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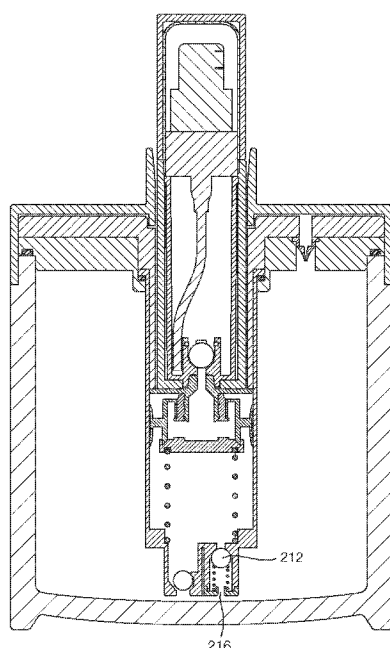
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**(54) Title:** METHODS, DEVICES AND SYSTEMS FOR REFILLING A LIQUID DISPENSER

Fig. 5



**(57) Abstract:** The present invention relates to a liquid refilling system (10) comprising a parent device (201) and a child or portable travel sized device (101) that can be releasably coupled to the parent device (201) to transfer liquid from the parent to the child device. The parent device (210) is provided with a pump (207) in liquid communication with a parent reservoir (203) containing the liquid. The pump of the parent device has a volume which is preferably substantially equal to the volume ( $V_{cr}$ ) of the child reservoir thereby enabling a minimal number of single actuations of the parent pump (207) to completely fill the child reservoir (103) if desired upon coupling thereof.

## METHODS, DEVICES AND SYSTEMS FOR REFILLING A LIQUID DISPENSER

## FIELD OF THE INVENTION

- 5 The present invention relates to methods, devices, and systems for refilling a liquid dispenser, such as a perfume dispenser.

## BACKGROUND OF THE INVENTION

10 Perfume dispensers are known in the art. Many perfume dispensers are bulky and unsuitable for convenient storage in small purses, handbags, and the like. One solution is to provide a perfume dispenser that is conveniently sized for storage in a purse or handbag. The small size of such a perfume dispenser, however, limits the amount of liquid perfume that it can store. Therefore, it is often desirable that these smaller perfume dispensers (hereinafter referred to as child device) have the ability to be refilled from a larger reservoir. Such reservoirs are typically also provided  
15 in the form of a perfume dispenser that also has the ability to apply an atomized perfume when desired, thereby providing a convenient applicator for use in the home (hereinafter referred to as the parent device ).

Some examples of refilling systems are described in WO 02/052977, WO 05/101969,  
20 US5524680 and WO2010094963. Whilst these devices may be satisfactory for their intended purpose, a continuing challenge is to provide a perfume dispenser that can atomize a liquid perfume for application by a user, which is travel sized and can be conveniently and easily refilled from another larger parent reservoir without undesirable spilling or accidental discharge of the liquid perfume during the refilling process. In particular, currently available refill perfume  
25 systems have a number of disadvantages. Firstly, the refilling process typically involves at the least the partial disassembly of the actuator of the atomizer of parent device, by the user to reveal the pump stem prior to its insertion into the base of the child device. This is both inconvenient and messy for the consumer and may also result in inadvertent damage to the parent actuator which may prevent its subsequent effective functioning. Secondly, the refilling systems also  
30 utilize the pump of the parent as the refill mechanism for the child device. Since the parent pump is designed to dispense a standard single perfume dose directly to a user, a single actuation thereof will not completely fill a child device. Consequently, refilling of the child requires multiple parent pump activation steps by the consumer in order to completely refill the child device. Again, this is inconvenient and time consuming for the user. Moreover it also requires a

degree of dexterity in order to hold the devices securely during the refilling process. Nevertheless the use of these devices may still also result in spillage onto the parent and or child device, adjacent surfaces and users' hands themselves further exacerbating the possibility of inadvertently releasing the hold of the devices and spillage.

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Alternative refill systems require the partial disassembly of the child device and the use of a funnel to decant the liquid from the parent reservoir to the child device. Such devices also suffer from problems of potential spillage and mess as discussed above.

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Other refill systems function by the incorporation of a suction pump such as described in US6863093 and EP2335833. These systems must be provided with a prefilled child device, whereby a vacuum is generated in the child device as the liquid is evacuated during use. However in order to enable subsequent refilling, the vacuum must be generated consistently upon expulsion of the liquid from the child reservoir. Typically, such devices are unable to maintain a

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vacuum over time and the child device can therefore no longer be refilled and reused. Moreover, such devices also require partial disassembly and accurate docking between the parent and child device in order to prevent inadvertent damage to the vacuum rendering the mechanism and child device redundant.

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WO2010/094963 describes an automated refill system comprising a bellows pump, whereby the child device is refilled upon coupling to the parent device. Such systems are however complex to manufacturer and require specialized materials for the bellows in order to function with fragrance compositions.

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Thus, there is still a need to provide a perfume refill system whereby the child device can be readily refilled from a parent device without the necessity to disassemble the parent device and or child thereby reducing inconvenience and mess and which also does not require multiple parent pump activations in order to refill the child device completely. Moreover, the system should enable simple, preferably intuitive docking of the child to the parent. There is also a need for a

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system, the construction of which does not result in a complex manufacturing process.

#### SUMMARY OF THE INVENTION

The present invention is a liquid refill system, preferably for a personal beauty care composition, more preferably a fragrance composition comprising:

a) A child device having a liquid reservoir having a volume and an air outlet valve, said device having a first portion having a dispensing mechanism and a second portion having a child component of a refill mechanism comprising a child liquid inlet and a child one way liquid refill valve associated therewith;

5      b) A parent device having a liquid reservoir containing a liquid and an optional air inlet valve, said device having a first portion having a parent component of a refill mechanism and a liquid outlet having a one way liquid outlet valve, associated therewith, said parent device having a pump, having a pump volume, in liquid communication with the parent liquid reservoir via a one way liquid inlet valve and in liquid communication  
10      with said liquid outlet, and optionally a liquid return valve, wherein the ratio of the volume of the parent pump to the volume of the child reservoir is 12:1 or less, preferably 1:1.

According to the invention, upon releasably coupling the child component of the refill  
15      mechanism to the parent component of the refill mechanism, preferably in a substantially co-linear configuration, and upon each single actuation of the parent pump, a seal is formed around a liquid pathway which extends from the parent outlet to the child liquid inlet and the child one way liquid inlet refill valve of the child reservoir, through which the liquid contained in the parent pump is transferred to the child reservoir, whilst air is expelled from the child reservoir via the  
20      child air outlet valve. Upon termination of the actuation of the parent pump typically via removal of the actuation force, the seal and the liquid pathway are disconnected, and the parent pump refills with liquid from the parent reservoir via the parent one way liquid inlet valve and inlet, and air enters the parent reservoir via the air inlet valve. The parent pump is actuated at least once can be repeatedly actuated, and refilled at least twice until the child reservoir is filled with the desired  
25      amount of liquid. The child component of the refill mechanism is then decoupled from the parent component of the refill mechanism.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1a and 1b are cross sectional views of one embodiment of the child device wherein the one  
30      way liquid inlet valve is open and closed respectively.

