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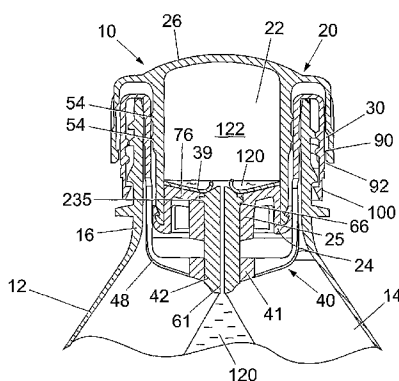
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(54) Title: CONTAINER CLOSURE WITH RUPTURABLE MEMBRANE AND MEANS FOR INTRODUCING AN ADDITIVE INTO THE CONTENTS OF THE CONTAINER



(57) Abstract: The present invention relates to a closure device (10) which includes a fluid chamber (22) containing an additive such as a liquid. The closure device (10) is fitted to an opening in the neck (16) of a container (12), such as a bottle. The additive can be introduced and mixed into a liquid in the container (12) by operation of the closure device (10). The closure device (10) includes a cap member (20) having a fluid chamber closed by a membrane (39). The closure device also includes a housing (40) having a plug member (42) mounted for vertical movement relative to the cap member (20) as the cap member rotates relative to the housing (40). The cap member (20) is provided with a primary engagement means, such as an internal thread (30), which engages with a corresponding primary engagement means provided on the housing, such as an external thread (50), to allow the cap member (20) to be lifted relative to the housing (40) from a closed position in which the plug member is positioned below the membrane to an open position in which the plug member is raised relative to the cap member to rupture the membrane (39), thereby allowing the additive to pass from the fluid chamber (22) to the liquid in the bottle (12). The closure device (10) enables mixing of the additive and liquid in the bottle (12) without opening the closure in such a way as to allow the liquid to escape.



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Container closure with rupturable membrane and means for introducing an additive into the contents of the container

5 The present invention relates to a closure device for releasing an additive liquid into a liquid in a container by operation of the closure device and to a container including such a closure device. The invention also relates to a method of assembling a closure device and a method of introducing an additive liquid by means of operating a closure device.

10 In a number of applications, such as mixtures of different liquids, it may be necessary to release and mix an additive liquid into another liquid shortly before the liquid mixture is used. It may not be possible or desirable to store the liquids in a premixed form, as they may react undesirably with each other when stored as the mixture for a period of time. An example of
15 this may be two component pharmaceuticals which have a longer shelf life when unmixed than they do when mixed. However, it can also apply to other liquids or to mixtures of liquids and gases, such as water, alcoholic beverages, other beverages, and other solvents or solutions. The liquid to which the additive liquid is introduced may be a carbonated or a non-
20 carbonated liquid.

An assembly for releasing an additive liquid into a liquid in a container upon release of a closure from the container is known from the prior art. International Patent Application WO97/05039 discloses a device for
25 releasing a liquid into another liquid held in a container. The known device is for use with containers having releasable closures. The device according to the prior art comprises a fluid chamber for storing a fluid. The fluid chamber is positioned adjacent an opening in the container. The fluid chamber comprises a fluid outlet for releasing fluid into the liquid.

The known device has the disadvantage that the closure must be at least partially opened to enable the mixing of the fluid stored in the fluid chamber with the liquid in the container. Moreover the device is complex to manufacture and requires many parts.

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According to a first aspect of the invention there is provided a closure device for use with a container having a main liquid compartment, the closure device comprising:

10 a cap member defining a fluid chamber which is at least partially bounded by a membrane,
a housing, and
a rupturing member arranged for longitudinal travel within an aperture in the housing,

15 wherein the cap member is provided with a primary engagement means which engages with a corresponding primary engagement means provided on the housing to allow the cap member to be rotated and lifted relative to the housing from a closed position in which the rupturing member is arranged within the aperture in the housing below the membrane to an open position in which the rupturing member ruptures the membrane to
20 provide a communication path in use from the fluid chamber to the main liquid compartment.

In one embodiment the primary engagement means on the cap member is an internal thread and the primary engagement means on the housing is
25 an external thread so that the cap member is lifted relative to the housing by rotation of the cap member. However other forms of primary engagement means are possible, for example a bayonet type engagement or a friction pull engagement or a longitudinal sliding engagement, or any other suitable form of engagement. The primary engagement means may

be adapted such that it does not allow the cap member and the housing to become completely separated from each other.

5 The housing may comprise an outer housing wall on which is provided the external thread and an internal secondary thread adapted in use to engage with an external secondary thread provided on a neck of an opening of the container. The external thread may have a relatively steep angle, so that the cap member rises quickly when rotated. The secondary threads may enable the outer housing wall in use to be screwed onto the
10 outside of the neck.

The housing may include an inner housing wall adapted to fit inside the neck of the opening and the closure device may include sealing means which seals between the fluid chamber and the inner housing wall. This
15 maintains a seal between the fluid chamber and inner housing wall, and therefore between the fluid chamber and the neck as the cap member and fluid chamber are lifted relative to the housing and container, in both the closed and open positions. The contents of the fluid chamber can thus pass into the main liquid compartment and be mixed, for example by
20 shaking the container, while the container is still sealed closed by the closure member, so that there is no risk of the contents escaping between the closure member and the container. The inner housing wall may be connected to the outer housing wall by a web which sits on top of the neck in use.

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The housing may further comprise a frame which supports the aperture in which the rupturing member is arranged so that the rupturing member is arranged inside the inner housing wall and extends upwardly towards the fluid chamber in use. The frame may be connected to the inner housing
30 wall. The frame may include apertures allowing fluid passage

therethrough, to avoid the creation of a vacuum between the fluid chamber and housing, so that the housing is free to slide relative to the cap member when the cap member is inserted into or withdrawn from the housing.

- 5 The rupturing member may include a nozzle directed away from the fluid chamber and a through hole opening at the top of the rupturing member and in communication with the nozzle.

10 In one embodiment the rupturing member may include guidance means to prevent relative rotation of the rupturing member and the housing and thread engagement means arranged to engage with an internal thread provided in the cap member to raise the rupturing member when the cap member rotates relative to the housing.

15 In another embodiment the rupturing member may include guidance means to prevent relative rotation of the rupturing member and the cap member and cam means arranged to engage with corresponding cam means provided in the housing to raise the rupturing member when the cap member rotates relative to the housing.

20 The cap member may include a top cap wall, an outer cap wall on which is provided the internal thread and an inner cap wall extending from the top cap wall to the bottom wall and arranged inside the outer cap wall. The bottom wall may be formed separately from the remainder of the cap member, which may be formed as a single moulding.

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The fluid chamber may be defined by the top cap wall, the inner cap wall and the membrane, which may be supported on the bottom wall.

The cap member may include an anti-tamper strip provided on the cap member to prevent rotation of the cap member relative to the housing without at least partial removal of the anti-tamper strip.

- 5 The anti-tamper strip may comprise an extension of the outer cap wall connected to the outer cap wall by a neck portion thinner than the outer cap wall, the extension being provided with a flange which engages beneath the outer housing wall to prevent lifting of the cap member relative to the housing. The strip may have a tab which can be pulled to
10 tear the strip from the outer cap wall along the neck.

