March 11, 1952 S. B. McLEOD 2,588,644

HYDRAULIC POWER UNIT

Filed Sept. 29, 1947

2 SHEETS—SHEET 1

FIG.1.

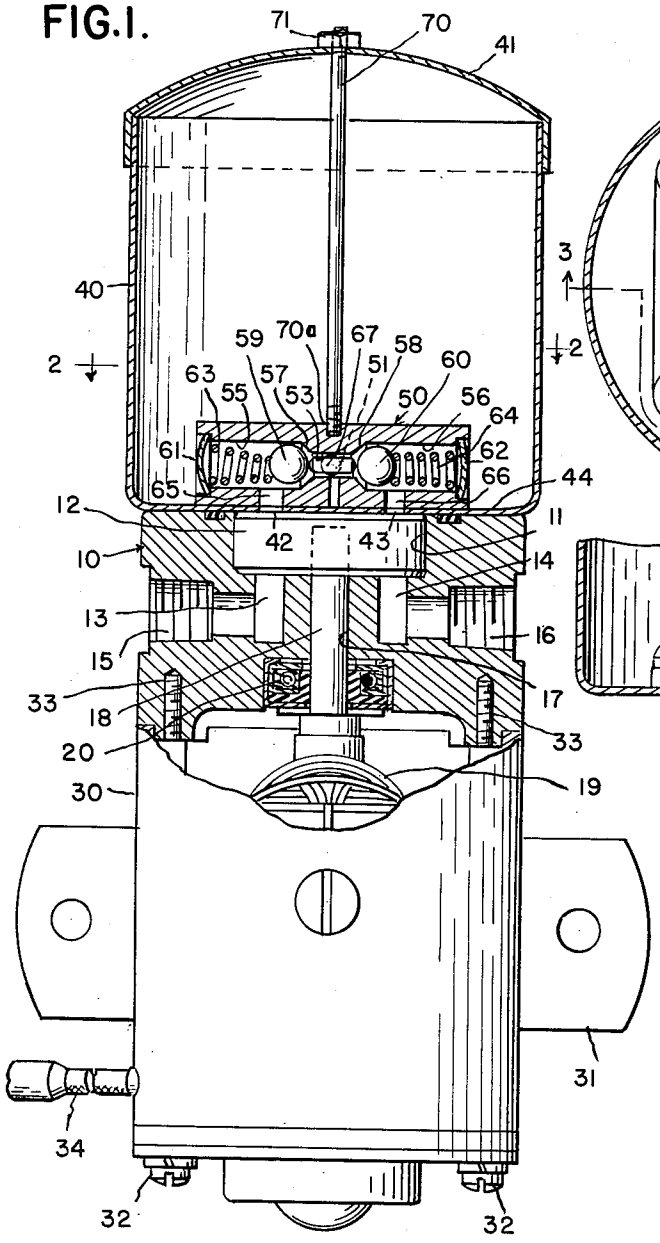
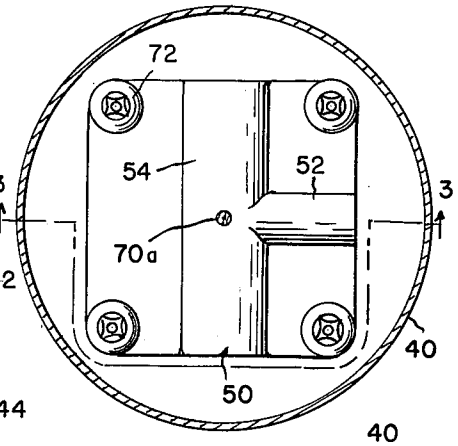


FIG.2.



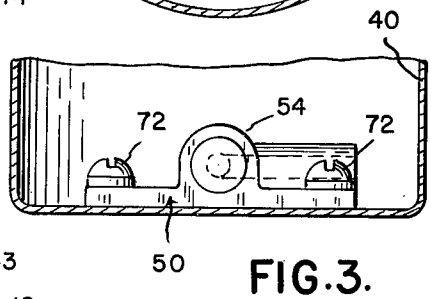


FIG.3.

