June 8, 1943. J. B. VAN DER WERFF 2,321,267

HYDRAULIC ACTUATOR FOR HYDRAULIC CONTROL VALVES

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FIG. 2.

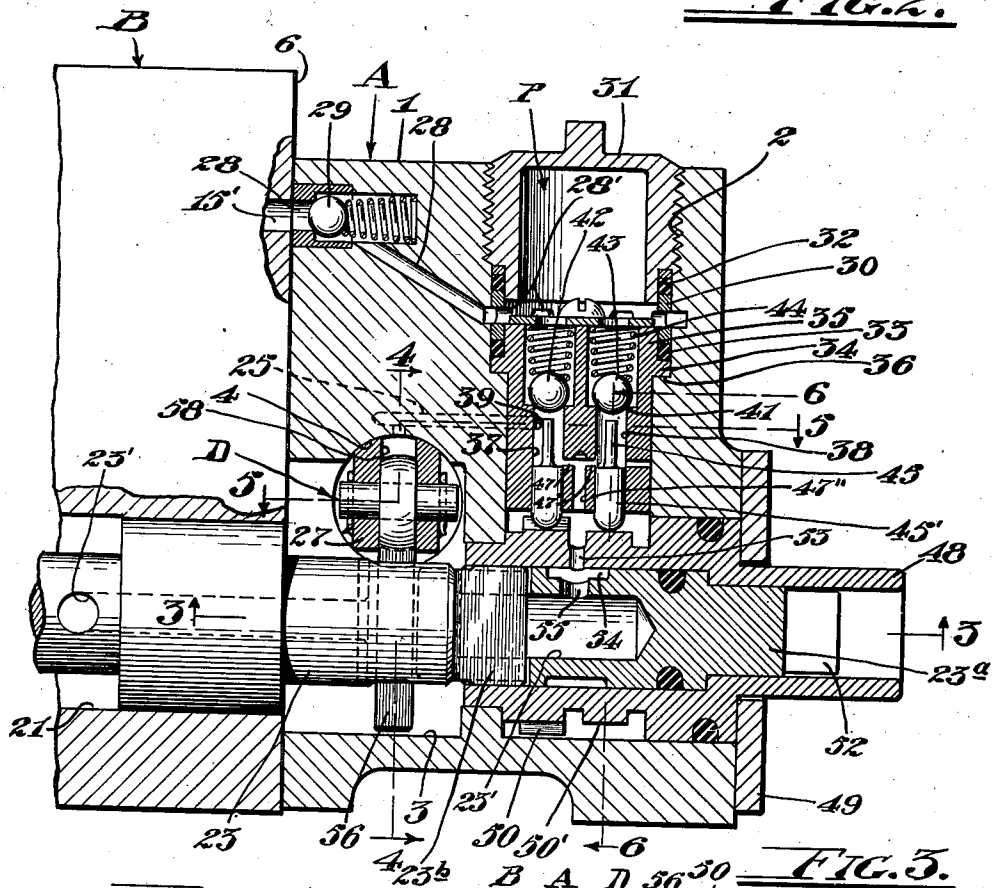


FIG. 1.

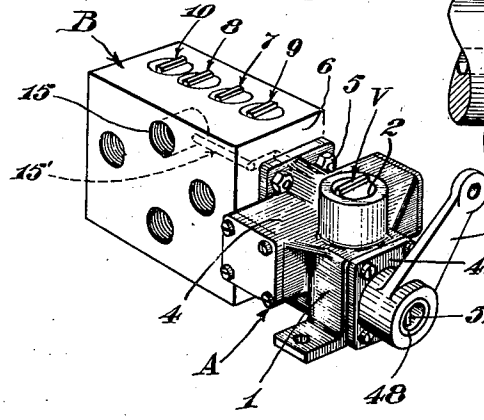
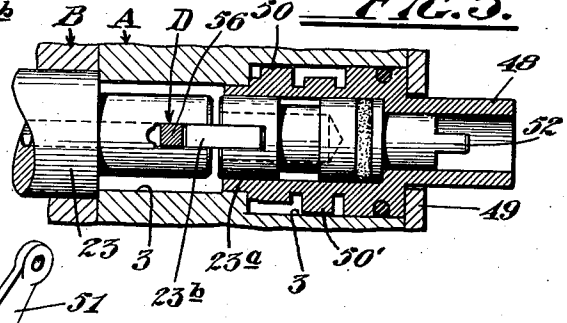


FIG. 3.



