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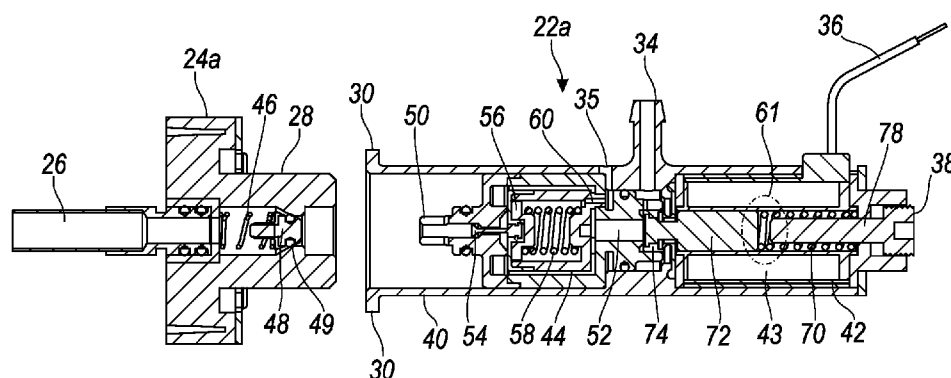


FIG. 8

(57) Abstract: A cartridge valve (22, 94) and system (10) are provided in which the cartridge valve (22, 94) includes a regulator (44, 96) and an adjustable stroke solenoid (42, 100) to facilitate stable flow control. Also, the cartridge valve (22, 94) includes a quick and easy installation and removal fitting (30 and 32).

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1 TITLE OF THE INVENTION

2 Cartridge Valve and System.

3
4 CROSS-REFERENCE TO RELATED APPLICATION AND PRIORITY INFORMATION5 This application claims the benefit of co-pending, prior filed U.S. provisional
6 application no. 63/069572, entitled "Cartridge Valve and System", filed August 24, 2020.7
8 TECHNICAL FIELD OF THE INVENTION9 This invention relates generally to flow control, and in particular to a cartridge
10 valve and related dispensing system.11
12 BACKGROUND OF THE INVENTION13 Many systems require fluid flow control. Some of those systems require only on-
14 and-off flow control. Others require control of the flow rate of one or more fluids. In
15 some of these systems, such as, without limitation, beverage dispensing systems, space
16 constraints are significant, and bear on the ease with which the flow control elements can
17 be calibrated or replaced.18
19 SUMMARY OF THE INVENTION20 In accordance with the teachings of the present invention, a cartridge valve and
21 dispensing system are provided which eliminate or substantially reduce problems
22 associated with prior art systems.

23 In particular, a valve is provided that includes a fluid inlet, a fluid outlet, a

1 regulator coupled to the fluid inlet and having a regulator outlet, and a solenoid, the
2 solenoid including an armature configured to retract a retraction distance from a closed
3 position to a retracted position, the armature adapted to stop fluid flow between the
4 regulator outlet and the fluid outlet in the closed position, and an adjustable stop
5 configured to adjustably set the retraction distance. The adjustable stop may be an
6 adjustment screw, including a shaft with an armature end that restricts retraction of the
7 armature beyond the retracted position.

8 In a particular embodiment, the valve includes a flow ring surrounding the
9 regulator outlet, the flow ring including at least one slot in fluid communication with the
10 regulator outlet and the fluid outlet, the fluid outlet being outside the flow ring, and
11 wherein increasing the retraction distance exposes a larger part of the at least one slot. In
12 some embodiments, the valve further includes a diaphragm coupled to a regulator end of
13 the armature, the diaphragm including a first section adapted to close the regulator outlet
14 in the closed position, and a second section having an outside diameter equal to or greater
15 than an inside diameter of the flow ring.

16 In another particular embodiment, the valve includes a flow ring surrounding a
17 ring outlet, the ring outlet in fluid communication with the fluid outlet, the flow ring
18 including at least one slot in fluid communication with the regulator outlet, the regulator
19 outlet being outside the flow ring, and wherein increasing the retraction distance exposes
20 a larger part of the at least one slot. In some embodiments, the valve further includes a
21 diaphragm coupled to a regulator end of the armature, the diaphragm including a first
22 section adapted to close the ring outlet in the closed position, and a second section having
23 an outside diameter equal to or greater than an inside diameter of the flow ring.

1 The valve may include a diaphragm coupled to a regulator end of the armature,
2 the diaphragm adapted to isolate the armature from fluid flowing from the regulator
3 outlet. In some embodiments, the diaphragm includes a first section adapted to close
4 fluid communication between the regulator outlet and the fluid outlet in the closed
5 position, and a second section adapted to isolate the armature from fluid flowing from the
6 regulator outlet.

7 In another particular embodiment, the valve includes a fluid passageway from the
8 regulator outlet to the fluid outlet, wherein the fluid passageway is closed by the armature
9 in the closed position, and wherein increasing the retraction distance increases fluid flow
10 through the fluid passageway.

11 The valve may also include tabs extending from it, adapted to couple with a
12 backblock in a bayonet fitting arrangement.

13 In particular embodiments, the regulator and solenoid are arranged in a
14 substantially linear arrangement, and housed axially in a substantially cylindrical
15 housing. In some embodiments, the regulator and solenoid are arranged substantially
16 linearly. In some other embodiments, the fluid outlet is positioned between the regulator
17 and the solenoid.

18 In a particular application, the valves may be used in a post-mix beverage system.

19 Important technical advantages are provided by the present invention. In
20 particular, and without limitation, the combination of a regulator and adjustable stroke
21 solenoid allows for stable flow control, and allows for a smaller solenoid size which
22 reduces costs and size, and accommodates greater service space. Furthermore, the
23 bayonet fitting allows for quick and easy installation and replacement of the valves.

1 Also, the reciprocating motion of an armature and solenoid diaphragm in a flow ring
2 cleans clogged particulate and some pulps, thereby rendering the valve of the present
3 invention suitable both for, without limitation, relatively consistent fluids and those with
4 varying amounts and sizes of particulate matter or pulp.

5
6 BRIEF DESCRIPTION OF THE DRAWINGS

7 Reference is made in the description to the following briefly described drawings,
8 which are not drawn to scale, and in which like reference numerals indicate like features:

9 FIGURE 1 illustrates a block diagram of one embodiment of a dispenser
10 according to certain aspects of the present invention;

11 FIGURES 2 and 3 illustrate one embodiment of an array of cartridge valves and
12 backblock, showing one installation approach;

13 FIGURES 4 and 5 illustrate different views of one embodiment of an uninstalled
14 cartridge valve and backblock;

15 FIGURES 6 and 7 illustrate, respectively, top and side views of one embodiment
16 of an uninstalled cartridge valve and backblock;

17 FIGURE 8 illustrates an enlarged sectional view of one embodiment of an
18 uninstalled cartridge valve and backblock;

19 FIGURE 9 illustrates an isometric view of one embodiment of an installed
20 cartridge valve and backblock;

21 FIGURE 10 illustrates a front view of one embodiment of an installed cartridge
22 valve and backblock;

1 FIGUREs 11 and 12 illustrate angled side views of one embodiment of an
2 installed cartridge valve and backblock;

3 FIGURE 13 illustrates an enlarged sectional view of one embodiment of an
4 installed cartridge valve and backblock;

5 FIGURE 14 illustrates an exploded isometric view of one embodiment of a
6 cartridge valve;

7 FIGURE 15 illustrates an exploded isometric sectional view of one embodiment
8 of a cartridge valve;

9 FIGUREs 16-18 illustrate, respectively, top, side, and sectional exploded views of
10 one embodiment of a cartridge valve;

11 FIGURE 19 illustrates an exploded isometric view of one embodiment of an
12 adjustable stroke solenoid;

13 FIGURE 20 illustrates an exploded isometric sectional view of one embodiment
14 of an adjustable stroke solenoid;

15 FIGUREs 21-23 illustrate, respectively, top, side, and sectional exploded views of
16 one embodiment of an adjustable stroke solenoid;

17 FIGUREs 24 and 25 illustrate isometric views of one embodiment of an armature
18 and solenoid diaphragm;

19 FIGURE 26 illustrates a side view of one embodiment of an armature and
20 solenoid diaphragm;

21 FIGURE 27 illustrates a sectional side view of one embodiment of an armature
22 and solenoid diaphragm;

FIGUREs 28 and 29 illustrate, respectively, exploded isometric and top views of one embodiment of a cartridge valve;

FIGUREs 30 and 31 illustrate schematic representations of one embodiment of a cartridge valve with the solenoid in its respective closed and retracted positions;

FIGUREs 32 and 33 illustrate, respectively, top and sectional views of one embodiment of an uninstalled cartridge valve and backblock;

FIGUREs 34 and 35 illustrate, respectively, angled top and sectional views of one embodiment of an installed cartridge valve and backblock with the solenoid in its retracted position;

FIGURE 36 illustrates an exploded view of one embodiment of an adjustable stroke solenoid;

FIGUREs 37a, 37b, and 38 illustrate alternatives for coupling a cartridge valve to a backblock and accessory options; and

FIGURE 39 illustrates one embodiment of an offset adapter for backwards compatibility with some existing systems.

DETAILED DESCRIPTION OF THE INVENTION

FIGURE 1 illustrates one embodiment of a dispenser 10 according to certain aspects of the present invention. In the example embodiment of FIGURE 1, dispenser 10 is a beverage dispenser; however, the present invention is not limited to beverage dispensers, and may be employed with virtually any dispenser or system that uses flow control.

Beverage dispenser 10 includes one or more valve modules 12, each associated

1 with one or more beverages. Each valve module 12 includes one or more cartridge
2 valves, to be described in detail below. A valve module may contain a single cartridge
3 valve (for example, for dispensing water, soda, or some other beverage or beverage
4 component), or a plurality of such valves, for dispensing two or more fluids. In a
5 particular embodiment, beverage dispenser 10 may be a post-mix dispenser, in which at
6 least one beverage base (such as, without limitation, a syrup or other concentrate) is
7 mixed with at least one diluent, such as plain or soda water, to form a finished drink. In
8 such a case, activating a valve module 12 to dispense a beverage opens at least one
9 diluent valve and at least one beverage-base valve, to which the respective diluent and
10 beverage base are coupled. Also, a beverage may be formed by mixing more than one
11 beverage base with more than one diluent. For example, a cherry cola may be formed by
12 mixing soda with a cola syrup and a cherry syrup (by opening three cartridge valves);
13 similarly, root-beer cola may be formed by mixing soda with a root-beer base and a cola
14 base (also by opening three cartridge valves).

15 When opened, the selected valves allow the fluids to flow through nozzle 14 into
16 a container 16 (such as, without limitation, a cup). A controller 18 controls the valves
17 within valve module 12 to allow dispense of a selected beverage. Controller 18 is also
18 coupled to a user interface 20 by which a user makes a beverage selection, which may be
19 any suitable user interface, including, without limitation, a push button, a lever, a voice
20 recognition system, a gesture recognition system, a touch screen, a smart phone, a
21 proximity sensor system, or any combination thereof. A valve module 12 may be
22 dedicated to a particular beverage (for example cola), or a valve module 12 may include
23 more than two valves to accommodate dispensing of multiple beverages in a post-mix

1 dispenser.

2 FIGURES 2 and 3 illustrate one embodiment of an array of four cartridge valves
3 22, and one approach for installing and uninstalling the valves. The use of four cartridge
4 valves is for example only, and fewer or more than four such valves may be used. In
5 FIGURE 2, three cartridge valves 22 are installed in backblock 24, and one (22a) is not
6 yet installed. In FIGURE 3, valve 22a is installed in backblock 24. Backblock 24 is
7 mounted to the dispenser 10, and provides a connection point for the cartridge valves 22
8 and their respective fluids, which are supplied through conduits 26. Backblock 24
9 includes a plurality of shut-off valves 28 (one is shown in FIGURE 2), one each of which
10 is coupled to an installed cartridge valve 22. Each shut-off valve 28 stops the flow of
11 fluid from its respective supply conduit 26 when its respective cartridge valve 22 is not
12 installed. Each shut-off valve 28 is opened, to allow fluid flow into its respective
13 cartridge valve 22, when its respective cartridge valve 22 is installed.

14 In the particular example shown, examples of one embodiment of a cartridge
15 valve 22 are installed and uninstalled in backblock 24 by use of a bayonet fitting.
16 Coupling with a bayonet fitting is advantageous because it allows easy engagement and
17 disengagement of the cartridge valves 22, thus facilitating more efficient maintenance.
18 However, any suitable connection may be used. The bayonet fitting is accomplished with
19 tabs 30 that extend from near the backblock-end of each cartridge valve 22. Tabs 30 pass
20 through openings 32 into a hollow space in backblock 24, and, upon rotation of the
21 cartridge valve 22, form an interference fit with the backblock 24. As shown in FIGURE
22 2, uninstalled valve 22a is oriented approximately 45° from the installed valves 22. Upon

1 insertion of the tabs 30, the valve is rotated approximately 45° to complete installation.

2 This process is reversed to uninstall a valve 22.

3 A fluid outlet 34 extends from each cartridge valve 22. When a valve 22 is
4 activated, its respective fluid flows through its respective fluid outlet 34 to nozzle 14.

5 Also shown is an air vent outlet port 35. Each valve 22 includes an electrical connection
6 36, which is coupled to controller 18 for activation of the respective valve 22. Each valve
7 22 also includes an adjustment screw 38 for use in calibrating the valve, to be described
8 in detail below.

9 FIGUREs 4 and 5 show front and rear isometric views, and FIGUREs 6 and 7
10 show top and side views, of an uninstalled valve 22 and backblock 24a. Backblock 24a is
11 shown as a discrete backblock, accommodating one cartridge valve 22. However,
12 backblock 24a may be a part of a larger backblock 24 such as shown in FIGUREs 1 and
13 2.

14 FIGURE 8 is an enlarged sectional side view taken along the site line shown in
15 FIGURE 6. As shown, valve 22 includes a housing 40, an adjustable stroke solenoid 42
16 (to be discussed in connection with FIGUREs 19-27), and a regulator 44. An example of
17 shut-off valve 28 is also shown, which includes a biasing spring 46 that pushes sealing
18 pin 48 onto an outlet seat 49 to close the shut-off valve 28 when cartridge valve 22 is not
19 installed. When cartridge valve 22 is installed (as in FIGURE 13), regulator inlet 50,
20 which extends from regulator 44, is inserted into shut-off valve 28 and overcomes the
21 spring 46 to unseat sealing pin 48 and open shut-off valve 28. Fluid can then flow from
22 supply conduit 26, through shut-off valve 28, through slots 51 (best seen in FIGUREs 14
23 and 16) of regulator inlet 50, and into regulator 44 of cartridge valve 22.

1 Regulator 44 may be any suitable regulator, but in a particular example includes a
2 CFValve™ made by Gate, LLC. Regulator 44 includes a regulator outlet 52. Regulator
3 44 provides a substantially constant output pressure, which, as will be discussed below,
4 will facilitate providing a substantially constant outlet flow rate. Inlet pressures often
5 have substantial variances (due to many factors), which affects flow rates and therefore
6 reduce the accuracy or quality of the system. For example, with a post-mix beverage
7 dispenser, inlet pressure variances, if not regulated, affect the ratio of diluent to
8 concentrate, thus reducing the quality of the finished beverage.

9 The illustrated example of regulator 44 also includes a metering pin 54, a
10 regulator diaphragm 56, a regulator spring 58, and an air vent 60 (air vent 60 vents
11 through outlet port 35 in housing 40). If inlet pressure is too low (below a threshold
12 pressure), the regulator spring 58 will urge the regulator diaphragm 56 against a sealing
13 ring 59 to close the regulator 44. As the inlet pressure reaches and exceeds the threshold
14 pressure, the regulator spring 58 is proportionally overcome and regulator diaphragm 56
15 retracts from sealing ring 59 so that fluid can flow around the metering pin 54 and into
16 the regulator 44, and eventually out the regulator outlet 52 when the cartridge valve 22 is
17 open. However, as the inlet pressure increases and the regulator diaphragm 56 retracts
18 farther from the sealing ring 59, the metering pin 54 (which is connected to and moves
19 with the regulator diaphragm 56) throttles the fluid flow through the regulator 44 by
20 reducing input orifice area, thereby controlling the fluid flow. Likewise, as the inlet
21 pressure decreases (but if still above the threshold pressure), the regulator diaphragm 56
22 and metering pin 54 move upstream toward the sealing ring, due to the spring 58, to
23 increase the input orifice area. The metering pin 54 may employ a tapered head to

1 modulate the input orifice area as it moves in and out in response to varying inlet
2 pressure.

