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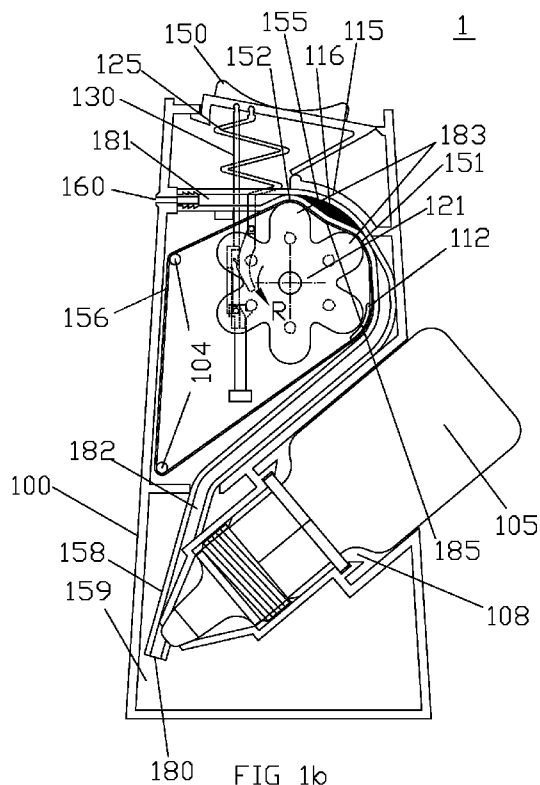
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(54) Title: INDEXABLE FLUID DISPENSER



(57) Abstract: The current invention discloses an indexable fluid dispenser suitable for ophthalmic treatments and delivering of ophthalmic agents such as eye drops. The fluid dispenser incorporates a tube made from compliant materials as the key dosing component. A rotor is used to manipulate the tube in the dosing process. The rotor has rotor lobes that press against the tube. The segment of the tube between the pressing points is considered a dosing section that houses a dosing chamber. A rotor control mechanism including several components may compel the rotor to make angular rotations of less than 360 degrees. Each stroke of angular rotation drives the fluid contained in the dosing chamber towards an outlet orifice, pushing a dose to be discharged. With each dosing process, a single dose of the fluid is discharged. Moreover, the fluid dispenser is capable of delivering a series of doses of the fluid by repeating the dosing process.



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PCT PATENT APPLICATION**TITLE****INDEXABLE FLUID DISPENSER****Inventor:****Nigel Kelly****Claim of Priority**

This application claims the priority of U.S. Serial No. 61/487,349 filed on May 18, 2011, the contents of which are fully incorporated herein by reference.

Field of the Invention

The current invention relates to a pump that may be used for dispensing fluids. More particularly, the current invention relates to a miniature dispensing pump for delivering eye drops or ear drops in small doses. The same pump designs may also be scaled-up to deliver much larger doses.

Background of the Invention

This patent application fully incorporates by reference the contents of U.S. Serial No. _____ with the title “Fluid Dispenser” filed on May 18, 2012, by the same inventor.

It is common practice to prescribe eye drops for ophthalmic treatments. Consequently, it is desirable to develop apparatus and devices that may help the application of ophthalmic fluids. Furthermore, it is preferred that the fluids are delivered in small doses such as approximately 5 to 50 micro-liters. Moreover, the ophthalmic fluids are preferably dispensed in small droplets that
5 avoid making noticeable impact on the eye.

To ensure that the fluids are delivered properly, a number of dispensers have been developed. However, most of these dispensers have shortcomings such as frequent wastage and high-impact delivery. In addition, some of the existing dispensers have complicated structures that require precision injection molding and complex assembly, making the device more costly to
10 manufacture.

The current invention adopts a number of unique designs to address the problems presented by the other apparatus and devices, ensuring that ophthalmic fluids are properly delivered.

In summary, other fluid dispensing devices are known in the art, but their structures are
15 distinctively different from the current invention. Moreover, the other inventions fail to address all of the problems solved by the invention described herein. A series of embodiments of this invention are illustrated in the accompanying drawings and will be described in more detail herein below.

Summary of the Invention

The current invention discloses an indexable fluid dispenser for administrating a fluid, comprising: a dispenser case; a reservoir capable of holding a plurality of doses of a fluid; a
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tube, made from compliant materials, enclosed in the dispenser case, the tube having an inlet end and an outlet end, the inlet end being disposed in the reservoir, the outlet end being fluidly connected to an outlet orifice, and the tube has a first pressing point and a second pressing point; a central axle disposed in the dispenser case; a rotor having a plurality of pressing members
5 evenly distributed around the central axle, the pressing members being capable of rotating around the central axle; wherein two of the pressing members act upon the first pressing point and the second pressing point respectively, wherein a segment of the tube between the first pressing point and the second pressing point is a dosing section housing a dosing chamber, suitable for containing a dose of fluid; and a rotor control mechanism, wherein the rotor control
10 mechanism is capable of driving an angular rotation of the rotor, wherein each angular rotation causes the pressing members to compel a dose of fluid in the dosing chamber out toward the outlet orifice. Therefore, each angular rotation of the rotor corresponds to a dosing process.

Preferably, the indexable fluid dispenser is a miniature pump and, particularly, a pump used for delivering eye drops or ear drops in small doses. However, the same pump designs may
15 also be scaled-up to deliver much larger doses, such as may be required in pumping water or other liquids from wells or tanks.

The current invention relies on the sequenced manipulation of the dosing section, which is between the first pressing point and a second pressing point on the tube. Such a design dictates that discrete doses can be released from the outlet orifice as one single discharge of
20 liquid. A segment of the tube is, essentially, 'cordoned-off' (or 'shut-off') by pressing the tube at the pressing points with pressing members on a rotor. The sequestered segment of the tube thus defines a dosing section that houses the dosing chamber, which contains one dose of the fluid. Further external manipulation of the tube is carried out by angular rotation of the rotor and

sequential actions on the tube by the pressing members. With each angular rotation, wherein a pressing member rotates to occupy the position held by an adjacent pressing member, the dose of fluid contained in the dosing chamber is driven out toward the outlet orifice, making the dispenser discharge a dose of the fluid.

- 5 The fluid dispenser draws from the reservoir in order to initially fill the internal volume of a single length of tube. The fluid is held in the tube, prior to its release from the dispenser. The internal volume of the tube acts as a buffer between the supply of fluid from the reservoir and expulsion of a dose of liquid from the outlet orifice of the dispenser. The inlet end of the tube draws fluids contained in the reservoir. The fluid dispensed may be any fluid or liquid.
- 10 The fluid may be a pharmaceutical formulation, solution, gel, or suspension. The fluid may be delivered to the eye, ear, or any other targets. A finite number of operations of the dispenser are then required to fill the tube along its length. However, the exact dose that exits the dispenser for delivery to the target is not instantaneously provided by the reservoir. Instead, a segment of the tube is mechanically sequestered to form a dosing section so that the segment contains one dose
- 15 of the fluid to be dispensed. The dispenser is designed so that when a dose of the fluid is discharged, the dosing section is refilled and the dispenser is capable of discharging another dose.

 Upon release from the outlet orifice, the fluid dosage stream forms itself into a collection of droplets as it moves through the air (as an inevitable consequence of surface tension effects -

20 which cause streams to break into droplets). Preferably, the dose is approximately between 5 to 50 micro-liters. The entire dose then moves along a trajectory that is partially defined by gravity to arrive at a fixed position at a known distance in front of the outlet orifice. Moreover, the

current invention provides for the dose of fluid to be expelled at a flow rate sufficiently low to limit the break-up of the dose into only a few closely grouped droplets.

The above features may be combined in any combination to construct alternative configurations of the dispenser. These features of the invention will be better understood
5 through the detailed description and accompanying drawings.

In general, the present invention succeeds in conferring the following, and others not mentioned, desirable and useful benefits and objectives.

It is an object of the present invention to provide a fluid dispenser that may be used to deliver ophthalmic fluids such as eye drops.

10 It is an object of the present invention to provide a fluid dispenser that uses a tube made from compliant materials.

It is an object of the present invention to provide a fluid dispenser that has a section of a tube to be sequestered to define a dosing section housing a dosing chamber.

15 It is an object of the present invention to provide a fluid dispenser that utilizes a rotor having pressing members to drive the fluid in the dosing chamber out toward an outlet orifice.

It is an object of the present invention to provide a fluid dispenser that utilizes a rotor having rotor lobes or rollers as pressing members.

It is an object of the present invention to provide a fluid dispenser that has a rotor control mechanism that triggers and stops the angular rotation of the rotor.

20 It is an object of the present invention to provide a fluid dispenser that discharges a precise dose of a fluid with each dosing process.

It is an object of the present invention to provide a fluid dispenser that is capable of delivering a series of doses with repetitive dosing processes.

It is an object of the present invention to provide a fluid dispenser that is light and portable.

It is another object of the current invention to provide a fluid dispenser that may be used for different purposes.

5 It is another object of the current invention to provide a fluid dispenser that may be used for delivery of ear drops.

It is still another object of the current invention to provide a fluid dispenser that is simple in structure and easy to manufacture.

10 It is yet another object of the current invention to provide a fluid dispenser that discharges a stream of fluid in a trajectory partly determined by gravity.

It is yet another object of the current invention to provide a fluid dispenser that, in use, does not contact a person's eye, the eye lids, the eye lashes, and soft tissues surrounding the eye.

It is yet another object of the current invention to provide a fluid dispenser that is easy to use.

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Brief Description of the Drawings

FIG. 1a shows a perspective view of a first embodiment of the invention.

FIG. 1b shows a sectional view of a first embodiment of the invention, with the pump head design shown in a rest position.

20 **FIG. 2a** shows an exploded view of some components of the first embodiment of the current invention.

FIG. 2b shows front and side views of a rotor.

FIG. 3a shows a sectional view of the first embodiment of the invention, with the pump head design shown in its first stage of operation.

FIG. 3b shows a sectional view of the first embodiment of the invention, with the pump head design shown in its second stage of operation.

5 **FIG. 4a** shows a sectional view of the first embodiment of the invention, with the pump head design shown in its third stage of operation.

FIG. 4b shows a sectional view of the first embodiment of the invention, with the pump head design shown in its forth stage of operation.

10 **FIG. 5** shows a front view of the rotor control mechanism for the first embodiment of the current invention.

