Nov. 20, 1962 K. E. RAMSEY 3,064,761

LIFT TRUCK MAST

Filed Oct. 19, 1960

3 Sheets-Sheet 1

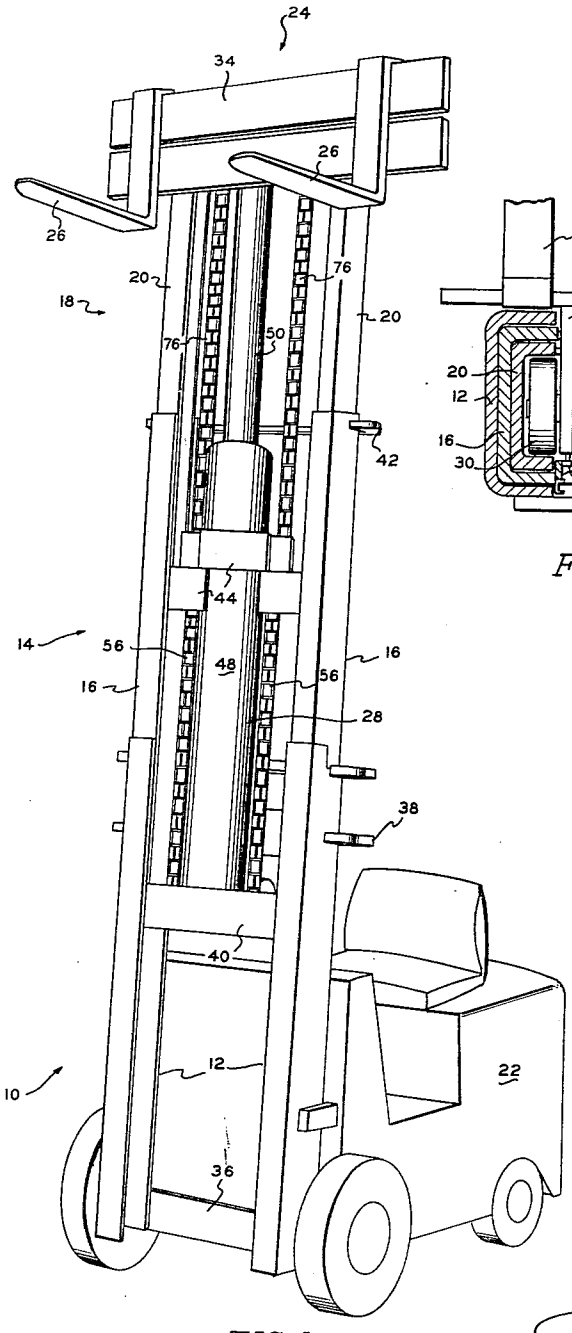


FIG. 1

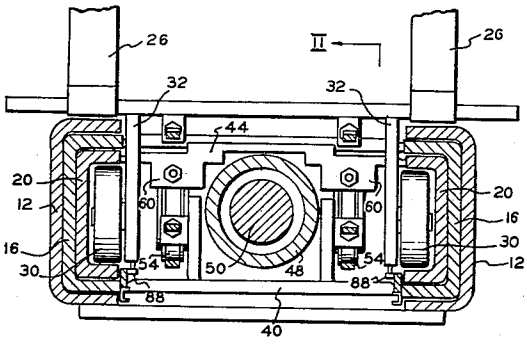


FIG. 4

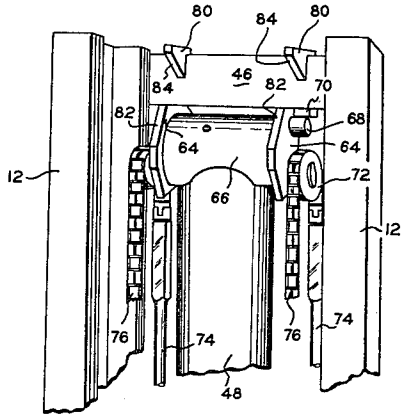


FIG. 3

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Nov. 20, 1962 K. E. RAMSEY 3,064,761