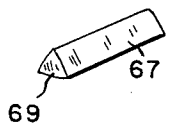


FIG.4.

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HYDRAULIC POWER UNIT

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2 SHEETS—SHEET 2

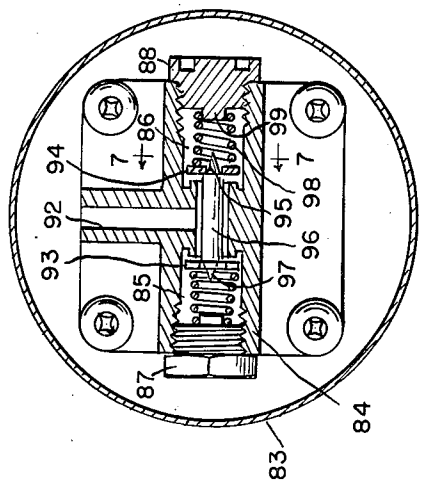


FIG.6.

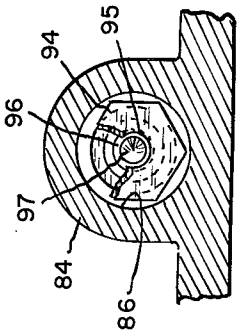


FIG.7.

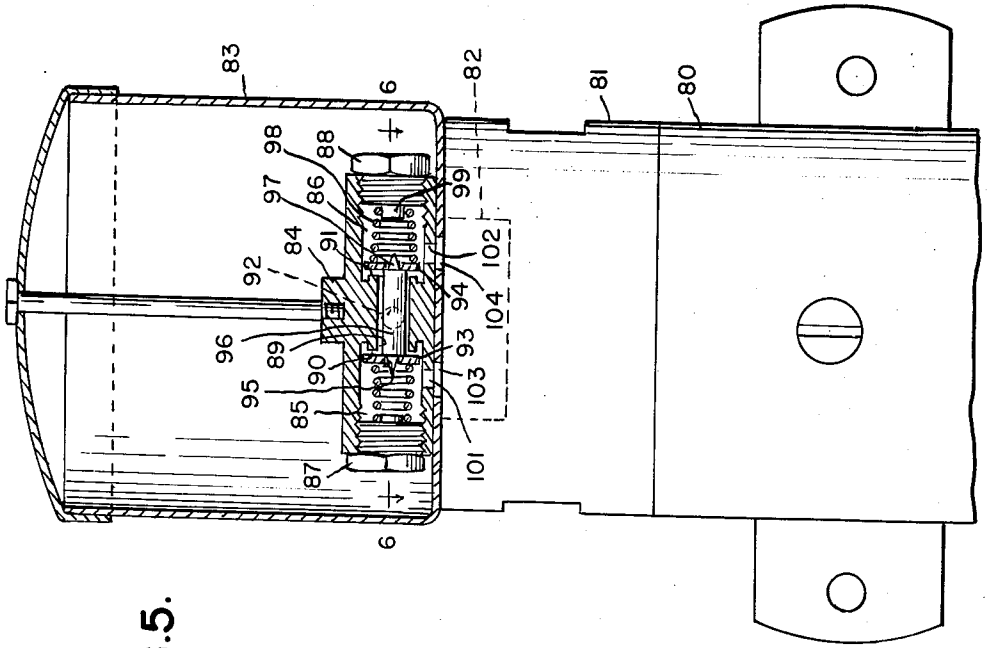


FIG.5.

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HYDRAULIC POWER UNIT

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Application September 29, 1947, Serial No. 776,635

15 Claims. (Cl. 103—2)

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The present invention relates to hydraulic power unit and more particularly to a combined pump, motor, reservoir and control valves therefor.

