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PUMP AND MOTOR HYDRAULIC SYSTEM

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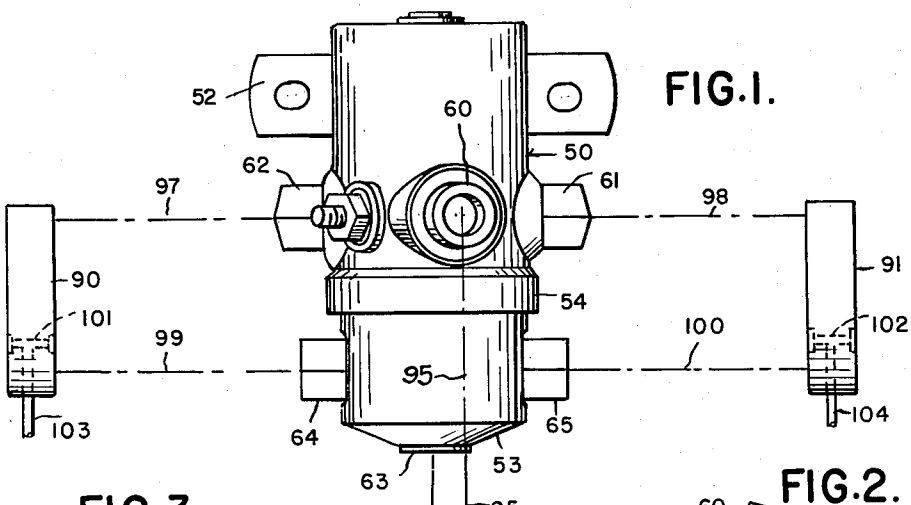

FIG.1.

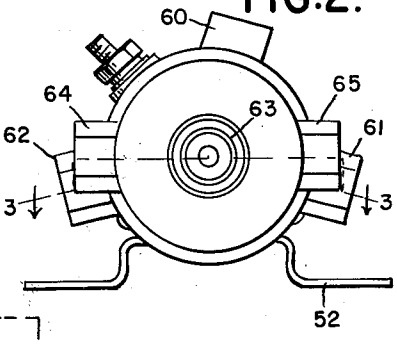

FIG.2.

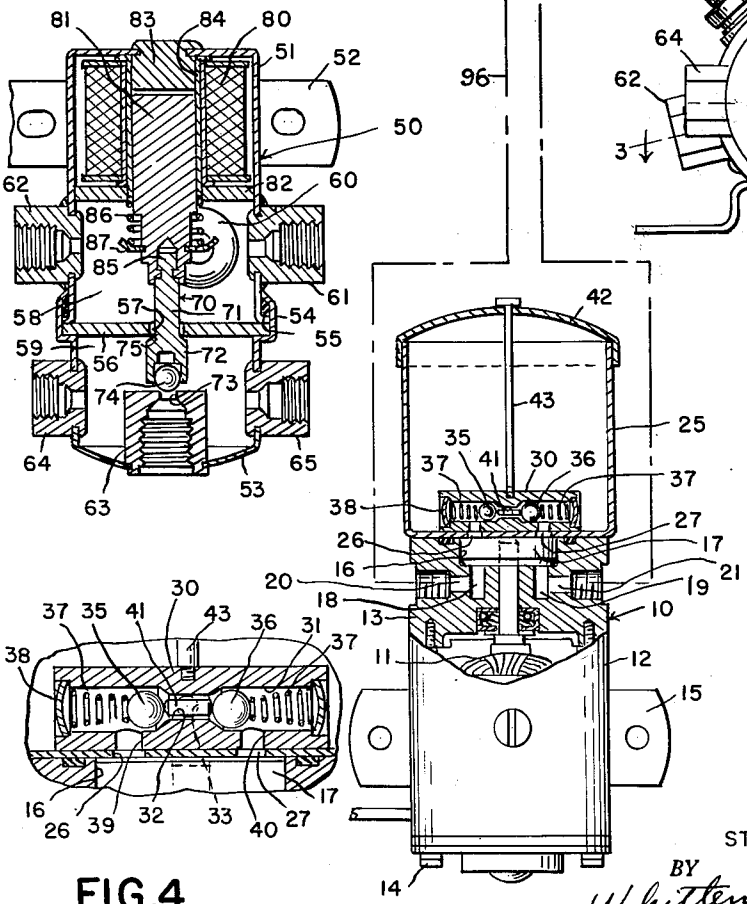

FIG.4.

