds the main body and engages with the surface of the larger diameter portion of the stepped bore. A forward end 372b of the valve member is supported by a component 380 which forms part of the rear or inner wall of a swirl chamber forming part of the outlet nozzle 370. An annular ring 390 on the component 380 engages in am annular recess 392 in a downstrteam end of the main body. The annular recess 392 extends over a significant portion of the length of the main body and allows this portion of the main body to be compressed radially.

The valve member 372 also has a resiliently deformable seal portion 388, which in the present embodiment it is the form of a sealing skirt, that projects from the main body to contact the surface of the larger diameter portion of the bore. The sealing skirt is spaced downstream from the ring portion 384 and is positioned in the portion of the main body having the annular recess 392. The valve member 372 and the bore 378 are configured so that when both the main body and the sealing skirt 388 are in their initial, resiliently biased positions, as shown in the drawings, the skirt lightly contacts the surface of the bore to form a seal which prevents fluid flowing along the bore to the outlet nozzle.

The precompression valve arrangement as shown in Figure 37 is arranged to control the flow of fluid, which may be a liquid such as a liquor or a mixture of liquid and air, from both the upper chamber 122 and the lower chamber 365 to the outlet nozzle 370. In the following description, the fluid being dispensed will be referred to as a liquid but it should be under stood that it may be a liquid/air mixture and that the liquid may be a liquor. When the dispenser is actuated, liquid from the upper chamber 122 is fed along an outlet channel 174 to enter the smaller diameter portion of the stepped bore, whilst liquid from the lower chamber is directed along an outlet channel 172 directly into the larger diameter portion of the stepped bore. The base region 389 and the ring 384 do not form fluid tight seals in the bore so that the liquid is able to flow from the channels 172, 174 past the base and the ring to enter a chamber 373a in the bore on the upstream side of the sealing skirt 388. The base region 389 may be adapted to flex inwardly to allow liquid to flow past and/or there may be grooves formed in its outer surface or other fluid passages through which the liquid can flow to enter the larger diameter portion of the stepped bore. Similarly, there may be grooves in the outer surface of the ring 384 through which the liquid can flow past the ring to enter the upstream chamber 373a or passageways may be formed through the ring.

In fig 38 is a more detailed view of the precompression valve member 372 on its own. The valve member as shown in figure 38 has a passage 394 which extends centrally through the main body. This passage is not present in the embodiment shown in figure 37 but may present for example where the upper chamber is used to dispense air to mix with a liquid dispensed from the lower chamber. In this case, the sealing skirt 388 only controls the release of liquid from the lower chamber and the air is directed through the central passage 394, past a one way valve 383 at the end of the passage 394 and out through radial passages 382 in the nozzle component 380 to mix with the liquid as it flows past the sealing skirt 388.

Operation of the precompression valve as shown in figure 37 will now be described. When the dispenser is actuated, liquid from the two pump chambers flows through the channels 172, 174 to enter the chamber 373a upstream of the sealing skirt as described above. At this stage, the main body and the sealing skirt 388 of the valve member 372 are both in their initial, resiliently biased configurations with the seal 388 making light contact with the surface of the bore to prevent liquid flowing past. A chamber 373b defined in the bore downstream of the sealing skirt 388 contains air which is at roughly atmospheric pressure so that as the pressure of the liquid in the upstream chamber 373a rises, a pressure differential is created between the upstream side of the seal 388 and the downstream side. As a result, the pressurised liquid in the upstream chamber 373a presses the sealing skirt 388 into closer contact with the surface of the bore so that the sealing skirt forms a tighter seal. The upstream face of the sealing skirt is concave to assist the liquid pressure upstream in deforming the sealing skirt in a radially outwardly into the surface of the bore.

Liquid in the upstream chamber 373a surrounds part of the main body of the precompression valve upstream of the seal 388 and as the pressure rises it exerts a force radially inwardly on the main body portion 372a causing it to deform or compress inwardly by collapsing the annular recess 392. This deformation draws the base of sealing skirt 388 radially inwardly away from the surface of the bore wall.

During an initial phase of the radially inward deformation of the main body, the liquid pressure in the upstream chamber 373a deforms the sealing skirt 388 radially outwardly to maintain contact between the outer edge of the seal 388 and the surface of the bore so that the valve remains closed. This deformation takes the sealing skirt 388 beyond its initially resilient deformed configuration so that the sealing skirt becomes loaded and its inherent resilience tries to re-from it inwardly back to its initial resiliently deformed configuration but is prevented from doing so by the pressure of the fluid in the upstream chamber 373a. Eventually, as the main body portion 372a continues to deform inwardly, the sealing skirt is no longer able to maintain contact with the surface of the bore and liquid is able to flow past the seal 388 to enter the downstream chamber 373b and flow to the outlet nozzle. The valve is configured so that this occurs at a desired liquid pressure.

The flow of liquid through the final outlet nozzle 370 is more restricted than the flow past the seal 388 so that the chamber 373b upstream of the seal 388 and the fluid passages leading to the outlet nozzle fill up with liquid and become pressurised (backpressure). As the pressure in the chamber 373b downstream of the sealing skirt 388 rises, the pressure differential across the sealing skirt 388 is reduced and eventually eliminated. Once the pressure differential has fallen sufficiently, the skirt 388 is restored to its initial resiliently biased configuration by its inherent resilience. This moves the radially outer edge of the skirt 388 further from the surface of the bore and so opening the flow path through the precompression valve further. This happens quite quickly after the valve has opened.

Whilst dispensing continues, the pressurised liquid in the chamber 373b upstream from the sealing skirt 388 also acts radially inwardly on the main body portion of the valve member 372 and so assists in holding the precompression valve open. Thus, the pressure of the liquid upstream of the seal 388 and the backpressure downstream of the seal 388 work together to hold the precompression valve open instead of against each other as is the case with most prior art precompression valves. This means that the minimum actuation force needed is only that required to open the precompression valve and the pressure in the channel will be governed by that or the backpressure depending on which is higher. This contrasts with the prior art precompression valve arrangements in which the minimum actuation force is dictated by a combination of the precompression pressure plus the backpressure.

Towards the end of the dispensing cycle, the pressure of the liquid acting on the resiliently deformable valve member will reduce and once it goes below that of the precompression pressure, the valve member 372 and the seal portion 388 will be restored to its initial resiliently biased configuration and the valve will close. The valve will also close if the user reduces the actuation force below the precompression pressure before the end of the dispensing cycle. So if someone is using a continuous spray pump or trigger and reduces the pressure on the actuator too much the valve will close and nothing will be discharged. Yet the initial precompression pressure can be set quite high and as high as the likely or required back pressure without any penalty in actuation force.

As discussed previously, the valve is kept in position in the chamber with the annular ring 384 which has indents in it to allow the fluids to pass. Other similar annular rings could be added for additional stability. Alternatively, the valve could have no rings and instead corresponding protrusions or ribs could be added to the chamber to hold it in position. In many ways this is better as it makes the valve a simpler shape and so easier and cheaper to make. The valve could also be made shorter in some applications so the body doesn't extend very far below the sealing skirt 388 and not as far as 384.

It is possible to make the chamber wall or part of it deformable so that either it or the valve or both are caused to deform at an angle away from the line of flow but having the chamber wall rigid is easier.

As discussed, it is desirable for a precompression valve to open at the required pressure and not to open a minimum amount so the fluid can just about get past as this leads to a big reduction in pressure of the fluid and a worse spray. Conventional precompression valves tend to partially open before they fully open as the pressure increases. In the precompression valve in accordance with the present invention, there are two actions which occur as the valve is opened. A main body portion of the valve is deformed or moved so that it draws the sealing member in a direction away from the sealing surface whilst the pressure of the liquid acting on the upstream side deforms the sealing member against its inherent resilience to maintain a seal with the sealing surface. As a result, the sealing member becomes pre-tensioned prior to the valve opening. Once the seal is eventually broken and liquid flows past the seal member, the pressure differential across the seal member is reduced so that the sealing member is able reform to it's initially resiliently biased configuration to open the valve fully. This dual action means that the valve opens fully and quickly at the desired pressure. If you don't want air to get back to the pump chamber when the pump is deactivated then you will want an additional skirt facing the opposite way near to the first skirt and this stops the air but is able to open easily to allows the liquid to flow past and so has no negative affect on the liquor movement.

In the present embodiment, the body of the valve member 372 is compressed by the pressure of the liquid to open the valve. However, in other arrangements, the body could be deformed or moved by or as a result of movement of the actuator of the dispenser rather than liquid pressure. The valve can also be arranged to open as a result of the sealing skirt being moved onto or over a formation in the bore rather than simply being drawn away from the surface of the bore. What is important is that the sealing skirt, or other sealing member, is deformed beyond its initially resiliently biased configuration by the liquid pressure acting on the upstream side prior to opening of the valve so that it is tensioned and springs back to its initial resiliently biased configuration to create an increased flow path through the valve when the pressure differential across it is reduced after the valve opens initially.
Instead of one or two skirts you can simply use a half O ring shape or raised annular ring and this squashes onto the wall instead so as the precompression valve deforms inwards the O ring reforms outwards maintaining the seal until the required pressure is reached when it comes away from the wall.

It is important in many pumps or triggers that the precompression valve closes quickly to prevent air getting back into the chamber yet you don't want it partially closing the hole for the reasons stated above. Being able to set a higher precompression pressure means that there is more force in the valve so when it shuts off it can do so quickly. But because the precompression pressure and the back pressure are working together instead of fighting each other, the valve won't tend to part close the hole. With the preferred design the gap between the chamber and valve is also much larger than you would get with a normal peg in the hole type valve considerably reducing any losses in performance.

For the precompression valve to collapse it either needs very flexible material or to have a hollow chamber such as 386 or to be foamed with closed cell bubbles inside and this would usually be made with a blowing agent during the moulding process. The latter is preferable because it is simple and cheap to make.

For continuous spray pumps or triggers and air / liquor pumps or triggers it is usually desirable to let some air back into the liquor pump chamber so that the first part of the spray or discharge contains a mixture of air and liquor to improve the performance. One way of doing this is to shape the precompression valve sealing skirt so that it is easy for the air to deform it and pass by upstream from the spray orifice to the chamber. So we have shaped it like a diaphragm or plunger in the sealing skirt area so outgoing liquor tends to increase the seal and incoming air tends to push it away from the wall.

For our designs we also often want a separate air chamber as well that can deliver air to the chamber containing the precompression valve and usually inside of the precompression valve. At the upstream end of the precompression valve there is a small tubular chamber and this goes over a raised plinth or upstand at the upstream end of the chamber and seals on it. Or, alternatively, there is a shaped plug 384 on the upstream end that goes into a tubular recess of the chamber upstream wall and this prevents the liquor getting around the plug and back to the air chamber. The air goes inside the precompression valve to 389 and then onto the chamber outside of the valve via a one way valve 383 or any other one way valve that is at least part of the precompression valve and this ensures that the air can enter the precompression valve but nothing can get back. The air can then either go direct to the back centre of the swirl chamber via a small central channel leading to a tapered or straight outlet orifice or there can be a side hole 382 in the precompression valve chamber leading to the outside of the precompression valve seal 388 so the liquor and air can mix there. This can be upstream or downstream of the seal on the precompression valve but downstream is usually preferred because the air in the top chamber can continue being delivered for longer than if it is upstream of the seal because the seal shuts it of sooner. Usually the air gets to the spray orifice before and during the start of the spray cycle and then the liquor pressure quickly becomes greater than that of the air so closes the one way valve in the precompression valve sealing off the air. Then once actuation is stopped the liquor pressure quickly reduces allowing the air to mix with it and then follows the liquor out through the spray orifice. This is a very fast action. Often or usually, there is also air in the liquor chamber which is also configured to deliver air at least at the start of the cycle.

In figure 39 we see more views of the trigger device with a chamber at the top containing liquor or liquor and air and a chamber at the bottom containing air or liquor and air with the liquor being fed from the top chamber though holes in the side wall. Here the precompression valve could be as shown but would normally be similar except the air would go around it as shown and the liquor or liquor and air would go through the middle of it as shown but would exit the valve through a hole upstream of the skirt valve at 390 mixing the liquors and air there. This is usually because the Air /Liquor ratio is so much higher than with the other configuration so air will still tend to be delivered at the start and end but also throughout the cycle. Sometimes liquor and air will be in both chambers and the valve would also be the same as this.

Many pumps or triggers including dual liquor triggers will not have an extra air chamber and some won't use air at all as in figure 37. These would usually not have an extra route through the back of the precompression valve which then may not be open at the back. The precompression valve would still deform or move in the same way so that the precompression pressure and the back pressure are both contributing to the action rather than fighting each other.

In our design we show the precompression valve as also forming the back wall or post 380 of the swirl chamber at the upstream side of 370. This could be made of a normal post with the spray insert on top of it as is the standard and the precompression valve would then go around the post like an O ring. It would be squashed rather than moved and allow the liquor to go around it.

The drawings tend to show the precompression valve as made of two parts but it would normally be one with a blowing agent being used to create a closed or open cell structure. Where there is a second air or air liquor route inside of the precompression valve the one way valve would then normally be formed between the precompression valve and an annular ring coming down from the downstream end of the chamber.

Most of the later figures focus on spray devices but the arrangements shown can be modified for use as dispensers and foamers.

For the precompression valve to collapse it either needs very flexible material or to be hollow or to be foamed with closed cell bubbles inside and this would usually be made with a blowing agent during the moulding process. The latter is preferable because it is simple and cheap to make. But it could also be hollow and made like a shaped balloon and even the sealing skirt could be hollow. It could also hold something like a gas or liquor or paste which could react to the change in pressure and contract as the pressure increases.

For continuous spray pumps or triggers and air / liquor pumps or triggers it is usually desirable to let some air back into the liquor pump chamber so that the first part of the spray or discharge contains a mixture of air and liquor to improve the performance. One way of doing this is to shape the precompression valve sealing skirt so that it is easy for the air to deform it and pass by from the spray orifice to the chamber. So we have shaped it like a plunger in the sealing skirt area so outgoing liquor tends to increase the seal and incoming air tends to push it away from the wall.

For our designs we also often want a separate air chamber as well that can deliver air to the chamber containing the precompression valve and usually inside of the precompression valve. At the upstream end of the precompression valve there is a small tubular chamber and this goes over a raised plinth or upstand at the upstream end of the chamber and seals on it. Or, alternatively, there is a shaped plug on the upstream end that goes into a tubular recess of the chamber upstream wall and this prevents the liquor getting around the plug and back to the air chamber. The air goes into the precompression valve via a one way flap valve or any other one way valve that is at least part of the precompression valve and this ensures that the air can enter the precompression valve but nothing can get back. The air can then either go direct to the back centre of the swirl chamber via a small central channel leading to a tapered or straight outlet orifice or there can be a side hole in the precompression valve chamber leading to the outside of the precompression valve so the liquor and air can mix there. This can be upstream of downstream of the seal on the precompression valve but downstream is often preferred because the air in the top chamber can continue being delivered for longer than if it is upstream of the seal because the seal shuts it of sooner. Usually the air gets to the spray orifice before and during the start of the spray cycle and then the liquor pressure quickly becomes greater than that of the air so closes the one way valve in the precompression valve sealing off the air. Then once actuation is stopped the liquor pressure quickly reduces allowing the air to mix with it and then follows the liquor out through the spray orifice. This is a very fast action. Often or usually, there is also air in the liquor chamber which is also configured to deliver air at least at the start of the cycle.

Sometimes the air will be in the bottom chamber and the liquor or liquor and air in the top chamber. Here the fluids from both chambers would normally mix upstream of the sealing skirt. This is usually because the air liquor ratio is so much higher than with the other configuration so air will still tend to be delivered at the start and end but also throughout the cycle. Sometimes liquor and air will be in both chambers and the valve would also be the same as this.

Many pumps or triggers will not have a second chamber and some won’t use air at all. These would usually not have an extra route through the back of the precompression valve which then may not be open at the back. The precompression valve would still deform or move in the same way so that the precompression pressure and the back pressure are both contributing to the action rather than fighting each other.

In our design we show the precompression valve as also forming the back wall or post of the swirl chamber. This could be made of a normal post with the spray insert on top of it as is the standard and the precompression valve would then go around the post like an O ring. It would be squashed rather than moved and allow the liquor to go around it. Or the valve could simply be somewhere upstream of the post and swirl.

The drawings tend to show the precompression valve as made of two parts but it would normally be one very flexible part or one with a blowing agent being used to create a collapsible cell structure. Where there is a second air or air liquor route inside of the precompression valve the one way valve would then normally be formed between the precompression valve and an annular ring coming down from the downstream end of the chamber. The second fluid could alternatively go in a route outside of the chamber containing the precompression valve from the second chamber and then back into the chamber downstream of the sealing skirt. This could be activated by a variation of the precompression valve or by using the small recess upstream of the valve and having the valve open the new route when required.

It is important that the precompression valve also closes quickly at the end of the cycle to prevent jetting or dribbling or large droplets at the end of the spray. It is normally designed to do this but there is a way of enhancing this action. the precompression valve could also have a second sealing skirt downstream of the main skirt and this could be the same shape but weakened in some way such as by thinning it out. So the second skirt opens much easier than the first but it also closes much faster so the first skirt controls the precompression level and the second the fast closure. Obviously the two skirts could perform the opposite roles instead.

The precompression valves usually prevent air getting back into the pump chamber and this can be achieved with a sealing skirt facing the opposite way that is placed upstream or downstream of the main skirt. When there are two main skirts then a third skirt can be added for the air control and this too would face the opposite way. This second skirt can also be made to partially seal so that a controlled amount of air is let back in with the volume depending on the level of seal.

The precompression valves have been shown working by using the sealing skirt to seal off the liquor and then the body of the valve reduces in size causing the skirt to eventually come away upstream from the wall and allow the liquor past. A similar approach would be to weaken the area immediately downstream of the sealing skirt so that once enough pressure had been reached a portion of the sealing skirt itself deforms downstream so eventually pulling the skirt away from the wall and allowing the liquor to pass.

The body of the valve could be rigid or non collapsible and the tube wall could be resiliently deformable instead so that as the pressure upstream of the sealing skirt increases the tube wall bows outwards and away from the sealing skirt. Initially the sealing skirt deforms to maintain the seal against the wall but eventually the wall deforms too far and the fluid passes downstream of the sealing skirt allowing the sealing skirt to reform to its original shape or thereabouts.

The precompression valves have been shown as stand alone components but they could just as easily be integrated into other devices such as pumps or triggers where flexible parts are used. One such example is a trigger device that has a domed pump chamber and is split into two parts with one part being made as a bi-injection moulding with a rigid and flexible material. The precompression valve could be used after the dome in much the same way as on the devices shown so far but rather than being a separate component it is part of the entire moulding.

It is shown in figs 40 and 41 as a flexible hollow tubular post 400 in a tube 411 with the main upstream skirt 401 working as the precompression valve and the downstream skirt 402 acting to prevent the air getting back to the pump chamber 403. The downstream skirt cannot resist the flow of the liquor out from the pump chamber as it simply deforms away from the wall 411 but it resists the flow of air back in by being pushed against the tube wall to form a seal. Similarly the upstream seal wouldn't form a seal against the air getting back in as it too would be deformed away from the wall.

In figs 42 and 43 we see the same trigger but with the integral precompression valve 430 formed immediately after the domed pump chamber 403 instead. This time though only half of the elongated tube 431 is used with half of the sealing skirts and it goes into a half tube 420 which is also elongated instead of a full tube. This is so it can be made closer to the pump chamber and so there is less dead space which enables a higher precompression level to be set plus it makes the manufacture of the entire device much simpler and cheaper. It works in the same way as the full tubular the precompression valve but only deforms on one side.

In figs 44 and 45 we see the same trigger device but with the precompression valve 440 being formed on the bottom of the pump chamber dome 441 itself so that it takes up even less space and generates even less dead space. An annular trench 450 is formed around the base of the extended dome 403 which has the sealing skirt or skirts around its circumference arranged so that they seal against the inside wall 451 of the trench. A space upstream of the trench and immediately opposite the exit hole 453 from the dome allows the extended bottom of the dome to extend out under pressure and this allows the bottom of the dome to work in the same way as the precompression valve eventually allowing the liquor to escape through there once the required pressure has been reached. The dome extension 441 could have strengthening ribs or could be shaped in any way to increase the amount of force needed to deflect in and hence to produce a higher precompression level. This could be achieved with less than a full dome extension and a trench that only extends part of the way around the dome chamber.

The precompression valve can be used in many other applications as well either as a stand alone device or as part of a device. The pressure level can be set really low so it only acts as a one way valve. Or two opposing skirts can be used so they both function as precompression level valves. They could be used for gases such as air as well as liquors and they can be used in applications such as air release valves for devices such as bottles where they could let gases out under pressure and air in to prevent the bottle collapsing but still remain leak proof for the liquor. Some bottles like shampoo bottles have one way precompression valves in the bottom or lid that hold the liquor until the bottle is pressed when some of it is discharged. These are often made in silicon which is expensive and are often only able to retain viscose liquors as they use a fine slit that naturally closes until deformed by pressure or two fine overlapping slits making a cross between them that work the same way but let more liquor pass. But these precompression valves will retain any fluid until positively deformed.

The precompression valve described previously and especially in figures 38, 40 and 41 works because it has a two stage action in this case squashing the body and deforming the sealing skirts. Any two stage action could be used that achieves the same effects and one such example is to use a body with the sealing skirts sealing inside and or on or under a tubular hole such as 410 like the plunger 400 or a separate device such as in figure 38, where the second action is the movement of the body in or away from the hole. The movement is generated by the fluid acting upon it and afterwards it resiliently returns to the sealing position either from its own action such as by fixing it in place as 400 and deforming a part of it and relying on its flexibility to cause it to reform or by using a spring or equivalent downstream of it that is deformed and then reforms afterwards. The device could be a bi-injection moulding with the body being rigid and at least the sealing skirts being flexible or it could all be flexible.

One example fig 40 of such an arrangement could be 400 with 402 sealing inside the hole 410 against the walls 411 and with 401 also sealing either inside the hole or on the top of it. The top of 400 where it is fixed to the rigid frame of the device acts as a trampoline and the fluid gets between it and the top of area around the hole 410 and lifts it up moving 400 in the hole. As it starts to move the seal 401 pushes` outwards as before maintaining the seal even when it is above the hole until it can no longer do so and the hole is exposed and the skirt reforms to its original position creating a large gap for the fluid to flow in. The fluid easily deforms the downstream skirt 402 and flows out. At the end of the cycle air cannot get back in due to 402 as before and the valve returns to its original position.

In fig 38 we saw the precompression valve and on page 59 line 23 we mentioned that it could be used with bottles or containers to replace the current valves used that hold in a paste or a liquor such as a shampoo but a gentle press of the flexible container causes the liquor to exit it through the lid. Such a lid 460 is shown in figure 46. The standard valve is usually made of silicone and is circular with a fine slit or cross made of two slits at right angles to each other. This is pushed into a tube arrangement 461 on the underside of the cap of the container lid and it is usually held in place by a separate ring made from a rigid plastic. Sometimes a one piece bi-injection moulding is made that has both designs in one. Like all devices it isn't perfect and one problem is that liquors like oil and water which are a fairly low viscosity tend to leak through the valve. Also, if they can only handle limited volumes in the container because when it is inverted excessive weight of the liquor causes the liquor to break through the valve. Silicone is difficult and slow to mould and is an expensive material.

Figure 47 shows the valve on its own. Alternative modifications to the design can be used and the essence of the design is the collapsible body and skirt seal that can be pulled away from the sealing wall of the body to create a larger gap as with the previous examples. For these types of applications the body tends to collapse much more than the others as a larger gap is required for the high flows needed.

We can use a version of our precompression valve 463 to replace the existing devices and it can be made in one part in one flexible plastic only so it will be cheaper to make and assemble plus it overcomes the problems associated with current designs. It is fundamentally the same design only it also has 2 concentric rings 464a and 464b at the back that can overhang around the outside of the tube 461 on the underside of the cap and hold it in place. These are shown as smooth but one or both could be shaped to ensure they stay in place against the rigid wall of the body and another rigid wall on the body could be outside of 464a to jam it in place and this can be seen in a modified version in figure 50 as 501. The inner flexible ring 464b is connected to the central tube 467 by 2 connecting webs with gaps between them for the liquor to pass through. The sealing skirt 465 normally seals on the inside of a smaller concentric tube 468 inside tube 461 but could equally seal on the inside of tube 461. The liquor reaches the sealing skirt 465 through the gaps at 471 in the connecting webs 470 and rapidly builds up pressure around the sealing skirt at 466 and on the central tube 467 of the valve which is normally hollow from the downstream end but could equally be solid or have fine bubbles inside it as before. The central tube 467 will deform until the sealing skirt 466 has to come away from the inside wall of tube 468 allowing the liquor to pass through the final orifice 469 and like before, the pressure at which it gives way can be regulated. The sealing skirt could sometimes be a raised annular protrusion like a half O ring instead but this isn't as reliable. It could also be made to stretch past the orifice instead or as well as collapsing inwards so that a larger gap is formed. Often the sealing skirt would be situated further upstream and the tube 468 would be made longer to accommodate this especially as sometimes there is a protrusion on the underside of a hinged lid that covers the outside that snaps into the orifice 469 sealing it for transport. An example of this can be seen in figure 50 with the indented orifice 502and an indented sealing skirt 463.

Normally, the bottle is flexible so pressing the bottle causes the liquor to exit the valve and once it is released the bottle the valve closes but as the bottle reforms it sucks air back inside by deforming the sealing skirt upstream away from the exit. This also sucks back any residual liquor in the orifice that may have dripped or hardened. Sometimes the container is deformable but will not reform afterwards and examples of this are polythene sachets or tubes containing toothpaste. With these, the liquor or paste is discharged as before but afterwards the container doesn't reform and is full of liquor anyway so no air is sucked back inside. With viscose liquors or pastes the standard valve doesn't have enough strength to close properly after use but ours can do so easily plus if required we can also have the sealing skirts facing both upstream and downstream to make it more airtight as before.

