Sept. 15, 1959 K. H. MINDRUM 2,904,203

LIFT TRUCK

Filed Dec. 24, 1956 4 Sheets-Sheet 1

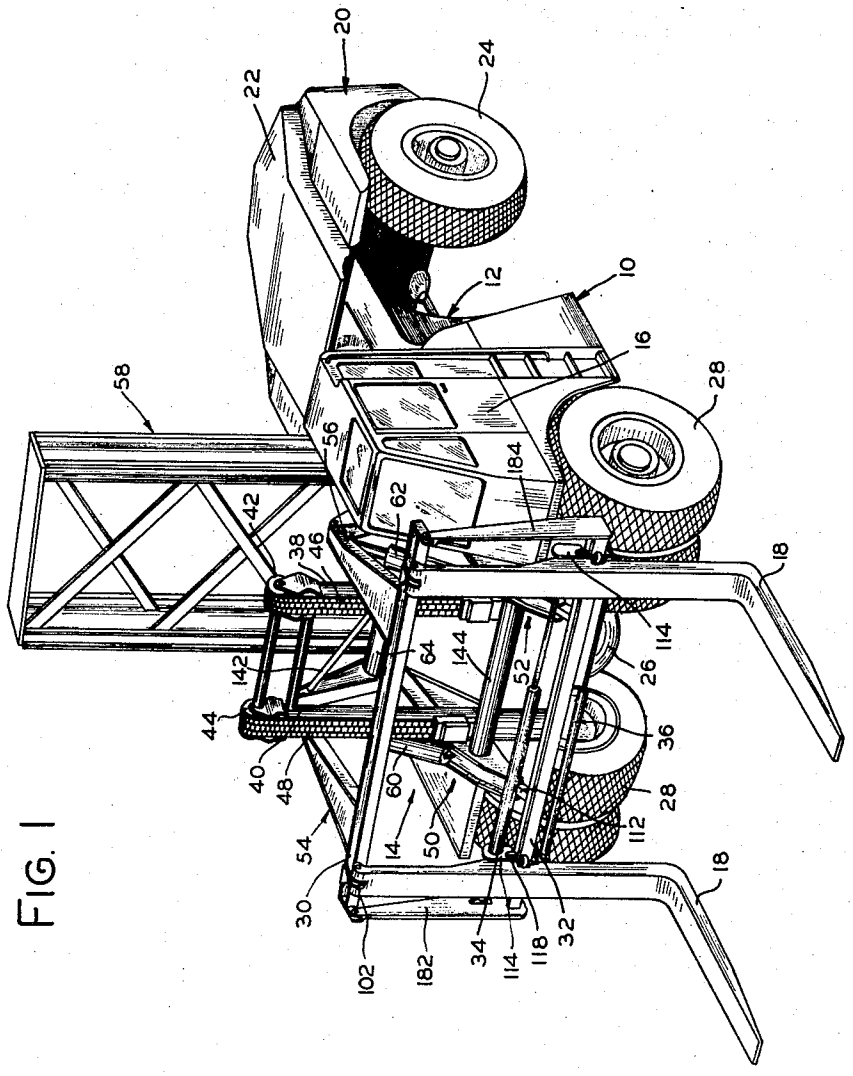

FIG. 1

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LIFT TRUCK

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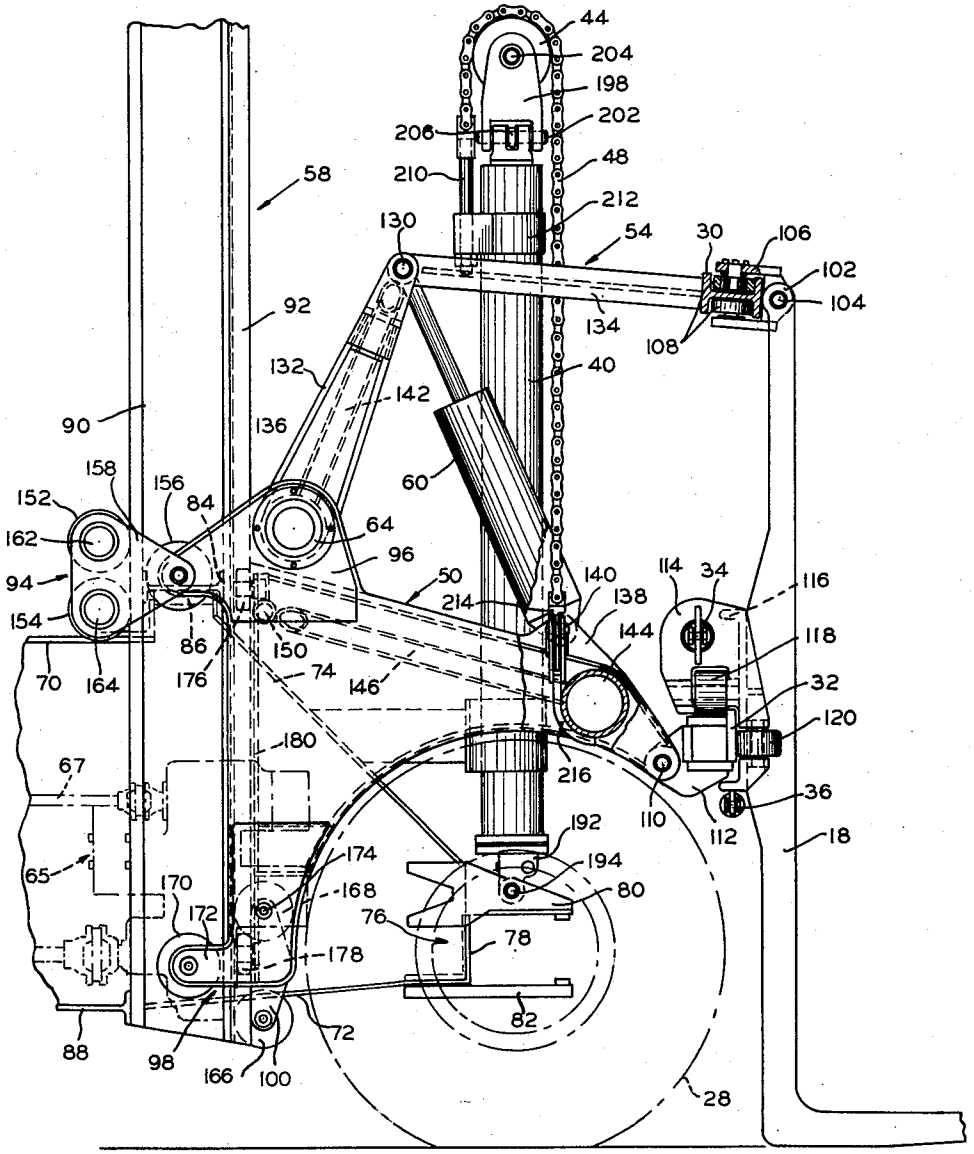
FIG. 2



