

[54] **FORK LIFT LEVELING CONTROL**
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[51] Int. Cl. **B66c 23/62**
[58] Field of Search 187/9, 17; 212/8, 212/145, 39; 214/673, 138 C

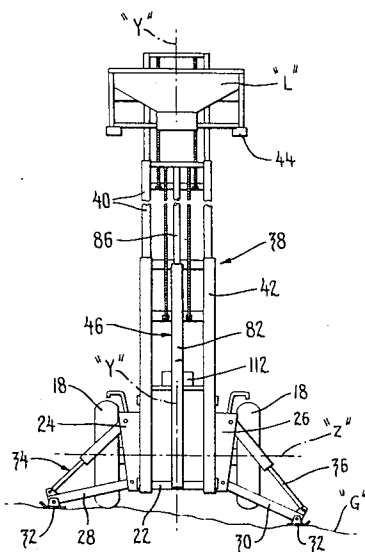
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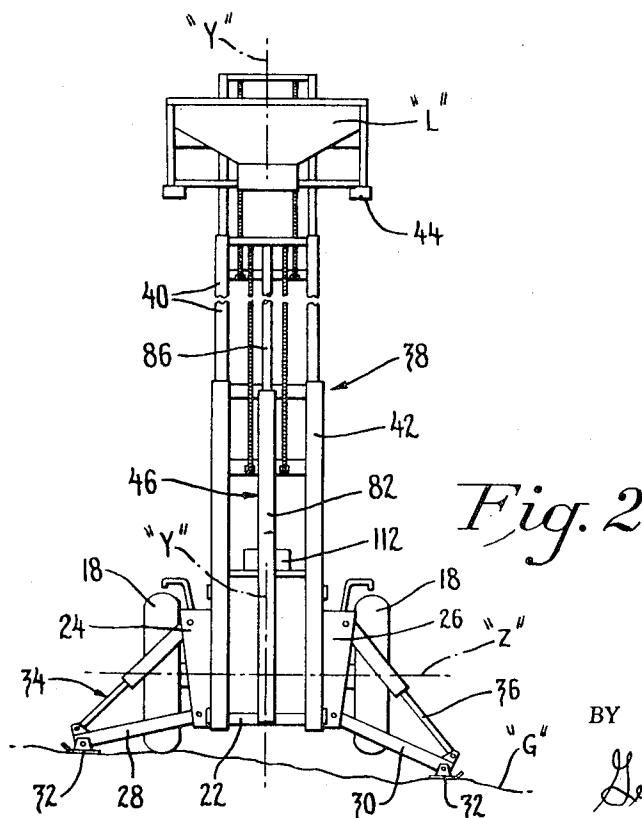
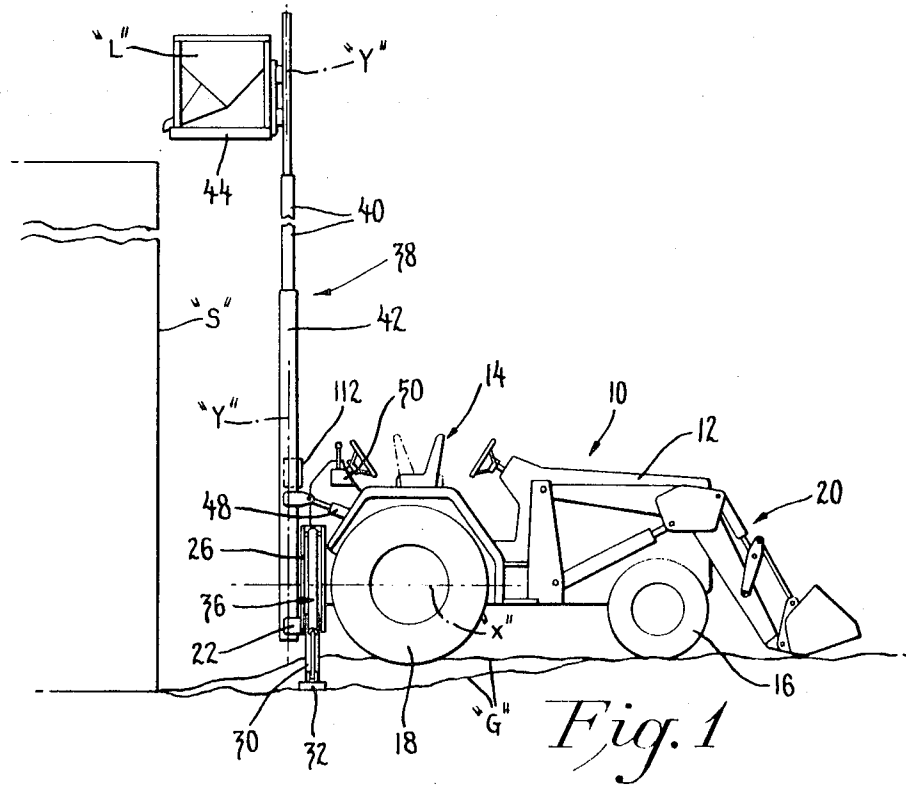
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[57] **ABSTRACT**