In figure 48 we see another version of the precompression valve and this shows the valve as part of a larger flexible insert that could be used in a pump, trigger or aerosol can or any device that deliver a fluid and especially a liquor. The body 4800 of the device is made as a rigid moulding and contains a spray nozzle insert 4801 which is held in place on the post 4804 of the body 4800 and a swirl chamber 4802 or equivalent is created between the nozzle 4801 and the post 4804 and a final spray orifice 4803 is in the nozzle 4801. The body is cylindrical and holds a flexible insert 4820. The flexible insert 4820 has a tubular post 4807 that goes into a tubular recess 4822 of the body 4800. The downstream end of the post 4809 actually butts up against the downstream end of the recess 4822 but is shown in the drawing as going past it but this is to represent the fact that in its rest position it is held in place somewhere upstream of 4821 and is pretensioned so the post 4807 is slightly squashed in its normal rest position. Extending out and upstream of the post is a circular plate 4811 with two valves 4814 and 4817 outboard of it and these seal against the inside of the outer walls 4813 and 4816 of the body 4800 in the recess 4812. The upstream valve 4814 is a non return valve that allows fluid downstream and past it to the spray orifice but nothing back from downstream of it upstream and it usually prevents air getting past. It has a circular skirt seal that is flexible and seals against the sloping wall 4813 of the body 4800 but can deform away from the wall into the recess 4812 to allow fluid to pass downstream. If anything tries to pass upstream it is pushed harder against the sloping wall 4813 maintaining the seal. The upstream seal 4817 is shaped like the downstream seal and seals against the body wall 4816. It would allow fluid to pass upstream but prevents any flowing downstream by being pushed harder against the wall 4816. This can be activated in several ways and one is that the fluid usually a liquor is pressurised and exerts a downstream force on the plate 4811 at 4818 and tries to get past the sealing skirt 4817 between it and the wall 4816. Initially nothing happens but as the pressure increases it starts to deform the plate 4811 downstream into the recess 4812 and as it does so the upstream skirt 4814 moves into the recess 4812 but initially still seals on the wall 4813. The upstream skirt 4817 is deformed downstream by the deformation of the plate 4811 and also is deformed outwards and downstream by the pressure of the fluid acting upon it and both actions increase the seal. Once a preset pressure is reached the upstream sealing skirt 4817 makes contact with a protrusion like a rib or a number of ribs of the body 4815 at 4823 and this exerts a force on the seal that tries to push it away from the wall. The greater the deformation of the plate the greater this force until the skirt seal 4817 is forced away from the wall allowing the fluid to pass. Once it passes the seal the pressure of it between the skirt 4817 and the wall 4816 rapidly approaches that of the upstream pressure allowing the skirt seal to return to its original shape which further increases the gap between it and the wall and allows the fluid to pass more easily. The fluid pushes the upstream sealing skirt 4814 away from the wall 4813 and then passes around the post 4807 to the recess 4806 and onto the swirl chamber 4802 and then the spray orifice 4803. The positioning and size of the ribs 4815 is critical as it is essential that the sealing skirt 4817 is able to deform around them for as long and as much as possible so that once it has come away from the wall it and it reforms it does so to quite an extent so its shape changes substantially which in turn increases the gap between it and the sealing wall 4816. If the ribs 4815 are too close to the edge of the sealing skirt 4817 then it won't be able to deform enough so they are positioned well inboard of it. If the ribs 4815 are too large then the sealing skirt 4817 won't be able to deform much before it is lifted off the sealing wall 4816. Equally, if the sealing skirt 4817 isn't long or flexible enough then it won't be able to deform enough to get the desired affect. Once the device is no longer activated the pressure of the fluid usually reduces to zero and the flexible insert 4820 returns to its original position and shape resetting any seals. Sometimes it may be required to keep the fluid at a raised pressure so the flexible insert would then return to its shape at that pressure but with the upstream skirt seal 4817 in its sealing position with no fluid flow.

A second action can also be used to enhance the movement of the sealing skirt towards the protrusion 4815 and that is the pressure of the fluid on 4818 also puts pressure on the flexible post 4807 squashing it and moving the flexible part 4820 downstream and this moves the sealing skirt at 4823 closer to the protrusion 4815. This movement can be limited by the strength of the post and also by the distance between the plate 4811 from the protrusion 4810 of the body 4800. Once these meet no further movement is possible. This is a complicated action as adjustments can be made to a number of different features to determine at what pressure the valve will give way. The key though is the same with all of the other versions where the sealing skirt deforms and then returns to its original shape or thereabouts and thus increases the gap for the fluid to pass.

For this to work properly the flexible part 4820 can be held in place somewhere upstream of 4821 or it can be free to move inside the outer part 4800 and the pressure of the fluid can cause the required action as described above. Or it can be free to move downstream and something like a rod or lever can push it mechanically downstream and that action coupled with the pressurised fluid would also result in the same action as described above. Alternatively, the flexible part 4820 can be fixed in place and the outer body 4800 can be moved towards it by pulling or pushing on it or on a lever or equivalent. Again, this coupled with the pressurised fluid produces the same action as it is the relative movement of the two parts that opens the sealing skirt and the release of the pressurised fluid that allows the skirt to return to its original shape or thereabouts increasing the size of the gap.

Figure 49 shows yet another variation of the valve. This time the sealing skirt 4912 of the upstream valve is sealing against a wall 4901 that is perpendicular to the flow of the fluid rather than parallel to it as in the other examples. Clearly the angle of the sealing wall can be varied very easily and can be at many angles. This is largely the same as the last example in fig 48 but there is an additional feature in the hole 4911 in the post 4917 of the flexible insert 4910 that allows further movement of the flexible insert 4910 relative to the body 4900 without relying on much or any deformation of the post 4917. The downstream valve 4916 has also been made to function independently of the upstream valve 4912 and an additional protrusion 4915 has been added to the flexible part 4910 that pushed into a recess 4904 on the body 4900 fixing the two parts together. The downstream skirt 4916 just acts as a simple one way valve allowing fluid to pass downstream by the action of the fluid pushing it away from the wall but fluid usually air from the downstream end cannot flow past it upstream because it retains the seal against the wall. There is also a refinement to the upstream sealing skirt 4912 which has a finer skirt 4913 around the edge to further enhance the sealing. Both skirts are shown as being inside the body 4900 by the sealing wall 4901 but this just depicts that they are pretensioned to maintain an interference fit against the wall and they would just sit against it in practice. One or more upstands or ribs 4919 are added to the sealing wall 4901 and these are initially clear of the sealing skirt 4912 or just touching them. As the flexible part 4910 and body 4900 move closer to each other either from a mechanical action or from the pressure of the fluid or both, the hole 4911 closes partially or completely and the upstands 4919 exert a growing pressure on the sealing skirt 4912 at the points of contact. This tries to push the sealing skirt 4912 away from the wall 4901 but it deforms downstream to compensate for it and the seals remains intact. At a predetermined pressure the sealing skirt 4912 can no longer deform any more and comes away from the wall 4901. Without the new finer skirt 4913 the sealing skirt 4912 would then reform to its original shape or thereabouts creating a larger gap as usual. However, once the main skirt 4912 has come away from the wall the new finer skirt 4913 continues to maintain the seal as being much thinner it is also much more flexible. After further deformation of the main skirt 4912 even the finer skirt 4913 can no longer maintain contact and it too comes away from the wall allowing the fluid to pass. Once it passes the two skirts 4912 and 4913 both reform to their original shape or thereabouts and the gap is now even bigger than would be the case with the main sealing skirt 4912 on its own. This idea of the double sealing skirt can be applied to any of the previous versions and any combination of any of the improvements can be applied to any of the examples. As in fig 48 it is essential that the ribs 4919 aren't too large and are positioned so they contact the sealing skirt 4912 as far away from the sealing edge as possible to give the sealing skirt as much chance to deform as possible. The sealing skirt 4912 is also made as deformable as possible for the reasons stated previously but since they are often very small they may not be able to deform enough hence the addition of the outer finer sealing skirt 4913.

Sealing skirts are commonly used on valves and plungers are just one of the examples. The skirts are also deformable so that an increasing fluid pressure deforms them in such a way that they deform more and more against the sealing wall until they finally can deform no more and come away from the wall. Sealing skirts have also been made to go against ribs and when they do so they are forced away from the wall also allowing fluid to pass. But in all previous designs the gap created is only the minimum gap needed to allow the fluid to pass. We have a two stage action where the skirt deforms and seals as normal but a second force such as a rib is brought to bear on the skirt inboard of the edge and the skirt can bend over further to maintain the seal initially so that when the skirt is driven off the sealing wall the skirt wants to reform to its original shape. As we have shown a second finer skirt can be added around the edge of the sealing skirt so that both skirts initially distort and then reform their shape whilst the valve is still open. Or deformation of the flexible body takes place to draw the sealing skirt away from the sealing wall so again the sealing skirt can revert to its normal shape or thereabouts whilst the valve is still open. This creates a larger hole than normal allowing free passage of the liquor yet the valve can still close as quickly as normal. Any combination of the above ideas could be used to achieve the required action. With normal sealing skirts they just cannot revert to their original shape whilst the valve is open.

We have discussed using these valves in pumps and triggers for continuous and pulsed dispensers and sprays as well as squeezy bottles but the valves could be used in any application where valves are currently used. Only the sealing skirt needs to be resiliently deformable provided a second action such as the valve itself moving downstream against ribs can be achieved. The valve could be used in pressurised airlines, in pipes carrying liquor or in drinks bottles, flexible pouches, a range of medical devices, spray nozzles as an anti drip or as a pressure regulating nozzle. For some water bottles, you would open the valve by sucking on the bottle and this would deform the body of the flexible initially insert downstream of the sealing skirt and then inside and upstream of the skirt. The squeeze bottle valve in fig 46 would work in this way.

It could be used in the opposite way to that described where instead of blocking off the fluid and then opening to allow it to pass it is normally open and then closes. Consider the valve shown in fig 38 and imagine it in a pressurised pipe such as a mains water pipe, a pressurised water system in the home, an oil pipe or a pipe carrying pressurised air. As long as the pressure in the pipe is high enough to deform the body of the valve sufficiently to keep the sealing skirt 388 away from the wall of the pipe the fluid will continue to flow and there will be a large gap for it to flow easily. But if the pipe suddenly sprang a leak the pressure would drop and the body would reform pushing the sealing skirt onto the wall and sealing off the pipe. Once the leak is repaired the system would be repressurised and the valve would open. The valves could also be made to work with temperature so the body could compress at temperatures below a set point opening the system and to close once that temperature is exceeded. The action could be enhanced if the body or sealing skirt contains a gas, liquor or paste that reacts to temperature or pressure to increase the movement. Alternatively the body itself could react to changes in temperature or pressure to enhance the action giving greater movement.

The figures shown tended to show the valve held in position by a downstream portion of the body having an internal flange although figs 46 and 47 showed an upstream wall of the body holding it in place. The flexible insert could also have an upstream hook or equivalent that attaches to part of the body or they could even be free to move inside the body or they could have an additional upstream sealing skirt with holes inboard of the sealing edge either in it or in the body of the valve that allows free passage of the fluid and the valve is held in position by the upstream skirt which doesn't deform so which always stays in place. Or some or design around the body of the valve could be used to hold it in place.

With one sealing skirt the valve can allow fluid to flow both ways but with two opposite facing sealing skirts as shown in some of the examples such as fig 48, it can only flow one way. The valve could also be used in combination with other valves such as the umbrella valve, the duck bill valve and others and these could be made a part of the same valve.

Most of the examples showed a tubular body and a circular sealing skirt going all of the way around it but the body can be shaped like the oval version shown and the sealing skirt doesn't have to extend all the way around the body. You could also use two Sealing skirts in series with both facing the same direction to achieve a stronger seal.

Any of the examples of the resiliently deformable inserts shown and especially the squeeze valve shown in figures 47 and 50 could be modified to be made as a bi-injection moulding with the outer component.

The dispensers described above in relation to figures 1 to 36 can be modified to incorporate a precompression valve in accordance with the invention.

Whereas the invention has been described in relation to what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not limited to the disclosed arrangements but rather is intended to cover various modifications and equivalent constructions included within the spirit and scope of the invention.

Claims

1) A valve having a body, a fluid inlet, a fluid outlet and a bore defined in the body and which forms at least part of a fluid passage from the inlet to the outlet, the valve further compromising a resiliently deformable valve member having a resiliently deformable body that is smaller than the bore and a resiliently deformable sealing skirt mounted to part of the body that engages with a sealing region of the inner surface of the bore to form a seal that in their initially biased configuration in a valve closed position close the valve bore to prevent fluid flowing through the bore, and in a valve open position do not close the valve bore and a fluid flow path through the bore is established, characterised in that the valve is configured such that when force is applied to the body or the resiliently deformable valve member at least part of the body of the resiliently deformable valve member is deformed causing the sealing skirt to also deform but to be still held in the sealing position on the bore by the pressure of the fluid acting upon it until a minimum fluid pressure level is reached when the sealing skirt comes away from the valve bore allowing the fluid to pass it and enabling the sealing skirt to at least partially reform to its original shape increasing the gap between the sealing skirt and the valve bore.

2) A valve as claimed in claim 1 where the action of the resiliently deformable valve member body being deformed causes at least part of the sealing skirt to deform to maintain the seal with the sealing region of the inner surface of the bore preventing fluid flow in the bore and where further compression of the body causes the sealing skirt to come away from the sealing region of the inner surface of the bore enabling fluid flow in the bore and where that fluid flow enables the sealing skirt to at least partially reform to its non deformed condition thus increasing the gap between the sealing skirt and the sealing region of the inner surface of the bore.

3) A valve as claimed in any of the preceding claims where the valve is a one way valve allowing fluid to pass from upstream to downstream of it.

4) A valve as claimed in claim 3 where the resiliently deformable valve member body has two sealing skirts with the upstream skirt preventing the flow of fluid from downstream to upstream of the valve.

5) A valve as claimed in any of the preceding claims where the valve is a two way valve allowing the fluid to pass from upstream to downstream and from downstream to upstream of it.

6) A valve as claimed in any of the preceding claims where the resiliently deformable valve member body has two or more sealing skirts.

7) A valve as claimed in the preceding claims where the upstream fluid is a liquor or a liquor and air and the downstream fluid is a liquor or air or a mixture of both.

8) A valve as claimed in the preceding claims where the upstream fluid is a paste or a paste and air and the downstream fluid is a paste or air or a mixture of both.

9) A valve as claimed in any of the preceding claims where the deformable body of the resiliently deformable valve member compresses at an angle away from the flow of the fluid where the angle is greater than 50 degrees.

10) A valve as claimed in any of the preceding claims where the sealing skirt is annular and circular.

11) A valve as claimed in any of the preceding claims where the sealing skirt is annular and circular and has a finer and more deformable sealing skirt around its edge.

12) A valve as claimed in claim 9 where the outer sealing skirt is at a different angle to the main sealing skirt.

13) A valve as claimed in any of the preceding claims where the sealing skirt forms the downstream wall of a pump chamber.

14) A valve described in the preceding claims where there are one or more protrusions on the resiliently deformable valve member body and downstream of the sealing skirt to prevent the skirt from flipping partially or totally inverted when the valve is open and being unable to return to its original position.

15) A valve described in the preceding claims where there are one or more protrusions on the sealing skirt of the resiliently deformable valve member body and downstream of the sealing skirt to prevent the skirt from flipping partially or totally inverted when the valve is open and being unable to return to its original position.

16) A valve described in the preceding claims where there are one or more protrusions on the wall of the bore defined in the body and downstream of the sealing skirt to prevent the skirt from flipping partially or totally inverted when the valve is open and being unable to return to its original position.

17) A valve described in the preceding claims where there are one or more protrusions or ribs on the wall of the bore defined in the body and downstream of the sealing skirt that act upon part of the sealing skirt and inboard of the sealing edge of it as the body of the resiliently deformable valve member body is deformed pushing part of the sealing skirt upstream and away from part of the bore wall and breaking the seal and opening the valve.

18) A valve described in the preceding claims where there are one or more protrusions or ribs on the resiliently deformable valve member body or the sealing skirt and downstream of the sealing skirt and inboard of the sealing edge of the sealing skirt act upon part of the bore defined in the body as the body of the resiliently deformable valve member body is deformed pushing part of the sealing skirt upstream and away from part of the bore wall and breaking the seal and opening the valve.

19) A valve described in the preceding claims where there are one or more protrusions or ribs on the resiliently deformable valve member body or the sealing skirt and downstream of the sealing skirt and inboard of the sealing edge of the sealing skirt act upon a ledge on part of the bore defined in the body as the body of the resiliently deformable valve member body is deformed pushing part of the sealing skirt upstream and away from part of the bore wall and breaking the seal and opening the valve.

20) A valve as claimed in any of the preceding claims where part of the deformable body of the resiliently deformable valve member is hollow or contains closed cell bubbles.

21) A valve as claimed in any of the preceding claims where part of the body of the resiliently deformable valve member also forms part of a swirl chamber.

22) A valve as claimed in any of the preceding claims where at least part of the resiliently deformable valve member body is proximal to the outlet orifice of the body of the valve.

23) A valve as claimed in the preceding claim where the orifice is a spray orifice.

24) A valve as claimed in the preceding claims where the valve is configured to open only when the fluid pressure acting upon the valve member is at or above a predetermined minimum value.

25) A valve as claimed in the preceding claims where the valve is configured to open only when the fluid pressure acting upon the valve member is at or above a predetermined minimum value and the deformable body of the resiliently deformable valve member deforms to a limited amount prior to the valve opening.

26) A valve as claimed in the preceding claims where the valve is configured to open only when the fluid pressure acting upon the valve member is at or above a predetermined minimum value and the sealing skirt of the resiliently deformable valve member deforms to a limited amount prior to the valve opening.

27) A valve as claimed in the preceding claims where the valve is used as a non drip valve.

28) A valve as claimed in the preceding claims where the valve is used as an air release valve.

29) A precompression valve, the valve comprising a body defining a fluid passage having an inlet end and an outlet end and a sealing surface within the passage, and a valve member located in the passage, the valve member having a resiliently deformable body portion dimensioned so that a flow path is defined between the body portion and a surface of the fluid passage along which a fluid can flow when the valve is open, the valve member further comprising a seal portion projecting from the body portion, the seal portion being resiliently deformable relative to the body portion, the seal portion contacting the sealing surface to prevent fluid flowing along the passage from the inlet end to the outlet end when both the body portion and the seal portion are in initial resiliently biased configurations, in which deformation of the body portion of the valve member under the application of a force from its initially biased configuration to a deformed configuration causes the seal portion to move relative to the sealing surface to open a flow path through the valve, the seal portion being resiliently deformable from its initial resiliently biased configuration to a deformed configuration under the pressure of a fluid acting

on an upstream side of the of the sealing portion when the valve is closed to maintain contact with the sealing surface to close the flow path during an initial phase of the deformation of the body portion from its initially resilient configuration to its deformed configuration.

30) A valve as claimed in claim 29, in which the seal portion is configured to recover from the deformed configuration towards its initial resilient biased configuration once the flow path has opened and the pressure differential across the seal portion is insufficient to overcome the inherent resilience of the seal portion.

31) A valve as claimed in claim 30, in which movement of the seal portion from the deformed configuration toward it's initial resiliently biased configuration increases flow area past the seal.

32) A valve as claimed in any one of claims 29 to 31, in which the body portion is deformable in response to the pressure of a fluid acting on the body portion upstream of the seal portion prior to the valve opening.

33) A valve as claimed in acclaim 32, in which the body portion is deformable in response to the pressure of a fluid acting on the body portion upstream and downstream of the seal portion when the valve is open.

34) An inserted precompression outlet valve suitable for any manual pump dispenser or trigger for dispensing a fluid that allows one or more fluids to pass from the pump to the final outlet but only after a certain set pressure has been achieved and designed in such away that the forces on the valve act in a direction substantially angled away from the line of flow of the fluids causing the valve to be deformed or moved away from the line of flow in such a manner that the backpressure force caused by the outlet hole also helps to move or deform the valve in a similar direction.

35) A fluid device comprising a valve as claimed in the preceding claims where the body of the valve is an integral part of the body of the device.

36) A fluid device as described in claim 35 where the body of the device is an outlet of a squeezy bottle or tube or flexible sachet or bag or any flexible container that delivers a bolus of liquor or paste past the resiliently deformable valve member when deformed.

37) A fluid device as described in claim 35 where the body of the device is an outlet of a squeezy bottle or tube or flexible sachet or bag or any flexible container that delivers a spray of liquor when deformed.

38) A fluid device as described in claim 35 where the body of the device is a squeezy bottle or tube or flexible sachet or bag or any flexible container that delivers a bolus of liquor or paste past the resiliently deformable valve member when deformed.

39) A fluid device as described in claim 35 where the body of the device is an outlet nozzle.

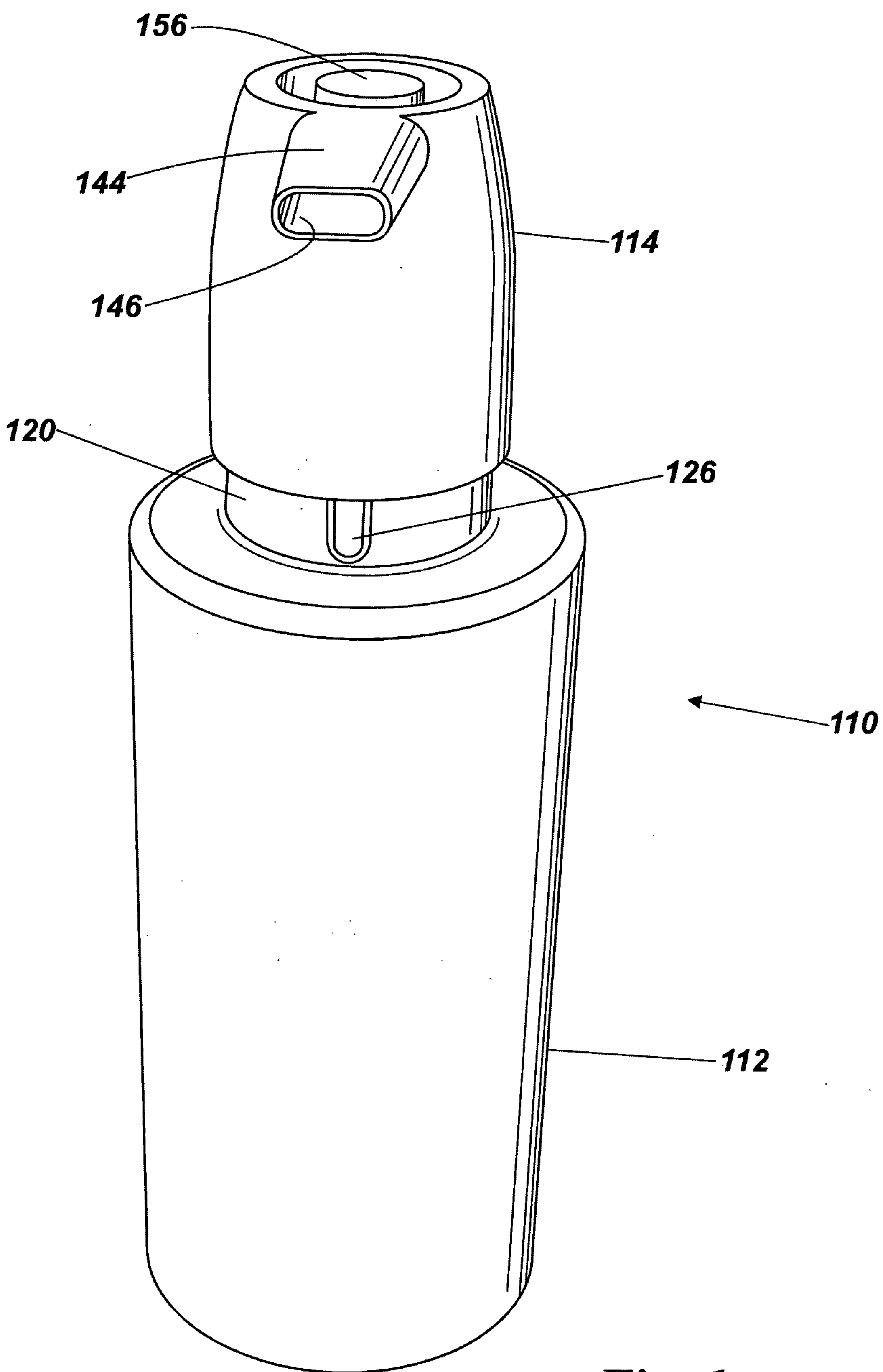


Fig. 1

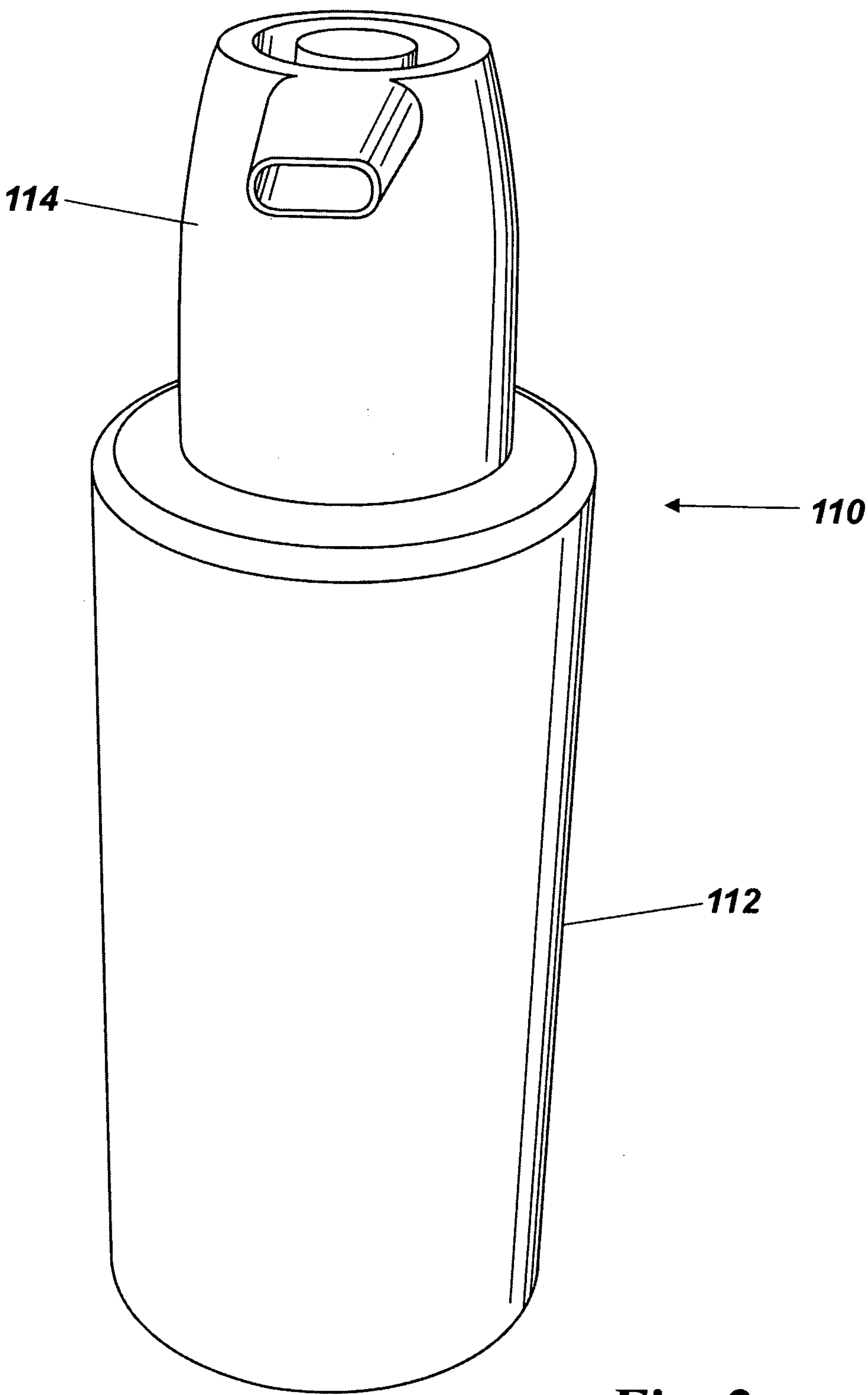


Fig. 2

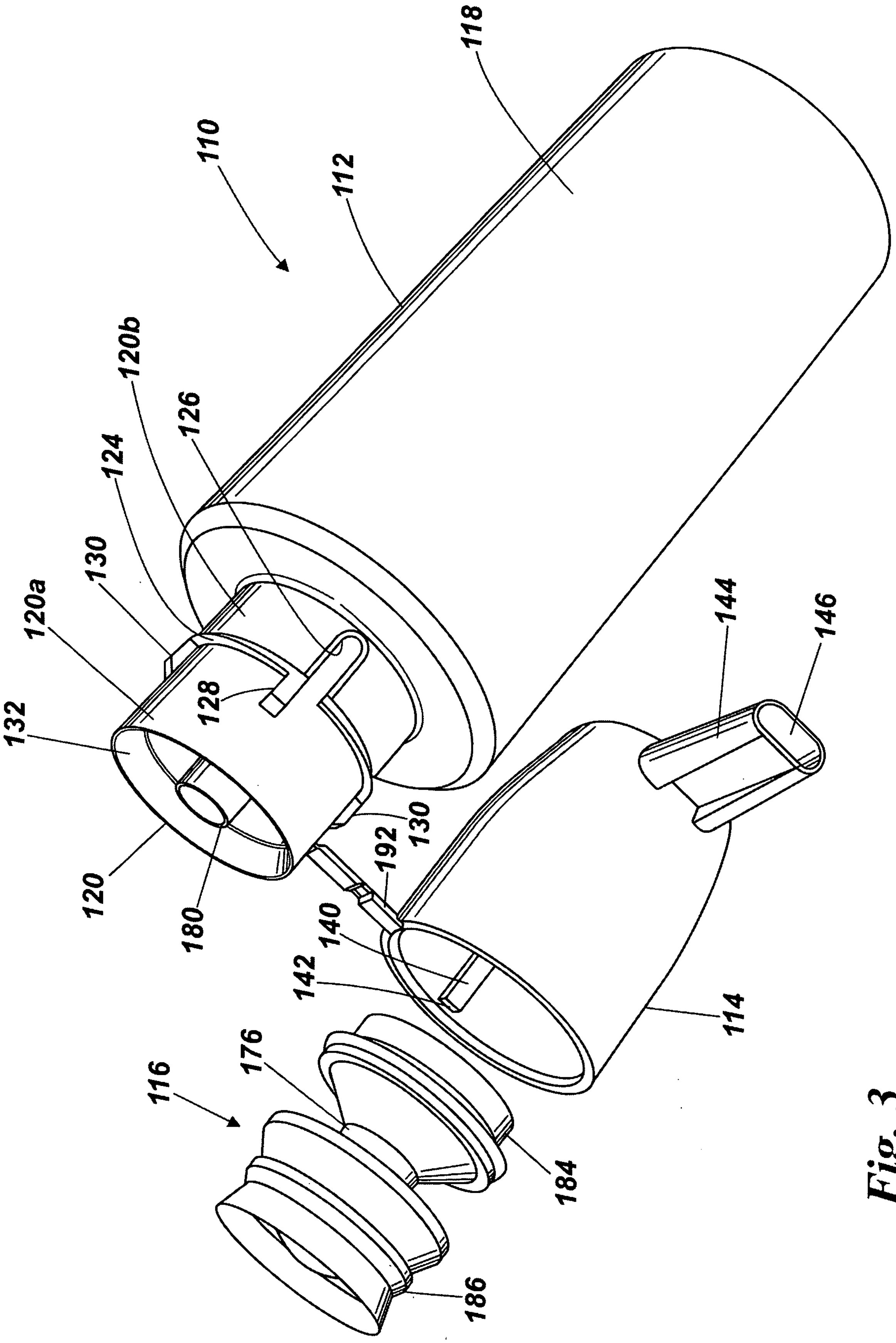

118
110
112
120b
126
124
130
120a
128
132
144
146
130
192
120
180
140
142
114
116
176
184
186

