March 17, 1942. H. F. VICKERS 2,276,357

HYDRAULIC SYSTEM

Original Filed May 7, 1935 4 Sheets-Sheet 1

Fig. 1

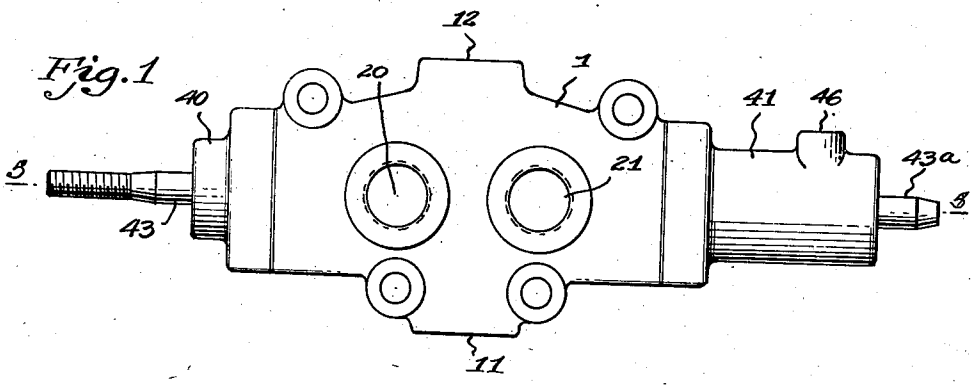


Fig. 2

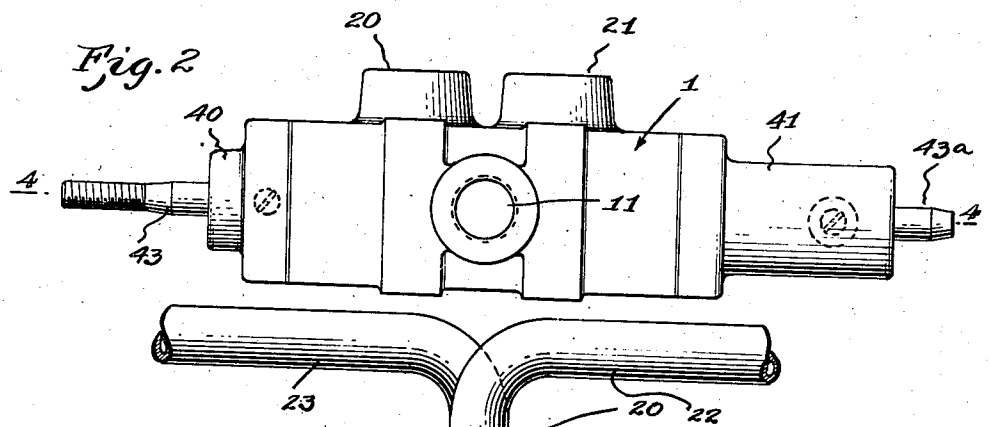
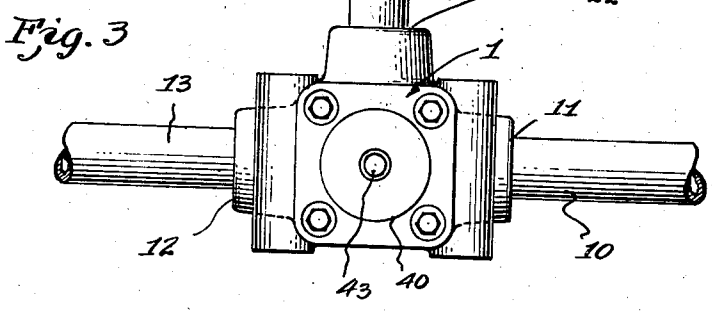


Fig. 3



INVENTOR.
Harry F. Vickers
BY
Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS

