(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
6 October 2011 (06.10.2011)

PCT

(10) International Publication Number
WO 2011/123865 A1

(51) International Patent Classification:
B05B 1/14 (2006.01)

(21) International Application Number:
PCT/US2011/031134

(22) International Filing Date:
4 April 2011 (04.04.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/320,464 2 April 2010 (02.04.2010) US

(71) Applicant *(for all designated States except US)*: **STA-RITE INDUSTRIES, LLC** [US/US]; 293 Wright Street, Delavan, WI 53115 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **LANG, John** [US/US]; 999 Anawanda Path, Inver Grove Heights, MN 55077 (US). **MOHR, Mark** [US/US]; 14119 350th Street, Lindstrom, MN 55045 (US). **JAEDIKE, Colin** [US/US]; 4017 Crystal Circle, Shoreview, MN 55126 (US).

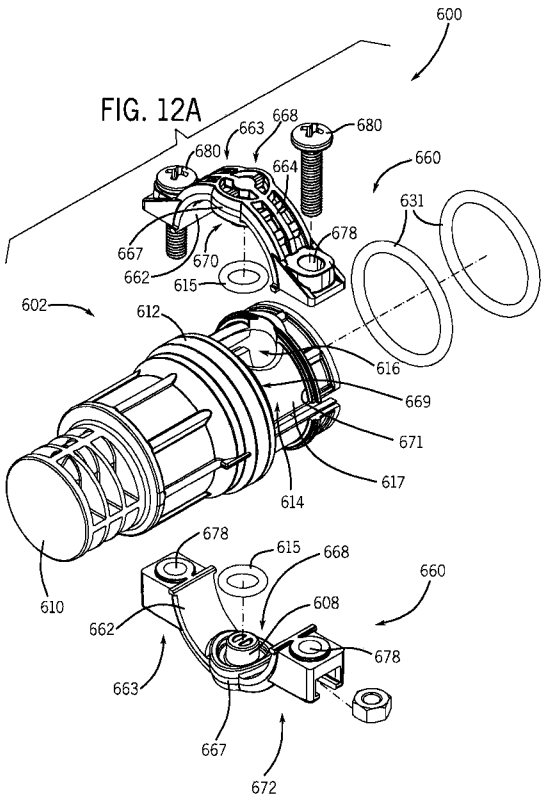
(74) Agents: **DAUGHERTY, Raye, Lynn** et al.; Quarles & Brady, 411 East Winsconsin Avenue, Ste. 2040, Milwaukee, WI 53202 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,

[Continued on next page]

(54) Title: AIR ASPIRATION DEVICE



(57) Abstract: Embodiments of the invention provide an air aspiration device to release trapped air in a pipe containing a solution that is to be delivered to a nozzle body. The air aspiration device can include an air port in fluid communication with the air and the solution, an exit port, and a passageway in fluid communication with the air port and the exit port. The air aspiration device can also include a main body and a female pipe fitting forming an end cap for one end of the pipe.

WO 2011/123865 A1

EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

AIR ASPIRATION DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to United States Provisional Application No. 61/320,464 filed on April 2, 2010. The entire disclosure of the prior application is considered part of the accompanying application and is hereby incorporated therein by reference.

BACKGROUND

[0002] The objective of an agricultural crop spraying machine is to effectively distribute an agro-chemical spray over the largest area of crop in the least amount of time. The conventional design for such a machine is a wheeled base unit, be it trailed or self-propelled, which carries a tank, pump, and controls. The conventional design supplies the agro-chemical to the distribution booms extending from either side of the wheeled base unit, perpendicular to the direction of travel.

[0003] Nozzle bodies are placed at regular intervals along the spray boom. This is referred to as a wet boom configuration. The primary role of the nozzle bodies is to provide a sealed connection between the pipe work of the boom supply and the spray tips distributing the agro-chemical. The nozzle bodies also position the spray tips at the correct angle with respect to the direction of travel. Each nozzle body has a turret to which the spray tips are attached to regulate spray pattern and flow rate.

[0004] The nozzle body is designed to siphon solution from the pipe or metal tubing from the bottom of the pipe. This orientation causes a situation where air, which is normally present in varying concentration, is pumped into the boom pipe. Air is less dense than the solution being applied and is therefore trapped in the top of the boom pipe above the solution. Air is a compressible gas that accumulates in the top of the boom and builds in pressure. When the sprayer is shut off at the end of a pass on the field or when the operator is finished spraying, the pressure in the boom pipe is still greater than the activation pressure in the diaphragm check valves (e.g., 0.5 bar) due to the air acting as an accumulator. This creates the problem of the nozzle assemblies continuing to dispense solution even after the sprayer valve is shut off. As the nozzle assemblies continue to dispense solution, the air pressure in the boom pipe decreases as the air volume expands. The nozzles will continue to dispense solution until the air pressure in the boom decreases to the point where the pressure in the

boom equals the activation pressure of the diaphragm check valve. With the presence of air in the boom pipe, shutoff times can be delayed by up to eight seconds, resulting in a significant amount of solution that is applied when and where it is not intended.

SUMMARY OF THE INVENTION

[0005] Some embodiments of the invention provide an air aspiration device for releasing air stored in a pipe when delivering a solution to a nozzle body with a feed spigot. The air aspiration device can include a main body that engages the pipe. The air aspiration device can also include a female pipe fitting that can be coupled to the main body. The female pipe fitting can form an end cap for one end of the pipe. The female pipe fitting can engage the feed spigot. The device can include an air port in the female pipe fitting that is in fluid communication with the solution and the air, and can further include a passageway through the female pipe fitting that is in fluid communication with the air port. The passageway can deliver both the solution and the air to the feed spigot. The air aspiration device can also include an exit port in the female pipe fitting that is in fluid communication with the passageway and that engages the feed spigot.

[0006] In another embodiment, the invention can provide an air aspirator assembly to release air trapped in a pipe when delivering a solution to a nozzle body that includes a feed spigot. The pipe can include an aperture. The assembly can include a main body that engages the pipe. The assembly can also include a female pipe fitting that engages the feed spigot and a clamp. The female pipe fitting can include an air port that is in fluid communication with the solution and the air, a passageway that is in fluid communication with the air port so that it can deliver both the solution and the air to the feed spigot, and an exit port in fluid communication with the passageway and that engages the feed spigot. The clamp can include a body portion having an internal surface with a button. The button can engage the aperture in the pipe in order to maintain an angular orientation between the main body and the pipe.

[0007] The invention can also provide a removable clamp for coupling an adapter to a pipe delivering a solution, the adapter including a first aperture, and the pipe including a second aperture. The removable clamp can include a body portion having a first clamp component and a second clamp component together creating an internal surface. The clamp can also include a first button located on the internal surface. The internal surface of the

body portion can engage an outer surface of the adapter so that the first button is received by the first aperture and the second aperture in order to maintain an angular relationship between the adapter and the pipe.

[0008] In another embodiment, the invention can provide a fluid delivery system. The fluid delivery system can include a boom delivering fluid from a fluid source, with the boom including a first section with a first aperture and a second section with a second aperture. The fluid delivery system can also include a tee adapter coupled to the first section and the second section. The tee adapter can receive fluid from the fluid source and deliver the fluid to the first section and the second section. The fluid delivery system can also include a first clamp and a second clamp. The first clamp can include a first button that can be received by the first aperture. The second clamp can include a second button that can be received by the second aperture. The first clamp can couple the tee adapter to the first section and the second clamp can couple the tee adapter to the second section in order to maintain an angular relationship between the first section and the second section.

[0009] These and other features, aspects, and advantages of the present invention will become better understood upon consideration of the following detailed description, drawings, and appended claims.

DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a perspective view of a wet boom incorporating two air aspiration devices.

[0011] FIG. 2 is a perspective view of one of the air aspiration devices and associated clamp assembly on the wet boom of FIG. 1.

[0012] FIG. 3 is perspective view showing an internal portion of the air aspiration device assembly in FIG. 2.

[0013] FIG. 4 is a side elevational view of the air aspiration device assembly of FIG. 2.

[0014] FIG. 5 is a rear elevational view of the air aspiration device assembly of FIG. 2.

[0015] FIG. 6 is a perspective view of the air aspiration device of FIG. 2.

[0016] FIG. 7A is a perspective view of another embodiment of an air aspiration device.

[0017] FIG. 7B is a side elevational view of the air aspiration device of FIG. 7A.

[0018] FIG. 7C is a cross sectional view taken along line 7C-7C of FIG. 7B.

[0019] FIG. 8A is a side elevational view showing an internal portion of the air aspiration device from FIG. 7A assembled with a boom and nozzle body.

[0020] FIG. 8B is a cross sectional view taken along line 8B-8B of FIG. 8A.

[0021] FIG. 9A is a perspective view of an alternative embodiment of the invention including an air aspiration device assembly on a dry boom.

[0022] FIG. 9B is a side elevational view of the air aspiration device assembly on the dry boom of FIG. 9A.

[0023] FIG. 9C is a cross sectional view taken along line 9C-9C of FIG. 9B.

[0024] FIG. 10A is a perspective view of an alternative embodiment of the invention including an air aspiration device assembly on a wet boom.

[0025] FIG. 10B is a side elevational view of the air aspiration device and the wet boom of FIG. 10A.

[0026] FIG. 10C is a cross sectional view taken along line 10C-10C of FIG. 10B.

[0027] FIG. 11A is a perspective view of a wet boom end cap.

[0028] FIG. 11B is side elevational view of the wet boom end cap of FIG. 11A.

[0029] FIG. 11C is a cross sectional view taken along line 11C-11C of FIG. 11B.

[0030] FIG. 12A is an exploded perspective view of another embodiment of the air aspiration device and clamp assembly.

[0031] FIG. 12B is a perspective view of the assembled air aspiration device and clamp assembly of FIG. 12A.

[0032] FIG. 12C is a side elevational view showing an internal view of the air aspiration device of FIG. 12B.

[0033] FIG. 12D is a cross sectional view taken along line 12D-12D of FIG. 12C.

[0034] FIG. 13A is a perspective view of an alternative embodiment of the air aspiration device and clamp assembly.

[0035] FIG. 13B is a perspective view of a female pipe fitting of the air aspiration device of FIG. 13A.

[0036] FIG. 13C is a side elevational view of the air aspirator and clamp assembly of FIG. 13A.

[0037] FIG. 13D is a rear view of the air aspirator and clamp assembly of FIG. 13A.

[0038] FIG. 13E is a cross sectional view taken along line 13E-13E of FIG. 13C.

[0039] FIG. 13F is a perspective view of an alternative female pipe fitting for the air aspiration device of FIG. 13A.

[0040] FIG. 13G is a side elevational view of the air aspirator and clamp assembly of FIG. 13A with the female pipe fitting of FIG. 13F.

[0041] FIG. 13H is a cross sectional view taken along line 13H-13H of FIG. 13G.

[0042] FIG. 14A is a perspective view of a wet boom incorporating two air aspiration devices and clamp assemblies and an integral clamp universal flange tee adapter.

[0043] FIG. 14B is a front elevational view of the wet boom of FIG. 14A.

[0044] FIG. 15A is a perspective view of a wet boom integral clamp universal flange tee adapter and clamp assembly.

[0045] FIG. 15B is a side elevational view of the wet boom integral clamp universal flange tee adapter and clamp assembly of FIG. 15A.

[0046] FIG. 15C is a cross sectional view taken along line 15C-15C of FIG. 15B.

[0047] FIG. 16A is a perspective view of a wet boom that includes a male camlock adapter, a universal flange tee adapter, and a universal flanged adapter attached to the boom with removable clamps.

[0048] FIG. 16B is an exploded perspective view of the universal flange adapter and associated clamp assembly of FIG. 16A.

[0049] FIG. 16C is a front elevational view of the wet boom of FIG. 16A.

[0050] FIG. 16D is a side elevational view of the wet boom of FIG. 16A.

[0051] FIG. 16E is a cross-sectional view taken along line 16E-16E of FIG. 16D.

[0052] FIG. 17A is a perspective view of a blank adapter.

[0053] FIG. 17B is a perspective view of a camlock adapter.

[0054] FIG. 17C is a perspective view of a nozzle body end cap adapter.

[0055] FIG. 17D is a perspective view of an hose barb adapter.

[0056] FIG. 17E is a perspective view of a universal flange adapter.

[0057] FIG. 17F is a perspective view of a universal flange tee adapter.

[0058] FIG. 17G is a perspective view of a 90° hose barb adapter.

[0059] FIG. 18A is a perspective view of a wet boom universal flange adapter with an integral clamp.

[0060] FIG. 18B is a side elevational view of the wet boom universal flange adapter of FIG. 18A.

[0061] FIG. 18C is a cross sectional view taken along line 18C-18C of FIG. 18B.

[0062] FIG. 19 is a graph showing the diaphragm check valve response time for a number of cycles for a wet boom pipe in an air saturated condition where no new air is introduced into the wet boom.

[0063] FIG. 20 is a bar graph illustrating test data shutoff performance for nozzle body diaphragm check valves for a wet boom that includes an air aspiration device embodying the invention versus a wet boom saturated with air and a wet boom purged of air.

[0064] FIG. 21 is a graph showing the diaphragm check valve performance for a standard boom configuration versus a boom configuration with an air aspirating device.

DETAILED DESCRIPTION

[0065] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of "including," "comprising," or "having" and variations thereof herein is

meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless specified or limited otherwise, the terms "mounted," "connected," "supported," and "coupled" and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further, "connected" and "coupled" are not restricted to physical or mechanical connections or couplings.

[0066] The following discussion is presented to enable a person skilled in the art to make and use embodiments of the invention. Various modifications to the illustrated embodiments will be readily apparent to those skilled in the art, and the generic principles herein can be applied to other embodiments and applications without departing from embodiments of the invention. Thus, embodiments of the invention are not intended to be limited to embodiments shown, but are to be accorded the widest scope consistent with the principles and features disclosed herein. The following detailed description is to be read with reference to the figures, in which like elements in different figures have like reference numerals. The figures, which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of embodiments of the invention. Skilled artisans will recognize the examples provided herein have many useful alternatives and fall within the scope of embodiments of the invention.

[0067] FIG. 1 illustrates a spray boom pipe 100 to which several nozzle bodies 10 are attached. The spray boom pipe 100 can be an agricultural boom and can be used for delivering a fluid solution (i.e., water and/or chemicals) to the nozzle bodies 10. Each nozzle body 10 includes spray tips 12, a main body 14, a turret 16, a valve assembly 18, and a pipe clamp 22. As an example in FIG. 1, two spray nozzles 12 are shown attached to ports 15 of the turret 16 of the nozzle body 10. In some embodiments, the turret 16 can include three, four, or five ports 15 to receive a corresponding number of spray nozzles 12. In some embodiments, the turret 16 can be a multi-port indexable turret. In some embodiments, the valve assembly 18 can be a diaphragm check valve assembly. Two wet boom adapters 103 are also shown in FIG. 1. The wet boom adapters 103 include an air aspiration device 102. The adapters 103 can also each include an adapter hinge 21 to attach the air aspiration device 102 to the spray boom pipe 100.

[0068] FIGS. 2-5 illustrate an air aspiration device 102 attached to the boom 100 with a hose clamp 104. The air aspiration device 102 can form an end cap on an end of the boom

100. As shown in FIG. 3, the air aspiration device 102 can include an air port 106 that is in fluid communication with the boom 100 and the solution (not shown) it delivers to the nozzle bodies 10. As discussed above, the boom 100 may also include air that is trapped above the solution inside the boom 100. The air aspiration device 102 is designed such that the air port 106 is in fluid communication not only with the solution in the boom 100, but also with the air trapped above the solution. This allows the trapped air to be siphoned from the boom 100 and delivered to the nozzle body 10 coupled to the air aspiration device 102.

[0069] FIG. 6 illustrates an air aspiration device 102 according to one embodiment of the invention. The air aspiration device 102 can be generally cylindrical and can include a main body 112 and a female pipe fitting 110. The main body 112 can be designed to engage the boom. The main body 112 can include a recessed portion 114 with a first shoulder 169 and a second shoulder 171. The air aspiration device 102 can include one or more apertures 116. While the apertures 116 are shown to be located in the recess 114 in FIG. 6, the apertures 116 may be located elsewhere in the air aspiration device 102.

[0070] FIGS. 7A-7C illustrate an alternative embodiment for an air aspiration device 202 including a clamp 230 that is integral with the main body 212. As shown in FIG. 7C, the clamp 230 includes a button 208 that is designed to sealingly engage an aperture in the boom, as will be further described below. The clamp 230 includes a body portion 233 with an internal surface 232 and an external surface 234. The clamp 230 can include a first clamping component 236 and a second clamping component 238 that are hinged together with a hinge pin 240. A fastener 242 can be used to tighten the internal surface 232 of the clamp against an exterior surface of a boom when attaching the air aspiration device 202 to the boom. As shown in FIG. 7A, the air aspiration device 202 can include ribs 244 that are beneficial for obtaining a more uniform thickness when manufacturing the device 202.

[0071] FIGS. 8A and 8B illustrate another embodiment of an air aspiration device 202 assembled on a wet boom pipe 100. A feed spigot 20 can be in fluid communication with the spray boom pipe 100. A pipe clamp 22 can secure the nozzle body 10 to the boom 100. The feed spigot 20 can also be in fluid communication with a valve chamber 24 via a first or upper feed point 26 and a second or lower feed point 28. The use of multiple feed points between the feed spigot 20 and the valve chamber 24 can result in increased flow capacity with little change in dimensional envelope and substantially no change in the geometry of the

diaphragm check valve assembly 18. In some embodiments, the first feed point 26 and the second feed point 28 can break into the valve chamber 14 at both the top side and the bottom side, respectively. This can allow greater flow rates and can be achieved with the feed spigot 20 and the main body 14 being a single molded piece.