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PUMP AND MOTOR HYDRAULIC SYSTEM

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1

The present invention relates to a hydraulic power system and more particularly to a hydraulic power unit designed for use in the system.

The invention is illustrated in connection with a pair of hydraulic motors which in the present instance are shown as pistons and cylinders. While the system has many possible applications, it is particularly useful as a system for operating tops of convertible vehicles. When used as a system for supplying power for raising and lowering the tops of convertible vehicles, it is desirable to provide for manual operation of the top in the event that power is not available for operation. Accordingly, a system has been devised to permit manual operation of the hydraulic motor in the event of power failure, and further provides for differential flow of hydraulic fluid to and from the hydraulic motor which is required by the difference in displacement due to the presence of the piston rod in the cylinder.

With the foregoing general remarks in mind, it is an object of the present invention to provide a hydraulic system for power actuation of mechanism which permits manual manipulation of the mechanism in the event of power failure.

It is a further object of the present invention to provide, in a hydraulic system, means compensating for differential flow of hydraulic fluid to and from a fluid motor.

It is a further object of the present invention to provide a hydraulic system including a reversible pump, a reservoir connected to the pump, valve means controlling the connections between the reservoir and pump, and additional valve means for controlling the flow of fluid from the pump to and from a hydraulic motor.

It is a further object of the present invention to provide a hydraulic power unit having valve means therein effective to open or close a by-pass connection to permit manual operation of fluid operated mechanism in the event of power failure in the hydraulic system.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawing, wherein:

Figure 1 is a diagrammatic view of the complete hydraulic system, with the hydraulic motors indicated diagrammatically and with the pump and reservoir unit partly in section;

Figure 2 is an end elevation of the hydraulic power unit employed in the system;

Figure 3 is a longitudinal section taken on the line 3—3 of Figure 2 so as to pass axially through the pump and motor connections; and

2

Figure 4 is an enlarged fragmentary section of the valve structure shown in Figure 1.

Referring now to the figures, in Figure 1 there is indicated at 10 a combined pump and reservoir unit which comprises an electric motor 11 mounted within a casing 12 which in turn is supported from a block 13 by suitable securing means such as the elongated attaching screws 14. An apertured bracket for attaching the unit to a suitable support surface is indicated at 15.

The block 13 at its upper surface is provided with a cylindrical recess 16, as best seen in the enlarged scale illustrated in Figure 4, which receives a gear pump 17 of the type comprising an internally toothed cylindrical member and an externally toothed pinion rotatable therein in which the pinion is provided with one less tooth than the internally toothed gear. The block 13 is provided with passages 18 and 19 communicating with opposite sides of the pump. A transverse passage 20, the outer portion of which is tapped for the reception of a suitable connecting device, is provided and communicates with the passage 18. A similar passage 21 communicating with the passage 19 is provided at the opposite side of the pump. A plurality of selectively operable hydraulic devices may be connected thereto. The motor 11 is reversible and it will be appreciated that the passages 19 and 21 and the passages 18 and 20 will be inlet or outlet passages, depending upon the direction of rotation of the motor.

Secured to the upper side of the block 13 is a reservoir 25 which is illustrated as formed of sheet metal and provided with ports 26 and 27 communicating with opposite sides of the pump 17. Located on the bottom of the reservoir 25 is a valve block 30 having a passage 31 extending longitudinally therethrough, the intermediate portion of which is reduced as indicated at 32. Communicating with the reduced portion 32 of the transverse passage 31 is a second passage 33 which communicates with the interior of the reservoir 25.

Located in the enlarged end portions of the passage 31 are ball valves 35 and 36 respectively, each being provided with a compression spring 37 urging the ball valve toward the seat formed by a conical portion interconnecting the intermediate reduced portion 32 of the passage and the relatively enlarged end portions thereof. The springs 37 are retained in place by sealing disks 38 which close opposite ends of the transverse passage 31. Opposite ends of the transverse passage 31 are connected to ports 26 and 27 respectively by transverse passages 39 and 40. Located

within the reduced portion 32 of the transverse passage 31 is a pin 41 of somewhat greater length than the reduced portion 32 which serves to prevent simultaneous seating of the ball valves 35 and 36. In the intermediate neutral position of the valves when no pressure is being applied thereto by the pump 17 the pin cooperating with the balancing springs 37 will result in both the ball valves 35 and 36 remaining off their respective seats by a small distance and thereby will permit a restricted flow of fluid therepast.

