Jan. 15, 1946. J. B. VAN DER WERFF 2,393,076

HYDRAULIC VALVE

Filed Nov. 30, 1942

Fig. 1.

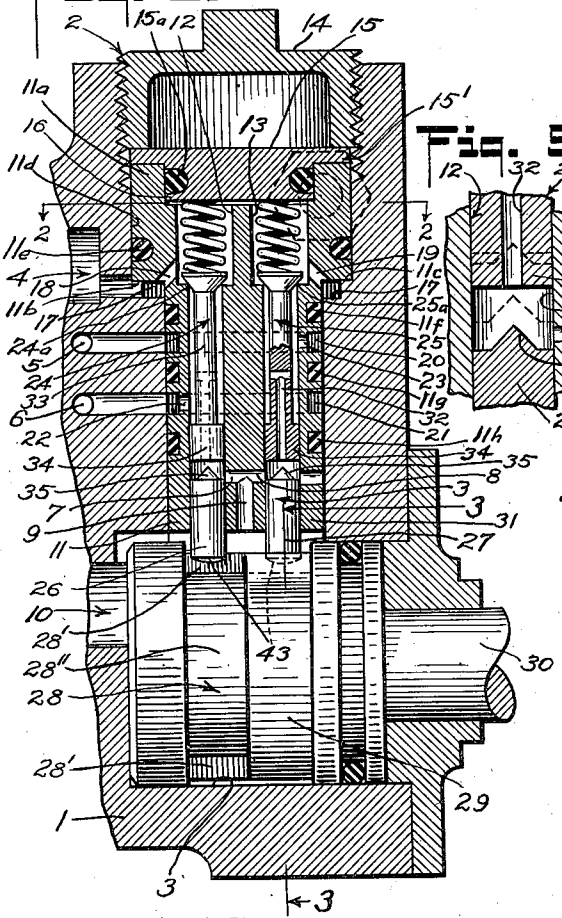


Fig. 5.

Fig. 2.

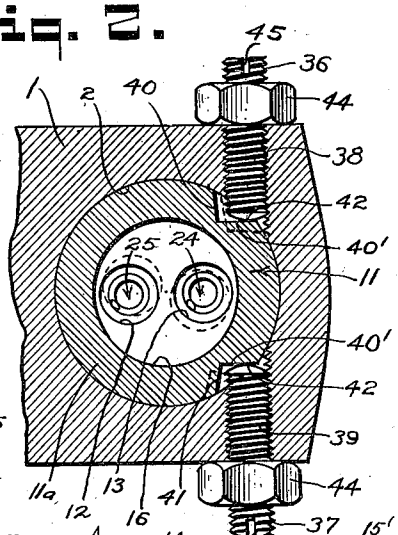


Fig. 4.

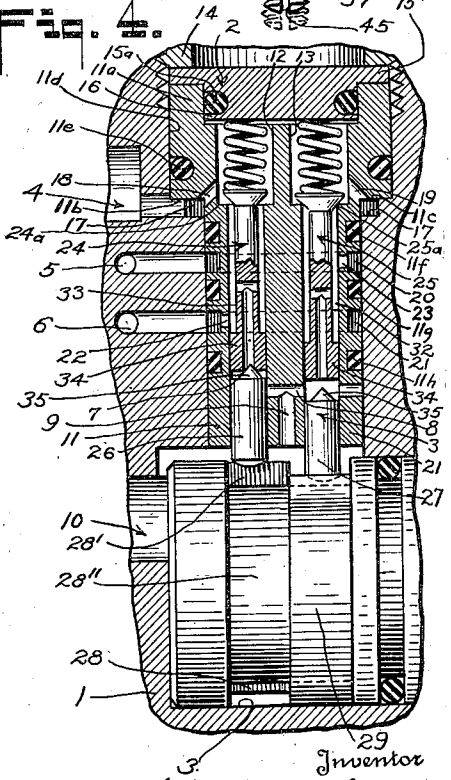
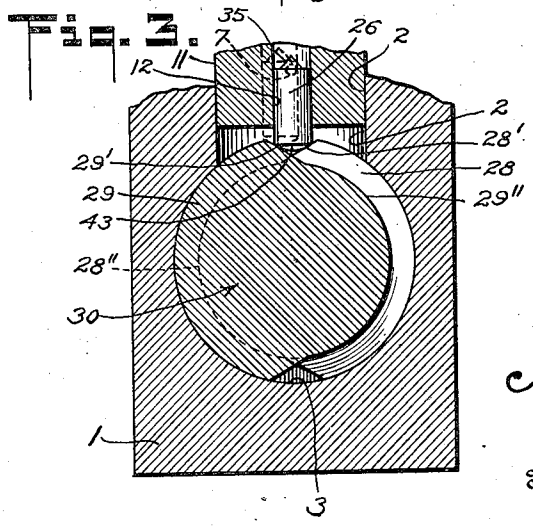


