Jan. 14, 1947. E. J. DUNHAM 2,414,192

INDUSTRIAL TRUCK

Filed July 24, 1944 2 Sheets-Sheet 1

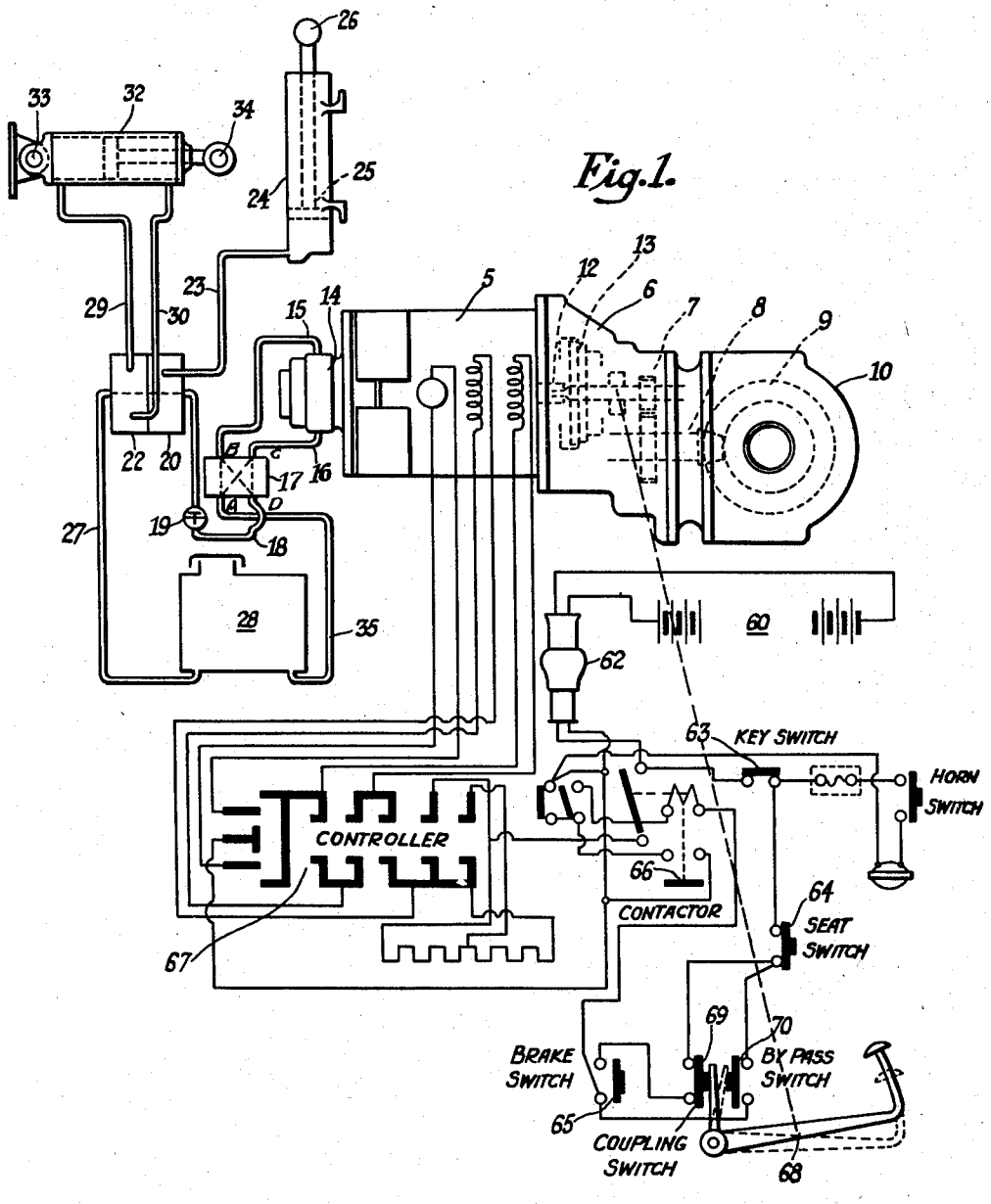


Fig. 1.

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Fig. 2.

