

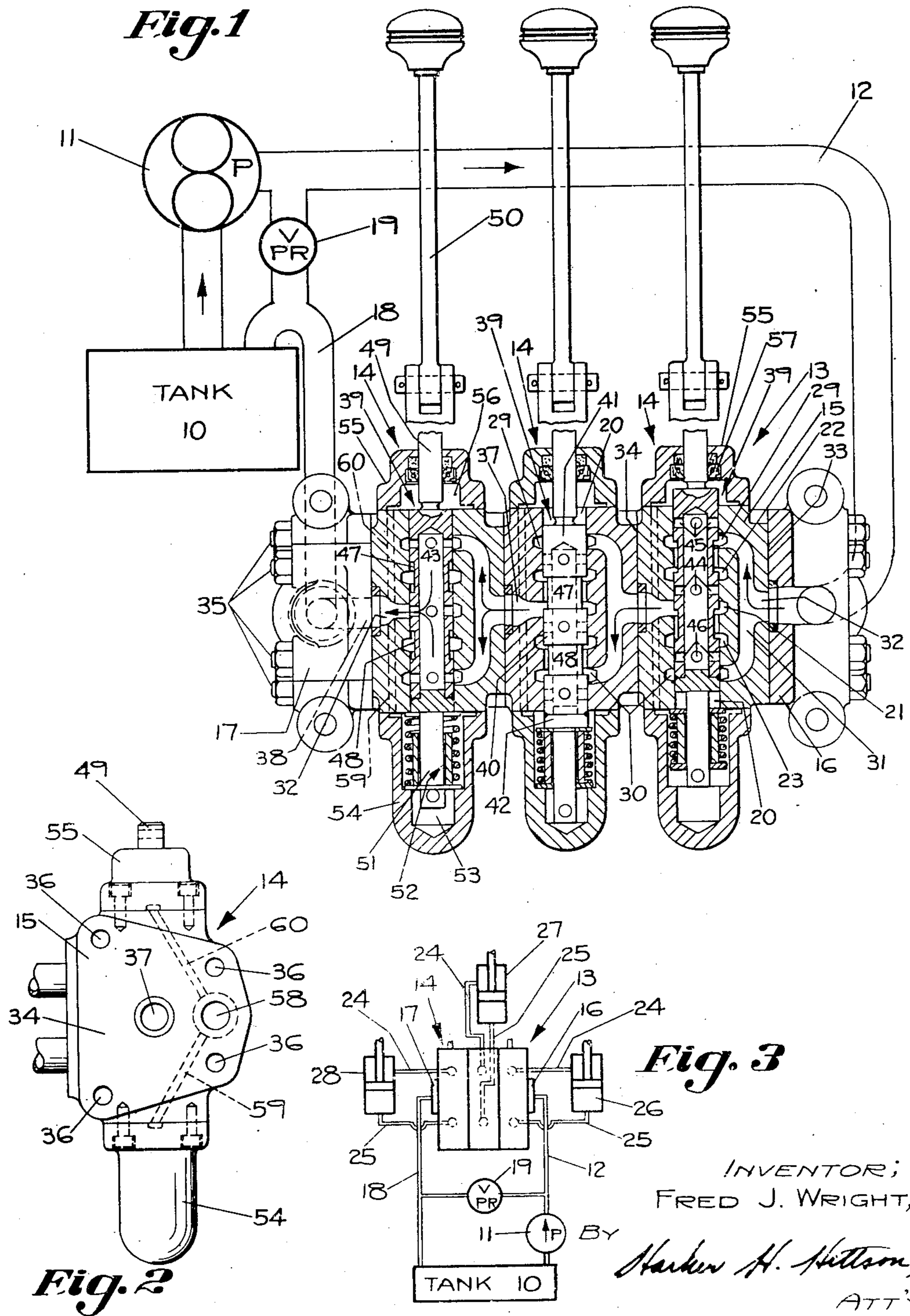
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HYDRAULIC VALVE

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HYDRAULIC VALVE

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5 Claims. (Cl. 277-57)

1

This invention relates to a hydraulic valve or a bank of hydraulic valves.

An object of the invention is to provide both an improved individual valve and an improved bank of valves.

