Oct. 30, 1962 J. T. GONDEK 3,060,688

HYDRAULIC SYSTEMS

Filed Sept. 18, 1959 2 Sheets-Sheet 1

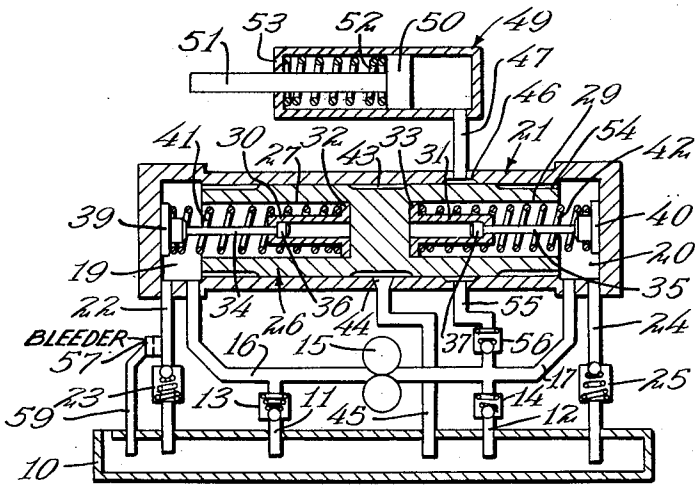


FIG. 1

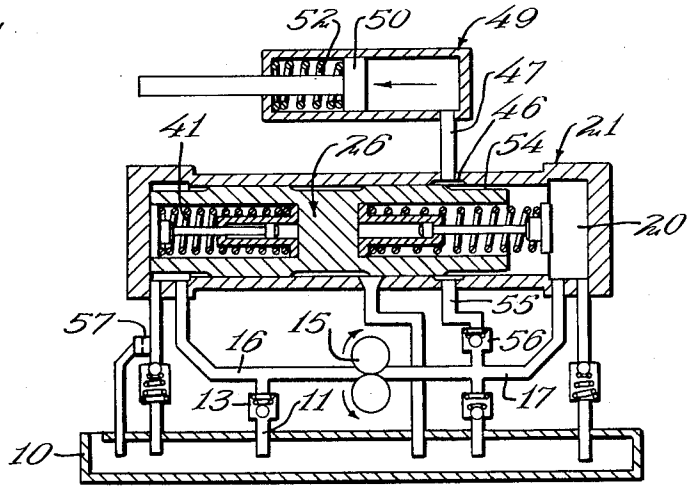


FIG. 2

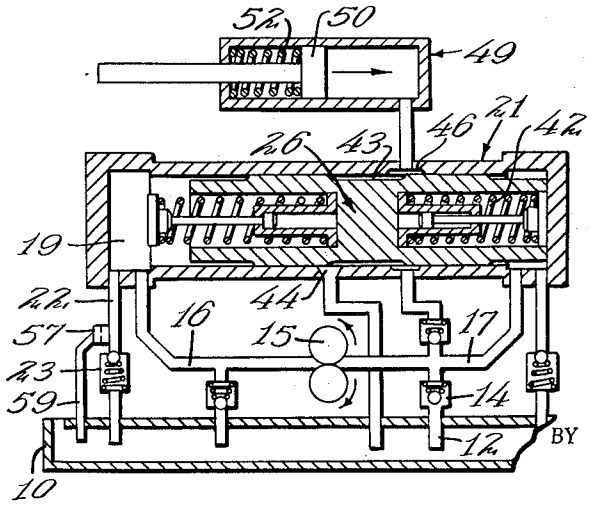


FIG. 3

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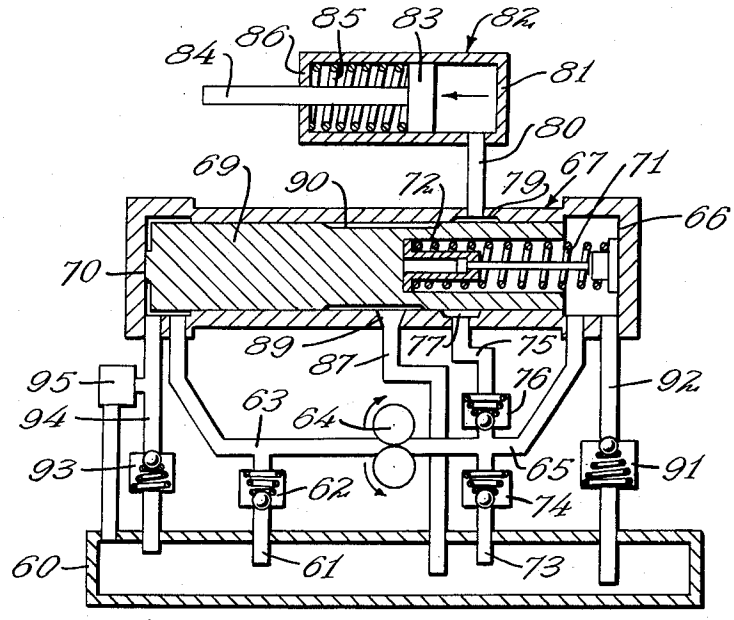


FIG. 4

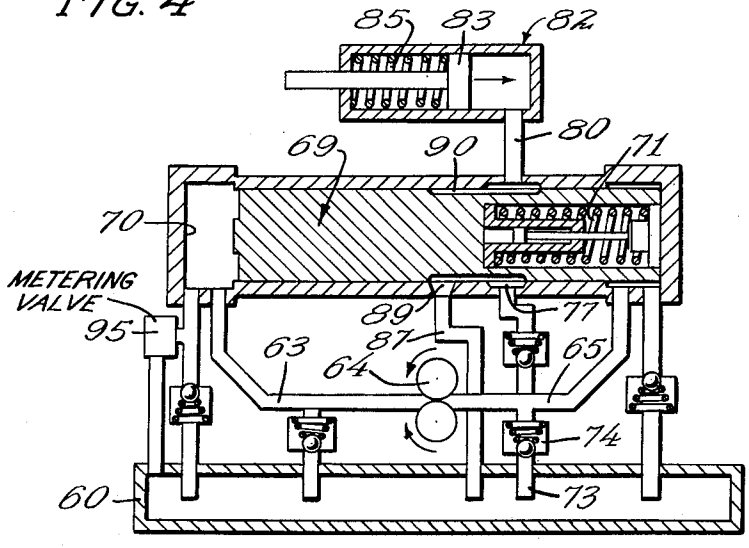


FIG. 5

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HYDRAULIC SYSTEMS

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9 Claims. (Cl. 60—52)

This invention relates to an improvement in hydraulic systems and deals particularly with a hydraulic system capable of moving an operating piston in one direction against spring pressure and holding the piston in any adjusted position.

Various types of devices which are reciprocated by use of a hydraulic piston require that the piston be held in an adjusted position for extended periods of time when the source of power supplying the hydraulic pressure is cut off. While this result may be accomplished through the use of a valve in the fluid supply line leading to the hydraulic piston, such a valve adds materially to the cost of construction, particularly where the valve must be automatically operated. It is an object of the present invention to provide a simple hydraulic system which will accomplish the desired result without the use of an added valve or other added elements.

A feature of the present invention resides in the provision of a hydraulic system including a reservoir, a reversible pump, a valve cylinder including a valve piston, and a hydraulic cylinder and piston which is operated by the valve. In the present system, the hydraulic piston is normally biased toward one extreme position by the use of a spring which acts to return the piston to a starting position when pressure on the opposite side of the piston is relieved.

A feature of the present invention resides in the provision of a valve which is urged in one direction when the hydraulic motor directs fluid to one end of the valve cylinder to open a port communicating with the hydraulic piston to act against the piston and to compress the spring acting there against. By driving the reversible pump in the opposite direction, the valve piston may be moved to an opposite extreme position which permits the flow of fluid from the hydraulic cylinder to the reservoir, permitting the spring to expand and urge the piston in the opposite direction. When the operation of the pump is stopped, the pressure acting against the valve piston is decreased through the use of a bleeder which permits a certain amount of fluid to return to the reservoir. The valve piston is of the automatic centering type so that the relief of pressure against the valve piston causes the piston to return to a central position in which the flow of fluid from the hydraulic cylinder to the reservoir is cut off.

These and other objects and novel features of the present invention will be more clearly and fully set forth in the following specification and claims.

