

(51) International Patent Classification:

F16H 61/00 (2006.01) H01F 7/16 (2006.01)
F16K 31/06 (2006.01)

(21) International Application Number:

PCT/US2016/036170

(22) International Filing Date:

07 June 2016 (07.06.2016)

(25) Filing Language:

English

(26) Publication Language:

English

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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).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

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

(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,

(54) Title: ON-OFF SOLENOID-ACTUATED VALVE FOR FAST FILL OF ACCUMULATOR FOR AUTOMATIC TRANSMISSIONS

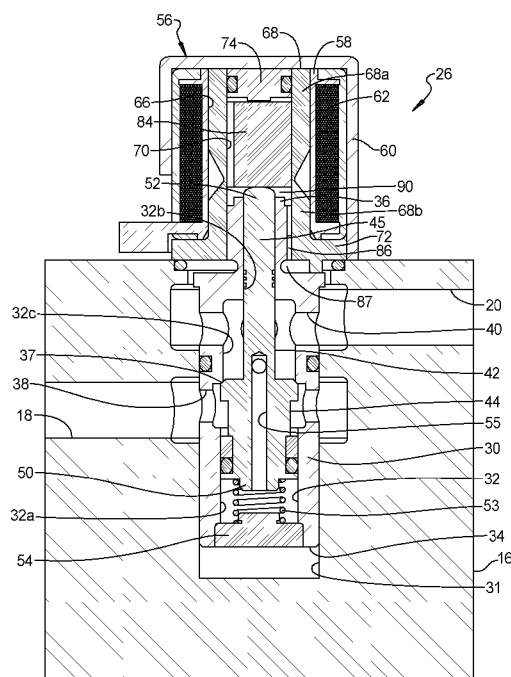


FIG 2

(57) Abstract: A solenoid-actuated valve (26) includes a solenoid (56) having a coil (62), flux core (68), an armature (84), a valve body (30) associated with the solenoid (56), the valve body (30) having a valve bore (32) with at least one first fluid port (38) and at least one second fluid port (40), at least one vent channel (86, 87) connecting an inside diameter of the flux core (68) to the at least one second fluid port (40). The valve bore (32) also has a first diameter, a second diameter greater than the first diameter, and a valve seat (37) disposed between the first diameter and the second diameter. The solenoid-actuated valve (26) further includes a valve member (42) axially and slidably disposed within the valve bore (32), the valve member (42) having a shaft (45) guided by the second diameter to assure alignment of the valve member (42) to the valve seat (37), and a valve element (44) that interfaces with the valve seat (37) for controlling fluid flow between the ports (38, 40).

ON-OFF SOLENOID-ACTUATED VALVE FOR FAST FILL OF ACCUMULATOR FOR AUTOMATIC TRANSMISSIONS

BACKGROUND OF INVENTION

1. *Field of Invention*

[0001] The present invention relates generally to automatic transmissions and, more specifically, to an on-off solenoid-actuated valve for fast fill of an accumulator for an automatic transmission.

2. *Description of the Related Art*

[0002] Conventional vehicles known in the art typically include an engine having a rotational output as a rotational input into a transmission such as an automatic transmission. The engine generates the rotational output which is selectively translated to the transmission which, in turn, translates rotational torque to one or more wheels. The transmission changes the rotational speed and torque generated by the engine through a series of predetermined gearsets, whereby changing between the gearsets enables a vehicle to travel at different vehicle speeds for a given engine speed.

[0003] In addition to changing between the gear sets, the automatic transmission is also used to modulate engagement with the rotational output of the engine, whereby the transmission can selectively control engagement with the rotational output of the engine so as to facilitate vehicle operation. By way of example, torque translation between the rotational output of the engine and the input into the automatic transmission is typically interrupted while the vehicle is parked or idling, or when the transmission changes between the gearsets. In conventional automatic transmissions, modulation is achieved via a hydrodynamic device such as a hydraulic torque converter. However, modern automatic transmissions may replace

the torque converter with one or more electronically and/or hydraulically actuated clutches (sometimes referred to in the art as a “dual clutch” automatic transmission). Automatic transmissions are typically controlled using hydraulic fluid and a hydraulic system including a pump assembly, a valve housing having one or more solenoid-actuated valves, and an electronic controller. The pump assembly provides a source of fluid power to the solenoid-actuated valves of the valve housing which, in turn, are actuated by the controller so as to selectively direct hydraulic fluid throughout the automatic transmission to control modulation of rotational torque generated by the rotational output of the engine. The solenoid-actuated valves are also typically used to change between the gear sets of the automatic transmission, and may also be used to control hydraulic fluid used to cool and/or lubricate various components of the transmission in operation.

