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HYDRAULIC OPERATING AND CONTROL SYSTEM

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Fig. 3

Fig. 4

Fig. 5

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The invention relates to the control of hydraulic actuators and compares hydraulically operated apparatus and it is more particularly concerned with hydraulic operating and control systems in which a plurality of actuators are supplied with pressure fluid and their operation controlled selectively from a central control station. One object of the invention is to provide an improved system of the above general character embodying novel features of construction for supplying fluid to and controlling the operation of a plurality of hydraulic actuators located remotely from the control station or on a structure which is relatively movable with respect to the station at which the source of pressure fluid and the manually operable control instrumentality are located. Another object is to provide an improved system for supplying pressure fluid to and controlling the individual operations of a plurality of hydraulic actuators from a central control station which materially reduces the piping or conduits required between the station and the actuators and which permits control of the actuators selectively by a single direction valve at the station. A more specific object is to provide a control system by which a plurality of actuators may be supplied with pressure fluid from a central control station through a single pair of supply conduits and in which the actuators may be selectively conditioned for control individually by a control valve interposed in the conduits and located at the control station. Still another object is to provide a hydraulic operating and control system in which a plurality of hydraulic actuators may be conditioned selectively by means of simple selector valve means to receive pressure fluid supplied through a single pair of conduits under control of a direction valve interposed in those conduits and in which the selector and direction valves may be located remotely from the actuators. Other objects and advantages of the invention will become apparent from the following detailed description of the preferred embodiment illustrated in the accompanying drawing in which:

Figure 1 is a circuit diagram of a hydraulic operating and control system embodying the features of the invention.

Figure 2 is a circuit diagram of the system equipped with a modified form of selector valve means and blocking valves.

Figure 3 is a side view of a lift truck equipped with a hydraulic system embodying the features of the invention.

Figure 4 is a front view of the lift truck shown in Fig. 1.

Figure 5 is a fragmentary top view of the lift truck shown in the preceding figure.

For purposes of illustration a preferred form of the improved hydraulic system and several different interchangeable valving arangements have been shown in the drawings and will be described in detail herein. Also, the application of a typical system to a lift truck has been illustrated. It is to be understood, however, that this is not intended to limit the invention to details of the particular systems or application illustrated, but that various changes and modifications may be made in the form, construction and arrangement of the parts and the system may be applied to other apparatus or machines without departing from the spirit and scope of the invention as more broadly or generally characterized in the appended claims.

The invention has particular utility in association with apparatus in which a plurality of hydraulic actuators are to be supplied with pressure fluid from a central station which may be either remote from the actuators or in which the actuators and the control station are carried by structures that are relatively movable. In either instance, there is the problem of providing the piping and valving required for the supply of fluid and for exercising control. The invention substantially reduces the piping requirements and additionally materially simplifies the valving.

By way of example, I have shown in Fig. 1 a system employing four hydraulic actuators 10, 11, 12 and 13 which may be installed at a location or carried by a supporting structure at a distance from or movable relative to the location or supporting structure for the source of pressure fluid and the control instrumentality. The actuators in this instance are operated by pressure fluid supplied from a single fluid source such as a pump P at the latter location.

In accordance with the invention, pressure fluid is supplied to all of the actuators from the pump P and returned to a sump or reservoir R associated with the pump by way of a single pair of main pressure fluid conduits 15 and 16. Where the supporting structures are relatively movable, the conduits may conveniently comprise flexible tubes of plastic or other suitable material. A control valve 17 disposed in proximity to the fluid source, that is, at the same location or control station, is operative to initiate fluid flow to the actuators and to control the direction of flow through the conduits and thus the directional operation of the actuators. To enable the actuators to be controlled individually by the control valve 17, the supply conduits 15 and 16 are connected to the actuators through valves 20, 21, 22 and 23 individual to the respective actuators. These valves may be of any suitable type normally operative to isolate the associated actuator from the fluid conduits 15 and 16 but operable by remote control to establish an operative connection between the actuator and the conduits.

Provision is made for operating the blocking valves 20-23 individually and selectively to condition the associated actuators for operation under control of the valve 17. It will be appreciated, of course, that the valves 20-23 may be arranged for operation in different combinations if desired, provided suitable means is included in the system for apportioning the flow of pressure fluid to the actuators to be operated simultaneously.