[0072] As shown in FIG. 8B, the air aspiration device 202 can include a passageway 218 and an exit port 219. The passageway 218 is in fluid communication with the air port 206 and the exit port 219, and also is in fluid communication with the solution and the air in the boom 100. The air port 206 can be formed in the female pip fitting 210 and can be designed so that the air port 206 is in fluid communication with the both the solution and the trapped air in the boom 100. The air port 206 can be positioned asymmetrically toward a top portion of the main body 212 and the boom 100. The passageway 218 can be designed to alter the direction of the solution and the air as the solution and the air travel from the boom 100 to the exit port 219. For example, the passageway 218 can be a right angle passageway. The turbulent flow path can help to mix the air with the solution to help release trapped air from the boom 100. Additionally, the right angle passageway helps keep the air aspiration device 202 from projecting too far from the end of the boom 100 for a more compact overall boom 100 length.

[0073] As shown in FIG. 8B, the female pipe fitting 210 engages the feed spigot 20. The feed spigot 20 can engage the female pipe fitting 210 at the exit port 219. This engagement allows solution and air trapped in the boom 100 to travel from the boom 100 to the air aspiration device 202, enter the air port 206, and pass through the passageway 218 and the exit port 219 of the air aspiration device 202 as it flows to the nozzle body 10 at the feed spigot 20.

[0074] Different embodiments of the air aspiration device can be designed to attach to the boom 100 in different ways. For example, the air aspiration device 202 can be designed to clamp to the boom 100 using an integral clamp 230, as shown in FIGS. 8A and 8B. The clamp 230 can include an internal surface 232, an external surface 234, a first clamping component 236, and a second clamping component 238 that are hinged together with a hinge pin 240. A fastener 242 can be used to tighten the internal surface 232 of the clamp against an exterior surface 111 of a boom 100 when attaching the air aspiration device 402 to the boom 100. An internal surface 232 of the clamp 230 can engage an external surface 111 of

the boom 100, as shown in FIGS. 8A and 8B. The clamp 230 can include a button 208 for engaging an aperture 113 in the boom 100. The button 208 sealingly engages the air aspiration device 202 to the boom 100. A gasket 215, such as an o-ring, can be used to help seal the button 208 and the aperture 113 in the boom 100. In addition, the button 208 ensures that the air aspiration device 202 maintains a specific angular orientation with respect to the boom 100. In other words, the air aspiration device 202 can be prevented by the button 208 from rotating when attached to the boom 100. This helps to ensure that the nozzle body 10 on the end of the boom 100 does not get out of spray timing with other nozzle bodies 10 located along the length of the boom 100. The engagement of the button 208 with the aperture 113 also helps to maintain the longitudinal placement of the device 202 with respect to the boom 100.

[0075] As shown in FIGS. 9A-9C, an alternative embodiment of an air aspiration device 302 can be designed to attach to the boom 100 by having an external surface 317 engage an internal surface 121 of the boom 100 (as shown in FIG. 9C). The air aspiration device 302 can include barbs 323 to help seal the external surface 317 of a main body 312 of the air aspiration device 302 against the internal surface 121 of the boom 100. The air aspiration device 302 can form an internal end cap for an end of the boom 100.

[0076] FIGS. 9A-9C illustrate that the air aspiration device 302 can also be used with a dry boom 107. The dry boom 107 can be used to support the nozzle body 10, and thus, indirectly support the wet boom 100 as well. Dry booms 107 can be used in circumstances where more nozzle bodies 10 and/or a longer wet boom 100 are necessary. Although the dry boom 107 is shown in conjunction with a specific embodiment of an air aspiration device 302, a dry boom 107 can be used with any of the embodiments of air aspiration devices as described herein.

[0077] FIGS. 10A-10C illustrate another alternative embodiment of an air aspiration device 402 where an external surface 417 of the device 402 engages the internal surface 121 of the boom 100. A main body 412 is attached to a female pipe fitting 410. In this embodiment, a clip 427 can be used to retain the female pipe fitting 410 with respect to the boom 100. The clip 427 passes through a slot 429 in the female pipe fitting 410. As shown in FIG. 10C, gasket 431, such as a rubber o-ring, can be used to help seal the external surface 417 of the air aspiration device 402 against the internal surface 121 of the boom 100.

[0078] FIGS. 11A-11C illustrate an end cap 550 that can be used on an end of a boom 100. The end cap 550 can include a cap portion 551 and a clamp portion 530. The clamp portion 530 of the end cap 550 is similar to the clamp 230 described above and shown in FIGS. 7A-7C. The end cap 550 can include a body portion 533 with an internal surface 532, an external surface 534, a first clamping component 536, and a second clamping component 538. The first and second clamping components 536, 538 can be hinged together with a hinge pin 540 and tightened with a fastener 542. The end cap 550 can also include a button 508 and gaskets 515, 531 to help seal the end cap 550 to the boom 100. The end cap 550 can be useful when an operator chooses to place an air aspiration device on one end of the boom 100, with an end cap 550 on the other end of the boom 100.

[0079] FIGS. 12A-12D illustrate another embodiment of an air aspiration assembly 600. The assembly 600 can include an air aspiration device 602 and a removable clamp 660. FIG. 12A illustrates the assembly 600 in an exploded view, and FIG. 12B illustrates the assembly 600 in an assembled condition. The air aspiration device 602 can include a main body 612, a female pipe fitting 610, a recessed portion 614, and an external surface 617. The device 602 can include apertures 616.

[0080] The removable clamp 660 can include a body portion 663 with an internal surface 662, an external surface 664, and buttons 608. The clamp 660 can also include a first side 667 and a second side 668. The clamp 660 can include a first clamping component 670 and a second clamping component 672. Each clamp component 670, 672 can include a first flange 674 and a second flange 676 with holes 678 for receiving fasteners 680.

[0081] When assembled, the internal surface 662 of the removable clamp 660 is designed to engage an external surface 617 of the air aspiration device 602 (as best shown in FIG. 12A), with the buttons 608 sealingly engaging the apertures 616 in the air aspiration device 602 (as best shown in FIG. 12D). Although a boom 100 is not shown in FIGS. 12A-12D, the buttons 608 can be designed to sealingly engage apertures in the boom, as discussed above. Gaskets 615, such as a rubber o-ring, can be used along with buttons 608 and to help seal the apertures 616 in the air aspiration device 602 to the boom 100. Gaskets 631 also help to seal the device 602 to the boom 100. The removable clamp 660 can fit snugly in the recessed portion 614 of the air aspiration device 602 so that the first side 667 engages a first shoulder 669 of the recessed portion 614 and the second side 668 engages a second shoulder 671 of the

recessed portion 614. This engagement helps to prevent the air aspiration device 602 from moving longitudinally with respect to the boom 100.

[0082] FIG. 12D illustrates that the air aspiration device 602 can incorporate a drain passage 635. The drain passage 635 is in fluid communication with the solution that is carried by the boom 100 and with the passageway 618, and can be located below the air port 606. The drain passage 635 can be sized to be smaller than the air port 606, so that the majority of the solution and the air trapped in the boom 100 are delivered through the passageway 618 by entering at the air port 606. In one embodiment, the drain passage 635 is generally circular and is about 4.5 mm in diameter; however, the drain passage 635 can have other sizes and shapes.

[0083] The drain passage 635 can allow an operator to drain the boom 100 at a faster rate. In embodiments where the air aspiration device does not include a drain passage 635, the solution near the end of the boom 100 near the air aspiration device needs to drain from the boom 100 by draining from a more internal nozzle body 10 that siphons solution through an aperture on the bottom of the boom 100. This can result in increased draining times for the boom 100 and, if the boom 100 is not perfectly level, may result in solution collecting near an end of the boom 100 and not fully draining from the boom 100.

[0084] FIGS. 13A-13G illustrate another embodiment of the air aspiration device 702 with a removable clamp 660. FIGS. 13A-13G also illustrate an air aspiration device 702 where a female pipe fitting 710 is removable from a main body 712 of the air aspiration device 702. The female pipe fitting 710 can be removed if the boom 100 becomes plugged or clogged.

[0085] The air aspiration device 702 can include a clip 727 that fits within slots 737 in the female pipe fitting 710 and slots 739 in the main body 712 in order to retain the female pipe fitting 710 with respect to the main body 712. If the clip 727 is removed, the female pipe fitting 712 can be removed from the main body 712. FIG. 13B illustrates the female pipe fitting 710 removed from the main body 712. As shown in FIG. 13E, the air aspiration device 702 can also include a passageway 718, an air port 706, an exit port 719, and a drain passage 735.

[0086] The female pipe fitting 710 can include an outer surface 741 with different features. In one embodiment, the female pipe fitting 710 can include an outer surface 741 with a grip 743 as shown in FIGS. 13A-13E. The grip 743 can help a user remove the female pipe fitting 710 from the main body 712 of the air aspiration device 702. In another embodiment, the outer surface 741 can include a hose barb connection 745, as shown in FIGS. 13F-13H. The hose barb connection 745 can be in fluid communication with the passageway 718 and can be used to recycle fluid or provide solution to another nozzle body 10.

[0087] FIGS. 14A-14C illustrate a fluid delivery system 800. The system 800 can include a boom 100, multiple nozzle bodies 10, pipe clamps 22, and air aspiration devices 102. The boom 100 can include a first section 100a and a second section 100b. The nozzle bodies 10 can be spaced along the boom 100 at regular intervals. The fluid delivery system 800 can also include an integral clamp universal flange tee adapter 882. The tee adapter 882 can be attached to an exterior surface 111 of the boom 100 with the clamps 830 that are integral to the adapter 882. The clamps 830 couple the first section 100a and the second section 100b to the tee adapter 882 and maintain the first section 100a and the second section 100b in rotational alignment, or rotationally timed. In other words, the clamps 830 maintain an angular relationship between the first section 100a and the second section 100b of the boom 100. A fluid source (not shown) can be in fluid communication with the adapter 882. The fluid can flow through the hollow channel of the boom 100 to the nozzle bodies 10 by passing through apertures in the boom 100 for the nozzle bodies 10 that are not on the ends of the boom 100, or through the exit ports in the air aspiration devices 102 . Although the fluid delivery system 800 in FIGS. 14A-14C shows an air aspiration device 102 on each end of the boom 100, an air aspiration device 102 need not be on each end of the boom 100 to remove trapped air from the boom 100. Rather, an end cap 550 or other device can be placed on one end of the boom 100. Any of the air aspiration devices discussed herein can be used in the fluid delivery system 800.

[0088] FIGS. 15A-15C further illustrate the integral clamp universal flange tee adapter 882 of FIGS. 14A-14C. The adapter 882 can include a main body 883 and a flange 884. The tee adapter 882 can also include two clamps 830 that are integral with the main body 883 of the adapter 882. The clamps 830 are of similar construction to the clamps 230, 530 discussed

above with respect to the air aspiration device 202 and end cap 502. The clamps 830 can include buttons 808 that sealingly engage apertures in the boom 100, as described above, and can include gaskets 815. The clamps 830 can include a body portion 833 with an internal surface 832 and an external surface 834. Additionally, the clamps 830 can include a first clamping component 836 and a second clamping component 838 that are hinged together with a hinge pin 840. Fasteners 842 can be used to tighten the internal surfaces 832 of the clamps 830 against an exterior surface of a boom when attaching the tee adapter 882 to the boom, as discussed above for FIGS. 14A and 14B.

[0089] FIGS. 16A-16E illustrates other types of adapters that can be incorporated into the fluid delivery system 800 with removable clamps 660. For example, the fluid delivery system 800 can include a universal flange tee adapter 886, a universal flange adapter 888, and a camlock adapter 890 each attached to the boom 100 with removable clamps 660. The removable clamps 660 can couple the universal flange tee adapter 886 to the first section 100a of the boom 100 and to the second section 100b of the boom 100 in order to maintain an angular relationship between the first section 100a and the second section 100b. Adapters 886, 888, 890 are further shown in FIGS. 17F, 17E, and 17B, respectively. FIGS. 16A-16E also illustrate apertures 113 in the boom where nozzle bodies may be attached to be in fluid communication with the boom 100.

[0090] The fluid delivery system 800 can also be configured to incorporate one or more of the other adapters shown in FIGS. 17A-17G. FIG. 17A illustrates a blank adapter 887, FIG. 17C illustrates a nozzle body end cap adapter 891, FIG. 17D illustrates a hose barb (HB) adapter 892, and FIG. 17G illustrates a 90° hose barb (HB) adapter 893. The fluid delivery system 800 can also be configured to incorporate adapters of a similar nature.

[0091] The adapters shown in FIGS. 17A-17G can attach to the boom 100 in a similar manner with one or more removable clamps 660. FIGS. 16B and 16C illustrate how the universal flange adapter 888 of FIG. 17E is attached to a boom 100. The adapter 888 can include an internal surface 889 that slides over the external surface 111 of the boom 100. One or more apertures 816 in the adapter 888 align with apertures 113 in the boom 100. The clamping components 670, 672 can be placed in a recessed portion 814 of the adapter 888 that includes apertures 816. The clamping components 670, 672 can be placed within the recessed portion 814 so that the buttons 608 align with the apertures 816 of the adapter 888

and the apertures 113 in the boom 100. Fasteners 680 can tighten the two clamping components 670, 672 together and the buttons 608 of the clamp 660 then sealingly engage the apertures 816 of the adapter 888 and the apertures 113 in the boom 100. The adapter 888 can also include a first shoulder 869 that engages the first side 667 of the clamp 660 and a second shoulder 871 that engages a second side 671 of the clamp 660. This engagement ensures that the adapter 888 maintains its position with respect to the boom 100 longitudinally and angularly.

[0092] All of the adapters shown in FIGS. 17A-17G, and other similar adapters, can be attached to the boom 100 with a removable clamp 660 in a similar fashion to that as described above with respect to the adapter 888.

[0093] Alternatively, the adapters shown in FIGS. 17A-17G, and other similar adapters, can be configured with an integral clamp for attaching the adapters to the boom 100. One such example already discussed above is the universal flange tee adapter 882 shown in FIGS. 15A-15C. Another example is the universal flange adapter 988 shown in FIGS. 18A-18C. Similar to the adapter 888 discussed above, the adapter 988 can include an internal surface 989 for engaging the external surface 111 of the boom 100. The adapter 988 includes an integral clamp 930, similar to the integral clamps 230, 530, and 830 discussed above. The integral clamp 930 provides another way to attach the adapters to the boom to maintain the adapters in a fixed longitudinal and angular position with respect to the boom.

[0094] The air aspiration devices described above provide several advantages for fluid delivery systems 800. By siphoning solution from a point higher than the bottom of the boom 100, the air aspiration devices reduce the amount of air that can be trapped in the boom 100. The air can also become mixed in the solution due to the turbulent flow caused by the passageway in the air aspiration devices altering the path of the solution and air as they flow from the boom 100 to the feed spigot 20 of the nozzle body 10.

[0095] The air aspiration devices also reduce the shut-off time of the diaphragm check valve 18. This results in less solution being dispersed that is not intended to be dispersed by the fluid delivery system 800. The air aspiration devices reduce the amount of air trapped in the boom 100 and reduce the pressure in the boom 100. Therefore, when the fluid delivery system 800 is shut off, the pressure in the boom is only slightly above the shut-off pressure of the check valve 18 in the nozzle body 10. This reduction in pressure of air in the boom 100

also helps reduce pressure variation among the nozzle bodies 10 along the length of the boom 100, which results in a more even application of solution to the targeted application. FIGS. 19-21 help illustrate the magnitude of the reduction of the response time for check valves 18 in a fluid delivery system 800 that employs an air aspiration device according to embodiments of the invention.

[0096] FIG. 19 is a graph illustrating the diaphragm check valve 18 response time for a nozzle body 10 shown as the number of cycles versus time for the response of the diaphragm check valve 18 with the wet boom pipe 100 in an air saturation condition. If no new air is introduced, after about six cycles, the response time for the check valve 18 to shut off is reduced from over about five seconds to about two seconds. Thus, for a system 800 not employing an air aspiration device, the response time of the check valve 18 is only lowered after several cycles.

[0097] FIG. 20 is a bar graph illustrating shut-off performance test data of diaphragm check valves 18 in a fluid delivery system using an air aspiration device, versus a wet boom pipe without an air aspiration device, in a boom with air and a boom without air. As shown in the bar graph, the response time of the diaphragm check valve 18 of the fluid delivery system without an air aspiration device in a wet boom pipe with trapped air was significantly higher (5.59 seconds) than the other two scenarios. The response time for the fluid delivery system with an air aspiration device was very similar to the response time of a fluid delivery system without an air aspiration device but having a wet boom completely saturated with fluid.

[0098] FIG. 21 is a graph illustrating diaphragm check valve performance by comparing the response time for check valves for a fluid delivery system incorporating an air aspiration device to the response time for check valves for a system without an air aspiration device. The response time for the diaphragm check valves for the two systems was checked at different pressures. As shown by the graph, the fluid delivery system with the air aspiration device recorded much shorter response times than the system without the air aspiration device, especially at lower pressures.

[0099] Additionally, the air aspiration devices are a passive system that require no electronics or power. As such, the air aspiration devices provide a consistent and robust system for reducing the amount of trapped air in a boom.

