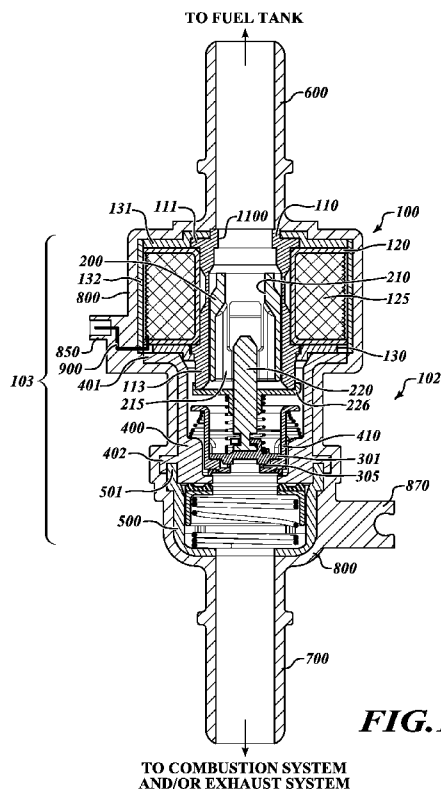




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[Continued on next page]

(54) Title: TWO STAGE IN-LINE VALVE



(57) Abstract: An in-line valve comprises a valve port and a solenoid assembly. The solenoid assembly comprises a hollow tubular pole piece, a bobbin, a coil, and flux collection plates. A fluted armature is within the pole piece. The armature comprises a hollow central passageway, a stem, and stays at a first end of the fluted armature. The stays brace the stem in the central passageway. The valve port adjoins the pole piece. Fluid communicates from between the stays at the first end of the fluted armature, through the hollow central passageway and through the pole piece to the valve port.



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TWO STAGE IN-LINE VALVE

Field

[001] This application relates to fuel valves and provides an in-line valve with two-stage operation.

Background

[002] Fuel valves typically have complicated housings and assembly processes. Many require angles to accommodate the various components. Angle flow valves can suffer from undesired pressure changes because of angles necessary to accommodate the various components and port requirements. Leak paths arise in the complicated geometry.

[003] When valves are drop-in assembled, side-by-side stacking of valve components adds further leak paths and leads to complicated sealing techniques, or a distribution of seals across a clam-shell style housing. And, spreading the valves side-by-side adds bulk.

SUMMARY

[004] The methods disclosed herein overcome the above disadvantages and improves the art by way of a two-stage in-line valve.

[005] An in-line valve comprises a valve port and a solenoid assembly. The solenoid assembly comprises a hollow tubular pole piece, a bobbin, a coil, and flux collection plates. A fluted armature is within the pole piece. The armature comprises a hollow central passageway, a stem, and stays at a first end of the fluted armature. The stays brace the stem in the central passageway. The valve port adjoins the pole piece. Fluid communicates from between the stays at the first end of the fluted armature, through the hollow central passageway and through the pole piece to the valve port. Fluid flows through the hollow central passageway, and thus through the center of the solenoid assembly.

[006] Additional objects and advantages will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the disclosure. The objects and advantages will also be realized and attained by means of the elements and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

- [001] Figure 1 is a cross-section view of a first in-line valve assembly.
- [002] Figures 2A-2D are views of a fluted armature.
- [003] Figure 3 is an exploded view of another in-line valve assembly.
- [004] Figure 4 is another cross-section view of another in-line valve assembly.
- [005] Figure 5 is an exploded view of the in-line valve assembly of Figure 4.
- [006] Figure 6 is a perspective view of a cage.
- [007] Figure 7 is a cross-section of an alternative armature and poppet.
- [008] Figure 8A is a cross-section of an alternative armature and poppet.
- [009] Figure 8B is a section view of the dash-enclosed area of Figure 8A.
- [010] Figure 9 is a view of a sleeve for a solenoid.

DETAILED DESCRIPTION

[011] Reference will now be made in detail to the examples which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts. Directional references such as “left” and “right” are for ease of reference to the figures.

[012] A drop-in assembly technique permits the formation of a solenoid assembly. A valve assembly is linearly associated with the solenoid assembly, so that drop-in or stacking of parts is facilitated. The in-line assembly technique facilitates expedient assembly. It also facilitates greater fluid pressure control through the in-line valve. Instead of angled pathways, which are harder to manufacture, the in-line valve assembly has a central bore. Instead of pressure drops and viscous losses in the angled pathways, the fluid flow is more linear and direct. Pressure changes can be controlled via more straightforward diameter changes within the hollow passage and among the sealing members. The pressure differential across the valve, from inlet port to outlet port, is more easily tailored by simple port diameter changes. For applications requiring a high flow rate, it is more readily achieved via the in-line fluid flow. The footprint of the valve is also reduced. Thus, an in-line valve offers many advantages over angle-flow valves.

[013] Further advantages can be realized when the solenoid assembly and valve assembly are assembled in to a central carriage that is over-molded. In some embodiments, the over-mold can secure drop-in or stacked fluid ports, while in other embodiments, the over-mold can integrally form the inlet and outlet valve ports with the outer housing. By integrating the solenoid assembly and valve assembly in to a

carriage, it is easier to customize porting and housing configurations during the molding process. This helps to meet customer specifications while reducing custom stock material.

[014] The carriage assembly method can complement or augment prior techniques. In one aspect, the assembly technique provides valve sleeves to seat valve assembly components. The valve assembly components are dropped within the valve sleeves, and then the valve sleeves are assembled together.

[015] However, the valve sleeve style offers several leak paths and requires o-rings and other seals to prevent leaks between valve sleeves. Thus, it is beneficial to over-mold the assembled valve sleeves, which can eliminate o-rings and other seals, reduce assembly complexity, and reduce sleeve attachment mechanism complexity.

[016] A second aspect forms a central carriage and eliminates o-rings and leak paths by over-molding the central carriage in a final step to form the outer housing 800. The valve ports 600, 700 are formed with the outer housing 800, permitting customization of the connection type (press-fit, quick-connect, snap fit, barbed end, etc.) and permitting customization of the end user mounting technique (mounting tabs, clips, pilot holes, etc) and mount orientation.

[017] So, a first aspect of the disclosure is shown in Figure 1. A housing 800 is over-molded around a central carriage 103 comprising a solenoid assembly 100 and a valve assembly 102. The valve ports 600, 700 are integrally molded with the housing 800. One or more mounting tabs, such as tab 870, is formed integrally with housing 800. Electrical port 850 is also integrally formed with housing 800. An electrical lead 900 can be threaded in between extensions 1322 in sleeve 132, or like gaps in sleeve 134. The electrical lead 900 can power the coil 125 to control the solenoid. An alternative plug 910 is shown in Figure 4, and the plug can include attachments to power coil 125.