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HYDRAULIC ACTUATOR FOR HYDRAULIC CONTROL VALVES

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FIG. 4.

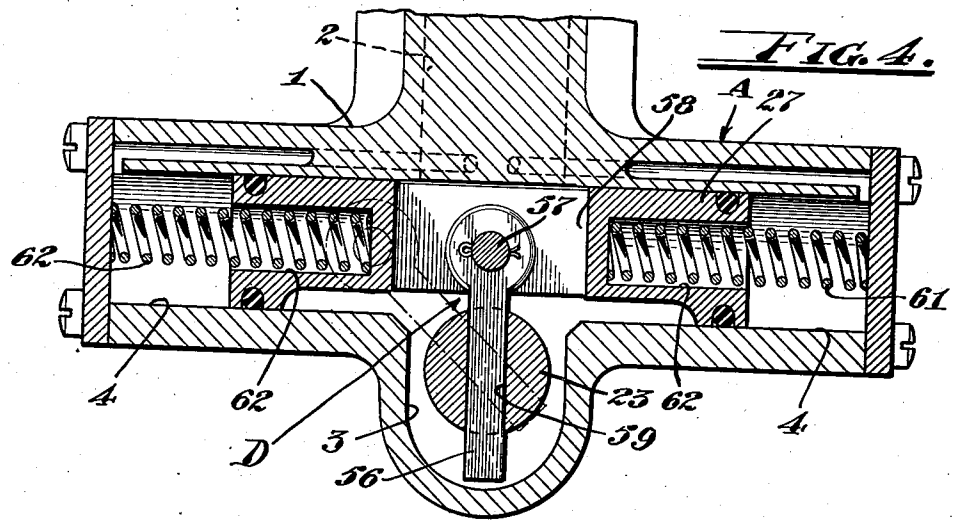


FIG. 5.

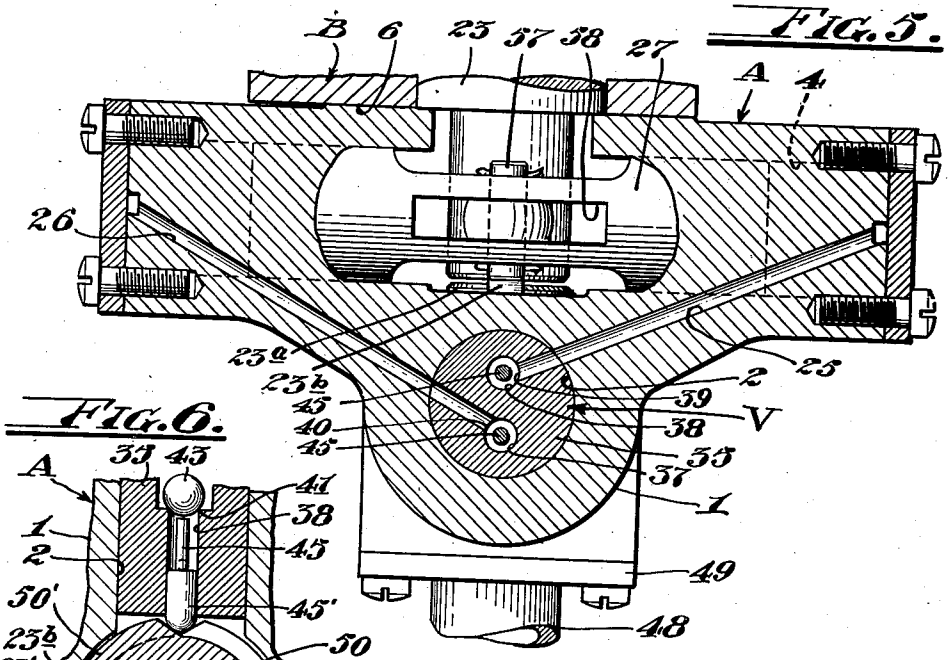
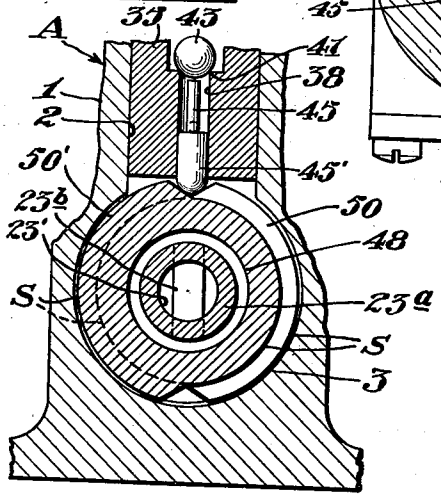


FIG. 6.



