July 5, 1949. W. W. SLOANE 2,475,298

HYDRAULIC CONTROL VALVE

Filed June 22, 1945 2 Sheets-Sheet 1

Fig. 7

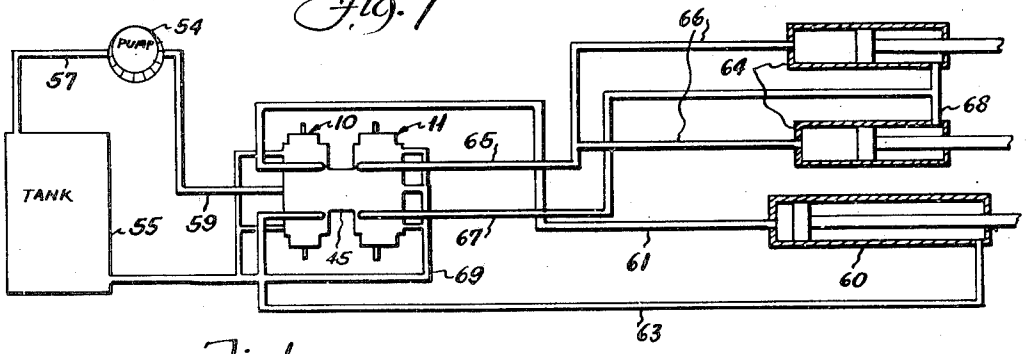


Fig. 1

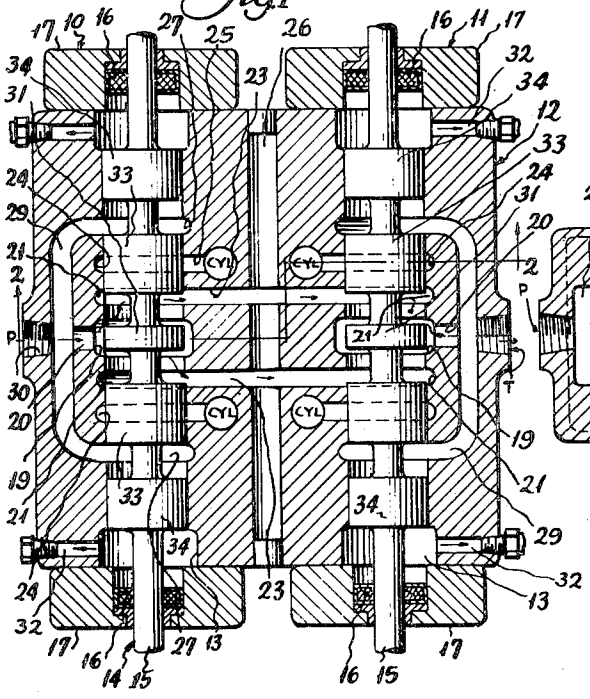


Fig. 2

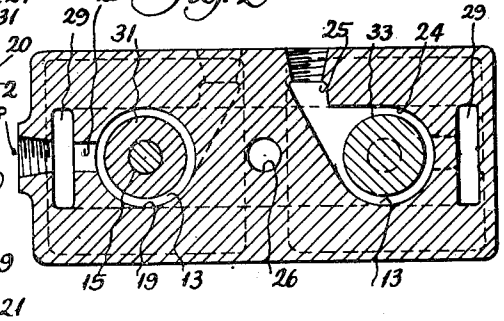
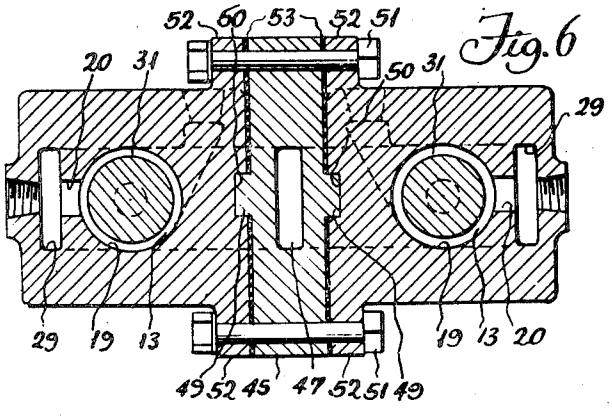


