Dec. 19, 1961 K. L. RETHMEIER 3,013,539

QUICK-ACTING REVERSING VALVE WITH SPEED COMPENSATION

Filed June 6, 1960

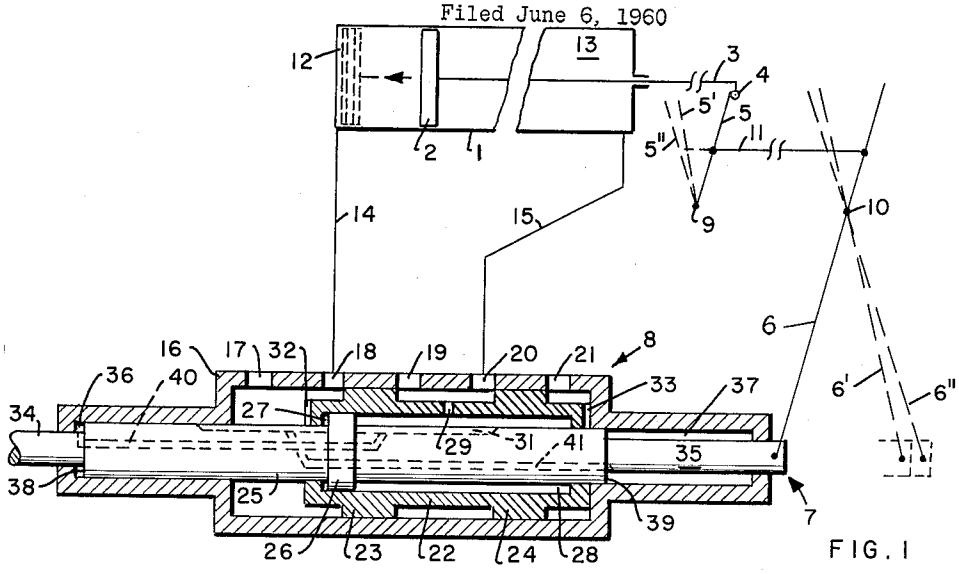

FIG. 1

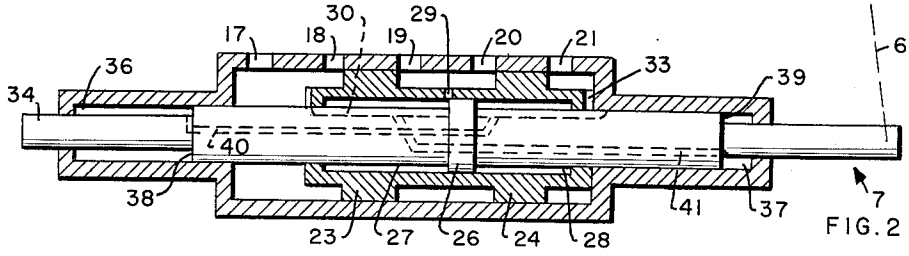

FIG. 2

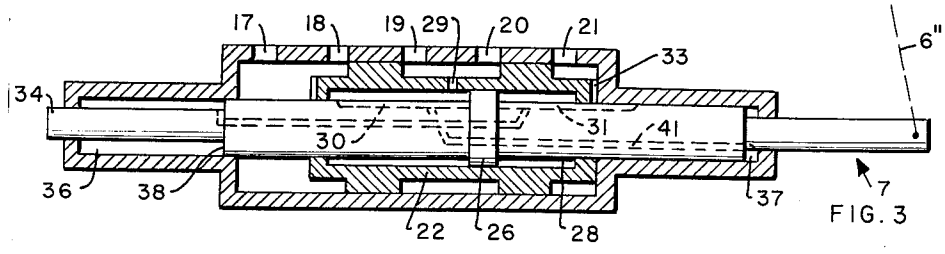

FIG. 3

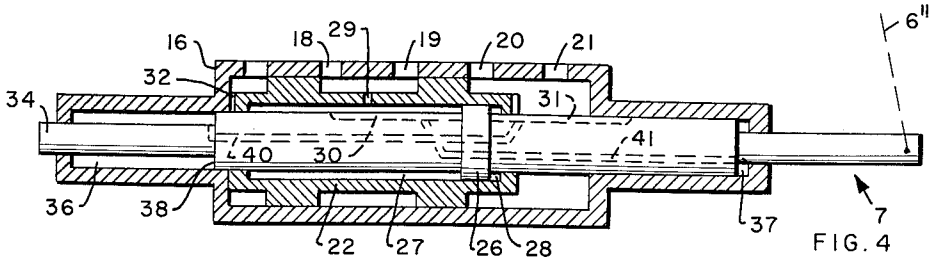

FIG. 4

INVENTOR
K. L. RETHMEIER
BY J. H. McCarthy
HIS AGENT

United States Patent Office 3,013,539
Patented Dec. 19, 1961

3,013,539

QUICK-ACTING REVERSING VALVE WITH SPEED COMPENSATION

Karel L. Rethmeier, Delft, Netherlands, assignor to Shell Oil Company, New York, N.Y., a corporation of Delaware