Fig. 3.



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2,393,076

HYDRAULIC VALVE

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Application November 30, 1942, Serial No. 467,317

7 Claims. (Cl. 277—21)

This invention relates to hydraulic control valves for use in aircraft and the like to control the hydraulically operated equipment thereof.

This application is directed to subject matter which is shown and described but not claimed per se in my copending application entitled Adjustable hydraulic control valve, Serial No. 453,271, filed August 1, 1942, now Patent 2,323,947, granted July 13, 1943, said subject matter being an improvement of the valve construction and arrangement embodied in another of my copending applications entitled Hydraulic actuator for hydraulic control valve, Serial No. 449,898, filed July 6, 1942, now Patent 2,321,267, granted June 8, 1943.

An object of this invention is to provide a hydraulic 4-way control valve unit in which a valve body member, a plurality of valve members, valve seats, operating means for the valve members, bores, ports and passages of the unit, are constructed, combined, arranged and operated to render the unit much more compact and of less weight than heretofore, to reduce the number and costs of machining operations, render easier the assembling and disassembling of the unit and insure an ample flow of hydraulic fluid with a minimum of pressure drop, thereby especially adapting the valve unit to efficient use in hydraulic systems in aircraft.

Another object is to provide a control valve such as described wherein a pressure valve and a return valve are mounted in a bore therefor and the return valve acts as a push rod for the pressure valve and is constructed and arranged to control return ports in the stem of the pressure valve and in the valve bore below the stems respectively whereby leakage of pressure fluid through the return ports upon opening the pressure valve is positively prevented and the unit is subject to a more reliable performance and may be more readily and accurately timed as to the desired action of said two valves.

A further object of my invention is to provide control valves of the character described wherein the four poppet valves and their seats are supported and contained in a single combined valve cage and seat member in the form of an insert adapted to be readily mounted in and removed from a single bore in a valve body member, it only being necessary to provide two bores in the cage and seat member to accommodate said four poppet valves and their associated operating elements.

With the foregoing objects in view, together with such other objects and advantages as may subsequently appear, the invention resides in the parts and in the combination, construction and arrangement of parts hereinafter described and claimed, and illustrated by way of example in the accompanying drawing, in which:

Fig. 1 is a vertical sectional view of a valve unit embodying the present invention with the valves in neutral position;

Fig. 2 is a horizontal sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary vertical sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary sectional view similar to Fig. 1 but showing the valve in an operating position;

Fig. 5 is an enlarged fragmentary sectional view of one of the valve-push rod arrangements embodying this invention.

Referring to the accompanying drawing more specifically, it is seen that the present embodiment of my invention is carried out in a 4-way hydraulic control valve having a valve body 1 provided with a main bore 2 opening at one face of the body and continued into the body to open into a cam shaft receiving bore 3 extending at right angles thereto.

Extending through the body 1 into bore 2 is a pressure fluid intake port 4 adapted to supply fluid to the valve unit from a source of supply of fluid under pressure, not shown. Leading from axially spaced points in the main bore 2 are cylinder ports 5 and 6 which provide for connection with lines, not shown, for conducting fluid to and from a hydraulic cylinder, also not shown.

Return fluid entering the bore 2 follows a course which will be hereinafter described and discharges through return ports 7 and 8, said return ports having a common passage 9 leading leading therefrom into the cam shaft bore 3. A return fluid outlet port 10 extends from the cam shaft bore 3 out through the body 1 as best seen in Fig. 1, for returning fluid to the source of supply as is well known in this art.

