Dec. 4, 1956 L. E. SIMMONS 2,772,694

HYDRAULIC CONTROL VALVE MECHANISM

Original Filed April 1, 1948 3 Sheets-Sheet 1

Fig. 1.

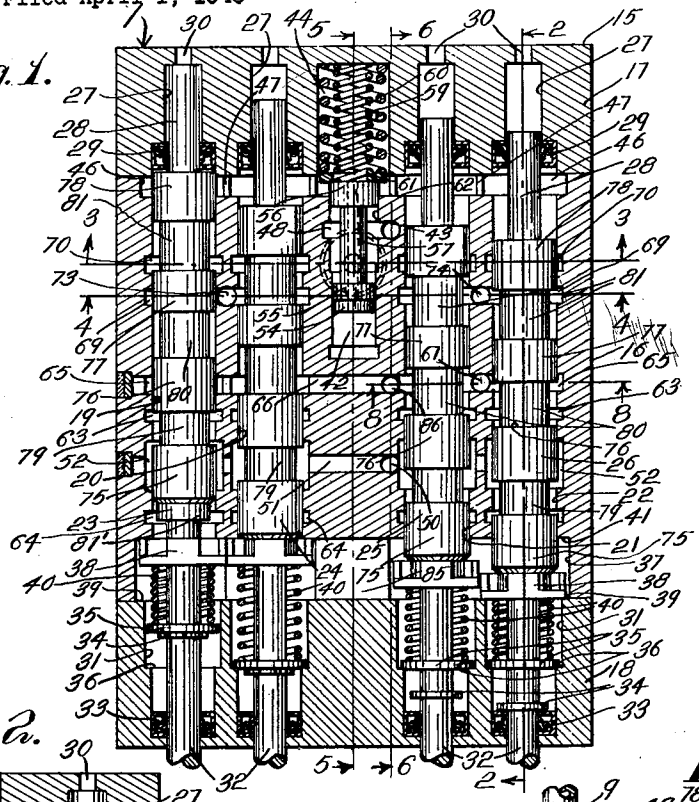


Fig. 2.

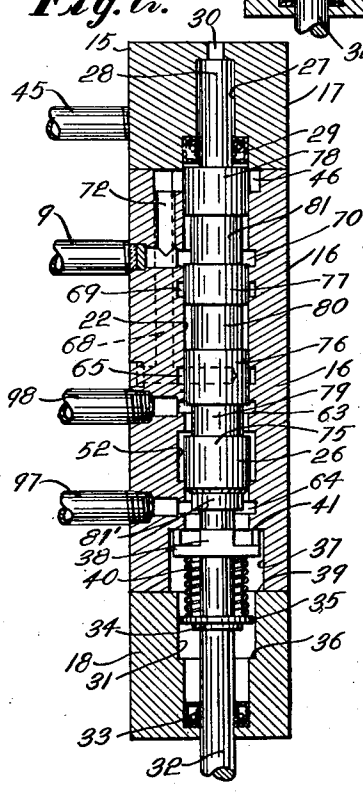


Fig. 3.

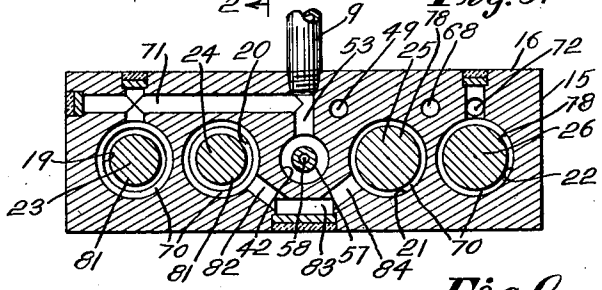
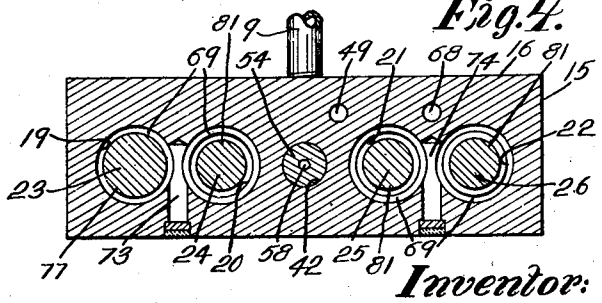


Fig. 4.



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HYDRAULIC CONTROL VALVE MECHANISM

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Fig. 5.

