CLOSED CENTER HYDRAULIC SYSTEM WITH PUMP AND ACCUMULATOR OUTPUT FOR HIGH SPEED LIFT

A single pump and a relatively large accumulator are used in a closed center hydraulic system for a lift truck to provide hydraulic pressure fluid for vehicle steering, load lifting, mast tilting and attachment operations. The operator may selectively utilize combined pump and accumulator output for high speed lift. This is achieved by pump contactor control means which the operator can selectively operate, when in the lift condition, independently of the pressure sensitive pump control means which automatically maintains the accumulator pressure between predetermined minimum and maximum pressures.

8 Claims, 1 Drawing Figure
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BACKGROUND OF THE INVENTION

Heretofore others have provided two or three pumps for satisfying the power steering, lifting, mast tilting and attachment functions in a lift truck. Some such prior art systems utilize two pumps for high speed raising of the load and some prior art systems use a separate pump and accumulator circuit for the steering function. These prior art systems have not only been high in initial cost but they are also less efficient than desired and costly to maintain.

BRIEF DESCRIPTION OF THE INVENTION

A single pump and pump motor are used in conjunction with a relatively large capacity accumulator to supply the normal hydraulic needs of the various control functions of the lift truck including steering, lifting, mast tilting and attachment control. The operator may shift the lift control valve to its raise position and achieve a needed flow from minimum to maximum as the control valve is moved to its full raise position. When the valve control is moved a slight bit more, a resilient cushion is compressed and a switch is actuated to cause the pump controller to close thereby putting the pump into operation to supply fluid in addition to that being supplied from the accumulator. The pump controller is also operated by a pressure sensitive control which maintains the accumulator pressure between predetermined minimum and maximum values. This invention provides the desired high speed lift function without necessitating the expense of a large pump or additional pumps. The large capacity accumulator permits a standard size pump and motor to be operated only to maintain the accumulator fluid pressure in its predetermined range. The accumulator provides an emergency supply of pressure fluid for steering in event of pump, pump motor or battery failure.

BRIEF DESCRIPTION OF THE DRAWING

The present invention is incorporated in a hydraulic control system for a lift truck as illustrated in the attached schematic drawing.

DETAILED DESCRIPTION OF THE DRAWING

Referring to the schematic drawing, a hydraulic control system for a lift truck includes a lift jack 11, a pair of tilt jacks 12, 13 and a reversible steering motor 14. A single hydraulic pump 16 has its intake line 17 connected with a fluid reservoir 18 and has its fluid delivery line 19 connected to a large accumulator 21. A check valve 22 is provided to prevent discharge of the accumulator 21 to the pump 16. Flow to the accumulator is by way of a check valve 23 and restrictor 24. The restrictor 24, which is connected in parallel with the check valve 23, regulates accumulator output. The pump 16 is driven by an electric motor 26 which is connected to a vehicle storage battery 27 by a contactor circuit 28 which includes a solenoid operated contactor 29 having a contact 31. The solenoid of the contactor 29 is connected by a circuit 32 to the battery 27 by way of a solenoid operated double pole switch 33 which is controlled by low and high pressure switches 34, 36 pilot operated by the pressure in the accumulator 21 by way of hydraulic lines shown by dash lines 37, 38. As illustrated, an ignition switch 35 is open and the accumulator is discharged. When the ignition switch 35 is closed, double pole switch 33 closes thus energizing the contactor coil causing the contactor 29 to close. The motor 26 now drives the pump to deliver pressure fluid to the accumulator. When the hydraulic pressure rises above a predetermined minimum, the pressure switch 34 will open; however, a holding circuit established through the high pressure switch 36 will maintain the double pole solenoid switch 33 closed until pressure reaches a predetermined maximum value at which time the pressure switch 36 will open to interrupt power to the solenoid of switch 33 thereby causing it to open. The opening of switch 33 will cause the contactor 29 to open thereby stopping the pump motor 26. When fluid is discharged from the accumulator during operation of the lift truck, the high pressure switch 36 will close; however, a circuit is not completed to energize the double pole switch 33 and the motor will not run until the low pressure switch 34 closes upon sensing a predetermined minimum value of pressure in the accumulator 21.

Pressure fluid from the accumulator 21 is used for steering under the control of an appropriate closed center valve 41 connected to the accumulator by delivery line 42 and connected to reservoir by return line 43. The steering control valve 41 is connected to opposite ends of the reversible hydraulic motor 14 by delivery lines 44, 46. Fluid returned to reservoir by return line 43 passes through a filter 47. A bypass valve 48 is connected in parallel with the filter 47 so as to permit return flow in case the filter becomes plugged. In order to protect the system against excessive pressures, a relief valve 51 is provided which will open at a predetermined pressure slightly above the maximum pressure setting for the high pressure switch 36.