It is now seen that all of the ports extend a comparatively short distance and in straight lines from one surface of the body member 1 into the valve receiving bore and the cam shaft bore, thereby simplifying the machine operation and insuring an ample and unrestricted flow of fluid.

Mounted as an insert within the bore 2 is a cylindrical valve cage and seat member 11 having spaced parallel valve-receiving bores 12 and 13 extending axially therethrough. This seat member has a close working fit in bore 2 and is

subject to rotation about its major axis to adjust or regulate the valve action as will be hereinafter more fully described.

A screw plug 14 is threaded into and seals the outer end of the bore 2, there being a flanged sealing disk 15 seated in a counterbore 16 at the outer end of the seat member 11 with its flange 15' lying between and against the plug 14 and outer end of the seat member. The disk 15 is grooved to receive a compressible sealing ring 15a of circular cross section, said ring seating against the wall of the counterbore 16 as best shown in Fig. 1.

The seat member 11 is provided with an enlarged head 11a at its upper end forming a shoulder 11b seating on a shoulder 11c in the bore 2. Above the shoulder 11b is a groove 11d for a compressible sealing ring 11e seating against the wall of bore 2. Similar packing rings 11f, 11g, and 11h are provided on the remainder of the seat member 11 to insure an effective sealing action.

The bore 2 is recessed or counterbored to provide an annular space 17 into which the pressure fluid intake port 4 opens. Radial ports 18 and 19 in the seat member 11 afford communication of the port 4 and space 17 with the outer end portions of the valve bores 12 and 13 in the seat member 11 at points spaced somewhat outwardly from valve seats 24a and 25a in said bores.

The two cylinder ports 5 and 6 register with annular grooves 20 and 21 in the seat member 11, there being a port 22 through the member 11 between the groove 21 and the valve bore 12 while a similar port 23 affords communication between the groove 20 and the valve bore 13, these grooves and associated ports being between the return ports 7 and 8 and the valve seats 24a and 25a.

As here provided pressure valves 24 and 25 of the spring loaded poppet type are arranged to be pressure and spring seated against the seats 24a and 25a respectively to selectively control the flow of operating fluid through the bores 12 and 13 and cylinder ports 5 and 6.

Push rods 26 and 27 are mounted in the bores 12 and 13, for operating the valves 24 and 25 and seal the inner ends of said bores. These push rods extend into the cam shaft bore 3 so that they will ride on cams 28 and 29 on a rotary cam shaft 30, and also serve as return valves for controlling the ports 7 and 8. In this connection it is noted that the ports 7 and 8 are in the partition 31 of the member 11, as is also the passage 9 leading from said ports into the cam shaft bore 3. Communication between the return ports 7 and 8 and the ports 22 and 23 is afforded by ports 32 in the stems 33 of the pressure valves 24 and 25. Each of these stems is of such diameter, or reduced cross-section, except at the enlarged lower end 34 thereof, as to afford a free flow of fluid in the bores 12 and 13 with respect to ports 22 and 23. The enlarged ends 34 of the stems operate with a working fit in and seal the bores 12 and 13 at points between the ports 22 and 23 and the return ports 7 and 8.

The arrangement of the valve stems 33 and the push rod-valves 26 and 27 is such that when the pressure valves 24 and 25 are closed, the upper conical ends 35 of said rods will be spaced inwardly from the valve stems regardless of the adjustment of the push rods as will be apparent with reference to Figs. 1 and 5. However, when the cams 28 and 29 are operated to lift the push rods the conical ends thereof will engage in and close the inner ends of the ports 32 in the stems 33 while the stems are lifted by said rods and the pressure valves are opened, as will be hereinafter more fully described. This closing of the ports 32 in the valve stems will prevent pressure fluid flowing out through ports 32 and ports 7 and 8 before the latter are closed by said rods.