March 17, 1942. H. F. VICKERS 2,276,357

HYDRAULIC SYSTEM

Original Filed May 7, 1935 4 Sheets-Sheet 2

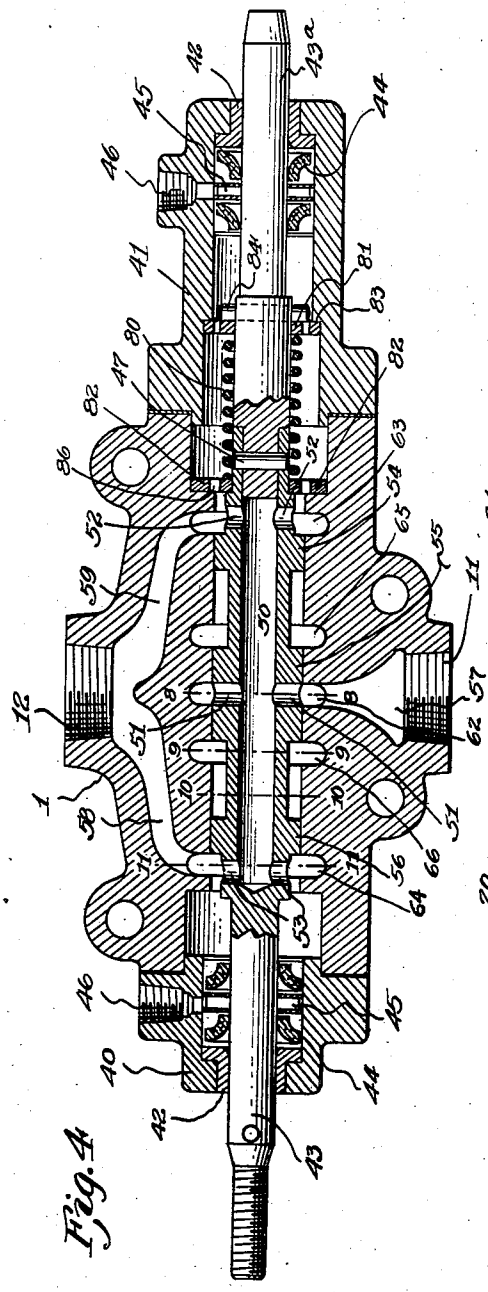


Fig. 4

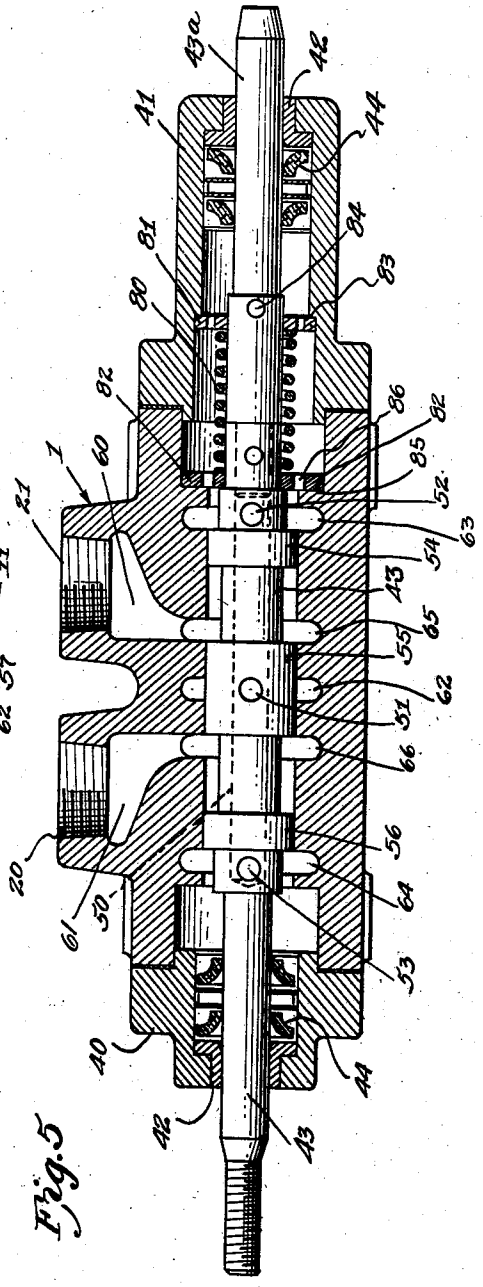


Fig. 5

INVENTOR.
Harry F. Vickers

BY
Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS

