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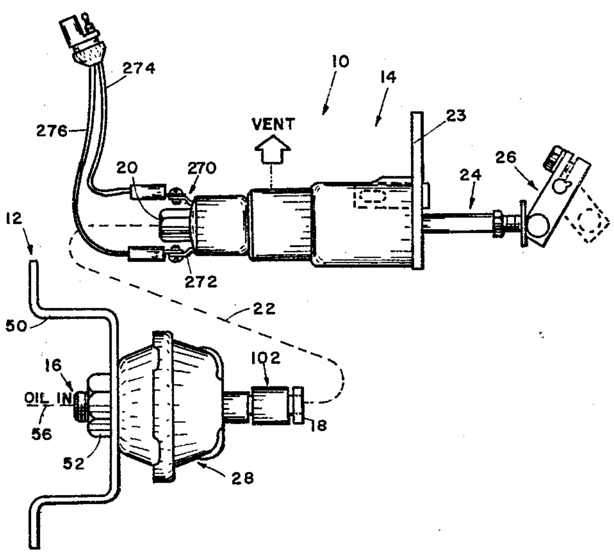
(54) **An actuator for use in an engine protection or shutdown system and a shutdown system for an internal combustion engine.**

(57) An actuator (14) for use in an engine protection or shutdown system, connectable to a source of fluid under pressure (12), which has a body (170) defining a chamber (172), an inlet port (29) and a vent port (224), and a cup-shaped piston (188) and rolling diaphragm (194) connected to a rod which is electrically actuated by a solenoid valve (240) to selectively move the rod from a first to a second position, to selectively connect the source of fluid to the vent port or the inlet port thus causing a shift between a shutdown and a run position. The invention extends to a shutdown system for an internal combustion engine including such an actuator in which the source of pressurized fluid may also include fluid control means (102) and pressure regulating valve means (296).



EP 0 094 249 A2

AN ACTUATOR FOR USE IN AN ENGINE PROTECTION OR SHUTDOWN SYSTEM AND A SHUTDOWN SYSTEM FOR AN INTERNAL COMBUSTION ENGINE.

The present invention relates to an acutator for use in an engine protection or shutdown system and a shutdown system for an internal combustion engine.

Compression ignition or diesel engines have fuel systems which inject or spray fuel into the engine cylinder at the end of a compression stroke. The air which enters the cylinder during the intake stroke is compressed and heated to a sufficiently high temperature to spontaneously ignite the fuel injected into the cylinder. Since compression ignition engines do not include electrical ignition systems as found on Otto-cycle engines, for example, they are turned off or shut down by controlling the injection of fuel into the cylinder.

Typical shutdown systems heretofore provided have been manually or electromechanically actuated. Prior electromechanical systems use a relatively large and expensive solenoid actuator which has a high amperage draw. It is desirable to employ an electrically actuated mechanism to shut down and start the engine since such mechanism may be tied to a key switch to prevent unauthorised operation of the engine.

Engine protection systems are also available which produce an output signal in response to a low oil pressure or a high engine temperature condition. The output signal of such protection systems is desirably used to actuate automatically the fuel shut-off solenoid. However, since typical diesel shutdown systems employ a high amperage draw solenoid, they are not readily incorporated into such existing engine protection systems. An example of an available engine protection systmem may be found in commonly owned U. S. Patent No. 3,602,207, entitled AUTOMATIC OVERRIDE FOR ENGINE SAFETY SHUTDOWN SYSTEMS and issued on August 31, 1971 to Kilmer.

A need exists for a relatively inexpensive, reliable, low amperage draw systme for shutdown of a compression ignition engine, which is usable when compressed air or vacuum are not available, and which may be tied into available engine protection systems.

According to a first aspect of the present invention an actuator for use in an engine protection or shutdown system and connectable to a source of fluid under pressure, characterised in that the acutator comprises: a body defining a chamber, an inlet port and a vent port, the ports opening into the chamber, a shiftable member disposed within the chamber and having a surface exposed to the inlet port and another surface exposed to atmosphere; an elongated rod extending into the chamber and being connected to the shiftable member; and an electrically actuated means on the body for selectively connecting the source of fluid to the inlet port to pressurize the chamber to shift the member and for opening the vent port to vent the chamber to atmosphere.

According to a second aspect of the present invention a shutdown system for an internal combustion engine in which the engine comprises a shutdown system for an internal combustion engine, the system comprising: a source of pressurized fluid; and an electromechanical actuator means connected to the source of pressurized fluid for shifting a control rod between a run position and a shutdown position, the actuator means including: a housing defining an inlet port at one end and a chamber, the control rod extending through an end of the housing opposite the inlet port and into the chamber, the inlet port being connected to the source of fluid; an expansible motor means within the chamber and connected to the rod for shifting said rod between the run and shutdown positions; and electrically actuated vent means on the housing for selectively opening and closing the inlet port and for venting fluid under pressure within the chamber to cause the motor means to shift the rod between the first and second position.

The actuator and shutdown systems in accordance with the present invention is readily incorporated into other engine protection systems due to the low amperage requirements of the electrically actuated means suitabley a solenoid vale. A relatively inexpensive, low amperage draw solenoid in combination with the source of fluid under pressure can replace the relatively expensive, large and high amperage draw fuel shut-off solenoids heretofore employed. The system and actuator are reliable in use and are relatively inexpensively manufactured and readily added to existing engines.

