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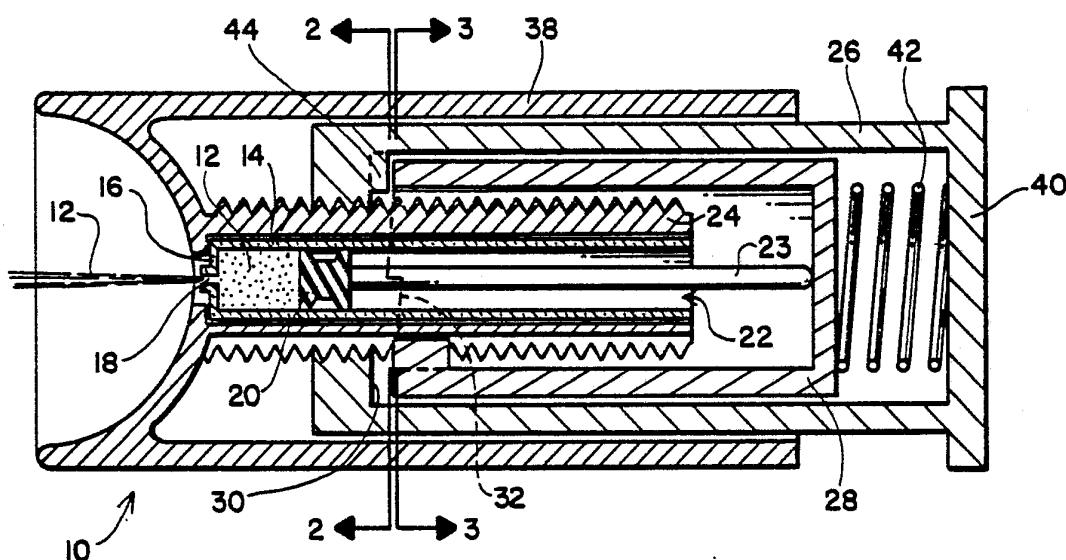
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(54) Title: LIQUID DISPENSING APPARATUS AND CARTRIDGE



(57) Abstract

An apparatus (10) for the repetitive dispensing of a predetermined quantity of eyedrops (12) has a cylinder (14) with a restricted opening (18) at a first end (16). A plunger (20) attached to a rod (23) extends into the cylinder (14) from end (22). Biasing member (28) has a ramped cam surface (32) incorporating a pair of steps (46), actuating member (26) has an opposed surface (30) with a projection (44) which rides on ramped cam surface (32) and drops off step (46) when actuating member (26) is rotated. Rotation of the actuating member (26) also advances the actuating member (26) on the threaded member (24). Spring (42) biases surfaces (30 and 32) together. As projection (44) drops over each step (46), plunger (20) is moved incrementally toward end (16) of cylinder (14) to discharge eyedrops (12) through opening (18). A disposable cartridge (50) may be substituted for the cylinder (14).

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LIQUID DISPENSING APPARATUS AND CARTRIDGE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an apparatus for the repetitive dispensing of a predetermined quantity of a liquid. It also relates to a cartridge containing the liquid to be dispensed in the apparatus. Most especially, it relates to such an apparatus and cartridge which are especially adapted for dispensing eyedrops in an improved manner.

2. Description of the Prior Art

Apparatus for the repetitive dispensing of a predetermined quantity of a liquid, such as eyedrops, is known in the art. For example, such an apparatus is described in my prior art U.S. Patent 3,934,585, issued January 27, 1976. While the apparatus there disclosed performs its intended function very effectively, it is sufficiently complex in construction that it is not feasible to supply the apparatus as a disposable unit, and the user must load the apparatus from a separate supply of eyedrops. A variety of other apparatuses for dispensing eyedrops or other liquids are also known in the prior art, as disclosed in, for example, the following issued U.S. patents: Lerner et al., U.S. 2,920 624, issued January 12, 1960; Schwartzman, U.S. 3,091,374, issued May 28, 1963; Petterson, U.S. 4,022,168, issued January 11, 1977; Sbarra et al., U.S. 4,111,200, issued September 5, 1978; and Shaw, U.S. 4,259,953, issued April 7, 1981. However, none of these prior art patents discloses structures suitable for modifying apparatus of the general type covered by my prior issued patent so that such apparatus may be provided as a disposable unit, or alternatively, so that a portion of the

1 apparatus may be provided as a disposable cartridge.

2

3 **SUMMARY OF THE INVENTION**

4

5 Accordingly, it is an object of this invention to
6 provide an apparatus for the repetitive dispensing of a
7 predetermined quantity of a liquid by the application of
8 pressure which is of sufficiently simplified construction
9 that the apparatus may be provided in disposable form.

10

11 It is another object of of the invention to
12 provide an apparatus for application of eyedrops
13 incorporating an improved, rotatable camming mechanism for
14 actuation.

15

16 It is a further object of the invention to provide
17 an improved, rotatable camming device for actuating an
18 apparatus for repetitive dispensing of a predetermined
19 quantity of a liquid.

