

Oct. 9, 1951

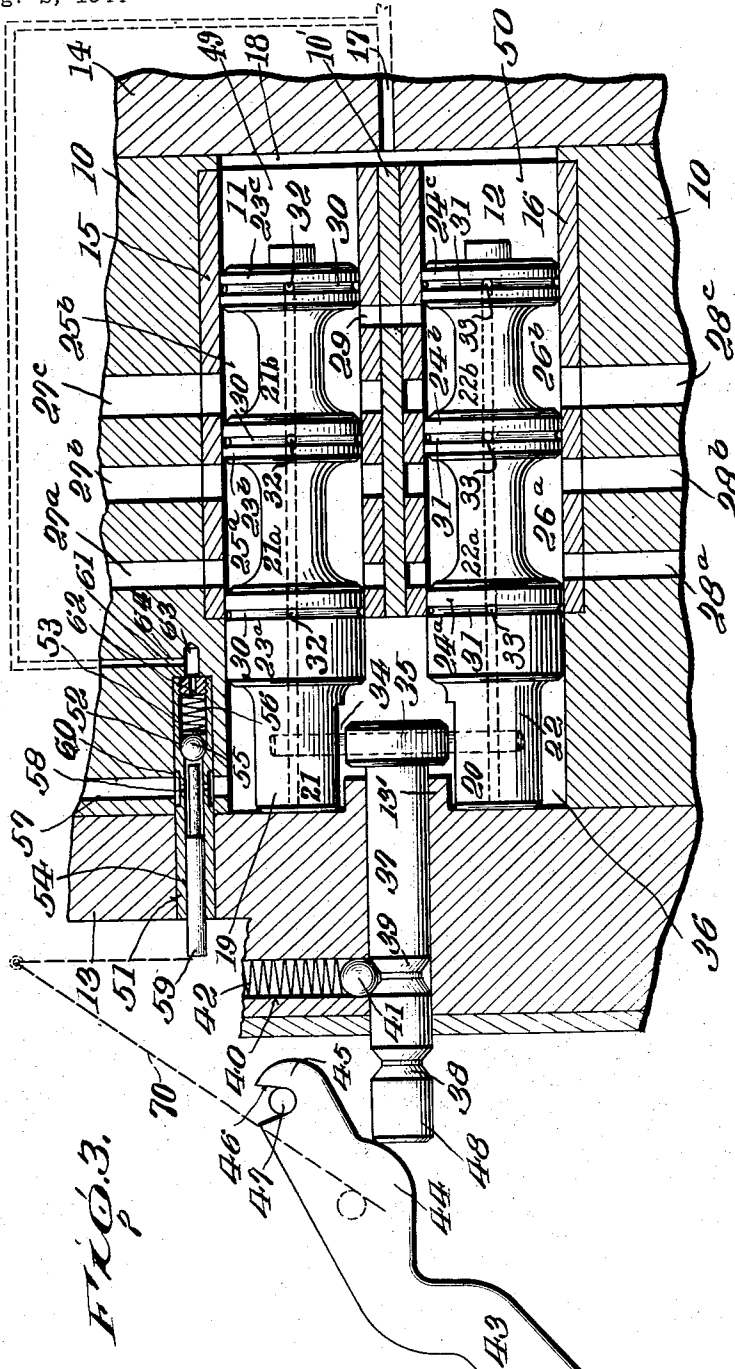
A. G. WINCHESTER

2,570,896

SHIFT-OVER VALVE

Filed Aug. 2, 1944

2 Sheets-Sheet 1



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Oct. 9, 1951

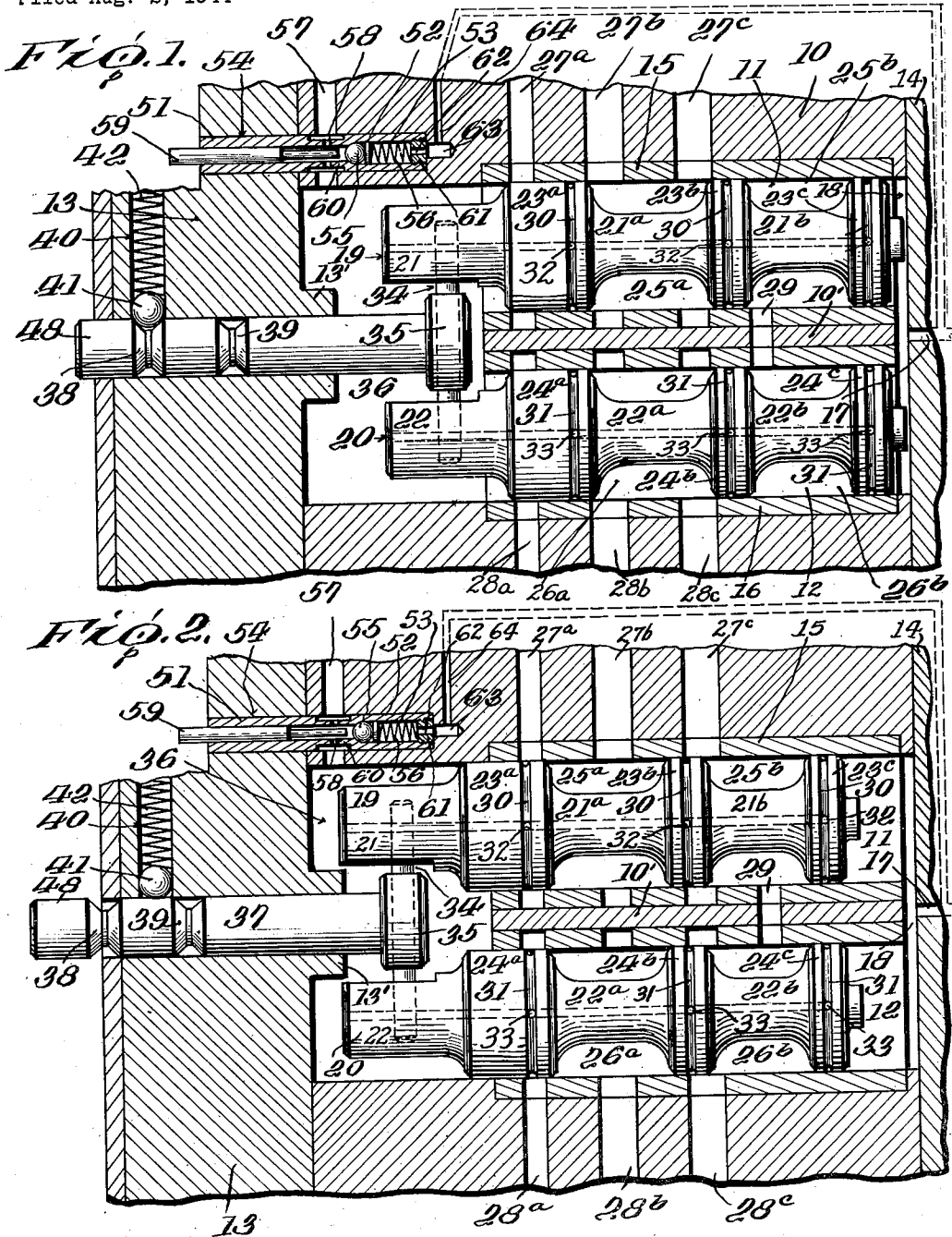
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,570,896

SHIFT-OVER VALVE

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Application August 2, 1944, Serial No. 547,789

10 Claims. (Cl. 277-20)

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My invention relates to valves; and more particularly concerns a fluid control valve for controlling the manner of operation of a fluid system.

An object of my invention is to provide a hydraulic valve of the general class described, which is unitary, compact, self-contained, and of small space requirements; which is simple, sturdy, displays long wear, high efficiency, and a high degree of reliability; which requires only a small number of movable parts, and these of simple and sturdy type, and hence involves low cost, both initially and in maintenance; and which valve is balanced, both dynamically and hydrostatically.