[00100] The air aspiration devices can be manufactured from materials including, but not limited to, polypropylene and polyoxymethylene.

[00101] It will be appreciated by those skilled in the art that while the invention has been described above in connection with particular embodiments and examples, the invention is not necessarily so limited, and that numerous other embodiments, examples, uses, modifications and departures from the embodiments, examples and uses are intended to be encompassed by the claims attached hereto.

CLAIMS

1. An air aspiration device to release trapped air in a pipe when delivering a solution to a nozzle body, the nozzle body including a feed spigot, the air aspiration device comprising:

a main body that engages the pipe;

a female pipe fitting coupled to the main body, the female pipe fitting forming an end cap for one end of the pipe and engaging the feed spigot;

an air port in the female pipe fitting that is in fluid communication with the solution and the air;

a passageway through the female pipe fitting that is in fluid communication with the air port, the passageway delivering both the solution and the air to the feed spigot; and

an exit port in the female pipe fitting that is in fluid communication with the passageway, the feed spigot engaging the exit port.

2. The air aspiration device of claim 1, wherein the main body is integral with the female pipe fitting and the air port is positioned asymmetrically toward a top portion of the main body and the pipe.

3. The air aspiration device of claim 1, wherein the passageway alters the direction of the solution and the air between the air port and the exit port.

4. The air aspiration device of claim 3, wherein the passageway forms a right angle between the air port and the exit port.

5. The air aspiration device of claim 1, and further comprising a drain passage in fluid communication with the solution in the pipe and in fluid communication with the passageway, the drain passage being located below the air port.

6. The air aspiration device of claim 5, wherein the drain passage is sized so that a majority of the solution and the air enter the passageway at the air port.

7. The air aspiration device of claim 1, wherein an exterior surface of the air aspiration device engages an interior surface of the pipe.

8. The air aspiration device of claim 7, wherein the exterior surface is on the female pipe fitting.

9. The air aspiration device of claim 1, wherein the female pipe fitting is removable from the main body.

10. The air aspiration device of claim 1, wherein an outer surface of the female pipe fitting includes a hose barb connection.

11. The air aspiration device of claim 1, wherein the female pipe fitting includes a slot that receives a clip in order to retain the female pipe fitting.

12. The air aspiration device of claim 1, wherein an interior surface of the air aspiration device engages an exterior surface of the pipe.

13. The air aspiration device of claim 1, wherein the main body includes a recessed portion, a first shoulder, and a second shoulder, the first shoulder being on an opposite side of the recessed portion from the second shoulder.

14. The air aspiration device of claim 13, wherein the recessed portion includes a first aperture and the pipe includes a second aperture, the first aperture and the second aperture receiving a first button of a removable clamp to maintain an angular relationship between the air aspiration device and the pipe.

15. The air aspiration device of claim 14, wherein the recessed portion includes a third aperture and the pipe includes a fourth aperture, the third aperture and the fourth aperture receiving a second button of the removable clamp to further maintain the angular relationship between the air aspiration device and the pipe.

16. The air aspiration device of claim 14, wherein the first shoulder engages a first side of the removable clamp and the second shoulder engages a second side of the removable clamp.

17. The air aspiration device of claim 1, wherein the main body further includes an integral clamp with an interior surface and an exterior surface, the interior surface engaging an outer surface of the pipe.

18. The air aspiration device of claim 17, wherein the interior surface includes a button and the pipe includes an aperture, the button received by the aperture when the air aspiration device is clamped to the pipe in order to maintain an angular orientation between the air aspiration device and the pipe.

19. The air aspiration device of claim 1, wherein the pipe is an agricultural boom.

20. The air aspiration device of claim 1, wherein the solution is an agricultural chemical.

21. The air aspiration device of claim 1, wherein the nozzle body receives at least three spray nozzles.

22. An air aspirator assembly to release air trapped in a pipe when delivering a solution to a nozzle body, the nozzle body including a feed spigot, the pipe including an aperture, the assembly comprising:

a main body that engages the pipe;

a female pipe fitting that engages the feed spigot, the female pipe fitting including an air port, a passageway, and an exit port,

the air port in fluid communication with the solution and the air,

the passageway in fluid communication with the air port, the passageway delivering both the solution and the air to the feed spigot,

the exit port in fluid communication with the passageway, the feed spigot engaging the exit port; and

a clamp including a body portion having an internal surface with a button, the button engaging the aperture in the pipe in order to maintain an angular orientation between the main body and the pipe.

23. The assembly of claim 22, wherein the clamp is integral with the main body.

24. The assembly of claim 22, wherein the female pipe fitting forms an end cap for one end of the pipe.

25. The assembly of claim 22, wherein the main body includes a second aperture and the clamp is removable from the main body, the button engaging the second aperture in addition to the aperture in the pipe in order to maintain the angular orientation between the main body and the pipe.

26. The assembly of claim 25, wherein the main body includes a recessed portion, a first shoulder, and a second shoulder, the first shoulder being on an opposite side of the recessed portion from the second shoulder.

27. The assembly of claim 26, wherein the first shoulder engages a first side of the clamp and the second shoulder engages a second side of the clamp.

28. The assembly of claim 22, and further comprising a gasket engaging the button to create a seal between the button and the aperture.

29. The assembly of claim 28, wherein the internal surface of the clamp includes a second button, the main body includes a third aperture and the pipe includes a fourth aperture, the second button engaging the third aperture and the fourth aperture to further maintain the angular orientation between the main body and the pipe.

30. The assembly of claim 29, and further comprising a second gasket engaging the second button to create a seal between the second button and the third aperture and the fourth aperture.

31. A removable clamp for coupling an adapter to a pipe delivering a solution, the adapter including a first aperture, the pipe including a second aperture, the removable clamp comprising:

a body portion having a first clamp component and a second clamp component together creating an internal surface; and

a first button located on the internal surface;

the internal surface engaging an outer surface of the adapter so that the first button is received by the first aperture and the second aperture in order to maintain an angular relationship between the adapter and the pipe.

32. The removable clamp of claim 21, wherein the adapter is a nozzle body end cap adapter that engages a nozzle body, and the nozzle body end cap adapter is in fluid communication with a feed spigot of a nozzle body.

33. The removable clamp of claim 31, wherein the first clamp component includes a first flange and a second flange, the first flange and the second flange each having a hole for receiving a fastener.

34. The removable clamp of claim 33, wherein the second clamp component includes a third flange and a fourth flange, the third flange and the fourth flange each having a hole for receiving the fasteners.

35. The removable clamp of claim 34, and further comprising a second button on the internal surface, wherein the first button is on the first clamp component, the second button is on the second clamp component, the adapter includes a third aperture, and the pipe includes a fourth aperture, the second button being received by the third aperture and the fourth aperture when clamping the adapter to the pipe to further maintain the angular relationship between the adapter and the pipe.

36. The removable clamp of claim 35, and further comprising a first gasket and a second gasket, the first gasket engaging the first button and the second gasket engaging the second button, the first gasket and the second gasket creating a seal between the adapter and the pipe.

37. A fluid delivery system comprising:

a boom delivering fluid from a fluid source, the boom including a first section with a first aperture and a second section with a second aperture;

a tee adapter coupled to the first section and the second section, the tee adapter receiving fluid from the fluid source and delivering the fluid to the first section and the second section;

a first clamp including a first button, the first button being received by the first aperture; and

a second clamp including a second button, the second button being received by the second aperture;

the first clamp coupling the tee adapter to the first section and the second clamp coupling the tee adapter to the second section in order to maintain an angular relationship between the first section and the second section.

38. The fluid delivery system of claim 37, wherein the first clamp and the second clamp are integral to the tee adapter.

39. The fluid delivery system of claim 37, wherein the first clamp and the second clamp are removable clamps.

40. The fluid delivery system of claim 37, and further comprising:

a plurality of nozzle bodies coupled to the boom, each one of the plurality of nozzle bodies including a feed spigot in fluid communication with the boom and a valve; and

an air aspiration device coupled to a first end of the boom, the air aspiration device releasing air trapped above the fluid to lower an air pressure in the boom in order to reduce a shut-off time of the valve.

41. The system of claim 40, and further comprising a second air aspiration device coupled to a second end of the boom.

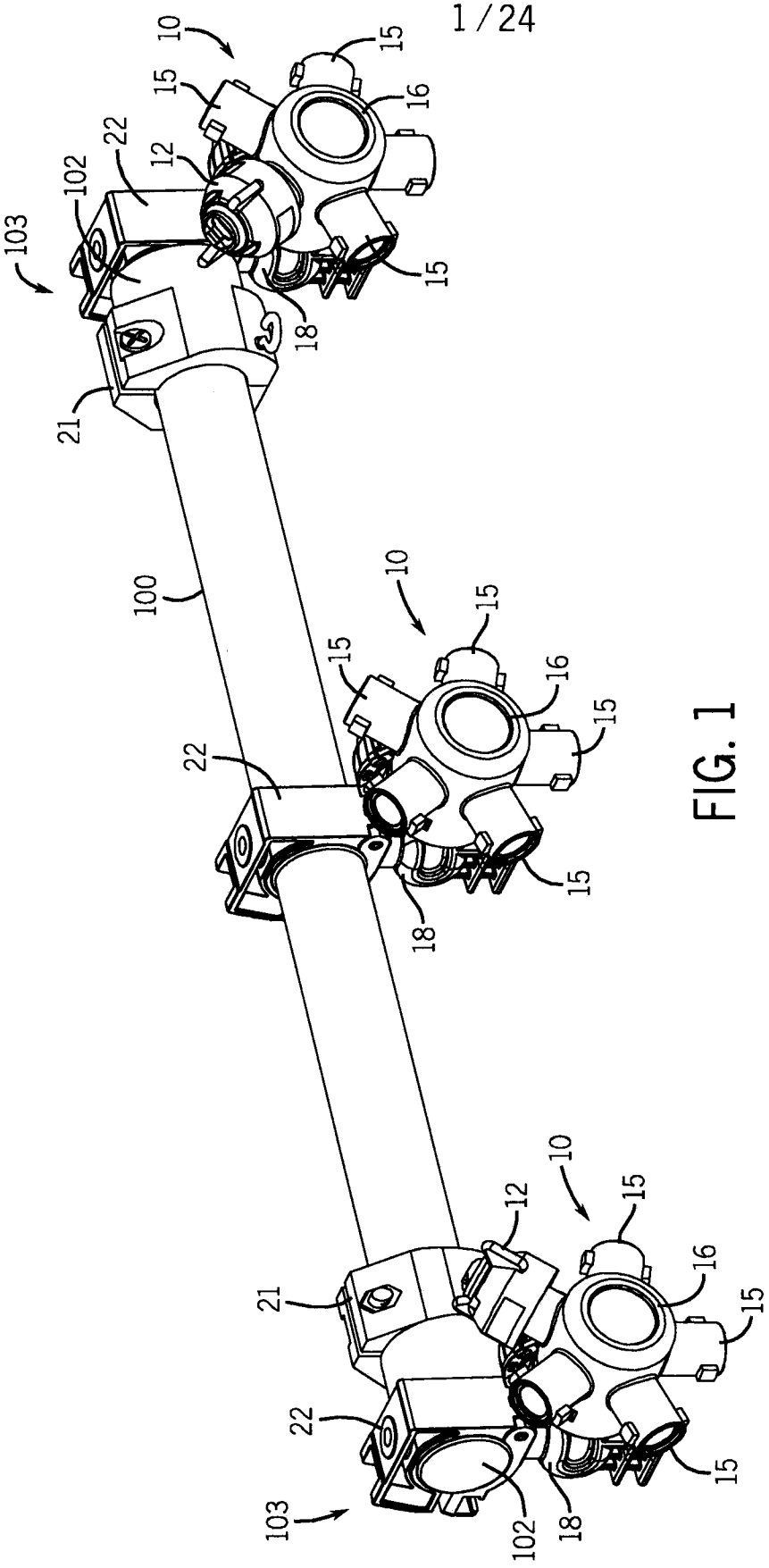

10
15
15
16
22
12
102
103
15
18
21
100
10
15
15
16
15
22
15
18
10
12
15
16
15
21
22
15
103
102
18