FIG. 6a shows a sectional view of the first embodiment of the invention, with the pump head design shown in its fifth stage of operation – commencement of dosing.

FIG. 6b shows a sectional view of the first embodiment of the invention, with the pump head design shown in its sixth stage of operation –completion of dosing.

15 **FIG. 7a** shows a sectional view of the first embodiment of the current invention, with the pump head design shown in its seventh stage of operation – return of the pump mechanism to a rest position.

20 **FIG. 7b** shows a sectional view of the first embodiment of the current invention, with the pump head design shown in its eighth stage of operation – resetting of the rotor control mechanism.

FIG. 8 shows the first embodiment of the current invention, with the pump head design shown in its ninth stage of operation – fully restored to its rest position.

FIG. 9 shows a sectional view of a second embodiment of the current invention with an alternative pump head design.

FIG. 10 shows a front view of an overcap attached to the indexable fluid dispenser, by means of a screw thread.

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Description of the Preferred Embodiments

The preferred embodiments of the present invention will now be described with reference to the drawings. Identical elements in the various figures are identified, as far as possible, with the same reference numerals. Reference will now be made in detail to embodiments of the present invention. Such embodiments are provided by way of explanation of the present invention, which is not intended to be limited thereto. In fact, those of ordinary skill in the art may appreciate upon reading the present specification and viewing the present drawings that various modifications and variations can be made thereto without deviating from the innovative concepts of the invention.

Figure 1a shows a perspective view of a first embodiment of the indexable fluid dispenser 1, illustrating the general outlook of the device.

Figure 1b shows a sectional view of a first embodiment of the current invention—an indexable fluid dispenser, with the pump head design shown in a rest position. Figure 1b provides an overview for the major components and the functionality of the indexable fluid dispenser 1. Shown in Figure 1b are a dispenser case 100 and a tube 158 residing in the dispenser case 100 and having a tube bore 182, an inlet end 180, and an outlet end 181. The dispenser case 100 forms a framework enclosure that houses the other components of the fluid dispenser 1. The tube 158 is preferably made of compliant materials that are flexible, easy to deform, and with

low stiffness. More particularly, the Durometer of the tube 10 is preferably between 30 and 70 Shore hardness. As shown in Figure 1b, the inlet end 180 is suspended in a holding tank 159, which contains the fluid to be dispensed, the outlet end 181 is connected to an outlet orifice 160 to form the discharge structures of the pump.

5 Also shown in Figure 1b is an optional dropper bottle 105 installed into a holding slot 108 in the dispenser case 100. The dropper bottle 105 and the holding tank 159, in combination, may serve as a reservoir that provides the fluid to be discharged from the fluid dispenser 1. Or the reservoir may only comprise the holding tank 159, without the dropper bottle 105. The dropper bottle contains the fluid to be dispensed. The dropper bottle 105 may be decanted into
10 the holding tank 159, providing supply of the fluid. With the design shown in Figure 1a and 1b, the tube 158 derives the fluid to be dispensed directly from the holding tank 159. Figure 1a illustrates an example of the reservoir design, which may be altered to suit the needs of different fluids and different pump heads.

Here, the term “pump head” refers to the overall design of various components of the
15 indexable fluid dispenser other than the reservoir structures. The pump head is the assembly that draws the fluid from the reservoir and discharges the fluid to a target, such as a human eye. As indicated above, the reservoir design may be altered. Similarly, the pump head design, which is the core of the current invention, may vary according to the fluid to be dispensed, the dose, and the usage of the fluid.

20 The fluid dispenser 1 may be used for various purposes. The preferred use of the fluid dispenser 1 is to deliver eye drops to a human eye. The fluid dispenser 1 may be used in an upright position, or it may be leaned forward to deliver a dose to a person whose eye is directly below the dispenser, as is typical with the use of dropper bottles, and the fluids discharged from

the fluid dispenser 1 may be applied in a trajectory that ends up on a target, such as an eye. The fluid dispensed may be any fluid or liquid. The fluid may be a pharmaceutical formulation, solution, gel, or suspension. The fluid may be delivered to the eye, ear, or any other targets. The viscosity of the fluid to be dispensed may range between 0.5 centipoise and 2000 centipoise, with the preferred range of 0.8 to 30 centipoise.

As shown in Figure 1b, the tube 158 is acted upon by a two rotor lobes 183 of a single contoured rotor 121. The rotor 121 is separated from the tube 158 by an optional band 156 which allows the rotor 121 to slide along the periphery of the tube 158 with reduced friction. The tube 158 is trapped between rotor 121/band 156 and a curved inner surface 116 of deflector 115. Two round guides 104 and one curved guide 112, as shown in Figure 1b, hold band 156 in position. As shown in Figure 3a, during operation band 156 moves, as shown in the direction of Arrow H, rolling against tube 158 which is supported by deflector 115.

The two rotor lobes 183 press against a first pressing point 151 and a second pressing point 152, defining the segment of the tube 158 between the first pressing point 151 and second pressing point 152 as a dosing section 185 that houses a dosing chamber 155, the dosing chamber 155 containing the fluid to be dispensed. In a dosing operation, the rotor 121 moves incrementally in the direction of arrow 'R' as shown in Figure 1b. The rotation of the rotor 121 drives the fluid in the dosing chamber 155 forward from the first pressing point 151, while rotor lobe 183 in contact with second pressing point 152 rotates away from its contact with tube 158 at the second pressing point 152, allowing a discharge of fluid from the outlet orifice 160 via outlet end 181.

The rotation of the rotor 121 is driven by a rotor control mechanism. The rotor control mechanism may be any mechanism that manages angular rotation of the rotor. As shown in

Figure 1b, the rotor control mechanism may comprise a push button 150 on top of the dispenser case 100. In addition, the rotor control mechanism may include a first spring member 125 and a cantilever 130, both the first spring member 125 and the cantilever 130 being attached to the push button 150 and positioned beneath the push button 150.

5 The indexable fluid dispenser 1 is suitable for discharging a single dose of fluid in each dosing process. The dose discharged in each dosing process may vary according to a variety of factors such as but not limited to the dimension of the tube bore and the distance between the first pressing point 151 and second pressing point 152. Preferably, the dose is between 1 to 100 micro-liters, with the preferred dose to range approximately 5 to 50 micro-liters. Moreover, the
10 indexable fluid dispenser 1 may be scaled up for use in larger discharges such as a water pump. In that case, the dose may be as large as 100 liters. Preferably, with each dosing process, a single dose of the fluid is discharged from the fluid dispenser 1. In addition, the fluid dispenser is capable of delivering a series of doses of the fluid with repetitive dosing processes.

 The fluid dispenser 1 may be made from any materials that suit the requirements to allow
15 the fluid dispenser 1 to operate properly. The dispenser case 100, which forms a framework enclosure that houses the other components of the fluid dispenser 1, may be made from materials that include but are not limited to metal, wood, and plastics such as but not limited to, polyethylene terephthalate (PET), polyethylene (PE), high-density polyethylene (HDPE), polyvinyl chloride (PVC), polyvinylidene chloride (PVDC), low-density polyethylene (LDPE),
20 polypropylene (PP), polystyrene (PS), high impact polystyrene (HIPS) and polycarbonate (PC), or paperboard coated with a suitable waterproof coating such as, but not limited to, polyethylene, or some combination thereof. The preferred materials for the dispenser case 100 are plastics, including but not limited to: acrylics, co-polymers, polypropylene, and most other families of

plastic resin. Similarly, the various components of the fluid dispenser 1 may be made from the same or different materials as the dispenser case 10. Some components may have special requirements as to the property of the materials. For example, the rotor 121 may be made from aluminum or Medium Density Fiber Board (MDF) and the band 156 may be made from a thin flexible plastic, such as cellophane.

Figure 2a shows an exploded view of some components of the first embodiment of the indexable fluid dispenser 1. For clarity purposes, some of the elements shown in Figures 1a and 1b, such as the push button 150, are not illustrated in Figure 2a.

Shown in Figure 2b is the rotor 121 in both a side view and a front view. The rotor 121 here has six rotor lobes 183 evenly distributed on the periphery of the rotor 121. The specific shape of the rotor lobes 183 may vary. For the six lobe rotor format, the indexation angle—the angle separating each two adjacent lobes—is 60 degrees. However, it should be noted that the number of lobes may vary from two to seventy-two. The preferred lobe numbers are three, four, and six. For a three-lobe rotor, the indexation angle is 120 degrees; for a four-lobe rotor, the angle is 90 degrees. As shown in Figure 2b, the rotor 121 has a hole in the middle hole 122, which may be engaged with an axle 111 separately shown in Figure 2a. Preferably, the axle 111 is attached to the dispenser case 100. The rotor 121 may rotate around the axle 111. The rotor blocks 124 attach to the rotor lobes 183 and are evenly distributed. From a side view, as shown in Figure 2b, the rotor blocks 124 protrude out of the rotor lobes 183.

Also shown in Figure 2a is the cantilever 130 illustrated in the upper and lower left panels. The cantilever 130 has a rounded cantilever end 131 that connects to push button 150, referring to Figure 1a. Such a structure dictates that the cantilever 130 may move vertically with the push button 150 and allows the cantilever 130 to articulate in a certain range in its connection

with the push button 150. Attached to the lower portion of the cantilever 130 is a release block 135. The release block 135 is a tapered piece with one side tilting upwards, as shown in Figure 2a.

Also shown in Figure 2a is the first spring member 125 having a top round connector 127
5 and a rounded trunnion 129 horizontally positioned and attached to the bottom of the spring member 125. The top round connector 127 allows the first spring member 125 to articulate in a certain range in its connection with the push button 150. Adjacent to the trunnion 129 and attached to the first spring member 125 is a trunnion pin 128. The trunnion pin 128 is also horizontally positioned. Figure 2a shows a sunken track 118 set in the inside of the dispenser
10 casing. The sunken track 118 is a substantially vertically placed piece having an inside track that is curved. In operation, the trunnion pin 128 is inserted into the sunken track 118 and is constrained to move within the sunken track 118 during dosing operation.

Also shown in Figure 2a is a tenon block 117, which is mounted to the inside of the dispenser case 100 by strut 161. The tenon block 117 slides within a slot 133 in the free end of
15 cantilever 130. Tenon block 117 provides sliding support for the free end of cantilever 130 via slot 133.

