

Jan. 8, 1952

W. M. GILMAN
INDUSTRIAL LIFT TRUCK

2,581,791

Filed June 18, 1949

4 Sheets-Sheet 2

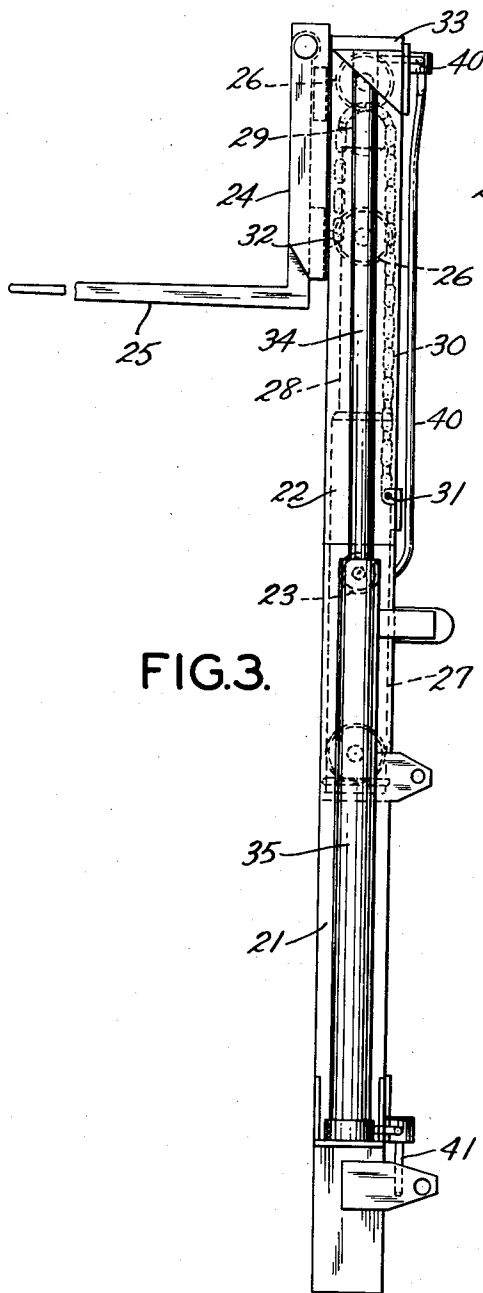


FIG. 3.

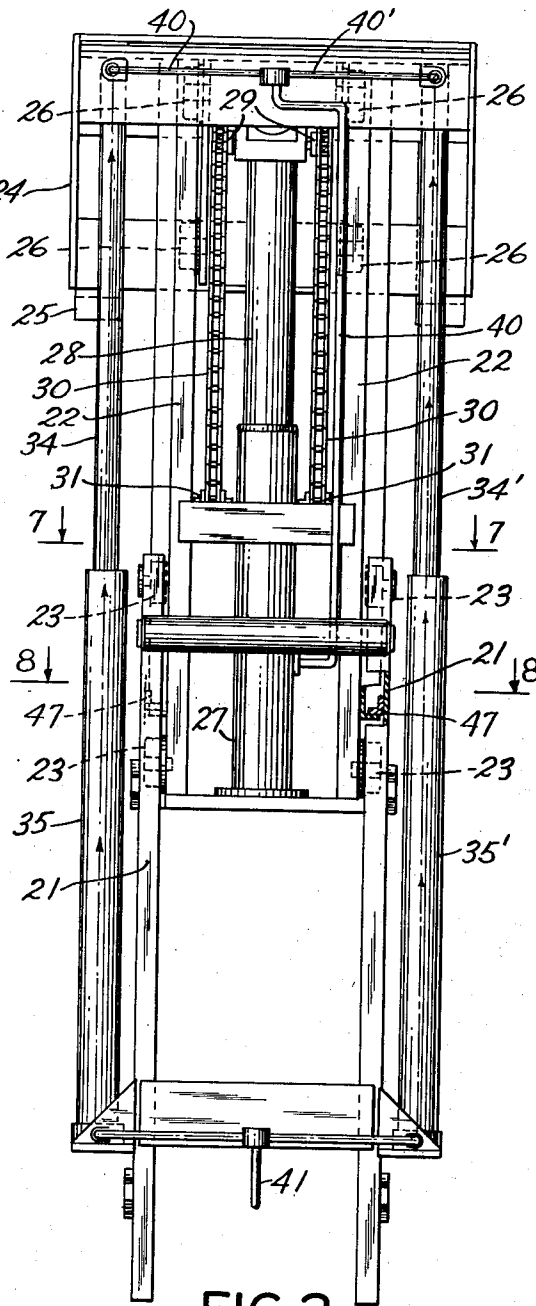


FIG. 2.

