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(71) Applicant: FLUID CONTROLS, INC.
8341 Tyler Boulevard
Mentor Ohio 44060(US)

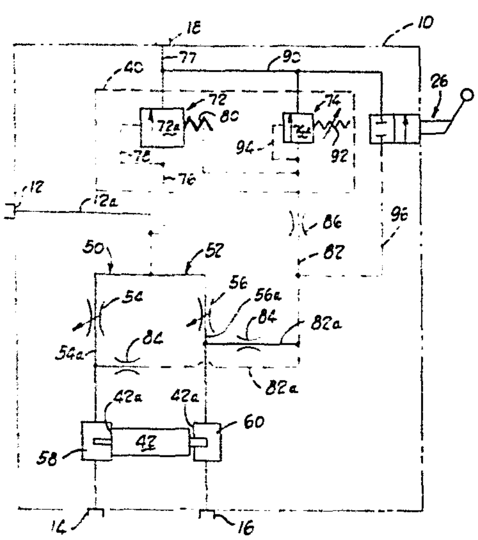
(72) Inventor: Grawunde, Frederick G.
3761 Countryside Road
Sarasota Florida 33583(US)

(74) Representative: Fisher, Bernard et al,
Raworth, Moss & Cook 36 Sydenham Road
Croydon Surrey CR0 2EF(GB)

(54) **Flow regulating valve.**

(57) A dual regulating control valve having integrated flow controlling and pressure relief sections, including a valve body (10) that defines an inlet port (12), a pair of outlet ports (14), (16) and a tank port (18). A pair of parallel flow paths (50, 52) extend between the inlet port and the outlet ports, each flow path including a respective adjustable orifice (54, 56) for adjusting the fluid flow rate in the associated flow path. A regulating valve assembly (40) is mounted in the valve body and includes a pressure differential controlling section (72) for maintaining a fixed pressure drop across each orifice (54, 56) and a pressure relief section (74) for limiting the maximum pressure at the discharge sides (54a, 56a) of the orifices; the pressure relief section (74) controls a fluid generated biasing force on the differential controlling section (72). At equalizing valve member (42) adjusts the fluid flow at the outlets (14, 16) to maintain equal pressures at the discharge sides of the orifices. A variety of on/off control devices (26) can be accommodated by the valve and, like the pressure relief section, control the biasing force on the pressure differential controlling element (72).

Fig.9



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FLOW REGULATING VALVE

The present invention relates generally to flow regulating valves and in particular to a pressure compensated dual flow regulator.

Background Art

It is often desirable to provide individual speed controls for multiple fluid pressure operated actuators that are driven by a single source of pressurized fluid. As is well known in the art, the operating speed of an actuator, particularly a fixed displacement type, is determined by the fluid flow rate through the actuator, provided that the driving fluid is substantially noncompressible. Pressure compensated, flow regulating valves are commonly used to adjust and maintain a constant flow rate through an actuator when desired.

Hydraulic systems utilizing multiple, fixed displacement actuators are often found on agricultural equipment as well as paving and salt spreading machinery. Typically, the actuators operate at different speeds and under varying load conditions and consequently, speed regulation becomes more complex. In a salt spreading vehicle, for example, two fluid motors are used to feed and dispense salt from the truck hopper onto the roadway. One fluid motor drives an auger which feeds salt from the hopper onto a dispensing device often comprising a spinning, horizontal disc that is driven by a second fluid motor. The spinning disc scatters salt or cinders radially outward from the back of the truck. In a salt spreading application, it is desirable to maintain a constant salt spreading rate regardless of the load placed on the auger and/or spinner. It should be apparent that the load placed on the auger will vary with the quantity of salt in the hopper. If a constant fluid flow rate through the auger motor is not maintained, the quantity of salt fed to the spinner will vary resulting in an attendant variation in the salt spreading rate of the truck.

Speed regulation of the auger and spinner motors, has been achieved in the past by the use of cascaded flow regulators. With this form of regulation, a first or primary regulator controls the fluid flow rate to one fluid motor by controlling the fluid communication between an inlet port and a by-pass port. Fluid at the inlet is diverted to the by-pass port to maintain a fixed flow rate at the outlet of the regulator. The by-passed fluid is conveyed to a second similar regulator having associated inlet and by-pass ports, for controlling the fluid flow rate to the second fluid motor. Fluid bypassed by the second regulator is returned to the tank or to a third regulator if additional fluid motors are in the circuit. Although under most operating conditions, this method of control is satisfactory, the use of independent flow regulators is considered unnecessarily costly. Moreover, the actuators operate independently of each other and one actuator will continue to operate even though the other actuator may have jammed or been rendered inoperative.

U.S. Patent No. 3,435,838, which is hereby incorporated by reference, discloses a pressure compensated regulating valve which converts an unregulated fluid input into two parallel, pressure compensated regulated outputs. In this prior valve, the flow rates along each fluid path are individually adjustable and are maintained regardless of the pressure at the outputs. Additionally, the valve disclosed in this patent includes valving for modifying the speed on one fluid motor in the event the speed of the other motor changes as a result of abnormal loading.

Although the valve has been commercially successful, it has been found desirable to improve its pressure regulation ability and to integrate additional functions such as pressure relief and remote on/off control into the valve body. Although pressure relieving devices and on/off controls were mounted on the valve body of the prior art valve, the devices were not part of the fluid regulated circuit but instead were part of separate, non-communicating circuits formed within the valve body.

Disclosure of the Invention

The present invention provides a new and improved dual flow regulating valve in which pressure relief and on/off controls are mounted on the valve body and integrated into the flow controlling circuitry disposed in the valve.

According to the preferred embodiment, the valve body defines an inlet connectable to a source of pressurized fluid and at least two outlets, connectable to separate fluid actuators. Parallel fluid flow paths extending between the inlet and each outlet are defined by the valve body and each flow path includes an orifice, preferably adjustable, which determines the fluid flow rate for each outlet and hence, the operating speed of an actuator fed by the associated outlet.

A pressure equalizing element preferably a slidable spool, monitors the pressure at each outlet and is operative to restrict fluid flow at one outlet upon sensing increasing pressure at the other outlet in order to maintain equal pressures at the discharge sides of each orifice. A pressure regulating valve assembly is mounted within the valve body and includes a pressure differential control element that is operative to maintain a predetermined pressure drop across each orifice. In the preferred construction, the element controls the fluid communication between the inlet and a discharge port. When the pressure drop across one or both orifices exceeds a predetermined threshhold, the element opens to reduce inlet pressure by discharging inlet fluid directly to the discharge port which typically communicates with a fluid reservoir or tank.

The regulating valve assembly also includes a pressure relief element that monitors the pressure at the discharge side of each orifice and is operative to reduce fluid pressure at the inlet when the pressure at the discharge side of either orifice exceeds a predetermined level.

In the preferred configuration, the regulating valve assembly is constructed as a cartridge valve that is threadedly received by the valve body. This construction not only reduces the overall cost of the valve, but more importantly, it has been found that a more precise pressure regulation is achieved.

According to the preferred embodiment, the pressure differential control element is urged towards an open position, i.e., a position that communicates the inlet port with the discharge port, by fluid pressure at the inlet and is urged towards a closed, fluid flow interrupting position by the combination of spring and fluid generated biasing forces. The fluid biasing force is provided by the fluid pressure at the discharge sides of the orifices that is communicated to the differential control element by a sensing line. The line preferably includes restrictors to damp out transients.

