

Nov. 21, 1944.

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2,363,111

HYDRAULIC VALVE

Filed Dec. 2, 1941

3 Sheets-Sheet 1

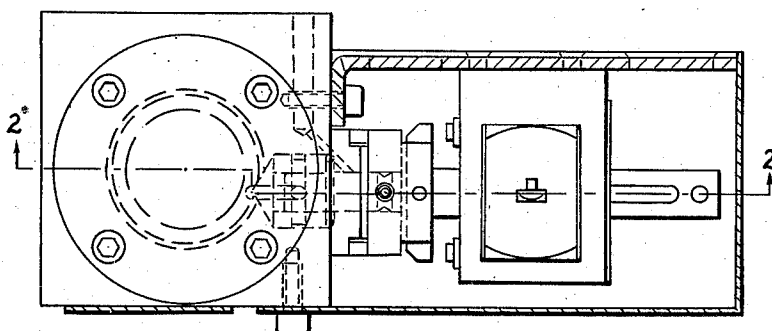


Fig. 4

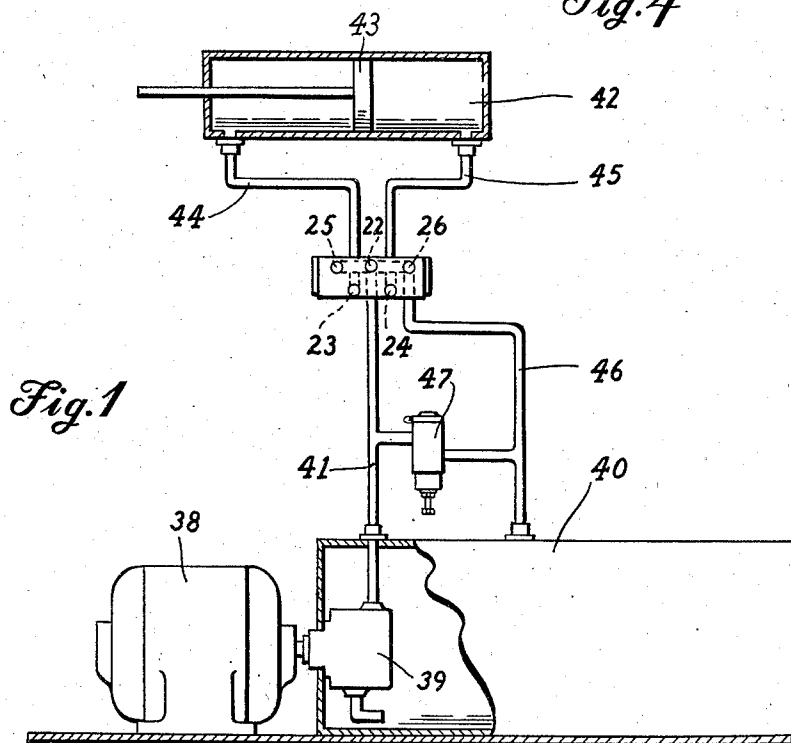


Fig. 1

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3 Sheets-Sheet 2

