

Oct. 17, 1933.

W. J. HUGHES

1,930,557

FOUR-WAY HYDRAULIC SWITCH

Filed Feb. 12, 1930

2 Sheets-Sheet 1

Fig. 1

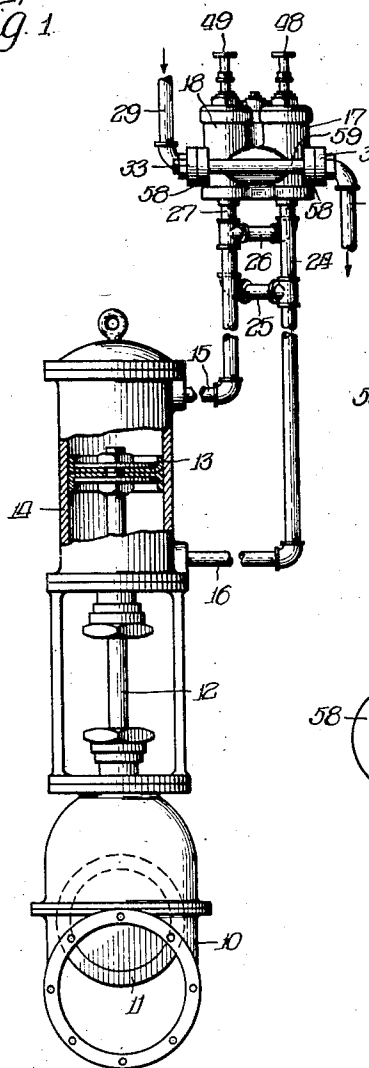


Fig. 2

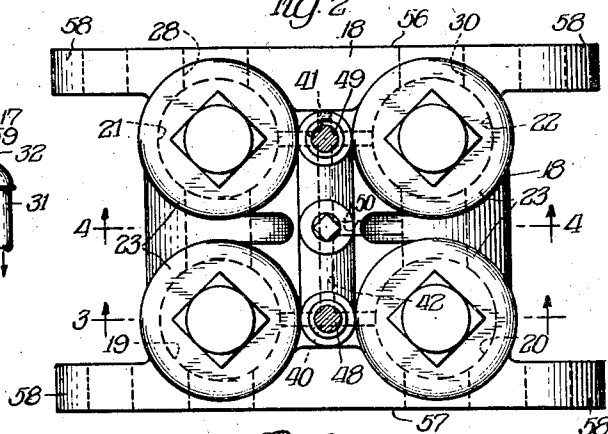


Fig. 3

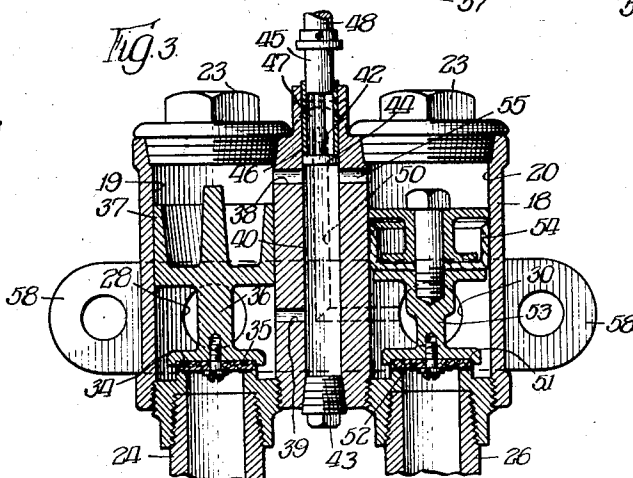


Fig. 4

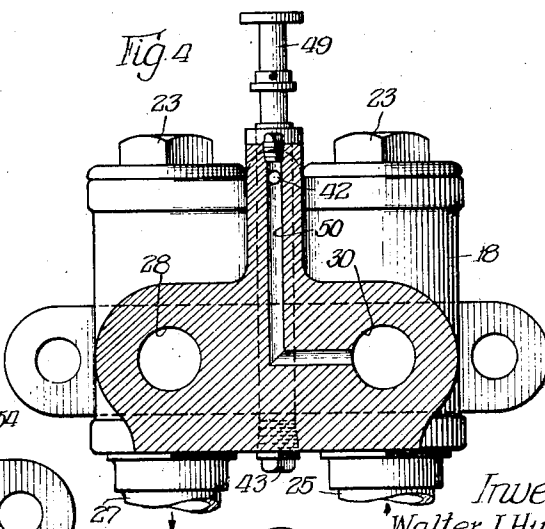
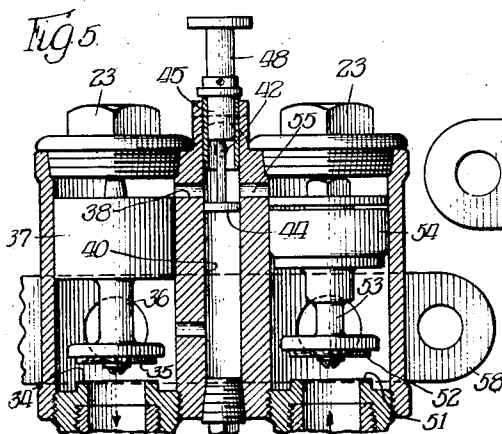


