United States Patent

[111] 3,593,823

[72] Inventor **Harry W. Thompson**
Chicago, Ill.

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[45] Patented **July 20, 1971**
[73] Assignee **Interlake Steel Corporation**
Chicago, Ill.
Continuation-in-part of application Ser. No. 737,199, June 14, 1968.

[54] **LOAD CARRIERS**
16 Claims, 24 Drawing Figs.

[52] **U.S. Cl.** **187/11,** 187/20, 187/95, 214/16.4
[51] **Int. Cl.** **B66b 9/20**
[50] **Field of Search** 187/9.11, 17, 20, 21; 254/148, 4, 58; 214/16.4

[56] **References Cited**

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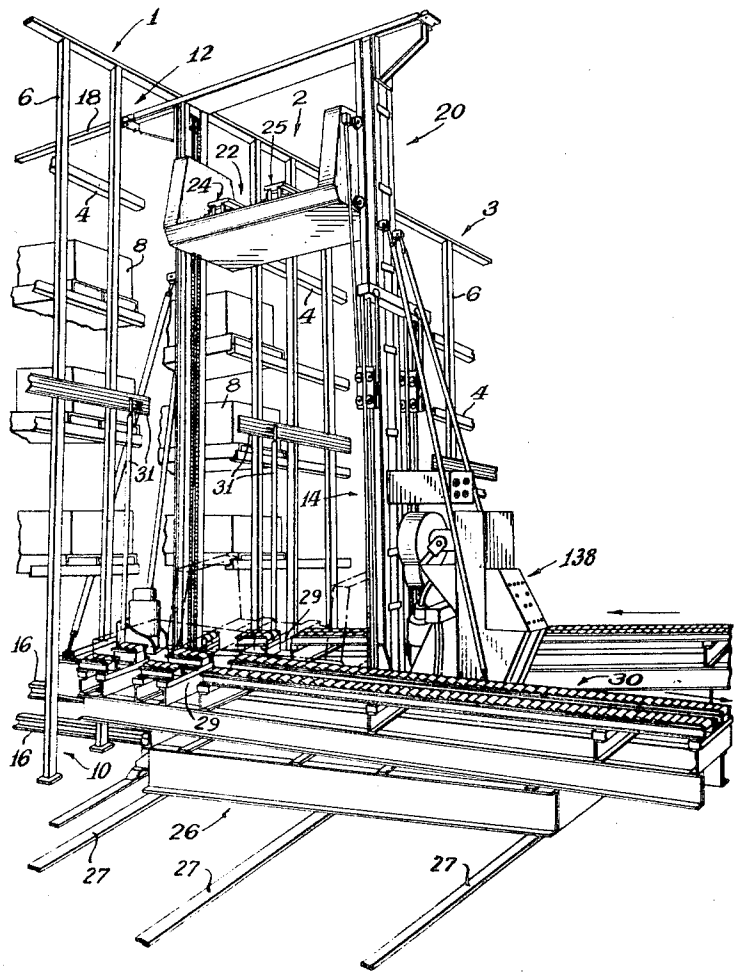
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Primary Examiner—Harvey C. Hornsby
Attorney—Molinare, Allegretti, Newitt & Witcoff

ABSTRACT: Improved load carriers for transferring articles to and from storage bins including a trolley base having a pair of vertical masts and having a lift platform located between the masts for handling the articles. A hoisting arrangement vertically moves the platform between the masts and includes a plurality of flexible hoist means. A hoist lift motor exerts a substantially equal lift force on each end of the platform through the flexible hoist means, the flexible means being trained about a series of sprockets or wheels arranged at various locations on the load carriers. The reeving arrangement of the flexible members is adjustable and an adjustable guard member is provided to prevent jumping of the flexible members.