Another object is to provide a hydraulic valve, adapted for controlling the separate and alternate energization of a main hydraulic system from a plurality of separate sources of fluid-transmitted energy, as desired, and which is capable of accomplishing this objective without danger of connecting these energy sources in the system at the same time.

Other objects will in part be obvious and in part pointed out hereinafter, during the development of the following description.

My invention accordingly resides in the several parts, elements and features of construction, and in the relation of each of the same to one or more of the others as described herein and as more fully defined in the accompanying claims.

In the accompanying drawings, wherein I disclose a preferred embodiment of my invention,

Figures 1, 2 and 3 are longitudinal sectional views, respectively showing the valve in initial position, intermediate, and final or end position; Figure 3, for clarity, also showing a manual return means for restoring an included element of the valve from final end position to initial limit position. Through conventional means, not shown, this manual return means is physically associated with a bleeder valve shown at the upper left of the casing in the three views.

As conducive to a more thorough understanding of certain features of my invention it may be noted that more and more importance, from a practical standpoint, has attached to the use of hydraulic systems for energy transfer. One such instance, for purposes of illustration, is disclosed in copending application for Letters Patent of the United States, Serial No. 547,788, filed of even date herewith, entitled Auxiliary Ship Steering Apparatus, and in the names of Albert Rivington Stone and Albert Girvin Winchester, now Patent 2,512,119 of June 20, 1950,

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wherein a hydraulic system is employed for operating the steering rudder of a ship. Ordinarily a main pump installation energizes the disclosed system. Upon the pump becoming disabled for any reason, however, as for example storm damage, damage or destruction by enemy action, or the like, shift-over to suitable stand-by or auxiliary equipment is made possible by means of a valve.

Despite whether the stand-by equipment be either arranged in opposed or additive relation to the main pumps, or other hydraulic source of energy, it is important to ensure that the stand-by equipment is not cut into the hydraulic system until the main energy source is disconnected, and that the stand-by equipment, when it is cut into operation, is connected in the proper direction.

Accordingly, an important object of my invention is to avoid certain disadvantages and difficulties attendant in the prior art, and to provide simple and inexpensive hydraulic valve means which ensure, an extremely efficacious manner, that associated main and stand-by energizing equipment will not be connected into a hydraulic control system at the same time, and that one such energizing means will be cut out of the system before the other is cut in.

Referring now more particularly to the embodiment of my invention disclosed in the three views of the drawings, casing 10 of manganese bronze or other suitable metal is longitudinally bored at 11 and 12, these bores being parallel and disposed one above the other. In the central, longitudinal vertical sectional views employed in the drawings, only a thin, longitudinal extent of the wall 10' of casing 10 serves to separate the bores 11 and 12. End plates 13 and 14 extend transversely across opposite ends of casing 10 and serve to close off the ends of bores 11 and 12.

Liners 15, 16 preferably are provided at the bore surfaces of the longitudinal bores 11 and 12, respectively. In the present instance these liners extend throughout the region of contact between the bores and cooperating pistons, and serve as bearing surfaces which may be readily replaced as upon occurrence of excessive wear after continued service.

A single end port 17 is provided centrally in the end plate 14. It will also be noted that wall 10' and liners 15, 16, terminate short of the end plate 14 so as to define a space 18. This space 18 provides a direct and unobstructed communi-

cation, within the casing, between port 17 and bores 11 and 12.

Valve elements slidable in their respective bores 11 and 12 are provided in the form of pistons 19 and 20. The two pistons respectively comprise shank portions 21a, 21b, and shank portions 22a, 22b, all of comparatively reduced section, spaced between a plurality of head portions 23a, 23b, 23c and 24a, 24b, 24c, respectively, of larger diameter. These head portions 23a, 24a, etc., serve effectively and efficiently the dual functions of bearing elements cooperating with corresponding liners 15, 16 to provide snug, smooth and gliding fit between the bearing elements, with entire absence of detrimental binding; and as well, to seal the corresponding annular chambers or recesses 25a, 25b and 26a, 26b, formed between liners 15, 16, head portions 23a, 23b, 23c and 24a, 24b, 24c, and shanks 21, 22. It is preferred to make the pistons of steel hardened and ground to size.

