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(54) **DEVICE, SYSTEM AND METHOD FOR TAMPER-PROOF OR TAMPER-EVIDENT LIQUID SUPPLY**

(57) The present disclosure relates to a device, system and method for tamper-proof or tamper-evident liquid supply. In particular, the disclosure relates to a closure (1) for a liquid container (2), wherein the closure (1) is a tamper-proof or tamper-evident closure arranged to deter or prevent removal of the closure by an unauthorised person, the closure comprising a vent passage (12) arranged to permit air flow through the closure (1), in use, and a vent valve (14) moveable between an open position and a closed position to control the passage of air through the vent passage (12), and a liquid passage (26) arranged to permit the passage of liquid through the closure (1), in use, and a liquid valve (28) moveable between an open position and a closed position to control the passage of liquid through the liquid passage (26), wherein the liquid passage (26) is arranged to permit the flow of liquid therethrough under the action of gravity when the liquid valve (28) is in the open position, and wherein the liquid passage (26) at least partially surrounds the vent passage (12).

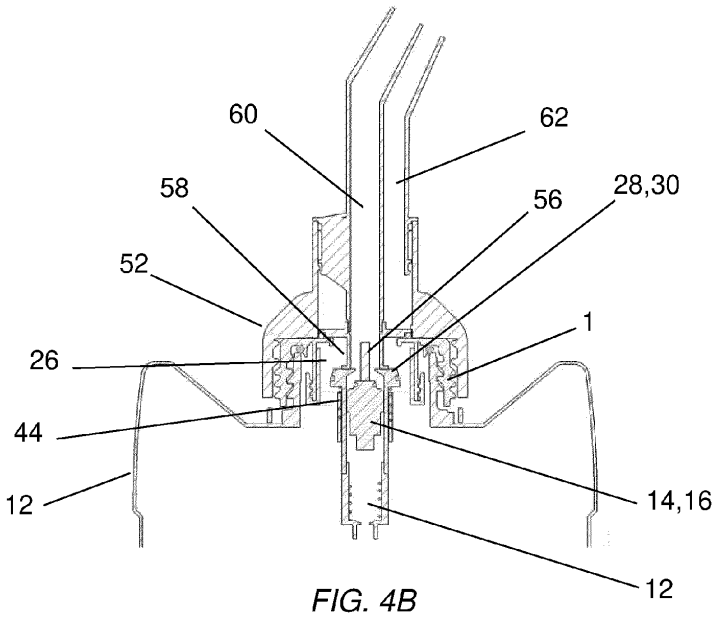

FIG. 4B

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Description

[0001] The present invention relates to a tamper-proof or tamper-evident closure for a liquid container, and in particular, but not exclusively, to a closure permitting liquid to be dispensed from the container by gravity. The present invention further relates to a system and method for distributing and dispensing liquids, wherein containers for storing and transporting liquids can be reused a number of times, with minimal processing of the containers being required between uses and with minimal wastage of material.

[0002] The supply of liquids for industrial, commercial and/or retail applications, such as concentrated chemical cleaning systems, requires the liquid to be stored in appropriate containers for distribution from the supplier to the user. Reusability of such containers is becoming an increasingly pressing issue, as the supplier (or whoever is responsible for placing the container into the market) is becoming increasingly responsible for the entire lifecycle of the container. Thus, it is desirable for the supplier to retrieve empty containers from the user, such that the container can be refilled and redistributed. This reduces the number of used containers being sent to landfill or being recycled and thus has obvious environmental benefits.

[0003] A problem arises from the fact that the supplier has little or no control over how a container is used whilst in the possession of a user. It is possible that the container may be used for other purposes, such as to store and/or transport liquids other than the liquid originally supplied in the container. Furthermore, the container may be used carelessly leading to contamination of the container. For example, the container may be left uncovered (e.g. with a cap of the container removed), thus introducing the possibility of liquids or other contaminants entering the container.

[0004] Since the supplier has little or no control over the use of the container, when processing the container for reuse the supplier must decontaminate the container by washing, rinsing or otherwise removing residual liquid from the container before the container can be refilled and redistributed. This creates a significant burden on the supplier and increases the costs involved with reusing containers. Furthermore, the necessary processing can be energy intensive, and thus the environmental benefits of reusing containers are diminished. Still further, when decontaminating container, the supplier must ensures that waste chemicals are appropriately disposed of. These factors reduce the motivation for suppliers to reuse containers.

[0005] Various closure systems are known which seal the container to prevent contamination during transport and storage, and to limit the user's ability to remove the closure, whereby the closure has a valve arrangement permitting liquid to be drawn from the container via a dip tube extending to the bottom of the container, for example by means of a dispensing pump external to the container and/or pressurisation of the container. However, the mode by which liquid may be dispensed from a container fitted with a tamper-proof or tamper-evident closure has hitherto been limited to such arrangements and alternative modes of dispensing liquids are desirable.

[0006] It is an object of the present invention to provide a tamper-proof or tamper-evident closure system and a method for distributing and dispensing liquids, in which containers used to store and transport the liquids can be returned to a supplier after use, and subsequently refilled and redistributed by the supplier within minimal processing of the containers by the supplier being required before reuse, and with minimal wastage of material. It is a particular object of the present invention to provide a closure for a container which permits liquid to be dispensed in a variety of dispensing modes, and a system and method of distributing and dispensing liquids from a container comprising such a tamper-evident or tamper-proof closure.

[0007] According to a first aspect of the present invention, there is provided a closure for a liquid container, wherein the closure is a tamper-proof or tamper-evident closure arranged to deter or prevent removal of the closure by an unauthorised person, the closure comprising a vent passage arranged to permit air flow through the closure, in use, and a vent valve moveable between an open position and a closed position to control the passage of air through the vent passage, and a liquid passage arranged to permit the passage of liquid through the closure, in use, and a liquid valve moveable between an open position and a closed position to control the passage of liquid through the liquid passage, wherein the liquid passage is arranged to permit the flow of liquid therethrough under the action of gravity when the liquid valve is in the open position, and wherein the liquid passage at least partially surrounds the vent passage.

[0008] Within the context of this specification, including the appended claims, the terms "tamper-proof closure" and "tamper-evident closure" are to be construed as follows. The term "tamper-proof closure" refers to a closure which is arranged to engage with the container so as to prevent removal of the closure from the container by an unauthorised person. For example, a "tamper-proof closure" may be engaged with the neck of a container by a locking mechanism, requiring a specific tool to remove the closure. Such a tool may only be available to the supplier, meaning that only the supplier is able to remove the closure, and a user is not able to remove the closure when the container is in their possession. The term "tamper-evident closure" refers to a closure which is removable from the container by any person, however any such removal is immediately evident. Thus, it can readily be determined if the closure has been removed.

[0009] The arrangement of the present invention provides separate flow paths for liquid and air through the closure. Accordingly, when fitted to a container, liquid within the container can be dispensed through the liquid passage of the closure and air can be returned into the

container through the vent passage. This permits liquid to be dispensed and pressure within the container to be equalised, without the need to remove the closure. Thus the closure can be made tamper-proof or tamper-evident, whilst still allowing a user to dispense the liquid within the container.

[0010] Accordingly, a supplier can maintain control over the internal contents of the container, even when the container is outside of the supplier's possession. Upon return of an empty container to the supplier, the supplier can determine whether the closure has been removed, or whether an attempt to remove the closure has been made. The supplier can therefore easily assess whether the container can be refilled and reused without further processing, or whether the container requires decontamination before further use.

[0011] The ability to dispense liquid under the action of gravity alone from a container fitted with a tamper-proof or tamper evident closure has hitherto been unrealised. In the present invention, the liquid passage at least partially surrounds the vent passage. This allows the dimensions of the liquid passage to be sufficiently large to allow the flow of liquid through the liquid valve under the action of gravity, without requiring additional means to draw liquid from the container, such as an external pump and/or pressurisation of the headspace within the container. Accordingly, liquid can be dispensed from the container under the action of gravity alone, permitting a wide range of dispensing modes to be achieved. In one example, liquid may be dispensed by pouring liquid out of the container, when the vent valve and liquid valves are in the open position.

[0012] The vent valve is preferably housed within the liquid valve. The vent passage and liquid passage are preferably concentric and the vent passage is located radially inwardly of the liquid passage. Such arrangements further facilitate achieving the desired dimensions of the liquid passage to allow the flow of liquid therethrough under the action of gravity.

[0013] Preferably, at least one of the vent valve and the liquid valve is biased to the closed position. Accordingly, both the vent passage and liquid passage are closed when the system is at rest. The closure is therefore sealed against the ingress or egress of fluid through the vent passage unless and until the vent valve and liquid valve are actively opened by appropriate means.

[0014] In some embodiments, the vent passage is arranged to terminate, in use, at a position near to a neck of a container to which the closure is fitted.

[0015] The closure may comprise a distal outer surface, in use. Preferably, the vent passage terminates at a position no more than 10 cm from the distal outer surface of the closure. Accordingly, the vent passage will terminate at a position near to the neck of the majority of containers for which the use of the present closure is envisaged. The distal outer surface of the closure is an uppermost surface of the closure when fitted to a container in its normal orientation (that is, an orientation in which the neck of the container is located at the top of the container).

[0016] The vent passage preferably comprises a restriction arranged to be located within a container to which the closure is fitted, in use, wherein a diameter of the restriction 5 mm or less, and most preferably 4.76 mm or less. In preferred embodiments, the diameter of the restriction is in the range 2 mm to 5 mm and is most preferably in the range 2 mm to 4.76 mm. During a gravity dispensing operation, a terminal point of the vent passage may be immersed within the liquid within the container. A restriction having a diameter in the above preferred range has been found to provide the necessary airflow for the return of air into a container during a gravity dispensing operation, whilst preventing liquid within the container from entering the vent passage.

[0017] The flow rate of liquid being dispensed from the container can be controlled in dependence on the diameter of the restriction in the vent passage: a smaller diameter restriction will limit air return into the container and thus will also limit liquid flow out of the container (since any liquid exiting the container must be replaced), whilst a larger diameter restriction will permit greater air return and thus faster flow rates of liquid out of the container. A diameter of 4.76 mm has been found to be an optimum diameter for permitting maximum air return into the container, without liquid entering the vent passage. A diameter of 2 mm has been found to be an optimum diameter for permitting the minimum necessary air return into the container.

[0018] The closure may comprise: a valve chamber; a first valve member arranged to open and close an inlet of the valve chamber, the inlet being an inlet into the valve chamber from a container to which the closure is fitted; and a second valve member arranged to open and close an outlet of the valve chamber, wherein the first and second valve members are functionally coupled such that movement of the second valve member to an open position causes movement of the first valve member to a closed position, the first and second valve members being arranged such that the first valve member is closed before the second valve member is opened.

[0019] With such an arrangement, a measured dose of liquid may be dispensed from the container. In one particular envisaged use of the invention, the closure may be fitted to a container arranged to be stored in an elevated position and upturned orientation, for example by being mounted to a wall or other fixture. Liquid is retained within the container by the closure with the liquid valve and vent valve in the closed position, thus preventing the passage of liquid through the closure. The first valve member is preferably arranged to open the inlet of the valve chamber when the second valve member is closed. At rest, liquid from the container thereby fills the valve chamber and is prevented from exiting the valve chamber by the second valve member. In a dispensing operation, the first valve member closes the inlet to the valve chamber and the second valve member opens the outlet of

the valve chamber, such that a fixed volume of liquid corresponding to the internal volume of the valve chamber is dispensed.

[0020] In some embodiments, when the vent valve and liquid valve are in the open position, the total area of the liquid passage at a point of maximum restriction within the liquid passage is greater than the total area of the vent passage at a point of maximum restriction within the vent passage. The respective points of maximum restriction in the liquid passage and vent passage are to be understood as being points within each respective passage at which the passage of fluid through that passage is most restricted. The point of maximum restriction is the point between the termini (the two extreme ends) of the passage that has the minimum total area. It will be appreciated that the shape and configuration of the passages may vary between different closures, and thus the point of maximum restriction within each passage may vary according to different embodiments of the invention.

[0021] It will be appreciated that the flow of fluid through each passage will be limited by the size of the passage at its point of maximum restriction. It will also be appreciated that the dimensions of the liquid passage required to permit the flow of liquid through the liquid passage at a particular flow rate will be larger than the dimensions of the vent passage to permit air return through the vent passage to replace liquid dispensed from the container. Therefore, with the above arrangement, it can be ensured that the liquid passage, when the liquid valve is in the open position, permits the flow of liquid therethrough, whilst air return into the container to replace the dispensed liquid is permitted through the relatively small vent passage.

[0022] A ratio of the total area of the liquid passage at the point of maximum restriction within the liquid passage to the total area of the vent passage at the point of maximum restriction within the vent passage is at least 5 to 1, preferably at least 10 to 1 and in some embodiments may be at least 20 to 1. Such ratios ensure the necessary balance between liquid flow out of the container and air return into the container.

[0023] The location of the point of maximum restriction in the liquid passage and/or the area of the liquid passage at the point of maximum restriction in the liquid passage, when the liquid valve is in the open position, may be variable depending on the extent to which the liquid valve is opened. Accordingly, the liquid valve can be opened to varying extents depending on the required flow rates of the dispensing operation and the particular liquid being dispensed. For example, the closure may comprise a liquid opening and a liquid valve member arranged to close the opening. As the liquid valve member is moved to the open position, an annular gap will be created between the inner circumference of the opening and the outer circumference of the liquid valve member. This annular gap may form the point of maximum restriction within the liquid passage. As the liquid valve member is moved further relative to the opening, the separation between the inner circumference of the opening and the outer circumference of the liquid valve member increases, and thus the position and total area of the annular gap also increased. Accordingly, the location of the point of maximum restriction will varying according to the extent to which the liquid valve is opened.

[0024] The liquid passage and liquid valve may be arranged such that the liquid valve is moveable to an open position in which the point of maximum restriction in the liquid passage is located at an opening of the liquid passage, said opening representing, in use, a final point of exit for liquid passing through the liquid passage of the closure from a container to which the container is fitted. Such an arrangement allows the area of the liquid passage at the point of maximum restriction, and thus the flow rate of liquid through the closure, to be varied according to extent to which the liquid valve is opened. Accordingly, the same closure may be suitable for a range of dispensing operations depending on the specific application, for example the mode of dispensing and the particular liquid being dispensed.