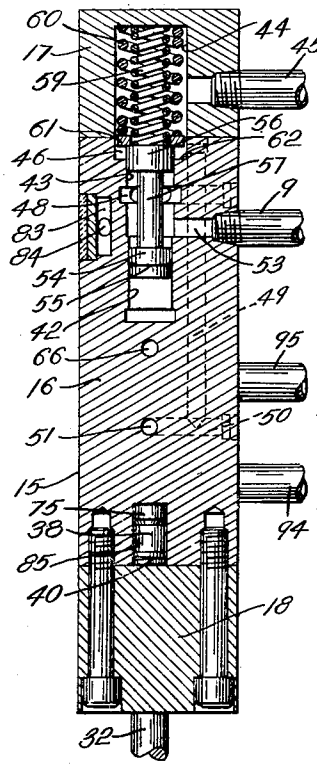


Fig. 6.

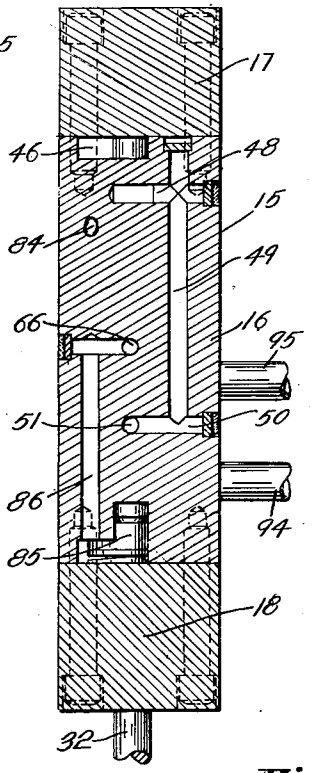


Fig. 7.

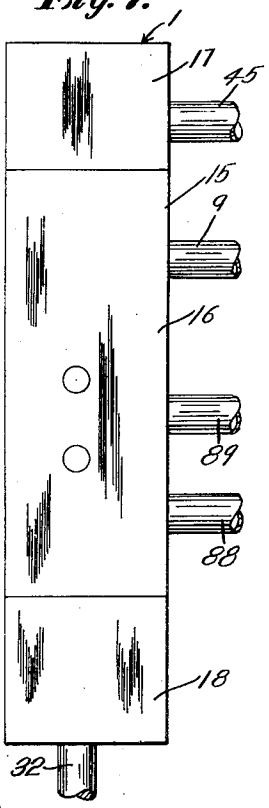


Fig. 8.

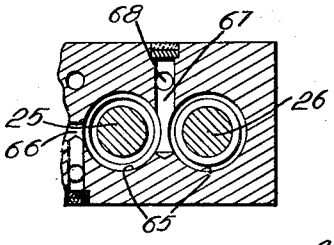


Fig. 9.

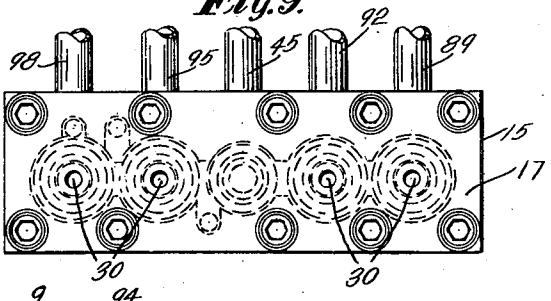
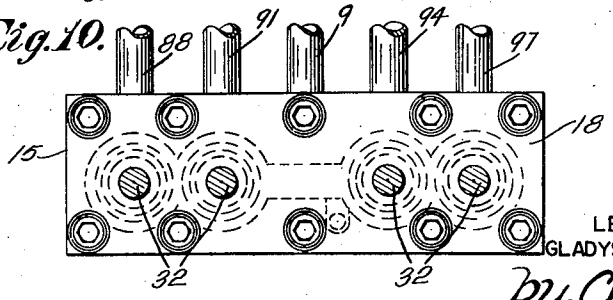


Fig. 10.