Figure 2a also shows ratchet 119 having ratchet pin 132. The ratchet 119 is shown in a generally upright position with the capability of moving sideways under the action of ratchet pin 132 striking release block 135. The ratchet pin 132 is horizontally placed and attaches to the top
20 of the ratchet 119. The structure of ratchet 119 is illustrated in more detail in Figure 5. The main function of ratchet 119 is to restrict rotation of the rotor 121 by restricting the movement of the rotor blocks 124.

Also shown in Figure 2a is the deflector 115 having a curved inner surface 116 curved guide 112, and guide block 113, wherein the guide block 113 serves to act as a sliding guide to cantilever 130 thus maintaining the cantilever 130 in a vertical position.

Figure 3a shows a sectional view of the first embodiment of the invention, with the pump head design shown in its first stage of operation. In addition, the left panel of Figure 3a provides a detailed illustration of part of a rotor control mechanism. Shown in Figure 3a are the dispenser case 100, push button 150, the first spring member 125 connected to the push button 150 with a rounded spring member end 127, the cantilever 130 connected to the push button 150 with a rounded cantilever end 131, the rotor 121 having rotor lobes 183, wherein two rotor lobes 183 press against the tube 158 at first pressing point 151 and second pressing point 152, sequestering a segment of the tube 158 as the dosing section 185 that houses a dosing chamber 155.

Figure 3b shows a sectional view of the first embodiment of the invention, with the pump head design shown in its second stage of operation, illustrating that the push button 150 is hinged from dispenser case 100 at hinge point 157. In addition, Figure 3b also shows the leaf spring 154 with one end attached to the push button 150 and the other end positioned on top of the deflector 115. Figure 3a provides a detailed illustration of the structures controlling the dosing process, including the cantilever 130 with the release block 135, the ratchet 119 having a ratchet pin 132, the trunnion 129 and the trunnion pin 128.

Figures 4a and 4b show a sectional view of the first embodiment of the indexable fluid dispenser, with the pump head design shown in Figure 4a its third stage of operation and in Figure 4b in its forth stage of operation. Shown in Figure 4 are essentially the same elements as in Figure 3. Marked in Figure 4a are the push button 150, the first spring member 125, the ratchet 119 having ratchet pin 132, and the release block 135. The dotted circle in Figure 4a

refers to several structures serving as a rotor control mechanism, the details of which are shown in Figure 5.

Figure 5 shows a front view of a rotor control mechanism for the first embodiment of the indexable fluid dispenser. Shown in Figure 5 are the cantilever 130 with the release block 135, the ratchet 119 having a ratchet pin 132 and a ratchet projection 136 positioned below a rotor block 124, the tenon block 117 providing sliding guidance to the cantilever 130 via slot 133, the rotor lobes 183, the sunken track 118, and the trunnion 129 positioned over a rotor block 124 at point 138. Figure 5 shows that the front view of the rotor block 124 is not a complete round shape. Each rotor block 124 has a flat surface 123, wherein one of the rotor blocks 124 is positioned against the ratchet projection 136 with the flat surface 123 engaged with ratchet face 137 on ratchet projection 136.

Figures 6a and 6b show sections of the first embodiment of the indexable fluid dispenser, with the pump head design shown in its fifth stage of operation in Figure 6a and its sixth stage of operation in Figure 6b, these figures showing the commencement and completion of dosing. Shown in Figures 6a and 6b are essentially the same elements as in Figures 3a and 3b. Marked in Figures 6a and 6b are the push button 150, the first spring member 125, the ratchet 119, the cantilever 130, the sunken track 118, and the discharged fluid 189.

Figures 7a and 7b shows a sectional view of the first embodiment of the indexable fluid dispenser, with the pump head design shown in its seventh stage of operation in Figure 7a and eighth stage of operation in Figure 7b. These Figures showing the return of the pump mechanism to its 'rest' position, and resetting of the rotor control mechanism. Shown in Figures 7a and 7b are essentially the same elements as in Figures 3a and 3b. Marked in Figures 7a and 7b are the push button 150, the first spring member 125, the ratchet 119 having ratchet pin 132,

the cantilever 130, the release block 135, the trunnion 129, the trunnion pin 128, the rotor block 124, and the sunken track 118. The dotted circle in Figure 7a refers to several structures serving as a rotor controlling mechanism, the details of which are shown in the left panel of Figure 7a.

Figure 8 shows the first embodiment of the indexable fluid dispenser, with the pump head design shown in its ninth stage of operation – fully restored to its rest position. Shown in Figure 8 are essentially the same elements as in Figure 3. Marked in Figure 8 are the dispenser case 100, the push button 150, the cantilever 130, and the ratchet 119.

It should be noted that not all elements are marked in any one particular figure. Therefore, a discussion of the dosing process may require reference to more than one figure for the detailed markings. In particular, Figures 2a and 2b and 5 serve to provide useful reference as to the positioning and movement of the various components.

Referring to Figure 3a, pressing the push button 150 starts the dosing operation and departs from the rest position shown in stage 1. The downward movement of the push button 150 through a set distance compresses the top of the first spring member 125 through an operating distance. This operating distance is absorbed by the first spring member 125 by compressing its height. The trunnion 129 is attached to the bottom of the first spring member 125, as shown in Figure 1a, and engages a rotor block 124 at point 138, as shown in Figure 45. At the rest position and initiation phase as shown in stage 1 and 2 in Figures 3a and 3b, rotor 121 is unable to move due to the next rotor block 124 (counter clockwise to the rotor block 124 engaging the trunnion block 129) being obstructed by ratchet projection 136 on ratchet 119. The compression built up in the spring member 125 is sufficient to provide the rotor block 124 a stroke sufficient to index that rotor block 124 into the position held by the next (counter clockwise) rotor block 124 (once the ratchet projection 136 is deflected at a later point in the

operating process). The rotor 121 then moves forward and rotate in direction R as shown in Figure 1a. As the rotor 121 rotates, the dosing chamber 155 is dragged in the direction of rotation – simultaneously pushing any fluid ahead of the dosing chamber 155 (beyond the second pressing point 152) toward the outlet orifice 160. Referring to Figures 3b,4a and 4b, the pressing of the push button 150 also results in the bending of the leaf spring 154 and the downward movement of the cantilever 130. Though the tripping mechanism is still in place, the compression of the first spring member 150 provides the force to overcome it.

Referring to Figures 3a, 3b, 4a and 4b, and 5, several structures control the rotation of the rotor 121. These parts are positioned adjacent to the rotor 121, such that ratchet 119 restricts rotation of the rotor 121 by constricting the rotor blocks 124. Pressing the push button 150 causes the cantilever 130 to move downward vertically while simultaneously compressing spring member 125 in order to accumulate the force required to rotate rotor 121. Ratchet pin 132 is aligned to vertical sliding surface 134. As the first spring member 125 and the cantilever 130 move downward (under the action of push button 150), sliding surface 134 also moves downward relative to ratchet pin 132.

Referring to Figures 5, 6a and 6b, at the required trigger point, lower surface 140 of release block 135 comes into contact with ratchet pin 132 and, with support provided to cantilever 130 by the tenon 117 in slot 133 (as shown in Figures 5 and 7a), release block 135 pushes ratchet pin 132 away – thus bending the ratchet 119. As ratchet 119 bends, the ratchet projection 136 is no longer capable of blocking the rotor block 124, as shown in Figure 5. The disengagement of the ratchet projection 136 with the flat surface 123 of the rotor block 124 allows the rotor 121 to rotate counter-clockwise in the direction of Arrow J under the compressed spring force already built up in the first spring member 125, as shown in Figure 6a.

The rotor 121 may quickly revolve, under the action of compressed first spring member 125, to the point where the next rotor block 124, originally engaged with trunnion 129 (as shown in Figure 5), is arrested by the ratchet projection 136 on the ratchet 119. By this time, the second flat surface 123 is engaged with the ratchet projection 136 of the ratchet 119. Referring to Figure 5 6b, the angular rotation of the rotor allows the rotor to drive a dose of fluid 189 from the outlet orifice 160, with the released volume being a function of the volume of liquid displaced in dosing chamber 155. Having moved the rotor through one dispensing cycle (60 degrees – for a 6 lobed rotor), the whole rotor control mechanism starts to return to its rest position - ready to resist the downward motion of the push button 150 for the next dosing cycle.

10 As shown in Figures 5 and Figure 7a, once release block 135 has driven ratchet pin 132 aside to permit dosing, the compression in the first spring member 125 is released and the leaf spring 154 (as marked in Figure 3a) starts to drive the push button 150 upwards. The cantilever 130 also starts moving upwards along with push button 150, allowing the ratchet pin 132 to come into contact with the upper surface 139 (as marked in Figure 5) of the release block 135. 15 Consequently, ratchet 119 deflects cantilever 130 to the left, as illustrated in the left panel of Figure 7a. With reference to Figures 7a, 7b and 5, push button 150 and first spring member 125 are moving upward. During this return, upper surface of trunnion 129 deflects around rotor block 124 is ,as shown in Figure 7b, ready to be repositioned above rotor block 124, as shown in Figure 8. Such a movement is possible partly due to the curved sunken track 118, which serves 20 to guide the trunnion pin 128. Re-engagement of the trunnion 129 with the rotor block 124 indicates that the fluid dispenser is ready for the next dosing operation, as shown in Figure 8. Upon return of the push button 150, the cantilever 130 and the first spring member 125 also

return to their rest position. As shown in Figure 8 stage 9, the rotor controlling mechanism and push button 150 have returned fully to their rest positions.

Figure 9 shows a sectional view of a second embodiment of the indexable fluid dispenser with an alternative pump head design. Shown in Figure 9 is a rotor 170 having a number of
5 rollers 171, with each roller being located by an axle 172. The rotor 170 has a central axle 177 around which the rotor 170 rotates. The rollers 171 are evenly distributed around the periphery of the rotor 170 and the number of rollers 171 may range from 2 to 72, with the preferred number to be 3, 4 and 6. This design may function under the control of the same triggering mechanism and rotor control mechanism as shown in the design illustrated in Figures 1 to 8. For clarity
10 purposes, the other structures are not shown in Figure 9.