[0025] According to a second aspect of the present invention, there is provided a container comprising a closure according to the first aspect, wherein the vent passage terminates at a position remote from a base surface of the container distal to a neck of the container. The base surface is to be understood as a bottom surface of the container when in a normal orientation (that is, in an orientation in which the neck of the container and the closure are located at the top of the container).

[0026] The vent passage may terminate in a portion of the container proximal to a neck of the container. In a normal orientation in which the container is rested with its base on the ground or other surface (that is, in an orientation in which the neck of the container and the closure are located at the top of the container), the proximal portion of the container may be a portion of the container that is closer to the neck of the container than to the base of the container (i.e. an upper half of the container, in its normal orientation). The vent passage may terminate at a distance no greater than 10 cm, and preferably no greater than 5 cm, from a base of the neck of the container. Thus, the vent passage will terminate at a position proximal to the neck of the container in the majority of containers for which use of the present invention is envisaged.

[0027] In accordance with a third aspect of the present invention, there is provided a system for dispensing liquids from a container, the system comprising a closure in accordance with the first aspect of the present invention, and further comprising a dispensing cap arranged to releasably engage with the closure. The dispensing cap comprises a first actuator arranged to move the vent valve from the closed position to the open position when the dispensing cap is engaged with the closure, and a second actuator arranged to move the liquid valve from the closed position to the open position when the dispensing cap is engaged with the closure.

[0028] A system in accordance with this aspect of the present invention permits a supplier to distribute a filled container to a user. Upon receipt of the container, the user can fit the dispensing cap to the closure, so as to open the liquid valve and vent valve and create a flow path for liquid out of the container (and air return into the container), without the need to first remove the closure.

[0029] Such an arrangement obviates the need for the user to open the container by removing the closure prior to use. This prevents liquid from being spilled, which avoids waste and may be particularly beneficial where the liquid is corrosive or otherwise hazardous. Importantly, the container may remain closed by the closure at all times when in the user's possession, since there is no need for the user to remove the closure in order to dispense liquid from the container. The supplier can therefore employ a tamper-proof or tamper-evident closure, such that removal of the closure is prevented, or at least that removal of the closure is made evident to allow the container, once returned, to be processed accordingly.

[0030] The dispensing cap may comprise a liquid duct and a vent duct, wherein, in use, the liquid duct is arranged to communicate with the liquid passage of the closure and the vent duct is arranged to communicate with the vent passage of the closure, and wherein the vent duct has a proximal end located towards the vent valve of the closure and an open distal end located away from the vent valve of the closure. In use, the open distal end of the vent duct is open to its surroundings and is not further connected to any tubing, conduit, pump or other apparatus. This arrangement allows liquid to be dispensed from the container under the action of gravity. Since the distal end of the vent duct is open, it provides a passage for air return into the container. Thus, when the container is upturned, liquid is free to exit the container under the action of gravity, with the necessary air return into the container via the vent duct of the dispensing cap and the vent passage of the closure.

[0031] The vent duct is preferably at least partially surrounded by the liquid duct. This allows the dimensions of the liquid duct to be maximised, having the benefits outlined above.

[0032] The dispensing cap may comprise a shield located, in use, between an opening of the vent valve of the closure and the proximal end of the vent duct of the dispensing cap, the shield being arranged to cover an opening of the proximal end of the vent duct and to provide an air flow path between the opening of the proximal end of the vent duct and the vent valve, in use. This arrangement is particularly useful for applications in which the container is maintained in an upturned orientation between subsequent dispensing operations. The shield covers the proximal end of the vent duct and prevents liquid from entering into the liquid duct via the vent duct. Undesirable dripping of liquid through the vent duct between dispensing operations is prevented.

[0033] The shield may have a substantially U-shaped cross-section, wherein a wall of the shield is arranged, in use, to deflect liquid from the opening of the vent valve to the liquid duct of the dispensing cap. The shield thus has the form of an umbrella covering the proximal end of the vent duct.

[0034] The first and second actuators of the dispensing cap may have a fixed position relative to the dispensing cap, such that when the dispensing cap is engaged with the closure, the first and second actuators act to open the vent valve and liquid valve, respectively. Accordingly, engaging the dispensing cap with the closure automatically opens the liquid valve and the vent valve. This may be particularly beneficial where liquid is to be dispensed by pouring. The user may fit the dispensing cap and then simply upturn the container to pour liquid out of the container, without any further action necessary to open the liquid valve and the vent valve.

[0035] Alternatively, the first and second actuators may be biased to an inactive position in which the first and second actuators do not open the vent valve and liquid valve when the dispensing cap is engaged with the closure, and wherein the first and second actuators are moveable into an active position in which the first and second actuators act to open the vent valve and liquid valve, respectively. This is particularly beneficial where the container is intended to be kept in an upturned orientation in between dispensing operations. At rest, the liquid valve and vent valve remain closed thus preventing liquid from exiting the container, even when the container is upturned. In order to dispense liquid, the first and second actuators can be moved into the active position so as to open the liquid valve and vent valve, thus permitting liquid to flow from the container under the action of gravity.

[0036] The dispensing cap may comprise an engagement portion coupled to the first and second actuators, the engagement portion being arranged to engage with a neck of a receptacle in use, such that movement of the receptacle towards the closure moves the first and second actuators into the active position. In use, a receptacle can be offered up to the engagement portion and the dispensing operation is commenced by moving the receptacle towards the closure so as to open the liquid and vent valves. This provides an easy mode of dispensing liquid into a receptacle. The engagement portion may be an annular portion and the vent duct and liquid duct of the dispensing cap are located radially inward of the engagement portion, such that the liquid duct and vent duct are positioned within the receptacle when a neck of a receptacle is engaged with the annular engagement portion.

[0037] In accordance with a fourth aspect of the present invention, there is provided a method of distributing and dispensing liquids, comprising, at a supplier end:

- filling a container with a liquid to be dispensed;
- fitting the container with a closure, wherein the closure is a tamper-proof or tamper-evident closure ar-

ranged to deter or prevent removal of the closure by an unauthorised person, the closure comprising:

a vent passage arranged to permit air flow through the closure, in use, and a vent valve moveable between an open position and a closed position to control the passage of air through the vent passage, and
a liquid passage arranged to permit the passage of liquid through the closure, in use, and a liquid valve moveable between an open position and a closed position to control the passage of liquid through the liquid passage, wherein the liquid passage is arranged to permit the flow of liquid therethrough under the action of gravity when the liquid valve is in the open position;

and at a user end:

- opening the vent valve and the liquid valve of the closure; and
- dispensing liquid from the container through the liquid passage of the closure by gravity.

[0038] The container is preferably placed into an upturned orientation in order to dispense liquid from the container under the action of gravity.

[0039] The closure may be a tamper-evident closure and the method may further comprise, at the supplier end:

- receiving the container returned by said user;
- determining whether the tamper-evident closure has been removed from said first container, or whether an attempt to remove the tamper-evident closure has been made;
- if it is determined that the tamper-evident closure has not been removed from said first container, or if it is determined that no attempt to remove the tamper-evident closure has been made, refilling said first container with the same liquid without first rinsing, washing or in any other way removing any residual liquid from within the container; and
- redistributing said first container to the same or another user.

[0040] The fourth aspect present invention provides a method by which containers for storing and transporting liquids, such as cleaning chemicals, may be reused with minimal processing required by the supplier between uses. In an initial use, the container is filled and distributed to a user, who is able to dispense liquid from the container, without the need to remove the closure of the container. Accordingly, the user has no need to remove the closure. The user is thus deterred or prevented from removing the closure. Whilst the closure remains on the container, insertion of any other liquids into the container is severely restricted and preferably prevented. Contamination of the container when outside of the supplier's possession is thereby prevented.

[0041] When the supplier receives a returned container, the supplier can determine whether or not the closure has been removed by virtue of the tamper-proof or tamper-evident closure. Thus, where it is determined that the closure has not been removed by the user, or that no attempt to remove the closure has been made, the supplier can infer that the container has not been filled with any other liquids, or otherwise contaminated, whilst in the possession of the user. The container can therefore be refilled with the same liquid, and redistributed to the same or another user without the need to first clean the container.

[0042] The container may preferably be fitted with a closure in accordance with the first aspect of the present invention. The method may comprise the use of a system in accordance with the third aspect of the present invention, wherein the vent valve and liquid valve are opened by fitting the dispensing cap onto the closure, and wherein the first actuator of the dispensing cap is arranged to open the vent valve and the second actuator of the dispensing cap is arranged to open the liquid valve.

[0043] Non-limiting embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a cross-section of a container fitted with a closure in accordance with the present invention;
Figures 2A and 2B are enlarged cross-sections of the closure of Figure 1;
Figure 3 is a cross-section of a dispensing cap in accordance with an aspect of the present invention;
Figures 4A to 4C are cross-sections of a system in accordance with the present invention, in use;
Figure 5 is a cross-section of a further dispensing cap in accordance with an aspect of the present invention;
Figures 6A to 6D are cross-sections of a further system in accordance with the present invention, in use;
Figure 7 is a cross-section of a further dispensing cap in accordance with an aspect of the present invention; and
Figures 8A to 8G are cross-sections of a further system in accordance with the present invention.

[0044] With reference to Figure 1, there is shown a closure 1 for a liquid container 2 according to the present invention. The closure 1 is a tamperproof or tamper evident closure arranged to deter or prevent removal of the closure 1 from the container 2 by an unauthorised person.

[0045] The mechanism by which the closure 1 is tamperproof or tamper evident is not particularly critical to the present invention. In the present arrangement, a tamper evident ring 6 is provided at a base portion of a neck 4 of the container 2, the ring 6 being arranged to engage with the base of the neck 4 of the container 2 by means of a ratchet mechanism. The closure 1 is arranged to engage with the tamper evident ring 6, such that the

closure 1 cannot be removed from the container 2 without destroying the integrity of the tamper evident ring 6. However, it will be appreciated that a number of tamperproof or tamper evident closure mechanisms may be adopted, without deviating from the inventive concept of the present invention. In one embodiment, for example, the closure 1 may be formed integrally with the container 2 or permanently attached to the neck 4 of the container 2 such that removal of the closure 1 is not permitted and the closure 1 is thereby tamperproof.

[0046] Figure 1 shows the closure 1 fitted to a container 2 containing liquid to be dispensed. Since the tamperproof or tamper evident closure 1 is not intended to be removed by the user, the closure 1 comprises a valve arrangement arranged to permit liquid to be dispensed from the container 2 without the need to remove the closure 1 from the container 2.

[0047] Figures 2A and 2B shows an enlarged view of the closure 1 when engaged with the neck 4 of the container. The closure 1 comprises a threaded inner surface 8 arranged to engage with a corresponding threaded outer surface 10 of the container neck 4, such that the closure 1 can be fitted to the container in a conventional manner.

[0048] The closure 1 comprises a vent passage 12 arranged to permit airflow through the closure 1, in use, and a vent valve 14 moveable between an open position and a closed position to control the passage of air through the vent passage 12. Figure 2A shows the vent valve 14 in the closed position and Figure 2B shows the vent valve 14 in the open positon.

[0049] The vent valve 14 comprises a valve member 16 having a seal 18, which engages with an opening 20 of the vent passage 12 so as to prevent any fluid (liquid or gas) from passing through the opening 12 when the vent valve 14 is in the closed position. In the illustrated embodiment, the seal 18 engages against an inner circumference 22 of the opening 20, however it will be appreciated that the seal 18 may engage with the vent passage 12 at alternative positions, such that fluid is prevented from passing through the closure 1 via the vent passage 12.

[0050] The vent valve member 16 is biased to the closed position by a spring 24.

[0051] The closure 1 further comprises a liquid passage 26 arranged to permit the passage of liquid through the closure 1 in use. A liquid valve 28 is provided which is moveable between an open position and a closed position to control the passage of fluid through the liquid passage 28. Figure 2A shows the liquid valve 28 in the closed position.

[0052] The liquid valve 28 comprises a valve member 30 having a seal 32, which engages with an opening 34 of the liquid passage 26, so as to prevent liquid or other fluid from passing through the closure 1 via the liquid passage 26 when the liquid valve 28 is in the closed position. In the illustrated embodiment, the seal 32 engages against a lower surface 36a of a flange portion 36 of the closure 1 so as to seal the opening 34 of the liquid passage 26, however it will be appreciated that the seal 32 may engage with the liquid passage 26 at alternative positions, such that fluid is prevented from passing through the closure 1 via the liquid passage 26.

[0053] The liquid valve member 30 defines a housing 38 having a substantially cylindrical internal volume forming a portion of the vent passage 12. The vent valve member 16 is provided within the internal volume of the liquid valve member 30, such that the vent valve 14 is housed within the liquid valve 28.

[0054] The liquid passage 26 is substantially annular in form, surrounding the vent passage 12. An outer surface 40 of the liquid valve member 30 defines a first wall of the liquid passage 26. The closure 1 comprises an annular projection 42 defining a second wall of the liquid passage 26 opposing the first wall.

[0055] The liquid valve member 30 is biased to the closed position by a spring 44.

[0056] When each of the liquid valve 28 and the vent valve 14 are in the closed position, as shown in Figure 2A, the closure 1 provides a continuous barrier sealing an opening defined by the neck 4 of the container 2, so as to prevent the ingress or egress of liquid (or other fluid) to/from the container 2. Accordingly, the contents of the liquid container 2 are sealed within the container 2 by the closure 1, without the need for an additional cap. However, in the illustrated embodiment, the threaded outer surface 8 of the closure may be used to engage with a further cap if an additional barrier to ingress or egress of liquid is desired.

[0057] In the illustrated embodiment, the vent passage 12 and liquid passage 26 are concentric and each is symmetrical about a central axis A of the closure 1. The closure 1 is screw threaded and the vent passage 12 is located radially inwardly of the liquid passage 26. With this arrangement, both valves can be opened by engagement of a screw threaded dispensing cap with the screw threaded outer surface 8 of the closure 1, as will described in greater detail below.