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FIG. 4.

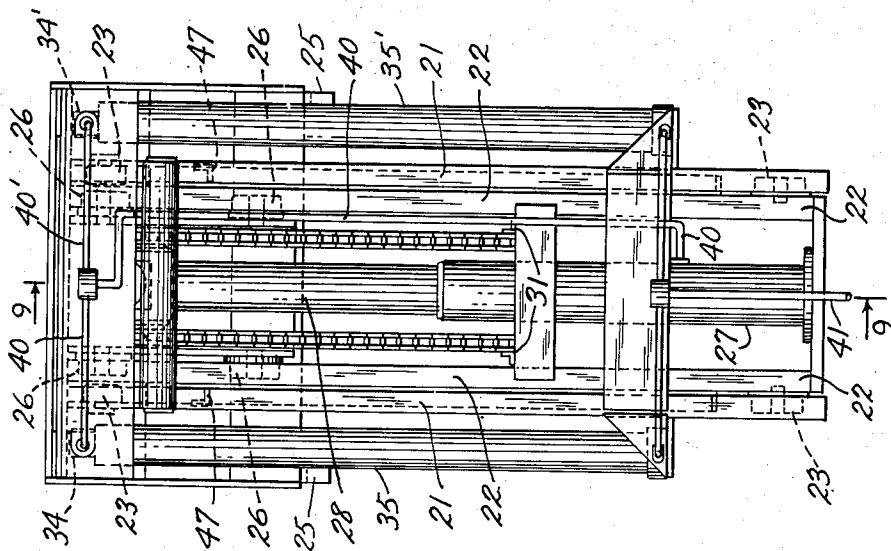


FIG. 6.

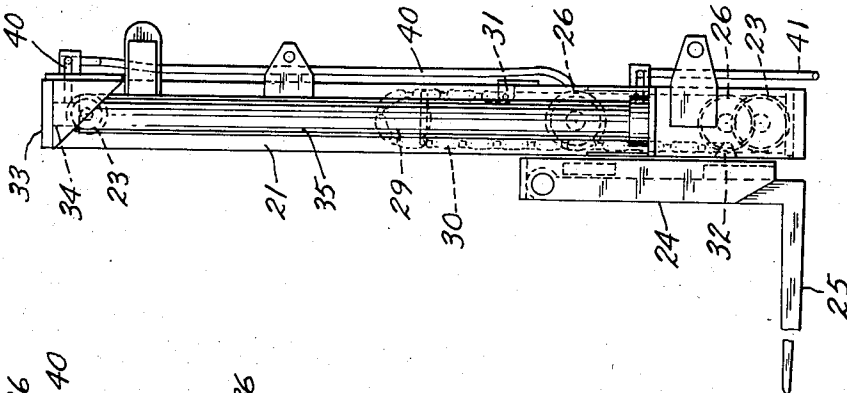
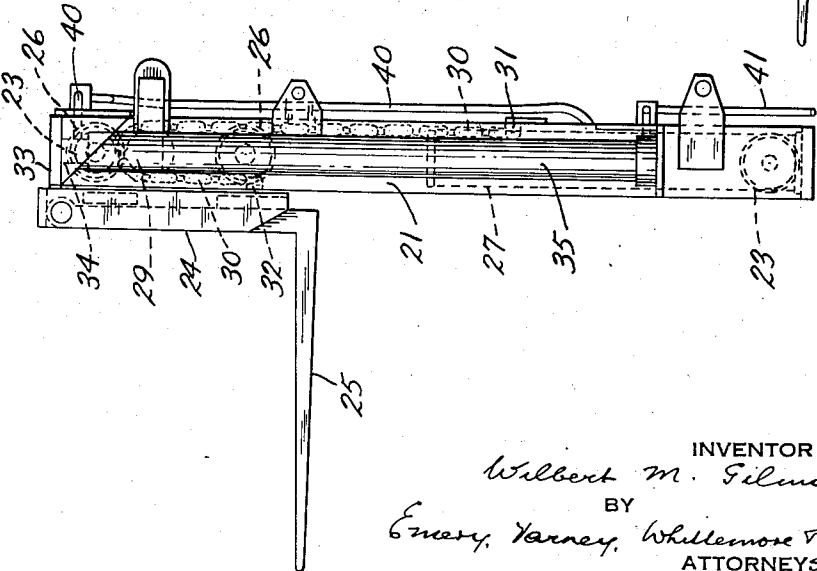


FIG. 5.



