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(71) Applicant: **RACER TECHNOLOGY PTE. LTD.**
[SG/SG]; No. 28, Changi South Street 1, Singapore 486772 (SG).

(72) Inventors: **KOH, Kee Joo, Willy**; c/o Racer Technology PTE. LTD., No. 28, Changi South Street 1, Singapore 486772 (SG). **FOO, Biao Jin, Ryan**; c/o Racer Technology PTE. LTD., No. 28, Changi South Street 1, Singapore 486772 (SG).

(74) Agent: **ONG, Lucille Frances, Kheng Lu**; Marks & Clerk Singapore LLP, Tanjong Pagar, P O Box 636, Singapore 910816 (SG).

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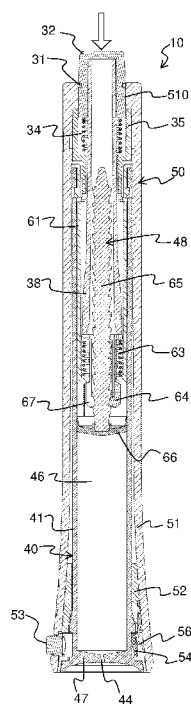


FIG. 1

(57) Abstract: A cartridge for a liquid dispensing device, the cartridge comprising: a tubular cartridge body; a base wall located at the cartridge body, a liquid dispensing opening provided in the base wall; a plunger provided in the cartridge body, the plunger comprising a pushrod and a disc seal provided at the pushrod to define a cavity in the cartridge between the disc seal and the base wall, the plunger being moveable forward towards the base wall to push liquid contained in the cavity out through the liquid dispensing opening, the pushrod comprising a number of teeth successively provided along at least part of its length, each tooth comprising a sloped annular surface and an actuating surface; a pusher actuable to move the plunger forward, the pusher comprising a number of forwardly projecting cantilever arms provided in continuous biased contact with the pushrod, and a return mechanism to return the pusher to the rest position.



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LIQUID DISPENSING DEVICE

FIELD

This invention relates to a liquid dispensing device, and in particular, to a device that dispenses a specific volume of a liquid with each actuation of the device.

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BACKGROUND

Liquids such as medicines, chemical reagents and skincare preparations often require a specific volumes of the liquid to be used in order for the liquid to be effective in its intended purpose. However, currently available methods using graduated measuring cups, cylinders, syringes, pipettes and so on are heavily dependent on human operator skill to accurately measure out the specific volume of liquid that is desired. There is thus a demand for a device that can accurately and repeatably dispense a specific volume of a liquid without depending on the skill of the person using the device.

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15 SUMMARY

According to a first aspect, there is provided cartridge for a liquid dispensing device, the cartridge comprising: a tubular cartridge body; a base wall located at a first end of the cartridge body, a liquid dispensing opening provided in the base wall; a plunger provided in the cartridge body, the plunger comprising a pushrod and a disc seal provided at a first end of the pushrod to define a cavity in the cartridge between the disc seal and the base wall, the plunger being moveable forward towards the base wall to push liquid contained in the cavity out through the liquid dispensing opening, the pushrod comprising a number of teeth successively provided along at least part of its length, each tooth comprising a sloped annular surface facing the base wall and an actuating surface facing a second end of the cartridge body; a pusher actuatable from the second end of the cartridge body to move the plunger forward upon application of a forward axial force on the pusher, the pusher comprising a number of forwardly projecting cantilever arms provided in continuous biased contact with the pushrod, each of the cantilever arms having an end surface to contact with and transmit the forward axial force onto the actuating surface of each of the teeth to move the plunger forward, each of the cantilever arms further having a sloped arm surface facing the second end of the cartridge body for backward sliding engagement with the sloped annular surface of each tooth without causing movement of the plunger when the pusher is returned to a rest position upon release of the forward axial force on the pusher; and a return mechanism provided in the cartridge body to return the pusher to the rest position.

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The cartridge may comprise a stopper provided in the cartridge body against which the pusher rests in the rest position, and the return mechanism may comprise a cartridge spring in axial engagement with the pusher and the stopper to return the pusher to the rest position upon release of the forward axial force on the pusher.

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The stopper may comprise an end plate of a tubular sleeve fixedly provided within the cartridge body, the end plate having a central through hole for passage of at least the cantilever arms therethrough.

10 The teeth may be provided on an external surface of the pushrod, and the cantilever arms of the pusher may be at least partially provided around the pushrod between the pushrod and a wall of the cartridge body.

The pushrod may comprise a hollow tube and the teeth may be provided on an internal surface
15 of the pushrod, and the cantilever arms of the pusher may be at least partially provided within the pushrod.

The cartridge may further comprise an external annular recess provided on an external surface of the cartridge body to engage an internal protrusion provided within a dispenser pen for
20 retaining the cartridge within the dispenser pen.

According to a second aspect, there is provided a dispenser pen comprising: a pen body for receiving and removably attaching therein the cartridge of the first aspect, the pen body having an open first end for insertion and removal of the cartridge into the pen body; and a push-
25 button mechanism provided at a second end of the pen body to apply the forward axial force on the pusher of the cartridge.

The push-button mechanism may comprise a dispenser button extending partially out of the second end of the pen body, the dispenser button being depressible into the pen body upon
30 application of the forward axial force on the dispenser button, the push-button mechanism further comprising a button extender to transmit the forward axial force from the dispenser button to the pusher of the cartridge.

The push-button mechanism further may comprise a button housing provided within the
35 second end of the pen body around a part of the dispenser button provided in the pen body, the

button housing containing therein a dispenser spring in axial engagement with the dispenser button to bias the dispenser button in a direction out of the second end of the pen body.

5 The dispenser button may be rotatable within the button housing between an unlocked position and a locked position, wherein in the unlocked position, the dispenser button is depressible into the pen body to dispense liquid from the cartridge, and wherein in the locked position, the dispenser button cannot be depressed into the pen body to dispense liquid from the cartridge.

10 The dispenser button may comprise a protruding tab to engage a rim of the button housing in the locked position to prevent depression of the dispenser button into the pen body, and the button housing may be provided with an axial slot to receive the protrusion in the unlocked position to allow depression of the dispenser button into the pen body.

15 The the internal protrusion may comprise a laterally-biased cartridge catch collar provided in the pen body, the cartridge catch collar being laterally displaceable against the lateral bias to disengage from the annular recess of the cartridge to allow removal of the cartridge from the pen body.

20 The dispenser pen may further comprise a transparent portion provided at the first end of the pen body to allow the disc seal to be seen when the disc seal is at the base wall of the cartridge.

The transparent portion may comprise a laterally depressible catch button provided to laterally displace the cartridge catch collar against the lateral bias.

25 According to a third aspect, there is provided liquid dispensing device comprising: the cartridge of the first aspect and the dispenser pen of the second aspect.

30 The liquid dispensing device may further comprise a base for receiving the first end of the pen body thereon to keep the dispenser pen in an upright position.

One of a top of the base and a rim of the first end of the pen body may be provided with an annular magnet and the other of the top of the base and the rim of the first end of the pen body is provided with a ferromagnetic ring to magnetically attach the pen body to the base.

35 The base may contain therein a vibration mechanism to provide a vibration to a bottom of the base for imparting a vibration to a skin surface that the bottom of the base is placed in contact

with together with liquid dispensed from the liquid dispensing device in order to enhance application of the liquid on the skin surface.

The base may be weighted to provide stability to the liquid dispensing device.

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The liquid dispensing device may further comprise a cap for covering the first end of the pen body to close the liquid dispensing opening of the cartridge when the cartridge is in the dispenser pen.

10 BRIEF DESCRIPTION OF FIGURES

In order that the invention may be fully understood and readily put into practical effect there shall now be described by way of non-limitative example only exemplary embodiments of the present invention, the description being with reference to the accompanying illustrative drawings.

15 FIG. 1 is a longitudinal section view of an exemplary embodiment of a liquid dispensing device.

FIG. 2a is a perspective view of a second exemplary embodiment of the liquid dispensing device.

FIG. 2b is a perspective view of the device of FIG. 2a when assembled.

20 FIG. 3 is a longitudinal section view of a cartridge of the device of FIG. 1.

FIG. 4a is an exploded assembly view of a cartridge body and a cartridge plunger mechanism of the cartridge of FIG. 3.

FIG. 4b is a close-up perspective view of a pusher of the cartridge plunger mechanism of FIG. 4a.

25 FIG. 4c is a bottom perspective view of a stopper of the cartridge plunger mechanism of FIG. 4a.

FIG. 4d is a close-up longitudinal section view of the pusher of FIG. 4b in its rest position and in engagement with a pushrod of the cartridge plunger mechanism of FIG. 4a.

FIG. 5 is an exploded assembly view of the cartridge plunger mechanism of FIG. 4a.

30 FIG. 6 is an exploded assembly view of a dispenser pen of the device of FIG. 1.

FIG. 7 is a longitudinal section view of the dispenser pen of the device of FIG. 1.

FIG. 8 is an exploded assembly view of a push-button mechanism of the dispenser pen of FIGS. 6 and 7.

FIG. 9 is a longitudinal section view of the push-button mechanism of FIG. 8.

35 FIG. 10 is a perspective view of the push-button mechanism of FIG. 8 in a locked position.

FIG. 11 is a perspective view of the push-button mechanism of FIG. 8 in an unlocked position.

FIG. 12 is a perspective view of the push-button mechanism of FIG. 8 with the dispenser button depressed.

FIG. 13 is a longitudinal section view of relative positions of the push-button mechanism of FIG. 9 in cooperation with the cartridge plunger mechanism of FIG. 5 in readiness for liquid dispensing.

FIG. 14 is a cross-sectional view of relative positions of the push-button mechanism of FIG. 9 in cooperation with the cartridge plunger mechanism of FIG. 5 when fully actuated by application of a forward axial force on the push-button mechanism and liquid is dispensed from the cartridge 40.

FIG. 15 is a longitudinal section view of relative positions of the push-button mechanism of FIG. 9 in cooperation with the cartridge plunger mechanism of FIG. 5 during return of the push-button mechanism and cartridge plunger mechanism towards rest positions.

FIG. 16 is a cross-sectional view of relative positions of the push-button mechanism of FIG. 9 in cooperation with the cartridge plunger mechanism of FIG. 5 in readiness for a subsequent liquid dispensing.

FIG. 17 is a close-up exploded assembly view of a cartridge catch mechanism of the dispenser pen of FIG. 6.

FIG. 18 is a longitudinal cross-section view of the cartridge catch mechanism in the dispenser pen during initial insertion of the cartridge into the dispenser pen.

FIG. 19 is a longitudinal section view of the cartridge catch mechanism in the dispenser pen as the cartridge approaches full insertion into the dispenser pen.

FIG. 20 is a longitudinal section view of the cartridge catch mechanism in the dispenser pen when the cartridge has been fully inserted into the dispenser pen.

FIG. 21 is a longitudinal cross-sectional view of the dispenser pen before engagement with a base of the device.

FIG. 22 is a longitudinal section view of the dispenser pen during engagement with a base of the device.

FIG. 23 is an exploded assembly view of the base of FIG. 22.

FIG. 24 is a perspective view of a travel cap of the liquid dispensing device.

FIG. 25 is a longitudinal section view of the travel cap fitted over first ends of the dispenser pen and the cartridge of the device.