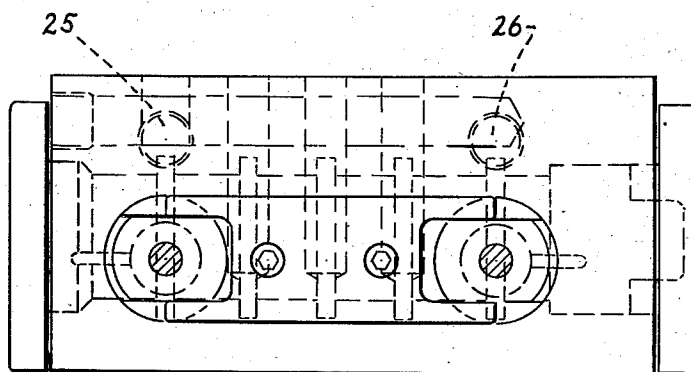


Fig. 3

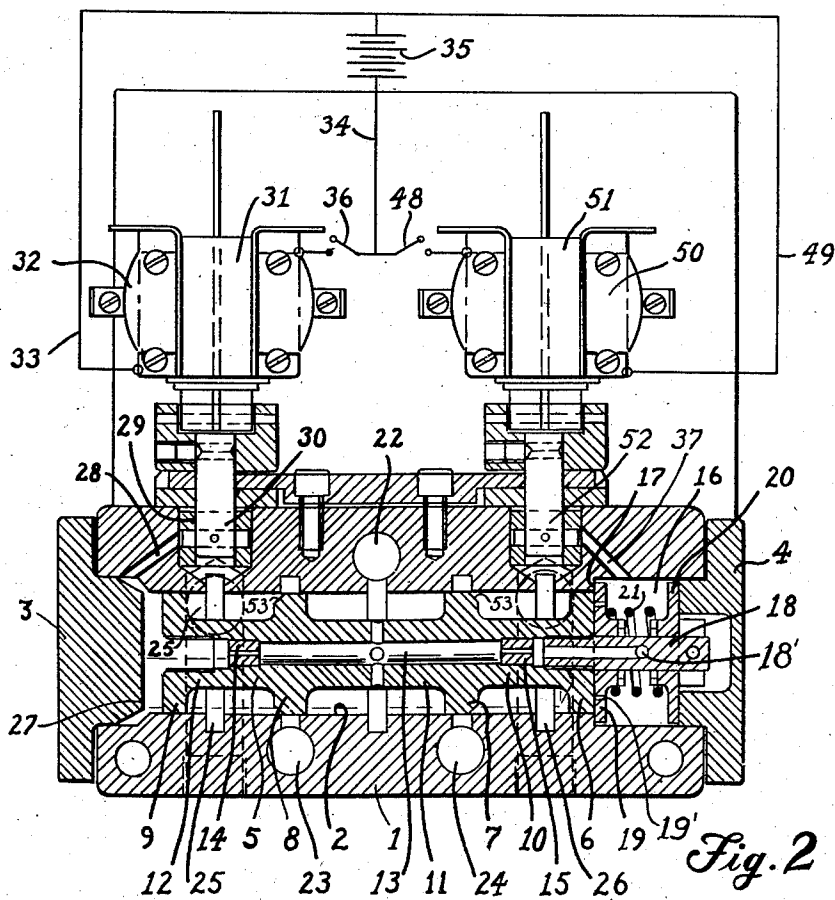


Fig. 2

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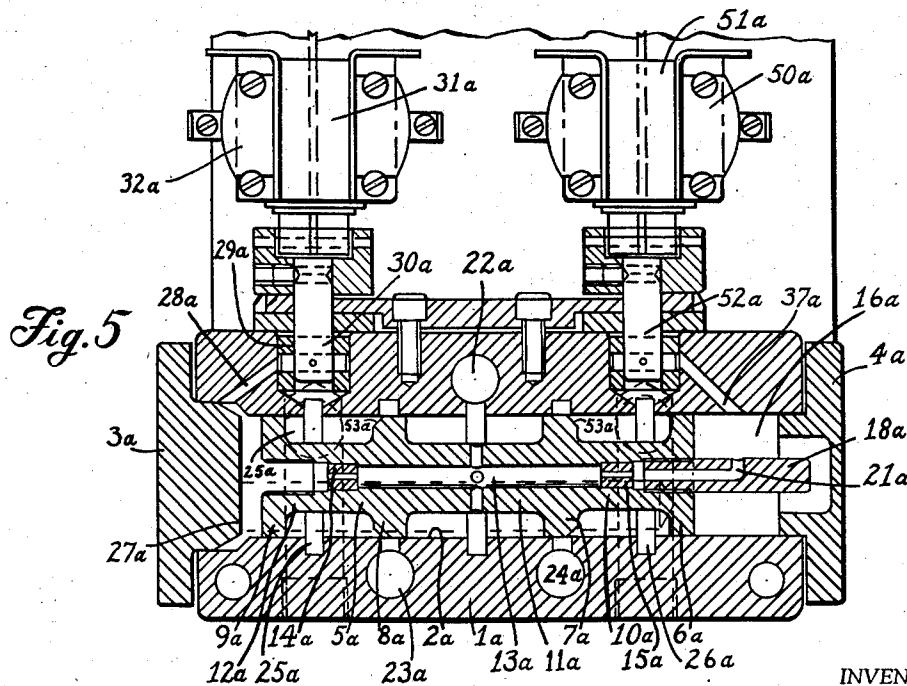
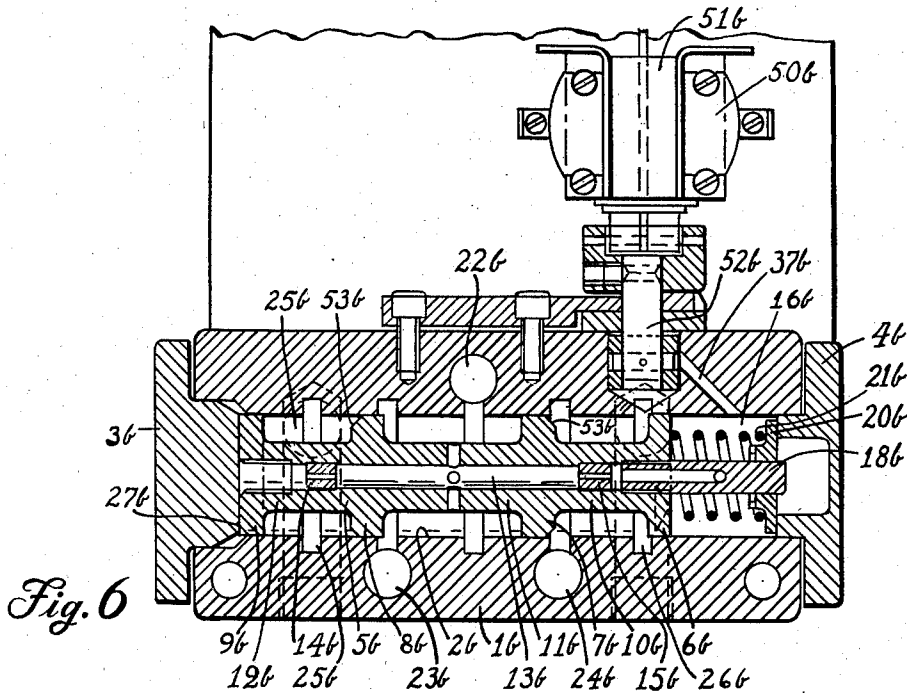
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HYDRAULIC VALVE

