

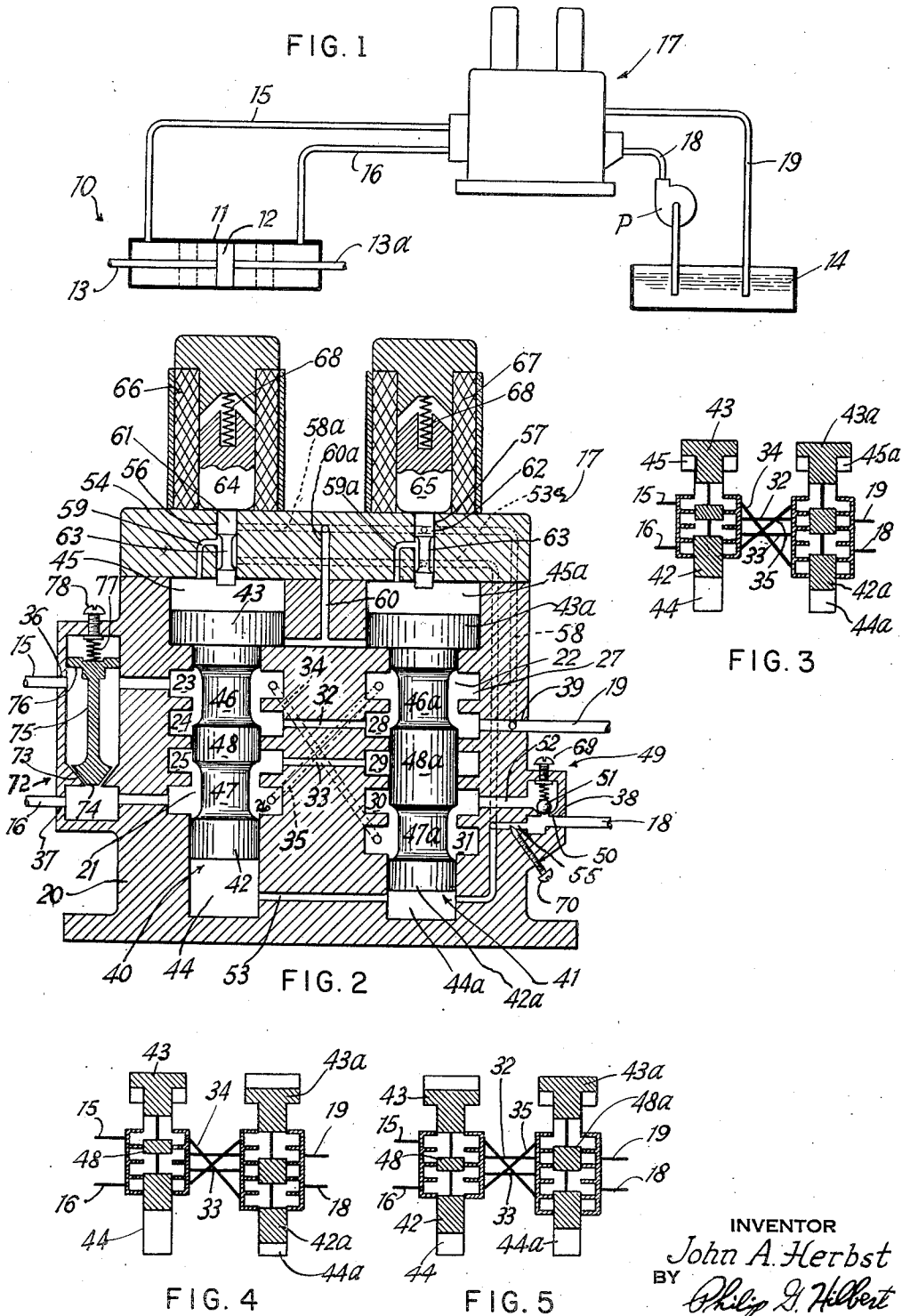
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HYDRAULIC VALVE

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HYDRAULIC VALVE

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This invention relates to a hydraulic valve of the type adapted to direct the flow of pressure fluid to a fluid pressure responsive mechanism.