[018] A solenoid assembly 100 comprises a hollow tubular pole piece 110, a bobbin 120, a coil 125, and flux collection plates 130, 131. The valve port 600 adjoins a first end 111 of pole piece 110 and can adjoin the upper flux collection plate 131. The valve port 600 can be molded, and alternatively additionally bonded, to either or both of pole piece 110 and upper flux collection plate 131. Adjoining the valve port 600 to the pole piece or flux collection plate eliminates a leak path. Leak path elimination can be augmented by using a bonding agent, locking feature, tortious flow path, geometry or a combination thereof. A tortious flow path permits inflow of molding material in to a gap,

and this can reduce valve weight by removing metal from the flux collector and or pole piece and then filling it with a lighter weight molding material.

[019] A fluted armature 200 is within the pole piece 110. The armature 200 comprises a hollow central passageway 210. A stem 220 and stays 215 are at a first end 217 of the fluted armature. The stem 220 extends out of the hollow central passageway 210 away from the first end 217. The stays brace the stem 220 in the central passageway 210. Fluid can freely communicate from between the stays at the first end of the fluted armature, through the hollow central passageway 210 and through an opening 1100 in the pole piece to the valve port 600.

[020] The fluid communication through the center of the pole piece 110 differs from the prior art. Prior art designs have forbidden fluid flow through the center of the solenoid assembly, preferring instead to restrict fluid flow from escaping through the solenoid assembly.

[021] Another distinction over the prior art removes an armature spring from within the pole piece. Instead of housing a spring within the solenoid assembly 100 to bias the armature 200, a poppet spring 224 can bias the armature 200 to a second end 113 of the pole piece. The poppet spring 224 can be outside the pole piece 110.

[022] A poppet 300 is mounted at the end of the stem 220. The poppet 300 comprises a disk 301 with seal 305. The seal 305 can be over-molded or snap-fitted to the disc, among other attachment methods. The stem 220 extends out of the armature 200 and comprises a notch 222 followed by a foot 2222 at a distal end. The poppet 300 attaches to the notch 222 and catches against the foot 2222 via a hook mechanism on the disc 301.

[023] Figures 7-8B detail alternative poppet 300 attachment. A snap ring 321 and an o-ring 323 can secure the disc 301 to the stem 220. The stem comprises a first neck-down 221 at a distal end, a neck-up 223 after the neck-down 221, and a slot 225 after the neck-up 223. The o-ring 323 is seated in the neck-down 221. The snap ring 321 is seated in the slot 225. The poppet 301 is movable along the neck-up 223 between the o-ring 323 and the snap ring 321.

[024] A first bleed channel 229 in the neck-up 223 and a second bleed channel 303 in the poppet 301 align to form a vapor flow passage 304. One or both of the first bleed channel 229 and the second bleed channel 303 can comprise steps for further flow restriction. A shim 307 can guide the motion of the poppet and can restrict fluid flow through the vapor flow passage 304.

[025] As shown in Figure 7, the valve assembly can further comprise a second slot 227 in the stem 220. A stop plate 331 abuts the pole piece 110 to limit the travel of the armature 200 out of the pole piece 110. A second snap ring 327 is in the second slot 227. A spring seat 325 abuts the second snap ring 327. An armature spring 329 is around the stem 220 and is biased between the stop plate 331 and the spring seat 325. The bias pulls the stem 220 away from the pole piece 110 and provides an elegant solution for avoiding the need to package an armature spring within the pole piece 110. When the solenoid assembly 100 is powered, magnetic forces can pull the armature towards the first end 111 of the pole piece and can overcome the spring force of armature spring 329.

[026] In Figure 1, stop plate 226 adjoins second end 113 of pole piece 110. Poppet spring 224 extends between the stop plate 226 and the poppet 300. The poppet spring 224 biases the poppet 300 towards the distal end of the stem 220 and towards the central orifice 413 of tubular cage 400.

[027] The stop plate 226 of Figure 1 has less material than stop plate 331. The valve sleeve design and over-mold of Figure 1 eliminates a leak path that requires an o-ring 332 in Figure 7. Also, the solenoid assembly design can impact leak paths and sealing techniques. For example, tubular sleeve 132 spans between flux collection plates 130, 131 without curving around the edges of the flux collection plates 130, 131. However, in Figure 7, the tubular sleeve 134, or can, crimps around an extension 610 of valve port 600, abuts pole piece 110, wraps around bobbin 120 and coil 125, maintains air gap 127, and crimps around stop plate 331. The tubular sleeve 134 has less reliable leak path sealing, and so requires o-rings 332, 334. Thus, by adjusting the extent of the valve sleeves and by adjusting the solenoid assembly components, the size and weight of the stop plates 226, 331 can be adjusted and the number of o-rings can be adjusted.

[028] When using sleeve 132 or 134, it is possible to include perforations 1320, as shown in Figure 9. The perforations 1320 can permit ingress of molding fluid in to air gap 127. The molding fluid can leak in to other gaps along valve sleeves and at pole piece 110 and flux collection plates 130, 131 and create fluid leak path sealing upon curing the molding fluid. For sleeve 132, a sheet material can be, for example, stamped and roll-formed. The sleeve can be attached to the solenoid assembly by, for example, crimping or joinery techniques such as the illustrated dove-tail tab 1326 in notch 1324. Extensions 1322 can be included to catch against lip 401 of cage 400. The two-stage operation of the in-line valve permits lower solenoid power, and the in-line design further

reduces necessary power consumption by the solenoid. The reduced power needs permits reduction in size and mass for the solenoid assembly 100. The reductions enable the lighter weight, perforated sleeve 132. While circular perforations 1320 are shown in Figure 9, other shapes, such as square, oval, rectangular, crenelated, etc. are possible.

[029] In Figure 1, a cup like wall of pressure chamber 500 acts as a valve sleeve to house internal components. Cage 400 also acts as a valve sleeve. A central carriage 103 is formed, as by catching a lip 401 of cage 400 against the sleeve 132, and by fitting a finger 402 of cage 400 to a rim 501 of pressure chamber 500. Placing the central carriage 103 in to a molding die permits over-molding with integral formation of valve ports, mounting features, and leak path sealing.

[030] Figure 4 forms a central carriage 103 by joining a rim 501 of pressure chamber 500 to finger 402 of cage 400. Lip 401 of cage is crimped to sleeve 134. Sleeve 134 crimps to or drop-in accepts extension 610 of valve port 600. And, likewise, surrounds solenoid assembly 100 by drop-in or forming the sleeve 134 around the solenoid assembly 100. Unlike Figure 1, the valve ports 600, 700 are part of the valve sleeves forming the central carriage. So, while valve port 700 was molded to pressure chamber 500 in Figure 1, the valve port 700 is integrally molded to pressure chamber 500. This alleviates a leak path between the over-mold and the pressure chamber 500, but can create a need to seal the connection between finger 402 and rim 501 using an o-ring 502 or equivalent sealant. Likewise, valve port 600 is a drop-in part, and it can be necessary to add an o-ring 602 or equivalent sealant. Over-molding the entire central carriage can alleviate some leak path concerns to remove o-rings 602, 336, 502.