[0058] The opening 20 of the vent passage 12 is located at a distal outer surface 46 of the closure 1. The vent passage 12 terminates at a position within the container 2 that is near to the neck 4 of the container 2. In preferred embodiments a distance D between the distal outer surface 46 of the closure 1 and a terminal point 48 of the vent passage 12 located within the container 2, when the vent valve is in the open position in use, is no greater than 10 cm. The terminal point 48 of the vent passage 12 is a point at which the vent passage 12 is open to the internal volume of the container 2.

[0059] The vent passage 12 comprises a restriction 50 located towards the terminal point 48 of the vent passage 12 within the container 2. The restriction may be located anywhere within the vent passage and is not necessarily limited to the location shown in Figure 2.

[0060] The restriction 50 also permits the flow rate of liquid dispensed from the container 2 through the liquid

passage 26 to be controlled by throttling air flow back into the container 2. Lower flow rates may be achieved by providing a smaller restriction and greater flow rates may be achieved by selecting a larger restriction. The diameter of the restriction 50 is preferably in the range 2 mm to 5 mm and is optimally in the range 2.00 to 4.76 mm. A restriction of this diameter has been found to allow maximum airflow into the container 2 through the vent passage 12 without liquid passing through the restriction 50 into the vent passage 12 when liquid is dispensed from the container 2 in an inverted orientation under the action of gravity, as described in greater detail below.

[0061] The restriction 50 defines a point of maximum restriction within the vent passage when the vent valve 14 is in the open position. That is to say, the restriction 50 represents a point within the vent passage 12 at which the passage of fluid through the vent passage 12 is most restricted. The point of maximum restriction is the point between the termini (the two extreme ends) of the vent passage 12 that has the minimum total area. It will be appreciated that the point of maximum restriction may be at alternative positions within the vent passage 12.

[0062] Figure 2B shows the closure 1 with the vent valve 14 and liquid valve 28 in the open position. The vent valve member 16 is moved against the bias of the spring 24 so as to disengage the seal 18 from the opening 20 of the vent passage 12, thus creating an uninterrupted path for air flow through the vent passage 12 from the opening 20 to the terminal point 48 of the vent passage 12 within the container 2. The liquid valve member 30 (housing the vent valve 14) is also moved against the bias of its spring 44 so as to disengage the seal 32 with the liquid passage opening 34, providing an uninterrupted path for the flow of liquid through the liquid passage 12 from the opening 34 into the container 2 around the outer surface 40 of liquid valve member 30.

[0063] As mentioned above, the restriction 50 in the vent passage 12 represents a point of maximum restriction in the vent passage 12. Similarly, the liquid passage 26 comprises a point of maximum restriction when the liquid valve 28 is in the open position, at which point the passage of fluid through the liquid passage 26 is most restricted. The point of maximum restriction within the liquid passage may vary depending on the extent to which the liquid valve 28 is opened (that is, the distance to which the liquid valve member 30 extends into the closure). In Figure 2B, the total area of an annular gap 27 between the liquid valve member 30 and the flange portion 36 of the closure is greater than the total area of the opening 34, such that the opening 34 represents the point of maximum restriction. However, it will be appreciated that the liquid valve member 38 extend into the closure by a lesser distance, such that the annular gap 27 has an area smaller than that of the opening 34, making the annular gap 27 the point of maximum restriction.

[0064] A total area of the liquid passage 12 at the point of maximum restriction in the liquid passage 12 (represented in this embodiment by the opening 34) is greater than the total area of the vent passage 12 at the point of maximum restriction in the vent passage 12 (represented in this embodiment by the restriction 50). This arrangement ensures that liquid is permitted to pass through the liquid passage 26 from the container 2 under the action of gravity, without passing through the vent passage 12. At the same time, air can be directed into the vent passage 12 to return into the container 2 through the vent passage 12, via the restriction 50, so as to equilibrate pressure within the container 2 and permit the flow of liquid out of the container 2. Accordingly, the arrangement of the vent valve 14 and liquid valve 38 in the closure 1 of the present invention permits liquid to be efficiently dispensed from the container 2 under the action of gravity, with air return into the container through the vent passage 12.

[0065] It will be appreciated that the points of maximum restriction within the vent passage 12 and liquid passage 26 may be at alternative locations to those shown in Figure 2B.

[0066] With the valve arrangement of the present invention, the liquid passage can at least partially surround the vent passage, thus allowing the dimensions of the liquid passage to be made sufficiently large to permit the flow of liquid through the liquid passage under the action of gravity.

[0067] With reference to Figure 3, there is shown an embodiment of a dispensing cap 52 in accordance with a further aspect of the present invention. The dispensing cap 52 is arranged to engage with the closure 1 so as to move the vent valve 14 and liquid valve 28 into the open position, in order to permit the flow of air and liquid through the vent passage 12 and liquid passage 26, respectively, as will now be described.

[0068] The dispensing cap 52 has a threaded inner surface 54 arranged to engage with the threaded outer surface 10 of the closure 1 so as to releasably engage the dispensing cap 52 with the closure 1. The dispensing cap 52 comprises a first actuator 56 arranged to engage with the vent valve member 16 and a second actuator 58 arranged to engage with the liquid valve member 30, when the dispensing cap 52 is engaged with the closure 1.

[0069] The dispensing cap 52 further comprises a vent duct 60 to permit the return of air into the container 2 and a liquid duct 62 to permit the flow of liquid out of the container 2 during a dispensing operation. The vent duct 60 has a proximal end 60a located towards the closure 1, in use, and an open distal end 60b located away from the closure 1, in use.

[0070] In the illustrated embodiment, the liquid duct 62 and vent duct 60 are provided in the form of a spout to permit liquid to be dispensed under the action of gravity. That is to say, the dispensing cap 1 permits liquid to be poured out of the container 2 when the container 2 is in an upturned orientation.

[0071] Referring now to Figures 4A and 4B, the engagement of the dispensing cap 52 with the closure 1

will be described. As shown in Figure 4A, the dispensing cap 52 is screwed onto the closure 1 and the first actuator 56 engages with the vent valve member 16 so as to move the vent valve member 16 against the bias of the spring 24 so as to open to the vent valve 14. The vent duct 60 of the dispensing cap 52 is brought into fluid communication with the vent passage 12 of the closure 1 such that the vent passage 12 and vent duct 60 in combination define a flow path for the return of air into the container 2 through the closure 1. At this stage, the liquid valve 28 remains closed.

[0072] Figure 4B shows the dispensing cap 52 fully engaged with the closure 1. The second actuator 58 moves the liquid valve member 30 against the bias of the spring 44 so as to open the liquid valve 28. The liquid passage 26 of the closure 1 is brought into fluid communication with the liquid duct 62 of the dispensing cap 52 are so as to provide a path for the passage of liquid out of the container 2 through the closure 1. In the configuration shown in Figure 4B, the system is ready for liquid to be dispensed.

[0073] Referring now to Figure 4C, a typical dispensing operation is shown. With the dispensing cap 52 engaged with the closure 1 as described above, the container 2 is inverted so as to pour liquid out of the container 2. Liquid flows out of the container 2 through the liquid passage 26 of the closure 1 and liquid duct 62 of the dispensing cap 52, whilst air returns through the vent duct 60 of the dispensing cap and vent passage 12 of the closure 1 to replace the liquid dispensed. Accordingly, liquid can be dispensed from the container 2 by pouring, without the need to first remove the closure 1. In this way, a supplier can ensure that a user's access to the interior of the container 2 is restricted thus limiting the opportunity for the container 2 to become contaminated.

[0074] Referring now to Figure 5, there is shown further embodiment of a dispensing cap 152 in accordance with an aspect of the present invention. Features in common with the embodiment of Figure 3 are illustrated with corresponding numerals.

[0075] The dispensing cap 152 comprises a first actuator 156 arranged to move the vent valve 14 of the closure 1 from the closed position to the open position when the dispensing cap 152 is engaged with the closure 1, and a second actuator 158 arranged to move the liquid valve 28 of the closure 1 from the closed position to the open position when the dispensing cap 152 is engaged with the closure 1. The first and second actuators 156, 158 are biased to an inactive position by a spring 164, as shown in Figure 5.

[0076] The dispensing cap 152 comprises a liquid duct 162 arranged to communicate with the liquid passage 26 of the closure 1, and a vent duct 160 arranged to communicate with the vent passage 12 of the closure 1, as will be described in further detail below. The vent duct 160 has a proximal end 160a which, in use, is located towards the vent valve 14 of the closure 1. Opposing the proximal end 160a is an open distal end 160b of the vent duct 160, which is located away of the vent valve 14 of the closure 1. In use, the open distal end 160b of the vent duct 160 is open to its surroundings and is not further connected to any tubing, conduit, pump or other apparatus.

[0077] The liquid duct 162 surrounds the vent duct 160 and has a proximal end 162a located towards the liquid valve 28 of the closure 1 and a distal end 162b located away from the liquid valve 28 of the closure 1, in use. A seal 166 is provided around an outer surface of the distal end 160b of the vent duct 160 which seals against an inner surface of the liquid duct 162, so as to close the distal end 162b of the liquid duct 162. In Figure 5, the seal 166 is an O-ring. This arrangement ensures that any residual liquid that may be present within the liquid duct 162 following a dispensing operation is contained, preventing dripping from dispensing, as explained in greater detail below.

[0078] The dispensing cap 152 further comprises an engagement portion 168 which in use couples with the first and second actuators 156, 158 so as to move the first and second actuators 156, 158 into an active position in which they engage with the vent valve member 16 and liquid valve member 30 of the closure 1 so as to open the vent valve 14 and liquid valve 28 of the closure 1. The engagement portion 168 is biased to an inactive position in which it does not engage with the first and second actuators 156, 158.

[0079] Figure 6A shows the dispensing cap 152 engaged with the closure 1 by means of cooperating screw threaded surfaces 8, 154. As can be seen, the first and second actuators 156, 158 are in an inactive position in which they do not engage with the vent valve member 16 or liquid valve member 30, respectively. The closure 1 shown in Figure 6A is identical to that shown in Figures 2A and 2B and features are therefore indicated with like numerals.

[0080] Figure 6A shows the container 2 in an upturned orientation before commencing a dispensing operation. The closure 1 and the dispensing cap 152 are thus also in an upturned orientation. Figure 6A also shows a receptacle 70 into which liquid is to be dispensed from the container 2. The engagement portion 168 of the dispensing cap 152 is shaped so as to engage with a neck 72 of the receptacle 70, with the vent duct 160 and liquid duct 162 of the dispensing cap 152 extending into the receptacle 70.

[0081] Referring now to Figure 6B, as the receptacle 70 is moved towards the container 2 (upwards as shown in Figure 6B), a portion of the liquid duct 162 is moved towards the container 2, such that the seal 166 provided at the distal end 160b of the vent duct 160 disengages with the inner surface of the liquid duct 162. This opens the liquid duct 162 of the dispensing cap 152 to the inner volume of the receptacle 70. Any residual liquid within the liquid duct 162 will at this stage drain into the receptacle 70. At this stage, the engagement portion 168 is moved against its bias and engages with the second ac-

tuator 158 but the vent valve 14 and liquid valve 28 remain closed.

[0082] As shown in Figure 6C, continued movement of the receptacle 70 towards the container 2 causes the second actuator 158 to move against its bias so as to engage with a surface of the liquid valve 28, at this stage without opening the liquid valve member 30. The first actuator 156 is fixed relative to the second actuator 158 to move therewith. Accordingly movement of the second actuator 158 by means of the engagement portion 168 causes movement of the first actuator 156 against its bias. The first actuator 156 engages with an outer surface of the vent valve member 16 and, as shown in Figure 6C, moves the vent valve member 16 against the bias of its spring 24 so as to open the vent valve 14 of the closure 1. This creates a ventilation flow path for the movement air from the receptacle 70 to the container 2 via the vent duct 160 of the dispensing cap 152 and the vent passage 12 of the closure 1. However, at this stage the liquid valve 28 remains closed and therefore liquid is not dispensed into the receptacle 70.

[0083] Referring now to Figure 6D, continued movement of the receptacle 70 towards the container 2 causes the second actuator 158 to move the liquid valve member 30 of the liquid valve 28 against its bias, so as to open the liquid valve 28. This creates a liquid path from the container 2 into the receptacle 70 via the liquid passage 26 of the closure 1 and the liquid duct 162 of the dispensing cap 152. Thus, liquid is able to transfer from the container 2 into the receptacle 70 and an air return from the receptacle 70 into the container 2 is permitted so as to equalise the pressure within both the container 2 and the receptacle 70 during the dispensing operation.

[0084] The dispensing operation continues for as long as the receptacle 70 is maintained in the position shown in Figure 6D, in which the vent valve 14 and liquid valve 28 are in the open position. When the desired quantity of liquid has been dispensed, the receptacle 70 is moved away from the container 2 (downwards in the orientation shown in Figure 6D), thus closing the liquid valve 28 and the vent valve 14 in the reverse procedure to the one described above. Since the distal end 162b of the liquid duct 162 is closed before the receptacle 70 can be fully removed (Figure 6A), any residual liquid within the liquid duct 162 is retained within the liquid duct 162 after the receptacle has been fully removed, thus avoiding unwanted dripping. Any such residual liquid within the liquid duct 162 after a first dispensing operation will drain into a further receptacle during a subsequent dispensing operation.

[0085] In use, the vent passage 12 of the closure 1 will typically become contaminated with liquid from the container 2 in between dispensing operations. Accordingly, in a subsequent dispensing operation, opening of the vent valve 14 may cause liquid to transfer into the vent duct 160 of the dispensing cap 152. At the end of said dispensing operation, it is therefore possible that liquid could remain within the vent duct 160 and result in undesirable dripping from the open distal end 160b of the vent duct 160 after the receptacle 70 has been withdrawn.