20

21 It is still another object of the invention to
22 provide an improved cartridge containing the liquid to be
23 dispensed in such an apparatus.

24

25 It is yet another object of the invention to
26 provide an apparatus for the repetitive dispensing of a
27 predetermined quantity of a liquid supplied by a bottle
28 inserted in the apparatus, which apparatus incorporates an
29 improved manner of equalizing pressure inside and outside
30 the bottle.

31

32 The attainment of these and related objects may be
33 achieved through the novel apparatus for repetitive
34 dispensing of a predetermined quantity of a liquid and
35 cartridge for such an apparatus herein disclosed. An
36 apparatus in accordance with this invention includes a
37 cylinder having a first end and a second closed end. The

1 first end of the cylinder has a restricted opening through
2 which the liquid may pass in response to pressure applied
3 to the liquid. At least one of the first and second ends
4 is movable within the cylinder toward the other end to
5 change volume of a space defined by the cylinder and
6 containing the liquid. A biasing member engages the second
7 end for moving the ends in steps toward one another. An
8 actuating member engages the biasing member by means of
9 opposed surfaces on each member. One of the opposing
10 surfaces constitutes a ramped cam having at least one
11 step. The other of the opposing surfaces has at least one
12 projection engaging the ramped cam opposing surface. A
13 means, such as a spring, biases the opposed surfaces toward
14 each other. The biasing and actuating members are
15 rotatable with respect to each other. Rotation of the
16 biasing and actuating members with respect to each other
17 moves the projection on the ramped cam opposing surface.
18 Movement of the projection over the step advances the ends
19 toward one another a distance corresponding to the step. A
20 cartridge in accordance with the invention for insertion in
21 an apparatus in accordance with the invention is formed
22 from a cylinder having a first end through which the liquid
23 is dispensed and a second, closed end. At least one of the
24 first and second ends is movable within the cylinder toward
25 the other to change volume of a space defined by the
26 cylinder between the first and second ends. The liquid to
27 be dispensed by the apparatus fills the space in the
28 cylinder between the first and second ends. In another
29 aspect of the invention, an apparatus for the repetitive
30 dispensing of a predetermined quantity of a liquid has a
31 housing including a cylinder having a first end through
32 which the liquid is dispensed through application of
33 pressure. An opening in the housing is configured to
34 receive a neck of a bottle. There is a reservoir in the
35 housing connected to the opening and to the cylinder. A
36 means in the housing applies pressure to liquid in the
37 cylinder. A tube extends from the opening and has a length

1 such that a first end extends above the liquid in the
2 bottle when the bottle is in the opening. The tube has a
3 second end connected to ambient pressure.

4
5 The simplified construction of the apparatus of
6 this invention allows the apparatus to be provided as a
7 disposable unit containing eyedrops to other liquid to be
8 repetitively dispensed in predetermined quantities by the
9 application of pressure. Alternatively, the liquid may be
10 provided in the cartridge of this invention, for easy
11 insertion in the apparatus. The form of the invention for
12 use with a bottle provides improved pressure relief for the
13 bottle.

14
15 The attainment of the foregoing and related
16 objects, advantages and features of the invention should be
17 more readily apparent to those skilled in the art, after
18 review of the following more detailed description of the
19 invention, taken together with the drawings, in which:

20
21 **BRIEF DESCRIPTION OF THE DRAWINGS**

22
23 Figure 1 is a lateral cross section view of an
24 apparatus in accordance with the invention.

25
26 Figure 2 is a cross section view, taken along the
27 line 2-2 in Figure 1.

28
29 Figure 3 is a cross section view, taken along the
30 line 3-3 in Figure 1.

31
32 Figure 4 is an enlarged view of a portion of the
33 apparatus shown in figure 1.

34
35 Figure 5 is a cross section view of a portion of
36 another apparatus in accordance with the invention.

37

1 Figure 6 is another cross section view of another
2 portion of the apparatus in Figure 5.

3
4 Figure 7 is another cross section view of a
5 portion of another apparatus in accordance with the
6 invention.

7
8 Figure 8 is another cross section view of a
9 portion of yet another apparatus in accordance with the
10 invention.

11
12 Figure 9 is a cross section view of still another
13 apparatus in accordance with the invention.

14
15 **DETAILED DESCRIPTION OF THE INVENTION**

16
17 Turning now to the drawings, more particularly to
18 Figure 1, there is shown an apparatus 10 for the repetitive
19 dispensing of a predetermined quantity of eyedrops 12
20 through the application of pressure, in accordance with the
21 invention. The apparatus 10 includes a cylinder 14,
22 containing the eyedrops 12. The cylinder 14 has a first
23 end 16 with a nozzle 18 through which the eyedrops 12 are
24 projected. A plunger 20 extends into the cylinder 14 from
25 a second end 22. Rod 23 extends from plunger 20 from the
26 second end 22 of the cylinder 14. As shown, the cylinder
27 14 is implemented as a sleeve, which is friction fit into
28 threaded member 24. Actuating member 26 is
29 circumferentially disposed around the threaded member 24
30 and threaded thereto. A biasing member 28 is also
31 circumferentially disposed around the threaded member 24,
32 between the threaded member 24 and the actuating member
33 26. Biasing member 28 engages the rod 23. Surfaces 30 and
34 32, respectively on the actuating member 26 and the biasing
35 member 28, are in opposing relationship (see also Figure
36 4). Threaded member 24 has a slot 34 (Figures 2 and 3)
37 extending along its length. Biasing member 28 has a spline