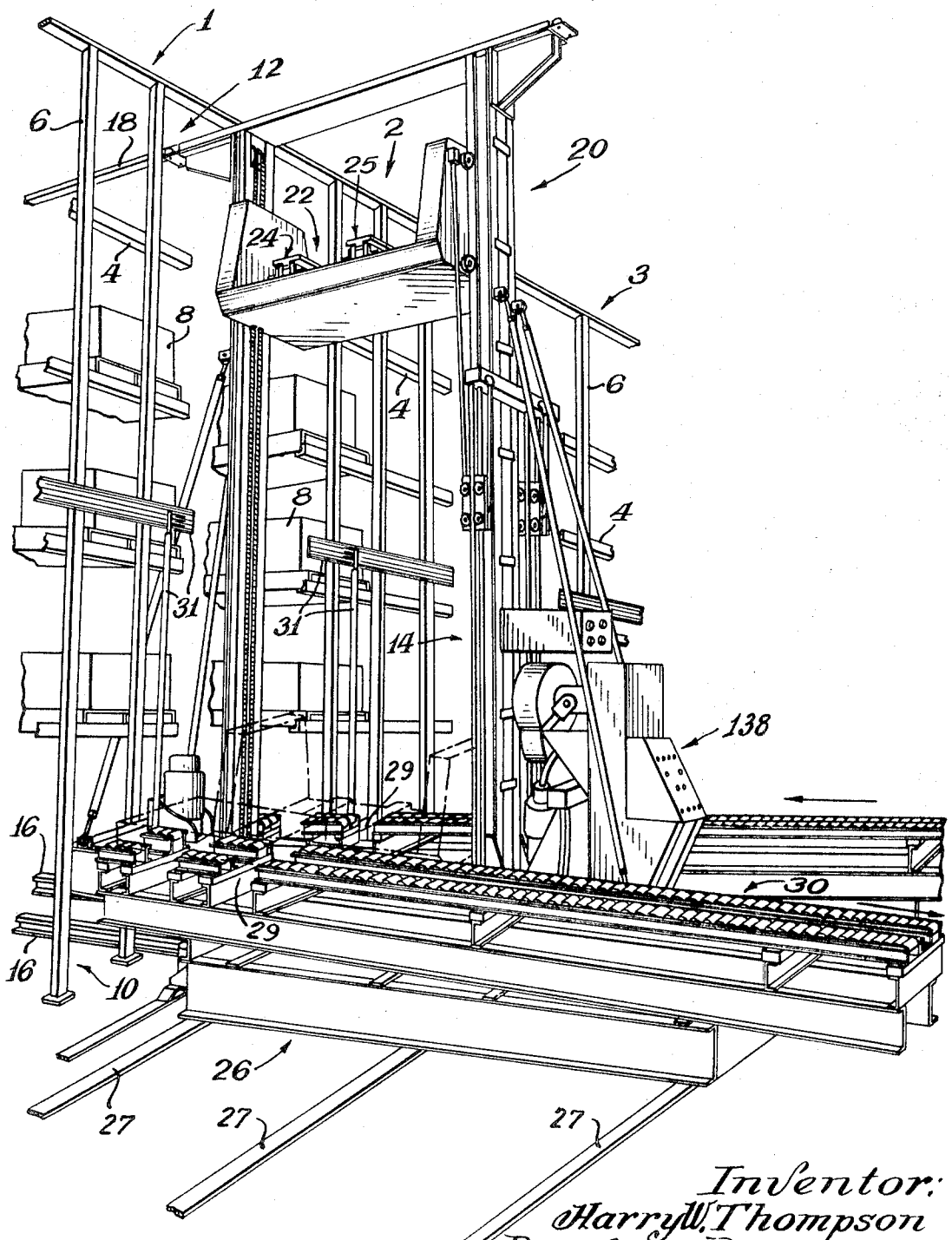


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