The present invention is capable of general application but may be used in the type of system disclosed in my prior Patent 2,388,755 granted November 13, 1945.

In accordance with the present invention, a hydraulic system including a reversible pump is provided with a by-pass and reservoir connection unit which serves to seal the pressure side of the pump and open the suction side of the pump to the reservoir to compensate for unequal volumes of flow due to piston rod displacement when the pump is connected to a hydraulic cylinder having a piston rod at only one side of a piston in the cylinder. In one embodiment of the present invention the mechanism is further constructed to afford pressure relief so as to prevent development of excessive pressures at the pressure side of the pump. Inasmuch as in the present construction the fluid flow is not through the unit to the cylinders or fluid motors, the unit can be made without regard to flow areas through the valve and consequently may be relatively small and inexpensive.

It is an object of the present invention to provide an improved hydraulic power unit characterized by its efficiency, extreme simplicity, the compactness of its arrangement and the economy with which it may be produced.

More specifically, it is an object of the present invention to combine a pump, motor, reservoir and control valves for supply fluid in a novel arrangement whereby a hydraulic system in which said unit is connected remains always fully charged with fluid.

It is a further object of the present invention to provide a reversible pump and reservoir unit in which the reservoir is connected at all times during operation of the pump to the suction side thereof.

It is a further object of the present invention to provide a by-pass connection for a reversible pump which remains open when the pump is idle to provide for manual operation of normally fluid operated mechanism but which is closed by operation of the pump in either direction.

It is a further object of the present invention to provide a by-pass between the pressure and suction sides of a pump adapted to remain open when the pump is idle, to close during normal pump operation, and to reopen in the event of

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excessive pressure at the pressure side of the pump.

It is a feature of the present invention to provide a hydraulic power unit comprising a block having a recess therein for the reception of a rotary pump, a motor supported from the block in driving relation with the pump, passages for circulating fluid communicating at one side of the recess with opposite sides of the pump, a fluid supply reservoir carried by the block having passages communicating at the opposite side of the recess with opposite sides of said pump, and valves for controlling the flow of supply fluid between the reservoir and pump.

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

Figure 1 is an elevation, partly in section, of my improved unit;

Figure 2 is a section on the line 2—2 of Figure 1;

Figure 3 is a section on the line 3—3 of Figure 2;

Figure 4 is a perspective view of the valve engaging element employed in my improved construction;

Figure 5 is a vertical elevation, partly in section, of a somewhat different embodiment of the present invention;

Figure 6 is a section on the line 6—6 of Figure 5; and

Figure 7 is an enlarged fragmentary section on the line 7—7 of Figure 6.

The present construction comprises a block 10 carried at the top of a motor housing 30 and supporting at its upper surface a fluid supply reservoir 40.

The block 10 is provided with a cylindrical recess 11 at its upper surface in which is mounted a rotary pump 12 of known type. Preferably the pump 12 is of the type comprising an annular, internally toothed rotor having a gear therein, the teeth of the gear being one less in number than the internal teeth of the rotor. Communicating with the bottom of the recess 11 is a pair of fluid circulating passages 13 and 14 which in turn connect with tapped connecting portions 15 and 16, respectively. It will be appreciated that the device illustrated is for use in supplying fluid to a hydraulic system and that the system will include conduits having threaded connecters cooperating with the connecting portions 15 and 16. Passages 13 and 14 serve as inlet and outlet connections to the pump, depending upon

the direction of rotation thereof. In other words, the pump is reversible and in one instance fluid will be drawn in through the passage 13 and discharged through the passage 14, whereas when the pump is rotated in the opposite direction, the direction of flow of the fluid is reversed.

The block 10 is provided with an opening 17 therethrough which is coaxial with the cylindrical recess 11 and which receives the drive shaft 18 of an electric motor indicated at 19. The lower end of the opening 17 is enlarged to receive a suitable seal and bearing 20 for the shaft 18.