1 36 (Figure 3), which fits into the slot 34 to prevent
2 rotation of the biasing member 28 with respect to the
3 threaded member 24. Threaded member 24 forms part of
4 housing 38, which extends around the apparatus, with the
5 exception of handle 40. A compressed spring 42 is
6 connected to handle 40 and extends between the handle 40 of
7 actuating member 26 and the biasing member 28.

8
9 Details of a ramped cam mechanism formed by
10 surface 32 on biasing member 28 and projection 44,
11 extending from surface 30 on actuating member 26 are shown
12 in Figures 3 and 4. There is a pair of steps 46 on the
13 surface 32. The surface 32 is inclined, leading up to each
14 step 46. Spring 42 (Figure 1) biases the surfaces 30 and
15 32 toward one another. Projection 44 rides up the inclined
16 surface 32 to each step 46 as knob 40 is turned. Turning
17 the knob 40 also advances the actuating member 26 on the
18 threaded member 24 toward first end 16 of the cylinder 14.
19 When the projection 44 drops over step 46, biasing member
20 28 is also permitted to move in stepwise increments
21 corresponding to the height of step 46 toward first end 16
22 of the cylinder 14. Biasing member 28 then pushes against
23 rod 23, to push the plunger 20 toward first end 16 of the
24 cylinder 14 a corresponding amount. The resulting pressure
25 on eyedrops 12 discharges a predetermined amount of the
26 eyedrops 12 through the nozzle 18 in the form of a jet.
27 For each half revolution of the actuating member 26, the
28 stepwise movement of plunger is repeated, until the plunger
29 20 has reached end 16 of the cylinder 14. The pitch of the
30 threads on threaded member 24 and actuating member 26
31 should be dimensioned so that leftward motion of the
32 actuation member 26 for each half revolution on threaded
33 member 24 corresponds to the height of step 46. The
34 eyedrops 12 should completely fill the space between end 16
35 and plunger 20 at all times. Trapped air in this space
36 would produce unpredictable operation due to compression of
37 the air. Because the ramped cam mechanism is not visible

1 in operation of the dispenser, the user does not know when
2 the jet of eyedrops will be discharged, and so does not
3 blink in anticipation.
4

5 Figures 5 and 6 show portions of another
6 embodiment of an apparatus in accordance with the
7 invention, in which the cylinder 14 is replaced with an
8 insertable cartridge 50, which is slidably positioned in
9 bore 52 of a threaded member 54, corresponding to the
10 threaded member 24 in Figure 1. Bore 52 has a wall 56
11 through which a hollow needle 58 extends. Cartridge 50 has
12 a cylinder 60, formed from glass or rigid plastic. End
13 plug 62, formed from a resilient, puncturable plastic is
14 inserted in end 64 of the cylinder 60. A plunger 66 and
15 rod 68 are inserted in the other end 70 of the cylinder 60,
16 with the eyedrops 72 between the plug 62 and the plunger
17 66. Actuating member 74 and biasing member 76 respectively
18 correspond to the actuating member 26 and biasing member 28
19 in Figure 1. The actuating member 74 and biasing member 76
20 each have removable caps 78 and 80 to allow insertion and
21 removal of new and spent cartridges 50. In other respects,
22 the construction and operation of the Figures 5 and 6
23 embodiment of the invention is the same as the Figures 1
24 through 4 embodiment.
25

26 Figure 7 shows another form of an insertable
27 cartridge 100 for use in a dispensing apparatus in
28 accordance with the invention. As in the Figure 5
29 embodiment, the cartridge 100 has a cylinder 102, formed
30 from glass or a rigid plastic, a plug 104 near one end of
31 the cylinder 102, and a plunger 106 extending into the
32 cylinder 102 from the other direction. Liquid 108 to be
33 dispensed fills the space between plug 104 and plunger
34 106. A second plug 110 is mounted in the tube 102 on the
35 other side of plug 104 from the liquid 108. Plug 110
36 supports an axially disposed, hollow needle 112, positioned
37 to puncture the resilient plug 104 in a manner similarly to

1 that of the needle 58 in Figure 5. Needle 112 extends
2 through aperture 114 in eyecup 116. In other respects, the
3 construction and operation of the Figure 7 embodiment of
4 the invention is the same as the Figures 1 through 4
5 embodiment.