The invention may be put into practice in various ways and an actuator and two engine protection or shutdown systems according to the present invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is an elevational view of an engine protection or shutdown system;

Figure 2 is a left end, elevational view of a pressure chamber incorporating the engine protection or shutdown system of Figure 1;

Figure 3 is a right end, elevational view of the pressure chamber of Figure 2;

Figure 4 is a fragmentary, cross-sectional view taken generally along line IV - IV of Figure 3;

Figure 5 is a top, plan view of a fluid control means incorporated in the engine protection or shutdown system of Figure 1;

Figure 6 is a cross-sectional view taken generally along line VI - VI of Figure 5;

Figure 7 is an end, elevational view taken of the actuator incorporated in the engine protection or shutdown system of Figure 1;

Figure 8 is a fragmentary, cross-sectional view of the actuator taken generally along line VIII - VIII of Figure 7;

Figure 9 is an enlarge elevational view of the shiftable plunger or valve element included in the actuator of Figures 7 and 8;

Figure 10 is an elevational view of an alternative engine protection or shutdown system; and

Figure 11 is a cross-sectional view taken generally along line XI - XI of Figure 10.

A preferred embodiment of an engine shutdown system in accordance with the present invention is illustrated in Figure 1 and generally designated 10. The system 10 includes a source of pressurized fluid 12 and an actuator 14. As illustrated, the source of pressurized fluid 12 includes an inlet 16 connectable to the lubricating system of the engine and an outlet 18. The outlet 18 is connected to an inlet 20 of the actuator 14 by a suitable line or hose designated 22.

The actuator 14 is mounted at a suitable location on or adjacent a compression ignition engine by a mounting flange 23. The actuator 14 includes an elongated rod assembly 24 which is adapted to pivot a lever assembly 26 from a run position illustrated in solid lines to a shutdown position illustrated in phantom in Figure 1. The lever assembly 26 controls the fuel flow to the internal combustion engine. When in the run position, fuel is permitted to flow to the injector nozzles. When in the shutdown position the fuel flow is cut off in a conventional fashion.

The source of fluid under pressure includes a pressure chamber 28 which is best seen in Figures 2, 3, and 4. The chamber 28 includes a housing 30 defined by a first cupshaped member or half 32 and a second cup-shaped member or half 34. The half 32 includes a base portion or bottom 36, a peripheral sidewall 38 and a flange 40. The base 36 has an inlet boss 42 joined hereto. The inlet boss 42 defines an inlet bore 44 which is axially aligned with an inlet aperture 46 in the base or 36. The boss 42 includes external threads 48. As seen in Figure 1, the pressure chamber 28 is secured to a mounting bracket 50 by a nut 52 threaded on the boss 42. The bore 44 is internally threaded at 54. The boss 42 is coupled to a hydraulic line schematically shown in Figure 1 and designated by the numeral 56. The line 56 is connected to the engine oil system.

The housing half 34 includes a base 60, a peripheral sidewall 62, a peripheral flange 64 and a skirt 66. Disposed within the chamber defined by the housing 30 is a cup-shaped diaphragm 70. The diaphragm 70 includes a central portion 72 and a peripheral bead 74. The bead 74 is clamped between the flange 40 of the housing half 32 and the flange 64 of the housing half 34. As seen in Figures 2 and 4, the skirt 66 of the half 34 is crimped at four locations 76 against the flange 40. As a result, the bead 74 is clamped between the flanges and a seal is achieved between the housing halves.

A surface 80 of the diaphragm 70 is exposed to an outlet port 82 defined by the housing half 34. A boss 84 is secured to the surface or base 60. The boss 84 defines an outlet passage or bore 86. Disposed between an inner surface of base 60 and the surface 80 of the diaphragm is a coil spring 90. The coil spring 90 biases the diaphragm 70 to a first or initial position wherein a surface 92 is adjacent the inlet 46. As should be readily apparent, when oil under pressure enters the inlet 46, the diaphragm 70 will shift toward the outlet 82 against the bias of the spring 90. Air within the pressure chamber between the surface 80 of the diaphragm and the outlet 82 and air within the line 22 will be compressed.

A flow control generally designated 102 is positioned in-line with the outlet 82 and the line 22.

As best seen in Figures 5 and 6, the flow control means 102 includes a machined body 104 defining an elongated passage 106. The passage 106 opens through an externally threaded inlet boss 108. As seen in Figure 4, the body 104 is secured to the outlet boss 84 of the pressure chamber 28 by the mating of external threads 110 and the internally threaded bore of the boss 84. The passage 106 is, therefore, coaxial with the outlet bore 86 of the chamber.

As seen in Figure 6, the body 104 defines an outlet recess or check valve chamber 114 which is axially aligned with the passage 106. The body 104 also defines a breather chamber 116 which is at right angles to the passage 106. Disposed within the chamber 114 is a generally circular disc 118. The disc 118 is held against a shoulder 120 defined by the body and by an end cap 122. The cap 122 includes a head 124 and a threaded hub 126. Disposed between the hub 126 and the disc 118 is an O-ring seal 128. The cap 122 clamps the disc 118 to the body. The disc 118 defines a plurality of flow holes or apertures 130 and a central aperture 132. Slidably supported within the central aperutre 132 is an umbrella seal or check valve element 134. The check valve element 134 includes a generally circular portion 136 which has a concave surface facing the disc 118 and a central shaft or post 138 which extends through the central aperture 132. The shaft 138 has an enlarged portion 140.

As should be readily apparent, air or other fluid flowing in the direction of Arrow A in Figure 6 will pass through the passage 106, through the holes 130 in the disc 118 and then through an outlet port 142 defined by the cap 122. The check valve element 134 can shift to the left, when viewed in Figure 6, and seat against the disc 118, thereby closing off the holes 130. The check valve element 134, therefore, prevents reverse flow of fluid back through the body 104 to the pressure chamber 28.