In the drawings forming a part of the specification:

FIGURE 1 is a sectional view showing diagrammatically the hydraulic system with the operating piston in centered relation.

FIGURE 2 is a view similar to FIGURE 1 showing the flow of fluid when the pump is operating in one direction.

FIGURE 3 is a view similar to FIGURE 2, showing the position of the parts when the pump is operating in the opposite direction.

FIGURE 4 is a sectional view showing diagrammatically a modified form of hydraulic systems when the operator pump is operating in one direction.

FIGURE 5 is a view similar to FIGURE 4 showing the arrangement of parts when the pump is operating in the opposite direction.

At the outset, it should be understood that the drawings are diagrammatic and no particular attempt has been made to proportion the various conduits to provide a desired speed of operation. For example, the speed of movement of the piston in returning to its starting position by expansion of the operating spring or external force against the piston rod is dependent upon the size of the conduits allowing fluid to return to the reservoir. Furthermore, the time required for the centering of the valve piston is dependent upon the size of the bleeder which permits this operation. Obviously, these conduits and elements may be properly proportioned to accomplish a desired purpose. Additionally, the seals normally used on the valve piston and hydraulic piston have been omitted to simplify the showing.

As illustrated in the drawings, the hydraulic system includes a reservoir 10 designed to contain a supply of hydraulic fluid. A pair of conduits 11 and 12 extend into the reservoir 10 to receive hydraulic fluid therefrom. The conduits 11 and 12 include check valves 13 and 14 respectively which permit fluid to be withdrawn from the reservoir but which act to prevent a return flow of fluid to the reservoir.

A reversible pump 15 is interposed between opposed conduits 16 and 17 leading to opposite end chambers 19 and 20 of a valve cylinder 21. The conduit 11 is connected to the conduit 16 and the conduit 12 is connected to the conduit 17. As a result, when the pump 15 is operating in one direction as in FIGURE 2 of the drawings, hydraulic fluid will be drawn through the conduit 11 and conduit 16 to the pump 15 and forced through the conduit 17 to the right end chamber 20 of the valve cylinder 21. When the pump 15 operates in a reverse direction as indicated in FIGURE 3, hydraulic fluid is drawn through the conduit 12 and the conduit 17 to the pump 15 which forces the fluid under pressure through the conduit 16 to the left hand pressure chamber 19 of the valve cylinder 21.

The valve chamber 19 is connected by a conduit 22 containing a check valve 23 to the reservoir 10. The right hand chamber 20 is connected by a conduit 24 containing a check valve 25 to the reservoir 10. The check valves 23 and 25 are in the form of pressure relief valves which open only when abnormal pressures are experienced in the chambers 19 and 20 as would occur in the event the pump 15 continued in operation after the controlled fluid motor pistons had reached their limit of movement.

A valve piston 26 is slidably supported within the valve cylinder 21 and is provided with sockets 27 and 29 in its opposite ends. Thimble like guides 30 and 31 are provided at the bases of the sockets 27 and 29 and are provided with peripheral end flanges 32 and 33 respectively. Plungers 34 and 35 have enlarged heads 36 and 37 which are slidable in the thimbles 30 and 31, the rods 34 and 35 being provided with pressure plates 39 and 40 at their outer ends. Springs 41 and 42 are interposed between the thimble flanges 32 and 33 and the pressure plates 39 and 40. The springs 41 and 42 urge the valve piston 26 into the centered positions illustrated in FIGURE 1 of the drawings.

A valve piston 26 is provided with a central peirpheral groove 43 which is in communication with a port 44 leading to a return conduit 45 in all positions of the valve piston. The conduit 45 is provided to permit the drainage of fluid to the reservoir 10. The valve cylinder 21 is provided with an internal groove 46 communicating with a conduit 47 leading to one end of a work cylinder 49. The work cylinder 49 slidably supports a piston 50 provided with a piston rod 51 extending from the cylinder. In normal installations, a spring 52 is interposed between the end 53 of the cylinder 49 opposite that to which the conduit 47 extends. As a result, fluid under pressure may be forced into the cylinder 49 against the

piston 50 to move the piston 50 and compress the spring 52. When the pressure to the right of the piston 50 as shown in the drawings is released, the spring 52 will return the piston 50 toward its starting position. Usually the conduits such as the return conduit 45 are of restricted size so that the piston 50 moves gradually rather than suddenly.