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FIG. 10.

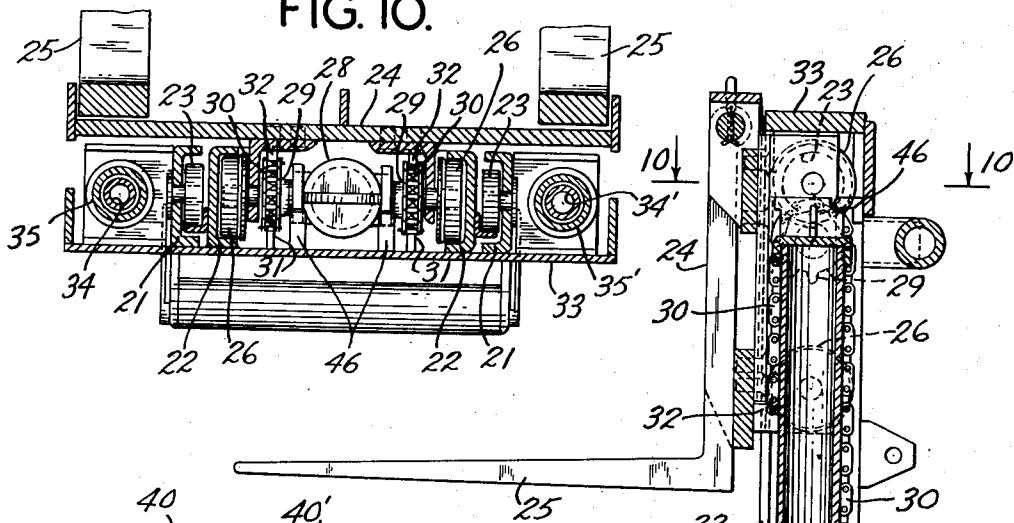


FIG. 11.

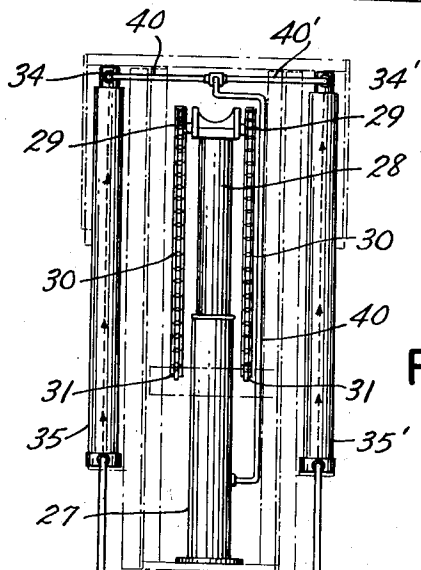
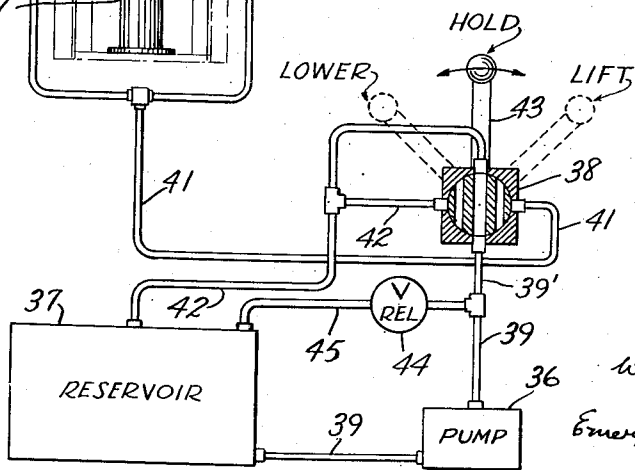


FIG. 9.



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2,581,791

INDUSTRIAL LIFT TRUCK

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Application June 18, 1949, Serial No. 100,018

13 Claims. (Cl. 187-9)

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This invention relates to improvements in lift trucks usable for high-stacking, loading of freight cars, and like purposes and in which, for convenience in loading, the load-carrier is customarily provided with a pair of forwardly projecting forks so that when the load-carrier is in its lowermost or loading position the forks will be substantially at floor level and can be shoved under the load like a scoop to pick it up. More particularly, the present improvements are based on a type of truck of the general character aforesaid and sometimes referred to as the "full-free lift" type, wherein the truck body is provided at its front end with a mast having a vertically extendible portion to increase its effective length, and wherein hydraulically-operated means are employed to raise the load-carrier from the bottom to the top of the extendible portion of the mast and then, with the load-carrier supported and held at the top of the extendible portion, raise the extendible portion to its upper or extended position on the mast.