Disposed within the chamber 116 is another check valve including a disc 118 and an umbrella seal or check valve element 134. The disc 118 within the chamber 116 is clamped to the body 104 by a cap 150. The cap 150 includes a hub 152 which is threaded to the body. The hub 152 defines an atmospheric breather port or bore 154. Supported on the cap 150 is a filter 156.

As should be readily apparent, when fluid is flowing in the direction of Arrow A, a check valve element 134 at chamber 116 prevents flow of air out of the breather port 154. When oil pressure to the inlet 46 of the pressure chamber 28 is reduced below the bias of the spring 90 and the diaphragm 70 is shifted towards the chamber inlet port, the check valve element 134 will shift and permit air at atmospheric pressure to pass through the breather passage, the holes 130 and the chamber 116,into the passage 106 and thence into the pressure chamber 28. This replenishes the usable air supply at the pressure chamber anytime the pressure in this chamber drops below atmospheric pressure. As explaiined in more detail below, this enables a start/shutdown/restart cycle to be repeated.

The actuator assembly 14 is best seen in Figure 7 and 8. As shown therein, the actuator assembly 14 includes a two-piece housing or body 170 which defines an actuator chamber or bore 172 of an expansible motor 174. A housing member 176 includes a base 178 defining a bore 180. Positioned within the bore 180 is a guide bushing 182. The rod assembly 24 includes an elongated rod member 184 which extends through the guide bushing 182 into the chamber 172. An aperture 183 defined by the housing member 176 vents that portion of the chamber 172 adjacent the bushing to atmoshpere.

The rod 184 is secured at an end 186 to a cup-shaped piston 188 of the motor 174. The piston 188 includes a head 190 and a skirt 192. The motor 174 further includes a cup-shaped rolling diaphragm 194 having a central area 196. The central area 196 is clamped to the piston head 190 by a retainer 198 and a suitable fastener 200. A seal 201 is disposed between the fastener and the retainer. The fastener 200, as seen in Figure 8, also threads into an internally threaded bore 202 in the rod 184. The diaphragm 194 further includes a peripheral bead 206. The bead 206 is clamped against a shoulder 208 of the body half 176 by a body half 212. The half 212 includes a peripheral flange 214. The body half 176 is swaged around flange 214 to join the halves and sealingly clamp the peripheral bead 206 of the rolling diaphragm 194. A coil spring 217 within the chamber 172 engages the piston 188 biasing the piston and the rod to the run position.

The body half 212 defines an inlet bore 220. Extending across the inlet bore 220 is a bridging member 222. The bridging member 222 defines a vent port 224 which opens through the outer surface of the body half 212 and which is connected to a vent bore 226. A seat 228 is defined by the bridging member 222 at the inlet to the vent bore 226.

An electrically actuated means in the form of a solenoid valve 240 controls flow of pressurized air into the chamber 172 and out the vent port. As shown in Figure 8, the solenoid valve 240 includes a housing 242 within which the conventional solenoid coil (not shown) is disposed. The housing 242 defines an inlet boss 244 which in turn defines an inlet passage 246. The passage 246 is axially aligned with the inlet 20 of the actuator. The solenoid 240 includes a plunger recess or chamber within which a valve plunger or core rod 250 is slidably disposed. The bore 246 opens into the plunger chamber 248. The core rod 250 is generally cylindrical in shape and defines a plurality of radially opening, axially extending slots 252, a front face 254 and a rear face 256. A flange 258 surrounds the front face 254. A coil spring 260 has an end which abuts the flange 258 and an end which abuts the shoulder of the plunger chamber 248. As a result, the spring 260 biases the core rod 250 so that the front face 254 sealingly engages the seat 228.

When the solenoid is deactivated, the vent port 224 is closed and fluid under pressure may enter the inlet 20, flow through the inlet passage 246 and into the plunger chamber 248. Fluid will then pass through the slots 252 and into the inlet bore 220 of the housing half 212. Fluid under pressure, therefore, acting against the rolling diaphragm 194 will shift the actuator rod 184 agains the bias of the spring 217. The rod 184 will shift from the run position to the shutdown position illustrated in Figure 1.

When the solenoid is actuated, the core rod or plunger element 250 will shift downwardly, when viewed in Figure 8, closing off the inlet passage 246 and opening the pressurized portion of the actuator chamber 172 to atmosphere through the vent port 224. The spring 217 returns the rod 184 to the run position.

As seen in Figure 1, terminals 270, 272 of the solenoid actuator 240 may be connected by suitable wires 274, 276 to a key switch for the engine.

In use the pressure chamber 28 is supported at a suitable point adjacent the engine. The inlet 16 is connected to the oil lubricating system of the engine. The actuator 14 is supported adjacent the engine with the rod assembly 24 engaging the lever assembly 26. A threadably adjustable end plate 280 of the rod assembly 24 is positioned to properly shift the lever assembly 26 between the run and the shutdown positions. To achieve engine start-up, the key switch is turned on, thereby actuating the solenoid valve 240. The plunger 250 is shifted to close off the inlet passage 246 and open the chamber 172 to atmosphere through the vent port 224. The rod 184 is shifted under the bias of the spring 217 to the run position. Upon engine start-up, the engine oil under pressure will enter the pressure chamber 28 through the inlet 16. This shifts the diaphragm 70 within the chamber 28 to compress the air within the chamber and within the line 22 connecting the chamber with the inlet port 20 of the actuator 14. A source of compressed air or pressurized fluid is, therefore, provided for engine shutdown.

When engine shutdown is desired, the solenoid is deactivated and the plunger shifts under the bias of the spring 260. The inlet passage 246 is opened and the vent bore 226 is closed. Compressed air generated by the pressure chamber 28 then passes into the chamber 172 causing the diaphragm to shift the actuator rod 184 into the shutdown position.