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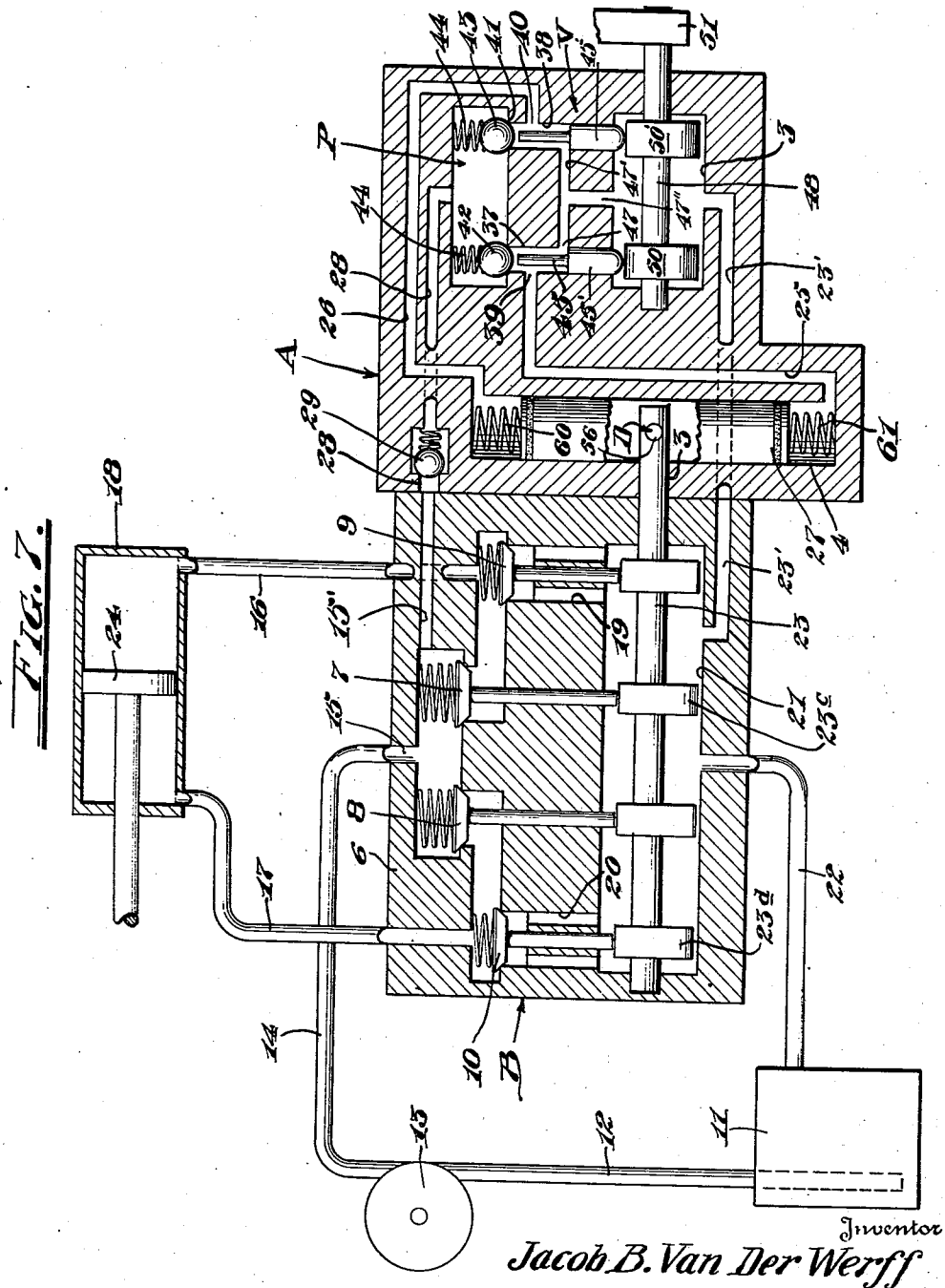


Fig. 1.