As illustrated, the reservoir 25 is provided with a removable cover 42 secured in place by an elongated bolt 43 which is threaded into a suitably tapped opening at the top of the valve block 30.

Referring now to Figure 3, the construction of the hydraulic power unit 50 is illustrated. This unit comprises an upper cylindrical casing portion 51 having an apertured supporting bracket 52 secured thereto and a lower generally cylindrical casing portion 53. Casing portions 51 and 53 are secured together in alignment by means of a reversely bent flange 54 formed on the casing portion 53 which cooperates with an outwardly turned flange 55 on the casing portion 51. A transverse partition 56 is supported between the flange portions 54 and 55. The partition 56 is provided with a port 57 which affords communication between the upper valve chamber 58 and the lower valve chamber 59.

Various inlet and outlet connections are provided to the upper chamber 58 and the lower chamber 59. The upper chamber 58 has a pump connection 60 and a pair of motor connections 61 and 62, all of these connections being located in the outer cylindrical wall of the casing portion 51. The lower chamber 59 is provided with a pump connection 63 which is located in the end wall of the casing portion 53 in alignment with the port 57 formed in the partition 56. In addition, a pair of motor connections 64 and 65 are provided. The connections 60, 61, 62, 63, 64 and 65 are in the form of internally threaded nipples appropriately secured to openings formed in the walls of the casing portions 51 and 53.

A valve element 70 is provided and has a reduced portion 71 passing through the port 57 and an enlarged portion 72 intermediate the partition and the pump connection 63. The pump connection 63 has a port 73 therein which provides a seat for a ball valve 74 rigidly secured to the lower end of the valve element 70. Intermediate the reduced portion 71 and the enlarged portion 72 of the valve element is a conical portion 75 which is constructed to serve as a valve in cooperation with the port 57.

The valve 70 is a two-position valve, its first position being the lower position, in which case the ball valve 74 seats upon and closes the port 73 formed in the pump connection 63. The second position of the valve 70 is the upper position as illustrated in Figure 3, at which time the conical portion 75 of the valve element seats in and closes the port 57 in the partition 56.

Means are provided for moving the valve between its two positions and these means take the form of a solenoid mounted in the upper casing portion 51 and comprising a winding 80 and a core 81 movable axially of the winding. The core 81, as illustrated in Figure 3, is solid and accordingly substantial forces can be exerted thereon by energization of the winding 80. The solenoid is mounted in the casing portion 51 by an annular plate 82 and by a plug 83 secured within a sleeve 84 located within the winding 80.

The core 81 is rigidly connected to the valve 70, the lower end of the core being suitably shaped to receive an enlarged end portion 85 thereof.

A compression spring 86 surrounds the lower end of the core where it extends beyond the winding 80 and engages an annular dished spring seat 87 which is supported in an annular groove adjacent the lower end of the core 81. The upper end of the spring 86, as illustrated, bears against the sleeve 84.

Referring again to Figure 1, the pump and reservoir assembly is connected to a pair of hydraulic motors 90 and 91 through the hydraulic power unit 50. The pump connector 60 on the unit 50 is connected by means of a conduit 95 to the pump passages 19 and 21. The other pump connector 63 is connected to the remaining pump passages 18 and 20 by a conduit 96. The motor connecters 62 and 61 are connected respectively to corresponding ends of the cylinders 90 and 91 by conduits 97 and 98 respectively. The motor connecters 64 and 65 are connected to the opposite ends of the cylinders 90 and 91 by conduits 99 and 100 respectively.

Before proceeding with an explanation of the operation of the system, attention is directed to the fact that the cylinders 90 and 91 during movements of the pistons 101 and 102 therein will cause a differential flow of hydraulic fluid through the conduits 97 and 98 on the one hand and the conduits 99 and 100 on the other hand. This is for the reason that the piston rods 103 and 104 displace a certain amount of fluid from the underside of the pistons 101 and 102. Accordingly, as the pistons move downwardly, for example, a greater quantity of fluid will be flowing through conduits 97 and 98 than will be returning through conduits 99 and 100.