Closed center control valves 56, 57, 58 are associated with the lift jack 11, tilt jacks 12, 13 and a lift truck attachment, not shown. A fluid delivery line 61 interconnects the accumulator 21 and the metering type lift valve 56. The valve 56 is connected to reservoir by a return line 62. The lift jack 11 is connected to the control valve 56 by a delivery line 63 in which a flow regulator 64 is operatively disposed. The parallel connected restrictor 66 and check valve 67 of the flow regulator regulate outflow of fluid from the jack 11 and permit relatively free fluid flow to the jack 11. When it is desired to raise the load with the lift jack 11, the operator will move a pivotally mounted control lever 71 clockwise, as viewed in the drawing, thereby shifting the control valve spool 75 upwardly to its raise position. The lever 71 is pivoted on the chassis 72 of the lift truck by a pivot pin 73 and includes an arm pivotally connected to a threaded rod 74 by a pin 76. The threaded rod 74 is connected at its lower end to the flow control element or spool 75. When the valve spool 75 has been moved upwardly through its metering range to a full flow raise position, an elastometer washer 81 will abut a flange 82 secured to the chassis 72 to give the operator a feel of the full raise position of the valve 56. A slight amount of additional force on the lever 71 will compress the resilient elastometer washer 81 and permit a slight additional movement of the rod 74 upwardly thereby causing a cam 83 to move a switch operating lever 84 sufficiently to actuate an electric switch 86. The switch 86 is in a motor operating circuit 87 connected in parallel with the pressure
sensitive switch operating control means and on closing of switch 86 the solenoid of the contactor 29 will be energized to close the contactor and provide electric power to the motor 26. Thus it can be seen that the operator may place the pump 16 in operation regardless of the condition of the pressure in the accumulator 21. The relief valve 51 will open at its predetermined pressure relief setting to discharge to reservoir to protect the pump and accumulator when the operator is operating the motor independently of the pressure sensitive controls therefor. The resilient washer is mounted on a nut 91 on the threaded portion of rod 74. The cam 83 also includes a nut portion 92 threadedly engaging the threaded portion of the rod 74. The axial position of the cam 83 and washer 81 can be adjusted to obtain proper metering control in raise position of control valve 56 and the desired operation of switch 86 upon predetermined compression of the resilient washer 81.

In summary, the present invention permits a relatively small electric pump motor and pump to be utilized to charge a relatively large accumulator 21 and the operator may select the high speed lift function on those occasions when the higher speed is desirable. The electric control means for placing the pump in operation independently of the pressure sensitive electric control means includes a manually operable switch which can be operated only when the lift valve is placed in its raise position.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A two speed lift system for a lift truck, comprising: a reservoir,
   a pump connected in fluid receiving relation to said reservoir and fluid delivery relation to said accumulator,
   a lift jack,
   a closed center control valve having neutral, raise and lower positions of adjustment,
   a fluid supply line interconnecting said accumulator and said control valve,
   a fluid delivery line interconnecting said control valve and said lift jack,
   a source of electric energy,
   an electric motor connected in driving relation to said pump,
   a power circuit interconnecting said electric motor and said source of electric energy,
   first electric control means operatively associated with said motor, source of electric energy and accumulator automatically maintaining the pressure in said accumulator between predetermined minimum and maximum values, and
   second electric control means including a manually operable switch for selectively energizing said electric motor to cause same to drive said pump independently of the value of the pressure in said accumulator when said switch is actuated,
   said lift jack being supplied with fluid from said accumulator when said control valve is placed in its raise position of adjustment of said manually operable switch is not actuated,
   said lift jack being supplied with fluid from said accumulator and from said pump when said control valve is placed in its raise position of adjustment and said manually operable switch is actuated.

2. The system of claim 1 wherein said switch is selectively operable only when said control valve is in its raise position of adjustment.

3. The system of claim 2 wherein said control valve is a metering type valve with a predetermined metering range in its raise position between partial flow and full flow positions and wherein said manually operable switch is actuable only when said control valve is adjusted in said metering range to said full flow position.

4. The system of claim 1 and further comprising manually operated valve control means operatively associated with said control valve including a shiftable element and wherein said switch is operatively associated with said shiftable element.

5. The system of claim 4 wherein said shiftable element is moved in one direction a predetermined distance when said control valve is shifted from its neutral position to its raise position and wherein a small additional shifting movement of said element in said one direction actuates said switch.

6. The system of claim 5 and further comprising resilient biasing means operatively associated with said manually operated valve control means resisting said additional shifting movement of said element.

7. The system of claim 6 and further comprising a pressure relief valve operatively associated with said accumulator and said reservoir operable to discharge fluid to the latter when a predetermined fluid pressure greater than said maximum value is reached in said accumulator.

8. The system of claim 7 and further comprising a fluid delivery line interconnecting said pump and said accumulator and a one way valve in said delivery line permitting flow from said pump to said accumulator and preventing flow from the latter to said pump and wherein said relief valve is connected to said delivery line downstream of said one way valve.

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