Fig. 3

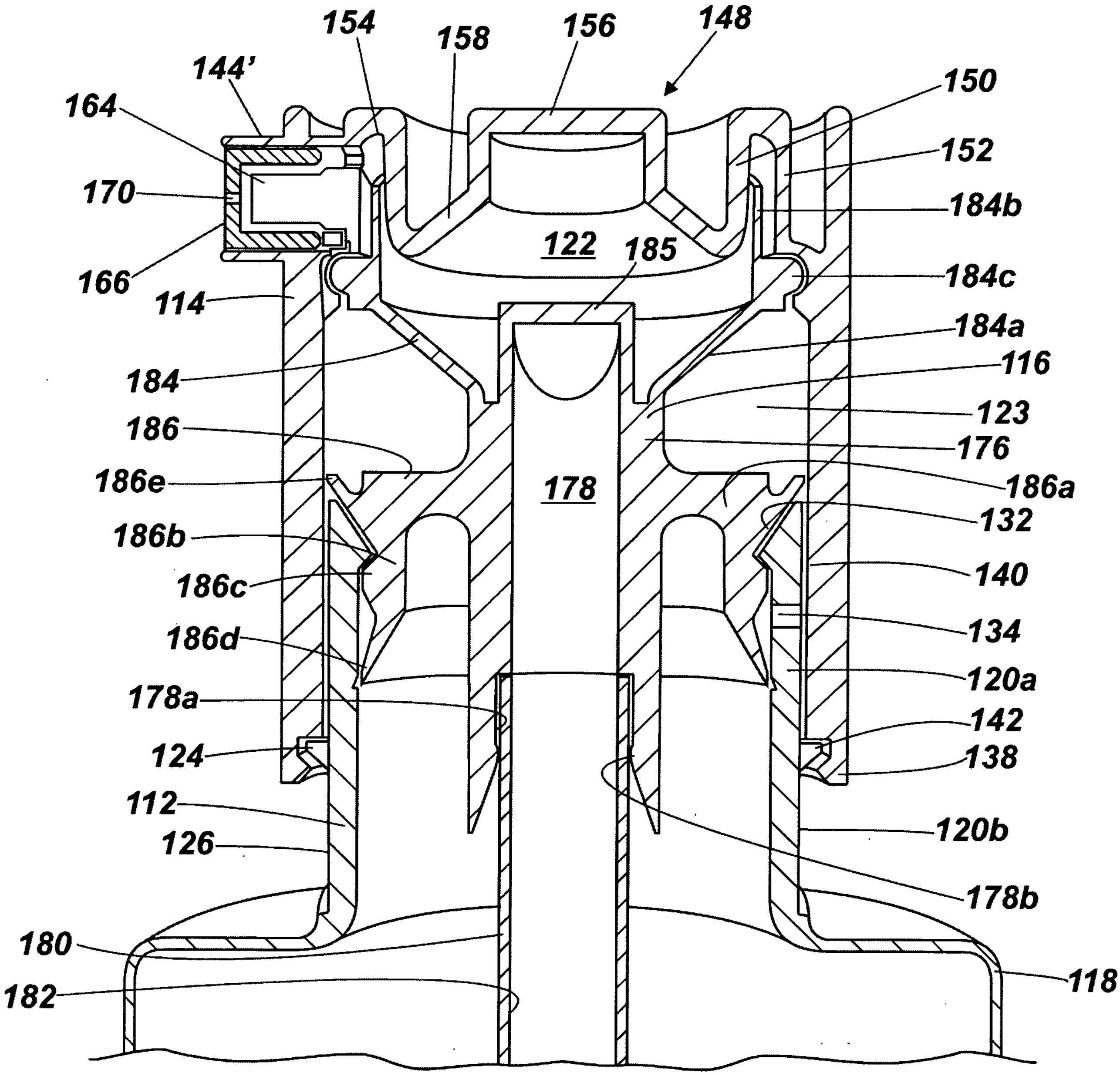

154
158
156
148
144'
164
150
152
170
184b
122
185
166
184c
114
184a
184
116
123
186
176
186e
178
186a
132
186b
140
186c
134
186d
120a
178a
142
124
138
112
120b
126
178b
180
118
182