Filed June 6, 1960, Ser. No. 34,048
Claims priority, application Netherlands June 23, 1959
4 Claims. (Cl. 121—157)

The invention relates to a quick-acting valve for automatically reversing the supply and the discharge of pressure medium respectively to or from the working spaces of a double-acting cylinder containing a working piston, which valve comprises a stationary housing provided with ports, a free valve body contained in the housing and co-operating with the said ports, and a control member adapted to be adjusted by the working piston and forming with the valve body two cylinder spaces, the control member being provided with a piston forming a partition between the cylinder spaces which are alternately connected to the pressure medium inlet and the pressure medium outlet by the displacement of the valve body relative to the control member.

Quick-acting valves of the above type are especially suitable for operating hydraulic piston engines, since the use of such valves completely eliminates a stoppage period of the working piston at the end of the stroke thereof, which occurs when conventional valves are employed. The quick-acting valve of the present invention may be used in operating a hydraulic piston engine as described in co-pending U.S. patent application, Serial No. 842,363, filed September 25, 1959 now Patent No. 2,965,077, issued on Dec. 20, 1960.

It has been found, however, that the stroke of the working piston of a hydraulic piston engine provided with a quick-acting valve of the above-mentioned type is not constant under all conditions, but increases with increasing speed of the piston engine. This renders a piston engine of this type less suitable for driving appliances requiring a constant stroke at all speeds. Moreover, at high speeds there is a risk of the piston abutting against the cylinder covers so that there is a stoppage period of the piston at the end of the stroke, which is highly desirable.

The object of the invention is to obviate this drawback.

To this end, according to the invention, means are provided which supply an extra amount of pressure fluid medium to the cylinder space communicating with the inlet of the pressure medium when the valve body and the control member move in opposite directions.

The control member is preferably coupled to a double-acting piston pump, each of the cylinder spaces of which communicates with one of the cylinder spaces in the valve body.

The larger the surface area of the pump piston relative to the surface area of the piston of the control member, the smaller will be the effect of the speed of the working piston of the hydraulic engine on the stroke length.

The invention will be explained with reference to the drawing, wherein:

FIGURES 1–4 are diagrams of longitudinal sectional views of the quick-acting valve according to the invention in four different positions of the valve body and the control member.

FIGURE 1 shows a double-acting cylinder 1, containing working piston 2 which is connected by means of a piston rod to a work-absorbing appliance (not shown). The piston rod 3 is coupled to an abutment member 4 and is adapted to adjust via the latter the control member 7 of the quick-acting valve 8 by way of the two levers 5 and 6. The levers 5 and 6 are pivotally supported by the fixed fulcrums 9 and 10 and interconnected by a hinged

coupling rod 11. The displacement of the valve may also be hydraulically derived from that of the piston as described in the U.S. patent application Serial No. 842,363, filed September 25, 1959 now Patent No. 2,965,077 issued on Dec. 20, 1960.

The working spaces 12 and 13 of the cylinder 1 communicate with the housing 16 of the quick-acting valve 8 through conduits 14 and 15, respectively. The housing 16 is provided with ports 17, 18, 19, 20 and 21 of which the port 19 is connected to a hydraulic medium inlet, the ports 17 and 21 to a hydraulic medium outlet. Port 18 communicates with working space 12 through conduit 14 and port 20 communicates with working space 13 of cylinder 1 through conduit 15.

A free cylindrical valve body 22 is contained in the housing 16 and is provided with shoulders of enlarged diameter or collars 23 and 24. An annular space within the valve body 22 is divided into two cylinder spaces 27 and 28 by the piston 26 mounted on the control rod 25 of the control member 7.

The hydraulic medium is supplied to and discharged from the cylinder spaces 27 and 28 through a fluid supply opening or port 29 provided in the valve body 22 and through longitudinal grooves 30 and 31 provided in the control rod 25. In the extreme positions of the valve body 22, one of these grooves 30 and 31 may be in communication with one of the outlet ports 17 and 21, respectively, through the grooves 32 and 33 respectively, formed on the ends of said valve body 22, when the control member 7 is in a certain position (see FIGURES 2 and 4).

