Oct. 30, 1962 A. W. GUNNING 3,061,046

LOAD HOISTING MAST WITH ROLLER CHAIN ANTI-FRICTION MEANS

Filed July 27, 1961 5 Sheets-Sheet 1

Fig. 1

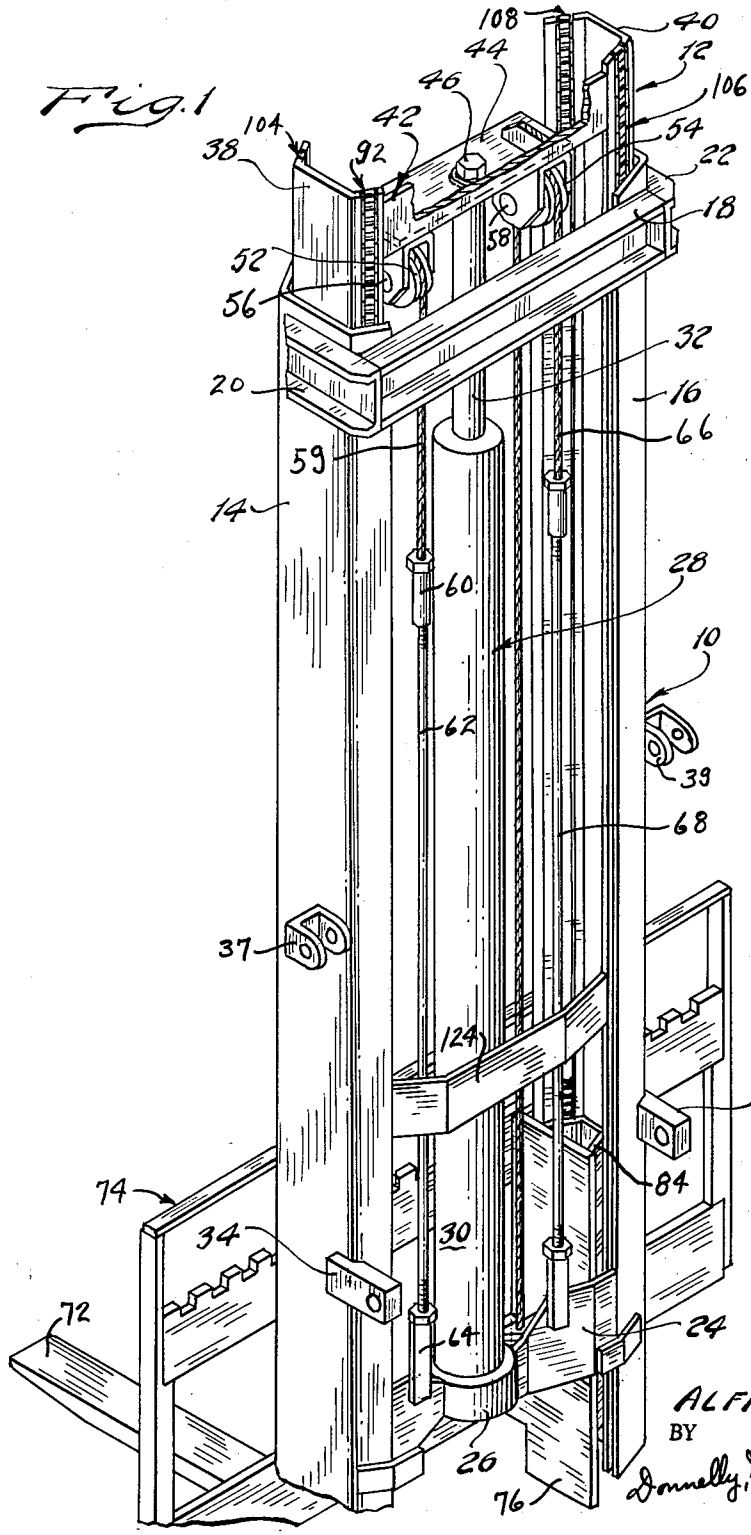

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Fig. 2

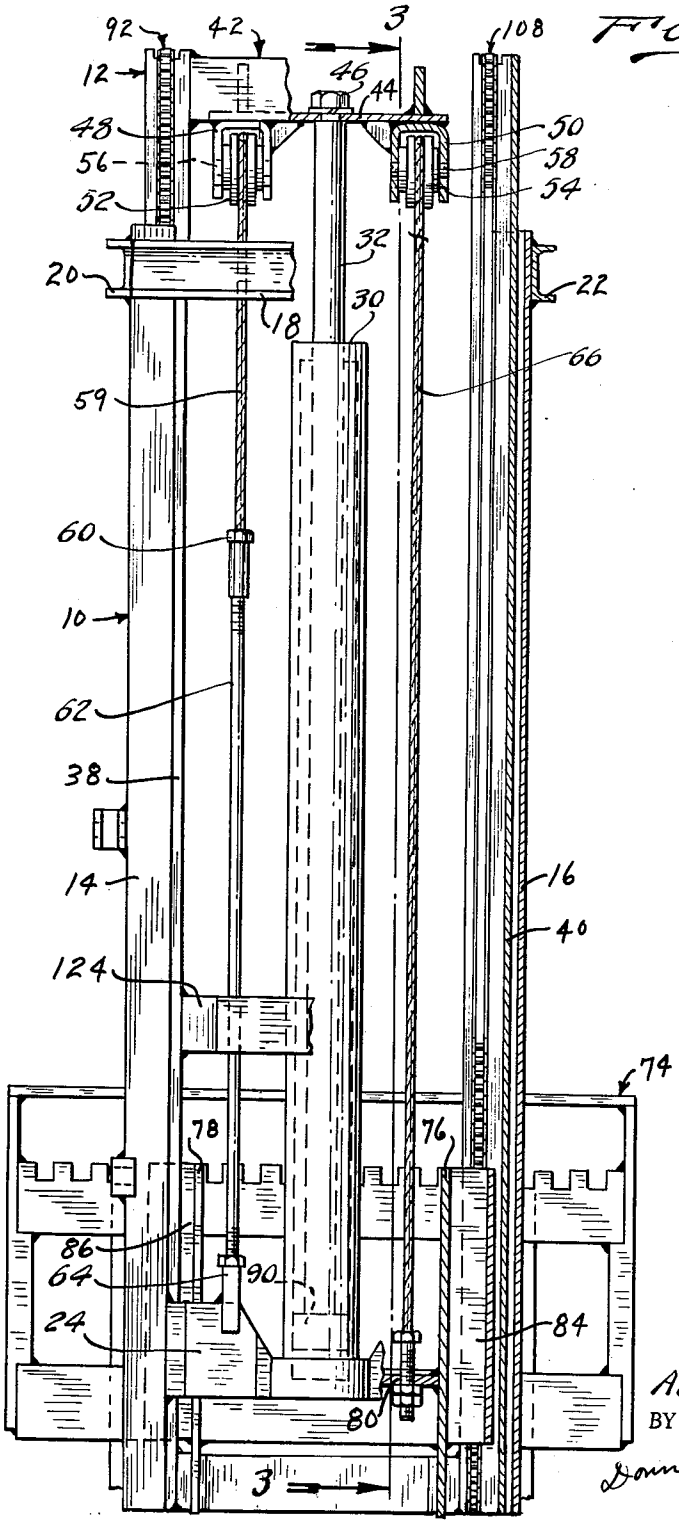

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Fig. 3

