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[54] **HYDRAULIC SYSTEM FOR A LIFT TRUCK**
 8 Claims, 3 Drawing Figs.

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 214/674, (Inquired); 91/412

ABSTRACT: A hydraulic system for use in a lift truck. A single pump supplies fluid to a flow priority valve which supplies fluid up to a predetermined flow to an upright tilt circuit and supplies any fluid above the predetermined flow to an upright lift circuit. The tilt circuit is connected to the lift circuit by a one-way valve so that the entire flow from the pump can be supplied to the lift circuit.

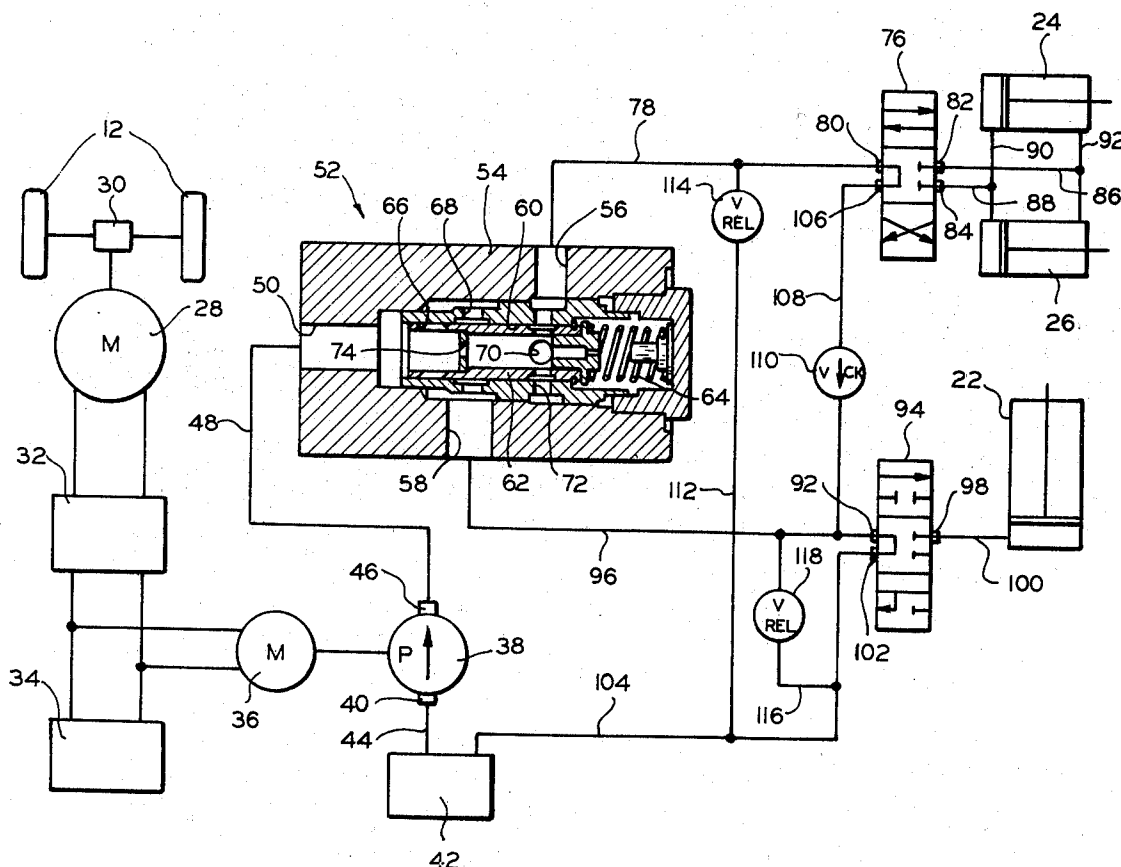


FIG. 1

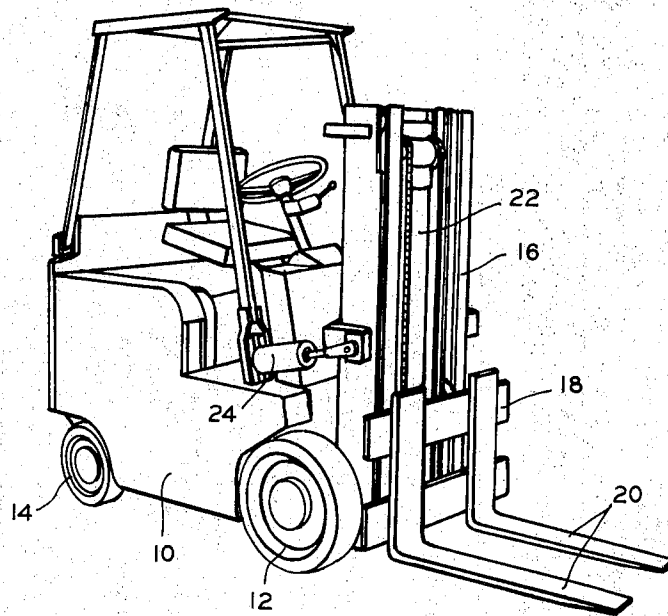
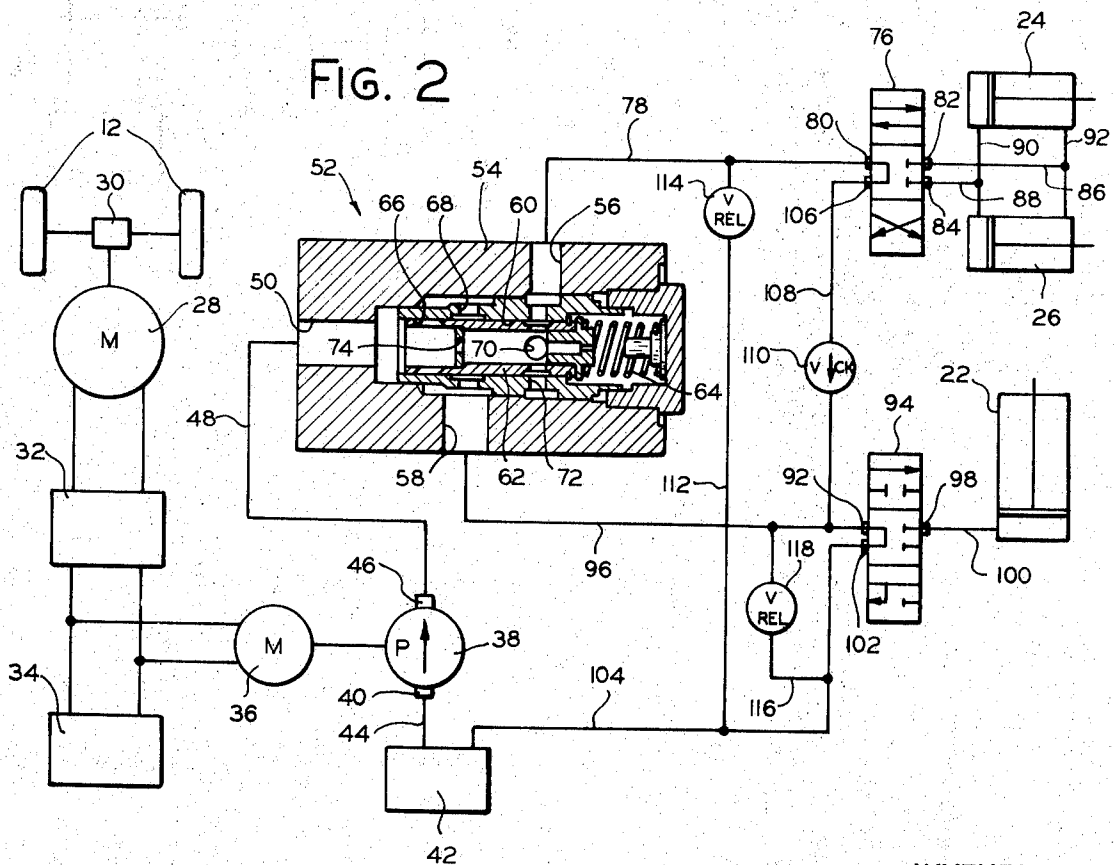


FIG. 2



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HYDRAULIC SYSTEM FOR A LIFT TRUCK

BACKGROUND OF THE INVENTION

The field of art to which this invention relates includes control systems for multiple fluid motors.

Building an electric lift truck to accept either a 36 or 48 volt battery with an acceptable performance for each voltage has been a longstanding problem in the industry, especially when it is necessary to minimize the work required to change batteries of different voltages and eliminate substantially all chance of error that might occur because of the battery change. The present invention has solved this problem by combining in a lift truck a motor control which automatically adjusts to the different voltages and a highly efficient hydraulic system which includes a tilt circuit with controlled fluid flow so that tilting of the upright is limited to a safe speed regardless of the pump output. Thus, no special procedure need be followed for switching to a battery of different voltage.

SUMMARY OF THE INVENTION

In carrying out my invention in a preferred embodiment, I provide the combination of a motor control which automatically adjusts to batteries having different voltages and a hydraulic system with a tilt circuit which limits the tilting speed of the upright regardless of pump output.

