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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 July 2015 (09.07.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/103343 A1

(51) International Patent Classification:
B60K 15/04 (2006.01)

(21) International Application Number:
PCT/US2014/072905

(22) International Filing Date:
30 December 2014 (30.12.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/921,722 30 December 2013 (30.12.2013) US

(72) Inventor; and
(71) Applicant : **COOLEY, Robert Charles** [US/US]; Fast Fill Systems, INC., 1195 N Springcreek Place, Suite C, Springville, Utah 84663 (US).

(74) Agent: **FOX, Angus Cannon**; Law Offices of Angus Fox, 4093 N Imperial Way, Provo, Utah 84604-5386 (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, BN, 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, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, 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, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, 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, KM, ML, MR, NE, SN, TD, TG).

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

(54) Title: TOP FILL, FULLY-INTEGRATED PRESSURELESS FLOW-CONTROL MODULE OPERATIVE WHEN TANK FLUID IS FROZEN

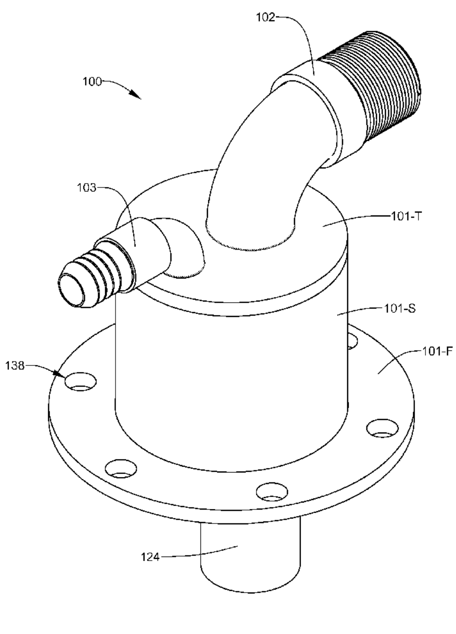

FIG. 1

(57) Abstract: A fully-integrated flow-control valve assembly, operative when tank fluid is frozen, is designed so that all but a float level float, a fluid bleed aperture, and a roll¬ over protection valve, are positioned outside the tank on which the flow-control valve assembly is mounted. The assembly includes a housing containing a valve cage equipped with a valve seat. A valve plunger, having a central bleed port, slides within the valve cage and seals against the valve seat after rising to a closed position. A bleed circuit casing is secured to the valve cage. A biasing spring that is compressed between the valve plunger and the bleed circuit casing, urges the valve plunger toward the valve seat, but is unable to move the valve plunger as long as fluid entering the bleed port is able to escape from the bleed circuit casing through a normal escape path.

WO 2015/103343 A1

TOP FILL, FULLY-INTEGRATED PRESSURELESS FLOW-CONTROL MODULE OPERATIVE WHEN TANK FLUID IS FROZEN

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates, generally, to valve assemblies and, more particularly, to flow control valve assemblies that are used to protect primarily fuel tanks from being overfilled with fuel. However, it is likely that such flow control valve assemblies may be used to protect types of containers, other than fuel tanks, from being overfilled with other kinds of fluids.

Description of the Prior Art

For many years large machinery fitted with fuel tanks have been equipped with fast fill systems to enable rapid filing of large capacity fuel tanks. The existing fast fill fuel systems rely on an air vent that prevents air from escaping the fuel tank when the required level of fuel has been attained. This causes pressure in the fuel tank to increase to a level that automatic shuts-off a fuel supply nozzle.

A major concern of this system is that when the fuel level activates the shut-off for the fuel supply nozzle, the shut-off can be overridden and fuel can continue to be forced into the fuel tank above the normal level. This can cause the fuel tank to rupture from the high pressure attained when filling.

U.S. Pat. No. 6,311,723, (by the applicant), has addressed this problem by devising a flow control valve assembly that prevents the build up of pressure within the fuel tank during and after filing. The flow control valve assembly also prevents the supply fuel nozzle from being overridden thus preventing the possibility of overfilling. U.S. Pat. No. 6,311,723 is hereby incorporated by reference.

The control valve assembly of U.S. Pat. No. 6,311,723 uses float valve to determine when the level of fuel in the fuel tank is at a desired level. When the desired level of fuel has been attained, the float valve is used to block the flow of fuel through a bleed pipe to stop the flow of fuel through a control valve. An open breather is provided within the fuel tank to allow gas to escape from the fuel tank during filling to prevent the fuel tank rupturing.

The flow control valve assembly operates very effectively on machinery that is predominately stationary. However, when the control valve assembly is mounted to vehicles' fuel tanks, such as those located in trucks and excavators, some difficulties may experienced during movement of the vehicle.

One problem that may be experience is that the float valve may become broken. The float valve comprises a float that is mounted on a pivotally movable elongate arm. This arm can break due to the large forces that are exerted on the arm by the surging fuel caused by movement of the vehicle.

In the event that the control valve assembly fails, in this or any other manner, the fuel supply nozzle will continue to fill the tank and pass fuel through the open breather until the nozzle is shut-off manually. This may lead to many hundreds or even thousands of litres of fuel being wasted and the spilt fuel being disposed.

Another problem that occurs is fuel is passed through the open breather during movement of the vehicle. Fuel surges cause fuel to flow through the open breather and escape the fuel tank. Again, this wastes fuel and is environmentally unfriendly. Further, the spilt fuel also creates a fire vehicle hazard.

Another problem associated with prior-art flow control valves is that they are typically used in bottom-filled tanks. This requires that the float assembly be located inside the tank near the top thereof, while the flow control valve is located near the bottom of the tank near where the fuel nozzle couples to the receiver. In order for the float assembly to control the flow control valve, a small-diameter bleed line is used to couple the flow control valve assembly—that is near the bottom of the tank—to the float assembly that is near the top of the tank. The bleed line can be routed either internal or external to the tank, depending on the design of the unit. The use of such a two-piece assembly precludes the use of such a device in smaller tanks.

What was needed is a fully-integrated flow control assembly that mounts at the top of the fuel tank. In such a fully-integrated unit, the float assembly and the flow control valve assembly are both installed within the tank near the top thereof. Only an inlet/vent head protrudes from the top of the tank. Installing the fully-integrated assembly is much simpler than installing the separate float and control valve assemblies, as there is no need to make a connection between the two devices.

The aforementioned problems were solved, as evidenced by the filing of PCT patent application No. PCT/US2013/000223 titled FULLY-INTEGRATED FLOW-CONTROL VALVE ASSEMBLY FOR TOP-FILLED FUEL TANKS, by the same inventor, on 24 Sep 2013. This flow-control valve, which is designed for internal mounting near the top of a fuel tank, is suitable for use with liquids, such as petroleum fuels, that do not freeze. However, for aqueous solutions which are likely to freeze at low temperatures, this flow-control valve can sustain damage if the tank is full and the aqueous fluid remains inside the flow-control valve.

What is needed is a fully-integrated flow-control valve assembly for top-filled tanks that is compatible aqueous solutions that may freeze.

SUMMARY OF THE INVENTION

Four embodiments of a top-fill, fully-integrated flow-control module operative when fluid in the tank is frozen are disclosed. The first embodiment flow-control module bolts to the top of a liquid storage tank. The first embodiment flow-control module is designed so that all but a fluid level float, a fluid bleed aperture, and a roll-over protection valve, are positioned above the top of the tank on which the flow-control valve assembly is mounted. The second embodiment module mounts by threadably engaging a threaded opening in the top of a liquid storage tank. Like the first embodiment flow-control module, the third embodiment flow-control module also bolts to top of a liquid storage tank. However, unlike the first embodiment module, all of the moving parts are located within the storage tank. The fourth embodiment flow-control module bolts to the side of a liquid storage tank very near the top thereof. The second, third and fourth embodiment flow-control modules also incorporate a feature that enables tank fill lines to be evacuated by reversing the pumping action once the storage tank has been filled.

The first embodiment flow-control module includes a housing having a top plate, a generally cylindrical side wall that is threadably secured to the top plate, and a mounting flange that is secured to the cylindrical side wall. A fluid inlet tube and a vent tube are affixed to the top plate. A valve cage, which incorporates a valve seat, is threadably secured to a first threaded socket on the underside of the top plate, which communicates with the fluid inlet tube. A valve plunger, having a bleed port on its face, slides within the valve cage and seals against the valve seat after rising to a closed position. A bleed circuit casing is threadably attached to the valve cage. A biasing spring that is compressed between the valve plunger and the bleed circuit casing, urges the valve plunger toward the valve seat, but is unable to move the valve plunger as long as fluid entering the bleed port is able to escape from the bleed circuit casing through a normal escape path. Escape of fluid is controlled by a fluid bleed valve that is coupled to a level-control float. When the tank reaches a filled level, the fluid bleed valve closes, thereby cutting off the fluid escape route from the bleed circuit casing. The biasing spring is then able to close the valve plunger. A fluid filler nozzle senses the increase in back pressure and shuts off the flow of fluid passing through the filler nozzle. A fluid bleed aperture, which provides fluid escape from the fluid bleed chamber at a rate that is much slower than that provided by the normal escape path, ensures that fluid drains out of the bleed circuit casing after filling so that freezing of the fluid will not damage the flow-control valve assembly. The roll-over protection valve comprises a caged stainless steel ball. The cage is secured to a vent drop tube that screws into a second threaded socket on the underside of the top plate, which communicates with the vent tube.

The shut-off function of the second, third and fourth embodiment flow-control module functions identically to that of the first embodiment flow-control module. The primary differences between the first and the second embodiment modules are the positioning of all moving parts within the tank, the mounting of the module using a plug having a male pipe threading, and the evacuation feature for tank fill lines of the second embodiment module. This evacuation feature is provided by a spring-biased movable seat for the valve plunger. After the storage tank has been filled, pumping action is reversed. The drop in air pressure at the mount of the tank lifts the movable seat so that air can flow from the vent tube, into the tank, over the top of the valve plunger and out through what is ordinarily the fill port.

The third embodiment flow-control module differs from the second embodiment module in that, like the first embodiment module, it is bolted to the top of the storage tank. Unlike the second embodiment module, major components of the module are bolted together using flanges and O-ring seals in grooves in the flanges rather than screwed together using single large threaded union joints. However, like the second embodiment module, the third embodiment module includes the evacuation feature for tank fill lines.

The fourth embodiment flow-control module utilizes most of the components of the third embodiment module. However, the roll-over protection valve has been modified, as have been the fluid bleed valve and level-control float assembly. On the fourth embodiment module, the fluid bleed valve and the level-control float move in directions which are orthogonal to the direction of movement of the valve plunger.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a downward isometric view of a first embodiment top-mount, top-fill, fully-integrated pressureless flow-control module operative when tank fluid is frozen;

Figure 2 is an upward isometric view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 1;

Figure 3 is a side elevational view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 1;

Figure 4 is an alternative side elevational view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 1;

Figure 5 is a bottom plan view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 1;

Figure 6 is a cross-sectional elevational view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 1, taken through section plane 6 – 6 of Figure 4;

Figure 7 is a cross-sectional isometric view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 1, taken through section plane 6 – 6 of Figure 4;

Figure 8 is a downward isometric view of a second embodiment top-mount, top-fill, fully-integrated pressureless flow-control module operative when tank fluid is frozen;

Figure 9 is an upward isometric view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 8;

Figure 10 is a side elevational view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 8;

Figure 11 is an alternative side elevational view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 8;

Figure 12 is a cross-sectional elevational view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 8, taken through section plane 12 – 12 of Figure 11;

Figure13 is a downward isometric view of a third embodiment top-mount, top-fill, fully-integrated pressureless flow-control module operative when tank fluid is frozen;

Figure 14 is an upward isometric view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 13;

Figure 15 is a top plan view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 13;

Figure 16 is a cross-sectional elevational view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 13, taken through section plane 16 – 16 of Figure 15;

Figure 17 is a cross-sectional elevational view of the top-mount, top-fill, fully-integrated pressureless flow-control module of Figure 13, taken through section plane 17 – 17 of Figure 15;

Figure 18 is an isometric view of a side-mount, top-fill, fully-integrated pressureless flow-control module operative when tank fluid is frozen;

Figure 19 is an alternative isometric view of a side-mount, top-fill, fully-integrated pressureless flow-control module of Figure 18;

Figure 20 is a side elevational view of the side-mount, top-fill, fully-integrated pressureless flow-control module of Figure 18;

Figure 21 is a cross sectional elevational view of the side-mount, top-fill, fully-integrated pressureless flow-control module of Figure 18, taken through section plane 21 – 21 of Figure 20;

Figure 22 is a cross sectional elevational view of the side-mount, top-fill, fully-integrated pressureless flow-control module of Figure 18, taken through section plane 22 – 22 of Figure 20;

PREFERRED EMBODIMENT OF THE INVENTION

The first embodiment top-fill, fully-integrated pressureless flow-control module operative when tank fluid is frozen will now be described in detail, with reference to the attached drawing figures 1 through 7.