In hydraulic mechanisms of the type including a reciprocable piston, valves have been used to direct the flow of pressure fluid in order to selectively move the piston in opposite directions. An object of this invention is to provide an improved valve of relatively simple construction which, in addition to controlling the direction of movement of the piston, is further adapted to be operated in a manner to allow the piston to be non-responsive to the pressure fluid, thereby allowing the piston to be actuated by auxiliary means; and further, to lock the piston in a given position under conditions where the pump operates at a nominal pressure which is a small fraction of the working pressure of the pressure fluid.

Another object of this invention is to provide a valve of the character described which is effective to control the operation of a hydraulic mechanism to provide four different operating conditions, such valve comprising two reciprocable valve means and valve actuating means for moving the valve means to positions providing four different combinations thereof, each combination of positions corresponding to one of the working conditions.

A further object of this invention is to provide a valve of the character described which includes a pair of valve means operable to move to selected positions whereby pressure fluid at working pressures may be directed to actuate a hydraulic mechanism, the valve means being moved by means of pressure fluid at a pilot pressure or pressures less than the pilot pressure.

Still another object of this invention is to provide in a valve of the character described, bypass valve means for allowing pressure fluid at working pressure to be moved from one side of the piston to the other side thereof in response to external pressures in excess of the working pressure which may be applied to the piston and improved valve means arranged to provide pressure fluid at working and pilot pressures.

Still a further object of this invention is to provide an improved hydraulic valve of simple but rugged construction, which includes a minimum number of parts, is easily controlled by electromagnetic means and is efficient to a high degree under working conditions.

Other objects of this invention will in part be obvious and in part hereinafter pointed out.

Accordingly, the invention consists in the fea-

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tures of construction, combinations of elements, and arrangement of parts which will be exemplified in the embodiment hereinafter described and of which the scope of invention will be indicated in the claims following.

In the drawing:

Fig. 1 shows schematically a hydraulic system including a control valve embodying the invention;

Fig. 2 is a vertical sectional view, diagrammatic in part, of said valve;

Figs. 3, 4 and 5 show diagrammatically the positions of moving parts of the valve for different operating conditions.

Referring in detail to the drawing, and particularly to Fig. 1, 10 designates a hydraulic mechanism of the type comprising a cylinder 11 closed at the opposite ends thereof, with a piston 12 reciprocable therein. Piston rods 13 and 13a extend from opposite sides of the piston, projecting through the cylinder end walls, for connection to members not shown, which are to be actuated by the mechanism. Pressure fluid from a source indicated at 14 is adapted to be selectively admitted to opposite ends of the cylinder 11 by way of lines 15, 16, in order to determine the direction of movement of the piston 12.

The flow of pressure fluid raised to a working pressure by means of a pump P, is controlled by a hydraulic valve 17, embodying the invention. The valve 17 has the lines 15, 16 connected on one side thereof, is connected on the other side thereof to pump P by a line 18 and to the sump of fluid source 14 by a line 19.

As shown in Fig. 2, the valve 17 comprises a body 20 formed with a pair of vertically extending, parallel bores 21, 22. The bore 21 is formed with a plurality of spaced, annular grooves 23, 24, 25 and 26 while bore 22 is formed with a plurality of spaced annular grooves 27, 28, 29, 30 and 31. The bores are interconnected by means of a pair of passages 32, 33 which extend respectively from grooves 24, 25 to grooves 28, 29, respectively and a pair of diagonal grooves 34, 35 which extend respectively from grooves 23, 26 to grooves 31, 27, respectively.

The valve body 20 is formed with a hollow boss on one side thereof which is provided with a pair of outlet ports 36, 37 which communicate with grooves 23, 26, respectively and with a hollow boss on the other side thereof which is provided with a pressure port 38; and a relief port 39 which communicate with grooves 30 and 23, respectively. Lines 15 and 16 are connected to

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outlet ports 36, 37 respectively and lines 18, 19 are connected to ports 38, 39, respectively.

Means is provided for effecting interconnection of the ports in selected combinations thereof. Such means comprises valve means 40, 41 reciprocally mounted in bores 21, 22, respectively. The valve means 40, 41 are of the spool type. Valve means 40 includes oppositely disposed heads 42, 43 of different pressure receiving areas, which are respectively located in cylinder portions 44, 45 at the opposite ends of the bore. Valve means 40 is formed intermediate the heads thereof with a pair of reduced portions 46, 47 located on either side of an enlarged portion 48. With valve means 40 in the position shown in Fig. 2, the enlarged portion 48 thereof is located in a manner to render grooves 24, 25 non-communicating while the pairs of grooves 23, 24; 25, 26, are respectively communicating.