In the specific type of truck just referred to, it is desirable that the hydraulic pressure line employed in the lifting mechanism shall not require the inclusion of flexible hose connections, since the constant flexing of such hose incidental to its use in these trucks, and the wear and tear thereon, rapidly leads to its deterioration, if not to actual rupture thereof, and thus substantially increases the expense of servicing the trucks; and the principal object of the present invention is so to organize the lifting mechanism as to eliminate the need for any flexible hose whatever.

In the accompanying drawings, Fig. 1 is a perspective view of a lift-truck in which the invention has been incorporated, the mast on the forward end of the truck-body being shown in its collapsed position; Fig. 2 is a rear elevation of the mast which is shown in its fully extended position, and on a slightly larger scale than that of Fig. 1; Fig. 3 is a side elevation of the mast also shown in its fully extended position; Fig. 4 is a view similar to that of Fig. 2 but with the mast shown in its collapsed position and with the load-carrier raised thereon; Fig. 5 is a side elevation corresponding to the rear elevation of Fig. 4; Fig. 6 is a side elevation similar to that of Fig. 5 except that the load-carrier is shown in its lowermost or loading position; Figs. 7 and 8 are detail sections, the planes of these sections being indicated respectively by the lines 7-7 and 8-8 of Fig. 2; Fig. 9 is a central vertical section through the mast on a still larger scale, the plane of this section being indicated by the

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line 9-9 of Fig. 4; Fig. 10 is a transverse section the plane of which is indicated by the line 10-10 of Fig. 9; and Fig. 11 is a view indicating diagrammatically the hydraulic pressure line, control valve and the relation of that valve to the reservoir, pump and rams.

In the present embodiment of the invention shown in the drawings, the mast comprises two frames one of which telescopes within the other, and both of which are disposed in a plane transverse of the truck body 20; the outer one 21 of these frames constitutes the main portion of the mast and is attached to the forward end of the truck body, while the other or inner frame 22 is connected to the outer frame so as to be vertically extendible thereon and thus may be referred to as the extendible portion or simply the extension of the mast. The upright members of both these frames are preferably channel-irons as shown; and guide rollers 23, carried by either frame and having bearing contact with the other, provide means not only for keeping the frames in operative contact while the inner moves on the outer, but also for reducing friction caused by their relative movement.

The load-carrier 24, desirably of the type having forks 25 projecting forwardly from its lower edge so that when it is in its lowermost or loading position, these forks will be at floor-level for convenience in loading, traverses the inner frame 22, similar guide rollers 26 being provided on that frame for bearing contact on the carrier, or vice versa, to guide the carrier as it moves on said frame and to reduce the friction of their relative movement.

To raise the carrier along the inner frame or extendible portion 22 of the mast in order to lift it from its loading position to its upper position on that frame, a hydraulic ram is employed one member of which is fastened to the inner frame or mast extension 22 and its other member operatively connected to the carrier. As shown in the present embodiment of the invention, it is the cylinder 27 of said ram that is fastened to the inner frame or mast extension 22, and the plunger 28 thereof that is connected to the carrier; and as here shown, the connection to the carrier comprises a pair of pulleys or idler wheels 29 carried by the upper end of the plunger 28 and a pair of cables or chains 30 passing respectively over the pulleys or idler wheels, one end of each of said cables or chains being attached at 31 to the inner frame or mast extension 22 and the other end thereof secured at 32 to the carrier.

