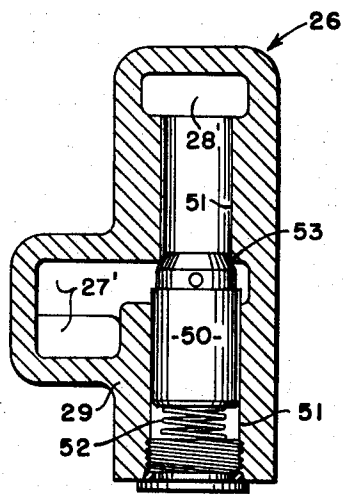
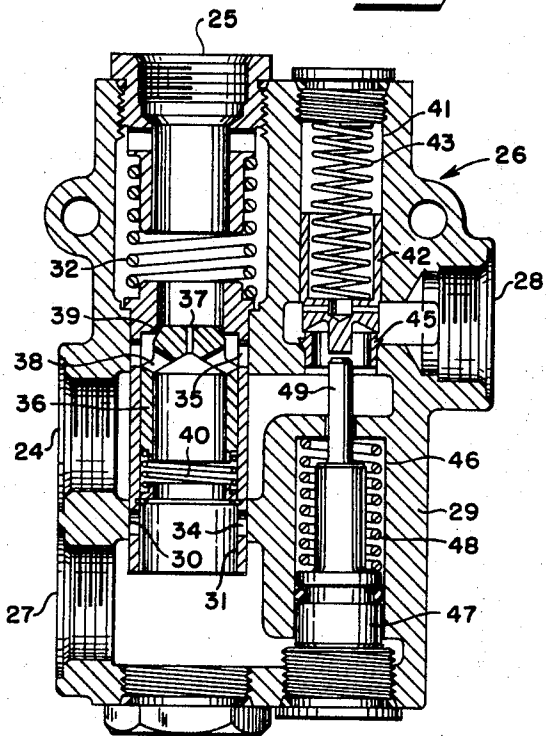
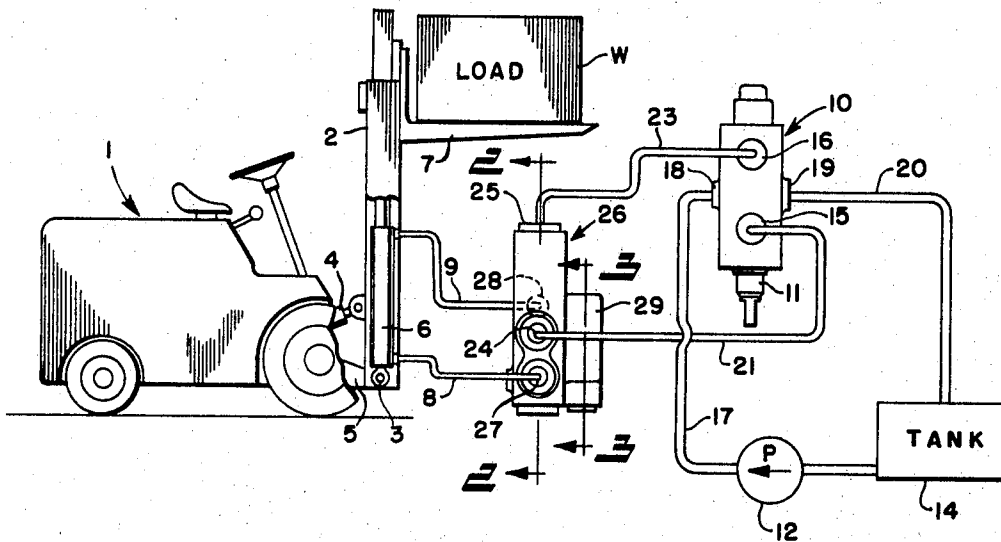


April 22, 1969

H. J. STACEY
FLOW CONTROL VALVE HAVING A PRESSURE
LIMITING TUBULAR VALVE MEMBER
Filed April 14, 1966

3,439,583



五.3

INVENTOR
HUGH J. STACEY

BY *Oberlin, Maky & Donnelly*
ATTORNEYS

1

2

3,439,583

FLOW CONTROL VALVE HAVING A PRESSURE LIMITING TUBULAR VALVE MEMBER

Hugh J. Stacey, Willoughby, Ohio, assignor to Parker-Hannifin Corporation, Cleveland, Ohio, a corporation of Ohio

Filed Apr. 14, 1966, Ser. No. 542,575

Int. Cl. F15b 13/042, 11/10

U.S. Cl. 91—420

9 Claims

ABSTRACT OF THE DISCLOSURE

A control valve having first and second passages therein for connection with the respective motor ports of a four-way directional control valve and with respective larger and smaller displacement ports of a fluid motor. A check valve in the second passage when closed permits return flow from the second passage to the first passage through another check valve in a third passage. The first passage is partly constituted by a tubular control valve which extends across the second passage and is caused to move to a position establishing communication between the first and second passages by a predominance of return pressure in the first passage. An orifice check valve in the tubular control valve restricts return flow of fluid through the first passage, but may be bypassed altogether through openings in the tubular control valve when moved by a substantial pressure drop across the orifice check valve.