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LIFT TRUCK

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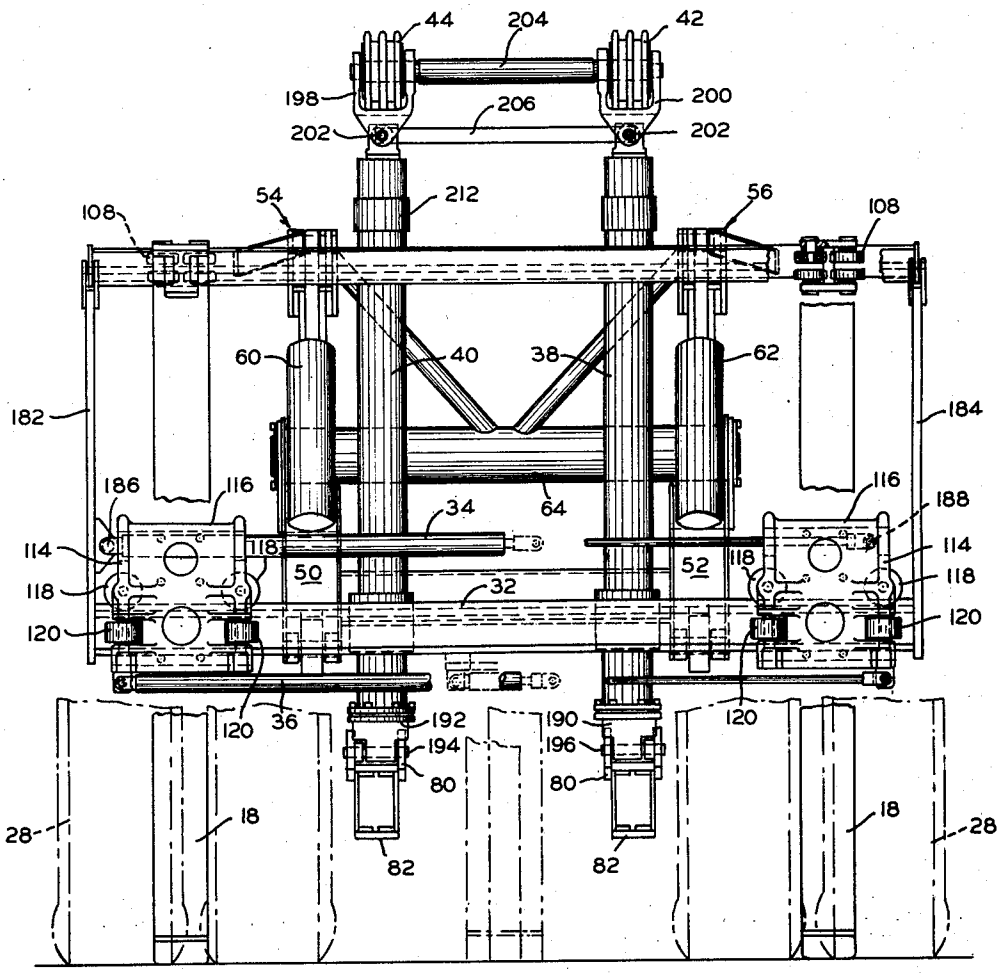
FIG. 3



