

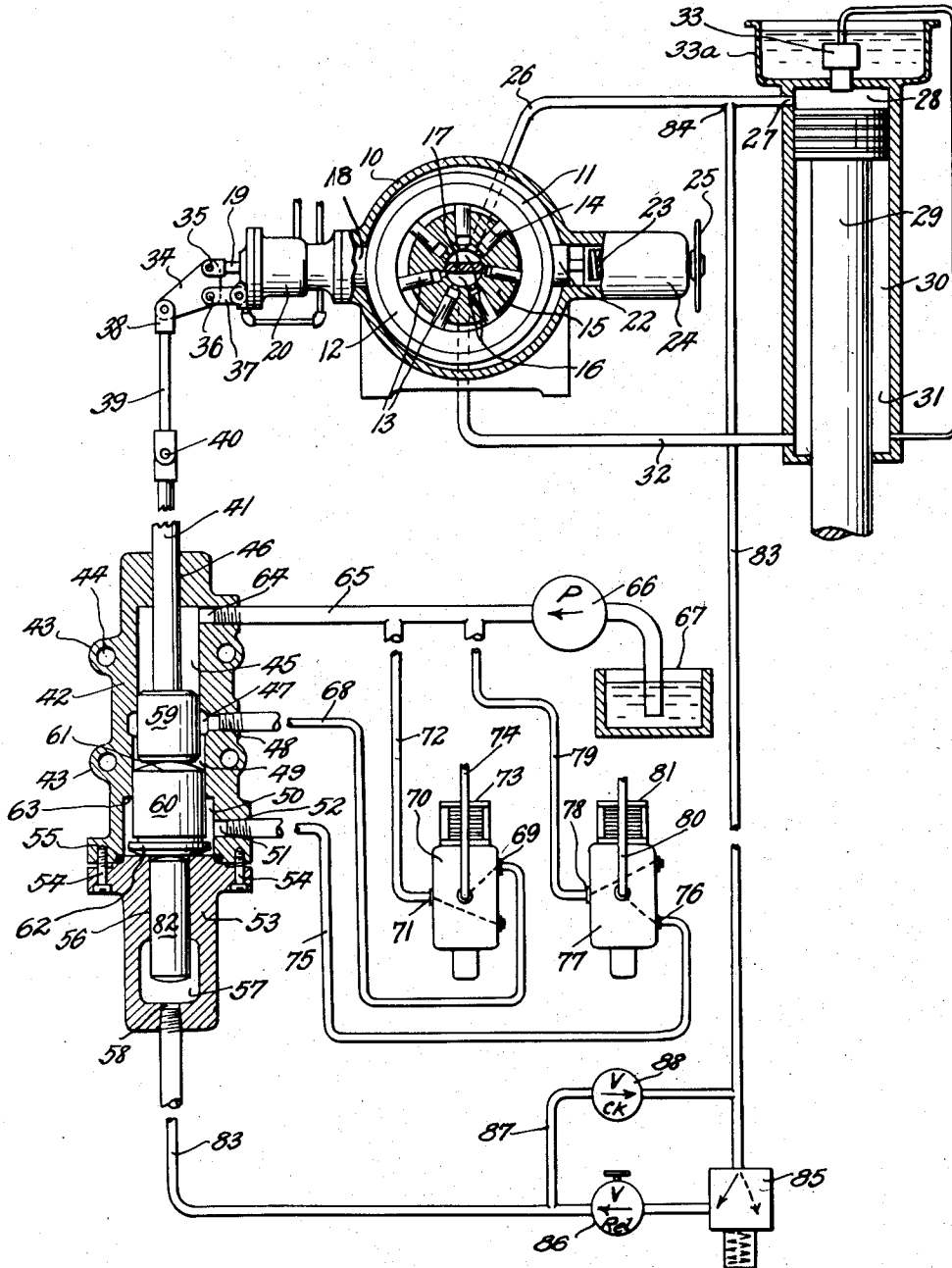
Aug. 11, 1953

W. R. TUCKER ET AL

2,648,312

CONTROL OPERATOR FOR HYDRAULIC PUMPS

Filed Nov. 28, 1951



INVENTORS

Warren R. Tucker
Glenn R. Pittman

BY *W. D. McLowell*

ATTORNEY

UNITED STATES PATENT OFFICE

2,648,312

CONTROL OPERATOR FOR HYDRAULIC PUMPS

Warren R. Tucker and Glen Richard Pittman,
Mount Gilead, Ohio, assignors to H-P-M De-
velopment Corporation, Mount Gilead, Ohio, a
corporation of Delaware

Application November 28, 1951, Serial No. 258,708

1 Claim. (Cl. 121—38)

1

The present invention relates generally to fluid-actuated pumps or motors, and more specifically to an improved fluid pressure-responsive control or operator for hydraulic pumps.