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UNITED STATES PATENT OFFICE

2,321,267

HYDRAULIC ACTUATOR FOR HYDRAULIC CONTROL VALVES

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Application July 6, 1942, Serial No. 449,898

10 Claims. (Cl. 137—139)

My invention relates to and has for its primary object the provision of a novel and highly efficient hydraulic actuator or servo-motor for effecting a dependable and precise power operation of a control valve in a high pressure hydraulic system of an airplane so that objectionable handle and operating loads encountered in the manual operation of such valves are eliminated.

Another object of my invention is to provide a hydraulic actuator of the character described which is subject to a convenient and advantageous mounting on the body member of the selective control valve, and supplied with operating fluid from said body member without requiring the use of external conduits, thereby making it possible to minimize weight, size and bulk and the number of parts in a servo motor-actuated control valve in a manner highly essential to aircraft efficiency.

Another object of my invention is to provide a novel combination of a hydraulic control valve and a hydraulic actuator therefor, wherein such units are associated with one another to provide the objects and advantages herein set forth and make it unnecessary to modify the construction of the control valve except as to the extension to surfaces of said body of the operating fluid intake port and the fluid return port thereof for communication with corresponding ports in the actuator.

Another object of my invention is to provide an actuator of the character described in which the operating handle need be given but a small amount of movement to operate the actuator to effect a full operation of the control valve, this small movement of the operating handle being considerably less than that required with a manually actuated control valve and making for a quicker control valve operation and reducing the time, attention and effort otherwise required of the pilot of the airplane.

A further object of my invention is to provide an actuator of the character described which, when the operating handle thereof is returned to neutral, will automatically return the motor parts of the actuator and the control valve to neutral position.

A further object of my invention is to provide an actuator such as described which is constructed and arranged so that the operating shaft of the control valve operated thereby is readily accessible for and subject to emergency manual operation and serves as an indicator or tell-tale signal as to the operation of the control valve.

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 the parts hereinafter described and claimed, and illustrated by way of example in the accompanying drawings, in which:

Fig. 1 is a perspective view of a valve actuator embodying my invention and shown as when connected with a hydraulic control valve;

Fig. 2 is an enlarged fragmentary vertical sectional view of the control valve actuator unit shown in Fig. 1;

Fig. 3 is a fragmentary horizontal sectional view taken on the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary vertical sectional view taken on the line 4—4 of Fig. 2;

Fig. 5 is a fragmentary horizontal sectional view taken on the line 5—5 of Fig. 2;

Fig. 6 is a fragmentary vertical sectional view taken on the line 6—6 of Fig. 2;

Fig. 7 is a diagrammatic view of a typical hydraulic system including the control valve-actuator unit of my invention.

Referring to the accompanying drawings more specifically, it is to be understood that although the hydraulic actuator A of my invention is subject to many and varied uses, it is especially well suited for operating a hydraulic control valve such as the one B shown in Figs. 1 and 2, in a high pressure hydraulic system of an airplane as shown for example in Fig. 7.

As here provided the actuator includes a body member 1 having a valve receiving bore 2 extending part of the way therethrough, a cam shaft receiving bore 3 extending through the body member at right angles to and intersecting the bore 2, and a cylinder portion 4 which intersects and extends at right angles to the shaft bore 3.

As shown in Fig. 1, the body member 1 is bolted as at 5 onto the body 6 of the control valve B which, as shown in Fig. 7, includes the usual pressure valves 7 and 8 of the poppet type, and similar return valves 9 and 10.

With reference to Fig. 7, a typical hydraulic system includes a fluid reservoir 11, a line 12 leading therefrom to a pump 13, a pressure line 14 leading from the pump to the pressure intake chamber or port 15 in the body 6 of the unit B, cylinder lines 16 and 17 leading from said intake chamber to opposite ends of a cylin-

der 18 and controlled by the valves 7 and 8; fluid return ports 19 and 20 controlled by the valves 9 and 10 and leading into the cam shaft bore 21, and a return line 22 leading from bore 21 back to the reservoir 11. A cam shaft 23 in the bore 21 is selectively operated to simultaneously lift a selected pressure valve and its associated return valve as is the common practice, in order to extend and retract the piston 24 in the cylinder 18, as the case may be.