3 The adjustable stroke solenoid 42, to be discussed in detail below, is shown in
4 FIGURE 8 in its resting (un-activated) position, in which the cartridge valve 22 is closed.
5 This closed state is brought about by solenoid spring 70, which urges armature 72 toward,
6 and its covering solenoid diaphragm 74 against, regulator outlet 52, with solenoid
7 diaphragm 74 sealing off the regulator outlet 52. In this position, a gap 61 exists between
8 the adjustment screw 38 and the armature 72.

9 FIGUREs 9-13 show various views of the example cartridge valve 22 installed in
10 backblock 24a. As can be seen in enlarged sectional view FIGURE 13, regulator inlet 50
11 in engaged with shut-off valve 28 and, when so engaged, compresses spring 46 to open
12 the shut-off valve 28. As also shown in FIGURE 13, the adjustable stroke solenoid 42, to
13 be discussed in detail below, is shown in its activated position, in which the cartridge
14 valve 22 is open. This open state is brought about by activating the solenoid coil
15 (windings) 43 via electrical connection 36, which retracts armature 72 and its covering
16 solenoid diaphragm 74 from the regulator outlet 52, to allow fluid flow from regulator
17 outlet 52 to fluid outlet 34. In this position, a gap 92 exists between regulator outlet 52
18 and the solenoid diaphragm 74, and no gap 61 is present (armature 72's end 84 is stopped
19 against adjustment screw 38's end 82). Adjustment screw 38 is an adjustable stop. Other
20 mechanisms may be employed to accomplish the stop.

21 FIGUREs 14-18 show exploded views of the example cartridge valve 22.
22 Housing 40 houses (at least partially) adjustable stroke solenoid 42 and regulator 44. The
23 overall arrangement is substantially cylindrical. In the particular example shown, fluid

1 outlet 34 extends from housing 40 between the solenoid 42 and regulator 44; however,
2 other arrangements can be used. A sealing cap 62 may be welded or glued to flange 64
3 of solenoid 42 and end 66 of housing 40 to seal the valve 22 and fix the solenoid 42 in
4 place.

5 As shown in FIGUREs 14-18, the regulator outlet 52 is surrounded by an outlet
6 flow ring 67 which includes slots 69. The solenoid diaphragm 74 moves within the outlet
7 flow ring 67 to alternately seal off regulator outlet 52 when valve 22 is closed, or to
8 retract from the regulator outlet 52 and create gap 92. The outside diameter of solenoid
9 diaphragm 74 (at its receptacle 88, see, e.g., Figure 25) is equal to or slightly larger than
10 the inside diameter of outlet flow ring 67, so that fluid exits through the slots 69. As the
11 diaphragm retracts from regulator outlet 52, the gap 92 increases, exposing a larger part
12 (greater cross-sectional area) of the slots 69 for increased flow from the regulator 44.

13 With the cartridge valve 22 in the open position, fluid flows through the fluid passageway
14 that runs from regulator outlet 52, through the gap 92 and out the slots 69 to fluid outlet
15 34. As a result, the exposed portions of the slots 69 are the effective outlet orifice of the
16 regulator 44.

17 In the example embodiment shown, three slots 69 are provided, but fewer or more
18 may be used, and indeed the outlet flow ring 67 (and therefore slots 69) may be omitted
19 altogether, or changed in shape. For example, and without limitation, it may be desirable
20 to omit flow ring 67 or to use more or larger slots 69 in high flow-rate applications, for
21 example and without limitation, in applications when dispensing plain or soda water at
22 high rates is desired.

FIGUREs 19-23 illustrate various views and elements of adjustable stroke solenoid 42. Adjustable stroke solenoid 42 includes adjustment screw 38, solenoid body 68 (which includes the coil 43 connected to electrical connection 36), solenoid spring 70, armature 72, and solenoid diaphragm 74. Adjustment screw 38 includes a head 76, shaft 78, and armature end 82. The sidewall of head 76 is threaded (or the head end of shaft 78, before it passes through spring 70), preferably finely (e.g., without limitation, approximately 50 threads per inch), and engages in matching threads on the inside of receptacle 80 of solenoid body 68 (see, e.g. FIGURE 13).

FIGUREs 24-27 illustrate various views of armature 72 and solenoid diaphragm 74. Armature 72 includes an armature end 84, armature head 86, and main body 89. Head 86 may be separated from the main body 89 of armature 72 by an armature neck 87, having a smaller diameter than the head 86 or main body 89. Head 86 may also be stepped in diameter. Solenoid diaphragm 74 “snaps” on to head 86 (or can otherwise be coupled to head 86). Solenoid diaphragm 74 may be made of a flexible material such as FKM rubber. When assembled, head 86 resides in diaphragm receptacle 88 of solenoid diaphragm 74 after being pressed through smaller diameter opening 90 of flexible diaphragm 74. Solenoid diaphragm 74 may include a diaphragm neck 91 having a smaller diameter than receptacle 88 and diaphragm flange 93. Armature 72 is made of magnetic metal, for example, without limitation, magnetic steel. The isolation of armature 72 from fluids, due to solenoid diaphragm 74, obviates concerns for corrosion of the armature 72, and thus allows the use highly magnetic metals for the armature 72 to achieve greater efficiency (corrosion resistant metals are often less magnetic). This greater efficiency allows for a smaller solenoid, thus reducing costs.

1 In operation, when the cartridge valve 22 is not activated (closed), the solenoid
2 spring 70 urges armature 72 and solenoid diaphragm 74 toward the regulator outlet 52 of
3 regulator 44, and diaphragm 74 seals off the regulator outlet 52 (as shown in FIGURE 8).
4 To open the cartridge valve 22, current is passed through the coil 43 through electrical
5 connection 36, and the resulting magnetic field retracts the armature 72 (and therefore
6 diaphragm 74 which is attached to the armature 72) from the regulator outlet 52, toward
7 end 82 of shaft 78, creating a gap 92 (shown in FIGURE 13) between solenoid diaphragm
8 74 and regulator outlet 52. When end 84 of armature 72 contacts end 82 of shaft 78 (as
9 shown in FIGURE 13), the retraction is stopped, and the armature 72 is in its retracted
10 position. The size of the gap 92 (the distance the armature travels to its retracted position
11 – also referred to as the retraction distance) determines how much area of slots 69 is
12 exposed for fluid flow from regulator outlet 52 to fluid outlet 34, and therefore controls
13 the outlet flow rate. That is, as gap 92 is increased, a larger part of the slots 69 is exposed
14 for outlet flow, thus increasing the outlet flow rate. Similarly, as gap 92 is decreased, a
15 smaller part of the slots 69 is exposed for outlet flow, thus decreasing the outlet flow rate.
16 The size, shape, number, and location of the slots 69 can be designed as appropriate for
17 the particular system in which the valves 22 will be used. The size of the gap 92 – and
18 therefore the outlet flow rate – is determined by the setting of adjustment screw 38; the
19 deeper adjustment screw 38 is set, the smaller the gap 92, and vice versa. Furthermore,
20 although a flow ring and slot structure are preferred in restricting flow from regulator
21 outlet 52, other structures may be used.

22 This combination of constant pressure (from regulator 44) and gap 92 adjustment
23 (from adjustable stroke solenoid 42) allows for very accurate control of flow rates. In

1 particular, because of regulator 44, the outlet flow rate will not be materially affected by
2 variations in input pressures. And by adjusting the gap 92, the outlet flow rate can be
3 adjusted as desired, for example, to accommodate the ratio preference for the fluids being
4 dispensed, to account for various viscosities in the fluids (for example due to temperature
5 or product characteristics), or for faster or slower dispenses (for example, without
6 limitation, to control foaming in carbonated fluids). Once the flow rate is set as desired
7 (via adjustment screw 38), the flow rate will be very stable because of the constant
8 pressure of the fluid output by regulator 44.

9 Also, by regulating input pressures with regulator 44, a smaller solenoid may be
10 used, because without pressure regulation, a solenoid must be able to seal against any
11 foreseeable input pressure, which may include relatively high pressures. Sealing against
12 those high pressures requires a relatively strong spring, and a larger solenoid to overcome
13 the spring when input pressures are lower. Because regulator 44 reduces these high input
14 pressures, the present invention allows use of a smaller solenoid, thereby reducing size
15 and cost. By reducing size, space can be better utilized, and more service space
16 accommodated. Adequate service space is important for efficient installation,
17 replacement, and calibration of the valves 22.

18 FIGUREs 28-34 illustrate an alternative embodiment of a cartridge valve
19 according to the present invention. As shown, cartridge valve 94 includes regulator 96,
20 flow module 98, and adjustable stroke solenoid 100. A housing 102 at least partially
21 encloses these elements. Sealing cap 104 may be welded or glued to end 106 of solenoid
22 100 and end 108 of housing 102 to seal the valve 94 and fix the solenoid 100 in place.

1 Regulator 96 operates as discussed above in connection with regulator 44, except
2 that the regulator outlet is comprised of one or more regulator outlets 110 which are in
3 fluid communication with the outside of flow ring 112, which is disposed within flow
4 module 98. Flow ring 112 includes slots 114, like flow ring 67 and slots 69 discussed
5 above. Flow ring 112 also includes a ring outlet 116 in fluid communication with outlet
6 annulus 118 through one or more ports 120. Outlet annulus 118 is in fluid
7 communication with fluid outlet 34, and sealed on either end with O-rings 119.

8 As in the first embodiment discussed above, armature 72 and solenoid diaphragm
9 74 move within flow ring 112 from a closed position, to an open, retracted position.
10 However, in the embodiment of FIGURES 28-34, in the closed position, diaphragm 74
11 seals ring outlet 116 to close the valve (rather than regulator outlet 52). In the retracted
12 position, some or all of slots 114 are exposed to allow fluid flow through the fluid
13 passageway that runs from the one or more regulator outlets 110 into flow module 98,
14 through slots 114 into flow ring 112, then through ring outlet 116, ports 120, and annulus
15 118 to fluid outlet 34.

16 FIGURES 30 and 31 are schematic representations of the operation of cartridge
17 valve 94, with FIGURE 30 showing adjustable stroke solenoid 100 in the closed position
18 (diaphragm 74 seals off ring outlet 116 and gap 61 is present), and FIGURE 31 showing
19 it in the open position. In the open position, armature 72 is retracted to its retracted
20 position, no gap 61 is present (armature 72's end 84 is stopped against adjustment screw
21 38's end 82), and gap 92 exists between diaphragm 74 and ring outlet 116. Flow arrows
22 in FIGURE 31 show fluid flowing from outside the flow ring 112 into the gap 92
23 (through slots 114). FIGURES 30 and 31 also demonstrate how flange 93 of solenoid

1 diaphragm 74 rolls as the armature retracts, and maintains the seal between the flow
2 module 98 and the armature.

3 As in the earlier described embodiment, the size of the gap 92 determines how
4 much area of slots 114 is exposed for fluid flow from the one or more regulator outlets
5 110 to fluid outlet 34, and therefore controls the outlet flow rate. That is, as gap 92 is
6 increased, a larger part of the slots 114 is exposed for outlet flow, thus increasing the
7 outlet flow rate. Similarly, as gap 92 is decreased, a smaller part of the slots 114 is
8 exposed for outlet flow, thus decreasing the outlet flow rate. The size, shape, number,
9 and location of the slots 114 can be designed as appropriate for the particular system in
10 which the valves will be used, and the size of the gap 92 – and therefore the outlet flow
11 rate – is determined by the setting of adjustment screw; the deeper adjustment screw is
12 set, the smaller the gap 92, and vice versa.

13 As also shown in FIGURES 30 and 31, flow ring 112 may be formed with internal
14 reserve space 122, which is spaced apart from ring outlet 116. When valve 94 is open,
15 reserve space 122 fills with fluid, and when valve 94 is closed, fluid is trapped in the
16 reserve space 122 at operating pressure. Also, flow module 98 is configured such that
17 fluid from regulator 96 communicates with the space around diaphragm neck 91 (and
18 armature neck 87). Pressure across armature head 86 is balanced by the trapped fluid in
19 reserve space 122 and the fluid in the space around neck 91. This design allows use of a
20 relatively small solenoid spring 70, and therefore a relatively small solenoid to overcome
21 the spring for opening. As described above, this reduces cost, and saves space which
22 allows for more service space.

FIGUREs 32 and 33 show top and sectional views of uninstalled cartridge valve 94, showing adjustable stroke solenoid 100 in its closed position. FIGUREs 34 and 35 show angled top and sectional views of installed cartridge valve with adjustable stroke solenoid 100 in its retracted position. Regulator 96 is shown in block form.

FIGURE 36 illustrates an exploded view of one embodiment of an adjustable stroke solenoid 100, showing one particular embodiment of an adjustment screw 124 and its threaded end 126.

The reciprocating action of the armature and solenoid diaphragm 74 within the flow ring (67 and 112) cleans the flow ring and the slots (69 and 114) of clogged particulate matter and some pulps. This cleaning function makes these embodiments particularly suited for use with, without limitation, both relatively consistent fluids and those that have varying amounts and sizes of particulate matter or pulp, such as, without limitation, juices.

FIGUREs 37a and 37b illustrate an alternative embodiment for coupling a cartridge valve to a backblock. As illustrated, cartridge valve 22b includes tabs (or retaining feet) 30a each having an anti-rotation boss 30b. The tabs 30a are inserted into and rotated within anti-rotation pocket 32a of backblock 24b, secured with an interference fit. Anti-rotation pocket 32a includes a matching contour for anti-rotational engagement with boss 30b.

FIGURE 38 illustrates another alternative embodiment for coupling a cartridge valve to a backblock. As illustrated, cartridge valve 22c includes retaining slots 130 for bayonet fitting with retaining bosses 132 of backblock 24c.

FIGUREs 37a and 38 also illustrate that accessories may be attached to the cartridge valves described herein. As shown in FIGURE 37a, accessory cleats 134 may be formed on the body of cartridge valve 22b, to secure accessories. In one non-limiting example, as shown in FIGURE 37a, a slide-lock 136 is slidingly engaged with the cleats 134 and accessory fitting 138, creating an interference fit and locking accessory fitting 138. Any suitable accessory may be used. As another non-limiting example, FIGURE 38 illustrates a flow director 140, which can be used to direct flow from fluid outlet 34 to a path parallel with the longitudinal axis of valve 22c.

FIGURE 39 illustrates one embodiment of an offset adapter 142 for backwards compatibility with some existing systems. In some existing post-mix dispensing systems, the spacing of water and syrup outlet connectors may prevent direct connection of one or more of the backblocks 24 (e.g., 24a, 24b, 24c) discussed herein. That is, when one discrete backblock 24 is installed, its position may interfere with installation of another. To obviate this problem, offset adapter 142 is provided to connect with the appropriate outlet connector 144 in an offset position (not centered with valve 22) and direct its flow within backblock 24d to valve 22, to accommodate spacing of two or more discrete backblocks 24.

Furthermore, the overall design configuration of the shown valve embodiments, a substantially straight cylinder, allows for a relatively high installed density, with relatively close mounting spacing. In a particular example, the backblock 24 shown in FIGUREs 2 and 3 (for 4 valves) may be approximately 4 inches wide by 3.75 inches tall, and the cartridge valve housing may have an outside diameter of approximately 1 inch. Furthermore, the 4 cartridge valves installed in the backblock are shown in a staggered

1 arrangement, which advantageously allows for a reduction in backblock size in at least
2 one dimension, thereby providing flexibility of design to accommodate space
3 requirements of the system in which the cartridge valves will be used. However, the
4 sizes and arrangements may vary depending on the requirements of the system.

5 Although this description of the present invention has been described largely in
6 terms of liquid fluids, it may also be used with gaseous fluids and gaseous fluid systems.
7 Also, the terms couple or coupled as used herein include direct coupling or indirect
8 coupling through intermediate members.

9 Particular features of each of the embodiments disclosed herein may be
10 interchanged with those of the other embodiments. Also, valve 22 or 94 may be
11 combined with a valve having a fixed outlet orifice (such as, without limitation, those
12 disclosed herein, or ones without a flow ring and slots, but without an adjustment
13 mechanism) to simplify ratio adjustment (e.g., in a post-mix dispenser with a beverage
14 base valve and a water valve for forming a finished beverage, the beverage base valve
15 may be adjustable as described herein, but the water valve may have a fixed orifice
16 between the regulator and the outlet for an un-adjustable constant flow, and thus only one
17 adjustment would be made in such a case).

18 Although the present invention has been described in detail, it should be
19 understood that various changes, alterations, substitutions, additions, and modifications
20 could be made without departing from the intended scope of the invention, as defined in
21 the following claims.