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3 Sheets-Sheet 3



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2,363,111

HYDRAULIC VALVE

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6 Claims. (Cl. 121—46.5)

This invention relates to hydraulic control valves and has particular adaptability in such cases as controlling the flow of liquid under pressure to a hydraulic cylinder adapted to reciprocate according to a manual control or through a continuous cycle. Hydraulic motors of the type herein contemplated are found, for instance as the traversing means for milling machines and the like.

An object of the invention is to provide a four-way valve capable of controlling light or heavy pressures with the expenditure of minimum of energy and movement.

More particularly it is an object to provide a four-way spool valve capable of obstructing the flow or of diverting it to alternate sides of a reciprocable piston and of venting one side of the piston together with solenoid means operable through a short travel to control movements of said valve.

Another object is to provide a control valve capable of responding promptly without setting up a hammering in the pressure lines.

Another object is to provide a general type of valve which lends itself to easy changes to accommodate itself to different desired sequences thus simplifying production from the manufacturers' standpoint and rendering it possible to use the valve for widely different services where interchangeable parts are provided.

Other objects and advantages will become more fully apparent as reference is made to the accompanying drawings wherein my invention is illustrated, and in which

Fig. 1 diagrammatically shows a typical hydraulic system having my improved control valve as a part thereof,

Fig. 2 is a horizontal section taken along the line 2—2 of Fig. 4,

Fig. 3 is an end elevation of that end of Fig. 2 adjacent thereto as illustrated,

Fig. 4 is a side elevation, with parts in section, of the right end of Fig. 2, and

Figs. 5 and 6 are views similar to Fig. 2 showing modified forms of the invention.

More particularly, 1 indicates a valve casing having a cylindrical bore 2 therethrough, the bore being closed at each end by the cylinder heads 3 and 4. A spool valve 5 is slidable in the bore 2. This valve is composed of a plurality of lands or piston-like portions 6, 7, 8 and 9 spaced from each other by the integral stems 10, 11 and 12. Axially through the valve is a passageway 13 open intermediate its end to the space between the portions

7 and 8 and restricted to small or minute diameter towards its ends by the bored plugs 14 and 15.

The bore 2 is enlarged at 16 at one end thereof forming a shoulder 17 at a point such that the shoulder is coplanar with the end of the portion 6 of the valve. Extending outwardly into the space 16 is a hollow plug or shaft 18 which is fixed into the bore 13 of the valve. A spring-seated washer 19 is slidable on the plug 18 and seats at its periphery on the shoulder 17. The washer 19 is provided with holes 19' to permit the free passage of fluid from one side to the other of the washer. Another spring-seated washer 20 is secured to the outer end of the plug 18 and a spring 21 urges the washers apart and acts to urge the valve 5 to the centered position illustrated. The bore 13 finds an outlet through the plug 18 into the space 16 through an opening 18' in the protruding end of the plug 18.