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LIFT TRUCK

Filed Dec. 24, 1956 4 Sheets-Sheet 4

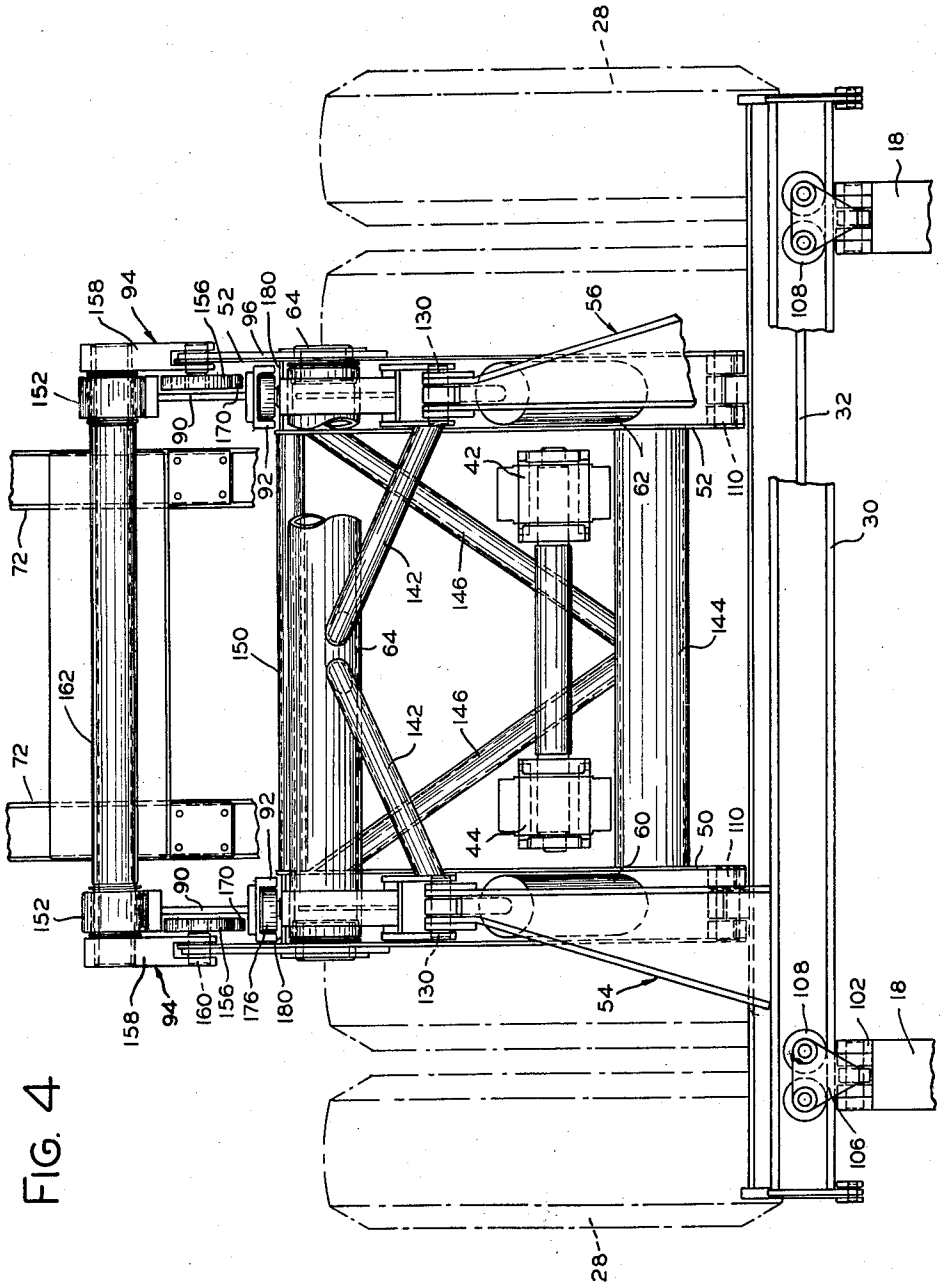

FIG. 4

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2,904,203

LIFT TRUCK

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Application December 24, 1956, Serial No. 630,207

38 Claims. (Cl. 214—731)

This invention relates to lift trucks and more particularly to a novel construction of the lifting mechanism for such trucks.

With the advent of demand in certain industries, such as the steel industry, for larger and larger load handling capacity in materials handling vehicles, it has become necessary to devise a basically new approach to the problems of construction and mounting of lifting apparatus for use with such vehicles. Heretofore such vehicles have generally utilized a hoisting mechanism for elevating fork tines which have been supported and guided by either a telescoping or a non-telescoping mast construction mounted on the vehicle frame or the drive axle housing adjacent to the forward end of the vehicle. As a result of such construction it has been necessary to provide a counterweight at the opposite end of the vehicle of sufficient mass to counterbalance both the rated load to be handled and a substantial portion of the combined mass of the fork tines, hoisting mechanism and mast construction. In very large capacity fork lift trucks, such an arrangement as above described has heretofore necessitated an undesirably long wheel base and/or large and expensive counterweight construction. In addition, as a result of the required length of wheel base, the minimum turning radius of such a truck has been considerably longer than is desired.

I have found that by constructing the lifting apparatus so that the major components thereof i.e., the hoisting mechanism, the fork tines, and the mast structure, are longitudinally spaced in a certain predetermined relation each relative to the others, that the turning radius and the wheel base of the truck may be made substantially less than with prior constructions and that the required mass of the counterweight may be substantially reduced, and that by combining the foregoing arrangement with certain unique features of construction, as will appear below, that a much improved and highly efficient lifting apparatus for lift trucks is provided.

It is therefore an object of my invention to provide improved lifting apparatus for trucks of the type specified constructed in such a manner that the wheel base and/or the counterweight mass are minimized for any such truck of a given load capacity.

It is a further object of my invention to provide lifting apparatus for trucks of the type specified wherein a novel lifting mast is mounted on the truck so as to provide a counterbalance effect on the load normally carried forwardly of the truck, and a novel load hoisting means is spaced longitudinally forwardly of such mast construction.

An additional object of this invention is to provide novel means for shifting laterally the fork tines of a lifting apparatus of the type specified.

Another object of this invention is to provide a lifting apparatus for a lift truck wherein the visibility of an operator is substantially unobscured during operation of the vehicle.

A further object of this invention is to provide a unique upright mast construction for lift trucks.

A still further object of this invention is to provide unique connecting and tilting means between load carrying means and upright mast means of lift trucks.

Another object of this invention is to provide means for synchronizing a plurality of load elevating motor means for use with lift trucks.

Still another object of this invention is to provide novel carriage means for fork tines of lift trucks.

Yet another object of this invention is to provide means for insuring a division of a load carried by a lift truck between a plurality of laterally spaced load elevating motor means.

Still another object of this invention is to provide a generally improved construction of lifting apparatus for trucks of the type specified.

Numerous other objects and advantages of this invention will be readily apparent from the detailed description which appears hereinbelow, when taken in conjunction with the accompanying drawings.

In carrying out my invention I have provided an operator's station which is mounted adjacent a forward corner of the truck body, a lifting mast construction which is mounted on the frame of the truck at a position rearwardly of the front axle thereof, hydraulic load hoisting means which is mounted forwardly of the mast construction and adjacent the axle means, load engaging means which is operatively connected to both the mast construction and to the hoisting means and which is mounted longitudinally forwardly of the hoisting means, and a variety of novel features associated with the foregoing construction.

In the drawings:

Figure 1 is a perspective view of a large capacity industrial lift truck which utilizes my invention;

Figure 2 is a side view in partial section of the forward portion of the truck illustrated in Figure 1, wherein certain parts which are unnecessary to an understanding of this invention have been left out in the interest of clarity;

Figure 3 is a front view in partial section of a part of the construction shown in Figure 2 wherein the lifting mast construction and certain associated parts have been left out, again in the interest of clarity; and

Figure 4 is a top view in partial section of the apparatus shown in Figure 2.

Referring now to the drawings and first to Figure 1, a large capacity lift truck is shown at numeral **10** and comprises a center body portion **12** in which is housed prime mover means such as an internal combustion engine, and a front body portion **14** which includes an operator's station or cab **16** in which a variety of control means are located for controlling tilting and elevating movements of load engaging fork means **18**, for operating the engine in body portion **12** and for controlling the transmission of power to, and the steering angle of a pivotable rear body portion **20** which comprises a counterweight **22** and dirigible wheels **24**, and which is described in detail and claimed in copending application Serial No. 630,197 of William A. Williamson, filed November 24, 1956.

The design of the vehicle shown in Figure 1 is disclosed and claimed in my United States Design Patent No. 181,872, granted to the assignee of the present application on January 7, 1958, for a term of fourteen years.