Referring now to Figures 1 through 7, the first embodiment flow-control module 100 includes a housing 101 having a top plate 101-T, a generally cylindrical side wall 101-S that is threadably secured to the top plate 101-T, and a mounting flange 101-F that is secured to the cylindrical side wall 101-S. A fluid inlet tube 102 and a vent tube 103 are affixed to the top plate 101-T. A valve cage 104, which incorporates a valve seat 105, is threadably secured to a threaded socket 106 on the underside of the top plate 101-T, which communicates with the fluid inlet tube 102. A first rubber O-ring 107 is used to seal the joint. A valve plunger 108, having a fluid bleed port 109 on its face, slides within the valve cage 104 and seals against the valve seat 105 after rising to a closed position. The valve plunger 108 is equipped with a second O-ring 110, which seals against the walls of the valve cage 104. A bleed circuit casing 111 is threadably attached to the valve cage 104. A third rubber O-ring 112 seals the joint. A fluid retention chamber 113 is formed between the bleed circuit casing 111 and the bottom of the valve plunger 108. The only escape for fluid entering the fluid retention chamber 113 through the fluid bleed port 108 is via a fluid escape passage 114. A biasing spring 115, that is compressed between the bottom of the valve plunger 108 and the bleed circuit casing 111, urges the valve plunger 108 toward the valve seat 105, but is unable to move the valve plunger 108 as long as fluid entering the fluid bleed port 109 is able to escape from the fluid retention chamber 113 and flow into the tank (not shown, but on which the flow-control module 100 is installed) through the fluid escape passage 114. There are two routes which fluid may take to enter the tank. The first is through a system bleed aperture 116, which allows fluid to drain from the fluid escape passage 114 at a rate that is insignificant compared with the much faster rate that fluid can enter the fluid bleed port 109. Nevertheless, the system bleed aperture 116 ensures that fluid drains out of the fluid escape passage 114 after filling so that freezing and concomitant expansion of the fluid will not destroy the flow-control valve assembly 100. A second route which fluid may take to enter the tank is through a valved aperture 117, and then into the tank through exit port 118 in the bleed circuit casing 111. The valved aperture 117 is part of a float stem guide 119, an upper portion of which slides into a socket within the bleed circuit casing 111. A float header 120, which is threadably secured to the bleed circuit casing 111, secures the bottom of the float stem guide 119. A fourth rubber O-ring 121 seals the joint between the float header 120 and the bleed circuit casing 111. It will be noted that the upper portion of the float stem guide 119 is equipped with a fifth rubber O-ring 122, and the lower portion of the float stem guide 119 is equipped with a sixth rubber O-ring 123. It will also be noted that the system fluid bleed aperture 116 is located within the float header 120. A float 124 moves upwardly within the float header 120 in response to a rising fluid level in the tank on which the flow control module 100 is installed. The float 124 is secured to a float stem 125, which is, in turn, secured to a float stem attachment spindle 126. Also secured to the float stem attachment spindle 126 is a bleed valve needle 127, which is installed within the valved aperture 117. The bleed valve needle 127 has a head 128 that is fitted with small diameter seventh rubber O-ring 129. As the float 124 rises in response to fluid approaching a completely-filled level 130, the float stem 125 causes the float stem attachment spindle 126 to also rise, thereby lifting the bleed valve needle 127 so that the head 128 and O-ring 129 seal the entrance 131 of the valved aperture 117. With the valved aperture 117 closed, the primary fluid escape route from the fluid retention chamber 113 is blocked. Thus, with fluid pressure equalized on both the top and bottom of the valve plunger 108, the biasing spring 115 is then able to close the valve plunger 108. A fluid filler nozzle (not shown) that is coupled to the fluid inlet tube 102 senses an increase in back pressure and shuts off the flow of fluid passing through the filler nozzle. A roll-over protection valve 132 comprises a stainless steel ball 133 within a ball cage 134. The ball cage 134 is secured to a vent drop tube 135 that screws into a second threaded socket 136 on the underside of the top plate 101-T, which communicates with the vent tube 103. A large-diameter eighth rubber O-ring 137 is also used to seal the joint between the mounting flange 101-F and the top surface of the tank. Six holes 138 in the mounting flange 101-F enable the flow control module 100 to be bolted to the tank.

The second embodiment top-fill, fully-integrated pressureless flow-control module will now be described in detail, with reference to the attached drawing figures 8 through 12.

Referring now to Figures 8 through 12, the second embodiment flow-control module 200 includes an externally threaded mounting plug 201 having a first internally threaded aperture 202 and a second internally threaded aperture 203. A fluid inlet tube 204, which is secured to the top of the mounting plug 201, is internally continuous with the first internally threaded aperture 202. A vent tube 205, which is also secured to the top of the mounting plug 202, is internally continuous with the second internally threaded aperture 203. A valve seat cage 206 is screwed into the first internally threaded aperture 202. A first biasing spring 207 is inserted within the valve seat cage 206, after which a movable valve seat body 208 is inserted within the valve seat cage 206. A valve plunger cage 209 is threadably secured to a lower portion of the valve seat cage 206, thereby trapping the first biasing spring 207 and the movable valve seat body 208 within the valve seat cage 206. A valve plunger 210, followed by a second biasing spring 211, are inserted into the valve plunger cage 209. After a bleed circuit casing 212 is secured to a bottom portion of the valve plunger cage 209, the second biasing spring 211 and the valve plunger 210 are trapped within the valve plunger cage 209. Components installed within the bleed circuit casing 212 function in a manner identical to the bleed circuit of the first embodiment flow-control module. As with the first embodiment flow-control module, when the bleed circuit closed, the valve plunger 210 slides upwardly within the valve plunger cage 209 until the sealing edge 213 of the valve plunger 210 seats against the conical sealing surface of the movable valve seat body 208, thereby increasing back pressure of filling fluid and signaling to the fluid dispensing nozzle that it should shut-off the flow of fluid. After a filing operation is complete, the pump can be operated in reverse to clear the fill lines. A reversing of the pump reduces the air pressure above the movable valve seat body 208. The apertures 214 within the valve seat body 208 enable this reduced pressure to be applied to a larger surface area of the movable valve seat body 208, thereby causing the valve seat body 208 to overcome the biasing force of the first biasing spring 207 and move upward away from the valve plunger 210. Because upward travel of the valve plunger 210 is limited by the shoulder 215 within the valve plunger cage 209, upward movement of the valve seat body 208 opens up a gap between it and the valve plunger 210, thereby allowing air to flow into the tank through the vent tube 205 and into the fill line, which become evacuated.

The third embodiment top-fill, fully-integrated pressureless flow-control module 300 will now be described in detail, with reference to the attached drawing figures 13 through 17.

Referring now to Figures 13 through 17, the third embodiment flow-control module 300, like the first embodiment flow-control module 100, bolts to the top of a fluid storage tank. Although its function is identical to that of the second embodiment flow-control unit, it structure is slightly different. The top housing 301 of the third embodiment module 300 has a cylindrical cavity 302 that functions as a valve seat cage. The valve plunger cage 303 is bolted directly to the top housing 301. An O-ring 304 seals the joint between the top housing 301 and the valve plunger cage 303. Another minor difference is that the bleed circuit casing 305 is bolted directly to the valve plunger cage 303.

The fourth embodiment top-fill, fully-integrated pressureless flow-control module 400 will now be described in detail, with reference to the attached drawing figures 18 through 22.

Referring now to Figures 18 through 22, the fourth embodiment flow-control module 400 is functionally identical to the second and third embodiments of the flow-control module 200 and 300, respectively. In fact, the fourth embodiment flow-control module 400 is a modified third embodiment module. The top housing 301 becomes a side housing 401 that is bolted to the side of the storage take near the top thereof. The vent drop tube has been eliminated and the rollover protection valve ball 402 has been inserted within the vent tube galley 403. The bleed circuit casing 404 has been redesigned to that movement of the fluid level float 405 can remain vertical.

Although only a single embodiment of the invention is shown and described herein, it will be obvious to those having ordinary skill in the art that changes and modifications may be made thereto without departing from the scope and the spirit of the invention as hereinafter claimed.

CLAIMS

What is claimed is:

1. A fully-integrated flow-control module for top-fill fluid storage tanks comprising:

a housing containing a fill tube and a valve cage equipped with a valve seat;

a valve plunger, having a central bleed port, slides within the valve cage and seals against the valve seat after moving to a closed position;

a bleed circuit casing is secured to the valve cage;

a biasing spring compressed between the valve plunger and the bleed circuit casing, which urges the valve plunger toward the valve seat, but is unable to move the valve plunger as long as fluid entering the bleed port is able to escape from the bleed circuit casing through a normal escape path;

a float level float which operates a fluid bleed valve that closes said normal escape path when the fluid storage tank is full;

a fluid bleed aperture for draining fluid from the bleed circuit when the storage tank is not being filled; and

a vent tube having roll-over protection valve which prevents escape of fluid within the tank in the event the tank is overturned;

wherein only the fluid level float is positioned so that it can be partially immersed in fluid within the tank.

2. The fully-integrated flow-control module of claim 1, which further comprises a movable valve seat which unseals the valve plunger when fill lines are evacuated by reversing a tank fill pump, thereby allowing air to enter the vent tube and pass into the fill tube.