In the past, it has been common practice to employ in connection with hydraulic pumps a servo-motor control comprising one or more fluid-pressure-responsive piston areas arranged to shift the flow-controlling member of the pump between various concentric and eccentric positions with respect to the primary rotor of the pump and thereby to vary the stroke of the pumping pistons and the consequent volumetric output of the pump. Ordinarily, the piston stages of the servo-motor control are arranged so as to shift the flow-controlling member of a pump between desired positions providing for full volumetric flow of fluid in either direction, in the case of reversible variable delivery pumps, and to a neutral or no-delivery position, wherein the flow-controlling member occupies a substantially concentric position with reference to the rotor of the pump. Various automatic control systems have been employed to exert fluid pressure upon the piston stages of a servo-motor control in accordance with varying positions of a ram or motor under control of the pump, or in accordance with variations in pressure at given points within the hydraulic system actuated by the pump.

It follows, therefore, that the primary object of the present invention is to provide an improved hydraulic control operator arranged to be connected with the usual servo-motor controls of an hydraulic pump, and which functions both selectively and automatically to control the volumetric output of the pump.

It is another object of the invention to provide a remote hydraulic control operator which may be selectively operated from a relatively low pressure pilot system, independent of the main hydraulic system of the pump to be controlled, and which also incorporates means automatically responsive to pressure conditions within the main hydraulic system for automatically controlling the volumetric output of a pump independently of the separate selectively operable pilot-actuated control members.

For a further and more detailed understanding of the present invention and the various additional objects and advantages derived therefrom, reference is to be had to the following description and the accompanying drawing, wherein the single figure is a diagrammatic view of a hydraulic control operator formed in accordance

2

with the present invention and operatively connected with a reversible, variable delivery hydraulic pump.

Referring now to the drawing, the numeral 10 designates generally the outer casing of a reversible-flow, variable delivery hydraulic pump. In the usual manner, the pump comprises an annular flow control ring 11 in which is rotatably supported an annular secondary pump rotor 12 carrying a plurality of radially disposed inwardly projecting pumping pistons 13. The pistons 13 are reciprocable within a like member of radially disposed cylinders 14 formed in a cylindrical primary rotor 15. The cylinders 14 are arranged to selectively communicate with the inlet-outlet ports 16 formed in a stationary valve pintle 17 about which the primary rotor 15 is rotated by means of an electric motor or other suitable power source, not shown.

In the form of pump shown in the drawing, the flow control ring 11 is engaged on one side by a fluid pressure-actuated plunger 18 which is movable within a servo-motor housing 20 and in response to fluid pressure conditions established in the servo-motor housing and controlled by a valve-actuating rod 19. The details of construction of the servo-motor, as shown in the drawing, correspond to that described in United States Patent No. 2,184,665 issued to Walter Ernst December 26, 1939. Arranged in diametrically opposed relation to the servo-motor plunger 18 is a second plunger 22 which engages the flow control ring 11, and which is connected to one end of a coil compression spring 23 mounted within a second casing extension 24. The tension of the spring 23 may be adjusted, in the usual manner, by means of a hand wheel 25 which extends exteriorly of the casing extension 24. The spring 23 and its plunger 22 are arranged to urge the flow control ring 11 of the pump leftwardly as viewed in the drawing, and to a position providing for maximum delivery of fluid pressure outwardly through a first inlet-outlet conduit 26, communicating at one end with one of the inlet-outlet ports 16 of the stationary valve pintle.

As shown in the drawing, the inlet-outlet conduit 26 communicates, as at 27, with the ram-advancing area 28 of a reciprocating hydraulic ram 29, the latter being carried in wiping engagement with the inner walls of a hydraulic cylinder 30. In this assembly, the ram-retracting area 31 of the motor communicates with one end of a second inlet-outlet conduit 32 connected with the opposite inlet-outlet port 16 of the

pump. In the usual manner, make-up fluid is supplied to and exhausted from the ram-advancing area by way of a surge and prefill valve 33 which communicates with a fluid reservoir 33a mounted atop the cylinder 30. As the flow control ring 11 of the pump is shifted from its full line position, as shown in the drawing, to an extreme right-hand position, the flow of fluid through the pump will be reversed to introduce pressure fluid within the conduit 32 and the ram-retracting area 31 of the motor.

