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CLUTCH CONTROL WITH INTEGRAL ACCUMULATOR DISCHARGE CONTROL

FIELD OF THE INVENTION

5 The present invention relates to control systems for a hydraulic clutch in an automatic transmission in a vehicle having a stopped vehicle engine shut-off system.

BACKGROUND OF THE INVENTION

10 Most passenger automotive vehicles and light trucks in North America have an automatic transmission. Gear shifts in the vehicle are effectuated by the opening and closing of various hydraulically powered clutches, brakes and synchronizers. Since the early 1990's, most automatic transmissions rely upon an electro-hydraulic logic system rather than simply upon hydraulically actuated logic systems to control the automatic transmission. To further fuel economy, many conventionally powered or non-hybrid
15 vehicles are provided with engine cut-off systems. In an engine cut-off system, the car engine is typically stopped when the vehicle operator stops the vehicle, be it in traffic or in response to a traffic signal. When the vehicle is stopped, typically the pump which provides a source of hydraulic pressure for the transmission is also stopped. To have an acceptable vehicle engine shut-off system, there must be a way to provide hydraulic
20 pressure to the transmission after the vehicle engine has been stopped without waiting for the engine to get up to full return speed. One way to provide immediate hydraulic pressure is to provide an electrically powered pump. An electrically powered pump is typically undesirable due to cost constraints as well as providing added weight and complexity to the automotive transmission. To allow there to be immediate pressure to
25 be supplied to the vehicle transmission, many vehicles with engine cut-off systems provide a hydraulic accumulator. It is desirable to provide an arrangement for a control system for a clutch in an automatic transmission wherein the components utilized for controlling pressure within the clutch can also be utilized in connecting the clutch with an accumulator when needed when utilizing the engine vehicle shut-off system.

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SUMMARY OF THE INVENTION

 To meet the above noted and other desires, a revelation of the present invention is brought forth. In a preferred embodiment, the present invention provides a control

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system for a clutch in an automatic transmission in a vehicle with a stopped engine cut-off system. The control system includes an accumulator hydraulically connected to the clutch via a poppet valve. A hydraulic pump is provided which is powered by the engine for pressurizing the accumulator. The hydraulic pump may be powered directly via the engine crank shaft or may be a hydraulic pump within the vehicle transmission. A check valve is provided to close off the accumulator from the hydraulic pump when the engine is cut off. An actuator is provided which may be a solenoid actuator or a hydraulic actuator controlled by a solenoid valve. A hydraulic housing having an axial bore is also provided. Connecting with the housing axial bore is a control port, exhaust port and a pressure supply port. A spool valve is slidably mounted within the hydraulic housing axial bore and is moved by the actuator. The spool valve has a first position or function connecting the control port with the exhaust port. The spool valve has a second pressure balanced position or function metering flow from the control port to the exhaust port and from the pressure supply port to the control port. The spool valve has a third position or function connecting the control port with the pressure supply port to increase the pressure in the clutch. The spool valve has a fourth extreme position or function which continues to connect the control port with the pressure supply port, but also causes an extreme end of the spool valve to displace the poppet valve that connects the accumulator with the clutch.

Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

Figure 1 is a sectional and schematic view of a control system for a clutch in a vehicle automatic transmission for a vehicle having a stopped vehicle engine-turnoff system of the present invention;

Figure 2 is a hydraulic schematic of the control system of Figure 1; and

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Figure 3 is a hydraulic schematic of an alternate preferred embodiment control system of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

5 The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

Referring to Figs. 1, 2 and 3, a control system 7 for a clutch 8 in an automatic transmission for a vehicle having a stopped vehicle engine turn off system is provided. As utilized herein, the word “clutch” also refers to other hydraulically powered
10 components such as synchronizers and brakes. The system includes a hydraulic accumulator 10. The accumulator 10 is charged by a hydraulic pump 12. The hydraulic pump 12 is powered by the vehicle engine 14. The vehicle engine 14 may power the hydraulic pump 12 off of the crank shaft or may be powered via a shaft within a transmission which is in turn powered by the engine 14. A first check valve 16 is
15 provided to close off the connection between the pump 12 and the accumulator 10 when the engine 14 is shut off.