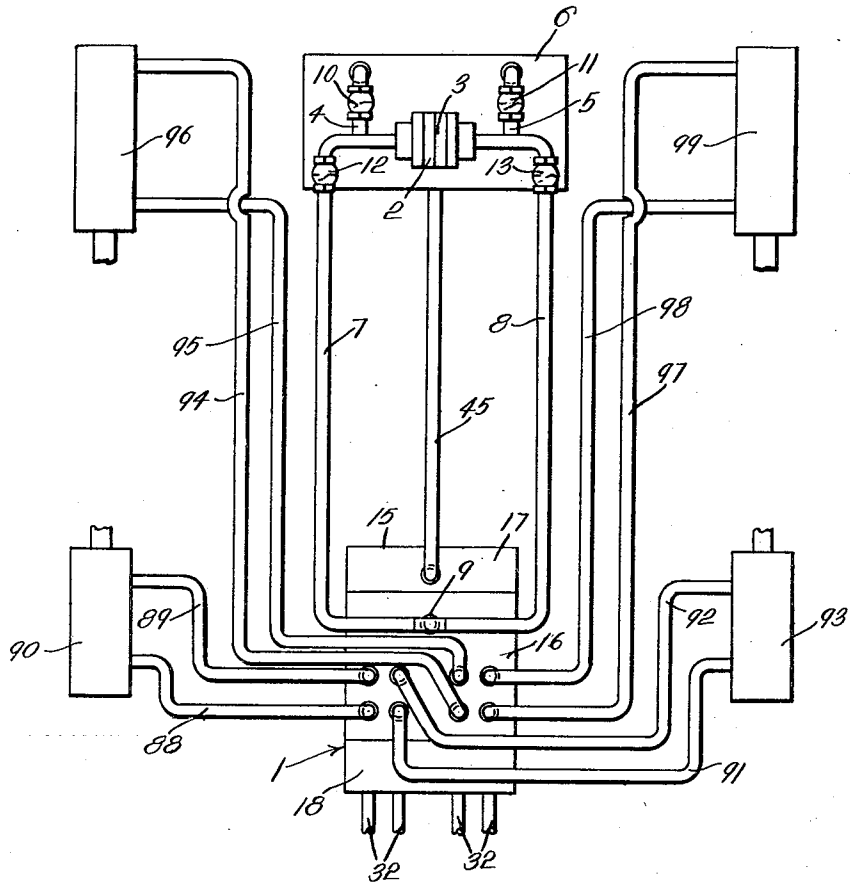
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HYDRAULIC CONTROL VALVE MECHANISM

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Fig. 11.



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HYDRAULIC CONTROL VALVE MECHANISM

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Original application April 1, 1948, Serial No. 18,465. Divided and this application February 7, 1951, Serial No. 209,745

2 Claims. (Cl. 137—621)

This invention relates to hydraulic systems and more particularly to a hydraulic control system having improved control valve mechanism and associated flow passage means.

An object of the present invention is to provide an improved hydraulic system. Another object is to provide an improved hydraulic control system having improved control valve mechanism and associated flow passage means. Another object is to provide an improved control valve mechanism. A further object is to provide an improved combined pilot and overload valve operable at different pressures in the hydraulic system. A still further object is to provide an improved balance type slide valve mechanism embodying an improved valve structure and associated flow passage arrangement. These and other objects and advantages of the invention will, however, hereinafter more fully appear.

This application is a division of a copending application, Serial No. 18,465, filed April 1, 1948, owned by Joy Manufacturing Company, assignee.

In the accompanying drawings there is shown for purposes of illustration one form which the invention may assume in practice.

In these drawings:

Fig. 1 is a horizontal sectional view taken through a control valve mechanism constructed in accordance with a preferred illustrative embodiment of the invention.

Fig. 2 is a longitudinal vertical section taken on line 2—2 of Fig. 1, with the valve in a different position.

Figs. 3 and 4 are cross sectional views taken respectively on lines 3—3 and 4—4 of Fig. 1.

Figs. 5 and 6 are longitudinal vertical sectional views taken respectively on lines 5—5 and 6—6 of Fig. 1.

Fig. 7 is a side elevational view of the valve mechanism.

Fig. 8 is a fragmentary cross sectional view taken on line 8—8 of Fig. 1.

Fig. 9 is a rear end view and Fig. 10 is a front end view of the valve mechanism.

Fig. 11 is a diagrammatic view illustrating the hydraulic system.