In the particular system illustrated, selective operation of the blocking valves is effected by selector valve means indicated generally at 25 connected with the valves by pilot lines 26, 27, 28 and 29 through which fluid under pressure may be supplied to operate the valves. As only a relatively small volume of fluid is required for operating the blocking valves, the pilot lines may consist of very small tubes such as the small diameter flexible tubing now commercially available. Pressure fluid for operating the blocking valves may be derived from the main source of pressure fluid either directly or through pressure reducing valve means or a separate source of pilot pressure fluid may be provided.

It is to be noted that the invention is not limited to use with any particular type of hydraulic fluid. To illustrate this aspect of the invention, the actuators 10-13 shown represent four basic types of hydraulic actuators.
In common use. Actuator 10 is of the type known as a single acting ram. It comprises in this instance a casing defining a cylinder 16, while at one end and having a reciprocable piston or ram 31 projecting from its other end. Pressure fluid is introduced into the closed end of the cylinder through a port 32 to advance the ram. Return of the ram is effected by the externally applied load, the fluid being exhausted from the cylinder through the port 32.

The actuator 11 shown is a double acting ram. It includes a casing defining a cylinder 33 fitted with a working piston 34. A piston rod 35 extends from the piston through a suitable packing gland in one end of the cylinder for connection with the load. Opposite end of the cylinder is adapted to be connected alternatively to a source of pressure fluid and to a drain conduit by way of ports 36 and 37.

The actuator 12 represents a rotary hydraulic motor. It may be of any preferred type such as a vane motor, a radial or axial piston motor or a gear motor. The rotating drive parts of the motor are enclosed in a chamber 38 defined by a casing 39. Ports 40 and 41 communicating with opposite sides of the chamber 38 serve alternately as supply and exhaust ports for fluid, depending on the direction in which the motor is driven.

The actuator 13 as shown is an oscillating type motor having a vane-like piston 42 pivoted at one edge to swing in an arc within an enclosing chamber 43 defined by a casing 44. Ports 45 and 46 communicate with the chamber on opposite sides of the piston for supplying fluid to and exhausting it from the chamber for swinging the piston back and forth.

The blocking valves associated with the actuators may also take various forms. The particular blocking valves 20-23 shown in Fig. 1 are in the form of double ball type check valves adapted to positively restrict fluid flow in one direction while permitting it to pass in the other direction. Fluid operated actuators are provided for opening to the valves to permit fluid flow in the normally restricted direction.

For operation with a one-way ram, the flow checking elements of the blocking valve 20 are arranged somewhat differently than the elements of valves used with double-acting actuators. Thus, the valve 20 associated with the one-way ram 10 has a casing 50 defining two parallel passages 51 and 52 connected intermediate their ends by a cross passage 53. The passage 52 is connected to one of the main pressure fluid conduits, in this instance to the conduit 16, while the other passage is connected to the port 32 of the actuator 10. Spring pressed balls 54 and 55 disposed in the passages 51 and 52 cooperate with suitable valve seats formed therein to positively block the flow of fluid from the conduit 16 to the actuator and from the actuator to the conduit.

The pilot pressure fluid operated means provided for opening the valve 20 acts to shift the balls 53 and 54 away from their valve seats. To this end, the passages 51 and 52 are fitted with plungers 56 and 57 having elongated stems 58 and 59 operative in the advance of the plungers to unseat the flow blocking balls. In the present instance, pilot line 26 is connected to the end of each passage behind the plunger to urge it in a valve opening direction when pilot pressure fluid is supplied through the line. The plungers are returned to normal position by spring means or by gravity when the pilot line is vented to drain.

Blocking valves 21, 22 and 23 may be alike in construction. As shown, each valve comprises a casing 60 defining passages 61 and 62 having valve seats intermediate their ends for engagement with spring pressed ball elements 63 and 64. Corresponding ends of the passages are connected respectively to the ports 36 and 37 of the actuator cylinder 33. Fluid conduits 15 and 16 are connected to the respective passages intermediate their ends. The arrangement is such that fluid flow from at least one end of the cylinder 33 is positively blocked, thereby locking the piston in a fixed position.

Pilot fluid operated actuators similar to those of the valve 20, herein shown as plungers 65 and 66, are provided for unseating the balls to open the passages for free fluid flow in either direction. With the passages so opened, the actuator is subject to operation by fluid supplied over one of the conduits 15 and 16 and exhausted through the other conduit, the direction of operation being controlled by the control valve 17. In the particular valve shown, the ends of the passages below the plungers 65 and 66 are both connected to the pilot line 27 whereby the plungers are urged to valve opening position by pilot pressure fluid supplied through the pilot line. The plungers are returned to normal retracted position by gravity or by suitable spring means when the pilot line is vented to drain.