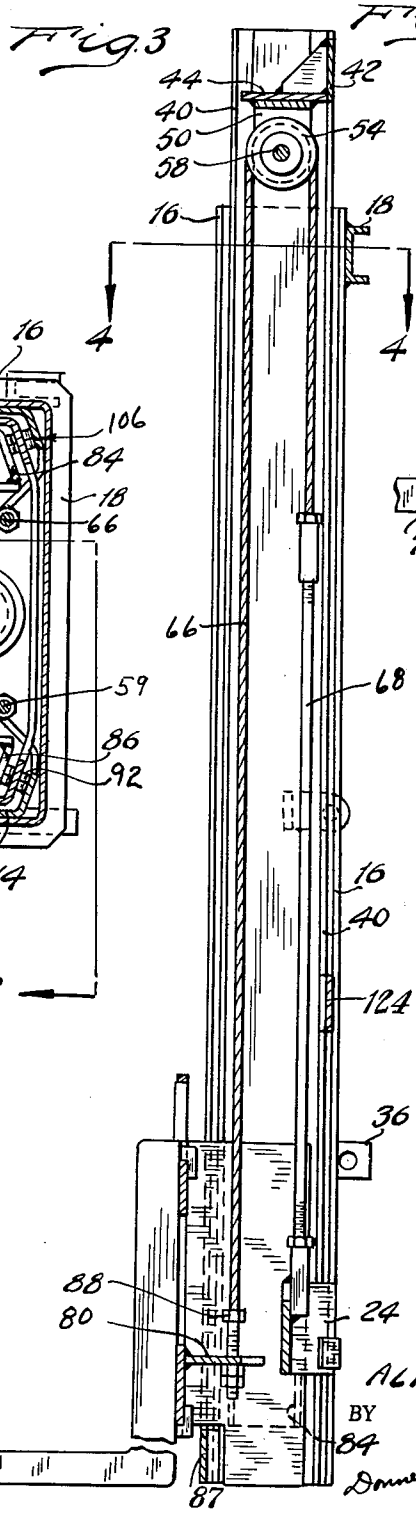

Fig. 4

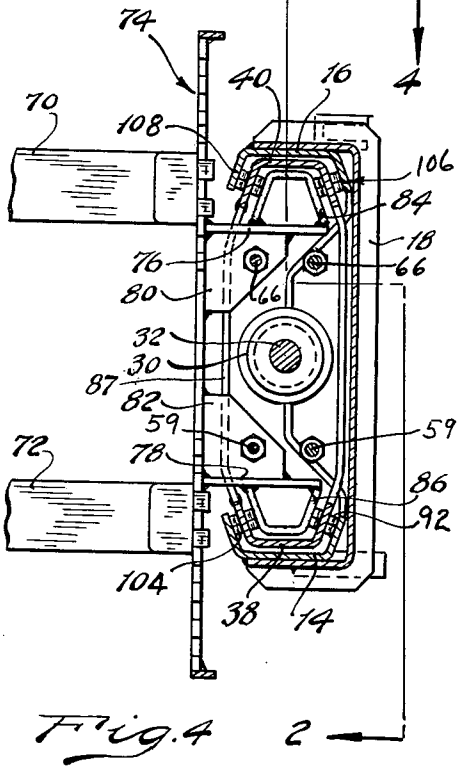

Fig. 5

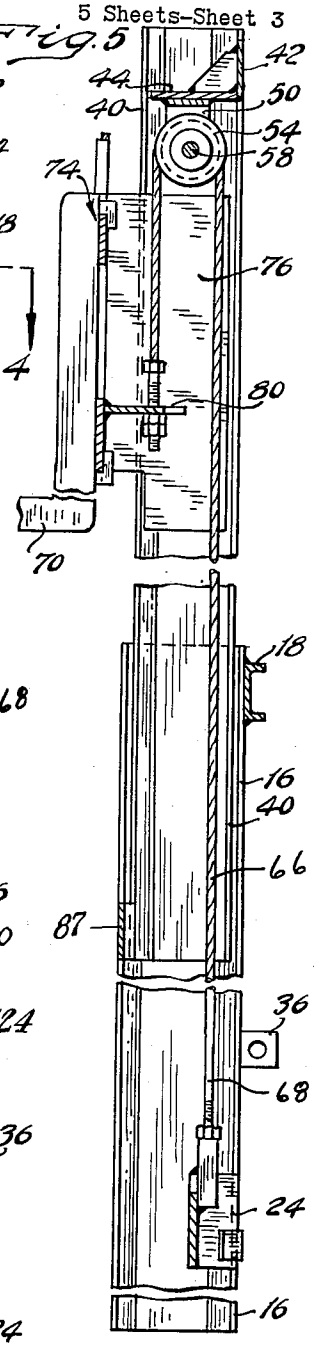

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Fig. 7

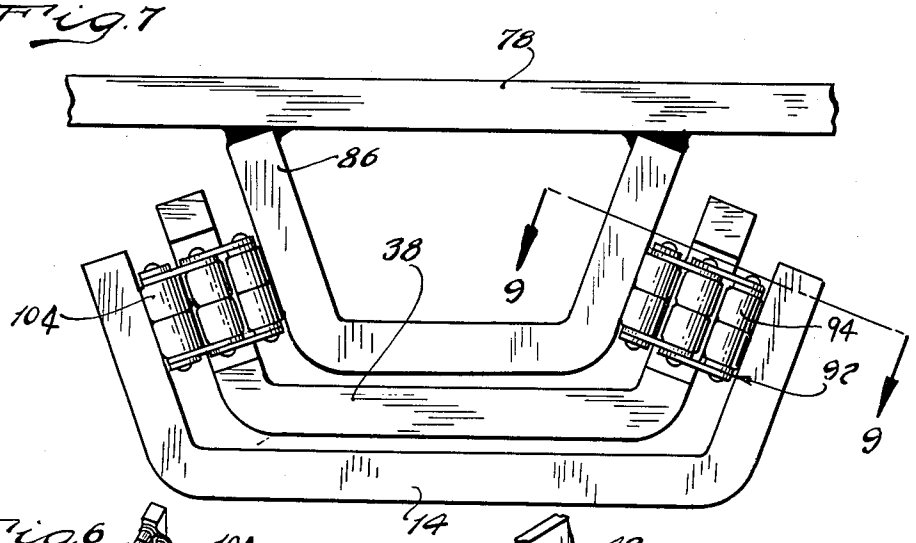

Fig. 6

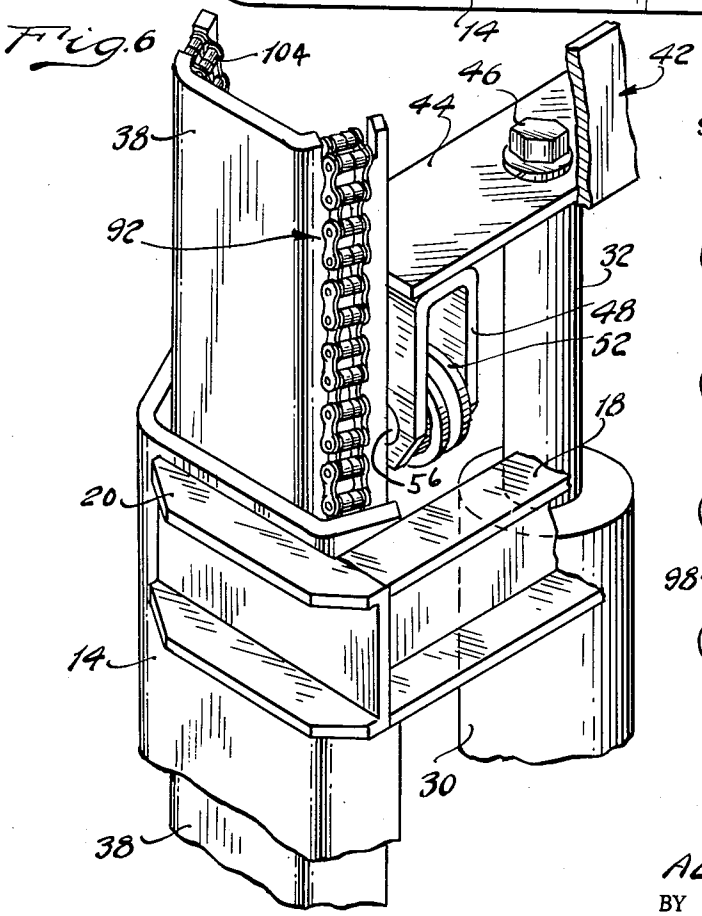

Fig. 8

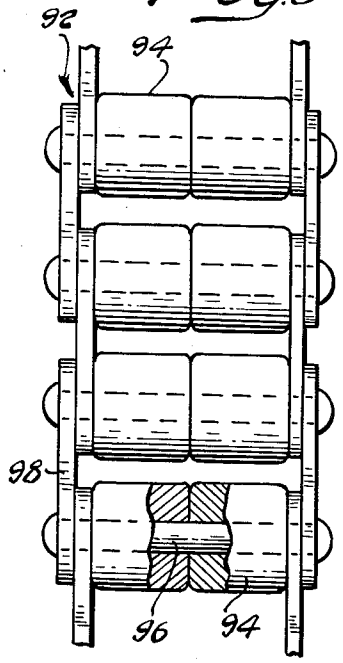