The cams 28 and 29 are constructed and arranged so that when one of them, for example cam 28, is operated to cause push rod 26 to unseat the pressure valve 24 so that operating fluid will flow through cylinder ports 22 and 6 leading from valve bore 12, said push rod will close the return ports 32 and 7 in valve bore 12, while the other cam 29 allows the push rod 27 to remain in or assume a position opening return ports 32 and 8 in valve bore 13. Thus the pressure fluid flows through the port 6 while the return fluid flows through port 5 and port 23 into valve bore 13 and out through port 32 in the valve stem of valve 25, return port 8, cam bore 3, and outlet port 10 back to the source of supply of pressure fluid. It is obvious that the turning of the cam shaft in the direction opposite that which brings the cam 28 into play will render cam 29 active and cam 28 inactive, thereby reversing the valve action and the flow as to the cylinder ports and associated valve ports.

Constituting the claimed subject matter of my hereinbefore noted copending application Serial No. 453,271 and here shown and described to clarify the operation of the valve, but not claimed, is an adjusting means wherein the valve seat member and push rods may be adjusted to regulate the speed of opening and closing of the valve members. This means takes into consideration the turning of the seat member 11 about its axis to shift the push rods with respect to the cams 28 and 29 as indicated for example by the dotted lines in Fig. 2. With reference to Fig. 3 it will be seen that shifting of the push rods in either direction will cause them to ride upward or downward on the rises 28' and 29' of the two cams thereby setting the push rods closer to or farther away from contact with the valve stems 33 and providing for a quicker or slower opening and closing action in consideration of a given degree of rotation of the cams. The adjusting means here employed includes set screws 36 and 37 mounted in screw threaded bores 38 and 39 which lead from opposite sides of the body 1 coaxially into the enlarged upper part of the bore 2 for contact with opposite sides of the seat member 11. It should be noted that the screws 36 and 37 are disposed between the two sealing rings 15a and 11e to prevent leakage. The head 11a of the seat member 11 is provided with recesses or notches 40 and 41 into which the inner ends of the set screws 36 and 37 extend. The inner ends of these set screws are rounded as at 42 and engage flat faces 40' in said recesses, which faces extend substantially at right angles to the axis of the screw, the rounded ends permitting of the necessary relative movement between the rounded ends and said flat faces when the screws are turned to turn the seat member 11 about its axis. This same rounded construction is present as at 43 at the ends of the push rods in contact with the cams to accommodate the shifting of said rods relative to the cams when the seat member is adjusted.

Lock nuts 44 are provided on the set screws

36 and 37, the outer ends of said screws having slots 45 therein for a screw driver or the like.

It should be noted that one extreme adjustment of the seat member 11 will position the inner ends of the push rods 26 and 27 upon the concentric dwells 28'' and 29'' of the cams 28 and 29, with said rods in the position shown in full lines in Fig. 5, fully opening the return ports 7 and 8 and spacing the outer ends of the push rods the maximum distance from the valve stem and requiring maximum movement of the operating means to open and close the valves. With the ports 7 and 8 fully open the piston of the hydraulic cylinder controlled by the valve assembly may be freely moved back and forth inasmuch as the fluid return lines throughout the system to opposite ends of the cylinder are open when ports 7 and 8 are open.

From the aforementioned extreme adjustment the seat member 11 may be turned to move the push rods into various elevations on the rises 28' and 29' of the cams thus setting the push rods to effect an opening and closing of the valve responsive to different degrees of movement of the operating means and also variously throttling the ports 7 and 8 so that the flow of return fluid may be retarded and the free movement of the piston likewise retarded over an appreciable range of adjustment.

The maximum outwardly adjusted position of the push rods as effected by turning the seat member 11 is indicated by the intermedially dotted lines in Fig. 5 at which time the rods close return ports 7 and 8 to effect a hydraulic locking of the piston and have the minimum spacing from the valve stems so that but a small movement of the cams and associated operated means will effect the opening and closing of the valves. Fig. 5 indicates the practicable limits of adjustment of the push rods as may be effected by the turning of the seat member 11.

When the cam shaft is turned to effect an operation of the valves one of the cams will lift its associated push rod and pressure valve, the lifted push rod then closing the associated return port, while the other cam will allow the other push rod to lower to a position opening the associated return port regardless of the said push rods being set in any position between the limits of their adjustments as effected by the turning of the seat member 11. Thus even if the push rods are set to close both return ports 7 and 8 while both of the pressure valves are closed, when either rod is actuated to open a pressure valve the other rod will be lowered by its associated cam to a position opening associated return port. If the push rods are set to rest on the dwells 28'' and 29'' then on a cam effected operation of one rod the other will remain on said dwell in position opening the associated return port.