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3 Sheets-Sheet 2

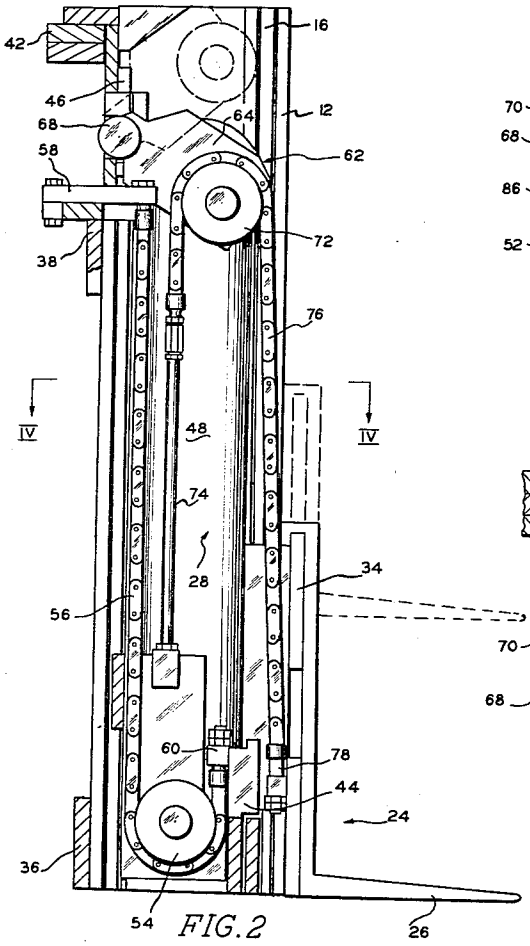


FIG. 2

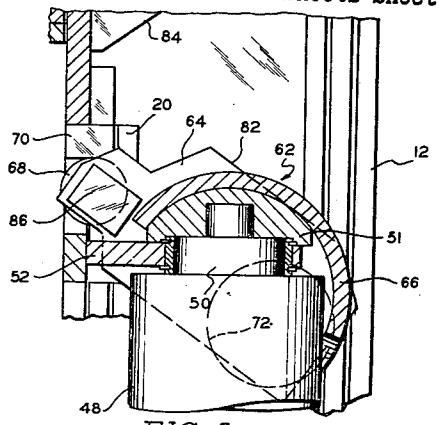


FIG. 5

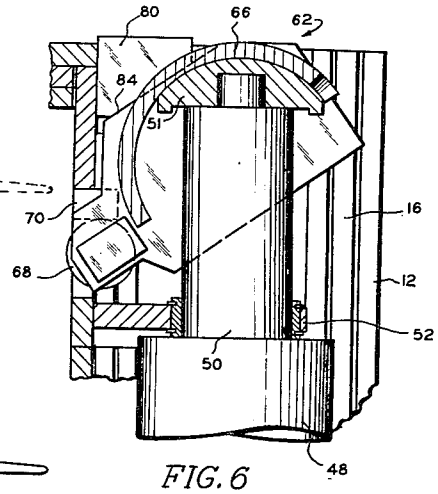


FIG. 6

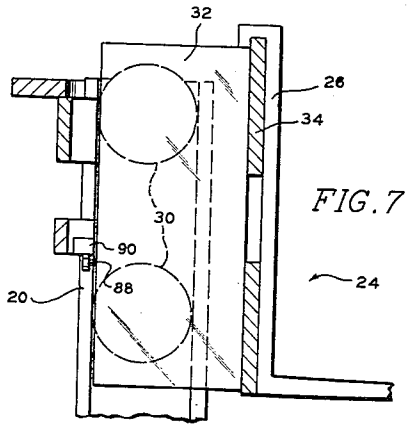


FIG. 7

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Nov. 20, 1962 K. E. RAMSEY 3,064,761