Considering first the operation of the combined pump and reservoir unit, it is assumed first that the pump 17 is rotating in such direction that fluid pressure is built up in passages 19 and 21 and will accordingly cause flow of fluid out of these passages. At the same time, the port 27 and passage 40 in the valve block 30 are exposed to pressure and accordingly pressure will build up in the right-hand end of the transverse passage 31 (as seen in Figure 4), causing the ball valve 36 to move to the left and engage its seat. Movement of the ball valve 36 to the left moves the ball valve 35 away from its seat through the medium of the pin 41, thereby establishing a connection between the reservoir 25 and the suction side of the pump 17 through the passage 33, the reduced portion 32 of the transverse passage 31, the left-hand end of the passage 31, the passage 39 and the port 26. Accordingly, if a differential flow exists between the pressure and suction side of the pump so that more fluid moves through the conduit 95 than is returning through the conduit 96, the deficiency may be made up by fluid withdrawn from the reservoir. If on the other hand operation of the motor results in the return of more fluid through the conduit 96 than is forced through the conduit 95 by the pump 17, the excess fluid may escape into the reservoir through the ports and passages enumerated. If the motor 11 is reversed the operation is identical with the exception that the passages formerly acting as outlet passages now serve as inlet passages.

Suitable circuit-controlling means are provided which insure that when the motor 11 is energized to operate motors 90 and 91, the solenoid wind-

ing 80 is also energized. Accordingly, at any time that the motor 11 is running in either direction to operate motors 90 and 91 the solenoid winding is energized, the solenoid core is moved upwardly as seen in Figure 3 and the valve element 70 serves to close the port 57 in the partition 56 and at the same time retains the ball valve 74 away from its seat 73 in the pump connecter 63.

It is assumed that the pump was rotating in a direction which supplied pressure fluid through the conduit 95 and this fluid enters the upper valve chamber 58 through the pump connecter 60. Since the valve element 70 has closed the port 57 in the partition 56 this fluid flows outwardly through the motor connecters 61 and 62 and thence into the upper ends of the cylinders 90 and 91. Downward movement of the pistons 101 and 102 in the cylinders results in the displacement of fluid from beneath the pistons through the conduits 99 and 100 into the motor connecters 64 and 65 respectively. As previously stated, the ball valve 74 at this time is off the seat 73 and accordingly this fluid escapes through the pump connecter 63 and returns through the conduit 96 to the pump.

If the motor 11 were reversed the flow of fluid would be from the pump through the conduit 96 to the pump connecter 63, thence outwardly through the motor connecters 64 and 65 through conduits 99 and 100 respectively to the underside of the cylinders 90 and 91. Fluid displaced from above the pistons 101 and 102 would move from the cylinders 90 and 91 through conduits 97 and 98 to motor connecters 62 and 61 respectively and thence outwardly through the pump connecter 60 and conduit 95 to the pump.

At any time when the solenoid winding 80 is not energized the valve 70 is urged to its first or lowermost position by the compression spring 86, at which time a by-pass connection is established between the chambers 58 and 59 through the port 57 in the partition 56. Accordingly, if for any reason there is a failure of electric power or if the solenoid 80 cannot be energized, it is still possible to effect manual operation of the mechanism connected to the motors 90 and 91. Manual movement of the pistons 101 and 102 in either direction in their cylinders will result in a flow of fluid through the conduits 97 and 98 and 99 and 100 in accordance with the direction of movement of the pistons and there will be a corresponding flow of fluid through the by-pass port 57 in the partition 56. Differential flow of fluid between the conduits 97 and 98 on the one hand and the conduits 99 and 100 on the other is permitted since the pump connecter 60 affords open connection to the reservoir 25 at any time when the pump 17 is idle. Thence when pistons 101 and 102 are manually moved upwardly as seen in the figure, thus displacing fluid from the operating portion of the system, this excess fluid passes through conduit 95 to the pump 17 and thence past the ball valve 36 through the passage 33 into the reservoir. Upon movement of the pistons in the opposite direction the total volume of the operating portion of the system is increased and the operating portion of the system remains completely filled with fluid as a result of a flow of fluid from the reservoir 25 past the ball valve 35, through the pump 17 and thence through the conduit 95.