FIG. 2 is a cross sectional view of one embodiment of the parent device.

FIG. 3 is a cross sectional view of the child and parent of figures 1a and 2 coupled together prior to the transfer of liquid;

FIG. 4 is a cross sectional view of the child and parent of figures 1b and 2 coupled together during liquid transfer;

FIG. 5 is a cross-sectional view of the child device of FIG. 1a coupled to an alternative embodiment of the parent device having a return valve, prior to the transfer of liquid;

5 FIG. 6 is a cross sectional view of the child device of FIG. 1b coupled to an alternate embodiment of the parent device having a return valve, during liquid transfer.

FIG 7 is a cross sectional view of the child device of FIG 1b coupled to an alternative embodiment of the parent device during excess fluid evacuation via the return valve.

## 10 DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a novel and unique liquid refilling system comprising a parent device and a child or portable travel sized device that can be releasably coupled to the parent device to transfer liquid from the parent to the child device. The parent device is provided with a pump in liquid communication with a parent reservoir containing the liquid. The pump of the parent device has a volume which is preferably substantially equal to the volume of the child reservoir thereby enabling a minimal number of single actuations of the parent pump to completely fill the child reservoir if desired upon coupling thereof. Consequently, the necessity for multiple parent pump actuations as in the prior art is avoided in addition to removal of the parent actuator disassembly step, and minimization and/or elimination of undesirable spilling and spraying of the liquid perfume during the refilling process.

The present invention may find utility for any personal beauty care compositions such skin care, grooming, body care, or oral care liquid may be also be used. Some non-limiting examples include after shaves, UV skin care compositions, skin care moisturizers, hand sanitizing compositions, and mouth rinses. Some non-limiting examples are described in US 5,883,059 and US2005/0169852. The invention finds particular utility as a fragrance composition.

Any fragrance compound, or combinations thereof, may be employed with the present invention. In some embodiments, the fragrance compounds may be derived from any suitable plant or synthetic material as described for example in Steffen Arctander "Perfume and Flavor Chemicals (Aroma Chemicals Vol. 1 and 2, 1969). Some non-limiting examples of liquid perfumes are described in US7413731; US7208464; and US7763742. While the present invention will be described herein with reference to the use of fragrance composition perfume for purposes of

illustration, it will be appreciated that other personal beauty care compositions and or shave care and hair removal compositions and devices may be used with the present invention as described above. The compositions for use herein are provided in a liquid form including creams and gels and may have a viscosity in the range of from 0.001 Pas to 40Pas, preferably from 0.001 to 20Pas  
5 more preferably from 0.001Pas to 10Pas, most preferably from 0.001Pas to 1 Pas measured at 25°C. For fragrance compositions the viscosity will preferably be in the range of 0.001 to 0.5Pas. Accordingly, the skilled person will select pumps, inlets and associated valves dependent upon the viscosity of the liquid to be transferred.

10 The liquid refill system comprises a parent device and a child device. The parent device comprises a parent liquid reservoir for storing a liquid and an optional air inlet valve. These devices may be provided from any suitable material and are typically manufactured from glass or plastic materials. The volumetric capacity of the parent liquid reservoir can vary widely depending upon the intended use and the nature of liquid stored in the parent liquid reservoir. For  
15 example, in one embodiment wherein the parent and child devices are intended for home consumer usage, the parent liquid reservoir has a liquid capacity of greater than 30 ml, or 50 ml, or 75 ml and/or less than 500ml, 300 ml, or 150 ml, or 100 ml. The child liquid reservoir may have a liquid capacity of 3ml or greater, 5ml or greater or 7ml or greater or 10ml or greater and or less than 20ml or 15ml. In an alternative embodiment where for example the parent device is  
20 made available to a consumer at a retail outlet so that the consumer can refill the child device in store, the parent liquid reservoir will typically be provided with a much larger capacity such as greater than 0.5L, 1L, or 10L or 15L or 20L. The child device may be provided with a liquid reservoir capacity of greater than 5ml, or 7ml or 10ml or 30ml or 50ml or 100ml. The parent air inlet valve is typically located in the first portion of the parent device and may in some  
25 embodiments be located within the pump. The parent air inlet valve ensures that the air pressure inside the parent device is at equilibrium with the external air pressure as the liquid is discharged from the parent device upon filling the child device with liquid there from.

Referring to figure 2, the parent device (201) has a first portion (105) having a parent component  
30 of a refill mechanism (208) and a liquid outlet (213) having a one way valve (209) associated therewith to control the flow of liquid from the parent device (201) to the child device (not shown). The first portion of the parent may be provided with a cap or cover for protection. The parent device (201) further comprises a pump (207) which is in liquid communication with the parent liquid reservoir (203) via a one way liquid inlet valve (210) and also in liquid

communication with the parent liquid outlet (213) which enables the liquid contained in the parent reservoir (203) to be transferred to the child reservoir through the pump (207) to the one way liquid outlet (213).

5 Preferably, the parent one way liquid inlet valve is in fluid communication with a fluid pick up means such as a dip tube (not shown) to ensure that liquid can be extracted from the lower portion and base of the parent liquid reservoir. The dip tube diameter may be varied to control the rate of liquid transfer as required. In an alternative embodiment the parent pump is configured such that it extends to the base of the parent liquid reservoir, which may optionally be provided  
10 with a sump, in order to extract all the liquid contained in the parent reservoir. In order to fill the child device with a minimum number of pump actuations the volume of the parent pump ( $V_{pp}$ ) and the volume of the child reservoir ( $V_{cr}$ ) should be similar. The ratio of the volume of the parent pump to the volume of the child reservoir is thus 12:1 or less, preferably 10:1 or less, more preferably 5:1 or less, even more preferably 3:1 or less. This corresponds to about 10 or less, 5 or  
15 less or 3 or less parent actuations in order to substantially fill the child reservoir; if the child reservoir is substantially empty prior to filling. The user may therefore decide if the child reservoir is to be completely filled or not. In an alternative embodiment, if the child is not substantially empty upon commencing the refilling process, the user may select to refill the empty portion.

20 Preferably in order to enable the child device to be filled by a single actuation of the parent pump, the parent pump liquid volume ( $V_{pp}$ ) is such that it is substantially equal to the volume of the child reservoir ( $V_{cr}$ ) so that  $V_{pp}:V_{cr}$  is 1:1. Thus, if the child device is substantially empty prior to filling and does not contain any liquid, the refilling procedure will result in the child reservoir  
25 being refilled to substantially its maximum capacity ( $V_{cr}$ ).