The diaphragm 194 is a rolling diaphragm which is essentially friction free. The diaphragm rolls on the inner peripheral surface of the chamber and the outer peripheral surface of the skirt piston. The friction-free nature of operation reduces the pressure requirements to shift the rod 184 and the lever assembly from the run to the shutdown position. The fluid control means 102 in the in line check valve prevents the pressurized fluid within the chamber 172 from flowing in reverse manner to the pressure chamber 28 when the oil pressure drops at the inlet 16. This maintains the system in the shutdown position. The check valve assembly within the breather chamber 116 permits atmospheric air to enter the pressure chamber to replenish the usable air supply within the chamber. In order to restart the engine, the cycle is merely repeated.

A relatively small and low amperage solenoid valve 240 controls the positioning of the actuator rod assembley 24. This small solenoid has a significantly reduced amperage draw when compared to prior fuel shut-off solenoids. The system is significantly less expensive than those heretofore provided. Further, the low amperage draw requirements of the solenoid valve permit the shut-down actuator to be incorporated directly into electromechanical engine protection systems without the need for a relay.

The system in accordance with the present invention is easily manufactured employing conventional materials. The pressure chamber diaphragm, for example, may be fabricated from an oil resistant rubber which meets S.A.E. Specification SC-518 and which withstands 862 KPa (125 PSI) without leakage. A suitable rubber is that sold under the brand name Johnson Compound 1758. The pressure chamber body halves may be stamped from suitable metal materials. The fluid control means 102 may be machined from a suitable material such as brass square stock or hex stock. The filter element 157 may be a coin sintered bronze material. The solenoid valve 240 should be vibration resistant and capable of operating continuously in an ambient temperature of 126.7°C (250°F), at a full voltage rating of 14 volts DC. The ambient temperature rating is preferably in the -40°C to 126.7°C (-40°F to 250°F) range. Such a solenoid valve is a commercially available item.

A shutdown system according to the present invention is full operable without an independent air pump or source of compressed air, The operating fluid is obtained hydraulically through the pressure chamber interconnection with the engine lubricating system.

An alternative embodiment of the shutdown system in accordance with the present invention is illustrated in Figure 10 designated 10'. The system 10' includes the actuator assembly 14 of the Figure 1 embodiment. The system 10' differs from the system 10 in that the source of fluid is obtained from the engine fuel system. The source of fluid for the system 10' is designated by the numeral 290. The source 290 includes a line 292 connected to the fuel return line of the engine fuel system. The line 292 is connected to an inlet 294 of a pressure regulating valve 296. The valve 296 includes an outlet 298 which is connected by a line 300 to the inlet 20 of the actuator 14. The vent port 224 of the actuator is connected by a line 302 to the fuel return line of the engine.

As best seen in Figure 11, the pressure regulating valve 294 includes a first member 310 having an externally threaded hub 312 which defines the inlet 294. The member 310 is threaded to a second body member 314. The member 314 defines the outlet 298. The members 310 and 314 define a valve chamber 316. Disposed within the valve chamber 316 is a coil spring 318 and a valve element 320. The valve element 320 is biased towards a seat 322 by the spring 318 which engages a shoulder 324 defined by the body member 314. Fuel under pressure entering the inlet port 294 shifts the valve element 320 off the seat 322. The valve 296 regulates fuel flow to maintain a desired minimum operating fluid pressure at the inlet port 20. It is presently preferred that the pressure regulating valve 296 provide a 138 KPA (20 P.S.I) minimum fuel pressure to the inlet port.

The system 10' incorporating the pressure regulating valve 296 also permits the shutdown system to be readily incorporated in a variety of internal combustion engines. With either the system 10 or the system 10', a fluid under pressure is used to shift the actuator assembly 24 to a shutdown position.

Various modifications are also possible, for example, a pressurized fluid source other than the pressure chamber or fuel system described could be used. For example, the actuator could be connected to an air accumulator if such exists on the vehicle or engine.

CLAIMS

1. An actuator (14) for use in an engine protection or shutdown system (10) and connectable to a source of fluid under pressure (12) characterised in that the actuator comprises; a body (170) defining a chamber (172) an inlet port (20) and a vent port (224), the ports opening into the chamber; a shiftable member (24) disposed within the chamber and having a surface exposed to the inlet port and another surface exposed to the atmosphere; an elongated rod (184) extending into the chamber and being connected to the shiftable member; and an electrically actuated means on the body for selectively connecting the source of fluid to the inlet port to pressurize the chamber to shift the member and for opening the vent port to vent the chamber to atmosphere.

2. An actuator as claimed in claim 1 in which the shiftable member comprises; a cup-shaped piston (188), a rolling diaphragm (194) having a central area secured to the piston and the rod and a peripheral bead (206) secured to the body and spring means (217) with the chamber and engaging the piston at the surface exposed to atmosphere for biasing the rod to a first position, the rod shifting to a second position against the bias of the spring when the inlet port is connected to the source of fluid.

3. An actuator as claimed in claim 2 in which an adjustable plate (280) is threadably secured to an end of the rod opposite the piston.

4. An actuator as claimed in claim 1,2, or 3 in which a guide bushing (182) carried by the body and encircling the rod.

5. An actuator as claimed in any one of the preceding claims in which the electrically actuated means comprises; a solenoid valve (240) having an inlet (246) and a spring loaded plunger (250), the plunger being shiftable from a first position at which the inlet communicates with the inlet port of the body to a second position closing off the inlet, the body further defining a vent bore (226) opening to atmosphere through the vent port (224) and a seat (228) at the vent bore engagable by the plunger when in the first position, the vent bore being placed in communication with the chamber when the plunger is in the second position.