WHAT IS CLAIMED IS:

1. A valve, comprising:
a fluid inlet;
a fluid outlet;
a regulator coupled to the fluid inlet and having a regulator outlet; and
a solenoid, comprising:
an armature configured to retract a retraction distance from a closed position to a retracted position, the armature adapted to stop fluid flow between the regulator outlet and the fluid outlet in the closed position; and
an adjustable stop configured to adjustably set the retraction distance.
2. The valve of Claim 1, wherein the adjustable stop is an adjustment screw, the adjustment screw including a shaft with an armature end that restricts retraction of the armature beyond the retracted position.
3. The valve of Claim 1, and further comprising a flow ring surrounding the regulator outlet, the flow ring including at least one slot in fluid communication with the regulator outlet and the fluid outlet, the fluid outlet being outside the flow ring, and wherein increasing the retraction distance exposes a larger part of the at least one slot.
4. The valve of Claim 3, wherein the flow ring has an inside diameter, the valve further comprising a diaphragm coupled to a regulator end of the armature, the diaphragm including a first section adapted to close the regulator outlet in the closed position, and a second section having an outside diameter equal to or greater than the inside diameter of the flow ring.
5. The valve of Claim 1, and further comprising a flow ring surrounding a ring

outlet, the ring outlet in fluid communication with the fluid outlet, the flow ring including at least one slot in fluid communication with the regulator outlet, the regulator outlet being outside the flow ring, and wherein increasing the retraction distance exposes a larger part of the at least one slot.

6. The valve of Claim 5, wherein the flow ring has an inside diameter, the valve further comprising a diaphragm coupled to a regulator end of the armature, the diaphragm including a first section adapted to close the ring outlet in the closed position, and a second section having an outside diameter equal to or greater than the inside diameter of the flow ring.

7. The valve of Claim 1, and further comprising a diaphragm coupled to a regulator end of the armature, the diaphragm adapted to isolate the armature from fluid flowing from the regulator outlet.

8. The valve of Claim 1, and further comprising a diaphragm coupled to a regulator end of the armature, the diaphragm including a first section adapted to close fluid communication between the regulator outlet and the fluid outlet in the closed position, and a second section adapted to isolate the armature from fluid flowing from the regulator outlet.

9. The valve of Claim 1, and further comprising a fluid passageway from the regulator outlet to the fluid outlet, wherein the fluid passageway is closed by the armature in the closed position, and wherein increasing the retraction distance increases fluid flow through the fluid passageway.

10. The valve of Claim 1, and further comprising tabs extending from the valve, the tabs adapted to couple with a backblock in a bayonet fitting arrangement.

11. The valve of Claim 1, and wherein the regulator and solenoid are arranged in a substantially linear arrangement, and housed axially in a substantially cylindrical housing.
12. The valve of Claim 1, wherein the regulator and solenoid are arranged substantially linearly.
13. The valve of Claim 1, wherein the fluid outlet is positioned between the regulator and the solenoid.
14. A beverage dispensing system, comprising:
 - a water valve coupled to a water inlet;
 - a beverage base valve coupled to a beverage base inlet;
 - a user interface;
 - a controller coupled to the water valve, the beverage base valve, and the user interface;
 - a nozzle;
 - wherein the water valve and the beverage base valve each comprise:
 - a fluid inlet;
 - a fluid outlet coupled to the nozzle;
 - a regulator coupled to the fluid inlet and having a regulator outlet; and
 - a solenoid, comprising:
 - an armature configured to retract a retraction distance from a closed position to a retracted position, the armature adapted to stop fluid flow between the regulator outlet and the fluid outlet in the closed position; and
 - an adjustable stop configured to adjustably set the retraction distance; and

wherein the controller, in response to the user interface, is operable to activate the water valve and the beverage base valve to dispense water and beverage base to form a finished beverage.

15. The system of Claim 14, wherein the water is carbonated.

16. The system of Claim 14, wherein each adjustable stop is an adjustment screw, the adjustment screw including a shaft with an armature end that restricts retraction of the armature beyond the retracted position.

17. The system of Claim 14, each valve further comprising a flow ring surrounding the regulator outlet, the flow ring including at least one slot in fluid communication with the fluid outlet, the fluid outlet being outside the flow ring, and wherein increasing the retraction distance exposes a larger part of the at least one slot.

18. The system of Claim 14, each valve further comprising a flow ring surrounding a ring outlet, the ring outlet in fluid communication with the fluid outlet, the flow ring including at least one slot in fluid communication with the regulator outlet, the regulator outlet being outside the flow ring, and wherein increasing the retraction distance exposes a larger part of the at least one slot.

19. The system of Claim 14, and further comprising:

a backblock adapted to respectively couple the water inlet and beverage base inlet to the water valve and beverage base valve, the backblock including a water shut-off valve coupled to the water inlet and a beverage-base shut-off valve coupled to the beverage base inlet, and

tabs extending from the water valve and the beverage base valve, the tabs adapted to couple the respective water valve and beverage base valve with the backblock in a

bayonet fitting arrangement, and wherein the coupled water valve opens the water shut-off valve, and the coupled beverage base valve opens the beverage-base shut-off valve.

20. The system of Claim 14, each valve further comprising a fluid passageway from the regulator outlet to the fluid outlet, wherein the fluid passageway is closed by the armature in the closed position, and wherein increasing the retraction distance increases fluid flow through the fluid passageway.

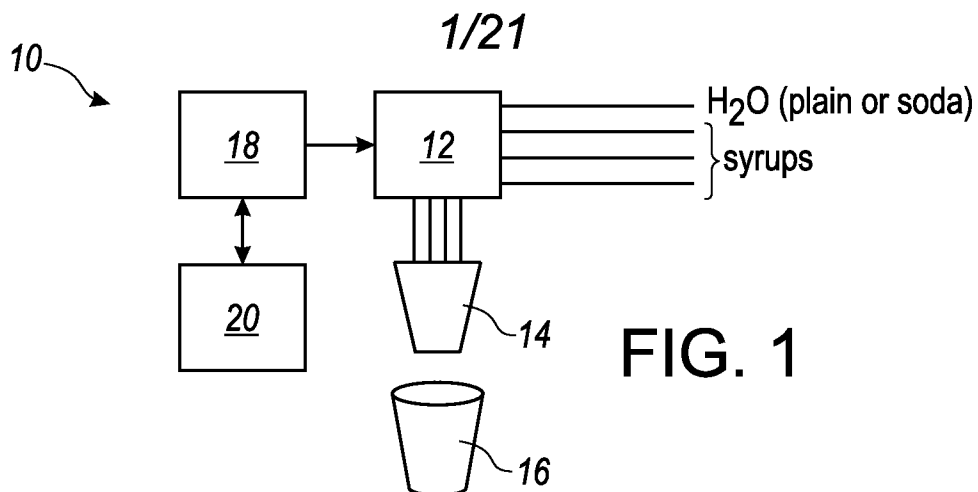


FIG. 1

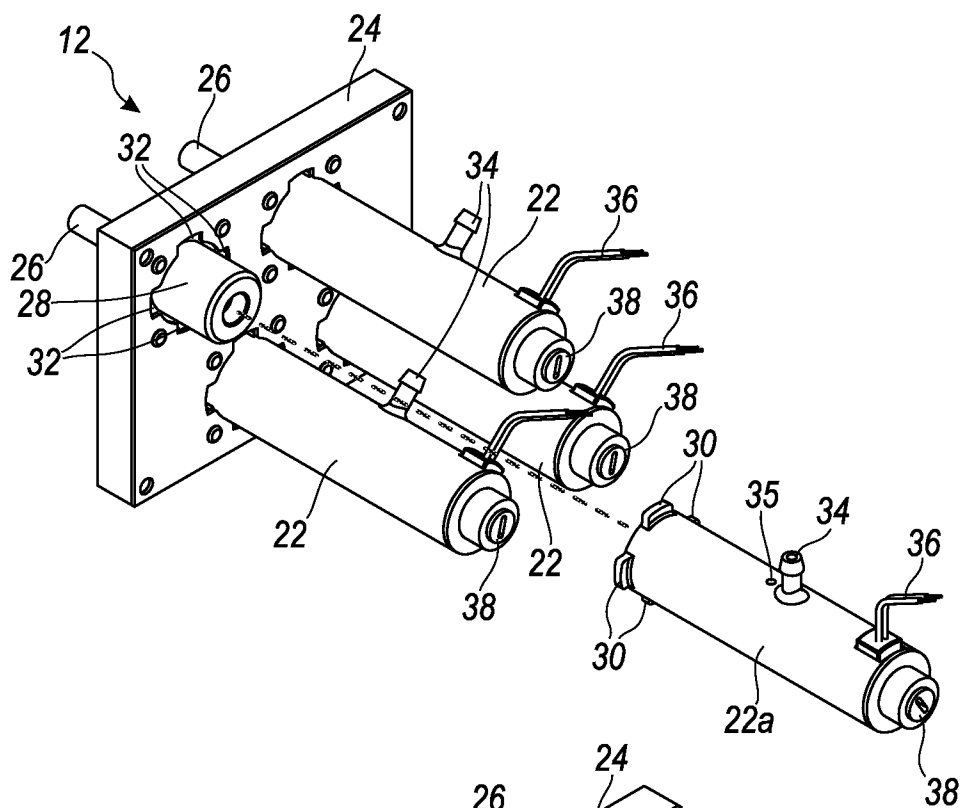


FIG. 2

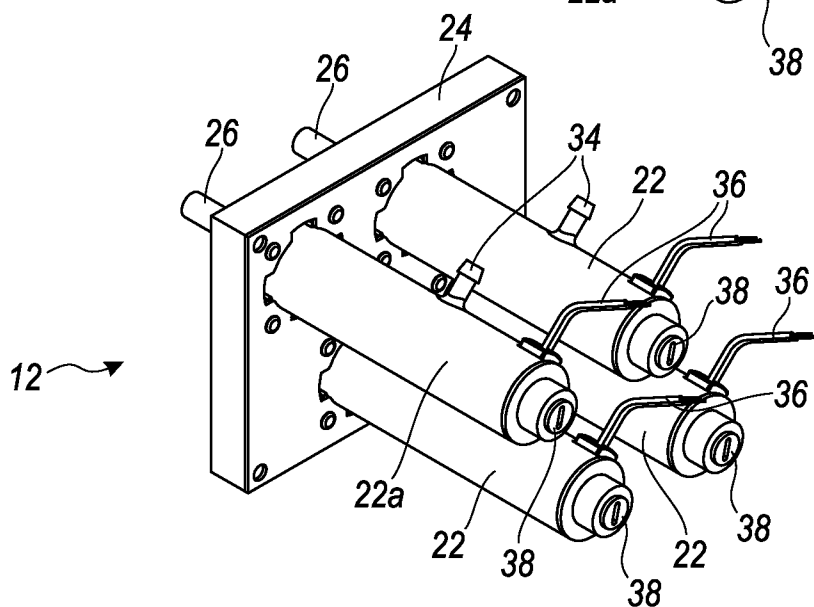
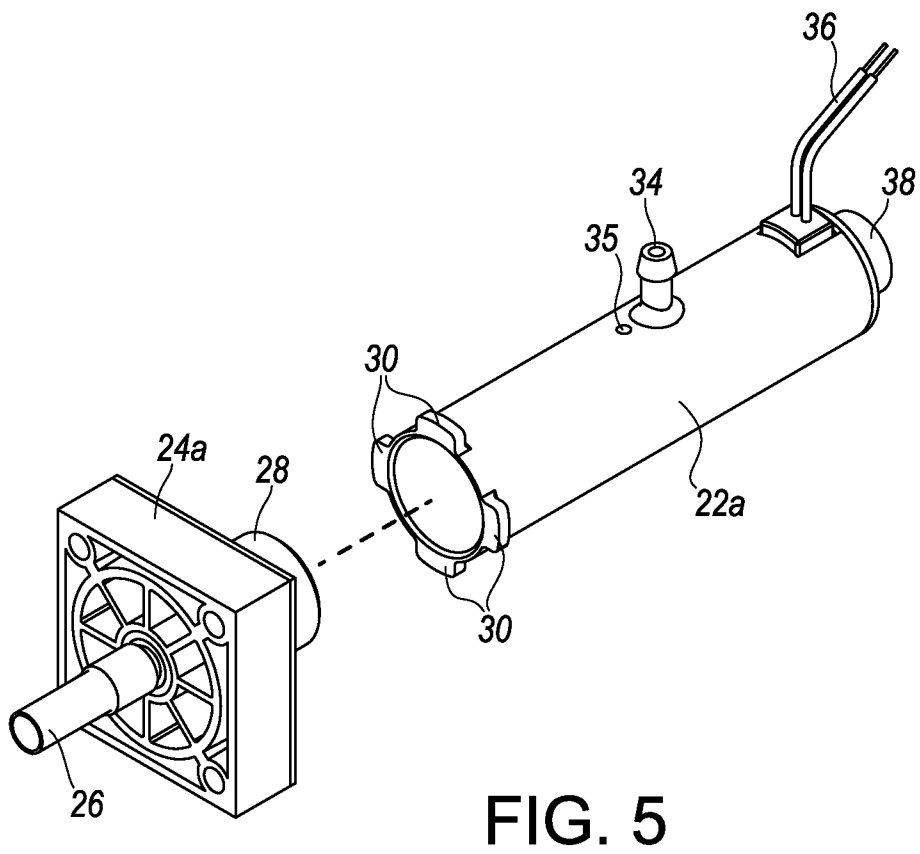
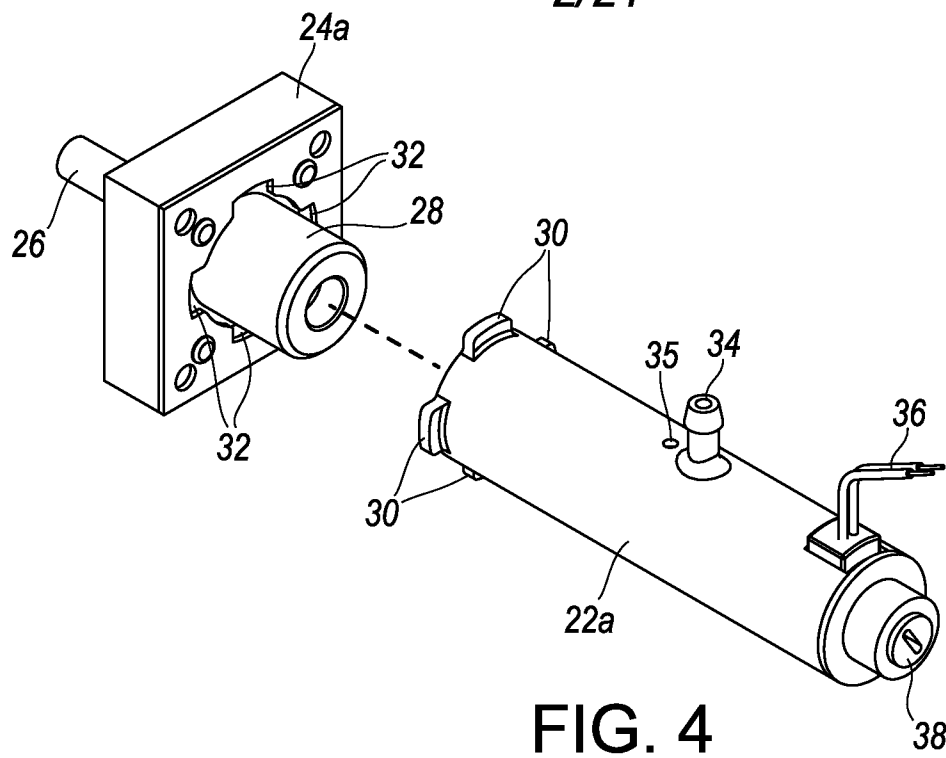