In normal operation, the differential control element maintains a predetermined pressure drop across the orifices, the pressure drop being determined by the spring biasing force. As long as the combination of fluid generated and spring generated forces exceeds the force applied by the inlet pressure, the element will remain closed. If the pressure drop increases beyond a predetermined value as a consequence of either excessive inlet pressure or alternately, insufficient pressure at the discharge sides of the orifices, the element will move to its open position to reduce the overall inlet pressure. It should be apparent that the pressure drop across the orifice is determined by the spring force applied to the pressure differential control element.

The pressure relief element monitors the fluid pressure at the discharge sides of the orifices and prevents the pressure of the regulated fluid flow from exceeding a predetermined level. In the preferred embodiment, the element is urged towards the flow interrupting position by a spring which determines the relief setting of the element. In the preferred embodiment, the relief element controls the fluid communication between the pressure sensing line and the discharge port. The pressure in the sensing line urges the element towards the open position. As long as the fluid generated force is less than the spring force, the element remains closed. When the relief setting is exceeded, the valve elment opens to communicate the pressure sensing line with the discharge port thereby eliminating or reducing the fluid generated closure biasing force on the pressure differential element. The inlet pressure easily overcomes the spring biasing closure force and drives the differential control element to its open position thereby dumping the inlet pressure directly to the discharge port.

With the present construction, the need for separate relief and pressure differential control valves is eliminated. In normal operation, the pressure differential control element monitors the fluid pressure at the discharge sides of the orifices and controls the inlet pressure to maintain a constant pressure differential. When the regulated fluid flow exceeds the pressure relief setting however, the fluid generated biasing force on the pressure differential element is reduced or terminated by the pressure relief element to enable the inlet pressure to easily open the pressure differential element in order to reduce or terminate inlet pressure.

According to another feature of the invention, the valve body includes a provision for accepting a variety of on/off control devices. To achieve this feature, the valve body includes a bore adapted to receive a variety of valve devices including a manually operated on/off valve as well as solenoid and pneumatically actuated on/off valves. Passages formed in the valve body, communicate the pressure sensing line and the discharge port with the valve body bore. The on/off device, when mounted in the bore, controls the communication between the passages in order to activate and deactivate the flow controlling function. When the device communicates the pressure sensing line with the discharge port, the fluid generated biasing force on the differential control element is reduced or eliminated and thus the element opens to communicate the inlet with the discharge port, dumping inlet pressure. When the on/off device is closed, the pressure sensing line is allowed to pressurize to apply a closure force to the pressure differential controlling element. With the preferred construction, the on/off control device controls the pressurization of the sensing line only and thus, is not required to handle large amounts of fluid flow. Put another way, the relief element controls the fluid biasing forces applied to the pressure differential control element.

The present invention discloses a simple and effective control valve that provides two pressure compensated, regulated flow outputs to drive two independent, preferably fixed, displacement fluid actuators. The valve is simple in construction and eliminates the need for a multiplicity of remotely mounted valving elements. Instead of employing separate pressure relief and on/off control valves to control the communication of pressurized fluid from a source to the flow regulating valve, a first valve element (differential controlling) disposed within the valve body controls the communication between the valve inlet and the discharge port whereas a second element (pressure relief) controls the biasing forces on the first element to effectively provide the relief and on/off control functions. Unlike the prior art, the pressure relief element monitors the pressure of the regulated fluid flow (at the discharge sides of the orifices) and not the inlet pressure.

Additional features and a fuller understanding of the present invention will be obtained in reading the following detailed description made in connection with the accompanying drawings.

Brief Description of the Drawings

Figure 1 is a top plan view of a control valve constructed in accordance with a preferred embodiment of the invention;

Figure 2 is a side elevational view of the control valve with portions broken away to show interior detail;

Figure 3 is another side elevational view of the control valve with portions broken away to show interior detail;

Figure 4 is a fragmentary, sectional view as seen from a plane indicated by the line 4-4 in Figure 1;

Figure 5 is a sectional view of the valve as seen from a plane indicated by the line 5-5 in Figure 1;

Figure 6 is a view of a portion of the control valve, partly in section, illustrating an alternate on/off control device mounted to the control valve;

Figure 7 is a sectional view of the valve as seen from the plane indicated by the line 7-7 in Figure 1, with parts removed for clarity;

Figure 8 is a sectional view of the valve as seen from the plane indicated by the line 8-8 in Figure 1, with parts removed for clarity;

Figure 9 is a schematic representation of the fluid circuitry and componentry of the control valve illustrated in Figure 1, and

Figs. 9A and 9B are schematic views of alternative valves to the manually-operated valve shown in Fig. 5.

Referring to Figure 1, the dual regulating valve embodying the present invention comprises a unitary, preferably cored casting 10 that defines a threaded inlet port 12 (see Figures 2, 3 and 5) connectable to a suitable source of pressurized fluid (not shown), a pair of threaded outlet ports 14, 16 connectable to fluid actuators (not shown) and a threaded discharge port 18 which is typically communicated to the tank or fluid reservoir of the fluid pressure system (not shown).

The type of valve disclosed by the present invention may be used in a salt spreading operation to control an auger actuator (not shown) which feeds salt from a hopper onto a spinning device which in turn is driven by a second or spinner actuator (not shown) that is also connected to the valve. To simplify the explanation, the valve will be described in connection with this application and in the illustrations which accompany the explanation, the external valve markings will be those that are provided on a valve used for a salt spreading operation. It should be understood however, that the disclosed invention has wide applicability and can be used in any fluid application in which a single source of pressurized fluid must be divided and controlled in order to operate a plurality of fluid actuators, preferably fixed displacement actuators.

The disclosed valve, once adjusted by the operator, provides a fixed flow rate to each outlet 14, 16 regardless of the load experienced by the actuator fed by the associated outlet, and thus actuator speeds are maintained independent of actuator load. As seen best in Figure 1, the disclosed valve includes a pair of hand controls 20, 22 marked "auger", "spinner", respectively. The operator rotates the controls 20, 22 to adjust the running speed of an associated actuator. Referring to Figure 5, a manual on/off control 26 is provided to enable the operator to activate and deactivate the valve and hence the actuators. Alternately, as seen in Figure 6, the manual control 26 can be replaced by a solenoid operated valve 26a for providing remote on/off control.

To facilitate the description, the operation of the valve will be described first with reference to Figure 9 which schematically illustrates the components and fluid circuitry of the valve. Like reference characters will be used where possible to represent the actual components illustrated in

Figures 1-8. The valve body 10 (represented by the dashed perimetral line, mounts a regulating valve assembly represented by the dashed line 40 and an equalizing spool 42, and defines various internal flow paths extending between these valve components and the ports 12, 14, 16 and 18 described earlier.

Pressurized fluid from a source is communicated to the valve via the inlet port 12. The valve defines a pair of parallel flow paths indicated generally by the reference characters 50, 52 which jointly communicate with the inlet 12, through a supply passage 12a. Each flow path 50, 52 includes an adjustable orifice 54, 56 having discharge sides 54a, 56a, communicating with outlet chambers 58, 60 disposed on either side of the equalizing spool 42. The fluid in the chambers 58, 60 apply lateral, opposed fluid generated forces to end faces 42a of the spool 42. The spool 42 moves in response to unequal pressures in the chambers 58, 60 and restricts fluid flow through the chamber of lesser pressure in order to maintain equal presures at the discharge sides 54a, 56a of the adjustable orifies 54, 56. The "auger" and "spinner" ports 14, 16 communicate fluid from the outlet chambers 58, 60 to respective spinner and auger fluid motors (not shown).