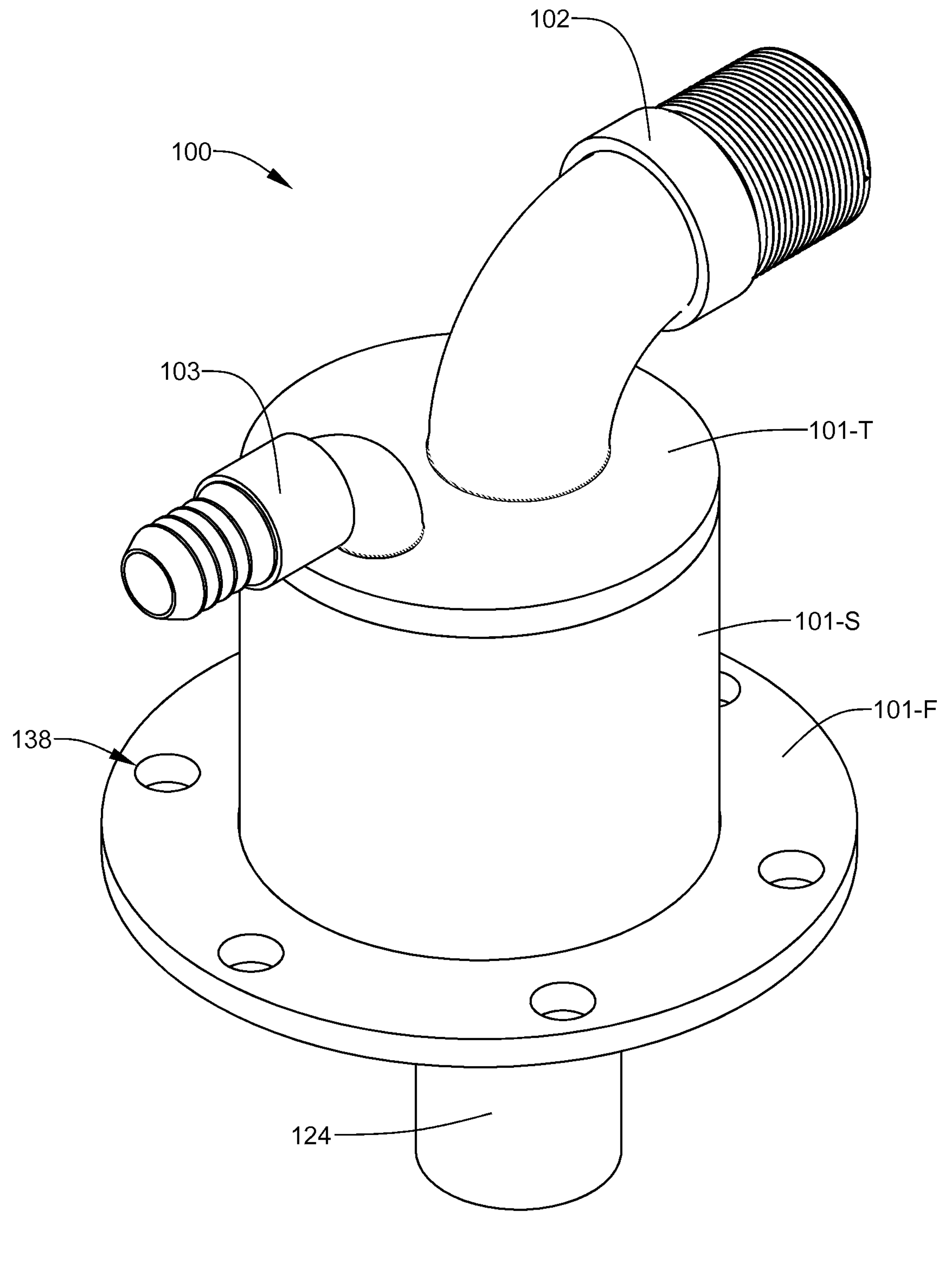

FIG. 1

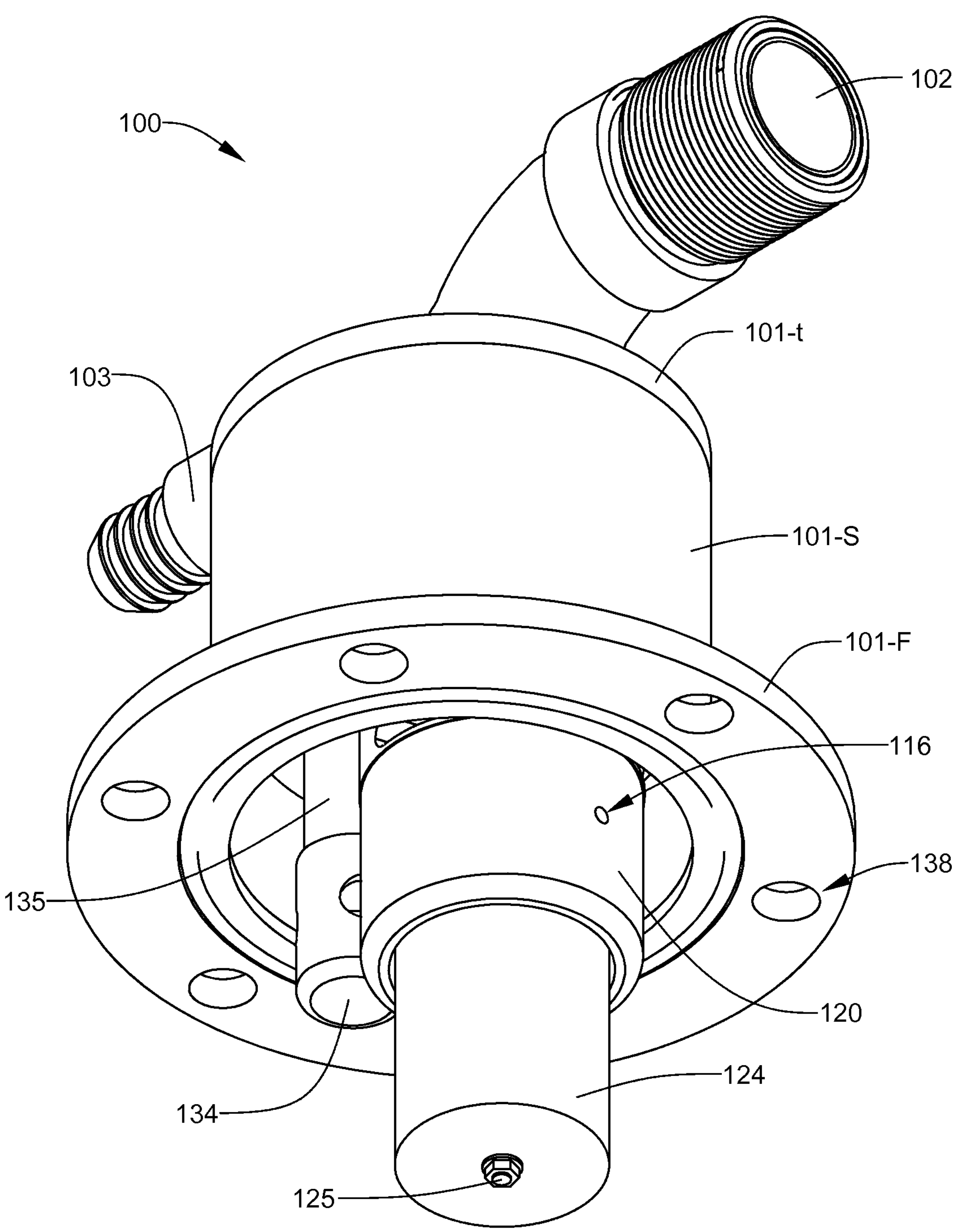

FIG. 2

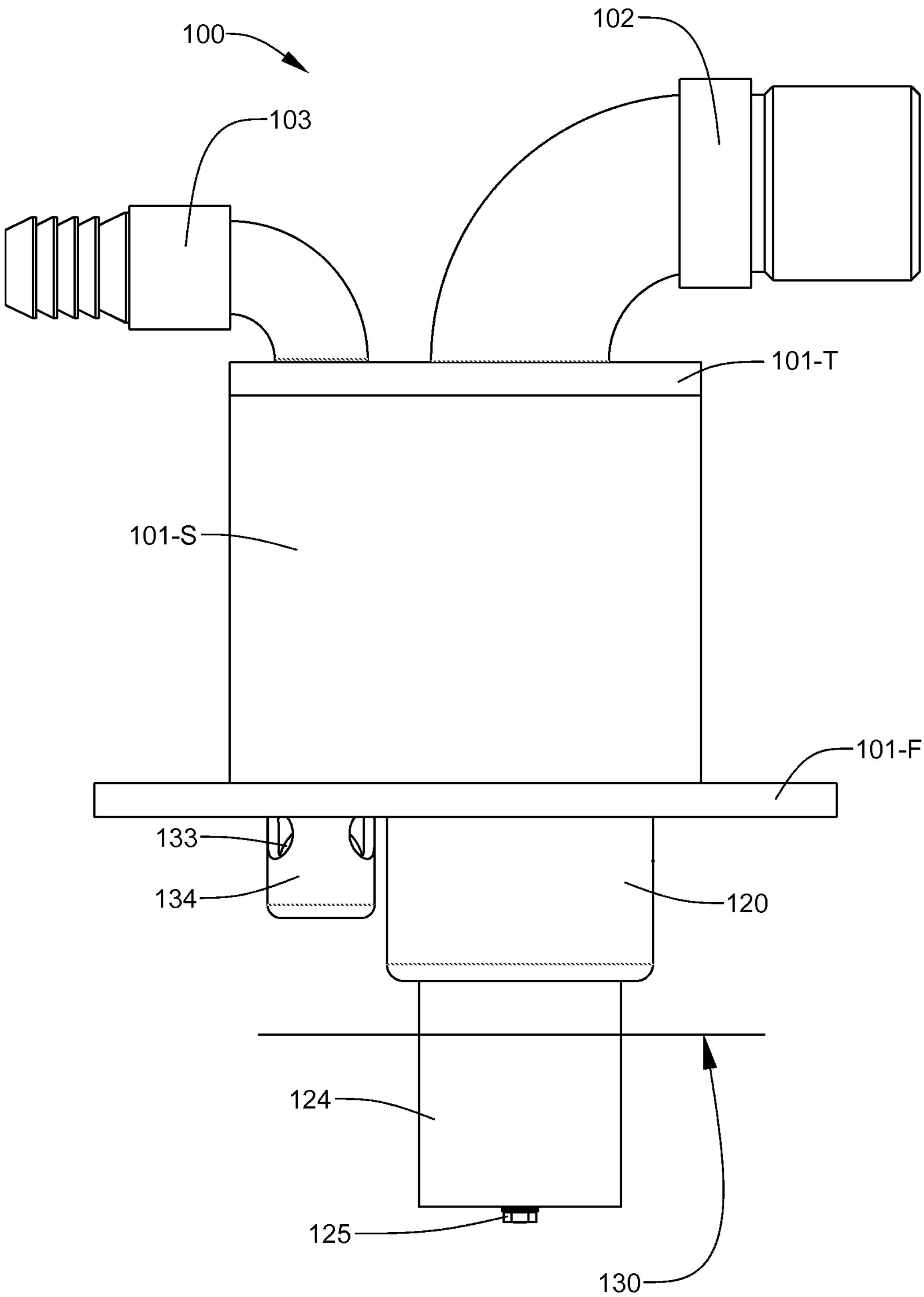

FIG. 3

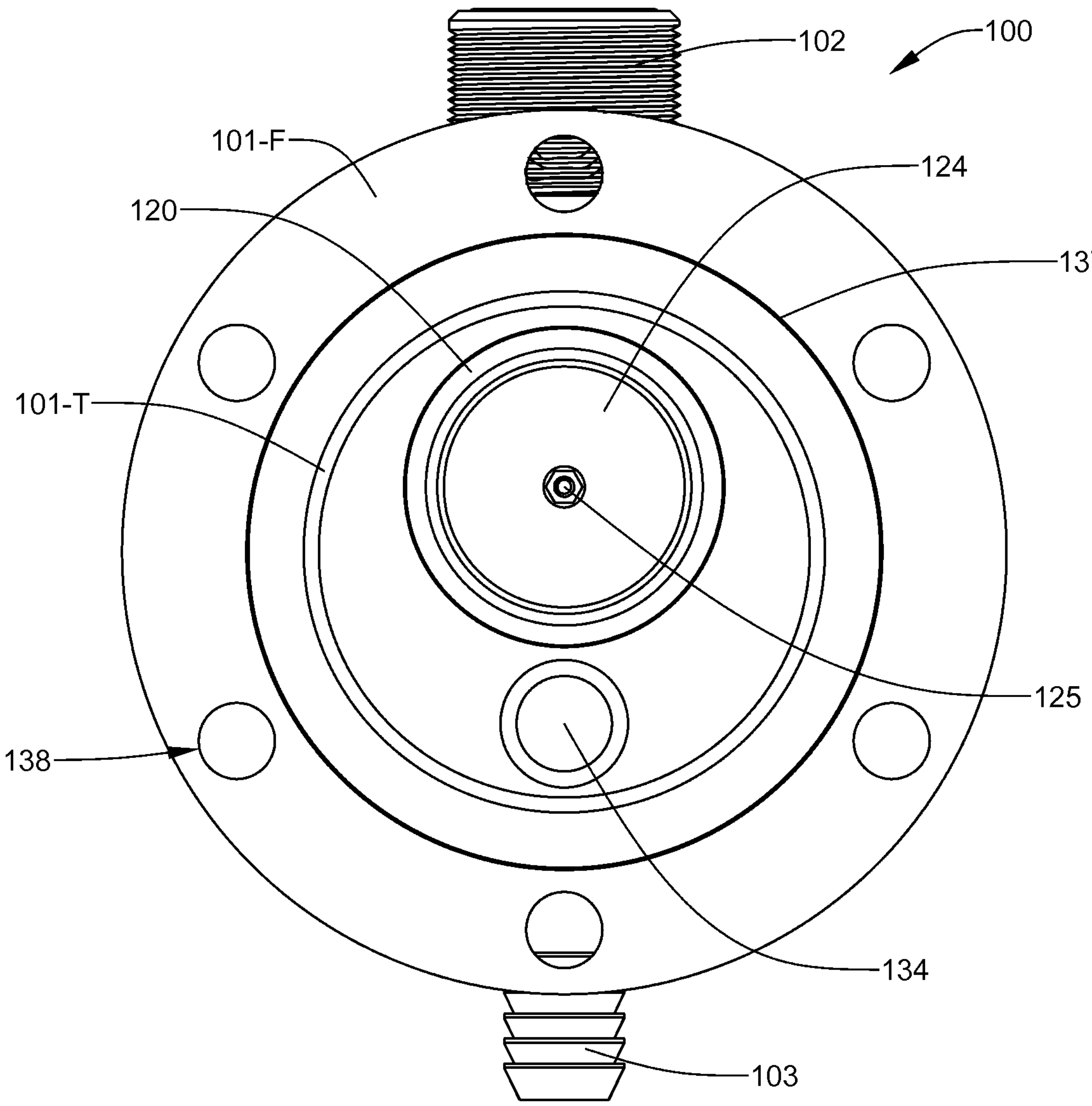

FIG. 4

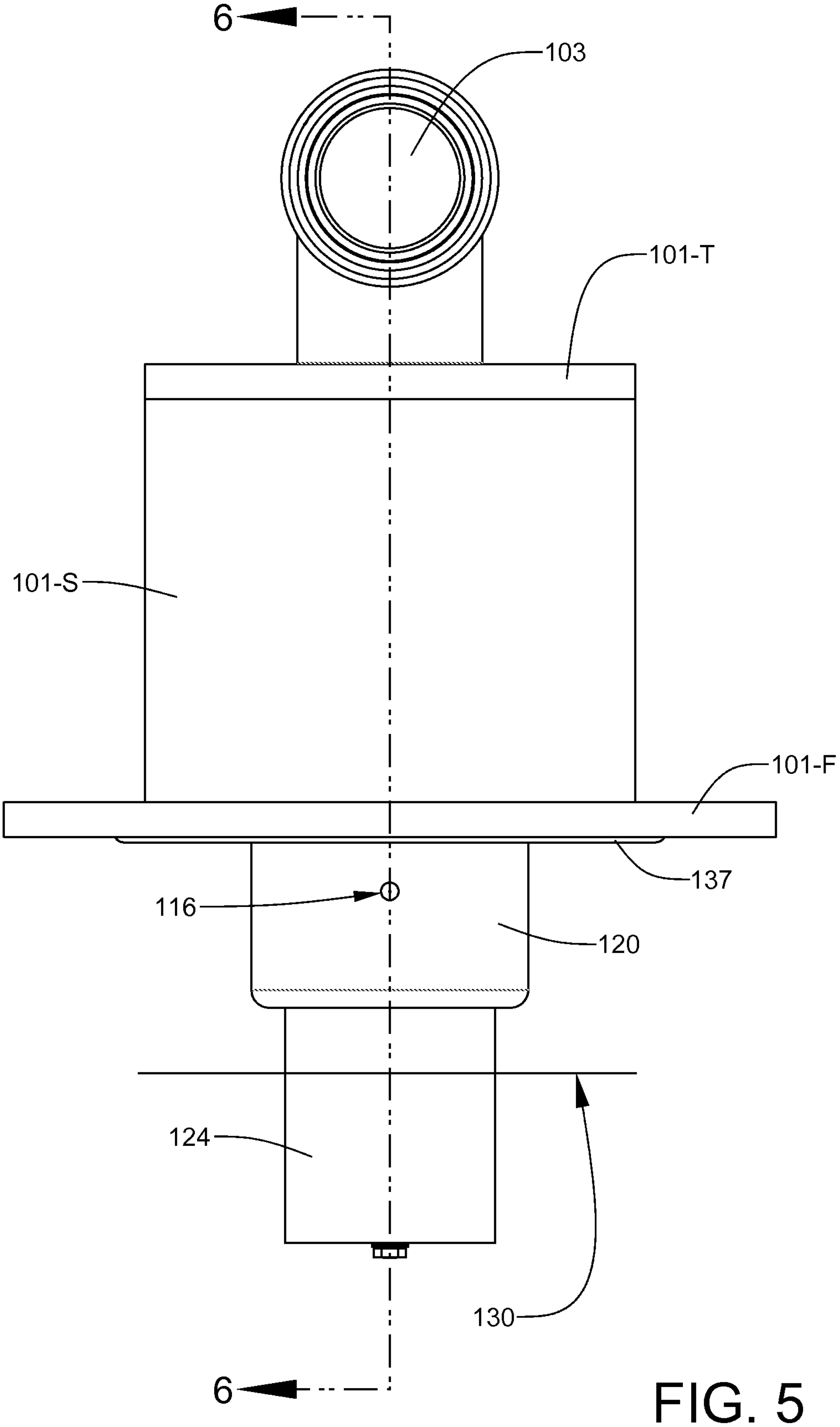

FIG. 5

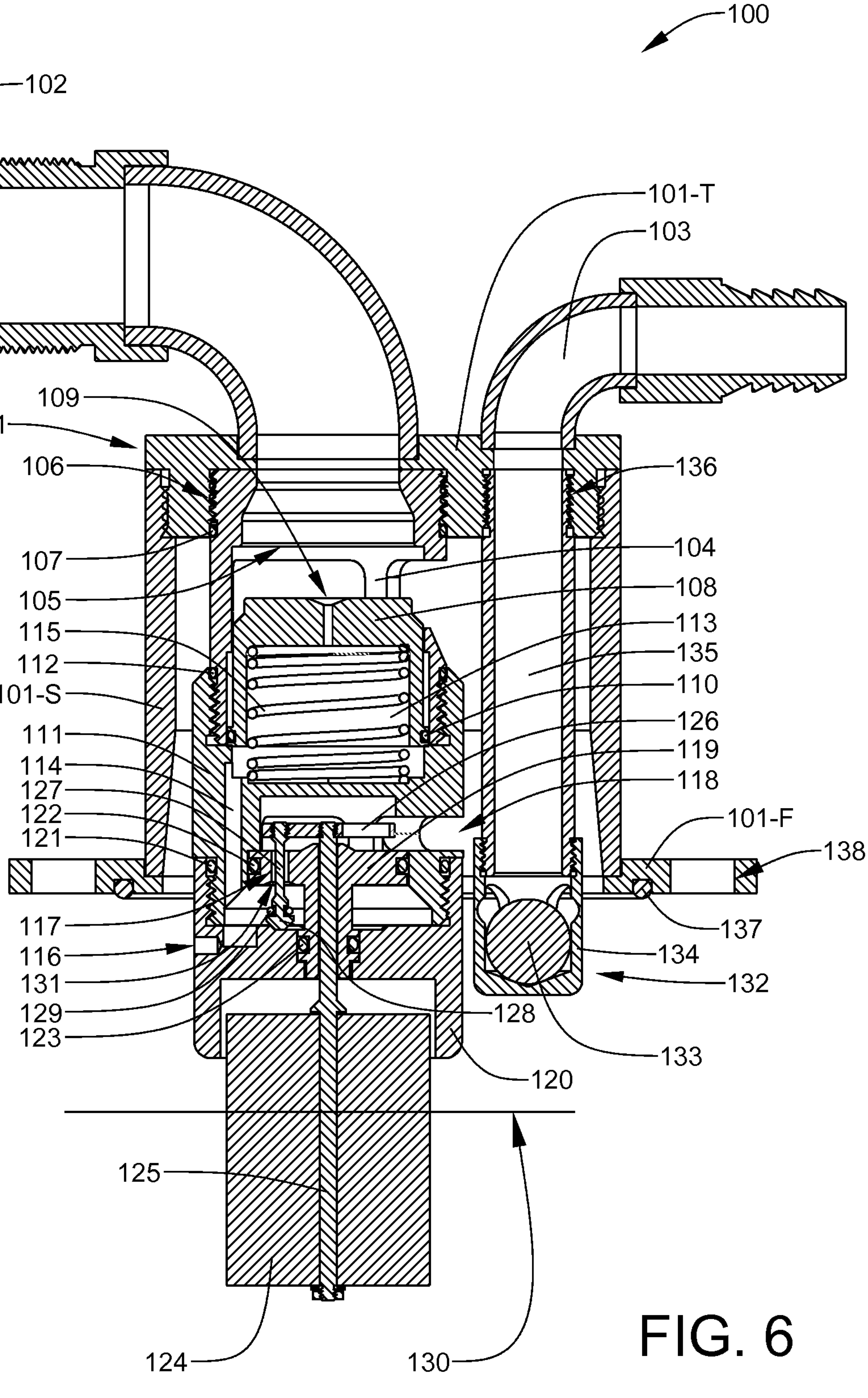
100
102
101-T
103
109
101
106
136
107
104
105
108