In this illustrative construction, as shown in the drawings, the improved hydraulic control system has embodied therein a control valve mechanism generally designated 1 which is associated with a reversible motor driven pumping means 2 (Fig. 11) comprising a conventional gear pump 3 having its opposite sides connected by conduits 4 and 5 to a liquid reservoir 6 herein a tank preferably containing a light oil. Branch conduits 7 and 8 lead to a conduit 9 connected to the pressure passages of the valve mechanism 1, as later described in detail. Connected to the conduits 4 and 5 are check valves 10 and 11 which permit liquid flow from the tank to the pump but which automatically prevent reverse flow. Connected in the conduits 7 and 8 are check valves 12 and 13 which permit liquid flow from the pump to the pressure conduit 9 of the valve mechanism but which automatically prevent reverse flow. By such arrangement the pump may be driven by its driving motor in either direction, and liquid under pressure may be supplied to the pressure conduit 9 irrespective of the direction of drive. During drive in one direction, liquid may flow from the tank through conduit 5, past the check valve 11 to the suction side of the pump, and liquid under pressure may be discharged from the pressure side of the pump, past the check valve 12 and through the conduit 7 to the pressure conduit 9. During reverse drive, liquid may flow from the tank through conduit 4, past the check valve 10 to the suction side of the pump and from the pressure side of the pump past the check valve 13 and through conduit 8 to the pressure conduit 9.

Now referring to the improved control valve mechanism 1, it will be noted that a horizontal rectangular valve box 15 includes a central body 16 and front and rear end heads or caps 17 and 18 suitably secured, as by screws, to the body. Extending longitudinally of the body are parallel horizontal bores 19, 20, 21 and 22 respectively containing reciprocable balanced spool type slide valves 23, 24, 25 and 26. The front head 17 has bores 27 aligned with the valve receiving bores, and the valves have stems 28 passing forwardly through sealing packings 29. The bores 27 at the outer sides of the packings are vented through ports 30. The rear head 18 has bores 31 aligned with the valve receiving bores, and stems 32 on the valves extend rearwardly through sealing packings 33. The stems 32 of the valves are pivotally connected to hand levers in the manner disclosed in the above mentioned copending application.

The slide valves, when the valve levers are released, move automatically into and are held in neutral position, and the second valve from the left, as viewed in Fig. 1, is shown in such position. To accomplish this function, each rearward valve stem 32 has a collar 34 fixed thereto, and surrounding the stems in advance of the collars are washers 35, the latter adapted to seat against shoulders 36 in the bores 31. The central body of the valve box has rear bores 37 communicating with the head bores 31, and spiders 38 surrounding the valve stems 32 are adapted to seat against the front walls 39 of these bores and to be engaged by reduced rear end portions of the valve bodies. Encircling the stems 32 between the washers and the spiders are coil springs 40 which yieldingly urge the washers and spiders apart. When the valves are in neutral position, in engagement with the collars 34, the washers are seated against the shoulders 36 and the spiders are seated against opposite end walls 41 and engaged by the reduced rear end portions of the valve bodies. When the valves are slid forwardly to the position shown at the left in Fig. 1, the washers 35 move away from their seats, and the springs are compressed so that when the valve levers are released, the springs return the valves to neutral position. When the valves are slid rearwardly to the position shown second from the right in Fig. 1, the spiders 38 are forced from their seats and the springs are compressed so that when the valve levers are released, the springs return the valves to neutral position. When the valves are moved rearwardly to the right hand position shown in Fig. 1, the spiders 38 seat against the front walls 39 of the bores 37 so that further rearward movement of the valves is limited by the spiders which then serve as stops. In this position also, the springs return the valves to neutral position when the valve levers are released.

The central body 16 of the valve box has a central longitudinal bore 42 (Fig. 4) and a coaxial larger bore 43. A chamber 44 in the front head is connected by a return conduit 45 back to the tank 6. At the front end of the body, coaxial with each valve receiving bore,

is an enlarged shallow bore 46 connected by ports 47 into lateral communication with one another, and the head chamber 44 communicates with the central one of these bores (as shown in Fig. 1) so that the bores 46 are connected to exhaust. Formed in the walls of the bore 43 is an annular groove 48 which is connected by a longitudinal passage 49 (Fig. 6) with a vertical passage 50 which communicates with a transverse pressure passage 51. Annular grooves 52 in the walls of the valve receiving bores communicate with the passage 51. A passage 53 (Fig. 5) connects the pressure conduit 9 with the rear end of the bore 43. Reciprocable in the bores 42, 43 is a combined pilot and relief valve 54 of the spool type having a rear spool 55 fitting the small bore 42 and a larger spool 56 fitting the larger bore 43. The spools are connected by a reduced portion 57. Extending axially through the valve is a passage 58 for connecting the bore at the rear side of the spool 55 with the exhaust chamber 44. Arranged in the head chamber are concentrically arranged coil springs of different size and strengths, and the light inner spring 59 acts on the front end of the valve 54 while the heavier outer spring 60 acts on a washer 61 which engages the front end of the valve and is adapted to seat against the rear wall 62 of the central bore 46. When there is no pressure in the passage 53, the light spring 59 holds the valve 54 in its rearmost position, with the groove 48 closed by the front valve spool 56, and at that time the washer 61 is seated against the wall 62.