If the pump is connected to one or more additional hydraulically operated units such for example as window lifters or means for sliding the seat of the motor vehicle, the power unit 50 permits selective actuation of the accessories in a very desirable manner. By way of example it may be assumed that the pump is connected to a window lifting motor which preferably must be provided with a solenoid operated control valve. When the solenoid comprising the winding 80 and core 81 is de-energized, the ball valve 74 is on the valve seat 73 and is effective to prevent actuation of the motors 90 and 91 when the pump 17 is operating. The pump 17 will therefore be effective to operate additional accessory hydraulic motors. Moreover, while the closure of the valve port 73 by the ball valve 74 prevents actuation of the motors 90 and 91, it does not prevent manual operation of the device connected to these motors since the requisite by-pass flow of hydraulic fluid may take place through the by-pass port 57, and the flow of fluid caused by differential displacement at opposite sides of the pistons 101 and 102 may take place as above outlined through the hydraulic line 95, which under these conditions is in communication with the interior of the reservoir 25.

It will thus be seen that the apparatus disclosed herein provides efficient means for interconnecting a reversible hydraulic pump to one or more hydraulically operated motors with provision for permitting differential suction and discharge flow and with additional provision providing for manual operation of the hydraulic motor means and mechanism operated thereby in the event of power failure.

The drawing and the foregoing specification constitute a description of the improved hydraulic power unit in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. A fluid power system comprising a reversible pump, a passage between opposite sides of said pump, a fluid reservoir connected to said passage, a normally open valve in said passage effective to close said passage to the pressure side of said pump and to open the passage between the reservoir and the suction side of said pump when said pump is operating, and to open the passage between the reservoir and both sides of said pump when said pump is idle, a valve body comprising a chamber having an intermediate partition provided with a by-pass port therethrough, a first pump conduit connecting one side of said pump to said chamber at one side of said partition, a second pump conduit connecting the other side of said pump to said chamber at the other side of said partition, a fluid motor, a first motor conduit connection at one side of said partition, a second motor conduit connecting the other side of said motor to said chamber at the other side of said partition, and a two-position valve in said chamber effective in the first position to close one of said pump conduits and in the second position to close said by-pass port.

2. A fluid power system comprising a reversible pump, a passage between opposite sides of said pump, a fluid reservoir connected to said passage, a normally open valve in said passage effective to close said passage to the pressure side of said pump and to open the passage between the reservoir and the suction side of said pump when said pump is operating, and to open the passage between the reservoir and both sides of said pump when said pump is idle, a valve body comprising a chamber having an intermediate

partition provided with a by-pass port therethrough, a first pump conduit connecting one side of said pump to said chamber at one side of said partition, a second pump conduit connecting the other side of said pump to said chamber at the other side of said partition, a fluid motor of the type requiring a differential flow of fluid between inlet and outlet, a first motor conduit connecting one side of said motor to said chamber at one side of said partition, a second motor conduit connecting the other side of said motor to said chamber at the other side of said partition, and a two-position valve in said chamber effective in the first position to close one of said pump conduits and in the second position to close said by-pass port.

3. A fluid power system comprising a reversible pump, a passage between opposite sides of said pump, a fluid reservoir connected to said passage, a normally open valve in said passage effective to close said passage to the pressure side of said pump and to open the passage between the reservoir and the suction side of said pump when said pump is operating, and to open the passage between the reservoir and both sides of said pump when said pump is idle, a valve body comprising a chamber having an intermediate partition provided with a by-pass port therethrough, a first pump conduit connecting one side of said pump to said chamber at one side of said partition, a second pump conduit connecting the other side of said pump to said chamber at the other side of said partition, a fluid motor of the type requiring a differential flow of fluid between inlet and outlet, a first motor conduit connecting one side of said motor to said chamber at one side of said partition, a second motor conduit connecting the other side of said motor to said chamber at the other side of said partition, a two-position valve in said chamber effective in the first position to close one of said pump conduits and in the second position to close said by-pass port, resilient means urging said valve toward one position and a solenoid effective when energized to move said valve to its other position.