Each end of the control rod 25 is provided with an extension or auxiliary rod (34 and 35) having a smaller diameter than the control rod. The annular surfaces 38 and 39 at the ends of the control rod 25 form together with the cylinder reservoir spaces 36 and 37 a double-acting piston pump. The cylinder reservoir space 36 communicates with the cylinder space 28 in the valve body 22 through the channel 40. Similarly the cylinder reservoir space 37 communicates with the cylinder space 27 in the valve body 22 through a channel 41. In the present embodiment, the channels 40 and 41 open into the grooves 32 and 33, respectively, of the control rod 25. This is, however, not essential; it is sufficient for the channels 40 and 41 to open into the space on either side of the piston 26, if the latter is practically in its central position relative to the valve body 22, as shown in FIGURE 2.

The quick-acting valve operates as follows. In FIGURE 1 the working piston 2 approaches the end of its stroke to the left. The valve body 22 is in such a position relative to the ports in the housing 16 of the valve 8 that the working space 13 on the right-hand side of the piston 2 communicates with the pressure medium inlet port 19 through the conduit 15 and the port 20, the working space 12 on the left-hand side of the piston 2 communicating with the pressure medium outlet port 17 through the conduit 14 and the port 18. In FIGURE 1 the piston 2 is shown when the abutment means 4 of the piston rod 3 contacts the lever 5. When the piston 2 is moved further to the left, the abutment means 4 engages the lever 5, so that the latter is placed in the position 5' and the control member 7 is consequently moved to the position shown in FIGURE 2. During this movement of the control member 7, the piston 26 of the control member supplies high-pressure medium from the cylinder space 28 to the pump cylinder space 36 through the channel 40. If the surface areas of the pistons 38 and 26 are not equally large, the difference in volumes between the cylinder spaces 36 and 28 may be supplied to or discharged from the port 19, through the opening 29,

which port 19 communicates with the inlet of pressure medium.

The pressure fluid medium driven from the pump cylinder space 37 during this movement of the control member 7, is discharged to the discharge port 17 through channel 41, the increase in the volume of the cylinder space 27 being ensured by the port 17 through the groove 30. If the left-hand side of the channel 41 opens into the cylinder space 27, no liquid will flow through the groove 30 if the surface areas of the pistons 26 and 39 are equal.

In the position of the control member shown in FIGURE 2 the communication between the cylinder space 27 and the discharge port 17 is broken, this space communicating with the supply port 19 through the supply opening 29. In this case the cylinder space 28 communicates with the discharge port 21 through the grooves 31 and 33. As the pressures on either side of the valve body are equal and the pressures on either side of the piston 26 are different, the valve body 22 will rapidly move to the left. However, at the beginning of this movement of the valve body the working space 13 still remains in communication with the supply port 19 through the conduit 15 and the port 20, the working space 12 remaining in communication with the discharge port 17 through the conduit 14 and the port 18. Thus, after the control member 7 has been placed in its position shown in FIGURE 2, the working piston 2 will move on to the left until the collar 23 of the valve body 22 has completely closed the port 18 and the collar 24 has completely closed the port 20. As a result of this displacement of the working piston 2 to the left, however, the control member 7 is also placed further to the right by way of the abutment means 4 and the lever system 5, 11 and 6. In quick-acting valves not provided with pump pistons 38 and 39 and channels 40 and 41, this displacement of the control member to the right causes the valve body to move in a direction opposite to that in which the reversal occurs. Hence, an extra amount of medium should be supplied to the cylindrical space 27, in order to move the valve body 22 to that position in which the collars 23 and 24 close the ports 18 and 20, respectively. During this period when the extra amount of medium is supplied to the cylindrical space 27, the piston 2 moves on to the left. The extent of this additional displacement of the piston 2 depends on the rate at which the medium is admitted into the cylinder space 13, and is directly proportionate thereto. At high piston speeds the stroke of the working piston will, therefore, be longer than at low piston speeds.

The use of the pump pistons 38 and 39 and the channels 40 and 41 prevents, however, this additional displacement of the piston 2. As FIGURES 2 and 3 show, a further displacement of the control member 7 to the right-hand side beyond the position in which the piston 26 is on the right-hand side of the opening 29 (positions 5" and 6" of the levers 5 and 6 in FIGURE 1) does not affect the position of the valve body 22 relative to the housing 16, since during the displacement of the control member to the right the increase in the volume of the cylinder space 27, which is required to maintain the valve body 22 in the same position relative to the housing 16, is ensured through the channel 41 by the decrease in the volume of the pump cylinder on reservoir space 37. Thus, the quantity of pressure medium required need not be supplied through the opening 29. During this displacement the volume of the pump cylinder space 36 increases, but since this space communicates with the discharge port 21, channel 40, groove 31 and groove 33, this displacement cannot create super-atmospheric pressure in the pump cylinder space. The displacement to the right of the piston 26 from the position shown in FIGURE 2 does not affect the position of the valve body 22 relative to the housing 16 only if the surface areas of the pistons 26, 38 and 39 are equal.