[0004] In a stop-start compatible vehicle system, the automatic transmission is required to be ready to launch the vehicle as a response to the operator’s accelerator input without delay. Since conventional automatic transmissions are powered by a mechanical oil pump driven by the engine, the transmission hydraulic circuit is not pressurized until the engine is running at a steady state condition, which results in late response to the operator’s accelerator pedal input in a stop-start event. As one solution to this problem, stop-start compatible automatic transmissions are often equipped with its own hydraulic power source.

[0005] One solution that has proved feasible and applied to mass production vehicles is in the form of a stop-start accumulator system. This system requires a hydraulic accumulator to store hydraulic energy for the hydraulic system used in the automatic transmission and a valve that is low leak to store the energy during engine stop and fast response to discharge the energy into the transmission hydraulic system faster than the vehicle operator accelerator pedal input.

[0006] Accordingly, it is desirable to provide a solenoid-actuated valve to assist an automatic transmission in stop/start vehicle applications by actively filling and controlling a discharge of the accumulator when commanded. Due to the increasing number of stop/start events and decreasing oil pump capacity for fuel efficiency improvements, it is desirable to provide a solenoid-actuated valve that is robust for actively controlling a fill and discharge when commanded.

SUMMARY OF THE INVENTION

[0007] The present invention provides a solenoid-actuated valve for use in controlling fluid flow to and from an accumulator used in an automatic transmission during stop/start engine events of a vehicle including a solenoid including a coil, flux core, and an armature for generating an axial actuation force. The solenoid-actuated valve also includes a valve body connected to and operatively associated with the solenoid, the valve body having a valve bore extending axially and at least one first fluid port for fluid communication between the valve bore and the accumulator and at least another second fluid port for fluid communication between the valve bore and a hydraulic control system of the automatic transmission. The solenoid-actuated valve also includes at least one vent channel connecting an inside diameter of the flux core to the at least one second fluid port. The valve bore has a first diameter and a second diameter with the first diameter being greater than the second diameter, and a valve seat disposed between the first inside diameter and the second inside diameter. The solenoid-actuated valve further includes a valve member axially and slidingly disposed within the valve bore, the valve member having a shaft guided by the second diameter of the valve body to assure alignment of the valve member to a seat of the valve body, and a valve element that interfaces with the seat for controlling fluid flow from the first fluid port of the valve body to the second port of the valve body.

[0008] One advantage of the present invention is that a new on-off solenoid-actuated valve is provided for fast fill of a hydraulic accumulator for an automatic transmission during stop/start engine events of a vehicle. Another advantage of the present invention is that the on-off solenoid-actuated valve allows fast fill of a hydraulic accumulator of a hydraulic system for the automatic transmission. Yet another advantage of the present invention is that the on-off solenoid-actuated valve improves contamination ingress to the electro-magnetic coil area or solenoid by adequately isolating the electro-magnetic coil section from a hydraulic section that contains contamination particles. Still another advantage of the present invention is that the on-off solenoid-actuated valve allows free fluid flow for faster filling of the hydraulic accumulator during stop/start engine events of the vehicle.

[0009] Other objects, features, and advantages of the present invention will be readily appreciated as the same becomes better understood after reading the subsequent description taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Figure 1 is a schematic view of one embodiment of a system, according to the present invention, for fast fill of a hydraulic accumulator for an automatic transmission.

[0011] Figure 2 is a schematic view of one embodiment of an on-off solenoid-actuated valve, according to the present invention, for fast fill of the hydraulic accumulator of Figure 1 illustrated in a first position.

[0012] Figure 3 is a view similar to Figure 2 illustrating the on-off solenoid-actuated valve in a second position.

[0013] Figure 4 is an enlarged view of a portion of the on-off solenoid-actuated valve of Figure 2.

DETAILED DESCRIPTION OF THE INVENTION

[0014] Referring now to the figures, where like numerals are used to designate like structure unless otherwise indicated, a system 10, according to one embodiment of the present invention, is shown for fast filling a hydraulic accumulator 12 used in conjunction with an automatic transmission, generally indicated at 14, in Figure 1 for a vehicle (not shown). The vehicle includes an engine (not shown) that cooperates with the automatic transmission 14. The engine generates rotational torque which is selectively translated to the automatic transmission 14 which, in turn, translates rotational torque to one or more wheels (not shown) of the vehicle. It should be appreciated that the engine and the automatic transmission 14 are of the type employed in a “hybrid” vehicle having engine stop/start events. It should also be appreciated that the engine and/or automatic transmission 14 could be of any suitable type, configured in any suitable way sufficient to generate and translate rotational torque so as to drive the vehicle, without departing from the scope of the present invention.