DETAILED DESCRIPTION

Exemplary embodiments of a liquid dispensing device 10 will be described below with

reference to FIGS. 1 to 25. The same reference numerals are used throughout the figures for the same or similar parts.

In general, the liquid dispensing device 10 comprises at least a cartridge 40 and a dispenser pen 50, as can be seen in FIG. 1. The device 10 may optionally also comprise a base 70 as shown in FIG. 2 to serve as a stand for the dispenser pen 50 when not in use. The optional base 70 will be described in greater detail below. The cartridge 40, as shown in greater detail in FIGS. 3 to 5, comprises a tubular cartridge body 41. The cartridge body 41 may be made of a biocompatible plastics material such as natural polypropylene, i.e., polypropylene without any pigment or colour additives, and is preferably transparent or translucent. A liquid dispensing opening 44 is provided in a base wall 47 located at a first end 411 of the cartridge body 41. A second end 412 of the tubular cartridge body 41 is unsealed during use of the device 10.

The cartridge 40 further comprises a plunger 48 provided in the cartridge body 41. The plunger 48 comprises a pushrod 65 and a disc seal 66 provided at a first end 651 of the pushrod 65 to define a cavity 46 in the cartridge 40 between the disc seal 66 and the base wall 47. The pushrod 65 may be made of natural polypropylene, for example. The liquid dispensing opening 44 is in fluid communication with the cavity 46. In use, the liquid to be dispensed is provided in the cavity 46. The cartridge 40 is preferably factory-filled and sealed at both ends 411, 412, for example, with a peel-off foil seal that is removable by hand before insertion of the cartridge 40 into the dispenser pen 50.

The plunger 48 is movable forward towards the base wall 47 to push liquid contained in the cavity 46 out through the liquid dispensing opening 44. The pushrod 65 comprises a number of teeth 659 successively provided along at least part of its length. Each tooth 659 may be configured as an annular barb, i.e., having a sloped annular surface 651 facing the first end 411 of the cartridge body 41 and an actuating surface 652 facing the second end 412 of the cartridge body 41. Thus, each tooth 659 may be said to have a taper profile. The number of teeth 659 provided on the pushrod 65 is preferably configured to be equal to the number of doses of liquid that can be dispensed from the cartridge 40. Each dose of liquid thus contains a volume of liquid equal to a cross-sectional area of the cavity 46 multiplied by the forward displacement of the plunger 48 with each actuation of the device 10. Each forward displacement of the plunger 48 may be equal to an axial pitch distance between adjacent teeth 659 on the pushrod 65. By configuring the axial pitch distance and cavity cross-sectional area appropriately, the device 10 may be accordingly configured to dispense a specific volume of

liquid with each actuation of the device 10 as desired.

The cartridge 40 also comprises a pusher 64 actuatable from the second end 412 of the cartridge body 41 to move the plunger 48 forward upon application of a forward (indicated by the downward arrow in FIG. 1) axial force on the pusher 64. The pusher 64 comprises a number of pusher claws 67 provided in continuous biased contact with the pushrod 65. The pusher claws 67 comprise cantilever arms 67 that project forward, and may be provided on a single ring 69 on which the cantilever arms 67 are preferably equally spaced from each other. In a preferred embodiment, the pusher 64 comprising the cantilever arms 67 and ring 69 may be integrally formed from a plastics material, for example, such as natural polypropylene. As can be seen in greater detail in FIGS. 4b and 4d, each of the cantilever arms 67 has an end surface 671 facing the first end 411 of the cartridge body 41 to contact with and transmit the forward axial force onto the actuating surface 652 of each of the teeth 659 to move the plunger 48 forward. Each of the cantilever arms 67 further has a sloped arm surface 672 facing towards the second end 412 of the cartridge body 41 for backward sliding engagement with the sloped annular surface 651 of each tooth 659. In this way, the pusher 64 may be moved backwards towards the second end 412 of the cartridge body 41 in sliding contact with the pushrod 65 without causing movement of the plunger 48 when the pusher 64 is returned backwards to its rest position (as shown in FIG. 13). Backward movement of the pusher 64 is effected by a return mechanism provided in the cartridge body 41, as will be described in greater detail below.

For example, in embodiments when the teeth 659 are provided on an external surface of the pushrod 65 as shown in FIGS. 1, 3 and 5, the pushrod 65 passes through the ring 69 of the pusher 64 and the cantilever arms 67 of the pusher 64 are at least partially provided around the pushrod 65 between the pushrod 65 and a wall of the cartridge body 41. In such embodiments, the continuous biased contact of the cantilever arms 67 with the pushrod 65 may be achieved by configuring the cantilever arms 67 to define when at rest an internal cross-sectional space of slightly smaller diameter than a smallest diameter of the pushrod 65. In this way, the cantilever arms 67 when assembled with the pushrod 65 will always be slightly radially displaced by the larger diameter of the pushrod 65 around which the cantilever arms 67 are positioned.

As mentioned above, the cartridge 40 further comprises a return mechanism provided in the cartridge body 41 to return the pusher 64 to its rest position. Returning the pusher 64 to its rest position completes one dispensing actuation of the cartridge 40 in which the plunger 48 is displaced forward, for example by a displacement corresponding to the axial pitch between

adjacent teeth 659 on the pushrod 65. A stopper 611 is preferably provided in the cartridge body 41 against which the pusher 64 rests in its rest position to prevent further backward movement of the pusher 64. The return mechanism comprises a cartridge spring 63 provided in axial engagement with the pusher 64 as well as the stopper 611. Upon application of the axial
5 force on the pusher 64, the cartridge spring 63 experiences a compression that returns the pusher 64 to its rest position upon release of the forward axial force on the pusher 64. The cartridge spring 63 may comprise a zinc-coated music wire spring, for example.

In an exemplary embodiment, the stopper 611 comprises an end plate 611 of a tubular sleeve
10 61 fixedly provided within the cartridge body 41, the end plate 611 having a central through hole 610 for passage of pushrod 65 and the cantilever arms 67 therethrough, as can be seen in FIG. 4c. When the pusher 64 is in its rest position against the stopper 611, as shown in FIG. 4d, resting surfaces 673 provided on the cantilever arms 67 engage the stopper 611 to prevent further backward movement of the pusher 64 within the cartridge body 41. In this embodiment,
15 the tubular sleeve 61 (which may also be referred to as a cartridge cap 61) houses the cartridge spring 63, the pusher 64, and the plunger 48 comprising the pushrod 65 and disc seal 66 within the cartridge. The sleeve 61, the cartridge spring 63, the pusher 64, and the plunger 48 comprising the pushrod 65 and disc seal 66 may be collectively referred to as a cartridge plunger mechanism 60 and provided as a sub-assembly 60 that is easily assembled with the
20 cartridge body 41 during manufacture of the cartridge 40, as shown in FIG. 4a. A male snap-fit part 62 is preferably provided on the sleeve 61 to interface with a female snap-fit part 42 provided on the cartridge body 41 to anchor the cartridge plunger mechanism 60 to the cartridge body 41.

25 The dispenser pen 50 comprises a pen body 51 for receiving and removably attaching therein the cartridge 40. The pen body 51 may be made of any desired material that is preferably aesthetically pleasing, for example, such as an ABS plastic that may be spray-painted a desired colour. The pen body 51 has an open first end 511 for insertion and removal of the cartridge 40 into the pen body 51. A push-button mechanism 30 as shown in FIGS. 8-12 is provided at a
30 second end 512 of the pen body 51 to apply the forward axial force on the pusher 64 of the cartridge 40 in order to dispense liquid from the cartridge 40.

In an exemplary embodiment, the push-button mechanism 30 as shown in FIGS. 8-12 comprises a dispenser button 32 extending partially out of a button opening 510 provided at the
35 second end 512 of the pen body 51. The dispenser button 32 is depressible into the pen body

51 upon application of the forward axial force on the dispenser button 32. The dispenser button 32 may be made of an ABS plastic, for example, and may be spray-painted as desired.

The push-button mechanism 30 may further comprise a button extender 38 that interfaces with
5 the cartridge plunger mechanism 60 to transmit the forward axial force from the dispenser
button 32 to the pusher 64 of the cartridge 40. For example, the button extender 38 may
comprise a tubular shaft 38 that has a first end 381 provided in axial contact with the pusher 64
and a second end 382 that fits into the dispenser button 32. For example, the dispenser button
32 may be configured to fit over the button extender 38 like a cap, as can be seen more clearly
10 in FIG. 9. The first end 381 of the button extender 38 is adjacent the ring 69 of the pusher 64
so that forward axial force applied to the dispenser button 32 is transmitted to the pusher 64
through the button extender 38 with minimal losses. A small gap (not shown) may be provided
between the first end 381 of the button extender 38 and the pusher 64 when the cartridge 40
has been fully inserted into the dispenser pen 50 in order to avoid accidental depression of the
15 plunger 48 leading to discharge of the liquid during insertion of the cartridge 40. Thus, the
button extender 38 serves as an extension from the dispenser button 32 to reach the cartridge
plunger mechanism 60. The button extender 38 may be designed to comprise a lead-in feature
that aids in alignment of the pushrod 65 in the cartridge plunger mechanism 60. The button
extender 38 may be made of an ABS plastic, for example.

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The push-button mechanism 30 may further comprise a button housing 35 provided within the
second end 512 of the pen body 51, as shown in FIG. 7. The button housing 35 as can be seen
in FIGS. 7 to 12 is preferably configured as a collar surrounding a part of the dispenser button
32 that is provided in the pen body 51, and may be configured to be securely snap-fitted with
25 the button housing 35. The button housing 35 may be made of an ABS plastic, for example.
The button housing 35 preferably contains therein a dispenser spring 34 in axial engagement
with the dispenser button 32 to bias the dispenser button 32 in a direction out of the second end
of the pen body 51. In this way, when the dispenser button 32 is depressed by application of
the forward axial force on the dispenser button 32, the dispenser spring 34 is compressed, and
30 the compressed dispenser spring 34 returns the dispenser button 32 to its rest position when the
forward axial force is released. The dispenser spring 34 is positioned around the tubular shaft
of the button extender 38, and one end of the dispenser spring 34 may optionally be
permanently secured with the dispenser button 32, for example using a press-fit and an
adhesive such as Loctite®. The dispenser spring 34 may comprise a stainless steel spring, for
35 example.