The above-mentioned displacement to the right of the piston 26 takes place gradually during the period when the valve body is reversed. For clarity, however, FIGURE 3 shows this displacement of the piston 26, the valve body 22 still being in the position shown in FIGURE 2. During the displacement of the piston 26 between the positions shown in FIGURES 2 and 3 the position of the valve body 22 remains the same. It is obvious that this will also be the case when the movement of the piston 26 takes place when the valve body is in a different position between the positions shown in FIGURE 3 and FIGURE 4, or when the displacement is effected gradually while the valve body 22 travels along the path between the positions shown in FIGURE 3 and FIGURE 4, i.e., in a direction opposite to the displacement of the control member.

In FIGURE 4, the reversal of the valve body 22 is complete. In this case the displacement of the valve body 22 is arrested by the left-hand wall of the inside of the housing 16, in the position in which the supply port 19 communicates through port 18 with conduit 14 leading to the working space 12, and the working space 13 communicates with the discharge port 21 through line 15 and port 20. In this position the discharge pressure prevails both at the left-hand side and at the right-hand side of the valve body 22, the left-hand side of the valve body being pressed against the left-hand inner wall of the housing 16 by the action of the pressure prevailing in the space 27. Hence, the valve body 22 will remain in the position shown. If desired, if the frictional resistance of the lever system is overcome by the pressure prevailing in the space 27, the piston 26 may be pressed so far to the right that the cylinder space is reduced to nil.

In the position of the valve body 22 shown in FIGURE 4, the working piston 2 moves to the right. At the end of the stroke the abutment means 4 contacts the lever 6, and the valve body 22 is reversed from the position shown in FIGURE 4 to the position shown in FIGURE 1 in the manner described above.

It is noted that the speed of the piston 2 continues to affect the length of the part of the travel covered during the period when the valve body 22 moves between its extreme positions. This effect may be reduced, however, by giving the pump pistons 38 and 39 a larger surface area than the piston 26. As a result, when the piston 26 is moved to the right from the position shown in FIGURE 2, the valve body 22 will move to the left relative to the housing 16 under the influence of the medium driven from the pump cylinder 37. This additional displacement to the left during the opposed displacement of the control member relative to the valve body is then superposed on the movement to the left of the valve body under the influence of the pressure medium supplied to the cylinder space 27 through the port 29. The higher the speed of the piston 2, the shorter will be the time required for reversing the valve body so that the increase in the length of the stroke resulting from the higher piston speed will be partly compensated.

The use of the invention prevents the piston 2 from abutting against the covers of the cylinder 1 at high speeds, which would result in an undesirable stoppage period of the engine at the end of each stroke. The use of the invention is also important in hydraulic piston engines adapted to drive an appliance for the proper operation of which a constant stroke is required.

The invention is not limited to the embodiment of the valve as shown in the drawing. If desired, the valve body may be designed as a flat valve. It is also noted that, if desired, the pump cylinders 36 and 37 may be placed at one side of the control rod 25, in which case they are separated by a common piston.

With the use of the arrangement as shown diagrammatically in the drawing, the control rod 25 will preferably consist of two hollow parts, each closed at one side and connected to each other by a piston body 26 at their open sides. The channels 40 and 41 are then ar-

ranged in the piston body, the ends of the control rod 25 being provided with openings through which the two hollow spaces within the two parts of the rod communicate with the spaces 36 and 37.

I claim as my invention:

1. A quick-acting valve for automatically reversing the supply and the discharge of pressure medium respectively to and from the working spaces of a double-acting cylinder containing a working piston, which valve comprises a stationary housing provided with inlet and outlet ports, a free valve body contained in the housing for selectively opening and closing said ports, a control member adapted to be adjusted by the working piston and forming within the valve body two cylinder spaces, port means for said cylindrical spaces, a piston on said control member forming a partition having port means therethrough between the cylinder spaces which are alternately connected through said port means to the pressure medium inlet and to the pressure medium outlet by the displacement of the valve body relative to the control member, and pressure fluid supply means including conduit means for supplying an additional amount of medium to the cylinder space communicating with the inlet of the pressure medium when the valve body and the control member move in opposite directions.

2. A quick-acting valve as claimed in claim 1, wherein the control member forms a piston pump which is coupled to a double-acting piston reservoir having two cylinder reservoir spaces each of which is in communication with one of said valve body cylinder spaces.

3. A quick-acting valve as claimed in claim 2, wherein the cylinder reservoir spaces of the piston pump are provided at the ends of the control rod.

4. A quick-acting valve as claimed in claim 2, wherein the surface area of the piston of the piston pump is at least equal to the surface area of the piston provided on the control member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,105,473	Dean	Jan. 18, 1938
2,361,757	Fink	Oct. 31, 1944
2,526,709	Tait	Oct. 24, 1950
2,602,437	Tancred	July 8, 1952
2,748,752	Baghuis	June 5, 1956