A load-lifting mechanism for fork-lift type load handling device which is equipped with power actuated extendable links for adjustable support of the device on the ground and automatic control means including a vertical level sensing device interconnected between the load lifting mechanism of the device and the extendable links for automatic adjustment of the extendable links in response to an inclined position of the load lifting device while simultaneously interrupting movement of the load until the lifting device is brought back into level position.

2 Claims, 3 Drawing Figures





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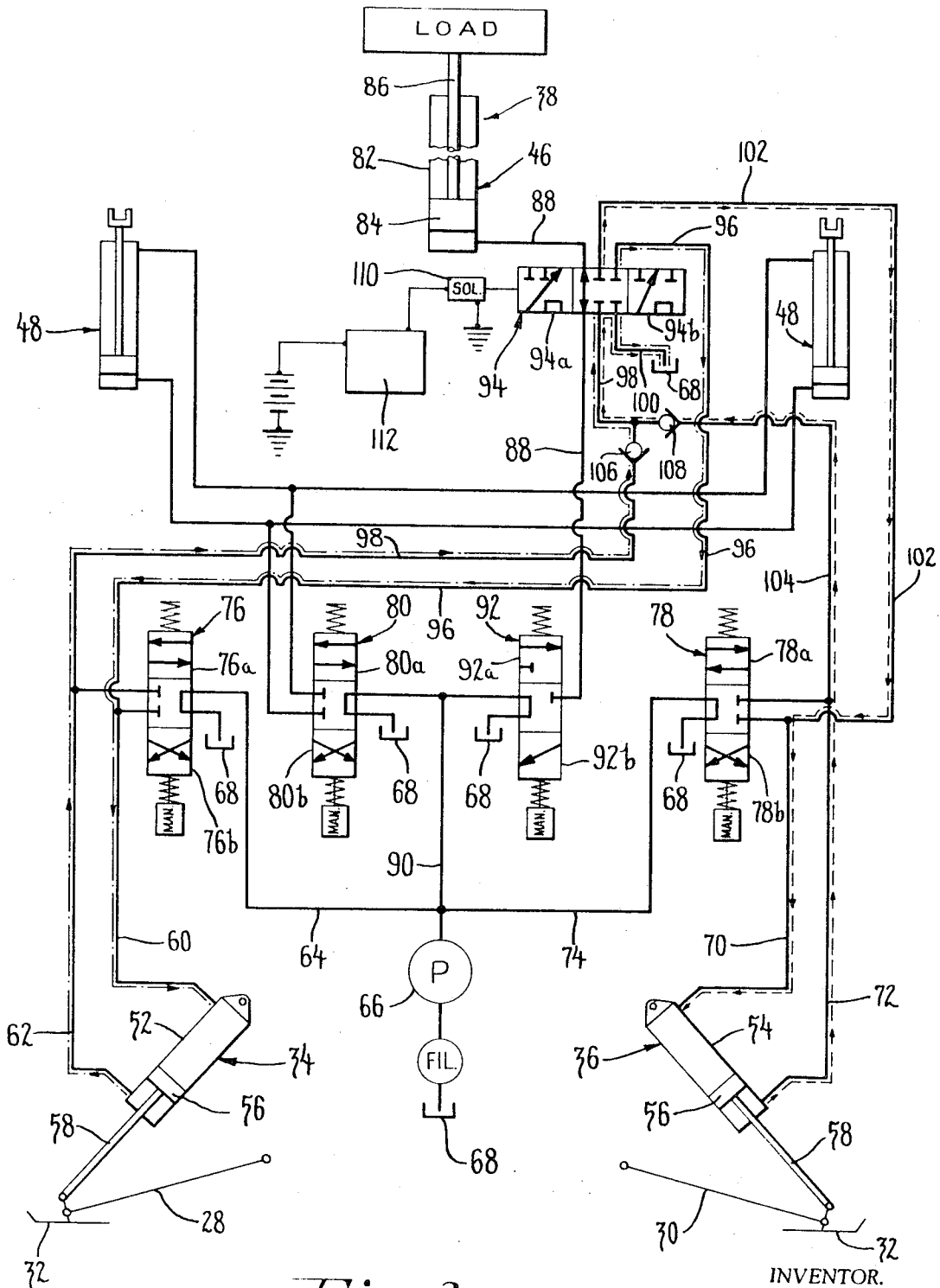