[031] Returning to the flow path, the seal 305 seats in a tubular cage 400. The cage comprises a lip 401 adjacent the solenoid assembly 100 and a central hole 403 in a distal end. A piston 410 is seated in the cage 400, the piston 410 comprising a seal 411 with a central orifice 413. A piston spring 420 biases the piston 410 away from the cage 400. The solenoid assembly 100 is configured to selectively block and unblock the central orifice 413 by electromagnetically moving the armature 200 to seat and unseat the poppet 300 with respect to the central orifice 413. So, in an unpowered state, the seal 305 blocks fluid flow through central orifice 413. But, when the solenoid is powered, the armature is drawn towards first end 111 of pole piece 110, which draws stem 220 and affiliated poppet 300 away from central orifice 413. This permits fluid flow from

valve port 600, through pole piece 110, through central passageway 210, between stays 215, and through central orifice 413.

[032] As shown in Figure 4, a piston spring 420 can be biased on a step 405 of cage 400 and biased against lip 407 of piston 410. The piston spring 420 is biased to lift the piston to open orifice 412 similar to that detailed below. As shown in Figure 5, the cage 400 further comprises, near the distal end, vent holes 430 between internal ribs 440. The piston spring 420 is biased against the internal ribs 440. The internal ribs 440 ensure a fluid flow path along the interior of the cage 400.

[033] A pressure chamber 500 is beneath the cage 400. The chamber comprises a second piston 510 with a seal 511 and a second piston spring 520. Second piston spring 520 is biased in the chamber 500 against the second piston 510 to block fluid flow through the vent holes 430. The second piston 510, the second bias spring 520, and the pressure chamber 500 can be configured to perform an over pressure relief function.

[034] A vapor flow path can be formed through the pole piece 110, through the central passageway 210, between the stays 215, through the cage 400, through one or more of the central orifice 413, the orifice 412, and the vent holes 430, and through the pressure chamber 500. Fluid can thereby traverse between valve ports 600 and 700 in line. Diameter changes along the vapor flow path impact fluid flow rates and pressure differentials between valve ports 60 & 700.

[035] The cage 400, the piston 410, the bias spring 420, and the poppet 300 are configured to perform a 2-stage flow restriction function, wherein the poppet 300, 301 regulates a first fluid flow pressure and the piston 410 and bias spring 420 regulate a second fluid flow pressure. The poppets 300, 301 and armature stems 220 are designed to permit lash, or play, along the distal end of the stem 220. The poppets 300, 301 can move a small amount, permitting pressure bleed. With reduced pressure, the solenoid assembly 100 can be smaller and weaker than other designs. A first minor pull of the armature 200 permits the pressure bleed through central orifice 413, and, after some pressure bleed, the solenoid assembly 100 energizes enough to pull the armature the rest of the way towards first end 111 of pole piece. The piston 410 can lift away from orifice 412 after the pressure bleed, opening vapor flow from one end of the valve to the other. When the solenoid assembly 100 deactivates, the poppet returns to block orifice 413, and piston 410 reseats against cage seat 414 to block orifice 412. Tank pressure maintains the valve assembly in the closed position.

[036] The poppets 300 are small enough to be held against orifice 413 by vapor pressure from the fuel tank. And, the piston spring 420 is designed to bias piston 410 upward, but be overcome by tank pressure until pressure is bled by poppets 300.

[037] However, an over pressure can occur in the fuel tank, causing an immediate need for pressure release. This is achieved by the vent holes 430 in cage 400. The bias spring 410 does not interfere with the vent holes 430 at least because internal ribs 440 position the bias spring 420 away from the vent holes 430. Pressure above a predetermined threshold overcomes second bias spring 520 in pressure chamber 500. Piston 510 moves downward and unseats seal 511. Over pressure is vented through the vent holes 430. When the pressure releases below the threshold, the bias spring 520 reseats the piston and seal 511 to block the vent holes 430.

[038] Regarding the solenoid assembly, sleeves 132, 134 electrically connect the flux collection plates 130, 131 to activate the solenoid, when powered. One of the flux collection plates 131 can be integrally formed with tubular sleeve 134, as by a stamping or drawing process. The pole piece 110 comprises the first end 111 and a second end 113. Flux collection plate 130 is press fit to the second end 113 of the pole piece 110. Flux collection plate 131 is integrally formed with the tubular sleeve 134 and is press fit to the first end 111 of the pole piece 110. Bobbin 120 spans between the first end 111 of the pole piece and the second end 113 of the pole piece. Coil 125 is seated in the bobbin 120. Tubular sleeve 132, 134 surrounds the bobbin 120 and the coil 125. As in Figure 1, tubular sleeve 132 can press fit against flux collection plates 130, 131. Instead of press fit, crimping, or joinery, it is also possible that the solenoid sleeve 132, 134 can be over-molded to at least one flux collector 130, 131. The housing 800 then integrates the solenoid assembly 100.

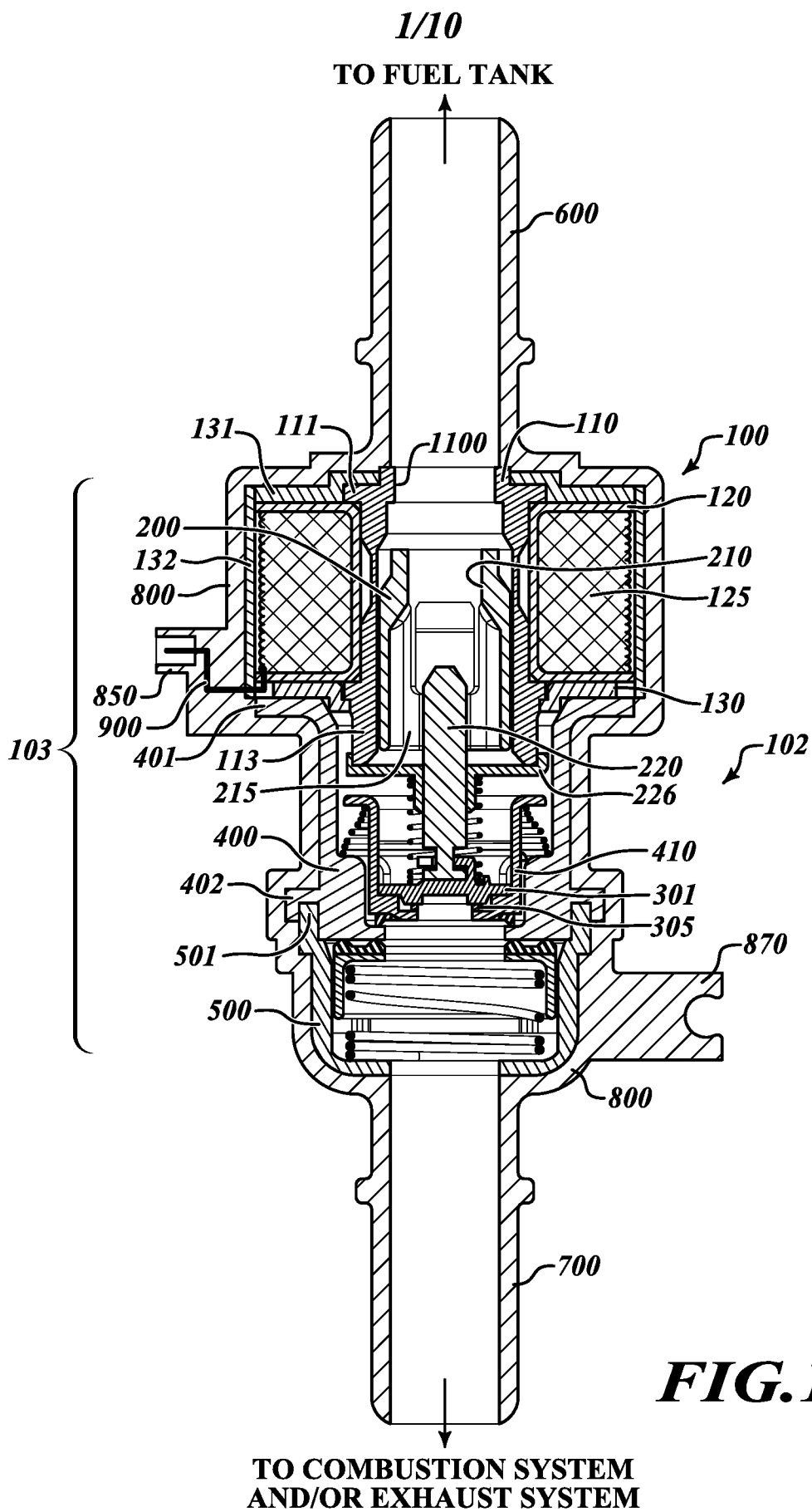
[039] Other implementations will be apparent to those skilled in the art from consideration of the specification and practice of the examples disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