- The primary engagement means of the cap member and housing may include mutually engageable detent means to prevent the rotation of the cap member relative to the housing beyond a predetermined limiting angle
15 of rotation. When the cap member is rotated, it may initially rotate relative to the housing, but once the detent means engage with each other, then the cap member and housing may rotate together.

- The housing may include an anti-tamper device which prevents rotation of
20 the cap member and housing relative to the neck of the container until a predetermined torque is applied to the cap member.

- The anti-tamper device may comprise an extension of the outer housing wall connected to the outer housing wall by at least one neck portion of
25 reduced cross-sectional area relative to the outer housing wall, the extension being provided with a detent means adapted to engage in use with a detent means provided on the neck of the container to prevent lifting of the housing relative to the neck without rupture of the at least one neck portion.

The fluid chamber may contain an additive liquid and a head space of pressurised gas.

5 According to a second aspect of the present invention there is provided a container having a main liquid compartment, an opening having a neck, and a closure device closing said opening, wherein the closure device comprises:

a cap member defining a fluid chamber which is at least partially bounded by a membrane,

10 a housing arranged in the neck, and

a rupturing member arranged for longitudinal travel within an aperture in the housing,

wherein the cap member is provided with a primary engagement means which engages with a corresponding primary engagement means provided

15 on the housing to allow the cap member to be rotated and lifted relative to the housing from a closed position in which the rupturing member is arranged within the aperture in the housing below the membrane to an open position in which the rupturing member ruptures the membrane to provide a communication path in use from the fluid chamber to the main
20 liquid compartment.

The closure device may be a closure device according to the first aspect.

25 The main liquid compartment may contain a primary liquid, which may contain water or be a beverage. However the primary liquid could be an alcoholic beverage, a cosmetic preparation, a pharmaceutical product, a dairy product or an agricultural feed or other product, or any other suitable liquid or semi-liquid substance.

The fluid chamber may contain an additive liquid. The fluid chamber may contain a head space of pressurised gas.

5 The housing may comprise an inner housing wall arranged inside the neck of the container and provided with internal sealing means to seal against an outer surface of the inner cap wall and external sealing means to seal against an internal surface of the neck of the opening.

10 According to a third aspect of the invention there is provided a method of introducing an additive liquid into a main liquid compartment of a container, the method comprising the steps of raising a cap member of a closure device and a fluid chamber defined by said cap member relative to a housing, wherein the fluid chamber is at least partially bounded by a membrane,
15 causing a rupturing member arranged for longitudinal travel within an aperture in the housing to move relative to the cap member from a closed position in which the rupturing member is arranged within the aperture in the housing below the membrane to an open position in which the rupturing member ruptures the membrane to provide a communication
20 path in use from the fluid chamber to the main liquid compartment, releasing pressurised liquid from said fluid chamber along said communication path into said main liquid compartment, and rotating the cap member further to remove the cap member and housing from the container.

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The closure device may be a closure device according to the first aspect.

During the raising of the fluid chamber relative to the housing a seal may be maintained between the fluid chamber and an inner housing wall of the
30 housing arranged in the neck of the container.

The cap member may be raised by rotating the cap member such that the fluid chamber is raised by screw thread action relative to the housing.

5 The cap member may be rotated by a first angle of between 0° and 90° , optimally about 45° , from the closed position to the open position. Further rotation of the cap member may be limited to a second angle of between 0° and 90° , optimally about 45° , by the mutual engagement of detent means provided on the cap member and housing. The second angle may
10 be predetermined by the position of the detent means, and may be selected so that it is sufficient to ensure opening of the plug member and consequent mixing of the additive liquid, allowing for manufacturing tolerances.

15 The raising of said cap member relative to the housing may be achieved by engagement of an internal thread on the cap member with an external thread on the housing.

20 The internal thread may be provided on an outer cap wall of the cap member.

The fluid chamber may be defined by a top cap wall, a bottom wall and an inner cap wall extending from the top cap wall to the bottom wall and arranged inside the outer cap wall, the membrane being arranged over an
25 aperture in the bottom wall.

The external thread may be provided on the outer face of an outer housing wall.

The rotation of the cap member further to remove the cap member and housing from the container may be achieved by engagement of an internal secondary thread on the housing with an external secondary thread provided on a neck of an opening of the container.

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The internal secondary thread may be provided on the inner face of the outer housing wall.

The inner cap wall may extend inside the neck of the container.

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The housing may include an inner housing wall arranged inside the neck of the container, and provided with sealing means to seal between an outer surface of the inner housing wall and an internal surface of the neck of the container.

15

During the raising of said cap member relative to the housing, a sealing means may seal between an external surface of the inner cap wall and an internal surface of the inner housing wall.

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The method may further include the step of at least partially removing an anti-tamper strip provided at the outer cap wall, thereby allowing rotation of the cap member relative to the housing.

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The method may further include the step of applying sufficient torque to the cap member, during the step of rotating the cap member further to remove the cap member and housing from the container, to remove an anti-tamper device.

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The invention will be described, by way of example only, with reference to the drawings in which:

Fig. 1 shows in elevation a closure device according to the invention secured to the neck of a container;

Figs. 2A, 2B, 2C and 2D are sequential cross-sectional drawings showing the operation of the closure device of Fig. 1 to introduce additive liquid into a container and to remove the closure device from the container;

Figs. 3A and 3B are expanded views from below and above respectively of the closure device of Fig. 1; and

Figs. 4A and 4B are expanded views from below and above respectively of a modified closure device according to the invention.

With reference to Figs. 1 and 2A to 2D there is shown a closure device 10 together with the upper part of a container 12. The container is a standard PET bottle having a main liquid compartment 14 and a standard 30 mm neck 16 with an external thread 18. For the purposes of this invention the thread is described as a secondary thread 18.

The closure device 10 comprises two main parts, a cap member 20, which defines a fluid chamber 22, and a housing 40. The cap member 20 includes a bottom wall 224, which although it may be made of a different material is secured to the remainder of the cap member 20 to form a unitary member. An aperture 225 is provided in the bottom wall 224. A rupturable membrane 39 is positioned on the bottom wall 224. The cap member 20 includes a top cap wall 26, an outer cap wall 28, and an inner cap wall 32, which may all be formed as a single moulding from polypropylene or any other suitable plastic. The outer cap wall includes an internal primary thread 30 adapted to engage a corresponding external primary thread on the housing 40, as will be described below. Together the internal and external primary threads form part of the primary engagement means which allow the cap member 20 to be lifted relative to

the housing 40. The outer cap wall 28 also includes surface depressions 34 on the outer surface to aid gripping of the outer cap wall. Any suitable surface features may be provided instead of the depressions 34 shown.

5 The housing 40 is also preferably formed as a unitary polypropylene moulding, although it can be formed from any other suitable material. It comprises a central collar 41 arranged on the central axis of the closure member 10, an outer housing wall 44 adapted to fit outside the neck 16, a web 45 which sits on top of the neck 15, an inner housing wall 46 which
10 extends down from the web 45 inside the neck and which seals against the neck 10, and a frame 48 which extends from the inner housing wall 46 and supports the central collar 41.

The outer housing wall 44 has an external primary thread 50 which
15 engages the internal primary thread 30 on the cap member as part of the primary engagement means. It also has an internal secondary thread 52 which engages the external secondary thread 18 on the neck 16 of the container.

