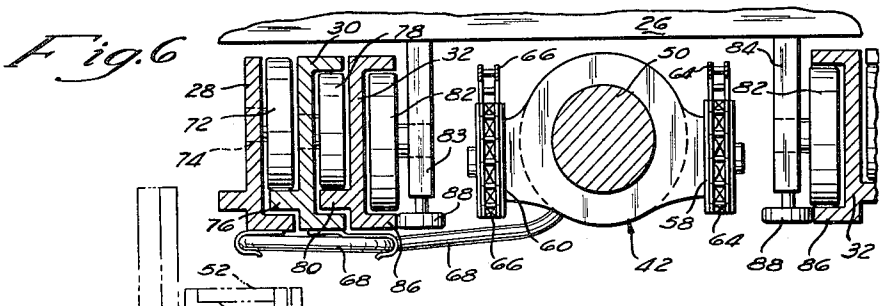
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TRIPLE TELESCOPIC HIGH FREE LIFT TRUCK

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Fig. 6



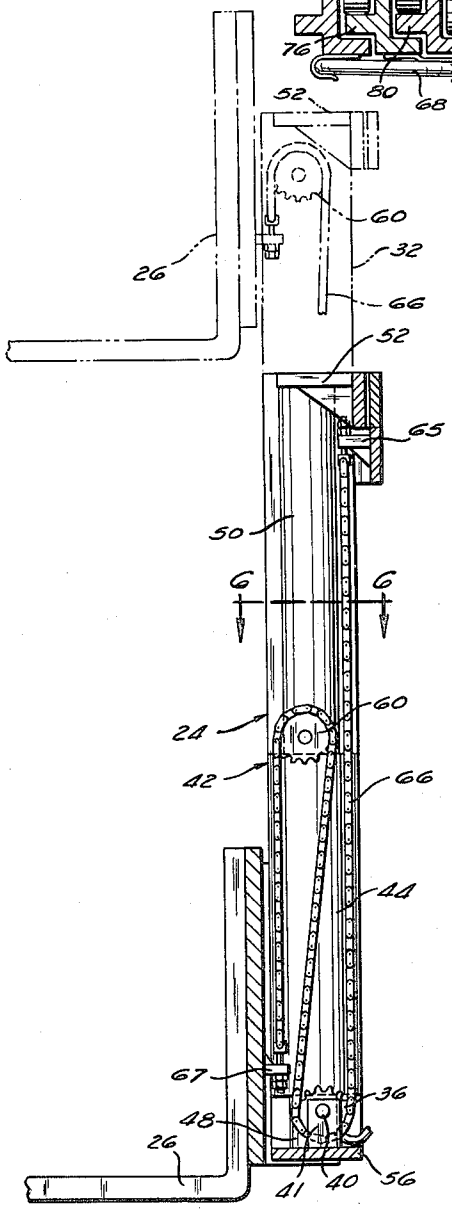


Fig. 5

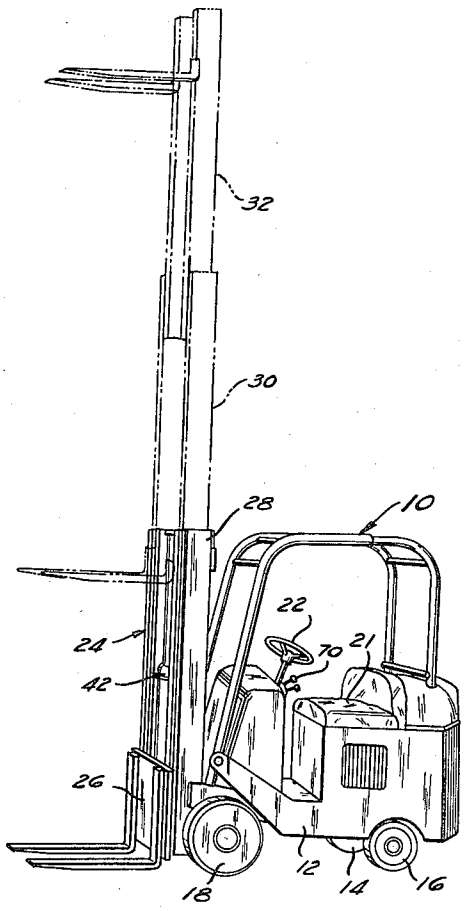


Fig. 1

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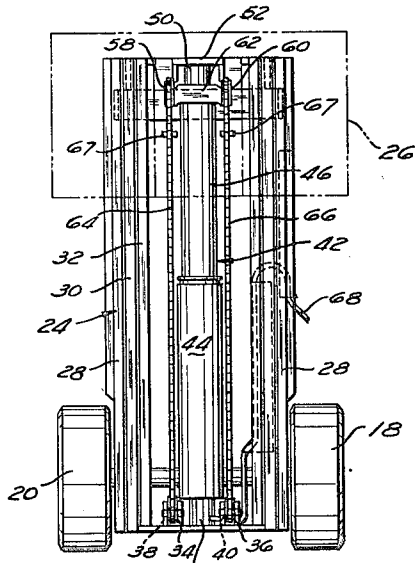


Fig. 3

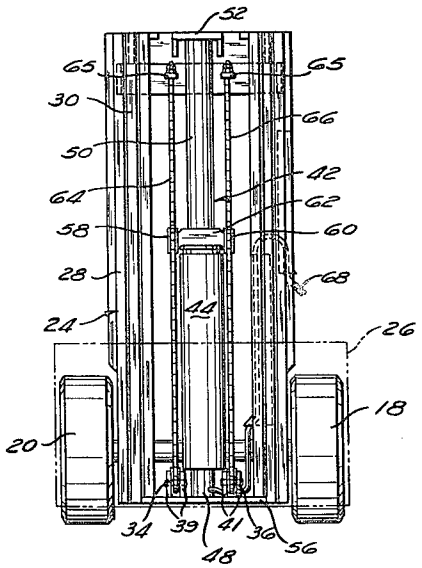