FIG. 1

FIG. 2

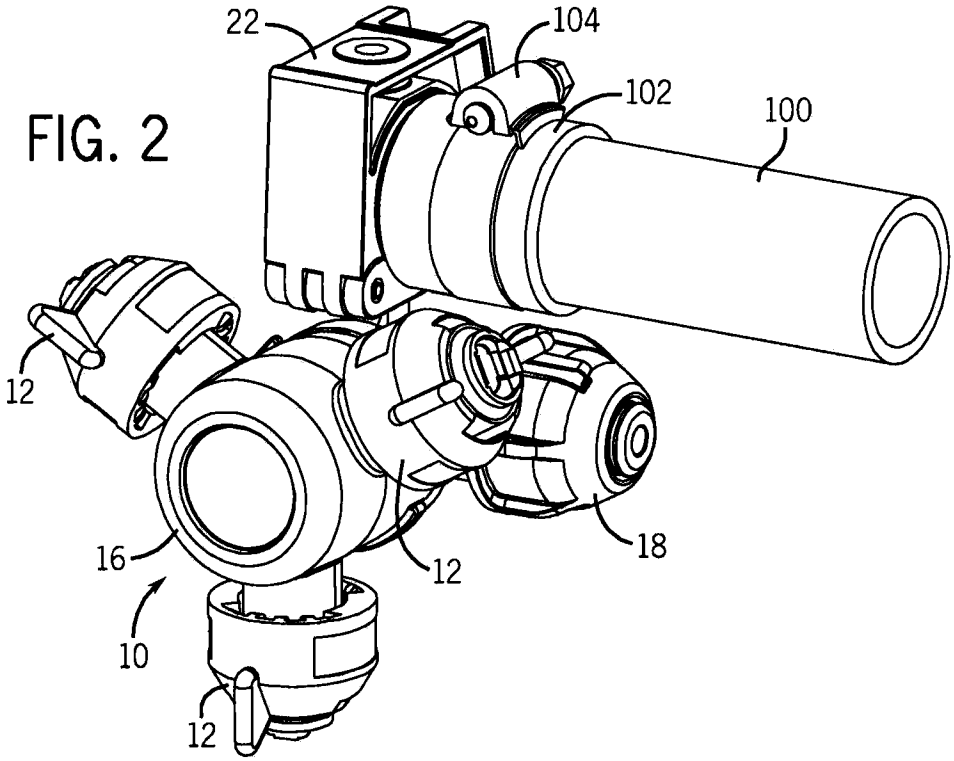


FIG. 3

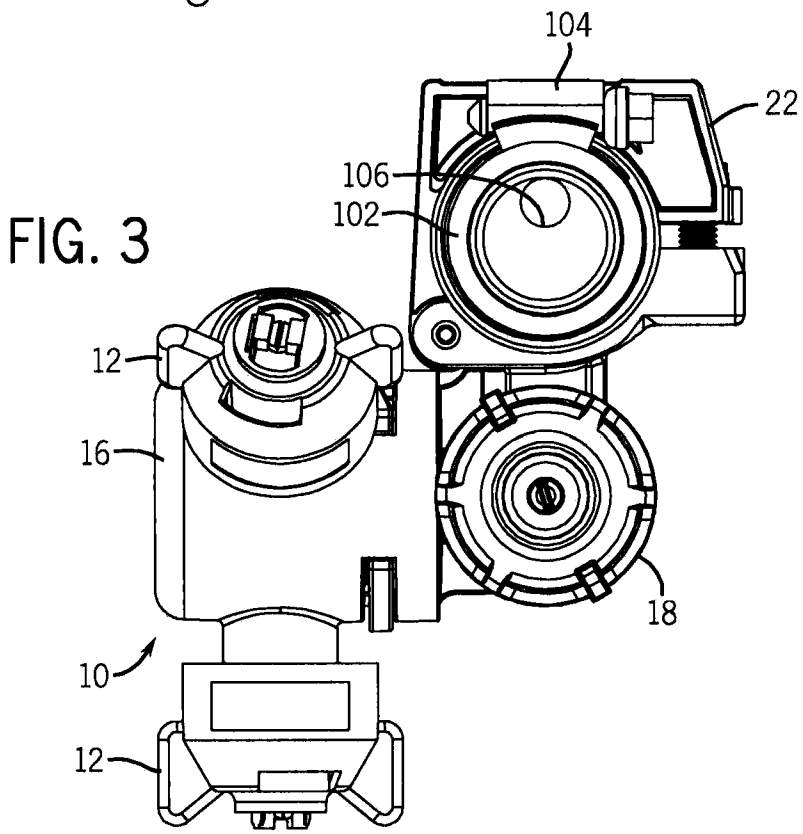


FIG. 4

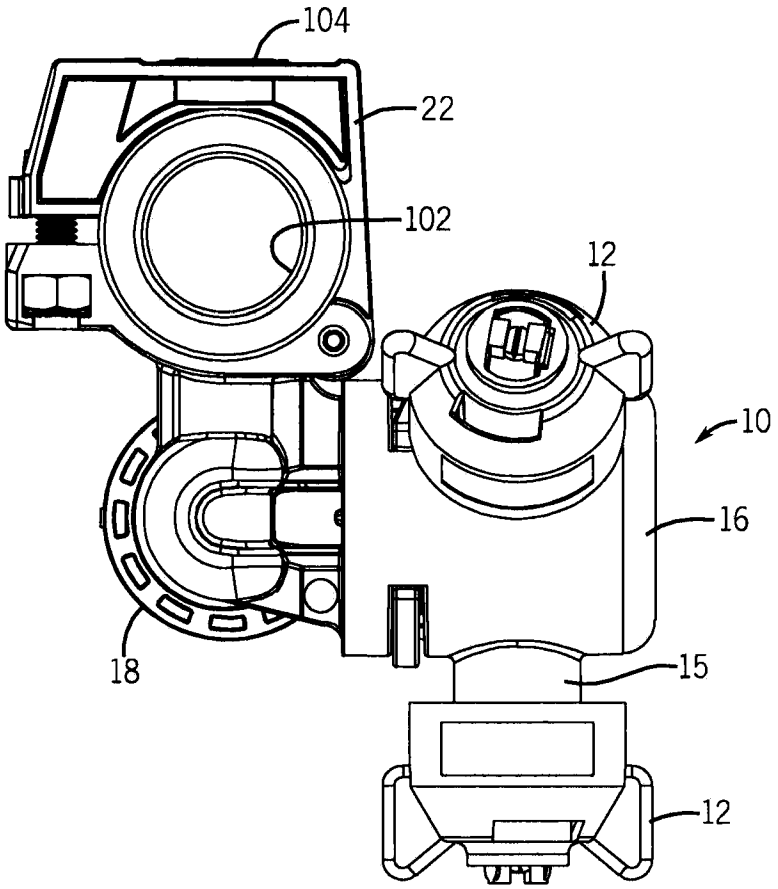
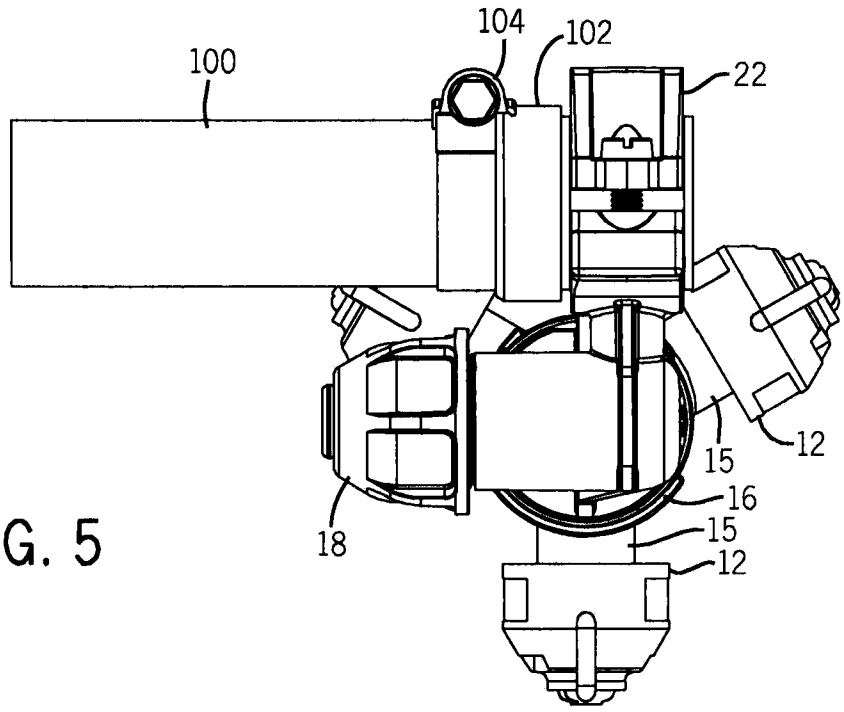