6. A shutdown system for an internal combustion engine characterised in that the system comprises; a source of pressurized fluid (12) and an electromechanical actuator means (14) connected to the source of pressurized fluid for shifting a control rod (184) between a run position and a shutdown position, the actuator means including; a housing (170) defining an inlet port (20) at one end and a chamber (172) the control rod extending through an end of the housing opposite the inlet port and into the chamber, the inlet port being

connected to the source of fluid; an expansible motor means (174) within the chamber and connected to the rod for shifting the rod between the rod and shutdown positions; and electrically actuated vent means on the housing for selectively opening and closing the inlet port and for venting fluid under pressure within the chamber to cause the motor means to shift the rod between the first and second positions.

7. A shutdown system as claimed in claim 6 in which the expansible motor means comprises; a piston (188) having a skirt (192) and a head (190), the rod being connected to the head; and a rolling diaphragm (194) having a central area connected to the piston head and a peripheral bead (206) secured to the housing so that fluid under pressure acts on the diaphragm to shift the piston within the chamber and the diaphragm rolls on the piston skirt and an inner peripheral wall of the chamber.

8. A shutdown system as claimed in claim 6 or 7 in which the vent means comprises; a solenoid valve (240) having a spring loaded plunger (250), the solenoid valve shifting the plunger from a shutdown position to a run position upon actuation, the housing defining a vent bore (226) opening to atmosphere and a seat (228) at the bore engaged by the plunger, the vent bore being placed in communication with the chamber upon actuation of the solenoid.

9. A shutdown system as claimed in claim 6, 7, or 8 in which the expansible motor means includes; spring means within the chamber and engaging the piston for biasing the piston to the run position of the rod.

10. A shutdown system as claimed in any one of claims 6 to 9 in which the vent means further defines an inlet bore (226) connected to the source of fluid, the plunger closing off the inlet bore the said plunger is in its run position and opening the inlet bore and closing the vent bore when the solenoid is deactivated and the plunger is in its shutdown position so that fluid under pressure flows through the inlet bore and the inlet port into the chamber.

11. A shutdown system as claimed in any one of claims 6 to 10 in which the source of pressurized fluid further includes; fluid control means(102) connected to the outlet port of the housing, the fluid control means including; a first check valve(114), communicating with atmosphere to permit air to flow into the pressure chamber through the outlet port when the diaphragm shifts to the first position; and a second check valve (114) which permits air under pressure to flow to the vent when the diaphragm moves to the second position and which prevents the flow to the pressure chamber from the vent means when the diaphragm moves to the first position.

12. A shutdown system as claimed in claim 11 in which the first and second check valves (114) each comprise; a disc (118) defining at least one aperture (130) therethrough; and an umbrella-shaped seal (134) including a post (138) extending through the disc, the seal being shiftable from a first position permitting flow through the aperture to a second position closing off the aperture and preventing reverse flow through the check valve.

13. A shutdown system as claimed in claim 11 or 12 in which the source of pressurized fluid (290) comprises; pressure regulating valve means (296) having an inlet (294) connectable to an engine fuel line (292) and an outlet (298) connected to the inlet bore of the vent means for connecting the actuator means to a liquid at a predetermined minimum pressure.