The regulating valve assembly 40 monitors the pressure at the discharge sides 54a, 56a of the orifices 54, 56 and continuously adjusts inlet pressure to maintain a constant pressure drop across the orifice and also prevents the pressure from exceeding a predetermined maximum. The assembly 40 includes a pressure differential controlling section indicated generally by the reference character 72 and a pressure relieving section indicated generally by the reference character 74. Pressurized fluid at the inlet 12 is communicated to the regulating valve assembly via a branch flow passage 76. The pressure differential controlling section 72 controls the fluid communication between the passage 76 and a discharge passage 77 that is connected to the dislodge port 18. The pressure differential controlling section 72 is operative to maintain a constant pressure differential across each orifice 54, 56 regardless of the demand or load exerted by the actuators. Those skilled in the art will recognize that the pressure differential across a fixed orifice determines the flow rate of a non-compressible fluid through the orifice. Thus, once the orifices 54, 56 are adjusted by the operator, the valve section 72 of the regulating valve assembly will adjust the inlet pressure in order to maintain a constant pressure differential across the orifices 54, 56 and in so doing insures a constant flow rate along each flow path, 50, 52.

In order to achieve this function, the differential controlling section 72 includes an element 72a that is biased towards an open position by inlet fluid pressure that is communicated to it by a branch line 76 and a pilot line 78. The element 72a is biased towards the closed position by a spring 80 and fluid pressure at the discharge sides 54a, 56a of the orifices 54, 56, communicated to the element 72a by a sensing line 82 that communicates with the orifices through a pair of branch lines 82a. Each branch line 82a includes a restricting orifice 84 to dampen transient pressure pulses. An orifice 86 is also located in the sensing line 82 and serves the same function.

The element 72a adjusts the inlet pressure in response to changes in the pressure sensed at the discharge ends of the orifice in order to maintain a constant pressure differential across the orifice. For example, increased loading of the auger actuator will be manifested as an increased pressure at the auger port 14. This pressure increase will drive the equalizing spool 42 rightwardly (as viewed in Figure 9) to restrict the flow along the spinner flow path 52 so that the pressure at the discharge side of the orifice 56 increases to a pressure substantially equal to the pressure exerted at the discharge side of the orifice 54 which will have increased due to the loading of the auger actuator. This increased pressure will be communicated to the element 72a via the sensing lines 82, 82a and will increase the force tending to drive the element towards its closed position. Thus, as the pressure at the outlet ports increases, so will the inlet pressure in order to maintain a constant differential across the orifices 54, 56.

The differential maintained across the orifices 54, 56 is substantially determined by the spring 80 and for the disclosed valve is preferably in the range of 3.515 kg/cm^2 (50 psi). This spring force causes the pressure at the discharge side of the orifices 54, 56 to be 3.515 kg/cm^2 (50 psi) less than the inlet pressure independent of the flow rate.

The pressure relieving section 74 of the regulating valve assembly 70 includes a pressure relief element 74a that controls fluid communication between the sensing line 82 and a fluid line 90 that communicates with the discharge passage 77, connected to the tank port 18. The element 74a is biased towards a flow interrupting position by a spring 92 and biased towards an open position by a pilot line 94 that communicates with the sensing line 82. When the pressure at the discharge sides of the orifices 54, 56 (communicated via the sensing line 82 and pilot line 94) applies a force to the element 74a in excess of the spring force, the element opens and communicates the sensing line 82 with the tank port 18. The depressurization of the sensing line 82, removes the fluid generated closure force on the element 72a, allowing inlet pressure to drive the element 72a open thus discharging inlet pressure directly to the tank port 18. The pressure relief element 74a recloses once the pressure at the discharge sides of the orifices 54, 56 is reduced below the relief setting of the element 74a.

The on/off control 26 for activating and deactivating the control valve, like the pressure relief element 74a, controls the fluid communication between the sensing line 82 and the tank port 18. In particular, the control 26 is moveable between closed and open positions. The element controls the communication between a branch line 96 that communicates with the sensing line 82 and the fluid line 90 which, as described earlier, communicates with the tank port 18 through the passage 77. When the control 26 is moved to its flow interrupting position, as seen in Figure 9, fluid flow along the branch line 96 is prevented, and the sensing line 82 is allowed to pressurize thus applying a closure biasing force to the differential control element 72a. When the control is shifted to its open position, the sensing line 82 is communicated with the tank port 18 via the lines 96, 90 and 77 and hence the sensing line 82 is depressurized. This depressurization, as described earlier, removes the fluid generated, closure biasing force on the element 72a and allows inlet pressure to open the element, thus communicating the inlet with the tank port 18, completely deactivating the control valve. It should be noted, that in the present configuration, the inlet pressure will not reduce to zero due to the closure force applied to the element 72a by the biasing spring 80. In the illustrated embodiment, the inlet pressure is reduced to approximately 3.515 kg/cm^2 (50 psi) when the valve is deactivated. In a typical fluid control application, a fluid pressure of 3.515 kg/cm^2 (50 psi) is considered negligible for in most systems, operating pressures will be excess of 70.3 kg/cm^2 (1000 psi).

As shown schematically, the hand operated on/off device 26 can be replaced by solenoid or pneumatically actuated valves 26a, 26b to provide remote control of the control valve. The alternate control devices operate in the same fashion as described above. Both control devices include shiftable elements that control the communication between the branch line 96 and the tank port 18.

Referring now to Figures 1-8, the actual construction of the control valve embodying the circuit and components schematically shown in Figure 9, is illustrated. The valve body 10 is preferably an integral casting having cored passages defining the various flow paths and fluid circuitry described above. Referring to Figures 7 and 8, the inlet port 12 communicates with a laterally extending cavity 110 through a short vertical passage 112, both formed in the valve body. The outer ends of the cavity 110 communicate with threaded bores 114, 116 through relatively short passages 122, 124 which partially define the orifices indicated as 54, 56 in Figure 9. The bores 114, 116 are adapted to receive respective orifice adjustment subassemblies 118, 120, shown in Figures 3 and 4. The orifice subassemblies 118, 120 include the respective hand control knobs 20, 22 attached to rotatable stems 126, 128 that threadedly engage mounting plugs 130, 132 that are threaded into the bores 114, 116. Each stem 126, 128 terminates in a cone shaped plug

134, 136 which together with the passages 122, 124 (shown in Figure 8) define the adjustable orifices 54, 56 shown in Figure 9. Rotation of the hand controls 20, 22 displaces the plugs 134, 136 towards and away from the passages 122, 124, depending on direction of rotation.

A detent mechanism in the form of a spring loaded pin 140, slidably disposed within a sleeve 142 press fitted into a bore 144 formed in the valve body, co-operates with recesses formed on the underside of each hand control 20, 22 to releasably lock the knob in any one of the ten positions (shown in Figure 1). In the preferred embodiment, when the knobs 20, 22 are rotated to the zero position, the respective plugs 134, 136 sealingly engage the ends of the passages 122, 124 and prevent fluid flow from the cavity 110 into the bores 114, 116.