The motor 19 is carried within the housing 30 which in turn is provided with mounting ears 31 by means of which the complete assembly is mounted for use. The housing 30 is assembled to the block 10 by means of long attaching screws 32 threaded into tapped recesses in the block 10 as indicated at 33. A conductor for supplying power to the motor 19 is illustrated at 34.

Located on the upper surface of the block 10 is the reservoir 40. As illustrated, the reservoir 40 may be in the form of a sheet metal cup having a removable closure 41. The bottom 44 of the reservoir 40 is provided with a pair of ports 42 and 43 which communicate with the pump 12 at opposite sides thereof. The bottom 44 further serves as a closure for the top of the pump-receiving recess 11.

Located within the reservoir 40 is a valve 50 which serves to provide and control fluid supply passages between the reservoir and the pump. A first passage 51 extends through a boss 52 and communicates with a short, relatively small transverse passage 53 formed in the central portion of a boss 54. At its outer ends the passage 53 communicates with enlarged end passages or openings 55 and 56. Intermediate the passage 53 and the two enlarged end openings 55 and 56 are conical valve seat portions 57 and 58, respectively. Located within the enlarged openings 55 and 56 are ball valves 59 and 60, respectively. The outer ends of the openings 55 and 56 are closed by caps 61 and 62, respectively, and intermediate the caps 61 and 62 and the ball valves 59 and 60 are balancing springs 63 and 64, respectively. Extending laterally from the enlarged openings 55 and 56 are supply passages 65 and 66 which communicate with the ports 42 and 43, respectively. Thus passage 51 may be considered as a supply passage connecting the reservoir to opposite sides of the pump through valve controlled branch passages comprising the passages 53, 55 and 65 as one branch, and the passages 53, 56 and 66 as the other.

Intermediate the ball valves 59 and 60 is a slidable element 67, shown in detail in Figure 4. The element 67 may conveniently be formed of metal of triangular cross section and preferably has rounded ends, as indicated at 69, to engage the ball valves 59 and 60. The element 67 is slidably received in the passage 53 but by virtue of its triangular cross section it permits flow of fluid through said passage 53.

The element 67 is of such length that when the ball valves 59 and 60 are symmetrically located with respect to their seats 57 and 58, respectively, both valves are in partially open position. On the other hand, it will be readily apparent that when one of the ball valves 59 or 60 closes by virtue of pressure existing in the passage with which it communicates, the other of the ball valves is mechanically moved to full open position.

Springs 63 and 64 are of substantially equal strength so that in the absence of pressure in the device the ball valves stand in the position shown in Figure 1.

The assembly of the parts includes the use of assembly bolts 72 (Figure 2) which extend through the valve body 50 and through corresponding openings formed in the bottom 44 of the reservoir into suitably tapped openings formed in the upper surface of the block 10.

The cover or closure 41 for the reservoir 40 is illustrated as secured in place thereon by means of a tie bolt 70 threaded at its lower end into a suitably tapped recess 70a in the upper surface of the valve body 50 and provided at its upper end with a nut 71.

The operation of my improved device is believed to be readily apparent, especially when taken in consideration with the full discussion of my prior construction contained in Patent 2,388,755. However, for completeness, it may be noted that upon the establishment of pressure by operation of the pump 12 in the circulating fluid passage 14, pressure will simultaneously be established within the enlarged opening 56 and will close the valve 60. At this time suction is established in the passage 13 at the opposite side of the block 10 and also in the opening 55. At this time, since the ball valve 60 is forced on its seat by pressure, the ball valve 59 is in fully open position, thus establishing communication between the interior of reservoir 40 and the suction side of the pump. As a result of this, and in the event that the demand for fluid in the pressure side of the circulating system is more than can be supplied from the suction side thereof, the difference in fluid required is made up by withdrawing fluid from the reservoir, as will be readily apparent.