March 17, 1942. H. F. VICKERS 2,276,357

HYDRAULIC SYSTEM

Original Filed May 7, 1935 4 Sheets-Sheet 3

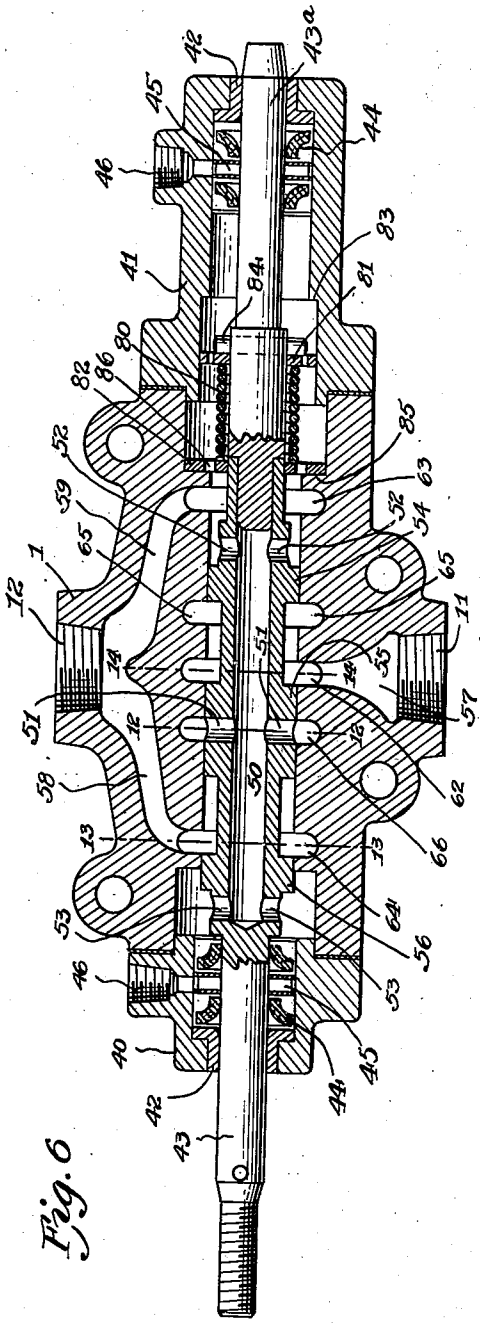


Fig. 6

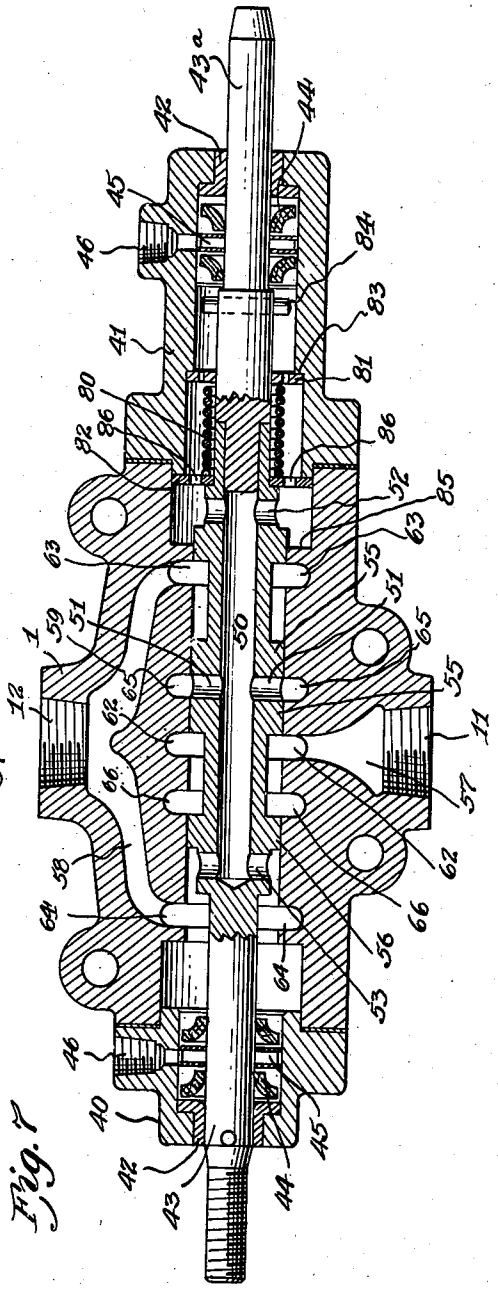


Fig. 7

INVENTOR.
Harry F. Vickers
BY
Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS.