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Fig. 10

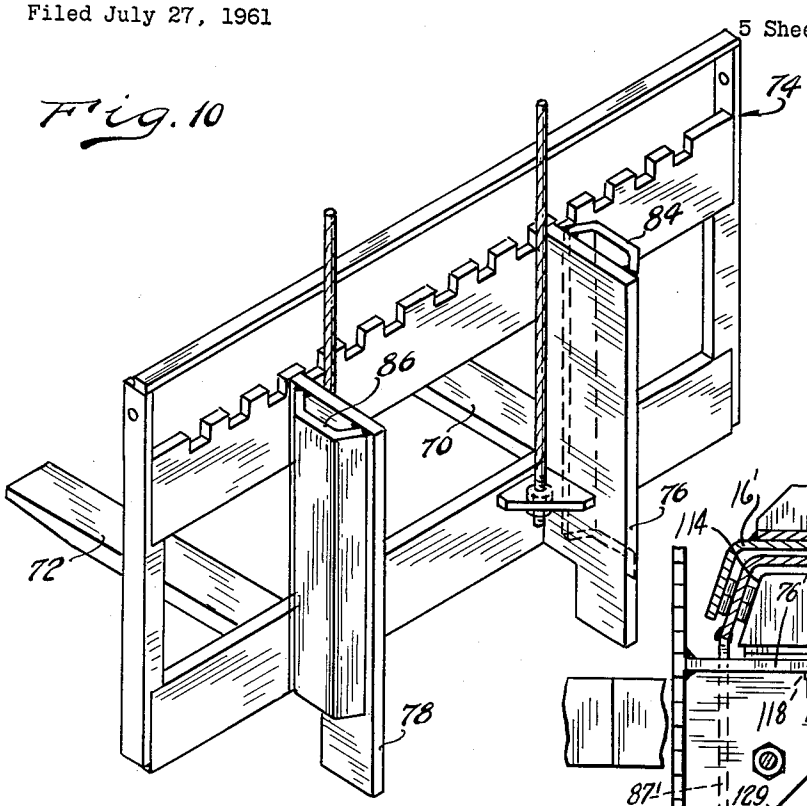


Fig. 11

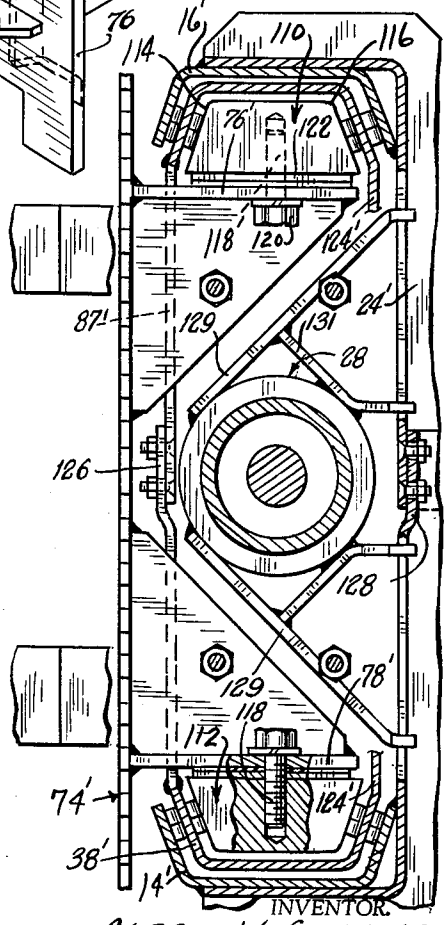
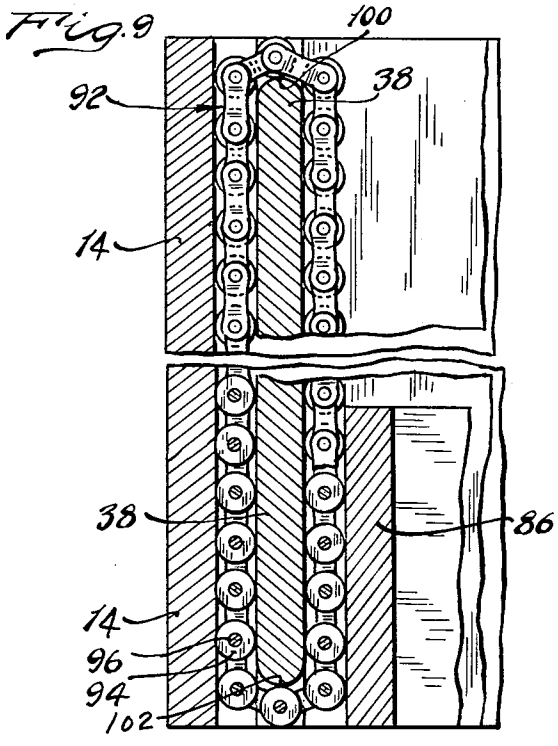


Fig. 9



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United States Patent Office 3,061,046 Patented Oct. 30, 1962

3,061,046

LOAD HOISTING MAST WITH ROLLER CHAIN ANTI-FRICTION MEANS

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Filed July 27, 1961, Ser. No. 127,240
10 Claims. (Cl. 187—95)

My invention relates generally to materials handling equipment, and more particularly to a load hoisting mast or fork-lift having multiple sections.