Returning to Figure 8, the branch sensing passages 82a shown in Figure 9, are formed by downwardly extending diagonal passages 150 and lateral passages 152 that communicate the bores 114, 116 with a recess 154 (shown best in Figure 5) formed near one end of the valve body. Each diagonal passage 152 includes an element 156 that forms the restriction 84, shown in Figure 9. Each of the bores 114, 116 also communicates with the opposite ends of a lateral bore 160 through relatively short, rectangular passages 162, 164 (see Figures 2 and 7). The bore 160 slidably supports the equalizing spool 42. As seen best in Figure 2, the spool 42 defines a plurality of pressure balancing grooves 166 and the end faces 42a. Laterally extending stops 172, 174 limit the maximum amount of movement for the spool 42. A plug 176 seals the bore 160 once the spool 42 is inserted therein.

The outlet chambers 58, 60 shown schematically in Figure 9, are defined by respective recesses 178, 180 that extend into fluid communication with the outlets 14, 16 (shown in Figure 7) by integrally formed, diagonal passages 182, 184. As described earlier, the spool 42 is responsive to pressures in the outlet chambers 58, 60 (recesses 178, 180 in Figure 2) and moves to restrict fluid flow in the outlet chamber having lower pressure. It should be apparent, that as long as equal pressures exist in the passages 162, 164, the spool member 42 will remain in the center position shown in Figure 2. Should however, one passage for example 162 increase in pressure (due to loading of the actuator communicating with the port 14) the increased pressure will drive the spool 42 towards the right (as viewed in Figure 2) to restrict fluid flow out of the outlet chamber passage 180 thereby increasing the pressure in the passage 164.

Referring now to Figure 5, the regulating valve assembly 40 preferably comprises a cartridge assembly threadedly mounted in the valve body 10. The valve body 10 includes a bore 190 that extends from the right side of the valve body (as viewed in Figure 5) and opens into fluid communication with the cavity 110 and includes a threaded portion 190a and a stepped portion 190b. The bore 190 communicates with a recess 192 and the recess 154 described earlier. The recess 192 communicates with the tank port 18.

In the illustrated embodiment, the bores 114, 116; the cone shaped plugs 134, 136; and the outlet recesses 178, 180 are unequal in size. As earlier discussed, the illustrated valve is configured for a salt spreading application. It has been found that, in general, an auger actuator will require a greater flow rate than the spinner actuator. By sizing the respective flow paths, in proportion to the expected flow demand in normal operation, a more precise control can be achieved. It will be recognized that for other fluid control applications, the flow paths may be equally sized or unequally sized to a greater extent depending on the expected flow demand at the outlets. Additionally, the shape of the cone shaped plugs 134, 136 can be modified to change the relationship betwen the rotation of the knobs 20, 22 and the change in the flow rate resulting from the rotation.

The regulating valve assembly 40 includes a threaded cap 40a, threadedly received by the bore portion 190a and a tubular body member 196 that sealingly engages the stepped portion 190b of the bore 190. The body member 196 slidably mounts a primary poppet 198 that is operative to control the communication between the left end opening 196a (as viewed in Figure 5) of the body member 196 and radial ports 200 formed in the body 196, (only one port 200 is shown in Figure 5). As should be apparent, the end opening 196 is in fluid communication with the inlet port 12 (via the passage 112) whereas the radial port 200 is in fluid communication with the tank port 18. In Figure 5 the primary poppet 198 is shown in its flow interrupting position in which it prevents fluid flow between the inlet port 12 and the tank port 18. The primary poppet is biased towards this position by a spring 202 captured within a spring chamber 204 defined by the cap 40a. A shoulder 198a determines the leftmost position of the primary poppet 198 (as viewed in Figure 5).

The primary poppet 198 forms the pressure differential controlling element (indicated schematically by the reference character 72a in Figure 9). As viewed in Figure 5 the poppet 198 is urged towards the right by fluid pressure at the inlet 12 and urged towards the left by the spring 202 and any fluid pressure communicated to the spring chamber.

As described earlier, fluid pressure from the bores 114, 116 is communicated through the diagonal passages 150 and lateral passages 152 to the recess 154 (see Figure 8). This regulated fluid pressure is communicated from the recess 154 to the spring chamber 204 through a relatively small aperture 206 formed in the cap 40a. Thus, the fluid pressure present in the bores 114, 116 which form the discharge sides 54a, 56a of the orifices 54, 56 shown in Figure 9 are communicated to the right side of the primary poppet 198 and apply fluid forces, urging the poppet towards the left (towards its fluid flow interrupting position).

In normal operation, the primary poppet 198 opens to communicate the inlet port 12 with the tank port 18 whenever the inlet pressure exceeds the combined force of the spring 202 and the regulated fluid pressure present in the bores 114, 116 (the discharge sides of the orifices). Thus in normal operation, the primary poppet 198 maintains a constant pressure drop across the orifices 54, 56, the pressure drop being determined by the spring 202 which in the preferred embodiment, exerts a force of substantially 50 psi on the primary poppet.

The fluid pressure in the spring chamber 204 is monitored by a pilot poppet 210 mounted centrally within the primary poppet 198 and biased towards a closed position by a spring 212 that is captured within a central bore 213 by a threaded Allen screw 214. When the fluid pressure in the spring chamber 204 applies a force in excess of that applied to the pilot poppet 210 by the spring 212, the poppet is unseated and communicates the spring chamber 204 with the tank port 18 through the bore 213, a radial stepped bore 220 formed in the primary poppet 198 and a radial port 215 formed in the body member 196. The fluid pressure in the spring chamber 204 discharged to the tank port 18 substantially reduces the closure biasing force on the primary poppet 198, allowing inlet pressure to drive the primary poppet towards the left thus communicating the inlet 12 with the tank port 18. When the regulated pressure in the bores 114, 116 is reduced below the relief setting of the pilot poppet 210, the poppet recloses allowing the spring chamber 204 to repressurize and reapply the closure force to the primary poppet 198, moving it to the left (as viewed in Figure 5) to interrupt the fluid communication between the inlet 12 and the tank port 18.

According to a feature of the invention, a variety of on/off control devices for activating and deactivating the control valve, can be accommodated. Referring to Figures 5 and 6, the valve body 10 includes a bore. 228 disposed above the regulating valve assembly bore 190, which also communicates with the recesses 154, 192 formed within the valve body. The bore 228 includes a threaded portion 228a and a multi-stepped portion 228b.

The on/off control device is mounted in the bore 228 and controls the fluid communication between the recesses 154, 192. When the recesses 154, 192 are communicated, the biasing fluid pressure in the spring chamber 204 (which as discussed earlier applies a closure force to the primary poppet 198) is discharged, allowing inlet pressure to open the primary poppet 198, thereby discharging inlet pressure directly to the tank port 18. When the recesses are isolated, the spring chamber 204 pressurizes and applies a fluid biasing closure force to the primary pooppet, urging it towards the left as viewed in Figure 5.

The control device 26 controls the fluid communication between the recess 192 and the recess 154 and comprises a rotatable stem 240 threadedly received by a collar 242 that is threaded into the threaded bore portion 228a. The stem 240 includes an annular seating element 244 that is engageable with a valve seat 246 defined at one end of the stepped portion 228b. Rotation of the hand lever 238 displaces the annular element 244 towards and away from the valve seat 246. When the element is rotated into engagement with the seat, the fluid communication between the recess 154 and the recess 192 is prevented and the control valve is activated due to the pressurization of the spring chamber 204. When the handle 238 is rotated to displace the element 244 away from the seat 246, the regulated line pressure present in the discharge chambers 112, 114 and hence in the sensing lines (passages 150, 152) 82a (shown in Figure 9) is dumped directly to the tank port 18 thus depressurizing the spring chamber 204, enabling inlet pressure to open the primary poppet 198, thus communicating inlet port 12 with the tank port 18.