FIG. 5



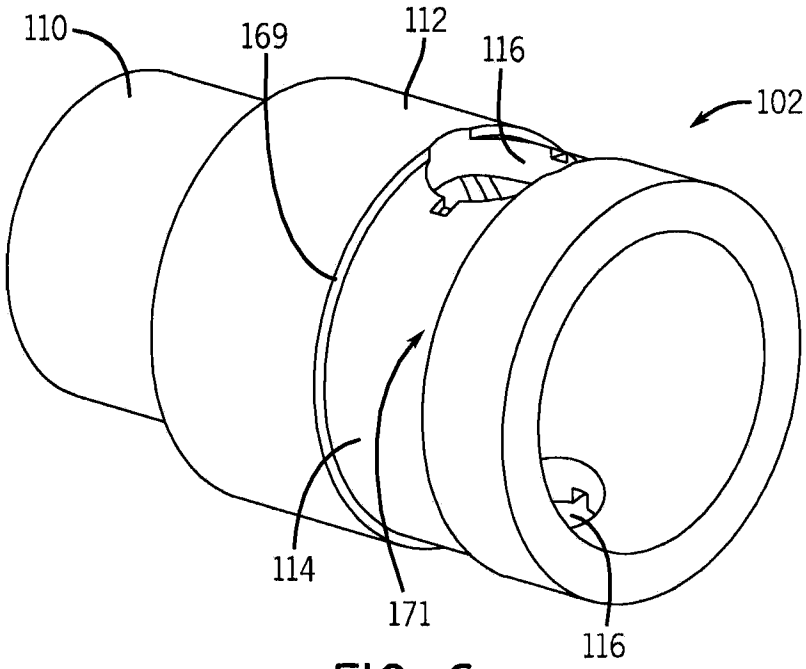


FIG. 6

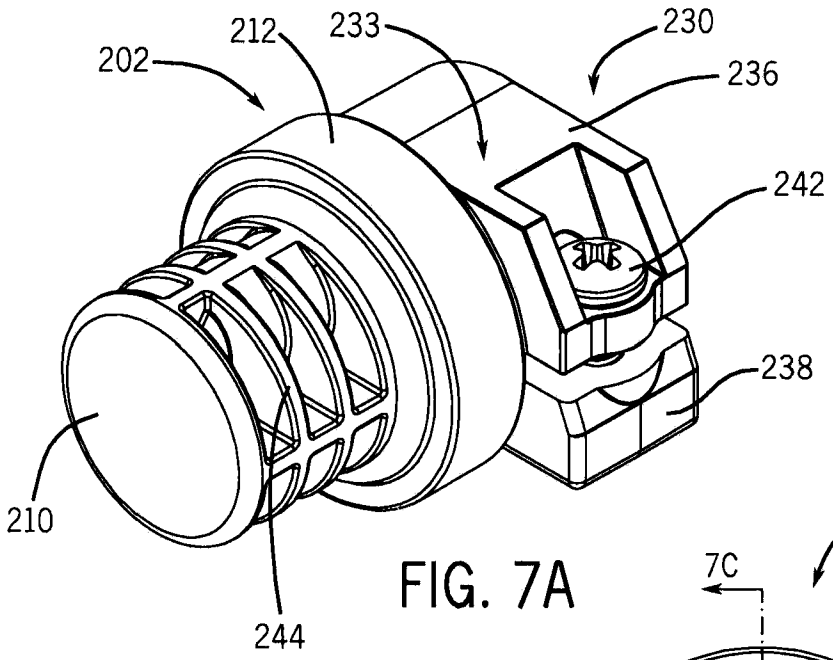


FIG. 7A

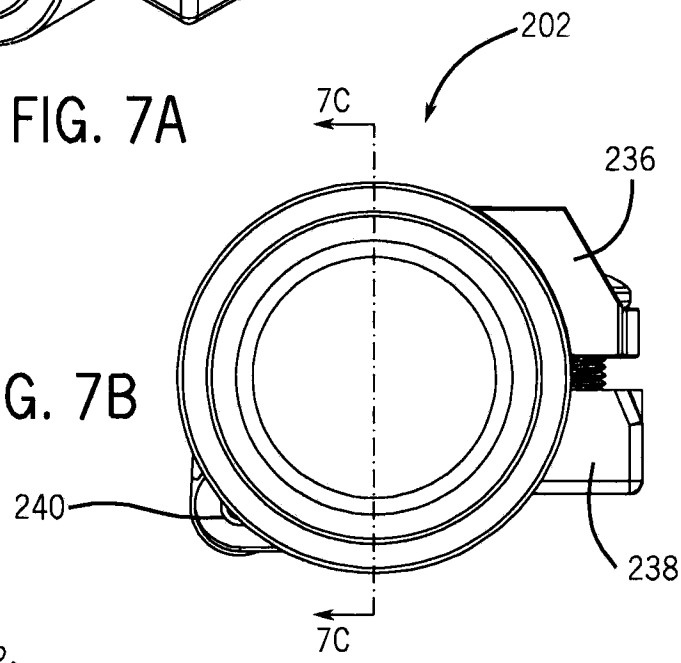


FIG. 7B

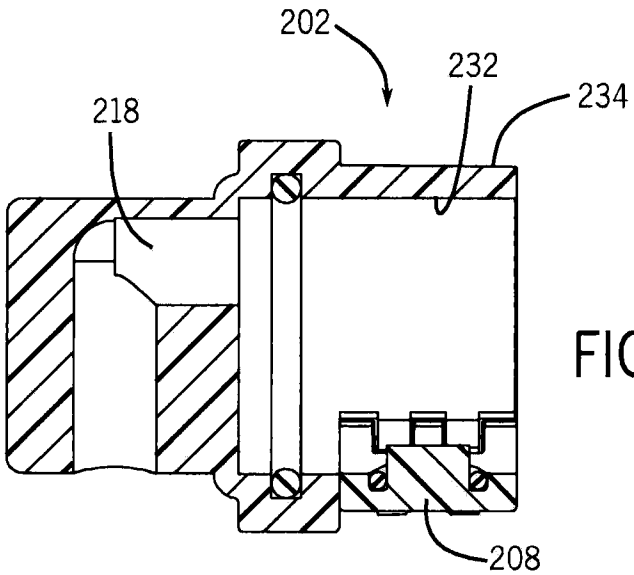


FIG. 7C

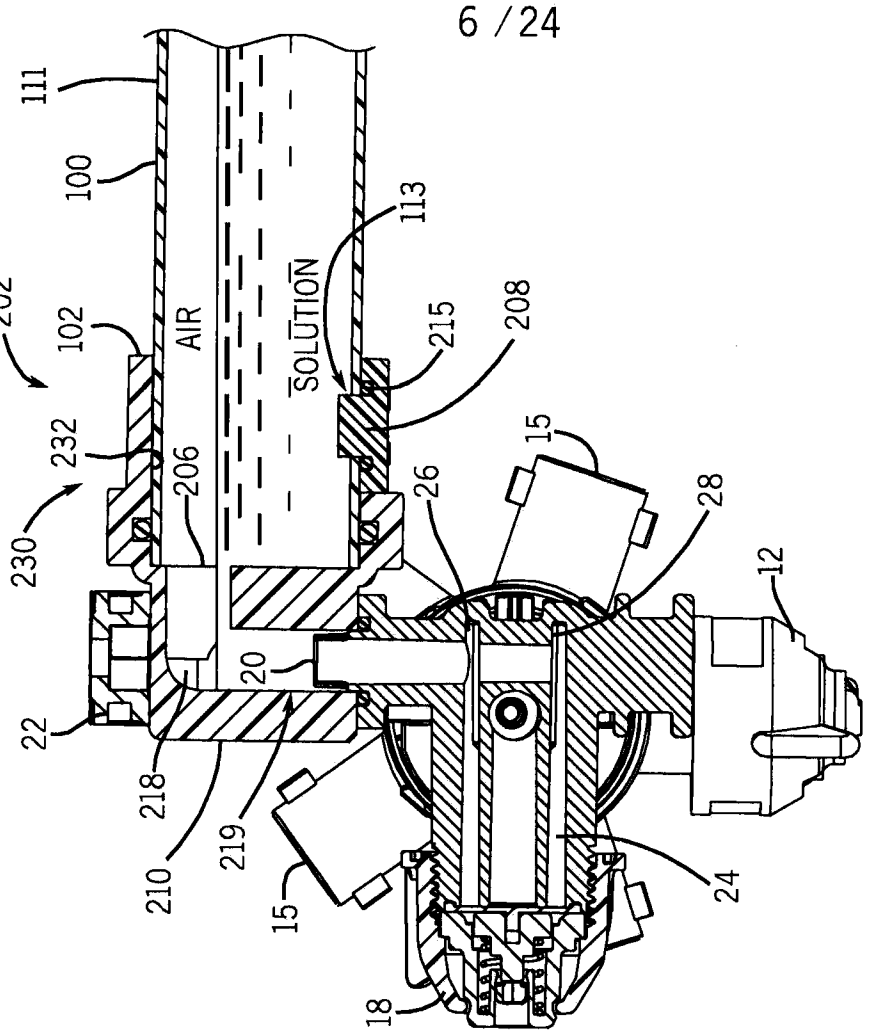

111
100
113
202
102
AIR
SOLUTION
215
208
232
206
15
26
28
230
12
20
22
218
219
210
15
24
18

FIG. 8B

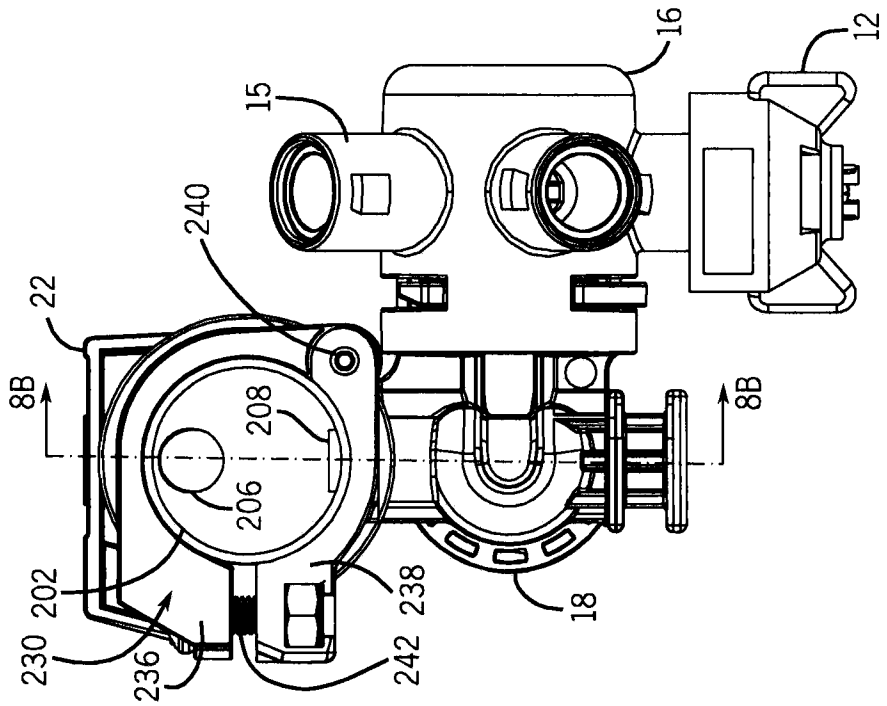

16
12
15
240
22
8B
208
206
8B
202
238
18
230
236
242

FIG. 8A

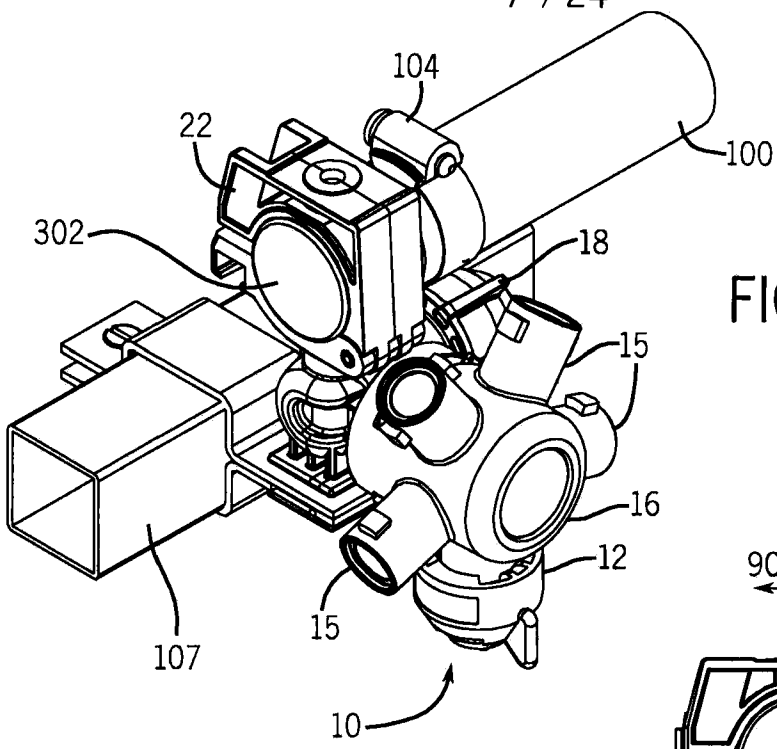


FIG. 9A

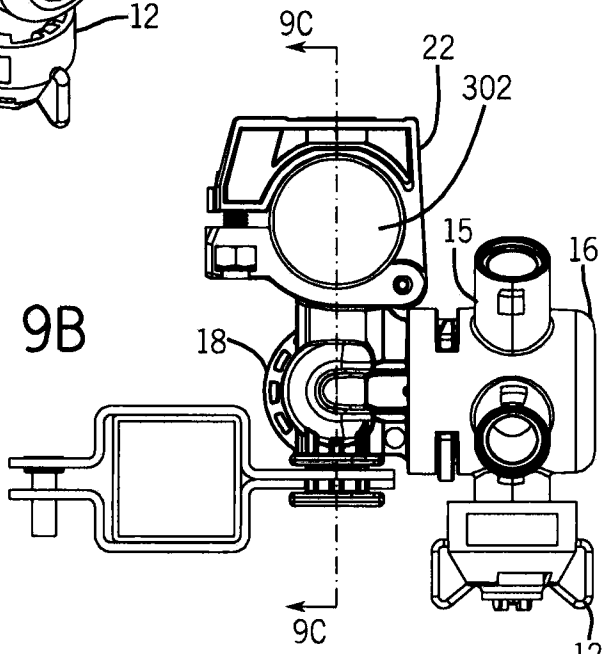


FIG. 9B

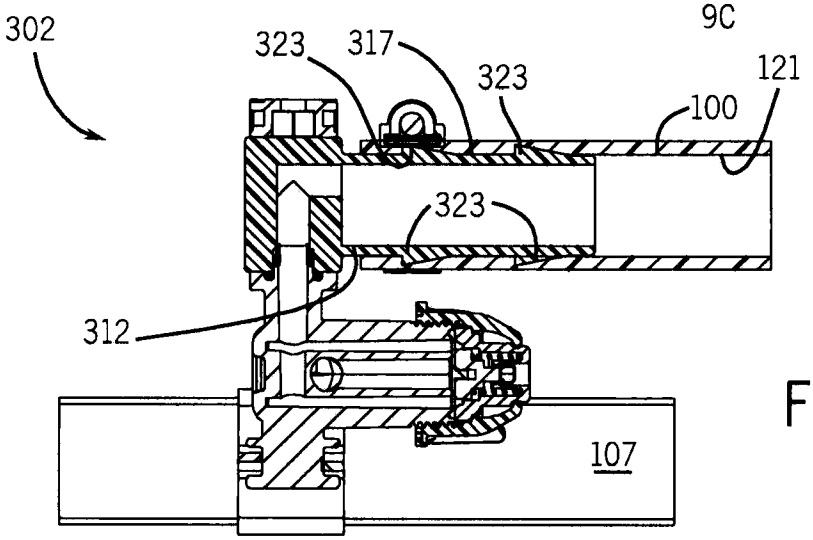


FIG. 9C

FIG. 10A

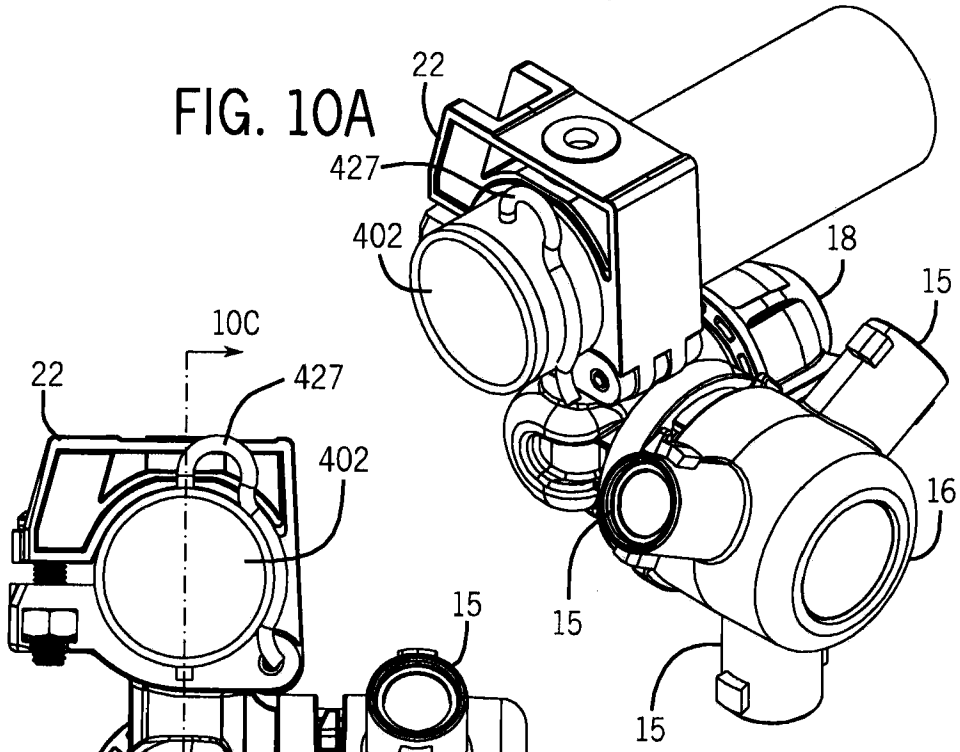


FIG. 10B

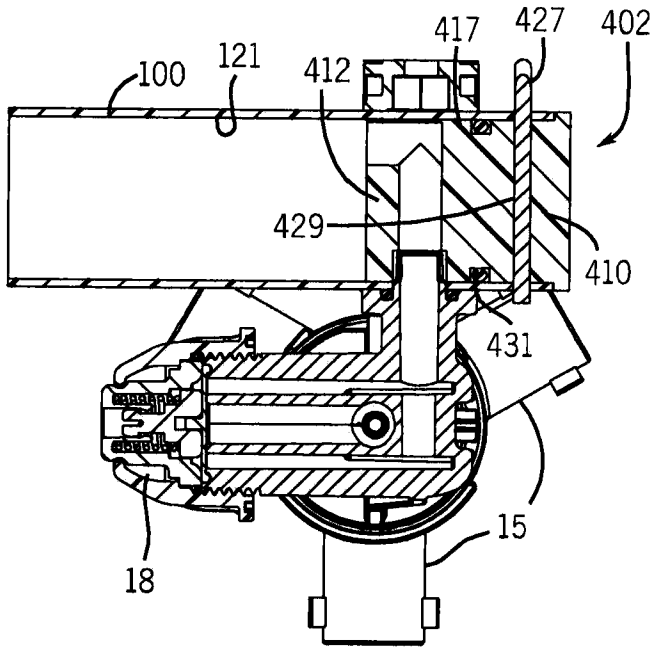


FIG. 10C

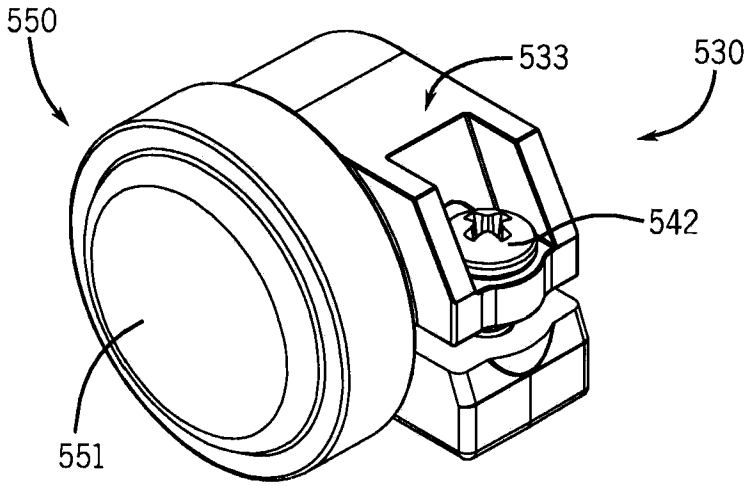


FIG. 11A

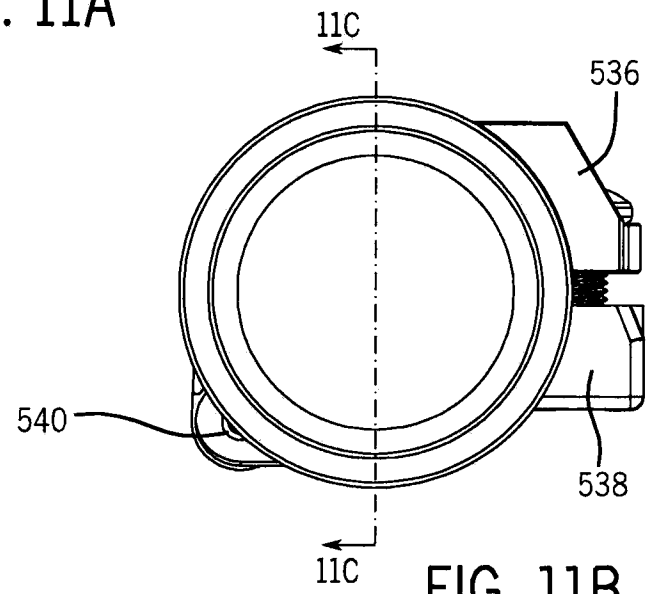


FIG. 11B

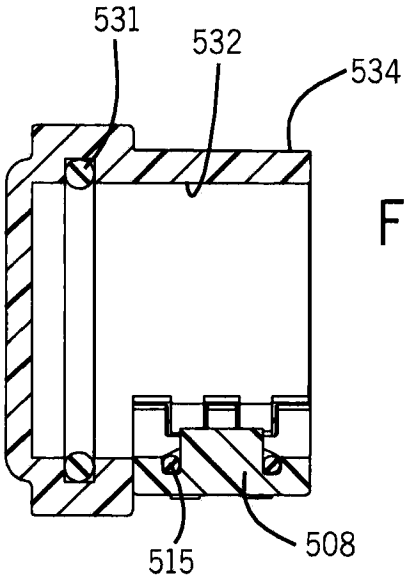
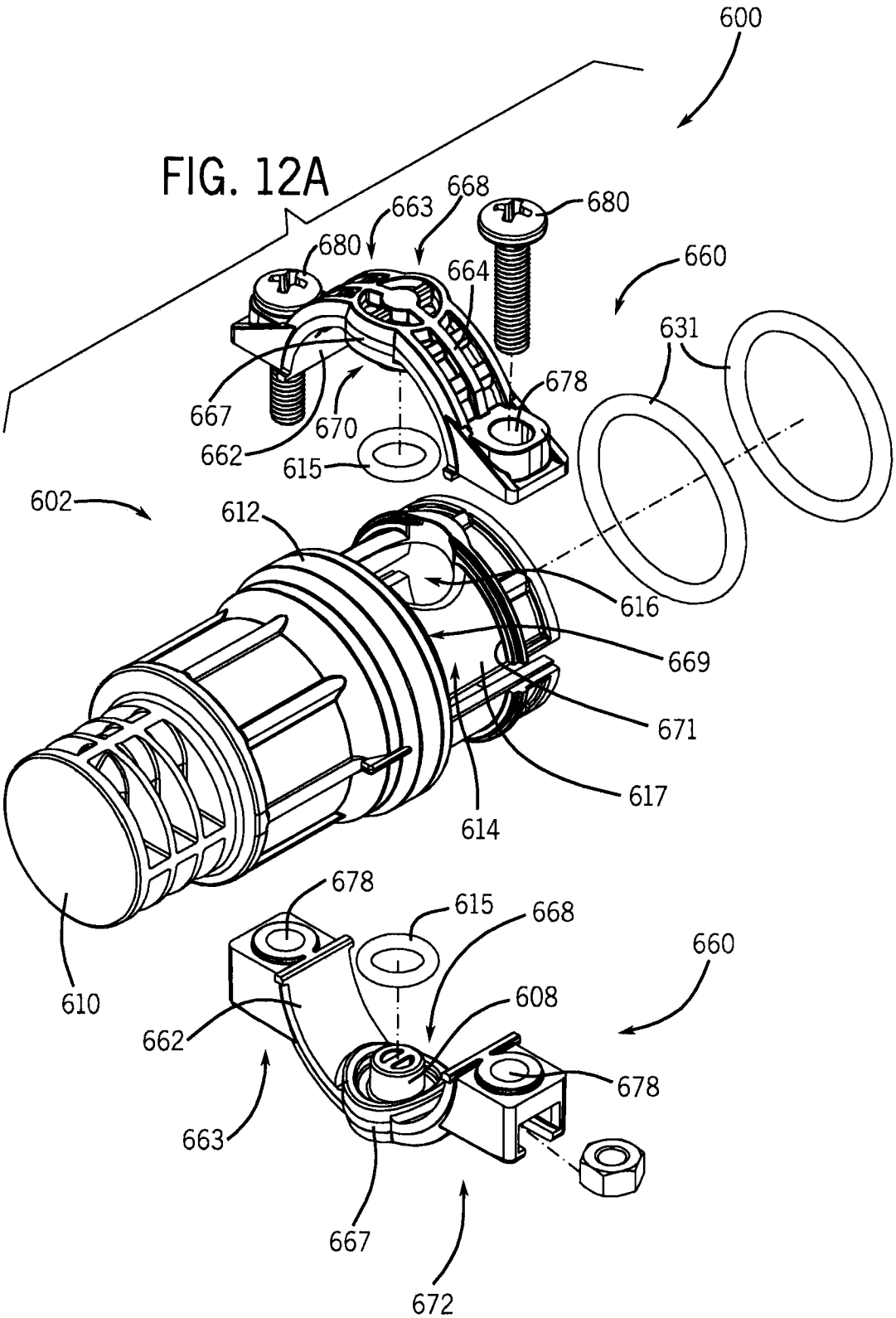


FIG. 11C

FIG. 12A


600
668
663
680
680
660
664
631
678
667
670
662
615
602
612
616
669
671
617
614
678
615
668
660
610
608
662
678
663
667
672