Valve means 41 includes oppositely disposed heads 42a, 43a of different pressure receiving areas, which are respectively located in cylinder portions 44a, 45a at the opposite ends of bore 22. Valve means 41 is formed intermediate the heads thereof with a pair of reduced sections 46a, 47a located on either side of an enlarged portion 48a. With valve means 41 in the position shown in Fig. 2, portion 48a is located so that groove 29 is in non-communicating relation with adjacent grooves 28, 30 while the pairs of grooves 27, 30; 30, 31 are in respectively communicating relation.

Fluid pressure means is provided for selectively moving valve means 40, 41 to predetermined positions, for the purpose hereinafter appearing. To this end there is provided valve means 49 adjacent the pressure port 38. Such valve means includes a seat 50 and a spring pressed ball valve 51 on the seat. The ball side of the seat is connected to groove 30 by a passage 52, the port 38 communicating with the other side of the seat. A passage 53 interconnects cylinder portions 44, 44a and continues vertically through a side portion of valve body 20 to the upper end thereof where the same registers with a passage 53a formed in a pilot valve housing 54 secured to the upper end of valve body 20. A passage 55 connects passage 53 with port 38.

Pilot valve housing 54 is formed with a pair of vertically extending bores 56, 57 which communicate at their lower ends with cylinder portions 45, 45a, respectively. Passage 53a communicates with bores 56, 57 at the lower ends thereof. A passage 58 extends upwardly in the side of valve body 20 from relief port 39 to the upper end of the body where the same registers with a passage 58a formed in pilot valve housing 54. Passage 58a communicates with bores 56, 57 at the upper ends thereof. Intermediate portions of bores 56, 57 are respectively connected to cylinder portions 45, 45a by passages 59, 59a formed in valve housing 54. The lower ends of cylinder portions 45, 45a are interconnected by a T-shaped passage 60 formed in valve body 20, the upper end of said passage registering with a passage 60a formed in valve housing 54 and communicating with passage 58a.

Pilot valve stems 61, 62 are slidably mounted in bores 56, 57, respectively, each stem including a reduced portion 63 intermediate the ends thereof. The stems 61, 62 are connected at their upper ends to plungers 64, 65, respectively of solenoids 66, 67 respectively, said solenoids being suitably mounted on the pilot valve housing 54. The valve stems 61, 62 are biased to the position

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shown in Fig. 2, the solenoids being deenergized, by means of springs 68 located between the rear of plungers 64, 65 and closures on the solenoid casings. With the valve stems in such position, passages 59, 59a are in communicating relation with the passage 53a and in non-communicating relation with passage 58a.

In operating the hydraulic system, pump P may be operated to provide a nominal pilot pressure of about 10 to 25 p. s. i., such pressure being adjustable through a screw 69 which regulates the spring bias on ball valve 51. Such pilot pressure is applied to the valve heads 42, 43, 42a, 43a by way of passages 55, 53 and 53a, valve stems 61, 62 being in their lowermost position. While the same unit pressure is applied to the heads at opposite ends of each of the valve means 40, 41, the greater pressure responsive areas at the upper end of the valve means will maintain the valve means in the position shown in Fig. 2.

It is apparent that with the valve means 40, 41 in the position shown in Fig. 2, both sides of the piston 12 in cylinder 11 are ported to the sump side of fluid source 14 by way of passages 32, 35 and the pressure side is also ported to the sump by way of passages 34, 32. Accordingly, with pump P operating to provide a nominal pilot pressure, piston 12 is freely reciprocable in cylinder 11 and may be actuated by auxiliary means other than pressure fluid from source 14, such means, not shown, being connected to the piston rods 13, 13a.

In order to effect movement of the piston 12 to either the right or left, or to lock the piston in a given position, solenoids 66, 67 are selectively energized by suitable means not shown.

To lock the piston 12 in a given position, both solenoids 66, 67 are energized, thereby lifting the pilot valve stems 61, 62 to their uppermost position in bores 56, 57 to connect passages 59, 59a with passage 58a. Accordingly, cylinder portions 45, 45a will be ported to the sump of fluid source 14, by way of passages 58a, 58 and relief port 39. At the same time the cylinder portions 44, 44a will be connected to the pressure port 38 by way of passages 53, 55. With pilot pressure applied to the valve heads 42, 42a and the valve heads 43, 43a subject to atmospheric pressure only, the valve means 40, 41 will rise in their respective bores to assume positions indicated in Fig. 3.