With the extremely high operating pressures used in hydraulic systems in airplanes and in other instances where the valves are large, the handle or operating load is so great as to make it difficult, if not in some cases impracticable, to rely on manual operation of the control valves. For this reason the hydraulic actuator of my invention is designed to operate such valves without the objections above recited.

To adapt the control valve B for operation by the actuator of my invention the intake port or chamber 15 thereof is extended as at 15' to open at the side of the valve body 6 to which the body member 1 of the actuator is secured, whereby to supply the operating fluid to the actuator. The return fluid passes from the actuator into the cam shaft bore 21 of the control valve B through a passage 23' in the cam shaft 23 and an extension 23a thereof. The shaft 23 is received in the shaft bore 3 in the actuator body member 1, and is adapted to be turned by the actuator as will be hereinafter described, and provides for the return of the operating fluid from the actuator to the aforesaid fluid return line.

In the actuator hereof is a manually operable valve means V for controlling the flow of operating fluid through cylinder ports 25 and 26 therein which lead to opposite ends of the cylinder 4 for operating the piston 27. A drive means D operatively connects the piston 27 with the control valve cam shaft for operating the latter when the piston is reciprocated, thereby hydraulically effecting the operation of the control valve responsive to an easily effected manual operation of the valve means V.

As shown in Fig. 2 the body 1 of the actuator is provided with an operating fluid intake port 28 for registration with the extension 15' of the pressure port of the control valve B, a check valve 29 being provided in the intake port to prevent back flow into the control valve. The inner end of the port 28 opens into ports 28' in a ring spacer 30 mounted in the valve receiving bore 2.

It should be noted that the intake port 28 and the bore 3 open through the same surface or side of the body member 1 to facilitate the attachment of the actuator to the control valve, the shaft 23 and its extension 23a in the bore 3 having the return passage 23' therein and therefore making it unnecessary to provide a return port through said surface. Moreover, the single bore 3 accommodates the concentric cam shafts for the actuator and the control valve respectively, also the drive means between the actuator piston and the cam shaft.

A screw plug 31 closes the outer end of the bore 2 and holds sealing rings 32 between it and the spacer ring 30. Similar sealing rings 33 are interposed between the spacer ring and an annular flange 34 on a valve cage 35 seated tightly fitted in the bore 2. The valve cage flange 34 rests on a shoulder 36 in the bore 2 so that the cage is securely held in place intermediate the ends of said bore to provide a pressure chamber P in the space between the plug 31 and outer end of the cage, said chamber being supplied with operating fluid from ports 28 and 28'.

As shown in Fig. 2, the valve cage is provided with spaced parallel valve bores 37 and 38 extending longitudinally therethrough to afford communication between the pressure chamber P and the cylinder ports 25 and 26 which latter terminate in ports 39 and 40 at points intermediate the ends of said bores. The lower ends of the bores 37 and 38 open into the shaft bore 3 of the actuator.

At points between the outer ends of the bores 37 and 38 and the ports 39 and 40 are seats 41 for ball poppet valves 42 and 43 held seated by suitable spring means 44.

Operating in the bores 37 and 38 between the valve seats 41 and the inner ends of said bores are push rods 45 the outer ends of which are disposed to engage the ball valves. These rods have enlarged piston-like portions 45' which serve as valve members with respect to fluid return ports 47 and 47' in the valve bores 37 and 38, the ports 47 and 47' having a common passage 47'' opening at the inner end of the valve receiving bore 2.

A tubular cam shaft 48 is rotatable in the bore 3 and telescopes the extension 23a of the cam shaft 23 of the control valve, being held in place by a removable plate 49. The extension 23a is keyed to the shaft 23 as at 23b. Cams 50 and 50' on the shaft 48 are provided to selectively operate the push rods 45 as shown in Figs. 2 and 5 dependent on the direction or rotation of the cam shaft. For this purpose the outer end of the shaft 48 is provided with an operating crank arm or handle 51 as shown in Fig. 1.

It should be noted that the outer end of the cam shaft extension 23a is provided with a flattened extension or lug 52 for a wrench or similar tool, not shown, and which may be employed for effecting an emergency operation of the control valve, if necessary. The lug 52 is visible in the outer end of the tubular cam shaft 48 and serves as a tell-tale signal or indicator by its position to show the operation of the control valve.