Fig. 4

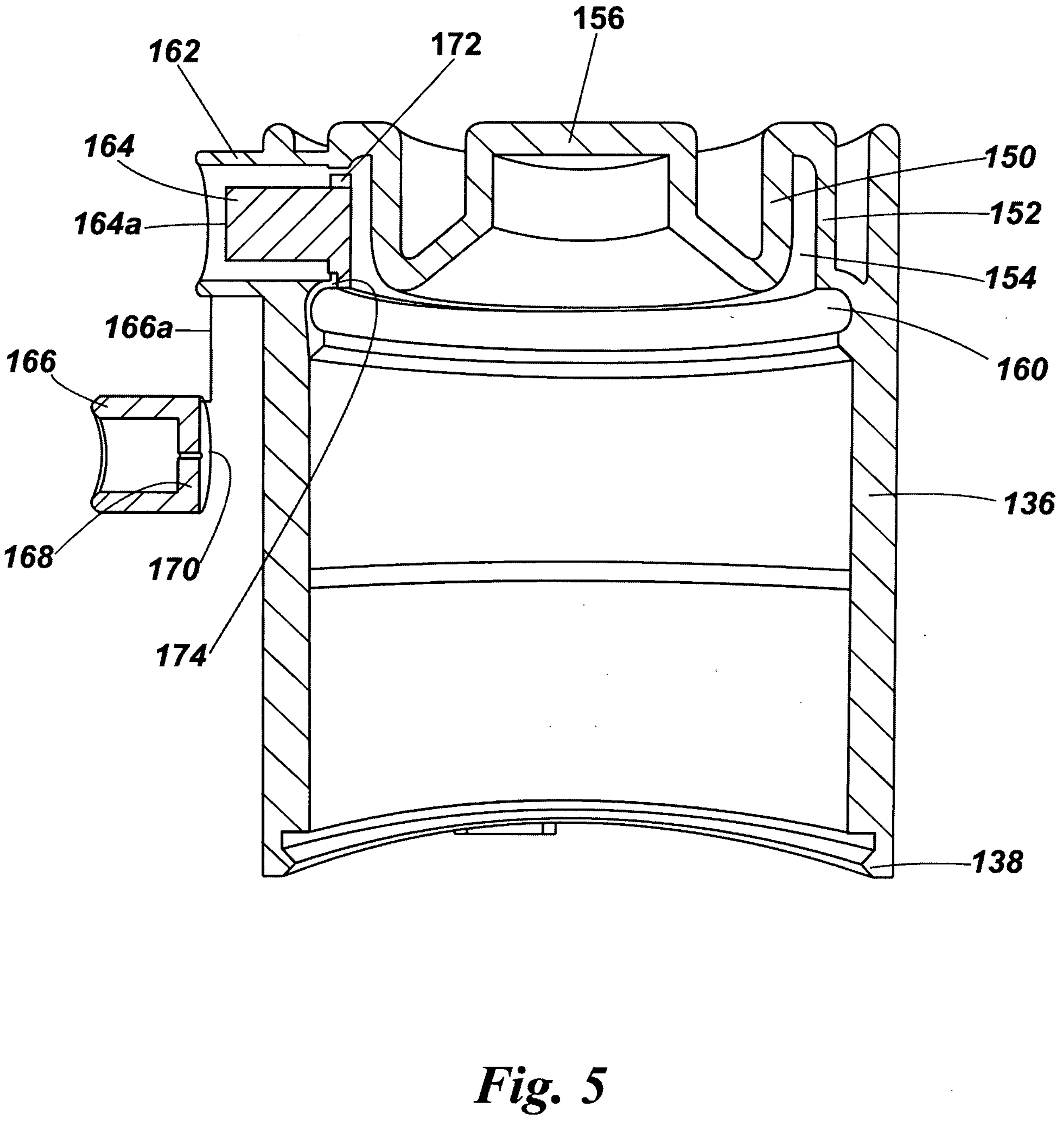

156
162
172
164
150
164a
152
154
166a
160
166
136
168
170
174
138

Fig. 5

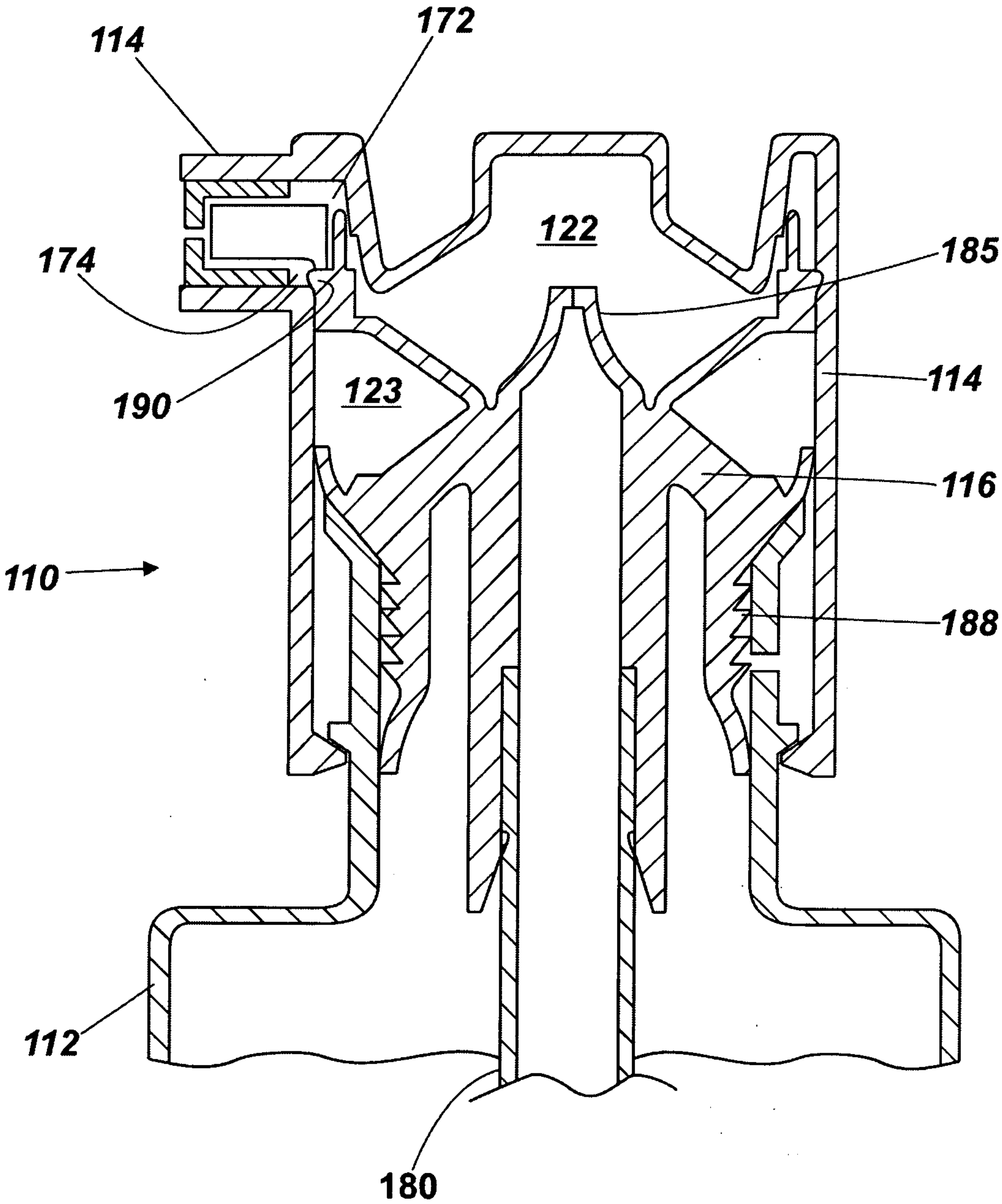


Fig. 6

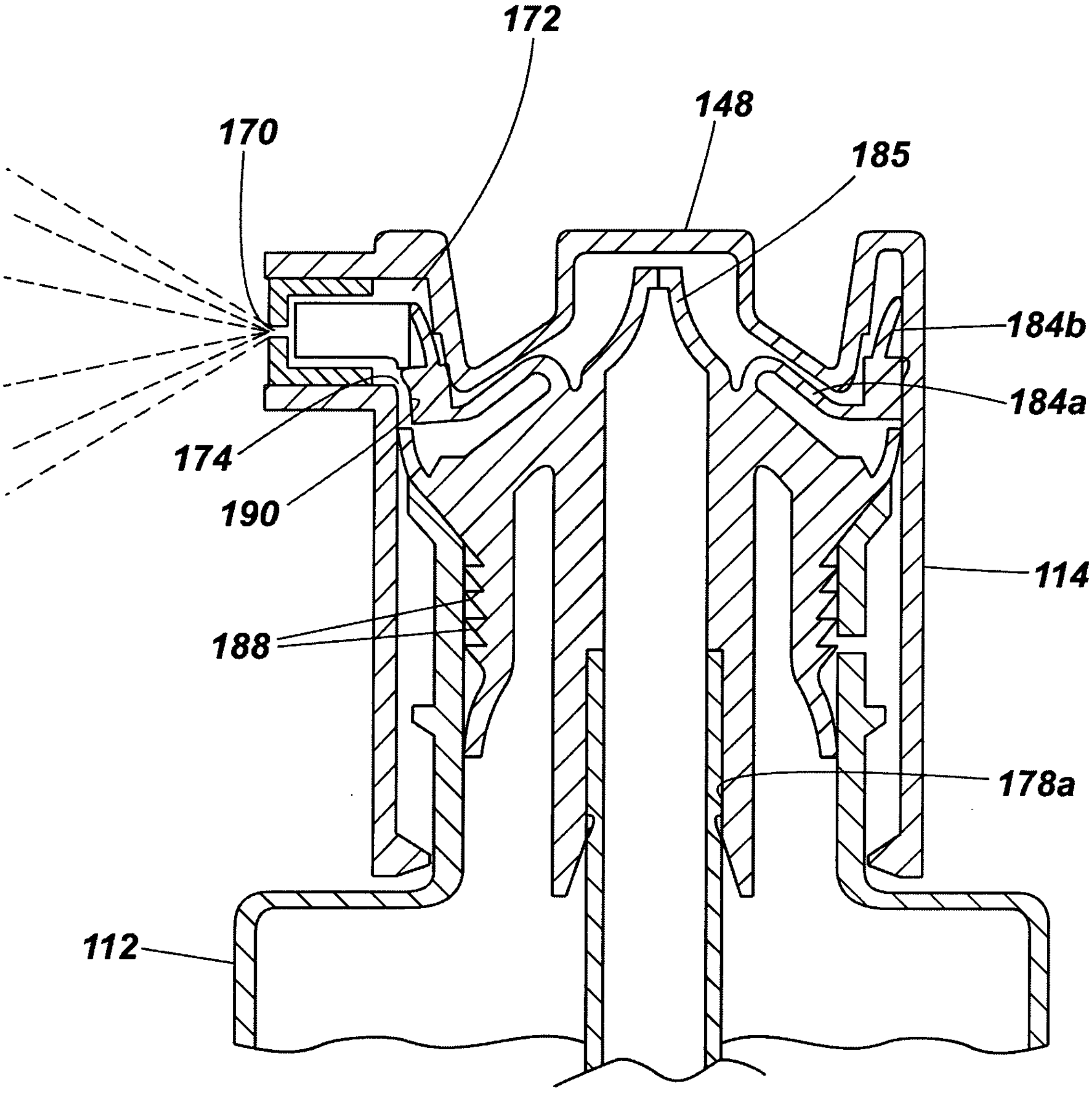


Fig. 7

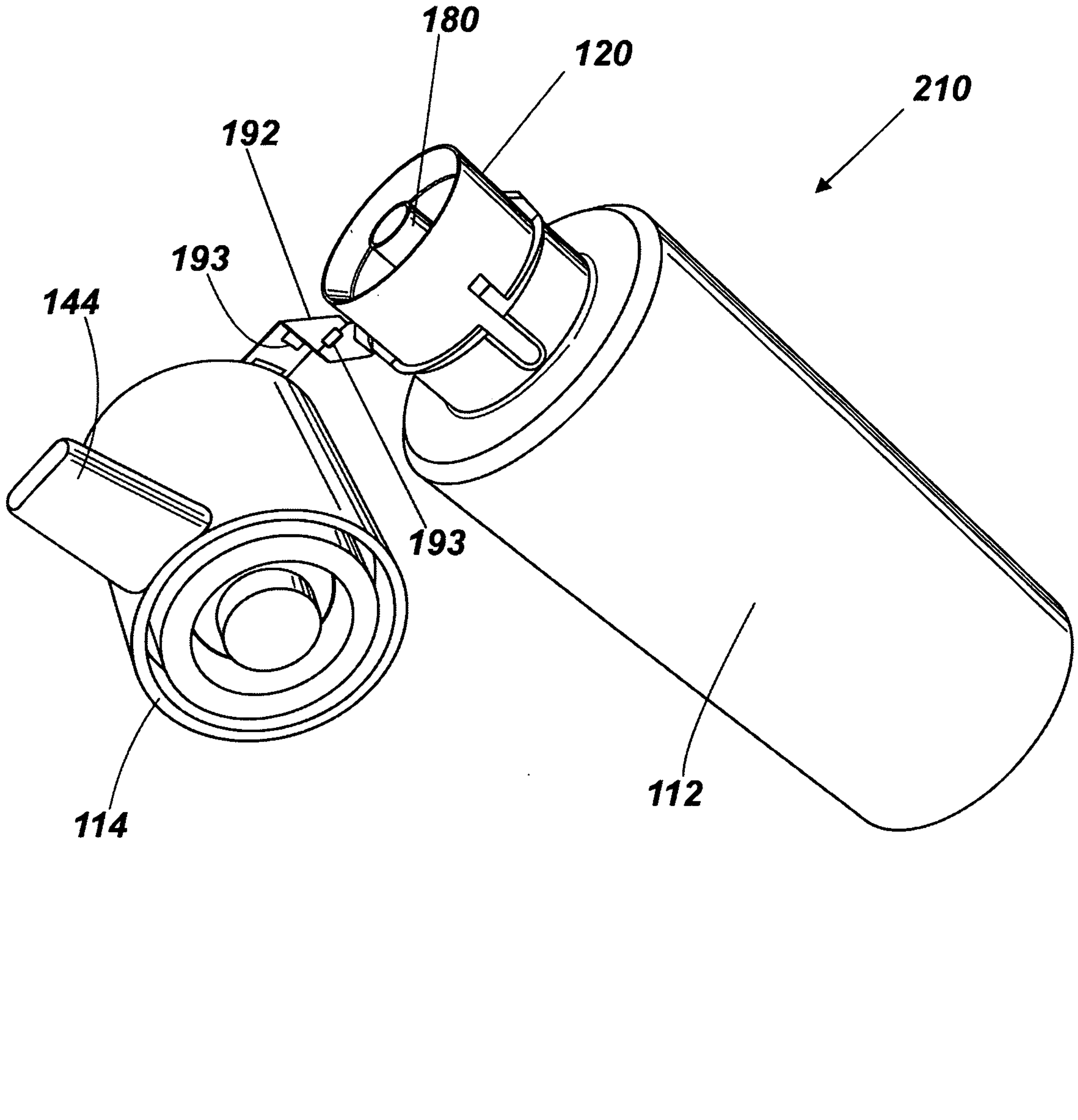


Fig. 8

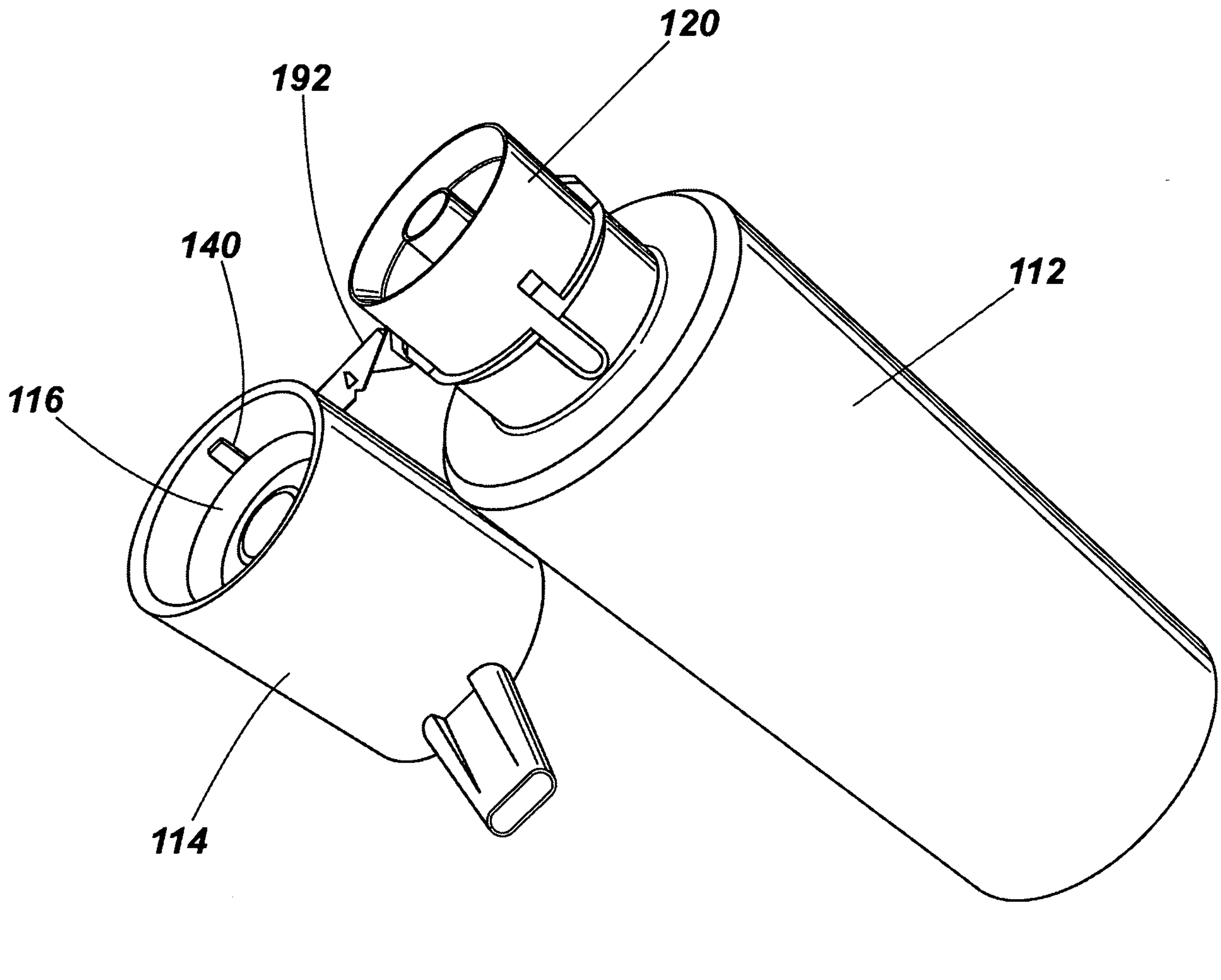


Fig. 9

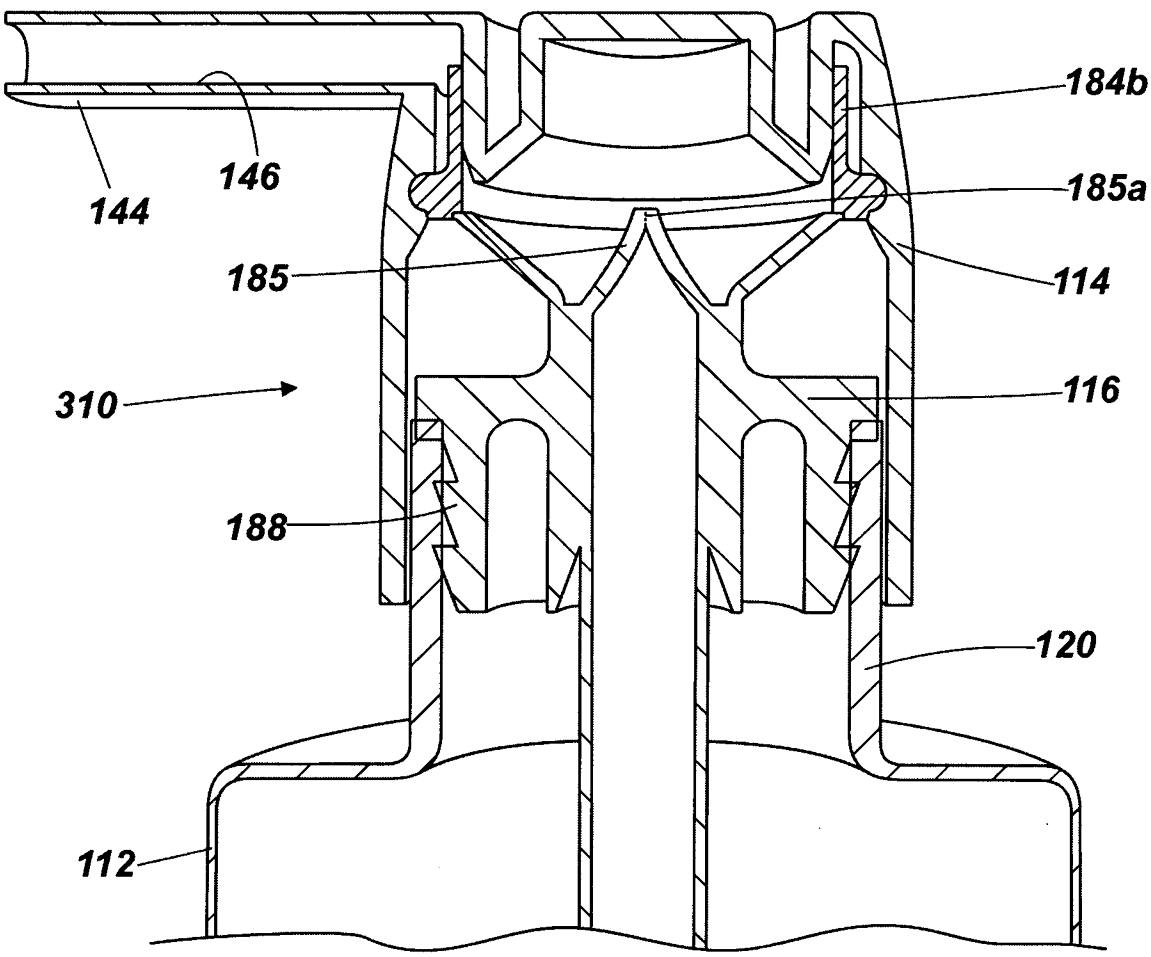


Fig. 10

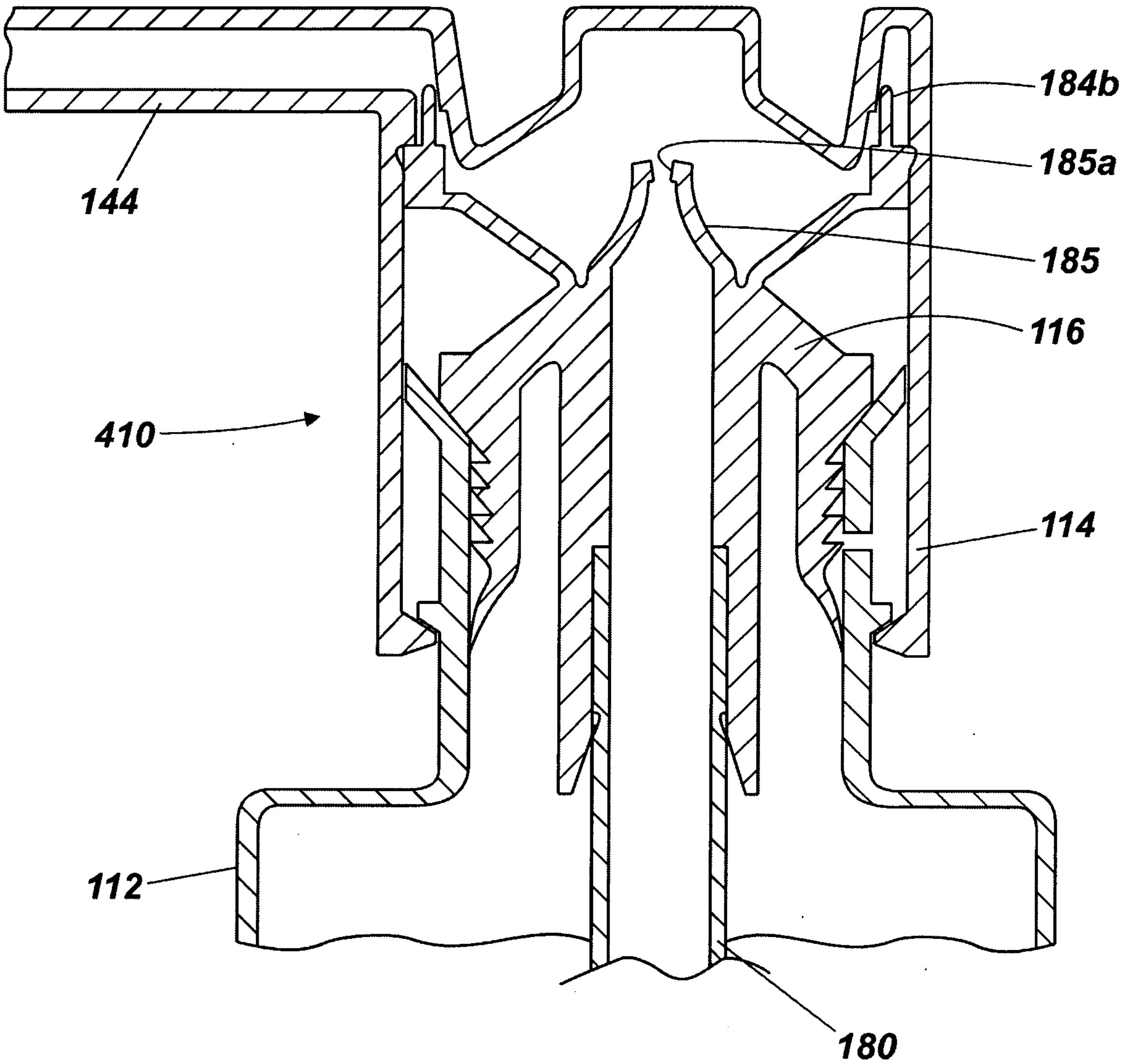


Fig. 11

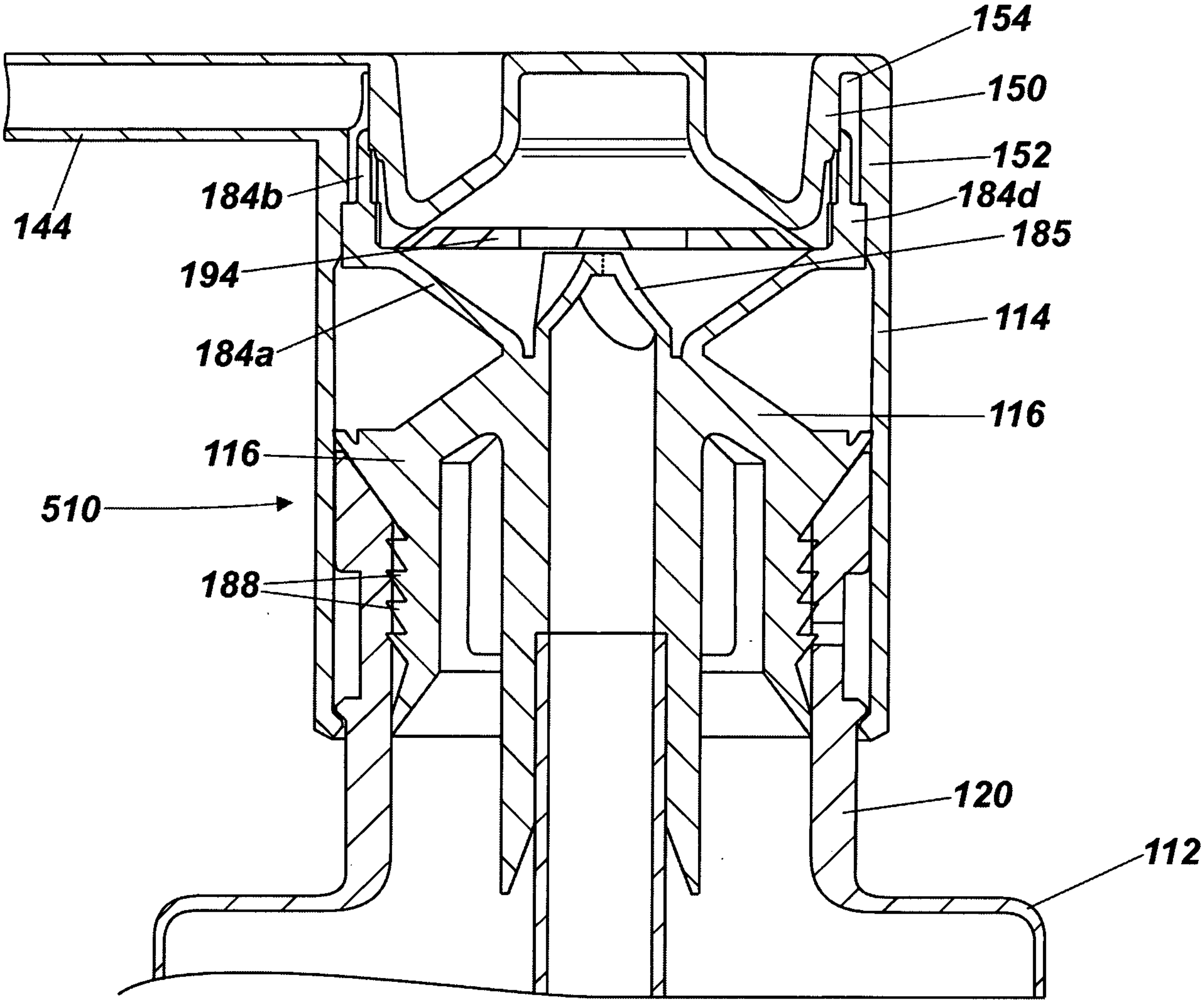
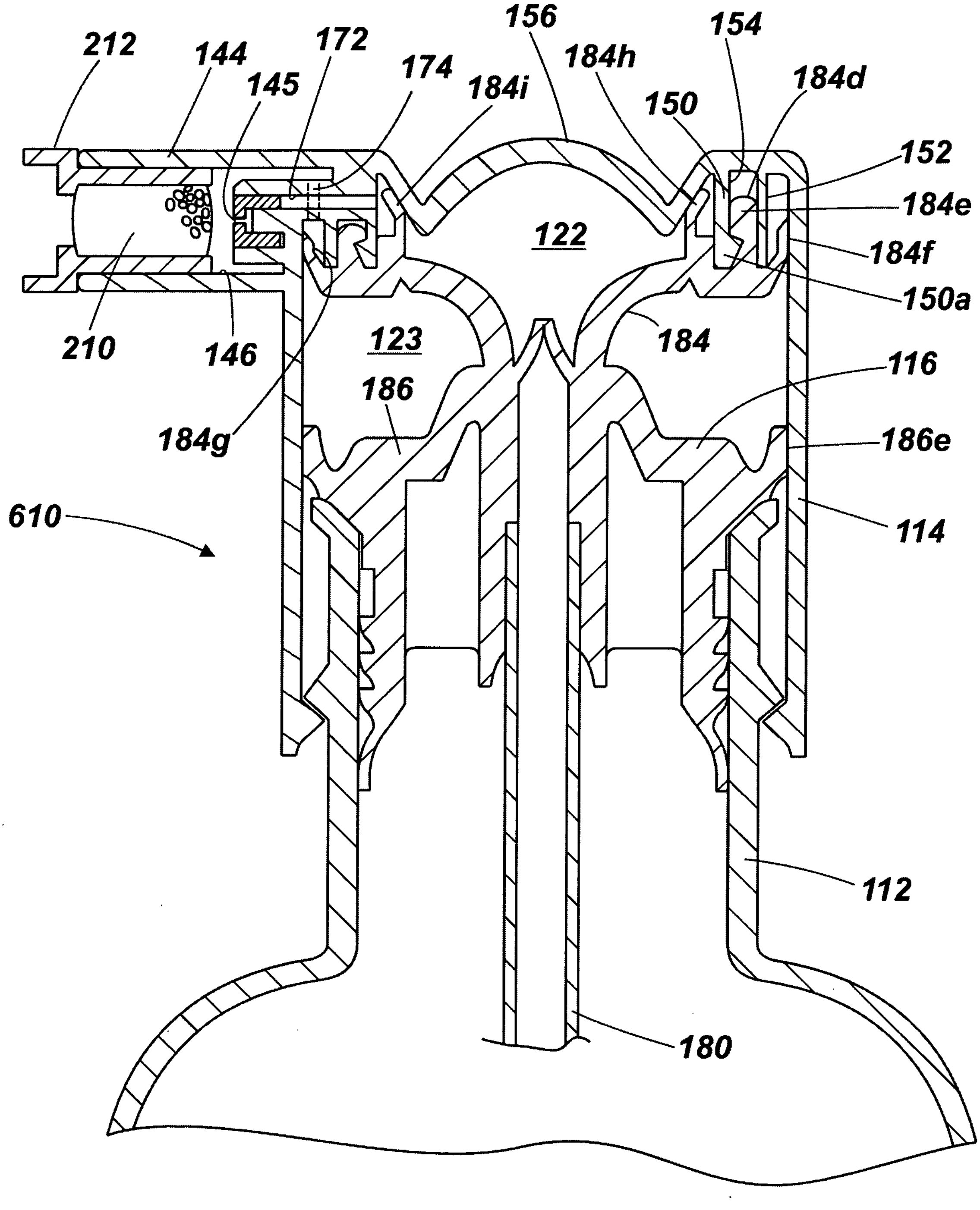

154
150
152
184d
185
114
116
120
112
144
184b
194
184a
116
510
188

Fig. 12



212
144
145
172
174
184i
156
184h
150
154
184d
152
184e
184f
150a
122
123
184
116
186
186e
210
146
184g
610
114
112
180