Fig. 6



INVENTOR
William W. Sloane
Clarence F. Poole
ATTORNEY

July 5, 1949. W. W. SLOANE 2,475,298

HYDRAULIC CONTROL VALVE

Filed June 22, 1945 2 Sheets-Sheet 2

Fig. 3

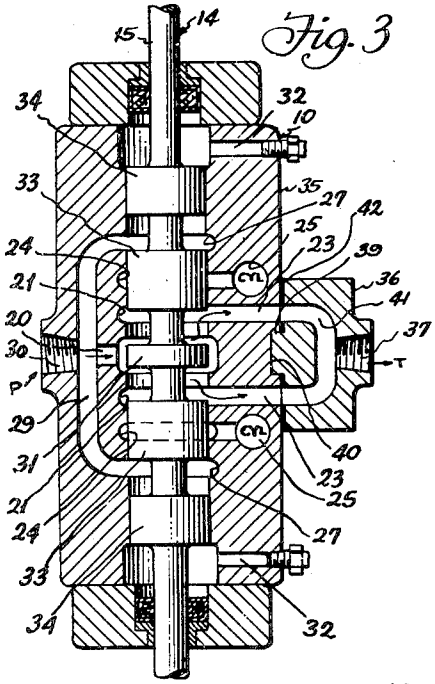


Fig. 4

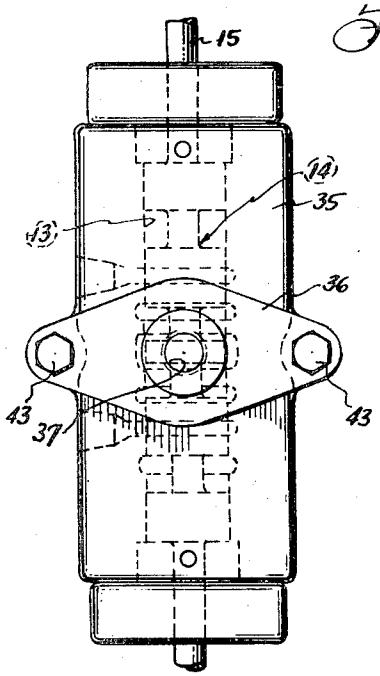
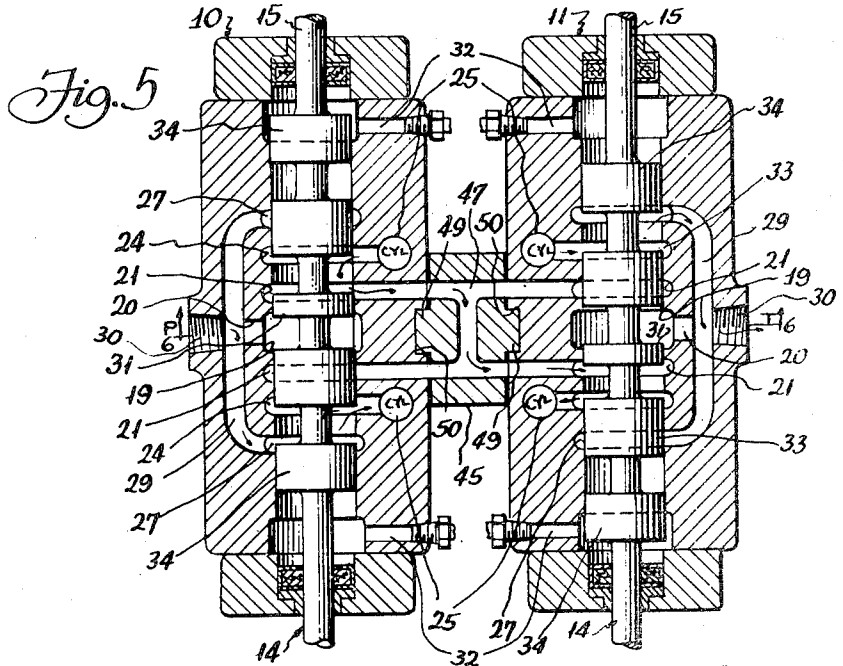


Fig. 5



INVENTOR
William W. Sloane
Clarence A. Poole
ATTORNEY

Patented July 5, 1949

2,475,298

UNITED STATES PATENT OFFICE

2,475,298

HYDRAULIC CONTROL VALVE

William W. Sloane, Chicago, Ill., assignor to Goodman Manufacturing Company, Chicago, Ill., a corporation of Illinois

Application June 22, 1945, Serial No. 600,950

9 Claims. (Cl. 60—97)

1

This invention relates to improvements in hydraulic control valves of the type particularly adapted to control operation of a number of work performing devices connected in series.