The rotor design in Figure 9 reduces the need to use a band 156 (as shown in Figure 1a) to reduce frictional forces between the rotor and tube. Instead, rollers 171 freely rotate about axles 172 to reduce frictional drag between the rollers 171 and the tube 158. In terms of function, the rollers 171 and the rotor lobes 183 (as shown in Figure 1a) are all pressing members
15 that act on the tube to sequester the dosing section and drive the fluid toward the outlet orifice.

In addition, Figure 9 shows an alternative reservoir design. Here no dropper bottle is attached to the fluid dispenser. A holding tank 178 integral to the dispenser case serves to provide the liquid to be dispensed. Such a design may be altered in many ways and may be used with different pump heads.

20 Figure 10 shows a front view of an overcap attached to the indexable fluid dispenser. Shown in Figure 10 is an overcap 231 covering the upper portion of the dispenser case 100. Here in Figure 10, the overcap 231 is screwed to the dispenser case 100 by means of screw

thread 230. Alternatively, the overcap 231 may be attached to the dispenser case 100 by a snap-on design.

Although this invention has been described with a certain degree of particularity, it is to be understood that the present disclosure has been made only by way of illustration and that
5 numerous changes in the details of construction and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention.

Claims

What is claimed is:

Claim 1: A fluid dispenser for administrating a fluid, comprising:

- 5 a dispenser case;
- a reservoir capable of holding a plurality of doses of a fluid;
- a tube, made from compliant materials, enclosed in the dispenser case, the tube having an inlet end and an outlet end, the inlet end being disposed in the reservoir, the outlet end being fluidly connected to an outlet orifice, and the tube has a first pressing
- 10 point and a second pressing point;
- a central axle disposed in the dispenser case;
- a rotor having a plurality of pressing members evenly distributed around the central axle, the pressing members being capable of rotating around the central axle;
- wherein two of the pressing members act upon the first pressing point and the
- 15 second pressing point respectively,
- wherein a segment of the tube between the first pressing point and the second pressing point is a dosing section housing a dosing chamber, suitable for containing a dose of fluid;
- and a rotor control mechanism,
- 20 wherein the rotor control mechanism is capable of driving an angular rotation of the rotor,
- wherein each angular rotation causes the pressing members to compel a dose of fluid in the dosing chamber out toward the outlet orifice.

Claim 2: The fluid dispenser of claim 1, wherein
the pressing members are rotor lobes.

5

Claim 3: The fluid dispenser of claim 2, wherein there are six rotor lobes.

Claim 4: The fluid dispenser of claim 1, wherein the rotor control mechanism comprises a push
button disposed on top of the dispenser case and a first spring member attached to a lower part of
the push button.

10

Claim 5: The fluid dispenser of claim 4, wherein
the pressing members are rotor lobes,

there are a plurality of rotor blocks, each rotor block being attached to a rotor lobe;

15

Claim 6: The fluid dispenser of claims 4-5, wherein

the rotor control mechanism further comprises a trunnion attached to a bottom of the first
spring member,

wherein the trunnion is horizontally positioned and disposed above a rotor block.

20

Claim 7: The fluid dispenser of claims 4-6, wherein

the rotor control mechanism further comprises a ratchet,
the ratchet has a ratchet projection and a ratchet pin,

and the ratchet projection sits against a rotor block and prevents rotation of the rotor block.

Claim 8: The fluid dispenser of claims 4-7, wherein

5 the rotor control mechanism further comprises a sunken track substantially vertically positioned in the dispenser case and a first spring member pin attached to a bottom of the first spring member,
the first spring member pin is inserted into the sunken track and is restricted to move along the sunken track.

10

Claim 9: The fluid dispenser of claims 4-8, wherein

the rotor control mechanism further comprises a cantilever attached to the push button and a release block attached to the cantilever.

15 Claim 10: The fluid dispenser of claims 4-9, wherein

the rotor control mechanism further comprises a leaf spring attached to the push button, the leaf spring bearing upon a deflector attached to the dispenser case.

Claim 11: The fluid dispenser of claims 4-10, wherein

20 the rotor control mechanism further comprises a tenon block attached to the dispenser case, wherein
the tenon block engages a sliding slot, the sliding slot providing sliding support and guidance to the cantilever.

Claim 12: The fluid dispenser of claim 4-11, wherein pressing the push button results in compression of the first spring member and bending of the leaf spring.

- 5 Claim 13: The fluid dispenser of claim 4-11, wherein pressing the push button causes the downward movement of the cantilever, wherein
- the release block presses against the ratchet pin, pushing the ratchet aside and causing the disengagement between the ratchet projection and the rotor block ~~stuck~~ in contact with the ratchet projection, thereby releasing the rotor.

10

Claim 14: The fluid dispenser of claim 13, wherein

pressing the push button results in compression of the first spring member and bending of the leaf spring,

the compression of the first spring member drives the trunnion to compel the rotor block

- 15 that is in contact with the trunnion to move downward, resulting in rotation of the rotor.

Claim 15: The fluid dispenser of claim 13-14, wherein

the rotation of rotor is stopped when the ratchet returns to an upright stance and the ratchet projection resists a rotor block.

20

Claim 16: The fluid dispenser of claim 13-15, wherein

the bent leaf spring forces the push button to move upward, resulting in upward movement of the cantilever.

Claim 17: The fluid dispenser of claim 2, further comprising
a band trapped between the rotor and the tube,
and the band reduces friction between the rotor and the tube.

5

Claim 18: The fluid dispenser of claim 17, wherein the band is thin and flexible.

Claim 19: The fluid dispenser of claim 1, wherein the pressing members are rollers.

10 Claim 20: The fluid dispenser of claim 19, wherein there are six rollers.

Claim 21: The fluid dispenser of claims 1-20, wherein the fluid is a pharmaceutical formulation,
solution, gel, or suspension, suitable for delivery to the eye.

15 Claim 22: The fluid dispenser of claims 1-21, wherein the dose has a volume of 1 to 100 micro-
liters.

Claim 23: The fluid dispenser of claims 1-22, wherein the fluid has a viscosity and the viscosity
is in a range between 0.5 centi-poise and 2000 centi-poise.

20

Claim 24: The fluid dispenser of claim 1, wherein
the reservoir comprises a dropper bottle attached to the dispenser case,
the dropper bottle contains a plurality of the doses of the fluid,

and the inlet end of the tube connects to the fluid contained in the dropper bottle.

Claim 25: The fluid dispenser of claim 1, wherein the reservoir comprises a holding tank integral to the dispenser case and the holding tank contains a plurality of the doses of the fluid.

5

Claim 26: The fluid dispenser of claim 25, wherein the reservoir further comprises a dropper bottle attached to the dispenser case, the dropper bottle being capable of decanting the fluid into the holding tank.

10 Claim 27: The fluid dispenser of claims 1-26, further comprising a screw-on outer cap covering the top of the dispenser case.

Claim 28: The fluid dispenser of claims 1-27, wherein all the elements are made from non-metallic materials.