WHAT IS CLAIMED IS:

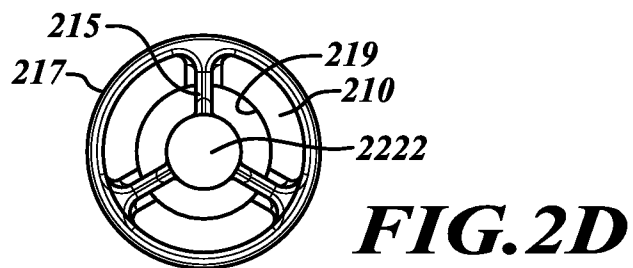
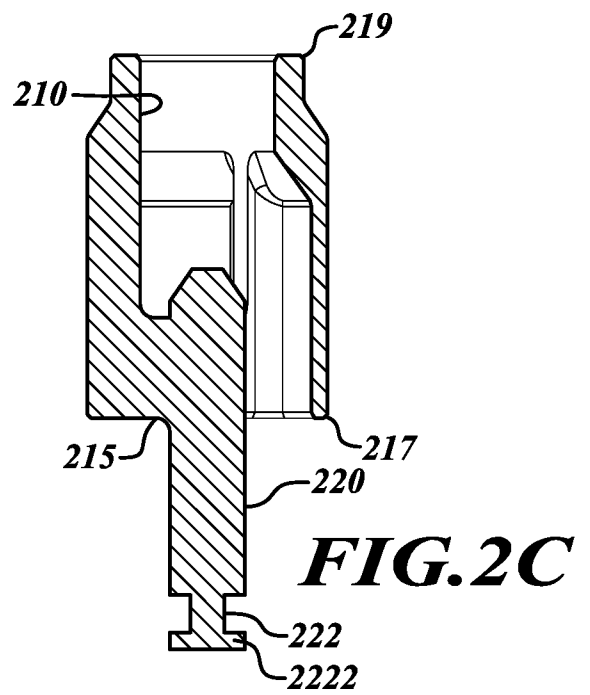
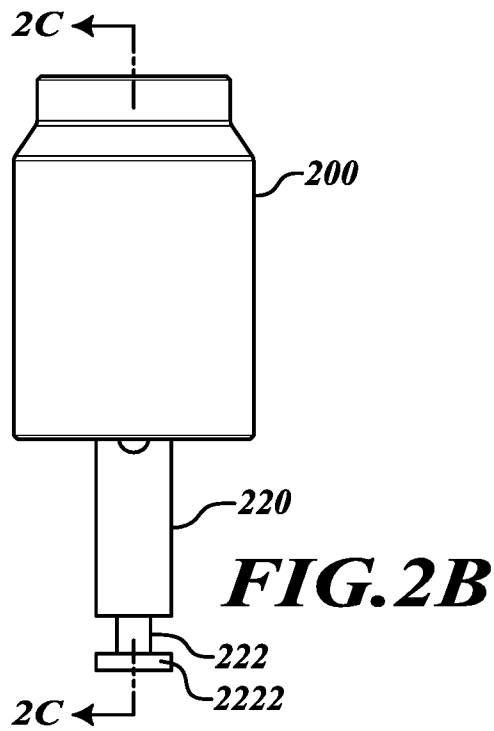
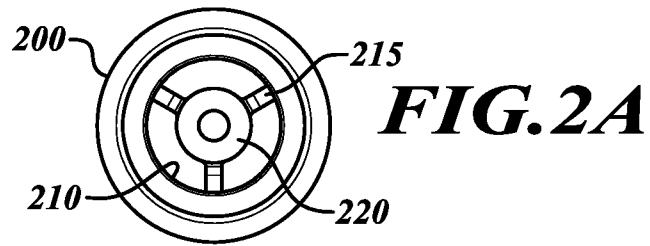
1. An in-line valve comprising:
a valve port;
a solenoid assembly comprising a hollow tubular pole piece, a bobbin, a coil, and flux collection plates; and
a fluted armature within the pole piece, the armature comprising a hollow central passageway, a stem, and stays at a first end of the fluted armature, the stays bracing the stem in the central passageway,
wherein the valve port adjoins the pole piece, and
wherein fluid communicates from between the stays at the first end of the fluted armature, through the hollow central passageway and through the pole piece to the valve port.
2. The in-line valve of claim 1, further comprising a poppet at the end of the stem.
3. The in-line valve of claim 2, wherein the poppet comprises a disk with seal.
4. The in-line valve of claim 2, wherein the stem extends out of the armature and further comprises a notch in a distal end, and wherein the poppet attaches to the notch.
5. The in-line valve of claim 2, further comprising a snap ring and an o-ring, wherein the stem extends out of the armature, wherein the stem further comprises a first neck-down at a distal end, a neck-up after the neck-down, and a slot after the neck-up, wherein the o-ring is seated in the neck-down, wherein the snap ring is seated in the slot, and wherein the poppet is movable along the neck-up between the o-ring and the snap ring.
6. The in-line valve of claim 5, further comprising:
a second slot in the stem;
a stop plate abutting the pole piece, the stop plate limiting the travel of the armature out of the pole piece;
a second snap ring in the second slot;
a spring seat abutting the second snap ring; and
an armature spring around the stem and biased between the stop plate and the spring seat.
7. The in-line valve of claim 5, further comprising a first bleed channel in the neck-up and a second bleed channel in the poppet, wherein the first bleed channel aligns with the second bleed channel to form a vapor flow passage.