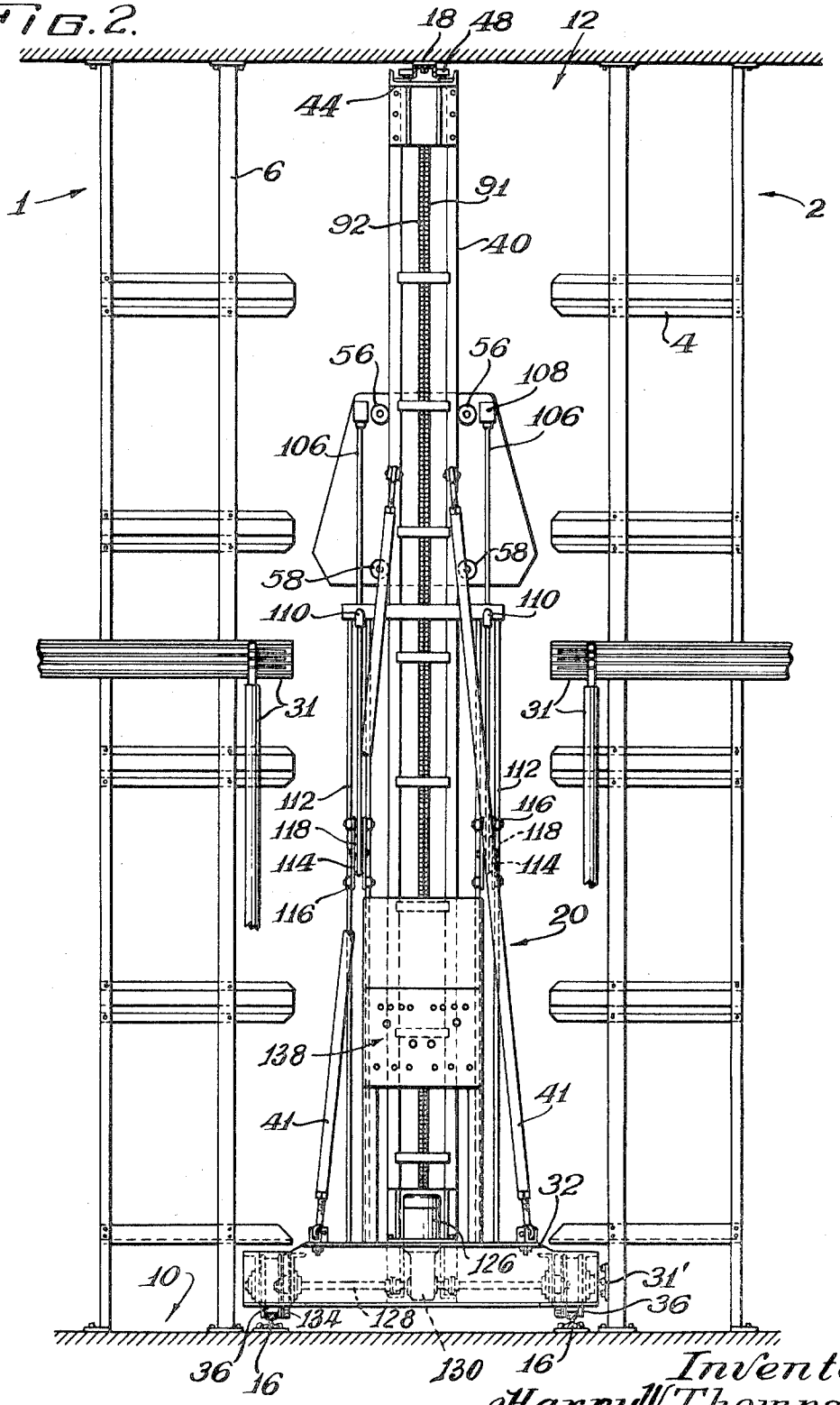
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FIG. 1.