The groove 46 is so positioned in the wall of the cylinder 21 as to communicate with the piston groove 43 when the piston valve 26 is in its right hand extreme position in the cylinder 21. The right hand end of the valve piston 26 is of reduced diameter as indicated at 54 to form a communication between the pressure chamber 20 and the cylinder 49 when the valve piston 21 is in its left hand extreme position as indicated in FIGURE 2 of the drawings.

A conduit 55 including a check valve 56 connects the conduit 17 with the valve cylinder groove or port 46. The check valve 56 permits fluid under pressure from the pump to flow into the groove 46 and through the conduit 47 to the work cylinder 49, but prevents fluid under pressure from flowing in a reverse direction from the cylinder 49. A bleeder 57 is connected to the conduit 22 or, in effect, to the pressure chamber 19. The bleeder 57 is connected by a conduit 59 to the reservoir 10.

The operation of the hydraulic system will now be described. When the pump 15 is operating in the direction indicated by the arrows in FIGURE 2 of the drawings, fluid is drawn from the reservoir 10 through the conduit 11 past the check valve 13, and into the conduit 16 leading to the pump intake. Fluid under pressure is directed to the conduit 17. This fluid may be transmitted through the conduit 55 and past the check valve 56 into the cylinder groove 46 connected by the conduit 47 to the right end of the cylinder 49. This fluid may therefore start moving the piston 50 to the left, compressing the spring 52.

Simultaneously, the fluid under pressure in the conduit 17 enters the pressure chamber 20 at the right end of the valve cylinder 21 and acts to move the valve piston 26 to the left. Thus the valve piston is moved to the left as well as the work piston 50 in the particular arrangement illustrated.

When it is desired to stop the movement of the piston 50, the pump 15 is stopped and the fluid is trapped in the right hand ends of the cylinders 49 and 21 so that the piston will remain in an adjusted position. In the event a certain amount of leakage takes place through the pump 15, the pressure to the right of the valve piston 26 will be relieved sufficiently to permit the spring 41 to move the valve piston 26 to the centered position shown in FIGURE 1 thus sealing the groove 46 by the wall of the valve piston.

When it is desired to move the piston 50 in the opposite direction, the pump 15 is rotated in the opposite direction as indicated by the arrows in FIGURE 3 of the drawings. This causes fluid to flow through the conduit 12, raising the check valve 14, and through the conduit 17 to the pump intake. The pump forces fluid under pressure through the conduit 16 to the pressure chamber 19 at the left end of the valve piston 26 thus moving this valve piston to the right as indicated in this figure. As the piston 26 moves to the right, the valve piston groove 43 bridges the space between the groove or port 46 and the pressure return port 44 allowing hydraulic fluid from the cylinder 49 to return to the reservoir and permitting the spring 52 to move the piston 50 to the right in the cylinder 49.

During this operation, a certain amount of the hydraulic fluid pumped by the pump 15 is bled off to the reservoir through the bleeder 57 and return conduit 59. Thus, as soon as the pump 15 is stopped, the pressure to the left of the valve piston 26 drops sufficiently to permit the spring 42 to return the valve piston to center position shown in FIGURE 1. Thus in this position, the port 46 is sealed by the wall of the valve piston 26 and the piston 50 remains in an adjusted position.

In some instances, the spring 52 biasing the piston 50 to the right may be omitted in the event there is a constant biasing force against the piston rod 51. In other words, if the piston 51 is subjected to a constant weight tending to move the piston, this biasing force may be substituted for the particular one disclosed. It should be understood, however, that whether or not the spring is provided, the piston is biased toward one end of the cylinder.

In the construction described, the valve piston 26 is movable in opposite directions from a central position. With this arrangement, once the piston 26 has moved into the position illustrated in FIGURE 2, the fluid may flow from the pump through the conduit 17 directly to the right hand end of the valve cylinder 21 through check valve 56 and connection 55 and through the groove such as 54 or reduced diameter end of the piston to the connection 47 to the work cylinder 49. In view of the fact that the connection 55 is directly connected to the connection 47 through the groove 46, the grooves or reduced diameter end portion of the piston can be eliminated. In FIGURES 4 and 5, I have described a modified form of construction which is somewhat simpler in design and in which the valve piston is normally biased toward one end of the valve cylinder.