The control system 7 also includes a solenoid powered actuator 18. The solenoid actuator 18 includes a magnetic housing or frame often referred to as a can or casing 20. The casing 20 is typically fabricated from a ferromagnetic material such as
20 steel. Mounted within the casing 20 is a bobbin 22. The bobbin 22 is typically made from a non-magnetic material such as a polymeric material such as a plastic. Wrapped around the bobbin 22 is a coil bundle shown schematically as item 24. An electrical connector (not shown) is provided to allow for connection with a transmission controller which controls current actuation of the coil 24. Positioned within the bobbin is a core or
25 flux tube 26. The flux tube 26 is magnetically connected along its top end with the casing 20 to establish magnetic continuity. The flux tube 26 along its lower end has a reduced diameter portion 28 which fits within a flux liner 30. The flux liner 30 also provides alignment for a pole piece 32. The pole piece 32 has an axial separation from the flux tube 26 commonly referred to as the flux choke 32. The pole piece 32 is also
30 fabricated from a magnetic material, typically a ferromagnetic material. An interior of the flux tube 26 and pole piece 30 can be coated with an optional thin non-magnetic material. The pole piece 32 is also provided with an integral flux washer 34. The flux washer 34 provides magnetic continuity between the pole piece 32 and the casing 20. Slidably mounted within the flux tube 26 and the pole piece 32 is a ferromagnetic

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armature 36. The armature 36 has an axially extending through bore 38 to allow for the passage of hydraulic fluid through the armature, especially in applications where the solenoid actuator 18 is in a submersible application. Positioned within an interior surface of a dome or top of the casing 20 is a stop 38 to prevent magnetic locking of the armature with the casing 20. A biasing spring directly contacting the armature 36 (not shown) may also be provided to bias the armature 36 to a predetermined axial position.

Connected with the actuator 18 is a hydraulic housing 42. The hydraulic housing 42 has a generally axial passage or bore 44. The hydraulic housing axial bore 44 has transversely intersecting exhaust port 46, first or upper control port 48, pressurized supply port 50 connected with pump 12 and second or lower control port 52. The control ports 48, 52 are fluidly connected with the clutch. At an upper end of axial bore 44, there is an upper damping and feedback chamber 54 which is connected via an orifice 56 with the upper control port 48. Adjacent an extreme end of the axial bore 44, there is a lower damping and feedback chamber 58 which via an orifice 60 is connected with the lower control port 52. Mounted in the axial bore 44 is a spool valve 62. The spool valve 62 has a reduced diameter portion or stem 64 connected with the armature 36. The spool valve 62 has a landing 66 to meter out fluid from the upper control port 48 to the exhaust port 46. The spool valve 62 also has a landing 68 to meter out hydraulic fluid from the pressurized supply port 50 to the lower control port 52. Lower damping and feedback chamber 58 and upper damping and feedback chamber 54 dampens movement of spool valve 62 and provide pressure feedback. A spring 70 is provided which biases the spool valve 62 to a normal off position wherein the clutch is essentially opened to exhaust upon non-actuation of the actuator 20. An extreme end of the spool valve 62 has a striker 65 which sealably penetrates into a passage 74. Passage 74 is fluidly connected with the control volume and additionally fluidly connected with the accumulator 10 via a poppet valve 76 having a ball 78.

In normal operation, spool valve 62 is biased to connect control port 48 with exhaust port 46 essentially placing the clutch in a (normally low) non-pressurized condition. With the car engine 14 running, the pump 12 is powered either on the engine block or via a shaft that turned by a transmission. The operation of pump 12 causes pressurized fluid to be sent to an accumulator 10 into such time that the accumulator is fully pressurized where upon check valve 16 will then close off from pump 12.