This application forms a continuation-in-part of my copending application, Serial No. 70,459, filed November 21, 1960, which is assigned to the assignee of my instant invention.

The construction of my invention comprises a relatively stationary mast section having spaced parallel channels or side rails. A relatively movable mast section is received within the stationary mast section, and it also is comprised of spaced parallel channels that are received in telescopic relationship with respect to the corresponding channels of the stationary mast section. A motor means, preferably in the form of a hydraulic ram, is provided for moving the movable mast section with respect to the stationary mast section.

A carriage is mounted on the mast for movement in a vertical direction and is formed with guide portions received within the channels of the relatively movable mast section. A chain and sprocket or pulley arrangement may be provided for the purpose of moving the carriage in the direction of motion of the relatively movable mast section when the hydraulic ram is actuated.

The hydraulic ram and the chain and sprocket or pulley arrangement are adapted to establish a one-to-one speed ratio between the hydraulic ram and the movable section and a two-to-one speed ratio between the carriage and the hydraulic ram.

Bearing elements in the form of rollers are situated between the sides of the channels for the movable mast section and they are arranged in the form of a continuous roller chain that encircles the channels of the movable mast section. This roller chain extends in the direction of motion of the movable mast section and establishes guidance of the movable mast section with respect to the stationary mast section. It provides guidance also for the carriage.

The mast construction of my invention is characterized by a relatively reduced degree of friction between the relatively movable portions thereof. It is capable also of accommodating a high degree of loading on the carriage. The load lifting capacity of the mast of my invention far exceeds the capacity of conventional mast sections of comparable size.

My mast construction is capable also of accommodating eccentrically placed loads on the carriage. Such eccentric loading establishes force couples that act about a transverse axis as well as an axis extending in a fore and aft direction. By contrast, masts of conventional construction are capable of accommodating only a slight degree of off-center or eccentric loading.

My improved mast construction is capable also of lifting loads of relatively large magnitude when the mast is titled in either a transverse direction, a fore and aft direction, or under certain operating conditions when the line of action of the force of gravity of the load is misaligned with respect to the longitudinal axis of the mast.

The provision of a mast of the type I am describing being the principal object of my invention, it is a further object of my invention to provide a mast comprising at least one relatively movable section and a load hoisting carriage that is mounted upon and guided within a movable mast section.

It is another object of my invention to provide a mast construction having a stationary mast section and at least one relatively movable mast section and which is capable of accommodating eccentric loading.

It is a further object of my invention to provide a mast construction having a stationary mast section and a relatively movable mast section and which is characterized by a relatively low degree of friction between the relatively movable portions thereof.

Further objects and features of my invention will become apparent from the following description and from accompanying drawings wherein:

FIG. 1 is an isometric view of a mast assembly embodying the principles of my invention;

FIG. 2 is a rear view of the mast construction of FIG. 1 with portions thereof shown in cross section, and is taken along section line **2—2** of FIG. 4;

FIG. 3 is a longitudinal cross sectional view of the mast construction of FIGS. 1 and 2, and taken along section line **3—3** of FIG. 2;

FIG. 4 is a transverse cross sectional view of the mast construction of FIGS. 1 and 2, and taken along section line **4—4** of FIG. 3;

FIG. 5 is a view that is similar to FIG. 3 and which shows the carriage and the movable section in extended positions;

FIG. 6 is an enlarged isometric view of an upper portion of the mast construction of FIGS. 1 and 2;

FIG. 7 is an enlarged plan view of a portion of the structure shown in FIG. 6 and showing also a portion of the carriage;

FIG. 8 is an enlarged sub-assembly view showing a portion of the roller chain that is employed in the mast construction of the present invention;

FIG. 9 is a broken, elevational sectional view, taken along section line **9—9** of FIG. 7;

FIG. 10 is an isometric view showing the carriage that is used with the mast construction; and,

FIG. 11 illustrates a modified form of guide means for the carriage.

Referring first to FIGS. 1 through 4, the relatively stationary mast section is identified generally by the reference character **10**, and the relatively movable mast section is identified generally by the reference character **12**. The relatively stationary mast section **10** comprises a pair of spaced channels **14** and **16** that are situated in spaced apart parallel relationship with the open sides situated in juxtaposition. A supporting structural bracket, preferably of channel shape, is identified by reference character **18** and is adapted to join together the upper portions of the channels **14** and **16**. To add greater support, the side channel brackets **20** and **22** are provided, as shown, at the ends of the bracket **18**. Bracket portions **20** and **22** may be secured in place by welding.

At the base of the mast section **10**, I have provided another bracket **24** that is adapted to join the lower most ends of the channels **14** and **16**. The intermediate portion of the bracket **24** extends inwardly to provide support for a base **26** for the conventional hydraulic ram generally identified by the reference character **28**. This hydraulic ram **28** includes a cylinder housing **30** supported by the bracket **24** and a ram or piston rod **32** that may reciprocate in telescopic fashion within the cylinder housing **30**. The piston rod **32** can be extended when fluid pressure is supplied to the cylinder housing **30** in a conventional fashion.

Pivot brackets are shown at **34** and **36** and are welded, or otherwise secured, to the channels **14** and **16**. The mast may be mounted upon a suitable wheeled vehicle,

or other chassis structure, in order to provide mobility for the mast construction. Other pivot brackets are shown at 37 and 39 and are welded to the channels 14 and 16 as shown. These may be connected to hydraulic cylinders of the type shown in U.S. Patent 2,877,868. This permits the mast construction to be tilted in a fore and aft direction about the axis of the pivot brackets 34 and 36.