LIFT TRUCK MAST

Filed Oct. 19, 1960 3 Sheets-Sheet 3

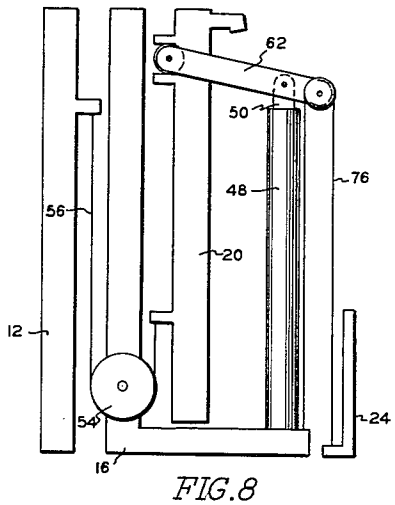


FIG. 8

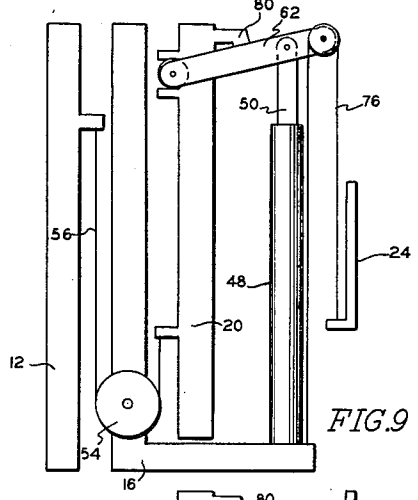


FIG. 9

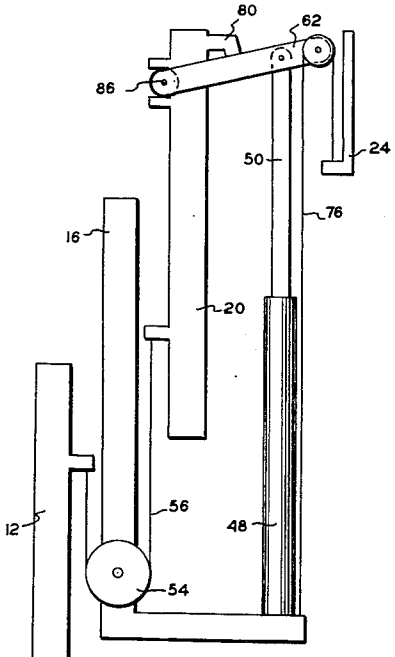


FIG. 10

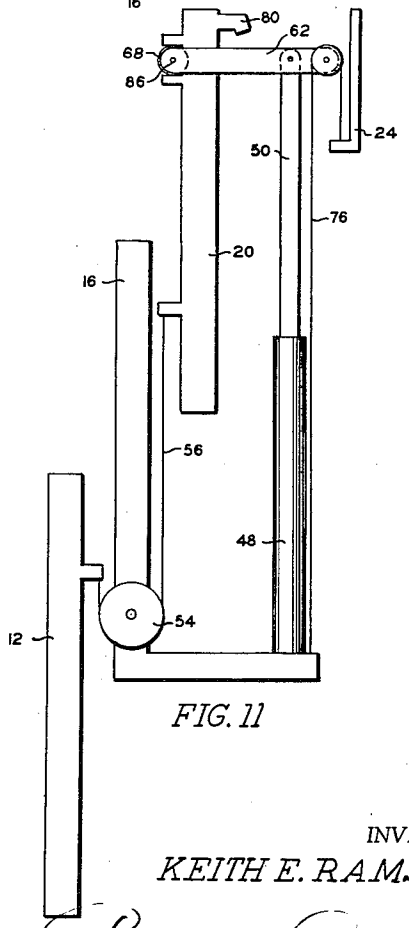


FIG. 11

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United States Patent Office 3,064,761 Patented Nov. 20, 1962

3,064,761
LIFT TRUCK MAST

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Filed Oct. 19, 1960, Ser. No. 63,677
12 Claims. (Cl. 187—9)

The invention pertains to a lift truck mast and particularly relates to a lift truck mast assembly of the three-mast extension type employing a hydraulic expansible motor.

In the interest of better utilization of warehouse and storage means, cartons and other articles being stored are often placed upon each other in stacked relation to considerable heights. Such stacking is usually accomplished by means of a vertically positionable load lifting platform mounted upon a lift truck and the platform is supported and guided upon mast structure. When raising loads to considerable heights, lift truck masts employing a plurality of telescoping mast elements, usually three, are employed and are usually interconnected in a manner which will permit the simultaneous vertical movement thereof during at least one phase of the lifting sequence. It is one object of the invention to provide triple-lift truck mast assembly wherein an improved and simplified construction is employed to produce a mast capable of lifting loads to considerable height.