FIG. 3

2/21



3/21

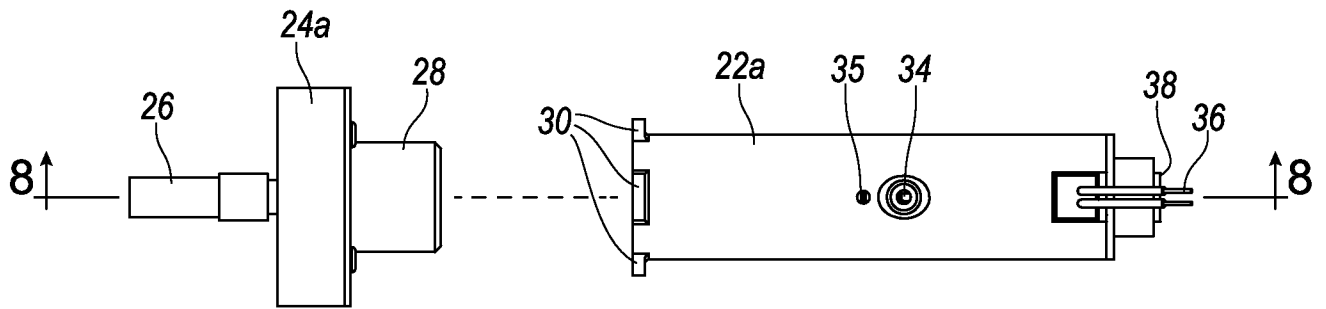


FIG. 6

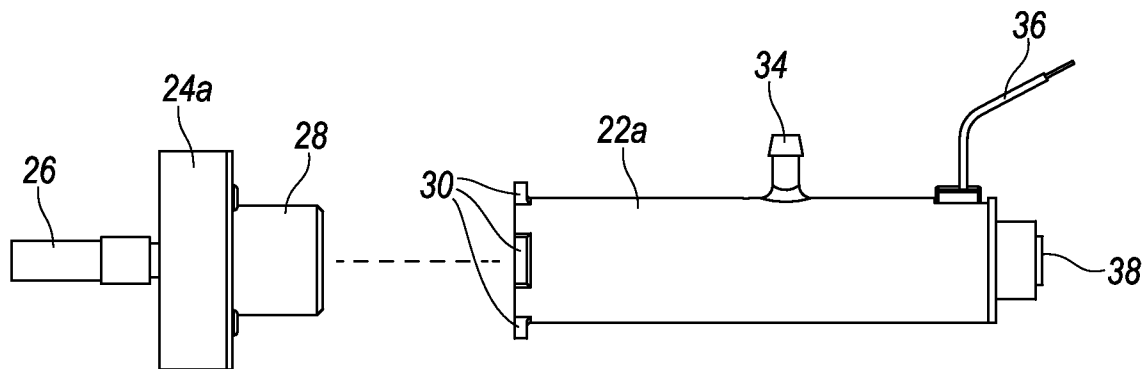


FIG. 7

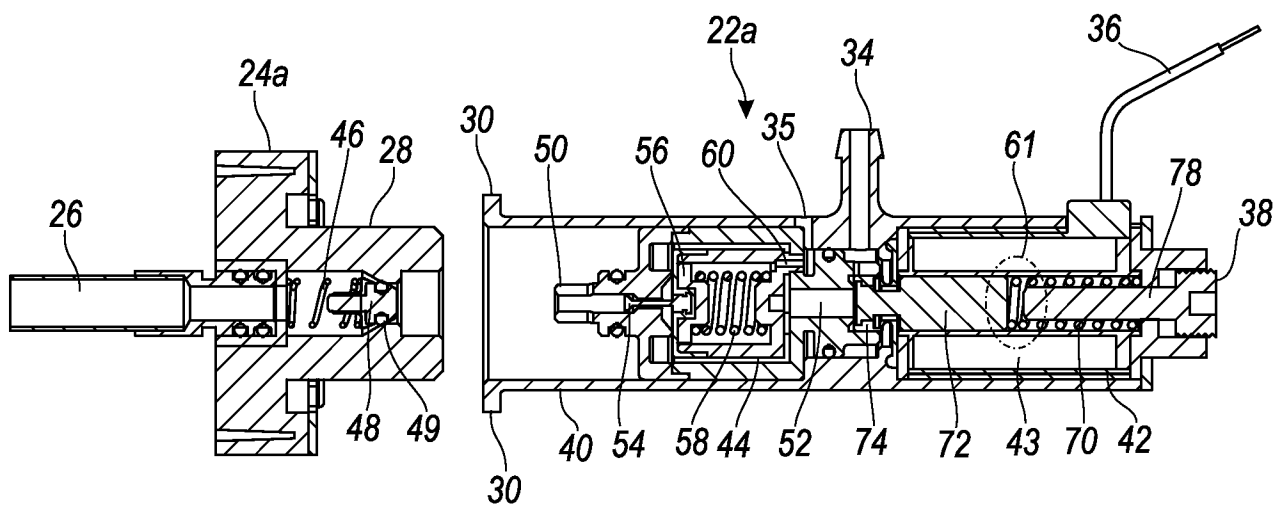


FIG. 8

4/21

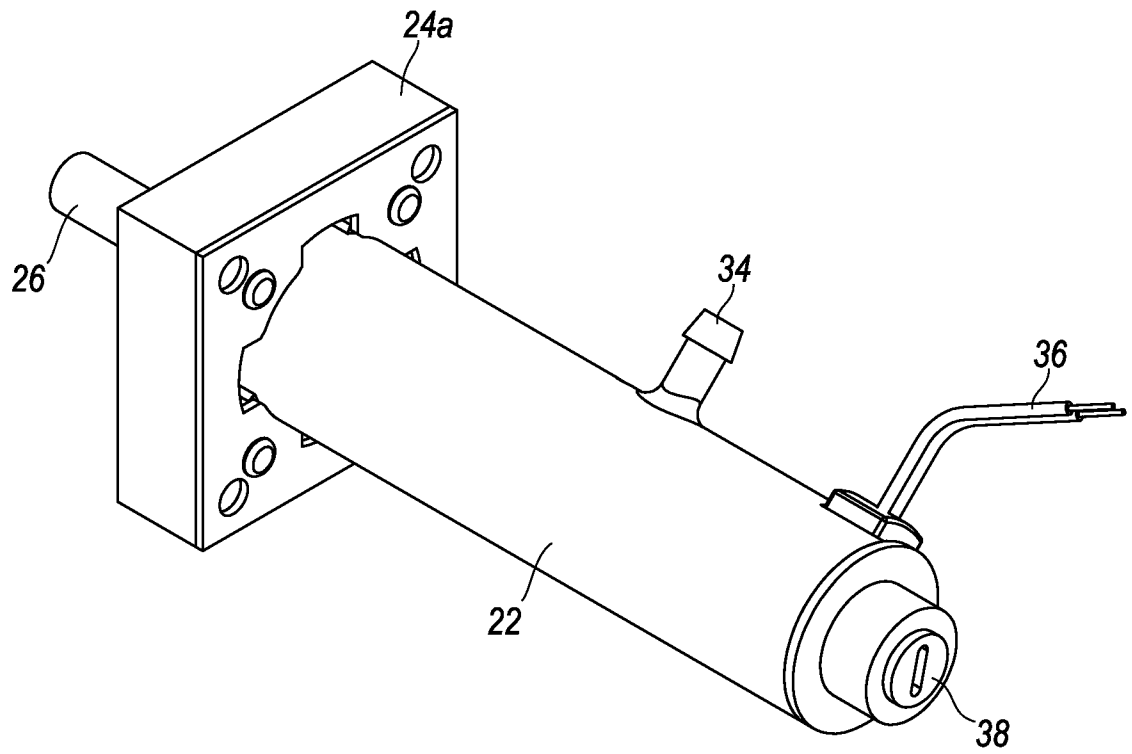


FIG. 9

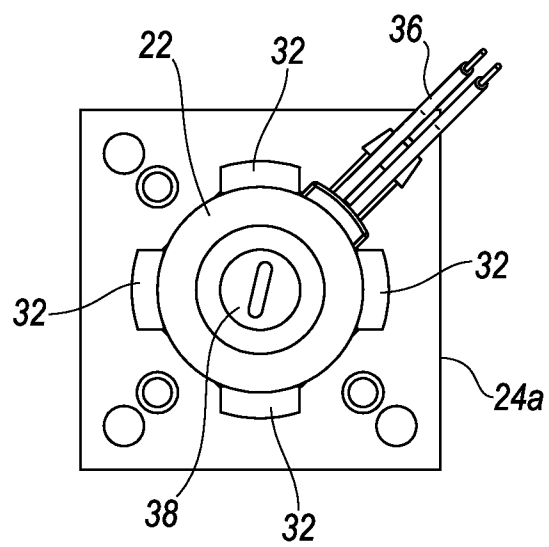
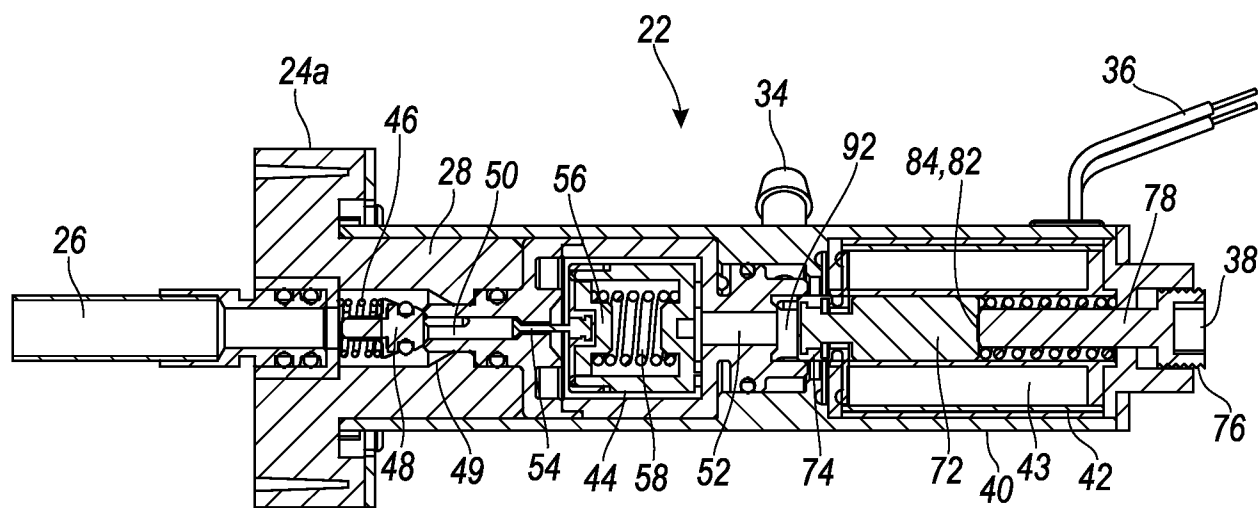
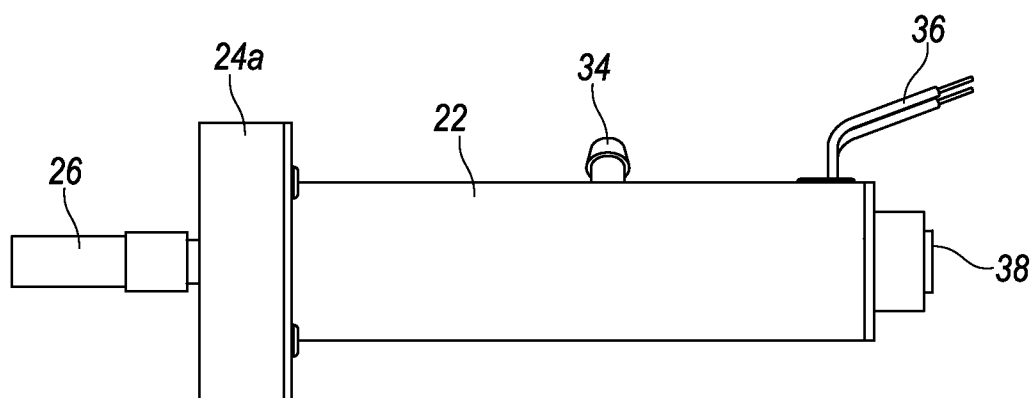
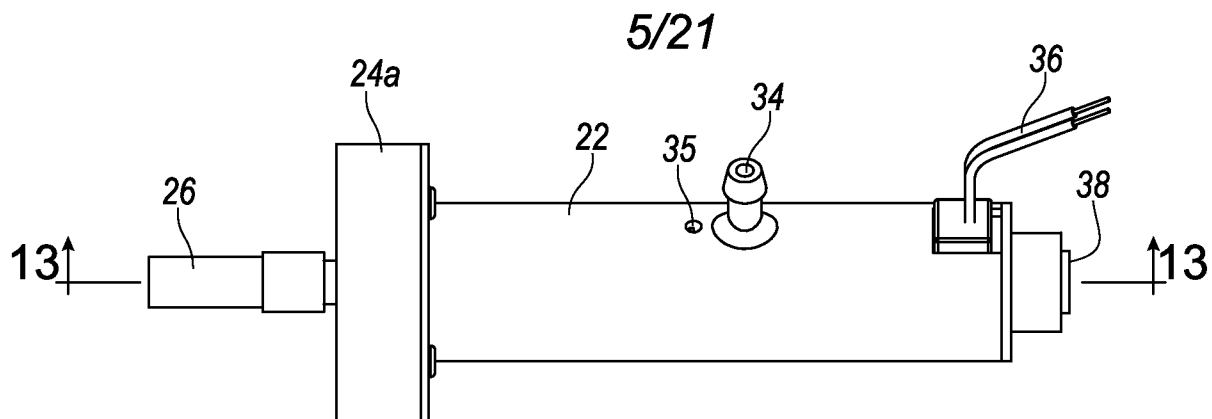