Fig. 13

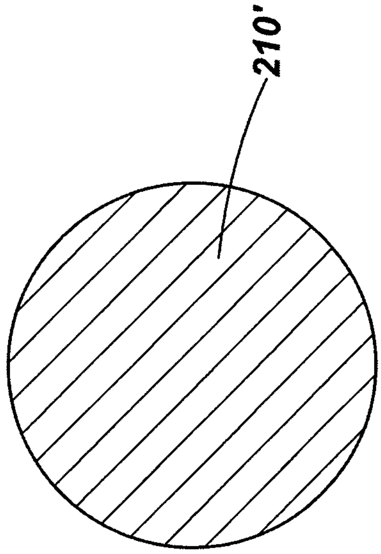


Fig. 14b

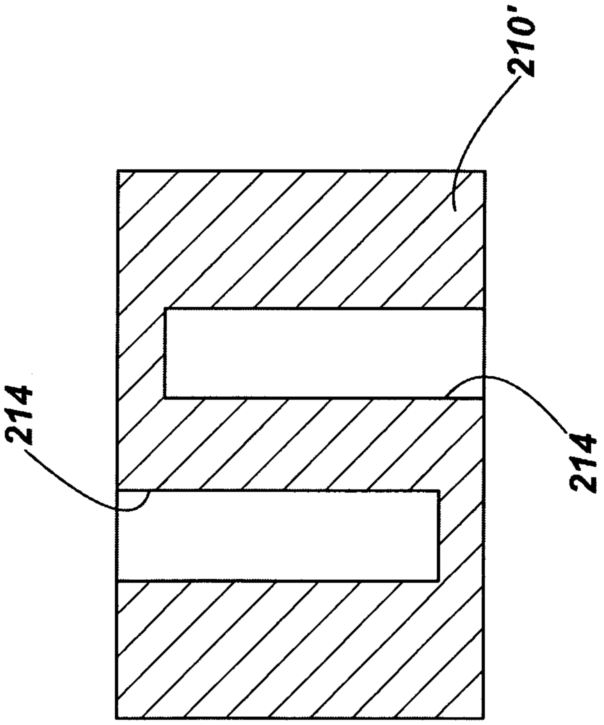


Fig. 14a

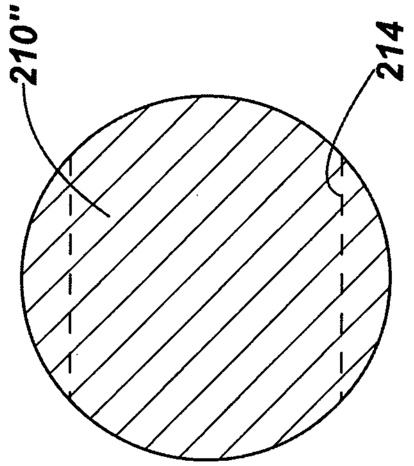


Fig. 15b

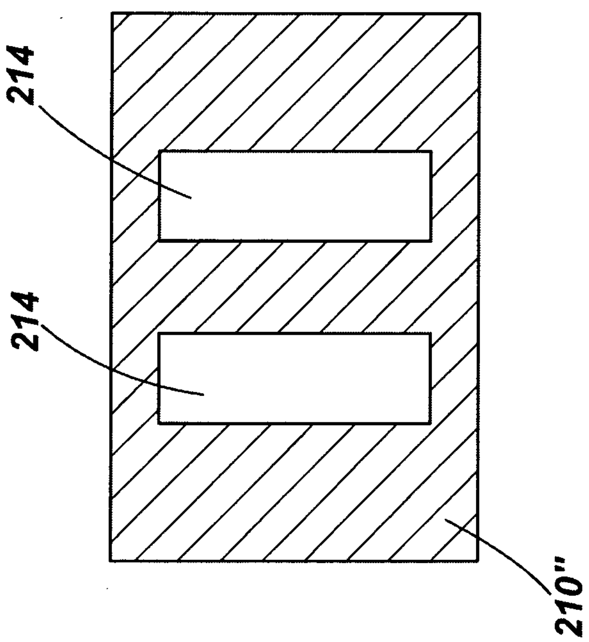


Fig. 15a

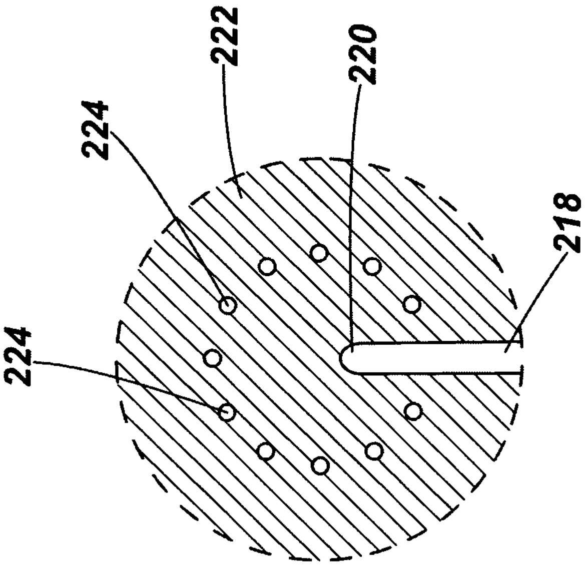


Fig. 16b

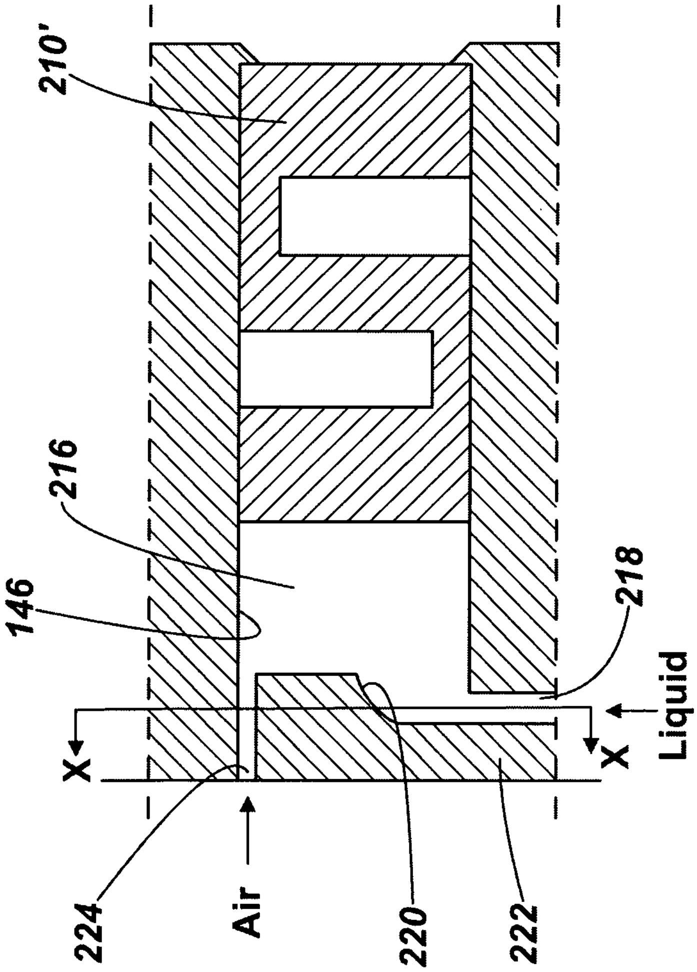


Fig. 16a

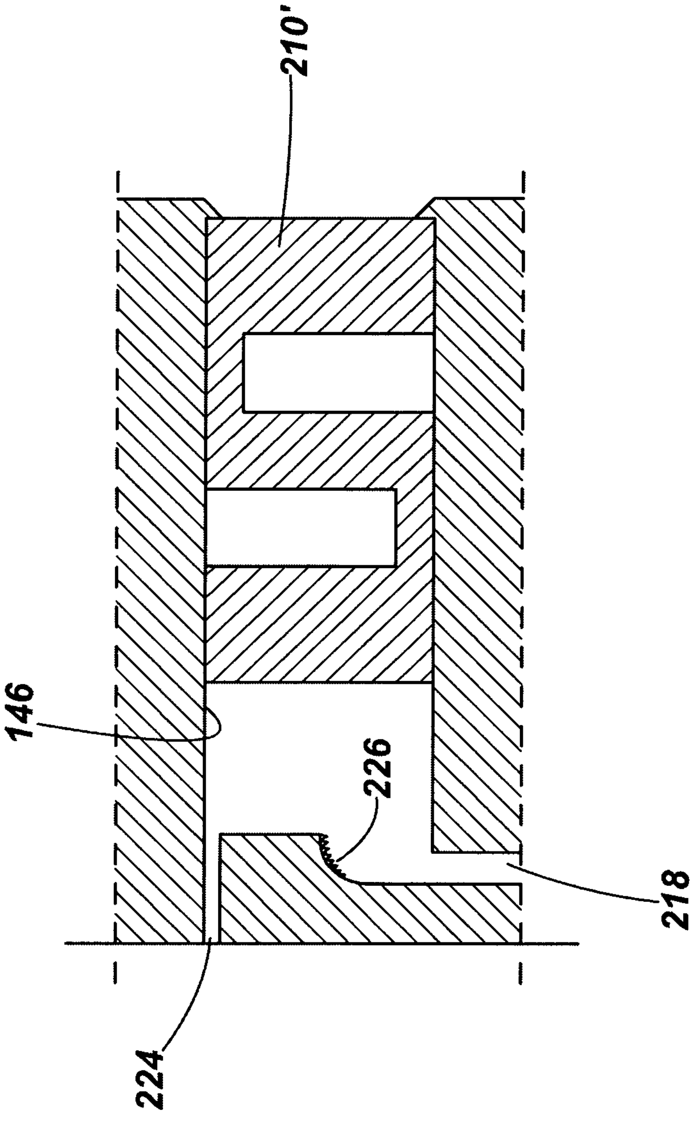


Fig. 17

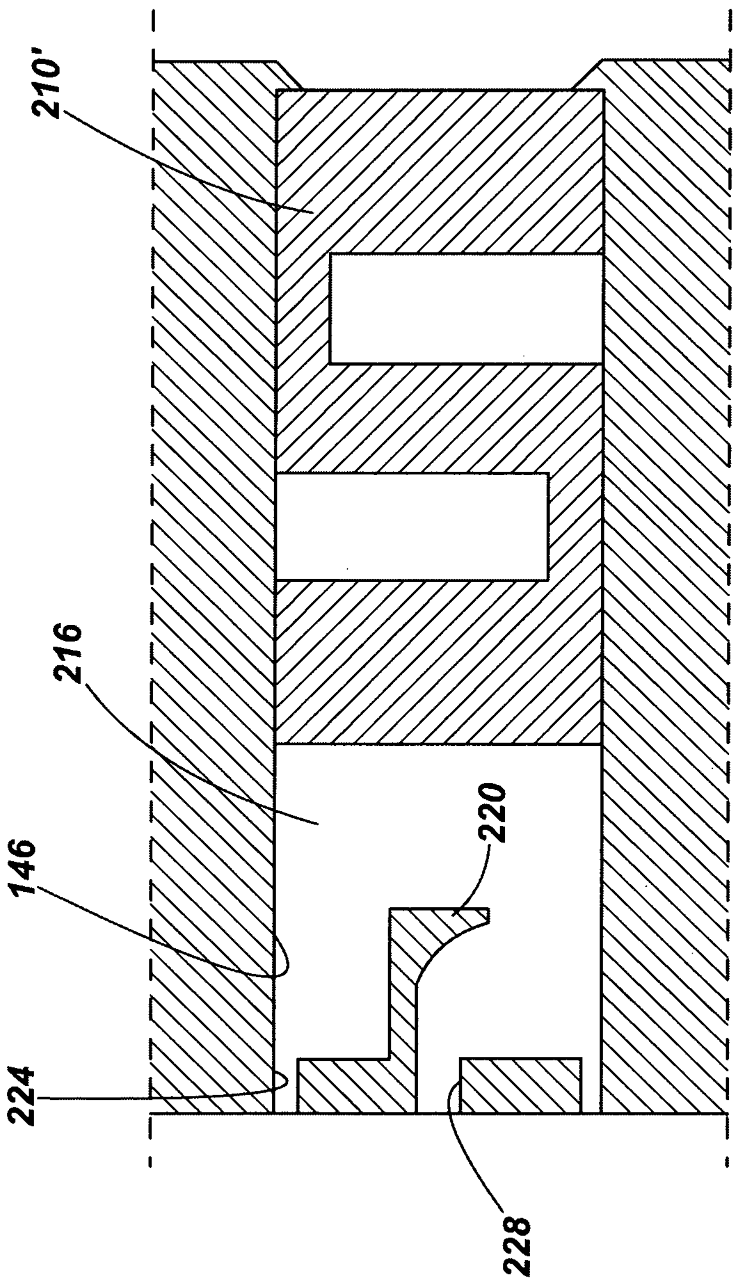


Fig. 18

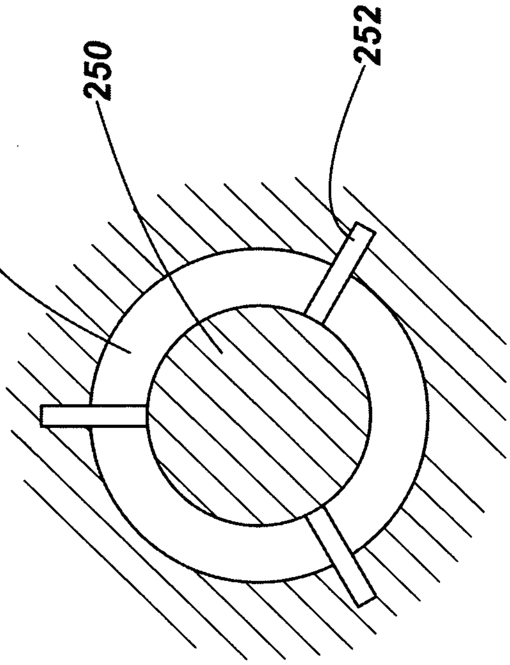


Fig. 19b

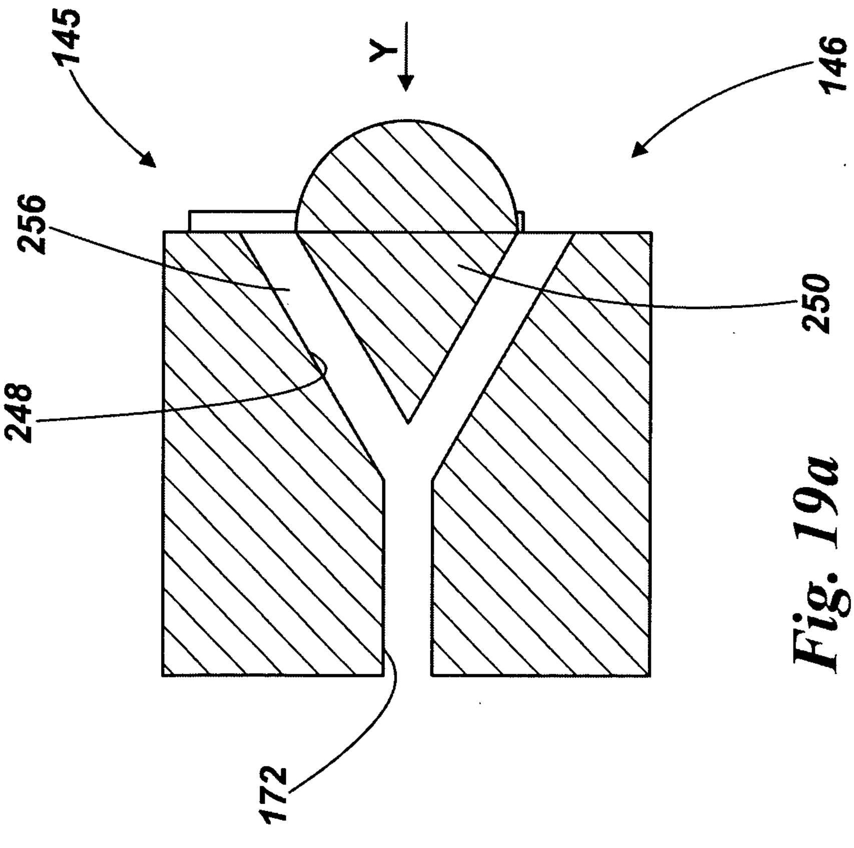


Fig. 19a

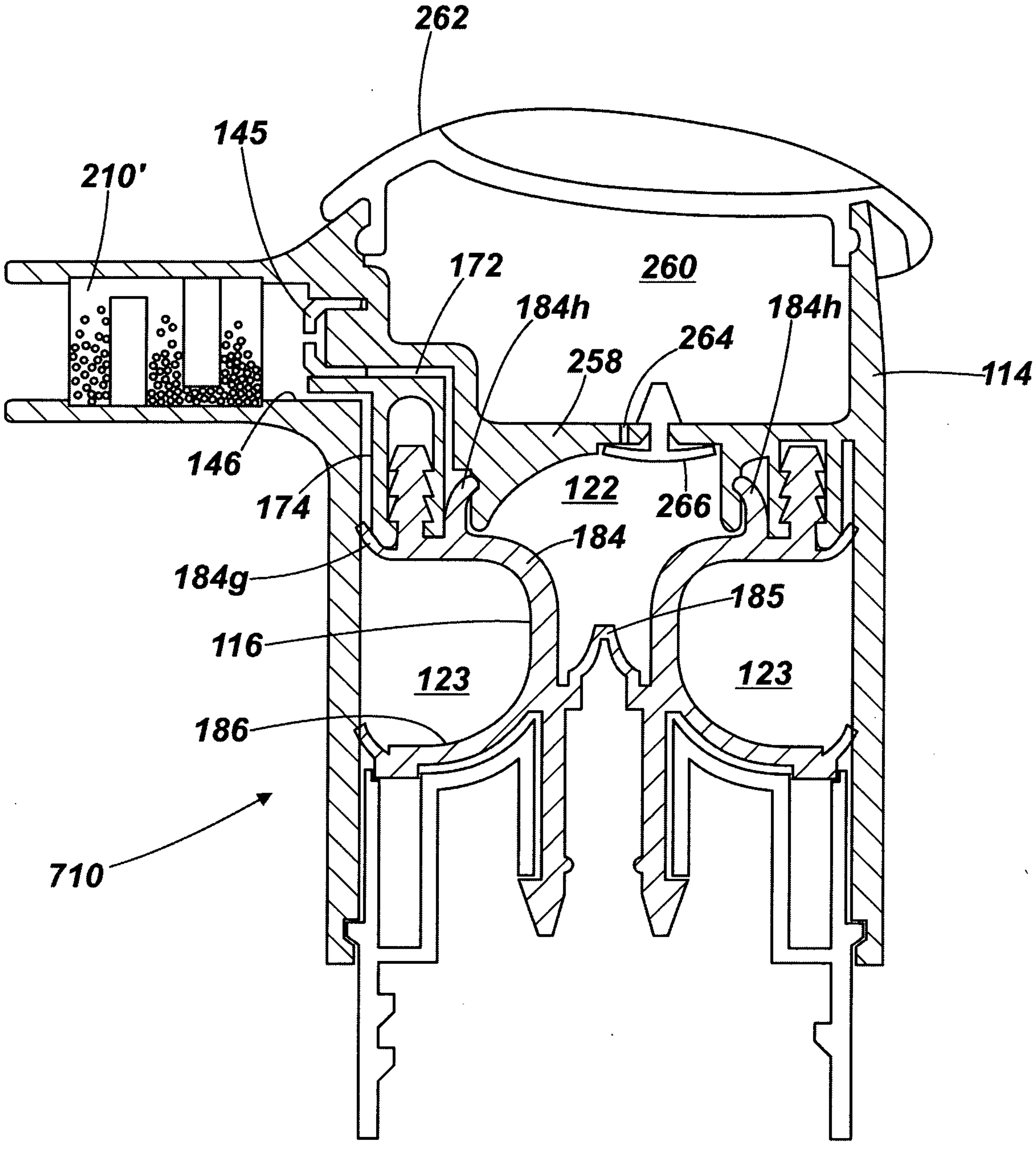

262
145
210'
172
260
184h
184h
264
258
114
146
174
122
266
184
184g
185
116
123
123
186
710