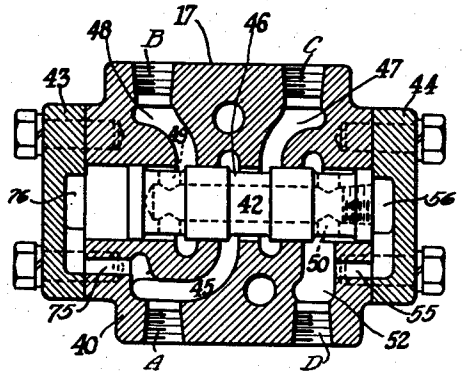


Fig. 4.

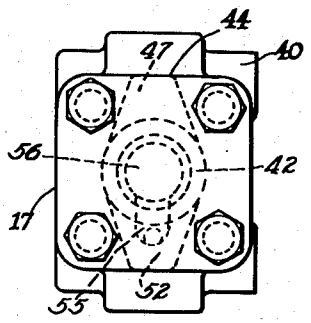
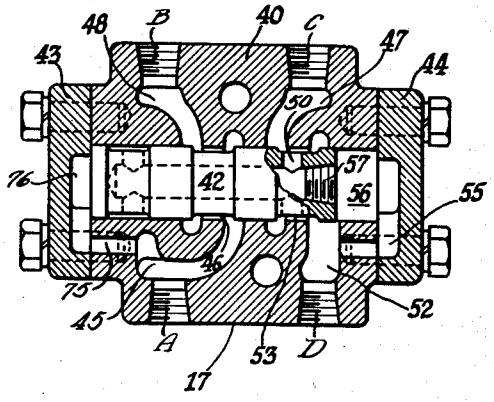


Fig. 3.



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UNITED STATES PATENT OFFICE

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INDUSTRIAL TRUCK

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10 Claims. (Cl. 214—113)

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This invention relates to industrial trucks, and more particularly is directed to an industrial fork truck of the type used for tiering and transporting material in warehouses, manufacturing plants, yards and docks.

Broadly considered, the present invention contemplates an electric truck operated from a storage battery or the like and having hydraulic means for raising and lowering the fork members upon which the load is carried, and for tilting the carriage at the forward end of the truck forwardly and rearwardly through a pump driven by the same motor which drives the axle of the vehicle.

In developing an electric fork truck of this type of small capacity capable of use in manufacturing establishments where the weight is such that a small truck is necessary because of elevator capacity or floor loading, it has been found to be impractical to provide two motors, one for driving the vehicle and the other for driving the pump which supplies the fluid pressure to the hydraulic system.

Consequently, the primary object of the present invention is to provide in an electric truck of this type an arrangement wherein a single electric motor is capable of driving both the vehicle axle and the pump for the hydraulic system.

This arrangement is possible due to the fact that a rotor type pump will operate equally well and with the same efficiency in either direction of rotation if a bleed line is applied to the pump bearings. With such a construction there is required a valve so constructed that it will take a flow of oil from the pump in either direction and supply a unidirectional flow to the lift and tilt valves which control the lifting and tilting operation of the load supporting carriage. The pump must also provide for a two-direction flow from the reservoir or sump tank.

Another object of the present invention is to provide a valve for this purpose which is automatic in operation and will maintain proper directional flow of the oil regardless of the direction of the rotation of the pump.

In designing a truck of this type it is also necessary to provide means for operating the hydraulic system from the driving motor when the vehicle is standing still, since only a single motor is used for operating the pump and drive axle. It is obviously necessary to use a coupling member between the motor and transmission or gear reduction into the axle, which coupling member is not only used for driving purposes but

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also as a means for uncoupling the motor from the driving axle when it is necessary to operate the hydraulic system while the vehicle is standing still. I have found that a conventional automotive type clutch provides the best means of coupling in this arrangement.

This automotive type clutch is used in the same manner as the normal clutch is conventionally employed, altho the speed of operation of the vehicle is controlled through a controller which operates to vary the speed of the driving motor. Consequently, the clutch is used as an uncoupling member only when the vehicle is standing still to declutch the driving axle when it is necessary to operate the electric motor for operating the pump. It will be apparent that when the vehicle is in motion all lifting and tilting operations are the same as on a conventional type of electric industrial truck, but a suitable control pedal is provided so that when it is necessary to operate the hydraulic system while the vehicle is standing still the axle can be declutched to prevent movement of the vehicle.

In order to prevent improper operation of the system certain control means is necessarily provided for cutting out the electric circuit to prevent racing of the electric motor if the coupling control member should be inadvertently opened when the device is in higher than low speed operation through the controller. In addition, means is provided for interrupting the power circuit to the motor whenever the vehicle brake is applied, and upon application of the brake the entire vehicle is brought to a stop and can only be reoperated by returning the controller to its first or low speed position whereby inching of the vehicle either forwardly or backwardly can be accomplished.