Another valuable function of the balanced arrangement of ball valves is serving as a by-pass around the pump 12. Thus where the unit is employed as a power unit for raising and lowering a convertible top, or other use, the balanced valves provide for a limited by-pass flow of fluid around the pump, and permits manual operation of the operated device. In this case flow of fluid is in one direction or the other through the following sequence of passages: passage 14, pump 12, port 43, passages 66, 53, 65, port 42, the other side of pump 12, and passage 13. Slow manual operation is permitted, whereas rapid operation with corresponding rapid flow of fluid through the valved passages will close one or the other of the ball valves, depending on the direction of flow.

Referring now to Figures 5 to 7, there is shown a somewhat different embodiment of the invention which while it operates on the same principles as the embodiment previously described has the additional function of pressure relief, as will presently appear. In this case the hydraulic power unit comprises a motor housing 80, a block 81 serving as the support for a pump 82, a reservoir 83 and a by-pass and reservoir connection unit indicated generally at 84. With the exception of the by-pass and reservoir connection unit 84, the construction of this embodiment is identical with that illustrated in Figure 1 and will therefore not be described in detail.

However, the by-pass and reservoir connection unit 84 provides the additional function of affording pressure relief in the event of attainment of excessive pressures at the discharge side of the pump 82.

The unit 84 is provided at its ends with en-

larged chambers 85 and 86 closed by threaded plugs 87 and 88 respectively. Intermediate the chambers 85 and 86 is a passage 89 of reduced diameter forming at its opposite ends valve seats 90 and 91. A reservoir passage 92 extends transversely from the unit 84 into the interior of the reservoir 83 and communicates with the reduced passage 89 intermediate the valve seats 90 and 91. Valve elements 93 and 94 are provided adjacent the valve seats 90 and 91, each of these valves being provided with a central port 95, as best illustrated in Figure 7. The valves 93 and 94 are of non-circular shape and are illustrated in Figure 7 as being hexagonal so as to provide for the flow of fluid around their edges within the chambers 85 and 86. Intermediate the valves 93 and 94 is a pin 96 which is of a smaller diameter than the internal diameter of the reduced passage 89 so as to provide for flow of fluid through the reduced passage either from end to end or from one end to and through the transverse reservoir passage 92. The ends of the pin 96 are provided with reduced extending portions 97 which are herein illustrated as conical and being of a diameter at their base substantially equal to the diameter of the port 95 formed in the valves. Intermediate the projecting end portions 97, the pin 96 is of somewhat larger diameter than the ports 95 formed in the valves so that when said valves are retained against the enlarged intermediate portion of the pin 96 as by spring pressure, the ports 95 are closed.

Balancing spring means are provided and take the form of compression springs 98 engaging the ported valves 93 and 94 at one end and seated at their other end against the plugs 87 and 88, these plugs being provided with centering projections 99 to retain the springs in centered relationship.

Means are provided for connecting chambers 85 and 86 to opposite sides of the pump 82 and these means take the form of passages 101 and 102 extending transversely from the chambers 85 and 86, respectively, and communicating with ports 103 and 104 formed in the bottom wall of the reservoir 83.

The operation of this embodiment of the invention is similar to that of the embodiment illustrated in Figure 1. When the pump is idle the springs 98 retain the pin 96 in centered position and the valves 93 and 94 are both retained away from their corresponding valve seats 90 and 91. At this time a by-pass is open between opposite sides of the pump comprising the port 103, the passage 101, chamber 85, reduced passage 89, chamber 86, passage 102 and port 104. By virtue of this arrangement a by-pass flow of fluid is permitted when the pump is idle. Therefore, the mechanism to which the pump is connected may be operated manually.