20 Internal sealing means 54 are provided to seal between the inner cap wall 32 and the inner housing wall 44. In the illustrated example the internal sealing means 54 are formed as ribs on the outer surface of the inner cap wall, but they could be formed as ribs on the inner surface of the inner housing wall, or as any other suitable sealing means. The internal sealing
25 means 54 prevents the contents of the container 12 passing between the inner cap wall 32 and the inner housing wall 44 during storage and while the cap member 20 is raised relative to the housing 40, as later described.

External sealing means in the form of a taper 56 and rib 58 are provided to
30 seal between the inner housing wall 44 and the neck 16 of the container

12. Such seals are well known in the art and serve to prevent the contents of the container 12 passing between the inner housing wall 44 and the neck during storage. A taper seal may be used for the internal sealing means 54 also.

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The central collar 41 has a movable plug member 42 which can slide longitudinally in an aperture 43 in the collar 41. A number of flutes 236 on the outside surface of the plug member 42 engage with a number of longitudinal grooves 237 (seen in Figs 3A and 3B) in the aperture 43, to prevent relative rotation of the plug member 42 and housing 40.

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A nozzle passage 61 is provided to convey pressurised liquid from the fluid chamber 22 when the closure device is opened.

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The upper surface 76 of the bottom wall 224 slopes towards the plug member 42, so that all the liquid is drained from the fluid chamber 22 when the plug member 42 ruptures the membrane 39 in the open position.

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In the illustrated example the bottom wall 224 includes a flange 74 which locks onto a corresponding flange at the edge of the inner cap wall 32 when the cap member is assembled. However any other suitable method of vapour-tight connection may be used, such as laser welding.

25

At the lower edge of the outer cap wall 28 is an anti-tamper strip 80, with a tab 81 which can be pulled to remove the strip. The strip is an extension of the outer cap wall 28, connected by a neck portion 84, and engaging the underside 88 of the outer housing wall 44 by a detent flange 86. Such anti-tamper strips are known in the art and are not described further. Until the anti-tamper strip 80 is at least partially removed, the cap member 20 cannot be unscrewed from the housing 40. Once the anti-tamper strip 80

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is at least partially removed the cap member 20 can be unscrewed from the housing 40 by interaction of the internal thread 30 on the cap and the external thread 50 on the housing. The threads include mutually engaging detent means 90, 92, best seen in Fig. 2D, which serve to limit the relative rotation of the cap member 20 and housing 40. It is to be understood that any suitable mutually engaging shape or protrusion may be used to limit this movement. The anti-tamper strip may be replaced by any other suitable anti-tamper means, or may be omitted.

At the lower edge of the outer housing wall 44 is provided a further anti-tamper device 100. The device is an extension of the outer housing wall 44, connected by one or more neck portions 104, and includes a detent flange 106 which engages a corresponding detent means 108 provided on the container neck 16. Such anti-tamper devices are known in the art and are not described further. A predetermined torque applied to the cap member 20 is required to break the neck portions 104 and allow the housing 40 to be raised on the secondary threads 18, 52 relative to the neck 16. The anti-tamper device 100 remains on the neck 16 of the container 12 below the detent 108. Any other suitable anti-tamper device may be used instead, or it may under certain circumstances be omitted.

Figs. 2A to 2D show the operation of the closure device of the invention.

In Fig. 2A the closure device 10 is secured to a container 12 containing a primary liquid (not shown), for example water, in its main liquid compartment 14. The fluid chamber 22 in the cap member contains a liquid additive 120 and a head space 122 of pressurised gas. The closure device 10 is in the closed position, in which the fluid chamber 22 is sealed closed by the plug member 42 which is engaged in the aperture 225 in the bottom wall 224. The housing 40 is screwed fully onto the neck 16

through the secondary threads 18, 52, and the cap member 20 is screwed fully onto the outer housing wall 44 through the internal and external primary threads 30, 50. The contents of the container 12 may be at atmospheric pressure, or may be pressurised to a pressure less than that of the fluid chamber 22. There is a seal 54 provided between the fluid chamber 22 and inner housing wall 46, and further seals are provided between the inner housing wall 46 and the neck 16 so that the contents of the container are sealed from the external atmosphere.

To trigger the firing of the liquid additive 120 into the main liquid compartment 14 of the container 12, the cap member 20 must be unscrewed relative to the housing 40 to the position shown in Fig. 4B, through a first angle of 45° according to the preferred embodiment. However it is to be understood that this first angle may be any desired angle by appropriate selection of the thread and pitch. First the anti-tamper strip 80 is at least partially removed so that the outer cap wall 28 is free to be raised relative to the outer housing wall 44. Then the cap member 20 is grasped and rotated. The primary threads 30, 50 have a relatively large thread angle, so that a relatively large vertical displacement is effected by a relatively small rotation. As the cap member rises, the fluid chamber 22 is lifted away from the plug member 42.

However, as the cap member turns relative to the housing 40 and plug member 42, an internal reverse thread in the aperture 225 engages with two dogs 235 to lift the plug member 42 relative to the cap member 20, since the plug member 42 is prevented from rotating relative to the housing by flutes 236 and grooves 237. When the upper pointed portion of the plug member 42 reaches the membrane, the plug member acts as a rupturing member and ruptures the membrane 39, as shown in Fig. 2B.

The main liquid compartment 14 comes into fluid communication with the

fluid chamber 22, and the pressurised additive liquid 120 is free to pass into the internal fluid passage 70, and out of the nozzle 61 into the main liquid compartment 14.

- 5 Typically the primary thread 30, 50 is a standard 30/25 PET bottle thread with 9mm pitch, of the type used with PET water bottles, and the closure device 10 is arranged so that the additive liquid 120 is fired into the main liquid compartment 14 when the cap member is rotated through 45° from the closed position under optimum tolerance. In practice this angle could
10 be smaller or greater, in the range 0° to 90°.

- The volume of the head space 122 is chosen to be sufficiently large so that all the additive liquid 120 is expelled into the main liquid compartment 14. The top surface 76 of the bottom wall 224 slopes down towards the
15 aperture 225, so that under gravity all the additive liquid flows to the aperture. The upper end of the plug member 42 is shaped to facilitate rupture of the membrane 39.

- Referring now to Fig. 2C, following release of the additive liquid 120, the
20 cap member 20 is rotated further through a second angle of 45° according to the preferred embodiment, until the mutually engageable detent means 90, 92 on the cap 20 and housing 40 engage with each other and prevent further relative rotation. Typically this happens when the cap member 20 is rotated through a total of 90° from the closed position. At this point the
25 torque on the cap member 20 is transferred to the outer housing wall 44 and the housing 40 begins to rotate relative to the container neck 16. In the illustrated embodiment an anti-tamper device 100 is provided on the housing 40, so an increased torque must be applied to first break the neck portions 104 of the anti-tamper device 100 before the housing can be
30 raised relative to the container 12 by engagement of the secondary

threads 18, 52. The secondary threads 18, 52 are typically MCA2 threads of 3.2mm pitch. Fig. 2C shows the closure device in a partially raised position. As the cap member 20 is rotated, the entire closure device 10 is lifted from the container 12, until it is as shown in Fig. 2D, removed from the container 12.

If required, the closure device 10 can be screwed back onto the container 12, to close the container. As the cap member is rotated, the cap member 20 will rotate back to its original position relative to the housing 40, and then the cap member 20 and housing 40 will rotate together on the external secondary thread 18 provided on the neck 16, until they can be rotated no further and the container 12 is sealed closed.

