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[54] **VARIABLE CAPACITY LIFT TRUCK**

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[51] **Int. Cl.** **B66f 9/20**

[58] **Field of Search** 212/48; 214/127, 214/142, 672, 673, 674, 762, 763, 764; 91/412, 433

[56] **References Cited**

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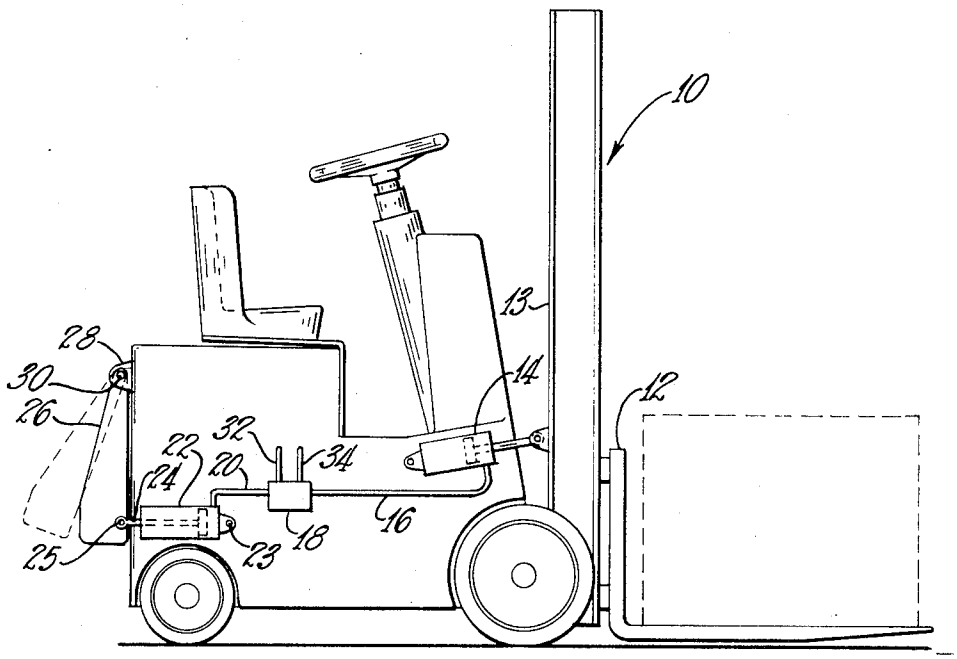
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[57] **ABSTRACT**

An industrial truck includes a shiftable counterweight for stabilizing the truck under various loading conditions. Means are provided for automatically shifting the counterweight in response to the load being supported by the lifting mechanism of the industrial truck and wherein the magnitude of counterweight movement is proportional to the magnitude of said load to thereby automatically position the counterweight for balancing the load.