The actuator shaft 48 is provided with apertures 53 communicating with a recess 54 and apertures 55 in the shaft extension 23a whereby fluid returned through the passage 47'' may flow into the return passage 23' formed in the extension 23a and the shaft 23 proper. As shown in Fig. 6 the key 23b is smaller than passage 23' and does not prevent the flow in said passage between the shaft sections.

The drive means D between the piston 27 and cam shaft 23 includes a drive pin 56 pivoted at one end on a pivot pin 57 mounted in a recess 58 in the piston slidably engaged in an opening 59 extending transversely through the shaft 23. When the piston moves, the drive pin 56 swings on the pivot 57 and like a crank arm, turns the cam shaft 23, said pin sliding in the opening 59 in said shaft while turning the shaft, as will be apparent with reference to Fig. 3.

Springs 60 and 61 engaged in sockets 62 in the ends of the piston and against the cylinder ends, operate to return the piston and associated parts to neutral position.

Operation

In the operation of the actuator, for example in a system as shown in Fig. 7, and assuming it is desired to move the piston 24 in cylinder 18 to the left, the operator moves the actuator crank

arm 51 to the left thereby rotating the cam shaft 48 so that cam 50 thereon will move the push rod 45 to unseat the ball 42 and close the return port 47. The other cam 50' is inoperative to actuate the push rod 45 for valve 43 during the above noted operation. The pressure fluid is now effective to shift the actuator piston 27 through open valve 42, bore 37, passage 25, and one end of cylinder 4 (lower end in Fig. 7). The fluid between the piston 27 and other end of the cylinder returns through the other cylinder passage 26, the then open return port 47' in valve bore 38, passage 47'', apertures 53 and 55 (Fig. 2), return passage 23' in the shaft 23, bore 21, and then into the return line 22.

As the piston 27 is thus moved, it rocks the drive pin 56 so that the cam shaft 23 is turned and the cams 23c and 23d for the pressure and return valves 7 and 10 respectively will simultaneously open said valves. Operating pressure is now effective in cylinder line 16 and the right end of the cylinders 18 to move the piston 24 to the left, whereas return fluid from the other end of the cylinder passes through the other cylinder line 17, the then open valve 10, into the shaft bore 21 and out through the return line 22 of the system.

After the actuator has operated the control valve, the handle or crank arm is returned to neutral (upright) position, thereby closing the valve 42 and opening the return port 47 in the valve bore 37. On the opening of the return port 47, it is seen that both ends of the cylinder 4 are connected to the return side of the system and the spring 60 then operates to return the piston 27 to neutral position as shown in Fig. 3, thereby also returning the control valve to neutral position.

To move the piston 24 to the right, the crank arm or handle 51 is moved to the right and turns the crank shaft 48 so that cam 50' will lift the valve 43 and cause the push rod thereof to close return port 47' in the valve bore 38. Pressure fluid now flows from chamber P, valve bore 38, passage 26 to the upper end (Fig. 7) of the cylinder 4 to move the piston 27 (downwardly) (in Fig. 7). Fluid returns from the lower end of the cylinder through the passage 25, then open return port 47, passage 47'', cam shaft bore 3, passages in shafts 48 and 23 to the cam shaft bore 21 in the control valve and into return 22 of the system.

This movement of the actuator piston causes the drive pin 56 to rock the cam shaft 23 so that the other pressure and return valves 8 and 9 respectively will be simultaneously opened. When thus opened these valves cause the pressure fluid to flow so as to move the piston 24 to the right as will be apparent with reference to Fig. 7. The operator returns the crank arm 51 to neutral and the valve 43 now closes and the port 47' is opened whereupon the spring 61 operates to return the piston 27 and the control valve to neutral.

It should be noted that but a small amount of movement of the cams, for example fifteen degrees of arc, is required to open one of the servo-unit valves and that thereafter the operating handle may be moved through say at least 140 degrees of arc while the cam continues to hold the valve open. This is provided for by means of the comparatively long concentric cam surfaces S as seen in Fig. 6. Thus the operating means may be employed for any other desired control function following the initial fifteen degrees of movement of the cams, it only being necessary to mechanically couple the cams or the shaft or handle to the mechanism or other device which it is desired to operate following the opening of the servo-unit valves.