The present invention relates generally as indicated to a directional control valve and more particularly to a directional control valve for use with, for example, the hoist cylinder of a fork lift truck or the like.

In hydraulically operated fork lift trucks and the like it is necessary to provide a pump capacity in conjunction with fluid motor size or displacement to enable lifting of loads on the lift fork at moderate speed while at the same time it is desirable to elevate the lift fork at a relatively rapid rate greater than pump capacity when there is little or no load thereon. Likewise, it is desirable to control the lowering rate of the lift fork under heavy load and to prevent cavitation due to fluid motor demand exceeding pump capacity.

It is accordingly, a principal object of the present invention to provide, in conjunction with a directional control valve, a valve assembly which automatically increases the lifting speed when there is only a light load or no load on the hoist cylinder.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail a certain illustrative embodiment of the invention, this indicative, however, of but one of the various ways in which the principle of the invention may be employed.

In said annexed drawing:

FIG. 1 is a schematic piping diagram illustrating one form of the present invention as employed with the hoist cylinder of a fork lift truck;

FIGS. 2 and 3 are cross-section views on enlarged scale taken substantially along the lines 2—2, and 3—3, respectively, of FIG. 1.

Referring to FIG. 1, the fork lift truck 1 has a mast 2 which is pivoted to the frame of the truck at 3, and a fluid motor 4 is operatively connected between the mast

2 and the truck frame 5 for movement of the mast 2 from the vertical position shown to a tilted back position. Within the mast 2 is the fluid motor 6 which is operatively connected with the lift fork 7 to raise and lower the latter, and to that end, fluid under pressure is admitted through conduit 8 into the lower head end of the motor 6 to raise the lift fork 7 and fluid under pressure is admitted through conduit 9 to the upper rod end of the motor 6 to lower the lift fork 7.

The reference numeral 10 denotes a conventional four-way open center directional control valve which has a valve spool 11 movable therein from a neutral position whereat fluid delivered by the pump 12 is returned to the tank 14 via a bypass passage (not shown) in said directional control valve 10. Normally, the motor ports 15, 16 of said directional control valve 10 would be connected by the conduits 8, 9 directly with the ports of the fluid motor 6 so that when the spool 11 is shifted in one direction or the other from the neutral position, fluid under pressure is conducted from one motor port 15 or 16 to one end of the fluid motor 6 through conduit 17 to the inlet port 18 while the fluid displaced by the other end of the motor 6 is conducted to the other motor port 16 or 15 and thence to the tank 14 via the return port 19 and conduit 20. It is to be understood that the directional control valve 10 may be equipped with more than one valve spool 11 for controlling other fluid motors such as the mast tilting motor 4.

In the present case the motor ports 15 and 16 of the directional control valve 10 are communicated by way of conduits 21 and 23 with the respective ports 24 and 25 of an intervening valve assembly 26 between the directional control valve 10 and the fluid motor 6, and the fluid motor 6 is connected by conduits 8 and 9 with the motor ports 27 and 28 provided in said valve assembly 26.

Referring now to FIGS. 2 and 3, the valve assembly 26 comprises a housing 29 having a bore 30 which is intersected by the ports and passages 24 and 27 and which has a control valve sleeve 31 therein which is biased by the spring 32 to the position shown in FIG. 2 wherein the openings 34 and 35 in said sleeve 31 are blocked by said bore 30 on either side of the port and passage 24. Within the sleeve 31 is a check valve 36 having an orifice 37 and passages 38 which communicate the port 25 with the port 27 when said check valve 36 is moved away from its seat 39, said check valve 36 being biased by the spring 40 against said seat 39.

The housing 29 has another bore 41 in which the check valve 42 is biased by the spring 43 against a seat 45 to close communication between the ports and passages 28 and 24 except when the pressure in the port and passage 24 exceeds that in the port and passage 28 by an amount greater than the force exerted by the spring 43. The housing 29 also has another bore 46 therein in which is disposed a pressure actuated plunger 47 exposed to pressure in the port and passage 27 and adapted to be urged thereby upwardly against the return spring 48 and against the fluid pressure in port and passage 24 acting on the other side of said plunger 47 so that its stem 49 will engage the valve member 42 and move it out of engagement with the seat 45 under certain pressure conditions as will hereinafter be explained in detail, so as to permit flow of fluid from the port and passage 28 to the port and passage 24.