6 Claims, 2 Drawing Figures



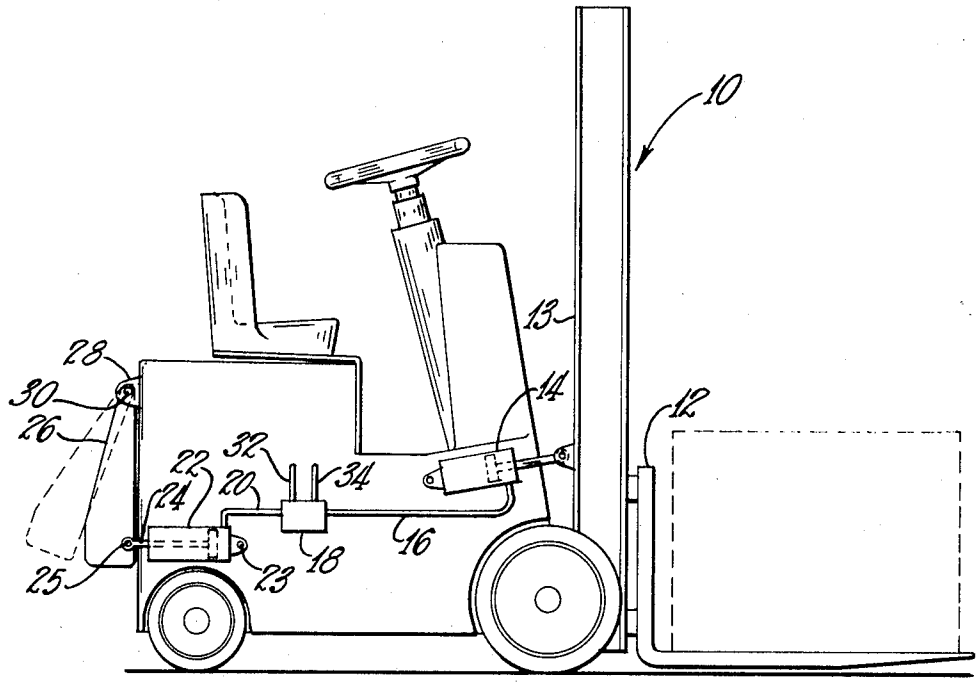


Fig. 1

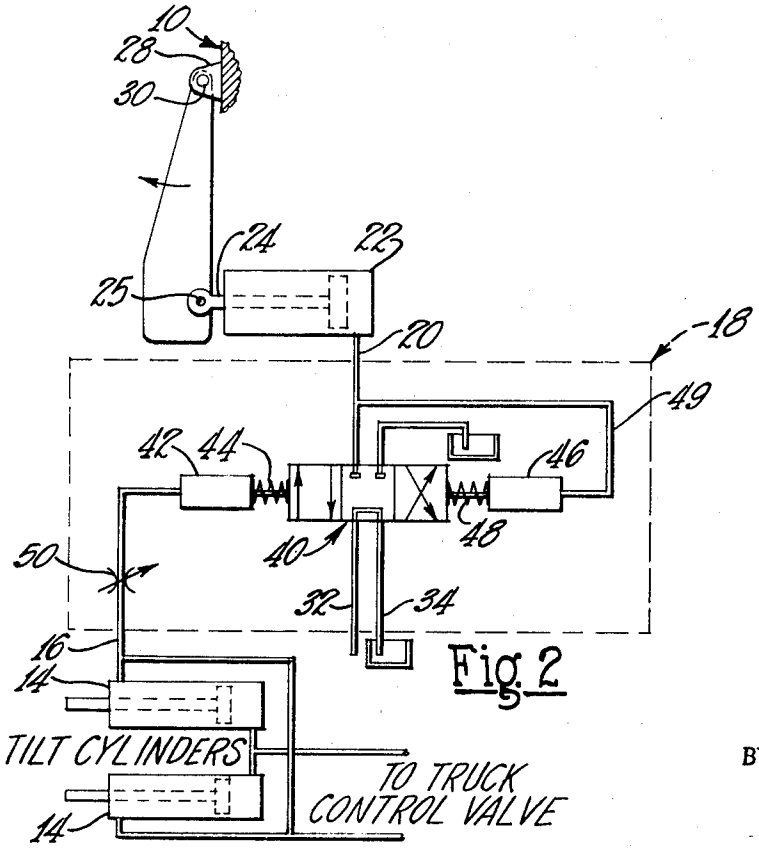


Fig. 2

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VARIABLE CAPACITY LIFT TRUCK

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to industrial trucks of the type having a counterweight which is movable for varying the capacity of the truck.

2. Description of the Prior Art

The most pertinent examples of prior art known to the applicant are U.S. Pat. No. 2,711,227, issued to W. L. Shimmon; U.S. Pat. No. 2,916,172, issued to B. H. Locke; U.S. Pat. No. 3,490,622, issued to Brackin; and U.S. Pat. No. 3,504,933, issued to Avis et al. All of these patents disclose an industrial truck having a counterweight which is shiftable to increase the load carrying capacity of the truck associated therewith. However, in all of the aforementioned patents except the Locke patent, actuation of the means for shifting the counterweight must be the result of a conscious manual act on the part of the truck operator. In these patents, an operator must manually actuate a valve or some other device in order to position the counterweight for most efficient operation of the truck. Thus, it should be evident that these types of arrangements are subject to human error and could result in a dangerous condition if the operator of the truck were to be careless in his adjustment of the counterweight positioning mechanism.