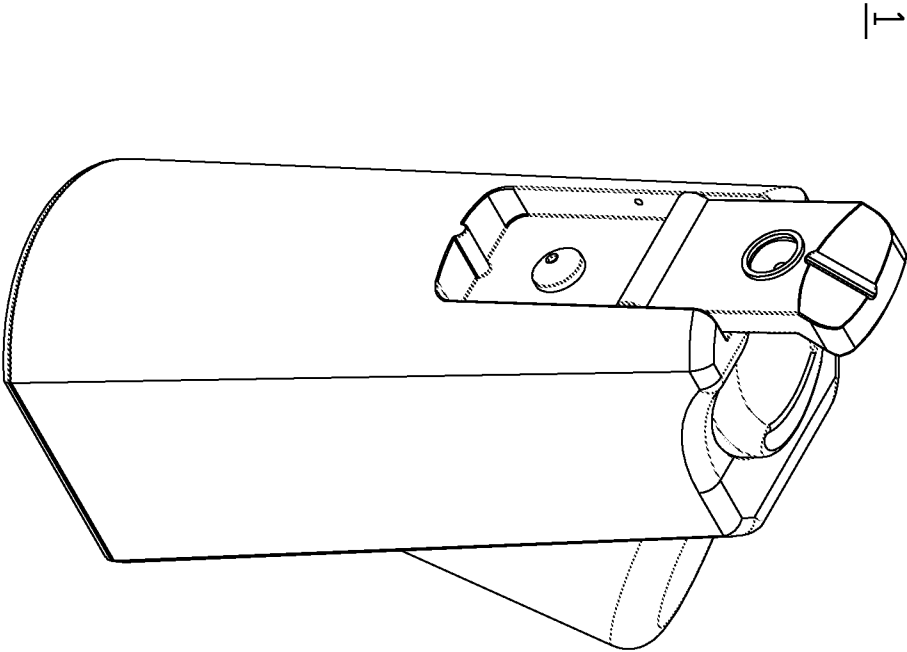
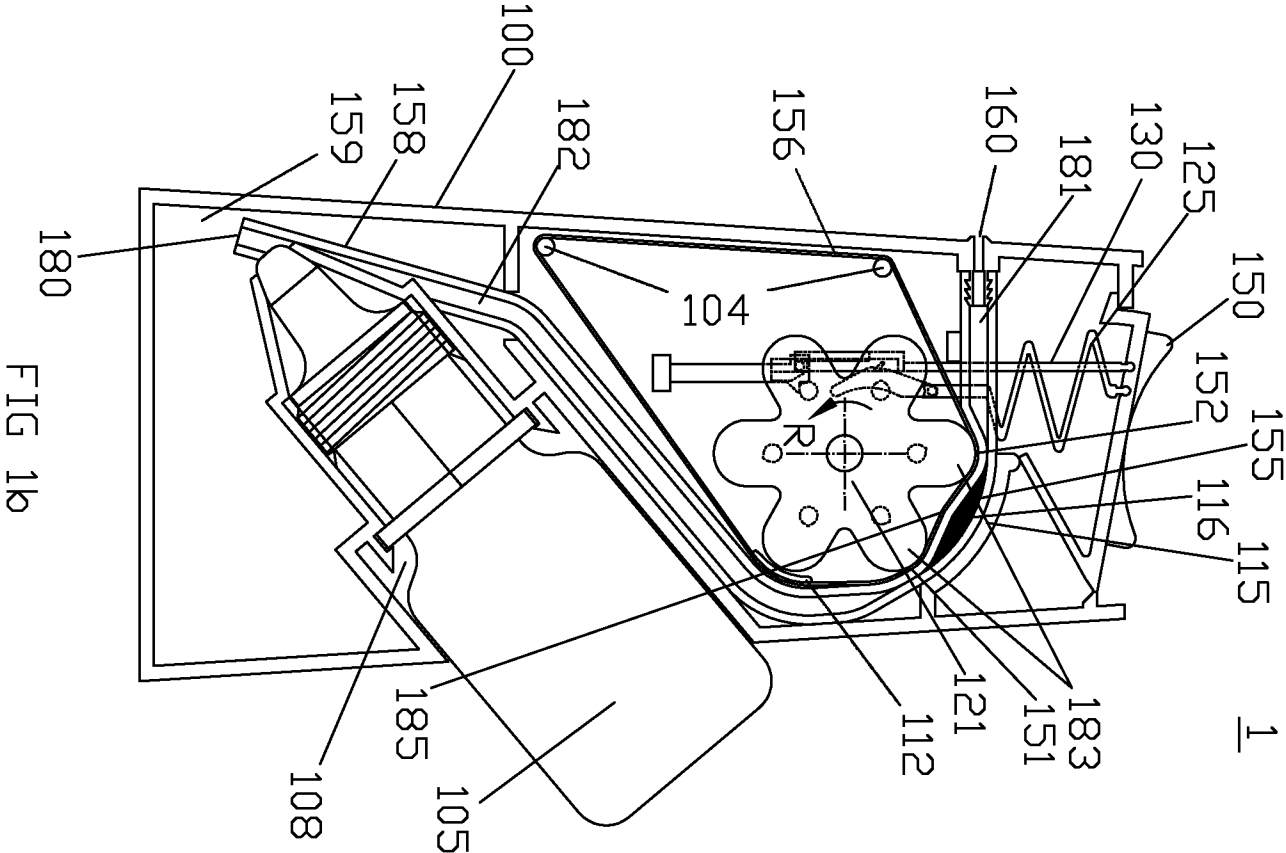
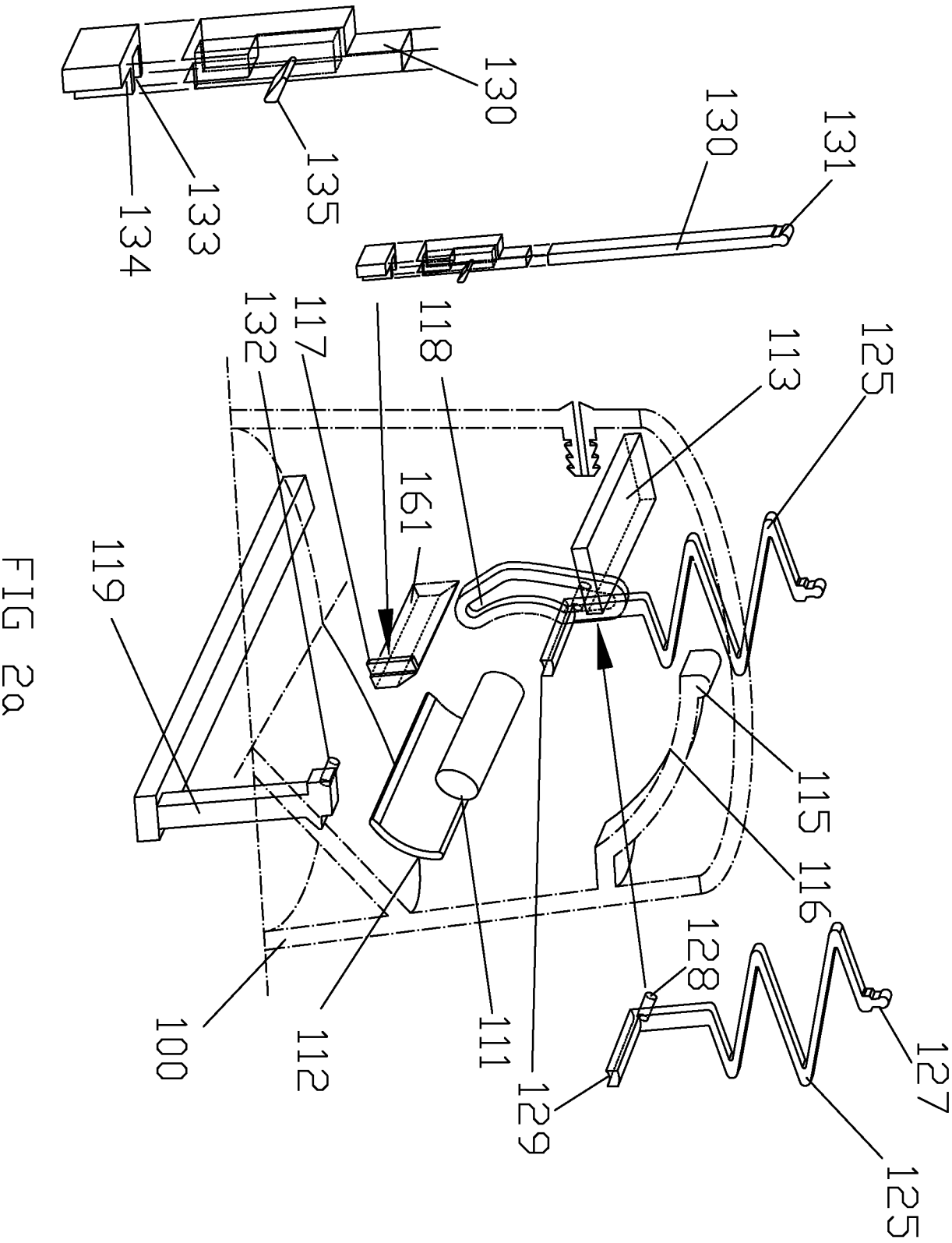


FIG 1a





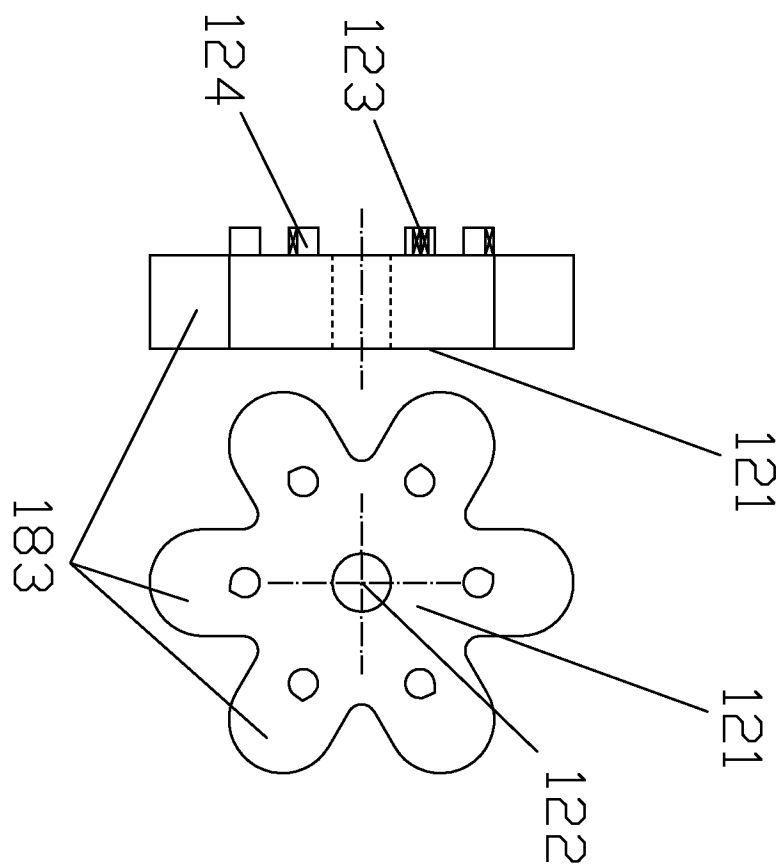
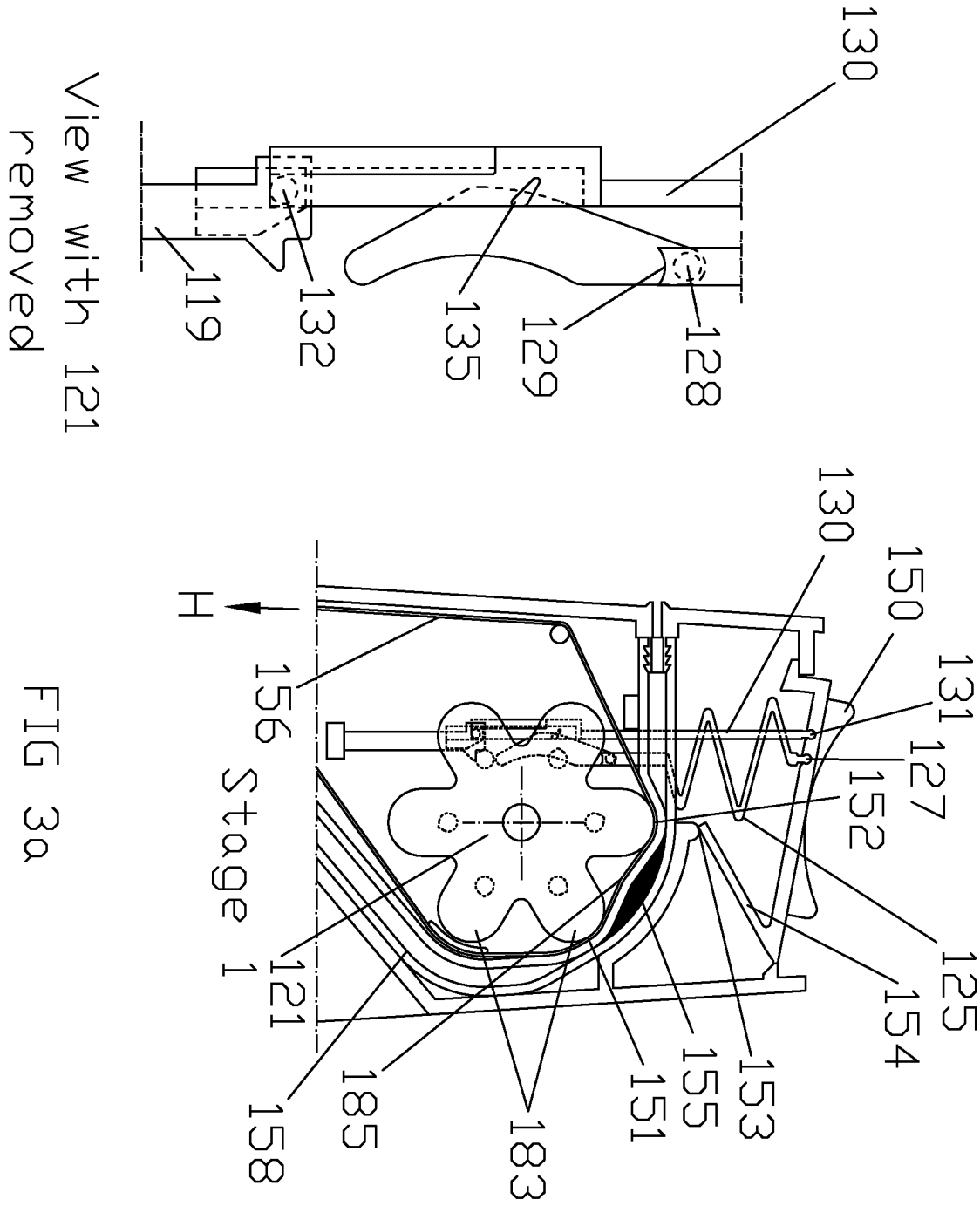