With the valve means 40, 41 in the positions indicated in Fig. 3, the outlet ports 36, 37 are disconnected from the pressure port 38 and relief port 39, and the piston 12 in cylinder 11 will be locked in position. At the same time, the pressure port 38 will be in communicating relation with relief port 39 by way of passages 32, 33. Accordingly, the pump P need operate only to supply pressure fluid at pilot pressure, yet the piston 12 is locked in position without the need for operation of the pump at a working pressure.

Assuming that it is desired to move the piston 12 to the right as indicated in dotted lines in Fig. 1, then solenoid 66 is energized, while solenoid 67 is deenergized. Accordingly, pilot valve stem 61 will be lifted to its uppermost position while pilot valve stem 62 is in its lowermost position. Cylinder portion 45 will be ported to the sump while cylinder portion 45a is subject to pilot pressure. With differential pressures applied to the heads of valve means 40, said valve means will rise to its uppermost position, while valve means 41, with both heads thereof subject to pilot pressure, will stay in its lowermost position, as indicated in Fig. 4.

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With the valve means 40, 41 in the positions indicated in Fig. 4, pump P is operated to raise the pressure of fluid from source 14 to a working pressure, said fluid passing by way of line 13, port 38, through valve means 49, to grooves 30, 31, passage 34 to groove 23 and thence to outlet port 36, line 15 to enter cylinder 11 on the left side thereof, looking at Fig. 1 and moving piston 12 to the right. At the same time displaced pressure fluid in cylinder 11 will pass by way of line 13, outlet port 37, groove 26, passage 35, grooves 27, 28, relief port 39 and line 19 to the sump of fluid source 14.

To move the piston 12 to the left, as indicated in dotted lines in Fig. 1, solenoid winding 67 is energized while solenoid winding 66 is deenergized. In this case, pilot valve stem 62 will be lifted to vent cylinder portion 45a to the sump of fluid source 14 by way of passages 59a, 58a, 59 and relief port 39, while pilot valve stem 61 assumes its lowermost position. Accordingly, with differential pressures applied to the heads of valve means 41, the same will move to its uppermost position, while with the same pilot pressure applied to the heads of valve means 43, the same will remain in its lowermost position, as indicated in Fig. 5.

Under such conditions, pressure fluid from port 38 will pass by way of passage 52, grooves 33, 29, passage 33, grooves 25, 26 to outlet port 37 and thence by line 13 to the right side of cylinder 11, moving piston 12 to the left. At the same time pressure fluid displaced by the piston, passes by way of line 15 to outlet port 36 and thence through grooves 23, 24, passage 32, groove 28, relief port 39 and thence to the sump of fluid source 14 by way of line 19.

A needle valve 70 extending into passage 55 in the pilot pressure line, may be adjusted to regulate the flow of pressure fluid into the pilot passages, thereby controlling the speed of stroking of valve means 40, 41. By such means, too rapid operation of the valve means and consequent hydraulic hammer is avoided. Relief passages 58, 58a provide means for removing any pressure fluid which may collect in the cylinder portions 45, 45a beneath the valve heads 43, 43a, such fluid passing to the passages 58, 58a and thence to the sump.

In the case of certain devices which may be actuated by the mechanism 10, as for example, a ship's rudder, possible counter pressures in excess of the working pressure of the mechanism, may be transmitted to the piston 12 through piston rods 13, 13a, and thereby injure associated mechanism. Accordingly, as shown in Fig. 2, there is provided a bypass valve 72. Such valve includes a valve seat 73, one side of which communicates with outlet port 37 while the other side thereof communicates with outlet port 36. A slidable valve element has a head 74 engaging seat 73, a stem 75 extending from said head and a second head 76 on the opposite end of stem 75. The head 76 is located about outlet port 36 and the valve element is normally biased to a closed position by a spring 77 for working pressures, as determined by regulating screw 78. The effective pressure responsive area of head 74 is equal to the effective pressure responsive area of the annular portion of head 76 on the inner side thereof.