6
7 Figure 8 shows another form of a cartridge 120 and
8 puncturing assembly 122 for use with the cartridge 120.
9 The cartridge 120 has a cylinder 124, closed at one end and
10 having a plug 126 near the other end, similar to the plugs
11 62 and 104 in Figures 5 and 7. The puncturing assembly 122
12 has a cylindrical mandrel 128 having an axially disposed
13 puncturing needle 130 positioned to puncture resilient end
14 plug 126 of the cartridge 120. Liquid 132 fills the space
15 defined by cylinder 124 and plug 126. Cylinder 124 is
16 dimensioned so that mandrel 128 enters the cylinder 124 as
17 cartridge 120 is pushed to the left during operation of the
18 apparatus. Since the cartridge 120 does not employ a
19 plunger and rod, a biasing member corresponding to biasing
20 member 28 in Figure 1 presses directly against end 134 of
21 the cartridge 120. In other respects, the construction and
22 operation of a dispensing apparatus incorporating the
23 cartridge 120 and puncturing assembly 122 in Figure 8 is
24 the same as the Figures 1 through 7 embodiments.

25
26 Figure 9 shows another dispensing apparatus 140 in
27 accordance with the invention. The apparatus 140 has a
28 generally cylindrically shaped body 142 having a threaded
29 opening 144 into which a conventional eyedrop bottle 146 is
30 inserted as shown. The body 142 contains a reservoir 148,
31 into which eyedrops 150 flow from the bottle 146. Conduit
32 152 connects the reservoir 148 to cylinder 154. The
33 cylinder 154 has a restricted opening 156 at end 158 and a
34 plunger 160, extending into the cylinder 154 from end 162.
35 A ramped cam 164 is disposed circumferentially around end
36 166 of the plunger 160, extending from the end 162 of
37 cylinder 154. Ramped cam 164 has a step 168, which defines

1 a path of travel of the plunger 160 within cylinder 154.
2 Projection 170 on the plunger 160 rides on the ramped cam
3 164 and drops over step 168 to define the stroke of the
4 plunger 160 within cylinder 154. Knob 172 is turned to
5 move the projection 170 along ramped cam 164. Spring 174
6 connects plunger 160 and knob 172, and is compressed to
7 urge the plunger 160 toward end 158 of the cylinder 154.
8 Rectangular portion 172a of knob 172 extends into portion
9 160a of plunger 160 so that rotary motion of knob 172 is
10 transmitted to plunger 160.

11 As the eyedrops 150 are discharged from the
12 apparatus 140, air pressure within the bottle 146 tends to
13 drop. A pressure equalization tube 180 extends into the
14 bottle 146 to allow entry of additional air as the eyedrops
15 150 are discharged. As shown, the pressure equalization
16 tube 180 has a hooked portion 181 and has its end 182
17 positioned at the center of gravity 183 of the volume
18 enclosed by bottle 146 and reservoir 148. Reservoir 148
19 within housing 142 is of sufficient size so that when a
20 full bottle 146 of eyedrops 150 is inserted in the housing
21 142 and inverted, the level of eyedrops 150 is below
22 opening 182. Under these circumstances, the opening 182
23 will be above the eyedrops 150, whatever the orientation of
24 the dispenser. The hooked portion 181 in tube 180 serves
25 to reduce leakage of eyedrops 150 through the pressure
26 equalization tube 180 either through splashing or drainage
27 over the tube 180.

28
29 Cylindrical lip 190 on the body 142 is used for
30 positioning the dispensing apparatus 140 in front of the
31 user's eye.

32
33 It should now be readily apparent to those skilled
34 in the art that a novel apparatus for the repetitive
35 dispensing of a predetermined quantity of a liquid by
36 application of pressure and cartridge for use in such an
37 apparatus capable of achieving the stated objects of the

1 invention has been provided. Because the apparatus of the
2 invention is of simplified construction, it may be provided
3 in disposable form, already charged with eyedrops 12 or
4 other liquid to be repetitively dispensed in a
5 predetermined quantity. Alternatively, a disposable
6 cartridge containing eyedrops 72 or other liquid to be
7 repetitively dispensed in a predetermined quantity can be
8 inserted into the apparatus. The rotatable, stepped cam
9 mechanism for actuating the apparatus allows the provision
10 of such an apparatus of simplified construction. The
11 pressure relief structure of the invention allows improved
12 operation of a dispensing apparatus of the invention used
13 with a conventional bottle of liquid.

14

15 It should further be apparent to those skilled in
16 the art that various changes in form and details of the
17 invention as shown and described may be made. It is
18 intended that such changes be included within the spirit
19 and scope of the claims appended hereto.

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WHAT IS CLAIMED IS:

1 1. Apparatus for the repetitive dispensing of a
predetermined quantity of a liquid comprising a cylinder
having a first end and a second end, the first end of said
cylinder having a restricted opening through which the
5 liquid may pass in response to pressure applied to the
liquid, a plunger extending into said cylinder from the
second end, a biasing member operatively connected to said
plunger for moving said plunger in steps toward the first
end of said cylinder, an actuating member engaging said
10 biasing member by means of opposed surfaces on each said
biasing and actuating members, one of the opposing surfaces
constituting a ramped cam having at least one step and the
other of the opposing surfaces having at least one
projection engaging the ramped cam opposing surface, and
15 means for biasing said opposed surfaces toward one another,
said biasing and actuating members being rotatable with
respect to each other, rotation of said biasing and
actuating members with respect to each other moving the
projection on the ramped cam opposing surface, and movement
20 of the projection over the step advancing said plunger
toward the one end a distance corresponding to the step.