Fig. 2

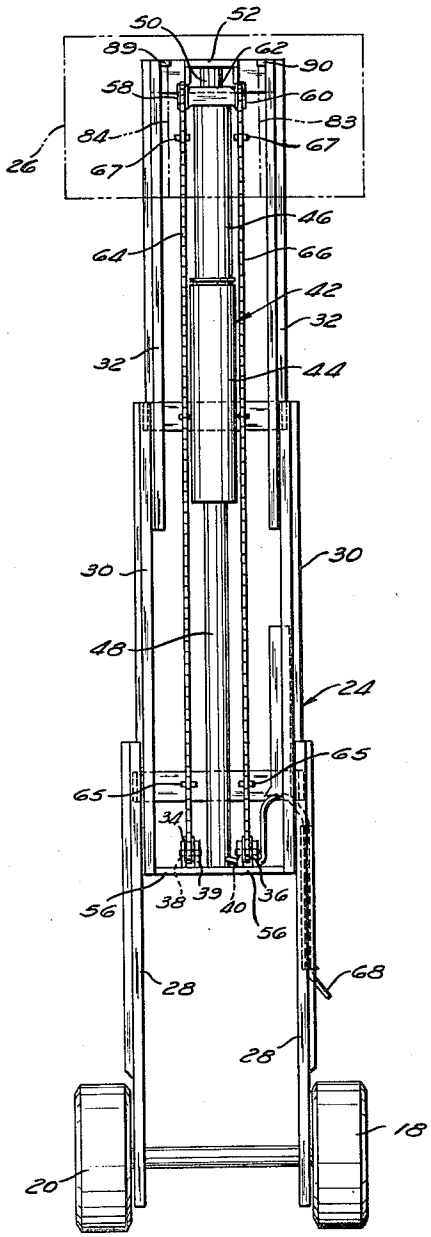


Fig. 4

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TRIPLE TELESCOPIC HIGH FREE LIFT TRUCK

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Application December 19, 1957, Serial No. 703,820

6 Claims. (Cl. 187—9)

This invention relates to an industrial lift truck and more particularly to a novel, improved apparatus for elevating a lift carriage of such a truck.