If now the pump is started in either direction pressure will build up at the pressure side thereof which communicates with the chamber 85 or 86 and this pressure will force the valve 93 or 94 onto its corresponding valve seat, thus closing the by-pass passage. However, closure of either valve 93 or 94 results in further opening of the other valve, thereby maintaining open the passage connecting the suction side of the pump with the interior of the reservoir to permit flow of fluid to or from the reservoir to compensate for unequal flow of fluid to and from the hydraulic motor.

If an excessive pressure is built up in either the chamber 85 or 86 as a result, for example, of interference with the normal operation of a device actuated by the hydraulic motor, the by-pass connection between opposite sides of the motor is again opened. This is accomplished by virtue of the pressure acting against one end of the pin 96 through the port 95 in the chamber subjected to the high pressure. When this pressure exerts a force sufficient to overcome compression of the spring opposing movement of the pin 96 away from the valve subjected to the excessive pressure, the pin 96 moves bodily away from said valve and thereby opens the port 95 in the valve. Accordingly by selecting the strength of the balancing springs 98, the maximum pressure which the pump 82 will deliver may be determined.

It is emphasized that the present construction represents a substantial improvement over my prior construction, particularly as to compactness, simplicity of mounting, efficiency of operation and the economy with which the construction may be produced.

The drawings 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. In a hydraulic system, a compact motor, pump, reservoir and valve assembly comprising a block having a vertical opening therethrough, a motor mounted at the underside of said block having a shaft extending through said opening, a recess in the top of said block communicating with said opening, a pump in said recess operatively connected to said shaft, fluid passages in said block connected with said pump, a fluid reservoir mounted at the top of said block and closing said recess, fluid passages connecting said reservoir to opposite sides of said pump, and valves in said last mentioned fluid passages, means interconnecting said valves to prevent simultaneous closure thereof, said valves being constructed and arranged to close the fluid passage connecting the reservoir to the pressure side of said pump and to open the fluid passage connecting the reservoir to the suction side of said pump.

2. In a hydraulic system, a compact motor, pump, reservoir and valve assembly comprising a block having a vertical opening therethrough, a reversible motor mounted at the underside of said block having a shaft extending through said opening, a recess in the top of said block communicating with said opening, a pump in said recess operatively connected to said shaft, fluid passages in said block connected with said pump, a fluid reservoir mounted at the top of said block and closing said recess, fluid passages connecting said reservoir to opposite sides of said pump, and valves in said last mentioned fluid passages, means interconnecting said valves to prevent simultaneous closure thereof, said valves being constructed and arranged to close the fluid passage connecting the reservoir to the pressure side of said pump and to open the fluid passage connecting the reservoir to the suction side of said pump.

3. In a hydraulic system, a block having a recess in its upper surface, a reversible pump in said recess, fluid passages in said block communicating with opposite sides of said pump, a supply reservoir carried at the top of said block, supply

passages extending through the bottom of said reservoir and communicating directly with opposite sides of said pump, pressure controlled supply valves in said supply passages, and means connecting said valves to prevent simultaneous closure thereof, said valves comprising a valve housing having a first passage communicating with said reservoir, a transverse passage provided with spaced valve seats and communicating with said first passage intermediate said seats, a ball valve for each of said seats, a slidable member mechanically interconnecting said ball valves to prevent simultaneous closure thereof, and balancing means normally retaining both of said ball valves open.

4. A pump and reservoir unit comprising a block having a recess in its upper surface, a reversible gear pump in said recess, a reservoir secured to the upper surface of said block and forming a closure for said recess and gear pump, ports in the bottom wall of said reservoir communicating with opposite sides of said pump, a by-pass and supply valve in said reservoir comprising a valve body on the bottom wall of said reservoir having ports in registry with the ports in said bottom wall, a by-pass passage connecting the ports in said valve body, a pair of aligned valve seats in said by-pass passage, valves cooperating with said valve seats, means preventing simultaneous closure of said valves, and a passage in said valve body affording communication between the interior of said reservoir and said by-pass passage at a point intermediate said valve seats.