Generally, the front body portion **14** is suitably mounted upon frame members which are supported by a forward drive axle means **26**, at the opposite ends of which are mounted dual drive wheels **28**. The fork tines **18** are mounted by means of a plurality of rollers upon a transversely extending I-beam **30** and a built-up box-

like member 32 which is spaced vertically below I-beam 30 and runs parallel thereto. Hydraulic cylinder means 34 and 36 (Fig. 3) are provided for effecting lateral adjustment of the forks in a manner to be described. Hydraulic hoist motors or cylinder assemblies 38 and 40 having sheave means 42 and 44 mounted atop the rams thereof are adapted to actuate vertically by means of chains 46 and 48 a pair of generally longitudinally extending bracket means 50 and 52 and a pair of transversely spaced link and lever means 54 and 56, which brackets and link and lever means are suitably connected to an upright mast construction 58 for vertical movement with the fork tines 18, hydraulic hoisting means 38 and 40, and other associated structure. The mast structure 58 is mounted upon the main frame of the truck in a manner to be described. Hydraulic motor means 60 and 62 are pivotably connected at the cylinder ends thereof to bracket means 50 and 52, respectively, and are extensibly connected at the piston rod ends thereof to the link and lever means 54 and 56, respectively, for tilting the fork tines 18 and associated structure out of a vertical plane in either direction about a main transverse pivot or torque tube 64 in a manner to be more fully described hereinafter.

An hydraulic transmission and torque converter assembly 65 (shown in phantom view in Figure 2) is mounted upon the frame of the vehicle near the forward end thereof and is connected to the prime mover by means of a drive shaft 67 and to the drive axle 26 by shaft means, not shown.

Referring now more particularly to the drawings, that portion of the main frame of the truck 10 which I have shown comprises upper and lower longitudinally extending pairs of members 70 and 72, a downwardly and forwardly extending frame member 74, and a forwardly located built-up construction 76 which is adapted to be mounted adjacent the inner wheels of each of the dual wheels 28 upon the arms of the housing of axle means 26. Each frame member 72 terminates at the forward end thereof in an upwardly extending portion 78 which extends transversely of the truck and which connects upper and lower members 80 and 82 of each structure 76. Frame member 74 is connected, as by welding, to the member 80 of each structure 76 at the one end thereof and, by means of a member 86, to a transversely extending I-beam 84 at the opposite end thereof. Member 86 also connects the frame member 70 to the I-beam 84. Extending transversely outwardly of each frame member 72 is another frame member 88 having an I-section, to one of the flanges of which section is connected, as by welding, the rearward flange of a vertically extending I-beam 90 which forms one side of the upright mast construction 58. The I-beam 84 extends between the upright sides 90 of the mast structure 58 for holding same in rigidly spaced relation, and also for connecting mast 58 with the upper frame members 70 and 74, as explained above. Welded to the forward flange of each of the I-beams 90 and extending longitudinally thereof is a channel member 92. The entire frame of the truck is, of course, supported at opposite ends thereof by the front and rear axles of the truck, on which are mounted the wheels 24 and 28, and the body portions 12, 14 and 20 of the truck, including the operator's cab 16 and the counterweight 22, are suitably supported by the truck frame.

In the interest of concisely and clearly describing my invention, I have intentionally omitted a full description of the complete frame and body construction of the truck 10, which does not form a part of my invention except insofar as necessary to provide means for locating and mounting certain components of my lifting apparatus.

The fork tines 18 are operatively connected to opposite ones of the upright I-beams 90 by means of the pair of link and lever means 54, 56, the pair of longitudinally extending bracket means 50, 52, the transversely extending members 30 and 32, a pair of roller assemblies 94 which is connected to opposite ends of the main pivot tube 64 by means of an associated pair of bracket members 96, and a pair of roller assemblies 98 which is connected to the bracket members 50 and 52 by means of a pair of brackets 100. The upper end of the vertical leg of each fork tine 18 terminates in a bifurcated portion 102 which is utilized for pivotally mounting the fork tine upon a pin 104 to which is pivotally connected a bifurcated bracket member 106 upon which is mounted inwardly thereof a pair of rollers 108 which are rollable in opposite channels of the I-beam 30. By means of this construction, rolling friction only is encountered between the fork tine mounting beam 30 and each fork tine 18 during lateral adjustment of the latter.

Each fork tine 18 is also rollably connected in the center portion thereof to the built-up box-like member 32 by means of a bifurcated and generally hook shaped bracket construction 114 (see Figure 3), which is connected to the vertical leg of the fork tine at a thickened portion thereof by a transversely extending channel member 116 and upon which is mounted to the sides thereof a pair of laterally spaced rollers 118 having horizontally extending axes of rotation, and a pair of laterally spaced rollers 120 located below and forward of rollers 118 and having vertically extending axes of rotation. Suitable sections are cut out of the sides of each bracket 114 for receiving the sets of rollers 118 and 120. The roller 118 may roll along the upper portion of structure 32 and the roller 120 along the front side thereof during lateral adjustment of the fork tine 18. Member 32 is pivotally connected at 110 to the ends of the brackets 50 and 52 by means of a pair of brackets 112.

Each link and lever means 54 and 56 comprises a transverse pivot shaft 130 which is mounted between spaced sides of a downwardly extending lever member 132 connected at the lower end thereof to the one end of the rotatable pivot tube 64, and a forwardly extending link 134 which is pivotally mounted upon shaft 130 at its one end and secured, as by welding, to the rear flange of I-beam 30 at its opposite end. It will be noted that the weight of each link and lever assembly is minimized by utilizing fabricated diverging members having essentially I-cross-sections.

Each of the bracket members 50 and 52 comprises a fabricated metal structure which is formed to provide a forwardly extending leg portion of narrowing cross-section which terminates adjacent the pivot pin 110, a downwardly extending leg portion which terminates in the portion forming a part of the roller assembly 98 and which generally follows the contour of the wheel 28 along the forward side thereof and an upwardly and rearwardly extending portion to which the roller assembly 94 is connected and through an opening in which extends one of the ends of pivot tube 64. The bracket members 96 are connected to brackets 50 and 52, as by welding; each includes a ball bearing 136 in which is supported for rotational movement one of the ends of pivot tube 64. In addition, each of the brackets 50 and 52 includes a forwardly located raised portion 138 to which is pivotally anchored by means of a pivot pin 140 one of the tilt cylinder assemblies 60 and 62.

The tilt cylinder assemblies are energizable to extend and retract the piston rods thereof for rotating the levers 132 in either a counterclockwise or a clockwise direction with the pivot tube 64, whereby the fork tines 18 and associated structure are rotated in a corresponding direction about the pivot pins 110 of the brackets 50 and 52. The link members 54, of course, which are connected between the levers 132 and the fork tines, impart the movement of the levers 132 to the fork tines. It will be apparent that in so doing each link 54 will pivot relative to both the pivoted upper end of the associated fork tine 18 and the upper end of the associated lever 132.