FIG 2b



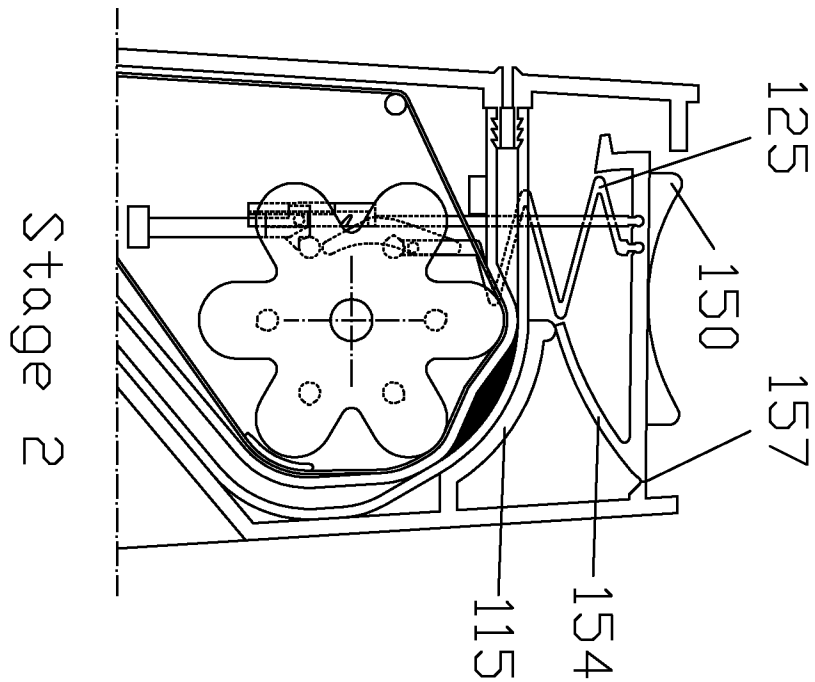
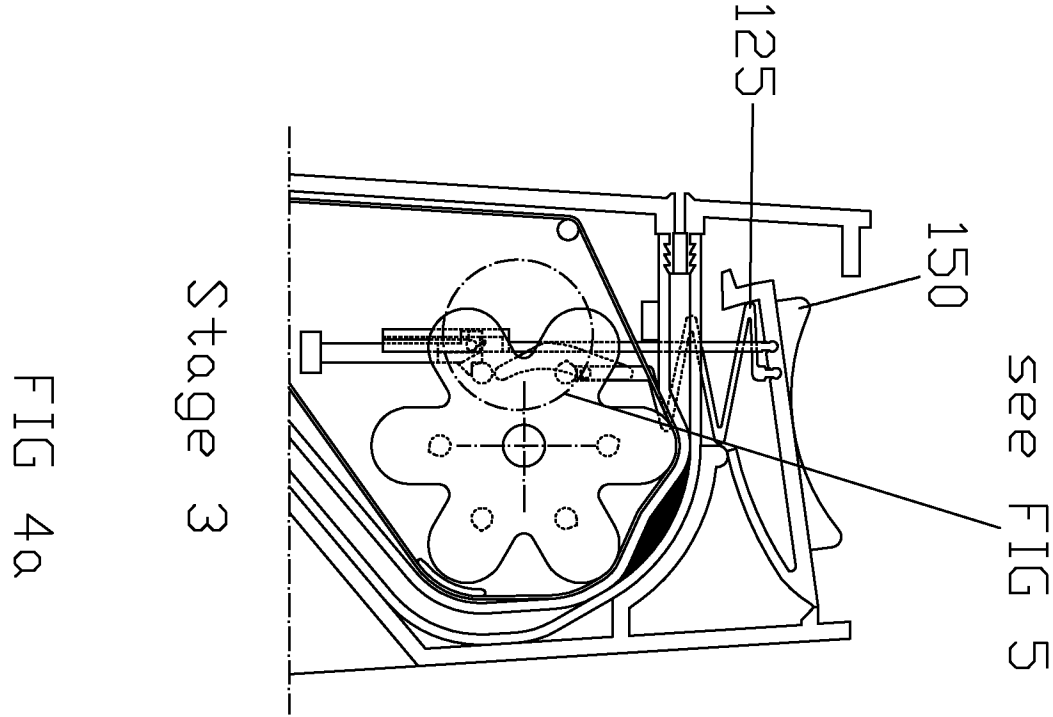


FIG 3b



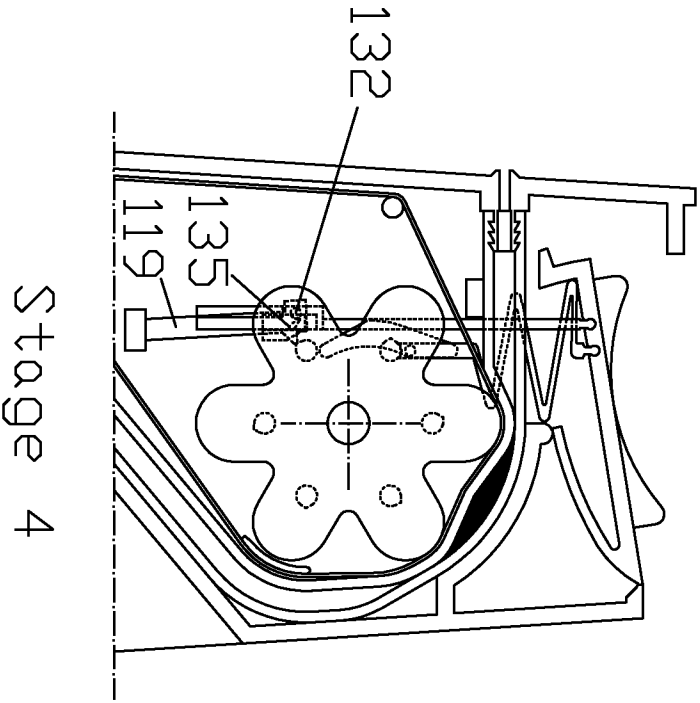


FIG 4b

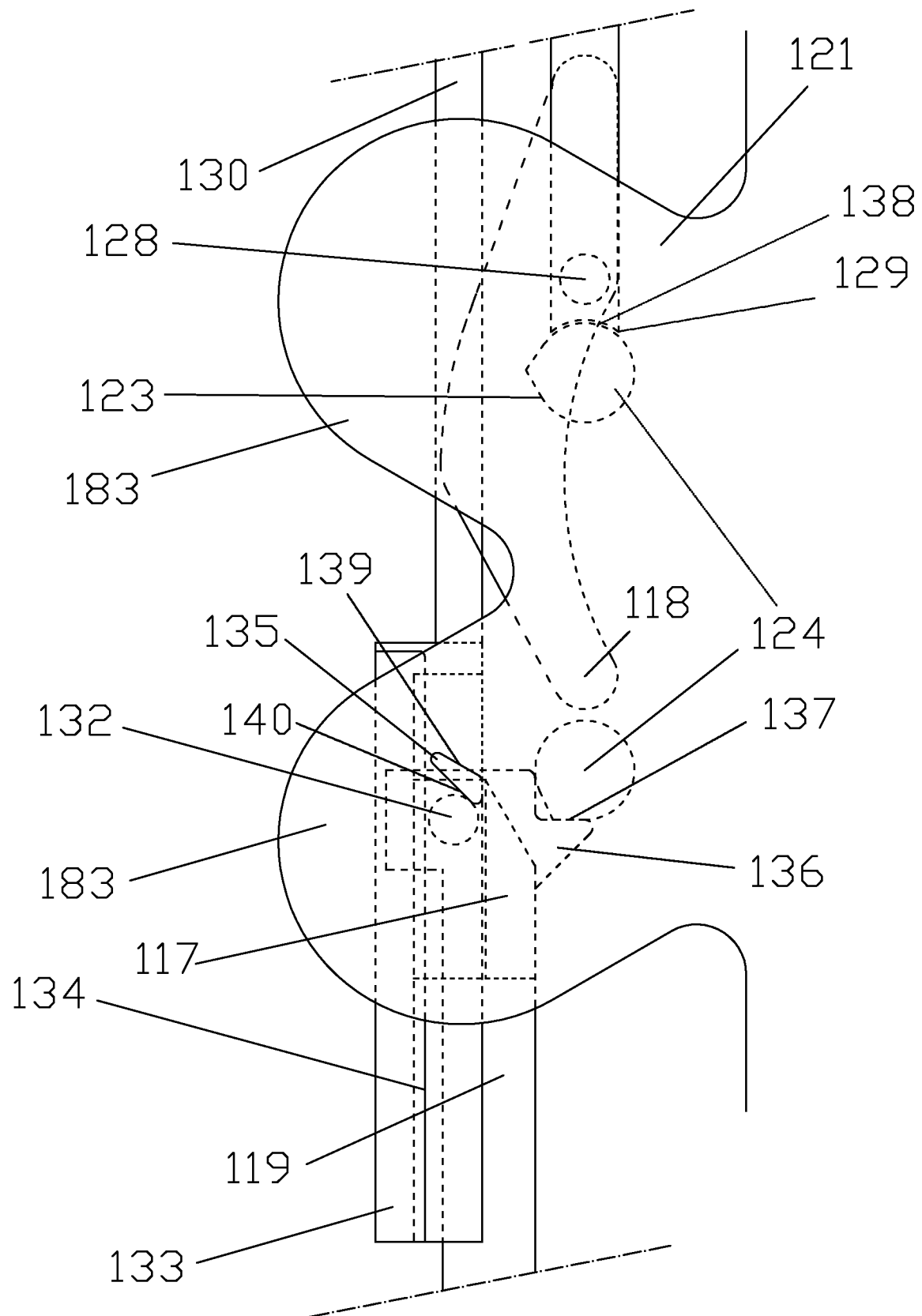
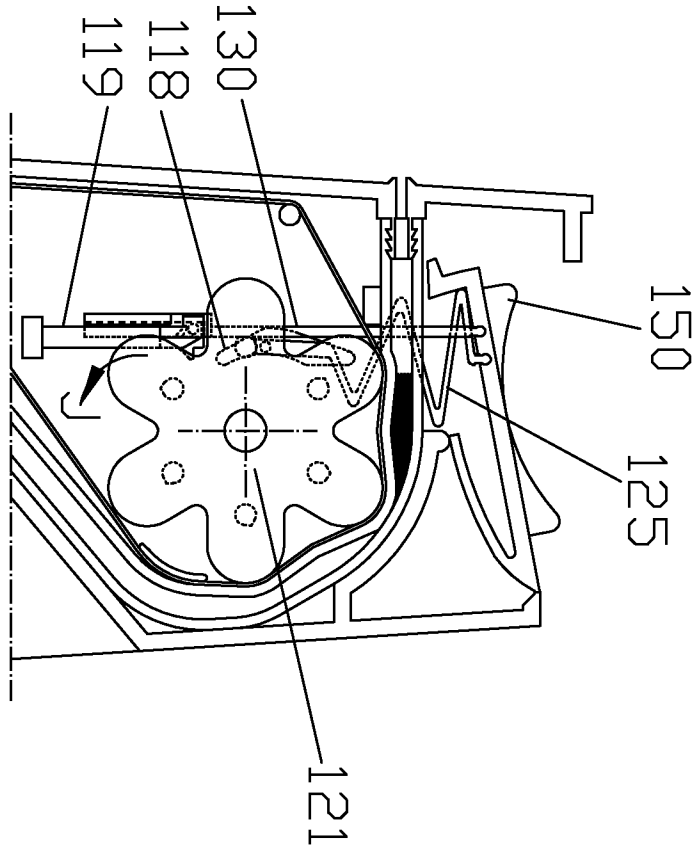