8. The in-line valve of claim 7, wherein one or both of the first bleed channel and the second bleed channel comprise steps.
9. The in-line valve of claim 1, further comprising:
 - a tubular cage comprising a lip adjacent the solenoid assembly and an orifice in a distal end;
 - a piston seated in the cage, the piston comprising a seal with a central orifice;
 - and
 - a piston spring biasing the piston away from the cage,wherein the solenoid assembly is configured to selectively block and unblock the central orifice by electromagnetically moving the armature to seat and unseat the poppet with respect to the central orifice.
10. The inline valve of claim 9, further comprising a stop plate abutting the pole piece and a poppet spring between the stop plate and the poppet, the poppet spring biasing the poppet towards the distal end of the stem and towards the central orifice.
11. The in-line valve of claim 9, wherein the cage further comprises, near the distal end, vent holes between internal ribs, and wherein the piston spring is biased against the internal ribs.
12. The in-line valve of claim 11, further comprising an orifice in the cage and a pressure chamber beneath the cage, the chamber comprising a second piston and a second piston spring, wherein the second piston further comprises a seal, and wherein the second piston spring is biased in the chamber against the second piston to block fluid flow through the vent holes.
13. The in-line valve of claim 1, wherein one of the flux collection plates is integrally formed with a tubular sleeve.
14. The in-line valve of claim 13, wherein the pole piece comprises the first end and a second end, wherein a second of the flux collection plates is press fit to the second end of the pole piece, and wherein the one of the flux collection plates integrally formed with the tubular sleeve is press fit to the first end of the pole piece, wherein the bobbin spans between the first end of the pole piece and the second end of the pole piece, wherein the coil is seated in the bobbin, wherein the tubular sleeve surrounds the bobbin and the coil, and wherein the tubular sleeve further press fits against the second of the flux collection plates.
15. The in-line valve of claim 1, further comprising a perforated sleeve connecting the flux collection plates.

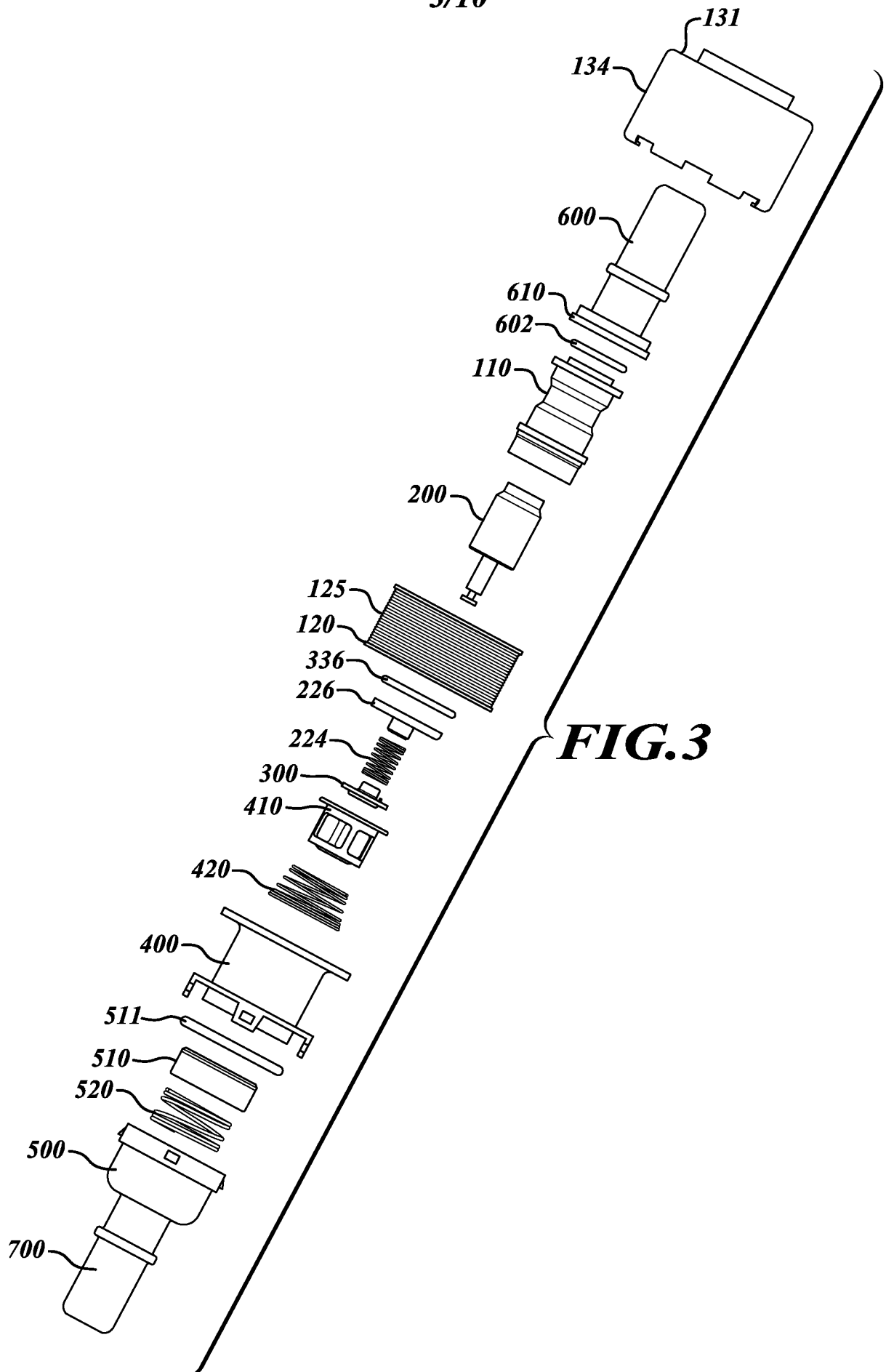
16. The in-line valve of claim 12, wherein a vapor flow path is formed through the pole piece, through the central passageway, between the stays, through the cage, through one or more of the central orifice, the orifice, and the vent holes, and through the pressure chamber.
17. The in-line valve of claim 16, wherein the second piston, the second bias spring, and the pressure chamber are configured to perform an over pressure relief function.
18. The in-line valve of claim 17, wherein the cage, the piston, the bias spring, and the poppet are configured to perform a 2-stage flow restriction function, wherein the poppet regulates a first fluid flow pressure and the piston and bias spring regulate a second fluid flow pressure.
19. The in-line valve of claim 1, wherein the armature is biased away from the valve port by a spring, and wherein the spring is not within the pole piece.
20. The in-line valve of claim 1, wherein the solenoid assembly, the cage, and the chamber are integrated via over-molding.
21. The in-line valve of claim 20, further comprising a solenoid sleeve over-molded to the solenoid assembly.
22. The in-line valve of claim 21, wherein the solenoid sleeve is perforated.
23. The in-line valve of claim 20, further comprising port connections comprising one of press-fit, quick-connect, snap fit, or barbed end that are integrated to the solenoid assembly and chamber via the over-molding.