In the upper part of casing 10, through liner 15, a set of three ports 27a, 27b, and 27c let laterally into bore 11 along the length thereof. Similarly, on the lower part of the casing, a set of three ports 28a, 28b and 28c let laterally into bore 12, along the length thereof preferably at points directly opposite the first three ports respectively. It will be noted that in the preferred embodiment these three ports, of each of the two sets of ports, after letting into the corresponding bores 11 and 12, extend completely and transversely therearound, in the form of annular grooves or recesses, to establish conditions of dynamic balance when fluid is introduced through said grooves.

Within dividing wall 10' between bores 11 and 12 (and to the right of piston header portions 23b, 24b when the like pistons are in their initial limit position in Figure 1), I provide a port 29, interconnecting bores 11 and 12. The purpose of this bore 29 will shortly be developed.

The ports within each set of three ports are so related to each other and to the ports of the other set, and to corresponding like pistons with their alternating shank and head portions of reduced and enlarged section, that in the initial limit position of the pistons shown in Figure 1, and corresponding in this preferred embodiment to the rest position where main energizing equipment, for example, is connected into the hydraulic system, the following relationships and connections are established: The head portions 23b, 24b block off port 29 from any of the ports of the two sets of lateral ports. Head portions 23c, 24c, moreover, effectively block the internal port 29 from end port 17. Simultaneously annular chambers 25a, 26a, defined respectively by liner 15, shank 21a and head portions 23a, 23b, and by liner 16, shank 22a, and head portions 24a, 24b, serve to interconnect corresponding lateral ports 27b and 27c, and 28b and 28c, respectively, of each set, while enlarged head portions 23a, 24a of the piston blocks the corresponding lateral ports 27a, 28a. For purposes of illustration it will be assumed that a main pump is connected at ports 27c and 28c and that these ports thus represent low and high pressure sides of the pump respectively.

The valve position represented in Figure 1 of the drawing permits the fluid from main energy source to pass between 27b, 27c and 28b, 28c without interference, while lines 27a, 28a connected as cross intake and output sides respectively of stand-by equipment are effectively blocked. It will also be assumed for purposes of illustration

that ports 27b and 28b are connected with high and low pressure sides of a fluid motor such as a hydraulic ram or rams or other load to be operated as by the main or emergency pumps depending upon the end limit position of the pistons.

The head portions 23a, 23b, 23c and 24a, 24b, 24c of the piston valves are provided with annular grooves or channels 30, 31 arranged peripherally thereabout in their outer cylindrical surfaces, and with lead-off or bleeder bores 32, 33 disposed in the bottoms of these grooves or traps and leading off in turn to axial or longitudinal channels in pistons 19 and 20.

It has therefore been observed that the wall 10' separating the two bores 11 and 12 terminates short of end plate 14. It should also be noted that the wall 10' terminates at a point considerably short of end plate 13, so that at this other or left end of the casing 10, the bores 11 and 12 let into a common compartment 36 having considerably larger dimensions. The opposite ends of the pistons adjacent this common space 36, and indicated for convenience at 21, 22, are interconnected by suitable means which here takes the form of an equalizing bar or yoke 34 extending transversely therebetween. This yoke 34 ensures that the two like pistons 19, 20 move together as a unit, and to this extent, serves as a tie-in means. The yoke also serves effectively as a medium through which forces may be transmitted for moving the pistons, all in a manner which will be fully developed.

Enlarged sleeve 35 centrally embraces yoke 34, and is securely attached transversely across the end of a connecting rod 37 which extends centrally through end plate 13, to the exterior.