[0086] In order to circumvent this issue, the dispensing cap 52 comprises a shield 174 located, in use, between the opening 20 of the vent valve 14 of the closure 1 and the proximal end 160a of the vent duct 160 of the dispensing cap 152. The shield 174 covers an opening of the proximal end 160a of the vent duct 160, so as to deflect liquid flowing from the vent passage 12 away from the opening of the vent duct 160. The shield 174 has the form of an inverted "U", so as to cover and surround the opening of the vent duct 160 but to provide an air flow path between the opening of the proximal end 160b of the vent duct 160 and the vent valve 14, in use. That is to say, the shield 174 permits air flow from the vent duct 160 into the vent passage 12 in an upward direction as illustrated in Figure 6D, but prevents liquid passing from the vent passage 12 into the vent duct 160 in the opposing direction. The shield 174 is shaped to as deflect any such liquid into the liquid duct 162 of the dispensing cap 152 and thus into a receptacle 70 during a dispensing operation.

[0087] Referring now to Figure 7, there is shown a further embodiment of a dispensing cap 252 in accordance with an aspect of the present invention. Features in common with the embodiments of Figures 3 and 5 are illustrated with corresponding numerals.

[0088] The dispensing cap 252 comprises a first actuator 256 arranged to move the vent valve 214 of the closure 201 from the closed position to the open position when the dispensing cap 252 is engaged with the closure 201, and a second actuator 258 arranged to move the liquid valve 228 of the closure 201 from the closed position to the open position when the dispensing cap 252 is engaged with the closure 201. The first and second actuators 256, 258 are biased to an inactive position by a spring (not shown).

[0089] The dispensing cap 252 comprises a liquid duct 262 arranged to communicate with the liquid passage 226 of the closure 201, and a vent duct 260 arranged to communicate with the vent passage 212 of the closure 201. As for the embodiment of Figure 5, the vent duct 260 has a proximal end 260a and an open distal end 260b. Similarly, the liquid duct 262 has a proximal end 262a and a distal end 262b. The distal end 260a of the vent duct 260 seals with the liquid duct 262 at its distal end 262b, so as to prevent dripping from the liquid duct 262 in between dispensing operations in the manner described above.

[0090] The configuration and operation of the dispensing cap 252 of Figure 7 is substantially the same as described above in respect of the embodiment of Figure 5.

[0091] Referring now to Figure 8A, the dispensing cap 252 is shown fitted to a closure 201, which in turn is fitted to a neck 4 of a container 2. The container 2 is in an upturned orientation for dispensing liquid from the container 2, and thus the closure 201 and dispensing cap 252 are also shown in an upturned orientation.

[0092] The closure 201 shown in Figure 8A comprises a liquid valve chamber 276 having an inlet 276a into the valve chamber 276 from the container 2 to which the closure 201 is fitted, and an outlet 276b through which liquid is dispensed, in use. In this regard, the terms "inlet" and "outlet" refer to the direction of the liquid flow through the closure 201 in use. In Figure 8A, the outlet 276b of the valve chamber 276 is closed by the liquid valve 228 of the closure 201.

[0093] The liquid valve 228 comprises a first valve member 278 arranged to open and close the inlet 276a of the valve chamber 276, and a second valve member 280 arranged to open and close the outlet 276b of the valve chamber 276. The first and second valve members 278, 280 are functionally coupled so that movement of the second valve member 280 to an open position causes movement of the first valve member 278 to a closed position. As shown in Figure 8A, when the first and second actuators 256, 258 are in the inactive position, the first valve member 278 of the liquid valve 228 is open and the second valve member 280 of the liquid valve 228 is closed. Accordingly, liquid from the container 2 occupies the valve chamber 276.

[0094] Referring now to Figure 8B, in a first stage of a dispensing operation, a receptacle 70 is brought into engagement with the engagement portion 268 of the dispensing cap 252 and moved in a direction towards the container 2 (an upwards direction as represented in Figure 8B). As discussed above in relation to Figure 6B, the seal between the vent duct 260 and liquid duct 262 at their distal ends 260b, 262b is broken to open the liquid duct 262 of the dispensing cap 252 to the receptacle 70. Further movement of the receptacle 70 in the direction of the container 2 moves the first actuator 256 into the active position thus opening the vent valve 214 to create a ventilation flow path for the movement of air from the receptacle 70 to the container 2 via the vent duct 260 of the dispensing cap 252 and the vent passage 212 of the closure 201 (as shown in Figure 8C).

[0095] As shown in Figure 8D, continued movement of the receptacle 70 towards the container 2 causes the second actuator 258 to engage with the second valve member 280 of the liquid valve 228. The second valve member 280 of the liquid valve 228 is functionally coupled to the first valve member 278 of the liquid valve 228, such that movement of the second valve member 280 to open the outlet 276b causes a concurrent movement of the first valve member 278 to close of the inlet 276a of the valve chamber 276. The mechanism by which the second valve member 280 and first valve member 278 are functionally coupled is such that the first valve member 278 is fully closed before the second valve member 280 is opened.

[0096] As shown in Figure 8E, further movement of the receptacle 70 in the direction of the container 2 causes the second valve member 280 of the liquid valve 228 to move into a fully opened position in which the flow of liquid from the liquid valve chamber 276 of the closure 201 into the liquid duct 262 of the dispensing cap 252 and subsequently into the receptacle 70 is permitted. Since the inlet 276a to the liquid valve chamber 276 is closed by the first valve member 278, a measured dose of the liquid is dispensed into the receptacle 70. This is a particularly useful arrangement for dispensing a chemical concentrate in an exact quantity into the receptacle 70 for further dilution with water or other solvent.

[0097] After a dispensing operation has been completed, the receptacle 70 is withdrawn and the second valve member 280 of the liquid valve 228 is biased to close the outlet 276b of the liquid chamber 276, as shown in Figure 8F. The first valve member 278 remains closed until the second valve member 280 is closed, after which the first valve member 278 moves into an open position as shown in Figure 8G to allow the valve chamber 276 to be refilled with the liquid from the container 2 through the inlet 276a for a subsequent measured dispensing operation.

[0098] The dispensing cap 252 comprises a shield 274 arranged to prevent the ingress of liquid into the vent duct 260 in the manner described above.

[0099] The various embodiments above illustrate the use of a closure in accordance with the present invention for dispensing of a liquid from a container by gravity, without the need to remove a closure from the neck of the container. Since the liquid passage of the closure is arranged to surround the vent passage, the internal dimensions of the liquid passage can be selected in order to permit a free flow of liquid through the closure under the action of gravity (with the container in an upturned orientation), without the need for additional means to draw liquid from the container. For example, liquid can be dispensed from the container without requiring a dispensing pump or pressurisation of a head space within the container. The valve arrangement of the present invention therefore permits liquid to be dispensed through the closure under the action of gravity by locating the liquid passage to surround the vent passage.

[0100] The invention has been described above with reference to specific embodiments, given by way of example only. It will be appreciated that different arrangements of the system are possible, which fall within the scope of the appended claims.

Claims

1. A closure for a liquid container, wherein the closure is a tamper-proof or tamper-evident closure arranged to deter or prevent removal of the closure by an unauthorised person, the closure comprising:

   a vent passage arranged to permit air flow through the closure, in use, and a vent valve moveable between an open position and a closed position to control the passage of air through the vent passage, and

   a liquid passage arranged to permit the passage

of liquid through the closure, in use, and a liquid valve moveable between an open position and a closed position to control the passage of liquid through the liquid passage, wherein the liquid passage is arranged to permit the flow of liquid therethrough under the action of gravity when the liquid valve is in the open position,
and wherein the liquid passage at least partially surrounds the vent passage.

2. A closure according to claim 1, wherein the vent valve is housed within the liquid valve and/or wherein the vent passage and liquid passage are concentric and the vent passage is located radially inwardly of the liquid passage.

3. A closure according to any preceding claim, wherein the vent passage is arranged to terminate, in use, at a position near to a neck of a container to which the closure is fitted, and preferably wherein the closure comprises a distal outer surface, in use, and the vent passage terminates at a position no more than 10 cm from the distal outer surface of the closure.

4. A closure according to any preceding claim, wherein the vent passage comprises a restriction arranged to be located within a container to which the closure is fitted, in use, wherein a diameter of the restriction is less than 5 mm.

5. A closure according to any preceding claim, wherein when the vent valve and liquid valve are in the open position, the total area of the liquid passage at a point of maximum restriction within the liquid passage is greater than the total area of the vent passage at a point of maximum restriction within the vent passage.

6. A closure according to claim 5, wherein a ratio of the total area of the liquid passage at the point of maximum restriction within the liquid passage to the total area of the vent passage at the point of maximum restriction within the vent passage is at least 10 to 1.

7. A closure according to claim 5 or 6, wherein the location of the point of maximum restriction in the liquid passage and/or the area of the liquid passage at the point of maximum restriction in the liquid passage, when the liquid valve is in the open position, is variable depending on the extent to which the liquid valve is opened, and preferably wherein the liquid passage and liquid valve are arranged such that the liquid valve is moveable to an open position in which the point of maximum restriction in the liquid passage is located at an opening of the liquid passage, said opening representing, in use, a final point of exit for liquid passing through the liquid passage of the closure from a container to which the container is fitted.

8. A container comprising a closure according to any preceding claim, wherein the vent passage terminates at a position remote from an internal base surface of the container distal to a neck of the container, and preferably wherein the vent passage terminates at a distance no greater than 10 cm, and preferably no greater than 5 cm, from a base of the neck of the container.

9. A system for dispensing liquids from a container, the system comprising:

a closure according to any one of claims 1 to 8, and
a dispensing cap arranged to releasably engage with the closure and comprising a first actuator arranged to move the vent valve from the closed position to the open position when the dispensing cap is engaged with the closure, and a second actuator arranged to move the liquid valve from the closed position to the open position when the dispensing cap is engaged with the closure.

10. A system according to claim 9, wherein the dispensing cap comprises a liquid duct and a vent duct, wherein, in use:

the liquid duct is arranged to communicate with the liquid passage of the closure and the vent duct is arranged to communicate with the vent passage of the closure, and
the vent duct has a proximal end located towards the vent valve of the closure and an open distal end located away from the vent valve of the closure, and preferably wherein the vent duct is at least partially surrounded by the liquid duct.

11. A system according to claim 10, wherein the dispensing cap comprises a shield located, in use, between an opening of the vent valve of the closure and the proximal end of the vent duct of the dispensing cap, the shield being arranged to cover an opening of the proximal end of the vent duct and to provide an air flow path between the opening of the proximal end of the vent duct and the vent valve, in use, and preferably wherein the shield has a U-shaped cross-section and wherein a wall of the shield is arranged, in use, to deflect liquid from the opening of the vent valve to the liquid duct of the dispensing cap.

12. A system according to any one of claims 9 to 11, wherein the first and second actuators have a fixed position relative to the dispensing cap, such that when the dispensing cap is engaged with the closure, the first and second actuators act to open the vent valve and liquid valve, respectively,
or wherein the first and second actuators are biased

to an inactive position in which the first and second actuators do not open the vent valve and liquid valve when the dispensing cap is engaged with the closure, and the first and second actuators are moveable into an active position in which the first and second actuators act to open the vent valve and liquid valve, respectively.

13. A method of distributing and dispensing liquids, comprising, at a supplier end:

- filling a container with a liquid to be dispensed;
- fitting the container with a closure, wherein the closure is a tamper-proof or tamper-evident closure arranged to deter or prevent removal of the closure by an unauthorised person, the closure comprising:

  ◦ a vent passage arranged to permit air flow through the closure, in use, and a vent valve moveable between an open position and a closed position to control the passage of air through the vent passage, and
  ◦ a liquid passage arranged to permit the passage of liquid through the closure, in use, and a liquid valve moveable between an open position and a closed position to control the passage of liquid through the liquid passage, wherein the liquid passage is arranged to permit the flow of liquid therethrough under the action of gravity when the liquid valve is in the open position;

and at a user end:

- opening the vent valve and the liquid valve of the closure; and
- dispensing liquid from the container through the liquid passage of the closure by gravity.

14. A method of distributing and dispensing liquids according to claim 13, wherein the closure is a closure according to any one of claims 1 to 8.

15. A method of distributing and dispensing liquids according to claim 14, wherein the closure is a closure of a system according to any one of claims 9 to 12, wherein the vent valve and liquid valve are opened by fitting the dispensing cap onto the closure, such that the first actuator of the dispensing cap opens the vent valve and the second actuator of the dispensing cap opens the liquid valve.