March 17, 1942. H. F. VICKERS 2,276,357

HYDRAULIC SYSTEM

Original Filed May 7, 1935 4 Sheets-Sheet 4

Fig. 15

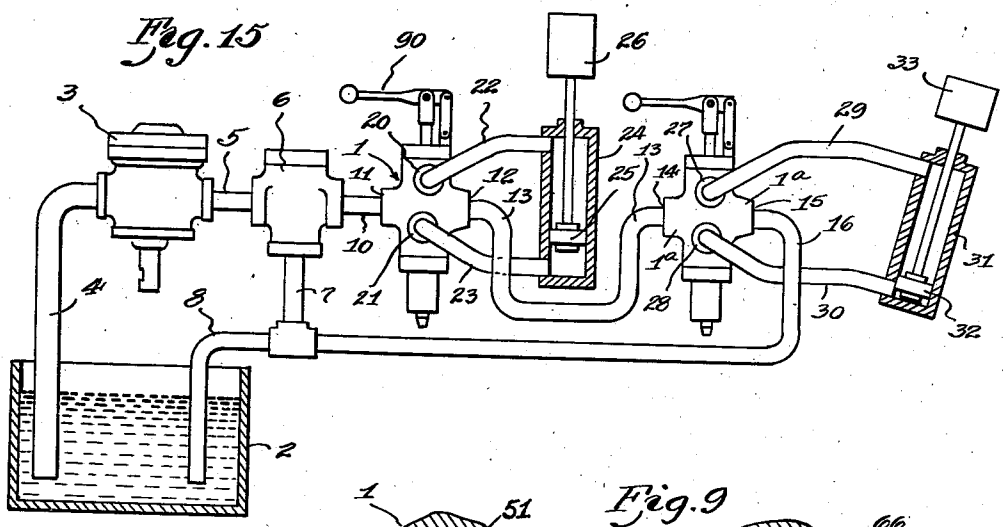


Fig. 8

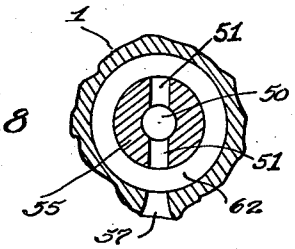


Fig. 9

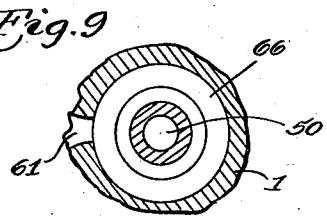


Fig. 10

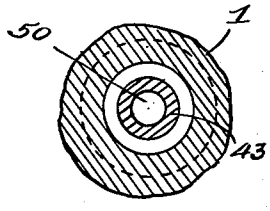


Fig. 11

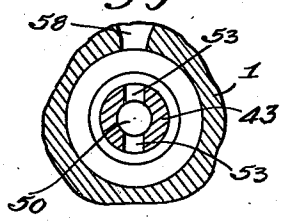
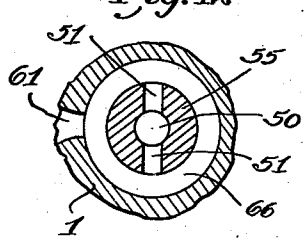


Fig. 12



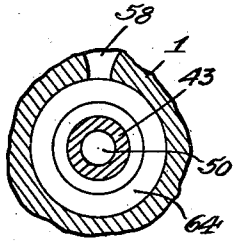


Fig. 13

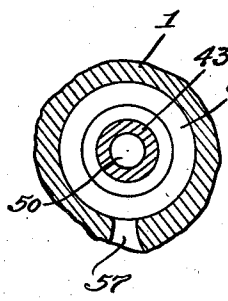


Fig. 14

INVENTOR.

Harry F. Vickers

BY

Barnes, Kisselle, Laughlin & Raisch

ATTORNEYS

Patented Mar. 17, 1942 2,276,357

UNITED STATES PATENT OFFICE

2,276,357

HYDRAULIC SYSTEM

Harry F. Vickers, Detroit, Mich., assignor to Vickers, Incorporated, Detroit, Mich., a corporation of Michigan

Application May 7, 1935, Serial No. 20,261
Renewed December 15, 1939

6 Claims. (Cl. 60—52)

This invention relates to a hydraulic system wherein hydraulic pressure is used to perform work, and to a valve structure useful in such system.