Another important feature of a lift truck mast, besides the height of load lift, pertains to the "free lift" capacity of the mast. "Free lift" pertains to the vertical distance the load carriage may move, with the mast in the lowermost position, before the mast begins to increase in height. The "free lift" phase of the mast assembly operation is employed in the initial lifting of the load from the floor whereby the load may be transported and it is desirable that the maximum "free lift" height be relatively high for purposes of clearance and versatility. As lift trucks are often employed in areas of limited vertical clearance, such as in railroad cars and doorways, it is of definite advantage that load lifting take place without an extension of the over-all mast height. Another important feature of the invention lies in the ability of the mast assembly disclosed herein to achieve a relatively high "free lift" without the extension of the mast.

Triple-mast structure having high "free lift" capabilities are known, see Shaffer U.S. Patent No. 2,918,143, however, prior tri-mast constructions having high "free lift" required the use of complicated and expensive hydraulic expansible motor construction and it is an important feature of the invention that the above advantages be achieved with the use of a simple expansible motor unit comprising a simple cylinder and piston arrangement.

The invention accomplishes the desired results by the utilization of a novel interconnection system between the masts and also, by a unique means for interconnecting one of the expansible motor elements, usually the piston, with the means lifting the load carriage during the "free lift" wherein a mechanical advantage is employed such that raising of the motor piston results in a vertical movement of the load carriage greater than twice that of the piston.

Another object of the invention is to provide a triple-mast lift assembly wherein a simple piston-cylinder expansible motor may be employed to sequentially lift a load carriage through a "free lift" phase and a mast raising phase wherein the transition between the two phases is free of objectionable velocity changes and the raising and lowering of the load carriage throughout the complete travel is relatively free of major vibrations.

A further object of the invention is to produce a tri-mast lift assembly which is of simplified construction, as compared to known equivalent mast constructions of assemblies, and which is capable of lifting heavy loads to considerable heights.

These and other objects of the invention arising from the details and relationships of the components of an embodiment thereof will be apparent from the following description and accompanying drawings wherein:

FIG. 1 is an elevational perspective view of a lift truck having a mast assembly in accord with the invention wherein the mast is in the extended relationship,

FIG. 2 is an elevational sectional view of the mast in the lowered position as taken along section II—II of FIG. 4,

FIG. 3 is an elevational perspective view of the upper section of the mast in the fully retracted position,

FIG. 4 is a plan elevational sectional view of the mast assembly as taken along section IV—IV of FIG. 2,

FIG. 5 is an elevational sectional detail view of the piston and lever construction with the components in the lowermost carriage position,

FIG. 6 is an elevational sectional detail view similar to FIG. 5 showing the lever and piston components relationship at the top of the "free lift" phase,

FIG. 7 is an elevational sectional view of one of the load carriage plates during the maximum mast extension phase, and

FIGS. 8 through 11 are schematic illustrations of the mast, motor, lever and load carriage relationships during the various lifting phases.

Referring to FIG. 1 the lift mast assembly basically consists of a pair of spaced outer channel members **12**, constituting an outer mast **10**, an intermediate mast **14** consisting of channels **16** and an inner mast **18** formed of spaced channels **20**. The channel elements of the mast **14** are slidably received within the outer channels **12** for telescopic movement thereto and the inner channels **20** are likewise related to the intermediate channels **16**. The outer mast **10** is connected, at its lower regions, to a lift truck **22** in a conventional pivotal manner, not shown, and hydraulic equipment is usually employed to permit the mast assembly to be tilted about its pivot connection relative to the lift truck. A load carriage **24** having forks **26** adjustably mounted thereon for transverse spacing is guidably supported upon the inner channels **20** as will be later described, and an expansible motor unit **28** is interposed between the intermediate and inner mast.

As shown in FIG. 4, the inside of the channels **20** of the inner mast constitute a guide way receiving rollers **30** which are rotatably mounted upon a pair of spaced carriage support plates **32**, two vertically spaced rollers being mounted on each plate. The support plates **32** support the transverse carriage members **34** upon which the forks **26** are adjustably mounted in any manner which is common in the art.