The device 10 may be provided with a travel lock to prevent accidental dispensing of the liquid during transportation of the device 10. The travel lock may be provided by configuring the dispenser button 32 to be rotatable within the button housing 35 between a locked position (FIG. 10) and an unlocked position (FIGS. 11 and 12). In the unlocked position, the dispenser button 32 is depressible into the pen body 51 to dispense liquid from the cartridge. In the locked position, the dispenser button 32 cannot be depressed into the pen body 51 to dispense liquid from the cartridge. To achieve this, the dispenser button 32 may be provided with a protruding tab 33 to engage an upper rim 352 of the button housing 35 in the locked position to prevent depression of the dispenser button 32 into the pen body 51, as shown in FIG. 10. The protruding tab 33 serves as a travel lock feature to prevent accidental depression and discharge of liquid from the cartridge 40 during transportation of the device 10. The button housing 35 is provided with an axial slot 37 that serves as a dispensing groove to receive the protruding tab 33 in the unlocked position to allow depression of the dispenser button 32 into the pen body 51. Thus, in the unlocked position as shown in FIG. 11, the protruding tab 33 of the dispenser button 32 is aligned with the axial slot 37 of the button housing 35. In use, to lock the dispenser button 32, a user turns the dispenser button 32 in a first direction (e.g. anti-clockwise) relative to the pen body 51 so that the protruding tab 33 is not aligned with the axial slot 37 (FIG. 10). To unlock the dispenser button 32, the user turns the dispenser button 32 in a second direction (e.g. clockwise) relative to the pen body 51 so that the protruding tab 33 becomes aligned with the axial slot 37 (FIG. 11), thereby allowing the dispenser button 32 to be depressed so that the protruding tab 33 slides into the axial slot 37 (FIG. 12). The push-button mechanism 30 is preferably configured to provide feedback to the user whenever the dispenser button 32 is turned to the locked position and to the unlocked position. In an exemplary embodiment, as can be seen in FIGS. 8 and 12, this may be achieved by providing a bump 353 over which the protruding tab 33 forcibly slides and a depression 355 into which the protruding tab 33 sits, the bump 353 and the depression 355 being appropriately located on the upper rim 352 of the button housing 352 such that audio and/or tactile feedback is generated when the unlocked and locked positions are respectively reached.

The dispenser button 32 may further be provided with an external annular groove 320 into which a silicone O-ring 31 may be fitted in order to provide a liquid seal against the pen body 51. In this way, liquid or solid particles are prevented from entering the pen body 51 through the button opening 510 to contaminate the liquid in the cavity 46.

In use, the cartridge 40 is unsealed and inserted into the dispenser pen 50 such that the first end 411 of the cartridge body 41 is at the first end 511 of the pen body 51 when the cartridge 40

has been fully inserted. The dispenser button 32 is rotated to the unlocked position in which the protruding tab 33 on the dispenser button 32 is aligned with the axial slot 37 on the button housing 35 in readiness for dispensing of the liquid, wherein the dispenser button 32, button extender 34 and pusher 64 are all in their rest positions as shown in FIG. 13, wherein the
5 pusher 64 engages a first tooth 659-1.

When the dispenser button 32 is depressed into the pen body 51 by applying the forward axial force on the dispenser button 32, as shown in FIG. 14, the button extender 38 is correspondingly moved forward, i.e., towards the first end 511 of the pen body 51. As the
10 button extender 38 is in contact with the pusher 64, the pusher 64 accordingly also moves forward, pushing against the actuating surface 652 of the first tooth 659-1, thereby pushing the plunger 48 comprising the pushrod 65 and disc seal 66 forward to displace the liquid from the cavity 46. The cartridge spring 63 is compressed by forward movement of the pusher 64 between the ring 69 of the pusher 64 and the stopper 611. The dispenser spring 34 is also
15 compressed between the depressed dispenser button 32 and the button housing 35.

When the dispenser button 32 is released upon removal of the forward axial force, the compressed dispenser spring 34 returns the dispenser button 32 backward towards its rest position, as shown in FIG. 15, in which the dispenser button 32 is on its way back to but not
20 yet fully returned to its rest position. At the same time, the compressed cartridge spring 63 returns the pusher 64 backward towards its rest position. The spring force from the cartridge spring 63 forces each of the cantilever arms 67 of the pusher 64 to flex and slide backwards along and over the taper profile of a next tooth 659-2, against the sloped annular surface of the next tooth 659-2, until the pusher 64 is back at its rest position and the end surfaces 671 of the
25 cantilever arms 67 engage the actuating surface 652 next tooth 659-2, as shown in FIG. 16.

Notably, the plunger 48 stays in the moved-forward position after having been moved forward by one step although the dispenser button 32, button extender 38 and pusher 64 have all been moved backwards to their rest positions (as shown in FIG. 16). This is because the force of the
30 cartridge spring 63 (as applied onto the ring 69 of the pusher 64 and correspondingly applied from the sloped arm surfaces 672 of the pusher 64 onto the sloped annular surface 651 of each tooth 659) is less than the friction force provided by the tight seal between the disc seal 66 and the inner wall of the cartridge body 41. Thus, while the device 10 is now in readiness for the next actuation, it should be noted that the plunger 48 has now been moved forward by one step.
35 The forward displacement travelled by the plunger 48 in each step preferably comprises a

distance of the axial pitch between adjacent teeth 659 on the pushrod 65. This may be achieved by configuring the axial slot 37 in the button housing 35 to have a length of at least the axial pitch between adjacent teeth 659 on the pushrod, thereby limiting the forward distance that can be travelled by the dispenser button 32 to the length of the axial slot 37. Where a small gap is provided between the first end 381 of the button extender 38 and the pusher 64 when the cartridge 40 has been fully inserted into the dispenser pen 50, the length of the axial slot 37 may be a sum of the axial pitch between adjacent teeth 659 and the height of the small gap. With each actuation of the device 10, the plunger 48 moves forward a further step. The plunger is preferably configured such that when the last remaining volume of liquid in the cartridge 40 has been dispensed, the disc seal 66 of the plunger 48 will preferably be adjacent the base wall 47 of the cartridge body 41, thereby avoiding waste of the liquid as no significant amount of liquid is retained in the expended cartridge 40 that is subsequently discarded.

In a preferred embodiment, the disc seal 66 may be brightly coloured (e.g. in red) so as to be visible at the first ends 411, 511 of both the cartridge body 41 and the pen body 51 when the last liquid dose has been dispensed. For example, the disc seal 66 may be made of a colour-pigmented polypropylene plastic material. The disc seal 66 becoming visible serves to indicate to the user that the cartridge 40 has been expended so that the cartridge 40 may be replaced with a new one. In order for the disc seal 66 to be visible through the first ends 411, 511 of both the cartridge body 41 and the pen body 51, as mentioned above, the cartridge body 41 is preferably transparent or translucent so that the disc seal 66 is visible through it, while a transparent portion 53 may be provided at the first end 511 of the pen body 51 through which the disc seal 66 in the cartridge body 41 may be seen.

In order for the cartridge 40 to be securely and yet removably attachable to the dispenser pen 50, a cartridge catch mechanism 90 may be provided at the first end 511 of the pen body 51, as can be seen in FIGS. 6 and 17-20. The cartridge catch mechanism 90 may comprise a dispenser weight 52 that houses therein a laterally displaceable cartridge catch ring 54, a laterally depressible catch button 53, a catch spring 56 and a dispenser cap 55. The dispenser weight 52 may have a general form of a truncated hollow cone. The dispenser weight 52 may be made of a die-cast zinc, for example. The catch button 53 may be made of a highly polished clear polycarbonate plastic and may be provided adjacent an opening formed in the cartridge catch ring 54 to serve as the transparent portion 53 for seeing the disc seal 66 therethrough when the disc seal 66 has reached the base wall 47 of the cartridge 40. The catch spring 56 is provided between the cartridge catch ring 54 and the inner wall of the dispenser weight 52, and

may be configured as a simple bent arm spring. An outer diameter of the cartridge catch ring 54 is smaller than an inner diameter of the dispenser weight 52. In this way, the cartridge catch ring 54 is laterally displaceable within the dispenser weight 52 by the bias of the catch spring 56 in a first direction and also laterally displaceable within the dispenser weight 52 by depression of the catch button 53 against the bias of the catch spring 56 in a second direction. Preferably, the catch button 53 is provided diametrically opposite the catch spring 56 so that the second direction is directly opposite that of the first direction. The catch spring 56 may be made of a spring steel with clear zinc plating, for example, while the cartridge catch ring 54 may be made of a 30% glass-filled nylon plastic.

To cooperate with the cartridge catch mechanism 90, an annular recess 43 may be provided at a first end 411 of the cartridge body 41, as can be seen in FIGS. 3 and 4. An outer diameter of the first end 411 of the cartridge body 41 is smaller than an inner diameter of the cartridge catch ring 54 so that the cartridge 40 may be inserted into the dispenser pen 50 through the cartridge catch ring 54, as shown in FIGS. 18-20. As the cartridge 40 is pushed into the pen body 51, as shown in FIG. 19, the cartridge 40 may laterally displace the cartridge catch ring 54 against the catch spring 56. Upon full insertion of the cartridge 40 into the pen body 51, as shown in FIG. 20, one side of the cartridge catch ring 54 that is biased by the catch spring 56 in the first direction engages the annular recess 43 of the cartridge 40 to securely attach the cartridge 40 within the pen body 51. In this way, the cartridge catch ring 54 serves as an internal protrusion in the pen body 51 to engage the annular catch recess 43 of the cartridge 40. To remove the cartridge, the catch button 53 is depressed and acts against the cartridge catch ring 54 to laterally displace the cartridge catch ring 54 against the catch spring 56 in the second direction, thereby disengaging the cartridge catch ring 54 from the annular recess 43 of the cartridge 40 to allow the cartridge 40 to fall out of the dispenser pen 50 under gravitational action. The cartridge catch mechanism 90 is preferably configured to provide an audio feedback to inform the user that the cartridge 40 has been fully inserted into the dispenser pen 50, for example, by emitting an audible click when the cartridge catch ring 54 engages the annular catch recess 43 of the cartridge 40.

The dispenser cap 55 serves to secure the cartridge catch mechanism 90 to the first end 511 of the pen body 51, and has the form of a ring to allow passage of the cartridge 40 therethrough. The dispenser cap 55 is thus provided at a rim of the first end 511 of the pen body 51. In an exemplary embodiment, the dispenser cap 55 may be made of a ferromagnetic material such as

an iron-silicon alloy, in order to magnetically attach the pen body 51 to an optional base 70 of the device 10, as shown in FIGS. 2a, 2b, 21-23. The dispenser cap 55 may be made of a metal injection-moulded ferrosilicon alloy with electrodeless nickel plating, for example. Accordingly, a top 702 of the base 70 may be provided with an annular magnet 72 to
5 magnetically attract the ferromagnetic dispenser cap 55. The annular magnet 72 may comprise a neodymium 40 magnet with chrome plating, for example, and may be securely provided on the base 70 by being fixedly inserted into an annular slot 78 provided at the top 702 of the base 70.

10 The base 70 may comprise a base body 71 in which a base weight 73 is preferably housed, so that the base 70 is weighted to prevent movement of the base 70 relative to a surface on which the base 70 is placed when the dispenser pen 50 is detached from the base 70 for use. The base weight 73 also serves to stabilise the base body 71 by lowering the centre of gravity of the device 10 when the dispenser pen 50 has been placed on the base 70. The base weight 73
15 may be made of a die-cast zinc while the base body 71 may be made of an ABS plastic that may be spray-painted, for example. A base cap 74 may be provided to keep the base weight 73 within the base body 71 by using known means such as self-threading screws 75 to secure the base cap 74 to the base body 71. The base cap 74 may be made of an ABS plastic, for example. A rubber pad 76 may be provided under the base cap 74 to prevent the base 70 from sliding on
20 the surface and also to conceal the screws 75. The rubber pad 76 may be adhered to the base cap 74 after assembly of the base cap 74 with the base weight 73 and base body 71, for example. The rubber pad 76 may comprise a 3M® 467 rubber and adhered to the base cap 74 using 200MP double sided tape. Further preferably, a cross-sectional area of a bottom 701 of the base 70 is larger than a cross-sectional area of the top 702 of the base so that the base 70 is
25 in stable equilibrium when placed on a horizontal surface to provide stability for the dispenser pen 50.