The system disclosed in FIGURES 4 and 5 of the drawings includes a reservoir 60 having an outlet connection 61 connected through a check valve 62 to a connection 63 leading to a gear pump 64. The other port of the gear pump 64, which is of a reversible type, is connected to a connection 65 leading to the right hand end 66 of a valve cylinder 67. The valve cylinder 67 includes a valve piston 69 which is urged toward the opposite end 70 of the cylinder 67 by a resilient means 71 interposed between the base of the socket 72 and the end 66 of the cylinder. Suitable spring guide means of the type previously described may be used to hold the spring in its proper relation.

A second discharge line 73 from the reservoir including a check valve 74 is connected to the connection 65 leading to the gear pump 64 and the other port of the gear pump is connected by the connection 63 to the end 70 of the cylinder 67. The check valves 62 and 74 permit fluid to flow from the reservoir and prevent a reverse flow of fluid to the reservoir. A by-pass connection 75 including a check valve 76 is connected to a first port 77 in the wall of the valve cylinder 67 communicating with a groove 79 encircling the piston 69 and leading to a connection 80 extending from the valve cylinder to one end 81 of the work cylinder 82. A piston 83 is slidable in the cylinder 82 and operates a piston rod 84. A spring 85 is interposed between the end 86 of the cylinder 82 and the piston 83, to urge the piston toward the cylinder end 81.

The check valve 76 is arranged to permit liquid to flow from the pump through the connection 75 but prevents a reverse flow of fluid from the work cylinder when the valve piston 69 is in the position indicated in FIGURE 1. Fluid under pressure flowing through the connection 65 acts merely to assist the spring 71 in holding the piston 69 in the position shown in FIGURE 1 when the gear pump is operating in the direction described.

A discharge connection 87 extends from the reservoir 60 to a port 89 in the wall of the valve cylinder 67. The valve piston 69 is provided with a central portion of reduced diameter indicated at 90 which is of sufficient length to bridge the space between the ports 77 and 89 when the piston 69 is moved to the opposite extreme position indicated of FIGURE 5 of the drawings.

As in the previous arrangement, a pressure relief valve 91 is interposed in a connection 92 leading from the end 66 of the valve cylinder 67 to the reservoir 60 and a simi-

lar pressure relief valve 93 is interposed in a connection 94 between the end 70 of the valve cylinder 67 and the reservoir 60. A metering valve 95 may be provided in shunt relation to the pressure relief valve 93 to permit a gradual release of pressure in the end 70 of the cylinder.

When the pump 64 is operating in one direction, as viewed in FIGURE 4, fluid is drawn from the reservoir 60 through the outlet 61, past the check valve 62, and into the connection 63 leading to the pump 64. The fluid is forced through the connection 65 to the end 66 of the valve cylinder 67, acting to urge the piston 69 to the left. Due to the biasing action of the spring 71, the piston 69 is normally already in this position.

Fluid also is forced past the check valve 76 through the connection 75 and port 77, flowing through the peripheral groove 79 to the connection 80 leading to the end 81 of the work cylinder 82. The fluid then forces the piston 83 to the left, compressing the spring 85.

Whenever the pump 64 is stopped, the piston 83 will remain in fixed position due to the fact that fluid cannot flow in a reverse direction past the check valve 76. Unless leakage takes place past one of the pistons or through the check valve 76, the piston 83 will remain indefinitely in a selected position. While not illustrated in the drawings, effective seals are provided for preventing leakage about the pistons.

When it is desired to move the piston 83 in a reverse direction, the pump 64 is operated in a reverse direction as indicated in FIGURE 5. This causes fluid to be drawn from the reservoir 60 through the outlet 73, past the check valve 74, through the connection 65 to the pump 64. The fluid is then forced through the connection 63 to the left hand end 70 of the piston 69, urging the valve piston 69 to the right, compressing the spring 71. Sufficient clearance is provided between the ends of the piston and the ends of the cylinder to permit the fluid to move the piston.