[0015] The system 10 includes a hydraulic system for the automatic transmission 14 and includes a pump (not shown) and a valve housing 16 with one or more valves such as a solenoid-actuated valve, generally indicated at 26 and according to the present invention to be described, that control fluid flow and fluid pressure from the pump in the automatic transmission 14. The valve housing 16 has at least one port 18 and at least one port 20 illustrated in Figures 2 and 3. The hydraulic accumulator 12 fluidly communicates with the port 18 of the valve body 16 via a fluid line 22 to store hydraulic fluid and energy in the hydraulic accumulator 12 and to deliver hydraulic fluid and energy to a hydraulic circuit of the hydraulic system via a fluid line 24 fluidly communicating with the port 20 to provide sufficient transmission line pressure to the automatic transmission 14. In one embodiment, the hydraulic accumulator 12 includes a housing having storage, a movable piston disposed in

the housing, and a spring biasing the piston. It should be appreciated that the hydraulic accumulator 12 and automatic transmission 14 are known in the art.

[0016] In one embodiment as illustrated in FIGS. 1-3, the system 10 includes a solenoid-actuated valve, generally indicated at 26 and according to the present invention, disposed on the valve housing 16 and between the fluid lines 22 and 24 to fill the hydraulic accumulator 12 at a relatively fast rate. In one embodiment, the solenoid-actuated valve 26 is a two-way or on/off solenoid-actuated valve. The solenoid-actuated valve 26 may be disposed on the valve housing 16. The system 10 also includes an electronic controller 28 electrically connected to the solenoid-actuated valve 26 for energizing and de-energizing a solenoid 56 to be described of the solenoid-actuated valve 26. It should be appreciated that the solenoid-actuated valve 26 allows for near instantaneous refill of the hydraulic accumulator 12, for example in less than one second, after a restart event of the engine.

[0017] The solenoid-actuated valve 26 includes a sleeve or valve body 30 disposed in a bore 31 of the valve housing 16. The bore 31 fluidly communicates with the port 18 and the port 20. The valve body 30 has a valve bore 32 extending axially and radially. The valve bore 32 has a first diameter 32a being the largest bore diameter, a second diameter 32b being the smallest diameter, and a third diameter 32c being a diameter in between the first diameter 32a and the second diameter 32b. The valve bore 32 has a biasing end 34 and an actuating end 36. The biasing end 34 has a first diameter greater than a second diameter of the actuating end 36. The valve bore 32 also has a valve seat 37 disposed between the first diameter and the second diameter. The valve body 30 also includes at least one first fluid port 38 and at least one second fluid port 40 to provide fluid communication with the at least one port 18 and the at least one port 20 of the valve housing 16, respectively.

[0018] The solenoid-actuated valve 26 also includes a valve member 42 or a valve (i.e., hydraulic control valve) slideably disposed within the valve bore 32 of the valve body

30. The valve member 42 has at least one poppet or valve element 44 and a shaft 45 extending axially from the valve element 42. The valve element 44 has a diameter greater than a diameter of the shaft 45. The valve element 44 is adapted to control the flow of pressurized hydraulic fluid between the ports 38 and 40 of the valve body 30. The valve member 42 further includes a biasing end 50 and an actuating end 52. It should be appreciated that the valve element 44 is slidingly disposed in the first diameter of the valve bore 32 and the shaft 45 is slidingly disposed in the second diameter of the valve bore 32 such that the shaft 45 is guided by the second diameter to assure alignment of the valve element 44 to the valve seat 37 in the valve bore 32 of the valve body 30. It should also be appreciated that the valve element 44 interfaces with the seat for the purpose of controlling flow from the port 38 to the port 40 of the valve body 30. It should further be appreciated that the valve member 42 is integral, unitary, and one-piece.

[0019] The solenoid-actuated valve 26 may include a biasing return spring 53 disposed in the valve bore 32 between the biasing end 50 of the valve member 42 and the biasing end 34 of the valve bore 32. The solenoid valve 26 further includes an end member 54 disposed in the biasing end 34 of the valve bore 32. It should be appreciated that the end member 54 is fixed to the valve body 30 and the valve member 42 moves axially relative to the valve body 30.

[0020] The valve member 42 has the valve element 44 disposed slidingly within the first diameter 32a of the valve bore 32 and the shaft 45 disposed slidingly within the second diameter 32b of the valve bore 32. The valve member 42 also includes a bore 55 extending axially therein that connects valve chambers, one on the port 40 and the other on the valve end 50 to achieve pressure balance on the valve element 44.