115
113
112
135
101-S
110
111
126
114
119
127
118
122
101-F
121
138
117
137
116
134
131
132
129
128
123
133
120
125
124
130

FIG. 6

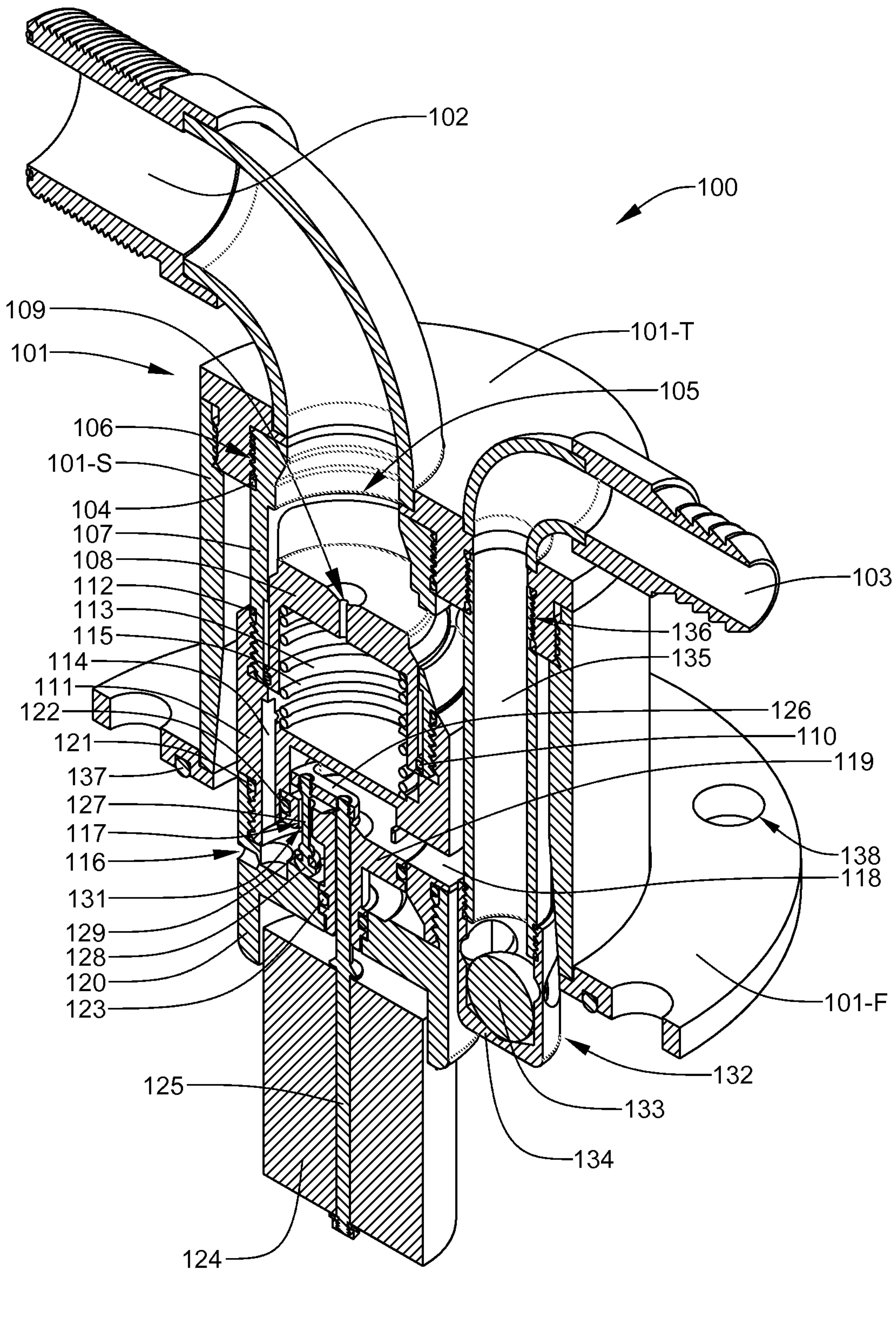
102
100
109
101
101-T
105
106
101-S
104
107
108
112
113
115
114
111
122
121
137
127
117
116
131
129
128
120
123
103
136
135
126
110
119
138
118
101-F
132
133
134
125
124