While I have shown and described a specific embodiment of my invention I do not limit myself to the exact details of construction set forth, and the invention embraces such changes, modifications and equivalents of the parts and their formation and arrangement as come within the purview of the appended claims.

I claim:

1. In a hydraulic control valve unit, a valve unit body having a cam shaft bore and a main bore which latter opens at its outer end on an outer surface of said body and at its inner end into said cam shaft bore, a valve cage member mounted in said main bore and having separate valve-receiving bores extending therethrough, sealing means for the outer end of said main bore, a valve seat intermediate the ends of each of said valve receiving bores, intake ports in said body and cage member opening into the valve receiving bores between said seats and the outer ends of said valve-receiving bores, valves adapted to seat on said seats, other ports for intaking and discharging fluid opening into said valve-receiving bores between the inner ends of the latter and the valve seats therein, stems on said valves extending past said other ports and being for the most part of such smaller diameter than the valve-receiving bores as to afford a passage in the latter between said other ports and said valve seats, enlargements on the inner ends of said stems having a working fit in and closing the said valve-receiving bores at points between the inner ends thereof and said other ports therein, discharge ports extending through said stems and said enlargements for discharging fluid through the enlargements into the inner end portion of said valve-receiving bores, other discharge ports leading from said inner end portions of said valve-receiving bores into said cam shaft bore, a fluid outlet port leading from said cam shaft bore to an outer surface of said body, push rods slidable in the inner end portions of said valve-receiving bores into and out of position closing said other discharge ports, valve members on said push rods adapted to be moved into and out of engagement with said enlargements to lift the said valves from their seats and at the same time close the discharge ports in said enlargements, a cam shaft in the bore therefor, and cams on said shaft for operating said push rods.

2. In a hydraulic control valve unit, a valve unit body having a cam shaft bore and a main bore which latter opens at its outer end on an outer surface of said body and at its inner end into said cam shaft bore, a valve cage member mounted in said main bore and having separate valve-receiving bores extending therethrough, sealing means for the outer end of said main bore, a valve seat intermediate the ends of each of said valve-receiving bores, intake ports in said body and cage member opening into the valve-receiving bores between said seats and the outer ends of said valve-receiving bores, valves adapted to seat on said seats, other ports for intaking and discharging fluid opening into said valve-receiving bores between the inner ends of the latter and the valve seats therein, stems on said valves extending past said other ports and being for the most part of such smaller diameter than the valve-receiving bores as to afford a passage in the latter between said other ports and said valve seats, enlargements on the inner ends of said stems having a working fit in and closing said valve-receiving bores at points between the inner ends thereof and said other ports therein, discharge ports extending through said stems and said enlargements for discharging fluid through the enlargements into the inner end portions of said valve-receiving bores, other discharge means including ports and leading from said inner end portions of said valve-receiving bores to an outer surface of said body, push rods slidable in the inner end portions of said valve-receiving bores into and out of position closing said ports of said other discharge means, valve members on said push rods adapted to be moved into and out of engagement with said enlargements to lift the said valves from their seats and at the same time close the discharge ports in said enlarge-

ments, a cam shaft in the bore therefor, and cams on said shaft for operating said push rods.

3. In a hydraulic control valve, a member having a bore therein, a valve seat intermediate the ends of said bore, a valve member within said bore having a stem with an annular passage therearound, said bore forming the outer wall of said passage, said stem carrying at one end a valve to seat on said seat and at its opposite end a head having a working fit in said bore, there being a port extending axially through said head and into said stem and opening out laterally therefrom into said annular passage, a push rod having a working fit within said bore and continuously closing the part of the bore which it occupies, means to operate said push rod initially to close said port through said head and at times by a farther movement to effect in addition a movement of the aforesaid valve away from its seat, a port communicating with said bore at one side of the aforesaid valve seat therein, a port located at the opposite side of said valve seat and at all times communicating with the aforesaid annular passage through its outer wall, and a port leading into said bore at a point which is at all times located at that side of the aforesaid head which is farthest from the aforesaid valve stem, the latter port being at times open and at other times closed by said push rod as it moves into engagement with said head.