There are a number of objects of the invention, the appreciation of which will develop as the following detailed description is considered. Notably among the objects is a system where work performing devices may be disposed in series in one system employing one pressure source, and wherein the work performing devices may be operated individually or simultaneously. Another object of the invention is the provision of a hydraulic system wherein the work performing devices may be held locked in given positions while the pressure source functions at substantially zero pressure, except for line resistance. A further object of the invention is the provision of a valve structure useful in such a system and which is so arranged as to effect a controlling action in various phases, and which is at all times in substantial hydraulic balance. In the accompanying drawings:

Fig. 1 is a side elevational view of a valve embodying the valve structure herein mentioned.

Fig. 2 is a side elevational view of the valve taken at right angles to Fig. 1.

Fig. 3 is an end elevational view of the valve showing the line connections.

Fig. 4 is a longitudinal section of the valve showing the same in neutral position taken substantially on line 4—4 of Fig. 2.

Fig. 5 is a longitudinal section of the valve taken at right angles to Fig. 4 substantially on line 5—5 of Fig. 1 and showing the valve in neutral position.

Fig. 6. is a longitudinal section similar to Fig. 4 showing the valve shifted to one extreme position.

Fig. 7 is a sectional view similar to Fig. 6 showing the valve in another of its extreme positions.

Fig. 8 is a sectional view taken substantially on line 8—8 of Fig. 4.

Fig. 9 is a sectional view taken on line 9—9 of Fig. 4.

Fig. 10 is a sectional view taken on line 10—10 of Fig. 4.

Fig. 11 is a sectional view taken on line 11—11 of Fig. 4.

Fig. 12 is a sectional view taken on line 12—12 of Fig. 6.

Fig. 13 is a sectional view taken on line 13—13 of Fig. 6.

Fig. 14 is a sectional view taken on line 14—14 of Fig. 6.

Fig. 15 is a diagrammatic view illustrating the lay-out of a hydraulic system in which the valves are employed.

The valve body is illustrated at 1. Two of such valves are shown as being included in the system shown in Fig. 15. In this system there is a supply reservoir 2 for containing a body of suitable liquid, which may be oil, and which will hereinafter be referred to as oil. A pressure source is shown in the form of a pump 3, which preferably is of a constant capacity type which pumps oil out of the supply tank 2 through a pipe line 4. The pump is connected by a line 5 to a pressure valve 6 adjustable to determine the maximum pressure desired in the system. When the pressure valve relieves, the oil may then flow back to the reservoir through pipes 7 and 8. The pressure valve connects into one of the valves of the invention through an inlet pipe 10, which connects into an inlet port 11; and this valve has an outlet port 12 to which an outlet pipe 13 is connected, and this pipe 13 connects to an inlet port 14 of a control valve 1—*a*; control valve 1—*a* has an outlet port 15, connected into which is an outlet pipe 16 which leads back to the return pipe 8. For the purpose of convenience one of the control valves in the system, shown in Fig. 15, is identified by the character 1—*a*, although it may be identical with the valve identified by the character 1. The valve 1 has ports 20 and 21 from which extend pipe lines 22 and 23 connected into opposite ends of a cylinder 24. In the cylinder is a piston 25 for shifting a load illustrated at 26. The valve 1—*a* has similar outlets 27 and 28 from which extend pipe lines 29 and 30 leading into opposite ends of a cylinder 31, in which there is a piston 32 for lifting a load illustrated at 33.

Referring now to Figs 4 to 7 inclusive: These figures show the controlling valve in cross-section, and the various ports, previously referred to in connection with Fig. 15, are identified by the reference characters which are applied to the valve 1 in Fig. 15.

The valves comprise a center portion closed at opposite ends by the caps 40 and 41 equipped with bushings 42 which serve as bearings for a slidable valve member 43. Opposite ends of the valve member slide through oil sealing devices or gaskets 44, there being preferably two used at each end separated by a spacer 45, each in line with an oil drain 46 for draining out any oil which escapes past the inner gasket. The outer seals act as wipers to prevent seepage from fol-

lowing the valve stem to the external surfaces of the valve.