The cap member can be assembled and the fluid chamber filled in a separate manufacturing process, and the assembled, filled cap member can be brought to the location of the bottle filling. Typically the gas forms a head space 122 in the fluid chamber 22 of between 0% and 60% of the volume of the fluid chamber 22.

After the fluid chamber 22 has been pressurised, the closure device 10 is secured to the neck 16 of a container 12 by engagement of the internal secondary thread 52 on the housing 40 with the external secondary thread 18 on the neck 16 of the container, to seal the contents of the container.

Figs. 3A and 3B show the separate components of the closure device 10. It can be seen that rotation of the cap member 20 relative to the housing 40 causes the plug member 42, which in the closed position does not extend above the top of the aperture 225 in the bottom wall 224, to move upwards relative to the cap member 20 and to pierce the membrane 39.

The plug member 42 includes a through hole 70 which communicates

directly with the nozzle passage 61. A plurality of flutes 236 arranged on the outer surface of the plug member 42 are restrained by a number of corresponding grooves 237 in the aperture 43 provided in the collar 41 of the housing 40. The outer surface of the plug member 42 also has two
5 dogs 235 above the flutes 236 which engage in the threads in the aperture 225 in the bottom wall 224. The aperture 225 is provided with a reverse thread.

As the cap member 20 is unscrewed in a clockwise direction relative to the
10 housing 40, the bottom wall 224 is raised and rotates clockwise relative to the plug member 42. The plug member is restrained from rotation by the flutes 236 and grooves 237, but is free to slide vertically upwards relative to the housing 40. As the bottom wall 224 rotates, the engagement of the
15 dogs 35 in the internal thread causes the plug member 42 to rise relative to the bottom wall. The internal thread in the aperture 225 is arranged with a thread angle which causes the plug member 42 to be raised after an appropriate rotation of the cap member (preferably 45°, typically
between 0° to 90°) to an extent which causes it to rupture the membrane 39 and allow the liquid additive 120 to be expelled under pressure from the
20 fluid chamber 22 through the through passage 70 and nozzle 61 to the main liquid compartment 14 of the container 12. Typically the internal reverse thread in the aperture 225 has a pitch greater than the pitch of the primary threads 30, 50, so that the plug 42 moves upwards relative to the cap member 20.

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Figs. 4A and 4B show another embodiment of the invention in which the upper surface of the bottom wall 324 is covered by a membrane 339. Parts which are the same as those described with reference to Figs. 1 to 3 are denoted by the same reference sign.

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In this embodiment rotation of the cap member 20 relative to the housing 40 causes the plug member 342, which in the closed position does not extend above the top of the aperture 325 in the bottom wall 324, to move upwards relative to the cap member 20 and to pierce the membrane 339.

5 The plug member 342 includes a through hole 370 which communicates directly with the nozzle passage 61. A plurality of flutes 335 arranged on the outer surface of the plug member 342 are restrained by a number of corresponding grooves provided in the aperture 325 in the bottom wall 324. The outer surface 362 of the plug member 342 also has a cam ramp 10 336 below the flutes 335 which engages with a corresponding cam ramp 337 in an aperture 343 provided in the collar 41 of the housing 40.

As the cap member 20 is unscrewed in a clockwise direction relative to the housing 40, the bottom wall 324 is raised and rotates clockwise, causing 15 the plug member 342 also to rotate, since it is restrained from rotation relative to the cap member 20 by the flutes 335 and the grooves in the aperture 325. As the bottom wall 224 rotates, the cam ramp 336 on the plug member 342 slides up the cam ramp 337 on the aperture 343, causing the plug member 342 to rise relative to both the housing 40 and 20 the bottom wall 324. The angle of the cam ramps 336, 337 is arranged such that the plug member 342 is raised after an appropriate rotation of the cap member (preferably 45°, typically between 0° to 90°) to an extent which causes it to rupture the membrane 339 and allow the liquid additive 120 to be expelled under pressure from the fluid chamber 22 through the 25 through hole 370 and nozzle passage 61 to the main liquid compartment 14 of the container 12.

Removal of the closure device 10 from the container 12 follows in the same way as described with reference to Figs. 2C and 2D.

The closure device of the invention is particularly useful when the liquid additive is incompatible with the material of the lower wall 224, 324. The membrane 39, 339 can be chosen from a suitable material, for example a foil of aluminium or other metal or a plastic film, which does not react with the contents of the fluid chamber 22. It should be noted that in these embodiments, or in any other embodiment, a liner may be used with the fluid chamber 22 if the material of the cap member 22 is incompatible with the liquid additive. For example a stainless steel insert (not shown) may be provided which fits inside the inner cap wall 32 and top cap wall 26.

The present invention provides a closure device which requires fewer components than prior art devices. The closure device is simple to manufacture, as in one embodiment it requires only three moulded components, the cap member body 20, the cap member bottom wall 224 and the housing 40. The closure device can be assembled and filled with the liquid additive 120 and then stored or transported before use on a standard container 12. It does not require separate filling at the bottling location. The closure device allows introduction and mixing of the liquid additive 120 into the contents of the main liquid compartment 14 of a container 12 without removal of the closure device 10 from the container 12.

The closure device can be used with any standard container 12, of any shape or volume, of any material, for example PET, glass, metal or any suitable plastic. The external secondary thread 18 on the neck 16 of the container 12 can be any standard thread.

The closure device optimises use of the volume within the neck 16 of the container 12, since the fluid chamber extends across the whole available area of the neck 16. The internal diameter of the fluid chamber 22 is

limited only by the thickness of the inner housing wall 46 and the inner cap wall 32. The volume of the fluid chamber 22 may be varied by varying the length of the fluid chamber.

- 5 The closure device cannot be operated to introduce the liquid additive 120 into the main liquid compartment 14 unless the anti-tamper strip 80 is at least partially removed, thereby providing security to the consumer that the additive has not been mixed with the contents of the container prematurely, for example while sitting on a shelf in a shop.

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The internal shape of the fluid chamber 22, which has a top surface 76 of the bottom wall 224 which slopes down towards the aperture 225 and plug member 42, ensures that only a minimum amount of residual liquid additive remains in the fluid chamber after release of the additive. The amount of residual liquid can be further reduced by providing cross grooves in the upper surface of the plug member 42, 342, as shown in Figs 7B and 8B. Hence the closure device 190 can be removed and placed on a surface without significant deposition of additive on the surface. The sloping shape allows the full amount of liquid additive 120 to be delivered even if the container is tilted from the vertical during operation of the closure device to fire the additive.

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The materials of the closure device can be selected to avoid any compatibility problems with the liquid additive 120. During storage the liquid additive is only in contact with the cap member 20 and the membrane 39, 339. The plug member can be made separately from a different material to the remainder of the housing, if required. A liner, for example of stainless steel, can be used inside the fluid chamber to avoid contact with the moulded cap member 20, if required. Certain flavouring or colouring additives are not compatible with sealant materials. The

bottom wall 224 can thus be manufactured, for example by inset moulding, so that the upper surface 76 of the bottom wall 224 is polypropylene or other suitable inert material, while the seals 64, 78 are protected below the material of the upper surface.