FIG 5



Stage 5

FIG 6a

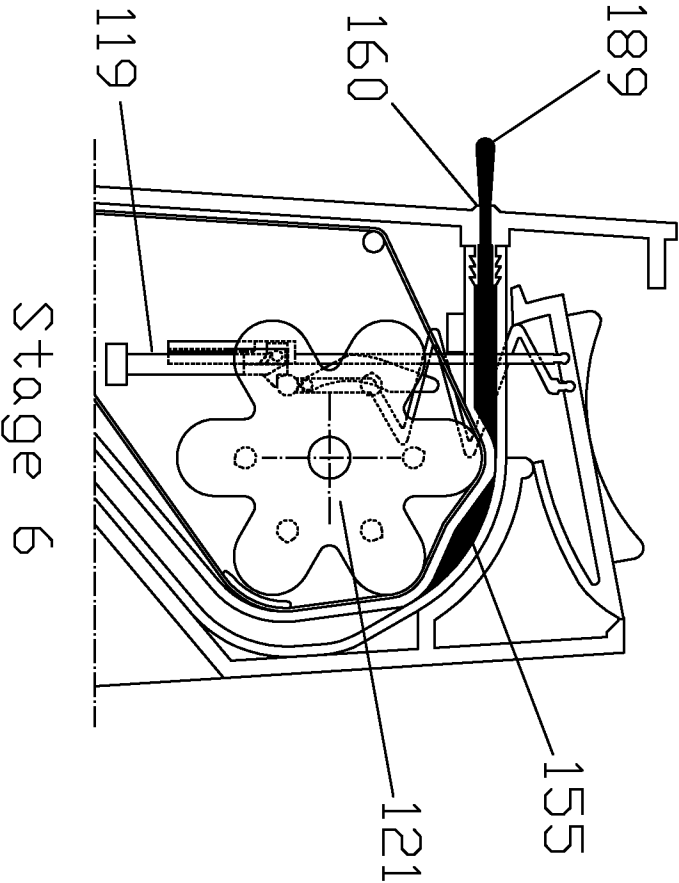


FIG 6b

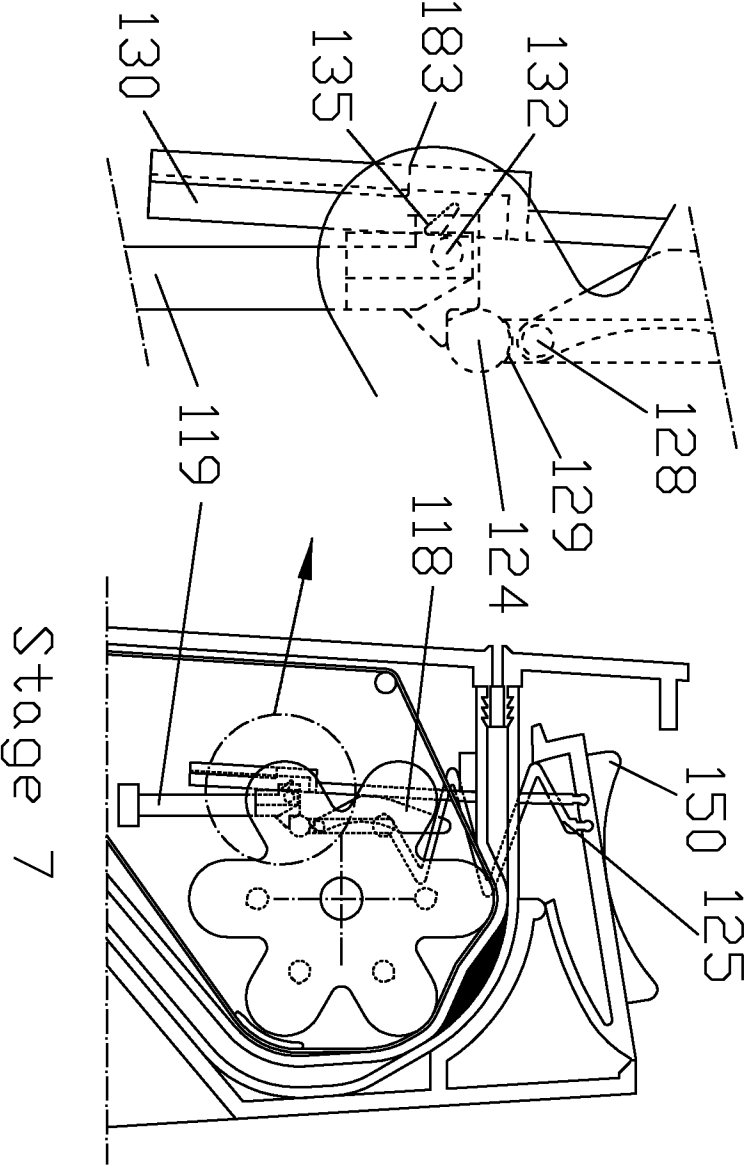
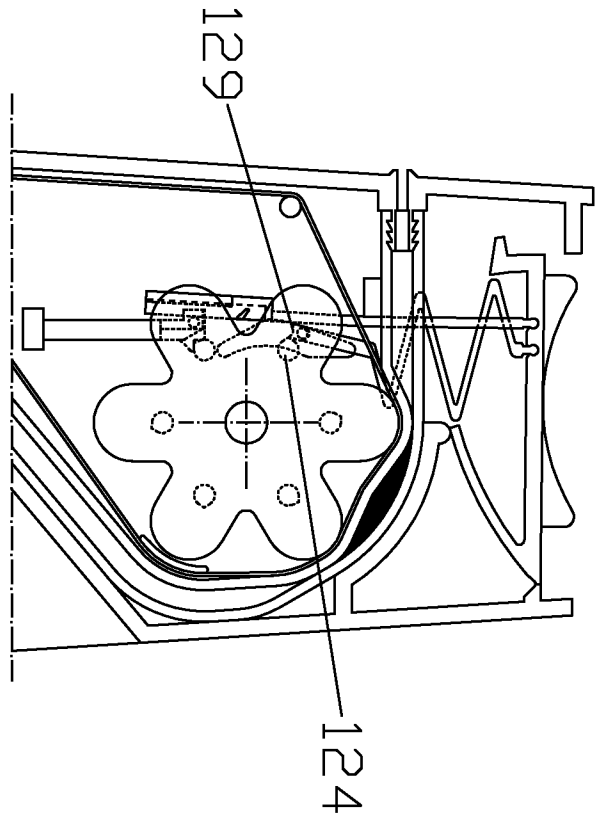
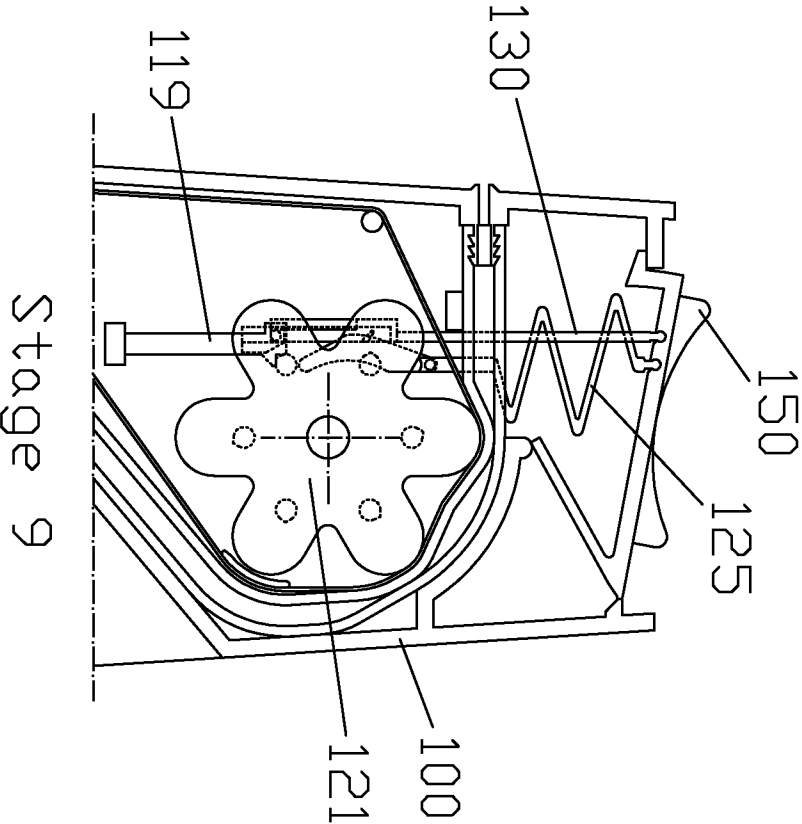