In certain types of machines, and more especially in coal loading machines operable for loading coal from the working face of a mine underground, it is desirable to use a single pump to provide pressure to independently perform a number of moving operations at the same time; as for example, it is often desirable to swing the gathering head and elevating conveyer of the loading machine laterally, and to simultaneously raise or lower it so that it will be in the proper position to gather coal when at the end of its lateral travel. This has been done by means of separate hydraulic cylinders connected in series to two 4-way hydraulic control valves, which are also connected in series so that fluid under pressure released from one end of one cylinder may be used to supply fluid to another cylinder and thus permit a single source of pressure to be used to operate both cylinders either independently or simultaneously. The valves used to control these operations have been of the spool or piston type having fluid passageways extending through the centers of the valve stems, with cross passageways leading from the valve pistons to these center passageways. Such valves are relatively complicated and expensive to manufacture, and the friction losses caused by fluid passing through the restricted passageways in the pistons and valve stem reduces the efficiency of the valve and can only be overcome by increasing the size of the valve, so as to provide larger diameter pistons with more adequate passageways therethrough. This increases the cost of the valve and is not always desirable or possible, especially where the space where the valves are to be used is restricted, as is usually the case with equipment operating underground.

The principal objects of my present invention are to provide a novel compact and simpler form of spool valve than has heretofore been provided, arranged to independently control the operation of a plurality of cylinders in series from a single source of fluid supply by so arranging the pistons and ports of the valve that the cylinder ports of the valve will be closed and fluid will be by-passed through the valve when in a neutral position, and when the valve is in one operative position or another, pressure released from one cylinder may pass through the valve and supply pressure to another cylinder.

Another object of my invention is to provide a 4-way completely reversible open center piston type valve, so arranged that its inlet passages may be outlet passages and vice versa, and adapted to be readily connected to operate as a single 4-way valve, or to be connected in series with other similar valves to independently operate

2

a plurality of hydraulic actuating devices connected in series.

A still further object of my invention is to provide a double piston valve in a single valve casing having a simplified and efficient arrangement of pistons and passageways so as to provide a simplified form of series connected valve, arranged to independently operate a plurality of hydraulic actuating devices connected in series.

In carrying out my invention I provide a 4-way spool or piston type of valve which eliminates all fluid passageways through the spool of the valve and which has a central by-pass port in the valve chamber, with a pressure inlet port and a pressure outlet port on each side of said by-pass port, and also has a piston valve movable in the valve chamber for controlling the passage of fluid to and from said ports. The piston valve includes a central piston narrower than the by-pass port, and includes pistons on opposite sides of said central piston wider than the by-pass port, so that when the valve piston is in a neutral position, fluid under pressure may pass through the by-pass port and by said central valve piston, through either or both of the outlet ports, and fluid in the cylinder ports may be blocked by said wider pistons; and when the valve is in one operative position or another, fluid may flow from one pressure port to one cylinder port while one of said pistons blocks the opposite pressure port, and may flow from the opposite cylinder port to the opposite pressure port, to operate another hydraulic operating device.

These and other objects of my invention will appear from time to time as the following specification proceeds and with reference to the accompanying drawings wherein:

Figure 1 is a central longitudinal sectional view taken through a valve constructed in accordance with my invention, showing two series connected valves mounted in a single valve casing, with the valves shown in a neutral or by-pass position;

Figure 2 is a sectional view taken substantially along line 2—2 of Figure 1;

Figure 3 is a central longitudinal sectional view taken through a modified form of valve constructed in accordance with my invention, showing a single valve in a by-pass position;

Figure 4 is a side view of the valve shown in Figure 3;

Figure 5 is a central longitudinal sectional view taken through two single valves connected in series, showing one valve in one operative position and the other valve in another operative position, and showing a simplified form of adapter for connecting said valves for series operation;

Figure 6 is a sectional view taken substantially along line 6—6 of Figure 5; and

Figure 7 is a diagrammatic hydraulic circuit

illustrating one manner in which the valves of my invention may be used.

In the embodiment of my invention illustrated in Figures 1 and 2 of the drawings, two series connected valves 10 and 11 are shown as being mounted in a valve casing 12 having parallel spaced valve chambers or cylinders 13, 13 extending longitudinally through the central portion thereof. Said valves are of the same construction so one valve only need herein be described in detail, and the same part numbers will be applied to similar parts of each valve 10 and 11 throughout the various figures of the drawings.