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 actuator for a hydraulic control valve having fluid intake and return passages, valves for controlling the flow of operating fluid to and from a fluid responsive motor, and valve operating means including a rotary shaft; the improvement which includes a body member having a fluid intake port and a fluid return port and adapted for attachment to said control valve to establish communication between said ports in said body member and said passages in said control valve, a cylinder associated with said body member, a reciprocable piston in said cylinder, a drive means operated by said piston for turning the shaft of said control valve, and manually operable valve means in said body member for controlling the flow of operating fluid to and from said cylinder for operating said drive means.

2. In a hydraulic actuator for a hydraulic control valve having fluid intake and return passages, valves for controlling the flow of operating fluid to and from a fluid responsive motor, and valve operating means including a rotary shaft; the improvement which includes a body member having a fluid intake port and a fluid return port and adapted for attachment to said control valve to establish communication between said ports in said body member and said passages in said control valve, a cylinder associated with said body member a reciprocable piston in said cylinder, a drive means operated by said piston for turning the shaft of said control valve, manually operable valve means in said body member for controlling the flow of operating fluid to and from said cylinder for operating said drive means, and spring means for returning said piston to neutral position.

3. In a hydraulic actuator for a hydraulic control valve unit having fluid intake and return passages, control valves and a means including a rotary shaft for selectively operating said valves; the improvement which includes: a body member attachable to said control valve unit and having a fluid intake port and a fluid return port adapted to register with said fluid intake passage and said fluid return passage, respectively, a cylinder portion in said body member, a fluid responsive piston reciprocable in said cylinder portion, cylinder passages for connecting said intake and return ports with opposite ends of said cylinder, selectively operable valve means for controlling the flow of fluid through said cylinder passages, and a drive means for rotating the valve operating shaft of said control valve unit responsive to movement of said piston.

4. In a hydraulic actuator for a hydraulic control valve unit having fluid intake and return passages, control valves and a means including a rotary shaft for selectively operating said valves; the improvement which includes: a body member attachable to said control valve unit and having a fluid intake port and a fluid return

port adapted to register with said fluid intake passage and said fluid return passage respectively, a cylinder portion in said body member, a fluid responsive piston reciprocable in said cylinder portion, cylinder passages for connecting said intake and return ports with opposite ends of said cylinder, selectively operable valve means for controlling the flow of fluid through said cylinder passages, a drive means for rotating the valve operating shaft of said control valve unit responsive to movement of said piston, and means affording access through said body member to said control valve shaft whereby the control valve may be manually operated.

5. In a hydraulic actuator for a hydraulic control valve unit having fluid intake and return passages, control valves and a means including a rotary shaft for selectively operating said valves; the improvement which includes: a body member attachable to said control valve unit and having a fluid intake port and a fluid return port adapted to register with said fluid intake passage and said fluid return passage respectively, a cylinder portion in said body member, a fluid responsive piston reciprocable in said cylinder portion, cylinder passages for connecting said intake and return ports with opposite ends of said cylinder, selectively operable valve means for controlling the flow of fluid through said cylinder passages, a drive means for rotating the valve operating shaft of said control valve unit responsive to movement of said piston, said selectively operable valve means including a tubular cam shaft adapted to telescope the shaft for the control valve so that access may be had to the control valve shaft for manual operation thereof, cams on said cam shaft, valves responsive to said cams, and an operating handle on said cam shaft.

6. In a hydraulic actuator for a hydraulic control valve, a body member having an intake port opening on one surface of said body member, and a cam shaft bore extended through said one surface, said intake port and said cam shaft bore being arranged to register with an intake port and an operating shaft bore respectively of the control valve, a cylinder in said body member in part opening into the said cam shaft bore, a reciprocable piston in said cylinder, a valve-receiving bore formed in said body member and opening into said cam shaft bore, a fluid passage leading from said intake port into said valve-receiving bore, cylinder passages leading from opposite ends of said cylinder to said valve-receiving bore, a fluid return passage leading from said valve-receiving bore into said cam shaft bore, a cam shaft in said cam shaft bore constructed for conducting return fluid into the operating shaft bore, valve means in said valve-receiving bore for controlling the flow of operating and return fluid relative to said cylinder, a drive means in said cam shaft bore actuated by said piston and adapted to be connected in said cam shaft bore with the operating shaft of said control valve, cams on said cam shaft for actuating said valve means, and means for turning said cam shaft.