When liquid under pressure is supplied through conduit 9 to the passage 53, the pressure acting on the effective rear pressure area of the large valve spool 56 forces the valve forwardly against the action of the spring 59 until it is stopped by engagement with the washer 61, and the groove 48 is opened so that liquid under pressure may flow from the passage 53 and passages 49, 50 and 51 to the pressure grooves 52. Formed in the walls of the valve receiving bores longitudinally thereof at opposite sides of the pressure grooves 52 are narrow annular service grooves or motor ports 63 and 64, while spaced forwardly of the grooves 63 are narrow annular grooves 65 which are connected in communication with one another by a transverse passage 66 which communicates with a vertical passage 67 connected to a longitudinal passage 68 communicating with one of the end exhaust chambers 46. Also formed in the walls of the valve receiving bores and spaced longitudinally thereof in advance of the grooves 65 are relatively narrow annular bypass grooves 69 and 70. As shown in Fig. 3, a transverse passage 71 connects the pressure passage 53 with the left hand groove 70, and a longitudinal discharge passage 72 connects the right hand groove 70 with one of the end exhaust chambers 46. As shown in Fig. 4, a passage 73 connects the pair of left hand grooves 69 together, and a similar passage 74 connects the right hand pair of grooves together. The slide valves each have four longitudinally spaced spools 75, 76, 77 and 78 separated by reduced portions to provide three annular spaces or grooves 79, 80 and 81 between the spools, and the rear end of each valve is reduced at 81'. When the valves are in neutral position, liquid under pressure may flow from passage 53 through passage 71 to the left hand groove 70, through the annular space 81 of the left hand valve 23 to the left hand groove 69, through passage 73 to the next adjacent groove 69 and through the annular space 81 of the next adjacent valve 24 to the next adjacent groove 70. Liquid may then flow from the groove 70 to a passage 82, a bore 83 and a passage 84 to the adjacent groove 70 next to the right in Fig. 1, and fluid flows from this groove through the annular space 81 of the valve 25 second from the right in Fig. 1 to the next adjacent groove 69 and from the latter through passage 74 to the right hand groove 69, and thence through the space 81 in the right hand valve 26 to the right hand groove 70 and through passage 72 and the communicating bore 46 to exhaust. When any of the slide valves is moved to cut off communication between the grooves 69 and 70, the bypass is closed, and pressure will build up in the bore 43 to move the pilot valve 54 from its closed position to the position shown in Figs. 1 and 5, and, at that time, liquid under pressure may flow through groove 48 and passages 49, 50 and 51 to the annular pressure grooves 52. The bores 37 at the rearward end of the central body are connected in communication with one another through a transverse passage 85 which is connected by a longitudinal passage 86 (see Fig. 6) which communicates with the transverse exhaust passage 66. As shown diagrammatically in Fig. 11, the annular service grooves 63 and 64 of the left hand valve receiving bore 19 are connected by conduits 88 and 89 to the opposite ends of a hydraulic motor cylinder 90. The service grooves 63 and 64 of the next adjacent valve receiving bore 20 are connected by conduits 91 and 92 to the opposite ends of a hydraulic motor cylinder 93. The service grooves 63 and 64 of the valve receiving bore 21 are connected by conduits 94 and 95 to the opposite ends of a hydraulic motor cylinder 96, while the service grooves 63 and 64 of the right hand valve receiving bore 22 are connected by conduits 97 and 98 to the opposite ends of a hydraulic motor cylinder 99. When the valves are moved to the position shown at the left in Fig. 1, liquid under pressure may flow from the grooves 52 to the grooves 63, while the grooves 64 are connected to the exhaust bores 37. When the valves are slid into the right hand position shown in Fig. 1, liquid under pressure may flow from the grooves 52 to the grooves 64, while the grooves 63 are connected to the exhaust grooves 65. When the valves are in the position shown second from the right in Fig. 1, the liquid is trapped in the grooves 64, while the grooves 63 are connected to exhaust. When the valves are positioned as shown second from the left in Fig. 1, the liquid is trapped in both grooves 63 and 64. The valves may also be positioned to connect either groove 64, 64 with the exhaust while liquid is trapped in the other groove. It is accordingly evident that by suitable positioning of the slide valves 23, 24, 25 and 26, liquid under pressure may be supplied to either end of the cylinders 90 and 96, while the other end is connected to exhaust, or the slide valves may be positioned to trap liquid within the motor cylinders. In the event the pressure in the system becomes excessive due to overload, the pressure in the bore 43 acting on the effective rear pressure area of the spool 56 of the valve 54 will move the latter forwardly against the action of the heavier spring 60 to connect the groove 48 with the central bore 46 which communicates with the exhaust chamber 44, thereby to reduce the pressure in the system.