The base 70 may optionally contain therein a vibration mechanism (not shown) that may be turned on and off to provide a vibration to the bottom 701 of the base 70 for imparting a
30 vibration to a surface on which the bottom 701 of the base 70 is placed. In use, the liquid may be dispensed onto the bottom surface 701 of the base 70 and the vibration turned on to apply the liquid with vibration onto a skin surface, so as to enhance effectiveness of the liquid in its intended purpose on the skin.

35 The device 10 may further comprise a cap 80 as shown in FIGS. 24 and 25 for covering the

first ends 411, 511 of the cartridge 40 and the pen body 51 in order to keep clean the liquid dispensing opening 44, as shown in FIG. 25. The cap 80 is preferably configured to have a finger removable snap fit with the first end 511 of the pen body 51, and may further comprise a stopper nub 84 configured to fit into the liquid dispensing opening 44 to prevent accidental discharge of liquid during transportation of the device 10 due to pressure differences during air travel, for example. The travel cap 80 may be made of a polypropylene plastic material, for example, and may be pigmented with a colour (e.g. black) as desired.

In an example of use, the device 10 may be configured as a dosage-specific liquid skincare product dispensing device 10 that allows one-handed operation of the device 10 to dispense the liquid and also allows replacement of cartridges 40 when the skincare product in the cartridge 40 is depleted. The device 10 dispenses a specific volume of skincare product with every press on the dispenser button 32, thereby ensuring that the correct dosage of the product is always obtained for use without being dependent on user skill or experience to obtain the right amount of product. In this configuration, the device 10 comprises the dispenser pen 50, the cartridge 40, the base 70 and the travel cap 80. The dispenser pen 50 normally sits upright on the base 70 on table- or counter-tops where users normally store the device 10. The device 10 is provided with the travel lock in the push-button mechanism 30 to prevent accidental dispensing of the liquid and the travel cap 80 serves to keep the liquid dispensing opening 44 clean. This allows the device 10 to be brought along when the user travels so as not to disrupt the recommended application frequency of the skincare product. The cartridge 40 contains the skincare product and is factory sealed directly after filling. The cartridge 40 can only dispense the skincare product by mating its mechanism with that in the dispenser pen 50. Depending on the formula of the skincare product, a specific dose of the product may be recommended to be used on a regular basis. The dispenser pen 50 and the cartridge 40 are designed to dispense the skincare product according to the recommended dosage with each press of the dispenser button 32. The cartridge 40 contains and allows a specific number of doses of the skincare product for a period of time. Once the content is spent, users can eject the emptied cartridge 40 and replace it with a new cartridge 40, where the cycle repeats. Cartridges 40 are preferably made of recyclable materials for environmental friendliness.

Appreciably, the device 10 may be used to dispense any other liquids besides skincare products, for example, such as haircare products, medications, liquid test samples, chemical reagents, adhesives, and so on, particularly where a specific amount of the liquid is desired to be dispensed with each actuation of the device 10.

Whilst there has been described in the foregoing description exemplary embodiments of the present invention, it will be understood by those skilled in the technology concerned that many variations and combination in details of design, construction and/or operation may be made without departing from the present invention. For example, while the pushrod in the above
5 described embodiment and as shown in the figures comprises externally provided teeth, in other embodiments, the pushrod may alternatively comprises a hollow tube where the teeth are provided on an internal surface of the pushrod and the cantilever arms of the pusher may be accordingly at least partially provided within the pushrod to apply the axial force to the actuating surfaces of the internal teeth of the tubular pushrod. While the described embodiment
10 provides an annular magnet on the base and a ferromagnetic ring at the rim of the pen body, in alternative embodiments, the annular magnet may be provided at the rim of the pen body and the ferromagnetic ring may be provided on the base. While polypropylene and ABS plastic has been mentioned above as the material that may be used for many of the components of the device, other appropriate materials may be used to form the components. While several of the
15 components have been depicted in the figures and/or described as having circular cross-sections or shapes, the components may be configured to have other shapes, cross-sectional or otherwise, without affecting the functioning of the device.

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CLAIMS

1. A cartridge for a liquid dispensing device, the cartridge comprising:
 - a tubular cartridge body;
 - 5 a base wall located at a first end of the cartridge body, a liquid dispensing opening provided in the base wall;
 - a plunger provided in the cartridge body, the plunger comprising a pushrod and a disc seal provided at a first end of the pushrod to define a cavity in the cartridge between the disc seal and the base wall, the plunger being moveable forward
10 towards the base wall to push liquid contained in the cavity out through the liquid dispensing opening, the pushrod comprising a number of teeth successively provided along at least part of its length, each tooth comprising a sloped annular surface facing the base wall and an actuating surface facing a second end of the cartridge body;
 - 15 a pusher actuatable from the second end of the cartridge body to move the plunger forward upon application of a forward axial force on the pusher, the pusher comprising a number of forwardly projecting cantilever arms provided in continuous biased contact with the pushrod, each of the cantilever arms having an end surface to contact with and transmit the forward axial force onto the actuating
20 surface of each of the teeth to move the plunger forward, each of the cantilever arms further having a sloped arm surface facing the second end of the cartridge body for backward sliding engagement with the sloped annular surface of each tooth without causing movement of the plunger when the pusher is returned to a rest position upon release of the forward axial force on the pusher; and
 - 25 a return mechanism provided in the cartridge body to return the pusher to the rest position.
2. The cartridge of claim 1, wherein the cartridge comprises a stopper provided in the cartridge body against which the pusher rests in the rest position, and wherein the return
30 mechanism comprises a cartridge spring in axial engagement with the pusher and the stopper to return the pusher to the rest position upon release of the forward axial force on the pusher.
3. The cartridge of claim 2, wherein the stopper comprises an end plate of a tubular sleeve
35 fixedly provided within the cartridge body, the end plate having a central through hole for

passage of at least the cantilever arms therethrough.

4. The cartridge of any one of claims 1 to 3, wherein the teeth are provided on an external surface of the pushrod, and wherein the cantilever arms of the pusher are at least partially provided around the pushrod between the pushrod and a wall of the cartridge body.
5. The cartridge of any one of claims 1 to 3, wherein the pushrod comprises a hollow tube and the teeth are provided on an internal surface of the pushrod, and wherein the cantilever arms of the pusher are at least partially provided within the pushrod.
6. The cartridge of any one of the preceding claims, further comprising an external annular recess provided on an external surface of the cartridge body to engage an internal protrusion provided within a dispenser pen for retaining the cartridge within the dispenser pen.
7. A dispenser pen comprising:
 - a pen body for receiving and removably attaching therein the cartridge of any one of claims 1 to 6; the pen body having an open first end for insertion and removal of the cartridge into the pen body; and
 - a push-button mechanism provided at a second end of the pen body to apply the forward axial force on the pusher of the cartridge.
8. The dispenser pen of claim 7, wherein the push-button mechanism comprises a dispenser button extending partially out of the second end of the pen body, the dispenser button being depressible into the pen body upon application of the forward axial force on the dispenser button, the push-button mechanism further comprising a button extender to transmit the forward axial force from the dispenser button to the pusher of the cartridge.
9. The dispenser pen of claim 8, wherein the push-button mechanism further comprises a button housing provided within the second end of the pen body around a part of the dispenser button provided in the pen body, the button housing containing therein a dispenser spring in axial engagement with the dispenser button to bias the dispenser button in a direction out of the second end of the pen body.
10. The dispenser pen of claim 9, wherein the dispenser button is rotatable within the button

housing between an unlocked position and a locked position, wherein in the unlocked position, the dispenser button is depressible into the pen body to dispense liquid from the cartridge, and wherein in the locked position, the dispenser button cannot be depressed into the pen body to dispense liquid from the cartridge.

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11. The dispenser pen of claim 10, wherein the dispenser button comprises a protruding tab to engage a rim of the button housing in the locked position to prevent depression of the dispenser button into the pen body, and wherein the button housing is provided with an axial slot to receive the protrusion in the unlocked position to allow depression of the dispenser button into the pen body.

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12. The dispenser pen of any one of claims 7 to 11 when dependent on claim 6, wherein the internal protrusion comprises a laterally-biased cartridge catch collar provided in the pen body, the cartridge catch collar being laterally displaceable against the lateral bias to disengage from the annular recess of the cartridge to allow removal of the cartridge from the pen body.

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13. The dispenser pen of any one of claims 7 to 12, further comprising a transparent portion provided at the first end of the pen body to allow the disc seal to be seen when the disc seal is at the base wall of the cartridge.

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14. The dispenser pen of claim 13 when dependent on claim 12, wherein the transparent portion comprises a laterally depressible catch button provided to laterally displace the cartridge catch collar against the lateral bias.

25

15. A liquid dispensing device comprising:
the cartridge of any one of claims 1 to 6; and
the dispenser pen of any one of claims 7 to 14.

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16. The liquid dispensing device of claim 15, further comprising a base for receiving the first end of the pen body thereon to keep the dispenser pen in an upright position.

17. The liquid dispensing device of claim 16, wherein one of a top of the base and a rim of the first end of the pen body is provided with an annular magnet and the other of the top of the base and the rim of the first end of the pen body is provided with a ferromagnetic ring to

35

magnetically attach the pen body to the base.

18. The liquid dispensing device of claim 16 or claim 17, wherein the base contains therein a vibration mechanism to provide a vibration to a bottom of the base for imparting a vibration to a skin surface that the bottom of the base is placed in contact with together with liquid dispensed from the liquid dispensing device in order to enhance application of the liquid on the skin surface.
19. The liquid dispensing device of any one of claims 16 to 18, wherein the base is weighted to provide stability to the liquid dispensing device.
20. The liquid dispensing device of any one of claims 15 to 18, further comprising a cap for covering the first end of the pen body to close the liquid dispensing opening of the cartridge when the cartridge is in the dispenser pen.