Other objects and advantages of the present invention will appear more fully from the following detailed description which, taken in conjunction with the accompanying drawings, will disclose to those skilled in the art the particular construction and operation of a preferred form of the present invention.

In the drawings:

Figure 1 is a diagrammatic view illustrating the control circuit and hydraulic system for an electric industrial truck of the type hereinabove described;

Figure 2 is a sectional view through the control valve mechanism between the pump and lift and tilt valves;

Figure 3 is a view corresponding to Figure 2 of the valve in its alternate position when the

direction of rotation of the pump has been reversed; and

Figure 4 is an end elevational view of the valve construction shown in Figures 2 and 3.

Referring now in detail to the drawings, there is provided an electric motor 5 which has secured to one end of the housing thereof a gear housing 6 containing reduction gearing 7 terminating in a pinion shaft 8 which in turn drives a ring gear 9 of a differential contained in the axle housing 10 for transmitting torque to the drive axle of the vehicle. Disposed between the motor shaft 12 and the gear train 7 is a coupling member 13 which, in the present form of the invention, can be a conventional type of automotive clutch having sufficient torque rating to take care of the torque developed in driving the vehicle.

In the opposite end of the motor housing 5 there is provided a pump 14 which is of the rotor type driven from the motor shaft and having an inlet connection 15 and a pressure outlet connection 16. This pump is capable of operating in either direction of rotation. To provide for proper flow of the fluid (preferably oil) into and out of the pump, there is provided an automatic control valve 17 shown more in detail in Figures 2 to 4. This valve 17 has a pressure outlet connection 18 leading through the check valve 19 into the hydraulic control valves 20 and 22. The control valve 20 is capable of operation for controlling the flow of fluid under pressure into the pressure outlet conduit 23 leading to the lower end of the cylinder 24 which may be of any conventional design. Within the lift cylinder 24 is a piston 25 operating through a cross head 26 to raise and lower a carriage mounted on an upright mast at one end of the vehicle and carrying a suitable load engaging means such as forks, fingers or the like. When the control valve 20 is in inoperative position the pressure line 18 is connected to the return line 27 leading to a sump or reservoir 28 thereby allowing the piston 25 to drop by gravity within the cylinder 24.

The control valve 22 has two pressure outlets indicated respectively at 29 and 30 leading to opposite ends of a tilt cylinder 32 which tilt cylinder is pivotally mounted at one end as at 33 to the frame of the vehicle and at the opposite end has a projecting piston rod 34 connected to the uprights at the forward end of a truck of this type for tilting them either forwardly or rearwardly.

Depending upon the position of the valve 22, the piston within the cylinder 32 is moved either forwardly or rearwardly, the lines 29 and 30 alternating as pressure lines and return lines leading back from the conduit 27 to the sump 28.

From the sump 28 there is provided an outlet conduit 35 leading into the valve 17, and from this valve to an inlet side of the pump 14.

Considering now in detail the valve 17, this valve comprises a body member 40, as shown in Figures 2 and 3, provided with a central bore receiving a piston or plunger 42, the bore being closed at its ends by cap members 43 and 44 bolted in any suitable manner to the end walls of the body member 40. When the pump is in normal operation, that is, in forward direction of rotation of motor 5, the fluid from the outlet line 35 of the sump 28 enters the port A in the valve body and passes from the port through the passageway 48 and through passageway 49 into the interior of the plunger 42 and thence outwardly through the outlet port C to the line 16 which is connected thereto and thence into the inlet side

of the pump 14. The oil is delivered under pressure through the outlet conduit 15 of the pump and thence back into the port B in the valve body 40, through the passageway 45 in the valve body and thence past the reduced portion 46 of the plunger 42 into the passageway 47 leading out through the port D to the pressure line 18 and thence through the check valve 19 into the control valves 20 and 22. The pressure through passageway 75 acts on the end of the plunger 42 in the chamber 76 to hold it in shifted position to the right as shown in Figure 2.