Fig. 3

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FORK LIFT LEVELING CONTROL

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to control mechanism for fork-lifts or the like and more in particular to an automatic adjustment mechanism for the load lifting mast of a load handling device.

Forklift trucks are commonly known and widely employed in industry for transport of a load from one location to another. Most of the fork-lift trucks are provided with vertical columns or masts along which the load can be lifted to a predetermined height level for deposit or removal of the load at high locations.

Although forklift trucks are most commonly employed in plants, warehouses, or storage facilities which generally have level ground surfaces, there is also a demand for these type of load handling devices to be employed outdoors or in facilities having uneven ground surfaces.

In the latter application and particularly when utilizing a load lifting column or mast of extreme height and when operating on an uneven ground surface, it becomes mandatory to maintain the load being carried by the high mast in a level, i.e., straight vertical position to prevent spilling of the load or subsequent tipping-over of the fork-lift truck towards one or the other side.

In the past it has been found extremely difficult to incorporate suitable control means for load handling devices of this type to maintain the load on the load lifting mast in a level position. Herebefore, a variety of manual or mechanical adjusting mechanisms have been proposed to assist in maintaining the load lifting mast in correct vertical position for prevention of spilling of the load or tipping over of the vehicle. These known mechanisms are time consuming to operate, add weight to the vehicle and are sometimes difficult to install within the existing vehicle structure.

The present invention provides improved automatically operable load levelling means for a load handling device of the type employing an upright column or mast along which the load has to be raised or lowered, preferably along a vertical center relative to the ground surface on which the device is operating. The present improved mechanism can be comparatively easily installed and can be advantageously coordinated with already existing vehicle support and levelling means.

Accordingly, it is the primary object of the present invention to provide improved automatic load levelling means for a load handling device including a sensing device associated with the load lifting mechanism for adjusting the vertical position of the load lifting means and which is automatically effective to actuate the load levelling mechanism of the load handling device to maintain the load lifting means in correct vertical position while at the same time stopping movement of the load along the load lifting means.

It is another object of the present invention to provide in a load handling device outwardly extending ground supporting stabilizing means which are independently adjustable by manual control means for load supporting engagement upon the ground surface and which are additionally automatically adjustable relative to an inclined position of the load lifting means of the device to adjust the load lifting means into correct vertical position.

It is a further object of the present invention to provide a load handling device of the fork-lift type which is equipped with a power actuated load lifting means and a pair of opposite power actuated ground support stabilizing means and having an automatic level sensing and control device incorporated between the power actuated load lifting means and stabilizing means for automatic individual adjustment of the stabilizing means in response to a respective inclination of the load lifting means for correction of the vertical position of the latter.