The valve 10 includes a piston valve 14 movable within the cylinder 13 and having a valve stem 15 extending through and projecting from opposite ends of said casing and slidably mounted in packing glands 16, 16 mounted in end closure members 17, 17 for opposite ends of said casing.

The valve cylinder 13 is provided with an annular port 19 forming a by-pass port for by-passing fluid from a pressure passageway 20 through annular pressure ports 21, 21 on opposite sides of said by-pass port. Said pressure ports 21, 21 lead to passageways 23, 23, herein shown as being connected with pressure ports 21, 21 of the valve 11. Said pressure ports 21, 21 are shown as being inlet ports in the valve 10 and are shown as being outlet ports in the valve 11, and in said valve 11, fluid is by-passed from said ports through said by-pass port and the passageway 20 to the return, when said valve is in a neutral position. A passageway 26, herein shown as extending through said valve casing between and parallel to the valve chambers 13, 13, is provided to connect said passageways 23, 23 together between the valves 10 and 11, to permit fluid to be supplied to either or both of the ports 21, 21 of the valve 11, when one or the other of the ports 21 in the valve 10 is closed.

A cylinder or service port 24 is provided on the outside of each pressure port 21. Said cylinder ports are connected with passageways 25, 25 leading to the outside of said valve and adapted to be connected to a suitable hydraulic actuating device, such as a cylinder, for supplying fluid under pressure thereto, to operate said device. A pressure port 27 is provided on the outside of each cylinder port 24. Said pressure ports are connected together by a passageway 29 which is also connected with the by-pass passageway 20, and is connected with the outside of said valve casing through an apertured portion 30 of said casing, which may be threaded to receive a suitable pipe fitting. Said last mentioned pressure ports in the valve 10 are adapted to supply fluid under pressure to either one of the cylinder ports 24, 24, depending upon the direction of movement of the piston valve 14 past the neutral position shown in Figure 1. Said pressure ports in the valve 11 serve as outlet ports, to release fluid from either of the associated cylinder ports 24, 24.

The piston valve 14 has a by-pass piston 31 herein shown as being formed integrally with the valve stem 15. Said valve piston 31 is narrower than the by-pass port 19, to permit fluid under pressure to pass thereby and through said port, to and through the ports 21, 21, and out the valve through the passageways 23, 23, when the valve is in a neutral position. Said valve piston also serves to block the passage of fluid through one or the other of said pressure ports when the valve is moved to one or the other operating position. Said piston valve also has a valve piston 33 spaced from said central valve piston on each side thereof, and herein shown as being formed integrally with said valve stem 15. Said last mentioned valve pistons 33, 33 are wider than the piston 31 and serve to block the cylinder ports 24, 24 when the valve is in a neutral position.

When the piston valve 14 has been moved to one operative position, the central piston 31 and the valve piston 33 on one side thereof will block the passage of fluid from the by-pass port 19 into either of said pressure ports 21, 21. When said valve piston is in an opposite operative position, said central piston 31 and said opposite valve piston 33 will block the passage of fluid from said by-pass port through either of said pressure ports 21, 21 (see Figure 5).

A valve piston 34 is spaced along the valve stem 15 outwardly from each valve piston 33. Said last mentioned valve pistons serve to prevent the passage of fluid from the outer pressure ports 27, 27 to the ends of the valve stem and to the packing glands 16, 16. Said pistons 34, 34 with said pistons 33, 33 also serve to form passageways to permit the passage of fluid from one pressure port 27 to an adjacent cylinder port 24 when the valve is in one operative position or another. Fluid leaking past said pistons 34, 34 is returned to the return through drainage passageways 32, 32.

When the piston valve 14 is in either operative position, the valve piston 33 opposite from the pistons 33 and 34 which form a passageway to permit the passage of fluid from one pressure port 27 to an adjacent cylinder port, will block the opposite pressure port 27. The valve piston 33 adjacent the cylinder port 24, which is open to pressure from the pressure port 27, will block the pressure port 21 adjacent said open cylinder port. Also, when said valve is in this operative position, the valve piston 33 blocking the pressure port 27 will open the adjacent cylinder port 24, to permit fluid to pass from said cylinder port out through the pressure port 21. When in this position the central valve piston 31 and the valve piston 33 adjacent the cylinder port which is open to pressure, serve to block the passage of fluid to and through the central by-pass port 19, as may clearly be seen with reference to Figure 5. Thus when the valve is in either operative position, fluid under pressure may be supplied to one cylinder through one pressure port 27 and may be released from the other cylinder through the adjacent pressure port 21 and through the passageway 23 and cross connecting passageway 26, to supply pressure to either or both of the pressure ports 21, 21 of the valve 11.