1 2. The apparatus of Claim 1 in which said
actuating member is axially disposed around said biasing
member.

1 3. The apparatus of Claim 1 in which said plunger
has a rod extending from the second end of said cylinder
and said biasing member engages the rod.

1 4. The apparatus of Claim 1 additionally
comprising a set of mating threads connecting a rotatable
member and a member of said apparatus fixed against
rotation, rotation of said biasing and actuating members
5 relative to one another also moving the mating threads a

longitudinal distance relative to one another corresponding to advancement of the plunger

1 5. The apparatus of Claim 4 in which said
rotatable member is said actuating member and said member
fixed against rotation is said cylinder.

1 6. The apparatus of Claim 4 in which said
rotatable member and said member fixed against rotation
include a keyway and a spline slidably positioned in the
keyway.

1 7. The apparatus of Claim 5 in which said
cylinder includes a cartridge containing the liquid to be
dispensed through the restricted opening, and the
restricted opening is formed by a needle mounted in said
5 cylinder to puncture a first end of the cartridge, and said
plunger forms a second end of the cartridge.

1 8. The apparatus of Claim 4 in which said biasing
means is a spring connected between the end of said biasing
member opposite from the opposed surfaces and an end of
said actuating member opposite from the opposed surfaces.

1 9. The apparatus of Claim 1 in which said
cylinder includes a cartridge containing the liquid to be
dispensed through the restricted opening, and the
restricted opening is formed by a needle mounted in said
5 cylinder to puncture a first end of the cartridge, said
plunger forms a second end of the cartridge, and the liquid
fills a space between said plunger and the first end of the
cartridge.

1 10. The cartridge of Claim 9 in which said
actuating member is disposed axially around said biasing
member, said actuating and biasing members have removable
end caps, and said biasing means is a spring connected

5 between the removable end caps.

1 11. The apparatus of Claim 1 in which the
apparatus is for dispensing eyedrops and includes a
projecting front member for positioning the restricted
opening in front of a user's eye.

1 12. A cartridge for insertion in an apparatus for
repetitive dispensing of a predetermined quantity of a
liquid comprising a cylinder having a first end through
which the liquid is dispensed, a second open end, a plunger
5 slidably and sealingly positioned in said cylinder and
spaced from the first end to form a space between said
plunger and the first end of said cylinder, a rod attached
to said plunger and extending from the open end of said
cylinder, and the liquid to be dispensed by the apparatus
10 in said cylinder filling the space.

1 13. The cartridge of Claim 12 in which the first
end of said cylinder is formed by a resilient, puncturable
plug attached to said cylinder and in opposing relationship
to said plunger.

1 14. The cartridge of Claim 13 additionally
comprising a puncturing member on the other side of the
first end from said plunger and including a hollow needle
for forming a restricted opening through the first end.

1 15. The cartridge of Claim 12 in which the liquid
is eyedrops.

1 16. Apparatus for the repetitive dispensing of a
predetermined quantity of a liquid comprising a cylinder
having a first end and a closed second end, the first end
of said cylinder having a restricted opening through which
the liquid may pass in response to pressure applied to the
5 liquid, at least one of the first and second ends being

movable within the cylinder toward the other end to change volume of a space defined by the cylinder and containing the liquid, a biasing member operatively connected to the
10 second end for moving the ends in steps toward one another, an actuating member engaging said biasing member by means of opposed surfaces on each said biasing and actuating members, one of the opposing surfaces constituting a ramped cam having at least one step and the other of the opposing
15 surfaces having at least one projection engaging the ramped cam opposing surface, and means for biasing said opposed surfaces toward one another, said biasing and actuating members being rotatable with respect to each other, rotation of said biasing and actuating members with respect
20 to each other moving the projection on the ramped cam opposing surface, and movement of the projection over the step advancing the ends toward one another a distance corresponding to the step.

1 17. The apparatus of Claim 16 in which the second end of said cylinder comprises a plunger extending into said cylinder in opposition to the first end and is movable toward the first end.

1 18. The apparatus of Claim 16 in which the second end of said cylinder is fixed and said first end comprises a plug slidably mounted in said cylinder and movable toward the second end.

1 19. The apparatus of Claim 16 additionally comprising a mandrel dimensioned to enter said cylinder as the first end is moved toward the second end, said mandrel including an axially disposed hollow needle for puncturing
5 the first end to form the restricted opening.

1 20. A cartridge for insertion in an apparatus for the repetitive dispensing of a predetermined quantity of a liquid comprising a cylinder having a first end through

5 which the liquid is dispensed, a second, closed end, at
least one of a said first and second ends being movable
within the cylinder toward the other end to change volume
of a space defined by the cylinder between said first and
second ends, and the liquid to be dispensed filling the
space defined by the cylinder between the first and second
10 ends.