7. In a hydraulic actuator for a hydraulic control valve, a body member having an intake port opening on one surface of said body member, and a cam shaft bore extended through said one surface, said intake port and said cam shaft bore being arranged to register with an intake port and an operating shaft bore respectively of the control valve, a cylinder in said body member in part opening into the said cam shaft bore, a reciprocable piston in said cylinder, a valve-receiving bore formed in said body member and opening into said cam shaft bore, a fluid passage leading from said intake port into said valve-receiving bore, cylinder passages leading from opposite ends of said cylinder to said valve-receiving bore, a fluid return passage leading from said valve-receiving bore into said cam shaft bore, a cam shaft in said cam shaft bore constructed for conducting return fluid into the operating shaft bore, valve means in said valve-receiving bore for controlling the flow of operating and return fluid relative to said cylinder, a drive means in said cam shaft bore actuated by said piston and adapted to be connected in said cam shaft bore with the operating shaft of said control valve, cams on said cam shaft for actuating said valve means, and means for turning said cam shaft, said valve means including sectional valve members arranged so that when one section of one valve is opened to permit the flow of operating fluid to one end of the cylinder the other section of said one valve shuts off communication of one cylinder passage with the return passage, while the other sectional valve remains in position with one section thereof closing the other cylinder passage to the operating fluid and the other section thereof opening said other cylinder passage to said return passage.

8. In a hydraulic actuator for a hydraulic control valve, a body member having an intake port and a cam shaft bore, said intake port and said cam shaft bore being arranged to register with an intake port and an operating shaft bore respectively of the control valve, a cylinder in said body member, a reciprocable piston in said cylinder, a valve-receiving bore formed in said body member and opening into said cam shaft bore, a fluid passage leading from said intake port into said valve-receiving bore, cylinder passages leading from opposite ends of said cylinder to said valve-receiving bore, a fluid return passage leading from said valve-receiving bore into said came shaft bore, a cam shaft in said cam shaft bore constructed for conducting return fluid into the operating shaft bore, valve means in said valve-receiving bore for controlling the flow of operating and return fluid relative to said cylinder, a drive means actuated by said piston and adapted to be connected with the operating shaft of said control valve, cams on said cam shaft for actuating said valve means, and means for turning said cam shaft, said valve means including sectional valve members arranged so that when one section of one valve is opened to permit the flow of operating fluid to one end of the cylinder the other section of said one valve shuts off communication of one cylinder passage with the return passage, while the other sectional valve remains in position with one section thereof closing the other cylinder passage to the operating fluid and the other section thereof opening said other cylinder passage to said return passage.

9. In a hydraulic actuator for a hydraulic control valve, a body member having an intake port and a cam shaft bore, said intake port and said cam shaft bore being arranged to register with an intake port and an operating shaft bore respectively of the control valve, a cylinder in said body member, a reciprocable piston in said cylinder, a valve-receiving bore formed in said body member and opening into said cam shaft

bore, a fluid passage leading from said intake port into said valve-receiving bore, cylinder passages leading from opposite ends of said cylinder to said valve-receiving bore, a fluid return passage leading from said valve-receiving bore into said cam shaft in said cam shaft bore constructed for conducting return fluid into the operating shaft bore, valve means in said valve-receiving bore for controlling the flow of operating and return fluid relative to said cylinder, a drive means actuated by said piston and adapted to be connected with the operating shaft of said control valve, cams on said cam shaft for actuating said valve means, and means for turning said cam shaft.

10. In a hydraulic control valve, a valve body member having a fluid intake port, a cam shaft bore and valve-receiving bores in communication with said intake port and extending into said cam shaft bore, cylinder ports leading from said valve-receiving bores through said body for conveying fluid to and from a hydraulic cylinder, valve seats in said valve-receiving bores between said cylinder ports and said intake port, pressure valves cooperating with said seats to control the flow of fluid from the intake port out through the valve bores and said cylinder ports, push rods operable in the valve receiving-bores to open and close said pressure valves, portions on said push rod shutting off communication of the inner ends of said valve receiving bores with said cam shaft bore, return ports leading from points in said valve receiving bores between the closed inner ends of the valve receiving bores and said valve seats to said cam shaft bore, a return fluid outlet leading from said cam shaft bore, said portions of said push rods acting as return valves to control said return ports, a cam shaft operable in said cam shaft bore; and cam means on said shaft for engaging and operating said push rods.

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