It may be seen from the foregoing that the valves 10 and 11 are of the same construction and that these valves are so proportioned and arranged that the exhaust passages and ports of one valve may also serve as inlet passages and ports, and vice versa, and that said valves may be combined in various other manners than shown in Figure 1.

Figure 3 in the drawings shows a single piston valve 14 mounted in a valve casing 35, and shows an adapter 36 mounted on the outside of said valve casing, to connect the pasageways 23, 23 together and permit fluid flowing through said passageways to be connected to a single outlet 37. Said adapter, as herein shown, is formed from a casting adapted to abut the outer face of the valve casing 35 and having a rectangular lug 39 projecting inwardly therefrom and adapted to register with a similar recessed portion 40 of said valve casing, to register the ends of a pas-

sageway 41 formed in said casing with the ends of the passageways 23, 23. Said passageway 41 is shown as being of a substantially U-shaped formation, and with the outlet 37 forms a substantially Y-shaped passage. A suitable packing member or gasket 42 may be interposed between the outside of said casing and said adapter, to prevent the leakage of fluid thereby. Said adapter may be secured to said casing by means of nuts and bolts 43, 43 extending through opposite ends thereof and extending through suitable ears (not shown) projecting from opposite sides of said valve casing.

When it is desired to connect two single valves in series, as shown in Figures 5 and 6, an adapter 45 may be provided. Said adapter, as herein shown, has an H-shaped passageway 47 formed therein, opposite ends of the legs of the H of which register with the passageways 23, 23 of the valves 10 and 11. Said adapter is provided with rectangular lugs 49, 49 projecting from opposite sides thereof which are adapted to register with corresponding recessed portions 50, 50 formed in the adjacent sides of the casings of said valves. Nuts and bolts 51, 51 passing through ears 52, 52 projecting laterally from opposite sides of said casing and through opposite ends of said adapter, are provided to secure said valves to said adapter. Suitable packing members, such as gaskets 53, 53, abut opposite sides of said adapter and the adjacent sides of said valve casings, to prevent the leakage of fluid thereby. It should here be understood that if desired the valves 10 and 11 can also be connected together by a pipe connected between the apertured portions 30, 30 and by connecting an adapter 36 to each valve to connect the passageways 23, 23 of each valve to a common inlet.

In the hydraulic diagram shown in Figure 7 the two valves 10 and 11 are shown as being connected together by the adapter 45, as in Figures 5 and 6. Fluid under pressure is supplied to the valve 10 by means of a fluid pump 54 connected to a fluid storage tank 55 by a pipe 57 and connected with said valve by a pipe 59. One service or cylinder port 24 of said valve is connected with the head end of a hydraulic operating cylinder 60 by means of a pipe 61. The opposite service or cylinder port 24 is connected with the piston rod end of said cylinder, by means of a pipe 63. One service or cylinder port 24 of the valve 11 is herein shown as being connected with the head ends of two hydraulic operating cylinders 64 by means of a pipe 65 and branch pipes 66, 66, to supply fluid under pressure thereto. The piston rod ends of said cylinders are connected with the opposite service or cylinder port 24 by means of a pipe 67 connected to a branch pipe 68, connected with the piston rod ends of said cylinders. Fluid is returned from the valve 11 to the fluid storage tank 55 by means of a return pipe 69. Thus, when the valve 10 is in one operative position, as for instance, the position shown in Figure 5, fluid under pressure will be supplied to the piston rod end of the cylinder 60 through the pipe 63, and fluid discharged from the head end of said cylinder will be conducted by the pipe 61 to the cylinder port 24 of said valve 10. Fluid under pressure will pass from said cylinder port through the pressure port 21 and passageway 23 to the valve 11, and when said last mentioned valve is in a neutral position, through said valve to the tank 55. When said valve, however, is in the operating position shown in Figure 5, fluid will pass through the pressure

port 21 of the valve 11 and cylinder port 24, to the piston rod ends of the cylinders 64, 64. Fluid will also be released from the opposite ends of said cylinders to the opposite cylinder port of said valve, to and through the outer pressure port 27 and passageway 29, to the tank 55.