Parallel spacing between the outer channels **12** is maintained by a lower cross member **36** and an upper cross member **38**, FIG. 2. The spacing between the intermediate channels **16** is maintained by a lower crossbar element **40** which interconnects the channels and an upper cross member **42** maintains the upper regions of the channels **16** in the desired spaced relationship. The cross member **44** interconnects the lower regions of the inner channels **20** and the upper regions of the inner channel are maintained in spaced relation by the cross member **46**, FIG. 3.

The expansible motor unit **28** consists of a cylinder component **48** which is mounted upon the intermediate cross member **40** and extends in a vertical direction substantially parallel to the mast assembly. A piston member **50** is operatively associated with the cylinder **48** and is provided with a pillow bearing element **51**, FIGS. 5 and 6, having a cylindrical convex upper surface. A guide

member 52, mounted upon the intermediate mast 14 slidably receives the piston and aids in guiding the same during its stroke.

A pair of rollers or pulleys 54 are rotatably mounted upon the lower cross member 40 of the intermediate mast on substantially opposite sides of the cylinder 48 and chains 56 are affixed at one end to brackets 58 formed upon the outer mast 10 near the upper regions thereof and pass underneath the rollers 54 having the other end affixed to the inner mast 18 at bracket 60. Chain take-up means are provided at bracket 60 to maintain the proper chain tension.

A lever element 62 is fulcrumed and pivotally associated with the upper region of the inner mast 18 and the configuration of the lever may best be appreciated from FIGS. 2, 3, 5 and 6. The lever 62 consists of a pair of parallel vertically extending plate members 64 having a cylindrical shaped bearing plate 66 interposed therebetween and the underside of the bearing plate 66 complementarily cooperates with the cylindrical surface of the piston mounted pillow bearing 51. A pivot roller 68 is mounted upon each of the plates 64 and is adapted to abut in rolling relationship to the underside of blocks 70 formed upon the crossbar 46 of the inner mast. The rollers 68 are located adjacent the inner end of the lever 62. A pair of rollers or pulleys 72 are rotatably mounted upon opposite sides of the lever plates 64 adjacent the outer end thereof and it will be appreciated from FIGS. 5 and 6 that the axis of the piston 50 lies intermediate the axes of the rollers 68 and 72. Suitable lubrication fittings may be provided in the bearing plate 66 to insure that the inner cylindrical surface of the bearing plate is adequately provided with grease or similar lubricant.

A pair of parallel tension rods 74 are affixed at their lower end to the intermediate cross member 40, extend vertically toward the rollers 72 and upper ends of the rods are provided with a turnbuckle which serves as an anchor for one end of chains 76 which pass over rollers 72 and downwardly to the load carriage bracket 78 to which they are affixed. The upper inner mast cross member 46 is provided with a pair of abutment elements 80, FIG. 3, and the upper surface 82 of the lever plates 64 is formed at an angle which corresponds to that of the abutment member surfaces 84, FIG. 6, whereby upon the pivoting of the lever 62 to the position of FIG. 6 a mutual abutting relationship of considerable area exists between the plates 64 and the abutments 80.

The operation of the mast assembly may be best appreciated with reference to FIGS. 8 through 11 wherein the components are illustrated schematically and the lever 62 is illustrated in a conventional form and shown as being pivotally attached to the inner mast 18 at an axis 86. FIG. 8 illustrates the mast components in their lowermost position, the three masts are fully retracted and the piston is retracted within the cylinder the maximum degree whereby the rollers 72 are in their lowermost position and the load carriage 24 is in its lowest position. The relationship of FIG. 8 is also that shown in FIG. 2 in the full lines. To lift the load from the floor, the lift truck is maneuvered to locate the forks 26 thereunder in the known fashion and the operator then introduces the pressurized medium, usually hydraulic fluid, into cylinder 48 to begin the raising of the piston 50. This operation begins the counterclockwise pivoting of lever 62 about pivot axis 86 and will cause the carriage 24 to be vertically lifted within the guides of the inner channels 20 due to the raising of the rollers 72 relative to the chains 76. It will be appreciated that as the rollers 72 are moving in a vertical direction under the influence of the piston, the vertical travel occurring in the carriage will be at least twice that of the vertical travel of the piston and, due to the fact that the piston is affixed to the lever 62 intermediate the roller axis and the pivot axis 86, the roller axis will be moved vertically through a greater distance than the piston and, hence, the travel of the carriage during the movement of the piston during this "free lift" phase will be more than twice that of the piston movement. By way of example, in one commercial embodiment of the invention a piston movement having a travel of 5⅝ inches during the "free lift" will raise the chain roller axis 8 inches and will cause a carriage lift of 16 inches.