[0021] The solenoid-actuated valve 26 also includes an electronically controlled solenoid, generally indicated at 56, for actuating the valve member 42 to control hydraulic

fluid pressure and flow between the port 38 and the port 40. The solenoid 56 includes a bobbin 58 and a can or housing 60 enclosing the bobbin 58. The bobbin 58 has a primary electromagnetic coil 62 wound thereon to create a magnetic field when energized. The solenoid 56 also includes a terminal (not shown) for connecting with the electromagnetic coil 62 and to ground (not shown). The coil 62 is made of copper wire. It should be appreciated that the terminal receives a digital control signal from a primary driver (not shown) such as the electronic controller 28.

[0022] The solenoid 56 further includes an internal diameter or channel 66 extending through a longitudinal axis of the bobbin 58. The actuating end 36 of the valve body 30 is disposed in the channel 72. The solenoid 56 also includes a flux core 68 co-axially disposed within the channel 66. The flux core 68 is generally cylindrical in shape with a generally circular cross-section. The flux core 68 has an aperture 70 extending axially therethrough forming an internal diameter. The flux core 68 may be made in more or more pieces including an upper flux return 68a and lower pole piece 68b. The flux core 68 has a flange 72 extending radially outward from the axial end thereof to contact the housing 60. The solenoid 56 includes an end cap 74 disposed within the flux core 68. The solenoid 56 further includes an armature 84 disposed in the aperture 70 of the flux core 68 for generating axial actuation force. It should further be appreciated that the armature 84 slides within the aperture 70 of the flux core 68 and contacts the shaft 45 of the valve member 42.

[0023] The solenoid 56 also includes at least one vent channel, such as a first vent channel 86 formed as a gap between the actuating end 36 and the aperture 70 of the flux core 68 and a second vent channel 87 formed as a gap between the valve body 30 and the housing 16 and fluidly connected to the port 20, and a chamber 90 between the armature 84 and the actuating end 36 to allow free oil flow to facilitate free movement of the armature 84. It should be appreciated that the vent channel 86 allows fluid flow therethrough to the chamber

90 to provide a valve element 44 which is at least 90% hydraulically balanced. It should also be appreciated that the chamber 90 provides a minimized displacement volume as illustrated in Figure 2 and a maximum venting volume as illustrated in Figure 3 via the vent channels 86 and 87.

[0024] As illustrated in Figure 1, the electronic controller 28 is in electrical communication with the solenoid-actuated valve 26 to activate or energize the solenoid 56 to actuate the valve member 42 or to deactivate or de-energize the solenoid 56 to de-actuate the valve member 42 to actively control fluid flow to and from the hydraulic accumulator 12. It should be appreciated that the electronic controller 28 is known in the art.

[0025] In operation, the solenoid-actuated valve 26 of the present invention is controlled by a control strategy for the system 10 to allow for near instantaneous refill of the hydraulic accumulator 12 under specific conditions. For example, if the engine of the vehicle re-starts after an engine stop event and then immediately requests an engine stop event but the hydraulic accumulator 12 is not yet full, the solenoid 56 of the solenoid-actuated valve 26 is energized by the electronic controller 28 to allow the hydraulic accumulator 12 to fill in less than one second. The solenoid 56 is then de-energized by the electronic controller 28 and the engine of the vehicle can be shut-off. It should be appreciated that this can only be done in conditions where transmission line pressure sag is not an issue, for example, when the vehicle has come to a stop with the foot of the operator on the brake. It should also be appreciated that, in this case, there is no risk to slip a clutch of the automatic transmission 14 if the transmission line pressure sages while filling the hydraulic accumulator 12.

[0026] The present invention has been described in an illustrative manner. It is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation.

[0027] Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the invention may be practiced other than as specifically described.

What is claimed is:

1. A solenoid-actuated valve (26) for use in controlling fluid flow to and from an accumulator (12) used in an automatic transmission (14) during stop/start engine events of a vehicle, said solenoid-actuated valve (26) comprising:

a solenoid (56) including a coil (62), flux core (68), and an armature (84) for generating an axial actuation force;

a valve body (30) connected to and operatively associated with said solenoid (56), said valve body (30) having a valve bore (32) extending axially and at least one first fluid port (38) for fluid communication between said valve bore (32) and the accumulator (12) and at least another second fluid port (40) for fluid communication between said valve bore (32) and a hydraulic control system of the automatic transmission (14);

at least one vent channel (86, 87) connecting an inside diameter of said flux core (68) to said at least one second fluid port (40);

said valve bore (32) having a first diameter and a second diameter, said first diameter being greater than said second diameter, and a valve seat (37) disposed between said first diameter and said second diameter;

a valve member (42) axially and slidingly disposed within said valve bore (32), said valve member (42) having a shaft (45) guided by said second diameter to assure alignment of said valve member (42) to said valve seat (37); and

said valve member (42) having a valve element (44) that interfaces with said valve seat (37) for controlling fluid flow from said first fluid port (38) of said valve body (30) to said second port (40) of said valve body (30).