Broadly stated, this invention comprehends the provision of a vertically disposed, multi-section mast assembly having first and second mast channels slidable relative to each other and to a third mast channel to respective upper and intermediate positions under the influence of a triple telescopic, hydraulic, high free lift hoist having a first plunger section extendible to an upper position, a second cylinder section for receiving the first section, and a third plunger section extendible to a lower position, also receivable in the second cylinder section. A lift carriage is adapted for vertical movement along the mast assembly under the force imparted thereto by the hoist through a chain and chain roller arrangement mounted on the mast assembly. A first chain roller is rotatably mounted at the upper end of the first section of the hoist, a second chain roller is rotatably mounted at the lower end of the second channel, and a drive chain is secured at one end to the upper end of the first channel, at the other end to the lift carriage and extends over the first chain roller and under the second chain roller whereby longitudinal force exerted successively by the first and third sections of the hoist is effective to elevate the carriage from surface level to the level of the first channel in extended position at a rate double that of the movement of the telescopic hoist sections.

It is an object of this invention to provide an industrial lift truck having a collapsible mast and a hydraulic hoist having a collapsible height equal to the collapsible height of said mast.

It is another object of this invention to provide an industrial lift truck having a three section mast assembly having sections extendible relative to each other for lifting a load carriage.

It is another object of this invention to provide an industrial lift truck having a collapsible mast extendible to a height greater than twice its collapsed height.

It is another object of this invention to provide an industrial lift truck having a load carriage extendible from a position near the top of a collapsed mast assembly to a high lift position together with the extension of a section of the mast assembly.

It is another object of this invention to provide an industrial lift truck having a load carriage elevatable from a surface level to the top of a collapsed mast assembly by a hydraulic lift hoist at a rate twice that of the movement of the lift hoist.

It is another object of this invention to provide an industrial lift truck having a tri-partite mast assembly and provision for elevating a second section relative to a first at a predetermined rate and for elevating a third section relative to the first section at a rate twice the predetermined rate.

It is another object of this invention to provide an industrial lift truck having a tri-partite collapsible mast assembly extendible longitudinally to a height greater than twice the collapsed height thereof and a hydraulic hoist means elevatable with extension of said mast assembly.

It is another object of this invention to provide an industrial lift truck having a tri-partite mast assembly and hydraulic means for extending said mast assembly to greater than twice its collapsible height through a pair of chain rollers and chains intercoupling the mast and hoist assemblies.

It is another object of this invention to provide an industrial lift truck having a tri-partite collapsible mast assembly including a pair of rotatable chain rollers mounted, respectively, at the lower extremity of one movable section of the mast and at the upper end of a section of a tri-section hoist and having a chain extending about the chain rollers and secured at respective ends to the lift carriage and the lower end of an intermediate mast section for lifting the mast assembly and carriage in response to an expansive force applied between the chain rollers.

Other and further objects and advantages will appear from the following detailed description of the invention taken with the accompanying drawings in which:

Figure 1 illustrates a view in perspective of a lift truck with carriage lowered, incorporating a mast and hoist improvements of this invention;

Figure 2 illustrates a front elevational view of the lift truck of Figure 1 with the carriage in its lowered position;

Figure 3 illustrates another front elevational view of the lift truck of Figure 1 with the carriage in an intermediately elevated position;

Figure 4 illustrates a front elevation view of the mast and hoist assembly of this invention with the load carriage in an elevated position at the upper extremity of its range;

Figure 5 illustrates a side elevational view in cross section of the mast and hoist assembly of this invention with the load carriage in its lowered position;

Figure 6 illustrates a plan view in section of the mast and hoist assembly of this invention.