The relatively movable mast section 12 comprises the parallel channels 38 and 40. As shown in FIG. 1, these channels are held together at the upper portion thereof by a bracket 42 that is secured in place by welding to the edge of a cooperating leg or flange of each of the channels 38 and 40. The bracket 42 is formed preferably with an L-shaped cross section and includes a portion 44 disposed in the region between the channels 38 and 40. As shown in FIG. 2, the aforementioned ram or piston rod 32 is secured to the portion 44 of the bracket 42 by means of a suitable threaded connection 46. Secured also to the portion 44 is a pair of U-shaped brackets 48 and 50 that support a pair of pulleys 52 and 54, respectively. Pulley 52 is disposed within the bracket 48 and is carried by a supporting shaft 56. The corresponding shaft for pulley 54 is shown at 58. A chain or cable 59 is trained over pulley 52 and is anchored by means of a suitable connection 60 to an anchor rod 62. This rod is connected in a fixed fashion by any suitable means to bracket 24, an appropriate threaded connection means being shown at 64. In a similar fashion, a chain or cable 66 is trained over pulley 54 and is anchored at one end thereof to an anchor rod 68 that is connected to the aforementioned bracket 24.

As best seen in FIGS. 4 and 10, I have provided a carriage having a pair of fork arms 70 and 72. These arms are secured to a vertical face plate structure generally identified by reference character 74. A bracket 76 in the form of a vertical, inwardly extended plate is secured to the face plate structure 74 in a perpendicular fashion and a corresponding laterally spaced apart bracket is provided at 78. A horizontal supporting plate 80 can be provided to add support to the bracket 76, the plate 80 being welded to the face plate structure 74 and the bracket 76. A corresponding supporting plate 82 is provided for the bracket 78.

Secured to the bracket 76 on the outer side thereof is a guide member 84 having a cross sectional shape that is similar to the cross sectional shape of the channels 16 and 40. The guide member 84 is secured to the bracket 76. In the embodiment shown in FIG. 4, the guide member 84 is in the form of an inverted channel with the open side thereof secured to the bracket 76 by any suitable means, as by welding. Another guide member 86 is secured to the bracket 78 and is similar to the guide member 84. The open end of the guide member 86 is secured to the bracket 78 by means of welding.

As best observed in FIGS. 1 and 4, the guide member 84, the channel 40 and the channel 16 are situated in nested relationship and they are formed with cross sectional shapes that are similar. In like fashion, guide member 86, channel 38 and channel 14 are situated in nested relationship and are formed with similar cross sectional shapes.

As best seen in FIGS. 3 and 5, the free end of the chain or cable 66 is connected to plate 80 of the carriage by means of a suitable connection 88. In a similar fashion, chain or cable, 59 is connected to plate 82 of the carriage.

As best seen in FIG. 2, the ram or piston rod 32 is connected to a piston 90. When fluid pressure is applied to the working chamber defined in part by piston 90 and the cooperating cylindrical chamber in the cylinder housing 30, the ram or piston rod 32 will be extended upwardly thus moving the movable stage or mast section 12 in an upward direction as viewed in the drawings relative to the stationary mast section 10. This, of course, also causes the pulleys 52 and 54 to move in an upward direction and the carriage thus is moved vertically upward also at a speed ratio of two-to-one relative to the rate of movement of the piston rod 32. The carriage 74 thus can be moved to any desired height within the limitations of the mast construction. One operating position of the carriage 74 is shown in FIG. 5.

As best seen in FIG. 4, the channel 16 is formed with side portions or flanges that diverge from the base or web portion thereof. In a similar fashion, channel 40 is formed with a base or web portion and with diverging side or flange portions, the angle of divergence being equal to the angle of divergence of the sides or flanges of the channel 16. Similarly, the guide member 84 is formed with diverging sides that are parallel to the sides of the channels 16 and 40. In one operating embodiment, the included angle between the base or web of the channel 16 and one of the cooperating sides or flanges of the channel is 105°. The corresponding included angle for the channel 40 and the guide member 84, of course, is equal to 105° also. The lowermost portions of the channels of mast section 12 are held together also by a cross bracket 87 and are situated as shown in FIGS. 3, 4 and 5 so that they will not interfere with the carriage.

As best seen in FIG. 9, I have provided a series of rollers between the guide member 86 and the channel 38, and between the channel 38 and the channel 14. These rollers are linked together to form a continuous roller chain that extends in a direction parallel to the direction of relative motion of the movable mast section 12 relative to the stationary mast section 10. The roller chain is generally identified by the reference character 92.

A sub-assembly view of the chain 92 is shown in FIG. 8 and comprises a series of rollers 94, each of which may be split into two parts as shown. The rollers rotate upon pins 96. The pins in turn may be linked together by chain links 98.

The chain 92 is trained over one of the sides of channel 38 and during operation of the mast, the chain circulates in a continuous fashion about the cooperating channel side. The upper and lower edges of the cooperating channel side can be recessed and rounded to accommodate the chain 92. These ends are shown in FIG. 9 at 100 and 102. The chain 92 functions as a guide means and as a bearing for the carriage 74 and for the channel 38 as they move relative to each other and relative to the stationary channel 14.

A corresponding chain 104 is trained over the other diverging side of the channel 38 and extends in a direction parallel to the direction of motion of the channel 38.