As indicated above, the blocking valves 22 and 23 may be similar to the valve 21 as above described. In this instance, the valve actuating elements of the valve 22 are connected to the pilot line 28 while the actuating elements of the valve 23 are connected to the pilot line 29. It will be appreciated that where additional actuators must be controlled the blocking valves may be of any type.

For operation of the valve member 85 when in off position vents the pilot line to the drain line 72. Upon actuation of the valve member 85 the pilot pressure fluid supplied through the pressure line conduit 70 to the actuator locks the piston 67 in its fixed position and the spring line 72 discharges the pilot fluid to the reservoir R.

In the present instance, the fluid supply line 70 is connected to the drain line 72 to divert the output of the pump to the reservoir. It will be understood that a flow restricting valve may be interposed in the drain line if desired to maintain a predetermined minimum pressure in the system for operation of auxiliaries.

In one of its operated positions the valve element 73 is operative to connect the pressure fluid line 70 to the conduit 15 while connecting conduit 16 to the drain line 72. In one of its operated position, the connections of the conduits 15 and 16 are reversed. It will be evident that valve 17 is thus operative both to initiate the flow of pressure fluid to a selected actuator and also to control the direction of operation of that actuator.

The selector valve means 25 may be of any preferred type. That shown in Fig. 2 comprises a group of two-way and multi-way valves 80, 81, 82 and 83 individual to the respective pilot lines 26-29. The valves shown are alike, each comprising a casing 84 defining a bore fitted with an axially sliding valve member 85 which is urged to an "off" position by a spring 86. The casing and valve elements are formed with ports and passages connected with one of the pilot lines and in this instance with the fluid supply conduit 70 and the drain line 72. The port and passage arrangement is such that the valve member 85 when in off position vents the pilot line to the drain line. Upon actuation of the valve by shifting the
movable member 85 to the "on" position against the action of its biasing spring, the associated pilot line is connected to the pressure fluid supply line 70. Fluid under pressure is thus delivered through the pilot line to the blocking valve actuating means to which that pilot line is connected. It will be understood, of course, that the selector valves may be connected to receive pressure fluid from a separate source if desired or that a pressure reducing valve may be interposed between the supply line 70 and the valve.

Referring now to Fig. 2 of the drawings, the actuators 10-13 have been equipped with blocking valves 20', 21', 22' and 23' of the spool type. Fluid supply conduits 15 and 16 extend to each of the valves except valve 20' associated with actuator 10 which terminates only one of the conduits. The valves normally isolate the conduits from the actuators. Pilot lines 26, 27, 28 and 29 also extend to the respective blocking valves and when connected by the selector valve to deliver pressure fluid to the blocking valves, the latter operate to condition the associated actuators for control by the control valve at the central station.

The valve 20' as shown comprises a casing 90 defining a valve chamber having one port 91 connected to the supply conduit 16 and another port 92 connected to the port 32 of the actuator cylinder 30. A valve member 93 reciprocable in the valve chamber is urged by a spring 94 to a position to block fluid flow to or from the cylinder 30. Pilot line 26 is connected to the valve chamber at the end opposite the spring 94 whereby pressure fluid delivered through the line is effective to shift the valve member to open position. In such position, communication is established between the conduit 16 and cylinder 30 for the delivery of pressure fluid to or exhaust of pressure fluid from the cylinder according to the setting of the control valve.

Valves 21', 22' and 23' as shown are alike. Each comprises a casing 95 defining a chamber fitted with a reciprocable valve member 96. Ports 97 and 98 in the casing connect the valve chamber with the fluid supply conduits 15 and 16. Ports 99 and 100 in the casing connect the valve chamber with the ports 36 and 37 of the actuator cylinder 33. The movable valve member 92 is normally urged by spring 101 to a position to positively block fluid flow to and from the actuator cylinder. Shifting of the valve member to its alternate or open position is effected by fluid pressure supplied to the valve chamber by way of the pilot line. In the operated position of the valve member the supply conduits 15 and 16 are connected through the valve to the ports 36 and 37 of the actuator cylinder so that the actuator is subject to control by the four-way control valve at the central station.