Referring now to the drawings, **10** represents generally an industrial truck to which the present invention is applied having a body **12** supported on a pair of dirigible wheels **14**, **16**, a pair of drive wheels **18**, **20**, and a driver's seat **21**. Wheels **14** and **16** are unitarily dirigible by a steering wheel **22** and suitable linkage (not shown). Wheels **18** and **20** in addition to being the truck drive wheels support the load carriage, mast and hoist assemblies of this invention. The mast assembly **24** is mounted on a forward axle between wheels **18** and **20** and a carriage **26** is movable by a hoist, described in detail hereinbelow, vertically along the mast assembly to any point between its lower level, as shown in Figures 1 and 2, to an intermediate, elevated level as shown in Figure 3. Mast assembly **24** during elevation of the carriage between the mentioned extremities is unaltered. For elevation of carriage **26** beyond the level shown in Figure 3, mast assembly **24** is extendible longitudinally from a position shown in Figure 3 to a position shown in Figure 4.

As shown more clearly in Figures 2, 3, 4, and 6, mast assembly **24** includes a first outer pair of channels **28** secured to the truck body, a second pair of intermediate channels **30** extendible vertically beyond channels **28**, and a third pair of inner channels **32** is extendible vertically beyond channel **30** whereby carriage **26** positionable near the upper extremity of channels **32** is elevated to its upper limit. In the completely extended position, channels **28**, **30** and **32**, which are of equal length, overlap to a small extent whereby the upper limit of carriage

26 is somewhat less than three times the height of a single mast channel section.

Referring now to Figures 2, 3, 4, and 6 of the drawings, it is observed that channel pairs 28, 30, and 32 are connected together and nested when in collapsed condition and that channels 28 are directly mounted at their lower end on the axle between wheels 18 and 20. Intermediate channel sections 30 are upwardly slidable relative to channels 28 in suitable guideways and have mounted at their lower ends, a pair of chain rollers 34, 36, rotatable on axles 38 and 40 extending therethrough and through bracket pairs 39 and 41 secured to the channels 30.

A hydraulic hoist 42 for elevating the channels comprises a cylindrical body 44 of approximately one-half the height of a single mast channel, an upper plunger 46 shown in Figure 3 also of approximately one-half the height of a single mast channel and a lower plunger 48 of a length substantially greater than one-half the height of a single mast channel. A cylindrical guide 50 is mounted at the upper end of channels 32 by a bracket 52 bolted to the guide and to the channel section and plunger 48 is secured to the lower end of channels 30 by attachment to a cross member 56 extending between the bottoms of the channels 30.

The hydraulic hoist cylinder assembly 42 corresponds in structure to the hoist cylinder assembly 20 disclosed in my Patent No. 2,670,811, issued March 2, 1954, to the assignee of the instant application.

As a part of the hoist apparatus, a pair of chain rollers 58 and 60 are mounted on opposite ends of a bracket 62 secured to the upper end of plunger 46 and 66 extend partially around respective pairs of chain rollers 34, 58 and 36, 60, and are secured at first ends near the upper end of channel 28 by brackets 65 and at the other ends to the carriage 26 by brackets 67 and appropriate nuts and bolts.

Truck 10 is provided with a suitable drive motor for propelling the truck about a yard, warehouse or other area and for further driving suitable hydraulic pumps for operating hoist 42. In addition, the elevation of carriage 26 is accomplished by supply of hydraulic fluid under pressure to hoist 42 through a line 68. A valve having a control arm 70 is provided for regulating the flow of hydraulic fluid to hoist 42 through line 68.

As seen clearly in Figure 6 of the drawing, channel sections 28, 30, and 32 are disposed for free relative movement by the provision of rolling friction therebetween. Channels 28 have rotatably mounted therein rollers such as roller 72 rotatable on an axle 74 secured in channel 28 which roller is peripherally engageable with a flange 76 on each channel 30. As channels 30 pass upwardly relative to channels 28, the rollers 72 roll against the flanges 76 to minimize the fricitonal retarding force thereagainst. In a similar manner, each channel section 30 is provided with a roller such as 78 rotatably mounted therein, and peripherally engageable with flanges 80 of channels 32 for minimizing frictional engagement and rollers 82 are rotatably mounted in a pair of guide plates 83 and 84 extending rearwardly from their attachment to the truck carriage. Each roller is peripherally engageable with a flange 86 of each channel 32 to provide freedom of movement of the carriage relative to other parts of the truck.