The valve member 43 may advantageously be composed of two parts, one of which is shown at 43a, which is plugged into the hollow end of the other part and fixed thereto as by means of a pin 47. The valve member has a central passageway 50 leading into which are ports 51, ports 52 and ports 53. The valve member has enlarged portions 54, 55 and 56 slidable in a central bore in the valve body. The valve body is cored to form a passageway 57 leading from the inlet 11 to the central bore and passageways 58 and 59 leading from the central bore to the outlet 12. The valve body is also provided with a passageway 60 connecting the central bore to the port 21 and a passageway 61 connecting the central bore to the port 20 (Fig. 5). The central bore has enlarged cored-out portions; 62 at the juncture between passageway 57 and the central bore; 63 and 64 between the central bore and the passageways 59 and 58; and 65 and 66 at the juncture between the central bore and the passageways 60 and 61 respectively.

A centering device is preferably employed for normally holding the valve in central or neutral position. This device resides in a coil spring 80 disposed between a washer 81 and a washer 82. The washer 81 is slidable in a bore of the cap 41 and is limited in movement by a shoulder 83 and is arranged to abut against a pin 84 carried by the valve member. The washer 82 is arranged to slide in a bore in the valve body and to abut against the shoulder 85. The washers are equipped with apertures 86 for the passage of oil therethrough to hydraulically balance the same.

The operation is as follows: First considering Fig. 4, where the valve is in central or neutral position, the oil from the pressure source passes in through port 11, through passageways 57 and 62, through the ports 51 and then through the bore 50 of the valve; the oil then passes through ports 52 and 53, passageways 59 and 58, and then through the outlet port 12. Referring to Fig. 15, it will be noted that the oil thus passes through valve 1 and then through conduit 13 to the valve 1—a, and if valve 1—a is in neutral position, and the oil will pass therethrough as just described and return through the supply tank to the conduit 16. Thus at this time, with both valves in neutral position, the pump is operating substantially at zero pressure except for line resistance.

Now assume that the valve 1 is shifted, say, to the position shown in Fig. 6, to operate the piston 25. This may be done by the handle 90 which may be operated by hand or by any suitable control means. The oil entering port 11 (Fig. 6) now flows in a channel between the enlargements 54 and 55, thus gaining access to the circumferential enlargement 65, which is connected to the passageway 60 (Fig. 5), so that the oil passes through port 21, conduit 23, and to the lower end of the cylinder 24 to lift the piston therein and the load 26. The oil above the piston 25 must be displaced. At this time the displaced oil flows from the cylinder through line 22 into passageway 61 to circumferential enlargement 66, which is now in communication with the ports 51. The oil thus passes into the bore 50 of the valve and out through the ports 52, passageway 59 and outlet port 12. Thus the work 26 may be lifted and the exhaust oil therefrom may pass freely through the valve 1—a (Fig. 15) and back into the reservoir. In the same manner, the valve 1 may be in neutral position and the load 33 lifted.

Now in order to reverse the movement of the piston 25, the valve is shifted to the position shown in Fig. 7. The incoming oil from the pump passes through port 11, and passageway 57, into the enlarged circumferential passageway 62, which is now in communication with the passageway provided between the enlargements 55 and 56, so that the oil has access into the circumferential enlargement 66 which is in communication with the passageway 61 (Fig. 5), the oil thus flowing through conduit 22 into the top of the cylinder 24. The oil below the piston 25 is displaced by passing through conduit 23, into port 21, passageway 60, into circumferential passageway 65, through the ports 51 into the central bore 50, out through ports 53, through passageway 58 and the outlet port 12. If the valve 1—a is in neutral position this exhaust oil passes freely therethrough and back to the reservoir. In like manner, valve 1 may be allowed to remain in neutral position and the piston 32 shifted downwardly in the cylinder 31. Thus it will be observed that either load may be shifted in either direction independently of the other and independently of the position of the other.