The diverging sides of the channel 40 also have cooperating roller chains 106 and 108 that correspond in function to the aforementioned roller chains 92 and 104, respectively. These chains 106 and 108 can be seen also in FIG. 1.

The sides or flanges of the channels 16 and 40 diverge with an angle that may be equal to the angle of divergence of the corresponding sides or flanges for the channels 14 and 38. The carriage 74 and the movable mast section 12 are guided during operation and the degree of friction between the moving surfaces is reduced to a minimum. The moments and forces that act upon the nested channels are distributed through the roller chains in a direction normal to the planes of the sides or flanges of the channels. Because of the divergence of the sides or flanges, the reaction forces for both static and dynamic loads that are experienced during operation are resolved into transverse components as well as fore and aft components. The ability of the mast construction to accommodate side loads and off-center loads on the carriage thus is greatly increased.

As previously indicated, the movable mast section 12 moves at a speed ratio one-to-one relative to the piston rod or ram 32. The rollers for the chains, however, engage the cooperating roller surface of the sides

or flanges of the channels for the movable mast section 12. The instantaneous center of rotation for the rollers between the carriage guide members 84 and 86 and the channels for the movable mast section 12 lie on the surface of the diverging sides or flanges of the movable mast section channels 38 and 40. This being the case, the peripheral speed of the surface of the rollers 94 that engage the carriage guide members 84 and 86 is equal to two times the rate of movement of the instantaneous center of rotation of the rollers 94. As previously indicated also, the carriage 74 moves at a speed ratio of two-to-one relative to the motion of the movable mast section 12. Thus, the periphery of the rollers 94 between the carriage guide members 84 and 86 and the movable mast section channels 38 and 40 and the cooperating roller bearing surface of the carriage guide members move at the same speed. There is, therefore, no scuffing action between the rollers 94 and the cooperating roller bearing surfaces of the movable mast section channels 38 and 40 and the carriage guide members 84 and 86.

In a similar fashion, scuffing action is entirely eliminated between the rollers 94 between the stationary mast section channels 14 and 16 and the channels 38 and 40 of the movable mast section 12. The instantaneous center of rotation for each of these rollers 94 lies on the surface of the sides or flanges of the stationary channels 14 and 16. The peripheral speed of the surface of the rollers 94 that engage the stationary channels 14 and 16 thus is equal to the speed of the piston rod or ram 32 itself. Since this is true, the speed of the roller pins 96 is equal to one-half the speed of the ram 32. Since this is true, the roller chain 92 as shown in FIG. 9 will circulate in a clockwise direction about the movable mast section channels when the carriage is moving in an upward direction. A corresponding circulation of the other roller chains during operation also will take place.

In a preferred form of my invention, the bracket 42 is arranged so that it will not interfere with the guide members 84 and 86 of the carriage 74 when the carriage reaches the uppermost position. These guide members and the cooperating brackets 76 and 78 will pass on either side of the portion 44 of the bracket 42. This feature increases the maximum height of the mast construction for any given overall height of the mast when it is in a stacked position.

In FIG. 11 I have shown a modified mast and carriage construction comprising guide members 110 and 112 that correspond in function to the aforementioned guide members 84 and 86, respectively. In other respects, the carriage of FIG. 11 corresponds in structure to the carriage of FIG. 10, and the corresponding elements have been identified by similar reference characters with primed notations.

The guide member 110 can be formed, if desired, of solid bar stock and it includes tapered sides 114 and 116, the angle of the taper being equal to the angle of divergence of the cooperating channels of the mast sections. The guide member 110 can be secured to a cooperating carriage bracket 76 by means of one or more bolts or studs 118. A fastening nut 120 is provided as indicated. In order to accommodate for manufacturing tolerances and to prevent tilting of the carriage 74 in those instances when the tolerances are large, I have provided shims 122 between the bracket 76 and the guide member 110.

The guide member 112 can be connected to its cooperating bracket 78 in a manner similar to that described with reference to guide member 110. It also may be shimmed to compensate for wear and manufacturing tolerances.

The lower ends of the movable mast channels 38 and 40 are fixedly connected by means of the bracket 124. It will be obvious that any one of several of the brackets 42, 87, 18, 24 and 124 may be made in a form to be adjustable in length, in any suitable manner, to provide adjustability between the channels of the stationary and movable mast sections to compensate for wear and manufacturing tolerances. This feature is shown at 126 and 128 in the embodiment of FIG. 11. The brackets 87' and 24', that correspond respectively to brackets 87 and 24 of the embodiment of FIGS. 1 through 10, are made adjustable in length by providing a bolted overlapping joint as shown. Similar joints can be provided for any of the other brackets. Bracket 24' may be used also to provide added support for the ram 28. Auxiliary brackets are provided at 129 and 131 for this purpose at the lower end of the ram. Also, bracket 24' is flanged like bracket 18 to increase its rigidity.

While it will be apparent that the preferred embodiments of the invention herein disclosed are well calculated to fulfill the objects above stated, it will be appreciated that the invention is suceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

Having thus described the principal features of my invention, which I claim and desire to secure by United States Letters Patent is:

1. A load lifting mast construction, comprising: a stationary mast section; movable mast section; said mast sections each having a pair of spaced, parallel side rails; a carriage; guide members on said carriage; each guide member and each rail for said stationary mast section having a pair of bearing surfaces; each rail for said movable mast section being disposed between a carriage guide member and a rail of said stationary section; a bearing surface on each side of each rail for said movable mast section; a plurality of bearing elements connected together to form a continuous, endless flexible bearing structure; said flexible bearing structure being trained over the rail for said movable mast section with t the bearing elements thereof being engagable with each of its bearing surfaces; and, means for moving said movable mast section and the carriage relative to said stationary mast section at separate speed ratios, the bearing surfaces for said guide members and the rails of said stationary mast section being engagable with said bearing elements.