In the present instance the improved control means of the invention for vertical adjustment of the load lifting means are incorporated in a tractor-type vehicle having front steering wheels and a pair of rear driving wheels. The load lifting device is attached to the rear end of the vehicle adjacent the rear driving wheels and the vehicle includes a pair of laterally extending stabilizer arms which are fluid actuated for stabilizing support on the ground. The load lifting means is in the form of an extendable mast which supports a load carrying member for vertical movement of the load along the mast to deposit a load onto or remove a load from elevated locations. The load lifting device is similarly fluid actuated from a common source of fluid under pressure and an automatic fluid control means in conjunction with a sensing device is incorporated between the fluid mechanism of the load lifting device and the fluid mechanisms of the stabilizer arms to (1) individually adjust anyone or both of the stabilizer arms in response to an inclined position of the load lifting device and (2) prevent vertical movement of the load along the load lifting device when the load lifting device is in an inclined position to thereby prevent spilling of the load or subsequent tipping-over of the vehicle.

The above objects and other features of the present invention will become more fully apparent by the following detailed description in reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate a preferred embodiment of the invention in which:

FIG. 1 is a side elevation of a load handling device including an upright load lifting means shown in extended position and incorporating the features of the present invention;

FIG. 2 is a rear end view of the load handling device of FIG. 1 shown in laterally adjusted operating position and;

FIG. 3 is a fluid diagram of the hydraulic system embodied in the present invention.

DETAILED DESCRIPTION OF THE INVENTION

With reference to the drawings, the load handling device illustrated in FIG. 1 and 2, in the present instance, comprises a tractor 10 having an engine compartment 12 and an operator station 14. The tractor vehicle 10 is suitably supported for movement on a pair of ground engaging front wheels 16 and a pair of rear driving wheels 18.

As for example illustrated in FIG. 1, tractor vehicle 10 may be of the front-end loader type commonly employed on construction sites for material removing and may thus be equipped with a front end bucket mechanism 20. Bucket mechanism 20, however, does not form any part of the present invention other than con-

veniently providing a counter-balancing means as will be described.

Commonly, front-end loaders of the type herein illustrated, may be selectively provided with a rear attachment, such as a back-hoe implement or the like, to provide various operating functions, for convenience and economy.

In the present instance, the rear end of tractor 10 is provided with an auxiliary support frame 22 extending transverse to a longitudinal center line "X" of the tractor. Mounted to the rear end frame 22 are a pair of opposite laterally extending brackets 24 and 26 respectively as seen in FIG. 2.

The lower ends of each of the brackets 24-26 pivotally secure each an outwardly extending stabilizer arm 28 and 30 respectively and each is provided at its outer end with a pivotable ground support pad 32. During travel of tractor vehicle 10, stabilizer arms 28-30 will be swung upwardly away from the ground whereas in stationary operating position of tractor vehicle 10, as illustrated in FIG. 1 and 2, stabilizer arms 28-30, as is known, will be swung downwardly for contact of support pads 32 upon the ground surface "G" to laterally stabilize tractor vehicle 10. As indicated in the figures, ground surface "G" may be relatively uneven in both transverse and longitudinal direction of tractor vehicle 10 requiring either stabilizer arm 28 or 30 to be disposed at a different angle relative to the other stabilizer arm.

As is common practice, stabilizer arms 28-30 are actuated for swinging movement towards or away from ground "G" by means of extendable link members 34 and 36 respectively which each have one end pivoted to the outer end of the respective stabilizer arm whereas the opposite ends of extendable links 34-36 are pivotally secured to the upper end of the respective side brackets 24-26 as most clearly shown in FIG. 2.

In the present instance, the auxiliary rear end frame 22 of tractor vehicle 10 supports a load lifting device generally indicated at 38. Load lifting device 38 comprises a vertically extendable column or mast assembly 40 comprised of a series of telescoped sections extendable from or retractable relative to a primary mast portion 42. The extendable mast assembly 40 supports a load carrying means as, for instance, a fork lift assembly 44.

Any other load support means such as platforms, gripper arms or the like may be incorporated instead. Load support means 44 is adapted to carry a load "L" for deposit on or removal from an elevated location such as the upper deck of a structure generally indicated at "S" to the left in FIG. 1.

The load "L" is adapted to be moved in vertical direction along extendable mast assembly 40 between the ground "G" and a designated elevated position, as is known in practice. Vertical movement of load "L" along mast assembly 40 is provided for by means of an extendable link 46 connected between the rear end frame 22 and the load "L" as seen in FIG. 2.