Interconnecting the inner sides of the levers 132 with

the pivot tube 64 are a pair of downwardly extending and converging structural strengthening members 142. A tubular member 144 is connected between the inner sides of brackets 50 and 52 near the forward ends thereof for aiding the rigidity of the entire lifting apparatus which extends forwardly of the upright mast structure 58. Another pair of tubular members 146 are welded to the center portion of tubular member 144 and diverge in a rearward direction therefrom to connect the center portion of said tubular member with the rear portion of the brackets 50 and 52, as best shown in Figure 4. The tubular member 144 is utilized for an additional purpose to be described. A transversely extending tubular member 150 is also connected to the brackets 50 and 52 at the rear portions thereof for aiding in rigidifying the structure of the lifting apparatus.

Each roller assembly 94 comprises the three rollers 152, 154 and 156. These rollers are mounted for rotation adjacent different vertices of a triangular shaped bracket member 158 which interconnects the three rollers. Each roller 156 projects inwardly from one of the brackets 158 and is rotatably mounted upon shaft 160 for vertical movement within the outwardly facing open portion of each I-beam 90. Each set of rollers 152, 154 is also mounted inwardly from one of the bracket members 158 upon one end of transversely extending tubular members 162 and 164 in vertically spaced relation to each other. The sets of rollers 152, 154 are positioned on opposite ends of tubular members 162, 164 so as to normally engage the rearwardly facing surfaces of the rear flanges of the I-beams 90, whereas the rollers 156 are mounted such that a slight clearance normally exists between the peripheries thereof and the outer forwardly facing surfaces of the rear flanges of said I-beams.

The roller assemblies 98 are associated with the forward flanges of the I-beams 90 in a manner similar to the association of roller assemblies 94 with the rear flanges of the I-beams. Each assembly 98 comprises rollers 166 and 168 which are adapted to roll vertically along the inner surface of one of the channel members 92 and a roller 170 which is mounted for rotation upon a rearwardly extending bifurcated portion 172 of the downwardly extending leg of one of the bracket members 50 or 52. A slight clearance is also provided for between the rollers 170 and the adjacent flanges of the I-beams 90. The triangular shaped brackets 100 interconnect the rollers 166 and 168, said rollers being supported between the downwardly extending leg portions of the bracket members 50 and 52 by the shaft members 174.

In addition to the above described roller assemblies 94 and 98, which are functionally associated with the I-beams 90, are sets of rollers 176 and 178 which are mounted in vertically spaced relation to each other and which are connected to rearwardly located and vertically and transversely extending members 180 of brackets 50 and 52. Rollers sets 176 and 178 extend rearwardly of members 180 and are located within the channel sections of members 92 for rotation in a plane transverse to the axis of the truck for a purpose to be described.

The ends of the I-beam 30 and the box-like member 32, which together carry the fork tines 18, are connected by means of triangular shaped members 182 and 184, which members are pivotally mounted on I-beam 30 and are rigidly secured to the member 32.

The transversely extending hydraulic cylinder assembly 34 is pivotally connected to member 182 by means of a pin and bracket 186, and is similarly connected to right hand bracket 114, as viewed in Figure 3, by a pin means 188. The hydraulic cylinder assembly 36, which is spaced vertically below the cylinder assembly 34, is pivotally connected at its opposite ends to the right and left hand brackets 114. Hydraulic valve control means of known construction, not shown, is provided in the operator's cab 16 for controlling the flow of pressure fluid to either one or both of the cylinder assemblies 34 and 36. In this manner, the fork tines 18 may be adjusted laterally in a variety of ways. For example, if the cylinder assembly 34 is alone energized to extend the piston rod thereof, the cylinder assembly 36 functions as a member which fixes the spacing between the fork tines 18, as they are moved together laterally from one side of the fork tine carriage means (I-beam 30 and member 32) to the other. Now if, at any given lateral position of the fork tines, the cylinder assembly 36 is energized, the cylinder assembly 34 will maintain the position of the right hand fork tine while extending or retracting movement of the cylinder assembly 36 will actuate the left hand fork tine away or toward the right hand fork tine, respectively. In addition, the cylinder assemblies 34 and 36 may be simultaneously energized, in which event the fork tines 18 are actuated toward each other when said cylinder assemblies are pressurized at the piston rod ends thereof, and are actuated away from each other when said cylinder assemblies are energized at the cylinder ends thereof. It will thus be apparent that a maximum degree of versatility is provided for automatically controlling the position of the fork tines both with respect to each other and with respect to the longitudinal axis of the truck.

The hydraulic hoisting cylinder assemblies 38 and 40 have bracket means 190 and 192 connected to bottom flanges of the respective cylinders, which bracket means are mounted upon pivot pins 194 and 196, respectively, for pivotal connection to the forwardly located frame members 80 which are mounted upon the arms of the axle housing, as hereinbefore explained. Bifurcated bracket members 198 and 200 are mounted to the ends of the respective piston rods by means of pivot pins 202 for pivotal movement in a plane transverse to the longitudinal axis of the truck. The sheaves 42 and 44 are relatively fixedly mounted on a transverse torque tube or shaft 204 which extends between the bracket members 198 and 200. A transversely extending member 206 is attached to the center portions of both pivot shafts 202 for aiding in maintaining a fixed lateral spacing between the cylinder assemblies 38 and 40.

The pivotal connections 202 between the piston rods and the brackets 198 and 200, in conjunction with the mounting of sheaves 42 and 44 on torque tube or shaft member 204, insures that vertical movement of the piston rods will be synchronized so that neither will move to a position above or below the other, and that bending stresses which might otherwise occur in the parts of the lifting mechanism are relieved.

For example, if it be assumed that the piston rod connected to bracket 200 tends to move upwardly ahead of the piston rod connected to the bracket 198, it will be seen that sheave 42 will be rotated a number of degrees in advance of sheave 44 which causes the torque tube 204 to "wind up," thereby exerting an additional load on the piston of cylinder assembly 38. This additional loading causes the hydraulic fluid in the system to be directed into cylinder assembly 40 as it follows the line of least resistance, whereby the piston rod of the latter assembly is advanced a slight amount to the elevation of the piston rod of assembly 38. The latter action induces a somewhat more rapid rotation of sheave 44 than of sheave 42 which "unwinds" tube 204 to its original untorqued condition. At this time the extension of the piston rods is equal. Pivoted brackets 198 and 200 function to relieve any bending stresses which would otherwise occur in the parts of the lifting mechanism during an action as aforesaid. Thus the piston rod of assembly 40 is maintained in transverse alignment with the rod of assembly 38. Whenever off center loading or any other factor results in a tendency of one piston rod to advance ahead of the other, the above described manner of interconnecting the brackets, sheaves and torque tube of the cylinder assemblies to each other and to the piston rods eliminates malfunctioning of the lifting ap-

paratus of my invention because of the automatic compensation and relief of bending stresses which is thereby provided.