Valves 22' and 23' are connected to their associated actuators 12 and 13 and to the supply conduits 15 and 16 in the same manner as the valve 21'. Normally these valves isolate their actuators from their supply conduits and are operable to connect the conduits to the actuator upon delivery of pilot pressure fluid through the respective pilot lines 28 and 29. The actuators are thus placed under control of the four-way control valve at the central station as before described. It will be understood that the blocking valves 20'-23' may be controlled by the selector valve means other than the valve means 25' shown. For example, selective control may be effected with selector valve means such as those shown in Fig. 1 or any other type of selector valve capable of directing pressure fluid selectively to the pilot lines.

Fig. 2 also shows selector valve means 25' and a control valve 17' of a different type but which are completely interchangeable with the corresponding valve means shown in Fig. 1. Valve 17' as shown is a four-way valve having a rotary member 105 adapted to be set by a manually operable actuator 106 in the neutral position in which it is shown or in either of two operated positions.

In the neutral position valve 17' connects the pressure supply conduit 70 to the drain line 72. In one operated position pressure conduit 70 is connected to supply conduit 15 while conduit 16 is connected to the drain line. In the other operated position the connections to the conduits 15 and 16 are reversed.

Selector valve means 25' combines the functions of individual valves 80-83 in one valve structure. In the particular form shown it comprises a casing 110 defining a cylindrical chamber fitted with rotary valve member 111. A plurality of ports in the casing terminate the pilot lines 24-29. These ports are spaced apart around the chamber and the valve member is formed with passages so that it may be positioned to establish communication between the pressure fluid conduit 70 and any selected pilot line. Preferably the valve member 111 is also formed with passages effective to vent all of the pilot lines to the drain line 72 when in neutral position and to maintain such venting for all but a selected pilot line when the valve member is positioned in a selective operation. Rotation of the valve member is effected by means of a manual operator 112.

By way of further illustration, installation of the improved hydraulic operating and control system in a lift truck has been shown in Figs. 3 and 5. It will be understood that this is merely exemplary and that while the system can be used to particular advantage in that environment, it is by no means limited to that use. The support 115 for the general four-wheeled industrial type truck and may be powered by a storage battery driven motor or by an internal combustion engine.

Supported at the front of the truck is an upright standard or mast 115 upon which a vertical work manipulating device is mounted for vertical movement. In trucks of this general character, the mast is usually pivoted adjacent its lower end on the truck to swing about a transverse axis. The mast may also comprise a plurality of telescopingly assembled sections adapted to be extended to afford a higher lift for the work manipulating device 116. The load manipulating device of the exemplary truck comprises a pair of jaws 117 operable to grip or release cylindrical objects such as rolls of paper, barrels, etc. The jaws in this instance are carried on a bracket 118 projecting forwardly from a circular table 119 mounted for rotation about a horizontal axis on a carrier 120 supported and guided for vertical movement on the mast 115. The bracket 118, in this instance, is mounted on the table for movement transversely of the axis of the table so that the jaws can be readily aligned with an object to be picked up without requiring movement of the truck. Additionally, the jaws 117 may be mounted for pivoting as a unit so that they may be projected laterally at either side of the truck as well as straight ahead.

In a lift truck of the type shown, raising and lowering of the carrier 120 and associated apparatus and extension of the mast 115 when required may be effected by one or more single acting rams of the same general character as the actuator 10. Tilting of the mast about its pivot will usually require the provision of a double acting ram similar to the actuator 11. Actuation of the various elements of the work manipulating device is effected by other hydraulic actuators carried by the device and consequently movable relative to the truck. Thus, the double acting hydraulic actuator 11 may be utilized for opening and closing the clamping jaws 117. A similar actuator may also be used for shifting the bracket 118 transversely of the supporting table 119. The table itself may be rotated about its axis by the rotary hydraulic motor 12 while the jaws may be swung from side to side by the oscillating motor 13.

In installations of the above character, the source of pressure fluid, that is, the pump P and reservoir R, are conveniently mounted on the body of the truck. In the case of trucks powered by internal combustion engines,
the pump may be driven directly from the truck engine. If the truck is battery powered, a separate motor M may be provided for driving the pump. The selector valve means and control are most conveniently located on a panel 121 at the front of the truck where they are within easy reach of the driver.

Since the actuators for the work manipulating device 116 are supported on a structure which is movable relative to the truck body, flexible conduits are required for supplying pressure fluid to and controlling such actuators. The improved system offers substantial advantages in this connection since only two main pressure fluid conduits 15 and 16 are required. These may be trained around guide pulleys provided at the upper end of the mast 115 as shown in Fig. 4. Where relatively long conduits are required, as, for example, in the case of trucks provided with multi-section masts, take-up reels may be provided on the mast or elsewhere on the truck to take up slack in the conduits when the mast is collapsed.