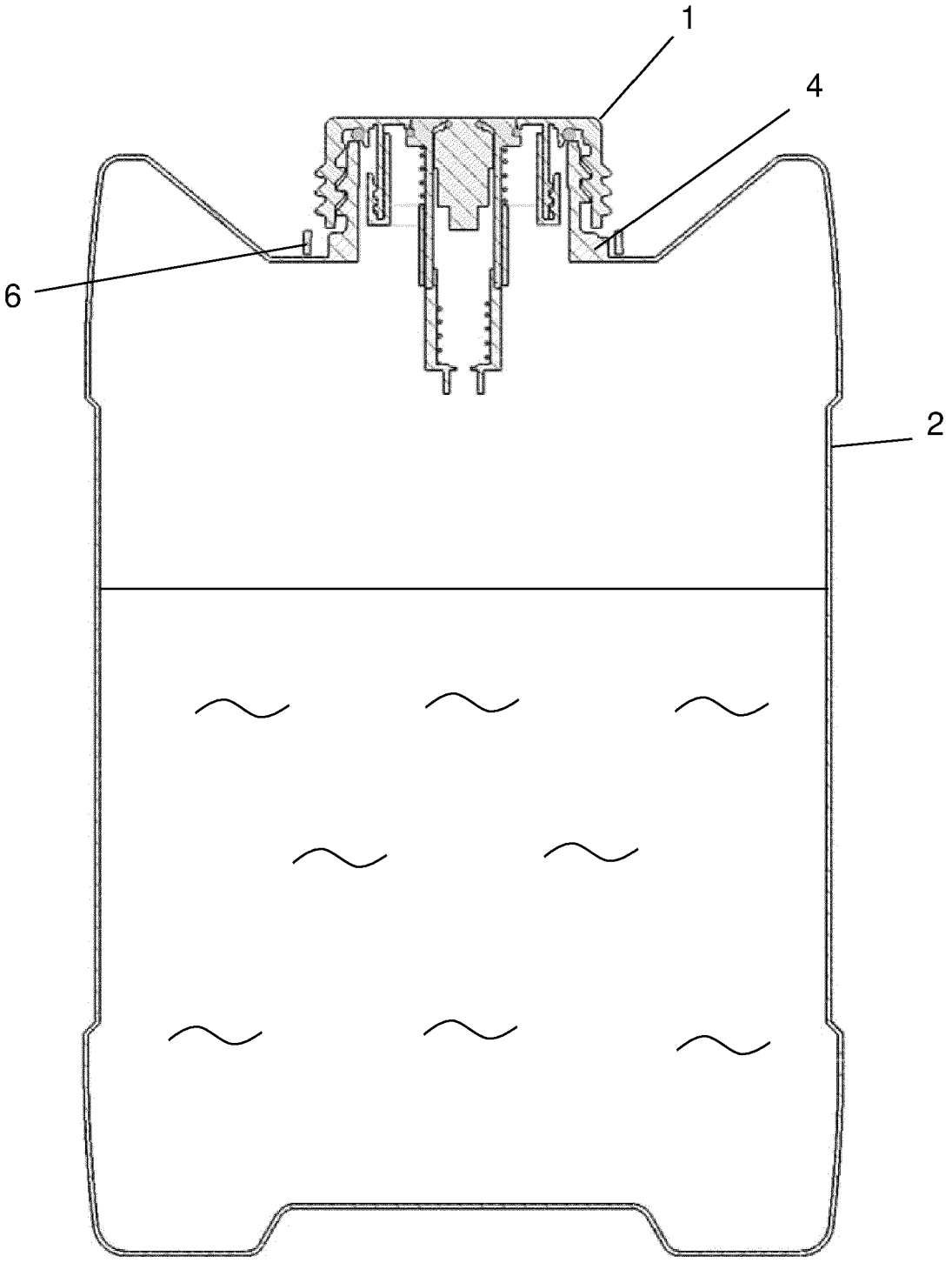

FIG. 1

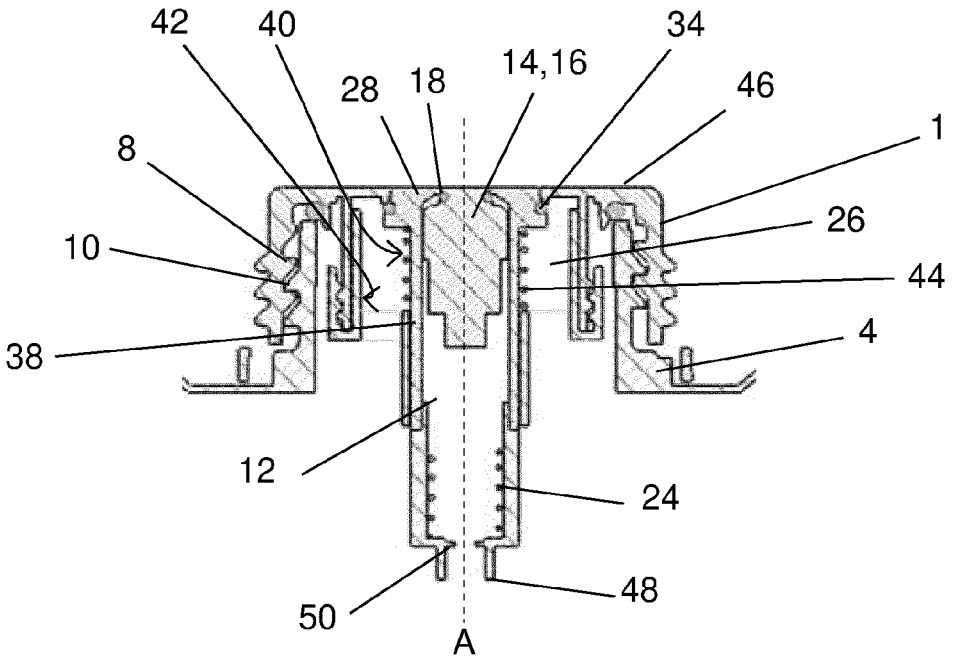
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FIG. 2A

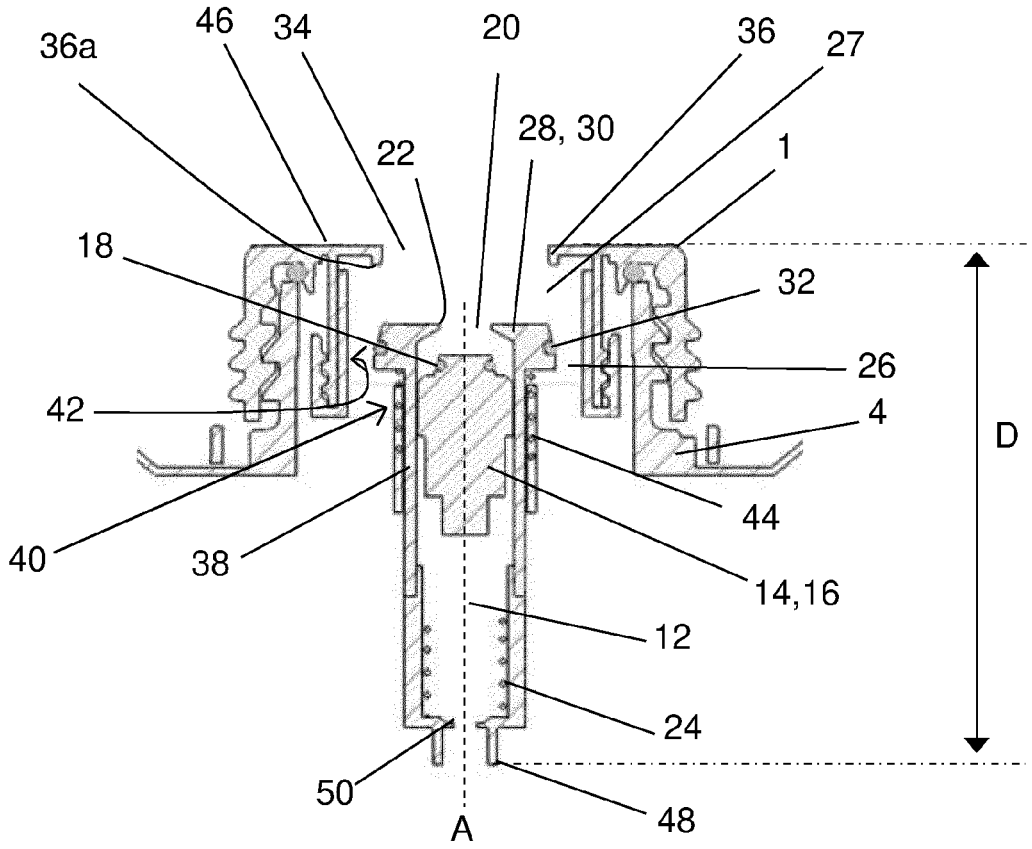
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FIG. 2B

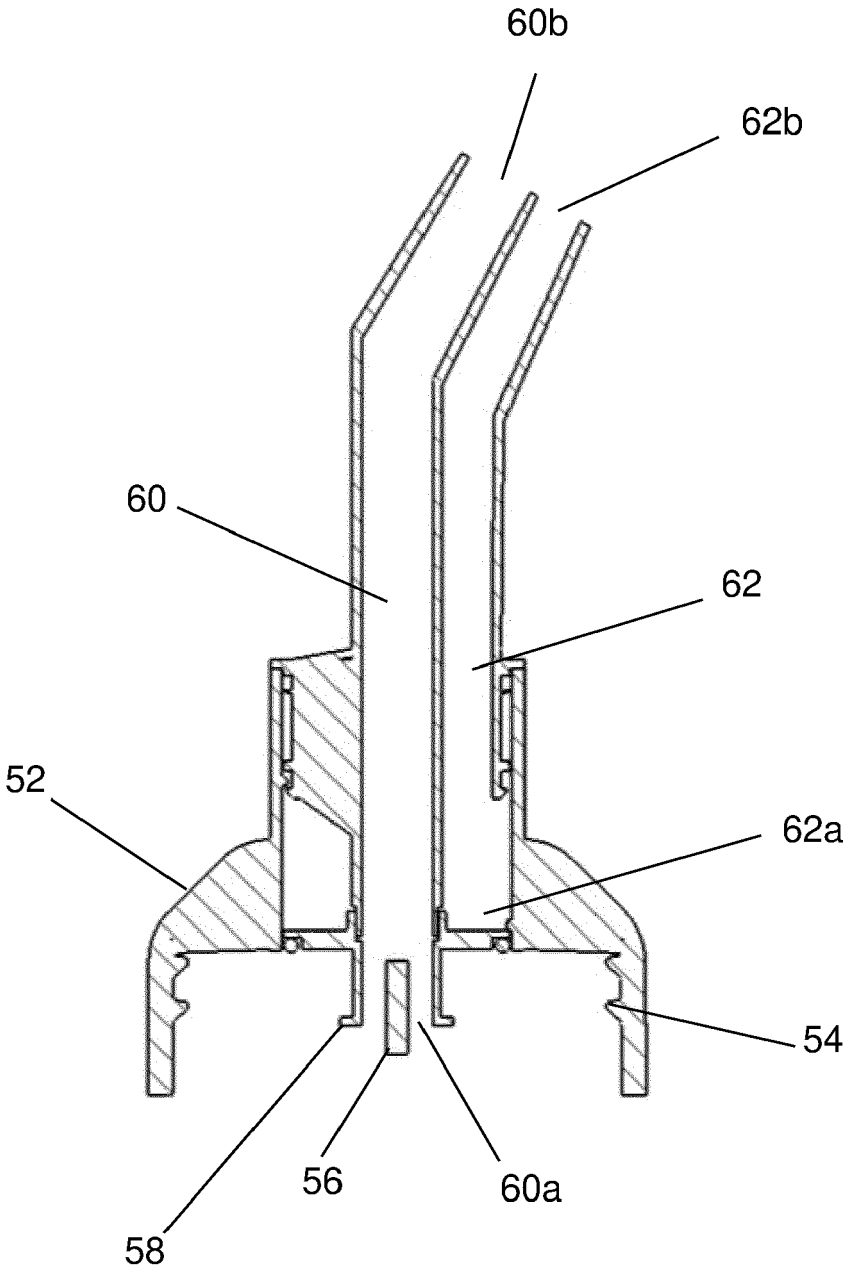

FIG. 3

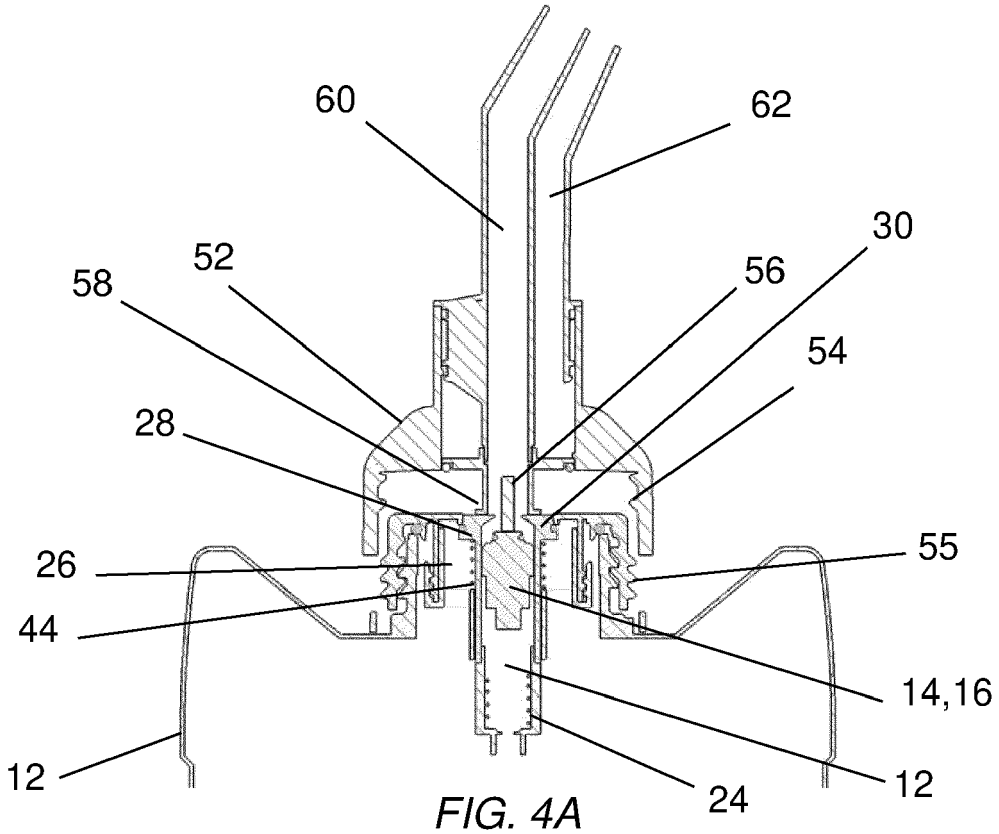
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FIG. 4A