As best shown in FIG. 3, the housing 29 has a check valve 50 disposed in a bore 51 which intersects the lateral extensions 28' and 27' of the passages 28 and 27 and which is biased by the spring 52 against the seat 53 to close communication between said passages 28 and 27 via extensions 28' and 27'. Of course, said check valve 50 will be

3

unseated when pressure in the passage 28 and extension 28' is greater than in the passage 27 and extension 27'.

Assuming that it is desired to actuate the fluid motor 6 to elevate the lift fork 7 and a substantial load W thereon, the directional control valve spool 11 will be shifted to close the bypass passage therethrough and to conduct fluid under pressure through the upper motor port 16 to the upper port 25 of the valve assembly 26 via conduit 23. Fluid under pressure therefore will unseat the check valve 36 for flow of fluid through the openings 38 and through the sleeve 31 into the lower motor port and passage 27 of said housing 29 from which the fluid under pressure flows through the conduit 8 into the lower head end of the fluid motor 6. The fluid displaced by the upper rod end of the motor will flow through the conduit 9 into the port and passage 28 of the housing 29, and since there is at this time a substantial load W on the lift fork 7, there will be sufficient pressure in the passage 27 to cause the plunger 47 to be moved upwardly so that its stem 49 opens the check valve 42 for return flow of fluid from the upper rod end of the motor 6 to the port and passage 24. Return flow then continues by way of the conduit 21 to the lower motor port 15 of the directional control valve 10 which is then in fluid communication with the return port 19, the latter leading to the tank 14 by way of the conduit 20.

In the event that there is little or no load W on the lift fork 7, the fluid pressure in the passage 27 will be insufficient to overcome the force of spring 48 whereby the plunger 47 is urged downwardly with the assistance of spring 48. As the plunger 47 moves down, the valve 42 is urged into engagement with seat 45 by spring 43 so that the fluid displaced by the upper rod end of the motor 6 will be returned at higher pressure from the port and passage 28 to the passage 27 via the check valve 50 and the extensions 28' and 27' thus to increase the speed at which the lift fork 7 is raised under little or no load W thereon.

Assuming now that it is desired to effect lowering of the lift fork 7 with a moderate or heavy load W thereon, the directional control valve spool 11 will be shifted to its other aforesaid operating position in which fluid under pressure is conducted from the lower motor port 15 via the conduit 21 to the port and passage 24 of the valve assembly 26, and fluid pressure in the passage 24 will open the check valve 42 for flow of fluid from the upper motor passage and port 28 through conduit 9 to the upper rod end of the motor 6 and the fluid displaced from the lower head end of the motor 6 will be returned to the tank 14 by way of the conduit 8 into the port and passage 27 and thence via the orifice 37 in the check valve 36 through the upper port 25 and the conduit 23 to the upper motor port 16 of the directional control valve 10 which is in fluid communication with the return port 19, the latter being connected with the tank 14 by means of the conduit 20. Thus, the pressure drop across the orifice 37 controls the rate of descent of the lift fork 7 when thus loaded.

When the pressure drop across the orifice 37 exceeds the force exerted by the spring 32 on the control sleeve 31, the latter will be forced upwardly whereby the openings 34 will intercommunicate the passages 24 and 27 with each other, thus tending to equalize the pressures therein for controlled descent of the lift fork 7, as determined by the pressure drop across the orifice 37. If the equalized pressure in the passages 27 and 24 is at a very high level due to a very heavy load W on lift fork 7, the control sleeve 31 is moved up further to relieve such excess pressure through the openings 35 to the upper port 25.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims, or the equivalent of such, be employed.

I therefore particularly point out and distinctly claim as my invention:

1. A control valve for use in conjunction with a four-

4

way directional control valve and a differential displacement fluid motor comprising a housing having first and second passages with ends adapted for connection with the respective motor ports of such directional control valve and with the respective larger and smaller fluid displacement ports of such motor, and a third passage intercommunicating said first and second passages; a check valve in said second passage normally blocking return flow of fluid in a direction from the end adapted to be connected to such motor to the end adapted to be connected to such directional control valve and permitting flow of fluid under pressure through said second passage in the opposite direction, means responsive to predominant pressure in said first passage over the fluid pressure in said second passage to open said check valve for permitting flow of such return fluid through said second passage; another check valve in said third passage opened by predominant pressure of return flow in said second passage over the fluid pressure in said first passage while said check valve in said second passage is closed thus to increase the total flow of fluid under pressure in said first passage; an orifice check valve disposed in said first passage to be opened by flow of fluid under pressure in said first passage in a direction from the end adapted to be connected to such directional control valve to the end adapted to be connected to such motor and to be closed by return flow of fluid through said orifice check valve thus permitting control of the rate of actuation of such motor when connected to said control valve as aforesaid by fluid under pressure flowing through said second passage to such motor; and a pressure actuated valve means in said first passage having means responsive to predominant return pressure in said first passage for opening communication between said first and second passages.