A more specific object of the invention is to provide a valve or bank of valves of the four-way spool type which when in the form of a bank of valves provides a series open or no-load by-pass circuit for the source of hydraulic fluid when all the valves are in their neutral positions and one in which the associated double acting motors may be operated in series, the valves having a further feature that oil leakage chambers are provided at opposite ends of the valve which are isolated from the pressure of the hydraulic fluid flowing through the feed and/or motor ports of the valve. Furthermore, in the banked valve arrangement there is a continuous drain passageway through all the valve bodies which drains the leakage chambers to tank.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings,

Fig. 1 is a diagrammatic view of a system including three banked valves shown in section and illustrating my invention in one of its embodiments;

Fig. 2 is a side elevational view of one of the four-way valve assemblies; and

Fig. 3 is a diagrammatic view of the complete hydraulic system incorporating the three banked four-way valves.

This application is a division of my application Serial No. 496,634 for a Hydraulic system, filed July 29, 1943, since abandoned, and of my application Serial No. 565,356 for a Hydraulic system and apparatus, filed November 27, 1944, now Patent No. 2,464,110 issued March 8, 1949.

Referring particularly to Figs. 1 and 3 of the drawings, the hydraulic system illustrated includes a tank 10 adapted to contain hydraulic fluid which acts as a source of supply for a pressure developing pump 11, the output of which is delivered to a pressure pipe or conduit 12 which conducts the hydraulic fluid to an assembly or bank 13 of similar or identical valves, each individual valve being designated by the reference character 14. Since the valves 14 are all identical in construction similar reference characters will be employed in describing the individual parts thereof.

Each valve 14 includes a main casting or body 15, the three bodies 15 being mounted adjacent

2

each other and held between feed and discharge end plates 16 and 17, respectively, the former of which receives the feed conduit 12 and the latter of which receives a discharge or tank conduit or pipe 18 which conducts the fluid back to the tank 10. A high pressure relief valve 19 interconnects the conduits 12 and 18 to protect the system against extensive pressure.

Referring particularly to the structure of each of the valves 14, the valve body or casting 15 is provided with a through bore 20 of bottom diameter which extends straight through the casting 15 from the top to the bottom. Adjacent the center of the bore 20 and in communication therewith is a central feed chamber 21 through which hydraulic fluid is either conducted into the bore 20 or conducted therefrom, depending upon the direction of flow of the hydraulic fluid.

On each side of the central feed chamber 21 and in communication with bore 20 is a motor chamber, the two motor chambers being designated 22 and 23. Each of the motor chambers 22 and 23 is connected by appropriate passageways in the body 15 and connecting conduits 24 and 25 to opposite ends of a double acting motor, those illustrated in Fig. 3 of the drawings being of the piston type and designated 26, 27 and 28, respectively, for the three valves, as viewed from left to right in Figs. 1 and 2 of the drawings. That is, each of the valves 14 is individual to a double acting motor 26, 27 or 28 and, as hereinafter described, is controllable to effect reverse operation thereof or to lock it in any position of adjustment while providing a by-pass path for the hydraulic fluid. Furthermore the system is such that any two or all three of the valves may be actuated from their neutral positions simultaneously to connect two or three of said motors 26, 27 and 28 in series.

Spaced outwardly from each motor chamber 22 and 23 and in communication with bore 20 is another feed chamber, the two feed chambers being designated 29 and 30. The two outside feed chambers 29 and 30 are permanently interconnected by a passageway 31 formed in the body or casting 15, and the passageway 31 is provided with an opening or port 32 which opens on a flat surface 33 forming one face of the casting 15 which has contact over a substantial area with a similar flat surface on the feed end plate 16.

The casting or body 15 has another flat surface or face 34 which is parallel with the flat surface 33 and on the opposite side of the body or casting 15, and this flat surface 34 is adapted to contact an adjacent flat surface 33 of an adjacent valve

3

body or casting 15 or, in the case of the left-hand valve body 15, to bear against and contact a similar surface on the discharge end plate 17.

The entire assembly of banked valves, including the three valves 14 and the end plates 16 and 17, is held together by four through bolts 35 which are provided with appropriate nuts on opposite ends and which extend through four aligned bolt holes 36 (Fig. 2) formed in all of the bodies or castings 15 and in the end plates 16 and 17. It is, of course, obvious that the number of valves 14 may be reduced to a minimum of one or increased to any desired number, though in certain aspects of the invention there are features which are provided particularly in contemplation of there being two or more individual banked valves 14 in the assembly.

The central feed chamber 21 leads through a short passageway to an opening or port 37 which is located substantially at the center of the flat surface 34 and thus is in alignment with the opening or port 32. As a consequence of this fact, by the mere expedient of assembling the castings 15, the central feed chamber 21 of each valve 14 will have permanent and direct communication through the aligned openings or ports 32 and 37 with the two end feed chambers 29 and 30 of the succeeding valve 14, through a passageway 31.