The Locke patent discloses a device which may be either manually actuated by the operator or automatically actuated by a mercury switch if the vehicle is tilted due to an attempt on the part of the operator to cause the truck to lift a load which is beyond the capacity of the lift truck with the counterweight in its then present position. However, this system also has certain obvious disadvantages. First, it should be noted in the Locke patent that no provision is made for automatically returning the counterweight to the position for most efficient operation when the truck has been unloaded. Secondly, the lift truck must be tilted or pivoted about the front axis into an unstable position before the mercury switch will actuate the counterweight positioning mechanism. Furthermore, it would appear that if the lift truck were operated over rough surfaces, as are frequently encountered in the use of industrial trucks, the resultant jostling and bumping could cause the mercury within the switch to continually actuate and deactuate the counterweight positioning mechanism resulting in an unstable condition during movement of the truck by shifting of the counterweight and thus presenting a safety hazard.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an industrial truck having a balanced counterweight which is automatically shiftable by an amount which is a function of the magnitude of the load being lifted.

It is another object of the present invention to provide a new and improved means for positioning the counterweight in an industrial truck and wherein the amount of counterweight movement is proportional to the pressure in a hydraulic load lifting circuit.

It is a further object of the present invention to provide an industrial truck having a counterweight which is automatically shiftable in response to the lifting of a load to provide better stability of said truck when lifting a heavy load and wherein said counterweight is automatically returned to the no-load position upon removal of the load from said industrial truck.

To accomplish the above objective, the present invention provides an industrial truck of the type having a counterweight which is shiftable in order to vary the capacity of said industrial truck including means for automatically varying the position of the counterweight in a manner which is a function of the magnitude of the load on the lifting mechanism on said industrial truck.

In a preferred embodiment, a pressure tap is connected from the pressurized side of either the load lifting hydraulic ram or the tilt cylinder of an industrial truck through a variable orifice to a pilot operated shuttle valve. Upon the existence of a predetermined amount of force being applied to either the lift or tilt cylinders due to the load, the pilot operated shuttle valve is actuated to connect a hydraulic cylinder attached to the counterweight to a pressurized hydraulic source. Thus, the hydraulic cylinder associated with the counterweight may be actuated by an amount which is a function of the pressure in the tilting or load lifting cylinders of the industrial truck. A variable orifice may be supplied in the hydraulic circuit between the tilt or load lifting cylinders of the industrial truck and the pilot operated valve in order to prevent pressure surges due to operation of the truck over a rough surface, thereby preventing inadvertent actuation of the pilot operated valve. In addition, a second pilot is connected to allow fluid flow out of the counterweight cylinder when the pressure within either the tilt or load lifting cylinders of the industrial truck falls below the pressure in the counterweight cylinder.

Other objects and advantages of the present invention will become more apparent from a reading of the detailed description of the preferred embodiment which follows hereinafter.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevational view of an industrial truck incorporating the mechanism of the instant invention.

FIG. 2 is a schematic hydraulic circuit disclosing one method of incorporating the instant invention into an industrial truck.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIG. 1, there is shown a standard industrial truck **10** having a pair of forks **12** or the like for lifting a load as shown in phantom. The forks **12** carrying the load are adapted to be raised and lowered in a standard manner along the mast **13** by means of a hydraulic cylinder (not shown) under the control of a vehicle operator. The industrial truck further includes a tilt cylinder **14** pivotally attached between the mast **13** and the frame of the industrial truck for tilting the mast under the control of a vehicle operator in a standard manner well-known in the art, thereby moving the load supported on the forks relative to the industrial truck. Since the load lifting and tilt cylinder control mechanisms are well-known in the art and form no part of the invention of the instant application, further description of these portions of the industrial truck and the hydraulic circuits associated therewith will not be undertaken at this time. It is sufficient to note that the load disposed on the forks **12** may be raised and lowered along the mast **13** under the control of a vehicle

operator and further that the mast 13 may be tilted toward or away from the main frame of the industrial truck. Although the means for automatically adjusting the position of the counterweight of the instant invention could be used in conjunction with the pressure in the load lifting mechanism of the industrial truck, for purposes of the preferred embodiment of the present invention, automatic operation of the counterweight positioning means has been connected to be operated in response to pressure in the tilt cylinder 14. It should be noted that tilting of the mast 13 will pivotally raise and lower the load on the forks 12 relative to the industrial truck 10.