The objects, features and advantages of my invention will become apparent to persons skilled in the art when the following detailed description is taken in conjunction with the drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of a lift truck embodying my invention; and

FIG. 2 is a drawing showing schematically the combination of the electric system and the hydraulic system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the reference numeral 10 denotes generally an electric-powered lift truck supported by a pair of drive wheels 12 and a pair of dirigible wheels 14 (only one of which is shown). Lift truck 10 includes an extendible upright 16 connected thereto for tilting movement. Upright 16 includes an elevatable carriage 18 adapted to have load engaging devices attached thereto, in this case a pair of fork arms 20 are shown. Upright 16 is extended by means of a single-acting fluid motor 22 and is tilted by means of a pair of fluid motors 24 and 26 which are connected between lift truck 10 and upright 16, as shown.

Referring now to FIG. 2, drive wheels 12 are driven by an electric motor 28 through a differential 30. Drive motor 28 is connected to a motor control 32 which is connectable to a battery 34 and which controls the speed and direction of rotation of motor 28. Motor control 32 is designed to automatically compensate for batteries of different voltage that may be used to drive motor 28, and so battery 34 may, for example, be either a 36 or 48-volt battery.

Also connectable to battery 34 is a pump motor 36 to which a pump 38 is drivably connected. Pump 38 includes an inlet port 40 connected to a reservoir 42 by means of a conduit 44 and an outlet port 46 which supplies pressurized fluid via a conduit 48 to the supply port 50 of a fluid flow priority valve 52. Valve 52 includes a body 54 in which is located a regulated fluid flow port 56 and a bypass port 58. Also located in a sleeve 60 disposed in body 54 is a hollow spool normally biased to the position shown by means of a helical spring 64. Spool 62 includes a plurality of openings 66 therein which cooperate with a plurality of openings 68 in sleeve 60 that communicate with bypass port 58. Also, spool 62 includes a plurality of openings 70 which cooperate with another plurality of openings 72 that communicate with regulated fluid flow port 56. A restriction 74 is disposed in spool 62 between openings 66 and 70.

At this point it will be clear that as pressurized fluid is supplied to port 50 and flows through valve 52 that a pressure differential will exist because of restriction 74 and act on spool 62 tending to bias it to the right against spring 64. As long as the fluid flow is below a predetermined level the spool 62 will not be moved sufficiently far enough to communicate openings 66 with openings 68, and thus all of the fluid being supplied to valve 52 will be directed to port 56. When fluid flow through valve 52 increases above the predetermined limit for flow through port 56, then the pressure differential acting on spool 62 will be sufficient to move spool 62 far enough to the right so that openings 66 are placed in communication with openings 68 with the result that fluid also will begin to flow to bypass port 58.

Fluid from port 56 is supplied to a tilt control valve 76 by means of a conduit 78 which is connected between port 56 and the supply port 80 of control valve 76. Tilt control valve 76 includes a pair of fluid motor ports 82 and 84 to which tilt motors 24 and 26 are connected in parallel by means of a pair of conduits 86 and 88 which communicate with a pair of branch conduits 90 and 92 that are connected to corresponding ends of the fluid motors. Tilt control valve 76 is a conventional open-center four-way valve and functions to direct pressurized fluid to either the head or rod ends of motors 24 and 26 or hydraulically lock the motors.

Pressurized fluid from bypass port 58 is supplied to the supply port 92 of a lift control valve 94 via a conduit 96. Valve 94 includes a fluid motor port through which fluid is supplied to motor 22 by a conduit 100. Also, valve 94 includes a return port 102 which is connected to reservoir 42 via a conduit 104. Valve 94 is a conventional open-center valve and serves to direct pressurized fluid to motor 22 or communicate motor 22 with reservoir 42 or block fluid flow to or from motor 22.

Tilt control valve 76 also includes a return port 106 which is connected by a conduit 108 to conduit 96. Disposed in conduit 108 is a one-way check valve 110 which permits fluid flow only in the direction from return port 106 to supply port 92.

A conduit 112 is connected between conduits 78 and 104 and has a relief valve 114 disposed therein. Similarly, a conduit 116 is connected between conduits 96 and 104 and has a relief valve 118 disposed therein.

In order to enable persons skilled in the art to more easily understand my invention, I will now explain the operation of it. It will be assumed that battery 34 is a 36-volt battery and is connected to motor control 32 and motor 36. Under this set of conditions it will be possible to operate drive motor 28 up to a maximum speed, dependent upon voltage of battery 34, and to operate motor 36 to drive pump 38 at a particular output based upon the voltage of battery 34. Pump 38 is sized so that when it is being driven by motor 36 which is connected to a 36-volt battery that the output will be sufficient to deliver the maximum regulated fluid flow from port 56 and to have a surplus fluid flow delivered through bypass port 58. Thus, there is sufficient pressurized fluid to operate tilt motors 24 and 26 and at the same time to operate lift motor 22. It will be noted that the hydraulic circuit makes use of only a single pump 38 and is very efficient in that the quantity of fluid that is initially directed to tilt control valve 76 is then redirected to lift control valve 94 so that the entire pump output can be utilized to operate lift motor 22. This is highly desirable since the efficiency of lift truck 10 is increased if the extendible upright 16 can be operated at a higher rate of speed.