The final or left-hand valve 14 will provide direct communication from its central feed chamber 21 through its opening 32 to an aligned discharge opening 38 formed in the discharge end plate 17, which opening 38 is connected by a passageway in said discharge end plate 17 to the discharge pipe 18. The feed plate 16 similarly provides communication from conduit 12 to the opening 32 of the right-hand valve 14.

Slidably rectilinearly in each valve bore 20 is a spool 39 of the drilled or hollow type. The spool 39 includes a central land 40 and spaced upper and lower or end lands 41 and 42. The center portion of the spool 39 is provided with a longitudinally extending bore 43 or, in other words, it is hollow. Each land of spool 39 is also provided with one or more radial bores which preferably extend entirely therethrough and extend at least from an outer surface thereof to the interior bore 43, the radial bores associated with lands 40, 41 and 42 being designated 44, 45, and 46, respectively.

The spools 39 also provide reduced shanks 47 and 48 between the lands 40 and 41 and 40 and 42, respectively. Adjacent its top the spool 39 is provided with an integral operating shaft or stem 49 adapted to be operated by a pivoted handle 50. Adjacent its bottom the spool 39 includes an extension shaft or stem 51. In the manufacture of the spool, according to one practice, the extension shaft 51 is provided with an integral head which is welded to the main body of the spool 39 and is turned down and ground smooth to form the bottom land 42. The extension shaft 51 is a part of the spring centering mechanism of the valve which is generally designated 52 and which is of substantial standard construction, operating to center the spool 39 whenever the operating lever 50 is released and predetermining the limit of throw of the spool 39 in either of its reverse directions of operation under the influence of handle 50.

The centering mechanism 52 is contained in a leakage oil reservoir or chamber 53 which is formed in a removable hollow bottom cap 54 which is removably attached to the base or bot-

4

tom of the body or casting 15. The operating shaft 49 for the spool 39 extends through a hole or opening in a top or upper cap 55 which is hollow to provide a leakage oil reservoir or chamber 56, which chamber also provides for the upward travel of the spool 39, particularly as illustrated in the right-hand valve 14. An oil seal 57 is provided for the operating shaft 49 where it extends through the cap 55.

One of the features of my invention lies in the particular arrangement of parts which prevents the seal 57 of each valve 14 being subjected to significant pressure which, if present, would tend to cause it to seize the stem 49 and would tend to blow it out. For example, it will be noticed by reference to Fig. 1 of the drawings that the left-hand valve spool 39 is in its neutral position and the right-hand valve spool 39 is in its upward operating position, and the central valve spool 39 is in its downward operating position. Under such conditions the motor 26 will be actuated in series with the motor 27 and they will be operating in reverse directions, the motor 28 being idle and its piston being sealed or locked in position, its valve 14 providing a by-pass for it.

It is to be particularly noted that for all three of the operating positions of a valve 14, which are illustrated, the chambers 53 and 56 are completely isolated by the lands 41 and 42 from the pressure of the hydraulic fluid in the system. In other words, the only fluid which can reach the chambers 53 and 56 is leakage fluid which leaks past the seals provided by the lands 41 and 42. As a consequence of this fact, under no circumstances will there be appreciable pressure in the chambers 53 and 56. This has two important characteristics: First of all it insures substantially complete balance of the spools 39 without requiring both the stems 49 and 51 to extend through seals or, in other words, to be exposed to atmosphere. Stated another way, it provides for a completely balanced valve, while permitting one end of the spool to be enclosed; in this instance, it being the bottom of the spool. A second important feature is that it relieves each seal 57 of hydraulic pressure, thus preventing its seizing or blowing out.

Furthermore, it is to be noted that this result is accomplished by a four-way valve which requires only three lands on the spool and which provides a no-load by-pass circuit when the spool is in its neutral position, thus eliminating the necessity for any external by-pass circuit.

To drain the leakage oil reservoirs or chambers 53 and 56 I have provided a drainage passageway which is a continuous passageway formed automatically through the entire assembly, merely upon the assembly of two or more valves 14, without requiring any external fittings or conduits. This construction is particularly important where the banked valve arrangement is employed, though it is desirable even for a single valve.

To this end, each of the bodies or castings 15 is provided with a through passageway 58 (see Fig. 2) which extends between aligned openings on the parallel opposite faces 33 and 34. Extending from each passageway 58 are connecting passageways or bores 59 and 60, formed in the casting or body 15, which extend through the bottom and top thereof, respectively, and are in permanent communication with the leakage oil reservoirs or chambers 53 and 56, respectively. In other words, there is a continuous drainage passageway from both chambers 53 and 56 which includes the common transverse passageway 58. When two or more valves 14 are assembled, the

5

individual passageways 58 are all in direct communication and provide a continuous drain passageway through the assembly, and the right-handmost passageway 58 communicates with a drain passageway in the end discharge plate 17 which is in permanent communication with the tank or discharge pipe 18.