The casing 1 has a plurality of small bores therethrough constituting fluid passages. The passage 22 contains fluid under pressure and inlets into the cylinder 2 between the piston-like portions 7 and 8, the portions 7 and 8 being sufficiently spaced so that the pressure passage 22 is always in communication with this space even though the valve 5 may be at the maximum of its travel in either direction. The passage or bore 13 is thus also in constant communication with the passage 22.

The valve portion 7 in centered position overlies one outlet passage 24 and the valve portion 8 overlies the outlet passage 23. If the valve 5 is moved to the left as viewed in Fig. 2 the pressure line 22 is placed in communication with the outlet 23 and if moved to the right it is placed in communication with the outlet 24. Drain outlets 25 and 26 are provided between the valve portions 8 and 9, and between the valve portions 6 and 7 respectively.

The cylinder head 3 has an internal shoulder 27 against which the valve portion 9 abuts when moved to its extreme position to the left, as viewed in Fig. 2. The shoulder is tapered to form a chamber therearound and an outlet or drain line 28 leads from this chamber to a further chamber 29 also formed in the casing. This latter chamber 29 is in the form of a cylinder having a cut-off valve 30 projecting thereinto. The valve 30 is connected at its upper end to a core 31 movable in a coil 32, the coil being connected by lines 33 and 34 to a source of electrical energy 35. A switch 36 in the line 34 opens and closes the power line.

Leading from the chamber 16 is an outlet or

drain line 37 which leads to a solenoid-controlled valve device which is a duplicate of that just described so the description will not be repeated.

In describing the operation reference will first be had to Fig. 1 in which a typical system, with which my control valve is adapted to function, is diagrammatically illustrated. In the system a motor 38 is adapted to drive a pump 39 fed from a tank or sump 40 thus furnishing a source of liquid pressure supply through a line 41. The line 41 leads into the pressure passageway 22 of the control device forming the subject matter of this invention. A hydraulic motor in the form of a cylinder 42 and a piston 43 is the device to be controlled so that a line 44 leads from one outlet 23 to one side of the piston 43 and another line 45 leads from the outlet 24 to the other side of the piston 43. The drain passage 25 connects into the drain passage 26 and a common line 46 leads back into the sump 40. Between the lines 41 and 46 is a pressure relief valve 47 which causes fluid being pumped through the line 41 to be bypassed back to the tank or sump 40 when a predetermined pressure is reached.

When it is desired that the piston 43 move to the right, as viewed in Fig. 1, the switch 36 is closed thus energizing the coil 32 and causing the solenoid valve 30 to open. This bleeds the chamber between the shoulder 27 and the valve portion 9 thus permitting the valve 5 to move to the left under the influence of the pressure fluid introduced through the inlet 22. The outlet 23 is thus uncovered and communication is established therethrough between the pressure lines 22 and 44. Simultaneously the outlet 24 is uncovered and communication is established to the drain line 26 so that the piston 43 can move to the right. If the switch 36 is then opened the spring 21 will urge the spool valve to return to its centered position which it will do as the chamber between the cylinder end 3 and the valve portion 9 fills with fluid.

If the switch 48 of the other circuit 49 is now closed the coil 50 will be energized causing the plunger or core 51 thereof to elevate the valve 52. Fluid will then flow from the chamber 16 through the passageway 37 and past the valve 52 thus permitting the spool valve 5 to move to the right. This will connect the pressure line 22 with the line 24 and admit fluid under pressure to the right side of the piston 43 and, at the same time, place the line 44 and port 23 in communication with the outlet 25 which drains the fluid from the left side of the piston 43, permitting the piston 43 to be driven to the left.

The portions 7 and 8 of the spool valve are bevelled at 53 to permit slight leakage therepast between the lines 23 and 25, and 24 and 26 so that the piston 43 may be manually shifted. It may thus be located while emplacing a heavy machine, for instance, so that it will thereafter function from a normally centered position.