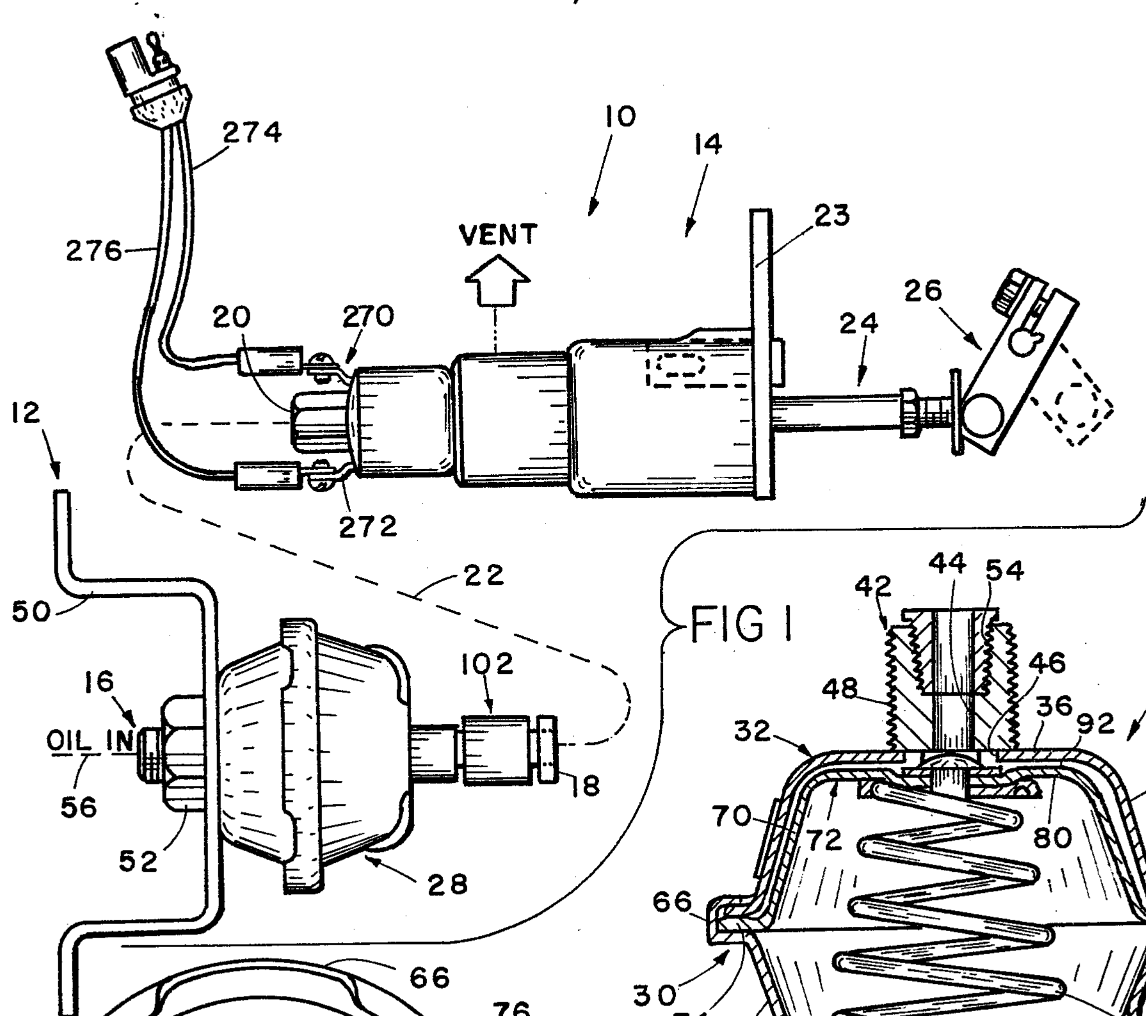


FIG 1

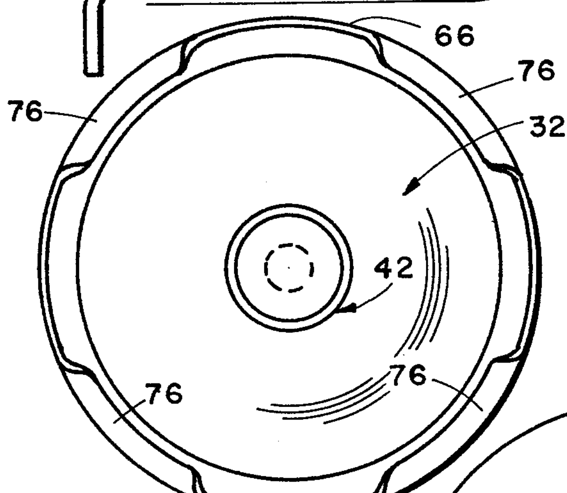


FIG 2

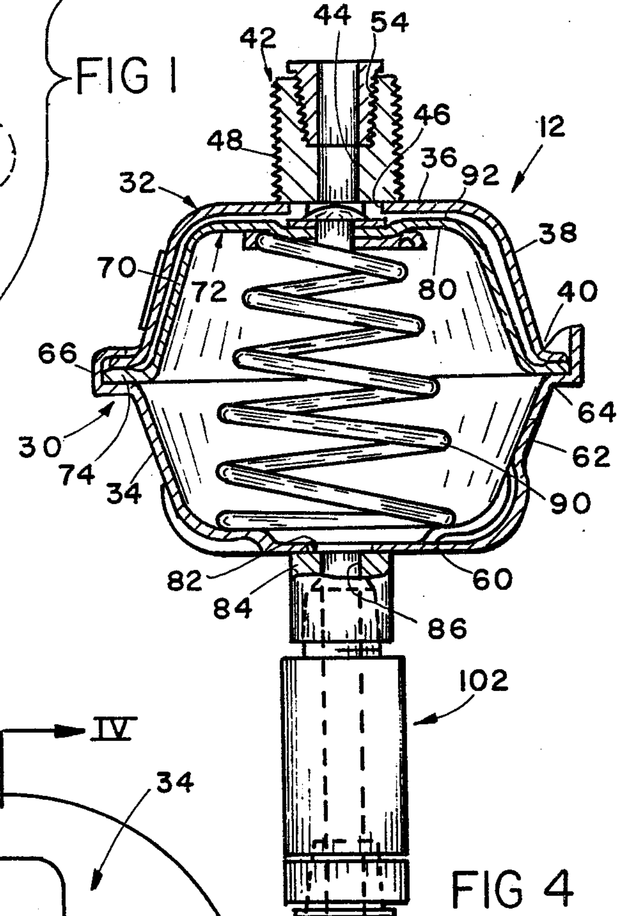


FIG 4

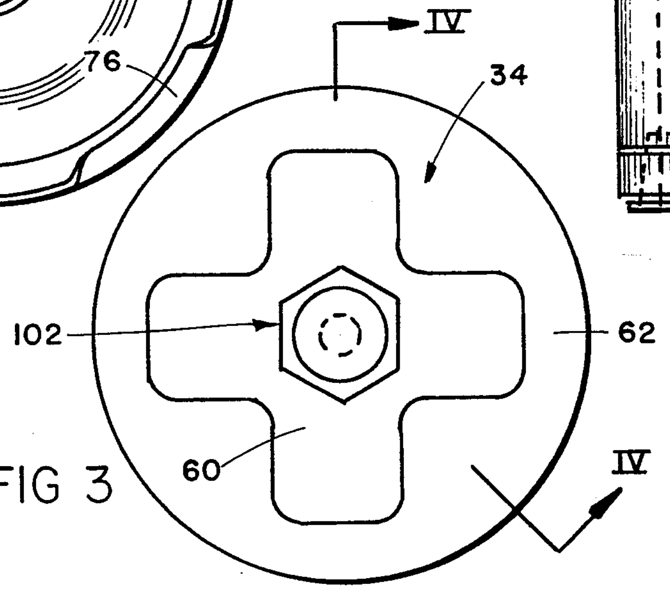


FIG 3

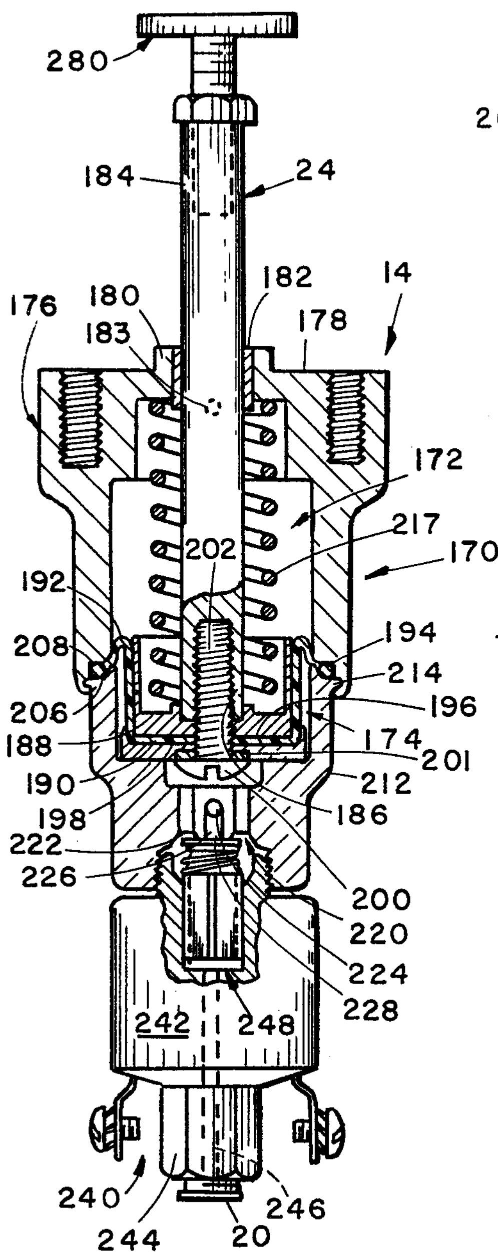


