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G. J. MARTIN ET AL

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DIRECTIONAL CONTROL VALVE

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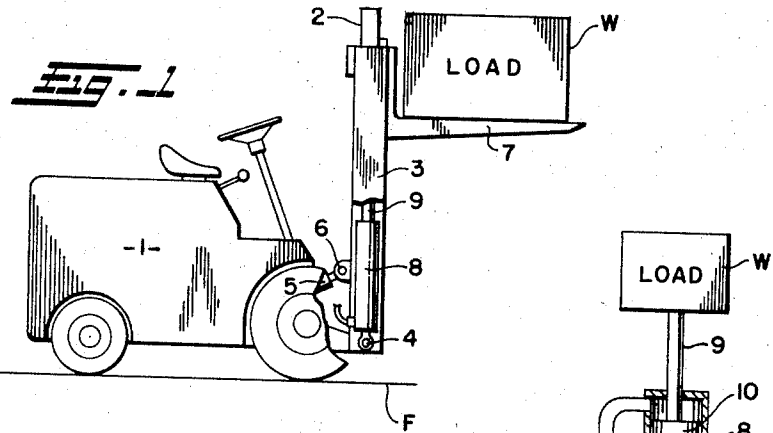
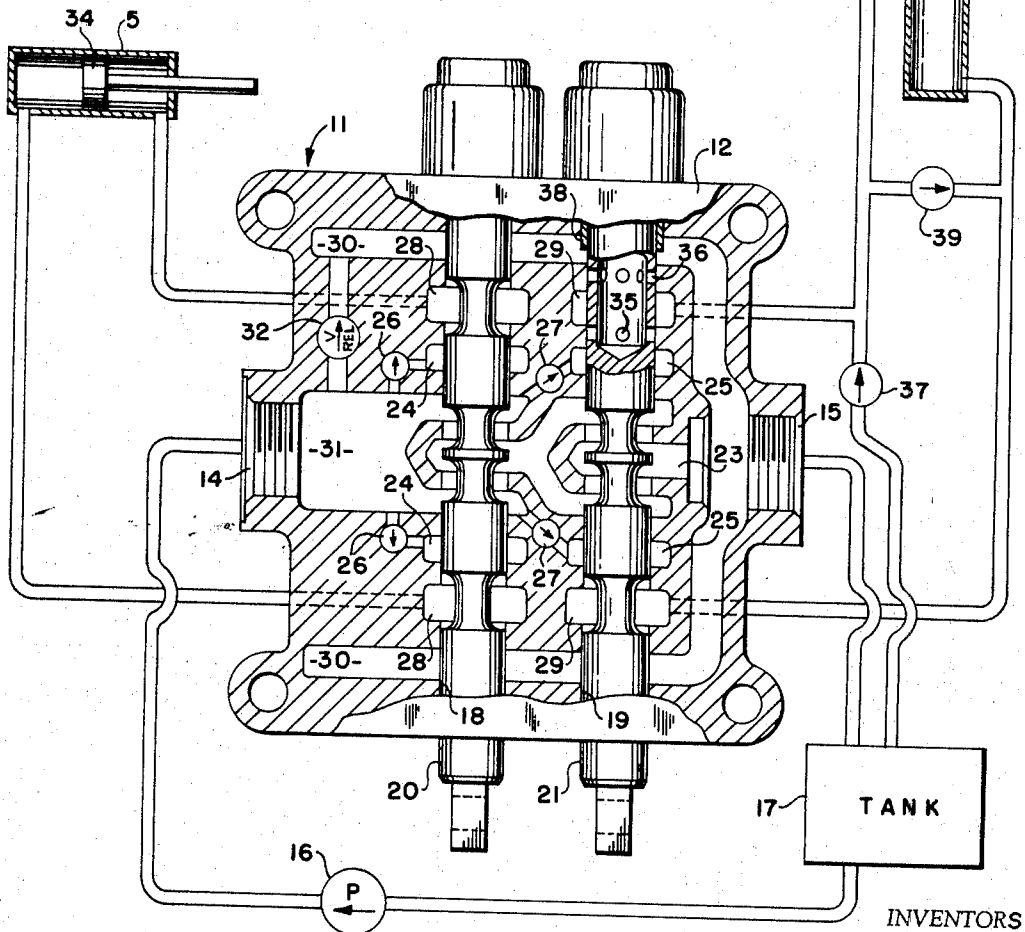


Fig. 2

BY *Oberlin, Maky & Donnelly*

ATTORNEYS

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DIRECTIONAL CONTROL VALVE

George J. Martin, Lyndhurst, and Hugh J. Stacey, Willoughby, Ohio, assignors to Parker-Hannifin Corporation, Cleveland, Ohio, a corporation of Ohio

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ABSTRACT OF THE DISCLOSURE

A directional control valve including a valve member movable to a position directing flow of high fluid pressure to the larger displacement portion of a fluid motor, and blocking the flow from the smaller displacement portion of the fluid motor to a return passage; and a check valve through which the returning fluid from the smaller displacement portion of the fluid motor is conducted to the larger displacement portion to obtain high speed operation of the fluid motor. A second check valve contained in a passage directly communicating the smaller displacement portion of the fluid motor with a tank is operative to conduct fluid directly to the motor from the tank bypassing the directional control valve in the event of negative fluid pressure in the smaller displacement portion of the fluid motor.