Alignment of the truck carriage is maintained by a further pair of rollers 88 rotatably mounted in guide plates 83 and 84 and peripherally engageable with the edges of flanges 86. As the carriage moves vertically relative to channels 32 the rollers 88 prevent misalignment of the carriage.

In the position of parts as shown in Figure 2, actuation of arm 70 to admit fluid flow through line 68 effects an extension of plunger 46 whereby bracket 62 and chain rollers 58 and 60 are ultimately raised to the positions shown in Figure 3 and carriage 26 is also elevated to the position shown in this figure. During such elevation, the chain rollers 58 and 60 move directly with plunger 46 and carriage 26 moves twice the rate of piston 46 since it is elevated by chains 64 and 66 drawn up by the movable chain rollers. Accordingly, carriage 26 arrives at the upper end of the collapsed channels simultaneously with the upper end of plunger 46 despite the fact that it is initially spaced twice as far away. Carriage guide plates 83 and 84 on carriage 26 engage respective stops 89 and 90 at the upper end of channel 32 as shown in Figs. 2, 3 and 4, to limit its upward movement with respect to this channel.

Further application of fluid to line 68 is effective to extend lower plunger 43 away from cylinder 44 to bear downwardly on cross member 56 and therefore chain roller axles 38 and 40 movable therewith. The downward thrust of plunger 48 produces a reactive thrust of cylinder 44 and plunger 46 upwardly whereby chains 64 and 66 are held upwardly with a force greater than the downward force of piston 48 since chain rollers 58 and 60 are not rotatable in this position and condition. Accordingly, the downward force of plunger 48 against channel 30 is overcome by the upward force applied thereto by chains 64 and 66 since the force of the chains is effective at a lever arm equal to the diameter of chain rollers 34 and 36 and plunger 48 is effective at a lever arm equal to the radius of the chain rollers. Accordingly, channel 32 and carriage 26 are elevated at a predetermined rate and channel 30 and chain rollers 34 and 36 are elevated at a rate of one-half the predetermined rate as chain rollers 34 and 36 are rolled up by the chains 64 and 66. As seen in Figure 6, by reason of the one to two ratio of elevation between channels 30 and 32, channel 32 is elevated faster and higher than channel 30.

From the foregoing description it is clear that the collapsible mast 24 is extendible to a height greater than twice the height of any of its separate channels by a hydraulic hoist having an overall length no greater than the length of either of the separate channels and that elevation of a carriage by the present invention is simple and effective.

Having thus described this invention in such full, clear, concise and exact terms as to enable any person skilled in the art to which it pertains to make and use the same, and having set forth the best mode contemplated of carrying out this invention, I state that the subject matter which I regard as being my invention is particularly pointed out and distinctly claimed in what is claimed, it being understood that equivalents or modifications of, or substitutions for, parts of the above specifically described embodiment of the invention may be made without departing from the scope of the invention as set forth in what is claimed.

What is claimed is:

1. A lift truck, a mast assembly comprising a first mast section, said first mast section having a pair of vertically disposed rails, the lower end of the rails of said first mast section being mounted on the lift truck, a cross-bar connecting the upper ends of said first mast section rails, a second mast section comprising a pair of spaced vertically disposed rails mounted for vertical movement on the rails of said first mast section, said second mast section having a base member connecting the lower ends of said rails, a third mast section comprising a pair of spaced vertically disposed rails mounted for vertical movement on the rails of said second mast section, said third mast section having a top member connecting the upper ends of the rails thereof, a load carriage mounted for vertical movement on said third mast section, a hoist cylinder assembly comprising a first cylinder having a length corresponding substantially to the length of the rails of one of said sections,