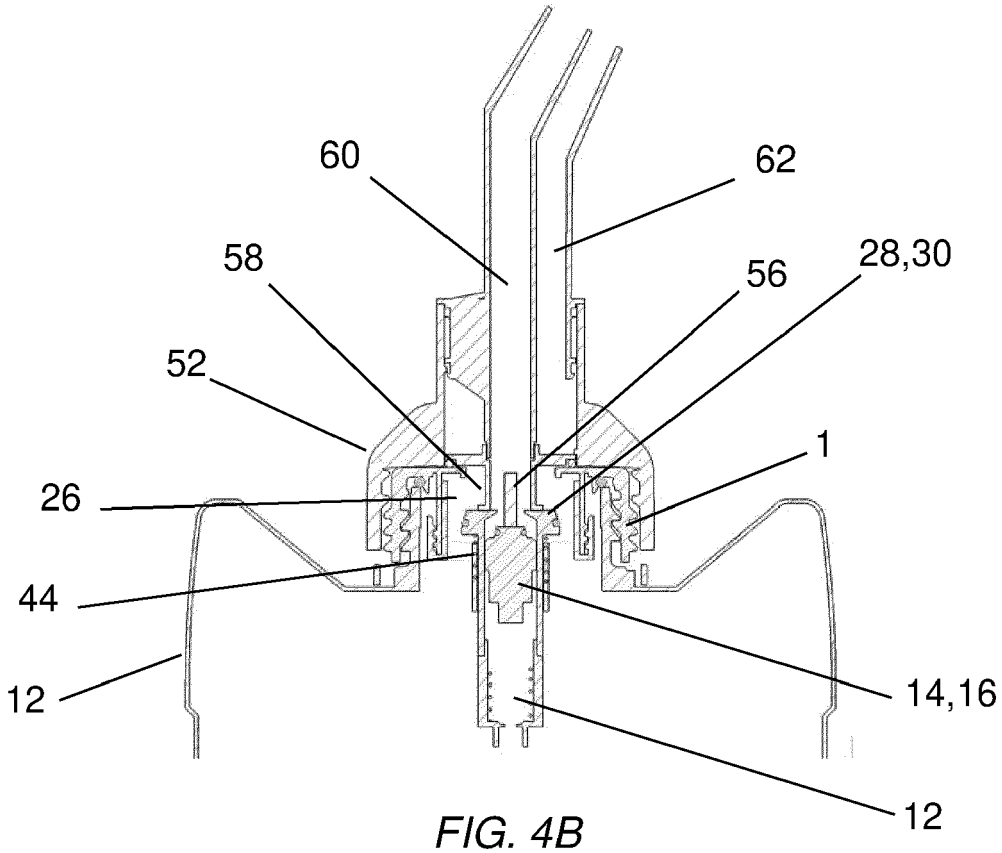
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FIG. 4B

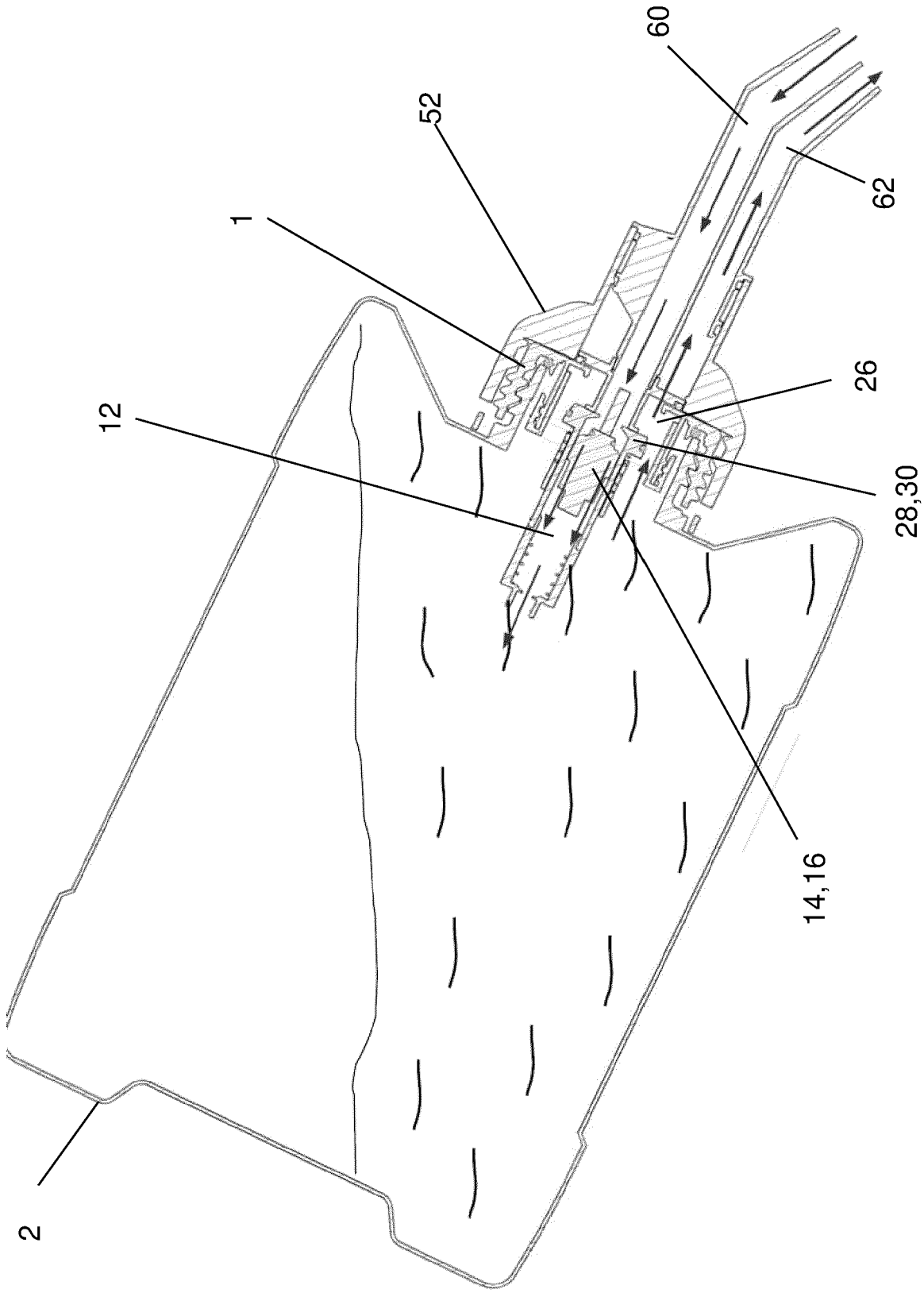


FIG. 4C

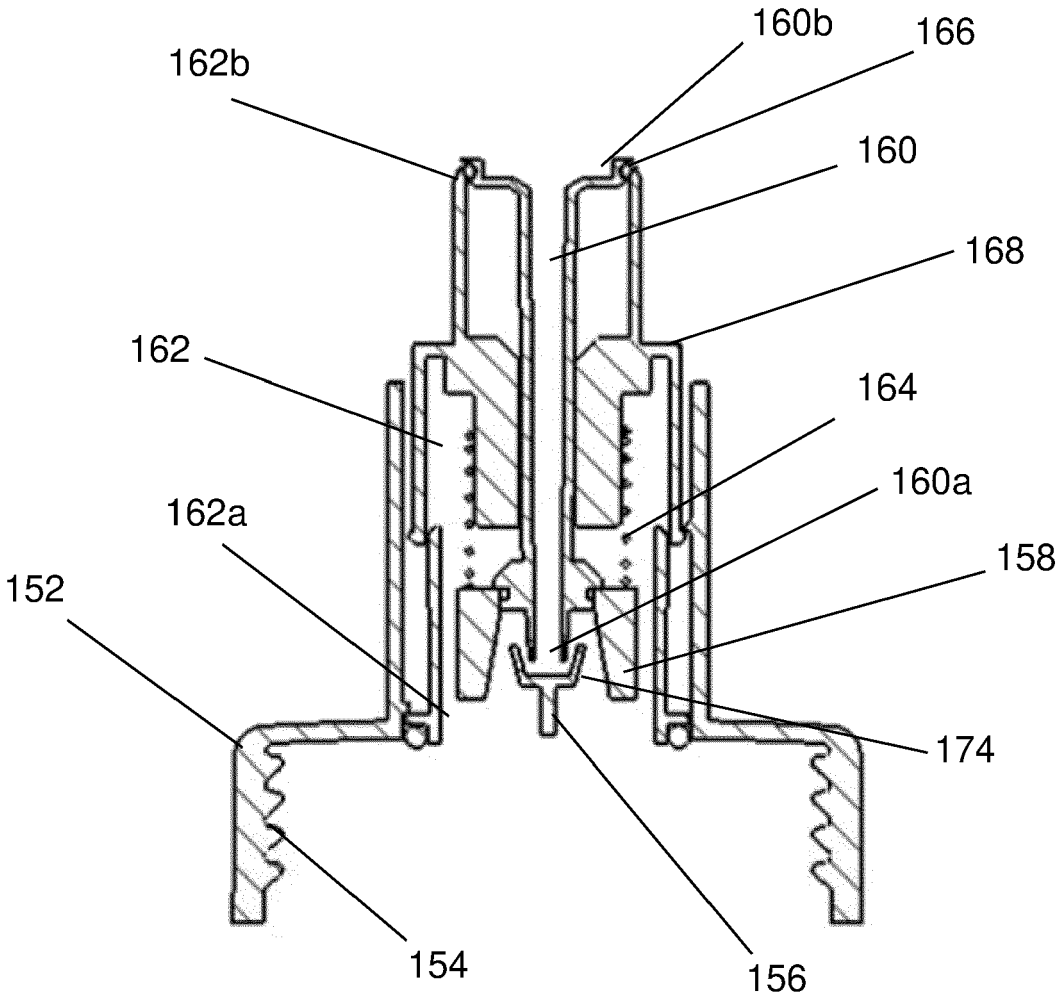
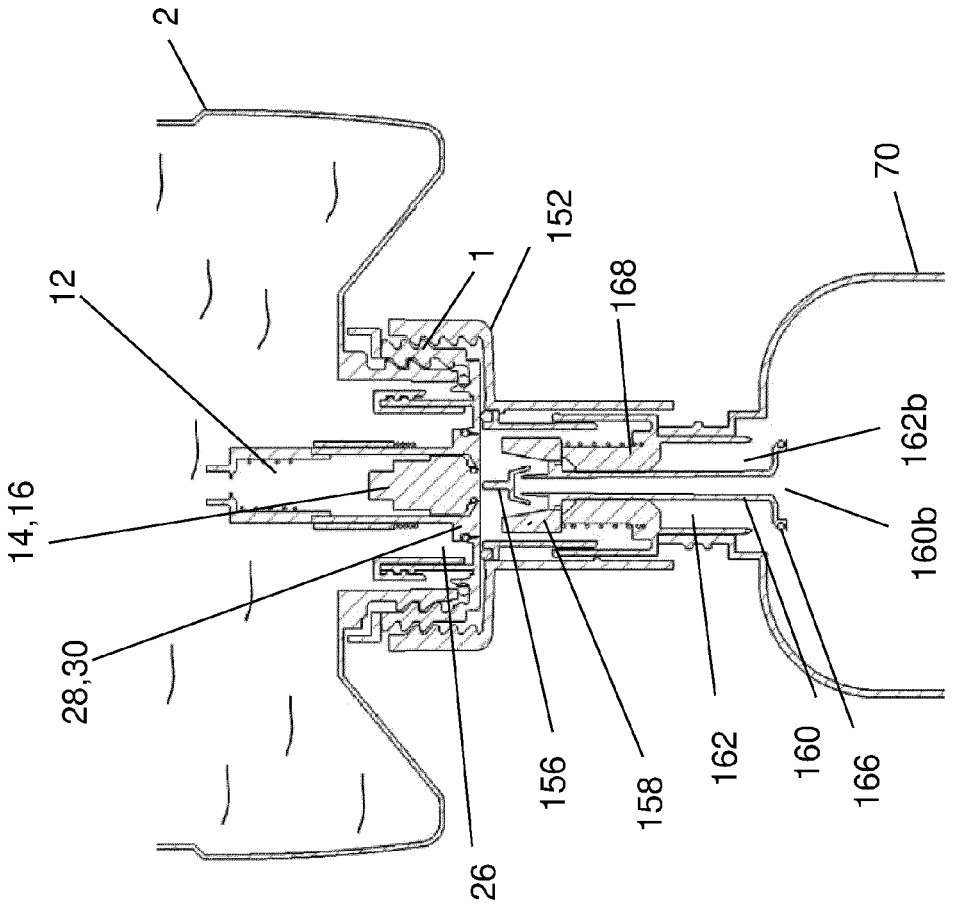


FIG. 5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162b
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156
158
162
160
166