The present invention relates generally as indicated to a directional control valve and more particularly to a directional control valve adapted for use in controlling the operation of a fluid motor subjected to varying load as in a fork lift truck or the like.

It is a principal object of the present invention to provide a directional control valve of the character indicated which enables high speed operation of a fluid motor when there is little or no load thereon.

It is another object of this invention to provide a directional control valve of the character indicated in which the movable valve element thereof has, in addition to its conventional operating positions to control the associated fluid motor, an additional operating position at which increased operating speed of the fluid motor is achieved under conditions of low load thereon.

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 being 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 side elevation view of a fork lift truck partly broken away to illustrate the fluid motors for raising and lowering the lift fork thereof and for tilting the column or mast on which the lift fork is movable; and

FIG. 2 is a cross-section view of one embodiment of the present invention.

Referring now in detail to the drawing, and first to FIG. 1, the reference numeral 1 denotes a fork lift truck to the lower front portion of which a telescoping mast structure 2-3 is pivotally mounted at 4, said mast structure 2-3 being adapted to be tilted back about pivot 4 as by a double-acting fluid motor 5 pivotally connected to the mast structure at 6 and pivotally connected at its other end, not shown, to the truck frame.

As aforesaid, the mast structure 2-3 herein is of telescoped form including a lower section 3 in which the

upper section 2 is vertically slidably guided and in turn the lifting fork 7 is vertically slidably guided in said upper section 2. Mounted on the pivot 4 is the double-acting fluid motor 8 having its piston rod 9 linked by chains or the like, not shown, to cause vertical movement of the upper mast section 2 with respect to the lower mast section 3 and vertical movement of the lift fork 7 with respect to the upper mast section 2. When the piston 10 (see FIG. 2) moves down in the cylinder 8, the upper section 2 moves down into telescoped relation within the lower section 3 of the mast structure, and then the lifting fork 7 moves down with respect to both sections 2 and 3 for placing the load W on the floor F.

Referring now in detail to FIG. 2, the valve assembly 11 herein comprises a housing 12 having a pressure inlet port 14 and a return port 15 adapted for connection with a pump 16 and tank 17 respectively, as shown in FIG. 2. Said housing 11 has a pair of bores 18 and 19 for the respective valve spools 20 and 21, said bores 18 and 19 being intersected axially therealong by a bypass passage 23 which communicates with the inlet port 14 at its upstream end and with the return port 15 at its downstream end; by pairs of pressure feed passages 24-24 and 25-25 communicating via the pairs of check valves 26-26 and 27-27 with the portion of the bypass passage 23 which is upstream of both spool bores 18 and 19; by pairs of motor passages 28-28 and 29-29 adapted to be connected to the respective motors 5 and 8, as shown in FIG. 2; and by a pair of return passages 30-30 which communicate with the downstream end of the bypass passage 23 and with the return port 15. As shown, the upstream end of the bypass passage 23 constitutes an inlet chamber 31 and disposed between said inlet chamber 31 and one of the return passages 30 is a relief valve 32.

In FIG. 2 both spools 20 and 21 are in neutral position for free circulation of fluid from the pump 16 to the tank 17 via the then open bypass passage 23.

The spool 20 for control of the fluid motor 5 may be of conventional form in which downward movement thereof places the upper pressure feed and motor passages 24 and 28 into communication with each other and the lower motor and return passages 28 and 30 in fluid communication with each other whereby the piston 34 in the motor 5 will be actuated toward the left and conversely, when the spool 20 is moved upwardly from neutral position, the lower pressure feed and motor passages 24 and 28 are placed in fluid communication with each other and the upper motor and return passages 29 and 30 are placed in fluid communication with each other thus to cause the piston 34 in the motor 5 to move toward the right. In both operating positions of spool 21, the bypass passage 23 is closed for buildup of pressure in chamber 31.

The two spools 20 and 21 herein are shown arranged for parallel operation, that is, the spools 20 and 21 may be operated independently or simultaneously, since pressure feed through the check valves 26 or 27 is not affected by closing of the bypass passage 23 by either or both spools 20 and 21.

It is to be understood that the pressure feed passages 25 for the downstream spool 21 may be communicated with the portion of the bypass passage 23 which is between the spool bores 18 and 19 and in that event, the valve assembly 11 is converted to series-parallel wherein only one spool at a time may be shifted to an operating position to actuate its associated fluid motor 5 or 8.

With reference to the spool 21, it is of hollow construction having axially spaced apart passages 35 and 36 which in the normal upwardly shifted position of said spool 21 are operative to communicate the upper motor

and return passages 29 and 30 with each other while the lower pressure feed and motor passages 25 and 29 are communicated with each other, thus to raise the piston 10 in the lift cylinder 8 with displaced fluid from the upper rod end of the cylinder 8 being conducted to the tank 17 via the upper motor and return passages 29 and 30 which are thus in fluid communication through passages 35 and 36.