It will be understood that the foregoing description of the pump 10 and of the hydraulic motor or ram is common to many types of hydraulic systems and, per se, constitutes no part of the present invention.

In accordance with this invention, a lever 34 is pivotally connected with the outer end of the servo-motor rod or shaft 19, as at 35, and is arranged for rocking movement about a pivot point 36 to move the rod 19 inwardly or outwardly with respect to the servo-motor casing 20 to thereby control movement of the flow control ring 11 of the pump between its various concentric and eccentric positions with respect to the rotor of the pump. The pivot point 36 is provided by a stationary bracket 37 rigidly secured to the outer end portion of the casing extension 20. The opposite end portion of the lever 34 is pivotally connected with a link 38 carried upon the upper end of a rod 39 which, in turn, is pivotally connected, as at 40, with the remotely extending actuator rod or shaft 41 of the present hydraulic control operator.

The control operator of the present invention comprises a main casing 42 having a plurality of laterally extended boss formations 43 formed with bolt-receiving openings 44 through which anchoring bolts, not shown, may be passed to secure the casing to a stationary support, such as the frame portion of a hydraulic press. The casing 42 is formed with a first bore 45 which communicates at one end with a relatively reduced diameter bore or passage 46 through which the actuator rod 41 extends, and terminates at its opposite end in a diametrically enlarged annular port 47. The port 47 communicates with a radially disposed conduit-receiving connection 48 terminating at the outer periphery of the casing 42. The first cylinder bore 45 is in direct communication with a second and slightly larger diameter cylinder bore 49 which, in turn, communicates with a third and still larger bore 50 formed in the lower end of the casing 42. The bore 50 is likewise provided with an inlet-outlet port 51 terminating in a conduit connection 52.

The lower end of the larger cylindrical bore 50 is closed by one end of a cylindrical casing extension 53 which is rigidly secured, as by cap screws 54, to the lower end of the casing 42. Advantageously, the mating end portions of the casing 42 and the casing extension 53 may be provided with cooperative shouldered regions arranged to receive and compress an annular sealing ring 55 which establishes a fluid-tight connection between the casing 42 and the extension 53. The extension 53 is formed with an axially disposed and relatively small diameter cylinder bore 56 which terminates toward the lower end of the extension 53 in an enlarged chamber 57. An inlet-outlet port 58 is provided in the lower end wall of the extension 53 and communicates with the chamber 57.

Slidably carried in wiping engagement with the walls of the first cylinder bore 45 is a fluid-pres-

sure-responsive piston 59 connected directly with the lower end of the actuator rod 41. The opposite ends of the piston 49 provide differential pressure areas upon the piston, with the lower pressure area being substantially greater than that of the upper pressure area, due to the reduction in area at the upper end of the piston occasioned by the rod 41. The second and relatively larger cylinder bore 49 of the casing 42 receives a second fluid-pressure-responsive piston 60 whose upper end is beveled, as at 61, for engagement with the lower pressure surface of the piston 59. The lower end portion of the piston 59 is provided with a relatively diametrically enlarged annular shoulder 62 which provides upon its under surface a pressure-responsive area of greater size than the beveled area 61 of the piston. Also, due to the diametric enlargement of the shouldered portion 62 of the piston 60, movement of the piston 60 in an upward direction is limited to the distance between the inner end of the casing extension 53 and the inwardly projecting ledge 63 formed between the bores 49 and 50. The limit of movement of the smaller piston 59 is equal to the distance between the beveled end portion 61 of the piston 60, when the latter occupies its lowermost position as shown in the drawing, and the upper end wall of the casing 42. This movement of the piston 59 is sufficient to actuate the rod 19 to cause the servo-motor mechanism to shift the flow control ring 11 of the pump between its extreme right and left-hand eccentric positions with respect to the primary rotor to cause a reversal in the direction of flow of fluid between opposite full-delivery positions of the pump.