FIG 8

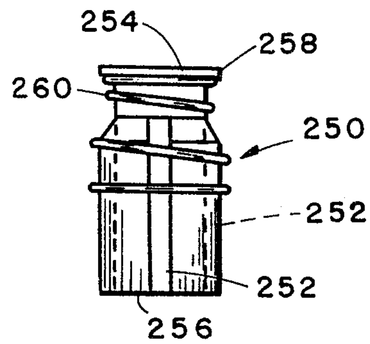


FIG 9

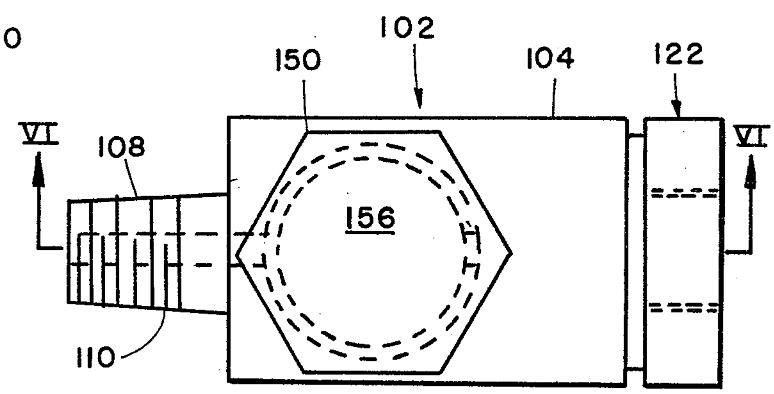


FIG 5

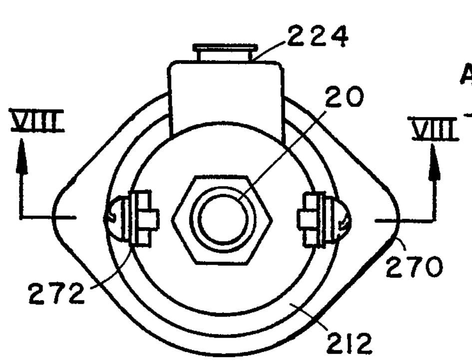


FIG 7

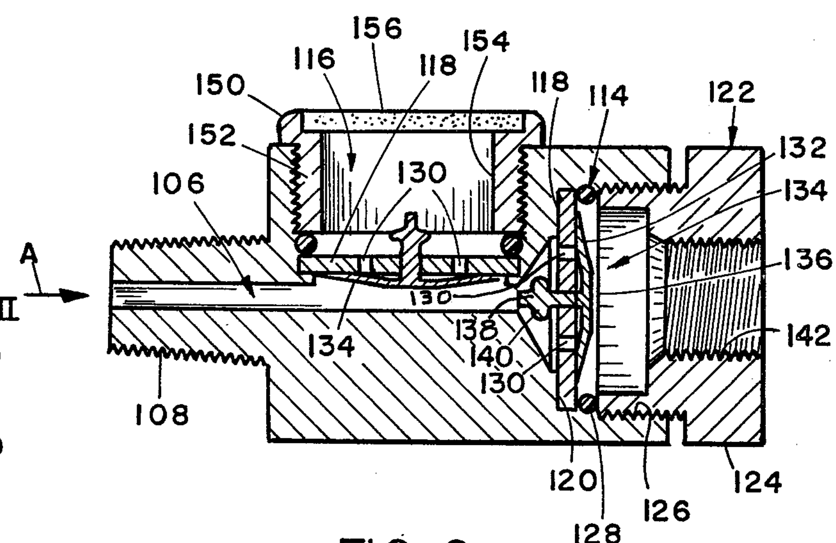
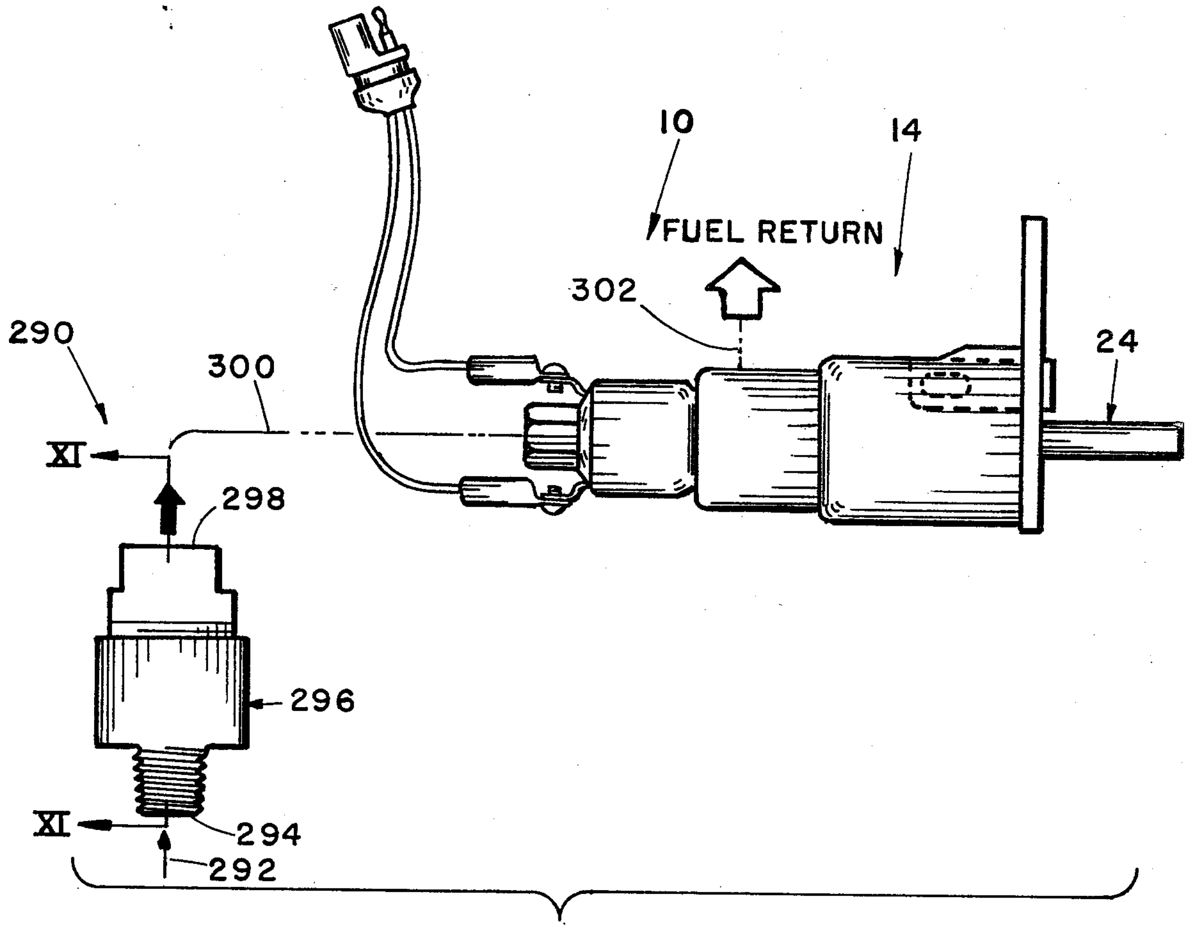