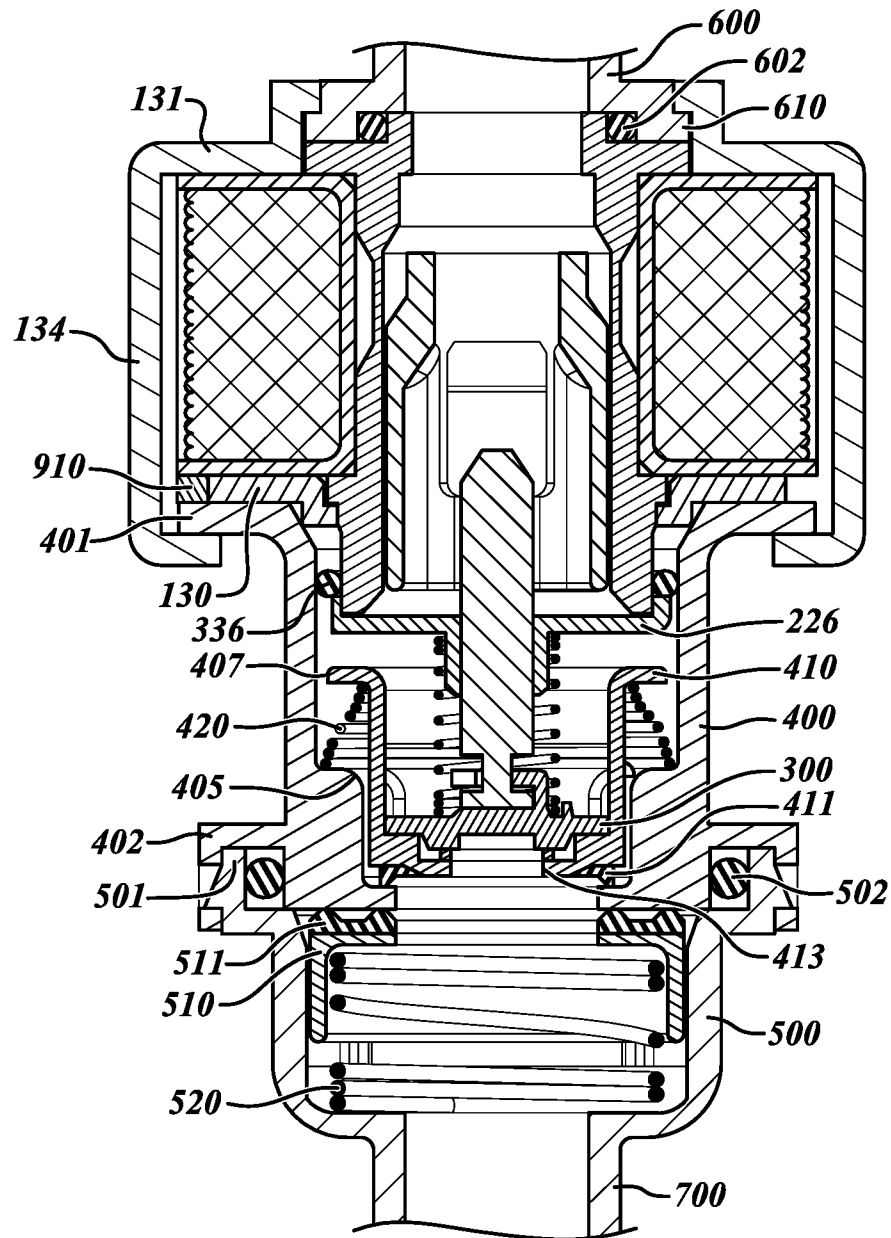
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4/10

**FIG.4**

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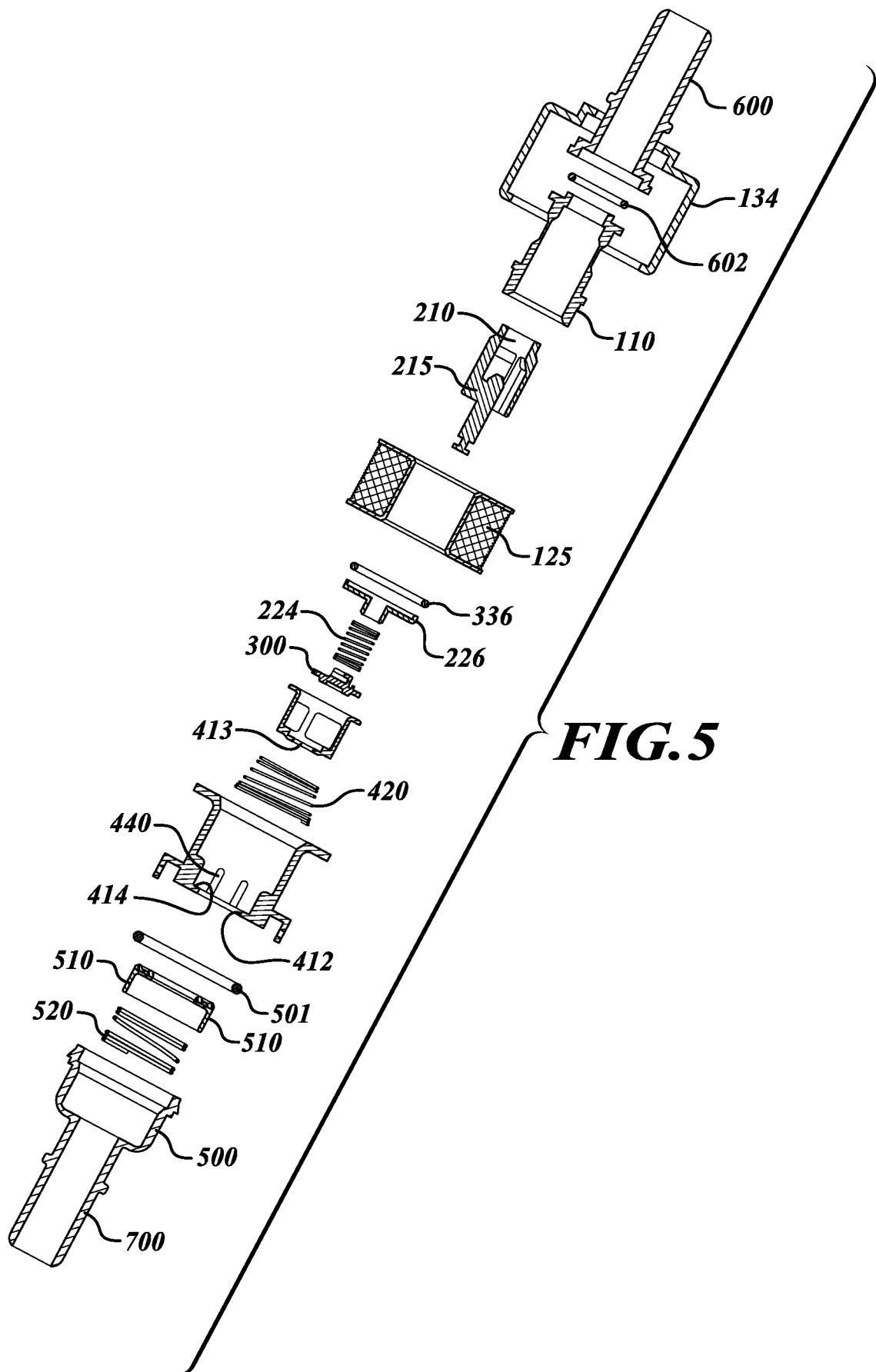