1 21. The cartridge of Claim 20 in which said
second end is fixed and said first end is slidably and
sealingly mounted within said cylinder.

1 22. The cartridge of Claim 20 in which said first
end is formed from a resilient, puncturable material.

1 23. The cartridge of Claim 20 in which said
second end is formed by a plunger which is slidably and
sealingly mounted within said cylinder.

1 24. The cartridge of Claim 23 in which said first
end is formed from a resilient, puncturable material.

1 25. The cartridge of Claim 24 additionally
comprising a puncturing member on the other side of the
first end from said second end and including a hollow
needle for forming a restricted opening through the first
5 end.

1 26. An apparatus for the repetitive dispensing of
a predetermined quantity of a liquid, comprising a housing
including a cylinder having a first end through which the
liquid is dispensed through application of pressure, an
5 opening in said housing configured to receive a neck of a
bottle, a reservoir for liquid in said housing, said
reservoir being connected to said opening and to said
cylinder, means for applying pressure to liquid in said
cylinder, and a tube for insertion into a bottle having its

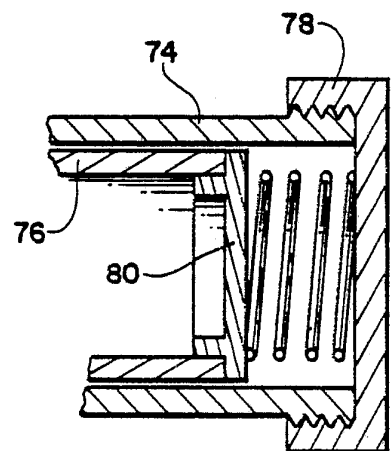
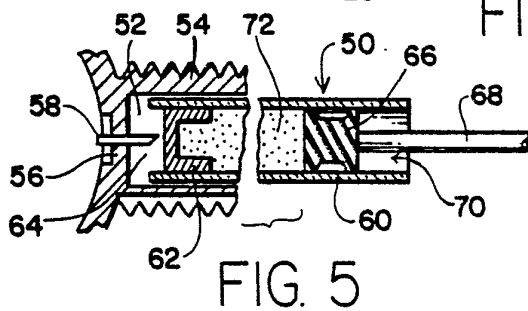
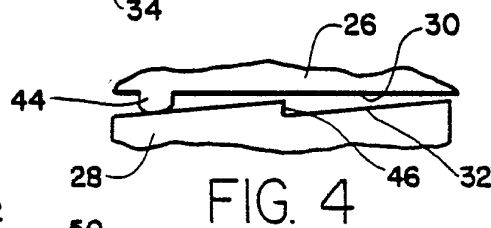
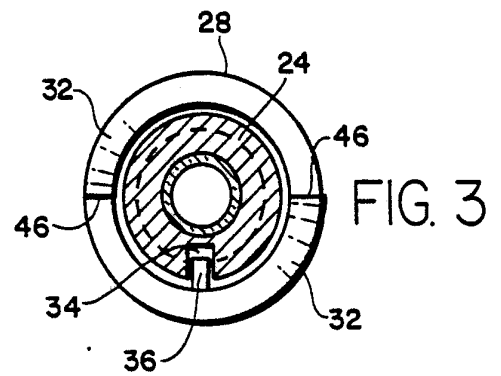
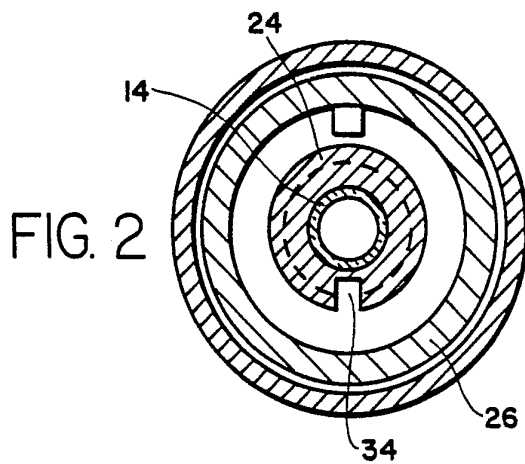
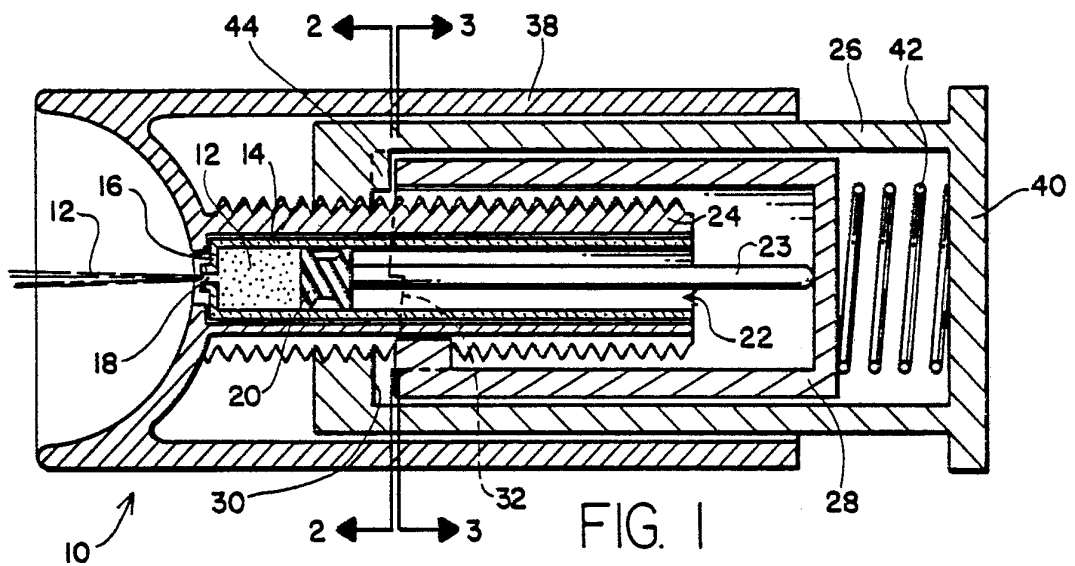
10 neck in said opening, said tube having a length such that a first end extends above liquid in the bottle when the bottle is in said opening, said tube having a second end connected to ambient pressure.