FIG 7a



Stage 8
FIG 7b



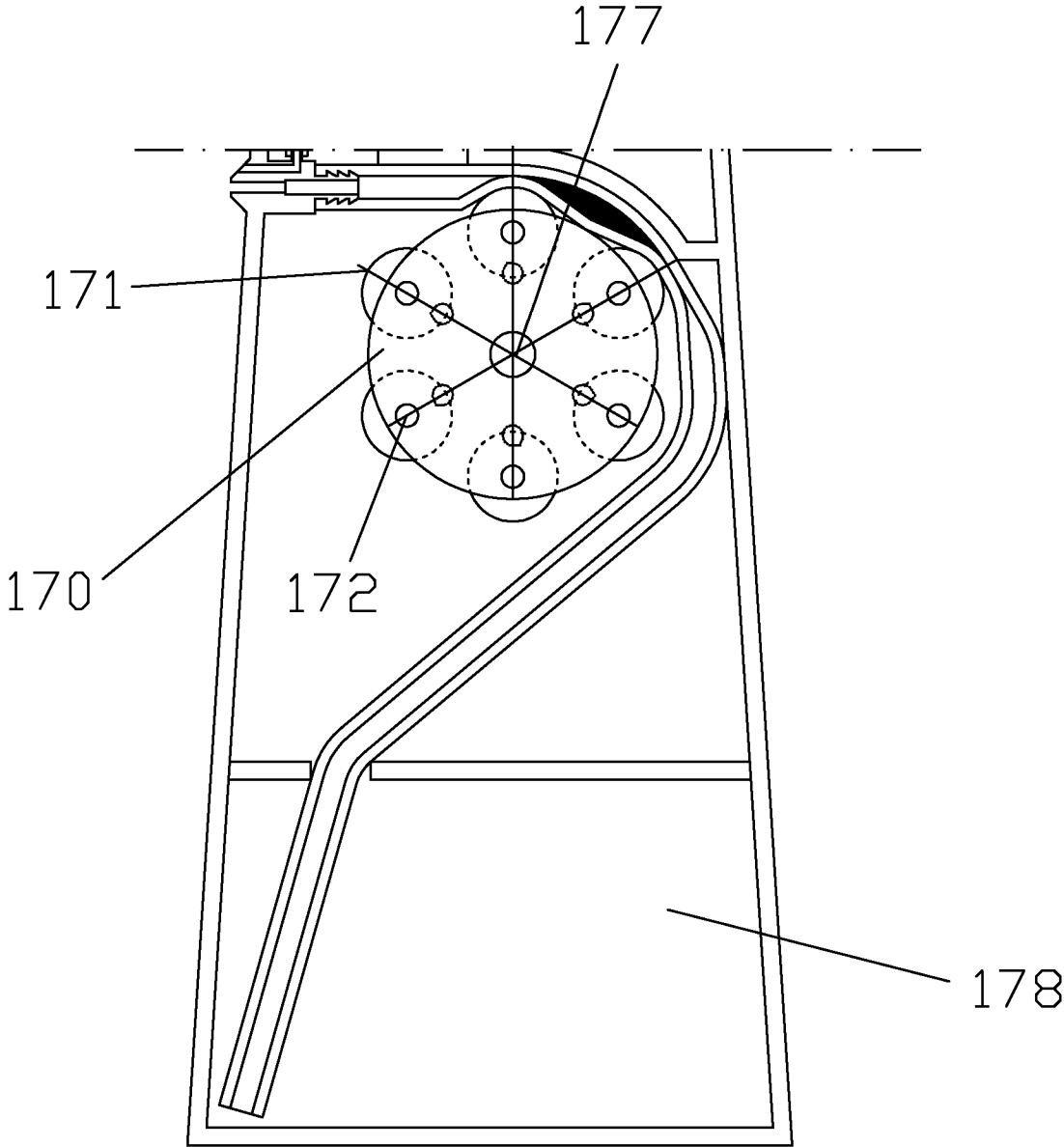


FIG 9

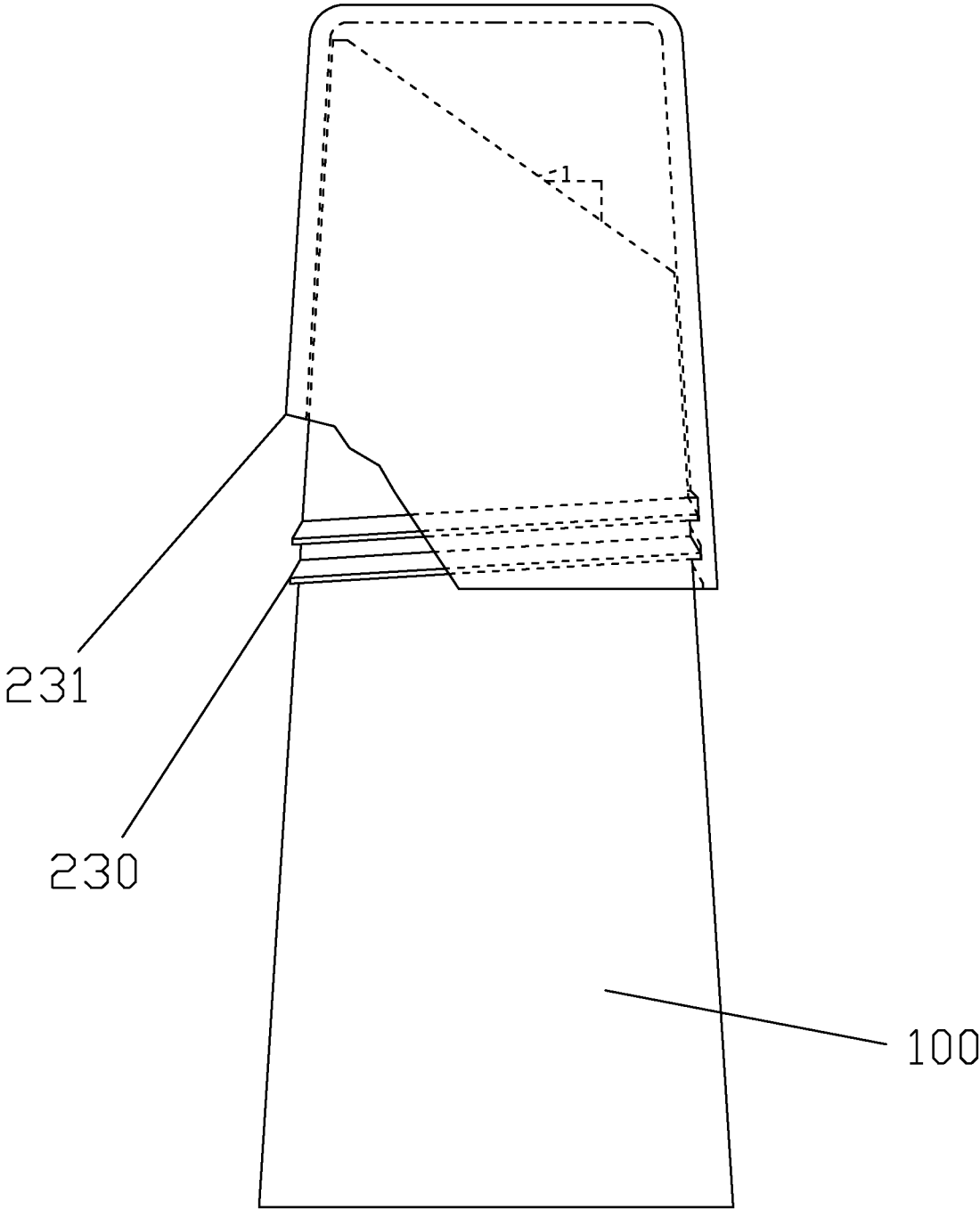


FIG 10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2012/038560

A. CLASSIFICATION OF SUBJECT MATTER		G01F 11/10 (2006.01) A61M 35/00 (2006.01) A61F 9/00 (2006.01)																					
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)																							
G01F 11/00, 11/10, 11/28, 13/00, A61F 9/00, A61M 11/00, 35/00, B65D 47/18, F01B 43/12																							
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)																							
PatSearch (RUPTO internal), Esp@cenet, PAJ, USPTO																							
C. DOCUMENTS CONSIDERED TO BE RELEVANT																							
Category*	Citation of document, with indication, where appropriate, of the relevant passages		Relevant to claim No.																				
Y	US 2009/0212133 A1 (JAMES F. COLLINS, JR.) 27.08.2009, par. [0109], [0110], [0137]-[0142], [0154]-[0157], [0164], [0183], [0184], [0200], [0334], [0335], fig. 1-3, 11, 30, 31		1, 19-28																				
A			2-18																				
Y	RU 2001309 C1 (NAUCHNO-TEKHNICHESKY KOOOPERATIV "KONTUR") 15.10.1993, col. 3, lines 8-9, col. 4, lines 1-13, col. 5, lines 4-12, col. 6, lines 17-20, 50-55, fig. 1		1, 19-28																				
Y	US 2007/0179457 A1 (WILLET F. WHITMORE et al.) 02.08.2007, par. [0064], [0080], [0081], [0084], fig. 2, 6, 7		24-26																				
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.																							
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