Connecting rod 37, moving with pistons 19, 20, reciprocates in end plate 13, between initial and end limit positions. For each limit position, I provide yielding latch or detent means for holding the connecting rod, and hence the piston assembly, against accidental movement. While the detent means may assume any of a variety of different forms without departing from the spirit of my invention, in the present embodiment I provide paired annular grooves 38, 39 on the periphery of the connecting rod 37 a distance apart equal to the extent of the piston travel. In end plate 13, in any suitable manner, I provide a vertical bore or channel 40, in which is seated a ball or similar detent 41, spring-pressed by coiled spring 42 into the cooperating annular recesses 38, 39. These recesses, spaced apart in the manner hereinbefore specified, are positioned along connecting rod 37 so that when the pistons are in their initial limit position, at the right end of casing 10 in the drawings, recess 38 will be directly below bore 40 and will receive and be latched by ball detent 41, and when the pistons are in their final or end limit position, at the left of casing 10 in the drawings, recess 39 will be disposed beneath and latched by ball detent 41. The detention provided by the aforesaid latching means is, as has been said, yielding in nature, and will permit positive shifting of the valve elements whenever desired. This effectively prevents accidental shifting of fluttering of the valve elements during operation and consequent disturbance of the system performance.

In the design of end plate 13 I provide such thickness of material, including base 13', that recesses 38, 39 during the longitudinal reciprocation of connecting rod 37, are maintained entirely within the confines of the plate. This simplifies construction somewhat, and requires

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only that the fit between rod 37 and end plate 13 be snug, smooth, and nicely machined, and that proper packing glands, not shown, be provided to seal the bore in which the rod 37 is recessed, from fluid within chamber 36.

The operation of ports 27a, 27b, 27c and 28a, 28b, 28c has been described for the initial or rest position of the valve. In the co-pending application this corresponds to the period of energization from a main pump, and to deactivation of available stand-by equipment.

When it is desired to change over from one energy source to another, however, pressure fluid from a suitable source is admitted through port 17 and space 18 to bores 11 and 12, at the right ends, Figures 1 through 3, of the pistons 19 and 20. In the co-pending application, this fluid courses through the port 17 from the stand-by equipment, as the latter is brought into operation. The pistons thus press aside the yieldable detent means referred to, and move as a unit, smartly to the left in the drawings, from the initial limit position to the final or end limit position shown in Figure 3. Unitary movement of the pistons is ensured preferably by applying substantially the same total fluid pressure on the adjacent piston ends. In the present instance unitary action is achieved by employing pistons 19 and 20, of like cross-section and by distributing fluid through space 18 at like pressures on the adjacent piston ends while the pistons are tied together by yoke 34.

It has been suggested at an earlier point herein that unless provision to the contrary is made, there is danger of inadvertently throwing both main and auxiliary stand-by power equipment into the line at the same time. To remove any possibility of this occurrence, I arrange the lateral ports and the head portions of the pistons so that as the pistons move from their initial end limit position under the influence of the impelling fluid entering at 17, the circuits or connections established in the initial end condition are broken before continued movement of the valve element to the left establishes connections between ports 27a, 27b and between ports 28a, 28b as well as a cross-connection between ports 27c, 28c through internal port 29.

In the co-pending application, fluid flow across ports 27c, 29 and 28c is equivalent to fluid short-circuit of the main pump. This effectively removes any possibility of the main pump being cut into the hydraulic system at the same time as the stand-by equipment, for independent connections are established between the stand-by equipment and the hydraulic system. Of course, for entirely practical reasons, the main pump should be de-energized as soon as possible after being cut out of the line.

It is of course to be understood that the transitory phase or stage of operation in which the movement of the pistons from one limit position to another is continuous and of comparatively short duration, the valves, through connecting rod 37, being yieldingly latched in either limit position.

Shortly after the straight-through connection of ports 27c, 29 and 28c has been established, continued movement of the valve pistons to the left opens, across each set of lateral ports, connections between the ports 27a and 27b, through chamber 25a, on the one hand, and between ports 28a and 28b, through chamber 26a, on the other hand. Thus, within each set of ports, ports 27a, 27b are paired, and ports 28a, 28b are paired, and

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connections established between the ports of each pair. In the co-pending application, this serves to connect the stand-by equipment to the line, and thence to ship-steering rams or the like. At this point, the connection between ports 27c, 29 and 28c remains established.