If the direction of the motor is reversed the fluid from the outlet line 35 of sump 28 again enters the port A, as shown in Figure 3, but due to the pressure in this case being delivered through the line 16 from the pump 14, the plunger 42 is shifted to the left as shown in Figure 3 whereby the fluid entering port A of the valve body passes through the reduced portion 46 of the plunger into the passageway 45 and thence outwardly through the port B into the conduit 15 leading into the pump 14. Similarly, oil under pressure leaving the pump through the conduit 16 enters port C of the control valve and thence through chamber 52 and the reduced portion 53 of plunger 42 into the chamber 47 and thence out through port D to the pressure line 18. With this construction it will be noted that due to the pressure connection from port C to port D, a portion of this fluid under pressure will be bypassed through the passageway 55 in the end cap member 44 and thence into the chamber 56, acting against the end of the plunger 42 whereby it is shifted to the position shown in Figure 3.

Referring now again to Figure 1 wherein is disclosed the electrical circuit provided for operating the motor 5, this circuit is energized from a storage battery indicated generally at 60. The battery circuit goes through the usual plug 62 into the control circuit through the key switch 63, a seat switch 64 which is closed whenever the operator is on the seat, and a brake switch 65 normally closed whenever the brake is in inoperative position. From the brake switch the circuit is connected through a contactor 66 into the controller indicated generally at 67. The details of the operation of the controller circuit for varying the speed of the motor or for reversing its direction of rotation are not a part of the present invention, and therefore do not need to be described in detail herein.

The coupling member 13 is engaged at all times that the vehicle is in motion and since the motor itself varies in speed there is no necessity for releasing the coupling member while the vehicle runs forwardly and backwardly. The only time that the coupling member 13 is released is when the vehicle is stopped and it is desired to operate the pump 14 without moving the vehicle. Under such conditions the coupling 13 is disengaged to prevent transmission of torque through the gears 7 to the axle.

When a stop is required in normal operation of the vehicle the operator applies the brake pedal (not shown) which breaks the electrical circuit at the switch 65 in all controller positions. In the first or low speed controller circuit, this can be reestablished by operation of the foot pedal, but in the second, third and fourth speeds it is necessary to return the controller back to the first position before the circuit can be reestablished. Thus, inching either forward or reverse can be accomplished in the first position.

While the vehicle is in motion the operation of

the lift and tilt valves 20 and 22 can be accomplished, since the pump 14 is operating at all times. However, if it is required to lift or tilt the load when the machine is not in motion, the foot coupling pedal 68 is actuated into the dotted line position shown in Figure 1, thus opening the coupling switch 69 and releasing or disengaging the coupling 13 in a conventional manner which disconnects the drive motor from the axle. The motor 5 can still be operated in this position, since the brake is engaged and consequently the circuit is still established through the operation of the controller. This is true whether or not the motor is rotating forwardly or reversely, since as previously explained, the control valve 17 is automatically operable in either direction of rotation to provide the proper directional flow of fluid through the valve and pump.

In order to prevent the operator from releasing the coupling 13 when the machine is in any speed and thus allow the motor 5 to race against the pump, there is provided a switch 69 which breaks the circuit if the coupling pedal is depressed. It is then necessary for the operator to reestablish the circuit by use of the controller. This prevents use of the coupling pedal unless he has a lift or tilt operation to perform with the vehicle when it is standing still.

Under some conditions it might be that the operator would have a load on the truck while the truck is on an incline or ramp, and where the load must be lifted or tilted while the vehicle is standing still. In this case, he must hold the machine with a foot brake which normally breaks the circuit. Thus, no power would be available for driving the motor and consequently the pump. To allow for this emergency there is provided a bypass switch 70 which contacts or closes the bypass circuit when the clutch or coupling pedal 68 is sufficiently disengaged, and thereby reestablishes the circuit to allow the motor and pump to run at the speed selected by the controller.

It is, of course, apparent that other switch control mechanisms operating in the proper sequence could be employed for controlling the operation of the motor 5 and the pump, but these switches should be coordinated with operation of the foot brake and coupling pedal to insure disengagement of the coupling when it is desired to lift or tilt the load while the vehicle is standing still and to prevent racing the motor 5 if the coupling pedal is disengaged while the vehicle is moving at a high rate of speed.

I am aware that various changes may be made in certain of the details of the construction herein disclosed, and I therefore do not intend to be limited except as defined by the scope and spirit of the appended claims.

I claim:

1. In an industrial truck having hydraulically controlled load-engaging means and a driving axle, a pump for supplying fluid under pressure to said hydraulic means, a reversible electric motor operable to drive said axle and said pump simultaneously in either direction, valve means automatically shiftable in accordance with the direction of rotation of said pump for providing flow of oil in the same direction to said hydraulic means from said pump, a controller shiftable into various speed controlling positions for operating said motor through a power circuit, switch means in said circuit controlled by operation of the truck brakes for opening said circuit to deenergize said motor, and coupling means for disengaging said motor from said axle and including switch means for bypassing said brake-controlled switch means to reestablish said circuit only when said controller is returned to low speed position.