In a matter of convenience the pilot lines 26-29 may be enclosed in a suitable sheath 122 which may constitute an ordinary flexible conduit such as those used for conveying pressure fluid. Flexible tubes for use as pilot lines are now available in sizes such that four or more of the tubes can readily be accommodated in a conduit of the size required for supplying pressure fluid to an actuator of any of the types shown herein. The sheathed group of pilot lines 122 is conveniently carried over a guide pulley adjacent the top of the mast 115 and extends to the blocking valves associated with the various actuators on the load manipulating device. Conduits 15 and 16 are connected to the blocking valves as previously described.

In the operation of a lift truck equipped with the improved hydraulic system, the actuators for the load manipulating device are controlled by simply actuating the selector valve mechanism 25 (or 25') for selecting the actuator to be operated and then manipulating the valve 17 (or 17') to initiate the proper directional movement of the actuator. Thus, the truck may be run up to a load such as a roll of paper with the jaws 117 open and if the actuator is to be actuated in a forward direction, by selecting the proper actuator and then controlling it through the medium of the control valve. When the jaws are aligned with the load, the truck may be moved forwardly and thereafter the jaw clamping actuator is selected and actuated to grip the load. If the operation of the lifting actuator may then be initiated to raise the manipulating device and the load and the latter may then be turned horizontally or at any other angle by selecting and directionally controlling the actuator 12. Additionally, the jaws may be pivoted to either side of the truck by selecting and operating the actuator 13.

It will be apparent from the foregoing that the invention provides a hydraulic operating and control system of novel and advantageous construction. The system finds particular utility in installations involving a plurality of hydraulic actuators which may be located remote from or on a structure relatively movable from the central control station. With the improved system only two main pressure fluid supply conduits are required while controls are effected through the medium of relatively small pilot lines, a substantial number of which may be enclosed in a single sheath of a size comparable to those of the main pressure fluid conduits.

The improved system is capable of utilizing a wide variety of valves and is capable of functioning with actuators of any of the conventional types. In general, it affords simple and efficient control of the operation of the actuators and it materially reduces the costs of piping and valves.

I claim as my invention:

1. In a hydraulic system including a plurality of pressure fluid operated actuators, a source of fluid under pressure, a pair of main fluid carrying conduits extending from said source to said actuators, a control valve operable to control fluid flow through said conduits, valve means interposed between each of said actuators and said pair of conduits normally effective to block the actuators against operation by pressure fluid supplied through the conduits, selector valve means located in proximity to said control valve and having individual pilot line connections with said blocking valve means, and means operable by pressure fluid supplied over said pilot line connections for actuating the blocking valve means to condition any selected one of said actuators for operation by pressure fluid supplied through said conduits and under the directional control of said control valve.

2. The combination with a pair of relatively movable supporting structures, of a source of pressure fluid carried by one of said structures, a direction control valve on said one structure having fluid connections with the pressure fluid source and a pair of blocking valves operable to block the actuator from said conduits, and valve means on said one structure operable to actuate said blocking valves individually and selectively to condition the associated actuator for operation by pressure fluid supplied through said conduits and under control of said control valve.

3. In a system for controlling the operations of a plurality of hydraulic actuators from a central control station remote from the actuators, in combination, a source of pressure fluid at said station, a single pair of conduits extending from said station to the actuators, a control valve at said station operable to connect said conduits alternately to said source and to a drain, a valve at each actuator of the type shown herein for actuating the linking fluid to block the actuator from said conduits, and valve means on said one structure operable to actuate said blocking valves individually and selectively to condition the associated actuator for operation by pressure fluid supplied through said conduits and under control of said control valve.

4. In a system for controlling the operations of a plurality of hydraulic actuators from a central control station, in combination, a source of pressure fluid at said station, a single pair of main pressure fluid conduits extending from the station to said actuators, a control valve at said station operable to connect said conduits alternately to said fluid source and to a drain line or to block the conduits against fluid flow, a blocking valve associated with each actuator normally operative to isolate the actuator from said conduits, fluid operated actuating means in each blocking valve operative to open the valve and thereby condition the associated actuator to receive pressure fluid from said conduits, a selector valve for each blocking valve, said selector valves being operable to direct pilot pressure fluid over any selected pilot line to actuate the corresponding blocking valve and thereby condition the associated actuator for operation by pressure fluid supplied through said conduits and under control of said control valve.