Fig. 5 illustrates a modification of the invention which is the same as the structure in Fig. 2 with the spring 21 omitted. Since the structure is otherwise the same the same numerals have been applied with the small letter *a* added and the description of parts will not be repeated. The operation is as follows: when the system is being supplied with fluid under pressure through the line 22a the valve may be in the centered position illustrated, but thereafter it will always come to rest at one end or the other of its bore. Thus, suppose the parts to be in the position illustrated and suppose that the solenoid

winding 32a is energized, the core 31a will be elevated thus opening the valve 30a and venting the fluid from the space between the valve end 9a and the bore end 3a. The valve 5a will move to the left by reason of the pressure against the other end of the valve 5a thus connecting the port 23a with the pressure source 22a and simultaneously connecting the port 26a with the port 24a. As the solenoid valve 30a is then closed pressure will build up in the chamber between the head 3a and the valve end 9a to balance the pressure on the other end of the valve 5a, but all forces are balanced and the valve will remain in its position to the left until the other solenoid valve is elevated in order to reduce the pressure at the right hand end 6a of the valve whereupon the valve 5a will move to the right. This movement will connect the port 22a to the port 24a, and the port 25a to the port 23a.

Fig. 6 shows a construction similar to that of Fig. 2 but with one solenoid and solenoid valve omitted and with the spring-seated washer 19 omitted so that the spool valve is spring biased to the left, as illustrated. Similar parts carry the same numerals with the addition of the small letter *b* so that a detailed description of parts will not be repeated.

The operation is as follows: suppose that the system is filled with fluid under pressure through the port 22b. The fluid pressure at each end of the spool valve will be balanced so that the pressure exerted by the spring 21b will maintain the valve in the extreme left position when the outlet valve 52b is closed. The operation is otherwise the same as the operation of the valve illustrated in Fig. 2 and described above.

What I claim is:

1. A hydraulic control valve comprising a casing having a bore therein, a pressure-fluid inlet passage extending through said casing and communicating with an intermediate portion of said bore, a pair of pressure-fluid outlet passages extending through said casing and communicating with said bore, one at each side of the pressure-fluid inlet, longitudinally of the bore, a reciprocable valve in the bore including a stem and a pair of spaced lands at each side of the fluid inlet, longitudinally of the bore, a passage extending longitudinally through the valve and communicating with said intermediate portion of the bore and the space between each end of the valve and the casing, so that pressure fluid from the inlet may pass to the space between each end of the valve and the casing, a drain from the space between each of said pairs of lands, a passage from the space between each end of the valve and the casing to the space between the proximate pair of lands for the venting of fluids from the spaces between the ends of the valve and the casing, and means for controlling the passage of fluid through said last-mentioned passages, the innermost of the pairs of lands closing the outlet passages to the passage of pressure fluid from the pressure-fluid inlet when the valve is in neutral position, and the valve being movable longitudinally of the bore to cause either outlet passage to be opened for the passage of pressure fluid from the pressure-fluid inlet, the other outlet passage, when the valve is so moved, being connected to the proximate drain.

2. A hydraulic control valve comprising a casing having a bore therein, a pressure-fluid inlet passage extending through said casing and communicating with an intermediate portion of said bore, a pair of pressure-fluid outlet passages ex-

tending through said casing and communicating with said bore, one at each side of the pressure-fluid inlet, longitudinally of the bore, a reciprocable valve in the bore including a stem and a pair of spaced lands at each side of the fluid inlet, longitudinally of the bore, a passage extending longitudinally through the valve and communicating with said intermediate portion of the bore and the space between each end of the valve and the casing, so that pressure fluid from the inlet may pass to the space between each end of the valve and the casing, a drain from the space between each of said pairs of lands, a passage from the space between each end of the valve and the casing to the space between the proximate pair of lands for the venting of fluids from the spaces between the ends of the valve and the casing, and electromagnetic means for controlling the passage of fluid through said last-mentioned passages, the innermost of the pairs of lands closing the outlet passages to the passage of pressure fluid from the pressure-fluid inlet when the valve is in neutral position, and the valve being movable longitudinally of the bore to cause either outlet passage to be opened for the passage of pressure fluid from the pressure-fluid inlet, the other outlet passage, when the valve is so moved, being connected to the proximate drain.