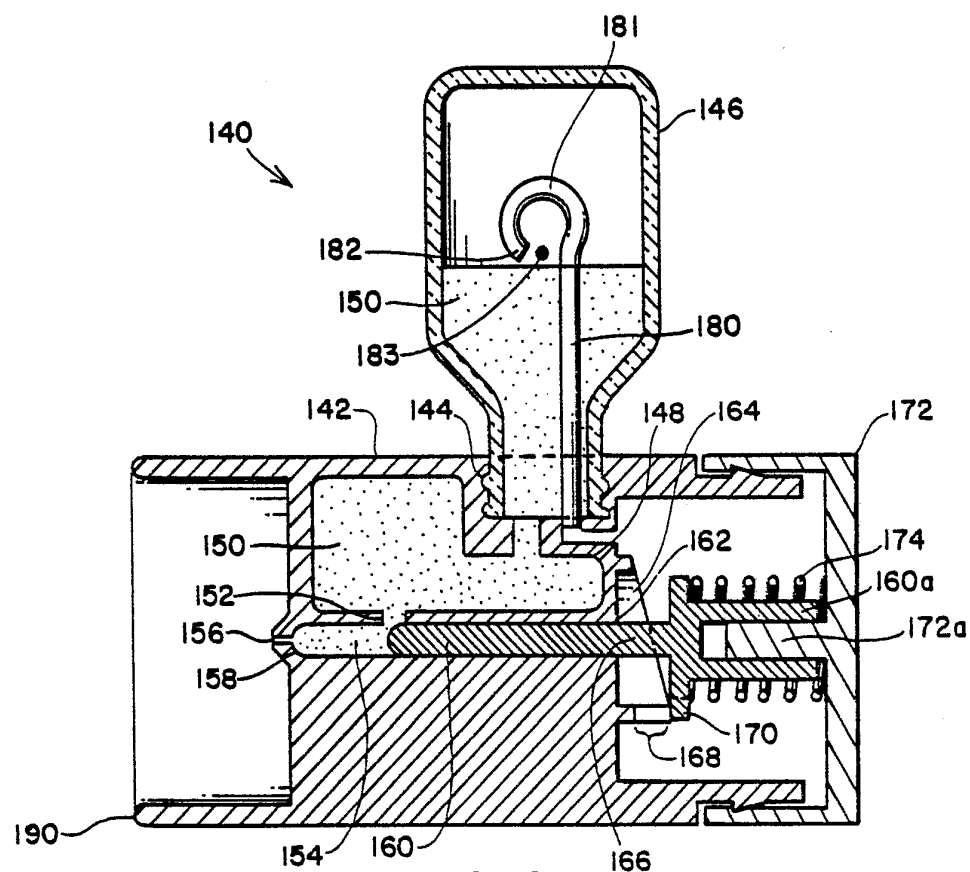
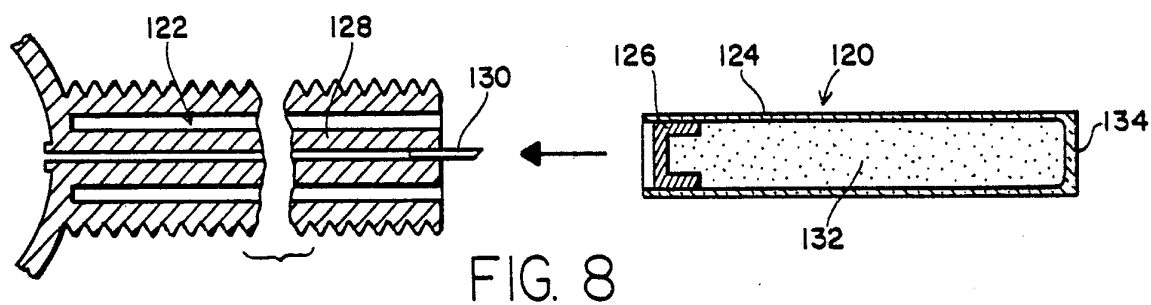
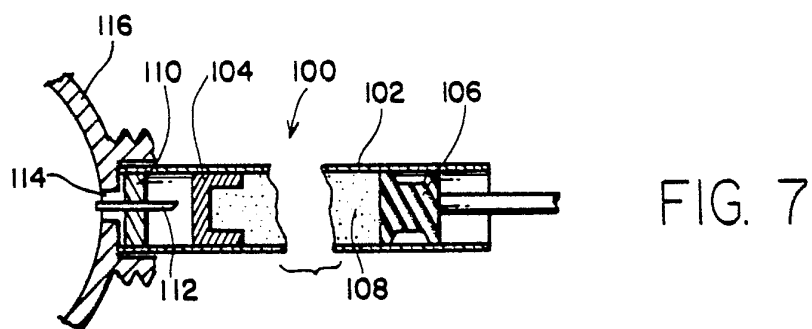
1 27. The apparatus of Claim 26 in which said tube includes a hook configuration proximate to the first end of said tube.