Fig. 5



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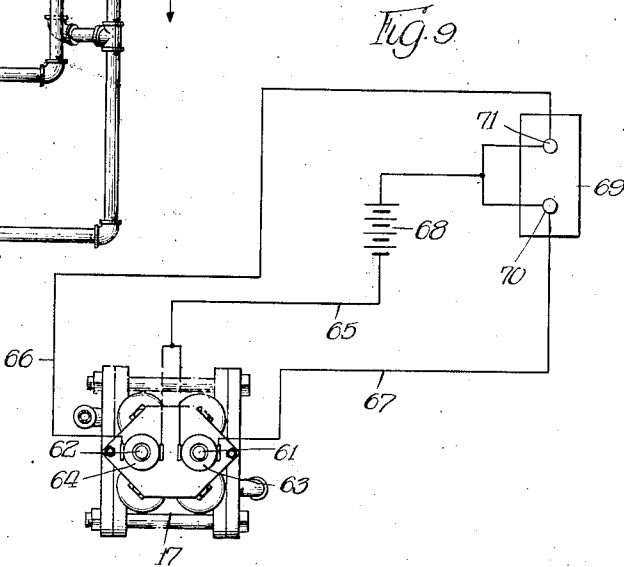
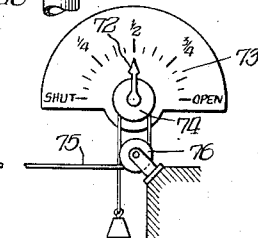
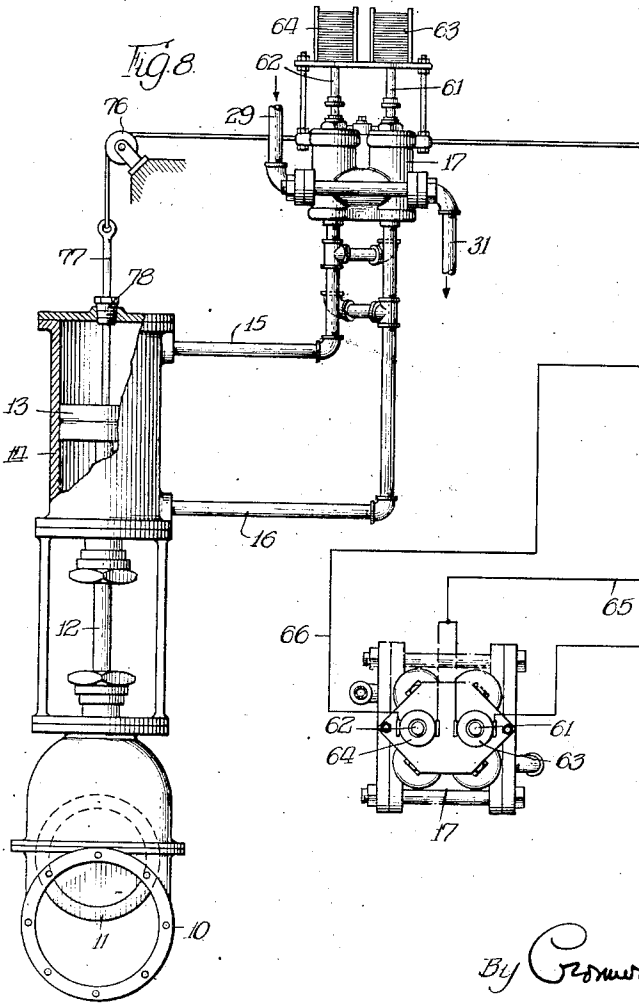
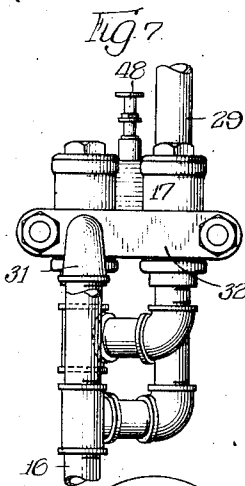
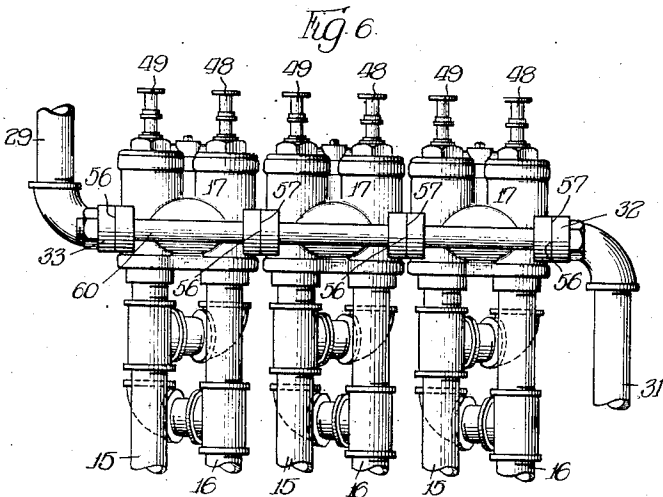
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FOUR-WAY HYDRAULIC SWITCH

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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

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## FOUR-WAY HYDRAULIC SWITCH

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Application February 12, 1930. Serial No. 427,762

8 Claims. (Cl. 137-139)

Large gate valves, because of the power required to open and close them, are ordinarily operated by hydraulic cylinders, which cylinders are controlled by four-way cocks positioned in the pressure and waste lines. The four-way cocks which have been most commonly used for this purpose have not been entirely satisfactory, however, because even a slight amount of leakage therethrough will allow the gate of a vertically movable valve to settle in a short time, and the close fit which must be maintained between the moving parts to prevent such leakage will cause sticking after a little corrosion occurs or foreign matter has found lodgment therein.

The object of this invention is to provide a novel four-way switch for controlling the operation of a hydraulic cylinder connected with a gate valve or other device.

The four-way switch of the invention is in many respects an improvement over the ordinary four-way cocks and other devices which have been used in the past for controlling the operation of hydraulic cylinders. It will effectively prevent leakage from one end of the cylinder to the other; it does not require any snug guiding fit between parts; it may be easily manipulated through either a local or a remote control; and it lends itself readily to a design wherein several of the switches controlling as many different cylinders may be connected together in a row and the same pressure and waste lines used for all.