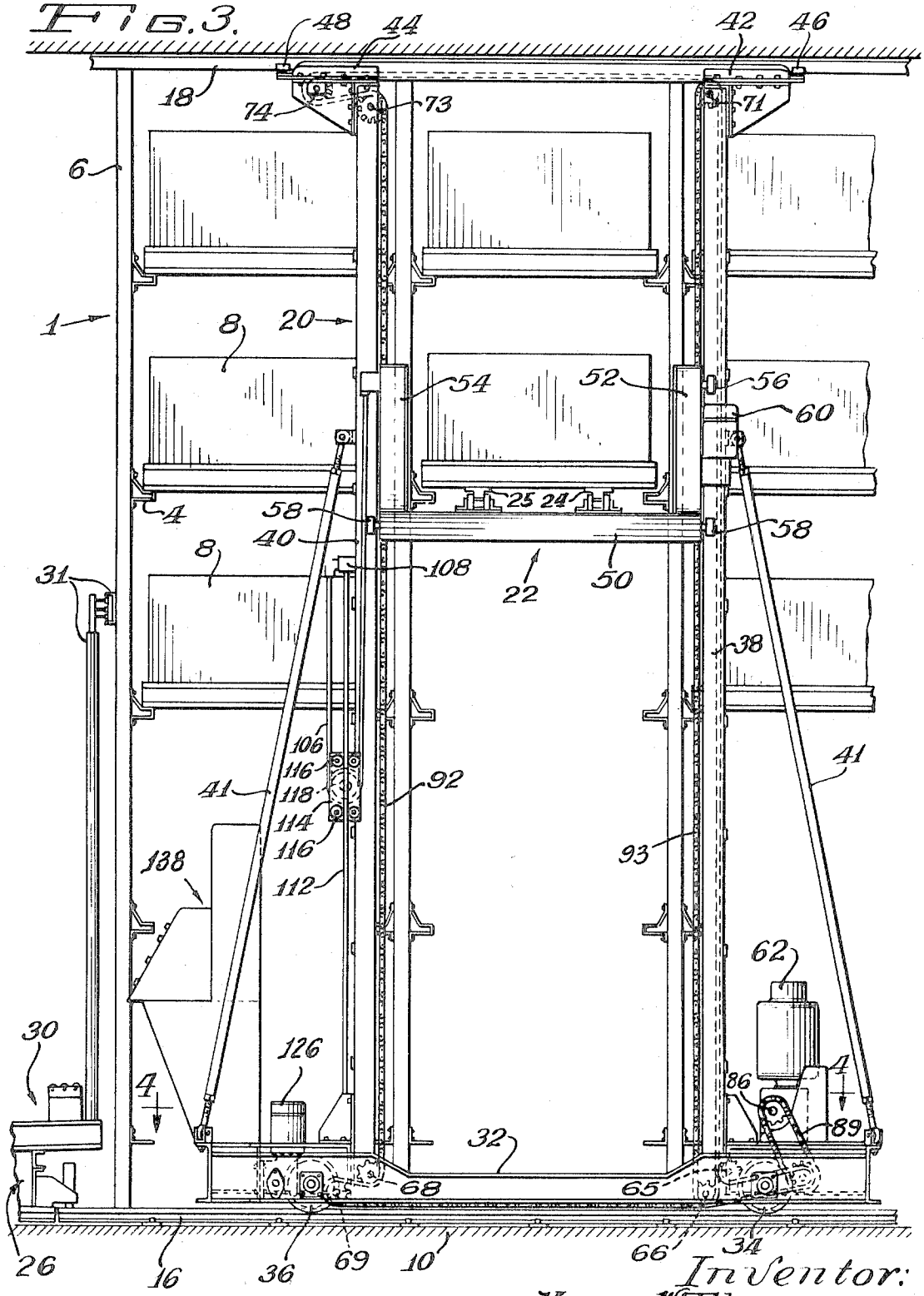
Inventor:
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

FIG. 2.



Inventor:
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

FIG. 3.