The clutch 8 controlled by the actuator 20 is normally connected with exhaust or sump via the exhaust port 46. This is the spool valve 62 first position. To pressurize the

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clutch 8, the solenoid actuator 20 is actuated by sending a current through the coil 24 causing a magnetic field to move the armature 38 downward (leftward in Fig. 1) causing the spool valve 62 to be displaced leftward against the action of spring 70 to pressurize the clutch 8. Actuator 20 is a proportional type solenoid valve and pressure within the clutch is balanced by the spool valve wherein if pressure within the clutch goes down, the spool valve 62 is displaced to the left causing the pressurized supply port 50 to be connected with the lower control port 52 to restore the pressure to the desired amount. Conversely if pressure within the clutch 8 is too high the pressure within chamber 58 acting on the total diameter of the spool valve overcomes the pressure in chamber 54 acting on a partial diameter of the spool valve causing the spool valve to be displaced upwardly (rightward in Fig. 1) thereby causing the control port 48 to be connected with the exhaust port 46 until the pressure within the clutch 8 connected with the control port(s) reaches a desired equilibrium pressure. In this second pressure balanced position, the spool valve 62 is metering the pressure within the clutch 8. Upon a desire to partially or fully pressurize the clutch 8, a greater current is sent through the coil 24 causing the armature 36 to be displaced to the clutch fill position allowing greater flow from the supply port 50 to the lower control port 52. The pressurizing position is the spool valve 62 third position.

When the vehicle of the transmission that the control system 7 is utilized for comes to a stop, to save on fuel economy, the engine is turned off. When the vehicle is to be restarted, the clutch 8 needs to be pressurized (assuming it is not already pressurized). The solenoid actuator will displace the spool valve 62 leftward causing the pressurized supply port to communicate with the lower control port 52. As a pump starts up, some initial flow may be transferred; however, typically this is not fast enough for optimum vehicle performance. Therefore, the solenoid actuator displaces the spool valve 62 further leftward to a fourth extreme position causing the striker 65 to displace poppet ball 78 to allow for the accumulator 10 to dump into the clutch 8 to provide instant response.

Referring to Fig. 3, an alternate preferred embodiment control system 207 according to the present invention is provided. In the control system shown schematically in Fig. 3, a hydraulic actuator 242 is provided and substitution for the solenoid actuator 20, as described previously in Figs. 1 and 2. A proportional solenoid valve 218 provides a master function for a slave hydraulic actuator and valve 242. The remainder of the control system 207 operates on a manner as similarly described.

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The description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.

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CLAIMS

What is claimed is:

1. A control system for a clutch in a vehicle automatic transmission for a vehicle having a stopped vehicle engine turn-off system, said control system
5 comprising:
a hydraulic accumulator;
a hydraulic pump mechanically powered by the engine for pressuring said accumulator;
a check valve to close off said hydraulic accumulator from said hydraulic pump
10 when the engine is cut-off;
a poppet valve to close off said hydraulic accumulator from the clutch of the transmission;
an actuator;
an exhaust; and
15 a valve moved by said actuator, said valve having a first position connecting said clutch with said exhaust , said valve having a second balanced position selectively connecting said clutch with said pump and said exhaust, said valve having a third position to connect said clutch with said pump to increase a pressure within said clutch, said valve having a forth extreme position to continue connecting said pump with said
20 clutch wherein an extreme end of said valve is a striker to open said poppet valve to connect said accumulator with said clutch.
2. A control system for a clutch in a vehicle automatic transmission for a vehicle having a stopped vehicle engine turn-off system, said control system comprising:
25 a hydraulic accumulator;
a hydraulic pump mechanically powered by the engine for pressuring said accumulator;
a check valve to close off said hydraulic accumulator from said hydraulic pump when the engine is cut-off;
30 a poppet valve to close off said hydraulic accumulator from the clutch of the transmission;
an actuator;

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a hydraulic housing, said housing having an axial bore and said housing having connecting with said axial bore, a control port connected with said clutch, an exhaust port, and a pressure supply port connected with said pump; and

5 a spool valve slidably mounted within said axial bore and moved by said actuator, said spool valve having a first position connecting said control port with said exhaust port, said spool valve having a second balanced position selectively connecting said control port with said pressure supply ports and said exhaust port, said spool valve having a third position to connect said control port with said pressure supply port to increase a pressure within said clutch, said spool valve having a forth third extreme
10 position to continue connecting said pressure supply port with said control wherein an extreme end of said spool valve is a striker to open said poppet valve to connect said accumulator with said clutch.

3. A control system as described in one or more of the preceding or following
15 claims wherein said actuator is a solenoid actuator.

4. A control system as described in one or more of the preceding or following claims wherein said actuator is a hydraulic actuator.