In the event that external, counter pressures are transmitted to the piston 12 by way of piston rods 13, 13a, and such pressures exceed the working pressure of mechanism 10, then the pressure

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fluid in cylinder 11 which has no egress to the sump of the fluid source 14, with valve means 49, 41 in the position indicated, will exert pressure against valve heads 74, 76 in accordance with the direction of said counter pressures. If such pressures are transmitted by way of piston rod 13, then pressure will be exerted against head 74, causing the valve element to move away from seat 73, and allowing pressure fluid to move by way of line 15 to the other side of piston 12.

If the counter pressures are transmitted by way of piston rod 13a, then pressure will be exerted against head 76, again causing the valve element to move away from seat 73 and allowing pressure fluid to pass by way of line 13 to the other side of piston 12.

It will be apparent that valve 17 is adapted to cause right or left movement of the piston 12 in hydraulic mechanism 10, as well as locking the same in a predetermined position or leaving the same free to be actuated by auxiliary means other than pressure fluid from source 14. The operating conditions are determined by the solenoid operated pilot valves whereby pilot pressures in a non-reversing arrangement, is used to actuate the valve means.

It is understood that the valve stems 61, 62 may be operated by any suitable mechanical or hydraulic means in lieu of the operating solenoids 66, 67.

It will thus be seen that there is provided a device and combinations thereof, in which the several objects of the invention are achieved and which is adapted to meet the conditions of practical use.

As various possible embodiments might be made of the above described invention, and as various changes might be made in the embodiment set forth, it is to be understood that all matter herein set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim as new and desire to protect by Letters Patent:

1. A hydraulic valve for directing the flow of pressure fluid at working pressure comprising a valve body formed with a pair of outlet ports, a pressure port and a relief port, a pair of communicating bores, said outlet ports communicating with one bore, said pressure and relief ports communicating with the other bore, valve means movable within each bore from one position to another position for effecting selective interconnection of said ports, each of said valve means including heads at the opposite ends thereof of differential area, said bores including cylinders for receiving each of said heads, connections between each of said cylinders and said pressure port, connections between each of the cylinders containing the valve head of greater area and said relief port and pilot valve means for selectively regulating the connections between each of said last mentioned cylinders and said pressure and relief ports.

2. A hydraulic valve comprising a body including a pair of outlet ports, a pressure port and a relief port, said body including a bore interconnecting said outlet ports and another bore interconnecting said pressure and relief ports, said bores being in communicating relation, slidable valve means in each bore, each valve means including heads at the opposite ends thereof of different area, each bore including a cylinder at one end thereof for receiving the valve heads of greater area and a cylinder at the other end

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thereof for receiving the valve heads of lesser area, each of said valve means being operative to move from one position to another position to interconnect said ports in selected combinations thereof, said body including a passage connecting said last mentioned cylinders with said pressure port and a pair of passages respectively connecting said pressure port and said relief port with said first mentioned set of cylinders, pilot valve means for selectively controlling the communication of each of said first mentioned cylinders and said pair of passages, and means for selectively actuating said pilot valve means.

3. A hydraulic valve comprising a body formed with a pair of parallel bores, a pair of outlet ports communicating with one bore, a relief and pressure port communicating with the other bore, a plurality of passages interconnecting said bores, each of said bores including cylinder portions at the opposite ends thereof, valve means slidably mounted in each bore and including means for effecting interconnection of said ports in selected combinations thereof upon movement of said valve means to selected positions thereof, each of said valve means including oppositely disposed heads of different area located in the respective cylinder portions, passages connecting the cylinder portions at the opposite ends of each bore with said pressure port, a passage connecting the cylinder portions containing the valve heads of greater area with said relief port, pilot valve means between each of said last mentioned cylinder portions and the passages extending therefrom and electromagnetic means for selectively actuating each of said pilot valve means whereby to selectively connect each of said last mentioned cylinder portions with said relief and pressure ports.