Upon the lever plates 64 abutting the inner upper crossbar abutments 80, as in FIGS. 6 and 9, the "free lift" phase is completed. Further expansion of motor 28, due to the direct connection now achieved between the piston 50 and inner mast 18 results in a tension within chains 56 sufficient to raise the intermediate mast 14 as well as the inner mast 18 and the load. The load carriage during this phase rises due to the relative telescoping between the outer, intermediate and inner masts and the movement of chain 76 over rollers 72 due to the increasing distance occurring between masts 14 and 18 continues under this relationship until the components assume the relationship of FIG. 10. At this time, an abutment, which may be in the form of a bolt 88, FIG. 7, mounted on the back of the carriage plates 32 engages a block 90 affixed to the inner channel and the load carriage now ceases to move relative to the inner mast 18. After the bolts 88 engage blocks 90 the dircet engagement of the load carriage and inner mast 18 will cause the inner mast 18 to raise at an increased rate due to the direct effect of the chains 76 passing over the rising rollers 72 and the transference of the lever fulcrum point to the axis of the rollers 72. As the inner mast 18 will be rising at a greater rate than the piston 50, the lever 62 will now pivot clockwise to some extent with respect to the inner mast, FIG. 11.

The velocity of vertical travel of the load carriage is relatively uniform and the transition between the "free lift" phase and the mast extension is smooth and of such nature as to not disturb loads upon the carriage. The length of the lever 62 and the relative positions of the axes 86, chain rollers 72 and piston pivot in a practical embodiment are such that the ratio of piston travel to load carriage movement during the "free lift" is slightly less than 1 to 3, the ratio becomes 1 to 3 during the second lifting phase, as from FIG. 9 to FIG. 10. During the final lifting phase, e.g., between FIGS. 10 and 11, the ratio will be slightly greater than 1 to 3, thus, substantially a uniform load lifting velocity may be produced throughout the lifting phases and the overall carriage lift is substantially 3 times the piston extension.

After the load upon the carriage is vertically and horizontally positioned as desired, the operator decreases the pressure of the fluid within cylinder 48 and the mast assembly will retract in a sequence opposite to that during lifting.

It will be appreciated that the lever construction disclosed in FIGS. 1 through 6 wherein the lever is provided with a concave bearing surface is only one example of lever construction and, if desired, a lever which is pivoted to the inner mast at a fixed point may be employed and would utilize the concepts of the invention. The lever construction of FIGS. 1 through 6 has the advantage of a large bearing surface and, most important, as the rollers 68 may roll back and forth under blocks 70 as the lever pivots the motor unit 28 need not move relative to the inner mast 18 as the piston-lever pivot axis does not travel in an arc.

It will, therefore, be appreciated that the invention discloses a construction utilizing a simple single cylinder and piston arrangement which permits an extensive extension of a three-mast lift assembly yet permits a relatively high "free lift." It will be noted that the retracted height of the piston and cylinder is substantially less than that of the mast assembly retracted height and the proportion of the "free lift" to the total mast height may be varied by employing a lever of greater or smaller dimensions relative to the positions of the roller axes and the pivot axes of the lever-piston and lever-inner mast connections. In effect, the lever provides a lost motion connection between

the piston and inner mast and during the movement of the lost motion connection, the carriage "free lift" is occurring.