FIG. 10



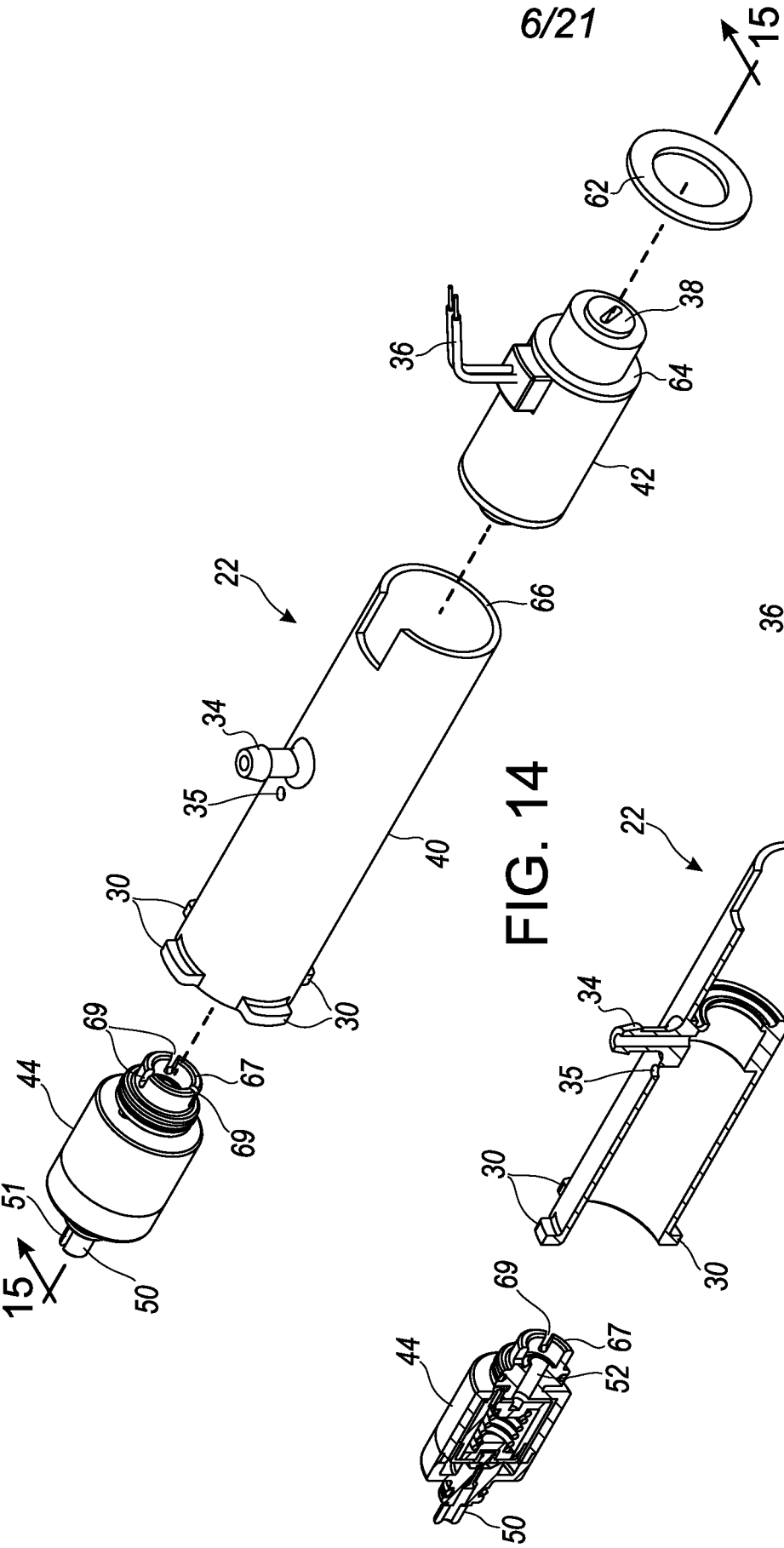
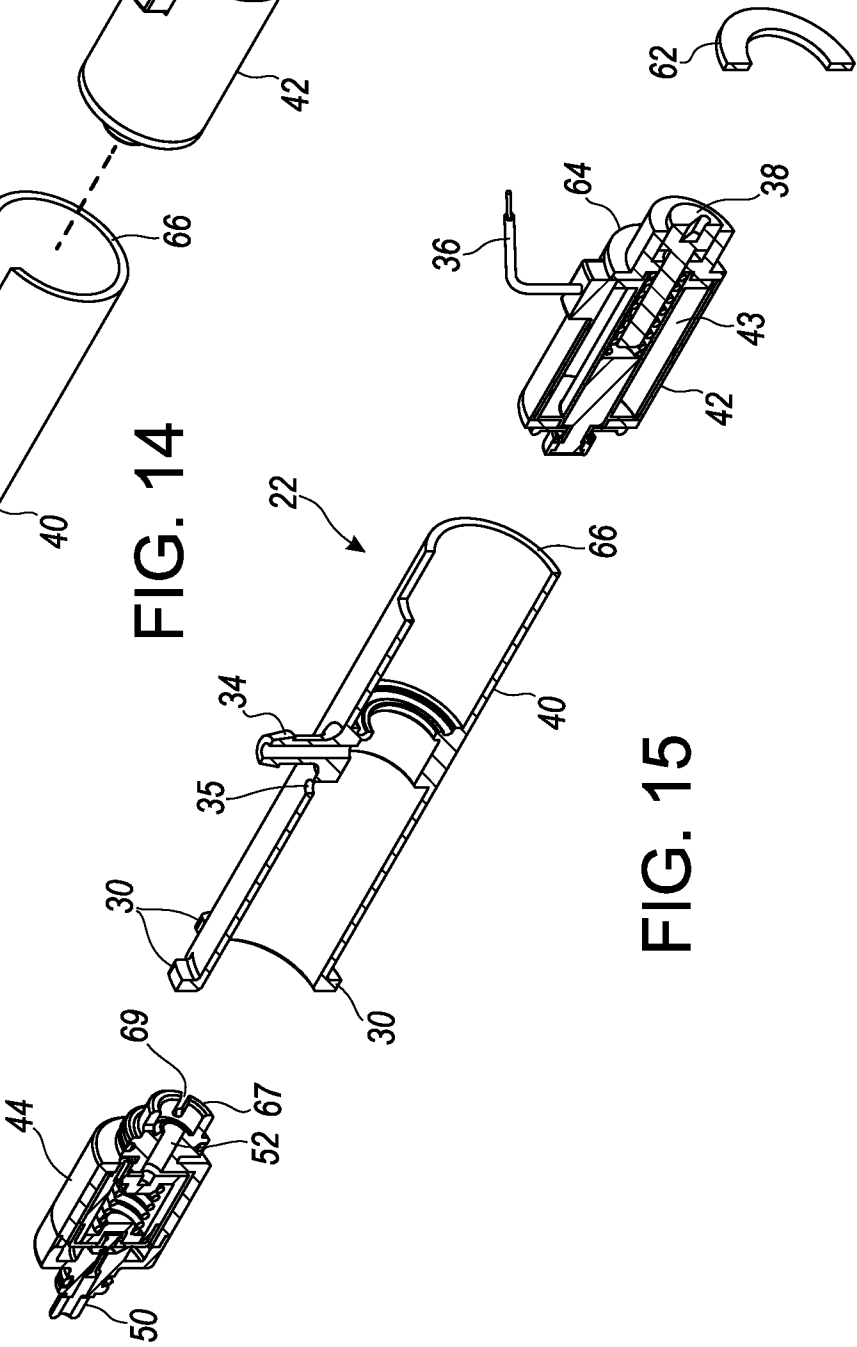
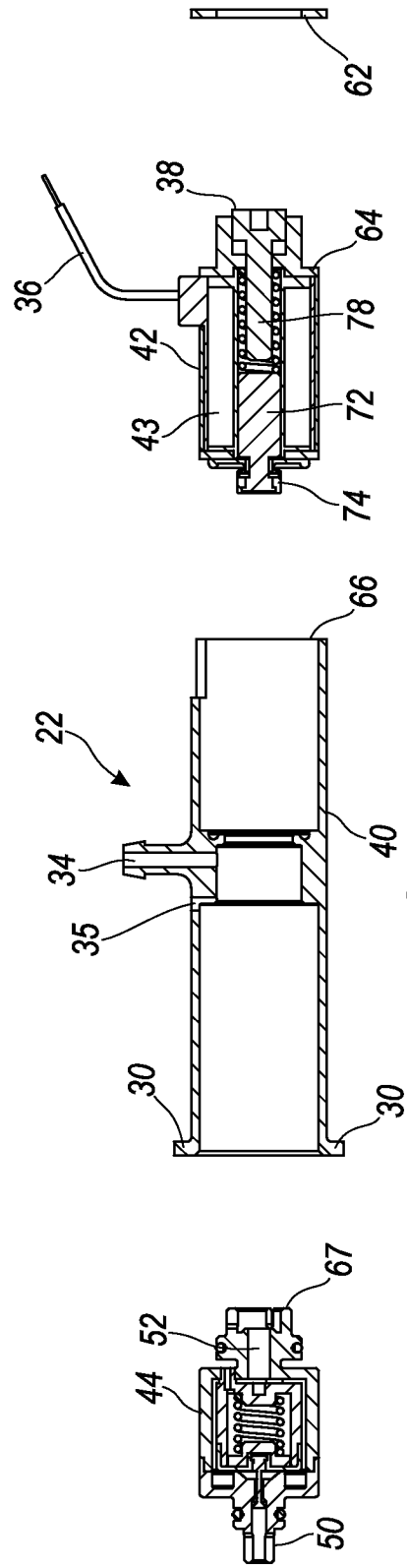
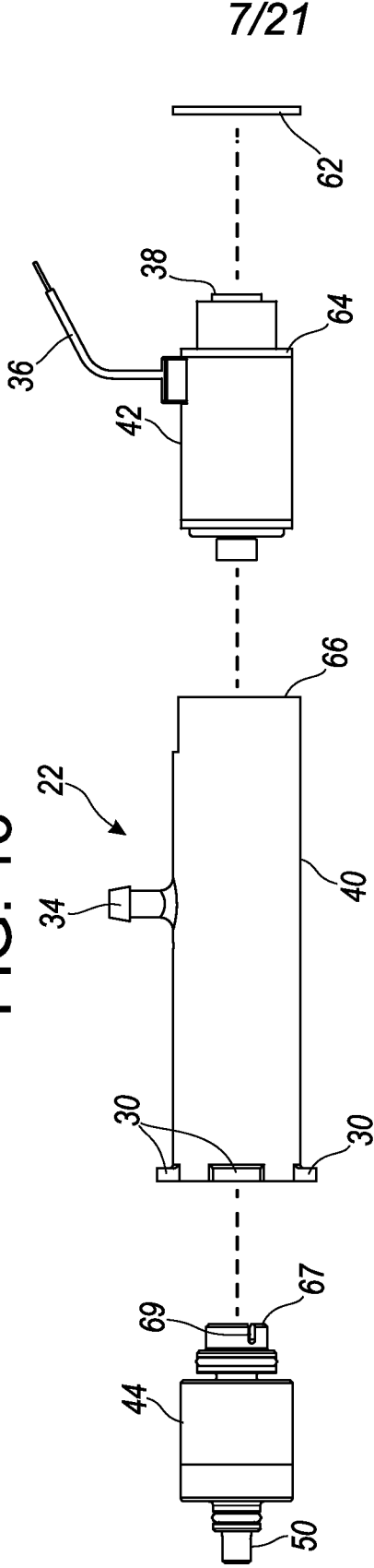
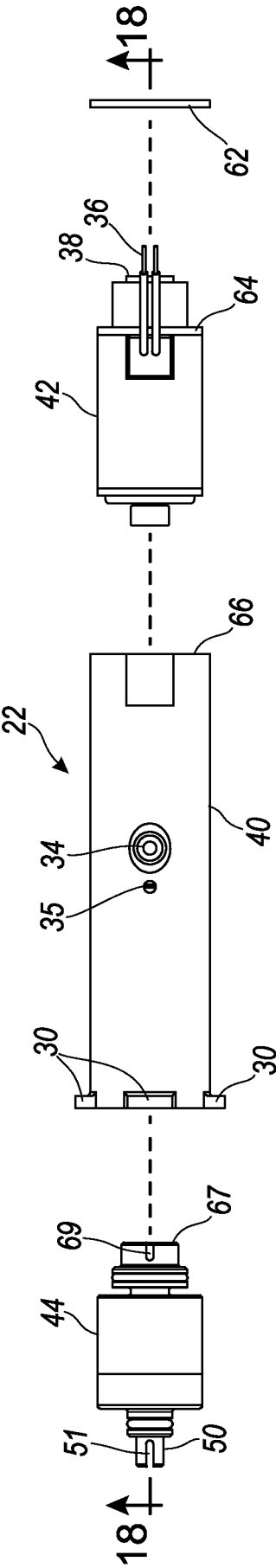