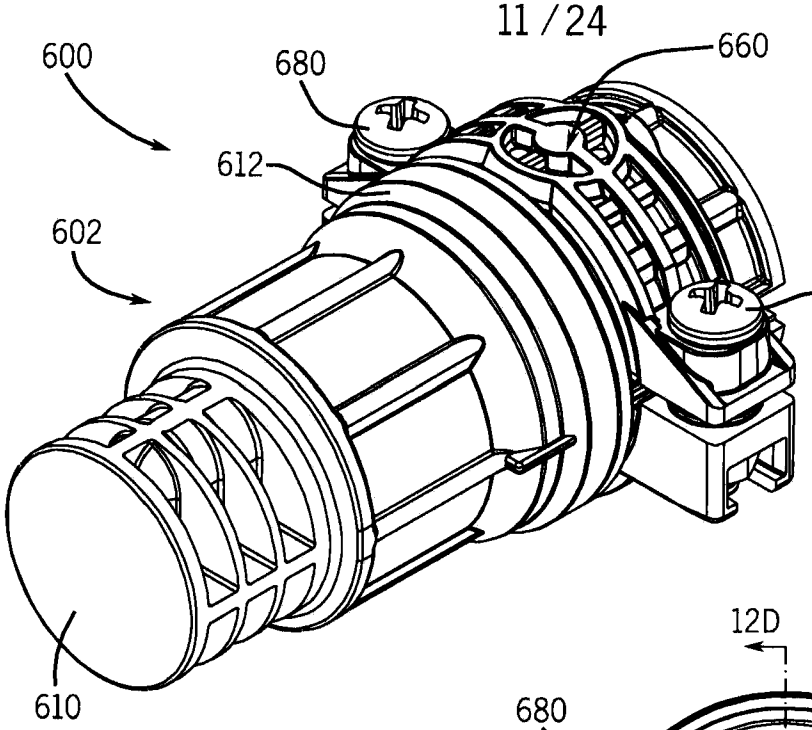


FIG. 12B

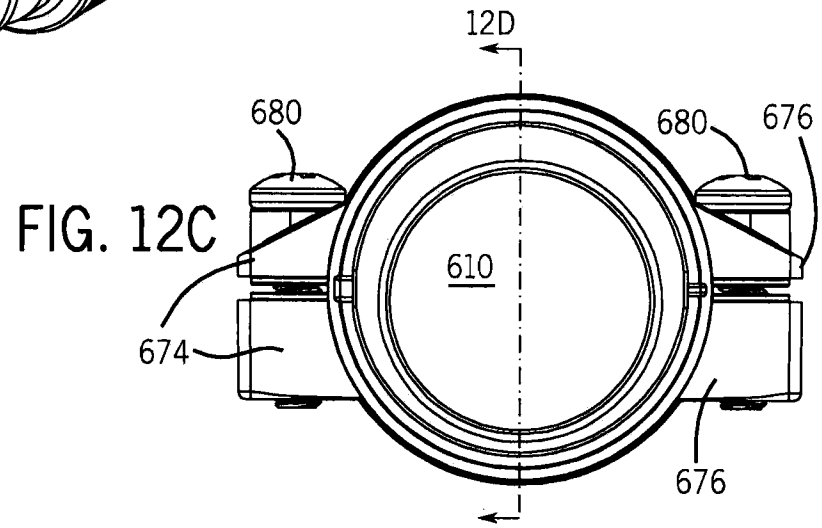


FIG. 12C

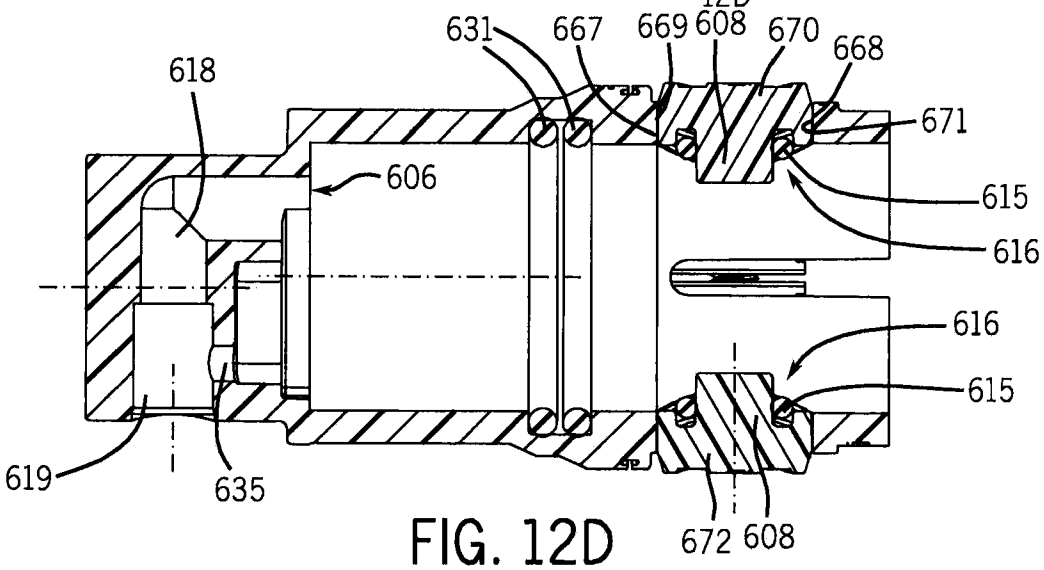


FIG. 12D

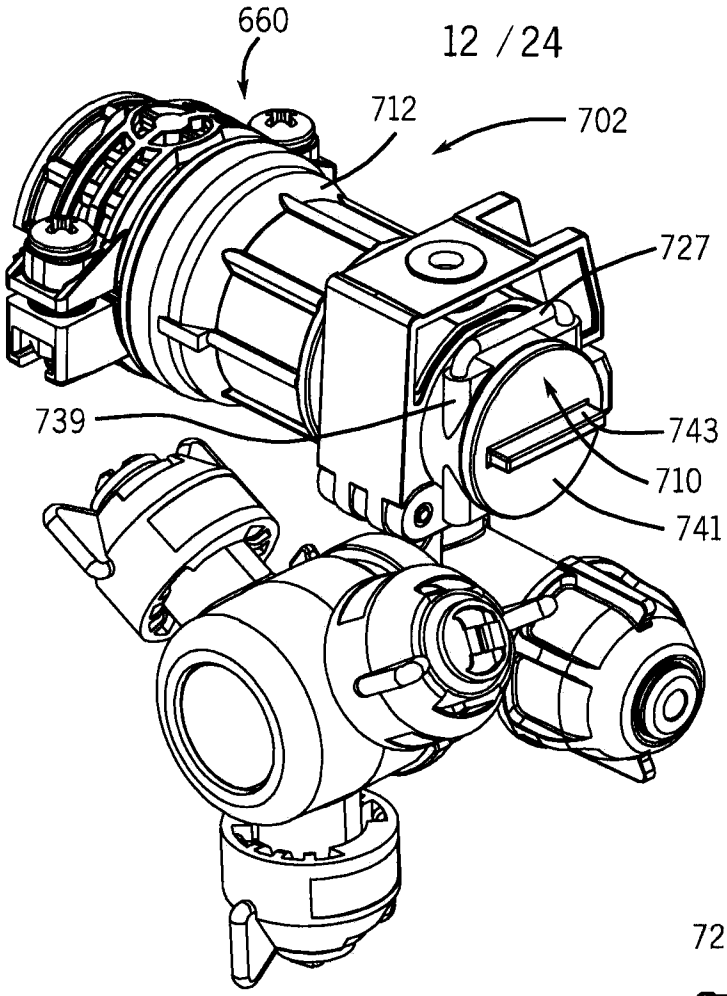


FIG. 13A

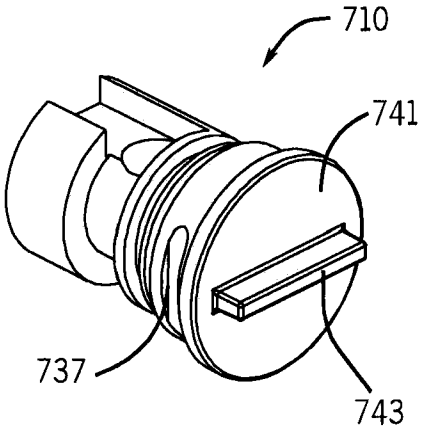


FIG. 13B

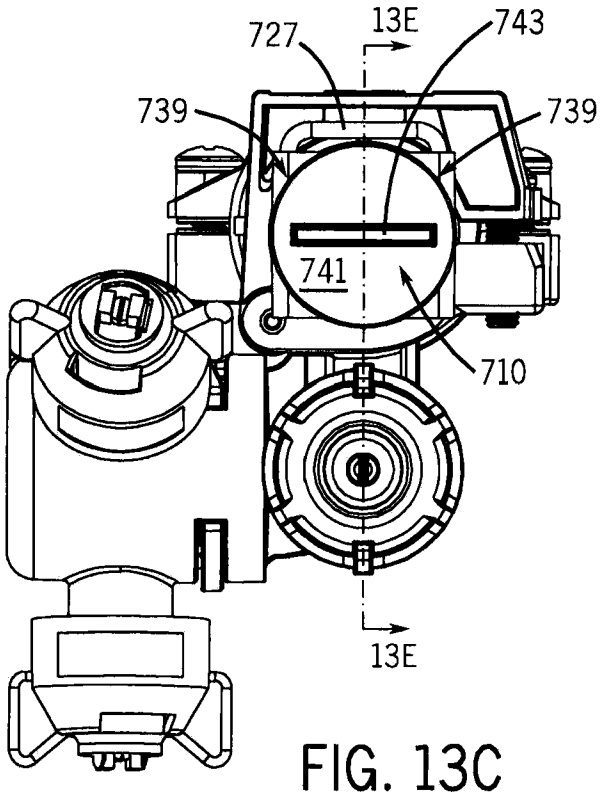


FIG. 13C

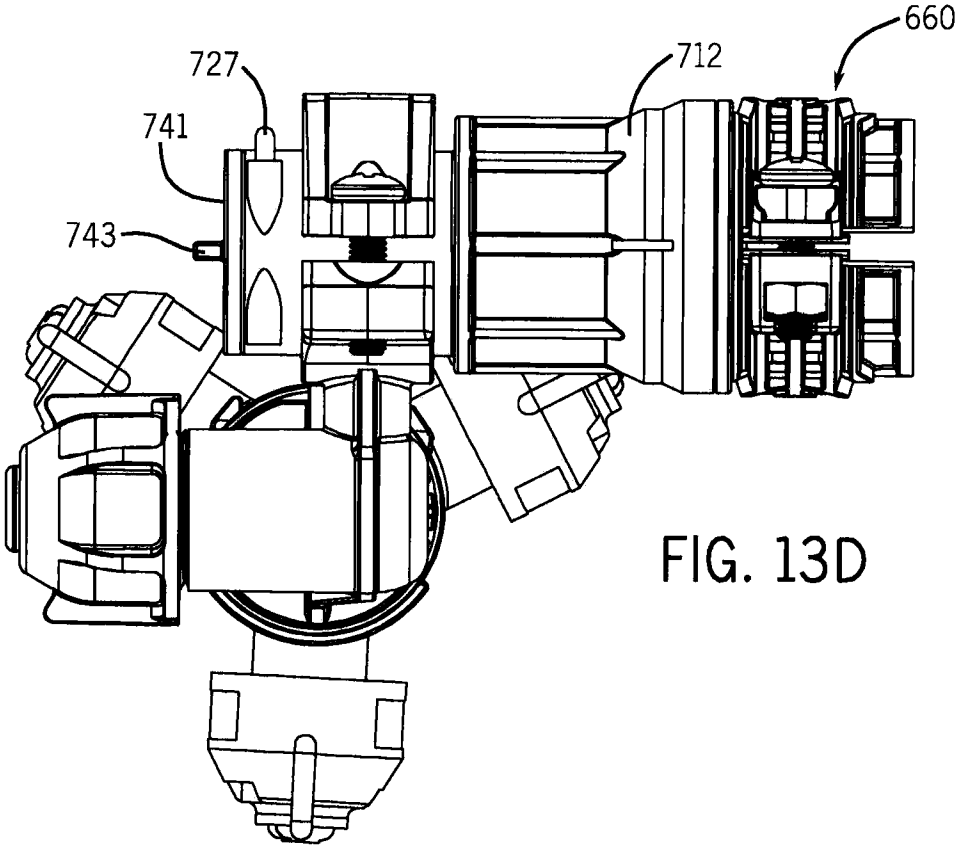


FIG. 13D

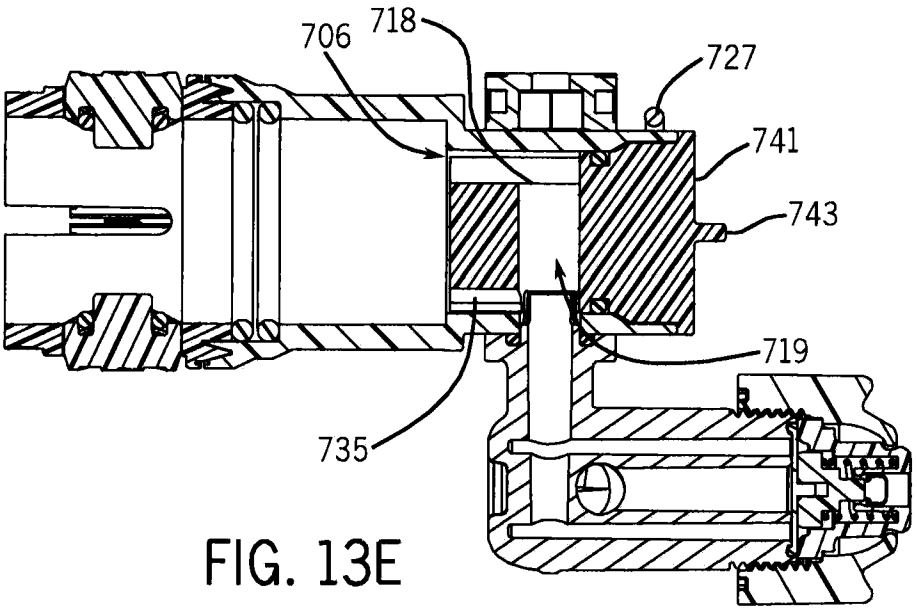


FIG. 13E

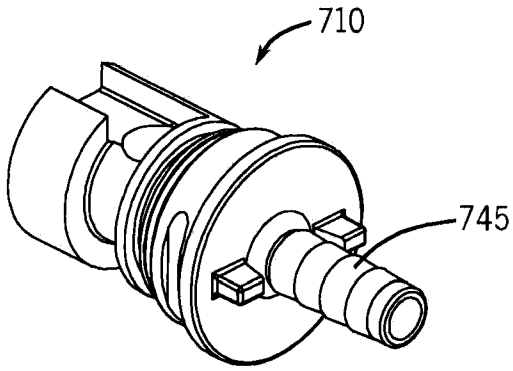


FIG. 13F

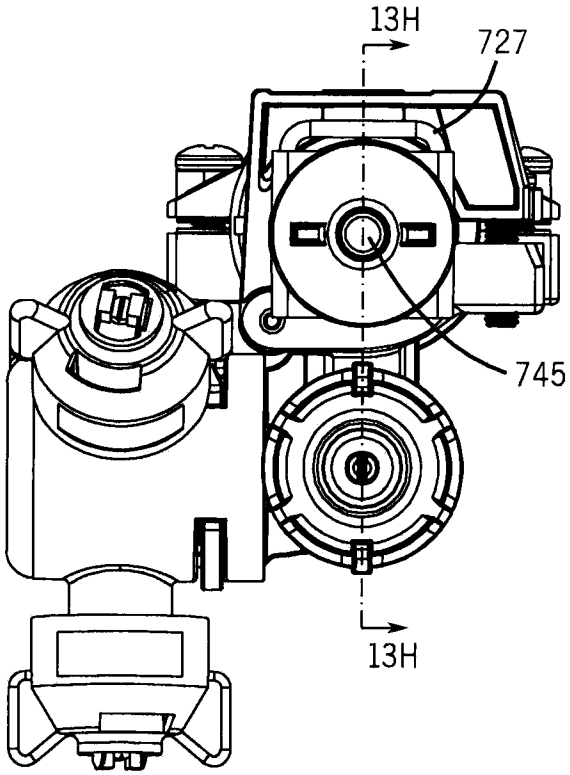