FIG. 5

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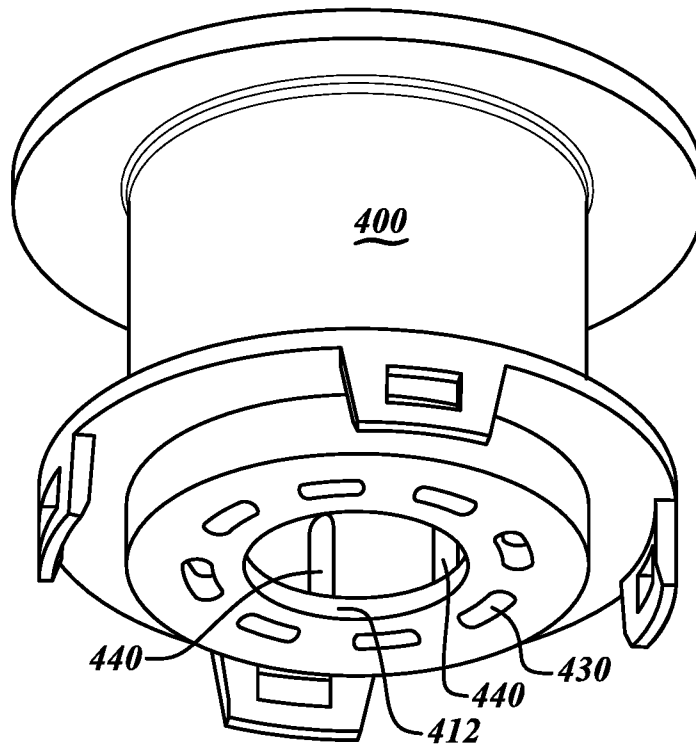


FIG. 6

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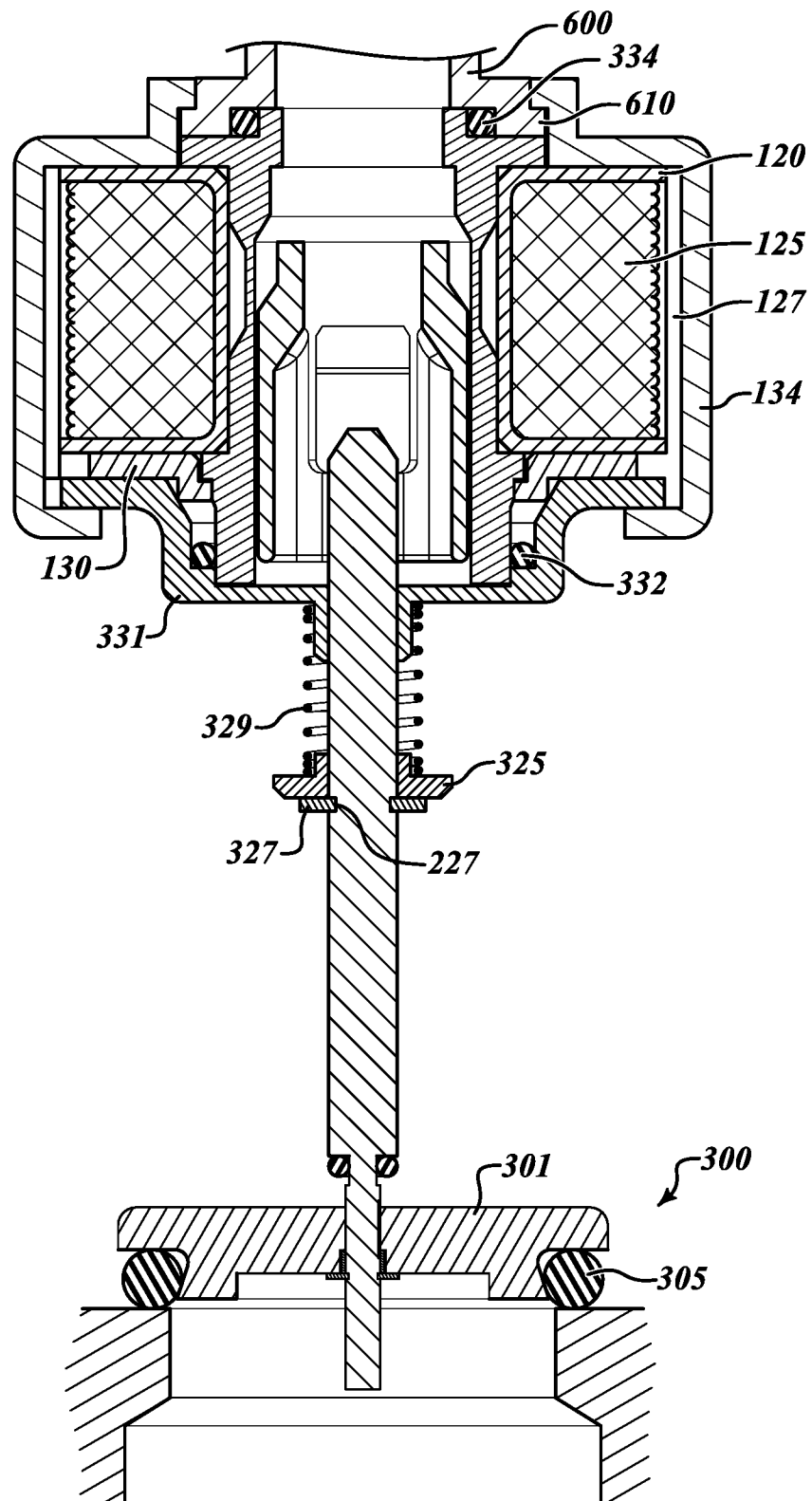