FIG. 14

FIG. 15





8/21

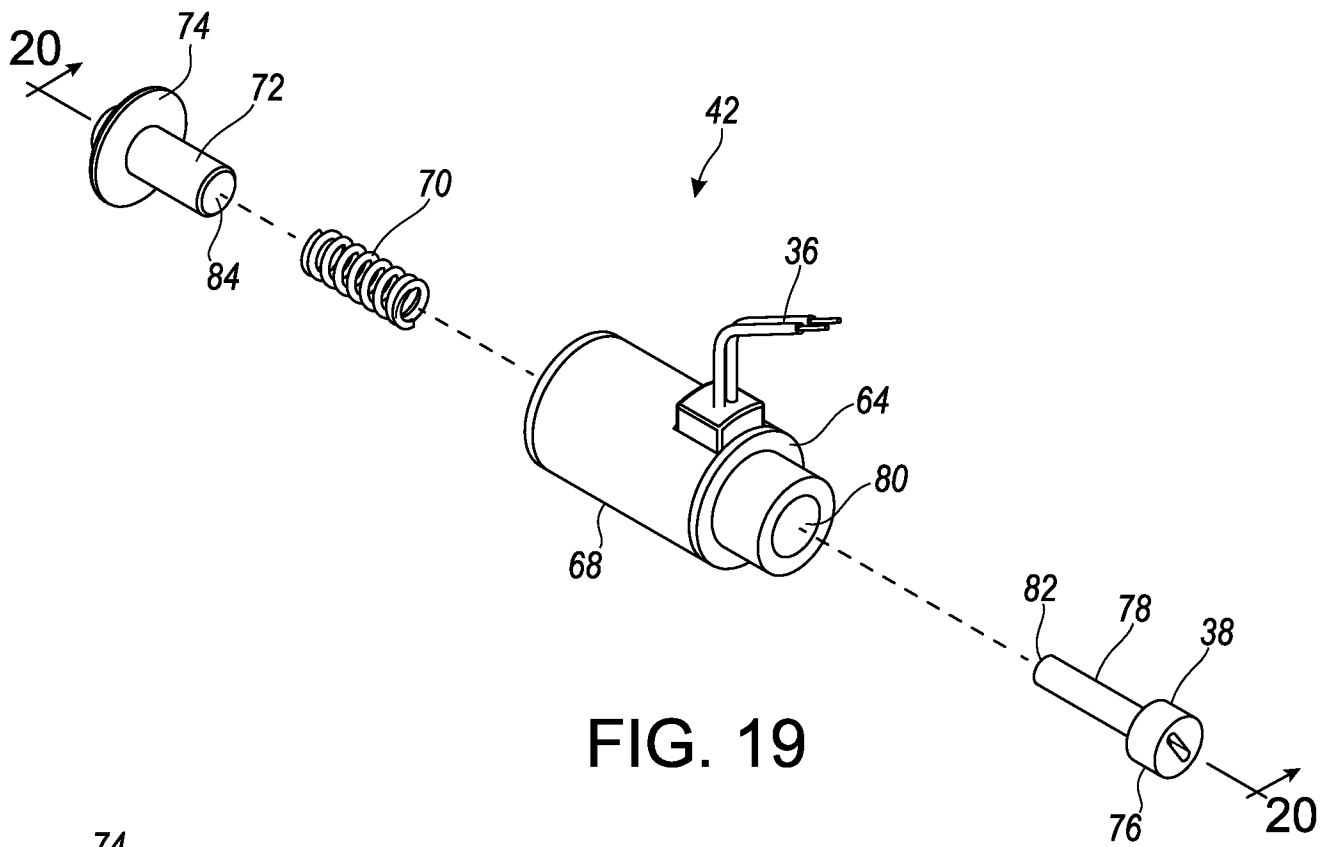


FIG. 19

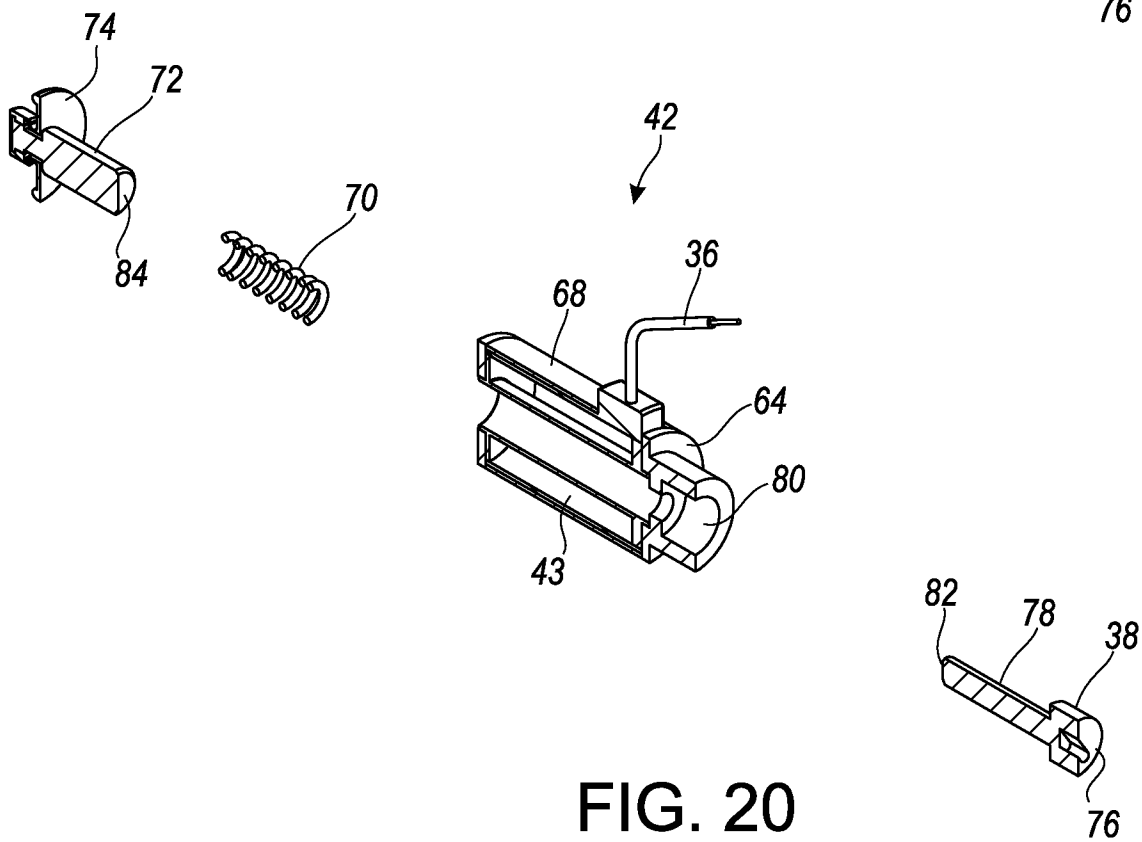


FIG. 20

9/21

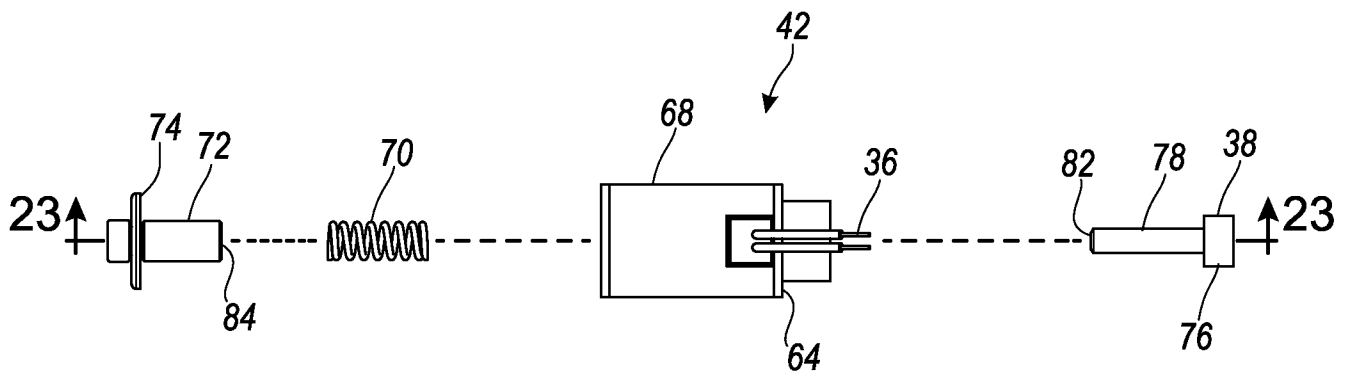


FIG. 21

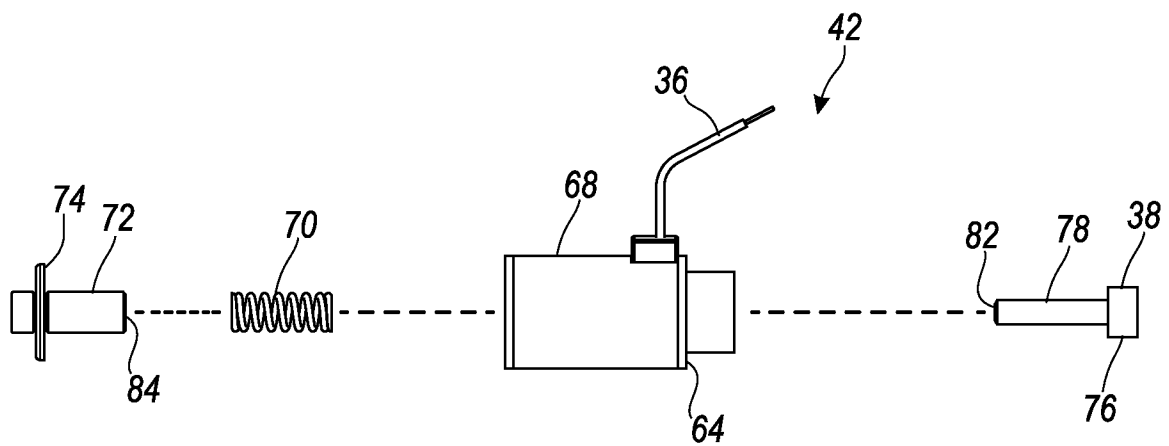


FIG. 22

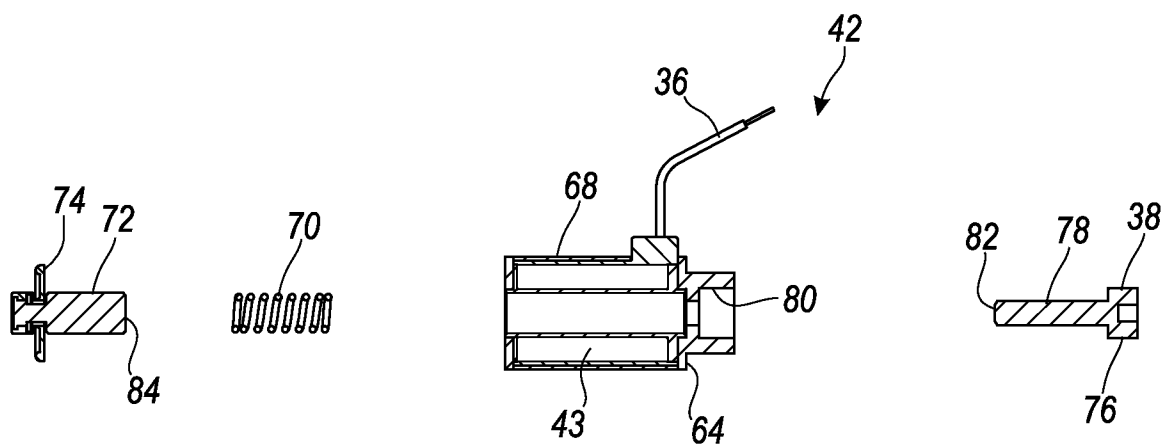


FIG. 23

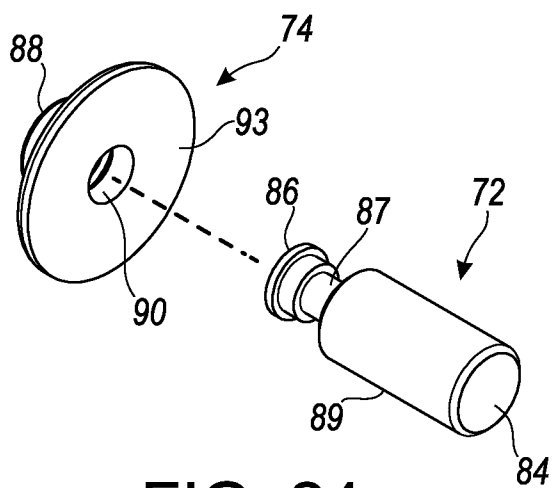


FIG. 24

10/21

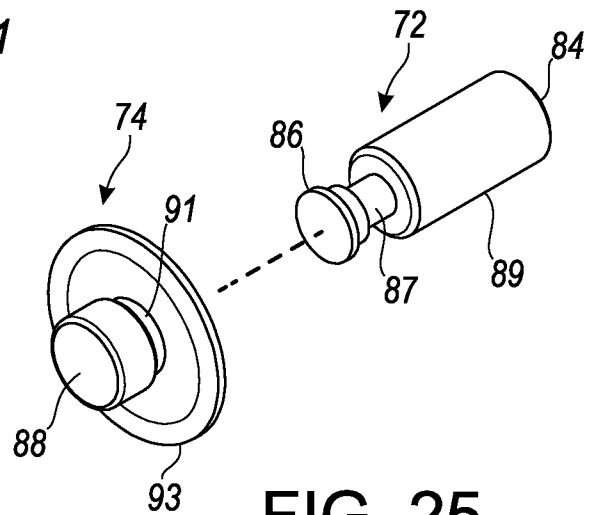


FIG. 25

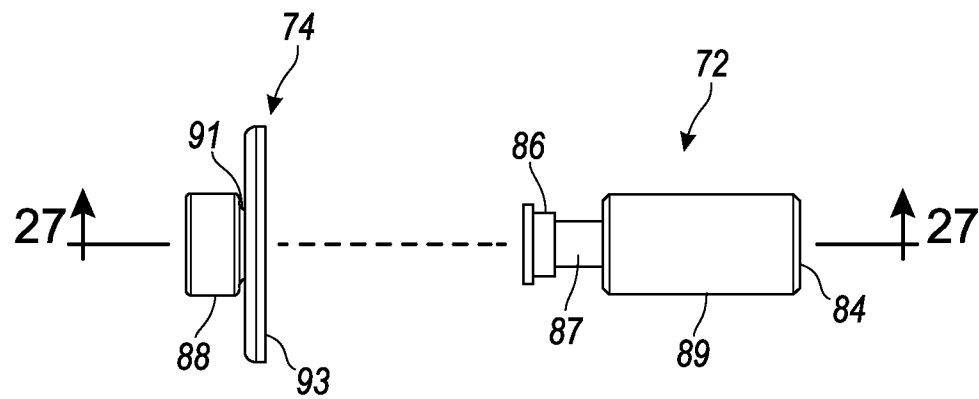


FIG. 26

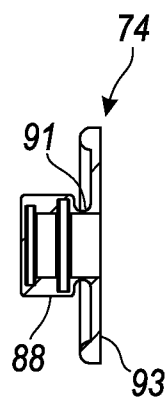


FIG. 27

11/21

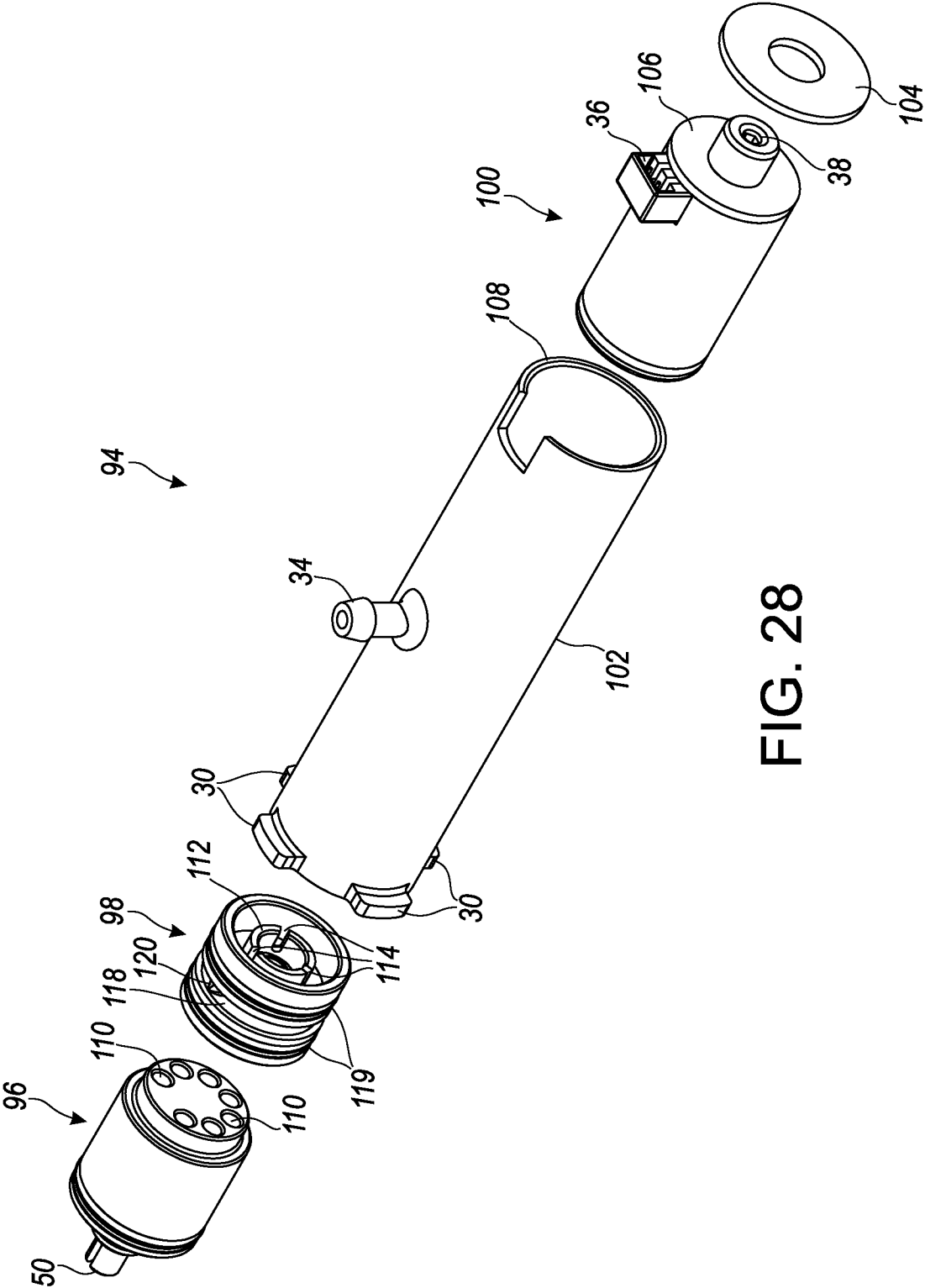


FIG. 28

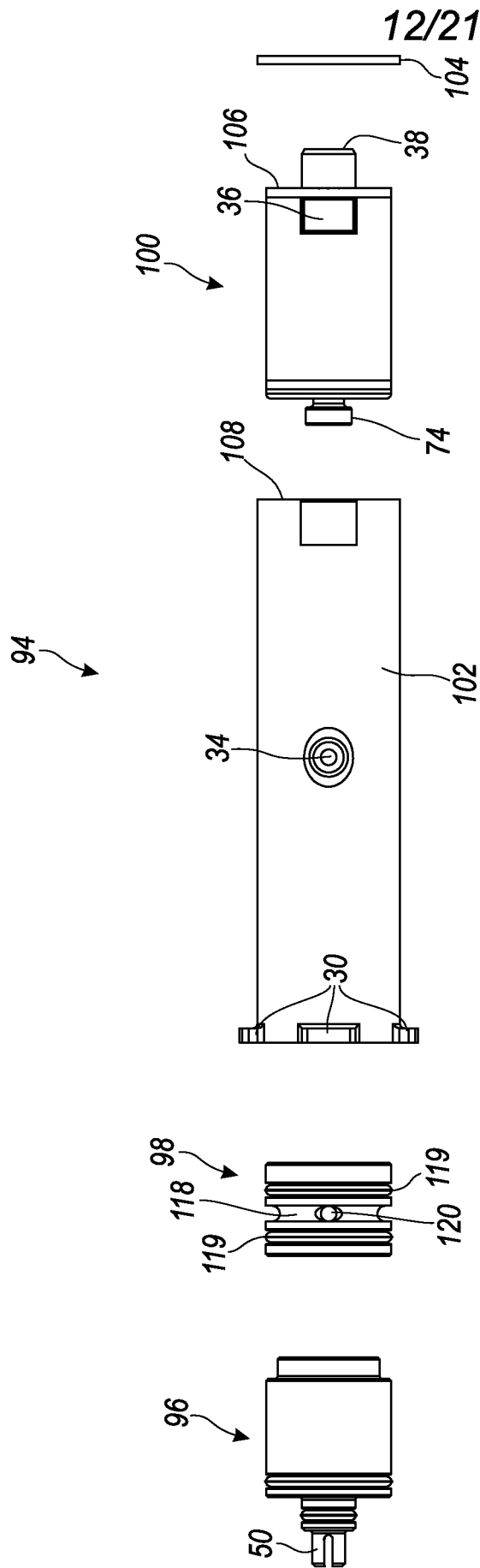


FIG. 29

13/21

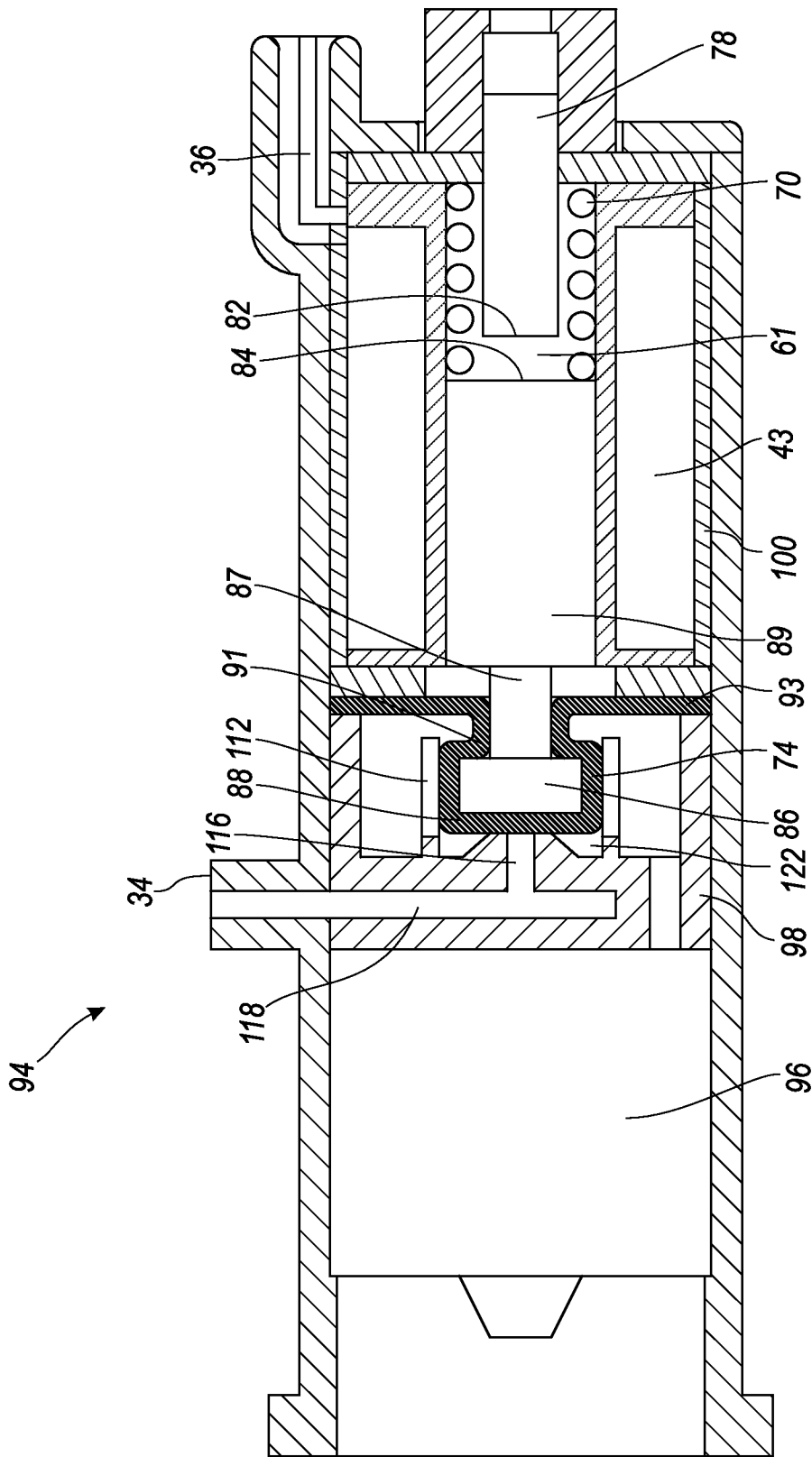


FIG. 30

14/21

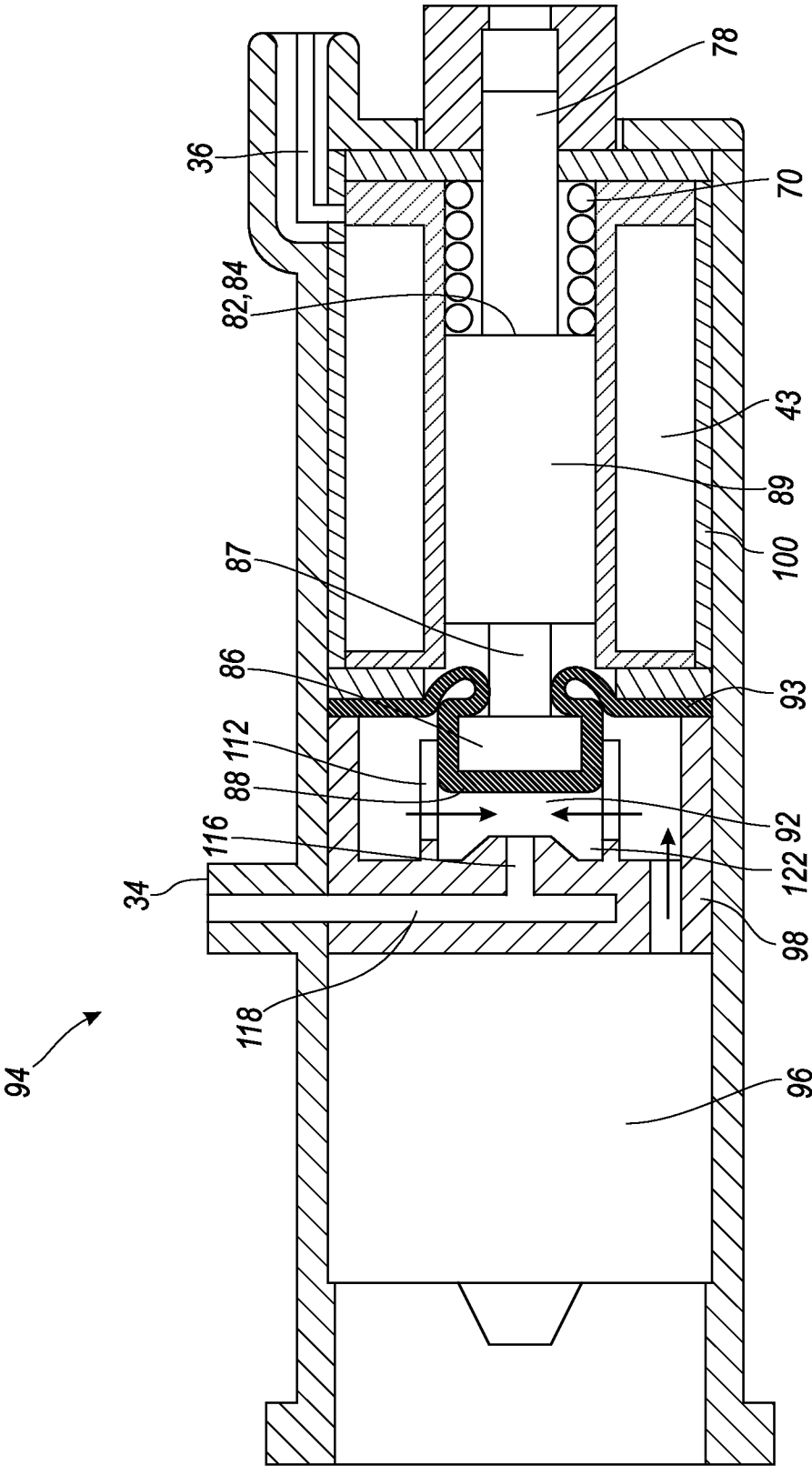


FIG. 31

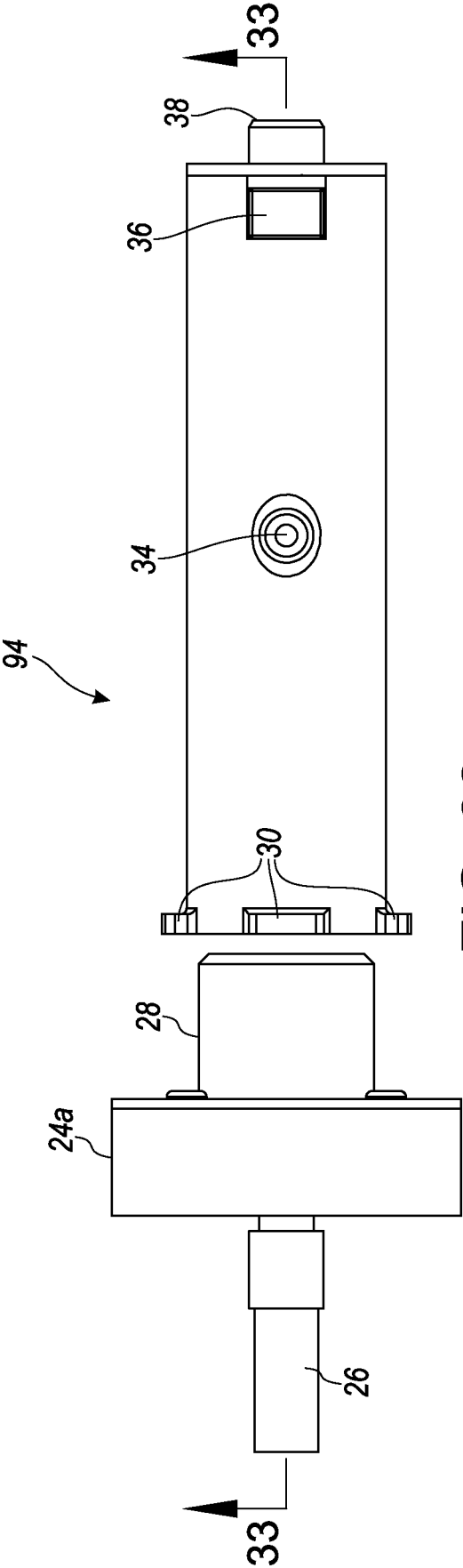


FIG. 32

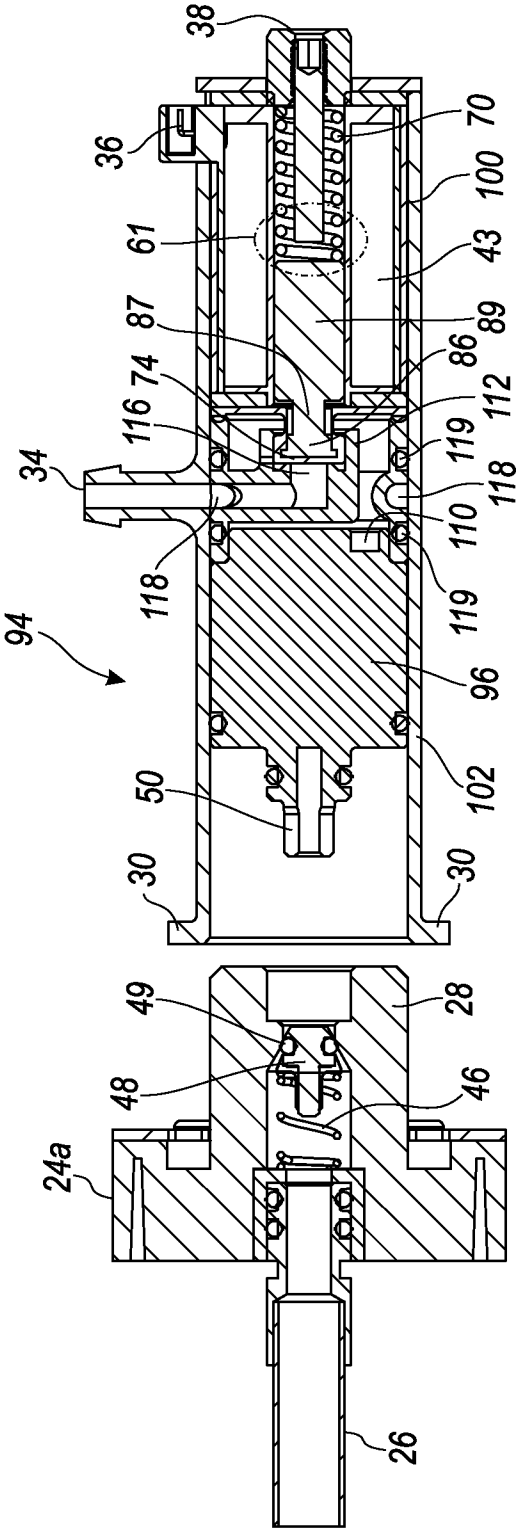


FIG. 33

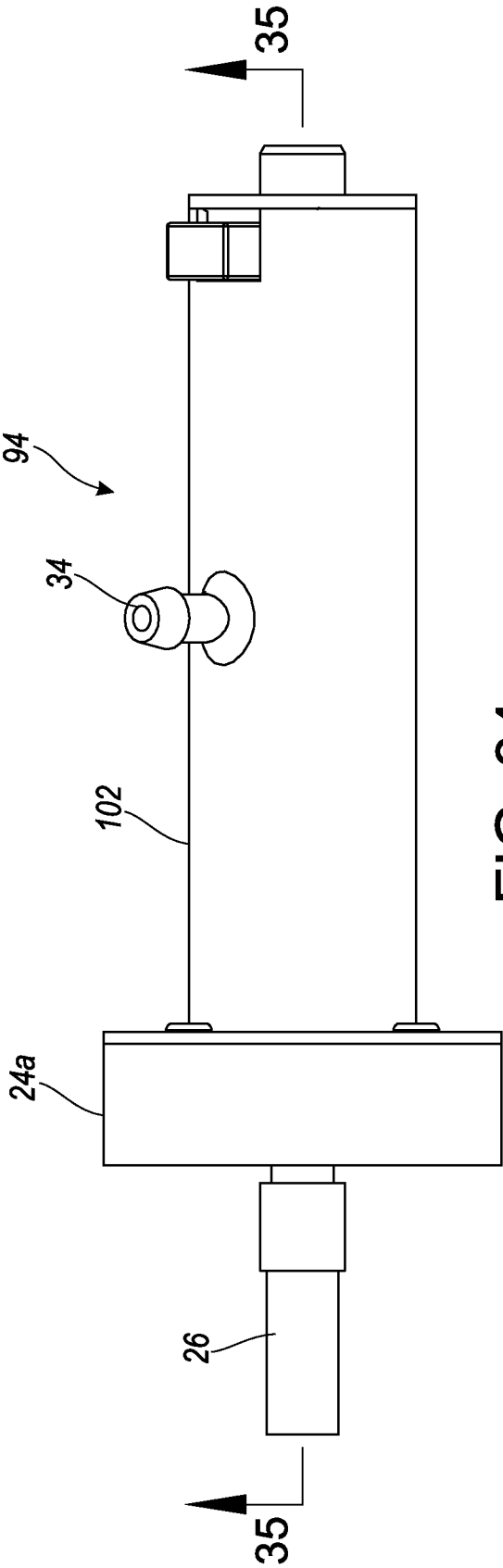


FIG. 34

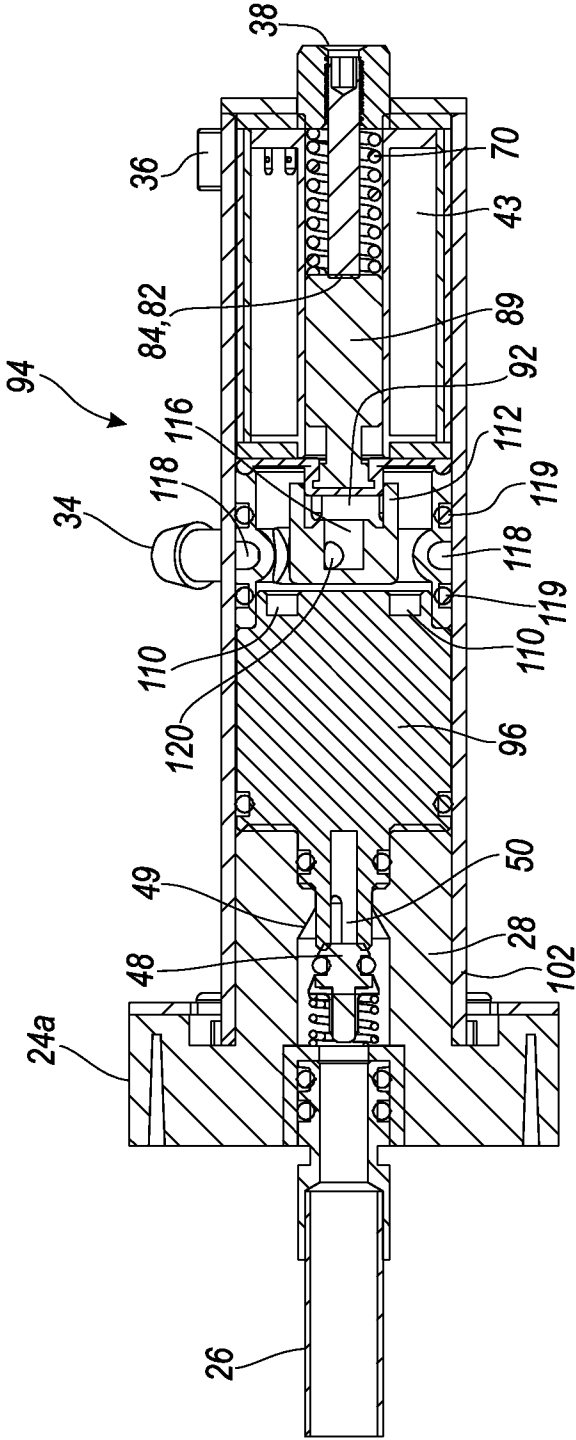