20 5. A control system as described in one or more of the preceding or following claims wherein said housing has two axially spaced intersecting control ports.

6. A control system as described in one or more of the preceding or following claims wherein said spool valve is pressure dampened by control pressure at upper and
25 lower ends of said axial bore.

7. A method of controlling a clutch in a vehicle automatic transmission for a vehicle having a stopped vehicle engine turn-off system, said method comprising:
providing a hydraulic accumulator;
30 providing a pump mechanically powered by the engine for pressurizing the accumulator;
providing a check valve to close off the hydraulic accumulator from the hydraulic pump when the engine is cut-off;

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providing a poppet valve to close off the hydraulic accumulator from the clutch of the transmission;

providing an actuator; and

5 providing the hydraulic housing having an axial bore and having connected with the axial bore a control port connecting with the clutch, an exhaust port, and a pressure supply port connected with the pump and slidably mounting within the axial bore, a spool valve biased to a first position connecting said control port with said exhaust port and moving the spool valve with the actuator to a second balanced position for selectively metering flow between the control port and said exhaust port and between
10 said control port and the said pressure supply port, and utilizing the actuator to move the valve spool to a third position connecting said control port with said pressure supply port, and utilizing the actuator to move the spool valve to a fourth extreme position continually connecting said control port with said pressure supply port and additionally, physically displacing a valve member within said poppet valve connecting said
15 accumulator with said clutch to allow said accumulator to dump into said clutch.

8. A method as described in claim 7 utilizing a proportional type solenoid valve as said actuator.

20 9. A method as described in claim 7 utilizing a master solenoid valve via a slave hydraulic actuator to move said spool valve.