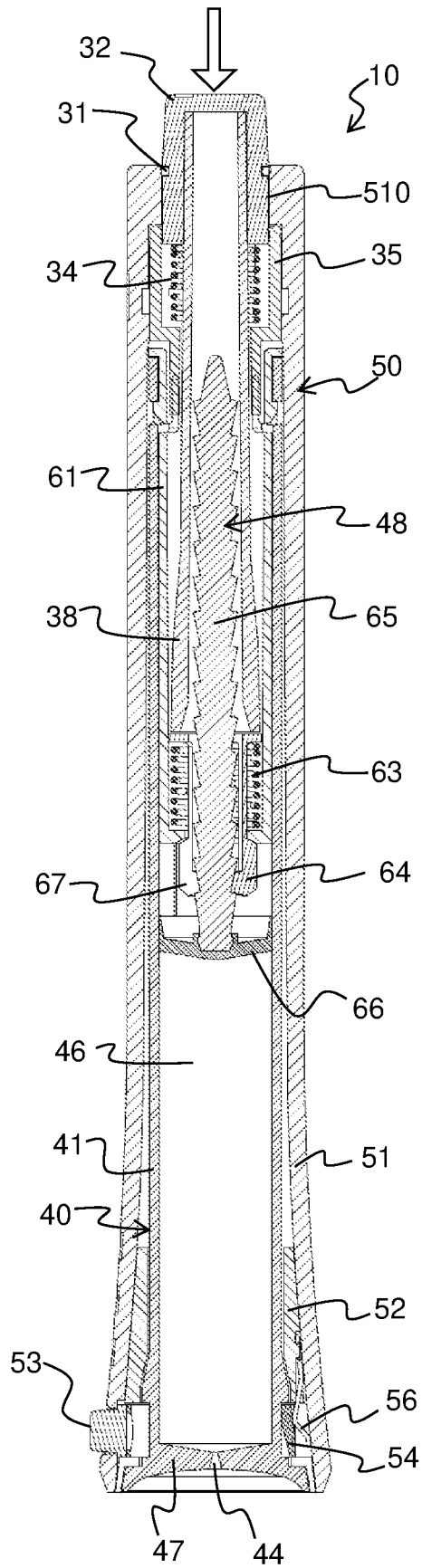


FIG. 1

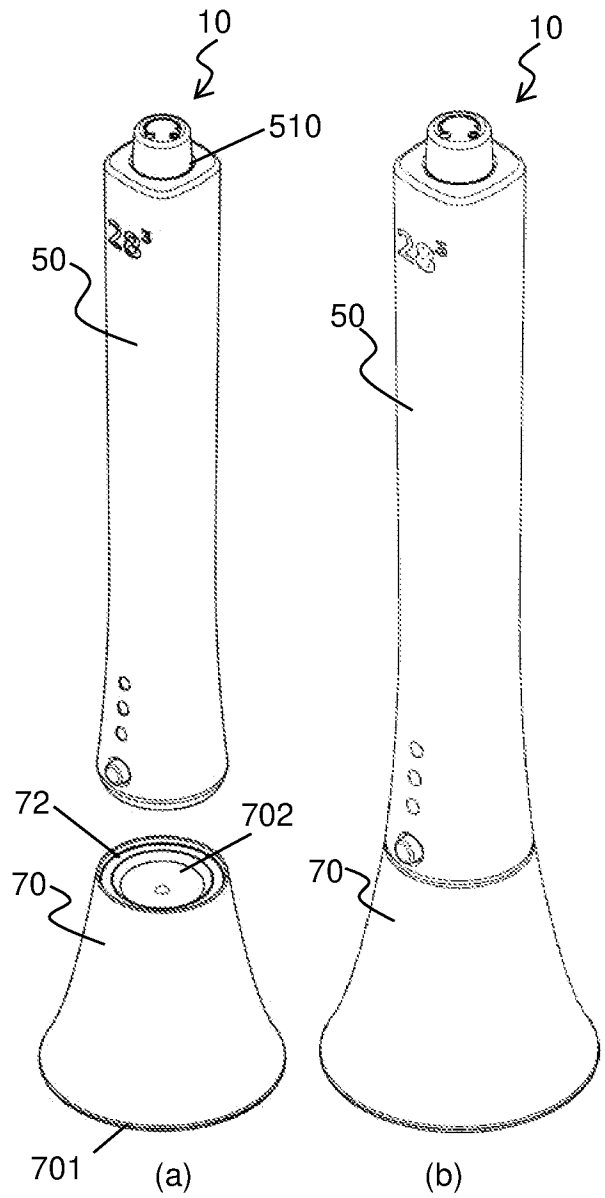


FIG. 2

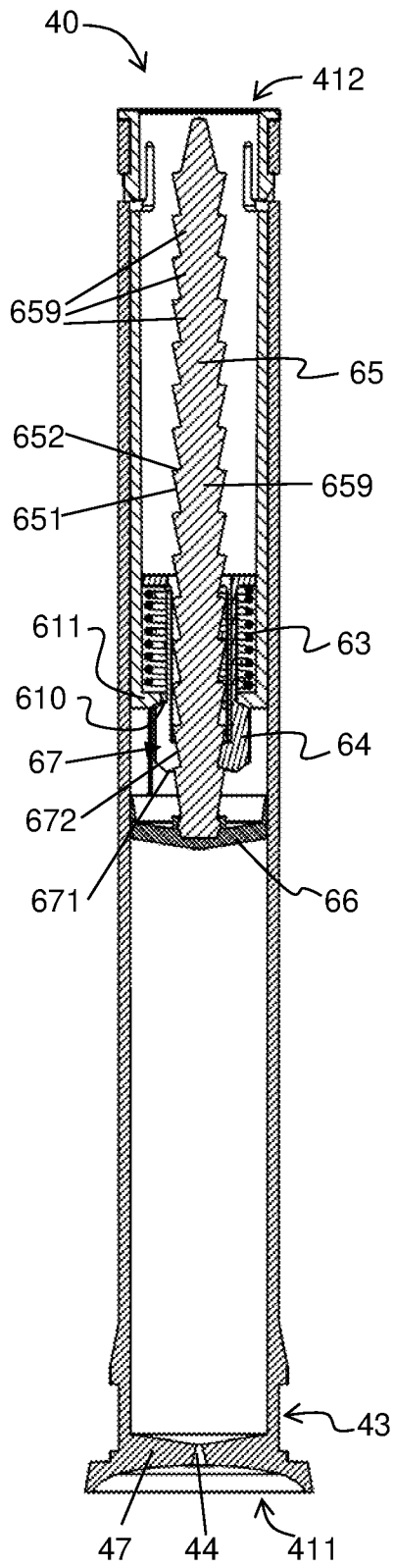


FIG. 3

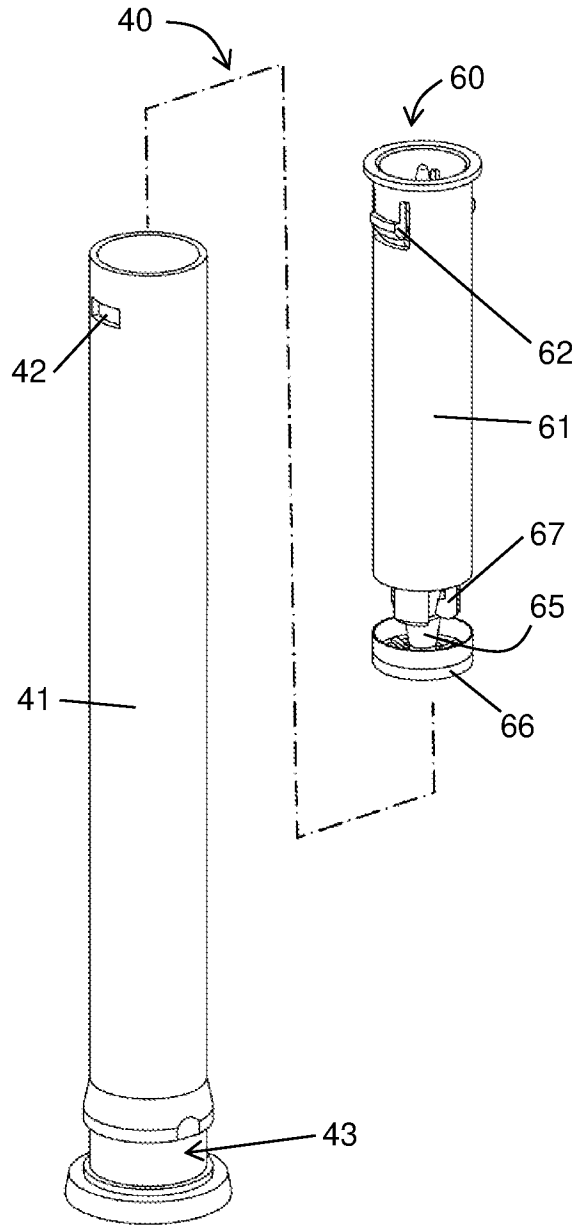


FIG. 4a

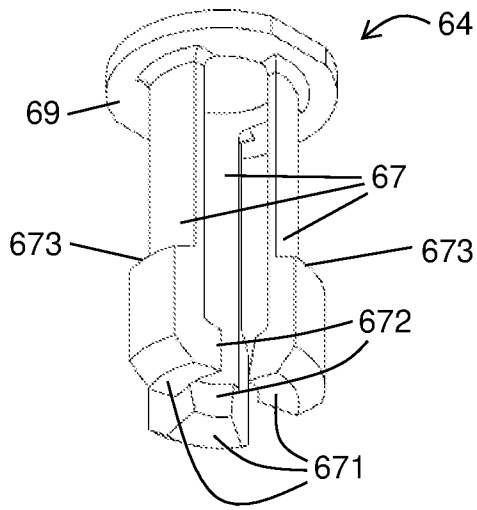


FIG. 4b

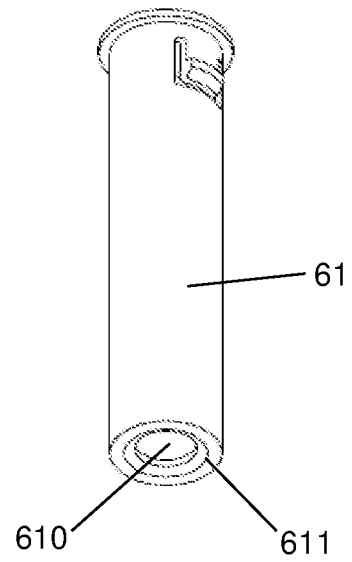


FIG. 4c

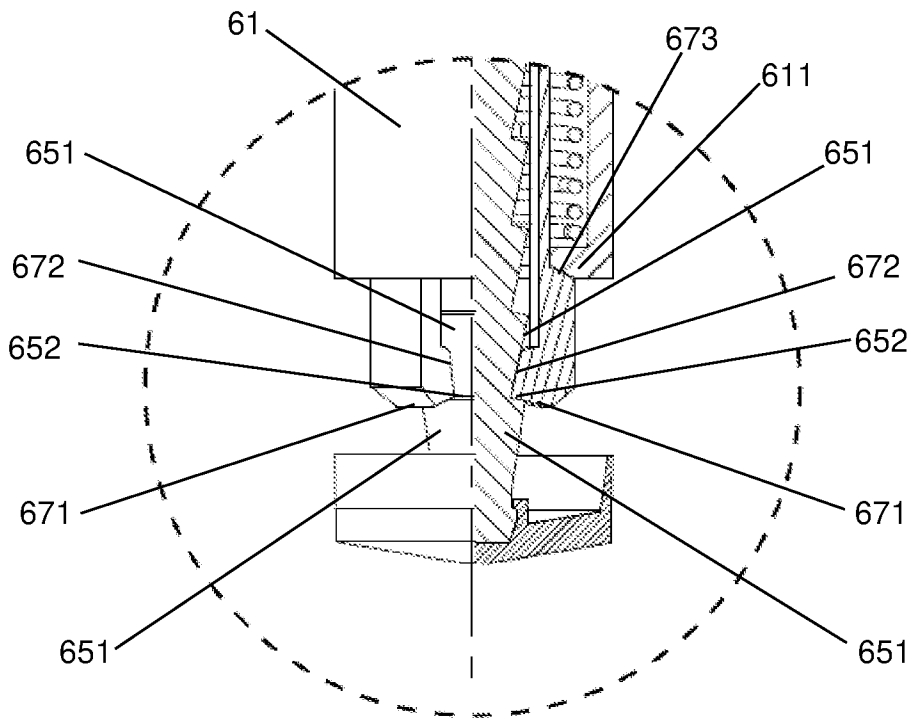


FIG. 4d