The upper end of the smaller cylinder bore 45 is provided with an inlet-outlet port 64 which is in constant communication, by means of a conduit 65, with the discharge of a pilot pump 66 arranged to draw fluid from a reservoir 67. Thus, the upper surface of the piston 59 is constantly subjected to fluid pressure derived from the pump 66 and is urged downwardly of the casing 42. To cause movement of the piston 59 in the opposite or upward direction, the port 47 is connected with one end of a conduit 68 which extends to the discharge port 69 of a three-way solenoid-operated valve 70. The valve 70 is further provided with an inlet port 71 which is connected by way of a conduit 72 with the supply conduit 65 leading from the discharge of the pump 66. The valve 70 is operable, upon energization of the solenoid 73, to connect the inlet port 71 with the outlet port 69, and thereby to introduce fluid under pressure of the pump 66 into the port 47 and cylinder bore 49. The valve 70 is operable, upon deenergization of the solenoid 73, to disconnect the outlet port 69 from the inlet port 71 and to establish communication between the outlet port 69 and an exhaust conduit 74. Thus, for example, when it is desired to shift the flow control ring 11 of the pump to its extreme right-hand position, reversing the direction of the flow of fluid from that disclosed in the drawing, the solenoid 73 of the valve 70 is energized to introduce fluid pressure within the cylinder bore 49 and beneath the lower surface of the piston 59. Due to the increased area of the lower surface of the piston 59 over the upper surface thereof, the piston is caused to move upwardly within the bore 45 and is maintained at its upper limit of movement against the wall of the casing defining the end of the bore 45.

The larger cylinder bore 50 has its port connected by way of a conduit 75 with the outlet port 76 of a second solenoid-actuated valve 77.

The valve 77 is substantially identical to the valve 70 and is provided with an inlet port 78 which is connected by the conduit 79 to receive the discharge of the pump 66, the valve 77 being provided with an exhaust conduit 80 and a solenoid 81. In operation, the valve 77, in its de-energized condition, establishes communication between the inlet port 78 and the outlet port 76 to pass fluid pressure from the pump 66 into the cylinder bore 50 of the actuator, and conversely, upon energization, the outlet port 76 is connected with the exhaust conduit 80 to relieve pressure fluid from the pump 66 within the bore 50, such pressure is transmitted to the relatively larger lower face of the shoulder 62 to cause the pistons 60 and 59 to rise vertically within the casing 42 in opposition to fluid pressure exerted upon the upper surface of the piston 59, and to a position where the shoulder 62 engages the ledge 63 of the casing and the flow-controlling member of the pump is shifted to a neutral or no-delivery position. Thus, it will be seen that the two separate pistons 59 and 60 provide for selective movement of the actuator rod 19 of the servo-motor of the pump to provide for full reversal of the pump, or shifting of the pump between a full delivery position and a neutral or no-delivery position. This control of the pump is accomplished through selective energization and deenergization of the valves 70 and 77, and it will be understood that the solenoids of these valves may, in accordance with usual practice, be automatically energized in response to the actuation of one or more switches, not shown, arranged to be opened or closed in accordance with the predetermined movement of the ram 29, or in accordance with predetermined pressures at various points within the hydraulic system.

To provide for the automatic shifting of the flow control member 11 of the pump to a neutral or pressure-holding position in response to a predetermined build-up in pressure within a given area of the hydraulic system, there is provided a third plunger or piston 82 which is reciprocable within the bore 56 of the casing extension 53. The piston 82 is arranged to abut the lower surface of the piston 60 at one end and communicates at its opposite end with the pressure chamber 57. The port 53 is connected with one end of a conduit 83 which has its opposite end connected, as at 84, with the inlet-outlet conduit 26 extending between the pump 10 and the ram-advancing area 28 of the motor. Interposed within the conduit 83 is a solenoid-actuated shut-off valve 85 which may be conditioned, by energization of its associated solenoid, to either open or close the conduit 83. Positioned within the conduit 83 between the valve 85 and the chamber 57 is a pressure relief valve which is adjustable to determine the pressure required to open the same and permit fluid to pass in a direction toward the chamber 57. Arranged in bypassing relation to the valves 85 and 86 is a conduit 87 in which is interposed a check valve 88 which opens only in a direction toward the inlet sides of the valves 85 and 86 to permit fluid to be exhausted from the chamber 57 in a direction toward the pump 10.

In operation, assuming that the ram 29 is employed to actuate the members of a hydraulic press, and it is desired to initiate an advancing stroke of the ram 29, the latter is maintained in its uppermost position, as shown in the drawing, by positioning the flow control member 11