The head portions 23a, 24a of the two piston valves are designed of such width as to ensure the intermediate straight-through connection between ports 27c, 29 and 28c before the ports 27a, 27b and 28a, 28b are connected in pairs within each set of ports. That is, to illustrate in one instance, head portion 23b will uncover port 27c before head portion 23a will uncover port 27a.

In the final limit position of the piston valves, shown in Figure 3, ball detent 41 engages in annular recess 39, yieldingly locking the valve elements in this position. In the intermediate position of Figure 2, on the contrary, the ball 41 is intermediate the recesses 38 and 39, and the valve elements are free to complete their travel in either direction.

While it is entirely possible to provide hydraulic means for restoring the valve elements from their final limit position in Figure 3, corresponding to system operation from stand-by equipment, to their initial position shown in Figure 1, corresponding to operation from main pumps, to do so involves unnecessarily great complication and complexity of construction. This would increase first cost, dimensions, and operating expenses. Accordingly, I find it advantageous to employ manual return means, and I have shown such means in Figure 3.

In Figure 3, I provide an operating arm or crank 43 having a convex cam portion 44 and an end 45 having an eye 46, which engages about a pivot pin 47. While this pin 47 is shown only schematically in Figure 3 as being disposed in space, it is of course apparent that this can be carried in any suitable manner, as by a bracket or arm struck from casing 10 or end plate 13. Cam 44 cooperates with stud 48 on the end of connecting rod 37. It will be noted that eye 46 is disposed uppermost, while arm 43 is designed to be swung downwardly. Thus, during a working stroke, the arm swings counter-clockwise about pin 47 as a pivot. Cam 44 engages stud 48, and bodily, through sleeve 35 and equalizing bar or yoke 34, restores the pistons 19, 20 from their end limit position, shown in Figure 3, to their initial limit position, shown in Figure 1. In so doing, the ball detent 41 is pushed upwardly, against the yielding urge of spring 42, out of engagement with recess 39. Ball 41 remains in its uppermost position, until the piston valves reach their position of Figure 3, whereupon the ball seats in recess 38.

While either limit position is being reached, some fluid will remain in bores 11 and 12 in advance of the pistons. Thus in reaching the valve position represented in Figure 1, fluid will remain in chamber 36, and while obtaining the setting shown in Figure 3, fluid will be in chambers 49, 50. It is necessary to remove this advanced fluid before movement of the pistons can be accomplished. To this end, I provide a novel type of bleeder means, at the upper left of casing 10.

A longitudinal sleeve 51 is let into casing 10, parallel to and above bore 11, through end plate 13. This sleeve is shouldered internally intermediate its length, at 52, so that a comparatively wide bore 53 is provided at the right of this shoulder, while a relatively narrow bore 54 is provided at the left thereof. This shoulder 52

also serves as a seat for ball 55 pressed by coil spring 56 disposed within the bore 53.

A lateral channel 57 extends from chamber 36 through the casing 10 and through sleeve 51, to the exterior. This channel passes across sleeve 51 through reduced-section port 58, so as to provide a straight-through connection. The chamber 36 is always open through channel 57.

Within reduced section bore 54 a plunger 59 is received for snug sliding fit therein. This plunger is adapted for movement with arm 43, by means of suitable linkage or other connection, as shown at 70 of Fig. 3. On the forward end of the plunger adjacent valve seat 52, there is a shank portion 60 of reduced section. This shank portion is adapted to contact ball valve 55 through seat 52, and to displace the same against spring 56. The reduced section shank portion 60 permits uninterrupted straight-through connection between chamber 36 and the exterior, through bore 57.

The linkage between arm 43 and plunger 59 is such that the latter is actuated to displace the ball 55 from seat 52 when the pistons are being restored from their Figure 3 position to their Figure 1 position.

A threaded cap 61 having a small bore 62 therein seats in the right end of sleeve 51, and as an abutment retains spring 56. Bleeder channel 63 in casing 10 connects between the right end of sleeve 51 in the figures and vertical bleeder line 64 which leads to the exterior and thence to end port 17, through connections not shown.