As is known, mast assembly 40 may be pivotable around a horizontal axis "Z" relative to rear end frame 22 and is supported for forward and aft tilting movement by means of extendable links 48 connected between the mast assembly and tractor vehicle 10. The load lifting device 38 is operated by means of controls 50 at the rear of tractor vehicle 10 forming a part of the operators station 14.

With more particular reference now to the schematic diagram in FIG. 3 each of the extendable links 34-36 for the stabilizer arms 28-30 comprise a fluid cylinder 52 and 54 respectively having a piston 56 reciprocally supported therein to which is attached a piston rod 58 for extension outwardly therefrom.

The rear end of fluid cylinder 52 of left hand stabilizer arm 28 is in communication with a conduit 60 and the front end of cylinder 52 is in communication with a conduit 62 for connection to the source of fluid under pressure by means of common conduit 64. The source of fluid under pressure may comprise a pump 66 and a reservoir 68 supported in the tractor vehicle 10.

Similarly, the fluid cylinder 54 of right hand stabilizer arm 30 is in communication with rear end conduit 70 and front end conduit 72 for selective fluid connection to the pump 66 by means of conduit 74.

The left hand stabilizer assembly 28-34 includes a left hand stabilizer selector valve 76 between the conduits 62-60 and conduit 64 for selective fluid communication of either conduit 62-60 with conduit 64 and pump 66. Left hand selector valve 76 is normally spring biased in closed position as shown in FIG. 3 and is manually shiftable between two operating positions 76a and 76b. In position 76a of valve 76 the rear end conduit 60 is connected to reservoir 68 and front end conduit 62 will be in fluid connection with conduit 64 and pump 66 to apply fluid pressure to the front end of cylinder 52 for raising movement of stabilizer arm 28. Shifting valve 76 to position 76b connects rear end conduit 60 with pump conduit 64 to apply fluid pressure at the rear of piston 56 for lowering of stabilizer arm 28. In this position, front end conduit 62 will be connected to the reservoir 68.

The right hand stabilizer assembly 30-36 is similarly provided with a right hand stabilizer selector valve 78 normally closed and manually shiftable between two operating positions 78a and 78b. Operation of right hand stabilizer selector valve 78 is identical to that of selector valve 76 as described above and, therefore, does not need to be repeated. Conventionally, manual control of stabilizer selector valves 76 and 78 is provided for at the control 50 in operator station 14 of the vehicle (FIG. 1).

Conventional lift mast tilt cylinders 48 are similarly fluid connected to pump 66 for conjoint operation by means of a common tilt selector valve 80 between tilt cylinders 48 and pump 66. Tilt selector valve 80 is of identical construction as valves 76-80 and manually shiftable between two operative positions 80a or 80b for selective application of fluid pressure to either the front end or rear end of tilt cylinders 48 as previously described in connection with stabilizer selector valves 76-78.

The extendable link 46 of load lifting device 38 similarly comprises a fluid cylinder 82 having a piston 84 reciprocally therein and a piston rod 86 for extension outwardly of cylinder 82 for connection to the load. Cylinder 82 of load lifting device 38 is selectively connectable by means of single fluid conduit 88 at the rear of piston 84 to a pump conduit 90 for selective application of fluid pressure to the rear end of cylinder 82 for raising of the load or, conversely, bleeding fluid from the rear of cylinder 82 back into reservoir 68 by means of pressure of the load on piston 84 to lower the load. The foregoing functions of lift cylinder 82 and controlled by a lift selector valve 92. Lift selector valve 92

is similarly manually operable between two operative positions 92a or 92b from the normally closed position shown in FIG. 3 by provision of suitable control means at the control station 50, the same as selector valves 76, 78 and 80. In the shifted position 92a of selector valve 92, conduit 88 will be connected to pump conduit 90 to apply fluid pressure behind piston 84 of cylinder 82 for lifting of the load. It will be understood that it is conventional practice to provide the front end of lift cylinder 82 with suitable air venting means (not shown) in order to dissipate atmospheric pressure in front of piston 84.

When shifting lift selector valve 92 from position 92a to position 92b direction of fluid flow will be reversed, i.e., fluid flows from rear end of cylinder 82 back into reservoir 68 due to the pressure on piston 84 by means of the load.