The outer frame or main portion 21 of the mast also has a ram, or preferably as shown in the present drawings, a pair of rams which are disposed symmetrically in the same transverse plane aforesaid, one on each side of the ram 27. One member of each ram of that said pair is fastened to the outer frame or main portion 21 of the mast and the other or movable member is disposed in such operative relation to the inner frame or mast extension 22 that it operates directly upon the latter and causes the latter to move concurrently with and at the same speed as said movable member. One way of bringing this about is to support the inner frame directly on said movable member or members as by attaching a cross-piece 33 to the upper end of the inner frame or mast extension 22 and securing the upper ends of the two movable members of said pair of rams directly to said cross-piece. As shown in the drawings, the members of said pair of rams which are secured to said cross-piece in the present embodiment of the invention are the plungers 34 and 34', their other members, namely, their cylinders 35 and 35' being fastened to the outer frame or main portion 21 of the mast. Where a pair of rams, such as 35 and 35', mounted on the outer frame or main portion 21 of the mast are used in lieu of a single ram so mounted, the hydraulic system may be referred to as a three-ram system to distinguish from a two-ram system which would be the case if a single ram replaced the pair 35 and 35' aforesaid. And for a purpose which will appear hereinafter in describing the operating sequence of the respective rams while lifting the carrier and inner frame, the sum of the cross-section areas of the pistons of the pair of rams 35, 35' (or if a single ram be substituted therefor, the cross-section area of its piston) should be less than the cross-section area of the piston of ram 27, and preferably substantially equal to one-half the cross-section area of the piston of ram 27.

Irrespective of whether the invention be embodied in a two-ram system or in a three-ram system, the cylinders of all the rams in the system are included in and constitute a part of the hydraulic pressure line having means, such as a pump 36, at one end of said line, to cause fluid to flow from a reservoir 37 on the truck body to the ram, or pair of rams as the case may be, mounted on the outer frame 21 and thence to the ram 27 carried by the inner frame 22, said ram 27 thus constituting the other end of the pressure line. The pump and means, such as a valve 32 to control the flow of the fluid aforesaid, are installed in a pipe-connection 39 leading, as shown in the present embodiment of the invention, from the reservoir to the respective cylinders of the pair of rams 35 and 35'.

In accordance with the present invention, the plungers 34 and 34' of said pair of rams are hollow and their interior spaces communicate with their respective cylinders on the one hand and on the other hand with the cylinder of the ram 27 carried by the inner frame 22, for which purpose a pipe-connection 40, 40' is provided. Thus, the said pressure line, as here shown, comprises that part of the pipe-connection 39 which extends from the discharge end of the pump to the rams 35, 35', the cylinders of these rams, the hollow plungers 34, 34' of these rams, the pipe-connection 40, 40', and the cylinder of the ram 27. With the pressure line thus constituted, the hydraulic connection between the pair of rams 35, 35' and the ram 27, that is, the pipe-

connection 40, 40', may be a rigid connection notwithstanding that the ram 27 must be capable of movement relative to said pair of rams; and this is of considerable advantage since it permits the use of inflexible pipe for the connection 40, 40' as distinguished from flexible hose which, under the constant flexing and wear and tear to which it is subject in lift trucks of this type, rapidly deteriorates if indeed the internal pressure to which it is also subject does not actually cause it to rupture. Thus, the possibility of using inflexible rather than flexible hose substantially reduces the expense of servicing such trucks.

The control valve 38 may be and preferably is a three-way valve of the open-center type and is provided with three external pipe-connections, to wit: connection 39' to the discharge end of the pump, a connection 41 to the respective cylinders of rams 35, 35', and a connection 42 to the reservoir 37. And said valve has three operative positions controlled respectively by a lever 43 which may be pivoted on the truck body in a location readily accessible to the operator. When this lever is in the position denoted "Lift" in the drawings, the control valve will be in a position to connect the discharge end of the pump with the respective cylinders of the rams 35, 35' through the connection 39' and the connection 41; and when in this position the control valve will block off the connection 42 to the reservoir. When said lever is in the position denoted "Hold" in the drawings, the control valve will be in position to connect the discharge end of the pump with the reservoir through the connection 39' and the connection 42; and when in this position the control valve will block off the connection 41 to the cylinders of the rams 35, 35'. When said lever is in the position denoted "Lower" in the drawings, the control valve will be in position to connect the cylinders of the rams 35, 35' with the reservoir through the connection 41 and the connection 42; and when the control valve is in this position, it is immaterial whether or not it blocks off the connection 39' to the pump, for in either case, though the pump continues to operate, it will merely draw fluid from the reservoir and return it directly thereto either through the control valve itself or through a relief-valve 44 installed in a pipe 45 connecting the discharge end of the pump directly to the reservoir. Said relief-valve will also serve as a safety device since it may be adjusted to come into operation whenever the load on the carrier exceeds the capacity for which the apparatus was designed to operate with safety.