When the pistons are moved to Figure 3 position, the fluid in 36 is forced through 57, 58, around shaft 60, 58 and 57 to the exterior, as for example, to a suitable storage reservoir, not shown. Upon movement of the pistons to Figure 1 position, the crank arm 43 is manipulated. This slides plunger 59 to the right, and shaft 60 unseats ball 55 against the force of spring 56, in counter movement to the direction of flow of fluid entering through bleeder line 64. Thus as pistons 19, 20 move to the right, fluid expelled through chambers 49, 50 passes through conduit 18, end port 17, bleeder line 64, bleeder channel 63, bore 62, bore 53, around unseated ball 55, through valve seat 52, to reduced-section bore 54, and thence out through upper transverse bores 56 and 57 to the storage reservoir or the like.

It will be noted that the valve described herein requires two pistons rather than a single piston. There is more than mere duplication of parts involved in the design of these pistons. Consideration will show that to effect the mechanical and functional equivalent of this construction with but a single piston would require an elongated, cumbersome and complicated assembly, totally unsatisfactory from a practical standpoint.

As it is, my new valve is neat, compact and comparatively simple. Its small number of moving parts, carefully machined and fitted, ensures a high degree of durability and long wear. The new assembly effectively ensures that power sources are separately and alternately thrown upon a hydraulic line, and that simultaneous cut-in is avoided. I have found, for example, that my new construction contributes immeasurably to the successful operation of the system set forth in the said co-pending application. The new valve is in hydrostatic balance, due to the bleeder line relief construction and in dynamic balance, due to the drain off means for leakage fluid in the head portions of the piston valves

and to the fact that the lateral ports are in the form of annular grooves extending completely around the bores 11 and 12.

The use of liners 15, 16 and sleeve 51 makes 5 reconditioning and overhauling comparatively simple and inexpensive.

As many possible embodiments may be made of my invention and as many changes may be made in the embodiments hereinbefore set forth, 10 it is to be understood that all matter described herein is to be interpreted as illustrative and not as a limitation.

I claim:

1. As a new article of manufacture, a hydraulic 15 valve comprising, in combination, a valve casing with lateral inlet and outlet ports therein and having a longitudinal bore extending therein, said casing having a further port at one end thereof opening into said bore, a valve element 20 slidable in said bore for controlling said lateral ports by fluid pressure at said end port, manually-operated means on said casing and connected with said valve element for restoring the same after movement thereof by fluid from the end 25 port, and bleeder control means actuated by said manually-operated means and connected with said longitudinal bore in advance of said slidable valve element, for receiving and passing excess fluid expelled through said casing.

2. A hydraulic valve comprising, in combination, a longitudinally bored valve casing, and a plurality of valve pistons slidable in said bored casing between two positions of control, said casing including a corresponding plurality of sets 30 of at least three ports each letting into said bore, the ports of each set being so disposed relative to each other and to said plurality of pistons that in one control position of said pistons, two ports of each set are connected one to the other 35 while the third is blocked off, and in the other limit position a straight-through connection is provided between like ports of said sets of ports and within each set of ports the other ports thereof are opened to each other in pairs.

3. A hydraulic valve comprising, in combination, a valve casing having a plurality of pistons 40 slidable longitudinally back and forth therein between two limit positions with an end port for admitting fluid to move said pistons and a corresponding plurality of sets of at least three ports 45 letting into said casing, the ports of each set being so disposed relative to each other and to said pistons that in one limit position of the latter paired ports of each set are opened to each other, the third port in each thereof being blocked 50 off, while in an intermediate position said pistons break off the first-mentioned connections and establish a cross-connection between a single port of each of said paired ports.

4. A hydraulic valve comprising, in combination, a valve casing having a pair of pistons 55 slidable longitudinally therein between two limit positions with an end port for admitting fluid to move said valve element out of adjacent limit position and a corresponding pair of sets of at 60 least three ports letting into said casing, the ports of each set being so disposed relative to each other and to said pair of pistons that in one limit position of the latter connections are estab- 65 lished such that paired ports of each set are opened to each other while the third port is blocked, and in the other limit position of the pair of pistons a cross-connection is provided between like ports of said sets of ports and within 70 each set of ports the remaining ports are opened

to each other; and spring-pressed ball detent means cooperating with complementary-shaped portions of the pair of pistons to hold the latter yieldingly in the limit positions.