5. A pump and reservoir unit comprising a block having a recess in its upper surface, a reversible gear pump in said recess, a reservoir having a bottom wall effective to close the top of said recess to complete a pump chamber, a by-pass valve body on the bottom wall of said reservoir, assembly elements extending through said valve body and said bottom wall into said block, and a valve controlled by-pass passage connecting opposite sides of said pump and extending through said bottom wall and said valve body, a supply passage in said valve body affording communication between said reservoir and said by-pass passage, normally open valves in said by-pass passage at opposite sides of said supply passage, and yieldable means retaining said valves open and effective to permit closure of the valve at the pressure side of said by-pass passage and means operable to increase the opening of the valve at the suction side of said by-pass passage as the other valve closes.

6. A pump and reservoir unit comprising a block having a recess in its upper surface, a reversible gear pump in said recess, a reservoir having a bottom wall effective to close the top of said recess to complete a pump chamber, a by-pass valve body on the bottom wall of said reservoir, assembly elements extending through said valve body and said bottom wall into said block, a valve controlled by-pass passage connecting opposite sides of said pump and extending through said bottom wall and said valve body, said valve body being thus immersed in fluid contained in the reservoir, said by-pass passage comprising a transverse passage extending completely through said valve body and enlarged at its ends to form chambers and having a reduced intermediate portion providing valve seats at the inner ends of said chambers, a passage connecting the reduced intermediate portion of said transverse passage with the interior of said reservoir, ball valves in said chambers, springs urging said ball valves toward said seats, and end closures for said chambers constituting spring seats.

7. A pump and reservoir unit comprising a block having a recess in its upper surface, a reversible gear pump in said recess, a reservoir having a bottom wall effective to close the top of said recess to complete a pump chamber, a by-pass valve body on the bottom wall of said reservoir, assembly elements extending through said valve body and said bottom wall into said block, a valve controlled by-pass passage connecting opposite sides of said pump and extending through said bottom wall and said valve body, said valve body being thus immersed in fluid contained in the reservoir, said by-pass passage comprising a transverse passage extending completely through said valve body and enlarged at its ends to form chambers and having a reduced intermediate portion providing valve seats at the inner ends of said chambers, a passage connecting the reduced intermediate portion of said transverse passage with the interior of said reservoir, ball valves in said chambers, springs urging said ball valves toward said seats, and end closures for said chambers constituting spring seats, and a rigid element in the reduced intermediate portion of said transverse passage of a length sufficient to hold both of said ball valves away from their respective seats.

8. A pump and reservoir unit comprising a block having a recess in its upper surface, a reversible gear pump in said recess, a reservoir having a bottom wall effective to close the top of said recess to complete a pump chamber, a by-pass valve body on the bottom wall of said reservoir, assembly elements extending through said valve body and said bottom wall into said block, and a valve controlled by-pass passage connecting opposite sides of said pump and extending through said bottom wall and said valve body, said valve body being thus immersed in fluid contained in the reservoir, said by-pass passage comprising a transverse passage extending completely through said valve body and enlarged at its ends to form chambers and having a reduced intermediate portion providing valve seats at the inner ends of said chambers, ball valves in said chambers, springs urging said ball valves toward said seats, and end closures for said chambers constituting spring seats, and a rigid element in the reduced intermediate portion of said transverse passage of a length sufficient to hold both of said ball valves away from their respective seats, said valve body having a second passage connecting at one end to the reduced intermediate portion of said transverse passage and at the other end opening directly into said reservoir adjacent the bottom thereof.