FIG. 35

17/21

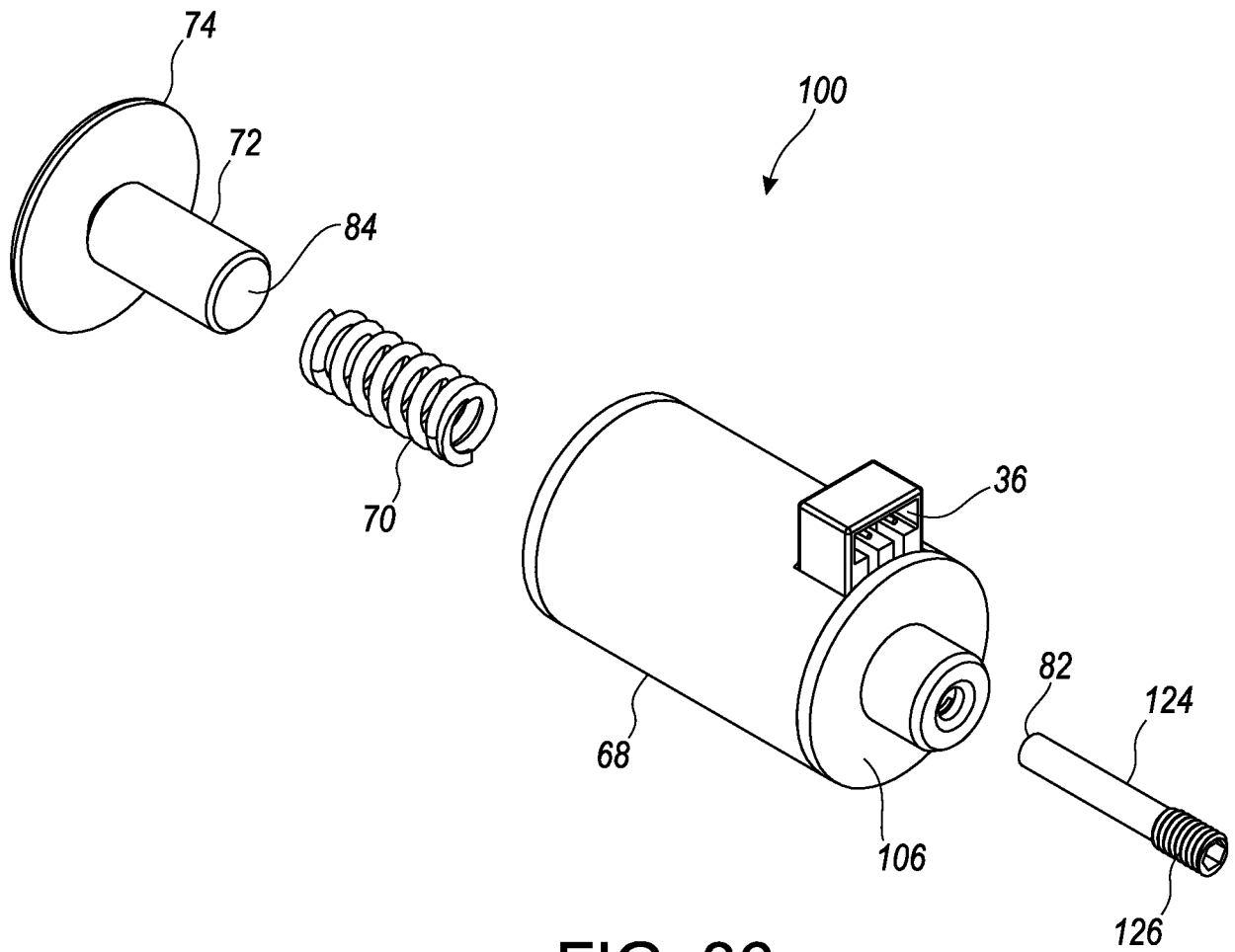
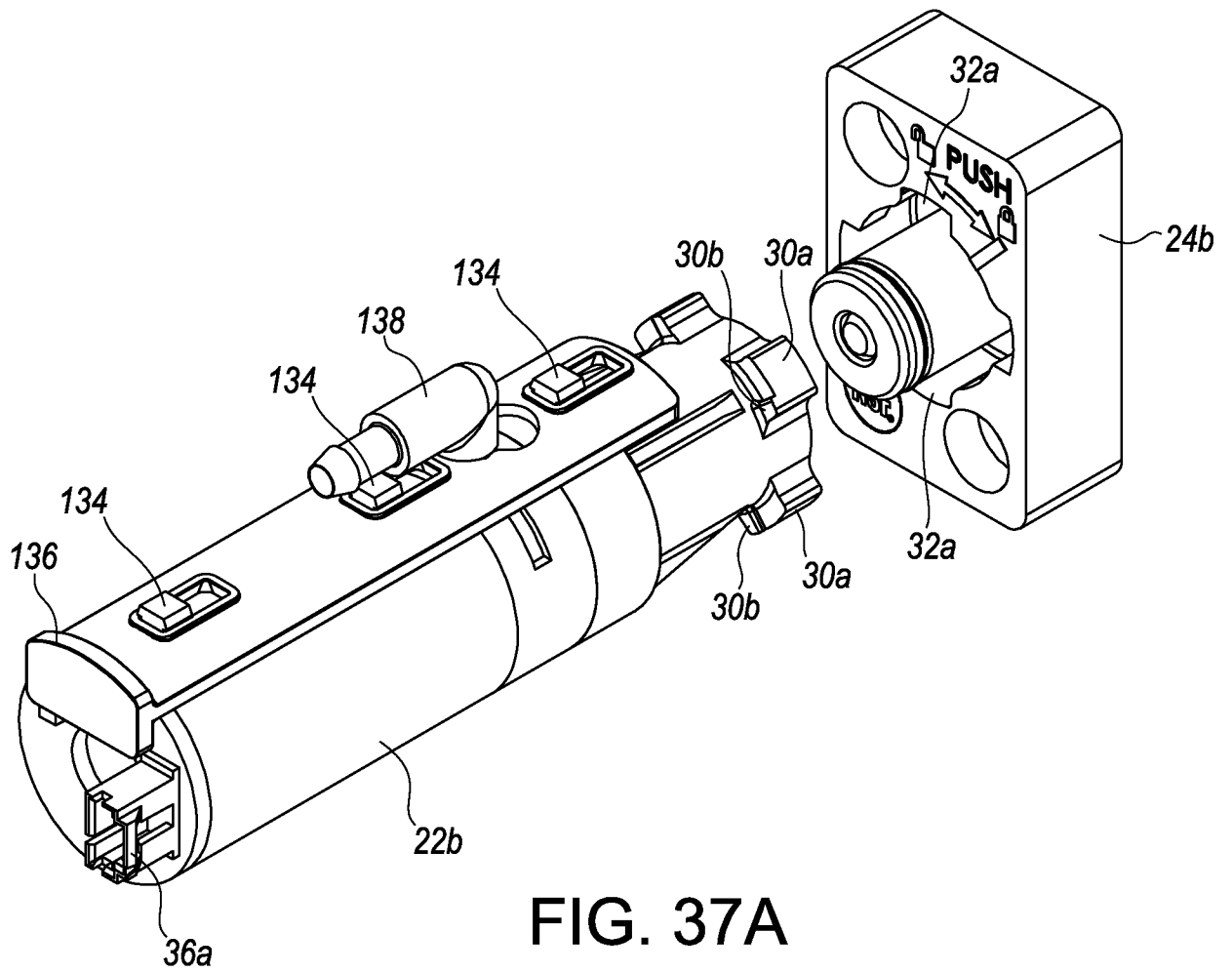


FIG. 36

18/21



19/21

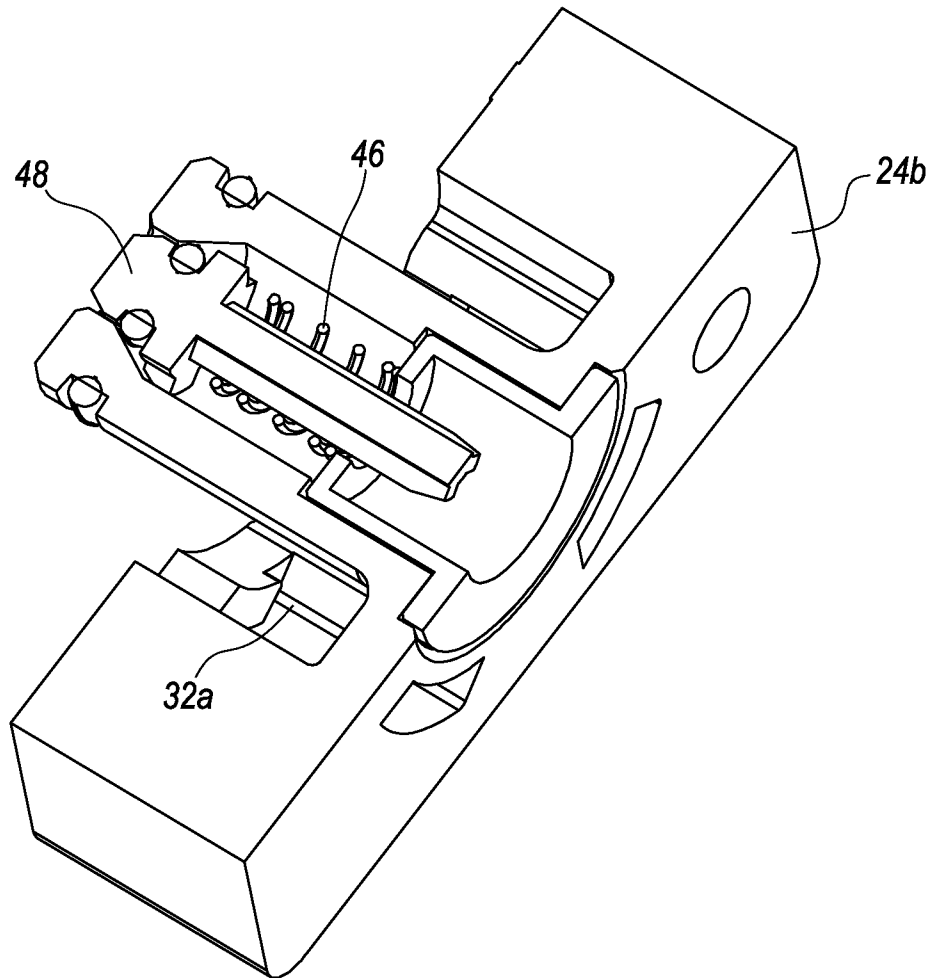


FIG. 37B

20/21

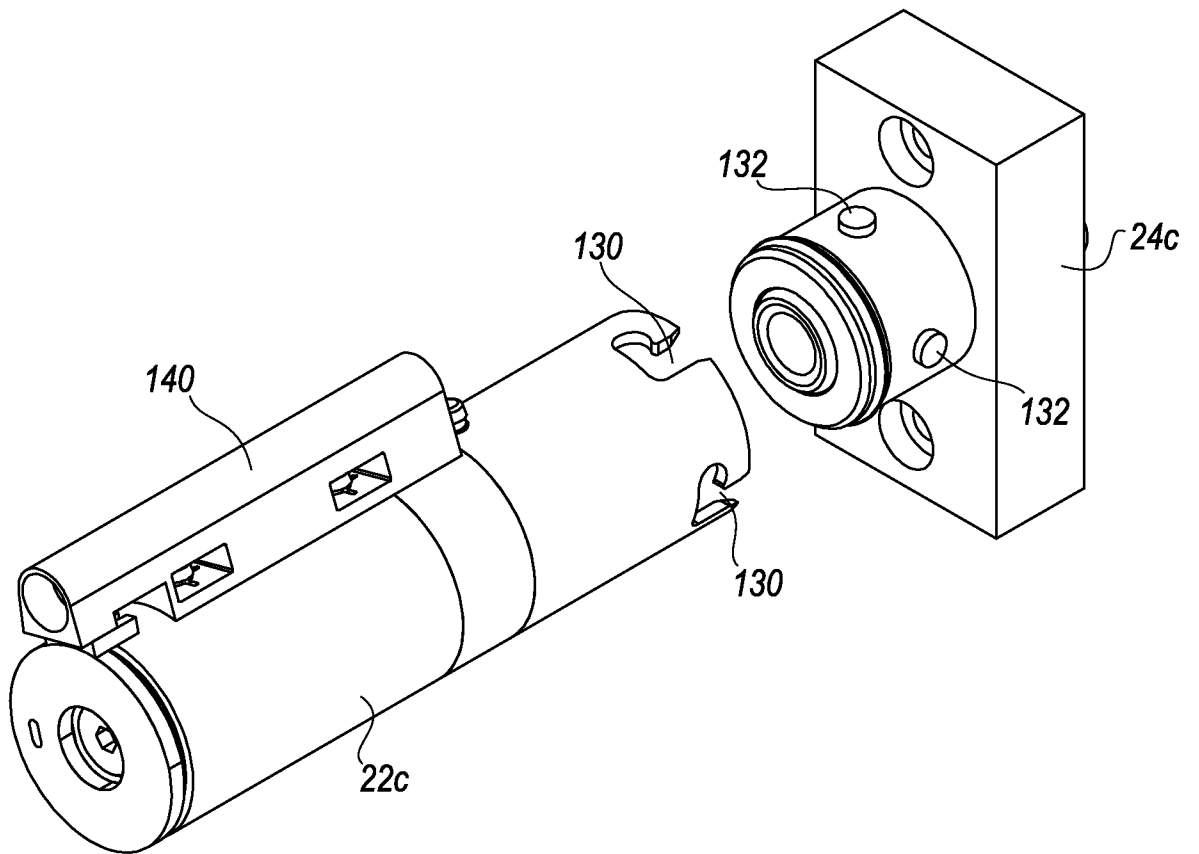


FIG. 38

21/21

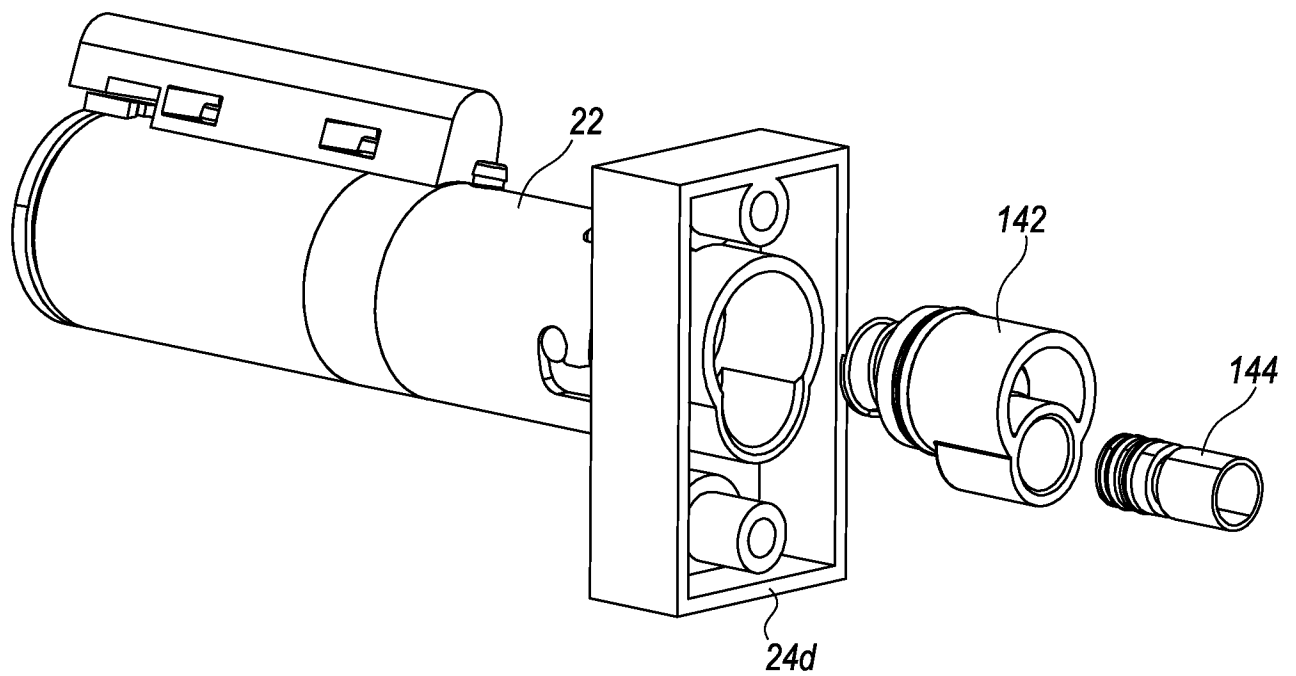


FIG. 39

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2021/047154

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F16K 31/06; B67D 1/00; B67D 1/12; B67D 3/02; F16K 31/02; H01F 7/08; H01F 7/16 (2021.01)
CPC - F16K 31/06; B67D 1/0037; B67D 1/0085; B67D 1/12; B67D 1/14; F16K 27/029; F16K 31/0644;
F16K 31/0658 (2021.08)

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)

see Search History document

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

see Search History document

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

see Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2019/0316704 A1 (MAC VALVES INC.) 17 October 2019 (17.10.2019) entire document	1-20
A	US 6,684,901 B1 (CAHILL et al) 03 February 2004 (03.02.2004) entire document	1-20
A	US 4,741,355 A (CREDLE et al) 03 May 1988 (03.05.1988) entire document	1-20
A	US 2013/0206793 A1 (SCHROEDER INDUSTRIES INC D/B/A SCHROEDER AMERICA) 15 August 2013 (15.08.2013) entire document	1-20
A	US 2009/0038690 A1 (ZUR et al) 12 February 2009 (12.02.2009) entire document	1-20

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

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

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"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

09 November 2021

Date of mailing of the international search report

DEC 20 2021

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, VA 22313-1450

Facsimile No. 571-273-8300

Authorized officer

Harry Kim

Telephone No. PCT Helpdesk: 571-272-4300