It will of course be understood that a motor (not shown) is provided to drive the pump and, if the truck is of the power-propelled type, that a motor (not shown) will also be provided for its propulsion, together with driving and steering mechanism (not shown) mounted on the truck body so that the operator, either standing or sitting in the truck, can maneuver the latter from place to place for loading and discharging the load. Moreover, the operator may obtain a clear view ahead for steering, by lowering the inner frame 22 either when the truck is loaded or when free of load; for this will leave a free space between the side members of the outer frame 21, as shown in Fig. 1. And since the frame members 21 and 22 of the mast are disposed in the same transverse plane, the fore and aft dimension of the space needed for installation of the mast on the truck body will be small, thus tending to reduce the over-all length of the

truck and make it more readily maneuverable in restricted areas. Also, it is to be noted that with the pair of rams 35, 35' on the outer frame 21, disposed symmetrically one on each side of the ram 27 on the inner frame 22, and with said frames and rams all lying in the same transverse plane, and with the inner frame connected to the outer frame by securing the top cross-piece 33 to the plungers 34, 34', the outer frame and the inner frame will mutually reinforce and strengthen each other and the outer rams and outer frame will increase the stability of the inner ram and inner frame.

The entire space within the pressure line is at all times filled with the hydraulic fluid, and when the truck is idle the lever 43 will generally be left in the position marked Hold thereby sealing off the pressure line. While the truck is being loaded, said lever will also generally remain in its Hold position although if the loading occurs while the carrier is in its lowermost position, said lever may be either in its Hold or in its Lower position. Assuming now that the carrier has picked up a load, the operation of lifting the carrier to its discharging position and holding it there until the load has been discharged, and then lowering it again, is as follows: The pump motor, unless already operating, is first put into operation to actuate the pump. Then the lever 43 is shifted into the position marked Lift; this moves the control valve 38 into position to connect the discharging end of the pump with the cylinders of the outer rams 35, 35' whereupon fluid is caused to flow from the reservoir through the pump and control valve in pipe 39, 39' and on into the pressure line. Since the sum of the areas of the pistons of the rams 35, 35' is substantially equal to one-half the area of the piston of the ram 27, this flow of fluid into the pressure line will first cause the plunger of ram 27 to rise which, through the chains 30, will in turn lift the load-carrier and cause it to traverse along the inner frame 22 until its traverse on that frame is checked either by moving the lever 43 to its Hold position or by a detent or detents 46 on the inner frame in the path of the carrier. When the lever 43 is moved to its Hold position it halts the further movement of the load-carrier relative to the inner frame or mast extension 22 because in that position the control valve 38 checks the flow of fluid to the pressure line; but when the movement of the load-carrier relative to the inner frame or mast extension 22 is halted by the detent or detents 46 the flow of fluid is not checked but continues to flow to the pressure line. In the latter case, the elevation of the load-carrier relative to the inner frame or mast extension 22 will be checked independently of the position of the control valve 38. Such detent or detents will generally be placed in a position on the inner frame to check the movement of the carrier only when it reaches the top of the inner frame, but may, if desired, be placed at any other point on that frame. As soon as the traverse of the carrier on the inner frame has been checked by the detent 46, and assuming that the lever 43 remains in its Lift position so as to permit the flow of fluid to the pressure line to continue, the plungers 34, 34' of the pair of outer rams 35, 35' will immediately commence to rise and cause the inner frame 22, together with the load-carrier attached thereto, to move vertically and provided the lever 43 still remains in its Lift position, will continue so as to move until that frame reaches its fully extended position whereupon, any fur-

ther upward movement of the inner frame will be checked by a detent or detents 47 thereon engaging the top of the outer frame 21. When the inner frame has reached its fully extended position, or if before it has reached that position, the load-carrier has been raised to the desired height for discharging the load, the lever 43 is moved from its Lift to its Hold position which brings the control valve 38 into position to block any further communication of the rams with the pump or reservoir and thus the rams hold the carrier and inner frame in their raised positions while the load is being discharged. The subsequent lowering of the inner frame and carriage is effected by moving the lever 43 from its Hold to its Lower position which brings the control valve 38 into position to connect the rams directly with the reservoir through the pipe-connection 41 and the pipe-connection 42 and in which position the weight of the carrier, inner frame and its ram, idler wheel and chain connections, together with the weight of the plungers of the outer rams, force enough fluid from the pressure line back into the reservoir to permit the carrier and inner frame to return to their starting or loading positions. It is unnecessary of course that the pump be kept in operation during the lowering period but its continuous operation during that period will not affect the result.