The hand operated on/off valve shown in Figure 5 can be replaced by a solenoid operated valve 26a (shown in Figures 6 and 9a) or a pneumatically operated valve 26b (shown schematically in Figure 9b) to provide remote control of the control valve. As illustrated in Figure 6, the solenoid operated valve 26a is constructed in a cartridge configuration and is threadedly received by the bore portion 228a. A valve body member 248 extends into the stepped portion 228b. The cartridge valve includes a piston assembly housed in the body member that controls the communication between the stepped portion 228b and radial ports 250 formed in the body member 248. When the valve is opened, the recesses 192 and 154 are communicated, thus dumping the regulated pressure directly to the tank port 18 and depressurizing the spring chamber 204 allowing the primary poppet 198 to open. When the solenoid valve is closed, fluid communication between the recesses 192 and 154 are prevented thereby enabling the pressurization of the spring chamber 204.

It should be apparent that the present invention provides a novel, dual regulating valve in which the pressure regulating, pressure relieving and on/off control functions are integrated into a single circuit. The valve is economical to manufacture, and requires less machining and componentry than the prior art valves without sacrificing reliability or performance.

Although the invention has been described with a certain degree of particularity, it should be understood that various changes can be made to it by those skilled in the art without departing from the spirit or scope of the invention as hereinafter claimed.

Claims

1. A flow regulating valve including a valve body 10 defining an inlet 12 and at least two outlets 14, 16, structure defining fluid flow paths 50, 52 extending between said inlet and each outlet, an orifice 54, 56 disposed in each flow path intermediate said inlet and said outlet and having an input end and an output end, and a pressure equalizer means 42 communicating with fluid pressure at each outlet and operative to maintain equal fluid pressures at the output ends 54a, 56a of said orifices, the flow regulating valve characterized by:

a) a regulating valve assembly 40 disposed in said valve body comprising a pressure differential controlling means 72 including means 72a for sensing fluid pressure at the output ends of said orifices, said differential controlling means operative to maintain a predetermined pressure drop across said orifices; and,

b) a pressure relieving means 74 communicating with the output ends of said orifices and operative to reduce fluid pressure at said inlet when the fluid pressure at the output ends of said orifices exceeds a predetermined level.

2. The control valve of claim 1 further characterized by line sensing means 82 for communicating fluid pressure at the output ends of said orifices to said pressure differential controlling means, the fluid pressure communicated to said differential controlling means applying fluid generated forces urging said control means towards a fluid flow interrupting position, and said pressure relieving means is operative to communicate said fluid pressure in said line sensing means to

a discharge port 18, thereby reducing the biasing force on said pressure differential controlling means.

3. The regulating valve of claims 1 or 2 further characterized by an on/off valve element 26 operative to control the communication between said sensing line and said discharge port.

4. The regulating valve of claim 3 wherein said on/off control is characterized by a solenoid operated valve 26a disposed in said valve body.

5. The regulating valve of any of the preceding claims characterized in that said orifices are manually adjustable.

6. The control valve of any of the preceding claims characterized in that said pressure differential control means and pressure relieving means are formed by a cartridge assembly 40 threadedly received by said valve body.

7. The control valve of any of the preceding claims wherein said pressure differential controlling means is biased towards a flow interrupting position by the combination of a spring biasing means 80 and fluid biasing means generated by fluid pressure communicated from the output ends of said orifices by a sensing passage 159 formed in said valve body.

8. A pressure compensated, dual regulator, including a valve body 10 defining an inlet port 12, at least two outlet ports 14, 16, a tank port 18 and a pair of fluid flow paths 50, 52 extending between said inlet port and said outlet ports, and an orifice 54, 56

disposed in each flow path, said orifices adjustable by means 20, 22 external to said valve body, the regulator characterized by:

a) a regulating valve assembly 40 received by said valve body including pressure differential controlling means 72 for maintaining a predetermined pressure drop across each orifice;

b) means 76 communicating the inlet port with said differential controlling means such that fluid at the inlet applies a fluid force to said differential controlling means urging it towards a position at which said inlet port is communicated with said tank port;

c) pressure sensing means 82 communicating fluid pressure at discharge sides 54a, 56a of said orifices to said pressure differential controlling means, said communicated fluid pressure applying a closure biasing force to said pressure differential controlling means urging it towards a flow interrupting position;

d) spring means 80 applying an additional closure force to said pressure differential controlling means;

e) pressure relief means 74 forming part of said pressure regulating assembly, for controlling the communication of said pressure sensing means with said tank port, said pressure relief means operative to communicate said pressure sensing means with said tank port when the fluid pressure at discharge sides of either of said orifices exceeds a predetermined level; and,

f) equalizing valve means 42 for maintaining equal pressures at the discharge sides of said orifices.

9. The regulator of claim 8 further characterized by on/off control means 26 operative to communicate

said pressure sensing means with said tank port in order to deactivate said regulator.

10. The regulator of claim 8 wherein said pressure sensing means is characterized by passages 150, 152 integrally formed in said valve body extending between the discharge sides of said orifices and a recess 154 formed in said valve body that communicates with said pressure differential controlling means.

11. The regulator of claims 8, 9 or 10 characterized in that said adjustment means for each orifice comprises hand operated control knobs 20, 22 having a plurality of detented positions.

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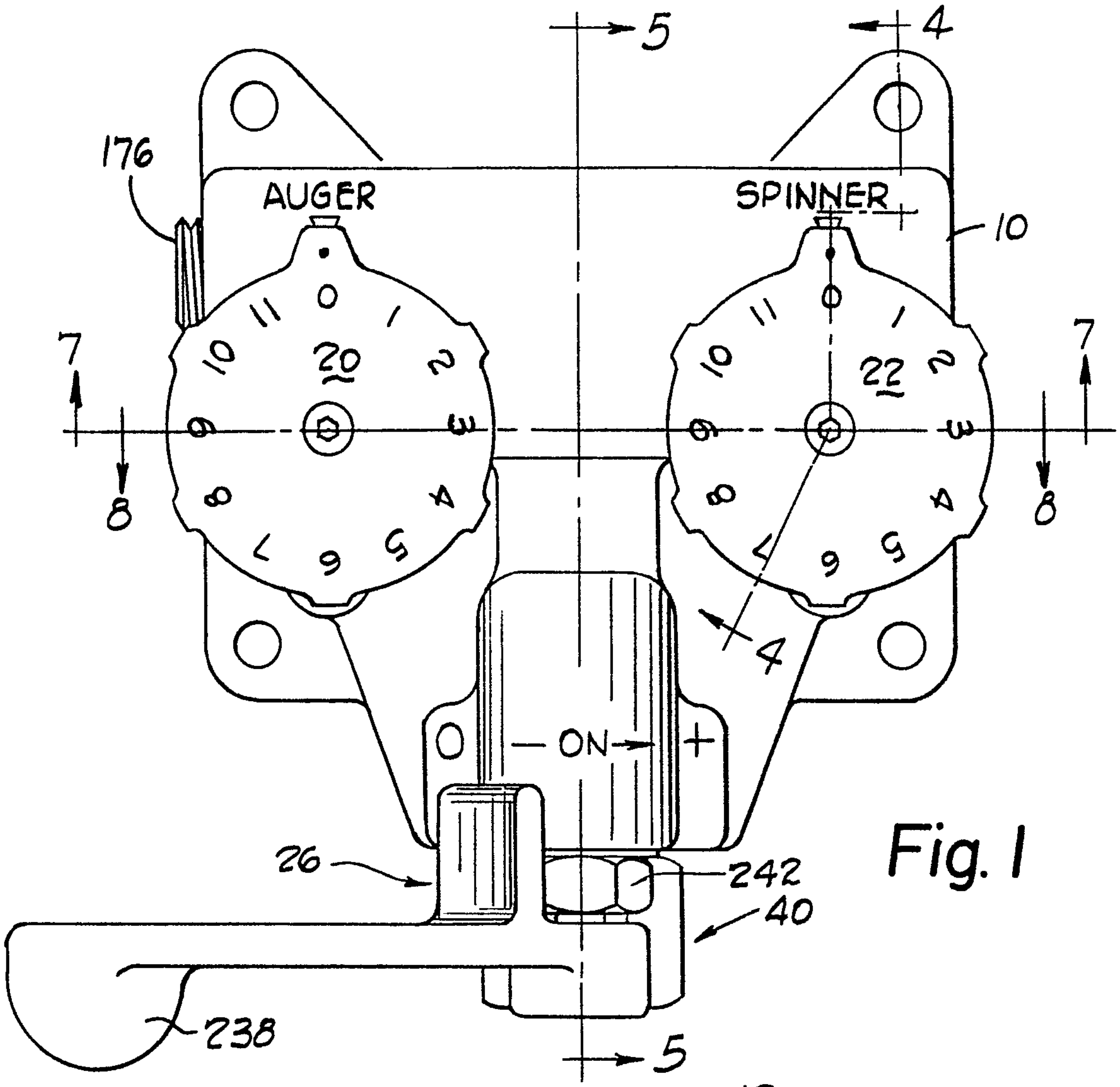