As the piston 69 moves to the right, the reduced diameter portion 90 of the piston 69 acts as a bridge between the port 89 and the port 7 thus permitting fluids to flow from the work cylinder 82 through the connection 80, about the reduced diameter piston portion 90 and through the port 89, leading to the connection 87 leading to the reservoir 60. Thus in this position, the work piston 83 may be returned to its normal position by the spring 85.

From the position shown in FIGURE 5, if the pump is stopped, fluid may flow gradually through the orifice in the valve 95 and may gradually permit the drainage of liquid from the right hand end 70 of the cylinder 67. Accordingly, the piston 69 gradually is returned by the spring 71 to the position shown in FIGURE 4 after the work piston 83 has moved the desired amount, or returned to its starting position.

In accordance with the patent statutes, I have described the principles of construction and operation of my improvement in hydraulic systems, and while I have endeavored to set forth the best embodiment thereof, I desire to have it understood that changes may be made within the scope of the following claims without departing from the spirit of my invention.

I claim:

1. A hydraulic system including a reservoir, a pair of connections leading from said reservoir including check valves permitting a flow of fluid from but not to said reservoir, a reversible pump connected to said connections and capable of withdrawing fluid from one connection and forcing it toward the other, a valve cylinder, a valve piston reciprocable between two extreme positions in said valve cylinder, passage means connecting said connections at respective locations intermediate said check valves and said pump to opposite ends of said valve cylinder, a return connection from a point intermediate the ends of said valve cylinder to said reservoir, a port in said cylinder normally closed by said valve piston in centered position thereof but in communication with one end of said valve cylinder in one extreme position of said valve piston, a work cylinder, a conduit connecting one end of said work cylinder to said port, a work piston reciprocable in said work cylinder and normally biased toward said one end thereof, said valve piston defining a passage between said port and said return connection in the other extreme position of said valve piston, valve piston centering means biasing said valve piston toward centered position in which said port is closed, and a bleeder connection between the other end of said valve cylinder and said reservoir to relieve pressure in said other end of said valve cylinder when said other end of said valve cylinder is or is not, subjected to fluid under pressure.

2. The structure of claim 1 and including a conduit connecting the passage means connecting said pump to said one end of said valve cylinder with said port, and a check valve in said last mentioned conduit permitting the flow of fluid toward said port but preventing a reverse flow from said port.

3. A hydraulic system including a reservoir, a valve cylinder, a valve piston reciprocable in said valve cylinder between two extreme positions, means operable to selectively direct fluid under pressure from said resorvoir to either end of said valve cylinder, a return connection from a point intermediate the ends of said valve cylinder to said reservoir, a port in said cylinder normally closed by said valve piston in centered position thereof but in communication with one end of said valve cylinder in one extreme position of said valve piston, a work cylinder, a conduit connecting one end of said work cylinder to said port, a work piston reciprocable in said work cylinder and normally biased toward said one end thereof, said valve piston defining a passage between said port and said return connection in the other extreme position of said valve piston, valve piston centering means biasing said valve piston toward centered position in which said port is closed, and a bleeder connection between the other end of said valve cylinder and said reservoir to relieve pressure in said other end of said valve cylinder when said other end of said valve cylinder is or is not, subjected to fluid under pressure.

4. A hydraulic system including a reservoir, a pair of connections leading from said reservoir including check valves permitting a flow of fluid from but not to said reservoir, a reversible pump connected to said connections and capable of withdrawing fluid from one connection and forcing it toward the other, a valve cylinder, a valve piston reciprocable between two extreme positions in said valve cylinder, passage means connecting said connections at respective locations intermediate said check valves and said pump to one end of said valve cylinder and to a port intermediate the ends of said valve cylinder, a work cylinder including a work piston, means normally biasing said work piston toward one end of said work cylinder, a connection from said port to said one end of said work cylinder, means normally biasing said valve piston toward one position in said valve cylinder, a second port in said valve cylinder normally sealed from said first port when said valve piston is in said one position, said valve piston connecting said first and second ports when said valve piston is moved toward the other end of said valve cylinder, a connection from said second port to said reservoir, and means for bleeding fluid from said other end of said valve cylinder, whereby when said pump is operating in one direction, fluid is forced from said reservoir to said first port and to said work cylinder, and when said pump is operating in the opposite direction fluid is forced from said reservoir to said one end of said valve cylinder to force said valve piston toward the other end of said valve cylinder, whereupon said first and second ports are connected and said connection to

said work cylinder is connected to said connection from said second port to said reservoir.