FIG. 7

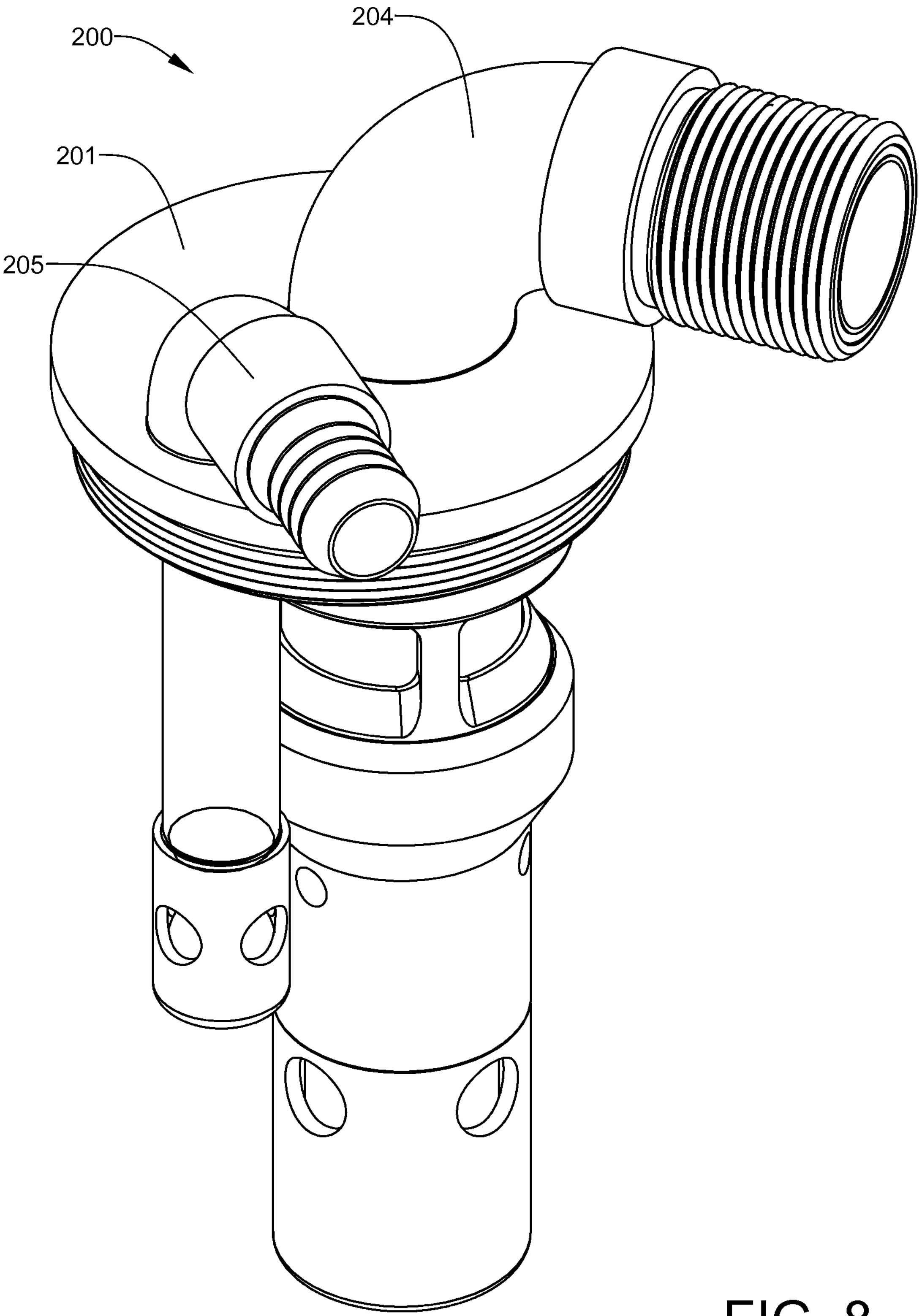

FIG. 8

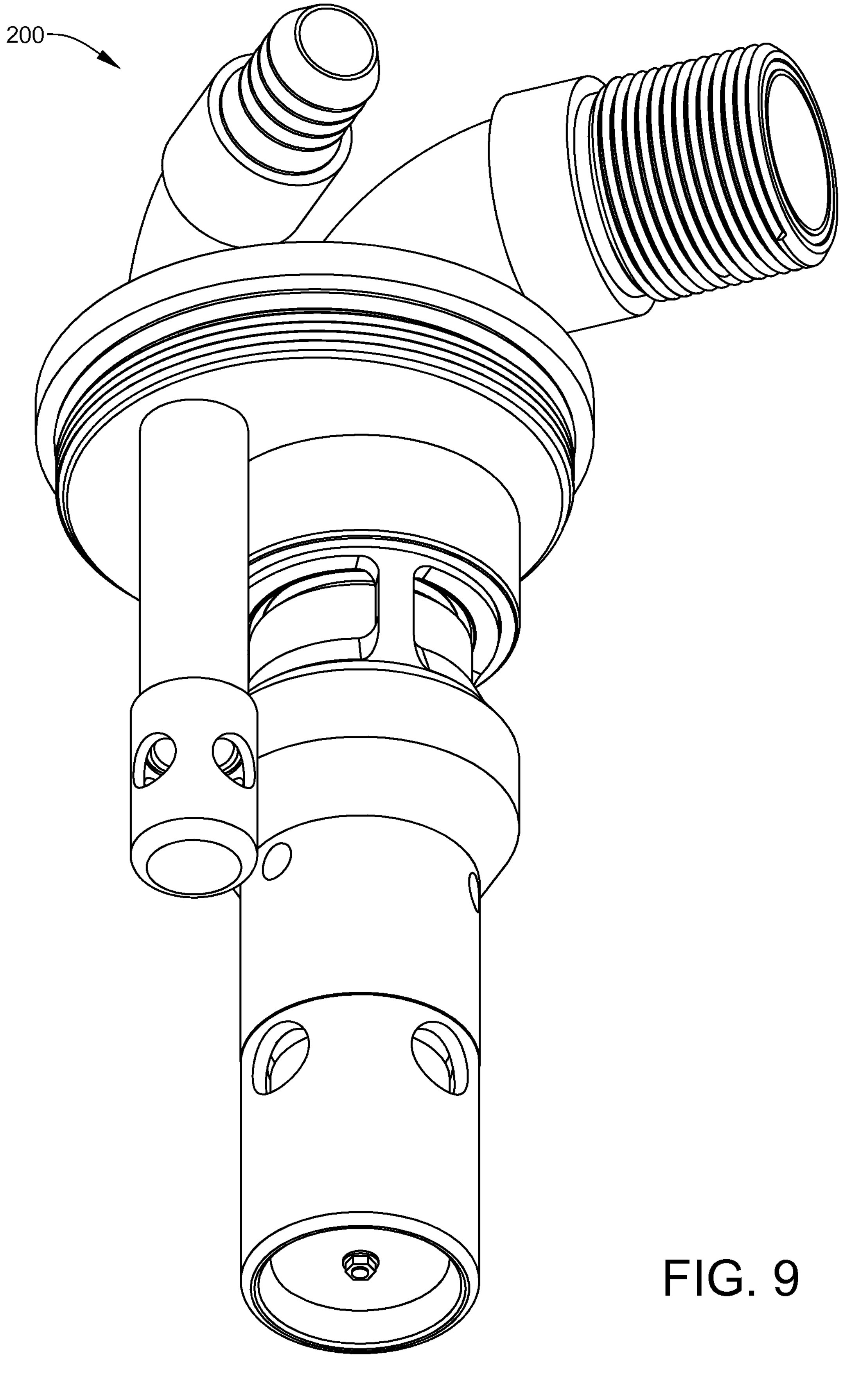

FIG. 9

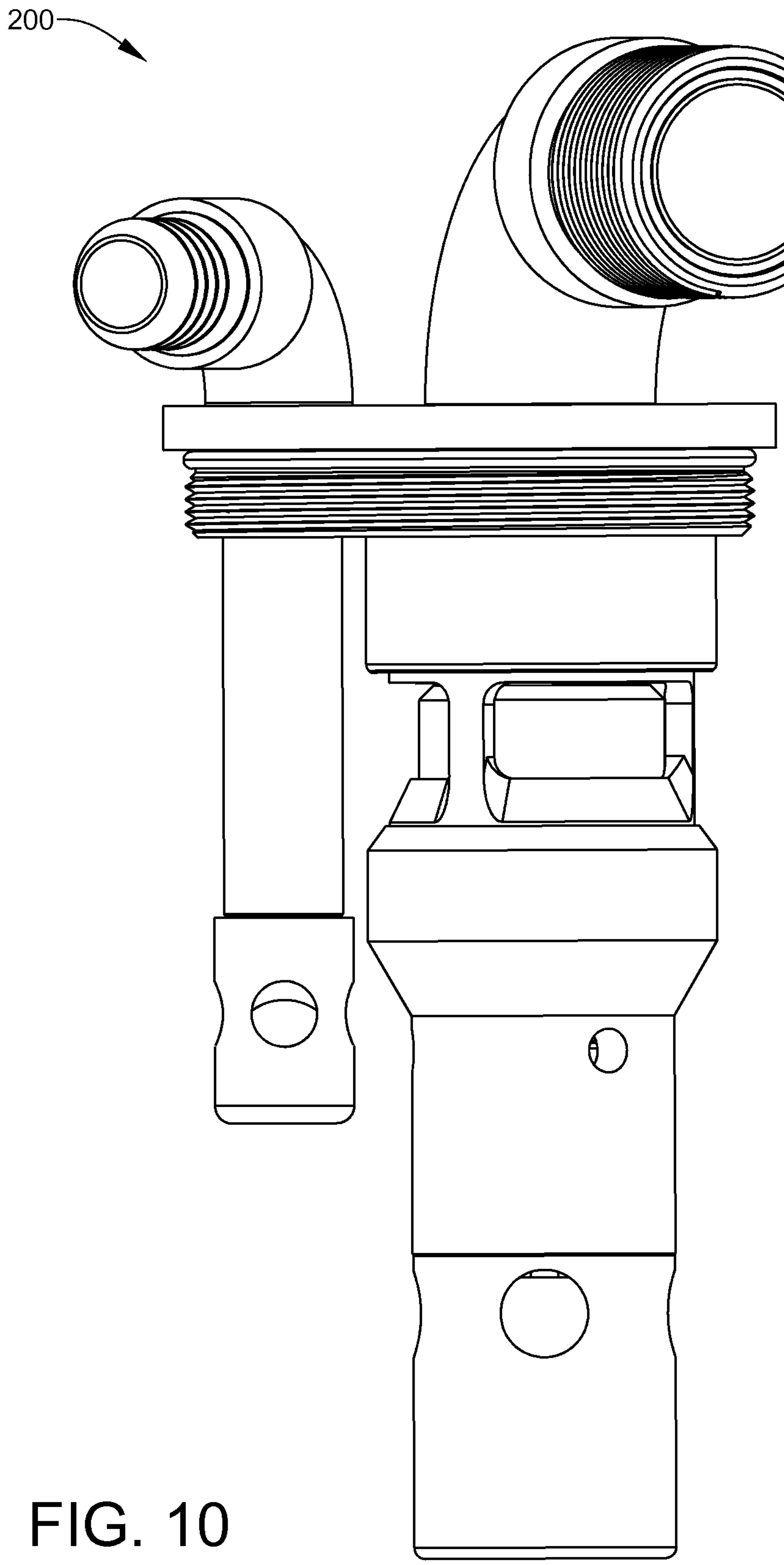

FIG. 10

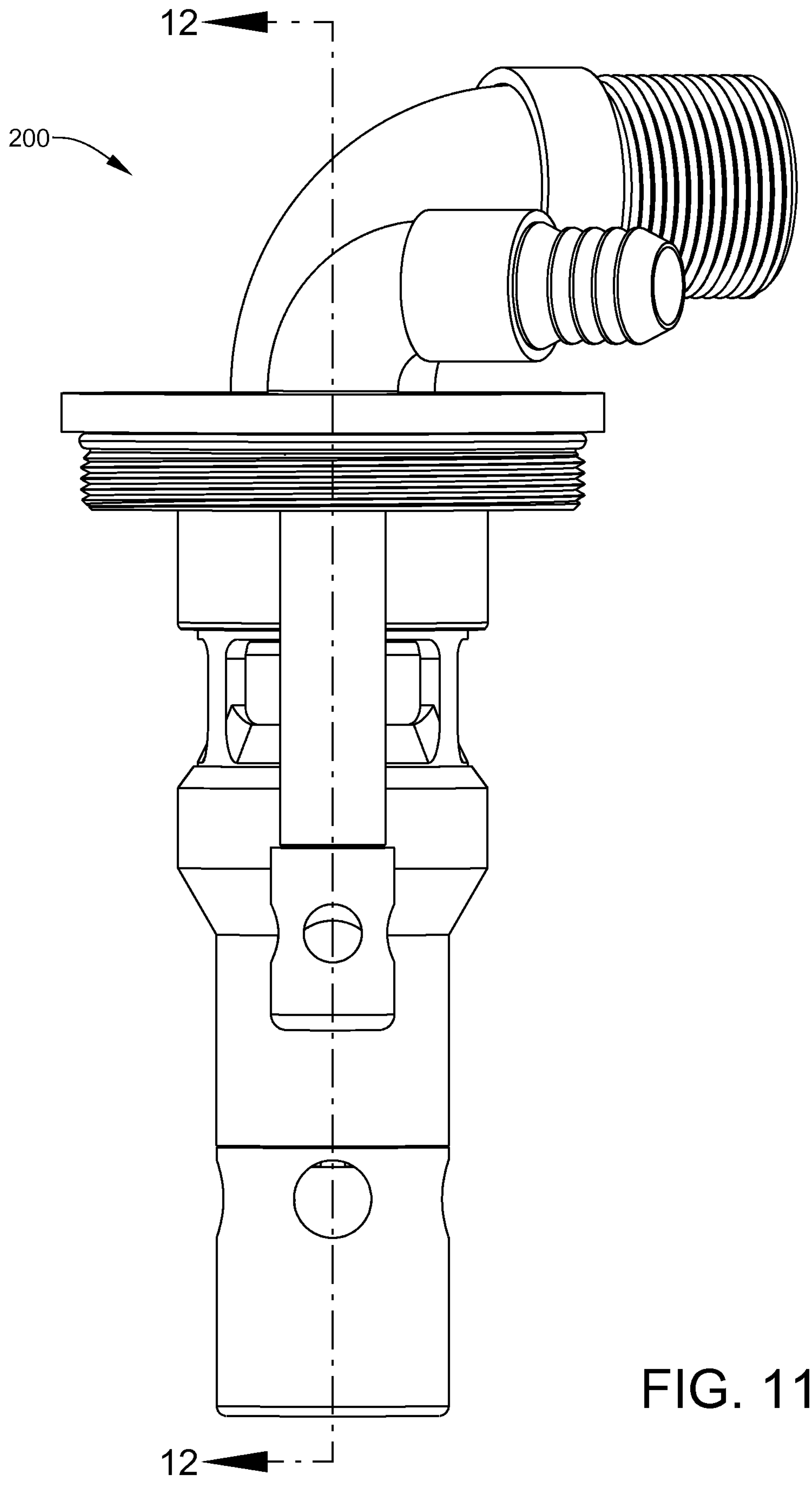

FIG. 11

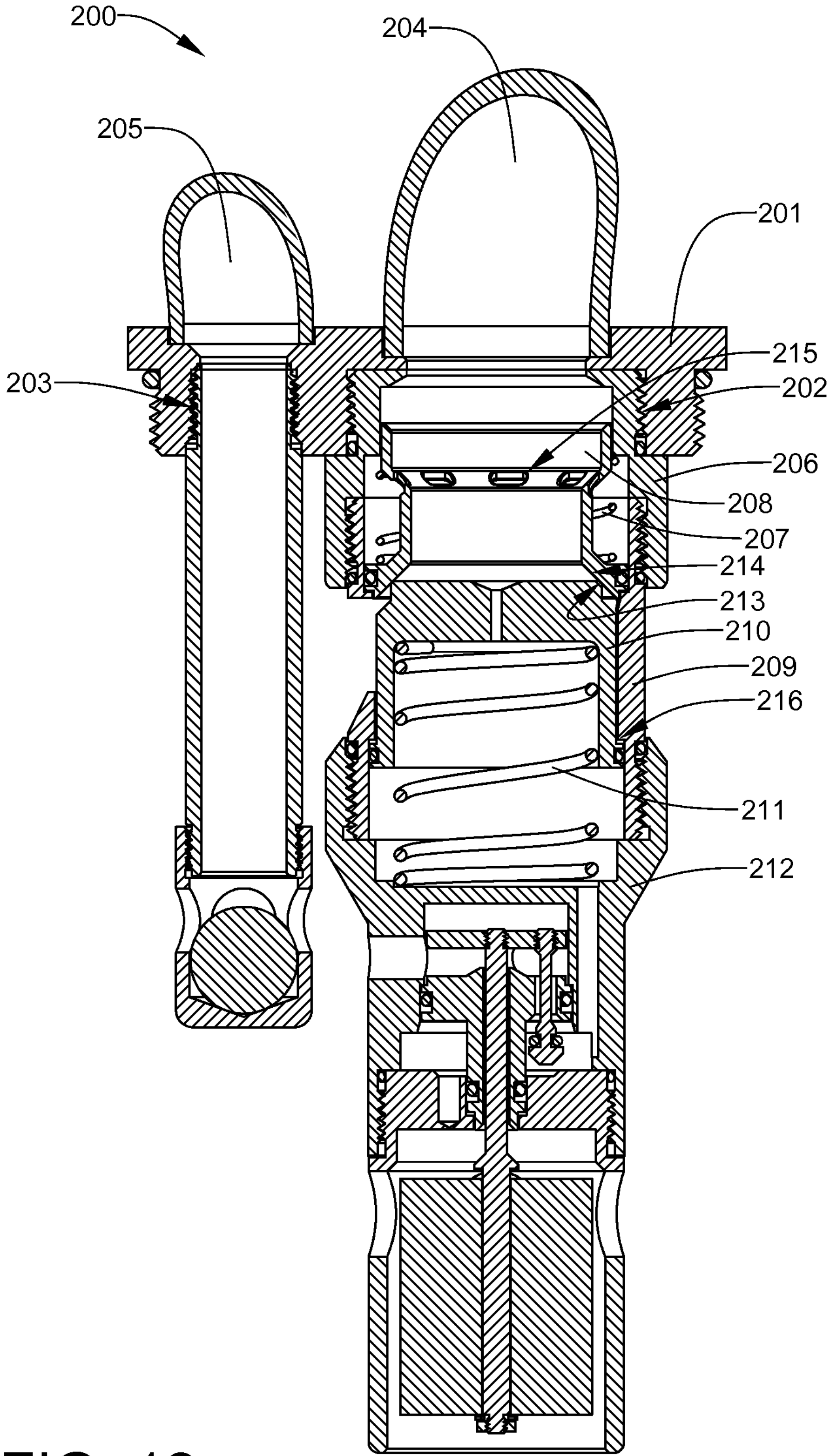
200
204
205
201
215
203
202
206
208
207
214
213
210
209
216
211
212