In circumstances where the child reservoir is not completely empty prior to filling, or the consumer does not desire to completely refill the child reservoir, and where the ratio of the parent pump liquid volume ( $V_{pp}$ ) to child reservoir volume is 12:1 or less or preferably 10:1 or less, the  
30 number of actuations required can be determined by visual inspection of the child device and reservoir by the consumer and or by the tactile cue due to for example the change of actuation force.

In a preferred embodiment as illustrated in Fig. 5-7, the parent pump (207) is provided with a liquid return valve (212) and associated return valve outlet (216) to enable any excess liquid not transferred to the child reservoir to be returned to the parent pump and reservoir. Figure 7 illustrates the open position of the liquid return valve (212). This is beneficial in circumstances when the child device reservoir is not completely empty prior to filling and thus the parent pump volume may be greater than the available child reservoir volume. The term substantially equal as used herein means that the volume of the parent pump is about 20%, preferably about 15%, more preferably about 10%, even more preferably about 5%, most preferably about less than 3% of the volume of the child reservoir. If a return valve is not present, any excess liquid may be expelled from the child dispenser via the air outlet valve.

In order to refill the child reservoir the child component of the refill mechanism is releasably coupled to the parent component of the refill mechanism (208), preferably in a substantially co-linear configuration as illustrated in Figs. 4-7. If present the parent cap is removed prior to coupling with the child. Upon each single actuation of the parent pump (207), a seal is formed around a liquid pathway which extends from the parent outlet (213) to the child liquid inlet (110) and the child one way liquid inlet refill valve (109) of the child reservoir (103). The liquid contained in the parent pump (207) is transferred through the liquid pathway to the child reservoir (103), whilst air is expelled from the child reservoir (103) via the child air outlet valve (104). Upon removal of the actuation force, thereby terminating the actuation of the parent pump, the seal and the liquid pathway may be disconnected, and the parent pump (207) refills with liquid from the parent reservoir (203) via the parent one way liquid inlet valve (211) and inlet (210). Air also enters the parent reservoir via the air inlet valve (204).

Depending on the ratio of the volume of the parent pump and the child reservoir as described hereinabove, the parent pump may require repeated actuation and refilling until the child reservoir is substantially completely filled with liquid, if required. The user may therefore select whether or not to completely fill the child reservoir. After the child is filled, completely or partially the child device may then be decoupled from the parent device (child and parent refill mechanism).

The term completely filled as used herein with regard to the child reservoir volume ( $V_{cr}$ ) means that the reservoir is at least 75% filled with liquid, preferably at least 85% filled, more preferably

at least 90% filled and even more preferably at least 95% filled and most preferably at least 98% filled.

In an alternative embodiment, the liquid reservoir of the the parent device may be provided as a collapsible reservoir, commonly referred to as a bag in bottle. In such embodiments the parent air inlet is not required.

Referring to the Figures 2 to 7, the parent pump mechanism is provided as a spring biased positive displacement pump comprising a spring, a one-way ball valve, a pump chamber and a plunger. A dip tube is attached to the parent pump and extends into the parent reservoir for drawing the liquid fragrance from the parent reservoir (not shown). The liquid fragrance is discharged from the parent pump through the liquid outlet that may be integrally formed with the plunger. The parent pump may be attached to a fitting that is in turn attached to a collar of the parent device if present.

In certain embodiments, the actuation force for the pump mechanism (i.e., the force required to begin to displace the plunger against the biasing force of the spring) is between about 3 N and about 10 N. In other embodiments, the actuation force is between about 5 N and about 8 N.

It will be appreciated that the parent pump mechanism may be provided in wide variety of other configurations such as a diaphragm pump. Some non-limiting examples of suitable pump mechanisms are also described in US 7870977 and US 6681961.

The parent pump mechanism may be actuated by depressing the plunger toward the parent reservoir through the pump chamber. As the liquid outlet and plunger are displaced toward the parent reservoir, liquid within the pump chamber is pressurized due to the decrease in volume of the pump chamber and seating of the ball valve. Liquid within the pump chamber is then pumped out of the outlet. Once a complete downward stroke of the plunger has occurred, the biasing force generated by compression of the spring will act to return the plunger to its original position. As the plunger travels away from the parent reservoir, the negative pressure generated by the volumetric expansion of the pump chamber unseats the ball valve and draws liquid through the dip tube from the reservoir into the pump chamber, after which the pump is primed for another pumping cycle.

The parent pump may be provided within a neck or collar of the parent device in order to secure the pump thereto with corresponding fitting means. Alternatively, a separate collar may be used to secure the pump to the parent device.

5 Referring to Fig. 1a and 1b, an embodiment of a child device (101) will now be described. The child device (101) comprises a liquid reservoir (103) having a volume ( $V_{cr}$ ) and an air outlet valve (not shown). The air outlet valve allows for internal pressure regulation of the child device (101) by expulsion of substantially air upon filling of the child reservoir (103) with liquid. The child device (101) has a first portion (105) having a dispensing mechanism (107) preferably a  
10 spray pump and atomizer attached to the child device and a second portion (106) having a child component of a refill mechanism (108), a liquid inlet (110) and a one way liquid inlet refill valve (111) associated therewith. The child dispensing mechanism may be provided with a protective cap (114).

15 The child reservoir (103) is in liquid communication with a liquid outlet of the child dispensing mechanism (107) such as a spray pump and preferably cap or an opening sealed with a stopper such as is typical with a flask. The child device (101) may comprise a child pump mechanism for pumping liquid from the child reservoir to the liquid outlet. A nozzle may be provided just upstream of the liquid outlet for atomizing the liquid. The nozzle and child pump mechanism  
20 may be provided in a wide variety of configurations as known in the art, including the pump mechanism described herein for the parent pump. In certain embodiments, the air inlet valve may be located within the child pump, if present.

The child reservoir (103) stores a liquid such as a fragrance composition that has been transferred  
25 from the parent reservoir (203). In some embodiments, the child reservoir has a liquid capacity of between about 1 ml and about 20 ml, or between about 3 ml and about 10 ml, or between about 5 ml and about 8 ml. The child device has a second portion (106) having a child component of a refill mechanism (108), a liquid inlet (110) and a one way liquid inlet refill valve (111) associated therewith. The one-way liquid inlet refill valve (111) is provided to regulate liquid flow into the  
30 child reservoir (103) from the parent device (201).

The child liquid inlet (110) and one-way liquid inlet valve (111) is in liquid communication with the child reservoir (103). In one embodiment the child one way liquid inlet valve is in liquid communication with the child reservoir and a child inlet tube that extends downwardly from a  
35 bottom surface of the child reservoir (not shown). The child inlet tube is configured so that it may

be slidably received within the liquid outlet of the parent device when the child device is releasably coupled to the parent device via the respective child and parent refill mechanisms. A downwardly depending skirt may encircle the child inlet tube.