Fig. 20

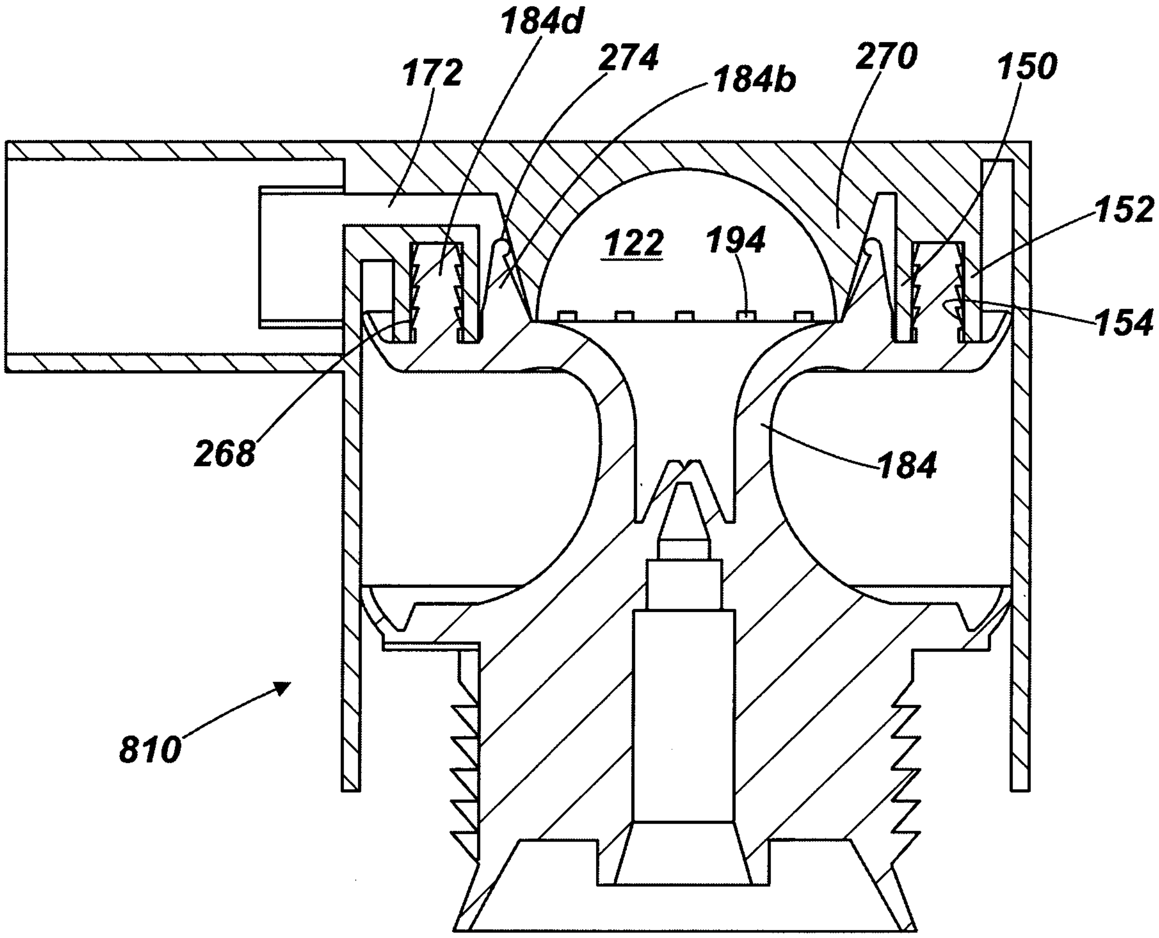


Fig. 21

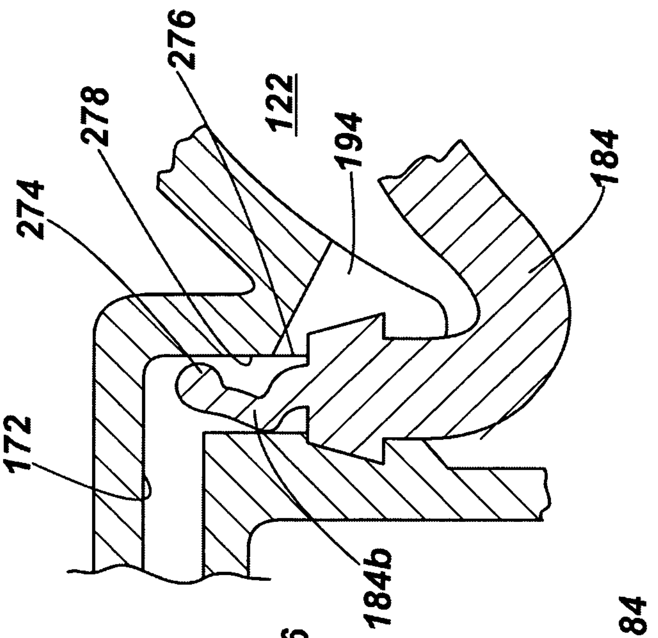


Fig. 22c

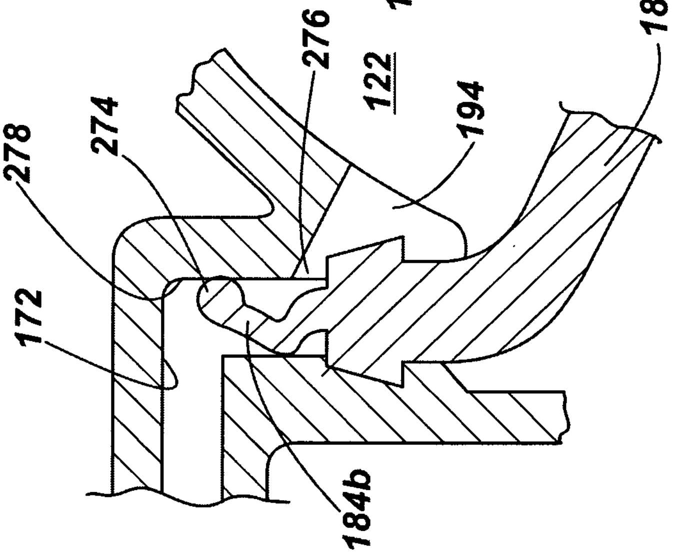


Fig. 22b

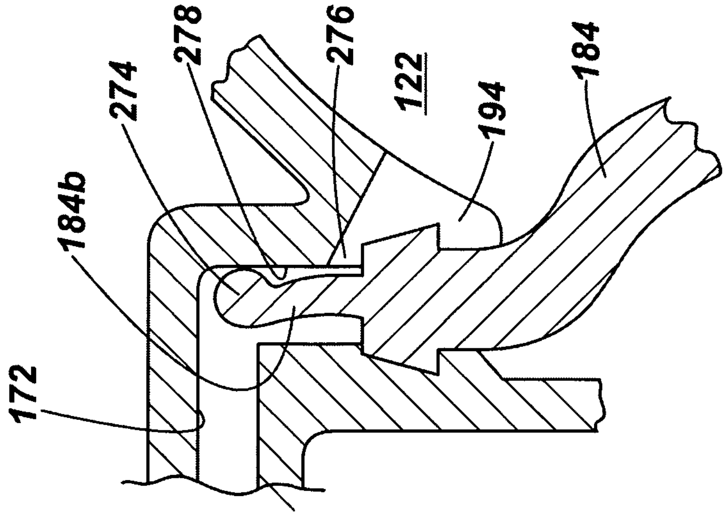


Fig. 22a

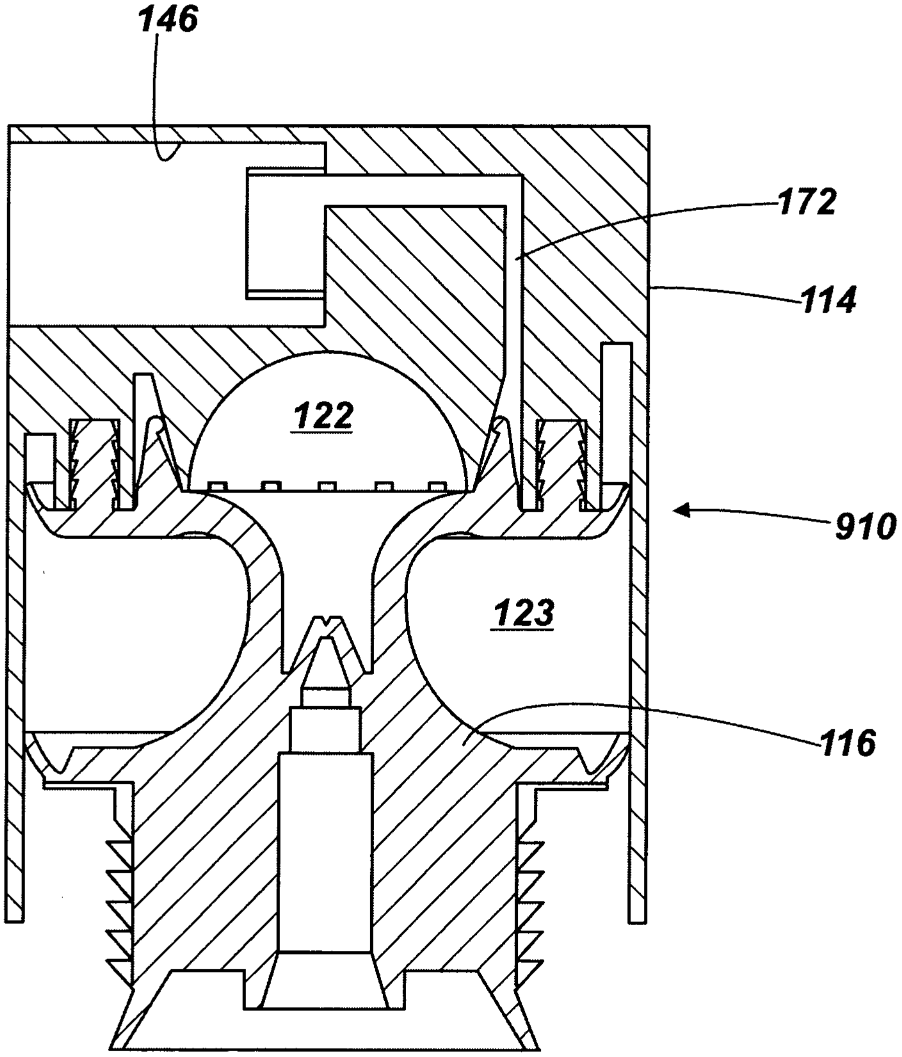


Fig. 23

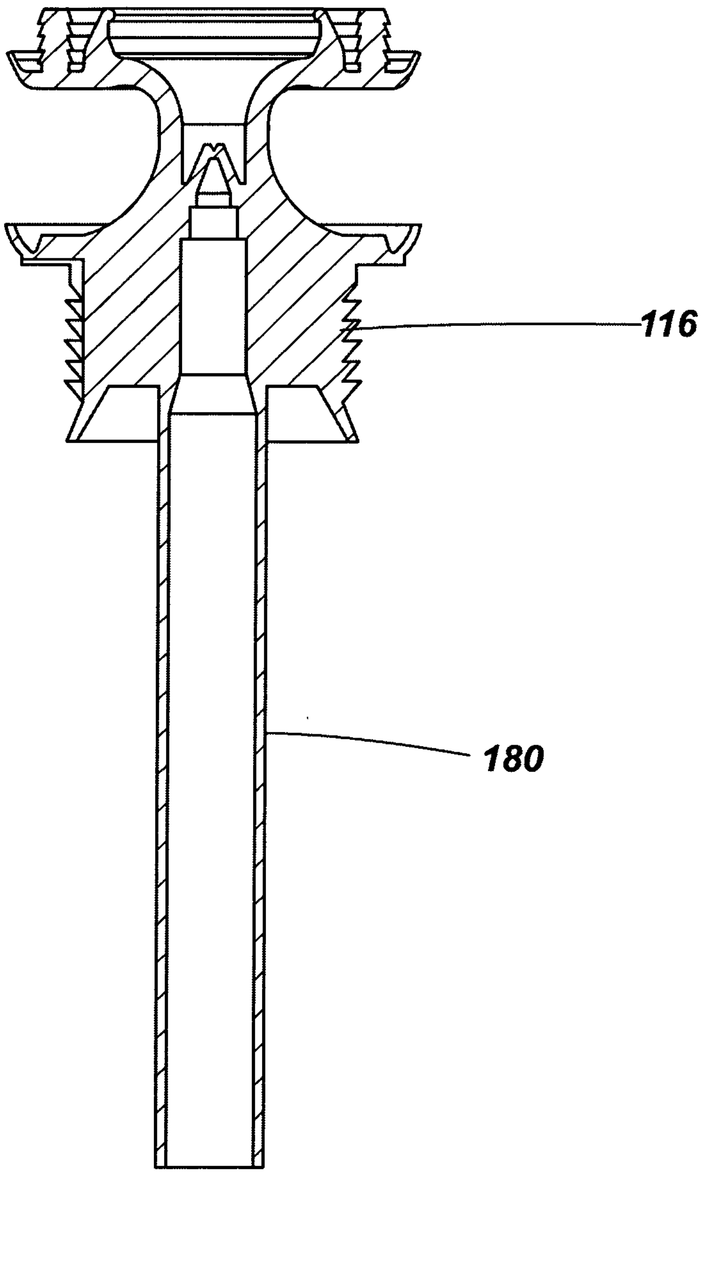


Fig. 24

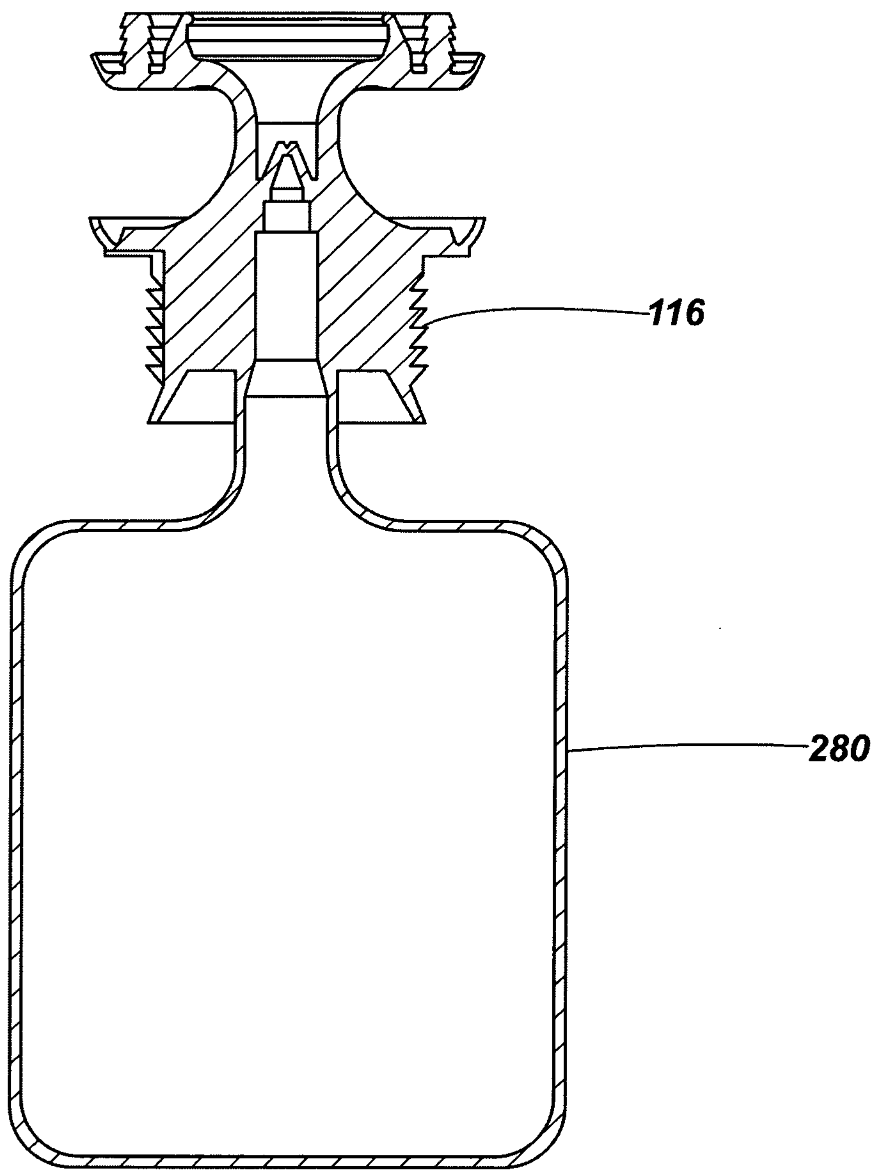


Fig. 25

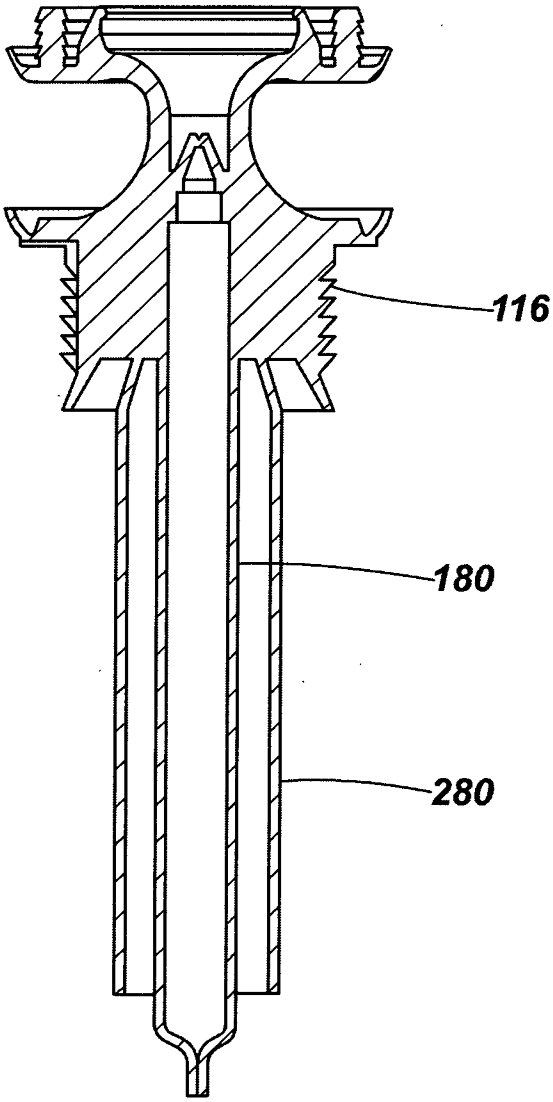


Fig. 26

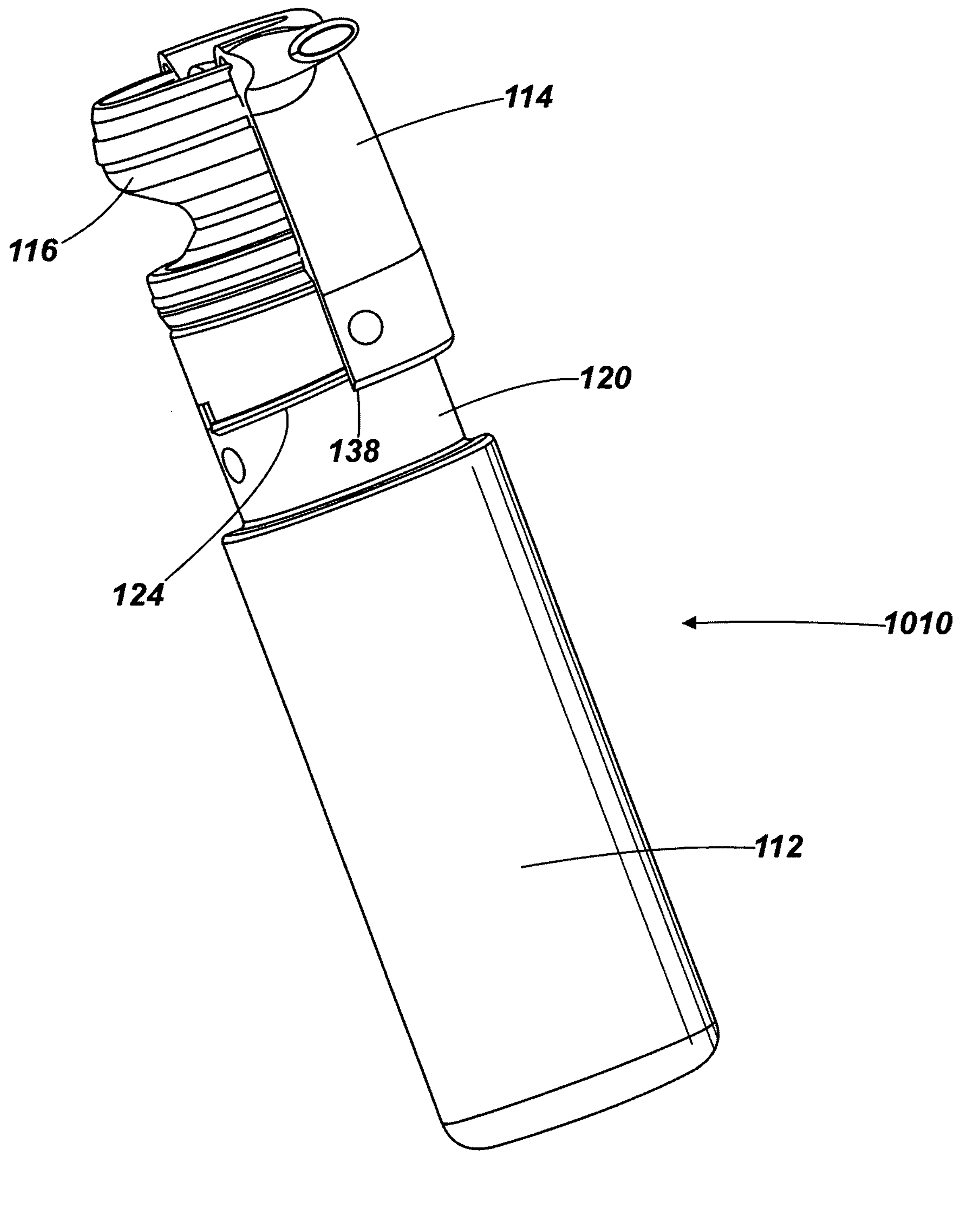


Fig. 27

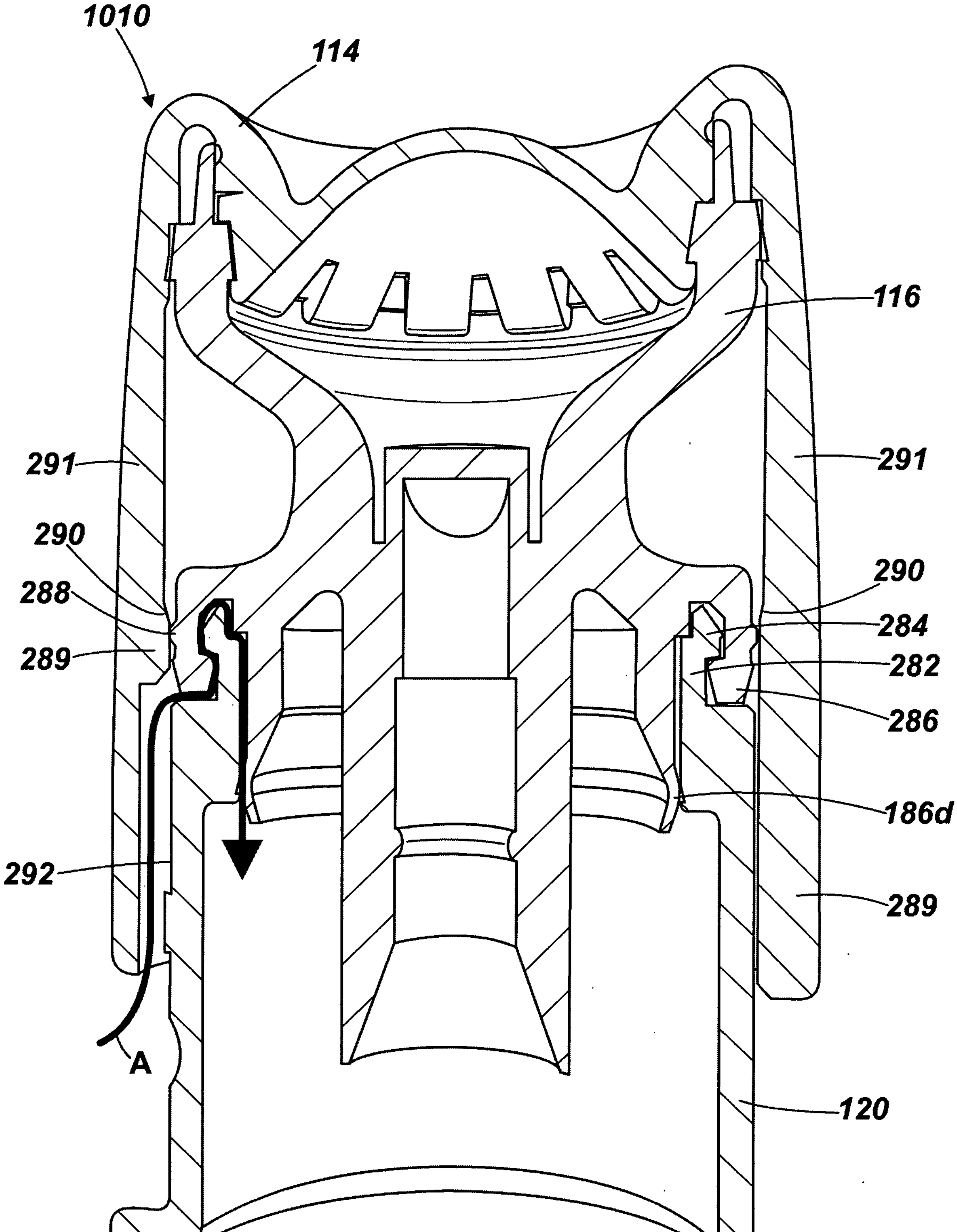

1010
114
116
291
291
290
290
288
284
289
282
286
186d
292
289
A
120

Fig. 28

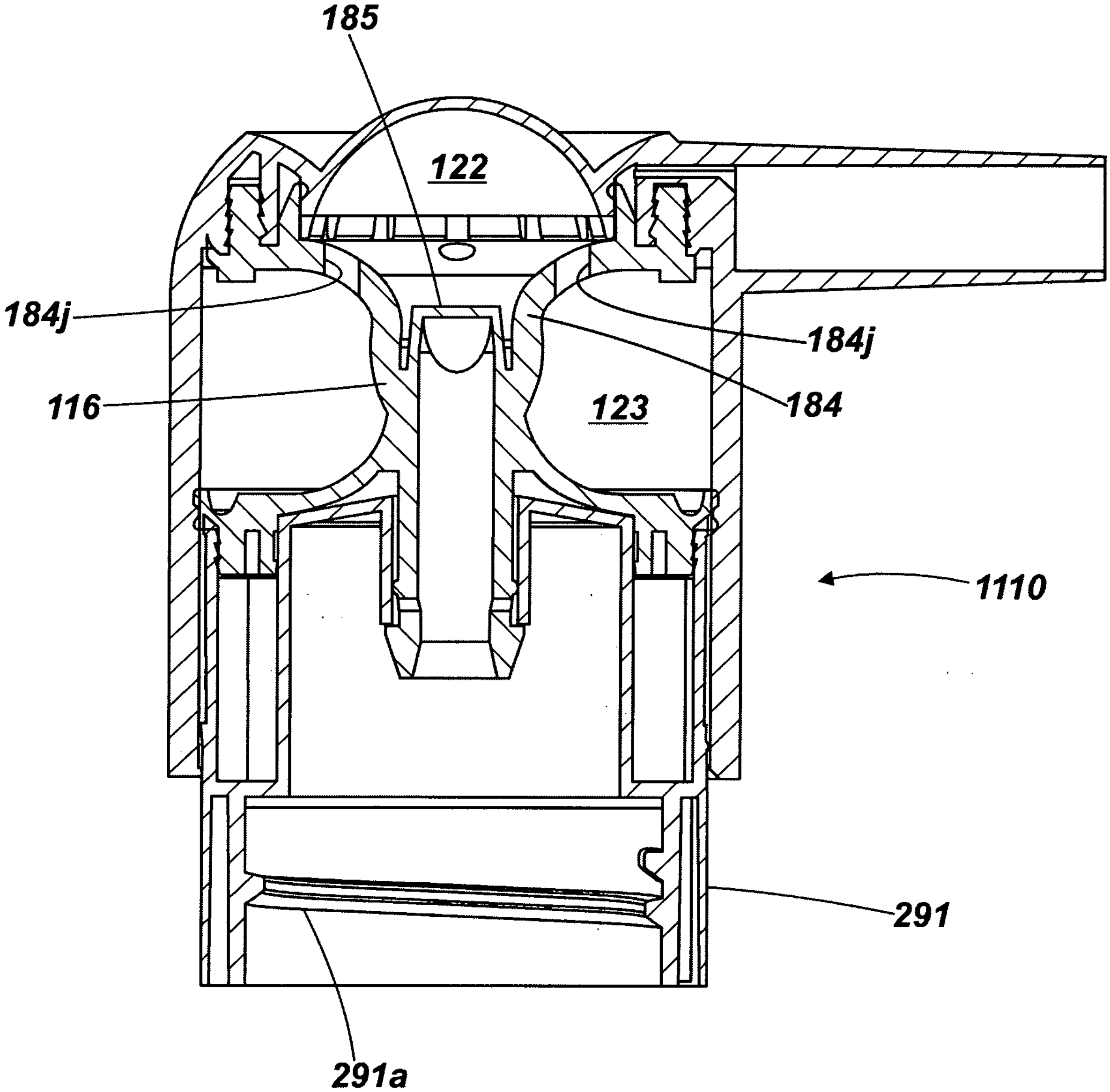


Fig. 29

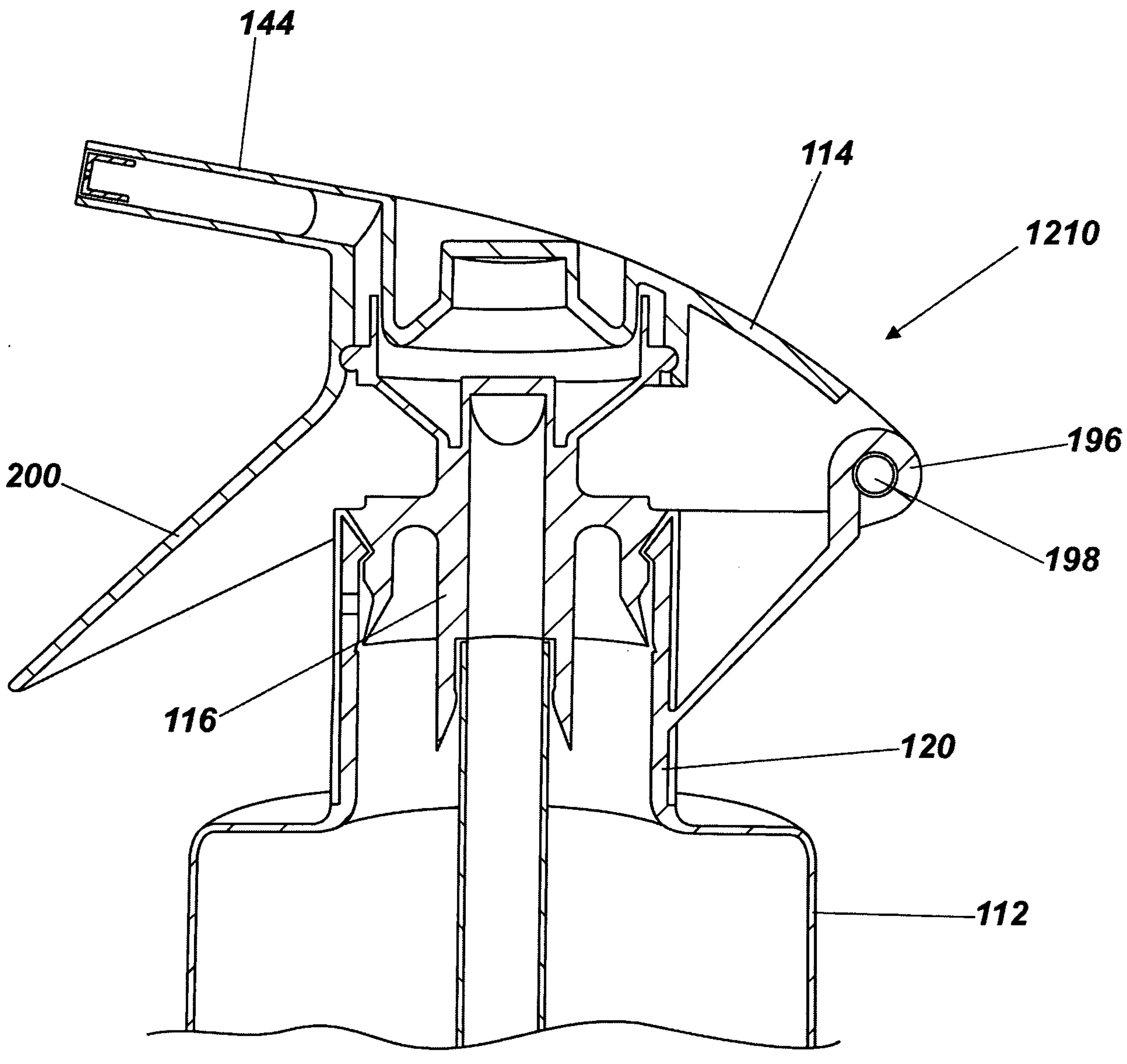


Fig. 30

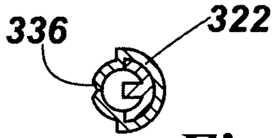

336
322

Fig. 32

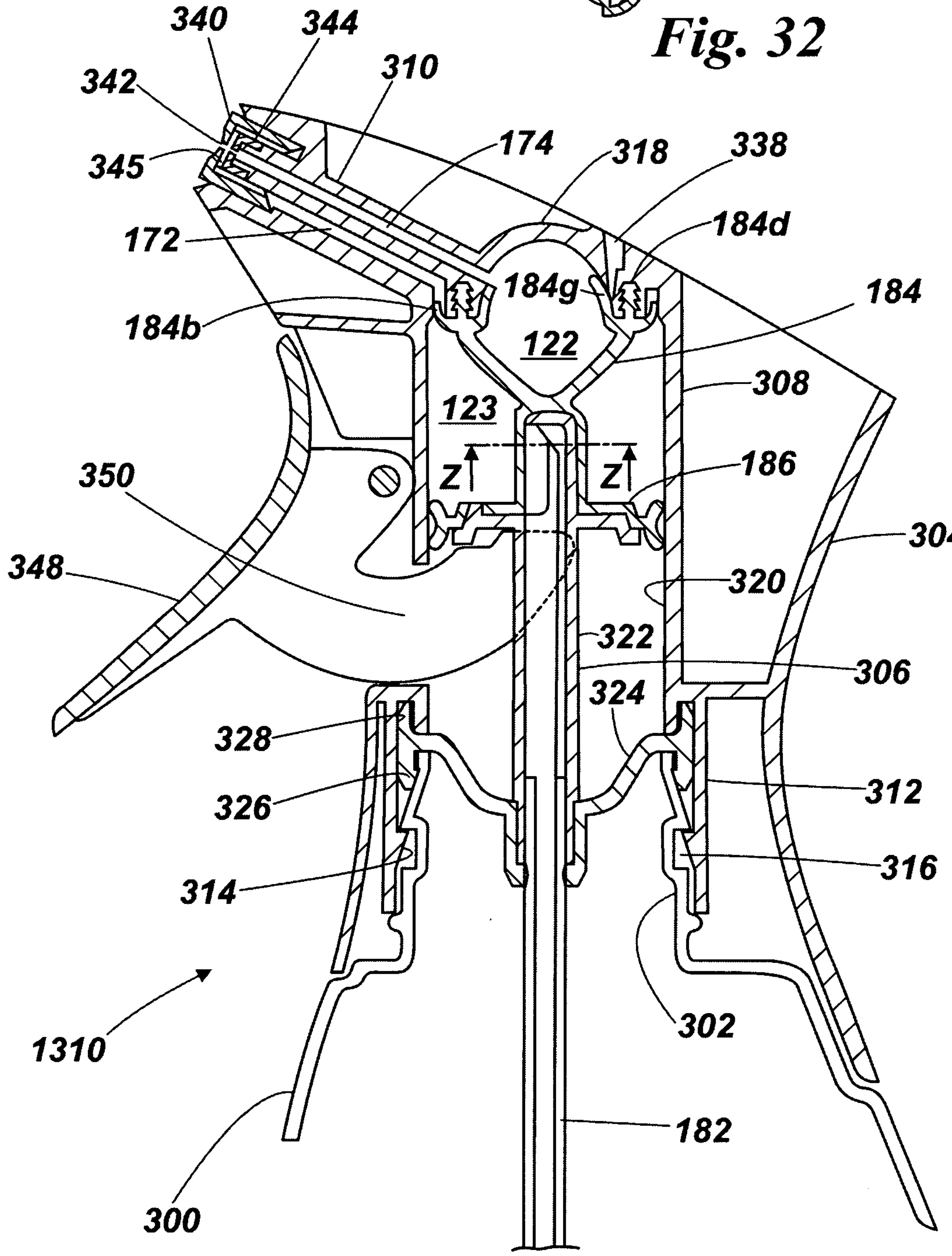

340
344
310
342
345
174
318
338
172
184d
184g
184b
184
122
308
123
Z
Z
186
350
304
348
320
322
306
324
328
312
326
316
314
1310
302
182
300