While I have herein shown and described one form in which my invention may be embodied, it will be understood that the construction thereof and the arrangement of the various parts may be altered without departing from the spirit and scope thereof. Furthermore, I do not wish to be construed as limiting my invention to the specific embodiment illustrated, excepting as it may be limited in the appended claims.

I claim as my invention:

1. In a hydraulic control valve, a casing having a valve chamber, a balanced piston valve reciprocably movable within said valve chamber and including a valve rod having a plurality of pistons thereon, said valve chamber having a plurality of annular ports spaced therealong including a by-pass port, a pressure port on each side thereof, a cylinder port spaced outwardly from each of said pressure ports, a pressure port spaced outwardly from each of said cylinder ports, a passageway connecting said last mentioned pressure ports together and communicating with the outside of said casing and with said by-pass port, and said valve pistons including a relatively narrow central by-pass piston of less width than said by-pass port, to permit unrestricted flow of fluid through said valve when in a neutral position, a pair of pistons each spaced outwardly from said by-pass piston, said pistons being of greater width than said by-pass piston and being adapted to block the flow of fluid to said cylinder ports when the valve is in a neutral position, or to admit fluid to one of said cylinder ports from one of said pressure ports and permit fluid to flow from the other of said cylinder ports out one of said other pressure ports when said valve is in an operative position, and said by-pass piston and said outer pistons being so spaced and proportioned as to block the flow of fluid through said by-pass port to either of said adjacent pressure ports when said valve is in a position to admit fluid under pressure to either of said cylinder ports.

2. In a hydraulic control valve, a casing having a valve chamber therein, a balanced piston valve reciprocably movable within said valve chamber and including a valve rod having a plurality of pistons thereon, said valve chamber having a plurality of annular ports spaced therealong including a by-pass port, a pressure port on each side thereof, a cylinder port spaced outwardly from each of said pressures ports and an outer pressure port spaced outwardly from each of said cylinder ports, a passageway connecting said last mentioned pressure ports together and communicating with the outside of said casing and with said by-pass port, and said valve pistons including a by-pass piston so proportioned and arranged as to be in non-lapping position to permit the flow of fluid therearound and through said by-pass port and valve when in a neutral position, a pair of pistons each spaced outwardly from said by-pass piston, said pistons being adapted to block the flow of fluid to said cylinder ports when said piston valve is in a neutral position, and a piston spaced outwardly from each of said last mentioned pistons, to block the flow of fluid from either end of said valve rod, and with said next adjacent pistons form-

ing pasageways when the valve is in one operative position or another, to permit the flow of fluid from one of said outer pressure ports to one of said cylinder ports, and said by-pass piston with said pistons on each side thereof forming passageways permitting the flow of fluid from one of said cylinder ports out of one of said other pressure ports depending upon the operative position of said valve piston.

3. In a hydraulic control valve, a casing having a valve chamber, a balanced piston valve reciprocably movable within said valve chamber and including a valve rod having a plurality of pistons thereon, said valve chamber having a plurality of annular ports spaced therealong including a by-pass port, a pressure port on each side thereof, a cylinder port spaced outwardly from each of said pressure ports and a pressure port spaced outwardly from each of said cylinder ports, a passageway connecting said last mentioned pressure ports together and communicating with the outside of said casing and with said central by-pass port, and said valve pistons including a relatively narrow by-pass piston of less width than said by-pass port, to permit unrestricted flow of fluid through said valve when in a neutral position, a pair of pistons each spaced outwardly from said by-pass piston, said pistons being of greater width than said by-pass piston and being adapted to block the flow of fluid to said cylinder ports when the valve is in a neutral position, or to admit fluid to one of said cylinder ports from one of said pressure ports and permit fluid to flow from the other of said cylinder ports out one of said other pressure ports when said valve is in an operative position, said by-pass piston and said outer pistons being so spaced and proportioned as to block the flow of fluid through said by-pass port to either of said adjacent pressure ports when said valve is in a position to admit fluid under pressure to either of said cylinder ports, and a piston spaced outwardly from each of said last mentioned pistons, to block the flow of fluid under pressure from either end of said valve rod.