FIG. 6B

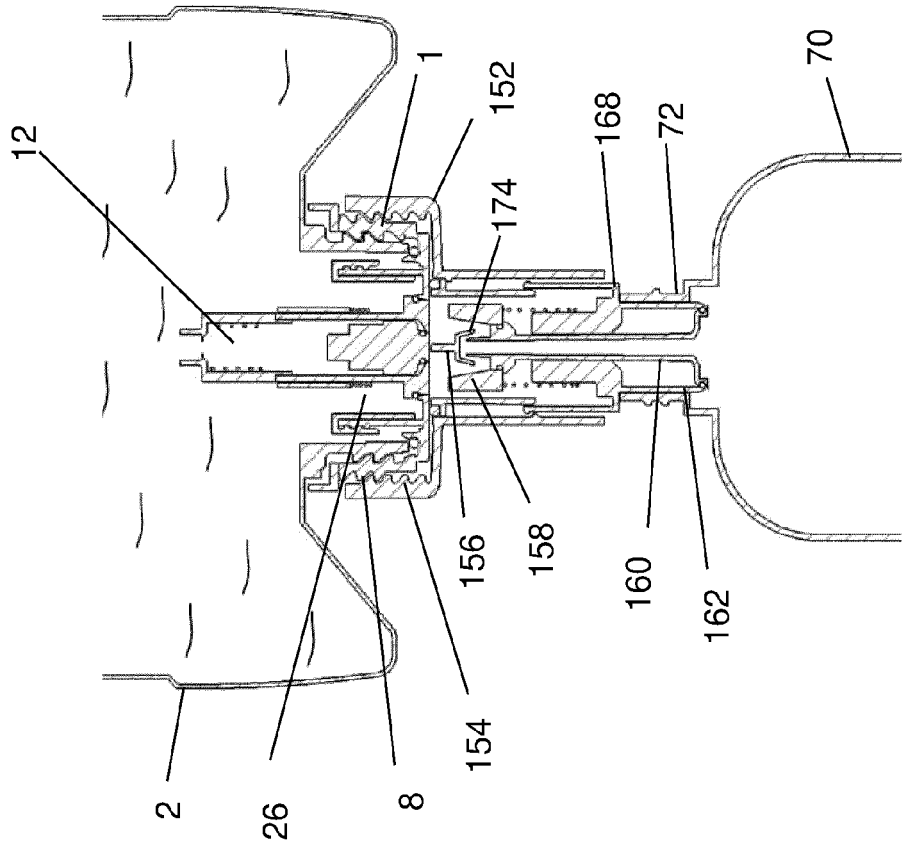

12
2
26
8
154
1
152
168
72
70
174
156
158
160
162

FIG. 6A

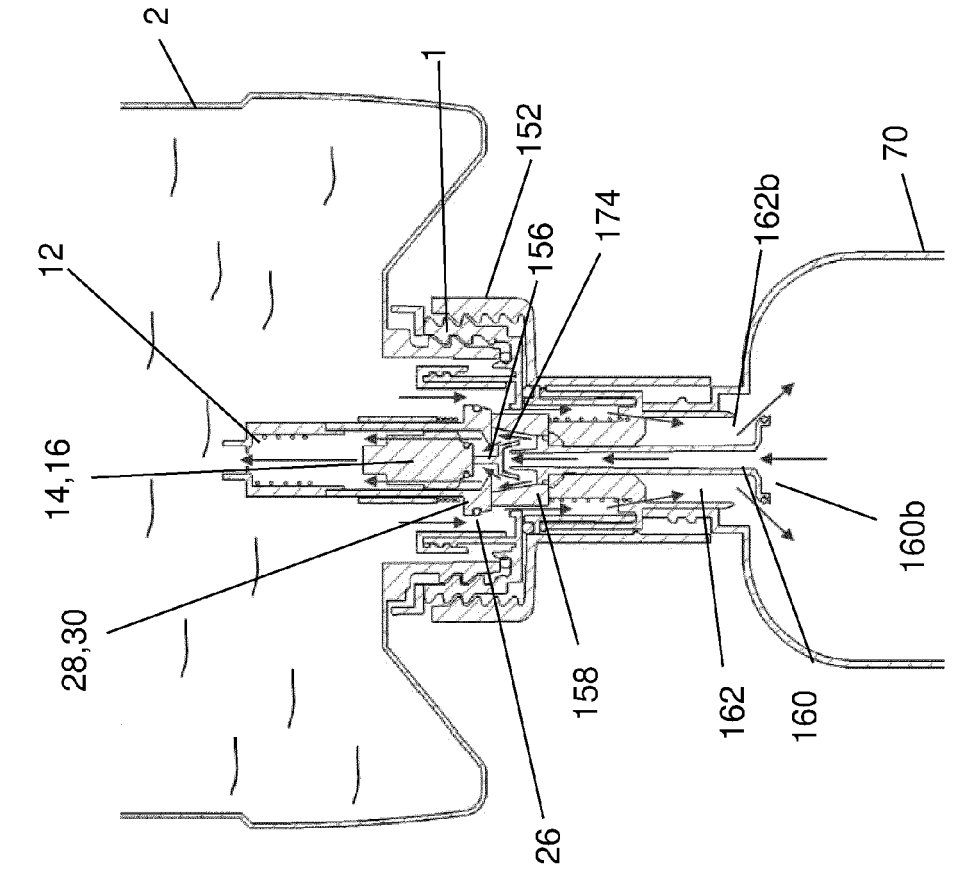
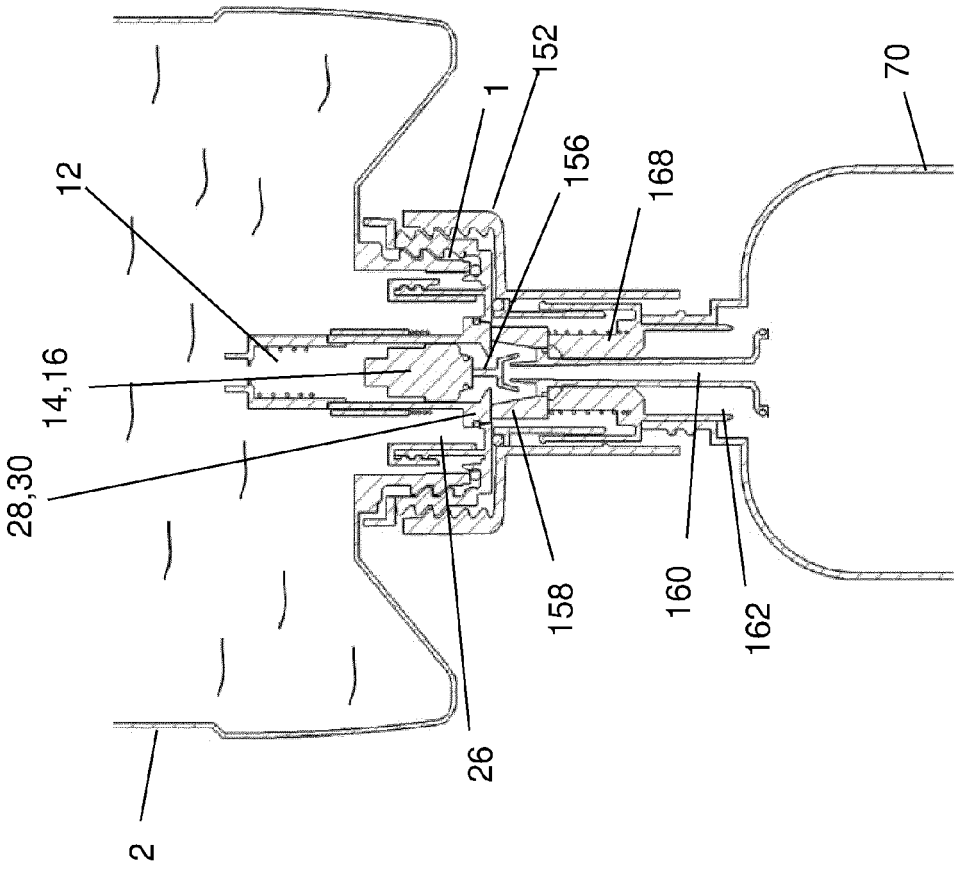

2
1
152
70
12
156
174
162b
14,16
160b
28,30
158
162
160
26

FIG. 6D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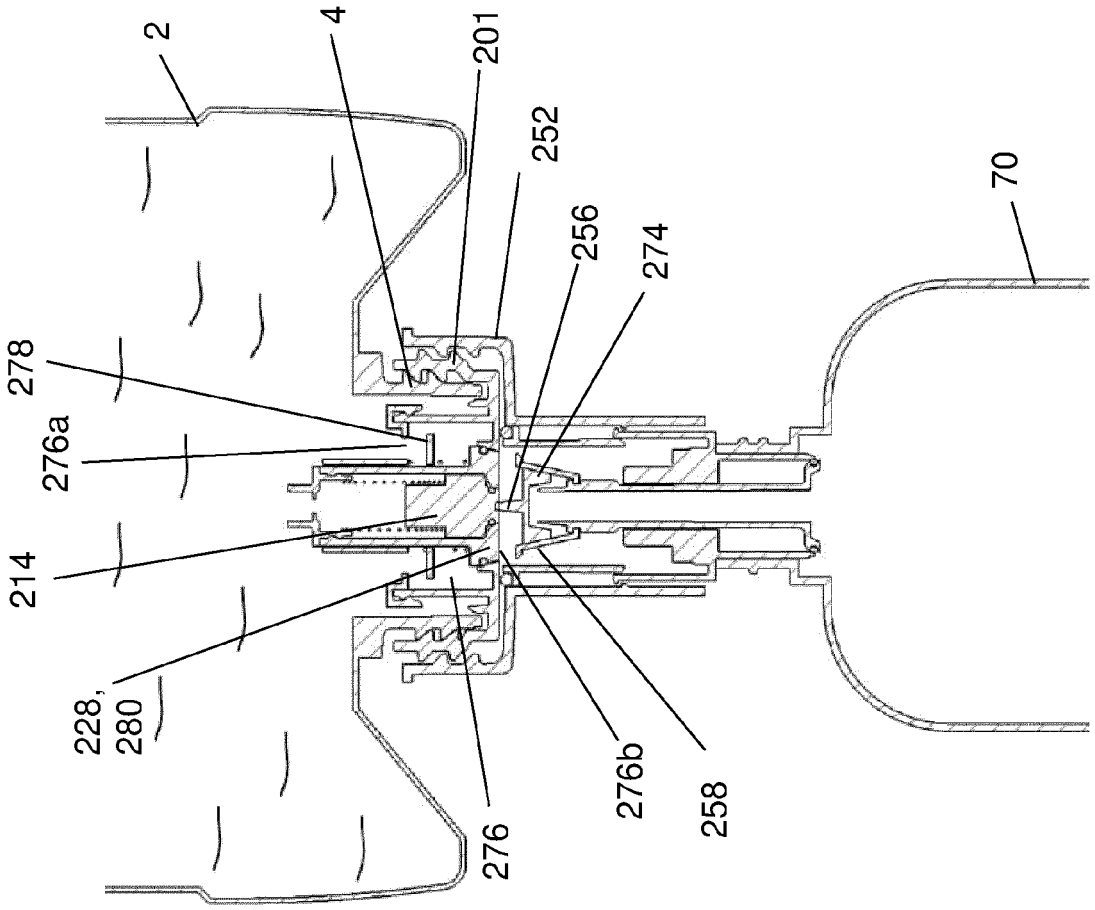
12
156
168
14,16
28,30
158
160
162
26
2

FIG. 6C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4
201
252
256
274
70
278
276a
214
228,
280
276
276b
258