The chain 48 is trained over the sheave 44 and is fixedly connected at its one end to an anchor bolt 210 which is attached to a fixed bracket 212 of cylinder assembly 40. The opposite end of chain 48 is suitably secured to a member 214 which is in turn welded to a forwardly curving member 216, said member 216 being welded along the inner curved portion thereof to an adjacent portion of the tubular member 144. The chain 46 is connected in like manner to the cylinder assembly 38 and to the tubular member 144.

In addition to the above described hoist motor synchronizing means, tube 64 functions also as a torque tube for insuring a division of a load carried by the fork tines between the hoist motors 38 and 40. If, for example, a load is off-center to such an extent that the left hand fork carries substantially the entire load, the hoist motor 40 will tend to carry only about one-half of such load, the remainder being transmitted to the hoist motor 38 through the mechanical circuit which comprises link 134, lever 132, torque tube 64, lever and link means 56, the fork carriage 30, 32, bracket 52, tube 144 and chain 46. Thus the hoist motors, which are preferably transversely spaced as shown for stabilizing the entire lifting apparatus and for minimizing torque stress therein, may be constructed to have a lifting capacity which is only about one-half of the rated load capacity of the truck. This is of great advantage both from the standpoint of cost and space requirements, as will be apparent to persons skilled in the art.

In operation, the hoist motors 38 and 40 may be selectively actuated upwardly or downwardly by control means, not shown, located in the cab 16 for actuating therewith the entire lifting apparatus which is vertically movable relative to the mast structure 58. For example, if the lifting apparatus is actuated from the position shown in Figure 1 to a raised position on mast structure 58, the movable ends of the chains 46 and 48 are actuated upwardly with the sheaves 42 and 44 to elevate the entire lifting apparatus, including link and lever means 54 and 56, bracket means 50 and 52, pivot tube 64, and the fork tines 18 and associated structure, with the roller assemblies 94 and 98. Whenever a load is carried by the fork tines, each upper set of rollers 152, 154 functions with the associated lower set of rollers 166, 168 to provide a couple which is resisted by the associated I-beam 90. In the event that an upwardly directed force should be imposed upon the fork tines, as for example might occur during a rearward movement of the vehicle over rough terrain, the sets of rollers 156 and 170 are provided to abut opposite inner surfaces of the flanges of the I-beams 90 in order to form couples which are also resisted by the I-beams. The rollers 156 and 170 are normally out of contact with the respective flanges of the I-beams 90 to minimize friction, but are always available for the purpose described.

The horizontal and vertical force components of a load which is supported by the fork tines are transmitted to the bracket members 50 and 52, and thence to the sets of roller assemblies 94 and 98, primarily through the sets of rollers 118 and 120 which abut two of the sides of the box-like member 32 in transverse relation to each other. A portion of the load is also taken by the rollers 108 which are normally in abutment with the forward flange of I-beam 30. If an upwardly directed force is imposed on the fork tines, an upwardly extending lip of member 32, which is located at the forward side thereof, eliminates the possibility of rollers 118 becoming disengaged from the member 32 (see Fig. 2), and such force is transmitted to the rollers 156 and 170 of roller assemblies 94 and 98 through the rollers 118 and the rollers 108. The rollers 176 and 178, which are mounted for vertical movement in channel members 92, are provided primarily for transmitting to the I-beams 90 any side thrust which might be imposed upon the fork tines and associated structure.

It is thus seen that all forces, irrespective of direction, which might act upon the fork tines 18 are resolved in the upright mast construction 58 in such a manner that the possibility of misalignment of and undue bending or torsional stresses upon any given component part of the lifting apparatus is minimized. For example, since the rollers 176 and 178 transmit side thrust to the I-beams 90, such forces are not taken by the roller assemblies 94 and 98, and the possibility of misalignment of said roller assemblies relative to the I-beams 90 is therefore minimized.

The entire lifting apparatus which connects the fork tines to the mast structure 58 is maintained relatively rigid for any given attitude or angle of tilt of the fork tines. If it is desired to vary the attitude or tilting angle of the fork tines, the cylinder assemblies 60 and 62 may be energized to rotate levers 132 with torque tube 64; consequent rotation of the fork tines about the pivoted connections 110 to bracket members 50 and 52 results.

From the above it will now be apparent to those skilled in the art that I have provided a lift truck which is constructed so as to provide a much improved distribution of weight than has been heretofore available, with consequent reduction in wheel base, turning radius and/or mass of counterweight, as well as an arrangement which provides for maximum operator visibility, all with great control versatility of fork tine location. Also, as a result of the very novel solutions to the various problems herein discussed, there is provided a lifting apparatus wherein the major components thereof, viz., the upright mast structure, the hydraulic hoisting means, and the fork tines, are each mounted on the truck in longitudinally spaced relation to the other, and wherein friction between the component parts of the lifting apparatus has been minimized and novel connecting and supporting means are provided for and as between the major components.

Although only one embodiment of the invention has been particularly described, it will be understood that many changes might be made in the form and arrangement of the parts without departing from the scope of the invention.

I claim:

1. A lift truck comprising frame means, axle means supporting said frame means at the one end thereof, an upright mast structure supported by said frame means substantially rearwardly from said axle means, a pair of laterally spaced hydraulic hoist motor means connected to said frame means adjacent the axle means, load carrying means supported by said pair of motor means and by said mast structure and spaced substantially forwardly from said motor means, and bracket means extending longitudinally on opposite sides of the axle means and connected between said mast structure and said load carrying means for supporting said load carrying means on the mast structure, said bracket means including first and second roller means spaced vertically and longitudinally relative to each other for connecting the one end of said bracket means to said mast structure, and wherein said mast structure includes a pair of laterally spaced channeled members the opposite flanges of each of which are in abutment with said first and second roller means, respectively.

2. A lift truck comprising an upright mast structure having a pair of transversely spaced and vertically extending channeled guideways, load carrying means mounted forwardly of said mast structure, bracket means connecting said load carrying means to each of said channelled guideways, first and second roller means connected to each said bracket means and to each said guideways in vertically and longitudinally spaced relation to each other for translating the force of a load supported by the load carrying means into a force couple which is resisted by each said guideways, said first and second roller means

being mounted to roll along the outer portion of the flanges of each said channel guideways, and third and fourth roller means mounted adjacent to said first and second roller means, respectively, and spaced longitudinally in opposite directions relative to said first and second roller means for vertical movement within the channelled portion of each of said guideways.