It shall be mentioned here that all of the manually operable selector valves 76, 78, 80 and 92 are normally biased in neutral or closed position, as shown in FIG. 3, so that upon each initial shifting of the respective selector valves from the controls 50, the selector valves will either remain in the shifted position if suitable lock means are provided or, conversely, they are automatically returned to the neutral or closed position after initial pressurized adjustment of cylinders 48, 52 or 54.

The primary feature of the present invention lies in the provision of automatic controls to automatically shift and retain the load in correct vertical position along a vertical line "Y" normal to the horizontal axis "Z" of the load handling device 10.

The present improved automatic load levelling control means comprises a load levelling control valve 94 disposed between the lift cylinder 82 and lift selector valve 92. In the normal operating position of load levelling control valve 94, as shown in FIG. 3, fluid communication is provided between the rear end of lift cylinder 82 and conduit 88 so that upon shifting of selector lift valve 92 into the appropriate position fluid communication is established between lift cylinder 82 and pump 66, or reservoir 68, as previously described.

Automatic load levelling control valve 94 is shiftable between two alternate positions, indicated at 94a and 94b, for selective fluid communication of pump 66 with either left hand stabilizer cylinder 52 or right hand stabilizer cylinder 54 in response to an inclined position of load lifting device 38. Thus, as load levelling control valve 94 is shifted to position 94a conduit 88 will be fluidly connected to conduit 96 which is in direct communication with conduit 60 of the left hand stabilizer cylinder 52 and by-passing left hand stabilizer selector valve 76. In this position of load levelling control valve 94, as indicated in FIG. 3 by means of dot and dash lines, fluid pressure communication is provided to the rear of piston 56 of left hand stabilizer cylinder 52. Front end conduit 62 of stabilizer cylinder 52, in this position, is connected by means of conduit 98, and conduit 100 to the reservoir 68 by means of a by-pass through valve 94. In the shifted position indicated at 94a fluid communication into or out of lift cylinder 82 will be blocked to thereby prevent or temporarily interrupt movement of the load along the mast assembly 40.

When load levelling control valve 94 is shifted to the position 94b conduit 88 will be fluidly connected to the rear end of right hand stabilizer cylinder 54 by means of conduit 102; by-passing the right hand stabilizer selector valve 78. In this position of load levelling control

valve 94, which is indicated in dash lines in FIG. 3, the front end of the right hand stabilizer cylinder will be fluidly connected by conduit 72 and by-pass conduit 104 to reservoir 68 by means of the same conduit 100 as in the previous position. In this position similarly, fluid communication to or from lift cylinder 82 through valve 94 is temporarily blocked to stop movement of the load along the mast assembly 40 until the inclined lateral position of the mast assembly is corrected.

Fluid conduits 98 and 104 communicate with the reservoir 68 in either shifted position of load levelling control valve 94 and are protected against back-flow of fluid pressure by means of appropriate conventional check valves 106 and 108 respectively.

Load levelling control valve 94 is automatically shifted from its normal position shown in FIG. 3, to either position 94a or 94b by means of an actuator such as solenoid 110 which in turn is connected for push or pull actuation to a position sensing device 112 of conventionally known structure. Thus, sensing device 112 may be of the hydraulically damped pendulum type or may be an electrical mercury switch for appropriate push or pull energization of solenoid 110 in response to either right or left lateral inclination of load lifting device 38 due to uneven ground conditions upon which the vehicle 10 is supported. Sensing device 112 is appropriately attached to the lifting device 38, as shown in FIG. 1 and FIG. 2, so as to be operable to pick-up a designated degree of inclination of the load lifting device 38 in response to the uneven ground conditions as illustrated in FIG. 1 and 2.

In operation of the present improved control mechanism the vehicle 10 (conventional lift truck or tractor as the case may be) is moved into operating position adjacent a load receiving or storage station "S." The opposite stabilizer arms 28-30 are then swung downwardly by means of actuation of stabilizer cylinders 52-54 through manipulation of stabilizer cylinder valves 76-78 for contact of pads 32 upon the ground "G." Appropriately the front end implement 20 is lowered onto the ground surface "G" by suitable hydraulic or mechanical means to provide a convenient counterbalance for the rear end load lifting device 38 during load lifting operation. It will be understood that the conventional front implement 20 may be substituted by an appropriate counterbalancing device, as is known.