Fig. 1

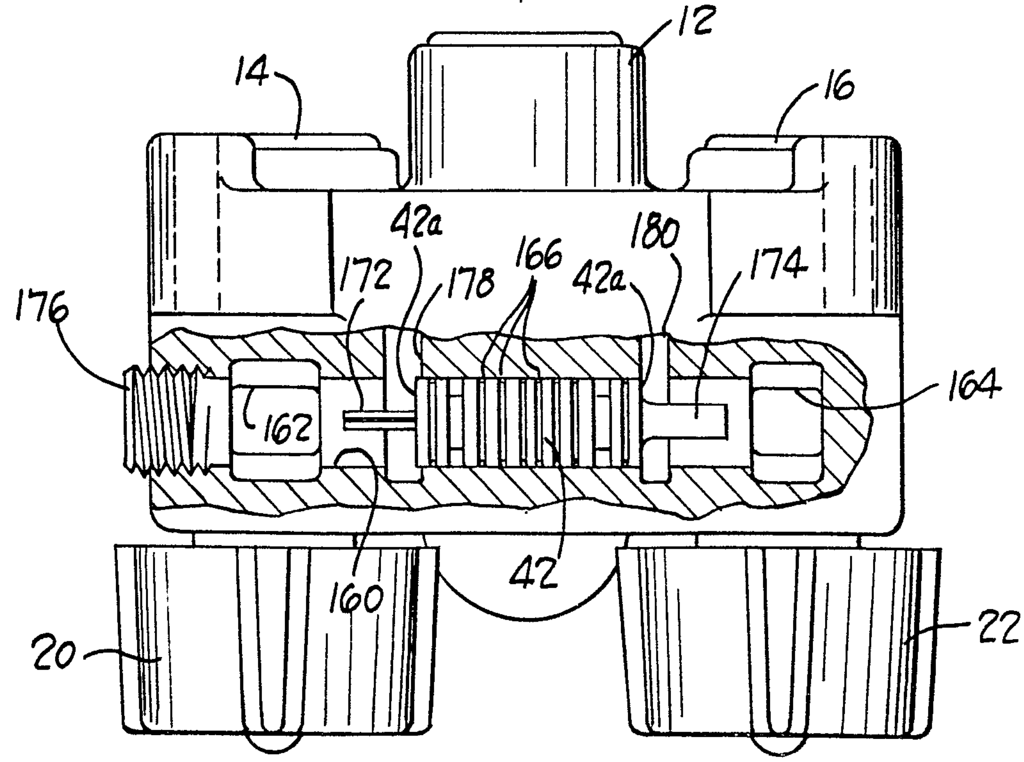
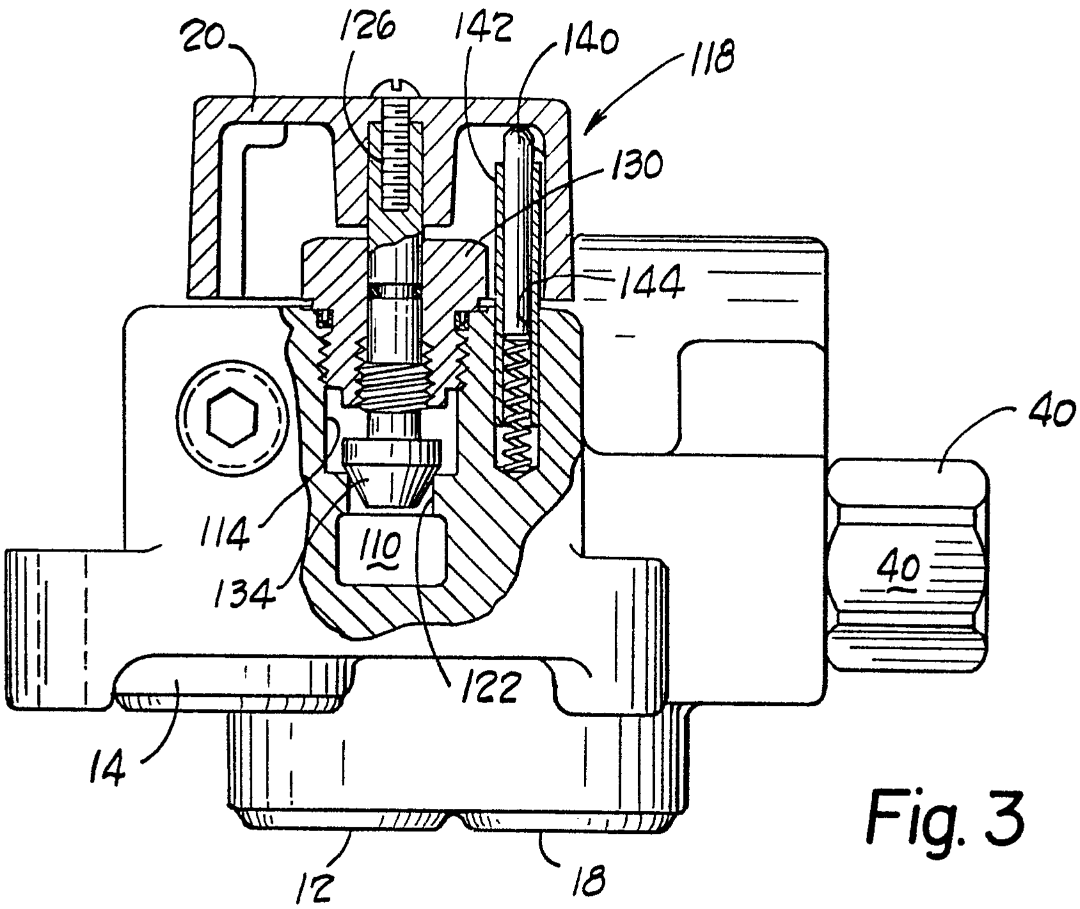