5. In combination, a valve casing having a pair of pistons slidable between two end limit positions with an end port in said casing for admitting pressure fluid to said pistons to displace the same and a corresponding pair of sets of ports letting laterally through said casing, each set comprising at least three ports the lateral ports of each set and the pair of pistons being so disposed that in one position of the latter paired ports of each set are open to each other while the third ports are blocked, and in the other limit position a cross-connection is provided between like ports of said sets of ports and within each set of ports the remaining ports are open to each other; and a bleeder valve in said casing and connecting with each end thereof for bleeding off excess fluid from that end of the casing towards which the pair of pistons is displaced.

6. A hydraulic valve comprising the combination of a valve casing having paired longitudinal bores therein; and two pistons movable together one in each bore between initial and end limit positions, said casing including at least one port leading into corresponding ends of the bores for admitting fluid to move said pistons, and two sets of at least three ports, the individual sets letting laterally through said casing into the individual bores with said lateral ports and said pistons being so related that in initial position the pistons establish a connection between paired adjacent ports of each set while blocking the third port, and in end position break said first-mentioned connections to establish a cross-connection of ports of the two sets through a port between said bores and interconnection, within each set, of the other two ports in pairs.

7. A hydraulic valve comprising the combination of a valve casing having paired longitudinal bores therein; two pistons movable together, one in each bore, between initial and limit positions; and an equalizing pin connecting said pistons together near corresponding ends thereof, said casing including at least one end port leading into corresponding ends of the bores for admitting fluid to move said pistons, and two sets of at least three ports, the individual sets letting laterally through said casing into the individual bores with said lateral ports and said pistons being so related that in initial position the pistons establish a connection between paired adjacent ports of each set while blocking the third port, and in end position break said first-mentioned connections to establish a cross-connection of ports of the two sets through a port between said bores and interconnection, within each set, of the other two ports in pairs.

8. A hydraulic valve comprising the combination of a valve casing having paired longitudinal bores; two pistons one in each bore and movable together between initial and end limit positions; a yoke interconnecting said pistons near the ends remote from said end port; and manually-operable means for applying force on said yoke to restore said pistons to initial positions, said casing including at least one end port opening through said casing into corresponding ends of the bores for admitting fluid to move the pistons and two sets of at least three ports, the individual sets letting laterally through said casing into the

individual bores with said lateral ports and said pistons being so related that in initial position the pistons establish a connection between paired adjacent ports of each set while blocking the third port, and in end position break said first-mentioned connections to establish a cross-connection between like ports of the two sets through a port between the bores and interconnect, within each set, the other two ports in pairs.

9. A hydraulic valve comprising the combination of a valve casing having paired longitudinal bores therein; liners in said bores serving as bearing surfaces; and two pistons one in each bore and movable together between initial and end limit positions, said casing including at least one end port opening through said casing into corresponding ends of the bores for admitting fluid to move the pistons and two sets of at least three ports, the individual sets letting laterally through said casing into the individual bores with said lateral ports and said pistons being so related that in initial position the pistons establish a connection between paired adjacent ports of each set while blocking the third port, and in end position break said first-mentioned connections to establish a cross-connection between like ports of the two sets through a port between the bores and interconnection, within each set, of the other two ports in pairs.

10. In combination, a longitudinally-bored valve casing; piston means slidable therein; a bleeder valve assembly mounted in said casing, said bleeder valve comprising a sleeve defining a longitudinal bore, a shouldered valve seat therein, a spring-pressed ball normally seating on said valve seat to close said bleeder valve, a manually-actuated plunger for unseating said ball, an outer port in said sleeve and casing, and an inlet port in said sleeve and casing; and connections from said respective inlet and outlet ports to opposite ends of said casing bore and on opposite sides of said piston, one connection being in constant communication with said outlet port and the other connection opening to said outlet port only upon unseating said ball valve.

ALBERT GIRVIN WINCHESTER.

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