Inventor:
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

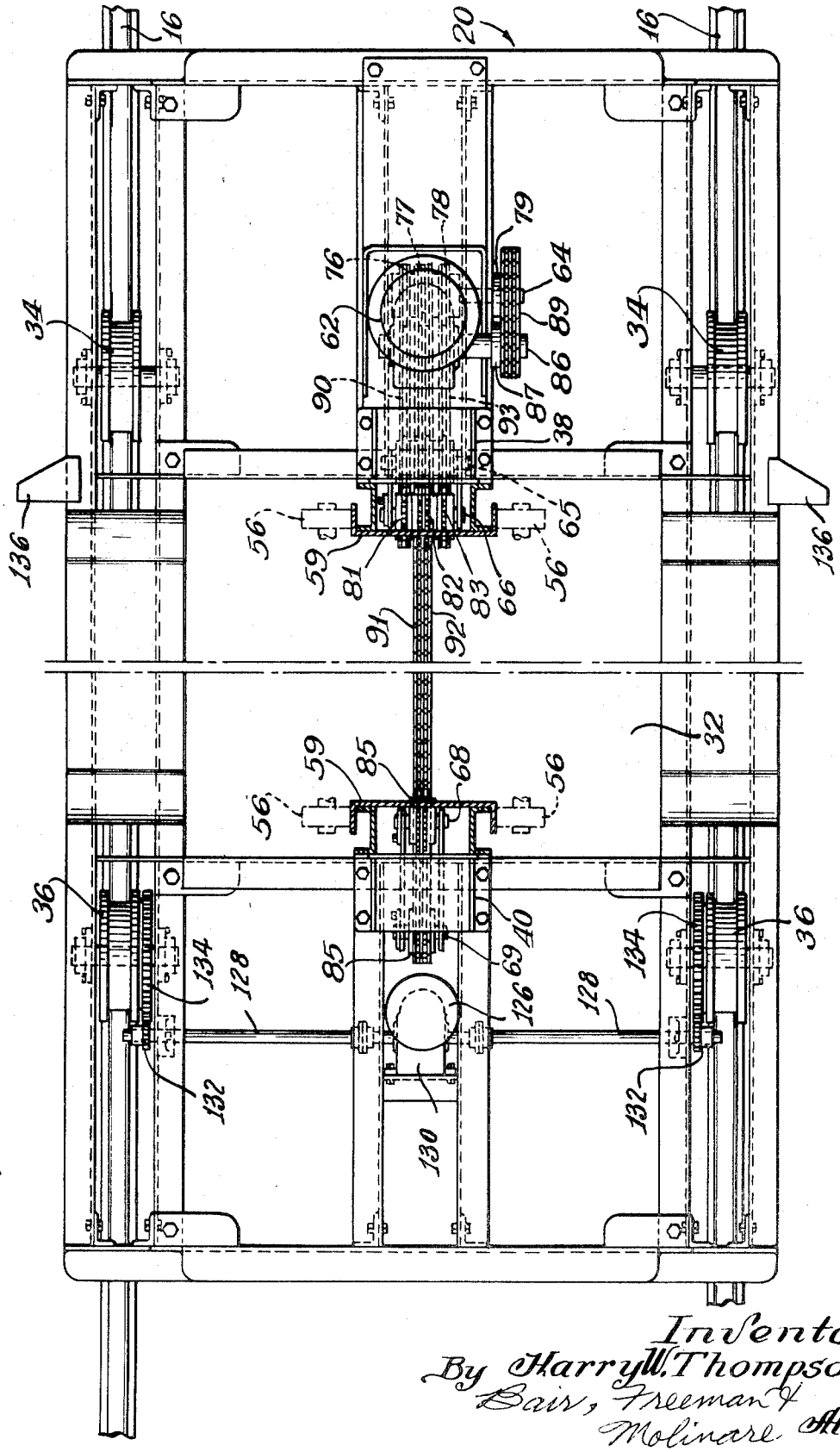


FIG. 4.

Inventor:
By Harry W. Thompson
Bair, Freeman & Molinare Attys.

FIG. 5.