- 5 Alternatively, the liquid outlet of the parent pump is in liquid communication with a parent discharge tube which can be inserted into the child inlet valve.

The child and parent devices each have a corresponding refill mechanism component (108 & 208) to enable releasable coupling of the child component of the refill mechanism to the parent  
10 component of the refill mechanism. As used herein the term coupling means that the child and parent devices are at least partially co-joined preferably in a co-linear configuration to enable refilling. Suitable mechanisms include lock and key type systems, screw thread, bayonet, elastomeric fitments, captive plug mechanisms, push fit and magnetic fitments as known and described in the art.

15 In one embodiment, the parent body preferably the first portion thereof is provided with cavity (215) to guide the coupling of the child to parent device. The internal dimensions of such a cavity are such as to at least accommodate a portion of the child device, preferably, the at least second portion of the child device, whilst still ensuring that the user can readily access the child device to  
20 enable placement and retrieval from the parent device. This enables easy alignment of the child and parent refill mechanisms by the user. The cavity may further be provided with a geometry which provides a 'lead in' to guide the placement of the child to the parent device.

Upon single actuation of the parent pump, preferably a vertical down stroke via the child device,  
25 a seal is formed around the liquid pathway from the parent outlet and the child inlet. The seal may be formed by any known mechanism. For example as described hereinabove, the parent outlet discharge /tube is pushed into the child outlet valve or the child inlet tube is pushed into the parent outlet. Alternatively, a portion of the surface adjacent the child inlet and parent outlet may be provided with a material such as silicone or rubber for example which will form a seal upon  
30 the application of pressure as the pump is actuated and thereby connect the child inlet and parent outlet respectively.

In one embodiment, the parent has an outlet discharge tube extending from the liquid outlet which can be inserted into the one way liquid inlet valve of the child or close proximity thereto

such that the child liquid inlet valve is opened by the mechanical action of the parent outlet tube or due to the application of liquid pressure as a consequence of the actuation of the parent pump mechanism as described in US 5524680.

- 5 After the child and parent refill component mechanisms have been coupled together, the parent pump may be actuated in order to transfer the liquid from the parent pump to the child reservoir. Upon actuation of the parent pump which is typically achieved by a exerting a substantially vertical downward force upon the child device which is transferred to the parent pump, a seal is formed around a liquid pathway from the parent liquid outlet and the one way liquid inlet refill
- 10 valve of the child reservoir. Liquid from the parent pump is then transferred via the liquid pathway to the child reservoir whilst the corresponding volume of air in the child reservoir is expelled via the child air outlet valve. Upon release of the downward force (end of the stroke) and completion of actuation of the parent pump, the seal and the liquid pathway are disconnected. The child may then be decoupled or disconnected from the parent device. The parent pump is
- 15 refilled (primed for next refilling action) with liquid from the parent reservoir via the parent one way liquid inlet valve and air enters the parent reservoir via the air inlet valve. The cap of the parent, if present, may then be replaced.

- The dimensions and values disclosed herein are not to be understood as being strictly limited to
- 20 the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as "40 mm" is intended to mean "about 40 mm."

## CLAIMS

What is claimed is:

1. A liquid refill system (10), preferably for a fragrance composition comprising:
  - a) A child device (101) having a liquid reservoir (103) having a volume ( $V_{CR}$ ) and an air outlet valve said device (101) having a first portion (105) having a dispensing mechanism (107) and a second portion (106) having a child component of a refill mechanism (108) comprising a child liquid inlet (110) and a child one way liquid inlet refill valve (109) associated therewith;
  - b) A parent device (201) having a liquid reservoir (203) containing a liquid and an optional air inlet valve (204) said device (201) having a first portion (205) having a parent component of a refill mechanism (208) and a liquid outlet (213) having a one way liquid valve (209), associated therewith, said parent device (201) having a pump (207) having a pump volume ( $V_{PP}$ ), in liquid communication with the parent liquid reservoir (203) via a one way liquid inlet valve (211) and in liquid communication with said liquid outlet (213) and optionally having a liquid return valve (212), wherein the ratio of the volume of the parent pump to the volume of the child reservoir is 12:1 or less.
2. A liquid refill system (10) according to claim 1, wherein the ratio of the volume of said parent pump to said child reservoir is 10:1 or less, preferably 1:5 or less, more preferably 1:3 or less.
3. A liquid refill system (10) according to claim 1, wherein the ratio of the volume of said parent pump to said child reservoir is substantially 1:1.
4. A liquid refill system (10) according to claim 1, wherein said child dispensing mechanism (107) is a spray pump.
5. A liquid refill system (10) according to any one of the preceding claims, wherein said parent device (201) comprises a cavity to accommodate at least a portion of said child device.
6. A liquid refill system (10) according to claim 1, wherein said parent device further comprises a liquid return valve (212) and liquid outlet (216).

7. A liquid refill system (10) according to claim 1, wherein the parent liquid reservoir (203) has a liquid capacity of 100ml or less, preferably 75ml or less and the child liquid reservoir (103) has a liquid capacity of 15ml or less, preferably 10ml or less.

8. A method of refilling liquid refill system according to claim 1, comprising the steps of releasably coupling the child component of the refill mechanism (108) to the parent component of the refill mechanism (208) and actuating the parent pump (207) at least once to form a seal around a liquid pathway which extends from the parent outlet (213) to the child liquid inlet (110) and the child one way liquid inlet refill valve (109) of the child reservoir (103), through which the liquid contained in the parent pump (207) is transferred to the child reservoir (103), whilst air is expelled from the child reservoir via the child air outlet valve, and upon termination of the actuation of the parent pump (207), the seal and the liquid pathway are disconnected, and the parent pump (207) refills with liquid from the parent reservoir (203) via the parent one way liquid inlet valve (211) and inlet (210), and air enters the parent reservoir (203) via the air inlet valve (204), and decoupling the child component of the refill mechanism (108) from the parent component of the refill mechanism (208).

9. A method according to claim 8, wherein said child component of the refill mechanism (108) is releaseably coupled to the parent component of the refill mechanism in a substantially co-linear configuration.