1 28. The apparatus of Claim 26 in which said pressure applying means is a plunger extending into said cylinder from an open, second end of said cylinder, a ramped cam including a step for defining a stroke of said
5 plunger operatively connected to said plunger, and a means for biasing the plunger toward the first end of said cylinder.

1 29. The apparatus of Claim 26 in which the first end of said tube terminates proximate to a center of gravity of a volume defined by said reservoir and the bottle.

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INTERNATIONAL SEARCH REPORT

International Application No PCT/US86/01172

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ³		
According to International Patent Classification (IPC) or to both National Classification and IPC IPC (4): A61M 1/00, 5/313, 35/00; A61J 7/00; G01F 11/06 U.S. Cl. 222/390, 604/298, 222/327, 222/328		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁴		
Classification System	Classification Symbols	
U.S.	604/209, 211, 218, 224, 294, 295, 298, 300-302 222/80-83, 183, 185, 207, 325-327, 378, 388 222/333, 340, 360, 390, 391, 541	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁵		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category ⁶	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
Y	US, A, 3,162,217 (POLI, A.A., JR.) 22 December 1962. See figs. 1, 5 and columns 2 and 3, lines 28-72, 0-19, respectively.	1-3, 16
Y	US, A, 4,498,904 (TURNER, ROBERT C.) 12 February 1985. See fig. 14 and column 9, lines 53-68, column 10, lines 0-68 and column 11, lines 0-5.	1-3, 16
Y	US, A, 4,531,944, (BECHTLE, SAMUEL) 30 July 1985. See figs. 1, 3 and column 3, lines 25-34.	11
A	US, A, 4,013,370 (GINGRAS, ANTOINE) 2 2 March 1977.	
Y	US, A, 3,535,068 (LARSON) 20 October 1970, see figs. 1-3 and column 2, 3 and lines 40-73, 0-26, respectively.	12-15
Y	US, A, 2,345,302 (SMITH) 28 March 1944, see page 2, column 1, lines 0-18.	12-15
¹⁵ * Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document 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 "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		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search ¹⁹		Date of Mailing of this International Search Report ²⁰
25 July 1986		18 AUG 1986
International Searching Authority ¹		Signature of Authorized Officer ²⁰
ISA/US		J. L. Kruter

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No ¹⁸
A	US, A, 4,019,654 (VAN MAREN) 26 April 1962, see column 1, lines 65-68, column 2, lines 0-15.	
Y	US, A, 3,353,537 (KNOX ET AL) 21 November 1967, see figs. 1, 3 and column 1, lines 54-69, column 7, lines 30-37.	26-29
Y	US, A, 4,522,319 (RICHTER) 11 June 1985, see column 3, lines 39-53 and column 4, lines 20-37.	26-29
Y	US, A, 2,733,848 (BOS HOUWERS) 7 February 1956, see column 3, lines 9-21.	27
Y	US, A, 4,444,560 (JACKLICH) 24 April 1984, see column 2, lines 10-17, 28-44.	28
A	BE, A, 620,213 (WELTY) 5 November, 1982, see figs. 1-3.	

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE 10

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers _____, because they relate to subject matter¹² not required to be searched by this Authority, namely:

2. ☐ Claim numbers, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out ¹³, specifically:

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING 11

This International Searching Authority found multiple inventions in this international application as follows:

- This international Searching Authority found multiple inventions in this international application as follows:
1. Claims 1-11, 16-19 drawn to a dispenser to treat the eye.
 2. Claims 12-15 drawn to a disposable cartridge.
 3. Claims 26-29 drawn to a dispenser and replaceable disposable cartridge.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
☐ No protest accompanied the payment of additional search fees.