The motor cylinders 90 and 93 may serve to actuate the operating means for clutches of a machine with which the hydraulic control system is associated, and the motor cylinders 96 and 99 may be associated with tilting jacks for the machine, all as is fully disclosed in the above mentioned copending application. Evidently, the valve mechanism may effect control of various other devices.

As a result of this invention an improved hydraulic control system is provided whereby devices to be controlled may be easily and quickly operated by the control valves, and simply by trapping liquid in the hydraulic motor cylinders the devices may be locked in adjusted position, and the cylinders may be quickly vented when desired. By the provision of the improved control valve mechanism, due to the novel valve and passage arrangement thereof, together with the provision of the combined pilot and relief valve, an improved control of the several hydraulic functions of the machine is provided. The reversible pump arrangement enables reverse operation of the machine while automatically maintaining the

desired pressure in the system. Other advantages of the invention will be clearly apparent to those skilled in the art.

While there is in this application specifically described one form which the invention may assume in practice, it will be understood that this form of the same is shown for purposes of illustration and that the invention may further be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What is claimed as new and desired to secure by Letters Patent is:

1. A control valve mechanism comprising a valve box having a bore, an operator shiftable balanced spool type slide valve arranged for axial movement in said bore, an inlet passage, a discharge chamber, bypass passage means communicating with said bore, said inlet passage and said discharge chamber and through which liquid freely flows when said valve is in neutral position from said inlet passage to said discharge chamber, said valve having passage means between certain of the spools thereof for permitting such flow when said valve is in neutral position and said valve cutting off such flow when it is moved out of neutral position, a transverse pressure passage communicating with said bore, and a spring loaded pilot valve normally cutting off communication of said pressure passage with said inlet passage when said slide valve is in neutral position and said bypass passage means is open, said pilot valve having a pressure area subjected to liquid under pressure in said inlet passage and passage means openable, due to the building up of pressure in said inlet passage when said slide valve is moved out of neutral position as aforesaid, to effect liquid flow from said inlet passage to said transverse pressure passage, said pilot valve having spring means for opposing movement of said pilot valve toward open position, and loading means for said spring means set to exert different pressures, said pilot valve moving under the influence of liquid under pressure into a position so that its passage means connects said transverse pressure passage in communication with said discharge chamber whenever the pressure in the system becomes excessive.

2. A control valve mechanism for a hydraulic motor comprising a valve box heaving a bore, an operator shiftable balanced spool type slide valve arranged for axial movement in said bore, transverse bypass passage means communicating with said bore, an inlet passage, a discharge chamber, said bypass passage means communicating with said inlet passage and said discharge chamber, said valve having a groove between certain spools thereof for permitting free flow of liquid through said bypass passage means for said inlet passage to said discharge chamber when said valve is in neutral position, said valve movable out of neutral position to cut off flow through said bypass passage means, a transverse pressure passage to which liquid flows from said inlet passage when said valve is moved out of neutral position to cut off liquid flow through said bypass passage means, parallel transverse exhaust passages respectively at the opposite sides of said pressure passage, one of said exhaust passages being disposed between said pressure passage and said bypass passage means, motor ports communicating with said bores at opposite sides of said transverse pressure passage, and a spring loaded pilot valve movable under the action of pressure fluid in said inlet passage and having passage means openable when said bypass passage means is closed for connecting said inlet passage to said transverse pressure passage, said slide valve being positionable in its bore to cut off liquid flow through said bypass passage means to cause the building up of pressure in said inlet passage to effect such opening of said pilot valve, said slide valve having spaced grooves for connecting either motor port to an exhaust passage and to said transverse pressure passage, said pilot valve having spring means acting thereon for opposing movement of said pilot valve toward open position, said pilot valve also serving as a pressure relief valve and being completely openable when subjected to excessive pressures in the system to connect said transverse pressure passage in communication with said discharge chamber.

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