FIG. 13G

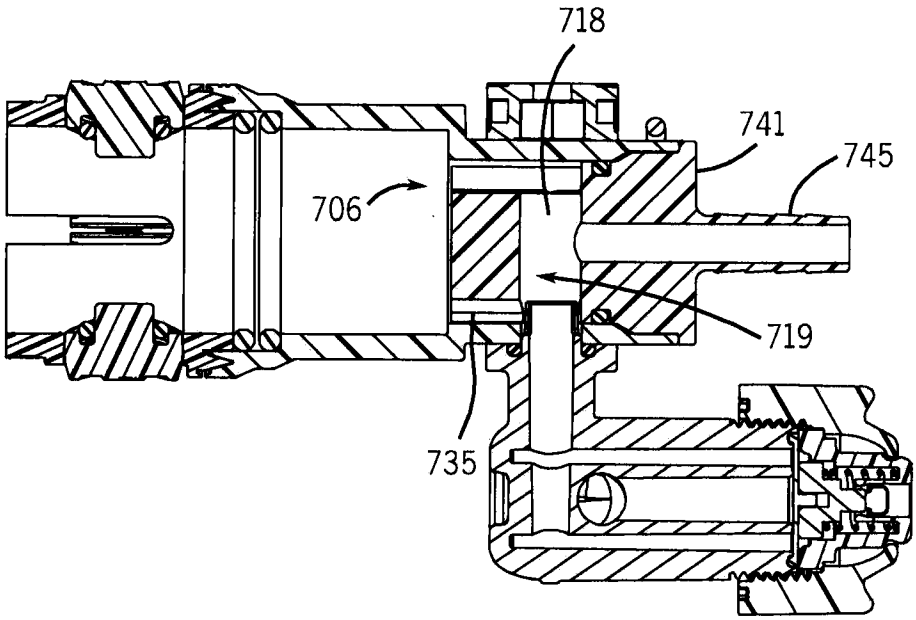


FIG. 13H

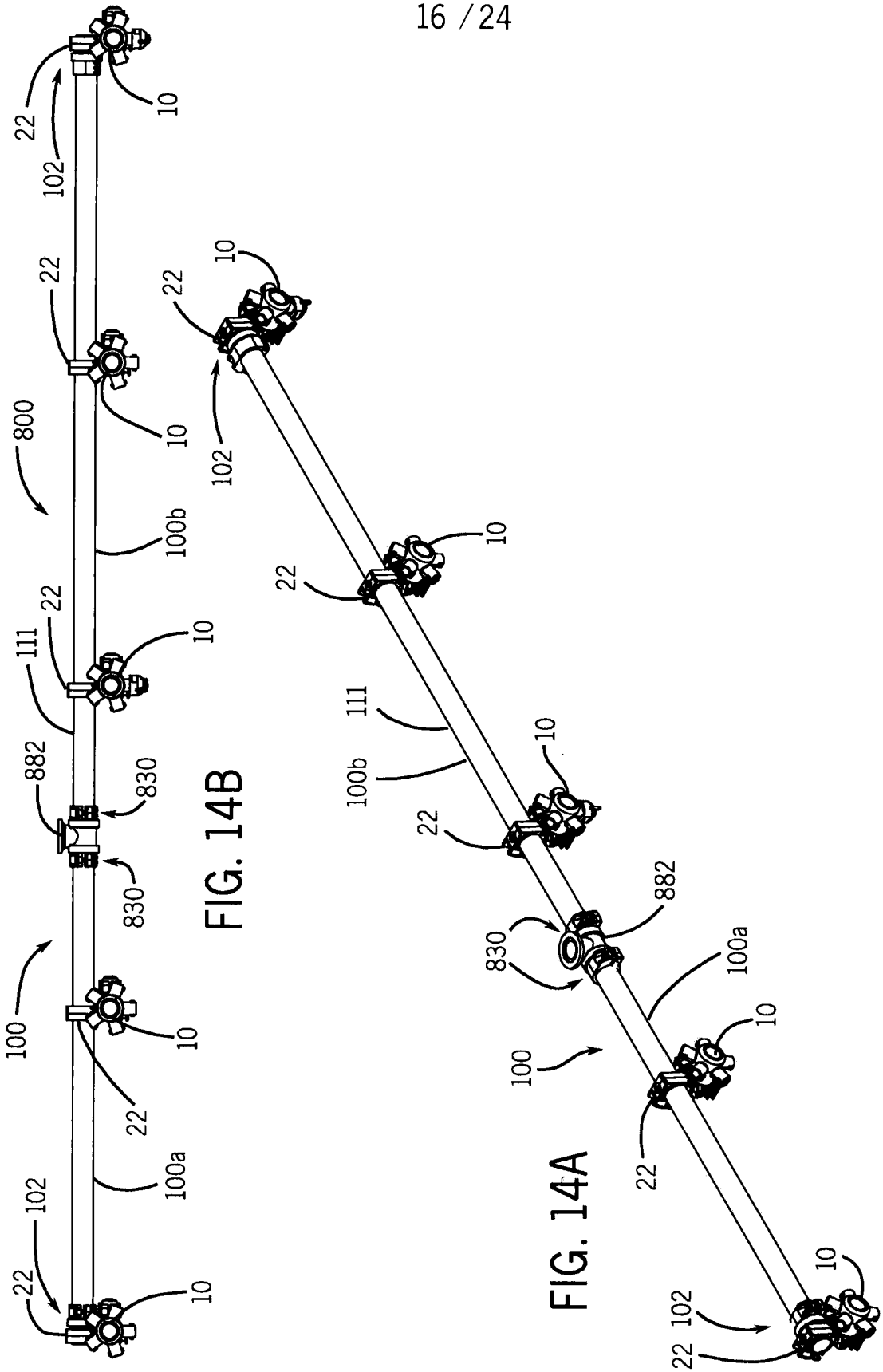


FIG. 14B

FIG. 14A

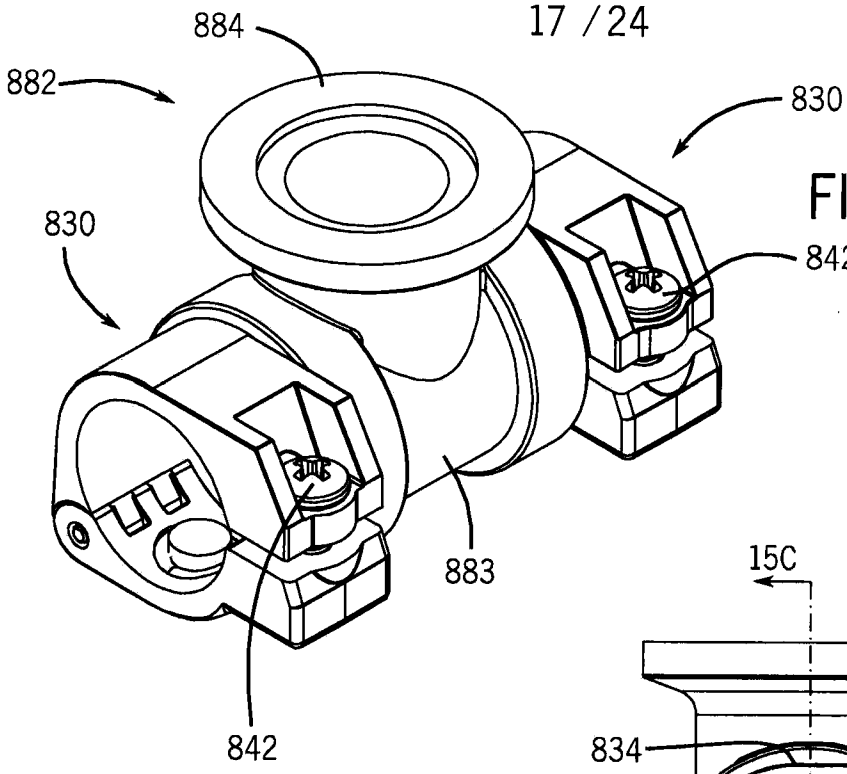


FIG. 15A

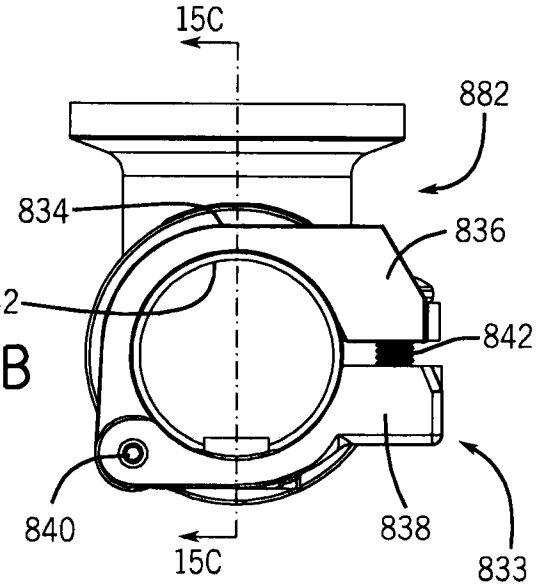


FIG. 15B

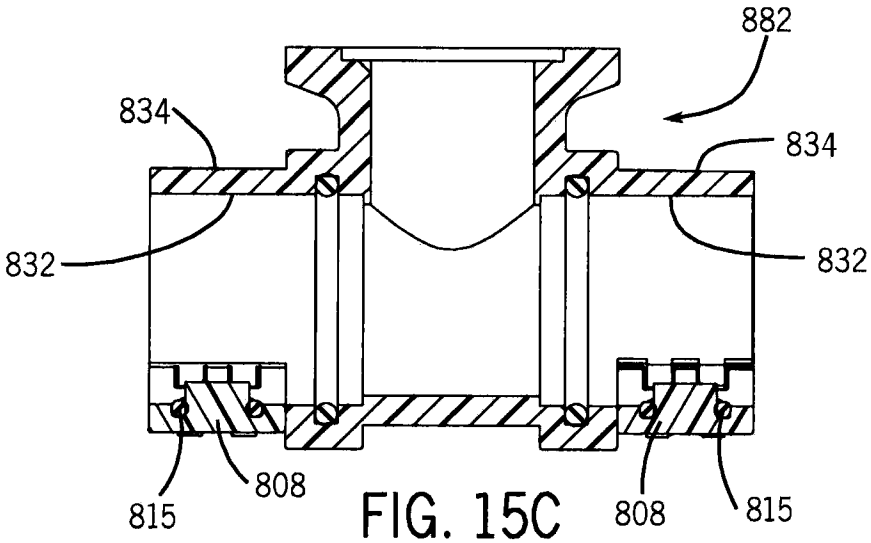


FIG. 15C

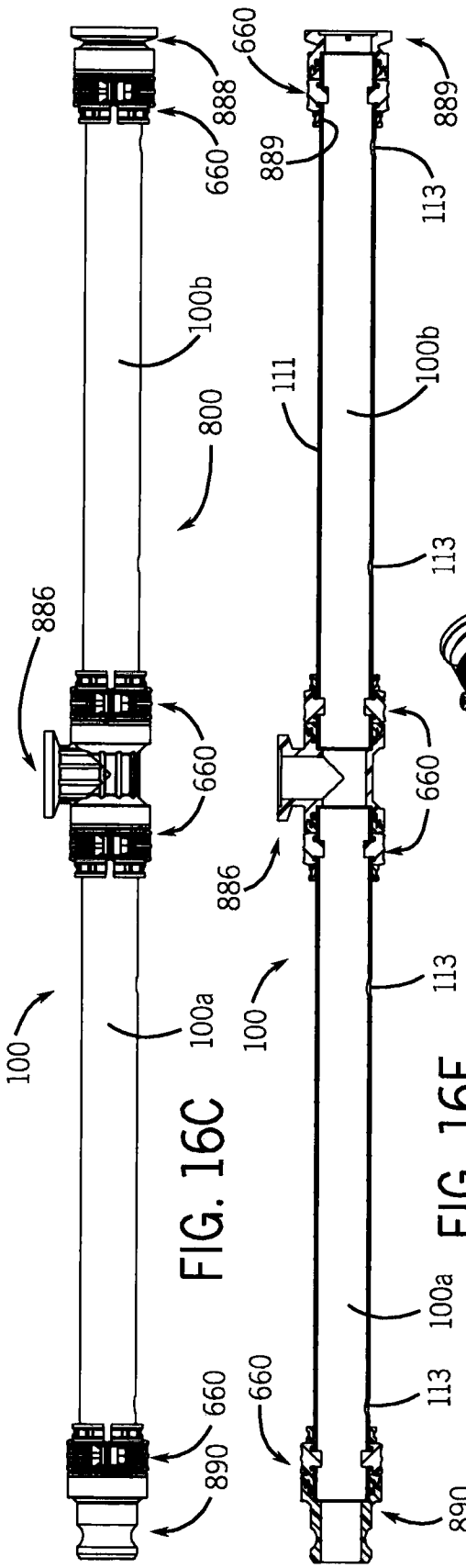


FIG. 16C

FIG. 16E

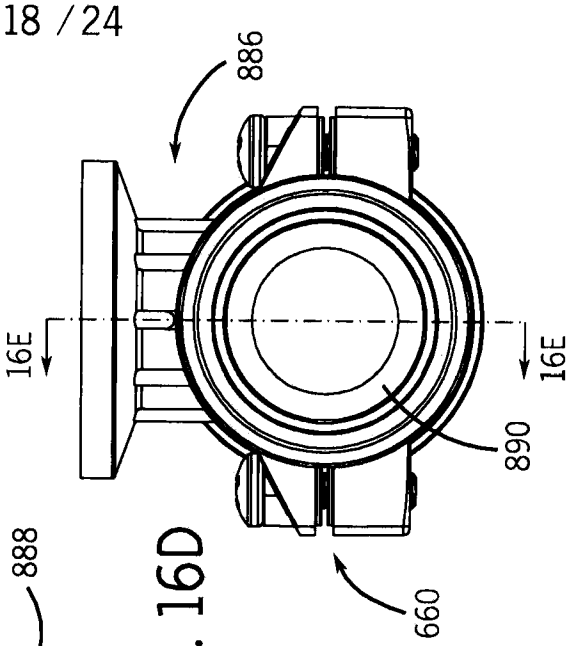


FIG. 16D

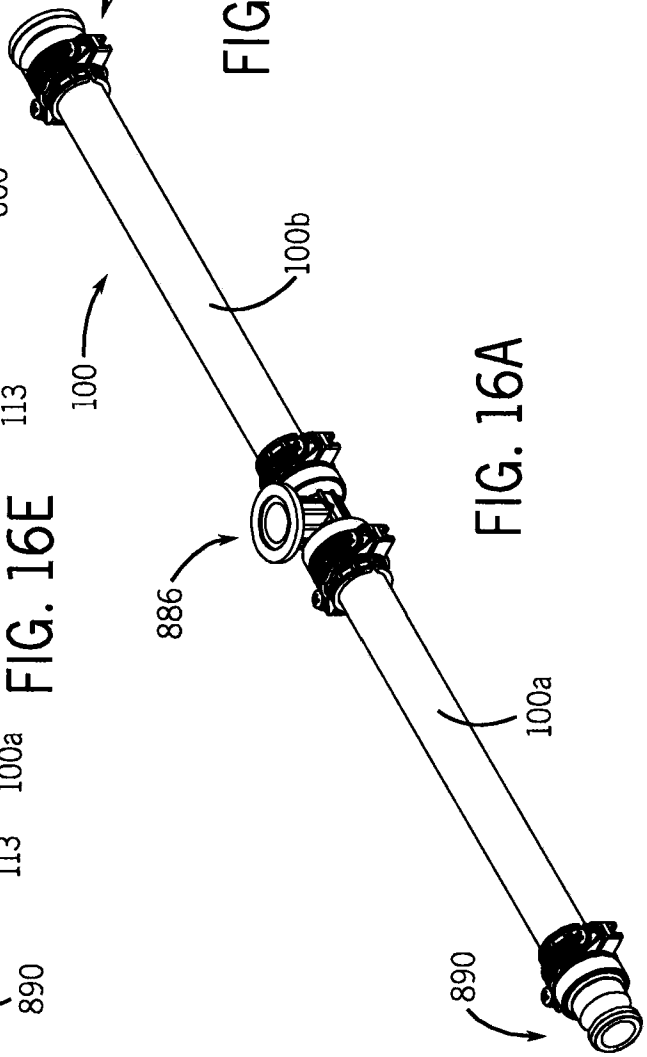
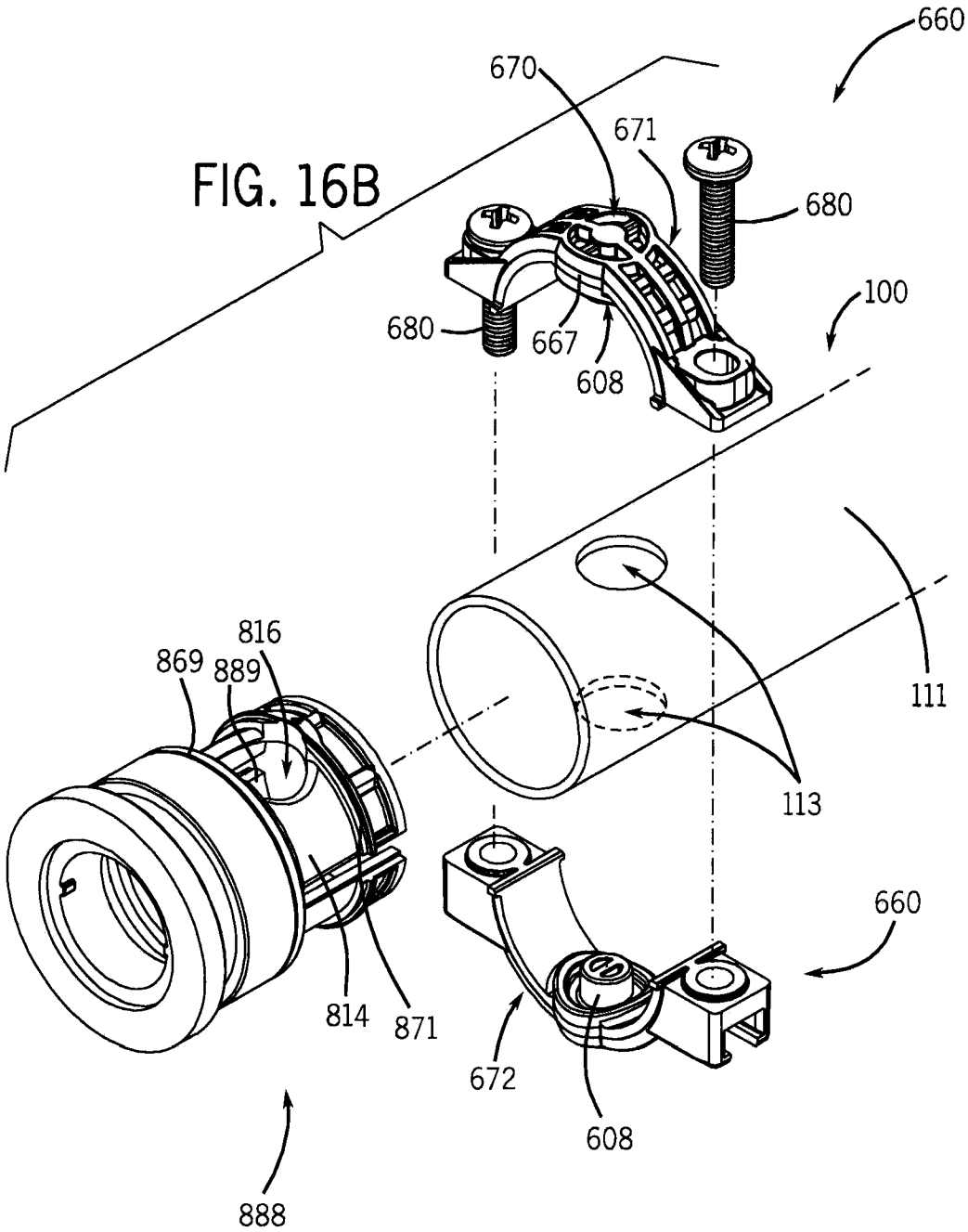