Fig. 31

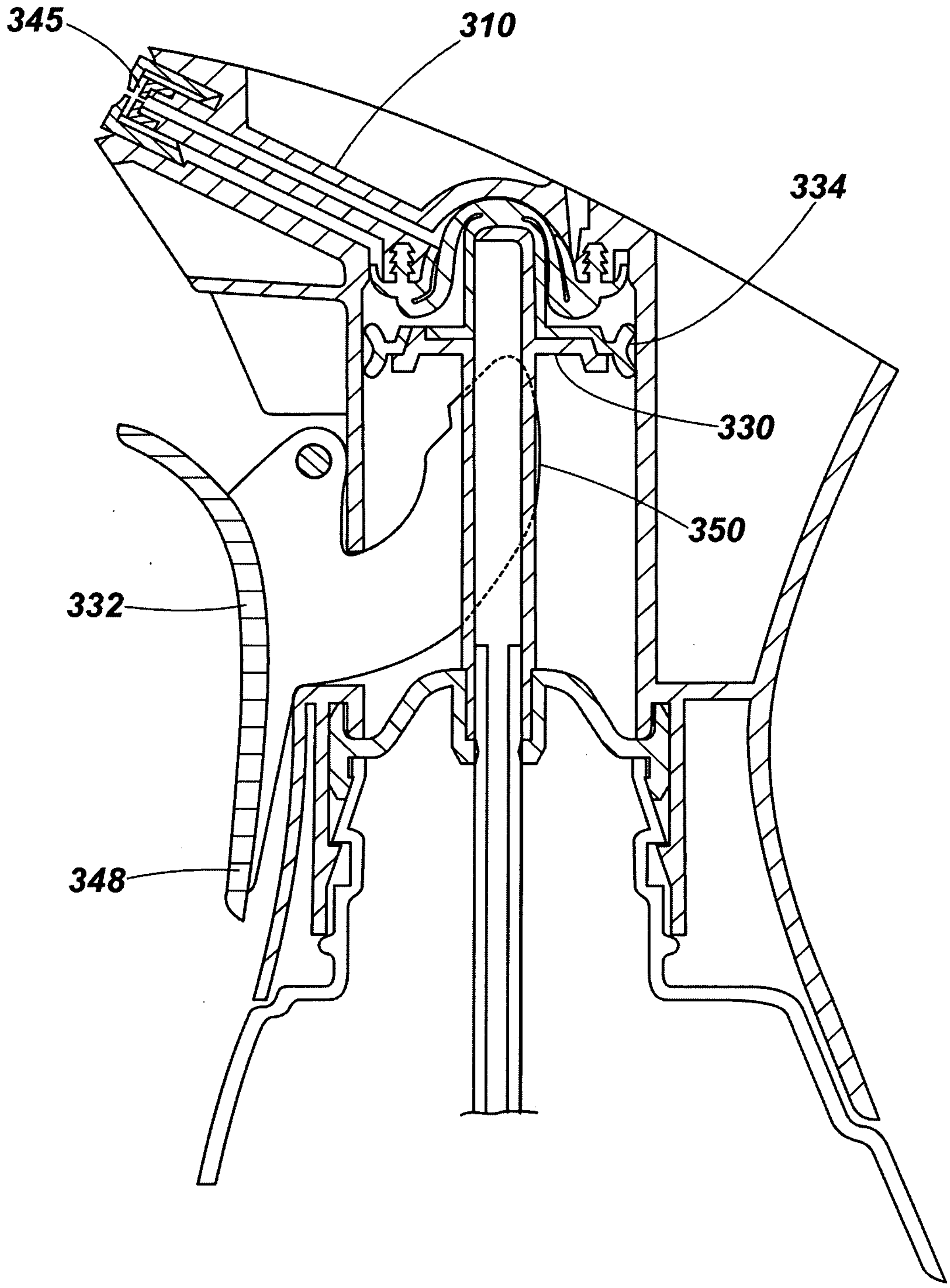


Fig. 33

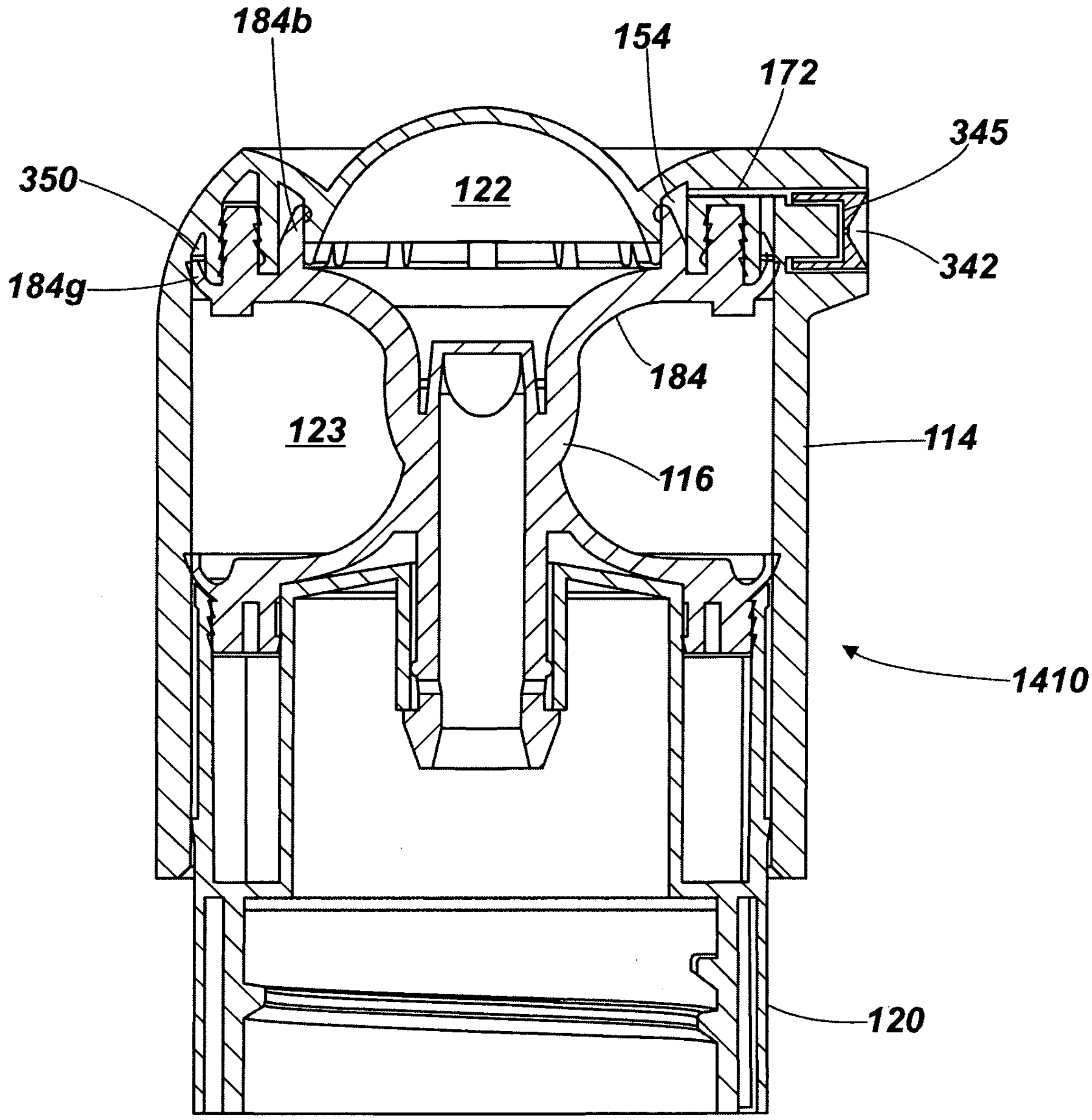


Fig. 34

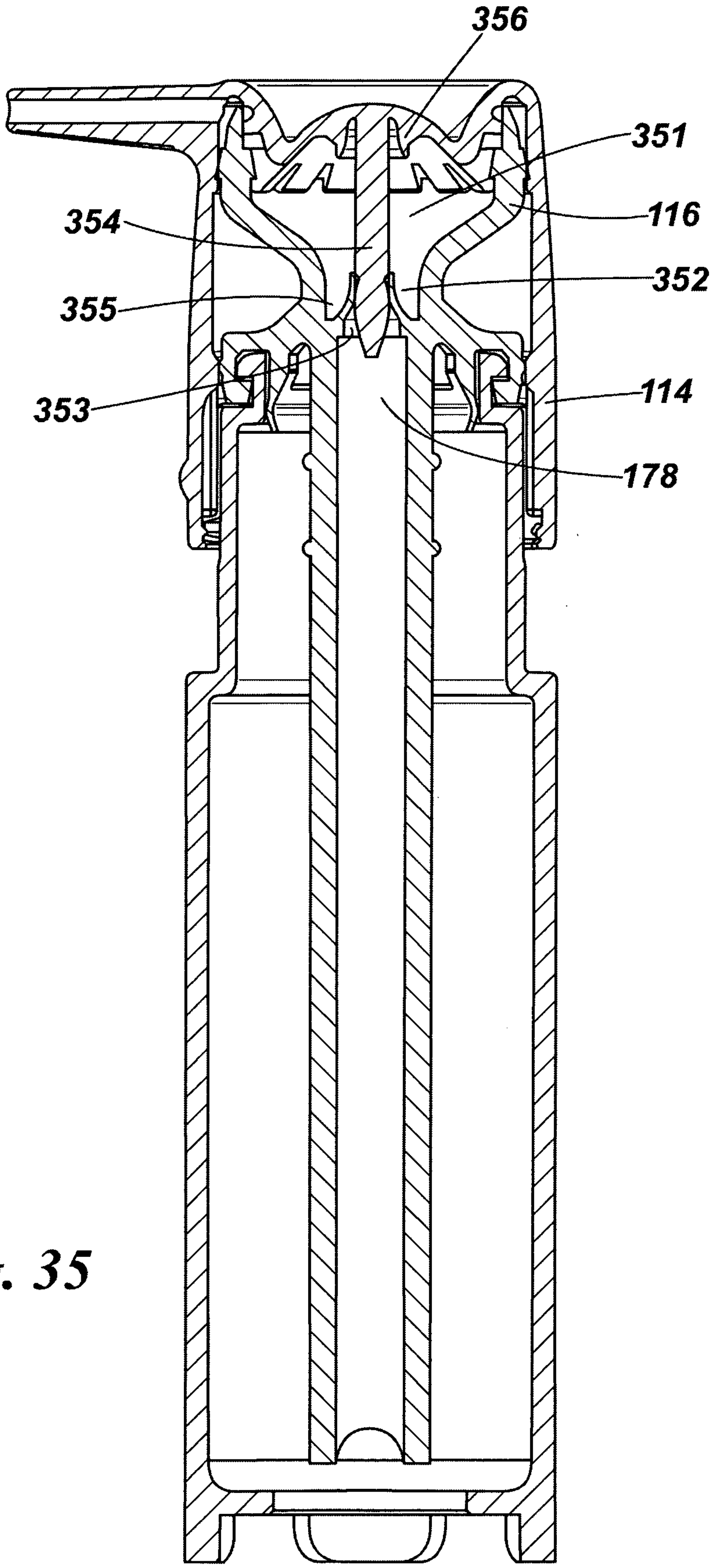


Fig. 35

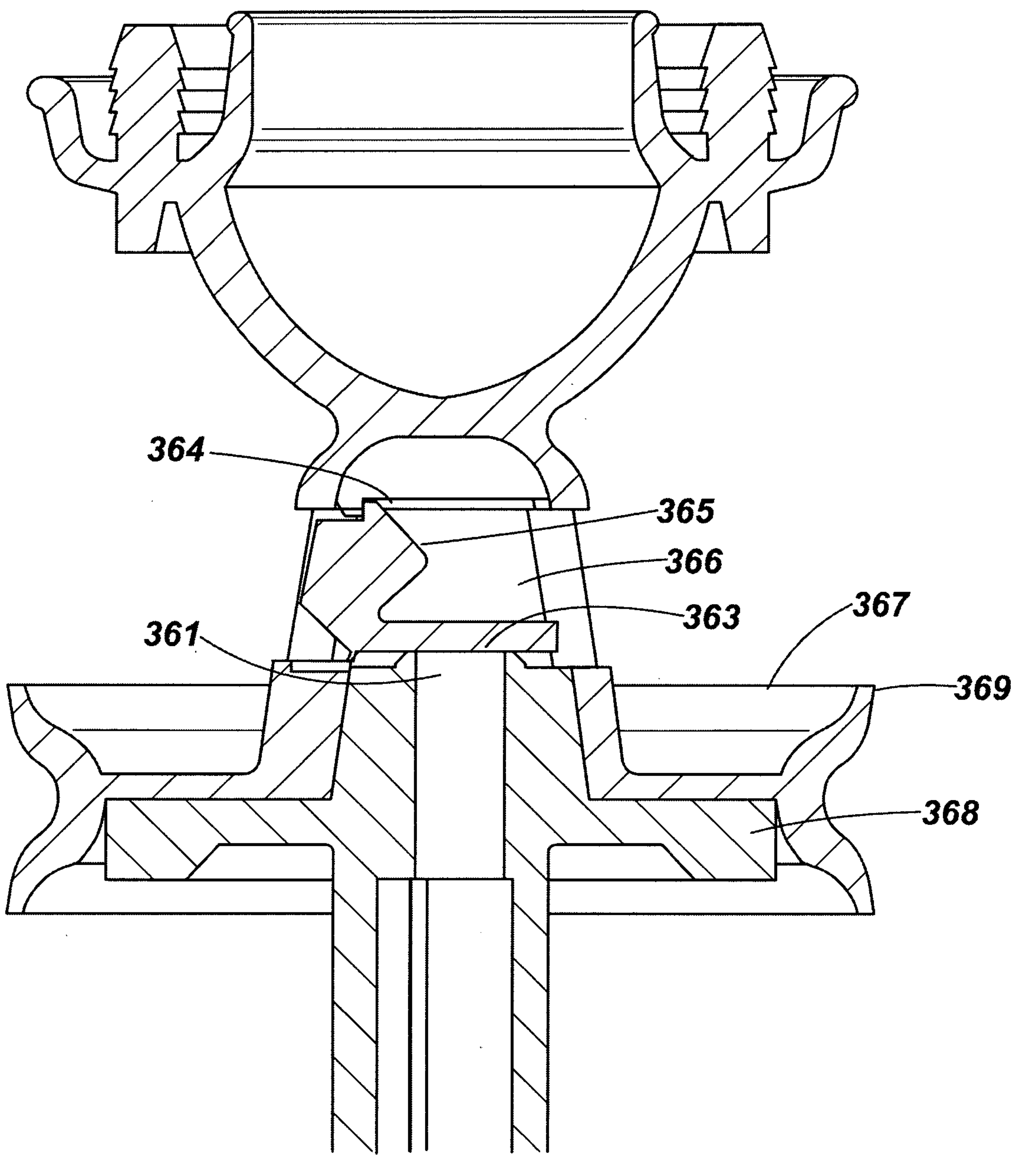


Fig. 36

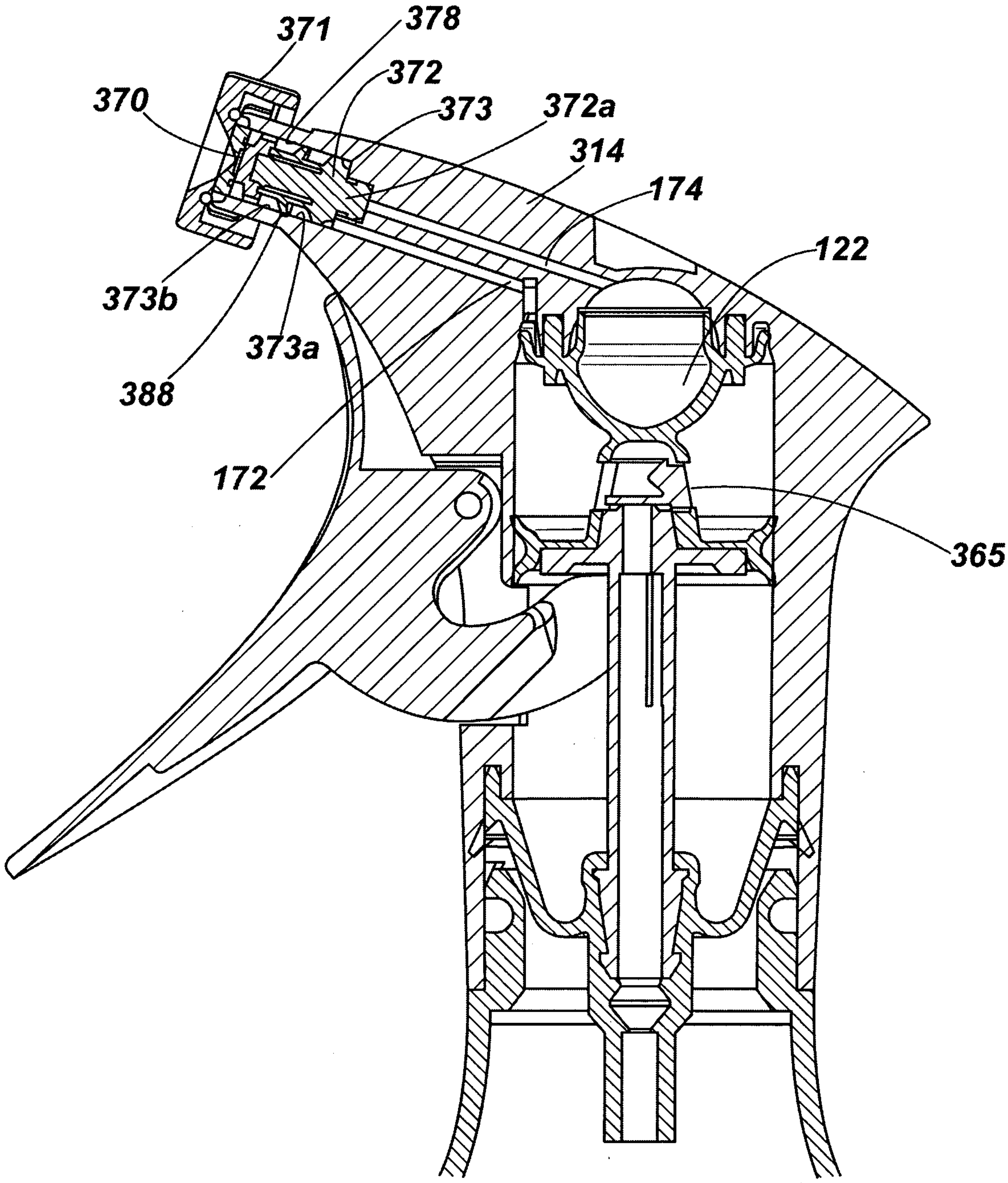


Fig. 37

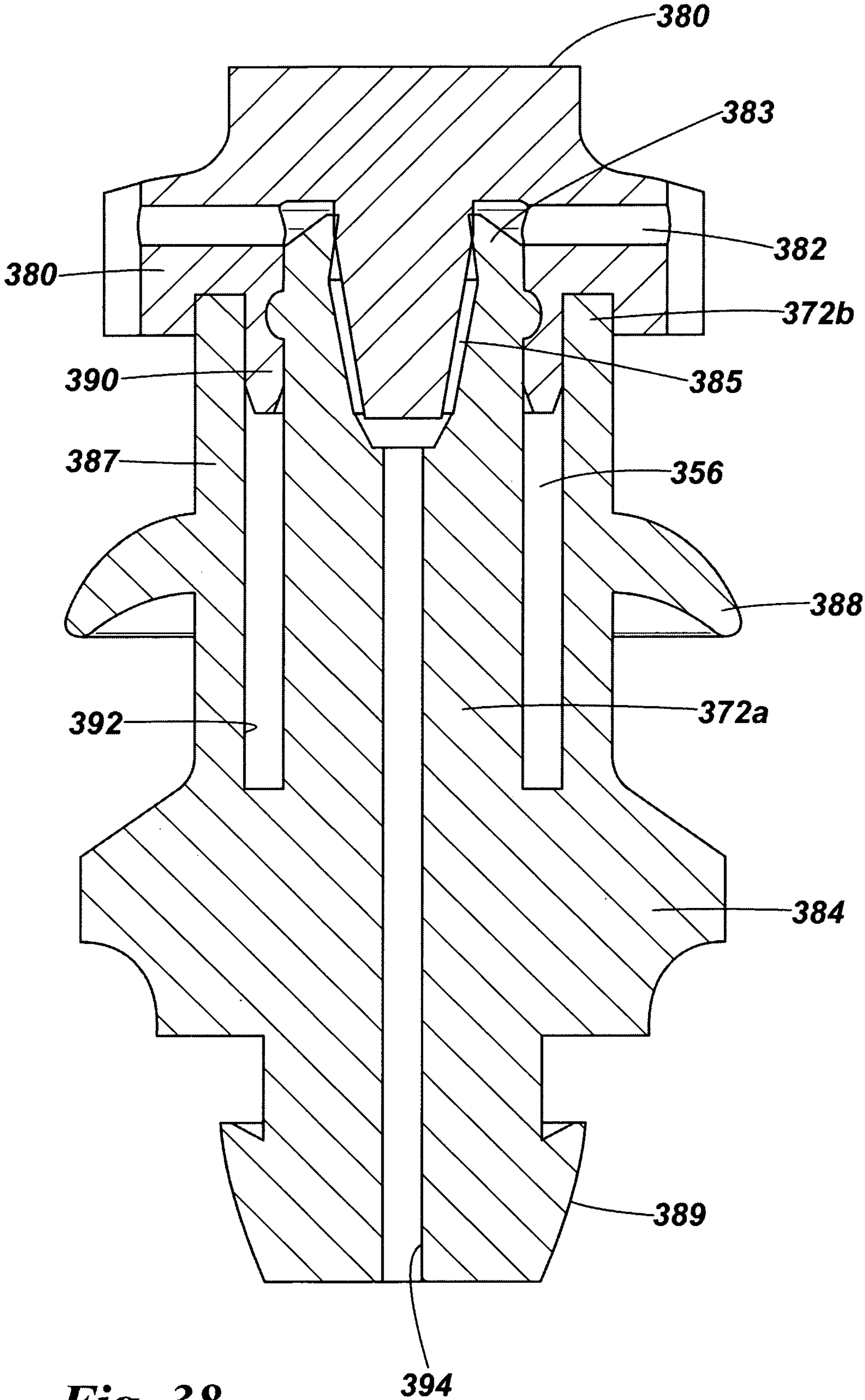


Fig. 38

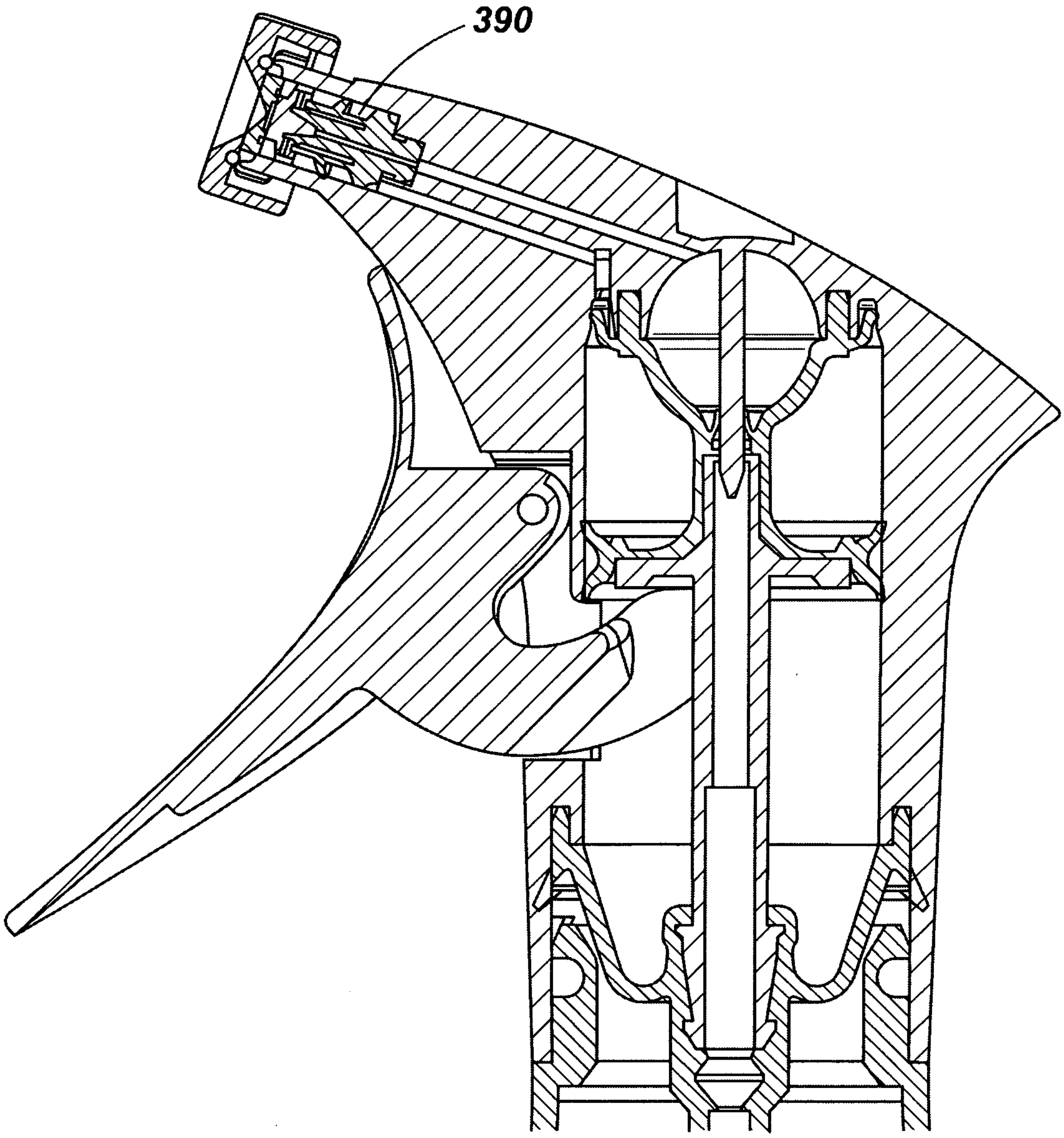


Fig. 39

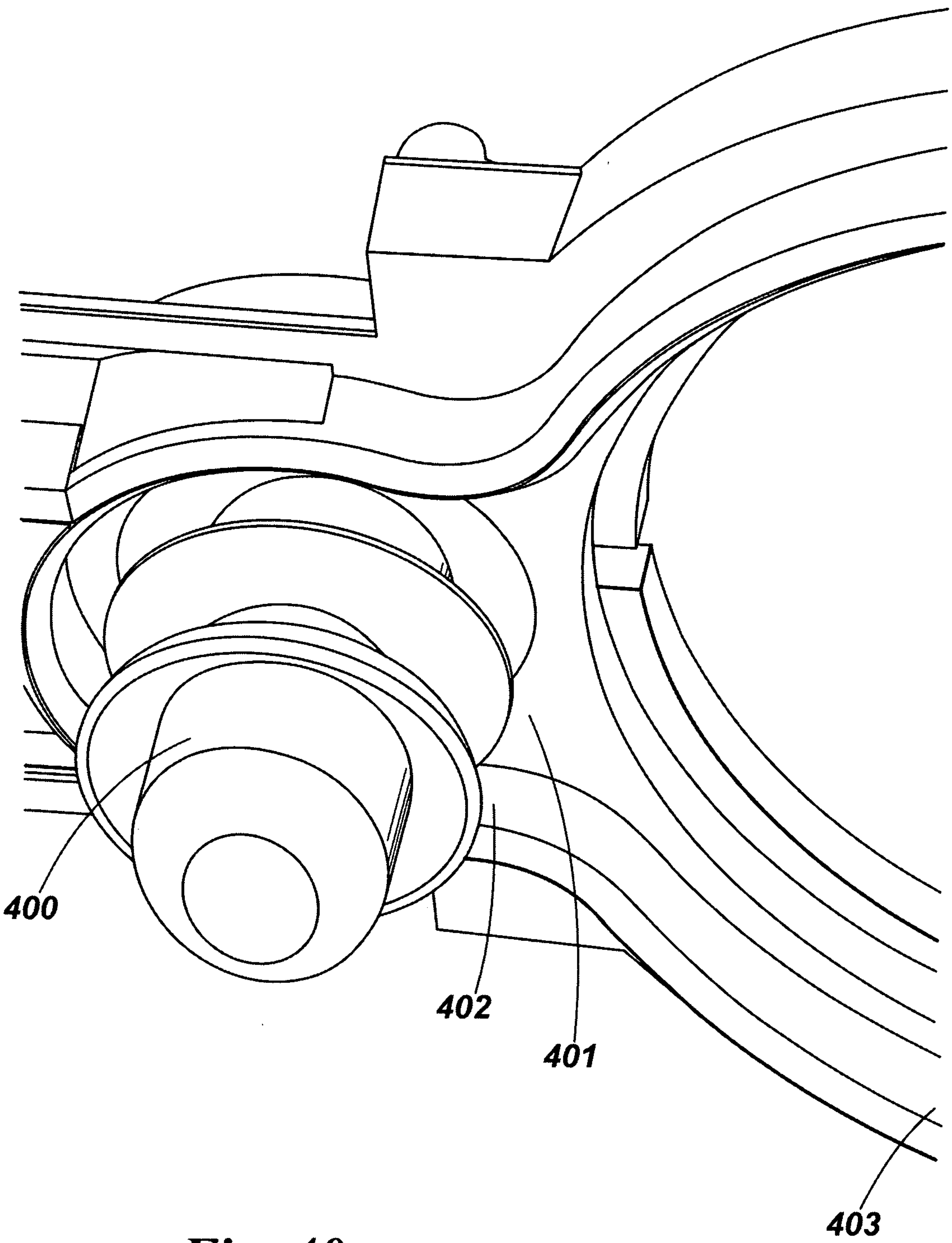


Fig. 40

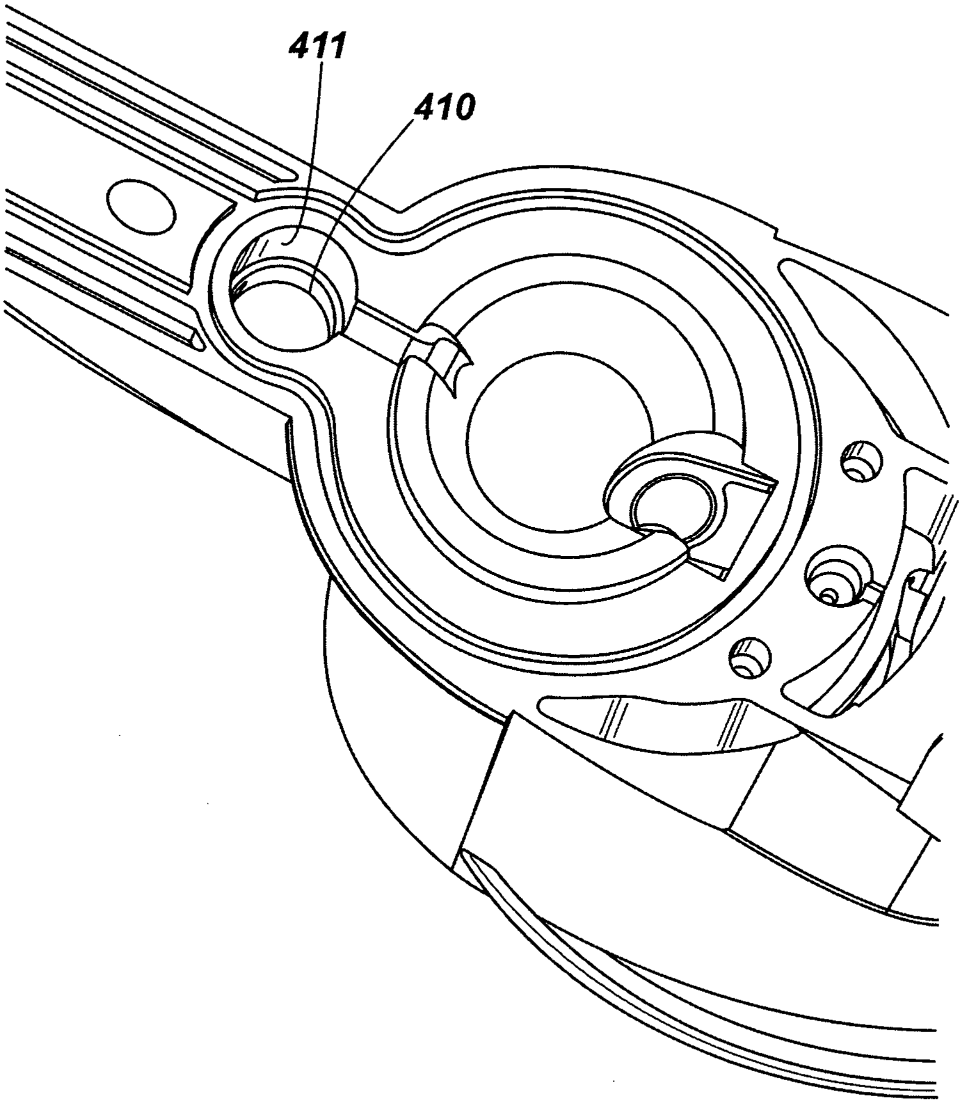


Fig. 41

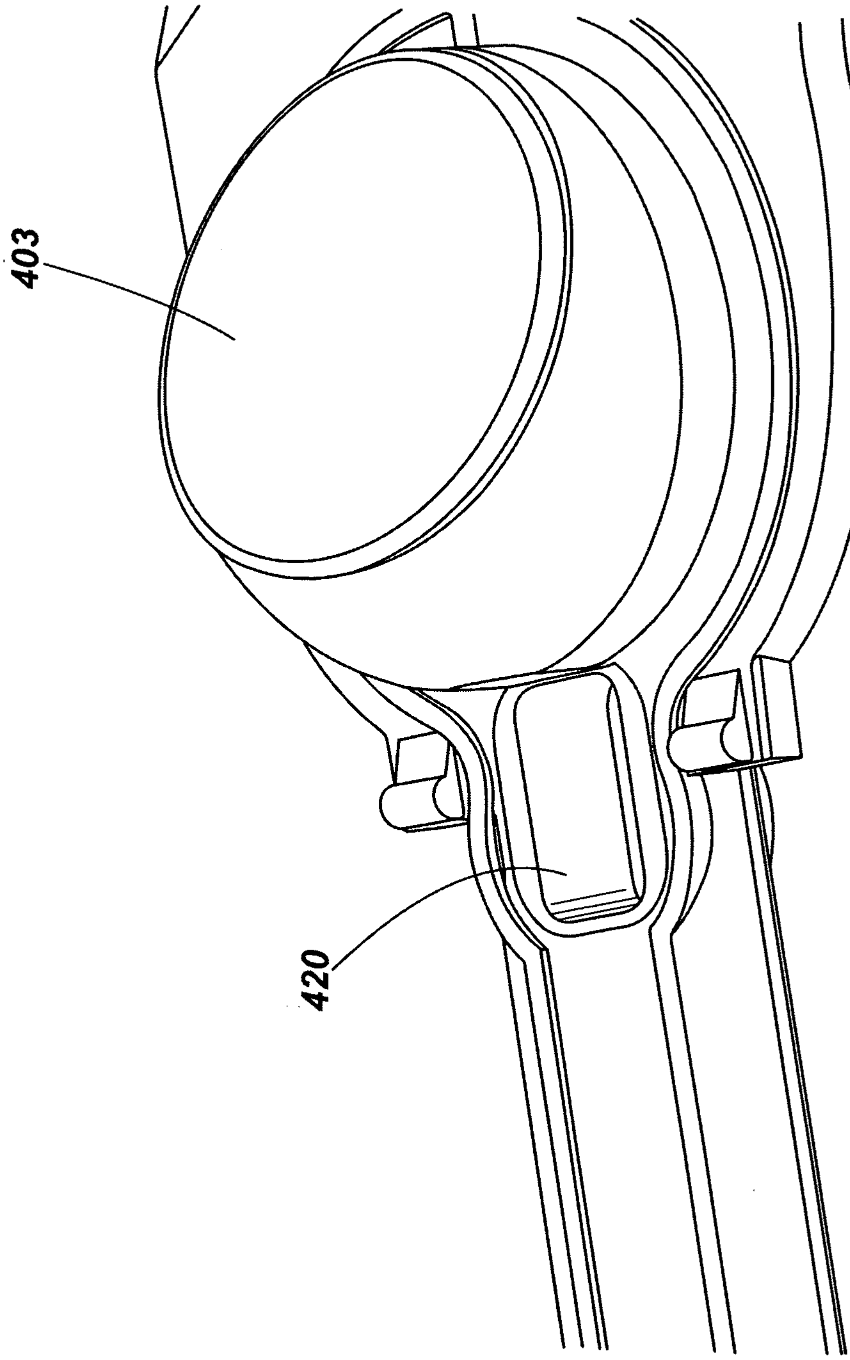


Fig. 42

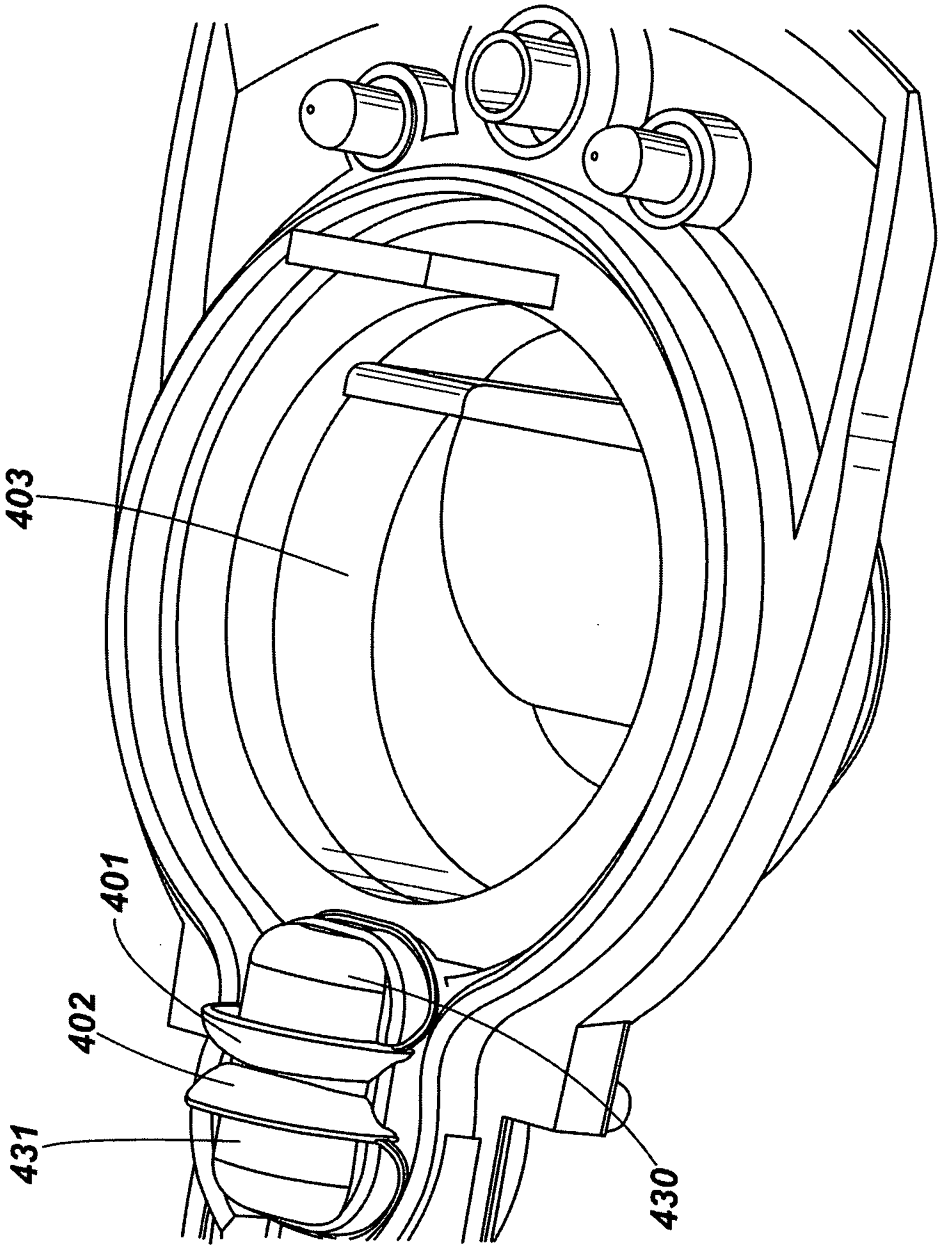


Fig. 43

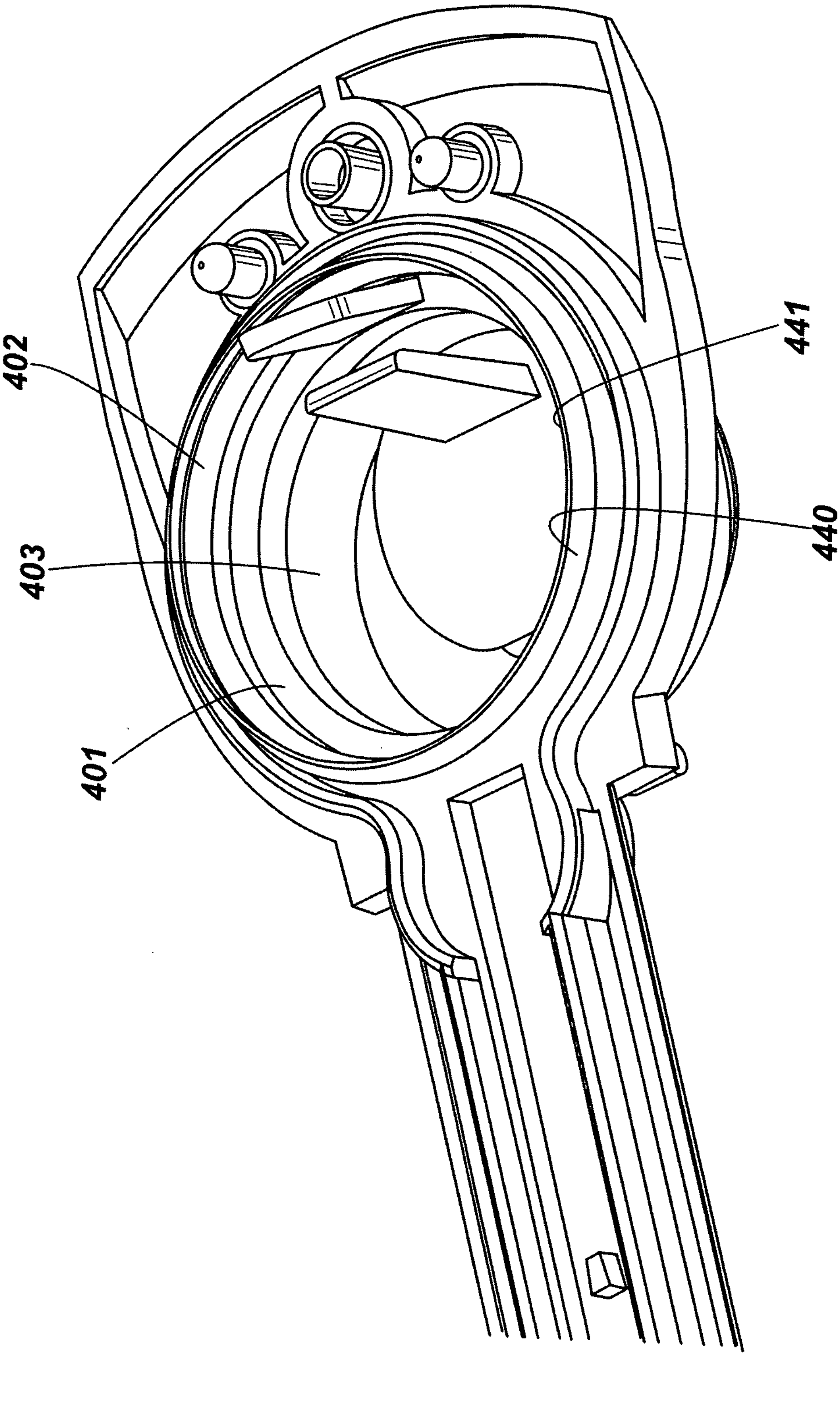


Fig. 44

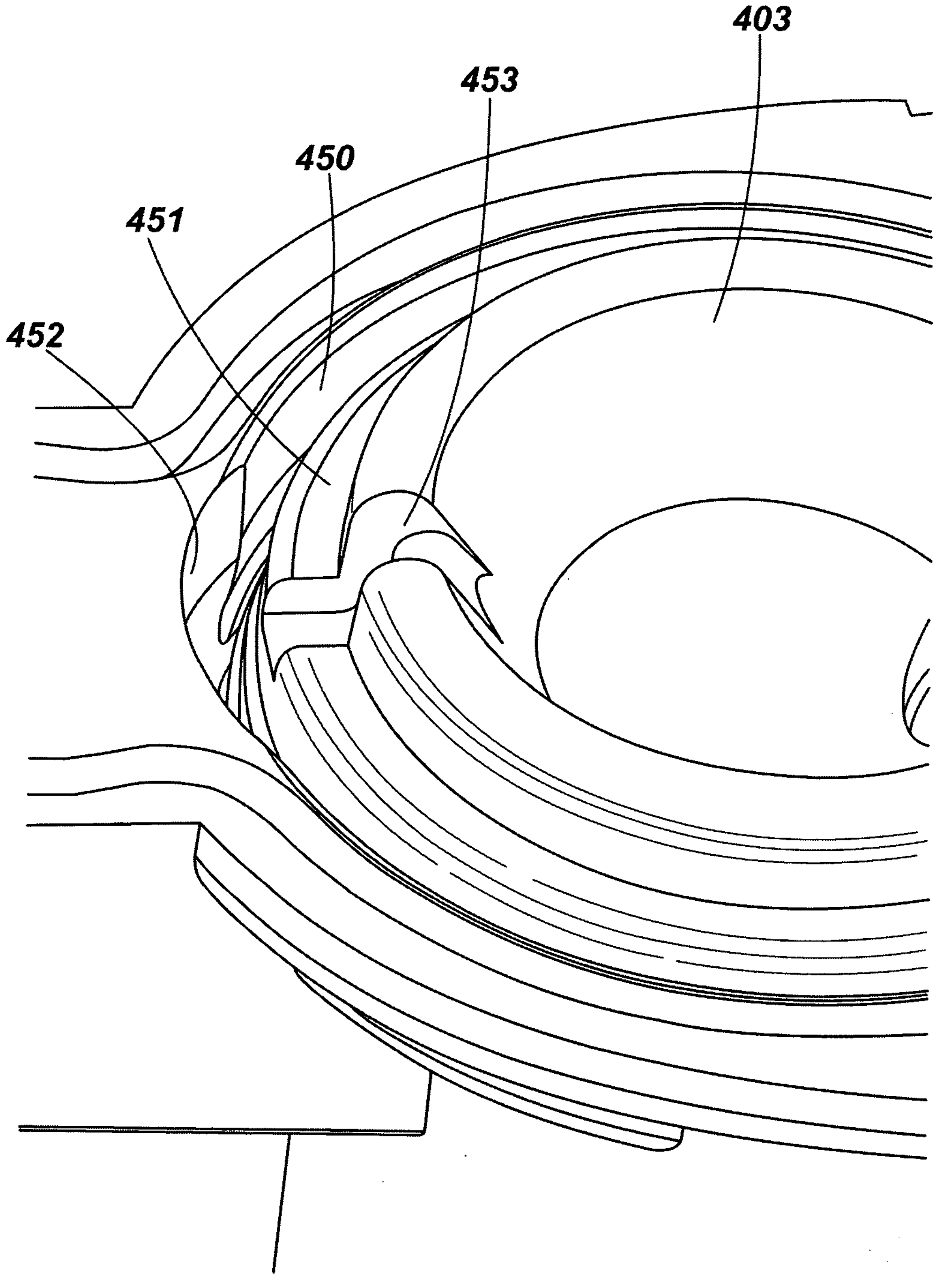


Fig. 45

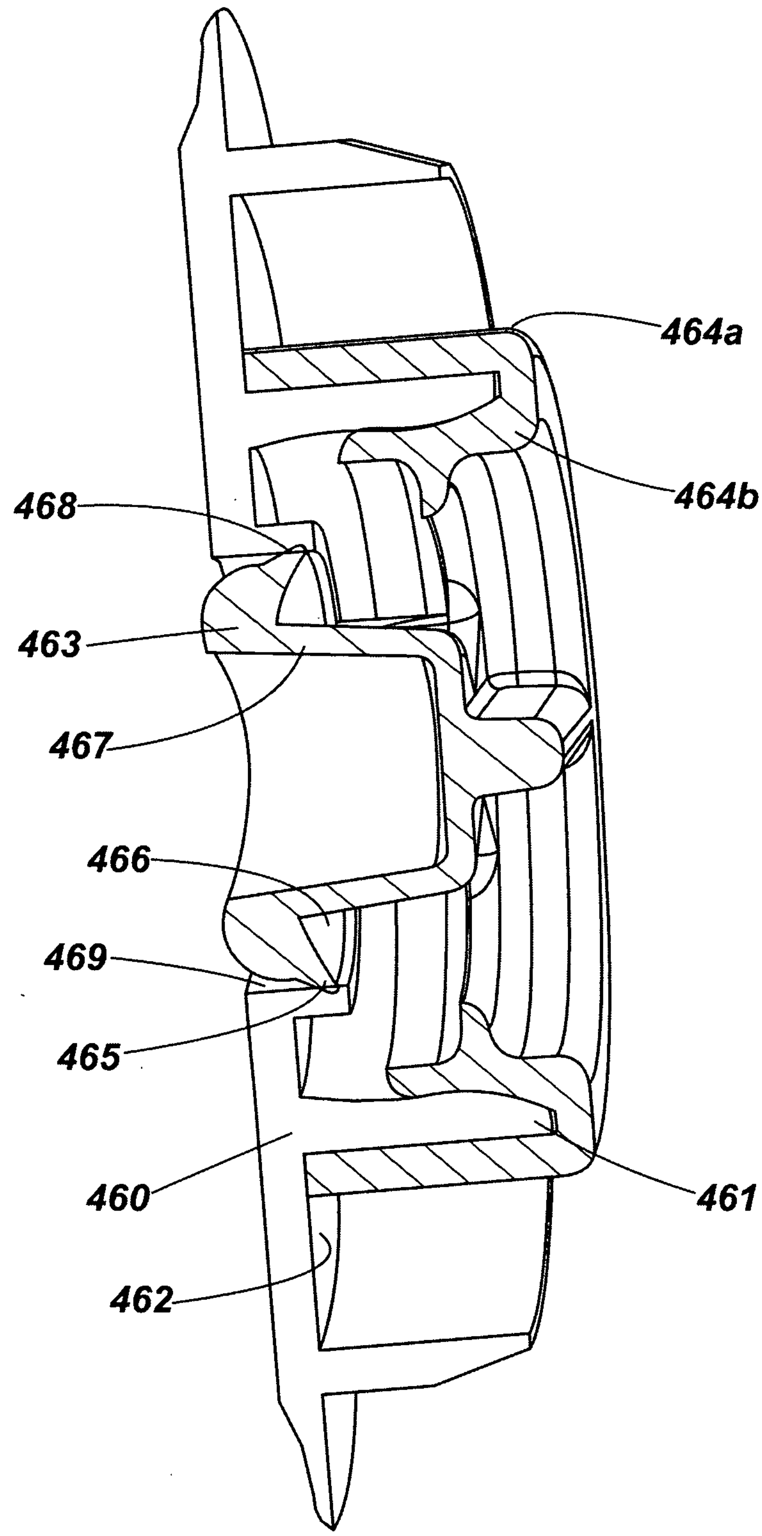


Fig. 46

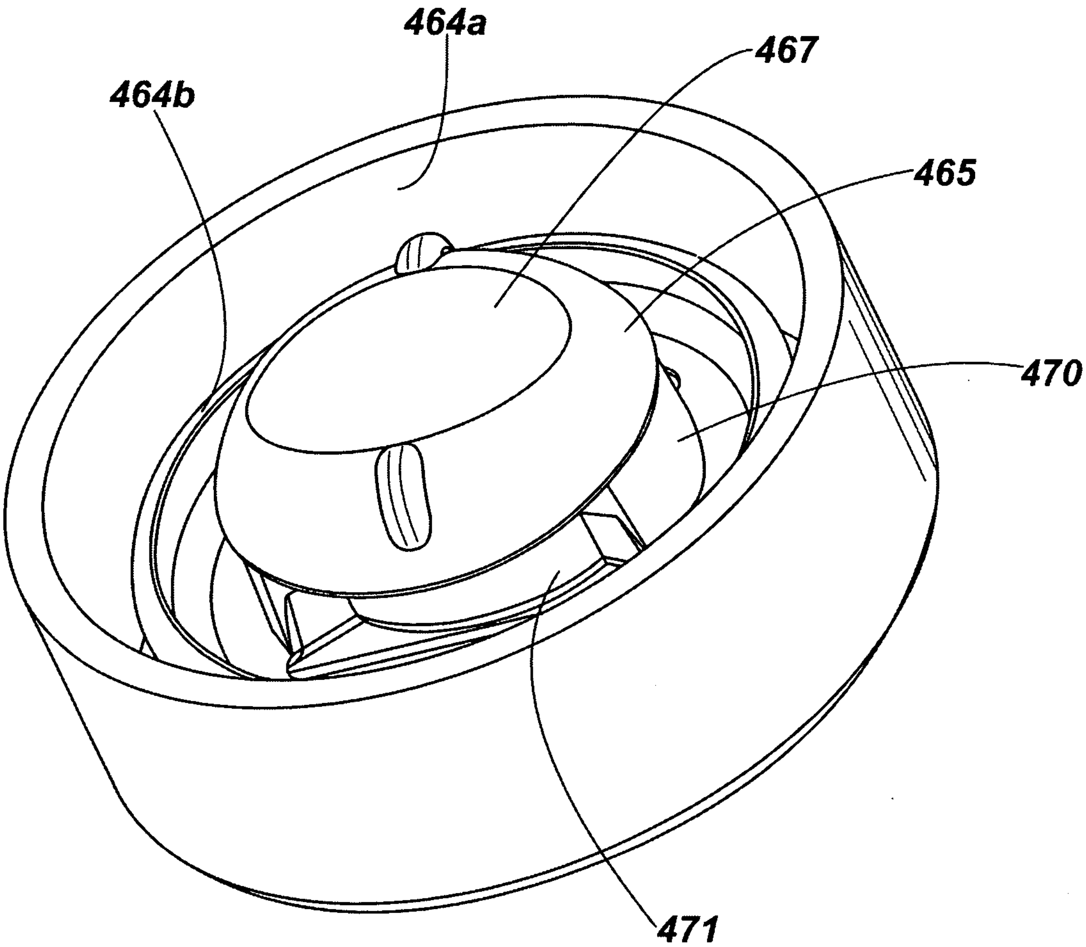


Fig. 47

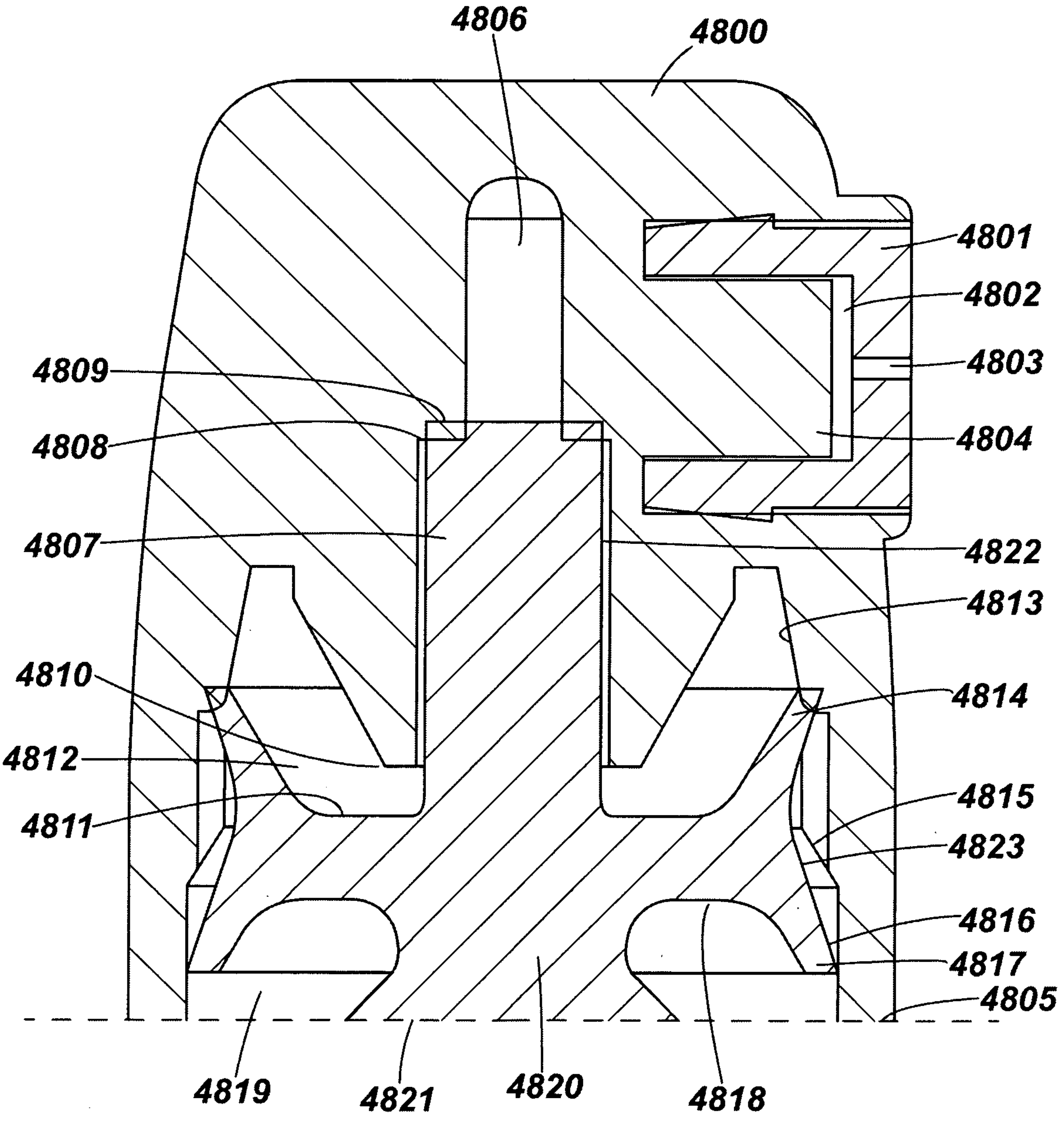

4806
4800
4801
4802
4803
4809
4808
4804
4807
4822
4813
4810
4814
4812
4815
4811
4823
4816
4817
4805
4819
4821
4820
4818

Fig. 48