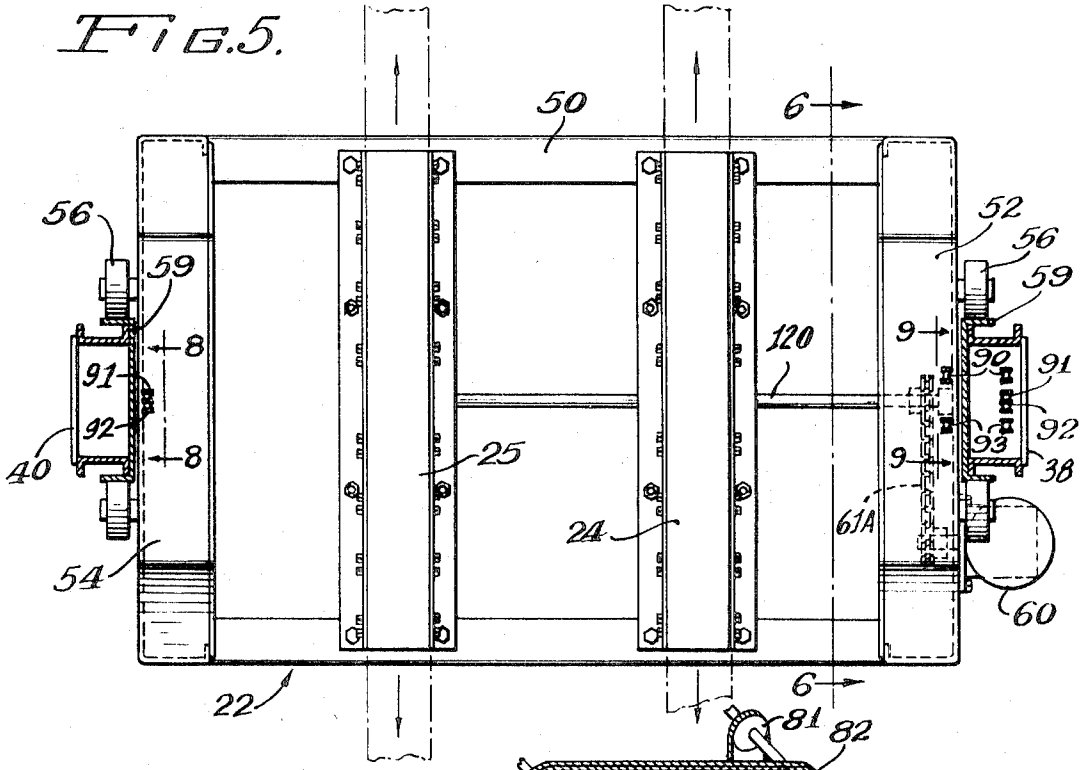


FIG. 6.

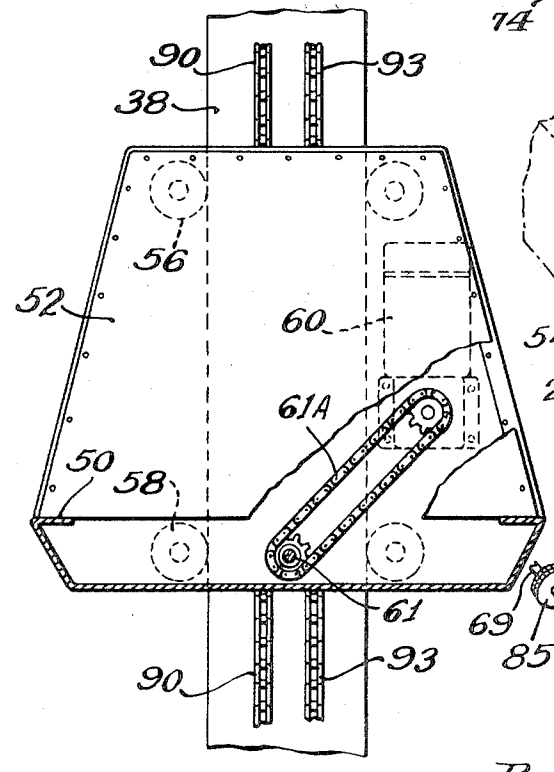
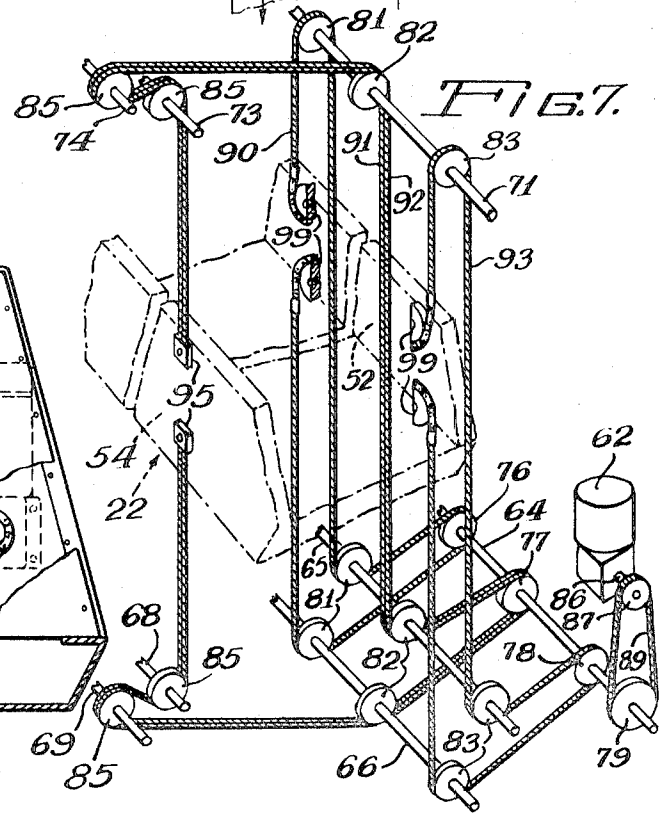


FIG. 7.



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Harry W. Thompson
By Bair, Freeman & Molinare Attys.

FIG. 9.