I claim:

1. A lift mast assembly comprising in combination, an outer mast, an intermediate mast and an inner mast in mutual telescopic relationship, a load carriage guided for vertical movement on said inner mast, a cylinder mounted on said intermediate mast, a piston operatively associated with said cylinder, lost motion means operatively interconnecting said piston and inner mast upon predetermined vertical movement of said piston, a first roller associated with said piston for movement therewith, a first chain affixed at one end to said intermediate mast passing over said roller and affixed at the other end to said load carriage, a second roller mounted upon said intermediate mast and a second chain fixed at one end to said outer mast passing under said second roller and fixed at the other end to said inner mast.

2. In a lift mast assembly as in claim 1 wherein said lost motion means operatively interconnecting said piston and inner mast comprises a lever fulcrumed at and pivotally associated with said inner mast, pivot means connecting said piston to said lever and cooperating abutment means defined on said lever and inner mast engaging upon completion of said predetermined piston movement.

3. In a lift mast assembly as in claim 2 wherein said first roller is rotatably mounted upon said lever, said pivot means connecting said piston and lever being interposed between the axis of said first roller and the lever fulcrum pivot.

4. A lift mast assembly comprising in combination, an outer mast, an intermediate mast and an inner mast in mutual telescopic relationship, a load carriage guided for vertical movement upon said inner mast, a hydraulic expansible motor comprising a cylinder and piston, means mounting said cylinder upon said intermediate mast, a lever pivotally associated at one end with said inner mast, means pivotally connecting said piston with the central region of said lever, cooperable abutment means defined on said lever and inner mast, a first roller rotatably mounted on the other end of said lever, a first chain affixed at one end to said intermediate mast passing over said first roller and affixed at the other end to said load carriage, a second roller rotatably mounted on said intermediate mast adjacent the lower regions thereof and a second chain affixed at one end to the upper regions of said outer mast passing under said second roller and affixed at the other end to the lower region of said inner mast.

5. In a lift mast as in claim 4 wherein a pair of sets of first rollers and first chains are employed, said sets being located on opposite sides of said piston and a pair of sets of second rollers and second chains, said last mentioned sets being disposed on opposite sides of said cylinder.

6. In a lift mast as in claim 4 wherein the pivot means connecting said piston to said lever comprises a concave cylindrical recess defined in said lever and a complementary convex pillow bearing member mounted upon said piston is received within said recess.

7. In a lift mast assembly as in claim 4 wherein means are carried by said load carriage directly abutting said inner mast near the maximum extension of said piston.

8. A lift mast assembly comprising, in combination, an outer mast, an intermediate mast and an inner mast in substantially vertical mutual telescopic relationship, a load carriage guided for vertical movement upon said inner mast, a single stage cylinder mounted upon said intermediate mast extending parallel thereto, a single stage piston operatively associated with said cylinder, motion multiplying lever means indirectly interconnecting said piston and load carriage whereby initial movement of said piston lifts said carriage a greater distance than the piston travel, means operatively interconnecting said inner mast and piston at the termination of said initial piston movement and means interconnecting said outer and inner masts upon said piston and cylinder lifting said inner mast relative to said intermediate mast raising said intermediate mast relative to said outer mast upon continued movement of said piston.

9. In a lift mast assembly as in claim 8 wherein said motion multiplying lever means comprises a lever pivotally associated with said piston and inner mast, a roller rotatably mounted on said lever and a chain affixed at one end to said intermediate mast passing over said roller and affixed at the other end to said load carriage.

10. In a lift mast assembly as in claim 9 wherein said means connecting said outer and inner masts lifting said intermediate mast comprises a second roller rotatably mounted on said intermediate mast and a chain affixed to said outer mast passing under said roller and affixed to said inner mast.

11. In a lift mast assembly as in claim 8 wherein said motion multiplying lever means lifts said carriage more than twice the distance of piston travel during said initial piston movement.

12. In a lift mast assembly as in claim 8 wherein said means interconnecting said inner mast and piston include first abutment means mounted on said load carriage and second abutments on said inner mast engaged by first abutment means during the final lifting phase of the vertical extension of said assembly directly lifting said inner channel through said motion multiplying means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,877,868	Gunning	Mar. 17, 1959
2,918,143	Shaffer	Dec. 22, 1959
2,936,047	Quayle	May 10, 1960
2,946,406	Henry	July 26, 1960