9. In a hydraulic system, a compact motor, pump, reservoir and valve assembly comprising a block having a vertical opening therethrough, a motor mounted at the underside of said block having a shaft extending through said opening, a recess in the top of said block communicating with said opening, said recess constituting the bottom and side walls of a pump chamber, rotary pumping means in said chamber operatively connected to said shaft, fluid passages in said block connected with said pump, a fluid reservoir and valve assembly mounted at the top of said block overlying said recess and constituting the top wall of said pump chamber, said reservoir and valve assembly having fluid passages

connecting said reservoir to opposite sides of said pump chamber, valve elements in said last mentioned passages, means interconnecting said valve elements to prevent simultaneous closure thereof, said valve elements being constructed and arranged to close the fluid passage connecting the reservoir to the pressure side of said pump and to open the fluid passage connecting the reservoir to the suction side of said pump.

10. In a hydraulic system, a compact motor, pump, reservoir and valve assembly comprising a block having a vertical opening therethrough, a motor mounted at the underside of said block having a shaft extending through said opening, a recess in the top of said block communicating with said opening, said recess constituting the bottom and side walls of a pump chamber, rotary pumping means in said chamber operatively connected to said shaft, fluid passages in said block connected with said pump, a fluid reservoir and valve assembly mounted at the top of said block overlying said recess and constituting the top wall of said pump chamber, said reservoir and valve assembly having fluid passages connecting said reservoir to opposite sides of said pump chamber, valve elements in said last mentioned passages, said valve elements being constructed and arranged to close the fluid passage connecting the reservoir to the pressure side of said pump and to open the fluid passage connecting the reservoir to the suction side of said pump.

11. In a hydraulic system, a compact motor, pump, reservoir and valve assembly comprising a block having a vertical opening therethrough, a motor mounted at the underside of said block having a shaft extending through said opening, a recess in the top of said block communicating with said opening, a pump in said recess operatively connected to said shaft, fluid passages in said block connected with said pump, a fluid reservoir mounted at the top of said block and closing said recess, fluid passages connecting said reservoir to opposite sides of said pump, and valves in said last mentioned fluid passages, said valves being constructed and arranged to close the fluid passage connecting the reservoir to the pressure side of said pump and to open the fluid passage connecting the reservoir to the suction side of said pump.

12. A block having a recess in one surface thereof, a pump in said recess, passages for circulating fluid formed in said block and communicating at the inner side of said recess with opposite sides of said pump, a supply reservoir on said block having a wall closing the outer side of said recess, a first passage including ports in said wall the opposite ends of which communicate at the outer side of said recess with opposite sides of said pump, a pair of balanced valves in said first passage, a second passage affording communication between said reservoir and said first passage intermediate said valves, rigid means interconnecting said valves arranged to provide for full opening of either valve upon closure of the other, and spring balancing means normally retaining both of said valves in partly open position.

13. A block having a cylindrical recess in one surface thereof, said recess constituting an end and side walls of a pump chamber, passages for circulating fluid formed in said block and communicating with opposite sides of said pump chamber, rotary pumping means in said chamber, a supply reservoir and valve assembly mounted against said block overlying said recess and constituting the other end wall of said chamber, said reservoir and valve assembly having a first fluid passage connected at opposite ends to opposite sides of said pump chamber, a second passage connecting an intermediate portion of said first passage to the interior of said reservoir, a pair of valve elements disposed in said first passage at opposite sides of the point of connection between said first and said second passage, said valve elements being constructed and arranged to close the portion of the first passage connected to the pressure side of said pump chamber and to open the portion of the first fluid passage connected to the suction side of said pump chamber.

14. The construction as defined in claim 13 including means interconnecting said valve elements to effect movement of either valve element to full open position upon movement of the other valve element to closed position.

15. In a hydraulic system, a block having a recess in its upper surface, a reversible pump in said recess, fluid passages in said block communicating with opposite sides of said pump, a supply reservoir mounted directly on the top of said block, the bottom wall of said reservoir having a pair of ports therein communicating directly with opposite sides of said pump, a valve body on the bottom wall of said reservoir, a supply passage in said valve body communicating with the interior of said reservoir, branch passages in said body connecting said supply passage to both of said ports, pressure controlled supply valves in said branch passages, and means connecting said valves to prevent simultaneous closure thereof.

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