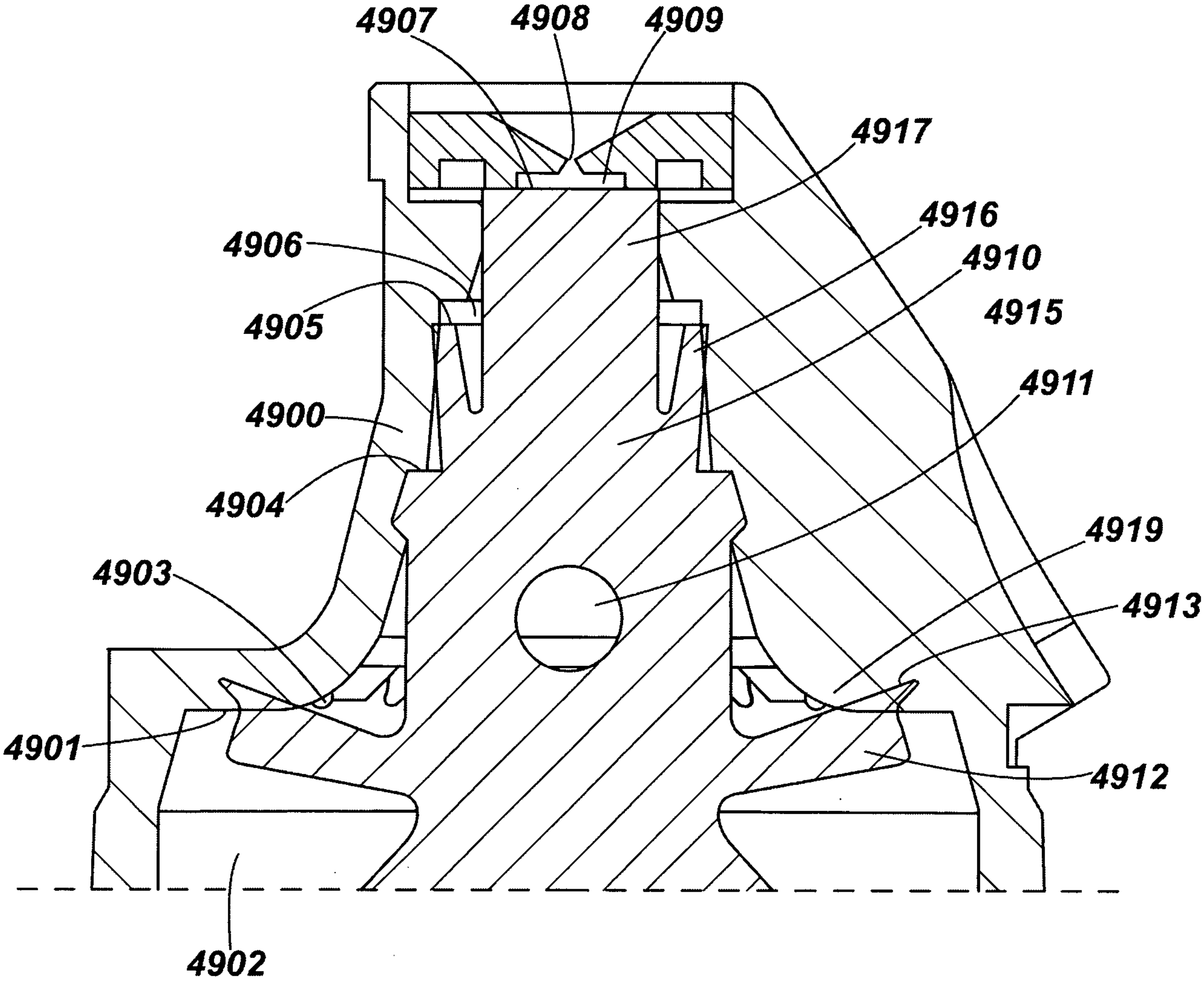

4907
4908
4909
4917
4916
4906
4910
4905
4915
4911
4900
4904
4919
4903
4913
4901
4912
4902

Fig. 49

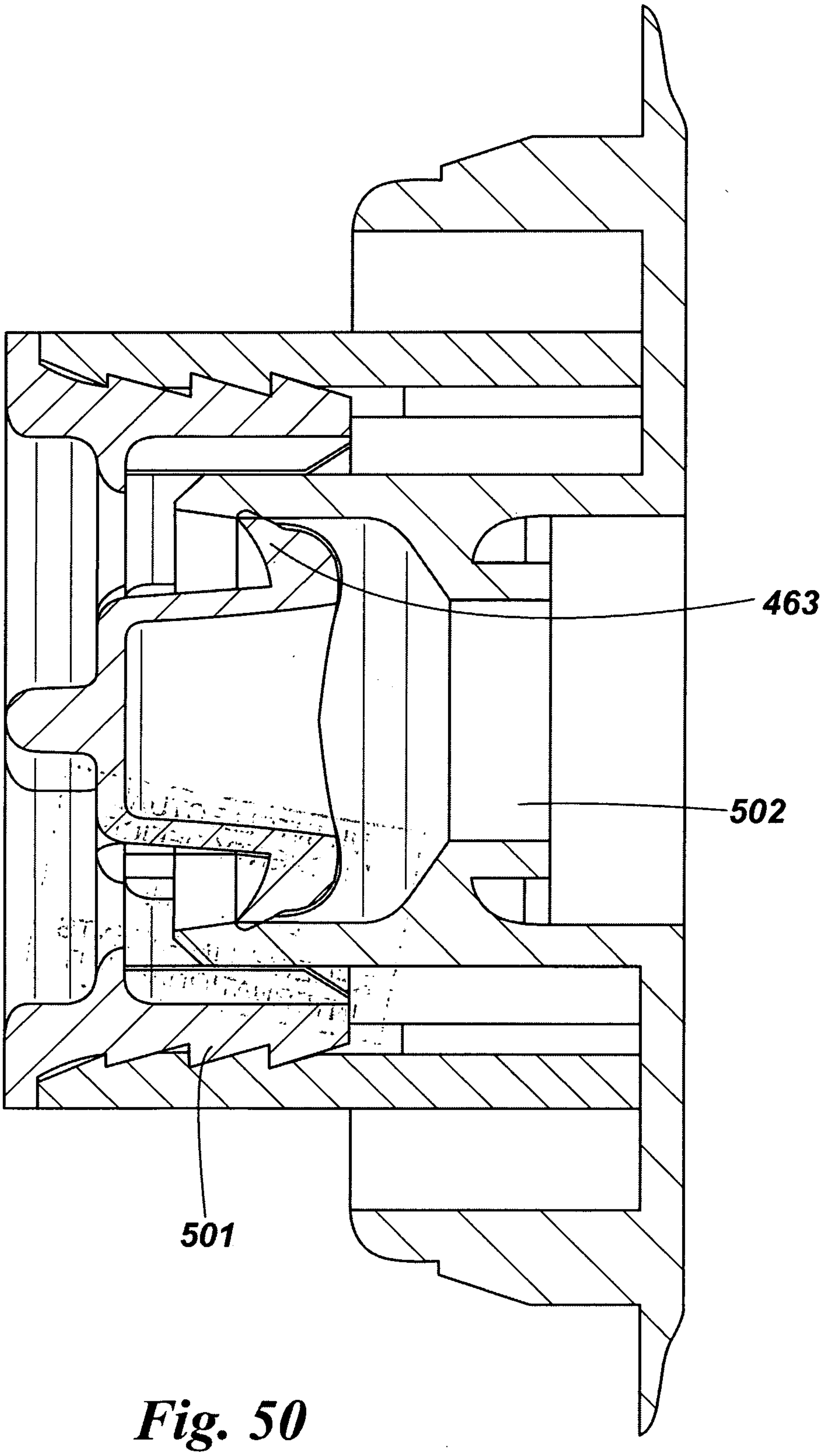


Fig. 50

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2010/050780

A. CLASSIFICATION OF SUBJECT MATTER
INV. B05B11/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 602 019 A2 (RYDER INT CORP [US]; PK SCIENT INC [US] RYDER INT CORP [JP]; PK SCIENT) 15 June 1994 (1994-06-15) column 5 - column 6; figures 2, 2A	1-4, 6-10,13, 21-39
X	US 6 557 736 B1 (OPHARDT HEINER [CA]) 6 May 2003 (2003-05-06)	34-39
A	column 6; figures 3-8	1-33

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 July 2010	05/08/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Fax: (+31–70) 340–3016	Schork, Willi

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2010/050780

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0602019	A2	15-06-1994	NONE		
US 6557736	B1	06-05-2003	DE	10300494 A1	31-07-2003