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The liquid additive 120 can be denser or more viscous, and the area of the nozzle passage 61 and internal fluid passage 70 can be increased if required, to improve the flow of a more viscous additive. Additives which require shaking to dissolve them can be used with the closure device of the invention, since it permits shaking of the container after firing with no risk of spillage through between the closure device and container, because the closure device remains sealed to the neck.

The closure device remains in one piece when removed, and can be recyclable. Recyclability is improved if the closure and housing are made of the same material.

Modifications and variations are possible without departing from the scope of the invention. In addition to the modifications and variations described above, the liquid additive may be replaced by a gel or a free flowing powder or the like. The bottom wall 224 may be formed integrally with the remainder of the cap member 20. The closure member may be used with a container holding a carbonated beverage, providing the pressure of the main liquid compartment 14 is less than the pressure of the fluid chamber 22. The primary threads 30, 50 may be of any suitable thread design, and arranged so that the closure device fires, that is ejects the liquid additive 120 into the main liquid compartment 14, after any suitable angle of rotation, for example 45°, and allows removal of the closure device from the container after any suitable further angle of rotation, for example 270° to 450°.

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CLAIMS

1. A closure device for use with a container having a main liquid compartment and an opening with a neck, the closure device comprising:
5 a cap member defining a fluid chamber which is at least partially bounded by a membrane,
a housing, and
a rupturing member arranged for longitudinal travel within an aperture in the housing,
10 wherein the cap member is provided with a primary engagement means which engages with a corresponding primary engagement means provided on the housing to allow the cap member to be rotated and lifted relative to the housing from a closed position in which the rupturing member is arranged within the aperture in the housing below the membrane and an
15 open position in which the rupturing member ruptures the membrane to provide a communication path in use from the fluid chamber to the main liquid compartment.
2. A closure device according to claim 1, wherein the primary
20 engagement means on the cap member is an internal thread and the primary engagement means on the housing is an external thread.
3. A closure device according to 2, wherein the housing comprises an outer housing wall on which is provided the external thread and an internal
25 secondary thread adapted in use to engage with an external secondary thread provided on the neck of the opening of the container.
4. A closure device according to any of claim 1 to 3, wherein the
30 housing further comprises a frame which supports the aperture in which the rupturing member is arranged so that the rupturing member is

arranged inside the inner housing wall and extends upwardly towards the fluid chamber in use.

5. A closure device according to any of claim 1 to 4, wherein the
5 rupturing member includes a nozzle directed away from the fluid chamber and a through hole opening at the top of the rupturing member and in communication with the nozzle.

6. A closure device according to any of claim 1 to 5, wherein the
10 rupturing member includes guidance means to prevent relative rotation of the rupturing member and the housing and thread engagement means arranged to engage with an internal thread provided in the cap member to raise the rupturing member when the cap member rotates relative to the housing.

15 7. A closure device according to any of claim 1 to 5, wherein the rupturing member includes guidance means to prevent relative rotation of the rupturing member and the cap member and cam means arranged to engage with corresponding cam means provided in the housing to raise
20 the rupturing member when the cap member rotates relative to the housing.

8. A closure device according to any of claims 1 to 7, wherein the
25 housing includes an inner housing wall adapted to fit inside the neck of the opening and wherein the closure device includes sealing means which seals between the fluid chamber and the inner housing wall.

9. A container having a main liquid compartment, an opening having a
30 neck, and a closure device according to any of claims 1 to 8 closing said opening.

10. A closure device according to claim 1, wherein the primary engagement means includes a mutually engaging bayonet coupling provided on the cap member and the housing to allow the cap member to be lifted relative to the housing after rotation of the cap member relative to the housing through a predetermined angle.

11. A closure device according to any preceding claim, wherein the cap member includes an anti-tamper strip provided on the cap member to prevent lifting of the cap member relative to the housing without at least partial removal of the anti-tamper strip.

12. A closure device according to claim 11, wherein the anti-tamper strip comprises an extension of an outer cap wall connected to the outer cap wall by a neck portion thinner than the outer cap wall, the extension being provided with a flange which engages beneath the outer housing wall to prevent lifting of the cap member relative to the housing.

13. A closure device according to any preceding claim, wherein the primary engagement means of the cap member and housing include mutually engageable detent means to prevent the rotation of the cap member relative to the housing beyond a predetermined limiting angle of rotation.

14. A closure device according to any preceding claim, wherein the housing includes an anti-tamper device which prevents rotation of the cap member and housing relative to the neck of the container until a predetermined torque is applied to the cap member.

15. A closure device according to claim 14, wherein the anti-tamper device comprises an extension of an outer housing wall connected to the outer housing wall by at least one neck portion of reduced cross-sectional area relative to the outer housing wall, the extension being provided with a
5 detent means adapted to engage in use with a detent means provided on the neck of the container to prevent lifting of the housing relative to the neck without rupture of the at least one neck portion.
16. A closure device according to any preceding claim, wherein the
10 fluid chamber contains an additive liquid.
17. A closure device according to any preceding claim, wherein the fluid chamber contains a head space of gas.
18. A closure device according to claim 17, wherein the gas is
15 pressurised.
19. A container having a main liquid compartment, an opening having a neck, and a closure device closing said opening, wherein the closure
20 device comprises:
a cap member defining a fluid chamber which is at least partially bounded by a membrane,
a housing arranged in the neck, and
a rupturing member arranged for longitudinal travel within an aperture in
25 the housing,
wherein the cap member is provided with a primary engagement means which engages with a corresponding primary engagement means provided on the housing to allow the cap member to be rotated and lifted relative to the housing from a closed position in which the rupturing member is
30 arranged within the aperture in the housing below the membrane to an

open position in which the rupturing member ruptures the membrane to provide a communication path in use from the fluid chamber to the main liquid compartment.

- 5 20. A container according to claim 19 wherein the closure device is a closure device according any of claims 1 to 18.

21. A method of introducing an additive liquid into a main liquid compartment of a container, the method comprising the steps of
- 10 raising a cap member of a closure device and a fluid chamber defined by said cap member relative to a housing, wherein the fluid chamber is at least partially bounded by a membrane,
- causing a rupturing member arranged for longitudinal travel within an aperture in the housing to move relative to the cap member from a closed
- 15 position in which the rupturing member is arranged within the aperture in the housing below the membrane to an open position in which the rupturing member ruptures the membrane to provide a communication path in use from the fluid chamber to the main liquid compartment,
- releasing pressurised liquid from said fluid chamber along said
- 20 communication path into said main liquid compartment, and rotating the cap member further to remove the cap member and housing from the container.

22. A method according to claim 21, wherein the closure device is a
- 25 closure device according any of claims 1 to 18.

23. A method according to claim 21 or 22, wherein the cap member is raised by rotating the cap member such that the fluid chamber is raised by screw thread action relative to the housing.