10. A method according to claim 8, wherein said parent pump (207) is activated at least twice.

Fig. 1a

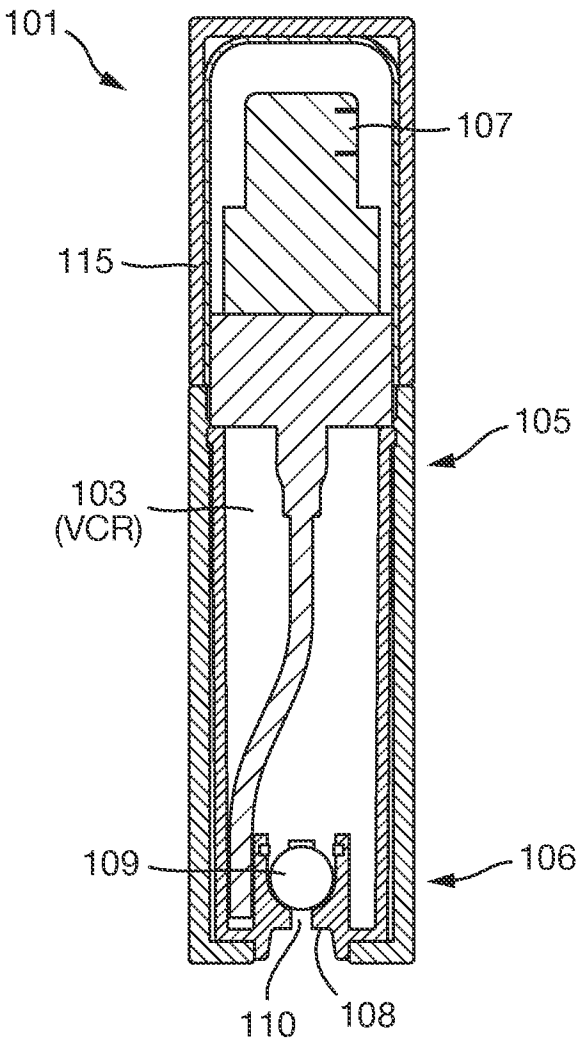
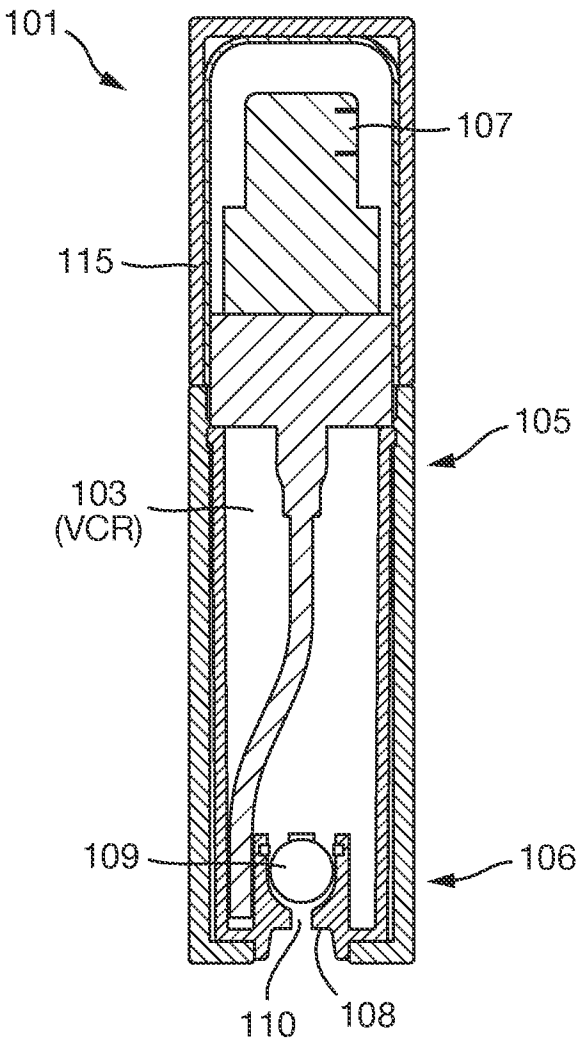
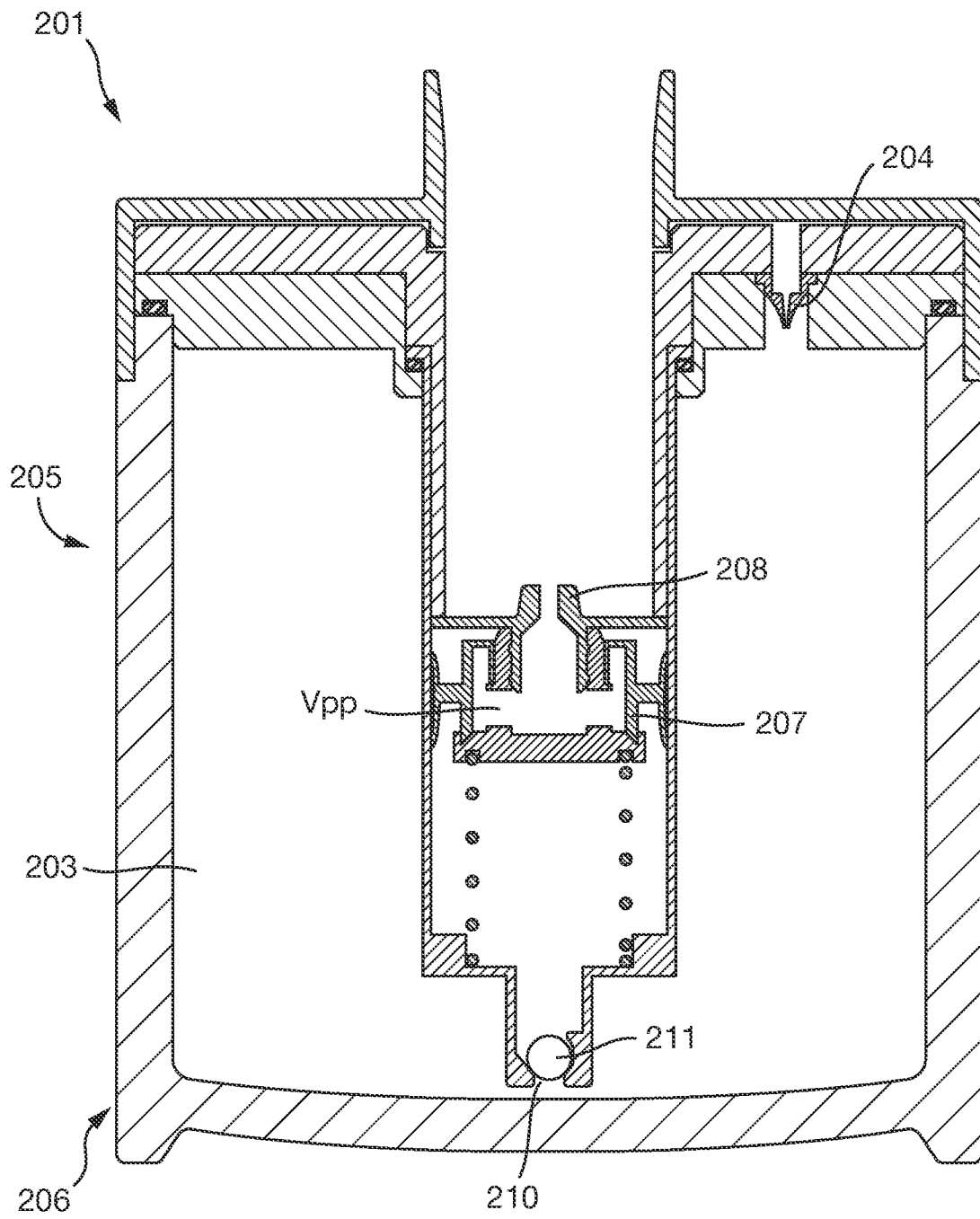