4. In a hydraulic control valve, a casing having a valve chamber, a balanced piston valve reciprocably movable within said valve chamber and including a valve rod having a plurality of pistons thereon, said valve chamber having a plurality of annular ports spaced therealong including a by-pass port, two outer pressure inlet ports spaced outwardly from said by-pass port, a pressure inlet passageway connecting said inlet ports with said by-pass port, a cylinder port spaced inwardly from each of said pressure inlet ports and a pressure outlet port spaced inwardly of each of said cylinder ports, on opposite sides of said by-pass port, and said valve pistons including a relatively narrow by-pass piston arranged to be in non-lapping position to permit unrestricted flow of fluid therearound and from said pressure inlet passageway through said by-pass port and out said outlet ports when said valve is in a neutral position, and said piston valve also including a pair of pistons each spaced outwardly from said by-pass piston, of a greater width than said by-pass piston, to block the flow of fluid through said by-pass port to and through either of said outlet ports when said valve is in position to admit fluid under pressure to either of said cylinder ports, and to permit the flow of fluid from said other cylinder port to said adjacent outlet port, to permit fluid under pressure discharged from said other cylinder port to supply pressure for operation of another hydraulic operating device, said pistons and said inlet and said outlet ports being so proportioned and arranged that said pressure outlet ports may be used as pressure inlet ports and said pressure inlet ports may be used as pressure outlet ports.

5. In a hydraulic control valve, a casing having a valve chamber, a balanced piston valve reciprocably movable within said valve chamber and including a valve rod having a plurality of pistons thereon, said valve chamber having a plurality of annular ports spaced therealong including a by-pass port, two outer pressure inlet ports spaced outwardly from said by-pass port, a pressure inlet passageway connecting said inlet ports with said by-pass port, a cylinder port spaced inwardly from each of said pressure inlet ports and a pressure outlet port spaced inwardly of each of said cylinder ports, on opposite sides of said by-pass port, and said valve pistons including a by-pass piston of less width than said central pressure by-pass port, to permit unrestricted flow of fluid therearound from said pressure inlet passageway through said by-pass port and out said outlet ports when said valve is in a neutral position, and said piston valve also including two pistons spaced outwardly from said by-pass piston, of a greater width than said by-pass piston, to block the flow of fluid through said by-pass port to and through either of said outlet ports when said valve is in position to admit fluid under pressure to either of said cylinder ports, and to permit the flow of fluid from said other cylinder port to said adjacent outlet port, to permit fluid under pressure discharged from said other cylinder port to supply pressure for operation of another hydraulic operating device, said pistons and said inlet and said outlet ports being so proportioned and arranged that said pressure outlet ports may be used as pressure inlet ports and said pressure inlet ports may be used as pressure outlet ports, and a piston spaced outwardly from each of said last mentioned pistons, to block the flow of fluid from either end of said valve rod.

6. In a hydraulic control valve, a casing having a valve chamber, a piston valve reciprocably movable within said valve chamber and including a valve rod having a plurality of pistons thereon, said valve chamber having a plurality of annular ports spaced therealong including a by-pass port, two outer pressure ports spaced outwardly from said by-pass port and a passageway connecting said last mentioned pressure ports together and with said by-pass port, a cylinder port spaced inwardly from each of said outer pressure ports and an inner pressure port spaced inwardly from each of said cylinder ports and on opposite sides of said by-pass port, passageways leading from said inner pressure ports to the outside of said valve, said valve pistons and said pressure ports being so proportioned and arranged that said outer and said inner pressure ports may serve as pressure intake or release ports, and means detachably mounted on the outside of said valve casing for connecting said inner pressure ports together to receive or discharge fluid through a common passageway including a fluid conducting member adapted to be detachably secured to the outside of said casing and having a Y-shaped passageway formed therein having communication with said inner pressure passageways, to lead said passageways to a common outlet, and an interengaging connection between said casing and said fluid conducting mem-

ber to register the branches of said Y-shaped passageways in engagement with said passageways leading from said inner pressure ports.