While the foregoing statements are indicative in a general way of the nature of the invention, other objects and advantages will be apparent to those skilled in the art upon a full understanding of the construction, arrangement and operation of the improved control mechanism.

One form of the invention is presented herein for the purpose of exemplification, but it will of course be appreciated that the invention is susceptible of embodiment in other structurally modified forms coming equally within the comprehensive scope of the appended claims.

In the accompanying drawings:

Fig. 1 is a face view of a gate valve which is operated by a hydraulic cylinder and is controlled in its operation by a four-way switch constructed in accordance with the invention;

Fig. 2 is a plan view of the switch casing;

Fig. 3 is a vertical section through the switch, taken on the line 3-3 of Fig. 2, showing the switch at rest;

Fig. 4 is a vertical section through the switch, taken on the line 4-4 of Fig. 2;

Fig. 5 is a section which corresponds to Fig. 3 but shows the switch in operation;

Fig. 6 is a side view of a row of the four-way switches connected together and using the same pressure and waste lines;

Fig. 7 is an end view of the row shown in Fig. 6;

Fig. 8 is a view which corresponds to Fig. 1 but shows a remote control for operating the switch and a remote dial for indicating the position of the gate; and

Fig. 9 is a plan view of the control means shown in Fig. 8, showing diagrammatically an electric circuit for the same.

In the drawings is shown a large gate valve of well known construction. The gate 11 of the valve is connected by a rod 12 to a piston 13 which reciprocates within a hydraulic cylinder 14, and the upper and lower ends of the cylinder connect respectively with pipes 15 and 16 which function alternately as inlets and outlets for the cylinder above and below the piston. The pipes 15 and 16 lead to a four-way switch 17 which constitutes the subject matter of the present invention.

The switch 17, which may be positioned either close to or far removed from the cylinder 14, as desired, includes a casing 18 of generally rectangular shape which contains four vertical cylinders 19, 20, 21 and 22. The cylinders are closed at their upper ends by screw plugs 23 and communicate at their lower ends with the previously mentioned pipes 15 and 16, the diagonally opposed cylinders 19 and 22 being connected to two branches 24 and 25 of the pipe 16 and the remaining diagonally opposed cylinders 20 and 21 being connected to two branches 26 and 27 of the pipe 15. A passageway 28, which connects at one end with a pressure line 29, extends horizontally through the casing and opens into the cylinders 19 and 21, and a similar passageway 30, which connects at the other end with a waste line 31, extends horizontally through the casing in spaced parallel relation to the passageway 28 into communication with the cylinders 20 and 22. The end of the passageway 28 which is opposite the junction with the pressure line 29 is closed by an adapter plate 32 which is also used to couple the waste line 31 to the casing, and the end of the passageway 30 which is opposite the junction with the waste line 31 is closed by a similar adapter plate 33.

The cylinders 19 and 21, which will herein-

after be referred to as the pressure cylinders because of their connection with the pressure line 29, are duplicates of each other, and therefore only the cylinder 19, which is the one shown sectionally in Fig. 3, need be described. The cylinder 19 is provided at its lower open end with a slightly constricted valve seat 34 on which a non-metallic valve disk 35 is adapted to rest, and the disk 35 is attached to the lower outspread end of the stem 36 of a relatively large piston 37, which piston fits snugly within the cylinder and is vertically movable therein. The side of the cylinder 19 which is toward the cylinder 20 is provided with upper and lower ports 38 and 39 which open into a vertical bore 40 which is located midway between the cylinders 19 and 20. The ports in the cylinder 21 which correspond to the ports 38 and 39 in the cylinder 19 open into a similar vertical bore 41 located between the cylinders 21 and 22, and the two bores 40 and 41 are connected together adjacent their upper ends by a small horizontal passageway 42.