4. In a hydraulic control valve, a valve cage means provided with a pair of bores, a valve unit in each of said bores, a valve seat intermediate the ends of each bore, a valve member within said bore having a stem with an annular passage therearound, said bore forming the outer wall of said passage, said stem carrying at one end a valve to seat on said seat and at its opposite end a head having a working fit in said bore, there being a port extending axially through said head and into said stem and opening out laterally therefrom into said annular passage, a push rod having a working fit within said bore and continuously closing the part of the bore which it occupies, means to operate said push rod initially to close said port through said head and at times by a farther movement to effect in addition a movement of the aforesaid valve away from its seat, a port communicating with said bore at one side of the aforesaid valve seat therein, a port located at the opposite side of said valve seat and at all times communicating with the aforesaid annular passage through its outer wall, a port leading into said bore at a point which is at all times located at that side of the aforesaid head which is farthest from the aforesaid valve stem, the latter port being at times open and at other times closed by said push rod as it moves into engagement with said head, and means to mechanically operate said push rods through a cycle of movements according to which when each of the first recited valves are closed the push rod which cooperates therewith remains in a spaced relation thereto, such push rod, at the times when it moves into contact with the head moving farther in the same direction and opening the valve at the opposite end of the valve stem.

5. In a hydraulic control valve unit, a valve unit body having a cam shaft bore and a main bore which latter opens at its outer end on an outer surface of said body and at its inner end into said cam shaft bore, a valve cage member mounted in said main bore and having separate valve-receiving bores extending therethrough, a valve seat intermediate the ends of each of said valve-receiving bores, intake means whereby fluid under pressure is admitted to said valve-receiving bores between said seats and the outer ends of said valve-receiving bores, the outer end portions of said valve-receiving bores being otherwise closed to confine the fluid pressure admitted to them by said intake means, valves positioned to seat on said seats, ports for intaking and discharging fluid opening into said valve-receiving bores between the inner ends of the latter and the valve seats therein, stems on said valves extending past said ports, portions of said stems being of reduced cross section between their end portions so as to afford passages in said valve-receiving bores between said ports and valve seats, enlargements on the inner ends of said stems having a working fit in and closing said valve-receiving bores at points between the inner ends thereof and said ports therein, discharge ports extending through said stems and said enlargements for discharging fluid through the enlargements into the inner end portions of said valve-receiving bores, other discharge means including ports and leading from said inner end portions of said valve-receiving bores to an outer surface of said body, push rods slidable in the inner end portions of said valve-receiving bores into and out of position closing said ports of said other discharge means, valve members on said push rods adapted to be moved into and out of engagement with said enlargements to lift the said valves from their seats and at the same time close the discharge ports in said enlargements, a cam shaft in the bore therefor, and cams on said shaft for operating said push rods.

6. In a hydraulic control valve, a member having a valve-receiving bore therein, a valve seat intermediate the ends of said bore, a pressure fluid intake port opening into said bore on one side of said seat, a fluid ingress and egress port opening into said bore on the other side of said seat, a return fluid port opening into said bore between the inner end thereof and the fluid ingress and egress port, a pressure valve arranged to seat on said seat, a valve stem on said pressure valve, an enlargement on the inner end of said stem having a working fit within the portion of the bore between said ingress and egress port and said return fluid port, a port through said enlargement, there being a space alongside said stem between it and the wall of said bore, the latter port communicating with said space to allow fluid admitted under pressure at times to pass from said fluid ingress and egress port and thence along a portion of said stem and through said enlargement thereof to said fluid return port, a push rod slidable in said bore to engage said enlargement and unseat said pressure valve, there being a valve portion on said push rod to close said port through said enlargement and said return port respectively when said pressure valve is unseated and opening such ports when said pressure valve is seated; and means to actuate said push rod.

7. The subject matter of claim 6, and the valve portion on said push rod for closing the port in said enlargement being of conical form and projecting toward said enlargement.

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