In the instant invention, a conduit 16 has been connected from the pressure side of the tilt cylinder 14 to a pressure responsive control mechanism 18. The pressure responsive control mechanism 18, is in turn connected by means of a conduit 20 to a second hydraulic cylinder 22 pivotally attached to the frame of the vehicle by means of a pivot pin connection 23 as shown in FIG. 1. A piston rod 24 of the hydraulic cylinder 22 is in turn connected by means of a pivot pin connection 25 to a movable counterweight 26 disposed at the rear of the industrial truck as shown in FIG. 1. The counterweight 26 is in turn pivotally supported on the frame of the industrial truck by means of a boss 28 having a pivot pin 30 passing through both the boss 28 and the counterweight 26. Although the counterweight 26 could be mounted on the industrial truck in many various ways, such as sliding rails or the like, for purposes of the preferred embodiment, the pivotal connection supplied between the boss 28 and the pivot pin 30 has been used.

The control mechanism 18 has been supplied with conduits 32 and 34 for adapting the control mechanism 18 to be connected to the normal hydraulic circuit of the industrial truck 10. One of the conduits 32 is thereby adapted to provide pressurized fluid to the control mechanism 18, while the other conduit 34 is adapted to return hydraulic fluid from the control mechanism 18 to the reservoir of the industrial truck , all which will be well understood by those skilled in the art to which this invention pertains.

Referring now to FIG. 2 wherein there is shown a schematic hydraulic circuit incorporating the mechanism of the instant invention for a more complete understanding of the hydraulic connections and apparatus within control mechanism 18 which may used to accomplish the objects of the present invention.

FIG. 2 shows in schematic the tilt cylinders 14 of the industrial truck 10. The tilt cylinder 14 is connected by means of the conduit 16 to control mechanism 18 for providing a pressure signal to actuate control mechanism 18. Upon actuation of control mechanism 18, fluid will flow through conduit 20 to pressurize the second hydraulic control cylinder 22 thereby moving the counterweight 26 pivotally attached to the frame of the industrial truck 10 as described above.

The automatic hydraulic control mechanism 18 includes a three-position, four-way closed center valve 40. The valve 40 is a pilot operated, spring centered shuttle valve having a first pilot 42 and associated spring 44 and a second pilot 46 and associated spring 48. The springs 44 and 48 are effective to maintain the spool of the valve 40 in the center or closed position when no pressure exists on either of the pilots 42 or 46. The pilot 42 is connected by means of conduit 16 to the rod end of tilt cylinders 14 whereby pressure in the tilt cylinder 14 may be effective to actuate the pilot 42 thereby moving the spool of shuttle valve 40 to the right as shown in FIG. 2 upon pressurization of the tilt cylinders 14. Conversely, pressure actuated pilot 46 is connected by means of a conduit 49 internally of the control mechanism 18 to sense hydraulic pressure in conduit 20, thereby adapting pilot 46 to move the spool of shuttle valve 40 to the left as shown in FIG. 2 to recenter valve 40 when the proper feedback pressure is reached. The internal hydraulic connections which result from movement of the spool of the closed center three-position four-way valve 40 should be evident to those skilled in the art from the standard hydraulic representations designated by flow arrows as shown on the valve 40.

For purposes of eliminating pressure fluctuations in the pressure signal from tilt cylinders 14 to pilot 42 due to operation of the industrial truck over rough surfaces, a variable orifice 50 has been incorporated internally of the hydraulic control mechanism 18 in the conduit 16 between the rod end of tilt cylinder 14 and pilot 42.

The importance of the previously described hydraulic connections and apparatus will become more fully apparent from the description of operation of the preferred embodiment which follows hereinafter.

DESCRIPTION OF OPERATION

Upon pressurization of the tilt cylinders 14, a pressure signal passes through conduit 16 to pilot 42 thereby actuating pilot 42 to move the spool of the shuttle valve 40 to the right against spring 48. This movement will connect conduit 32 associated with the pressurized hydraulic system of the industrial truck to conduit 20 thereby pressurizing hydraulic cylinder 22 to begin moving counterweight 26. As counterweight 26 moves outwardly and upwardly, the pressure in hydraulic cylinder 22 increases thereby increasing a feedback pressure in conduit 49 communicating with pilot 46. When the counterweight 26 has moved outwardly and upwardly a sufficient amount, the back pressure in cylinder 22 and resulting feedback pressure in conduit 49 through its connection with conduit 20, will cause this back pressure to actuate pilot 46 to return the spool of valve 40 to its normally centered position. This will shut off the flow of hydraulic fluid from conduit 32 through valve 40 to the counterweight cylinder 22. Since the shuttle valve 40 is of the closed center type, the hydraulic fluid within cylinder 42 will remain in a pressurized state maintaining counterweight 26 in a position which is a function of the hydraulic pressure in tilt cylinders 14 and conduit 16.