Also both loads may be simultaneously moved without regard to direction. In other words, both loads may be lifted or lowered simultaneously or one lifted and one lowered. Suppose, for example, that the load 26 is being lifted and that the load 33 is being lifted—the pressure under the piston 32 results in the same pressure being above the piston 25 and this pressure, of course, is determined on the work being performed. The pressure under piston 25 is necessarily sufficient to lift both loads. If load 26 is being lifted and load 33 being lowered, the oil displaced from cylinder 24 passes into the upper end of cylinder 31 and the oil below the piston 32 is displaced and returns to the reservoir. In this case whatever pressure is required above the piston 32 to lower the work is present in the upper part of the cylinder 24. However, there may be substantially no pressure at this time, and, in fact, there may be a negative condition in the event the load 33 is so arranged as to shift downwardly by gravity. When the load 33 gravitates downwardly, for example, the movement may be controlled by the valve 1a determining the flow of liquid through pipe 30. If load 26 is raised at this time, the liquid discharged from cylinder 24 into cylinder 31 is under no pressure, and this has been termed a negative condition. By a proper valve control and in a similar manner, the load 26 may be lowered while the load 33 is raised or both loads may be lowered simultaneously.

While only two work-performing devices have been shown herein, it is to be understood that as many work-performing devices or cylinders may be installed in a single system, the limits of which depend upon the capacity of the pressure source or pump and the setting of the relief valve. Any time the work to be performed requires a pressure higher than that at which the relief valve is set, the relief valve (the structure of which is not shown) opens and returns the oil to the reservoir.

It will be observed that the pistons may be locked in any given position, for when the valves are in neutral position the oil in the particular cylinder system which that valve controls is locked and cannot escape from either end of the

cylinder. At this time the pump functions at zero pressure except for line pressure as to this particular valve so that if another valve is positioned to perform work, substantially the only pressure on the pump is that created by this one piece of work. In other words, if the valve 1 is in neutral position, the pressure required to lift work 33 reacts directly through valve 1 and to the pump and has no effect upon the piston 25.

The centering device functions as follows: In Fig. 4 the valve is in neutral position and the spring 80 is expanded and the washers abut respectively against the shoulders 83 and 85. When the valve is moved to the left, as shown in Fig. 6, the washer 81 compresses the spring and as soon as the valve is released, the spring shifts the same back to neutral position. When the valve is shifted to the right (Fig. 7), the washer 82 compresses the spring and upon release of the valve the spring shifts the same back to neutral position. The present valve system is particularly adapted for use on certain types of vehicles in which there are movable elements which must be controlled simultaneously or independently by the operator of the vehicle. In some cases, one valve will control one direction of movement of an element and another valve will control another direction of movement of the same element. With the above spring centering device, when the element has been moved a certain distance in one direction, the operator may simply release the valve handle and the movement will stop. He may then move the other valve and upon its release, the corresponding movement of the element will stop. This is extremely important in many cases since the operator has not only to take care of the running of the vehicle but, also, of the movable elements thereon.

Moreover, the valve at all times remains substantially in hydraulic balance. Any line pressure in the bore 50 or passageways 58 and 59 or in the passageways defined by any two of the enlargements on the valve member equalizes itself in opposite directions. Also the centering washers with their apertures remain in the hydraulic balance so that a relatively light spring is all that is needed to center the valve. This system is useful for performing various kinds of work, for example, it is useful on road building machines, such as graders where the blade of the grader is to be vertically adjusted, bulldozers, snow plows and hoists on industrial tractors. The valve and system may also be applied to forcing presses.

In some of the claims appended hereto it is specified that the valves are arranged in series in the circuit. This description is taken by an analogy from electrical art in that the flow of oil first passes through one valve and then through the other valve or valves in succession. For convenience also the claims use the word "oil" instead of fluid or liquid, but it is emphasized that the use of this word is not intended to limit the invention to oil, as the invention may be employed with any liquid suitable for the purpose.

I claim:

1. A hydraulic system comprising in combination a pressure source for oil, a circuit for the oil comprising conduits which returns the oil to the pressure source, a plurality of valves arranged in series in the circuit, each having an inlet and an outlet, each valve having a movable valve member which has a neutral position and in which position the inlet and outlet are connected so that the oil flows through the valve, a work performing device associated with each valve and each connected to its respective valve by two conduits, said two conduits being closed when the movable member of the respective valve is in neutral position, each movable member being shiftable independently of the other movable members to a position where the inlet and outlet are closed as to each other, and one of said conduits of the work performing device is connected to the inlet and the other connected to the outlet, whereby oil passing into the valve runs to the work performing device and oil is discharged from the work performing device back into the circuit.