The vertical bores 40 and 41 are closed at their lower ends by screw plugs 43 and contain near their upper ends small closely fitting pistons 44 which are formed on the lower ends of plungers 45. The pistons 44, in their uppermost positions, seat against the lower rims of bushings 46 and close off communication between the horizontal passageway 42 and the portions of the bores 40 and 41 into which the ports 38 and 39 open. The shanks of the plungers 45 immediately above the pistons 44 are reduced in diameter to leave vertically elongated annular spaces within the bushings 46 into which the ends of the passageway 42 open through registering apertures in the bushings. The upper end of the plunger in the bore 40 terminates in a headed push rod 48, while the upper end of the plunger in the bore 41 terminates in a headed push rod 49. The horizontal passageway 42 is connected with the waste passageway 30 by an L-shaped duct 50 which is located centrally of the casing between the cylinders 20 and 22.

The cylinders 20 and 22, which will herein-after be referred to as the waste cylinders because of their connection with the waste line 31, are duplicates of each other, and therefore only the cylinder 20, which is shown sectionally in Fig. 3, will be described. The cylinder 20 is provided at its lower open end with a slightly constricted valve seat 51 on which a non-metallic valve disk 52 is adapted to rest, and the disk 52 is attached to the lower outspread end of the stem 53 of a relatively large piston 54, which piston fits snugly within the cylinder above the waste passageway 30 and is vertically movable in the cylinder. The side of the cylinder 20 which is toward the cylinder 19 is provided in its upper portion with a port 55 which opens into the bore 40 above the piston 53 at a point substantially opposite the upper port 38 in the cylinder 19.

The operation is as follows:

The push rods 48 and 49 are normally maintained in their uppermost positions, as shown in Fig. 3, by the pressure of the water in the line 29, which pressure acts upwardly on the bottoms of the pistons 44 through the communicating ports 39 in the lower portions of the side walls of the cylinders 19 and 21. There is no back pressure on the pistons 44 because the passageway 42 above the same communicates with the waste passageway 30 through the duct 50.

With the push rods 48 and 49 in their upper-

most positions, the pressure of the water in the cylinders 19 and 21, although acting with equal force in opposite directions against the tops and the bottoms of the pistons 37 in the cylinders by reason of the by-passes around the pistons provided by the ports 38 and 39, acts unopposed against the tops of the valve disks 35 and holds such disks tightly seated. At the same time, the pressure of the water in the cylinders 19 and 21 is communicated to the upper ends of the waste cylinders 20 and 22 through the ports 55 therein and acts against the tops of the pistons 54. Since the bottoms of the pistons 54 are open to the waste passageway 30, no back pressure is present and the pistons 54 hold the valve disks 52 tightly seated.

When the push rod 48, for instance, is depressed, as shown in Fig. 5, the piston 44 in the bore 40 blanks off the ports 38 and 55 from the lower portion of the bore and places such ports in communication with the waste passageway 30 through the passageways 42 and 50. Thereupon, the pressure on the bottom of the piston 37 in the pressure cylinder 19, being greater than the opposing pressure on the relatively small top of the valve disk 35, moves the piston and valve disk upwardly and permits water under pressure to flow down through the branch pipe 24 of the pipe 16 into the lower end of the cylinder 14, causing the piston 13 to rise and the gate 11 connected thereto to open. The pressure of the water being forced out of the upper end of the cylinder 14 acts upon the bottom of the valve disk 52 in the waste cylinder 20 and raises the disk from its seat. The piston 54 in the cylinder 20 offers no resistance to such upward movement because the space in the cylinder above the same is in open communication with the waste passageway 30 by reason of the position of the piston 44 below the port 55.