24. A method according to any of claims 21 to 23, wherein the cap member is further rotated to remove the cap member and housing from the container by engagement of an internal secondary thread on the housing with an external secondary thread provided on a neck of an opening of the container.
- 5

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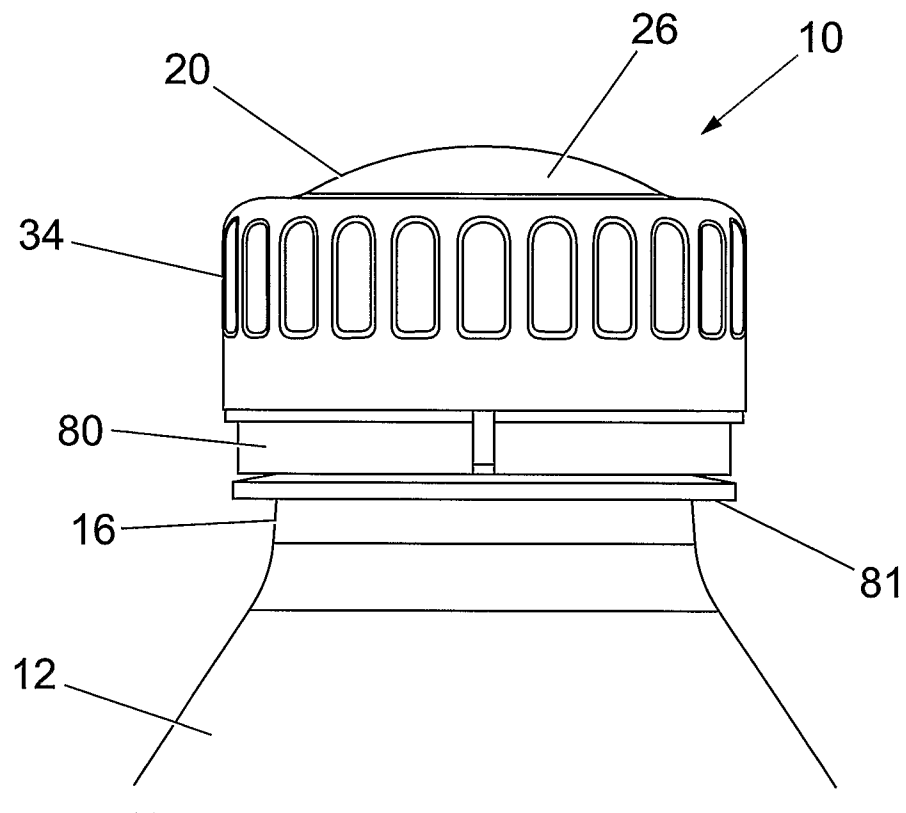