When the spool 21 is shifted downwardly from its FIG. 2 neutral position, the lower motor and return passages 29 and 30 are placed in fluid communication with each other and the aforesaid passages 35 and 36 place the upper pressure feed and motor passages 25 and 29 into fluid communication with each other thus to move the piston 10 downwardly in the cylinder 8. In the event of a heavy load W on the piston 10 such that the displacement tends to exceed the capacity of the pump 16 with resultant pressure drop, additional fluid to prevent cavitation of the upper rod end of the cylinder 8 is supplied through the check valve 37.

When the spool 21 is in its normal upwardly shifted position, loads up to the maximum for which the equipment is designed are lifted at a rate which is related to the capacity of the pump 16 and the size of the fluid motor 8. On occasion, when there is little or no load on the lifting fork 7, it is desired to raise the lifting fork 7 at a substantially faster rate than could be achieved with the pump 16. Rapid elevation of the lifting fork 7 when little or no load is imposed thereon is accomplished herein by moving the spool 21 upwardly beyond its normal above-described upwardly shifted position. When the spool 21 is thus additionally shifted upwardly, the upper passages 36 therein are covered by the sleeve member 38 which extends partway into the upper return passage 30 and thus the return flow of fluid from the motor 8 is blocked, whereby higher pressure fluid due to the differential displacement of the fluid motor 8 then must pass through the check valve 39 to cause the piston 10 to be moved upwardly at an increased rate of speed when little or no load W is imposed thereon.

We therefore particularly point out and distinctly claim as our invention:

1. In combination, a differential displacement fluid motor; a pump; a tank; a directional control valve comprising a housing having inlet, return, and motor passages and conduit means providing passages for fluid communication between said inlet passage and said pump, between said return passage and said tank, and between said motor passages and said fluid motor; a valve member movable in said housing to either of two operating positions whereat one motor passage is in fluid communication with said inlet passage and the other motor passage is in fluid communication with said return passage or vice versa thereby to actuate said fluid motor in one direction or the other; said valve member being movable to another operating position whereat one motor passage leading to the larger displacement portion of said fluid motor is in fluid communication with said inlet passage for raising the motor piston and whereat fluid communication with the other motor passage leading to the smaller displacement portion of said fluid motor through said valve member is completely blocked; and a further conduit means directly interconnecting said conduit means between said motor passages and fluid motor and having a check valve means therein for conducting returning fluid from the smaller displacement portion of said fluid motor to the larger displacement portion of said fluid motor whereby said fluid motor piston is raised at increased speed by the combined flow from said pump and from the smaller displacement portion of said fluid motor.

2. The combination of claim 1 wherein another check valve means in a passage directly communicating the smaller displacement portion of said fluid motor with said tank is operative to conduct fluid directly to said motor

from said tank bypassing said directional control valve in the event of negative fluid pressure in said other motor passage.

3. The combination of claim 1 wherein said valve member comprises a valve spool movable in a bore in said housing which is intersected by said inlet, return, and motor passages; said spool having a passage therein which, in said two operating positions, selectively communicates said other motor passage with said return passage or with said inlet passage; said spool passage being blocked by said bore in said another operating position of said spool.

4. In a directional control valve for controlling the actuation of a double acting differential displacement fluid motor, the combination of a housing having a pressure inlet passage for connection with a fluid pressure source, motor passages having conduit means attached thereto for connection with a fluid motor, and a return passage for connection with a tank; a valve member movable in said housing from a neutral position whereat communication between said inlet passage and said motor passages is blocked thereby to operating positions whereat said motor passages are alternately communicated with said inlet and return passages respectively; said valve member having another operating position whereat one motor passage which is adapted to be connected to the larger displacement portion of the motor is in fluid communication with said inlet passage and whereat communication with the other motor passage through said valve member is completely blocked; and check valve means interconnecting said conduit means for conducting fluid pressure from the conduit means which is to be connected to the smaller displacement portion of the fluid motor to the conduit means which is to be connected to the larger displacement portion of the fluid motor without passing through said valve member to obtain high speed operation of the fluid motor.

5. The directional control valve of claim 4 wherein said valve member comprises a valve spool movable in a bore in said housing which is intersected by said inlet, return, and motor passages; said spool having an internal passage which, in said two operating positions, selectively communicates said other motor passage with said return passage or with said inlet passage; and means is provided for blocking said spool passage in said another operating position of said spool.

6. The directional control valve of claim 5 wherein said spool passage comprises a bore in said spool intersected at axial intervals by openings which in neutral position of said spool are blocked by portions of the bore in said housing on either side of said other motor passage.

7. The directional control valve of claim 6 wherein said means for blocking said spool passage as aforesaid comprises a bore portion in said housing adjacent said return passage which blocks one of said openings when said spool is moved to said another operating position.

8. The directional control valve of claim 6 wherein said means for blocking said spool passage as aforesaid comprises a sleeve in said housing bore which blocks one of said openings when said spool is moved to said another operating position.

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CARROLL B. DORITY, Jr., *Primary Examiner.*

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