2. A solenoid-actuated valve (26) as set forth in claim 1 wherein said at least one vent channel (86, 87) is formed between said valve body (30) and the valve housing (16).

3. A solenoid-actuated valve (26) as set forth in any one of claims 1 and 2 wherein said flux core (68) has an inside diameter (78) therein.

4. A solenoid-actuated valve (26) as set forth in claim 3 including a chamber (90) in said inside diameter (78) disposed between said shaft (45) and said armature (84) and fluidly communicating with said at least one vent channel (86, 87).

5. A solenoid-actuated valve (26) as set forth in any one of claims 1 and 2 including a bobbin (58) and said coil (62) being disposed about said bobbin (58).

6. A solenoid-actuated valve (26) as set forth in claim 5 wherein said bobbin (58) is made of a plastic material.

7. A solenoid-actuated valve (26) as set forth in claim 5 including a housing (60) disposed about said bobbin (58).

8. A solenoid-actuated valve (26) for use in controlling fluid flow to and from an accumulator (12) used in an automatic transmission (14) during stop/start engine events of a vehicle, said solenoid-actuated valve (26) comprising:

a solenoid (56) including a coil (62), flux core (68), and an armature (84) for generating an axial actuation force;

a valve body (30) connected to and operatively associated with said solenoid (56), said valve body (30) having a valve bore (32) extending axially and at least one first fluid port (38) for fluid communication between said valve bore (32) and the accumulator (12) and at least another second fluid port (40) for fluid communication between said valve bore (32) and a hydraulic control system of the automatic transmission (14);

a chamber (90) in said flux core (68);

at least one vent channel (86, 87) connecting said chamber of said flux core (68) to said at least one second fluid port (40);

said valve bore (32) having a first diameter and a second diameter, said first diameter being greater than said second diameter, and a valve seat (37) disposed between said first diameter and said second diameter;

a valve member (42) axially and slidingly disposed within said valve bore (32), said valve member (42) having a shaft (45) guided by said second diameter to assure alignment of said valve member (42) to said valve seat (37); and

said valve member (42) having a valve element (44) that interfaces with said valve seat (37) for controlling fluid flow from said first fluid port (38) of said valve body (30) to said second port (40) of said valve body (30).

9. A solenoid-actuated valve (26) as set forth in claim 8 wherein said at least one vent channel (86, 87) is formed between said valve body (30) and the valve housing (16).

10. A solenoid-actuated valve (26) as set forth in any one of claims 8 and 9 wherein said flux core (68) has an inside diameter (78) therein.

11. A solenoid-actuated valve (26) as set forth in any one of claims 8 and 9 wherein said chamber (90) is disposed between said shaft (45) and said armature (84).

12. A solenoid-actuated valve (26) as set forth in any one of claims 8 and 9 including a bobbin (58) and said coil (62) being disposed about said bobbin (58).