Fig. 1

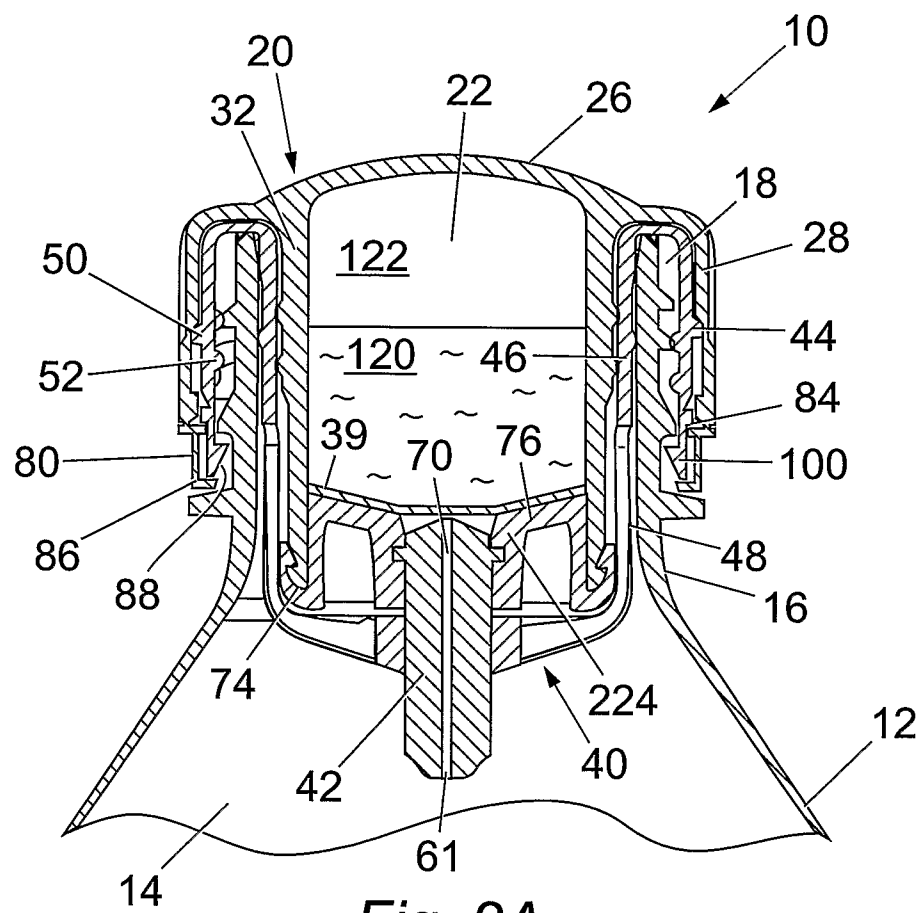


Fig. 2A

3 / 7

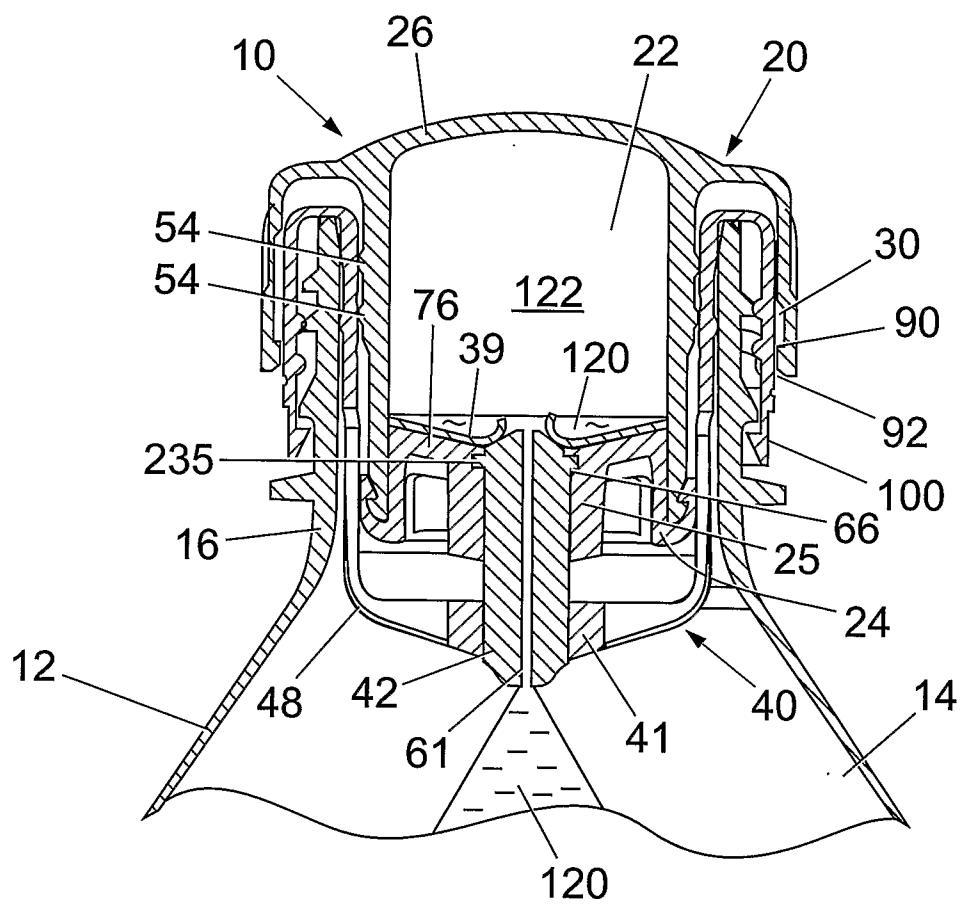


Fig. 2B

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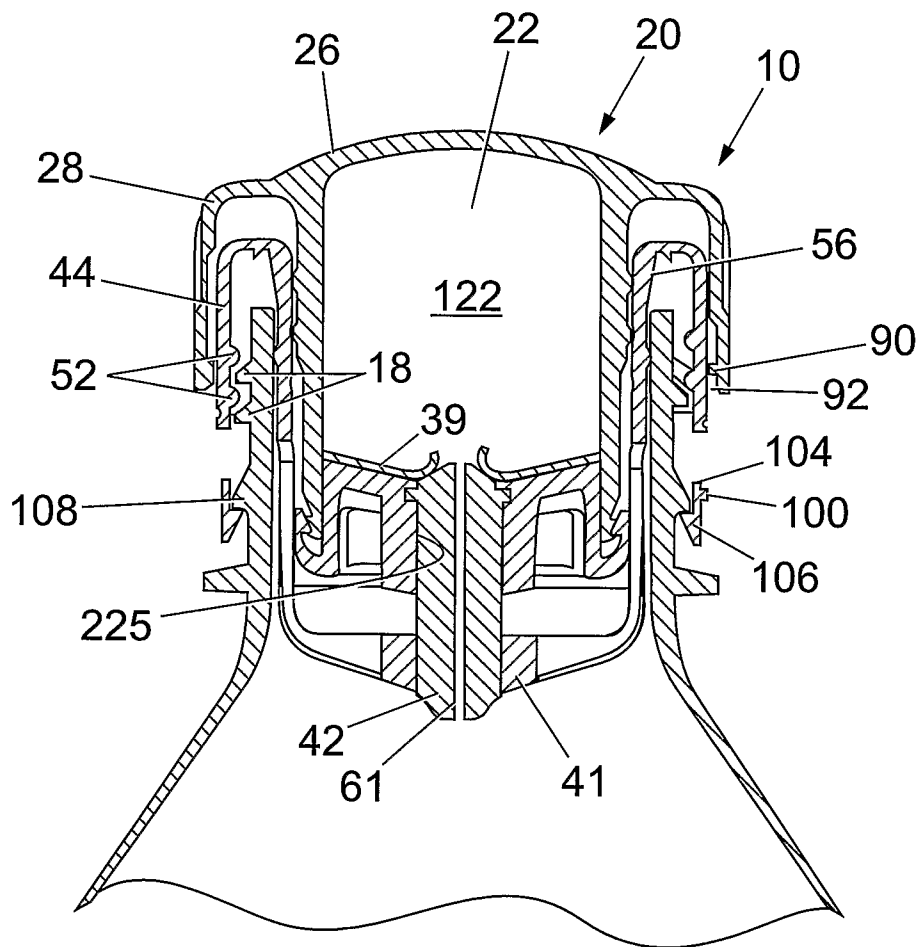


Fig. 2C

5 / 7

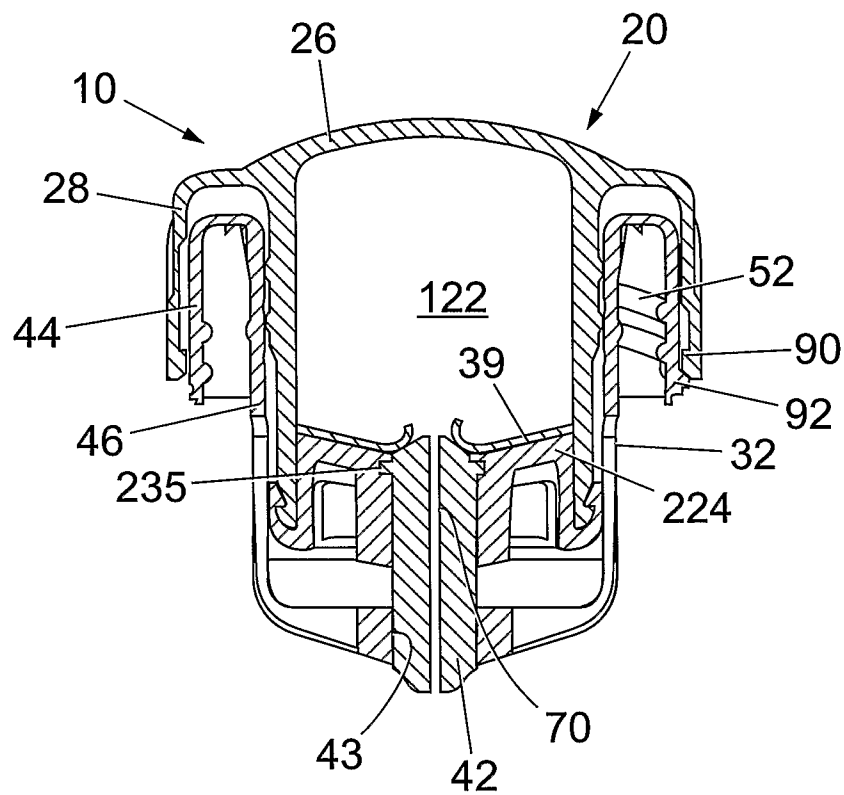


Fig. 2D

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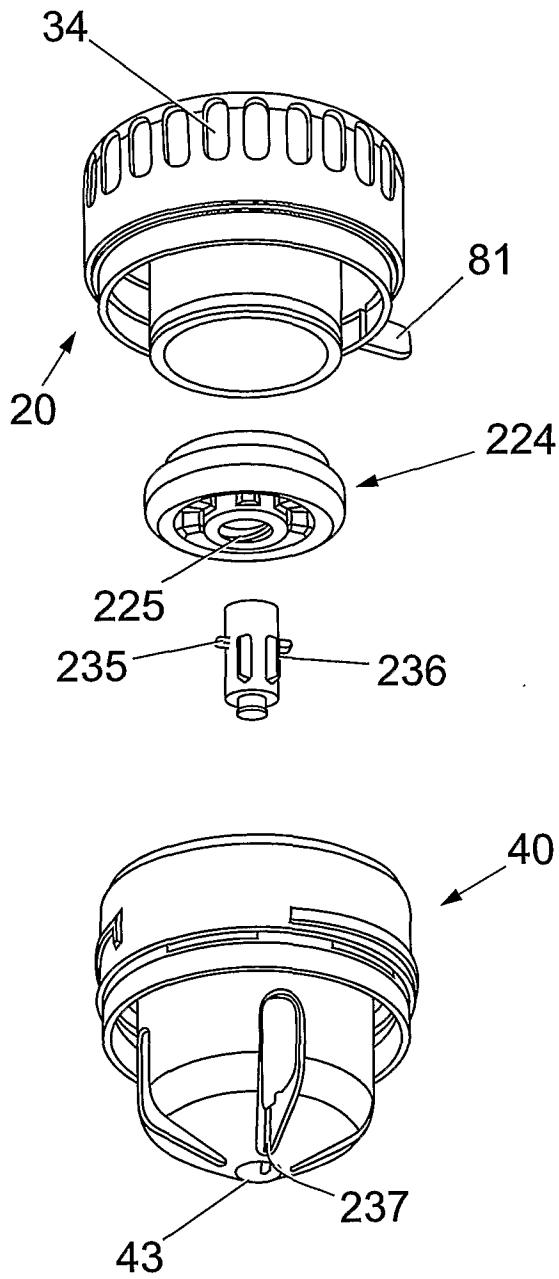