2. A hydraulic system comprising in combination a pressure source for oil, a circuit for the oil comprising conduits and which returns the oil to the source, a plurality of valves arranged in series in the circuit, each having an inlet and outlet, a cylinder for each valve, a piston in the cylinder, two conduits connecting each valve to the respective cylinder on opposite sides of the piston, each valve having a shiftable valve member, said valve member having a neutral position and in which position the inlet and outlet are connected and the two conduits are closed off from the circuit, said movable member being shiftable to a position to close off the inlet and outlet from each other and connect one of the cylinder conduits to the inlet and the other cylinder conduit to the outlet, whereby the oil entering the inlet passes to the cylinder to shift the piston and oil displaced by the piston returns into the circuit and out the valve outlet.

3. A hydraulic system comprising in combination a pressure source for oil, a circuit for the oil comprising conduits and which returns the oil to the source, a plurality of valves arranged in series in the circuit, each having an inlet and outlet, a cylinder for each valve, a piston in the cylinder, two conduits connecting each valve to the respective cylinder on opposite sides of the piston, each valve having a shiftable valve member, said valve member having a neutral position and in which position the inlet and outlet are connected and the two conduits are closed off from the circuit, said movable member being shiftable to a position to close off the inlet and outlet from each other and connect one of the cylinder conduits to the inlet and the other cylinder conduit to the outlet, whereby the oil entering the inlet passes to the cylinder to shift the piston and oil displaced by the piston returns into the circuit and out the valve outlet, said movable valve members being movable independent of each other whereby the pistons may be shifted individually and simultaneously.

4. A hydraulic system comprising in combination a pressure source for oil, a circuit therefor comprising conduits for returning the oil to the source, a plurality of valve members disposed in series in the circuit, and each having an inlet and an outlet, a cylinder for each valve, conduits connecting the opposite ends of each cylinder to its respective valve, a piston in each cylinder, said valves each having a movable valve member, each movable independently of other members, each movable valve member having a neutral position and in which position the inlet and outlet of its valve are connected and conduits to the cylinder are closed off from the circuit, each having another position in which the inlet and outlet are closed from each other and one cylinder conduit is connected to the inlet and the second cylinder conduit is connected to the outlet, and

having a third position in which the inlet and outlet are closed from each other and in which the said one cylinder conduit is connected to the outlet and said second cylinder conduit connected to the inlet.

5. A hydraulic system comprising in combination a pressure source for oil, a circuit for the oil comprising conduits which returns the oil to the pressure source, a plurality of valves arranged in series in the circuit, each having an inlet and an outlet, each valve having a movable valve member which has a neutral position and in which position the inlet and outlet are connected so that the oil flows through the valve, a work performing device associated with each valve and each connected to its respective valve by two conduits, said two conduits being closed when the movable member of the respective valve is in neutral position, each movable member being shiftable independently of the other movable members to positions where the inlet and otlet are closed as to each other, and one of said conduits of the work performing device is connected to the inlet and the other connected to the outlet, whereby oil passing into the valve runs to the work performing device and oil is discharged from the work performing device back into the circuit, and means for automatically moving said valve members to neutral position to lock liquid in said wark performing device when said valve member is released after being moved to an operating position.

6. A hydraulic system comprising in combination a pressure source for oil, a circuit for the oil comprising conduits and which returns the oil to the source, a plurality of valves arranged in series in the circuit, each having an inlet and outlet, a cylinder for each valve, a piston in the cylinder, two conduits connecting each valve to the respective cylinder on opposite sides of the piston, each valve having a shiftable valve member, said valve member having a neutral position and in which position the inlet and outlet are connected and the two conduits are closed off from the circuit, said movable member being shiftable to work positions to close off the inlet and outlet from each other and connect one of the cylinder conduits to the inlet and the other cylinder conduit to the outlet, whereby the oil entering the inlet passes to the cylinder to shift the piston and oil displaced by the piston returns into the circuit and out the valve outlet, said movable valve members being movable independent of each other whereby the pistons may be shifted individually and simultaneously, and means in said system for normally maintaining the movable member of each of said valves in its neutral position and for positively moving the members to their neutral position from their work positions.

HARRY F. VICKERS.