13. A solenoid-actuated valve (26) as set forth in claim 12 including a housing (60) disposed about said bobbin (58).

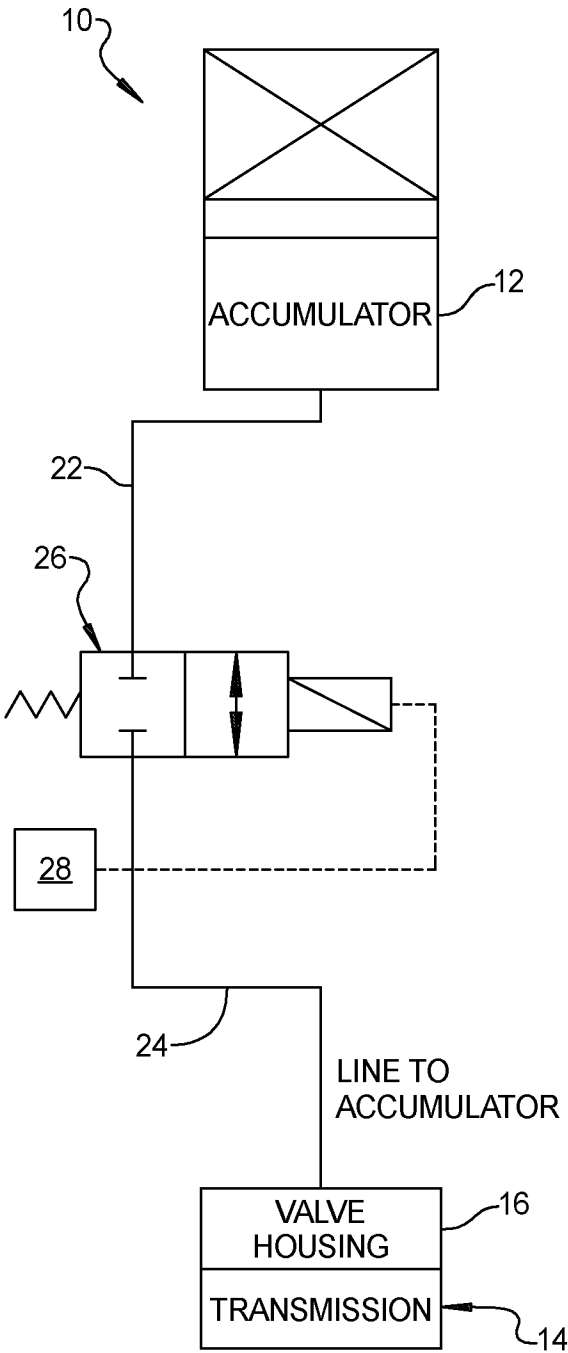