FIG 6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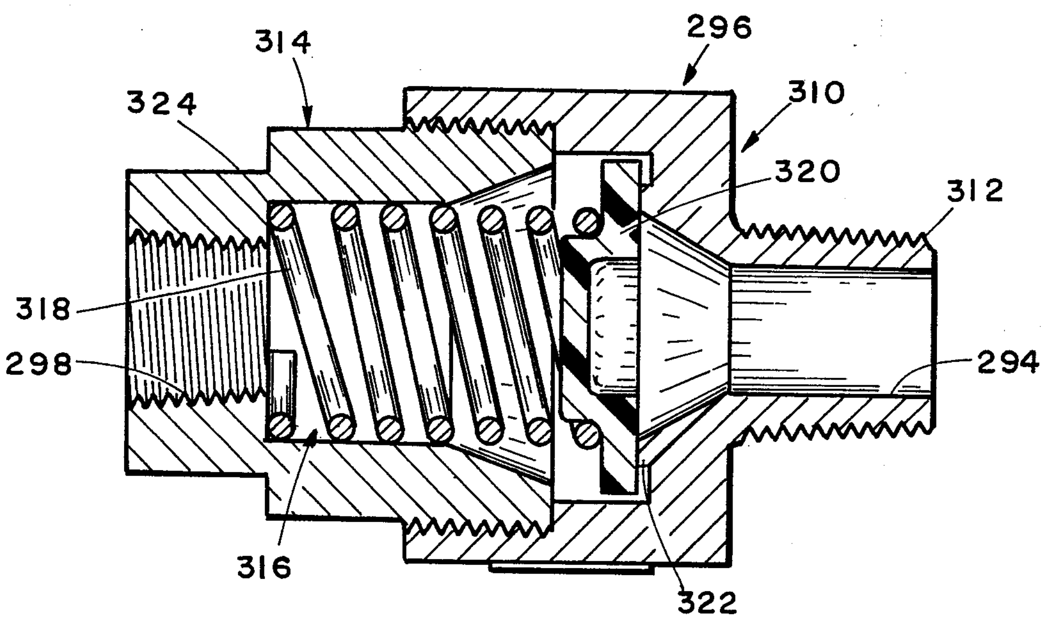
290
300
24
XI
298
296
XI
294
292

FIG 10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296
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FIG 11