2. A load lifting mast construction, comprising: a stationary mast section; a movable mast section; said mast sections each having a pair of spaced, parallel side rails; a carriage; guide members on said carriage; each guide member and each rail for said stationary mast section having a pair of bearing surfaces; each rail for said movable mast section being disposed between a carriage guide member and a rail of said stationary section; a bearing surface on each side of each rail for said movable mast section; a plurality of bearing elements connected together to form a continuous, endless flexible bearing structure; said flexible bearing structure being trained over the rail for said movable mast section with the bearing elements thereof being engagable with each of its bearing surfaces; means for moving said movable mast section and the carriage relative to said stationary mast section at separate speed ratios, the bearing surfaces for said guide members and the rails of said stationary mast section being engagable with said bearing elements; and, means for adjustably mounting said guide members on said carriage.

3. A load hoisting mast, comprising: a stationary mast section; a relatively movable mast section situated in nested telescopic relationship with respect to said stationary mast section; a load carriage supported by said mast; said carriage including guide members disposed within said movable mast section; means for moving said movable mast section relative to said stationary mast section; means for moving said carriage relative to said mast sections including mechanism responsive to relative motion of said mast sections and adapted to move said carriage in the direction of said relative motion; a flexible bearing member encircling said rela-

tively movable mast section and extending in a direction parallel to the direction of relative motion; said flexible bearing member including rollers; and, said rollers accommodating a relatively friction free movement of said movable mast section and said carriage.

4. A load hoisting mast, comprising: a stationary mast section; a relatively movable mast section; said mast sections being disposed one within the other in nesting relationship; a carriage carried by said mast and including guide members received within said movable mast section: a roller chain encircling said movable mast section and extending in a direction parallel to the direction of relative movement between said mast sections; and, said roller chain forming a continuous circuit about said relatively movable mast section, whereby relatively friction free movement of said movable mast section and said carriage can be accommodated.

5. A load hoisting mast, comprising: a stationary mast section; a relatively movable mast section; each mast section comprising a pair of spaced channel members; each channel member having diverging sides, the corresponding channel members of each section being situated one within the other in nesting relationship; a carriage supported by said mast and including carriage guide members situated within the channel members of said movable mast section; a roller chain encircling each of the channel members of said movable mast section and extending in a direction parallel to the direction of relative motion between said mast sections; means for moving said movable mast section and said carriage, whereby the rate of movement of said carriage is equal to twice the rate of movement of said movable mast section; and, said roller chains forming a continuous circuit about the channel members of the movable mast section, whereby relatively friction free motion of said movable mast section and carriage can be accommodated.

6. A load hoisting mast, comprising: a stationary mast section; a relatively movable mast section; each mast section comprising a pair of spaced channel members; each channel member having diverging sides, the corresponding channel members of each section being situated one within the other in nesting relationship; a carriage supported by said mast and including carriage guide members situated within the channel members of said movable mast section; a roller chain encircling each of the channel members of said movable mast section and extending in a direction parallel to the direction of relative motion between said mast sections; means for moving said movable mast section and said carriage, whereby the rate of movement of said carriage is equal to twice the rate of movement of said movable mast section; said roller chains forming a continuous circuit about the channel members of the movable mast section, whereby relatively friction free motion of said movable mast section and carriage can be accommodated; and, means for adjusting the spacing between said guide members on said carriage.

7. The combination as set forth in claim 5 wherein the channel members of at least one mast section include bracket structure adapted to maintain the channels in spaced parallel relationship, and means for adjusting the spacing of said channel members.

8. The combination as set forth in claim 6 wherein the channel members of at least one mast section include bracket structure adapted to maintain the channels in spaced parallel relationsip, and means for adjusting the spacing of said channel members.

9. A load lifting mast construction comprising: a stationary mast section, a relatively movable mast section, said mast sections each having a pair of spaced parallel channel members, the channel members of each section comprising side portions that diverge relative to each other, a load carriage, guide members on said carriage, each guide member being situated within a separate channel member of said movable mast section and having a pair of bearing surfaces that are parallel to the sides of the channels for said movable mast section, a plurality of continuous, flexible bearing structures, each bearing structure having bearing elements that are joined together, one bearing structure being trained over each side portion of the channel members for said movable mast section with the bearing elements thereof engageable with the associated carriage guide member and the side portion of the channel members of the stationary mast section.

10. A load hoisting mast comprising a stationary mast section, a relatively movable mast section, a load carriage supported by said mast, each mast section comprising a pair of spaced parallel channels having diverging sides, means for moving said movable mast section relative to said stationary mast section, means for moving said carriage relative to said mast sections including mechanism responsive to relative motion of said mast sections and adapted to move said carriage in the direction of said relative motion, a separate flexible bearing member encircling each side of each channel for said movable mast section and extending in a direction parallel to the direction of relative motion of said mast sections, each of said flexible members comprising bearing elements and means for joining said bearing elements together to form a continuous recirculating chain, said guide members having diverging bearing surfaces that are parallel to the sides of the channels of said movable mast section and said bearing elements being engageable with the sides of said guide member and the sides of the channel members of said stationary mast section whereby relatively friction free movement of said movable mast section and said carriage is accommodated.

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