To review briefly the operation of the system and the valve, if all the valves are released they will have moved automatically to their neutral positions and locked their individual motors 26, 27 and 28 in position. This locking is effected by virtue of the fact that the two motor ports 22 and 23 are sealed between central land 40 and one of the end lands 41 or 42. This is clearly illustrated by the left-hand valve in Fig. 2 of the drawings.

Furthermore, an open or substantially no-load path will be provided for the flow of fluid delivered by the pump 11 since it will flow through the feed passageway 31 of the right-hand casting 15, dividing and flowing through the two branches thereof and through the end feed chambers 29 and 30 thereof, thence through the bores 45 and 46 in the lands 41 and 42 and into the central bore 43 in the spool 39, passing through the radial bores 44 in central land 40 into the central feed chamber 21 from which it will flow to the central valve 14 and over a similar path which will again occur in the left-hand valve 14, finally passing through opening 38 and connecting passageway in end plate 17 to tank 10 by way of conduit 18. If the right-hand spool 39 is moved upwardly by operating its lever 50 to actuate the motor 26 in one direction, the parts will be in the positions illustrated in Fig. 1 of the drawings. In this case the hydraulic fluid in passageway 31 can only flow through the upper feed chamber 29, since the lower feed chamber 30 is blocked by land 42.

The hydraulic fluid will thus flow from feed chamber 29 through valve bore 20 along the reduced shank portion 47 of the spool 39 and into the motor port 22 from which it will be conducted by conduit 24 to the upper end of piston motor 26, actuating said piston motor. Returning fluid from the motor 26 will flow through conduit 25 to motor chamber 23, thence through valve bore 20 along reduced shank 48 to the central feed chamber 21. From central feed chamber 21 the fluid will flow to passageway 31 of the central valve 14 and be directed to the bottom feed chamber 30 thereof, being directed to the motor 27 over a path which is obvious from the above description of the right-hand valve 14, ultimately being delivered to the passageway 31 of the left-hand valve through which it will flow, by-passing the motor 28.

The valve assembly, of course, provides for the series operation of the hydraulic motors 26, 27, and 28, thus making it possible to operate two or more of them simultaneously.

Also, as above pointed out, the spools 39 under all operating conditions are balanced and furthermore the leakage chambers in the caps 54 and 55 are isolated from the hydraulic fluid flowing through the feed and motor chambers as well as the feed passageways of each valve, with the desirable characteristics above pointed out.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended, and I therefore wish not to be restricted to the precise construction herein disclosed.

Having thus described and shown an embodi-

6

ment of my invention, what I desire to secure by Letters Patent of the United States is:

1. A four-way spool valve including a body having a straight bore extending therethrough, a feed chamber located adjacent the center of said body and communicating with said bore, a pair of motor chambers on opposite sides of said feed chamber and also communicating with said bore, a feed chamber located outwardly of each motor chamber and also communicating with said bore, a passageway leading from said central feed chamber to a feed opening on one side of said body, a passageway leading from both of said end feed chambers and confining the flow of hydraulic fluid therefrom to a feed opening on the opposite side of said body in alignment with the first mentioned feed opening, a spool slidable in said bore, said spool being hollow and having three lands including a center land and two end lands, each of said lands having a radial opening extending from the hollow interior of said spool to the land surface and cooperating with the hollow spool and feed chambers and said passageways to provide an open path for flow of hydraulic fluid through said valve when the spool is in its neutral position, said spool being operable in reverse directions to shut off said open path and connect opposite ends of said motor chambers with said center and one of said end feed chambers, respectively.

2. A banked valve assembly including a plurality of duplicate four-way spool valves, means assembling said valves in banked arrangement, each of said valves including a body having a straight bore extending therethrough, a feed chamber located adjacent the center of said body and communicating with said bore, a pair of motor chambers on opposite sides of said feed chamber and also communicating with said bore, a feed chamber located outwardly of each motor chamber and also communicating with said bore, a cap on each end of said body, each cap providing an oil leakage chamber communicating with an end of said bore, a spool slidable in said bore and having a stem extending through one of said caps, an oil seal for said stem where it extends through said one cap, said spool being hollow and having three lands including a center land and two end lands, each of said lands having a radial opening extending from the hollow interior of said spool to the land surface and cooperating with the hollow spool and feed chambers and passageways to provide an open path for flow of hydraulic fluid through said valve when the spool is in its neutral position, said spool being operable in reverse directions to shut off said open path and connect opposite ones of said motor chambers with said center and one of said end feed chambers, respectively, a common drain passageway in said body communicating with both said end cap oil leakage chambers and isolated in said body from said spool receiving bore and from said feed and motor chambers, said end lands being constructed so that they always isolate the oil leakage chambers in said end caps from the pressure of hydraulic fluid in said feed or motor chambers for all positions of adjustment of said spool, a passageway leading from said central feed chamber to a feed opening on one side of said body, and a passageway leading from both said end feed chambers and confining the flow of hydraulic fluid therefrom to a feed opening on the opposite side of said body in alignment with said first mentioned feed opening, said common drain pas-