The lifting operation just described may be said to consist of two stages, first the raising of the carrier alone, and second the raising of both the carrier and inner frame together. During the first lifting stage in which the carrier is raised to the top of the inner frame, the lifting force exerted by the pump will be opposed by the combined weight of the load, the carrier, the plunger of the inner ram, and the idler wheels and chains attached to said plunger, if the slight opposing force due to friction be neglected. During the second lifting stage, the only additional weight opposing the lifting force exerted by the pump, again neglecting friction, will be the weight of the inner frame, the cylinder of the inner ram, and the hollow plungers of the outer rams. It is indeed due to this weight differential and the fact that the combined piston areas of the outer rams is substantially equal to one-half the piston area of the inner ram, that causes the plunger of the latter to complete its lifting stroke before the plungers of the outer rams begin theirs. Since, however, this weight differential will be small in comparison with the total weight opposed to the action of the pump during each lifting stage, the carrier will move from its lower or loading position to its upper or discharging position at a substantially uniform speed throughout, that is, with no marked difference between its speed during one lifting stage and its speed during the other. And the same will be true in lowering the carrier to its loading position again, for after a load has been discharged and the lever 43 shifted to the position marked Lower, the carrier and inner frame will first move downward together as their combined weight forces the fluid in that part of the pressure line between the outer rams and the control valve 38, back into the reservoir. At the end of this stage the inner frame will have reached its collapsed position within the outer frame, and the carrier, without any substantial change in speed, will continue its downward movement since its weight and that of the plunger of the inner ram, idler wheels and chains attached thereto, will force the fluid out of the cylinder of the inner

ram and thus permit the carrier to reach its lowermost position.

I claim as my invention:

1. In a hydraulic lift-truck, the combination of a mast comprising a main portion and a vertically extendible portion, a load-carrier operatively connected to the extendible portion, a hydraulic ram to elevate the carrier upon the extendible portion, a second hydraulic ram to raise the extendible portion upon the main portion of the mast, said second ram having a hollow plunger communicating with both its own cylinder and the cylinder of the first named ram, a fluid reservoir, means to cause fluid to flow from the reservoir to the cylinder of said second ram, and means to check the elevation of the load-carrier relative to the extendible portion of the mast without checking the flow of fluid to the cylinder of said second ram.

2. The combination set forth in claim 1 and further characterized by this: that the means to cause fluid to flow from the reservoir to the cylinder of said second ram comprises a pump and that the means to control said flow of fluid comprises a valve.

3. The combination set forth in claim 1 and further characterized by this: that the cylinder of the first named ram is fastened to the extendible portion of the mast, that the plunger of the first named ram is operatively connected to the carrier, that the cylinder of said second ram is fastened to the main portion of the mast, and that the plunger of the second named ram is secured directly to the extendible portion of the mast.

4. In a hydraulic lift-truck, the combination of a mast comprising a main portion and a vertically extendible portion, a load-carrier operatively connected to the extendible portion, a hydraulic ram to elevate the carrier upon the extendible portion, a pair of hydraulic rams to raise the extendible portion upon the main portion of the mast, each ram of said pair having a hollow plunger communicating with its own cylinder and the cylinder of the first named ram, a fluid reservoir, a pump to cause fluid to flow from the reservoir to the respective cylinders of the rams of said pair, and means to check the elevation of the load-carrier relative to the extendible portion of the mast without checking the flow of fluid to the cylinders of said pair of rams.

5. In a hydraulic lift-truck, the combination of a mast provided with a vertically extendible portion, a load-carrier movable on said extendible portion, a hydraulic ram one member of which is fastened to said extendible portion and the other member operatively connected to said carrier, a second hydraulic ram provided with a hollow plunger which communicates at one end with its cylinder and at the other end with the cylinder of the first named ram, and said second ram having its said cylinder and its said plunger fastened respectively to said mast and the extendible portion of said mast, a fluid reservoir, a pipe-connection between said reservoir and the cylinder of said second ram, a pump and a control valve in said connection, a pipe-connection between the hollow plunger of said second ram and the cylinder of the first named ram, and means to check the flow of fluid to said second ram independently of said control valve.

6. In a hydraulic lift-truck, the combination of a mast provided with a vertically extendible portion, a load-carrier movable on said extendible portion, a hydraulic ram one member of which is fastened to said extendible portion and the

other member operatively connected to said carrier, a second hydraulic ram having a hollow plunger which communicates with both its own cylinder and the cylinder of the first named ram, and said second ram having its said cylinder fastened to said mast and its said plunger in operative relation to the extendible portion of said mast, a fluid reservoir, a pipe-connection between said reservoir and the cylinder of said second ram, a pump and a control valve in said connection, an inflexible pipe-connection between the hollow plunger of said second ram and the cylinder of the first named ram, and means to check the flow of fluid to said second ram independently of said control valve.