3. A hydraulic control valve comprising a casing having a bore therein, a pressure-fluid inlet passage extending through said casing and communicating with an intermediate portion of said bore, a pair of pressure-fluid outlet passages extending through said casing and communicating with said bore, one at each side of the pressure-fluid inlet, longitudinally of the bore, a reciprocable valve in the bore including a stem and a pair of spaced lands at each side of the fluid inlet, longitudinally of the bore, a passage extending longitudinally through the valve and communicating with said intermediate portion of the bore and the space between each end of the valve and the casing, so that pressure fluid from the inlet may pass to the space between each end of the valve and the casing, a drain from the space between each of said pairs of lands, a passage from the space between each end of the valve and the casing to the space between the proximate pair of lands for the venting of fluids from the spaces between the ends of the valve and the casing, and manual means for controlling the passage of fluid through said last-mentioned passage irrespective of the position of the valve, the innermost of the pairs of lands closing the outlet passages to the passage of pressure fluid from the pressure-fluid inlet when the valve is in neutral position, and the valve being movable longitudinally of the bore to cause either outlet passage to be opened for the passage of pressure fluid from the pressure-fluid inlet, the other outlet passage, when the valve is so moved, being connected to the proximate drain.

4. A hydraulic control valve comprising a casing having a bore therein, a pressure-fluid inlet passage extending through said casing and communicating with an intermediate portion of said bore, a pair of pressure-fluid outlet passages extending through said casing and communicating with said bore, one at each side of the pressure-fluid inlet, longitudinally of the bore, a reciprocable valve in the bore including a stem and a pair of spaced lands at each side of the fluid inlet, longitudinally of the bore, a passage extending longitudinally through the valve and communi-

cating with said intermediate portion of the bore and the space between each end of the valve and the casing, so that pressure fluid from the inlet may pass to the space between each end of the valve and the casing, a drain from the space between each of said pairs of lands, a passage from the space between each end of the valve and the casing to the space between the proximate pair of lands for the venting of fluids from the spaces between the ends of the valve and the casing, means for controlling the passage of fluid through said last-mentioned passages, and means for normally maintaining the valve in neutral position with the innermost of the pairs of lands closing the outlet passages to the passage of pressure fluid from the pressure-fluid inlet, the valve being movable longitudinally of the bore to cause either outlet passage to be opened for the passage of pressure fluid from the pressure-fluid inlet, the other outlet passage, when the valve is so moved, being connected to the proximate drain.

5. A hydraulic control valve comprising a casing having a bore therein, a pressure-fluid inlet passage extending through said casing and communicating with an intermediate portion of said bore, a pair of pressure-fluid outlet passages extending through said casing and communicating with said bore, one at each side of the pressure-fluid inlet, longitudinally of the bore, a reciprocable valve in the bore including a stem and a pair of spaced lands at each side of the fluid inlet, longitudinally of the bore, a passage extending longitudinally through the valve and communicating with said intermediate portion of the bore and the space between each end of the valve and the casing, so that pressure fluid from the inlet may pass to the space between each end of the valve and the casing, a drain from the space between each of said pairs of lands, a passage from the space between one end of the valve and the casing to the space between the proximate pair of lands for the venting of fluid from the space between said end of the valve and the casing, means for controlling the passage of fluid through said last-mentioned passage, the innermost of the pairs of lands closing the outlet passages to the passage of pressure fluid from the pressure-fluid inlet when the valve is in neutral position, and the valve being movable longitudinally of the bore to cause either outlet passage to be opened for the passage of pressure fluid from the pressure-fluid inlet, the other outlet passage, when the valve is so moved, being connected to the proximate drain.

6. A hydraulic control valve comprising a casing having a bore therein, a pressure-fluid inlet passage extending through said casing and communicating with an intermediate portion of said bore, a pair of pressure-fluid outlet passages extending through said casing and communicating with said bore, one at each side of the pressure-fluid inlet, longitudinally of the bore, a reciprocable valve in the bore including a stem and a pair of spaced lands at each side of the fluid inlet, longitudinally of the bore, a passage extending longitudinally through the valve and communicating with said intermediate portion of the bore and the space between each end of the valve and the casing, so that pressure fluid from the inlet may pass to the space between each end of the valve and the casing, a drain from the space between each of said pairs of lands, a passage from the space between each end of the valve and the casing for the venting of fluid from said space, and means for independently and man-

ually controlling the passage of fluid through said last-mentioned passages irrespective of the position of the valve, the innermost of the pairs of lands closing the outlet passages to the passage of pressure fluid from the pressure-fluid inlet when the valve is in neutral position, and the valve being movable longitudinally of the bore

to cause either outlet passage to be opened for the passage of pressure fluid from the pressure-fluid inlet, the other outlet passage, when the valve is so moved, being connected to the proximate drain.

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