FIG 1

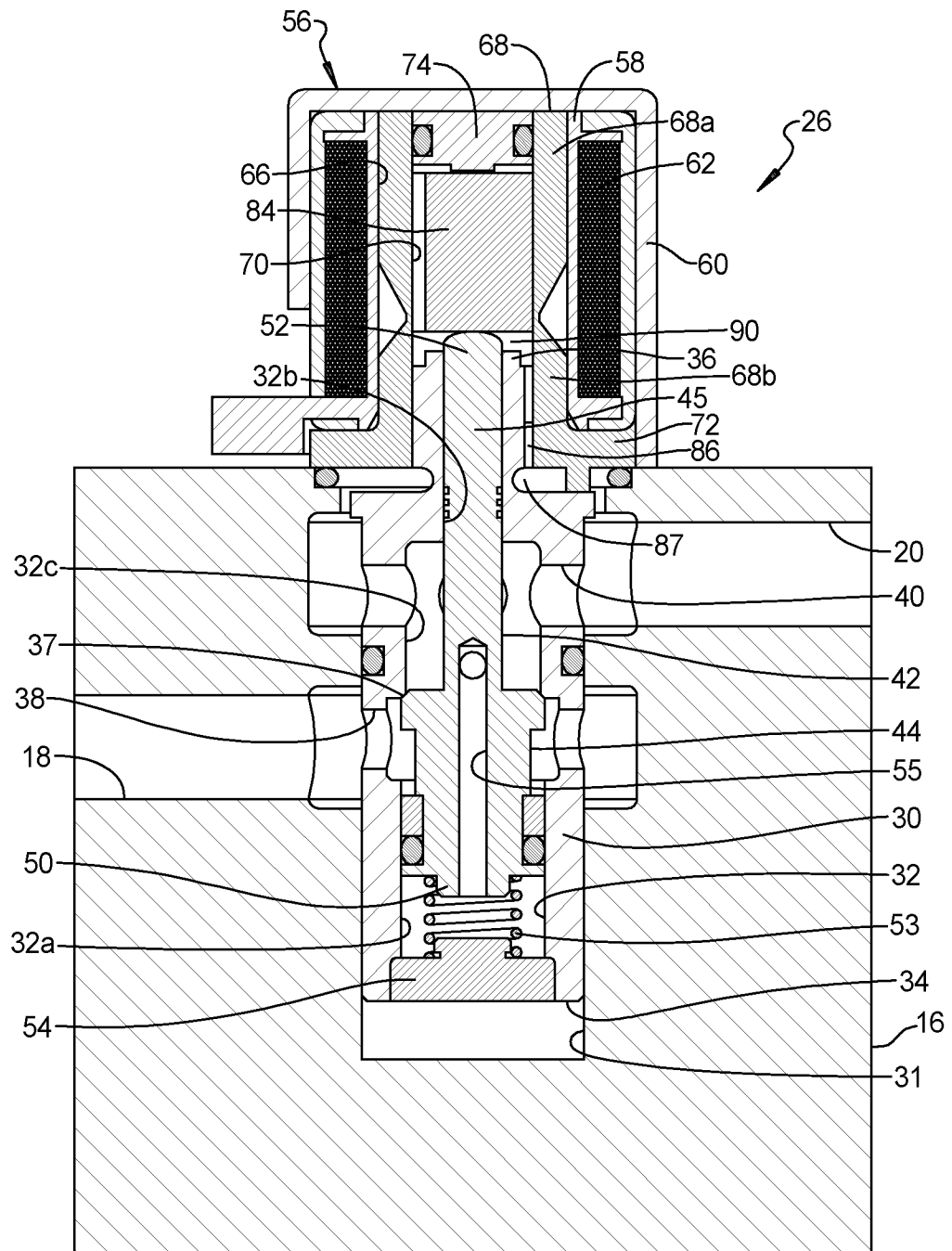


FIG 2

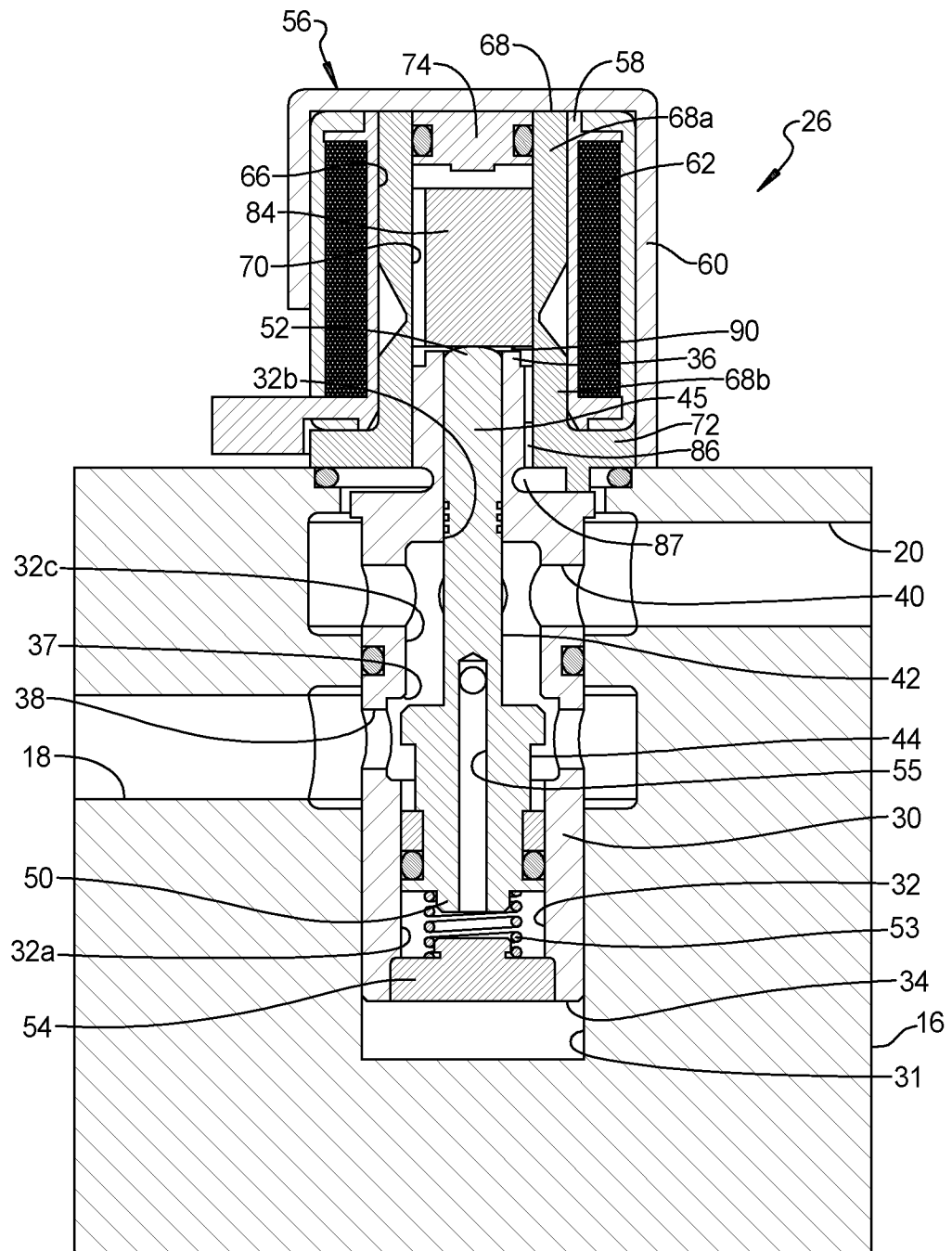
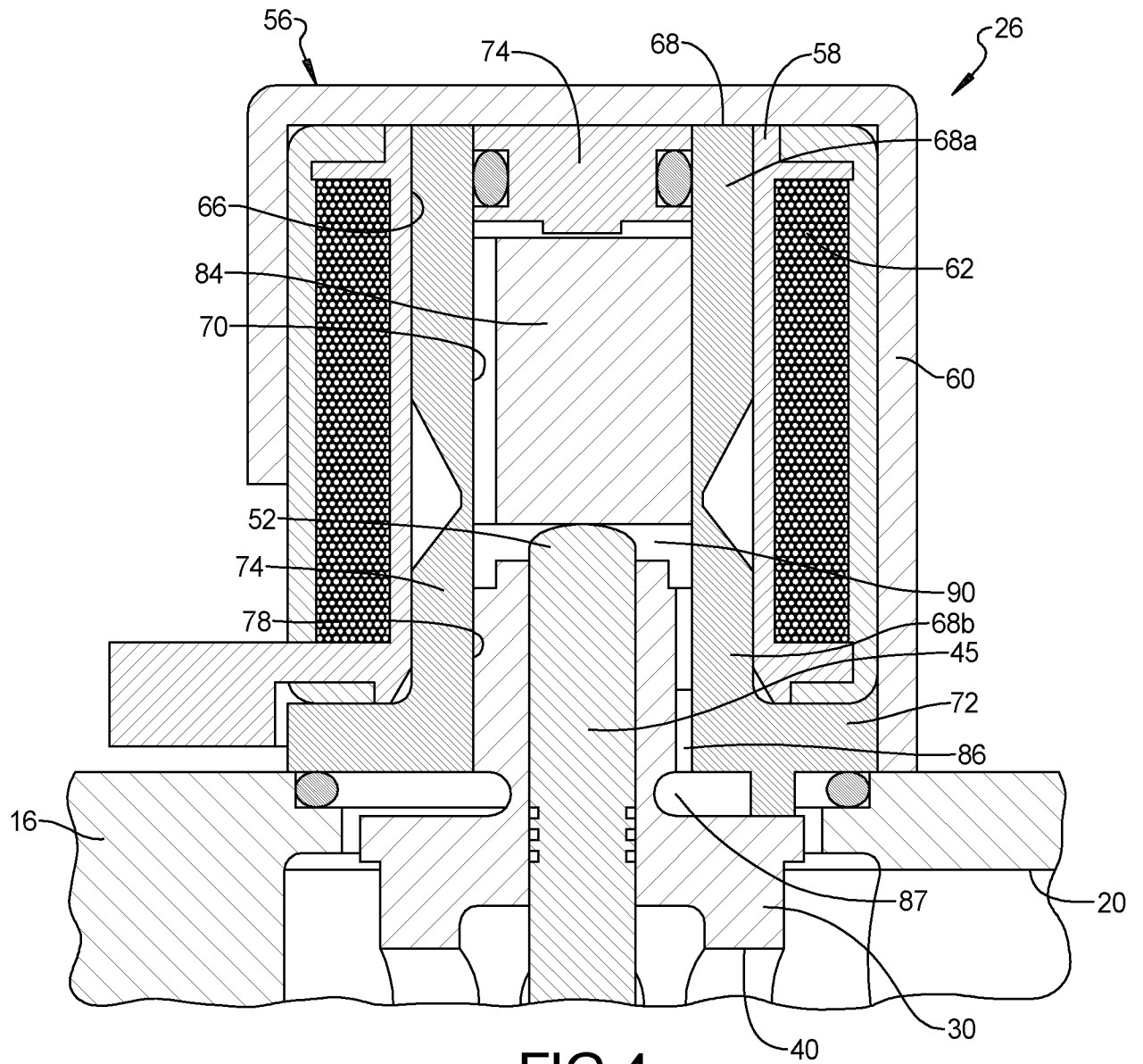