7. In a hydraulic lift-truck, the combination of a mast provided with a vertically extendible portion, a load-carrier movable on said extendible portion, a hydraulic ram one member of which is fastened to said extendible portion and the other member operatively connected to said carrier, a pair of hydraulic rams each having a hollow plunger which communicates with its cylinder and with the cylinder of the first named ram, and each of said pair of rams having one of its members fastened to said mast and its other member secured directly to the extendible portion of said mast, a fluid reservoir, a pipe-connection between said reservoir and the cylinder of each ram of said pair, a pump and a control valve in said connection, an inflexible pipe-connection from the cylinder of the first named ram to each of the hollow plungers of said pair of rams, and means to check the flow of fluid to said pair of rams independently of said control valve.

8. A hydraulic lift-truck comprising, in combination, a truck body, a mast thereon comprising a main portion secured to the truck body and an extension movable upon the main portion, a load-carrier movable on the extension, a fluid reservoir, a pressure line including means to cause and means to control the flow of fluid thereto from the reservoir, a hydraulic ram in said pressure line one member of which ram is fastened to said extension and the other member operatively connected to said carrier, means to check the movement of said carrier relative to said extension at a given point on said extension without checking the flow of fluid to said pressure line, and a second hydraulic ram in said pressure line one member of which second ram is fastened to the main portion of the mast and the other member of said second ram operating directly on the extension of said mast, and one of the members of said second hydraulic ram consisting of a hollow plunger communicating with both its own cylinder and the cylinder of the first named ram.

9. A hydraulic lift-truck comprising a truck body, a mast having a main portion and an extension movable longitudinally on the main portion, a load-carrier movable longitudinally on said extension, a ram carried by and movable with said extension and the plunger of which is operatively related to the load-carrier to lift the latter on said extension, a second ram supported on the main portion of said mast and the plunger of which is operatively related to said extension to elevate the latter on the main portion of said mast, a reservoir, a conduit connecting the reservoir with the cylinder of said second ram, and a conduit connecting said cylinder with the cylinder of the other ram, and characterized by this: that the main portion of said mast is longitudinally immovable on the truck body, the reservoir fixed to said body, and the cylinder of

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said second ram fixed to the main portion of said mast so that the relative positions of the reservoir and the cylinder of said second ram remain fixed, whereby the conduit connecting the cylinder of said second ram with the reservoir may be a rigid rather than a flexible connection.

10. The hydraulic lift defined in claim 9 further characterized by this: that the conduit connecting said cylinders passes through the plunger of said second ram, and that the extension of said mast, the cylinder of the first named ram, and the plunger of said second ram are rigidly connected so as to move together as a single integrated unit.

11. A hydraulic lift-truck comprising a body, a mast having a main portion longitudinally immovable on said body and an extension longitudinally movable on said main portion, a load-carrier longitudinally movable on said extension, a ram the cylinder of which is fast to said extension and the plunger of which is operatively related to said load-carrier to raise the latter on said extension, a second ram the cylinder of which is fast on the main portion of said mast and the plunger of which is hollow and operatively related to said extension to elevate the latter on said main portion, a reservoir fixed to said body, a rigid conduit connecting the reservoir with the cylinder of said second ram, and a rigid conduit connecting the hollow plunger of said second ram with the cylinder of the other ram.

12. The hydraulic lift-truck defined in claim 11 and further characterized by this: that the extension of said mast, the cylinder of the first named ram, and the plunger of said second ram

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are all rigidly connected so as to move together as a single integrated unit.

13. A hydraulic lift-truck comprising a truck body, a mast having a main portion and an extension movable longitudinally on the main portion, a load-carrier movable longitudinally on said extension, a ram carried by and movable with said extension and the plunger of which is operatively related to the load-carrier to lift the latter on said extension, a second ram supported on the main portion of said mast and the plunger of which is operatively related to said extension to elevate the latter on the main portion of said mast, a reservoir, a conduit connecting the reservoir with the cylinder of said second ram, and a conduit connecting said cylinder with the cylinder of the other ram, and characterized by this: that the conduit connecting said cylinders passes through the plunger of said second ram, and that the extension of said mast, the cylinder of the first named ram, and the plunger of said second ram are rigidly connected together so as to move as a single integrated unit.

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