4. A fluid power system comprising a reversible pump, a passage between opposite sides of said pump, a fluid reservoir connected to said passage, a normally open valve in said passage effective to close said passage to the pressure side of said pump and to open the passage between the reservoir and the suction side of said pump when said pump is operating, and to open the passage between the reservoir and both sides of said pump when said pump is idle, a valve body comprising a chamber having an intermediate partition provided with a by-pass port therethrough, a first pump conduit connecting one side of said pump to said chamber at one side of said partition, a second pump conduit connecting the other side of said pump to said chamber at the other side of said partition, a fluid motor of the type requiring a differential flow of fluid between inlet and outlet, a first motor conduit connecting one side of said motor to said chamber at one side of said partition, a second motor conduit connecting the other side of said motor to said chamber at the other side of said partition, a two-position valve in said chamber effective in the first position to close one of said pump conduits and in the second position to close said by-pass port, resilient means urging said valve toward said first position and a solenoid effective when energized to move said valve to its said second position.

5. A fluid power system comprising a reversible pump, an electric motor therefor, a passage between opposite sides of said pump, a fluid reservoir connected to said passage, a normally open valve in said passage effective to close said passage to the pressure side of said pump and to open the passage between the reservoir and the suction side of said pump when said pump is operating, and to open the passage between the reservoir and both sides of said pump when said pump is idle, a valve body comprising a chamber having an intermediate partition provided with a by-pass port therethrough, a first pump conduit connecting one side of said pump to said chamber at one side of said partition, a second pump conduit connecting the other side of said pump to said chamber at the other side of said partition, a fluid motor of the type requiring a differential flow of fluid between inlet and outlet, a first motor conduit connecting one side of said motor to said chamber at one side of said partition, a second motor conduit connecting the other side of said motor to said chamber at the other side of said partition, a two-position valve in said chamber effective in the first position to close one of said pump conduits and in the second position to close said by-pass port, resilient means urging said valve toward said first position, a solenoid effective when energized to move said valve to its said second position, and means for energizing said solenoid when said motor is operating to actuate said fluid motor.

6. A fluid valve comprising a valve chamber having an intermediate partition provided with a port therethrough, pump connections at opposite sides of said partition, motor connections at opposite sides of said partition, and a two-position valve in said chamber effective in its first position to close one of said pump connections and in the second position to close said port.

7. A fluid valve comprising a valve chamber having an intermediate partition provided with a port therethrough, pump connections at opposite sides of said partition, motor connections at opposite sides of said partition, a two-position valve in said chamber effective in its first position to close one of said pump connections and in the second position to close said port, resilient means urging said valve toward its first position, and a solenoid effective when energized to move said valve to its second position.

8. A fluid valve comprising a valve chamber having an intermediate partition provided with a port therethrough, pump connections at opposite sides of said partition, motor connections at opposite sides of said partition, a two-position valve in said chamber effective in its first position to close one of said pump connections and in the second position to close said port, resilient means urging said valve toward its first position, and a solenoid effective when energized to move said valve to its second position, said valve in its first position opening said port and permitting by-pass flow of fluid therethrough to provide for manual operation of motor means connected to said motor connections.

9. A fluid valve comprising a casing having a partition extending thereacross, a port through said partition, pump connections to said casing at opposite sides of said partition, one of said connections being aligned with said port and providing a valve seat in said casing, a two-position valve element extending through said

port having a first valve portion effective in the first position to seat on said valve seat and having a second valve portion effective in the second position of said valve element to seat on said port.

10. A fluid valve comprising a casing having a partition extending thereacross, a port through said partition, pump connections to said casing at opposite sides of said partition, one of said connections being aligned with said port and providing a valve seat in said casing, a two-position valve element extending through said port having a first valve portion effective in the first position to seat on said valve seat and having a second valve portion effective in the second position of said valve element to seat on said port, resilient means urging said valve element toward its first position, and a solenoid effective when energized to move said valve element to its second position.

11. A fluid valve comprising a casing having a partition extending thereacross, a port through said partition, pump connections to said casing at opposite sides of said partition, one of said connections being aligned with said port and providing a valve seat in said casing, a two-

position valve element extending through said port having a first valve portion effective in the first position to seat on said valve seat and having a second valve portion effective in the second position of said valve element to seat on said port, resilient means urging said valve element toward its first position, and a solenoid in said casing having a core connected to said valve element and effective when energized to move said valve element to its second position.

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