Fig. 3A

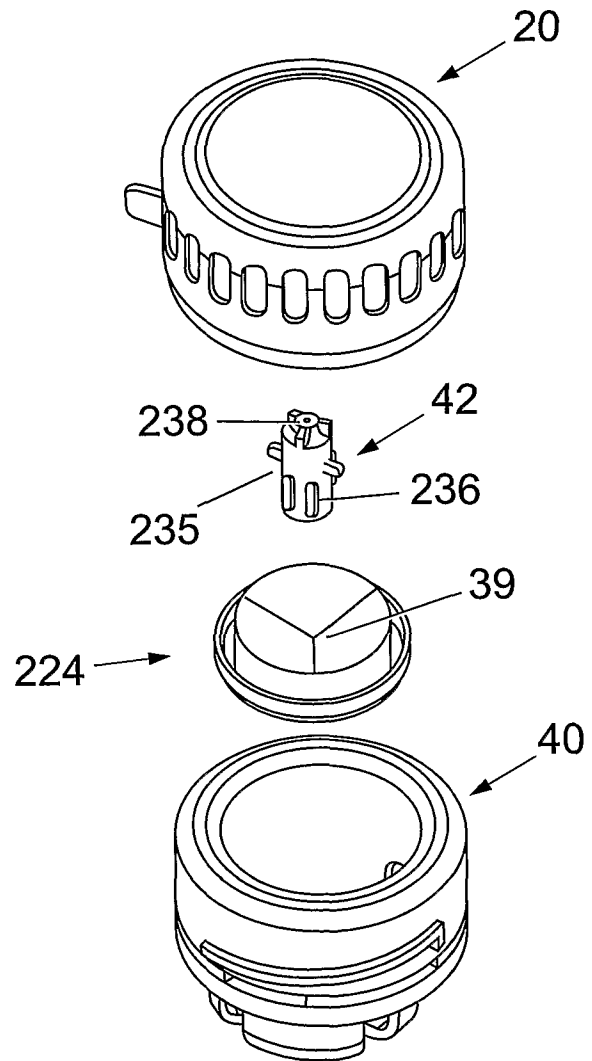


Fig. 3B

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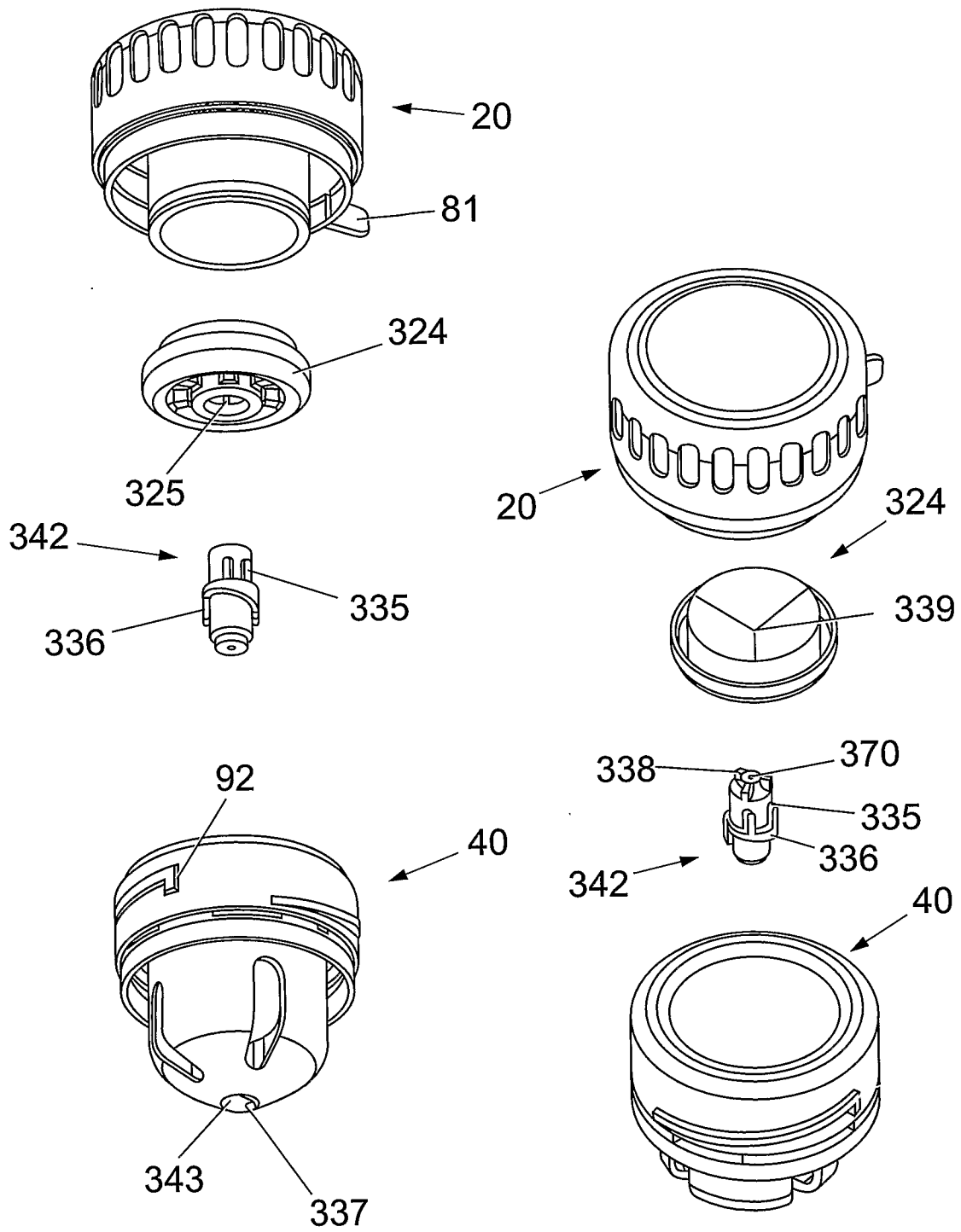


Fig. 4A

Fig. 4B

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2007/050483

A. CLASSIFICATION OF SUBJECT MATTER

INV. B65D51/28

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)

B65D

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

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

EPO-Internal

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A	WO 2004/033336 A (LEO ENGINEERING PTY LTD [AU]; WELLINGTON IND PTY LTD [AU]; NEUMEYER MA) 22 April 2004 (2004-04-22) page 8, line 13 - page 14, line 31 figures 1-9	1, 9, 19, 21
A	DE 10 2004 017765 B3 (SEAQUIST LOEFFLER KUNSTSTOFFWE [DE]) 25 May 2005 (2005-05-25) abstract; figures 1-10	1, 9, 19, 21
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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

27 November 2007

Date of mailing of the international search report

04/12/2007

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INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2007/050483

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 2004/200740 A1 (CHO YOUNG KOOK [US]) 14 October 2004 (2004-10-14) abstract; figures 4a,4b -----	1,9,19, 21

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International application No

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