5. In a system for controlling the operations of a plurality of hydraulic actuators from a central control station, in combination, a source of pressure fluid at said station, a single pair of main pressure fluid conduits extending from the station to said actuators, a control valve at said station operable to connect said conduits alternately to said fluid source and to a drain line or to block the conduits against fluid flow, a blocking valve associated with each actuator normally operative to isolate the actuator from said conduits, fluid operated actuating means in each blocking valve operative to open the valve and thereby condition the associated actuator to receive pressure fluid from said conduits, a pilot line extending from
the actuating means of each blocking valve to said control station, and selector valve means at said station settable to connect any selected one of said pilot lines to said pressure fluid source while venting the non-selected pilot lines to drain.

6. In a system for controlling the operations of a plurality of hydraulic actuators from a central control station, in combination, a source of pressure fluid at said station, a single pair of main pressure fluid conduits extending from said station to said actuators, a control valve at said station operable to connect either conduit to said source while connecting the other conduit to a drain line, a valve displaced closely adjacent each actuator having one pair of ports connected to the actuator and another pair of ports connected to said conduit, a valve member normally urged to a position to close said ports, pilot lines connected to supply pressure fluid to said valves to shift their movable members for opening the ports, said pilot lines extending to said station, and selector valve means settable to connect any selected one of said pilot lines to said pressure fluid source while connecting the remaining lines to said drain line.

7. In a system for controlling the operations of a plurality of hydraulic actuators from a central control station, in combination, a source of pressure fluid at said station, a single pair of main pressure fluid conduits extending from said station to said actuators, a control valve at said station operable to connect either conduit to said source while connecting the other conduit to a drain line, a valve displaced closely adjacent each actuator having one pair of ports connected to the actuator and another pair of ports connected to said conduit, a valve member normally urged to a position to close said ports, pilot lines connected to supply pressure fluid to said valves to shift their movable members for opening the ports, said pilot lines extending to said station, a selector valve at said station terminating said pilot lines, said valve having a member rotatable to connect any selected pilot line to said source of pressure fluid and simultaneously connect the other pilot lines to said drain line.

8. In an operating and control system for hydraulic actuators, in combination, an actuator comprising a cylinder fitted with a reciprocable piston, said cylinder having a port for admitting pressure fluid to and exhausting pressure fluid from the cylinder, a blocking valve connected to said port, a source of pressure fluid, a control valve, a conduit extending from said control valve to said blocking valve, said control valve being operable to connect said conduit alternatively to said source or to a drain, a first check valve in said blocking valve normally closing the valve against fluid flow from the cylinder to the conduit, a second check valve in said blocking valve normally closing the valve against fluid flow from the conduit to the cylinder, and pressure fluid operated means in said blocking valve operative to open both check valves to establish communication between the cylinder and the conduit.

9. In an operating and control system for hydraulic actuators, in combination, an actuator comprising a cylinder fitted with a reciprocable piston, said cylinder having a port for admitting pressure fluid to and exhausting pressure fluid from the cylinder, a blocking valve connected to said port, a source of pressure fluid, a control valve, a conduit extending from said control valve to said blocking valve, said control valve being operable to connect said conduit alternatively to said source or to a drain, a first ball valve element in said blocking valve normally closing the valve against fluid flow from the cylinder to the conduit, a second ball valve element in said blocking valve normally closing the valve against fluid flow from the conduit to the cylinder, a pair of pressure fluid operated plungers positioned to shift said ball elements to valve opening position upon operation.

10. In an operating and control system for a hydraulic actuator, in combination, an actuator comprising a cylinder fitted with a reciprocable piston, said cylinder having a port for admitting pressure fluid to and exhausting pressure fluid from the cylinder, a blocking valve connected to said port, a source of pressure fluid, a control valve, a conduit extending from said control valve to said blocking valve, said control valve being settable to connect said conduit alternatively to said pressure fluid source or to a drain, said blocking valve including normally closed check valve means effective to block fluid flow to and from said actuator cylinder, pressure fluid actuated means operable to open said check valve means, a manually operable valve located at a point remote from said blocking valve, and a pilot line connecting said manually operable valve with said blocking valve for delivering pressure fluid to the blocking valve from said remote point independently of said control valve for opening said check valve means for fluid flow either to or from the actuator cylinder in accordance with the setting of said control valve.

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