Fig. 1b



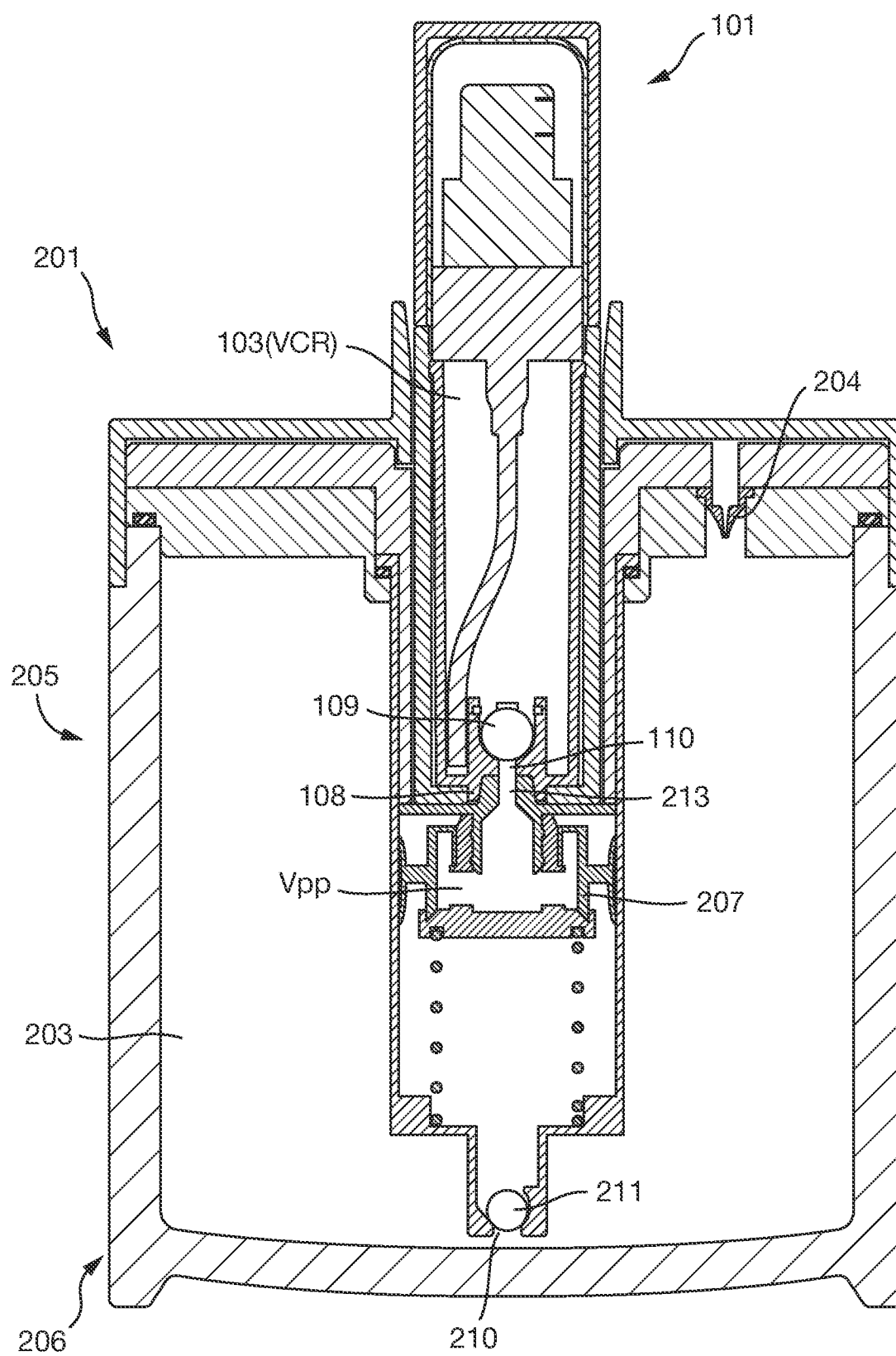
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Fig. 2



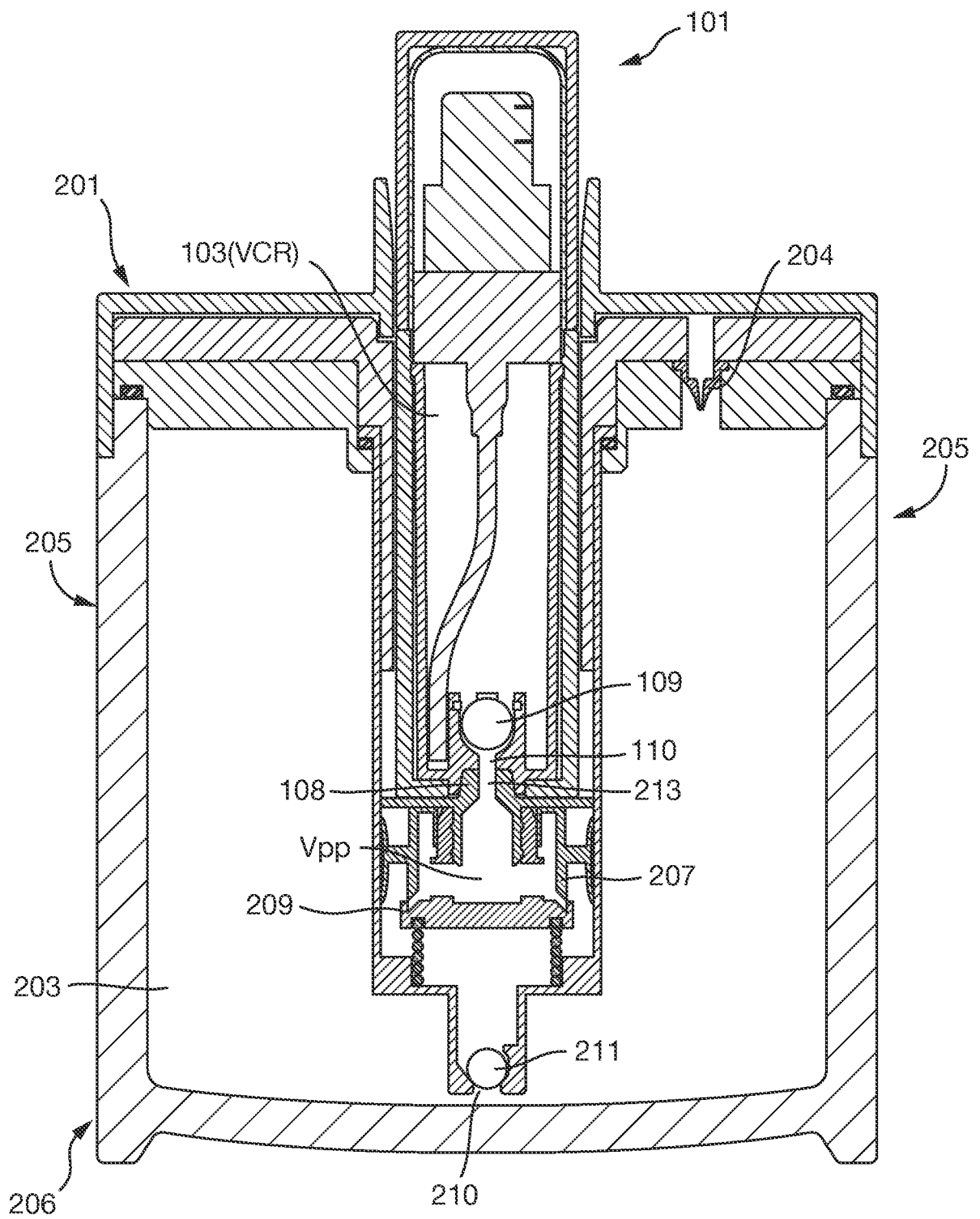
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Fig. 3