3. A lift truck having a frame comprising a pair of vertically extending transversely spaced channeled guideways mounted upon the truck frame, hoist motor means mounted upon the truck forwardly of said pair of guideways, load carrying means suspended forwardly of the hoist motor means, longitudinally extending bracket means connecting the load carrying means to said pair of channelled guideways, said bracket means including roller means associated with said pair of guideways for permitting vertical guided movement of said load carrying means relative to the pair of guideways, said hoist motor means being operatively connected to said bracket means for raising and lowering said load carrying means relative to said guideways, pivot means connecting the load carrying means to the bracket means, said load carrying means including a vertically extending portion above the pivot means, means including lever mechanism operatively connected between a portion of the bracket means and the upper end portion of the load carrying means, motor means connected between the bracket means and lever means for pivotally actuating the load carrying means about its pivoted connection to the bracket means, means associated with said load carrying means permitting lateral adjustment of a portion thereof relative to the truck, and motor means for actuating the load carrying means in a lateral direction.

4. A lift truck as claimed in claim 3 wherein an operator's station is mounted upon the truck in laterally spaced relation to said hoist motor means and forwardly of the channeled guideways.

5. A lift truck as claimed in claim 3 wherein sheave means are provided atop said hoist motor means which are pivotable in a direction transverse of the truck.

6. A lift truck as claimed in claim 5 wherein said hoist motor means comprises a pair of laterally spaced hydraulic cylinder and piston assemblies, said sheave means being pivotally connected atop the piston rod of each such assembly, and means are provided connecting said sheave means such that vertical movement of said pair of motor means is synchronized.

7. A lift truck as claimed in claim 3 wherein channelled portions of said guideways open in opposing relation to each other, and a second pair of vertically extending and transversely spaced channeled guideways are connected to corresponding surfaces of said first pair of guideways and have channeled portions thereof facing in the same direction and in perpendicular relation to the said channeled portions of said first pair of guideways, said bracket means being also connected to said second pair of guideways.

8. A lift truck comprising a vertically extending mast structure supported upon the truck, load carrying means spaced longitudinally forwardly from said mast structure, and bracket means connecting said load carrying means to said mast structure, said load carrying means including a transversely extending member having a plurality of perpendicularly related sides, load engaging means, and first and second roller means connected to said load engaging means in such a manner that the first roller means is rollable along one side of said transversely extending member and the second roller means is rollable along the second side of said transversely extending member, said transversely extending member being pivotally connected to the one ends of said pair of longitudinally extending bracket members.

9. A lift truck comprising frame means, body means supported by said frame means, a vertically extending mast structure supported by said frame means, axle means, vertically extending motor means mounted adjacent said axle means and forwardly of said mast structure, load carrying means mounted forwardly of said motor means and operatively connected thereto and to said mast structure for vertical movement relative to said mast structure when said motor means is energized, and an operator's station mounted upon said body means forwardly of said mast structure and generally transversely of said motor means, whereby substantially maximum visibility is afforded the truck operator during operation of the truck.

10. A lift truck comprising a pair of vertically extending and transversely spaced channelled guideways mounted upon the truck and having channelled portions facing outwardly from the truck in opposite directions, load carrying means operatively connected to said guideways for vertically guided movement relative thereto, a second pair of vertically extending and transversely spaced channelled guideways supported by forwardly located flanges of said first pair of channelled guideways and having the channelled portions thereof facing in a direction which is substantially parallel to the longitudinal axis of the truck, said load carrying means being also operatively connected to said second pair of guideways for guided movement relative thereto, and vertically extending motor means supported by said truck in longitudinally spaced relation to said first and second pairs of guideways and to said load carrying means.

11. A lift truck as claimed in claim 1 wherein the connection between said motor means and said load carrying means comprises chain and sheave means, and a transversely extending member secured to one end of said chain means and to said bracket means and spaced longitudinally from said load carrying means.

12. A lift truck as claimed in claim 1 wherein said bracket means comprises a pair of laterally spaced members connected to similarly laterally spaced and vertically extending channelled members of said mast structure, and pivot means connecting said load carrying means to the forward ends of said bracket means.

13. A lift truck as claimed in claim 12 wherein said load carrying means is also connected to said bracket means by linkage means which is actuatable to cause the load carrying means to be pivoted about its connection to the ends of said bracket means.

14. A lift truck as claimed in claim 13 wherein motor means is connected to each said bracket means and to said linkage means for actuating the load carrying means about the pivoted connections thereof to said bracket means.

15. A lift truck as claimed in claim 10 wherein the means which operatively connects the load carrying means to said first pair of channelled guideways comprises a pair of generally longitudinally extending bracket means, and first and second roller means connected to said bracket means in longitudinally and vertically spaced relation to each other for vertically directed rolling movement along the outer surfaces of each said channelled guideways of said first mentioned pair thereof during energization of said motor means.

16. A lift truck as claimed in claim 10 wherein the operative connection between said load carrying means and said second pair of guideways comprises a pair of longitudinally extending bracket means connected at the one ends thereof to said load carrying means, and roller means connected to the opposite ends thereof for vertically directed movement within the channels of said second pair of channelled members during energization of said motor means.

17. A lift truck as claimed in claim 15 wherein third roller means are connected to each one of said pair of bracket means for vertically directed movement within said second pair of channel means, the axes of said third

roller means being transverse to the axes of said first and second roller means.

18. A lift truck as claimed in claim 17 wherein fourth roller means is connected to each said bracket means adjacent each said first and second roller means for vertically directed movement within the channelled portion of said first pair of channelled guideways.

19. A lift truck as claimed in claim 8 wherein said load carrying means extends vertically above said pair of bracket means, and linkage means are provided for connecting the upper end of said load carrying means to said bracket means, and motor means connected to said bracket means and to said linkage means for actuating the load carrying means about its pivoted connection to the one ends of said bracket means.

20. A lift truck as claimed in claim 19 wherein said upper end of said load carrying means includes a transversely extending I-beam which is connected to said linkage means.

21. A lift truck as claimed in claim 20 wherein roller means are rollable within a channelled portion of said I-beam.

22. A lift truck as claimed in claim 20 wherein motor means are provided for actuating the vertically extending portion of said load carrying means laterally of said I-beam and of said plural sided member.