During the above described operation, the valve disk 35 in the inactive pressure cylinder 21 and the valve disk 52 in the inactive waste cylinder 22 remain firmly seated under the pressure of the water in the passageway 28. As long as the push rod 48 is held down, the piston 13 in the cylinder 14 will continue to rise toward its uppermost position and the gate 11 will move therewith. When the push rod 48 is released, it will immediately return to its uppermost position, with the top of the piston 44 against the lower rim of the bushing 46, under the pressure of the water acting against the bottom of the piston 44, and, the ports 38 and 55 in the bore 40 being again placed in communication with the lower portion of the bore, the pistons 37 and 54 will be forced down and the valve disks 35 and 52 will become firmly seated.

When the push rod 49 is depressed, the action occurring in the cylinders 21 and 22 is the same as the previously described action in the cylinders 19 and 20, the valve disk 35 in the pressure cylinder 21 permitting water under pressure to flow from the passageway 28 through the branch pipe 27 of the pipe 15 into the upper end of the cylinder 14 to force down the piston 13 and close the gate 11, and the valve disk 52 in the waste cylinder 22 rising under the pressure of the water being forced out of the lower end of the cylinder 14 through the pipe 16 and the branch pipe 25.

The four-way switch of the invention employs the pressure of the water to hold all four valves therein tightly seated and thereby eliminates leakage from the cylinder 14. By employing the

four-way switch, the movement of the gate 11 may be easily, accurately and quickly controlled.

In Figs. 6 and 7 is shown a row of the switches 17, which switches have been connected together in such a way as to permit the use of the same pressure and waste lines for all without requiring the employment of manifolds. Referring for the moment to Figs. 1 and 2, it will be observed that the two inner end faces 56 and 57 of the casing 18 against which the adapter plates 32 and 33 are adapted to be positioned, are parallel to each other and are provided with laterally extending lugs 58 which are apertured for the reception of tie bolts 59. In the arrangement shown in Figs. 6 and 7, the tie bolts 59 have been removed, the end faces 56 of the casings have been positioned contiguously against the end faces 57 of the adjoining casings, the adapter plates 32 and 33 have been placed against the remaining exposed end faces of the first and last casings, and relatively long tie bolts 60 have been passed through the apertured lugs 58 and drawn up tightly against the adapter plates. This unified battery of switches may be located near the hydraulic cylinders and gate valves, or it may be located instead at quite a distance therefrom.

In Figs. 8 and 9 is shown an electrical control for the switch 17. The two plungers 45 of the switch, instead of terminating upwardly in the push rods 48 and 49, are connected with solenoid cores 61 and 62 which are surrounded respectively by stationary solenoid coils 63 and 64. The coils are connected by wires 65, 66 and 67 to a storage battery 68 or other source of current and to a panel 69 having switch buttons 70 and 71 thereon. When the button 70 is pressed, the circuit through the coil 63 will be closed and the plunger attached to the core 61 will be depressed, causing the gate 11 to open, and when the button 71 is pressed, the circuit through the coil 64 will be closed and the plunger attached to the core 62 will be depressed, causing the gate to close. The movement of the gate 11 will of course continue only as long as the button which has been pressed is held down.

The position of the piston 13 in the cylinder 14, or the position of the gate 11 in the valve 10, may be shown to the operator by the position of an indicating arm 72 on a suitably marked dial 73. The arm 72 is rigidly mounted on a rotatable pulley 74 about which one end of a cable 75 is wound. The cable 75 passes around two or more guide pulleys 76 and is attached at its other end to a rod 77 which extends downwardly through a packing gland 78 in the top of the cylinder 14 and is attached to the piston 13. When the piston 13 moves either up or down, the rod 77 and the cable 75 move a corresponding distance, thereby rotating the pulley 74 and changing the position of the indicating arm 72.

I claim:

1. In combination, a valve, a hydraulic cylinder, a piston in the cylinder connected to the valve, a source of fluid under pressure for moving the piston in the cylinder, means for controlling the flow of fluid to and from the cylinder comprising a body containing two groups of fluid operated valves and means for selectively admitting the pressure fluid to the valves of a group so as to cause closing of same and for venting the pressure so as to cause opening of same.