7

sageway in each body having aligned openings on opposite faces whereby a continuous isolated through drain passageway is provided in the banked valve assembly.

3. A banked valve assembly including at least three duplicate four-way spool valves, means assembling said valves in banked arrangement, each of said valves including a body having a straight bore extending therethrough, a feed chamber located adjacent the center of said body and communicating with said bore, a pair of motor chambers on opposite sides of said feed chamber and also communicating with said bore, a feed chamber located outwardly of each motor chamber and also communicating with said bore, a cap on each end of said body, each cap providing an oil leakage chamber communicating with an end of said bore, a spool slidable in said bore and having a stem extending through one of said caps, an oil seal for said stem where it extends through said one cap, said spool being hollow and having three lands including a center land and two end lands, each of said lands having a radial opening extending from the hollow interior of said spool to the land surface and cooperating with the hollow spool and feed chambers and passageways to provide an open path for flow of hydraulic fluid through said valve when the spool is in its neutral position, said spool being operable in reverse directions to shut off said open path and connect opposite ones of said motor chambers with said center and one of said end feed chambers, respectively, a common drain passageway in said body communicating with both said end cap oil leakage chambers and isolated in said body from said spool receiving bore and from said feed and motor chambers, said end lands being constructed so that they always isolate the oil leakage chambers in said end caps from the pressure of hydraulic fluid in said feed or motor chambers for all positions of adjustment of said spool, a passageway leading from said central feed chamber to a feed opening on one side of said body, and a passageway leading from both said end feed chambers and confining the flow of hydraulic fluid therefrom to a feed opening on the opposite side of said body in alignment with said first mentioned feed opening, said common drain passageways in each body having aligned openings on opposite faces whereby a continuous isolated through drain passageway is provided in the banked valve assembly.

4. A banked valve assembly including at least three duplicate four-way spool valves, means assembling said valves in banked arrangement, each of said valves including a body having a straight bore extending therethrough, a feed chamber located adjacent the center of said body and communicating with said bore, a pair of motor chambers on opposite sides of said feed chamber and also communicating with said bore, a feed chamber located outwardly of each motor chamber and also communicating with said bore,

8

a spool slidable in said bore, said spool being hollow and having three lands including a center land and two end lands, each of said lands having a radial opening extending from the hollow interior of said spool to the land surface and cooperating with the hollow spool and feed chambers and passageways to provide an open path for flow of hydraulic fluid through said valve when the spool is in its neutral position, said spool being operable in reverse directions to shut off said open path and connect opposite ones of said motor chambers with said center and one of said end feed chambers, respectively, a passageway leading from said central feed chamber to a feed opening on one side of said body, and a passageway leading from both said end feed chambers and confining the flow of hydraulic fluid therefrom to a feed opening on the opposite side of said body in alignment with said first mentioned feed opening.

5. A banked valve assembly including a plurality of duplicate four-way spool valves, means assembling said valves in banked arrangement, each of said valves including a body having a straight bore extending therethrough, a feed chamber located adjacent the center of said body and communicating with said bore, a pair of motor chambers on opposite sides of said feed chamber and also communicating with said bore, a feed chamber located outwardly of each motor chamber and also communicating with said bore, a spool slidable in said bore, said spool being hollow and having three lands including a center land and two end lands, each of said lands having a radial opening extending from the hollow interior of said spool to the land surface and cooperating with the hollow spool and feed chambers and passageways to provide an open path for flow of hydraulic fluid through said valve when the spool is in its neutral position, said spool being operable in reverse directions to shut off said open path and connect opposite ones of said motor chambers with said center and one of said end feed chambers, respectively, a passageway leading from said central feed chamber to a feed opening on one side of said body, and a passageway leading from both said end feed chambers and confining the flow of hydraulic fluid therefrom to a feed opening on the opposite side of said body in alignment with said first mentioned feed opening.

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