23. A lift truck comprising a vertically extending mast structure supported by the truck, a load carrying means mounted forwardly of said mast structure, and bracket means connecting the load carrying means to the mast structure for vertical movement relative thereto, said load carrying means comprising a laterally shiftable fork tine, a transversely extending channelled member, roller means connecting said fork tine to said channelled member and rollable along a channeled portion of said channelled member during lateral movement of said fork tine, and fork tine tilt means connected to said channelled member and pivotally connected to said bracket means, said fork tine being pivotally connected to the bracket means forwardly of the pivotal connection of the tilt means thereto.

24. A lift truck comprising an upright mast structure supported by the truck, a pair of fork tines mounted forwardly of said mast structure and operatively connected thereto for vertical movement relative thereto, said operative connection including a transversely extending and generally rectangular framework adapted to permit lateral movement of the fork tines relative thereto, a first motor means connected between said fork tines, and a second motor means connected between one side of said framework and one only of said fork tines, said first and second motor means being energizable in such a manner that one or both fork tines may be actuated laterally of the framework.

25. A lift truck as claimed in claim 24 wherein said first and second motor means are individually or simultaneously energizable to actuate said fork tines together in a lateral direction, to actuate one of said fork tines laterally while maintaining the other of said fork tines in a fixed position, or to actuate said fork tines simultaneously laterally relative to each other.

26. A lift truck as claimed in claim 24 wherein said first motor means is energizable to actuate one of said fork tines laterally along said framework while the other of said fork tines remains in fixed position, said second motor means is energizable to actuate said fork tines laterally together along said framework and in fixed spaced relation to each other, and said first and second motor means are simultaneously energizable to actuate both said fork tines either toward or away from each other along said framework.

27. A lift truck comprising frame means, a drive axle mounted adjacent the forward end of said frame means, a vertically extending mast structure supported upon said frame means, a pair of laterally spaced hydraulic motor means mounted at the one ends thereof adjacent outwardly extending arms of said axle means, load carrying means mounted forwardly of said mast structure and said motor means, bracket means pivotally connected to said load carrying means and connected to said mast structure, linkage means connecting said load carrying means to said bracket means including a transversely extending pivot member and lever means connected adjacent the one end thereof to said pivot member, motor means connected to said bracket means and to the opposite end of said lever means for actuating said lever means rotatably about the axis of said pivot member whereby said load carrying means is actuated rotatably about the pivoted connection thereof to said bracket means, and means connecting said hoist motor means to said bracket member for actuating said load carrying means, said bracket means and said linkage means vertically relative to said mast structure during energization of said hoist motor means.

28. A lift truck as claimed in claim 27 wherein the vertically extending mast structure comprises a pair of transversely spaced and vertically extending channelled members, and said bracket means is connected to each one of said channeled members by roller means which are rollable along opposite outer flanges of said channelled members during vertical movement of said pair of hydraulic motor means.

29. A lift truck as claimed in claim 28 wherein additional channelled means are mounted forwardly of said first mentioned channelled means which face forwardly of said truck and which are also operatively connected to said bracket means.

30. A lift truck comprising frame means, a drive axle means mounted adjacent the forward end of said frame means, a vertically extending mast structure supported upon said frame means, a pair of laterally spaced and vertically extending hydraulic motor means supported upon said frame means, load carrying means mounted forwardly of said mast structure and said motor means, bracket means connecting said load carrying means to said mast structure, chain and sheave means for operatively connecting said pair of motor means to said bracket means, said sheave means being pivotable transversely of the truck and relative to said hydraulic motor means.

31. A lift truck as claimed in claim 30 wherein means is connected to both said sheave means in such a manner that vertical movement of said pair of motor means is synchronized.

32. A lift truck as claimed in claim 31 wherein said latter means comprises a transversely extending shaft adjacent the opposite ends of which are mounted said sheave means, said shaft being cooperable with the pivoted connections between said sheave means and said motor means for continuously maintaining each one of said pair of motor means at substantially the same elevation as the other irrespective of any tendency of one of said pair to move vertically at either a faster or slower rate than the other thereof.

33. A lift truck comprising frame means, axle means supporting said frame means at the one end thereof, an upright mast structure supported by said frame means rearwardly from said axle means, a pair of laterally spaced hydraulic hoist motor means connected to said frame means forwardly from said mast structure, and load carrying means supported by and operatively connected to said pair of motor means and said mast structure and spaced forwardly from said motor means, said operative connection including a transversely extending torque tube, and a pair of laterally spaced linkage means connected at the one ends thereof adjacent opposite ends of said torque tube and connected at the other ends thereof to said load carrying means for substantially equalizing the load carried by said pair of hoist motor means.

34. A lift truck as claimed in claim 33 wherein said operative connection also includes a pair of laterally spaced and longitudinally extending bracket means for connecting said load carrying means to said mast structure and for supporting said torque tube.

35. A lift truck as claimed in claim 34 wherein a transversely extending member extends between said pair of bracket means for fixing the lateral spacing thereof, and lifting chain means associated with each of said pair of hoist motor means and connected at one end thereof to said latter transverse member for causing said load carrying means, said pair of bracket means, said pair of linkage means, and said torque tube to be actuated vertically relative to said mast structure during vertical movement of said pair of hoist motor means.

36. A lift truck as claimed in claim 35 wherein said operative connection also includes said pair of transversely spaced bracket members, said transversely extending member and said chain means.

37. A lift truck as claimed in claim 36 wherein an off-center loading of said load carrying means is substantially equally distributed between said pair of hoist motor means through said operative connection.

38. A lift truck as claimed in claim 24 wherein said first and second motor means each comprises an hydraulic cylinder and piston assembly, the cylinder and piston rod ends of said first motor means being connected to opposite ones of said fork tines, respectively, while the one end of said second motor means is connected to one of the fork tines and the other end thereof is connected to one side of the framework.

References Cited in the file of this patent

UNITED STATES PATENTS

518,633	Steur	Apr. 24, 1894
901,205	Stoffels	Oct. 13, 1908
1,975,252	Clark	Oct. 2, 1934
2,360,407	Dunham et al.	Oct. 17, 1944
2,366,378	Barrett	Jan. 2, 1945
2,456,320	Repke	Dec. 14, 1948
2,545,417	Ulinski	Mar. 13, 1951
2,554,930	Ulinski	May 29, 1951
2,709,018	Schenkelberger	May 24, 1955
2,738,087	Arnot	Mar. 13, 1956
2,748,966	Gohrke	June 5, 1956