5. The structure of claim 4 and including a check valve in the passage means connected to said first port to prevent a flow of fluid through said passage means from said first port.

6. A hydraulic system including a reservoir, a pair of connections leading from said reservoir including check valves permitting flow of fluid from but not to said reservoir, a reversible pump connected to said connections and capable of withdrawing fluid from one connection and forcing it toward the other, a valve cylinder, a valve piston reciprocable between two extreme positions in said valve cylinder, passage means connecting said connections at respective locations intermediate said check valves and said pump to one end of said valve cylinder and to a port intermediate the ends of said valve cylinder, a work cylinder including a work piston, means normally biasing said work piston toward one end of said work cylinder, a connection from said port to said one end of said work cylinder, means normally biasing said valve piston toward said one end of said valve cylinder, a second port in said valve normally sealed from said first port when said valve piston is at said one end of said valve cylinder, said valve piston connecting said first and second ports when said valve piston is moved toward the other end of said valve cylinder a connection from said second port to said reservoir, and means for bleeding fluid from said other end of said valve cylinder, whereby when said pump is operating in one direction, fluid is forced from said reservoir to said first port and to said work cylinder, and when said pump is operating in the opposite direction fluid is forced from said reservoir to said one end of said valve cylinder to force said valve piston toward the other end of said valve cylinder, whereupon said first and second ports are connected and said connection to said work cylinder is connected to said connection from said second port to said reservoir.

7. The structure of claim 6 and including a check valve in the passage means connected to said first port to prevent a flow of fluid through said passage means from said first port.

8. A hydraulic system including a work cylinder, a work piston slidably disposed in said work cylinder, means normally biasing said work piston toward one end of said cylinder, passage means for admitting and withdrawing fluid to and from said one end of said work cylinder, a valve cylinder, a valve piston slidably disposed in said valve cylinder for controlling the fluid to and from said work cylinder through said passage means, means for applying sufficient force against the valve piston in one direction to shift said valve piston in said one direction to effect an increase in the pressure of fluid admitted to said work cylinder via said passage to such an extent that the action of said biasing means is overcome and said work piston is moved to a preferred position in a direction away from said one end of the work cylinder, means for blocking escape of fluid from said work cylinder when said valve piston has shifted sufficiently far in said one direction, means for applying sufficient force against the valve piston in an opposite direction to move said valve piston in said opposite direction to effect a decrease in the pressure of fluid within said one end of said work cylinder to such an extent that the action of said biasing means shifts said work piston to a preferred position in a direction toward said one end of the work cylinder, and means for causing shifting of said valve piston in said one direction when said sufficient force in said opposite direction decreases so that escape of fluid from said work cylinder is again blocked when said valve piston has shifted sufficiently far in said one direction, said means for applying sufficient force conveys a fluid medium under pressure to cause said valve piston to be moved in an opposite direction, and said last named means includes a passage for permitting escape of fluid from said valve cylinder to hasten the shifting of said valve piston in one direction when said force decreases due to a decrease in pressure of said fluid medium.

9. A hydraulic system including a reservoir, a valve cylinder, a valve piston reciprocable in said valve cylinder between two extreme positions, means operable to selectively direct fluid under pressure from said reservoir to either end of said valve cylinder, a return connection from a point intermediate the ends of said valve cylinder to said reservoir, a port in said cylinder normally closed by said valve piston in centered position thereof but in communication with one end of said valve cylinder in one extreme position of said valve piston, a work cylinder, a conduit connecting one end of said work cylinder to said port, a work piston reciprocable in said work cylinder and normally biased toward said one end thereof, said valve piston defining a passage between said port and said return connection in the other extreme position of said valve piston, valve piston centering means biasing said valve piston toward centered position in which said port is closed, and means at the other end of said valve cylinder operable to gradually relieve pressure in the other end of said valve cylinder to hasten the shifting of said valve piston to centered position when the force of the fluid directed to said other end of said valve cylinder is decreased.

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