said first cylinder having a piston rod substantially the length of the cylinder, said first cylinder and piston rod mounted between the base member of said second mast section and the top member of said third mast section, a second cylinder concentric with and carried by said first cylinder, said second cylinder having a cylindrical piston rod surrounding the first cylinder, the piston rod of said second cylinder having a pair of spaced sprockets at the top thereof at each side of the piston rod, a pair of similarly spaced sprockets mounted on the base of said second mast section, a pair of chains each having one end thereof anchored to said cross-bar on said first mast section, said chain arranged to extend downwardly from said cross-bar around the sprockets at the base of said second mast section thence upwardly around the sprockets of the piston rod of said second cylinder and thence downwardly to the load carriage, the other ends of each of said chains being anchored to said load carriage whereby extension of said second piston rod raises said load carriage to the top of said third mast section, and extension of said first piston rod moves said third mast section upwardly along the second mast section and at the same time moves said second mast section upwardly along the first mast section.

2. A lift truck, a mast assembly comprising a first mast section, said first mast section having a pair of vertically disposed rails, the lower end of the rails of said first mast section being mounted on the lift truck, a cross-bar connecting the upper ends of said first mast section rails, a second mast section comprising a pair of spaced vertically disposed rails mounted for vertical movement on the rails of said first mast section, said second mast section having a base member connecting the lower ends of said rails, a third mast section comprising a pair of spaced vertically disposed rails mounted for vertical movement on the rails of said second mast section, said third mast section having a top member connecting the upper ends of the rails thereof, a load carriage mounted for vertical movement on said third mast section, a hoist cylinder assembly comprising a cylinder having a length corresponding substantially to the length of the rails of one of said sections, said cylinder having a piston rod substantially the length of the cylinder, said cylinder and piston rod mounted between the base member of said second mast section and the top member of said third mast section, a pair of spaced sprockets mounted on the base of said second mast section, a pair of sprockets carried by the lift cylinder assembly, a pair of chains each having one end thereof anchored to said cross-bar on said first mast section, said chain arranged to extend downwardly from said cross-bar around the sprockets at the base of said second mast section thence upwardly around the sprockets of the lift cylinder assembly and thence downwardly to the load carriage, the other ends of each of said chains being anchored to said load carriage whereby extension of said piston rod moves said third mast section upwardly along the second mast section and at the same time moves said second mast section upwardly along the first mast section.

3. A mast assembly for a lift truck comprising first, second and third mast sections, said first mast section being fixed to the lift truck and projecting vertically therefrom, said second mast section mounted for vertical movement on said first mast section, said third mast section being mounted for vertical movement on said second mast section, a load carriage mounted for vertical movement along said third mast section, said second mast section having a base member at the bottom thereof, said third mast section having a cross-bar at the top thereof, a hoist cylinder assembly mounted between said base member and said cross-bar, said assembly comprising a first hydraulic cylinder having a piston rod, said first hydraulic cylinder having a length

substantially the height of one mast section, said piston rod having a length substantially the length of one mast section, a second hydraulic cylinder having a piston rod, sprockets mounted on said last-named piston rod and on the base of said second mast section, a chain anchor at the top of said first mast section, said chain extending from said anchor down around the sprocket on said base member thence up around the sprocket carried by said last-named piston rod and thence down to said load carriage whereby actuation of said second cylinder moves the carriage upwardly along the third mast section and actuation of said first cylinder moves said third mast section upwardly along the second mast section and at the same time moves said second mast section upwardly with respect to the first mast section.