FIG. 12

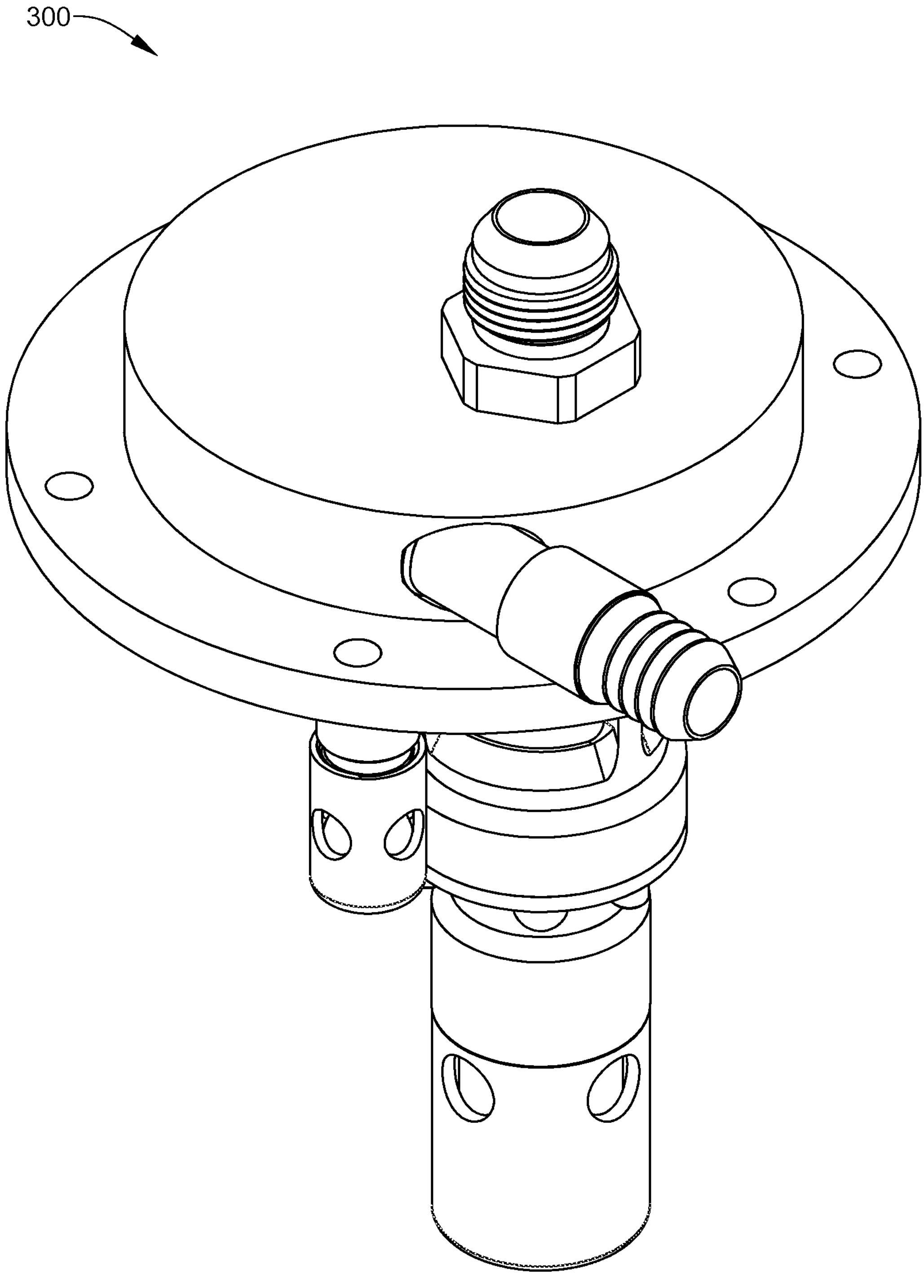

FIG. 13

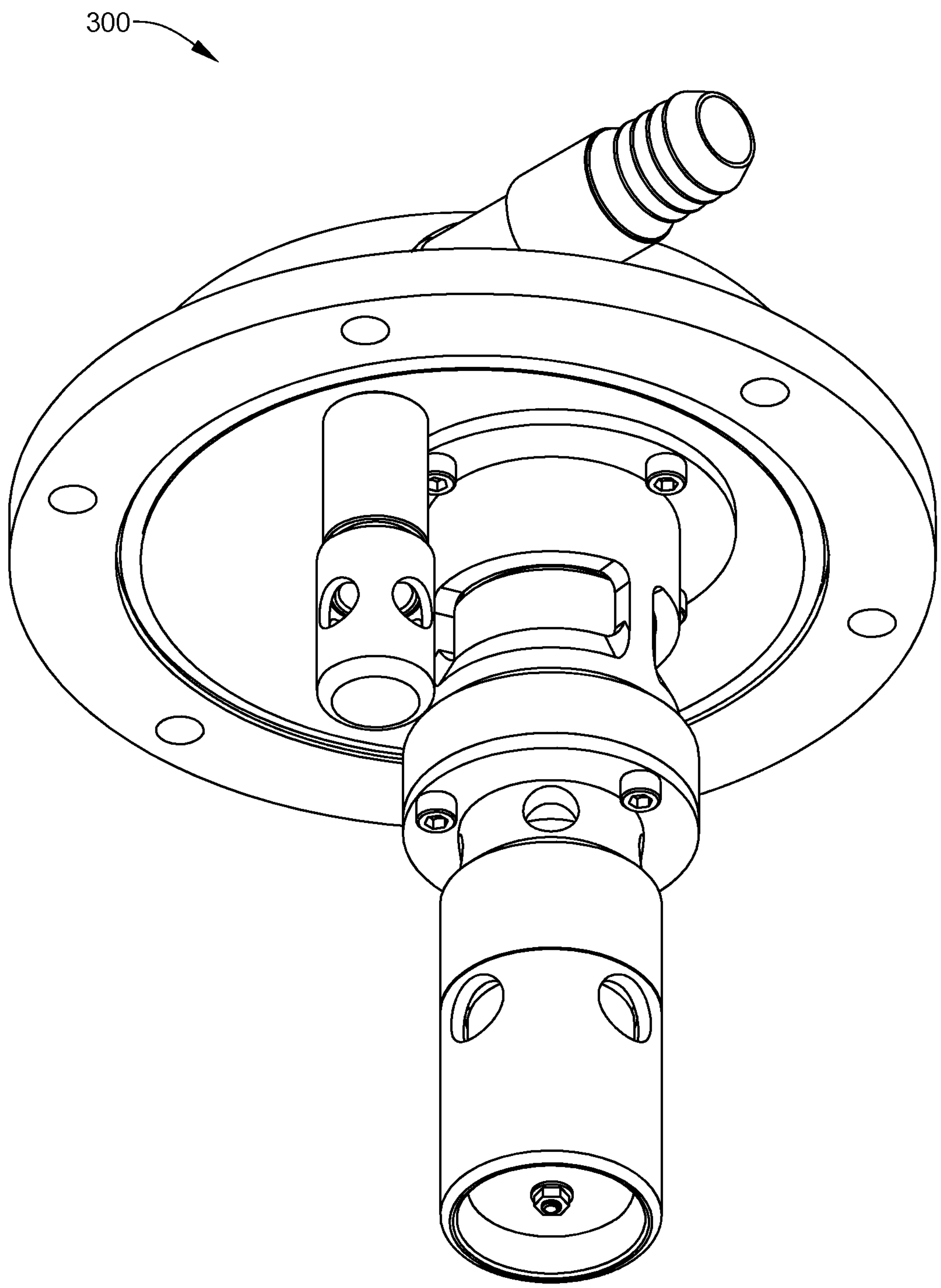

FIG. 14

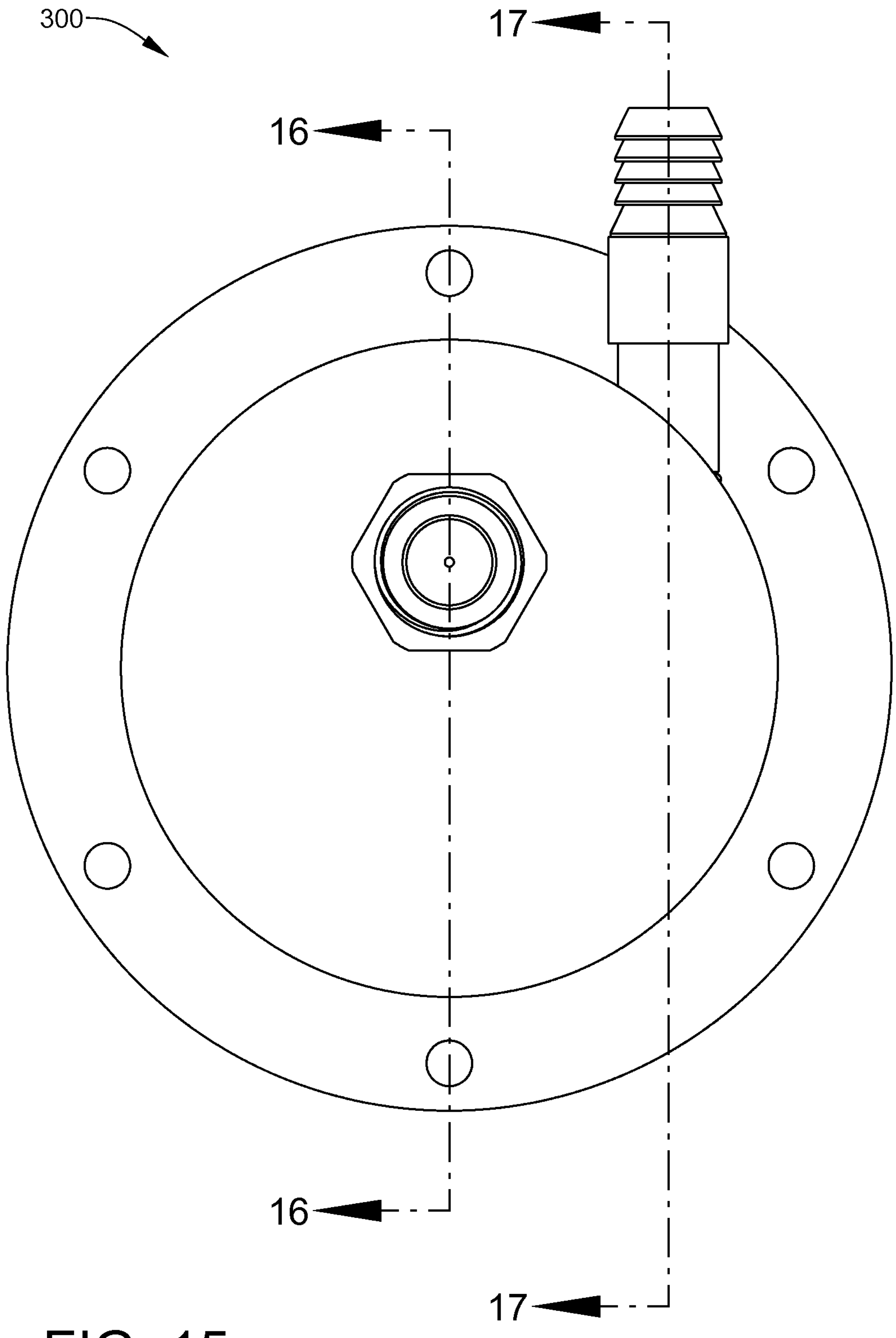

FIG. 15

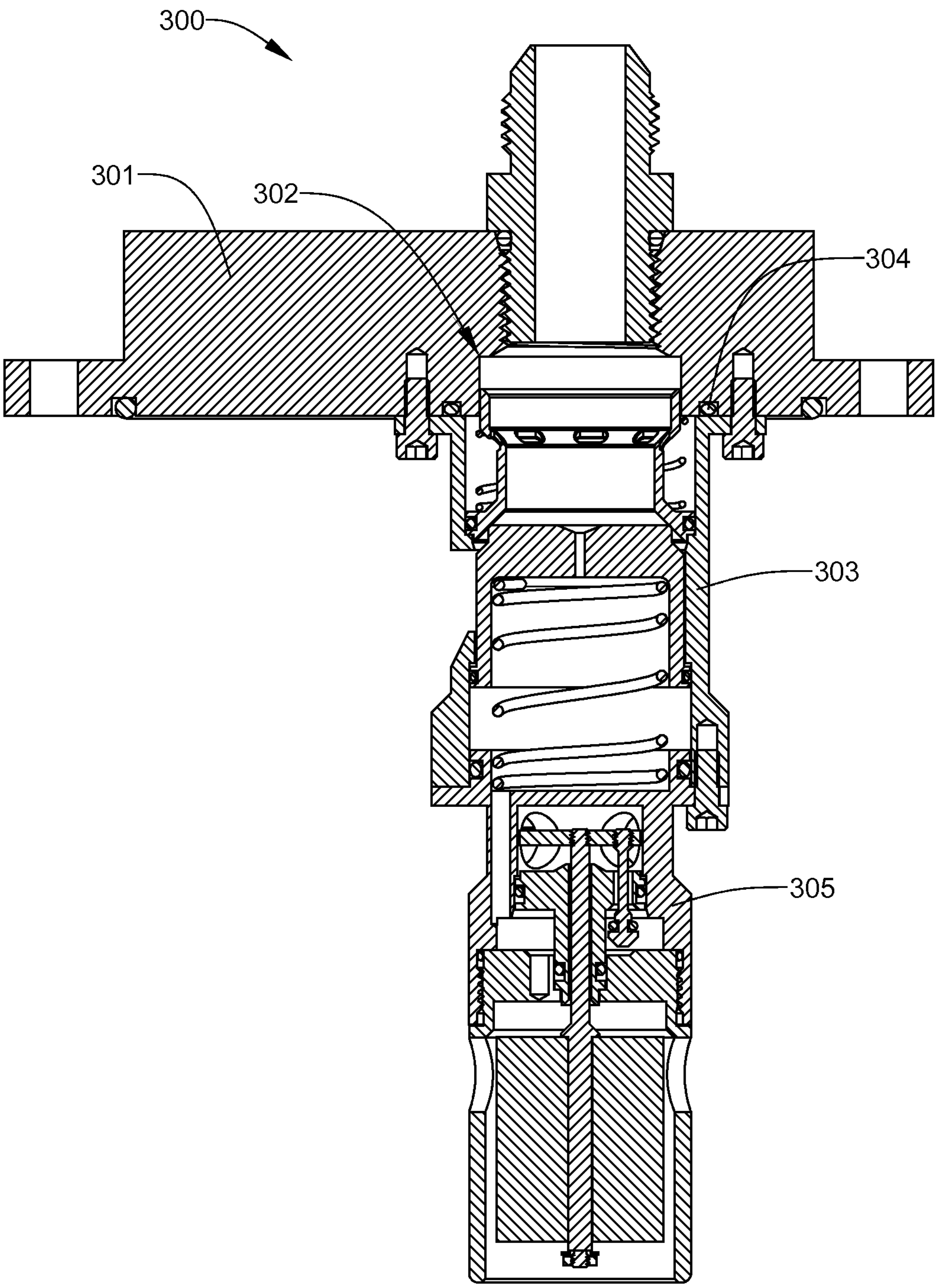

FIG. 16

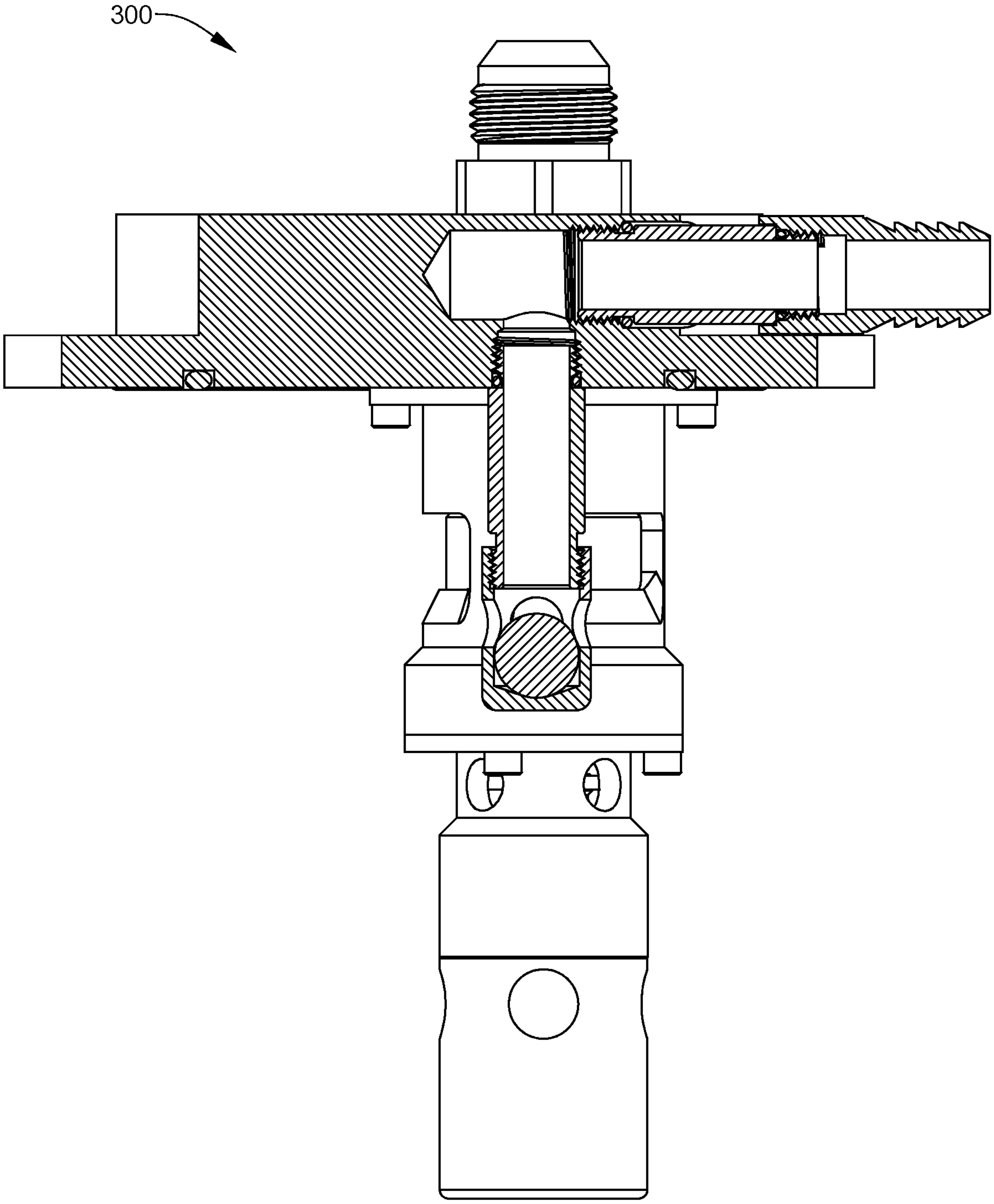

FIG. 17

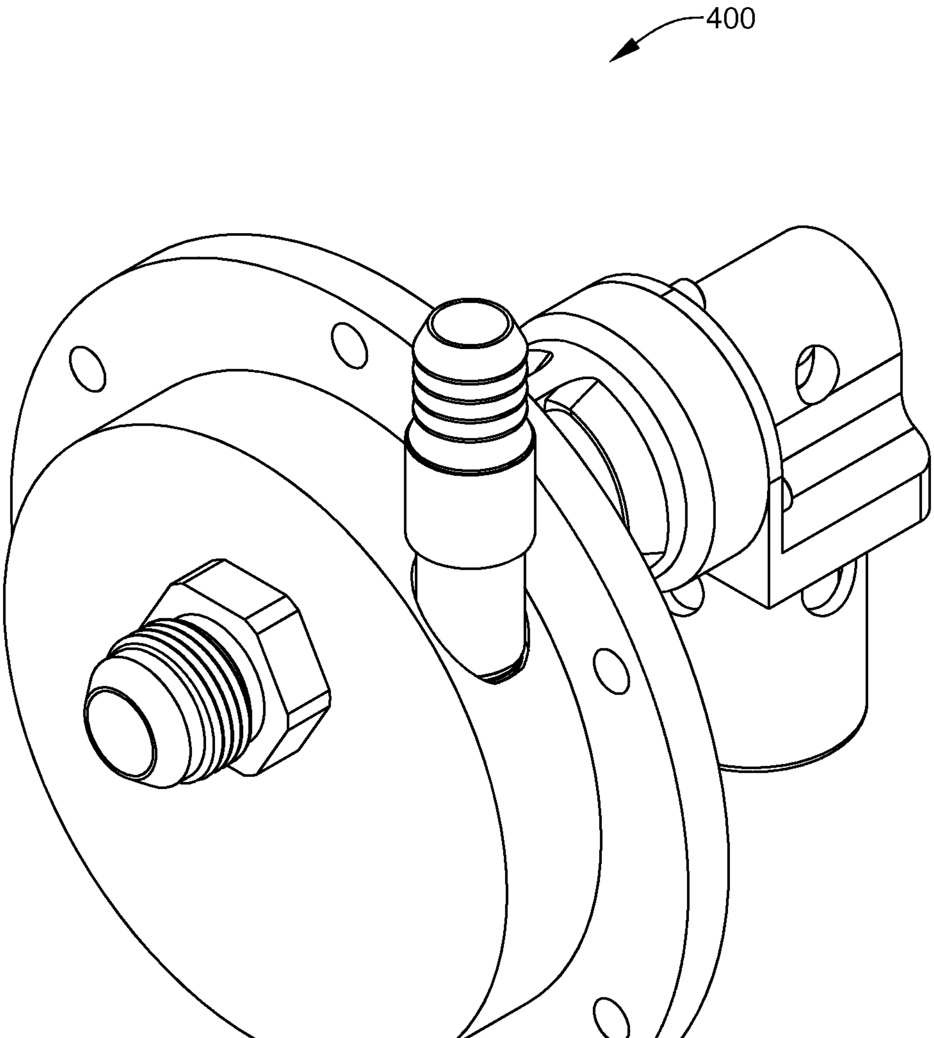

FIG. 18

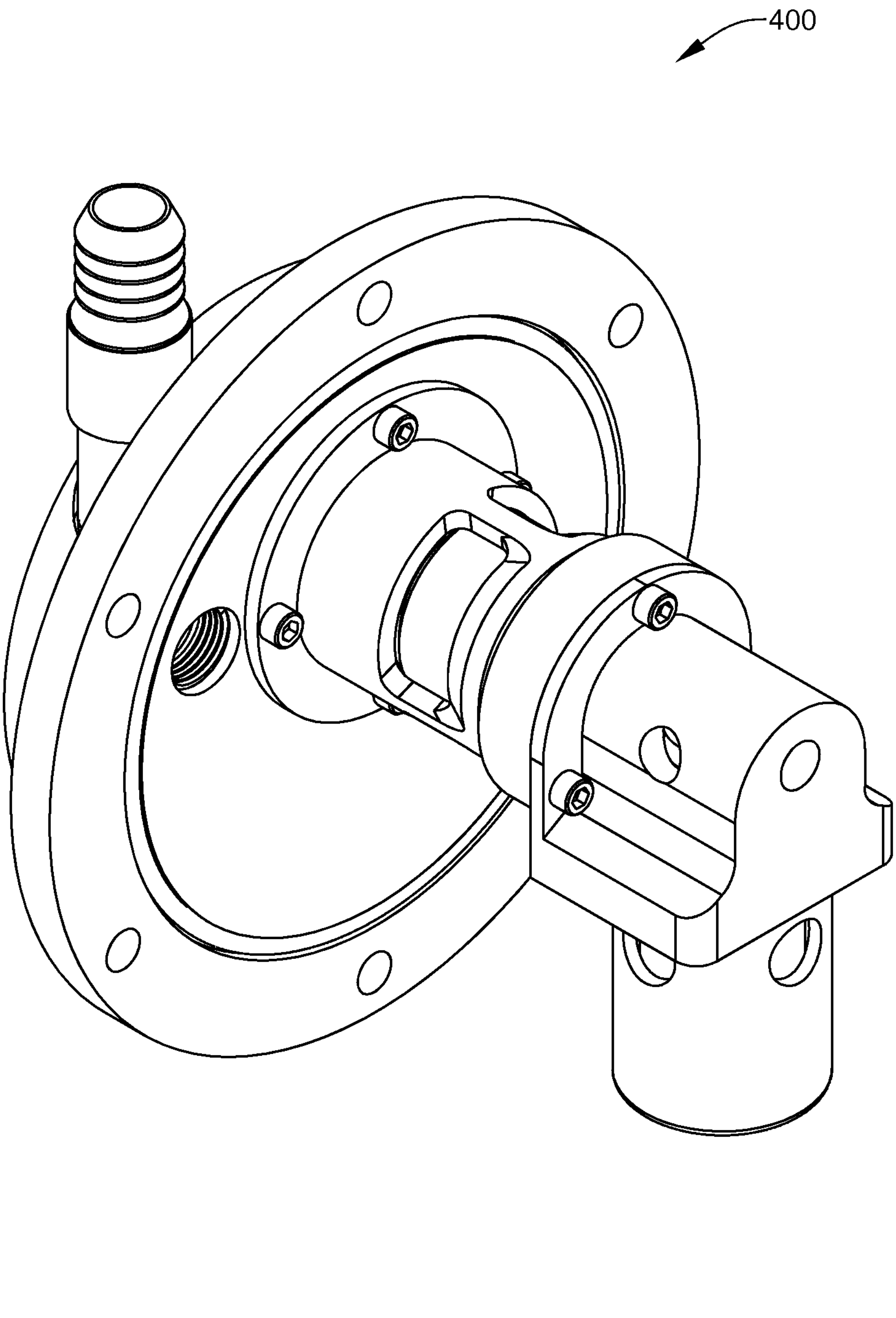

FIG. 19

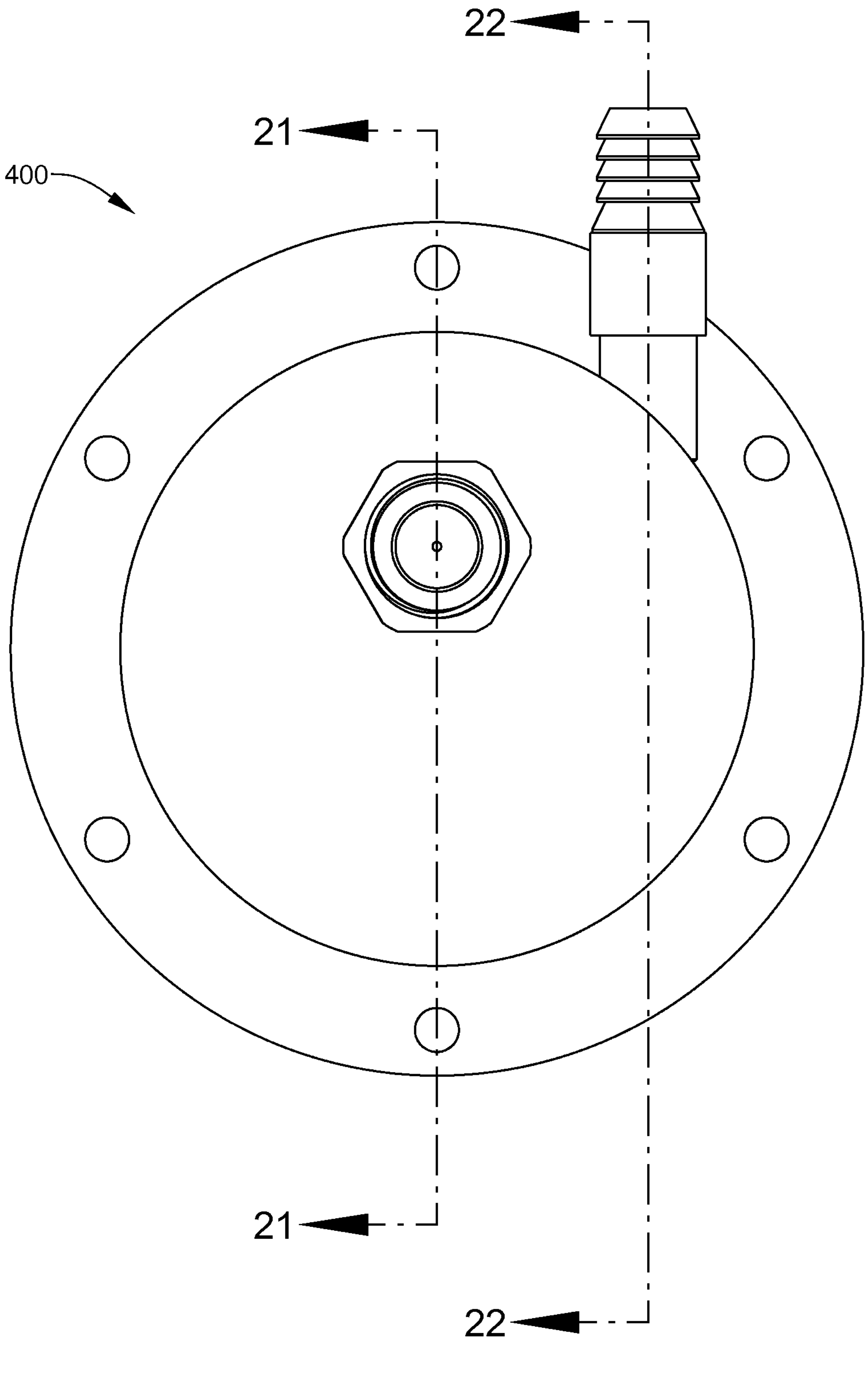

FIG. 20

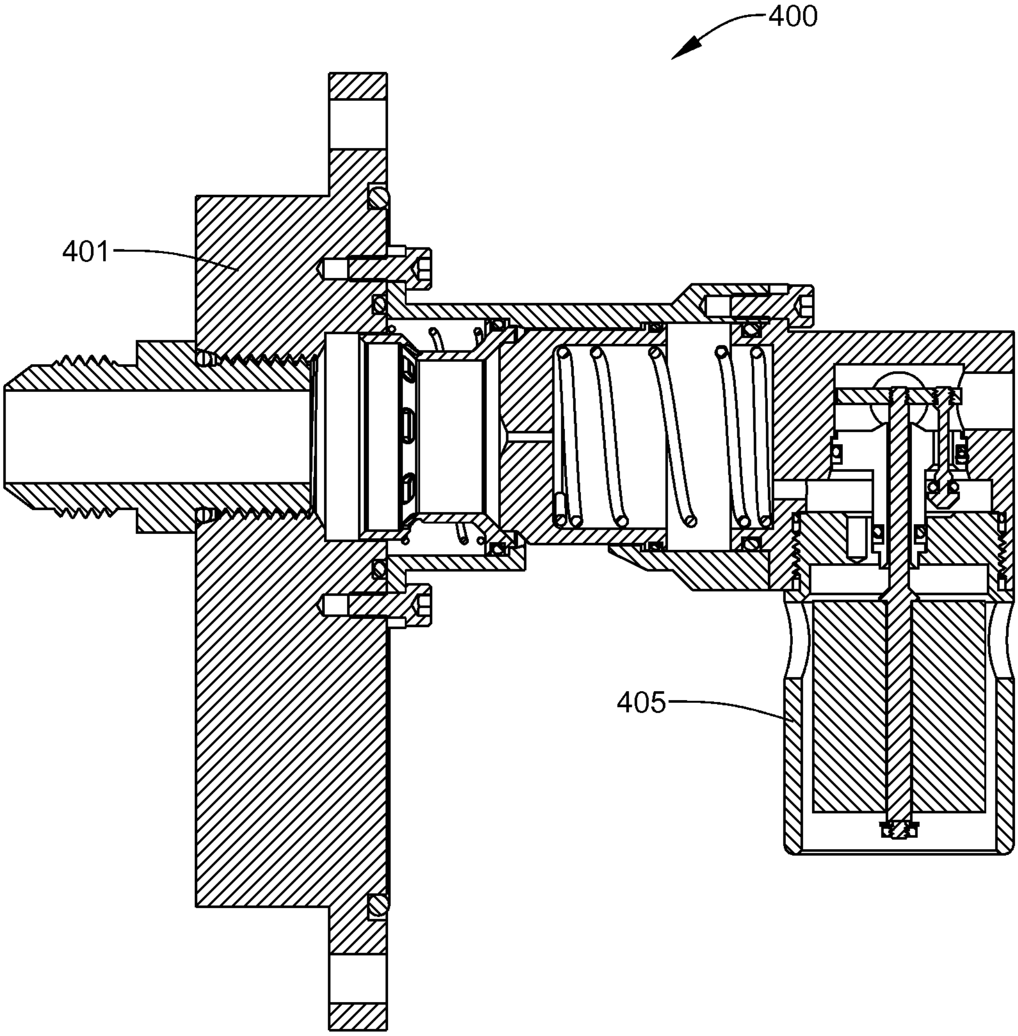

FIG. 21

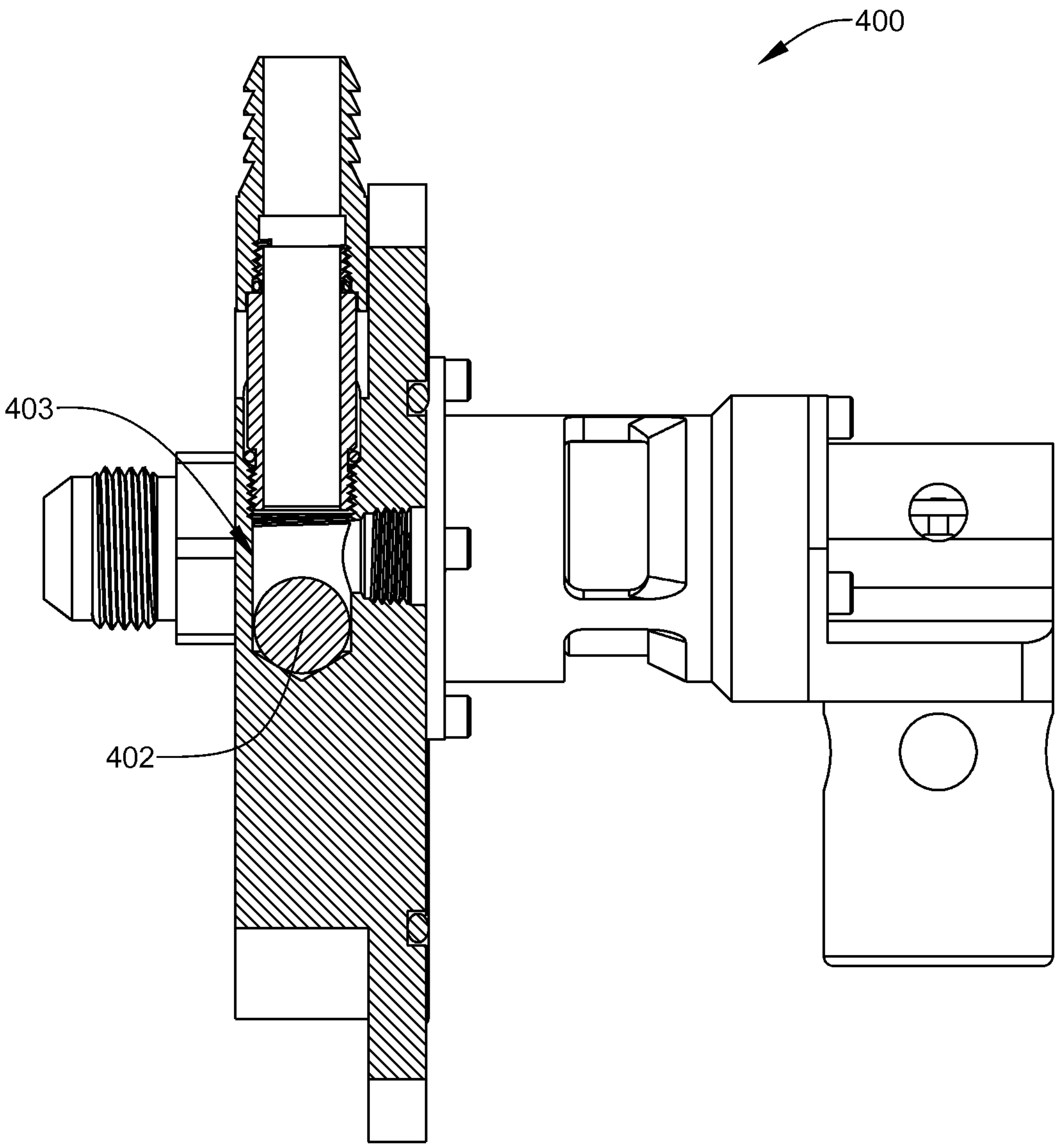

FIG. 22

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/072905

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B60K 15/04 (2015.01)
CPC - B60K 2015/03368 (2015.01)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - B60K 15/04; F16K 21/00, 21/18, 24/04, 31/18, 31/22, 33/00 (2015.01)
CPC - B60K 2015/03368, 2015/03388, 2015/03394, 2015/03538, 2015/03552; F16K 24/042, 24/044, 24/046 (2015.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 137/171, 176, 187, 197, 409, 423, 430, 432, 433, 434 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Orbit, Google Patents, Google.
Search terms used: tank, fill, valve, top, float, bleed, rollover, spring, overturn

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,839,465 A (PHILLIPS et al) 24 November 1998 (24.11.1998) entire document	1-2
A	US 5,535,772 A (ROETKER et al) 16 July 1996 (16.07.1996) entire document	1-2
A	US 2004/0003844 A1 (YAMADA et al) 08 January 2004 (08.01.2004) entire document	1-2
A	US 6,347,640 B1 (MEYER) 19 February 2002 (19.02.2002) entire document	1-2
A	US 6,158,456 A (ENGE) 12 December 2000 (12.12.2000) entire document	1-2

☐ 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
05 March 2015	23 APR 2015

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