Upon lowering of the load on the forks 12 of the industrial truck 10 and release of the hydraulic pressure in the tilt cylinders 14 and conduit 16, the back pressure in cylinder 22 resulting from displacement of counterweight 26 will act on pilot 46 through conduit 49 to move the spool of the pilot operated shuttle valve 40 to the left as shown in FIG. 2. This movement will connect conduit 20 to conduit 34 thereby allowing the pressurized hydraulic fluid contained in counterweight cylinder 22 to flow back through valve 40 and conduit 34 to reservoir, thus permitting counterweight 26 to pivot downwardly and to the right as shown in FIG. 2 to its normal lowered position.

If the industrial truck to which the hydraulic circuit of the instant invention has been incorporated is oper-

ated over a rough surface it should be realized that the pressure in hydraulic cylinders **14** and consequently pressure in conduit **16** will have a tendency to fluctuate due to bouncing and jostling of the load disposed in the forks **12**. This could result in an uneven or jerking pressure signal to pilot **42**. Consequently, it has been found desirable to incorporate a variable orifice **50** into the hydraulic line **16** connecting to pilot **42** to thereby allow adjustment for damping out any rapid pressure fluctuations in conduit **16** and provide for smooth operation of the pilot **42** associated therewith.

Having thus described the invention as to enable one of ordinary skill in the art to practice the teachings disclosed herein, I now claim:

1. In an industrial truck having a load lifting member supported thereon for movement relative thereto, said load lifting member being adapted to support a load thereon; a first hydraulic cylinder operatively mounted between said load lifting member and said industrial truck, said first hydraulic cylinder being adapted to move said load lifting member relative to said industrial truck; a counterweight mounted on said industrial truck, said counterweight being adjustable to various positions for counterbalancing a load which may be supported on said load lifting member; means automatically responsive to the hydraulic pressure in said first cylinder for adjusting the position of said counterweight as a function of the load on said load lifting member; and means for preventing the transmittal of rapid fluctuations in pressure signal from said first hydraulic cylinder to said automatically responsive means whereby said industrial truck may be operated over rough surfaces without affecting the position of said counterweight.

2. The invention of claim **1** wherein said counterweight is pivotally attached to said industrial truck, and including a second hydraulic cylinder operably connected between said industrial truck and said counterweight for moving said counterweight in response to actuation of said automatically responsive means whereby said counterweight may be moved by an amount which is a function of the load on said load lifting member.

3. The invention of claim **2**, wherein said means for automatically adjusting the position of said counterweight comprises a pilot operated shuttle valve having a first pilot for moving said shuttle valve in one direction, a first conduit communicating between said first hydraulic cylinder and said pilot for actuating said shuttle valve in response to pressure in said first hydraulic cylinder, a second conduit communicating between said shuttle valve and said second hydraulic cylinder, and a third conduit communicating between said shuttle valve and a pressurized source of hydraulic fluid on said industrial truck, whereby movement of said shuttle valve in response to actuation of said first pilot will cause hydraulic fluid to flow from said pressurized source to said second hydraulic cylinder for moving said counterweight.

4. The invention of claim **3** including pressure damping means disposed in said first conduit for preventing the transmittal of rapid fluctuations in pressure signal from said first hydraulic cylinder to said first pilot.

5. The invention of claim **3** wherein said means for automatically positioning said counterweight further comprises a second pilot adapted for moving the spool of said shuttle valve in the other direction, and a fourth conduit communicating between said second pilot and said second conduit to thereby enable said second pilot to move the spool of said shuttle valve in the opposite direction upon the existence of a predetermined pressure relationship between said fourth conduit and said first conduit.

6. The invention of claim **5** wherein said second pilot is operable in response to the existence of pressure in said fourth conduit higher than the pressure in said first conduit for moving the spool of said shuttle valve to relieve the pressure in said second hydraulic cylinder thereby returning said counterweight toward the initial unloaded position.

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