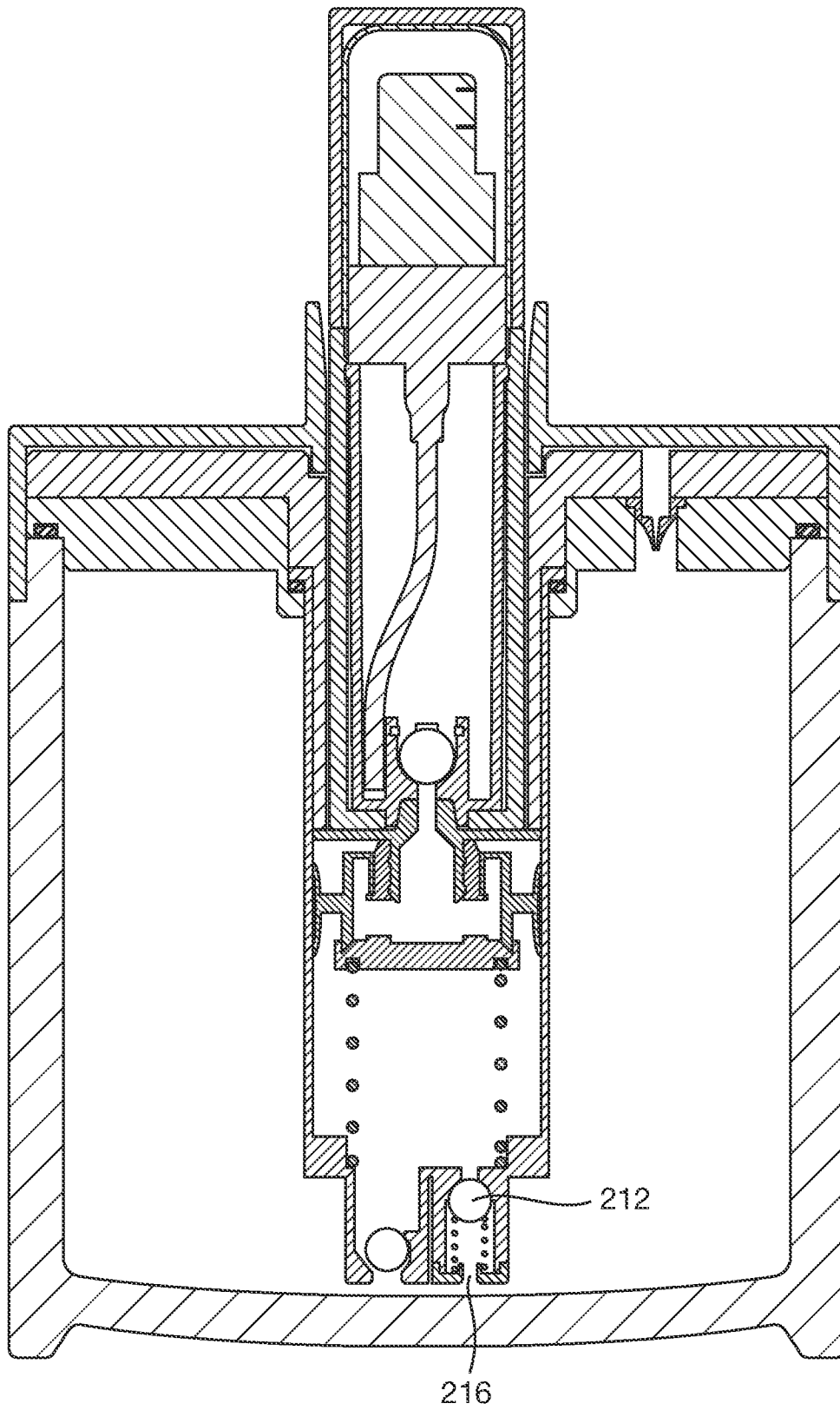
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Fig. 4