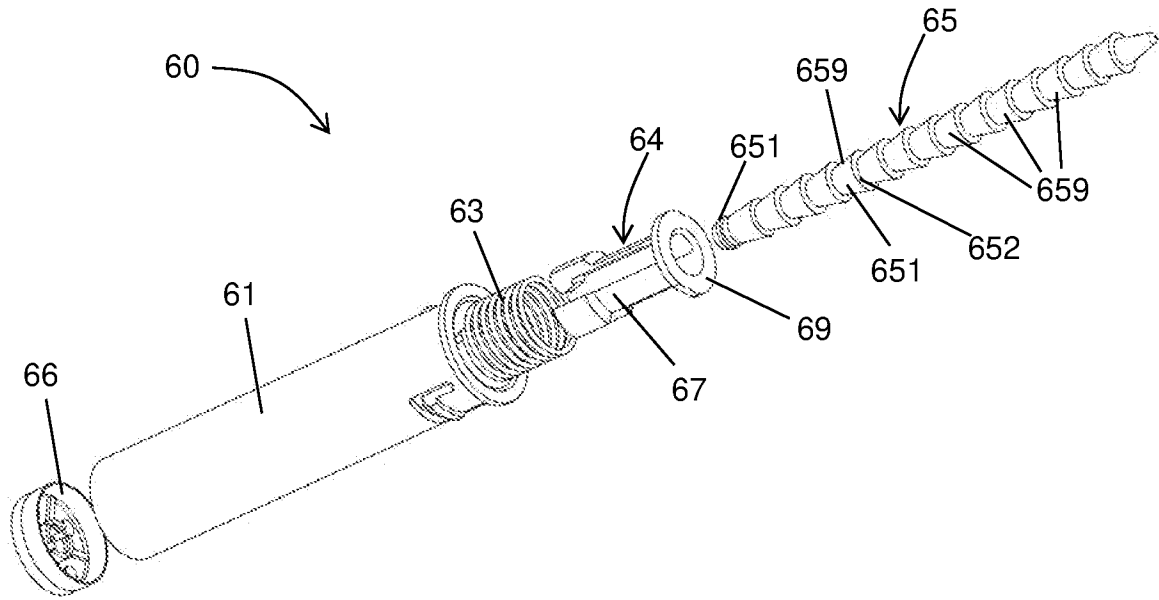


FIG. 5

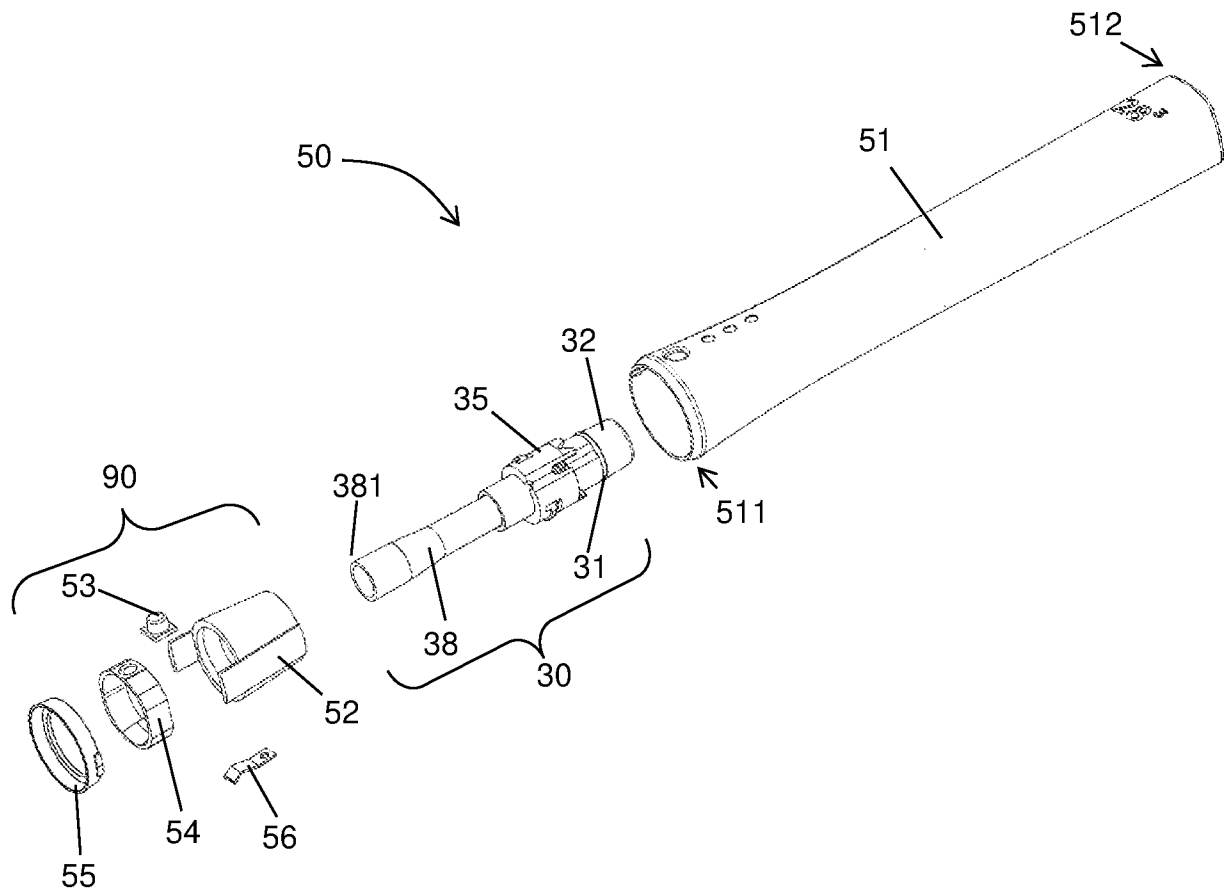


FIG. 6

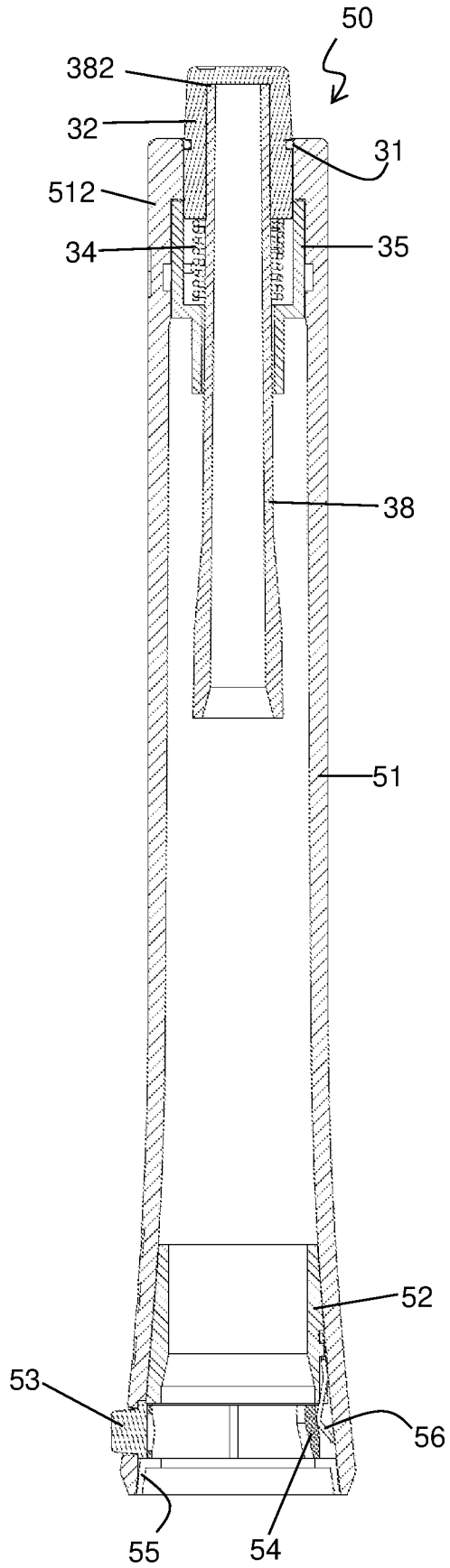


FIG. 7

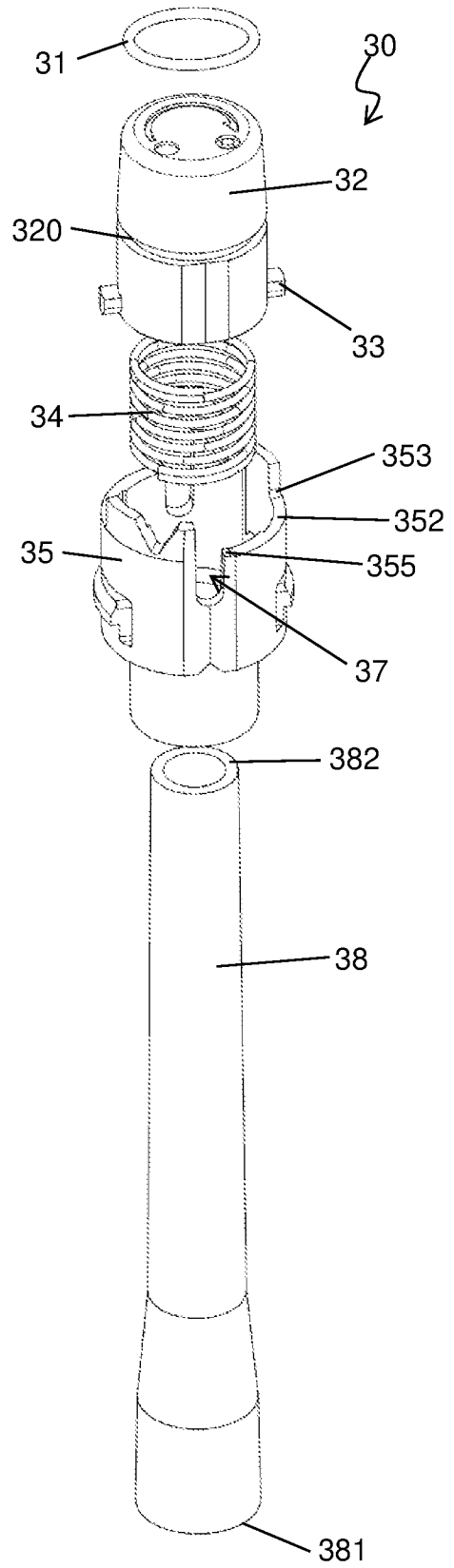
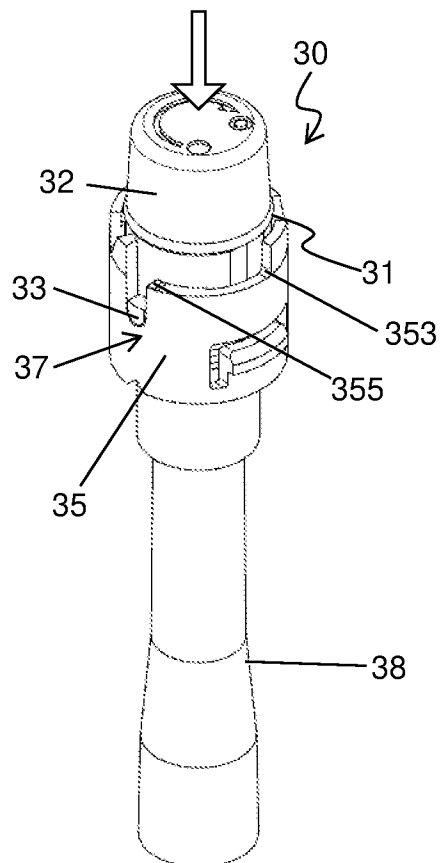
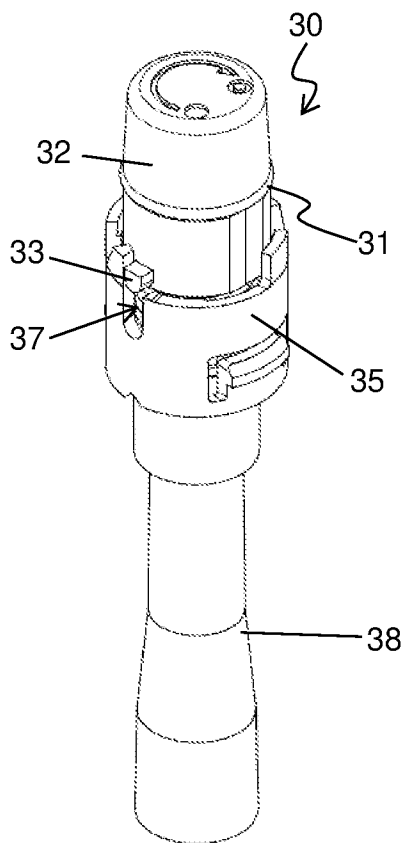
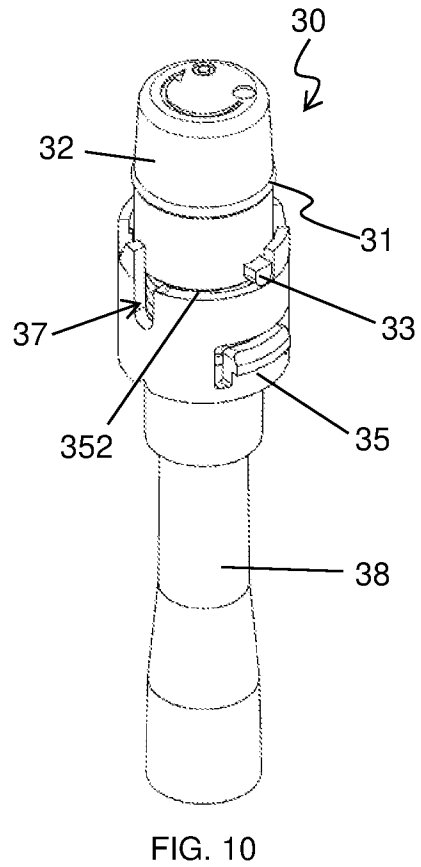
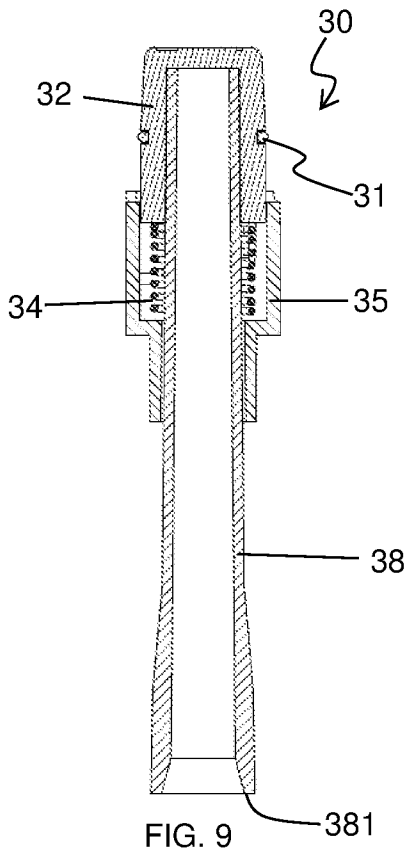