2. Means for controlling the inflow of pressure

water to and outflow of waste water from a hydraulic cylinder, comprising a hydraulic switch having a body provided with a through passage for pressure water and a through passage for waste water, a pair of piston-operated valves in said body for admitting water from the pressure passage to said hydraulic cylinder and for admitting waste from the hydraulic cylinder to said waste passage, and a pilot valve for controlling the operation of said pair of piston operated valves in unison by admitting pressure water above the pistons to cause closing and venting the space above the pistons to cause opening.

3. The combination of a hydraulic cylinder and a hydraulic switch for controlling operation of said cylinder, the body of the switch having a pressure water passage and a waste water passage, a pair of piston operated valves, one in conjunction with each of said passages, a pilot valve for operating said pair of valves in unison, said pilot valve admitting pressure water above the pair of pistons to cause closing and venting the space above the piston to waste to cause opening, the inlet port for pressure water being closed when the vent port is open and vice versa.

4. The combination of a hydraulic cylinder and a hydraulic switch for controlling flow of water to and from said cylinder, the body of the switch having a pressure water passage and a waste water passage, a pair of cylinders in said body one in conjunction with each of said passages, a piston-operated valve in each of said cylinders, a port interconnecting said cylinders above said pistons, a passage for pressure water leading to one of said cylinders above the piston, a vent leading from one of said cylinders, and a pilot valve for selectively opening and closing the said pressure and vent passages.

5. The combination of a hydraulic cylinder and a hydraulic switch for controlling the flow of pressure water to and waste water from said cylinder, said hydraulic switch having a body containing a pressure passage and a waste passage, control valves in said body for controlling flow out of said pressure passage to said hydraulic cylinder and into said waste passage from said hydraulic cylinder, said body being adapted for joining with another like body so that the pressure passage and the waste passage in one will coact with those in the other to form continuous passageways for fluid flow.

6. The combination of a hydraulic cylinder and a hydraulic switch for controlling the flow of pressure water to and waste water from said cylinder, the body of the switch containing four compartments two of which communicate with a common pressure water conduit and two of which communicate with a common waste water conduit, a valve in each of said compartments, means for utilizing the pressure of the water from the pressure water conduit in such a way as to maintain all of said valves closed, and means for altering the effect of the pressure water on cooperating pairs of pressure and waste valves to open or close the valves in each pair in unison.

7. The combination of a hydraulic cylinder and a hydraulic switch for controlling the flow of pressure water to and waste water from said cylinder, said switch having a body containing four valves, a continuous pressure passageway through said body in communication with two of said valves, a continuous waste passageway through said body in communication with the

other two of said valves, means for hydraulically actuating pairs of pressure and waste valves in unison, and means for joining a group of said switch bodies in line with the pressure and waste  
5 passageways in each arranged in end-to-end relation to form continuous pressure and waste manifolds throughout the length of the group.

8. The combination with a hydraulic cylinder, a pressure line, and a waste line, of a switch for  
10 controlling the flow of pressure water to and waste water from said cylinder, said switch including four valves two of which are arranged in the pressure line and the other two of which

are arranged in the waste line, pistons associated with the valves, means for normally conducting liquid from the pressure line to all four of the pistons in such direction as to maintain the  
80 valves closed, and control means associated with each pair of pressure and waste valve pistons for both rendering the liquid-conducting means to that pair ineffective to maintain the valves closed and causing the liquid in the pressure line  
85 to act in the opposite direction on the pressure valve piston in that pair, whereby to open such pressure valve.

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| 15 | 90  |
| 20 | 95  |
| 25 | 100 |
| 30 | 105 |
| 35 | 110 |
| 40 | 115 |
| 45 | 120 |
| 50 | 125 |
| 55 | 130 |
| 60 | 135 |
| 65 | 140 |
| 70 | 145 |
| 75 | 150 |