Now, if battery 34 which is a 36 volt battery is replaced with a 48-volt battery, then motor control 32 automatically adjusts to the higher voltage. Motor 28 will operate at a higher top speed and motor 36 likewise will operate at a higher speed which causes the output of pump 38 to increase. Although the output of pump 38 increases, the fluid flow directed to tilt motors 24 and 26 does not exceed the predetermined flow limit because of the operation of valve 52. This is beneficial from the standpoint of safety since if the tilt motors were to operate at a higher speed the stability and safety of operation of lift truck 10 could be adversely affected. The excess fluid flow is directed by valve 52 to bypass port 58, and hence to lift con-

trol valve 94 where it may be used to extend lift motor 22. At this point it will be obvious that the increased output of pump 38 will all be directed to operate fluid motor 22 which will result in a greater speed of extension of upright 16 which is generally desirable.

At this point it will be clear that regardless of whether the battery utilized in lift truck 10 is a 36 or 48-volt battery the operator is not required to make any adjustment to the electric or hydraulic system of the truck.

While the hydraulic circuit has been disclosed in conjunction with an electric lift truck, it will be obvious that it is equally applicable to a gasoline engine powered lift truck. While only a single embodiment of my invention is described in detail, it will be understood that this description is intended to be illustrative only. Various modifications and changes can be made to my invention without departing from the scope and spirit of it.

I claim:

1. For use with a vehicle having an extendible upright connected thereto for tilting movement and variable-speed motor means, the combination comprising a fluid reservoir, a pump drivingly connected to the motor means and including an inlet port connected to the said reservoir and an outlet port, a priority flow control valve having a supply port connected to the said pump outlet port, a regulated fluid flow port and a bypass port, the said priority valve being operable to direct the entire fluid flow thereto through the said regulated fluid flow port until a predetermined fluid flow is reached and to then direct any additional fluid flow through the said bypass port, first fluid motor means connected between the vehicle and upright for tilting the upright, a first open-center valve connected to the said first motor means for controlling operation of the said first motor means, the said first valve including a supply port connected to the said regulated fluid flow port and a return port, second fluid motor means connected to the upright for extending the upright, a second open-center valve connected to the said second motor means for controlling operation of the said second motor means, the said second valve including a supply port connected to the said bypass port and a return port connected to the said reservoir, and a valve connected between the said first valve return port and the said second valve supply port and operable to permit fluid flow only from the said first valve return port to the said second valve supply port.

2. The combination as set forth in claim 1 wherein the said first motor means includes at least one double-acting piston

and cylinder-type fluid motor.

3. The combination as set forth in claim 1 wherein the said second motor means is a single-acting fluid motor.

4. The combination as set forth in claim 1 and including a first relief valve connected between the said regulated fluid flow port and the said reservoir and a second relief valve connected between the said bypass port and the said reservoir.

5. For use in a vehicle having an extendible upright connected thereto for tilting movement, the combination comprising a motor control connectable to a source of electric energy and adjustable to the voltage of the source, drive motor means operatively connected to the said control, a fluid reservoir, a pump motor connectable to the source of electric energy, a pump drivingly connected to the said pump motor and including an inlet port connected to the said reservoir and an outlet port, a priority flow control valve having a supply port connected to the said pump outlet port, a regulated fluid flow port and a bypass port, the said priority valve being operable to direct the entire fluid flow thereto through the said regulated fluid flow port until a predetermined fluid flow is reached and to then direct any additional fluid flow through the said bypass port, first fluid motor means connected between the vehicle and upright for tilting the upright, a first open-center valve connected to the said first motor means for controlling the operation of the said first motor means, the said first valve including a supply port connected to the said regulated fluid flow port and a return port, second fluid motor means connected to the upright for extending the upright, a second open-center valve connected to the said second motor means for controlling operation of the said second motor means, the said second valve including a supply port connected to the said bypass port and a return port connected to the said reservoir and a valve connected between the said first valve return port and the said second valve supply port and operable to permit fluid flow only from the said first valve return port to the said second valve supply port.

6. The combination as set forth in claim 5 wherein the said control automatically adjusts to the voltage of the source of electric energy.

7. The combination as set forth in claim 5 wherein the said first motor means includes at least one double-acting piston and cylinder-type fluid motor.

8. The combination as set forth in claim 5 and including a first relief valve connected between the said regulated fluid flow port and the said reservoir and a second relief valve connected between the said bypass port and the said reservoir.

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