FIG. 8



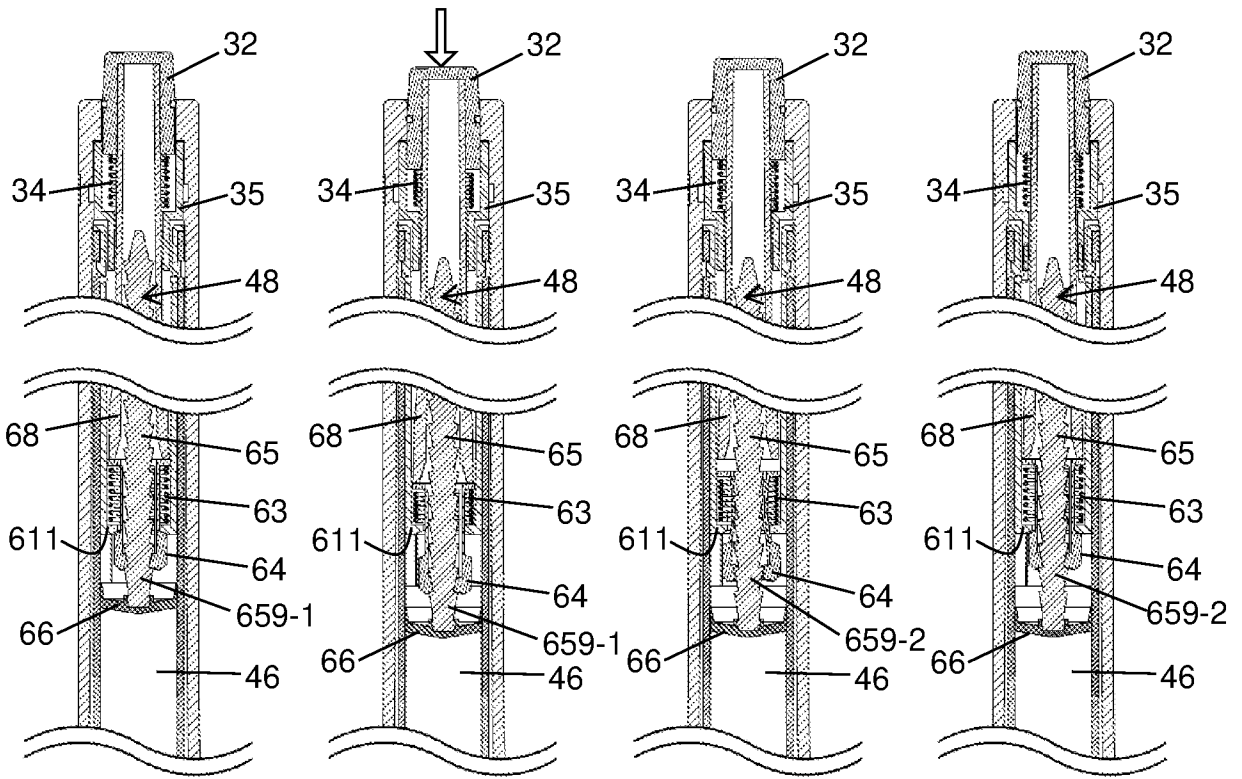


FIG. 13

FIG. 14

FIG. 15

FIG. 16

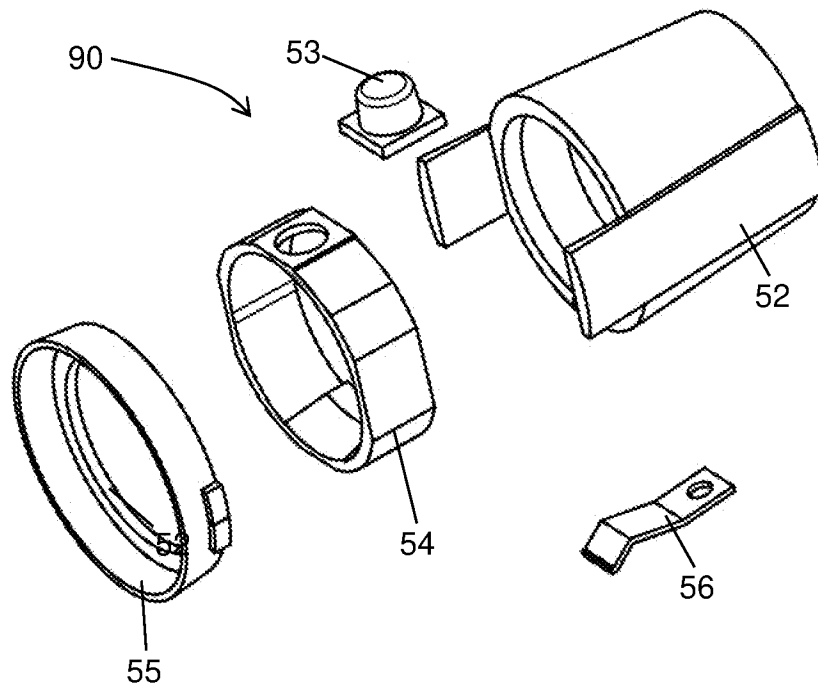


FIG. 17

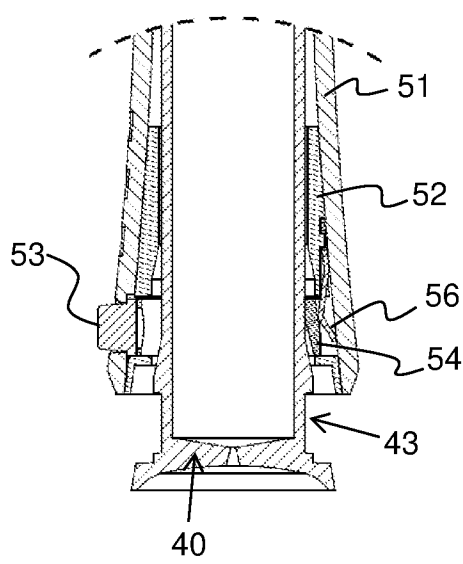


FIG. 18

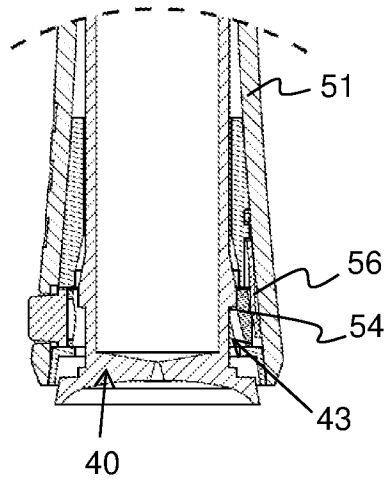


FIG. 19

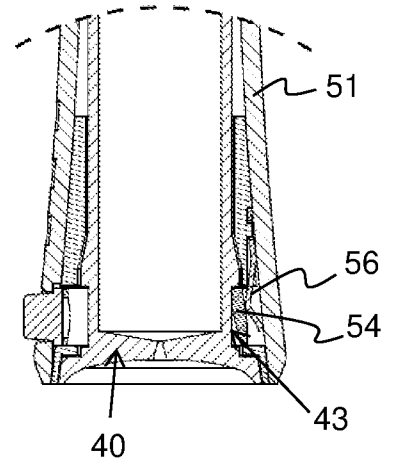


FIG. 20

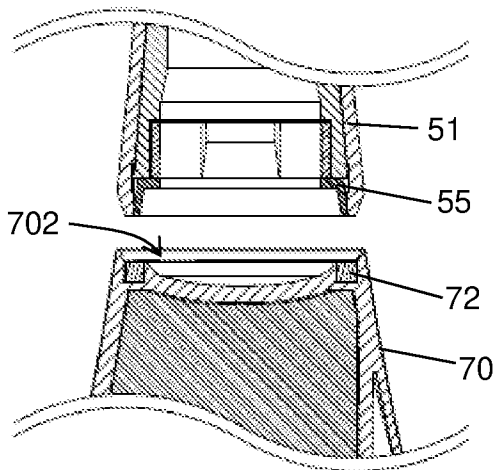


FIG. 21

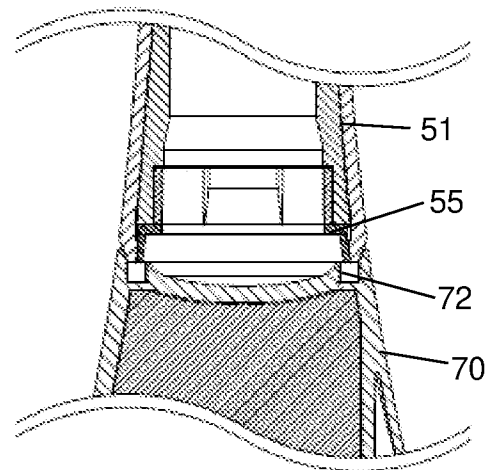


FIG. 22

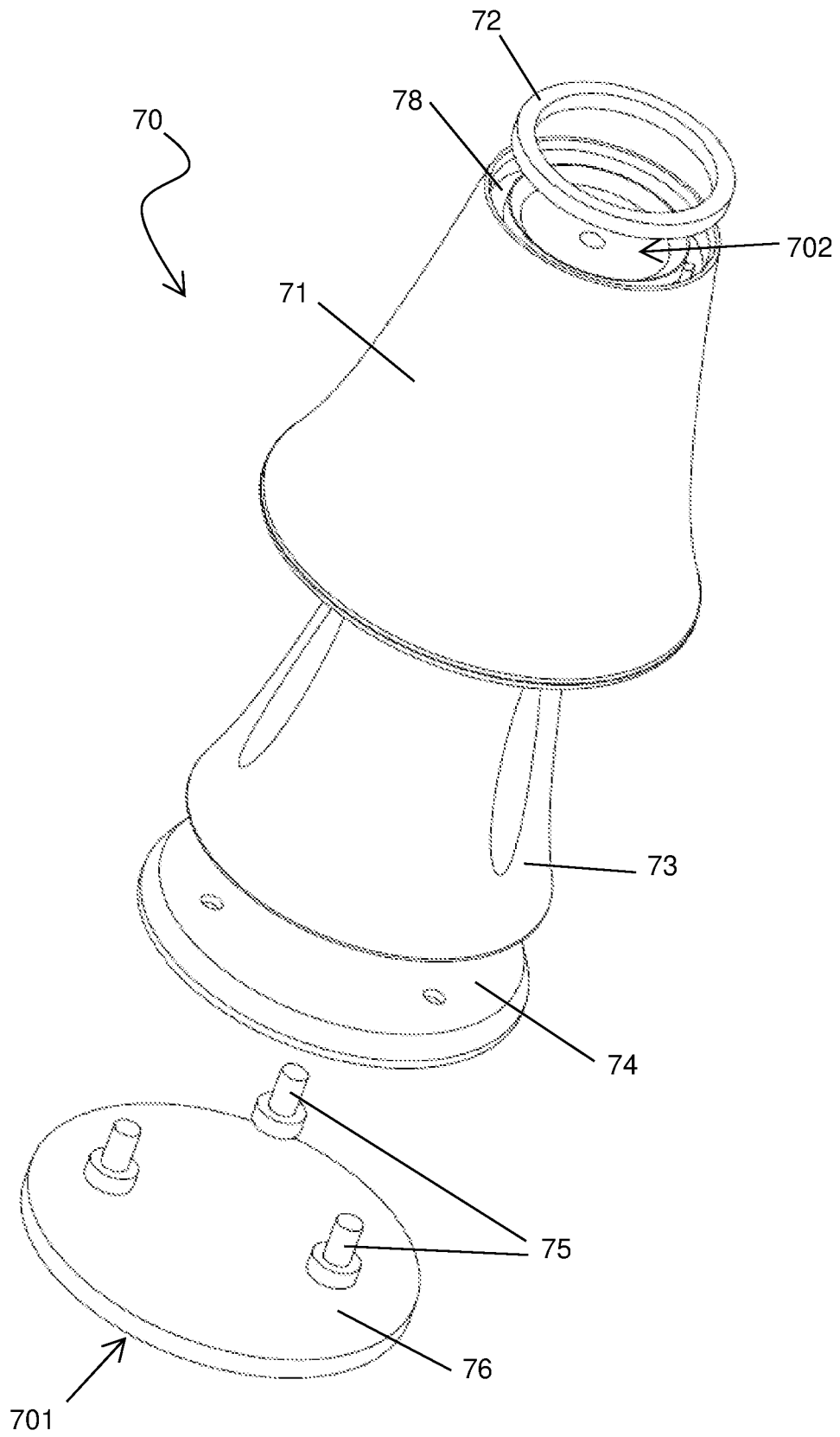


FIG. 23

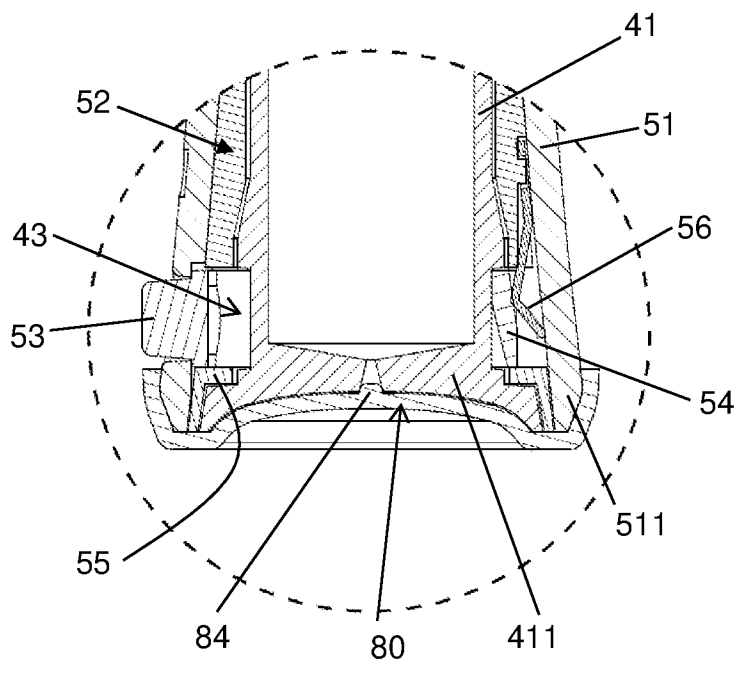
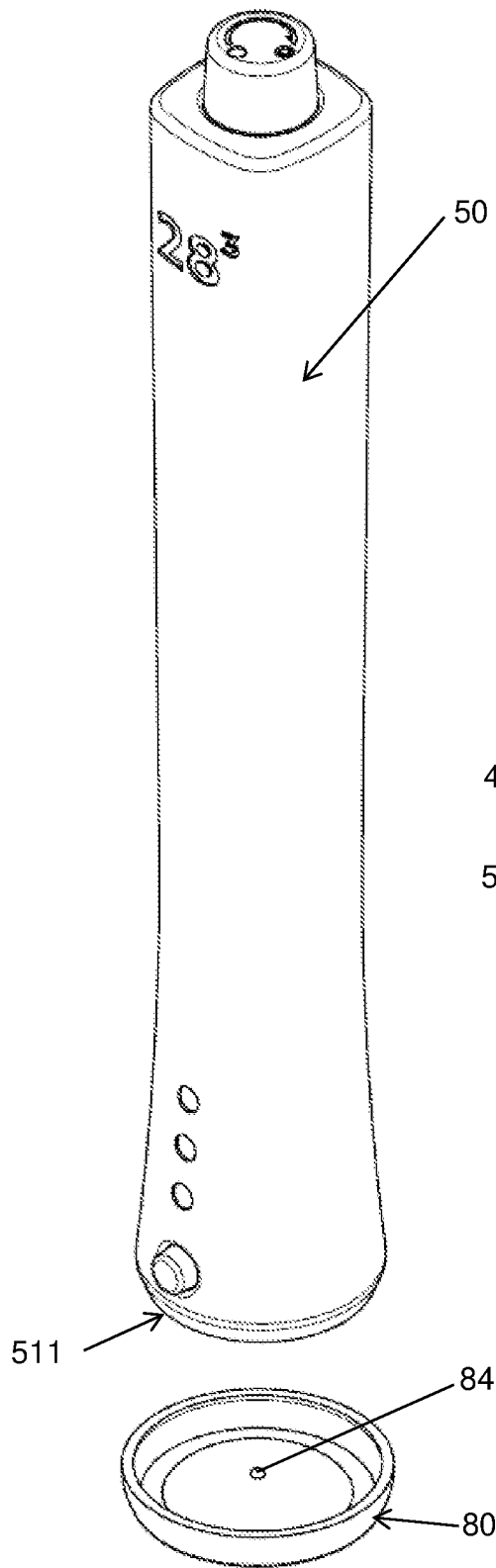


FIG. 25

FIG. 24

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SG2019/050316

A. CLASSIFICATION OF SUBJECT MATTER

A61M 5/315 (2006.01) A61M 5/24 (2006.01) A61M 35/00 (2006.01) B05C 17/01 (2006.01)

According to International Patent Classification (IPC)

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A45D; A61M; A61C; B05C

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

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

Database: FamPat

Keywords: cartridge, ampoule, ampule, plunger, piston, teeth, tooth, arm, branch, cantilever, fork, 药筒, 熔丝盒, 柱塞, 活塞, 牙, 齿, 牙齿, 悬臂, 悬挑, 腕臂 and related terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	DE 3900926 A1 (DISETRONIC AG.) 17 August 1989 fig. 1, 9 pg. 2, 3, 6, 7, 10 of the machine translation	1, 4-16, 19, 20 17, 18
X	WO 2017/180545 A1 (3M INNOVATIVE PROPERTIES COMPANY) 19 October 2017 pg. 7 lines 11-21, pg. 8 lines 5-14, pg. 9 lines 3-22, pg. 10 lines 7-14 fig. 1, 2, 4, 5	1, 2, 4
A	EP 0498737 A1 (TERUMO KABUSHIKI KAISHA) 12 August 1992 WHOLE DOCUMENT	

Further documents are listed in the continuation of Box C.

See patent family annex.

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

20/08/2019

(day/month/year)

Date of mailing of the international search report

17/09/2019

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PLQ 1, Paya Lebar Quarter

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Ho Siow Ling (Dr)

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SG2019/050316

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015/0335824 A1 (NZIKE P. ET AL.) 26 November 2015 WHOLE DOCUMENT	
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/SG2019/050316

Note: This Annex lists known patent family members relating to the patent documents cited in this International Search Report. This Authority is in no way liable for these particulars which are merely given for the purpose of information.

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