As indicated in FIG. 1 and 2, ground "G" provides uneven surface elevations relative to the horizontal axis "Z" of the vehicle 10. Thus, in order to correct the vertical position of load lifting device 38 so as to prevent slipping of the elevated load "L" or tipping-over of the load handling device due to displacement of the center of gravity, the stabilizer arms 28-30 will have to be adjusted independently of each other to move the mast assembly 40 into a safe vertical position i.e., parallel to vertical line "Y."

With reference to FIG. 2, if not adjusted, the load lifting device 38 would be sharply inclined towards the right in FIG. 2 due to the uneven ground condition. Such an inclination of load lifting device 38 will be detected by sensing device 112 which then functions to energize solenoid 110 for appropriate repositioning of load levelling control valve 94. Repositioning of control valve 94 from normal to the position 94b (indicated by dash lines in FIG. 3) causes temporary interruption of fluid communication between lift cylinder 82 and pump 66. Such interruption will occur in ei-

ther position 94a or 92b of lift selector valve 92 to stop movement of the load along the mast assembly 40. Simultaneously, in position 94b, conduit 88 is connected through conduits 102 and 70 to the rear end of right hand stabilizer cylinder 54 for further extension of extendable link assembly 36 in order to upright load lifting device 38 until it is parallel to vertical line "Y."

As explained earlier, the front end of the right hand stabilizer cylinder 54 in the position 94b of valve 94 will then be connected by conduits 72, 104, 98 and 100 to the reservoir 68 for back-flow of fluid from the front end of cylinder 54 due to reduced chamber volume by fluid pressure at the front end of cylinder 54. In this position, check valve 108 effectively prevents any back-flow of fluid from reservoir 68.

Extension of right hand stabilizer cylinder 54 in the manner described above and independent of left hand stabilizer cylinder 52, causes the right rear wheel 18 to be lifted from the ground as shown in FIG. 1 and 2.

Thus, it will be obvious from the foregoing disclosure in connection with the illustrations in the drawings that the present invention provides an improved, fully automatic, load levelling means for a vertical load lifting device which is immediately responsive to a predetermined inclination of the load lifting device to correct this condition by utilization of existing levelling means associated with the load handling device while at the same time temporarily interrupting load movement along the load lifting device until the inclined position is corrected.

Although the present invention has been described by means of a preferred embodiment it will be obvious to anyone skilled in the art to make various modifications in detail and structural arrangement without departing from the spirit and essential characteristic of the invention as defined by the scope of the appended claims.

What I claim is:

1. In a load handling apparatus on a vehicle having a mast stabilized by hydraulically extensible ground engaging stabilizer arms on opposite sides of the mast, a manually operated control valve for each arm and a power source, an automatic control system for stabilizing the mast comprising: a sensing device for detecting angular deviation of the mast to either side of the vehicle of the load handling apparatus to a vertical axis, an actuator for receiving a signal from said sensing device, a hydraulic valve operated by said actuator for overriding the stabilizer arm manual valve by directing two-way flow to either one of the stabilizer arms around the manual control valves by connecting the stabilizer arms to the power source whenever said sensing device detects angular deviation of the mast in the direction of either one of the stabilizer arms.

2. In a load handling apparatus on a vehicle having a load lifting device for raising or lowering of a load, and ground engaging hydraulically extensible stabilizer arms to prevent the load handling apparatus from leaning toward either side of the vehicle, a load leveling system comprising a source of power for actuation of the adjustable stabilizer arms and power control means including an inclination sensing device for detecting angular deviation to either side of the vehicle of the load handling apparatus to a vertical axis, a leveling control and an actuator connecting said sensing device with said leveling control, said leveling control selectively connecting said power source to the adjustable stabilizer arms and the load lifting device upon a signal from said sensing device to said actuator to automatically prevent movement of the load lifting device and actuate an adjustable stabilizer arm whenever a predetermined side inclination of the load handling apparatus toward an adjustable stabilizer arm occurs.

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