7. In a hydraulic control valve, a casing having a plurality of parallel spaced valve chambers formed therein, a piston valve reciprocably movable within each of said valve chambers, each of said valve chambers having a plurality of annular ports spaced therealong including a by-pass port, an inlet passageway opening from one side of said casing to said by-pass port of one chamber, an outlet passageway opening from the opposite side of said casing to said by-pass port of another of said chambers, two outer pressure ports formed in each of said chambers and spaced outwardly from said by-pass port, pressure passageways connecting said pressure ports with said by-pass port, cylinder ports spaced inwardly of said pressure ports, an inner pressure port spaced inwardly of each cylinder port, said inner pressure ports being on opposite sides of said by-pass port, passageways in said valve casing connecting said inner pressure ports of one chamber with said inner pressure ports of another of said chambers, said piston valves each including a valve rod having a central by-pass piston of less width than said by-pass port to permit unrestricted flow of fluid therearound and from one chamber to another through said passageways, and out of said casing, when said valves are in a neutral position, said piston valves also each including two pistons spaced outwardly from said central by-pass piston, for blocking the flow of fluid from said by-pass port through either of said inner pressure ports when said valve is in an operative position, and a passageway between said valve chambers and extending parallel therewith for connecting together said passageways connected between said inner ports of each of said valves, so fluid under pressure flowing from one of said inner ports in one chamber may flow to either of said inner ports in another of said chambers, to supply fluid under pressure to said other chamber when said first valve is in various operative positions, so as to permit independent or simultaneous operation of said valves in series.

8. In a hydraulic control valve, a casing having a valve chamber, a balanced piston valve reciprocably movable within said valve chamber and including an imperforate valve rod having a plurality of pistons thereon, said valve chamber having a plurality of annular ports spaced therealong including a by-pass port, two outer pressure inlet ports spaced outwardly from said by-pass port, a pressure inlet passageway connecting said inlet ports with said by-pass port, a cylinder port spaced inwardly from each of said pressure inlet ports and a pressure outlet port spaced inwardly of each of said cylinder ports, on opposite sides of said by-pass port, and said valve pistons including a central by-pass piston arranged to be in non-lapping position to permit unrestricted flow of fluid therearound and from said pressure inlet passageway through said by-pass port and out said outlet ports when said valve is in a neutral position, and said piston valve also including a pair of pistons each spaced outwardly from said by-pass piston, of a greater width than said by-pass piston, to block the flow of fluid through said by-pass port to and through either of said outlet ports when said valve is in position to admit fluid under pressure to either

of said cylinder ports, and to permit the flow of fluid from said other cylinder port to said adjacent outlet port, to permit fluid under pressure discharged from said other cylinder port to supply pressure for operation of another hydraulic operating device, said pistons and said inlet and said outlet ports being so proportioned and arranged that said pressure outlet ports may be used as pressure inlet ports and said pressure inlet ports may be used as pressure outlet ports, the operation of said hydraulic control valve being characterized in that the operating pressure is confined in ports surrounding said imperforate valve rod.

9. In a hydraulic control valve, a casing having a valve chamber, a balanced piston valve reciprocably movable within said valve chamber and including an imperforate valve rod having a plurality of pistons thereon, said valve chamber having a plurality of annular ports spaced therealong including a by-pass port, two outer pressure inlet ports spaced outwardly from said by-pass port, a pressure inlet passageway connecting said inlet ports with said by-pass port, a cylinder port spaced inwardly from each of said pressure inlet ports and a pressure outlet port spaced inwardly of each of said cylinder ports, on opposite sides of said by-pass port, and said valve pistons including a central by-pass piston arranged to be in non-lapping position to permit unrestricted flow of fluid therearound and from said pressure inlet passageway through said by-pass port and out said outlet ports when said valve is in a neutral position, and said piston valve also including a pair of pistons each spaced outwardly from said by-pass piston, of a greater width than said by-pass piston, to block the flow of fluid through said by-pass port to and through either of said outlet ports when said valve is in position to admit fluid under pressure to either of said cylinder ports, and to permit the flow of fluid from said other cylinder port to said adjacent outlet port, to permit fluid under pressure discharged from said other cylinder port to supply pressure for operation of another hydraulic operating device, said pistons and said inlet and said outlet ports being so proportioned and arranged that said pressure outlet ports may be used as pressure inlet ports and said pressure inlet ports may be used as pressure outlet ports, the operation of said hydraulic control valve being characterized in that the operating pressure is confined in ports surrounding said imperforate valve rod, and a piston spaced outwardly from each of said last mentioned pistons to block the flow of fluid from either end of said valve rod.

WILLIAM W. SLOANE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,521,628	Jones	Jan. 6, 1925
1,775,856	Hauser	Sept. 16, 1930
1,842,725	Link	Jan. 26, 1932
2,109,162	Boehle	Feb. 22, 1938
2,167,106	Dunham	July 25, 1939
2,237,871	Stone	Apr. 8, 1941
2,247,140	Twyman	June 24, 1941
2,276,357	Vickers	Mar. 17, 1942