4. A hydraulic valve comprising a body formed with a pair of adjacent bores, one of said bores being formed with a first, second, third and fourth annular grooves adjacent each other, the other of said bores being formed with a first, second, third, fourth and fifth annular grooves adjacent each other, said body being formed with a pair of outlet ports communicating respectively with the first and fourth annular grooves of said first mentioned bore, a pressure port communicating with the fourth groove of said second mentioned bore, a relief port communicating with the second groove of said second mentioned bore, a passage connecting the first groove of the first mentioned bore with the fifth groove of the second mentioned bore, a passage connecting the fourth groove of the first mentioned bore with the first groove of the second mentioned bore, a passage connecting the second groove of the first mentioned bore with the second groove of the second mentioned bore, a passage connecting the third groove of the first mentioned bore with the third groove of the second mentioned bore, valve means slidably mounted in each bore for selectively connecting said ports through said passages, each valve means including oppositely disposed heads of different area, said bores including oppositely disposed cylinder portions for receiving said valve heads, a pair of passages respectively connecting each of the cylinder portions containing valve heads of one area with said pressure port and said relief port, a passage connecting each of the cylinder portions containing valve heads of the other area with said pressure port, pilot valve means operable to selectively connect one of said pair of passages with

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one of said ports, and means for actuating said pilot valve means.

5. A hydraulic valve comprising a body including a pair of communicating bores, one of said bores having a pair of outlet ports, the other of said bores having a pressure port and a relief port, valve means reciprocally mounted in each bore for movement to positions causing said ports to be interconnected in selected combinations thereof, each of said valve means including oppositely disposed heads of different area, said bores having cylinders to receive said heads, a passage in said body connecting each of the cylinders containing the heads of smaller diameter with said pressure port, a pair of passages in said body respectively connecting the other cylinders with said pressure and relief ports, pilot valve means between each of said last mentioned cylinders and said pair of passages for selectively connecting said last mentioned cylinders to said pressure and relief ports, and normally closed pressure responsive valve means between said pressure port and the bore communicating therewith.

6. A valve as in claim 5, and further including by pass valve means interconnecting said outlet ports.

7. A hydraulic valve for controlling the flow of pressure fluid including a first outlet port, a second outlet port, a pressure port, a relief port, and a pair of reciprocable valve means movable from one position to another position, said valve being operative with each of said valve means in said one position to connect said outlet ports and said pressure port to said relief port, said valve being further operative with each of said valve means in said other position to disconnect said outlet ports from said pressure and relief ports, to interconnect said outlet ports and to interconnect said pressure and relief ports, said valve being further operative with one of said valve means in said one position and the other valve means in the other position to connect said first outlet port with said pressure port and to connect said second outlet port with said relief port, said valve being further operative with said one valve means in said other position and said other valve means in said one position to connect said first outlet port with said relief port and to connect said second outlet port with said pressure port.

8. A valve as in claim 7, and further including means operative for independently moving each of said valve means to the selected positions thereof.

9. A hydraulic valve for directing the flow of pressure fluid comprising a body formed with a pair of adjacent communicating bores, a pair of outlet ports in one bore, pressure and relief ports in the other bore, valve means reciprocable in each bore for effecting interconnection of said ports in selected combinations thereof, each of said valve means including oppositely disposed fluid pressure responsive heads of different area, a passage connecting opposite ends of said bores with said pressure port, a passage connecting one end of each bore with said relief port, normally closed pressure responsive valve means between said pressure port and said second mentioned bore whereby to admit pressure fluid at pilot pressure to said first mentioned passage and pilot valve means operative to selectively control the flow of pressure fluid at pilot pressure to the opposite ends of said bores and to one end of said bores.

10. A valve as in claim 9, and further including needle valve means between said pilot valve means and said second mentioned valve means for regulating the rate of flow of pressure fluid at pilot pressure.

11. A hydraulic valve for directing the flow of pressure fluid including a body formed with a pair of adjacent, communicating bores, one of said bores having a pair of outlet ports, the other of said bores including a pressure port and a relief port, reciprocable valve means in each bore for effecting interconnection of said ports in selected combinations thereof, each valve means including oppositely disposed pressure responsive heads of different area in cylinder portions at the opposite ends of the bore associated therewith, pressure responsive valve means between said pressure port and the bore associated therewith, a passage in said body directly connecting said pressure port and the opposite ends

of said cylinder portions, said pressure responsive valve means being normally closed to direct pressure fluid at pilot pressure to said passage and responsive to pressures greater than said pilot pressure to direct pressure fluid to said bores.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,550,467	Thoma	Aug. 18, 1925
2,214,119	Brisbane	Sept. 10, 1940
2,215,115	Buffington	Sept. 17, 1940
2,218,861	Stumpf	Oct. 22, 1940
2,477,669	Stephens	Aug. 2, 1949

FOREIGN PATENTS

Number	Country	Date
515,617	Great Britain	Dec. 11, 1939