4. A mast assembly for a lift truck comprising first, second and third mast sections, said sections being substantially the same in length, said first mast section being fixed to the lift truck and projecting vertically therefrom, said second mast section mounted for vertical movement on said first mast section, said third mast section being mounted for vertical movement on said second mast section, a load carriage mounted for vertical movement along said third mast section, said second mast section having a base member at the bottom thereof, said third mast section having a cross-bar at the top thereof, a hoist cylinder assembly mounted between said base member and said cross-bar, said assembly comprising a first hydraulic cylinder having a piston rod, said first hydraulic cylinder having a length substantially the height of one mast section, said piston rod having a length substantially the length of one mast section, a second hydraulic cylinder having a piston rod, said second hydraulic cylinder and rod having a length substantially one-half the length of a mast section, sprockets mounted on said piston rod and on the base of said second mast section, a chain anchor at the top of said first mast section, a chain extending from said anchor around the sprocket on said base member thence around a sprocket carried by said piston rod and thence to said load carriage whereby actuation of said second cylinder moves the carriage upwardly along the third mast section and actuation of said first cylinder moves said third mast section upwardly along the second mast section and at the same time moves said second mast section upwardly with respect to the first mast section.

5. A load carriage and mast assembly for a lift truck comprising a first mast section mounted at its lower end on the lift truck, a second mast section having a length corresponding to the first mast section and being telescopically mounted on said first mast section for vertical sliding movement with respect thereto, a third mast section having a length corresponding substantially to the length of said first and said second mast section, said third mast section being telescopically mounted for sliding movement on said second mast section, a load carriage mounted for vertical reciprocation along said third mast section, said second mast section having a transverse base at its lower end, said third mast section having a transverse abutment at its upper end, a hydraulic cylinder assembly interposed between the base of said second mast section and the abutment of said third mast section, said hydraulic cylinder assembly comprising a first cylinder having a length corresponding substantially to the length of one mast section, a piston rod within said cylinder having a length corresponding substantially to the length of one mast section, a second cylinder mounted between the base of said second mast section and the abutment on said third mast section, said second cylinder having a length corresponding substantially to half the length of a mast section, said second cylinder having a piston rod length substantially half the length of a mast section, a pair of sprockets carried by the piston rod on said second cylinder, a pair of sprockets carried by the base member of said second mast section, a pair of chains anchored

near the upper end of said first mast section, said chains extending from the upper end of said first mast section downwardly and around the sprockets on said base member of the second mast section, said chains extending upwardly therefrom and around the sprockets carried by the piston rod of said second cylinder, said chains extending therefrom downwardly and having the ends thereof anchored to said load carriage whereby actuation of said second cylinder moves the load carriage from the bottom of the third mast to the top thereof and actuation of said first cylinder moves said third mast section upwardly with respect to said second mast section and at the same time moves said second mast section vertically upward with respect to said first mast section.

6. A load carriage and mast assembly for a lift truck comprising a first mast section mounted at its lower end on the lift truck, a pair of chain anchors near the top of the first mast section, a second mast section having a length corresponding to the first mast section and being telescopically mounted on said first mast section for vertical sliding movement with respect thereto, a third mast section having a length corresponding substantially to the length of said first and said second mast section, said third mast section being telescopically mounted for sliding movement on said second mast section, a load carriage mounted for vertical reciprocation along said third mast section, said second mast section having a transverse base at its lower end, said third mast section having a transverse abutment at its upper end, a hydraulic hoist cylinder assembly interposed between the base of

said second mast section and the abutment of said third mast section, said hydraulic cylinder assembly comprising a cylinder having a length corresponding substantially to the length of one mast section, a piston rod within said cylinder having a length corresponding substantially to the length of one mast section, a pair of sprockets carried by the piston rod on said hoist cylinder assembly, a pair of sprockets carried by the base member of said second mast section, a pair of chains secured to the chain anchors of said first mast section, said chains extending from the upper ends of said first mast section downwardly and around the sprockets on said base member of the second mast section, said chains extending upwardly therefrom and around the sprockets carried by the hoist cylinder assembly, said chains extending therefrom downwardly and having the ends thereof anchored to said load carriage whereby actuation of said cylinder moves said third mast section upwardly with respect to said second mast section and at the same time moves said second mast section vertically upward with respect to said first mast section.

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