Fig. 2



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144
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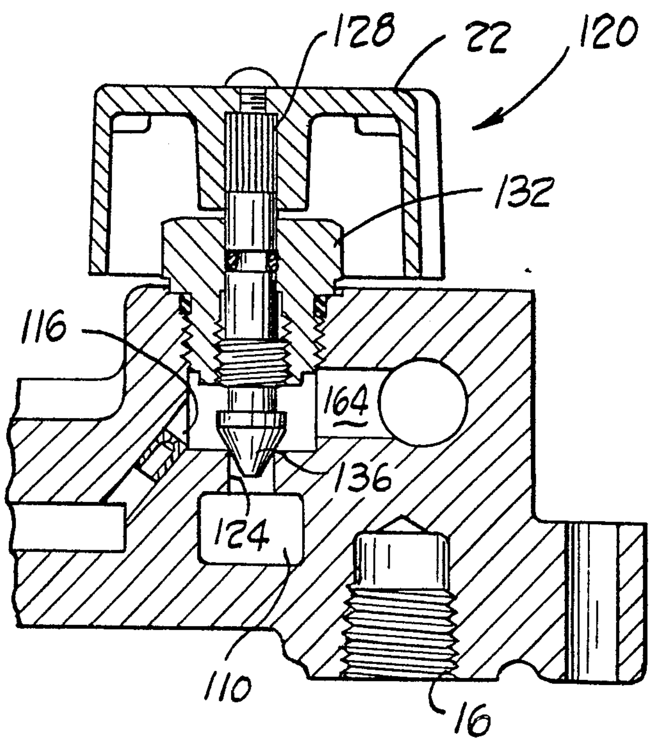
12
18

Fig. 3



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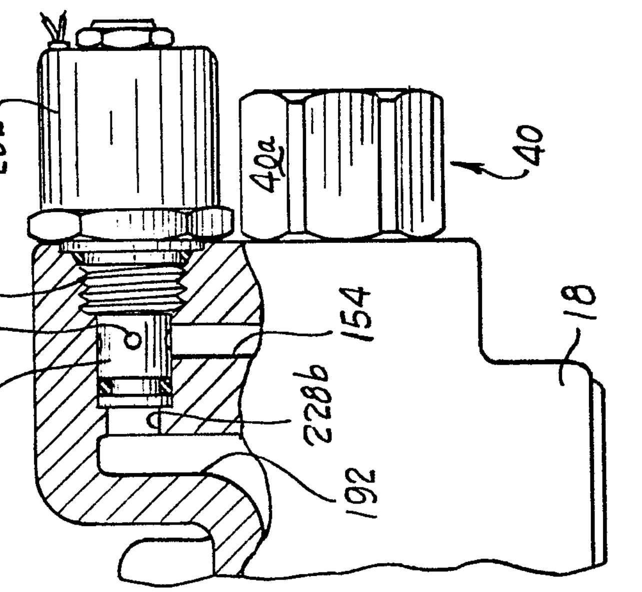
16

Fig. 4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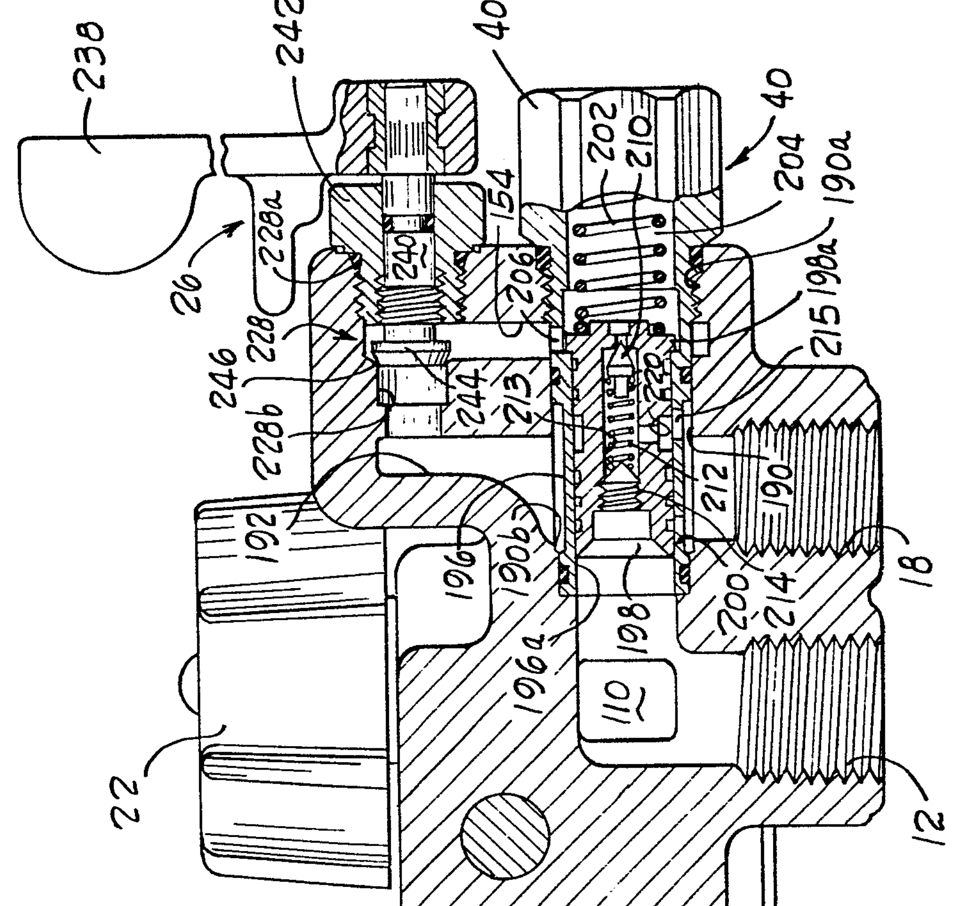
154
228b
192
18
40a
40

Fig. 6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190b
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196a
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22
12
40