of the pump in its neutral position providing for no displacement of fluid through either of the conduits 26 or 32. To maintain the flow control member 11 in its neutral position, the valve 77 is deenergized to establish communication between the discharge of the pump 66 and the lower surface of the larger piston 60. At this time, the valve 70 is also deenergized to connect the lower surface of the smaller piston 59 with exhaust, pressure from the pump 66 being constantly introduced into the bore 45 to react upon the upper surface of the piston 59. With the valves 70 and 77 in this condition, the piston 60 is maintained in its uppermost position at which time the piston 59 occupies an intermediate position within the bore 45. Energization of the valves 77 establishes communication between the lower surface of the piston 60 and the exhaust conduit 80, thus permitting the pressure from the pump 66 acting upon the upper surface of the piston 59 to move the pistons 59 and 60 to their lowermost positions as shown in the drawing, and to move the actuator rod 19 of the servo-motor outwardly and thereby to shift the flow control member 11 of the pump to its extreme left-hand position providing for full displacement of fluid into the ram-advancing area 28. Thus, the ram 29 is caused to advance rapidly within the cylinder 60 to initiate a pressing cycle which continues until the ram bottoms, or until sufficient pressure is built up within the ram-advancing area 28 and the discharge of the pump 10 to open the pressure relief valve 86 and admit pressure fluid into the chamber 57 beneath the smaller plunger 82. When the pressure within the discharge of the pump 10 increases to a predetermined high pressure, the plunger 82 is moved upwardly with a consequent upward movement of the pistons 59 and 60 in opposition to the pressure of fluid acting upon the upper surface of the piston 59. This upward movement shifts the rod 19 inwardly sufficiently to place the pump on a pressure holding cycle sufficient to maintain a given holding pressure within the discharge of the pump to compensate for any leakage or slippage within the system. When it is desired to retract the ram 29 after its pressing cycle, the valve 70 is energized to cause pressure fluid from the pump 66 to be introduced within the bore 49 to react against the larger lower surface of the piston 59 and move the same to its extreme upward position within the bore 45 providing for a reversal in the direction of fluid flow from the pump 10. Thus, fluid discharged from the pump is introduced within the ram-retracting area 31 of the motor by way of the conduit 32 to retract the ram 29 to its uppermost position as shown in the drawing. The valve 70 is then deenergized to once again initiate an advancing stroke, or to maintain the ram in its upper stationary position.

In view of the foregoing, it will be seen that the present invention provides an improved hydraulic control actuator for variable delivery hydraulic pumps which is characterized by its versatility in operation in controlling selectively and automatically the various positions of the flow-controlling member of a pump in accordance with the desired operation of the pump. Further, in view of the employment of a piston which is responsive to a predetermined build-up in pressure within the hydraulic system controlled by the pump to automatically shift the pump to a holding position, in addition to piston stages

which are selectively operable to shift the pump between neutral and full delivery positions, it is possible to obtain a given holding pressure within the hydraulic circuit to compensate for any slippage within the pump or leakage within a circuit controlled thereby. Further, the present actuator may be arranged in remote relation to the pump which is controlled thereby to thus reduce installation problems with respect to various hydraulic circuits.

While a single representative illustration of the present control actuator has been disclosed in detail, it will be understood that various modifications may be resorted to without departing from the spirit of the invention or the scope of the following claim.

We claim:

A hydraulic control operator comprising a casing formed with a first cylinder bore, a second relatively diametrically enlarged cylinder bore communicating with and forming a longitudinal continuation of said first cylinder bore, a pressure chamber communicating with the second cylinder bore at the end thereof opposite the first cylinder bore, a first inlet-outlet port communicating with the first cylinder bore, a second inlet-outlet port communicating with the second cylinder bore at the end thereof communicating with the first cylinder bore and a third inlet-outlet port communicating with said pressure chamber; a first piston reciprocable in the first bore of said casing and having a relatively reduced diameter actuator rod extending axially outwardly from one end thereof and outwardly through said casing, said first piston being mov-

able differentially within the first cylinder bore of said casing in response to the introduction of pressure fluid within the first and second ports of said casing; a second piston reciprocable in the second bore of said casing and having a first end surface arranged to abut the end of said first piston opposite the actuator rod and a second diametrically enlarged end portion extending within the pressure chamber of said casing, said second piston being operable, in response to the introduction of fluid pressure within the third port of said casing to move said first piston and its actuator rod in opposition to fluid pressures exerted upon said first piston; and piston-cylinder means connected with said casing and closing one end of the pressure chamber formed therein, said means comprising a fluid-pressure-responsive piston of smaller diameter than said first and second pistons and arranged in axially abutting relation to said second piston and movable to shift said first and second pistons and the actuator rod longitudinally of said casing.

WARREN R. TUCKER.

GLEN RICHARD PITTMAN.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,239,882	Davis -----	Apr. 29, 1941
2,302,922	Tucker -----	Nov. 24, 1942
2,417,858	Becker -----	Mar. 25, 1947
2,443,345	Ernst -----	June 15, 1948
2,447,707	May -----	Aug. 24, 1948
2,455,837	Waldie -----	Dec. 7, 1948