2. In an electric industrial truck having a reversible motor, a control circuit therefor, an axle driven by said motor, normally engaged coupling means between said motor and axle for driving said truck in either direction, a pump driven by said motor in either direction of rotation for developing fluid pressure, hydraulic load lifting and tilting means controlled by pressure fluid flowing in a constant direction, valve means interposed between said pump and hydraulic means automatically providing for constant flow of fluid to said pressure-controlled means in the same direction regardless of the entering direction of fluid flow from said pump into said valve means, a brake switch in said control circuit opening said circuit when the truck brakes are applied, and switch means for bypassing said brake switch upon complete disengagement of said coupling means whereby said motor can drive said pump while said truck is held stationary by brake application.

3. In combination, a reversible electric driving motor, hydraulically operated load control means, a rotary fluid pump driven directly from said motor, a fluid reservoir, a pressure line to said load control means, a valve having an inlet connection from said reservoir and an outlet connection to said pressure line, and automatic means within said valve for directing fluid from said inlet connection to the suction side of said pump and from the discharge side of said pump to said outlet connection regardless of the direction of rotation of said pump.

4. The truck of claim 3 wherein said last-named means includes a shiftable plunger providing proper fluid flow direction in accordance with the direction of rotation of said pump.

5. The device of claim 3 wherein said last-named means includes means automatically shiftable in accordance with direction of rotation of said pump to maintain connection between said reservoir and the suction side of said pump.

6. In an electric industrial truck, drive means therefor including a reversible motor for driving said truck in either direction, a clutch for disengaging said motor from said drive means, hydraulically operated load engaging means including control valves and a fluid pressure circuit in which the fluid pressure is always in the same direction, a pump connected to said motor for supplying fluid under pressure, and valve means including a pressure outlet connected to said fluid circuit and an automatically shiftable plunger responsive to the direction of fluid flow under pressure from said pump for connecting the pressure side of said pump to said pressure outlet regardless of the direction of rotation of said pump.

7. In an industrial truck having hydraulic load engaging means and a driving axle, a pump for supplying fluid under pressure to said hydraulic means, an electric motor operable to drive said axle and said pump simultaneously, a controller shiftable into various speed controlling positions for operating said motor through a power circuit, switch means in said circuit controlled by operation of the truck brakes for opening said circuit to deenergize said motor, and coupling means for disengaging said motor from said axle and including switch means for bypassing said brake controlled switch means to reestablish said circuit only when said controller is in low speed position.

8. In an industrial truck having hydraulic load

engaging means and a driving axle, a pump for supplying fluid under pressure to said hydraulic means, an electric motor operable to drive said axle and said pump simultaneously, a controller shiftable into various speed controlling positions for operating said motor through a power circuit, means in said circuit for opening the same upon actuation of the truck brakes, manually operable clutch means for disengaging said motor from said axle, and switch means for bypassing said brake-controlled means responsive to actuation of said coupling means to reestablish said motor circuit only when said controller is in low speed position.

9. In an industrial truck having hydraulic load engaging means and a driving axle, a pump for supplying fluid under pressure to said hydraulic means, an electric motor operable to drive said axle and said pump simultaneously, a controller shiftable into various speed controlling positions for operating said motor through a power circuit, said circuit including a switch operated by actuation of the truck brakes for opening said circuit, normally engaged coupling means between said

motor and said axle, and switch means for bypassing said brake-controlled switch upon complete disengagement of said coupling means whereby said motor can drive said pump while said truck is held stationary by said brakes.

10. In an industrial truck having hydraulic load engaging means and a driving axle, a pump for supplying fluid under pressure to said hydraulic means, an electric motor operable to drive said axle and said pump simultaneously, a controller shiftable into various speed controlling positions for operating said motor through a power circuit, said circuit including a switch operated by actuation of the truck brakes for opening said circuit, normally engaged coupling means between said motor and said axle, and switch means for bypassing said brake-controlled switch upon complete disengagement of said coupling means whereby said motor can drive said pump while said truck is held stationary by said brakes, said controller preventing reestablishment of said circuit by said bypass switch means except when said controller is in low speed position.

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