Fig. 5

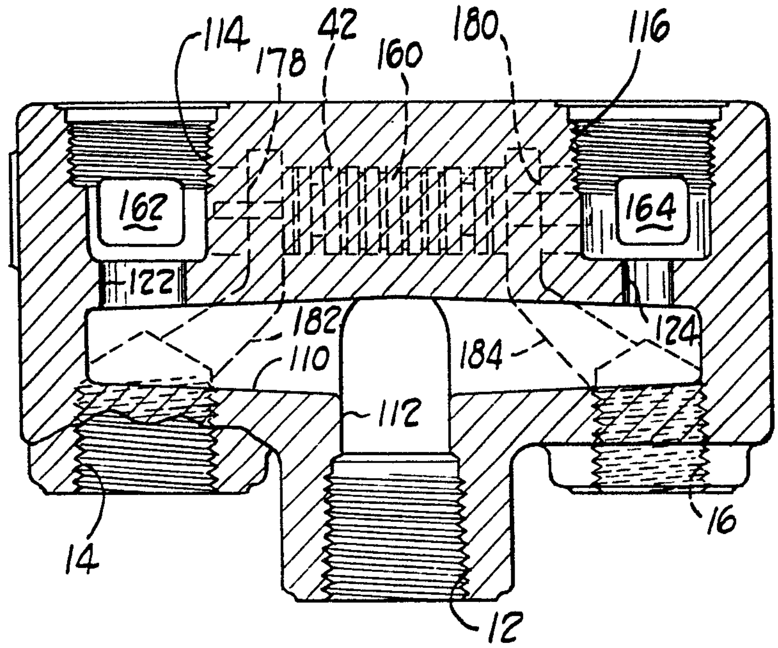
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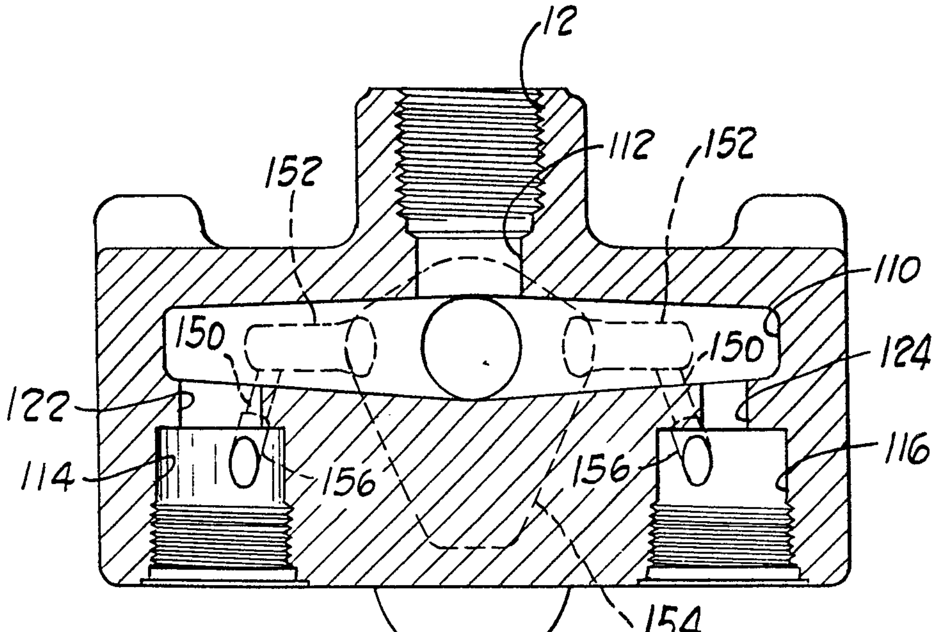
Fig. 7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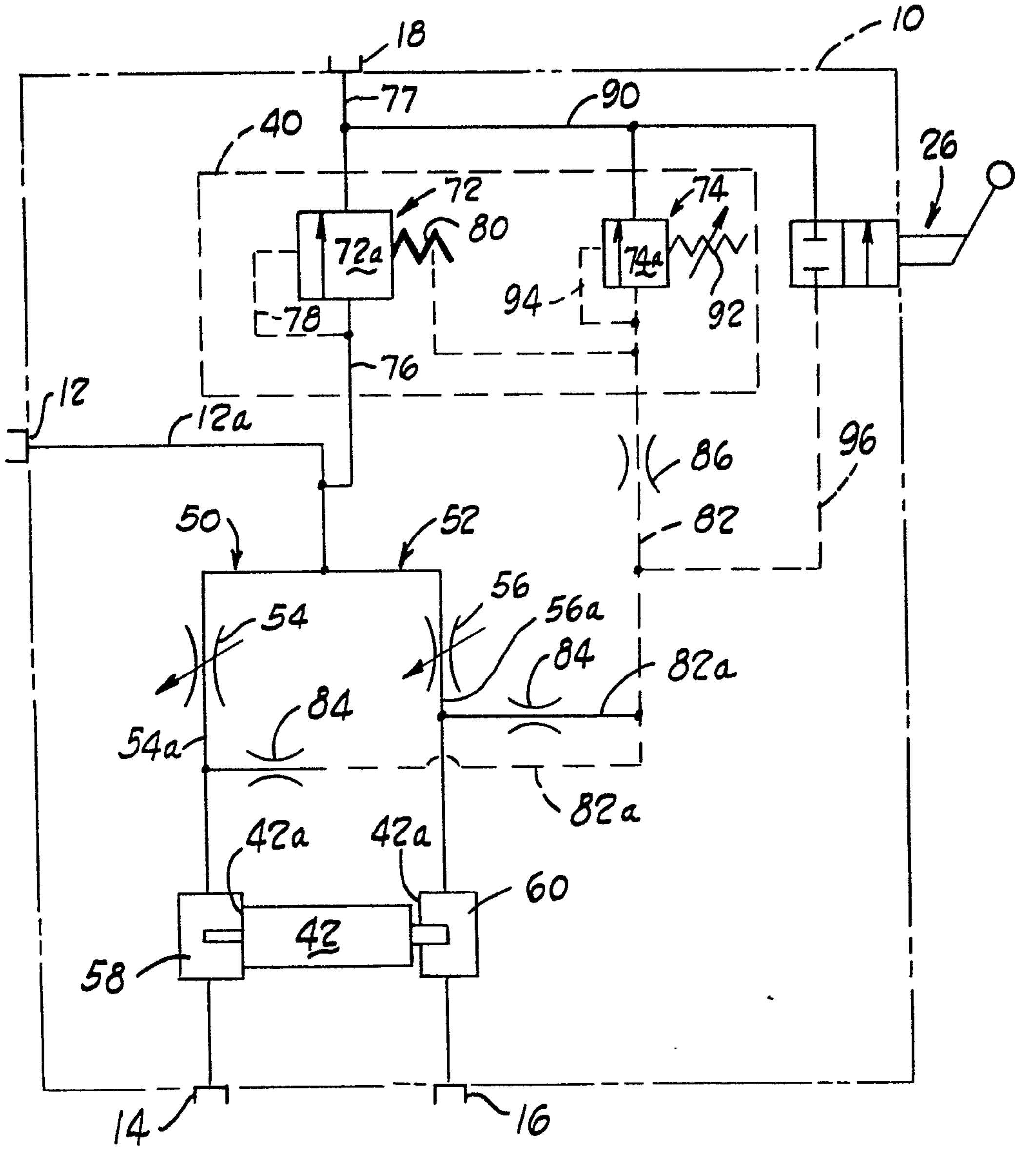
156
156
116
154

Fig.8

Fig. 9



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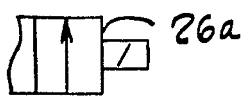

PNEUMATIC

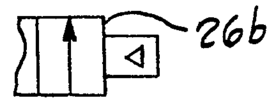

Fig. 9A

Fig. 9B

European Patent Office

EUROPEAN SEARCH REPORT

0082617
Application number

EP 82 30 6377

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
X	US-A-3 827 453 (T.J. MALOTT et al.) * Claims 1, 5, 10, 11 ; figures 2, 3 *	1,2,5, 7,8,10	F 15 B 13/06 F 15 B 11/05 F 15 B 11/22
D,A	US-A-3 435 838 (A.M. BOWER) * Complete document *	1,2,7, 8,10, 11	
A	US-A-3 847 180 (N.W. KROTH et al.) * Column 1, line 62 - column 2, line 6 ; column 7, line 41 - column 8, line 2 ; figure 5 *	3,9	

TECHNICAL FIELDS SEARCHED (Int. Cl. 3)

F 15 B 13/00
F 15 B 11/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	28-02-1983	LEMBLE Y.A.F.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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