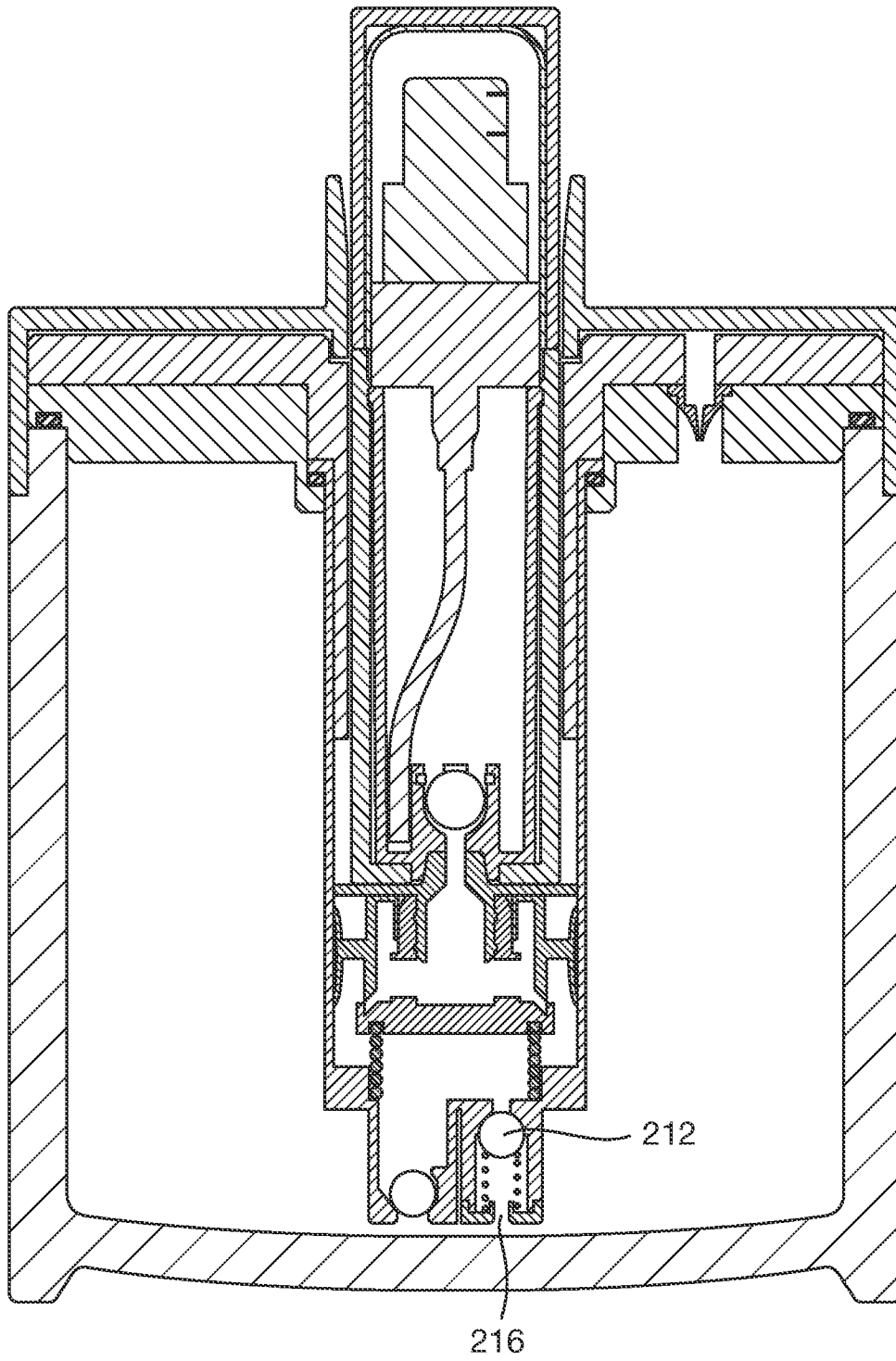
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Fig. 5



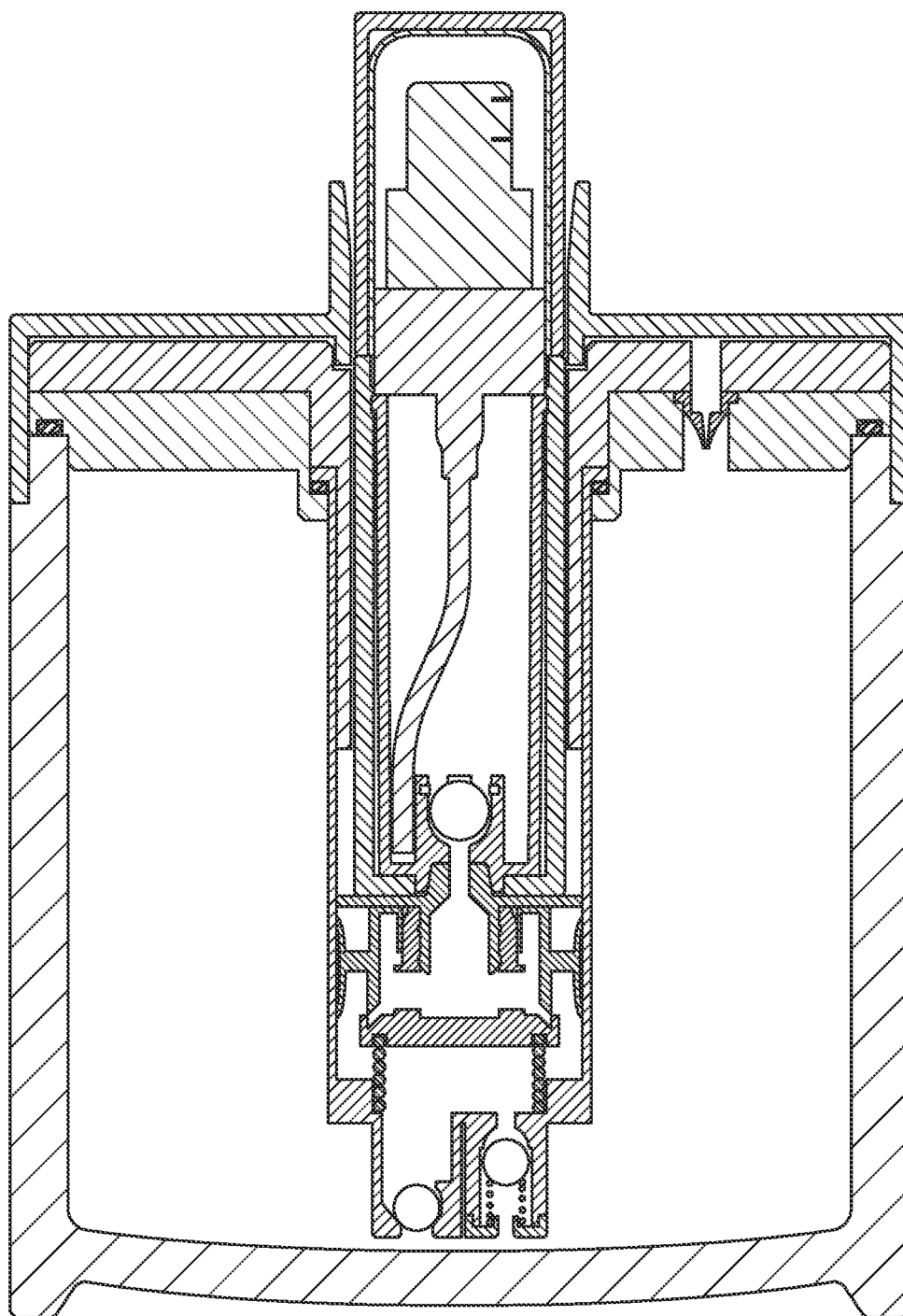
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Fig. 6



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Fig. 7



## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2015/039843

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 practicable, 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. |
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| A         | paragraph [0020] - paragraph [0034];<br>figures                                                                                                                            | 6                     |
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Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

9 September 2015

Date of mailing of the international search report

17/09/2015

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Authorized officer

Krysta, Dieter

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2015/039843

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