2. The control valve of claim 1 wherein said orifice check valve disposed in said first passage restricts return flow through said first passage; and said pressure actuated valve means is opened upon predetermined pressure drop across said orifice check valve.

3. The control valve of claim 2 wherein said pressure actuated valve means is tubular and has a seat therein for said orifice check valve means, said pressure actuated valve means having openings therein which are normally blocked by the wall of said first passage, but which permit flow through said first passage bypassing said orifice check valve means upon further movement of said tubular control valve means due to a further increased pressure drop of return flow across said orifice check valve means.

4. In combination, a differential displacement fluid motor; a pump; a tank; valve means; and conduit means operatively interconnecting said motor, pump, tank, and valve means whereby fluid pressure actuation of said motor is controlled by said valve means; said valve means including a directional control valve having an operating position wherein fluid under pressure delivered by said pump to said directional control valve is conducted through a first passage to the larger displacement portion of said motor and wherein returning fluid displaced by the smaller displacement portion of said motor is conducted through a second passage; a check valve in said second passage normally blocking the return flow of fluid through said second passage to said directional control valve; means responsive to predominant fluid pressure in said first passage over the fluid pressure in said second passage to open said check valve for permitting flow of such return fluid through said second passage; and another check valve in a third passage between said first and second passages opened by predominant fluid pressure in said second passage over that in said first passage to conduit returning fluid in said second passage to said first passage thus to increase the speed of actuation of said motor; said directional control valve having another operating position wherein fluid under pressure delivered by said pump to said directional control valve is conducted through said

5

second passage and check valve therein to the smaller displacement portion of said motor, and wherein returning fluid displaced by the larger displacement portion of said motor is conducted through said first passage to said directional control valve; and pressure actuated valve means in said first passage actuated by predominant return pressure in said first passage for opening communication between said first and second passages.

5. The combination of claim 4 wherein said pressure actuated valve means in tubular and contains a seat for an orifice check valve means disposed therein for restricting return flow through said first passage; said pressure actuated valve means being opened upon predetermined pressure drop across said orifice check valve means.

6. The combination of claim 5 wherein said pressure actuated valve means has an opening therein which is normally blocked by the wall of said first passage, but which permits flow through said first passage around said orifice check valve means upon further movement of said tubular control valve means due to a further increased pressure drop of return flow across said orifice check valve means.

7. In combination, a control valve, a four-way directional control valve, and a differential displacement fluid motor, said control valve comprising a housing having first and second passages connected with the respective motor ports of said directional control valve and with the respective larger and smaller fluid displacement ports of said motor, and a third passage intercommunicating said first and second passages; a check valve in said second passage normally blocking return flow of fluid in a direction from said motor to said directional control valve and permitting flow of fluid under pressure through said second passage from said directional control valve to said motor; means responsive to predominant fluid pressure in said first passage over the fluid pressure in said second passage to open said check valve for permitting flow of such return fluid through said second passage; and another check valve in said third passage opened by predominant pressure of return flow in said second passage while said check valve in said second passage is closed thus to increase the speed of actuation of said motor according to the increased total flow of fluid under pressure in said first passage; a tubular control valve having an

6

opening therein constituting a portion of said first passage for flow of fluid therethrough and extending across said second passage; spring means biasing said tubular control valve to a position closing communication between said first and second passages; said tubular control valve being moved against said spring means in said first passage upon predominance of return pressure in said first passage to open communication between said first and second passages.

8. The combination of claim 7 further comprising an orifice check valve means in said tubular control valve for permitting flow of fluid under pressure through said first passage to said motor and permitting restricted return flow of fluid through said first passage; said tubular control valve being moved to open position as aforesaid upon predetermined pressure drop of return flow across said orifice check valve.

9. The combination of claim 8 wherein said tubular control valve has openings therein downstream of said orifice check valve which are normally blocked by the wall of said first passage, but which permit flow through said first passage bypassing said orifice check valve upon further movement of said tubular control valve due to a further increased pressure drop of return flow across said orifice check valve.

References Cited

UNITED STATES PATENTS

2,890,683	6/1959	Pitch	91—436
2,980,135	4/1961	Tennis	91—436
3,071,926	1/1963	Olson et al.	91—436
3,129,720	4/1964	Allen et al.	91—436
3,224,343	12/1965	Nevulis	91—436
3,241,461	3/1966	Drone	91—436
3,247,867	4/1966	Martin	91—420
3,267,966	8/1966	Williams	91—436

MARTIN P. SCHWADRON, *Primary Examiner.*

B. L. ADAMS, *Assistant Examiner.*

U.S. Cl. X.R.

91—436, 447; 137—596.2, 493.6