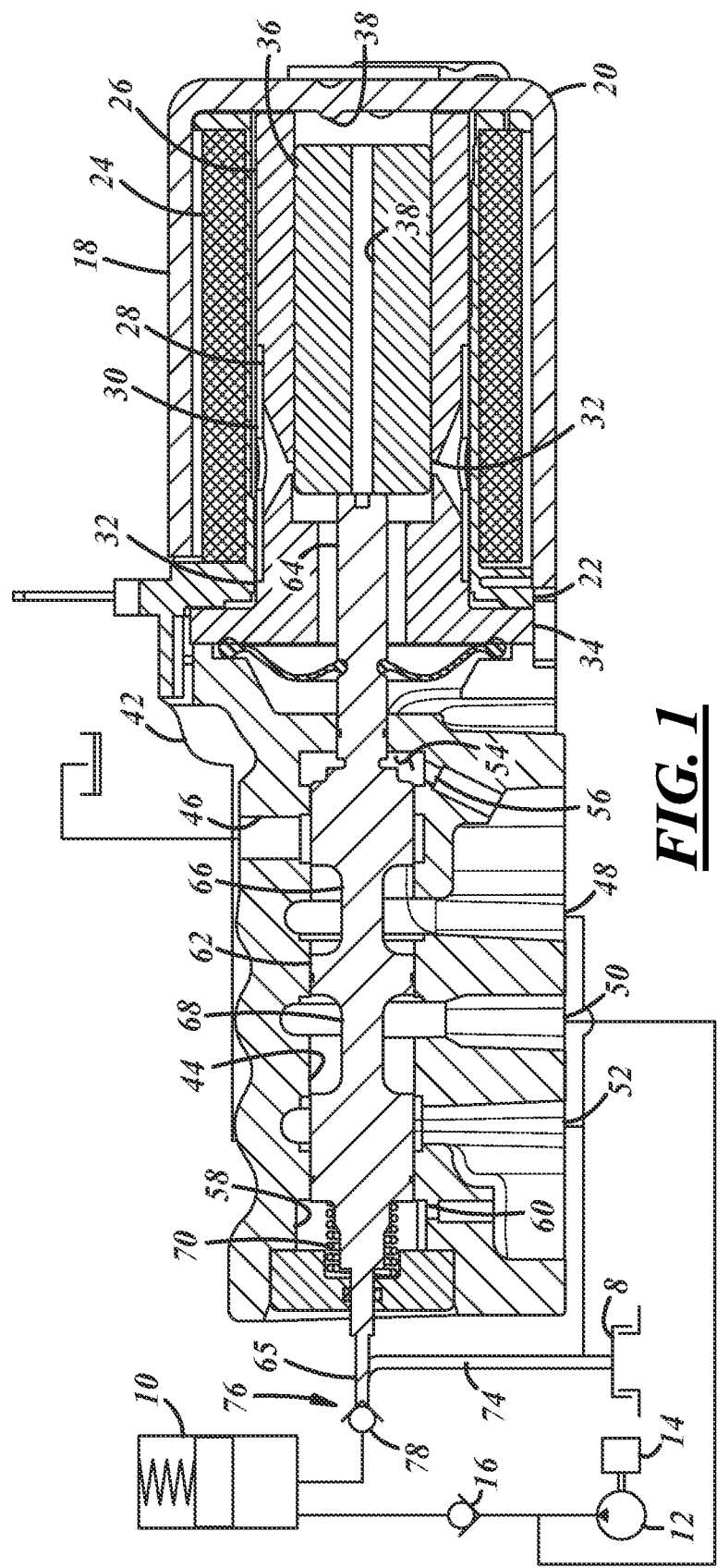


FIG. 1

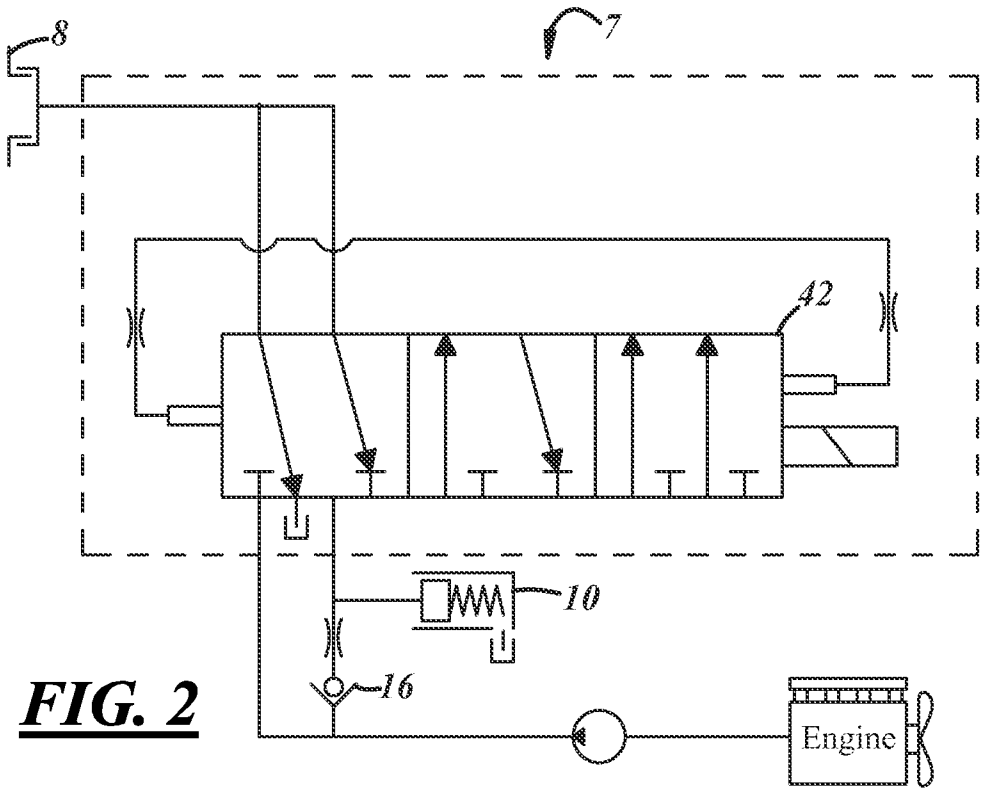


FIG. 2

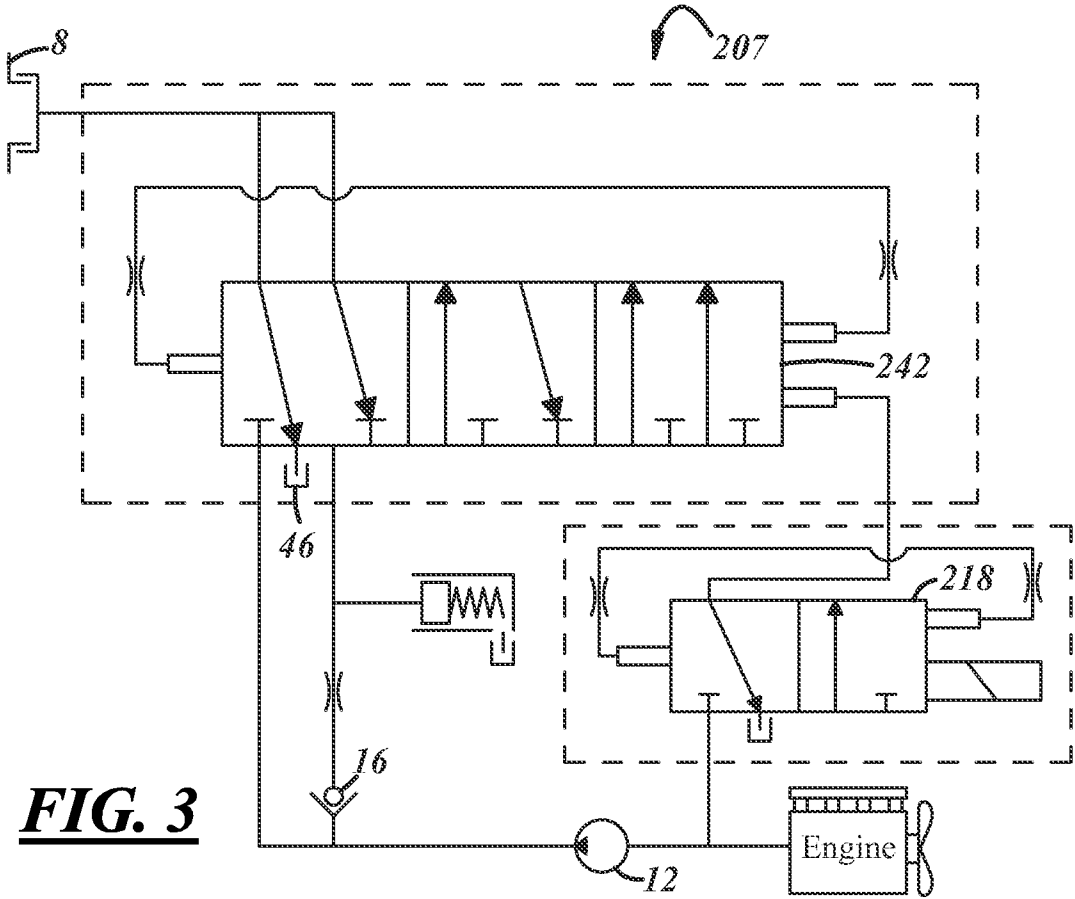


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/029201**A. CLASSIFICATION OF SUBJECT MATTER****F16H 61/08(2006.01)i, F16H 61/433(2010.01)i, F16H 45/02(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 61/08; F15B 9/00; B60W 10/04; B60W 10/02; F16D 29/00; F16D 71/00; F16H 61/433; F16H 45/02

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: idle stop, clutch, pump, accumulator, check valve, poppet valve, and solenoid

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2013-0232962 A1 (GM GLOBAL TECHNOLOGY OPERATIONS L.L.C.) 12 September 2013 See paragraphs [0007], [0021], [0022], [0028], [0031], [0037] and figures 1, 2.	1-9
A	US 2013-0118854 A1 (GM GLOBAL TECHNOLOGY OPERATIONS L.L.C.) 16 May 2013 See paragraphs [0030], [0031], [0034], [0035], [0044] and figure 2A.	1-9
A	US 2013-0116898 A1 (LUNDBERG et al.) 09 May 2013 See paragraphs [0021], [0023] and figures 1, 2.	1-9
A	US 2008-0064569 A1 (BAXTER et al.) 13 March 2008 See paragraph [0022] and figures 1, 3.	1-9
A	US 2008-0277239 A1 (GASSMANN et al.) 13 November 2008 See paragraph [0033] and figure 7.	1-9



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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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

"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

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/029201

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