FIG. 8A

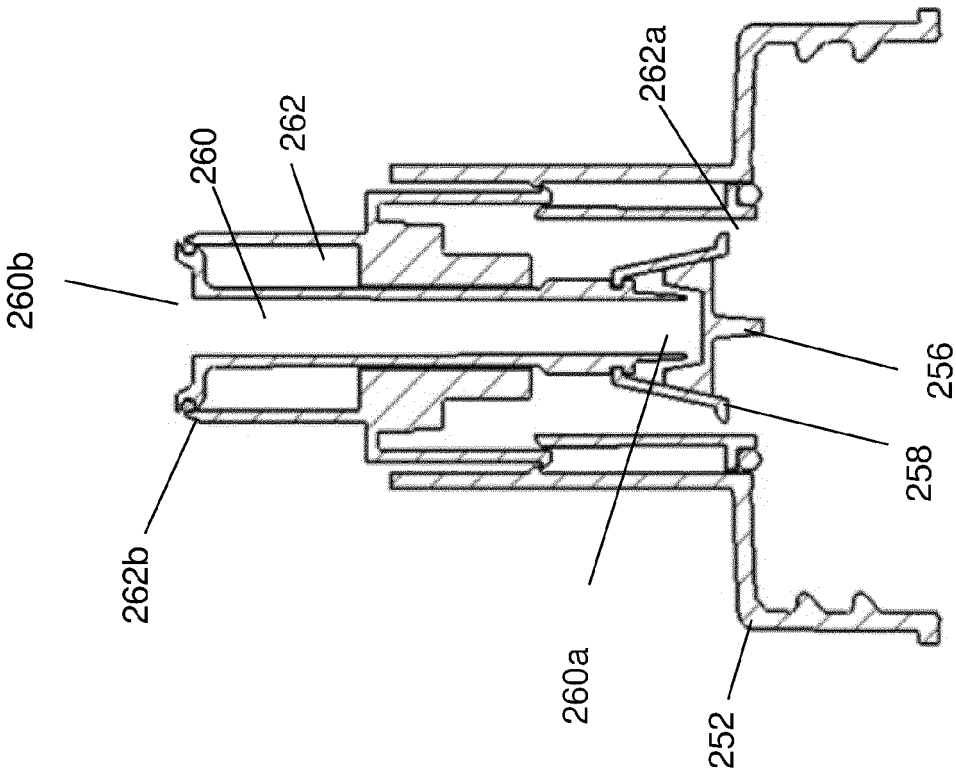

262a
262
260
260b
256
258
262b
260a
252

FIG. 7

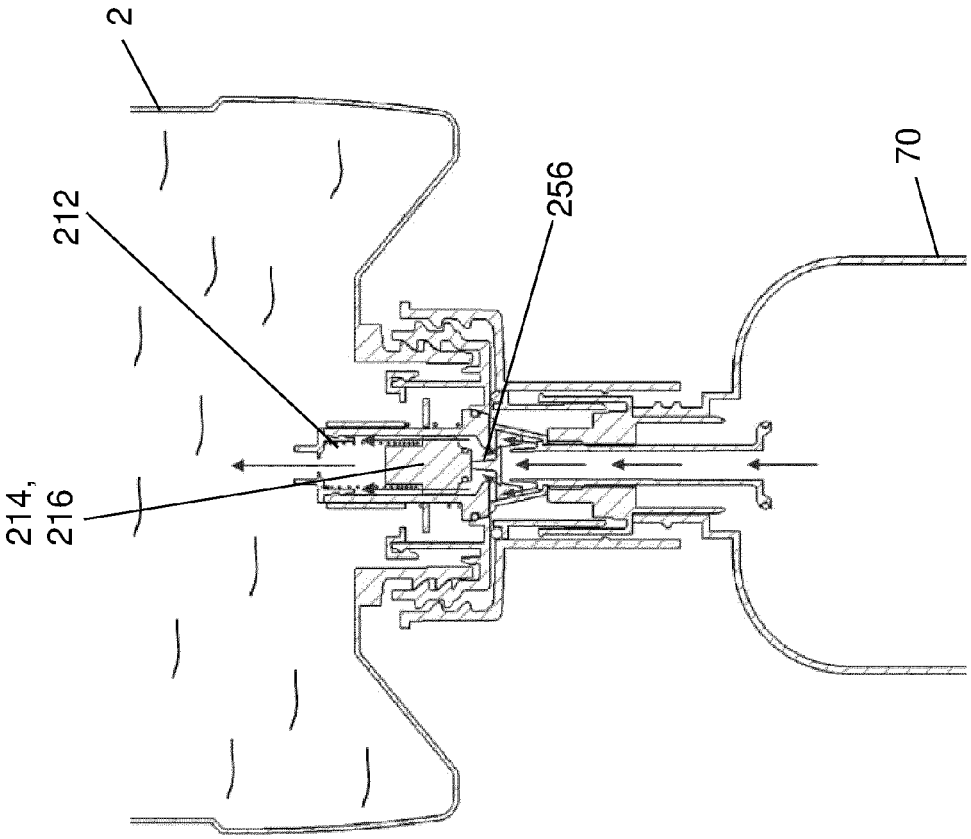


FIG. 8C

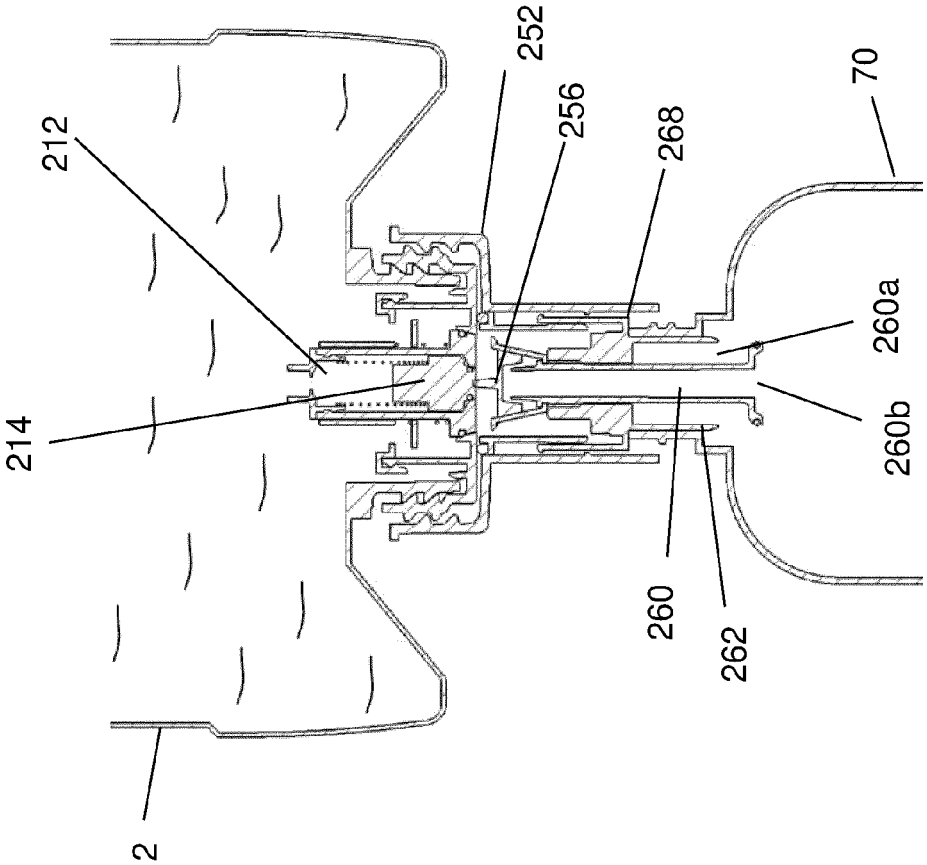
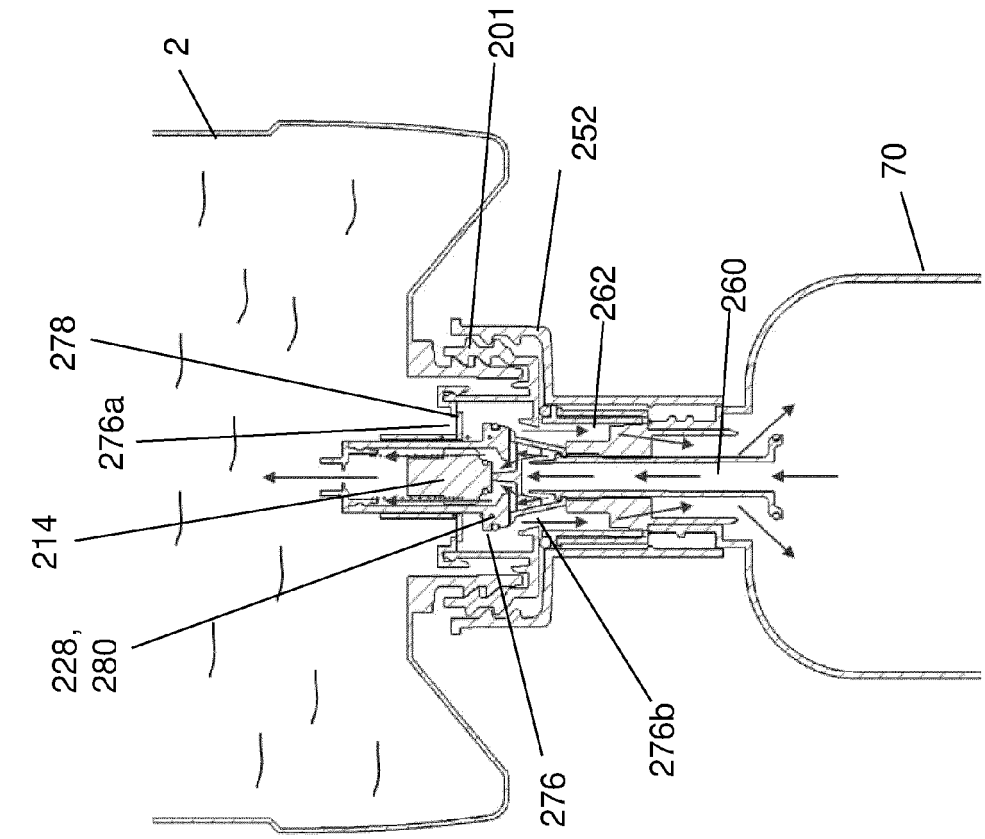


FIG. 8B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252
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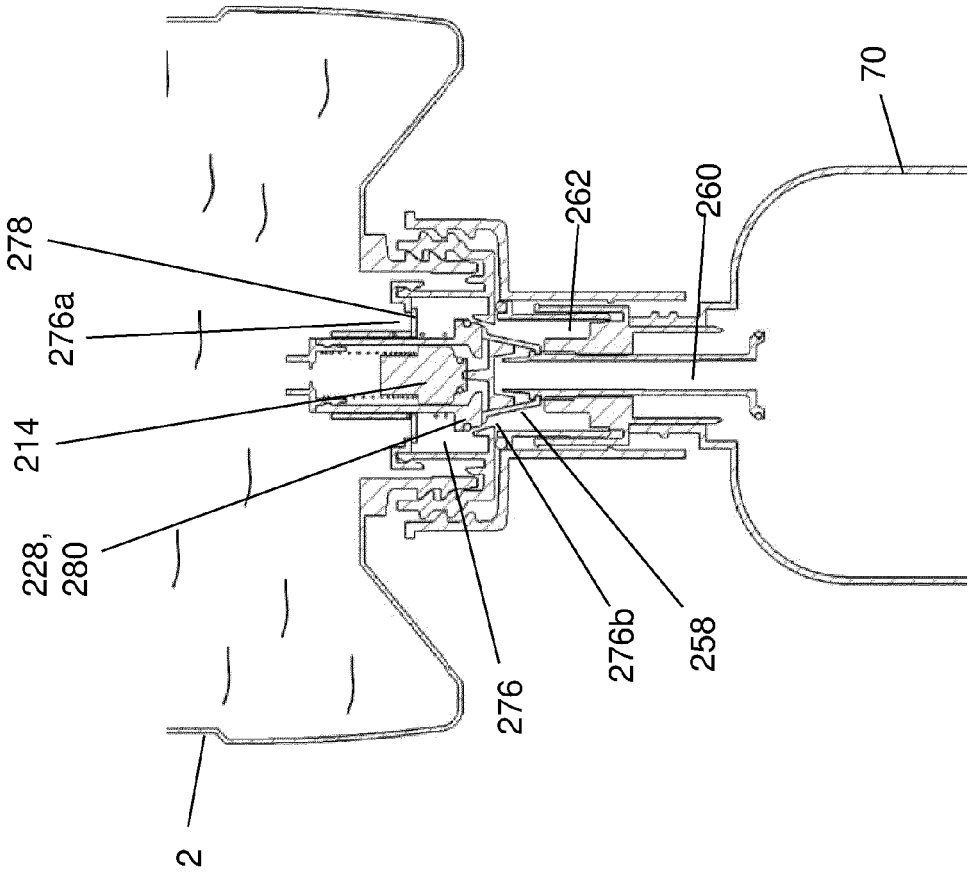
278
262
260
276a
214
228,
280
276
276b

FIG. 8E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262
260
276a
214
228,
280
276
276b
258
2

FIG. 8D

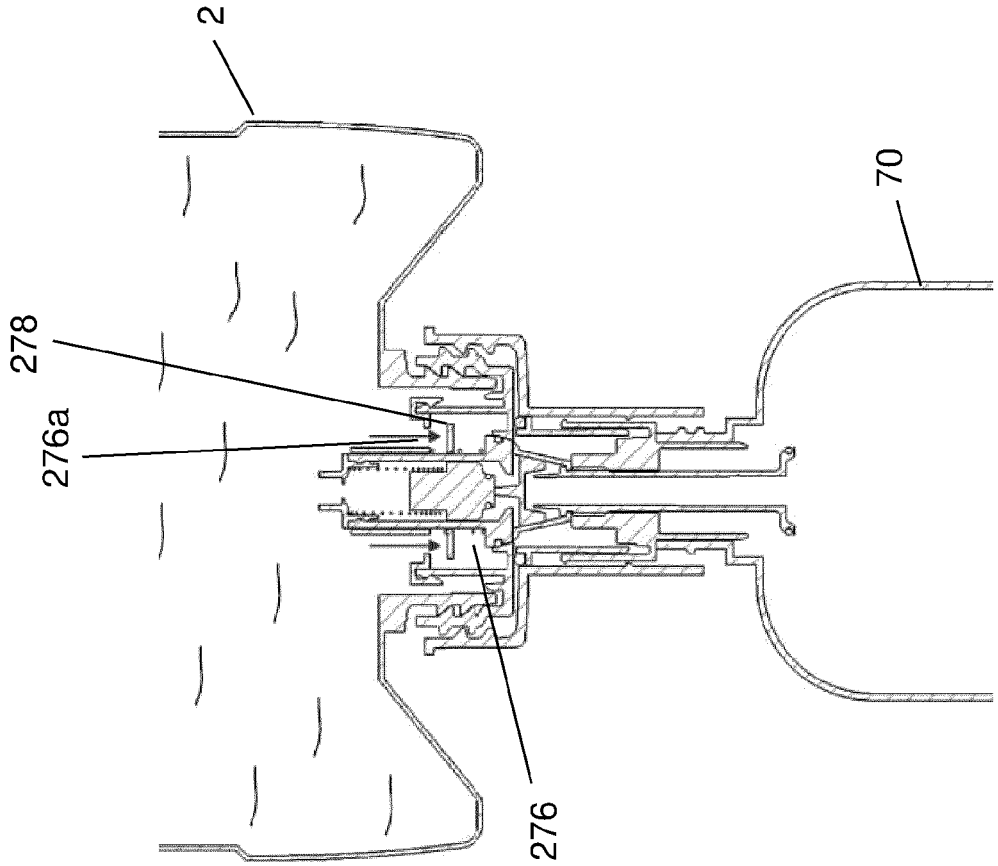

FIG. 8G

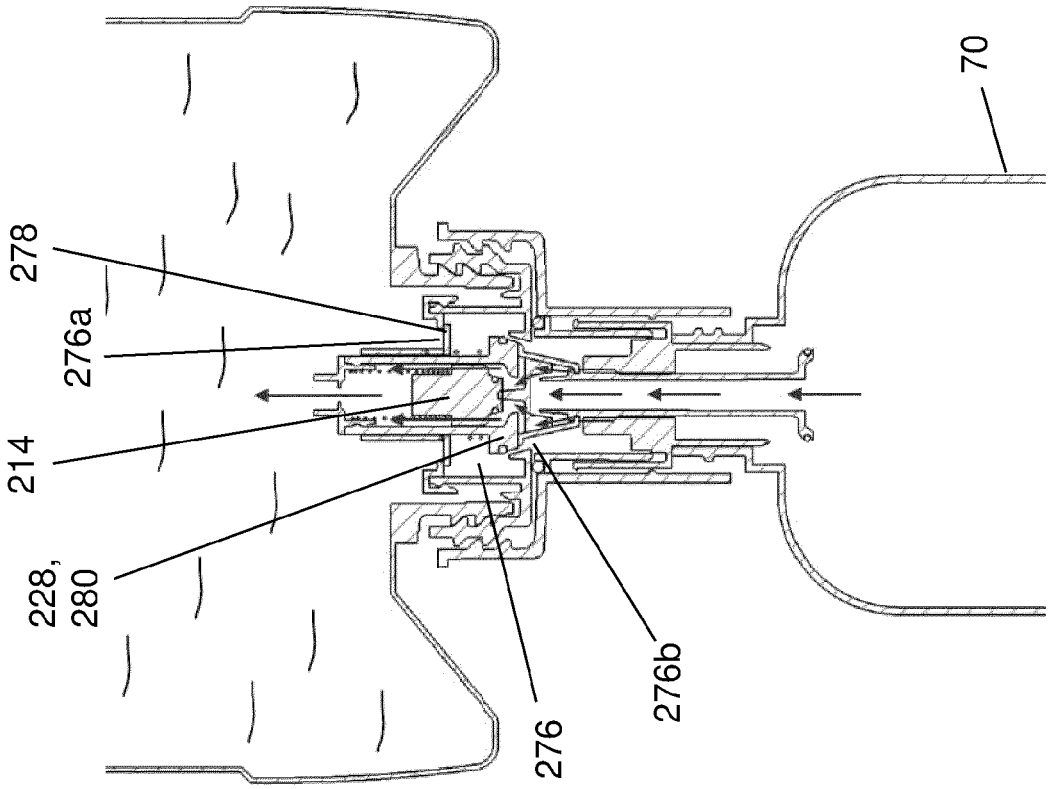

FIG. 8F

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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 4041

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B65D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 January 2024	Dominois, Hugo

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