FIG. 7

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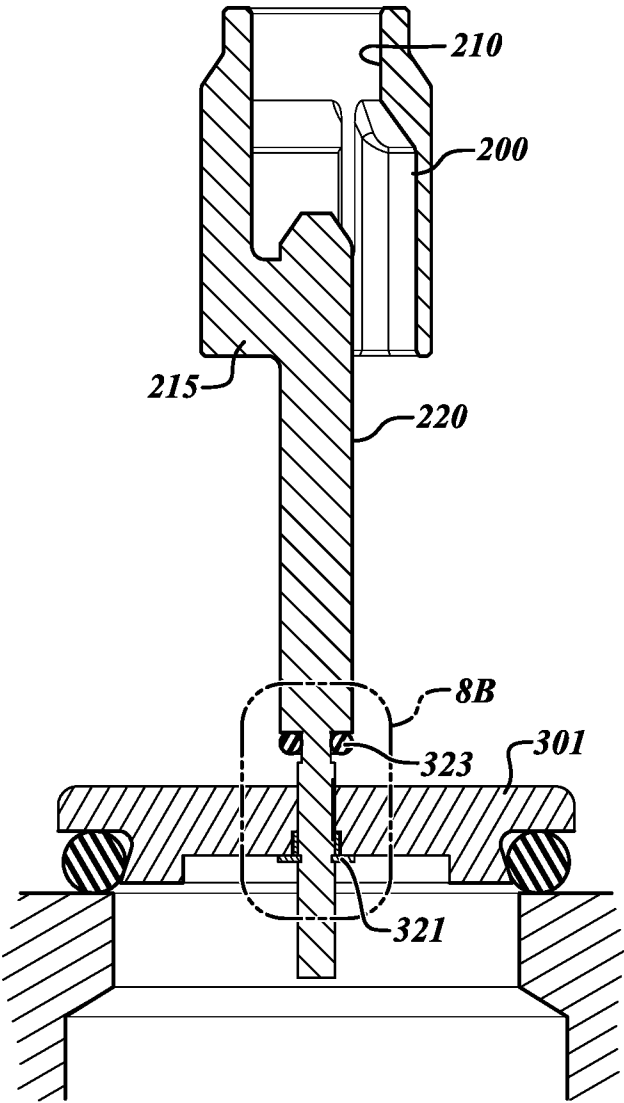


FIG. 8A

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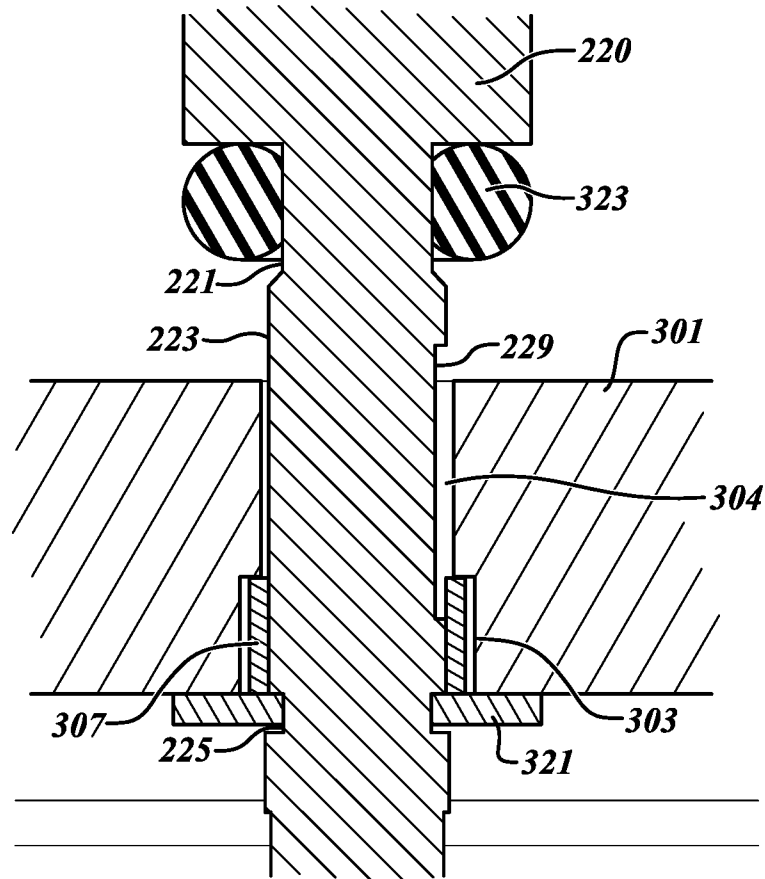
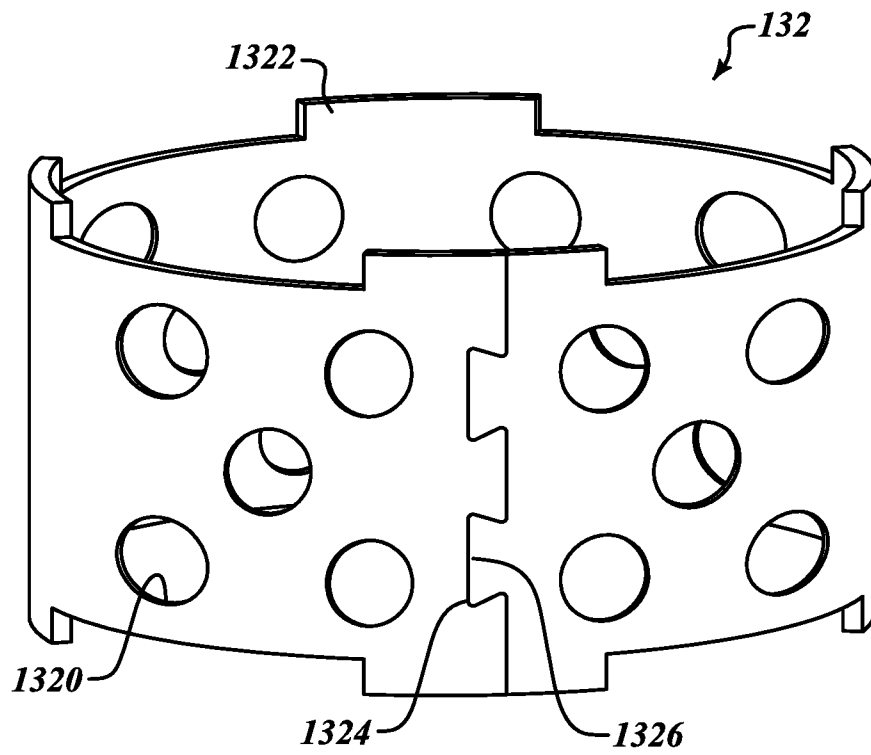


FIG. 8B

10/10***FIG. 9***

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/067369**A. CLASSIFICATION OF SUBJECT MATTER****B60K 15/01(2006.01)i, F16K 15/02(2006.01)i, F02B 25/08(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
B60K 15/01; F16K 31/12; F16K 31/02; F16K 31/36; H01R 16/60; F16K 15/02; F02B 25/08Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: valve, port, solenoid, armature, poppet, stem, channel and piston**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2013-0075639 A1 (EATON CORPORATION) 28 March 2013 See paragraphs [0014]-[0016], claim 1 and figures 1-4.	1-23
A	US 6010360 A (OHAI, REYNOLDS) 04 January 2000 See column 1, line 30 - column 3, line 16 and figure 5.	1-23
A	US 2008-0203342 A1 (RYUEN et al.) 28 August 2008 See paragraphs [0044]-[0064] and figures 1-10.	1-23
A	US 2010-0155633 A1 (PFAFF, JOSEPH L.) 24 June 2010 See paragraphs [0024]-[0037] and figures 1-2.	1-23
A	US 2013-0087727 A1 (VOLZ et al.) 11 April 2013 See paragraphs [0024]-[0036] and figures 1-8.	1-23



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search

12 April 2016 (12.04.2016)

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Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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