FIG. 16A

FIG. 16B


660
670
671
680
680
667
608
100
111
113
816
869
889
814
871
660
672
608
888

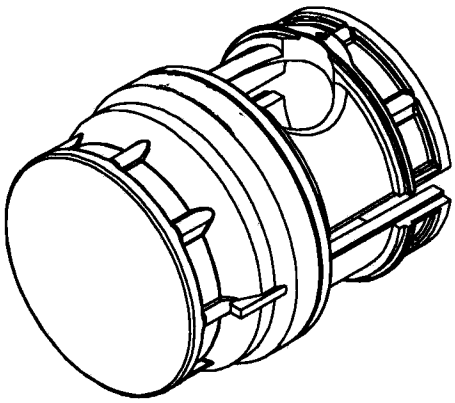


FIG. 17A

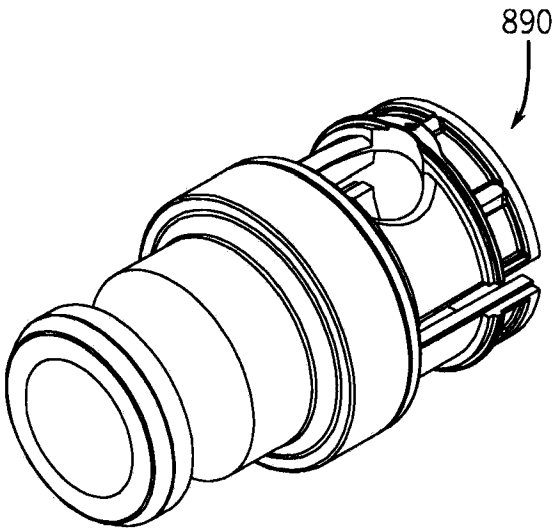


FIG. 17B

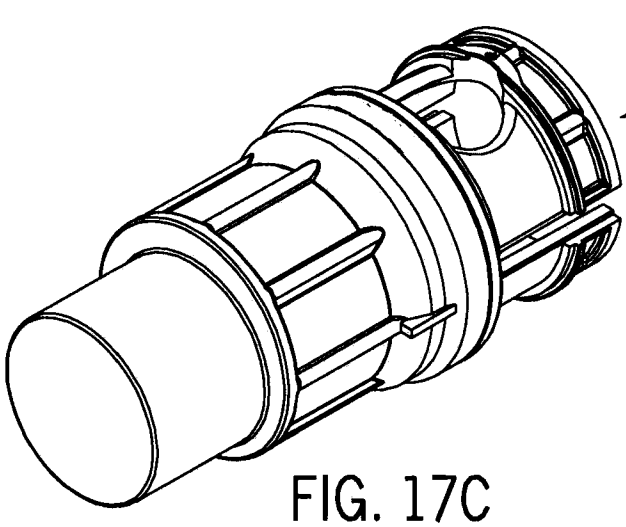


FIG. 17C

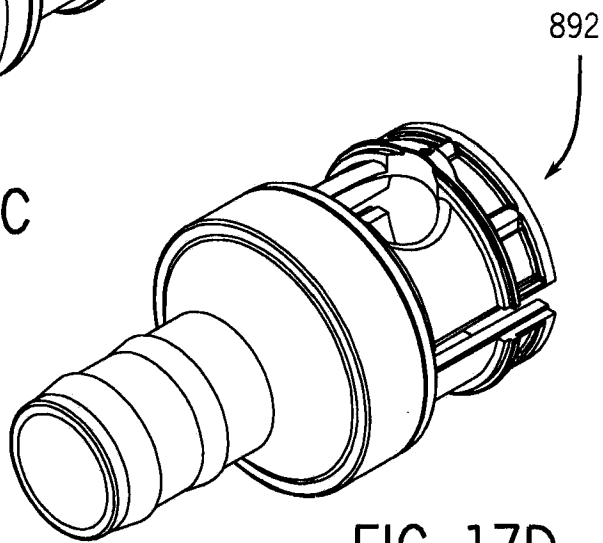


FIG. 17D

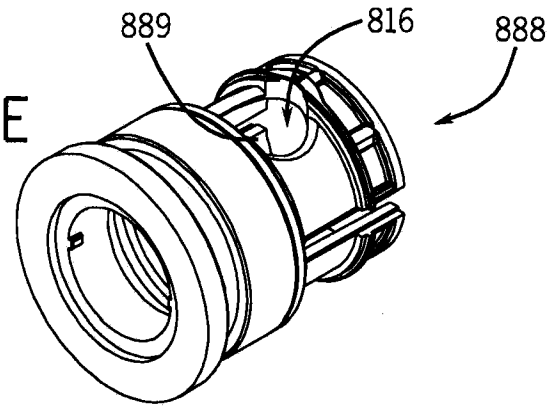


FIG. 17E

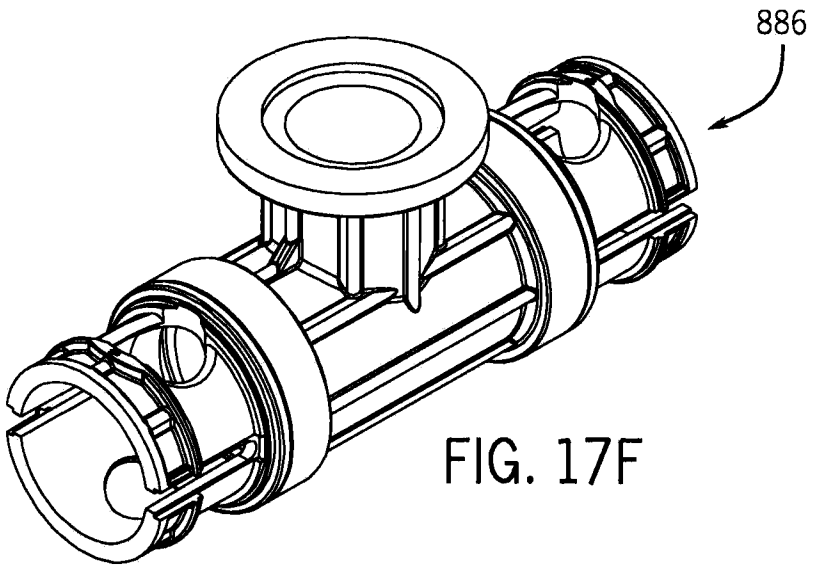


FIG. 17F

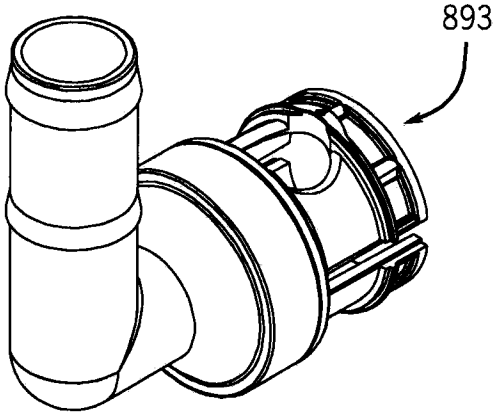


FIG. 17G

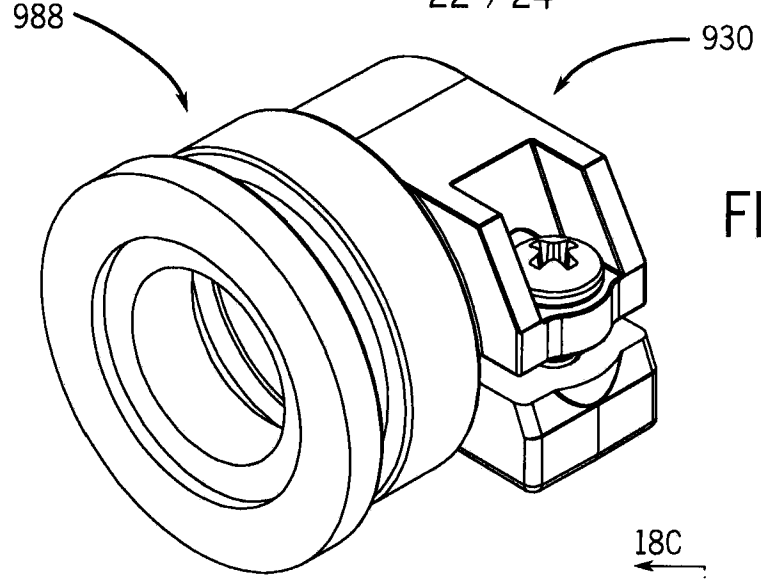


FIG. 18A

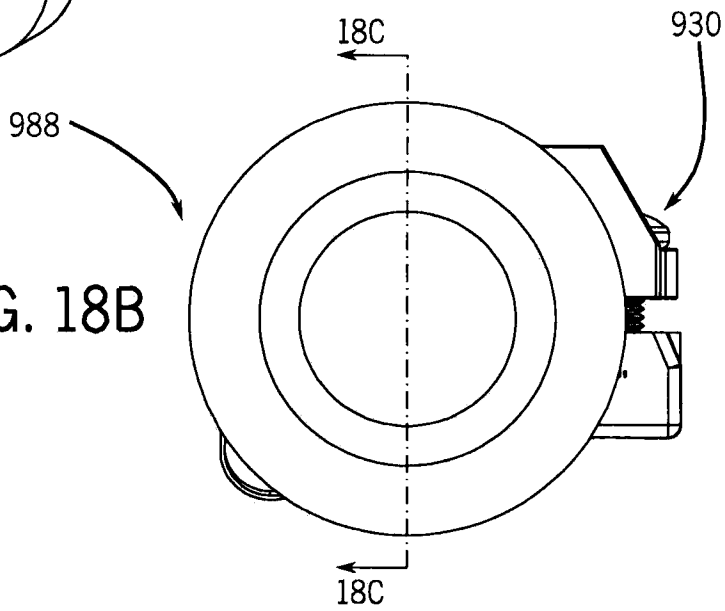


FIG. 18B

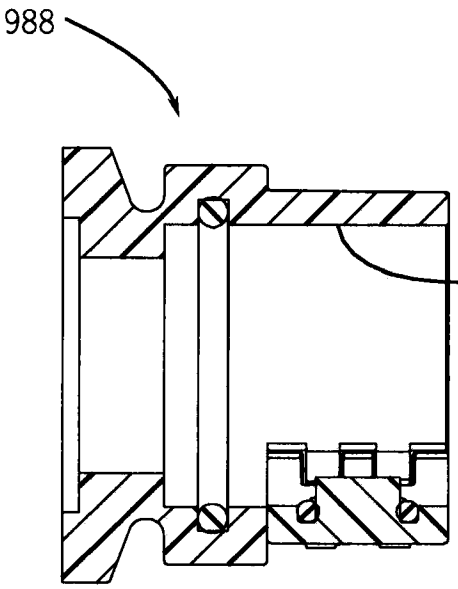


FIG. 18C

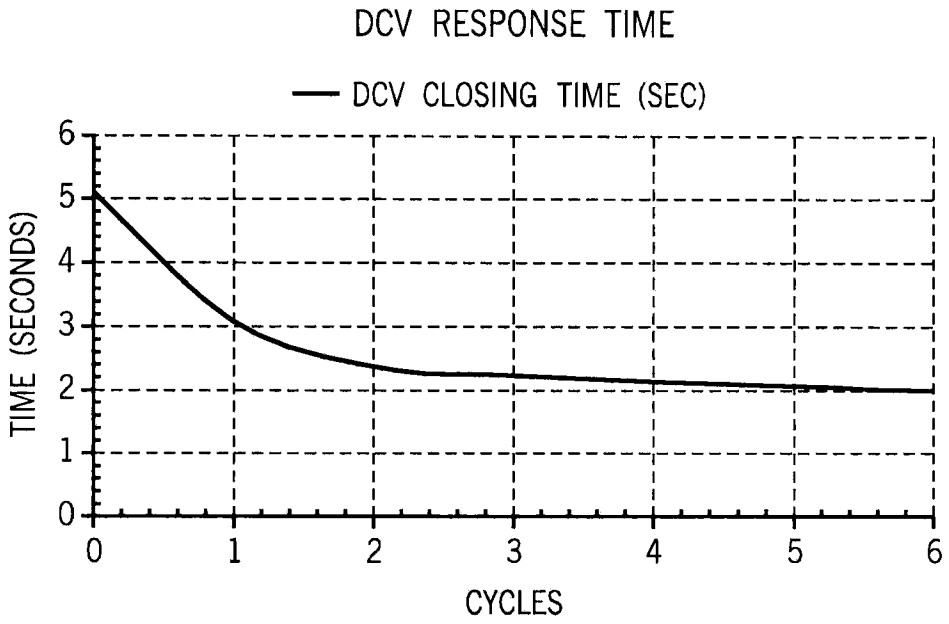

DCV RESPONSE TIME
DCV CLOSING TIME (SEC)
TIME (SECONDS)
0
1
2
3
4
5
6
CYCLES

FIG. 19

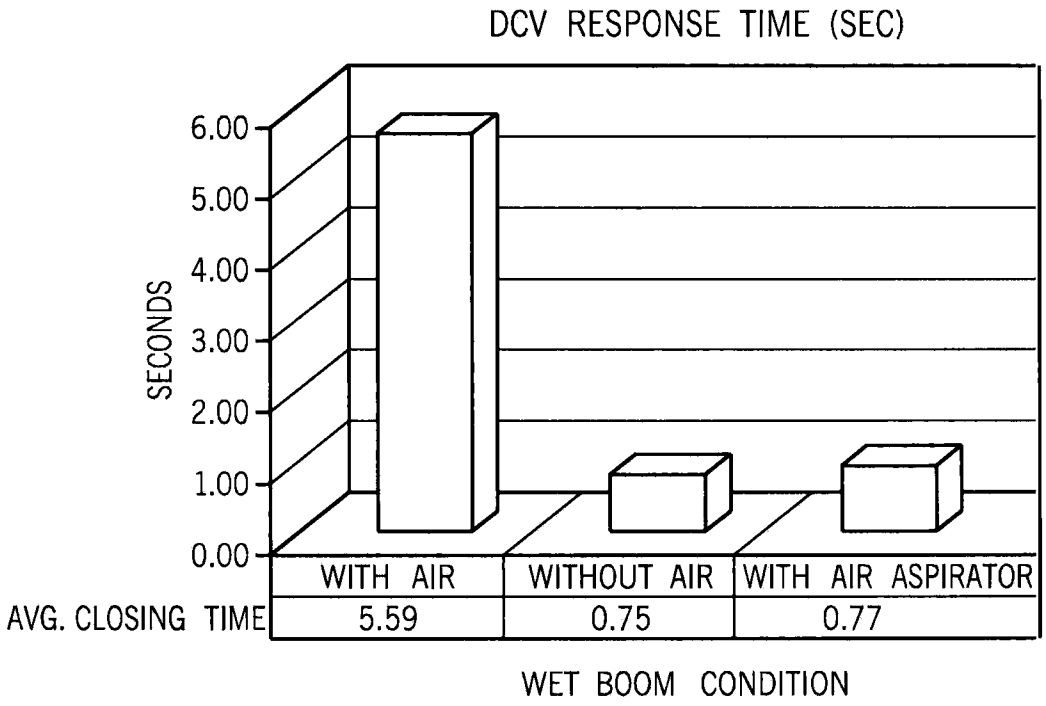

DCV RESPONSE TIME (SEC)
SECONDS
6.00
5.00
4.00
3.00
2.00
1.00
0.00
WITH AIR
WITHOUT AIR
WITH AIR ASPIRATOR
AVG. CLOSING TIME
5.59
0.75
0.77
WET BOOM CONDITION

FIG. 20

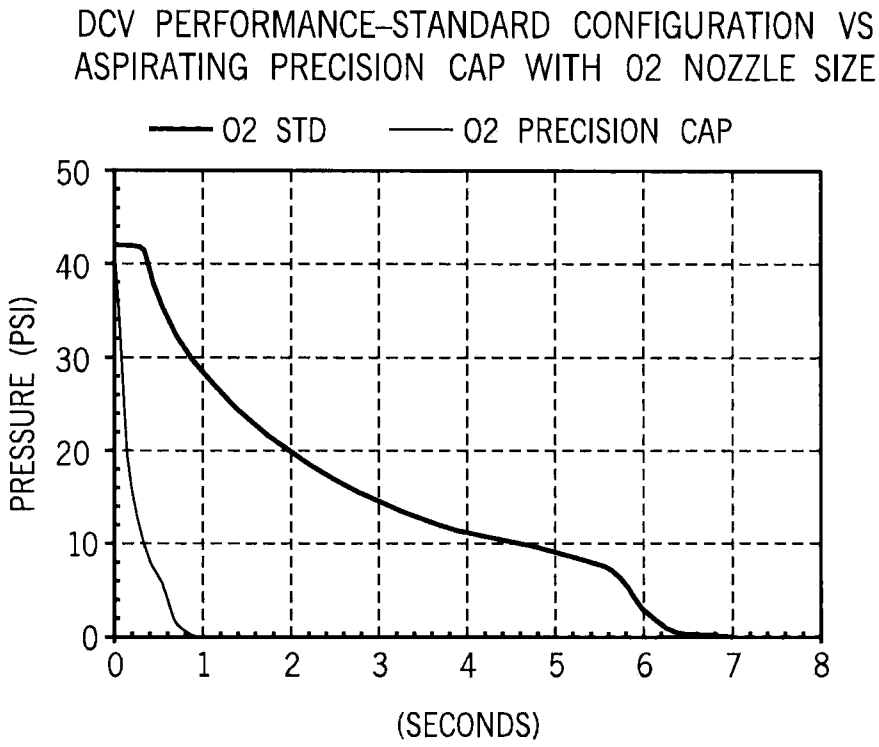

DCV PERFORMANCE–STANDARD CONFIGURATION VS ASPIRATING PRECISION CAP WITH 02 NOZZLE SIZE
02 STD
02 PRECISION CAP
PRESSURE (PSI)
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
(SECONDS)

FIG. 21

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/031134

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B05B 1/14 (2011.01)
USPC - 239/170
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)
IPC(8) - B05B 1/00, 1/14, 1/20, 1/30, 15/06, 15/06B; F16L 37/23 (2011.01)
USPC - 137/14.04, 14.05; 239/159, 170, 444, 449, 550, 569, 574; 285/84, 373, 420

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)
PatBase

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2008/0054636 A1 (REID) 06 March 2008 (06.03.2008) entire document	31-36
Y	US 7,458,619 B2 (CASSEL et al) 02 December 2008 (02.12.2008) entire document	31-36
Y	US 6,398,128 B1 (HAMILTON et al) 04 June 2002 (04.06.2002) entire document	32
Y	US 2,755,106 A (BRENNAN et al) 17 July 1956 (17.07.1956) entire document	36
A	EP 357154 A2 (VAN STEIJN) 07 March 1990 (07.03.1990) entire document	1-30
A	US 2008/0087750 A1 (WADDELOW et al) 17 April 2008 (17.04.2008) entire document	1-30

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

* 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 application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 July 2011	03 AUG 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/031134

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
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, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

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

SEE CONTINUATION SHEET

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ 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 claims Nos.:
1-36

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2011/031134

CONTINUATION FROM BOX III

This application contains claims directed to more than one species of the generic invention. These species are deemed to lack unity of invention because they are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for more than one species to be examined, the appropriate additional examination fees must be paid. The species are as follows:

Species I) an air aspiration device having a main body, pipe fitting, air port, passageway, and exit port; Figs. 1-6.

Species II) a fluid delivery system including a boon, a tee adapter, and first and second clamps where the clamps couple the tee adapter; Figs. 10A-C.

The claims are deemed to correspond to the species listed above in the following manner:

Species I) Figures 1-6; claims 1-30

Species II) Figures 10A-C; claims 37-41

The following claims are generic: claims 31-36.

The species listed above do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, the species lack the same or corresponding special technical features for the following reasons:

Species I) claims 1-30; have the special technical feature of an air aspiration device having a main body, pipe fitting, air port, passageway, and exit port. This special technical feature is not present in species II.

Species II) claims 37-41; have the special technical feature of a fluid delivery system including a boon, a tee adapter, and first and second clamps. This special technical feature is not present in species I.

Species I and II lack unity of invention because even though the inventions of these species require the technical feature of a clamp for maintaining angular orientation, this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of US 2008/0054636 A1 to Reid.

Since none of the special technical features of the Species I and II inventions is found in more than one of the inventions, unity of invention is lacking.