FIG 3



A. CLASSIFICATION OF SUBJECT MATTER**F16H 61/00(2006.01)i, F16K 31/06(2006.01)i, H01F 7/16(2006.01)i**

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)

F16H 61/00; F15B 13/044; F16K 31/06; G05D 7/03; F16D 39/00; F16K 15/18; H01F 7/16

Documentation 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 models

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

eKOMPASS(KIPO internal) & keywords: solenoid valve, accumulator, transverse port, transmission, coil, fluid, and sleeve

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013-0167950 A1 (NOMICHI et al.) 04 July 2013 See paragraphs [0071]–[0073], [0085], [0087] and figure 2.	1–13
Y	US 2013-0264164 A1 (OTANEZ et al.) 10 October 2013 See paragraphs [0009], [0018]–[0020] and figure 1.	1–13
Y	US 2005-0076959 A1 (YAMAMOTO, YASUSHI) 14 April 2005 See paragraphs [0028]–[0031], [0036], [0037] and figures 1, 3.	6
A	US 2015-0377376 A1 (PIERBURG G.M.B.H.) 31 December 2015 See paragraphs [0026]–[0035] and figure 1.	1–13
A	US 6405757 B1 (JABCON, LEONARD J.) 18 June 2002 See column 5, line 47 – column 6, line 58 and figure 5.	1–13



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

03 March 2017 (03.03.2017)

Date of mailing of the international search report

03 March 2017 (03.03.2017)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/036170

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