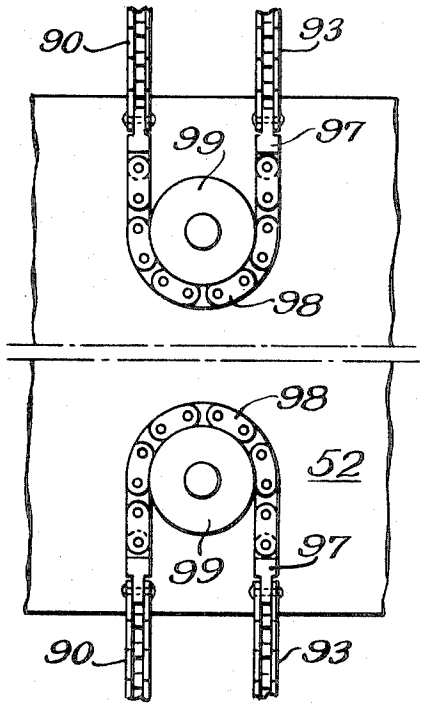


FIG. 8.

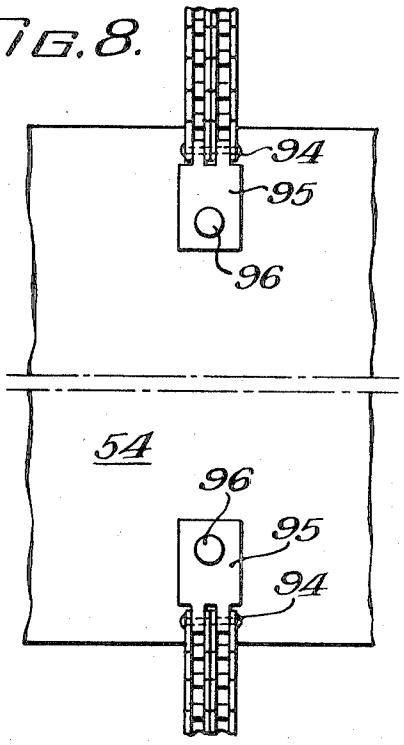


FIG. 10.

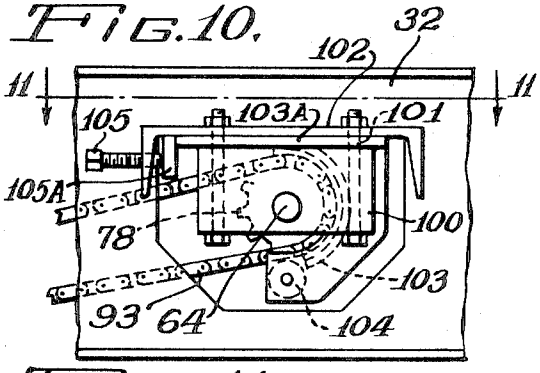


FIG. 13.

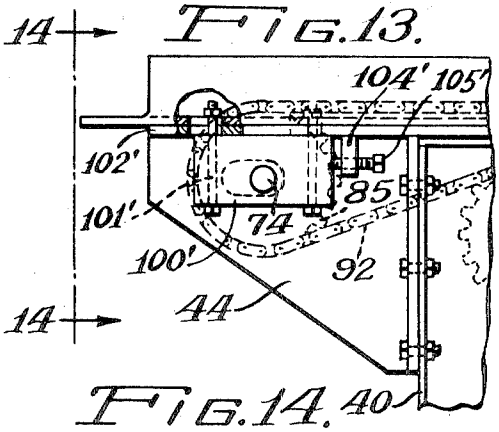


FIG. 11.

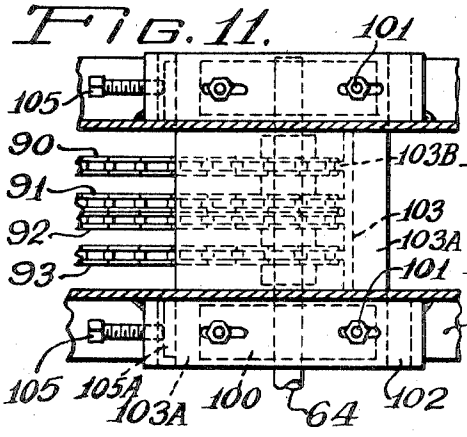


FIG. 12.

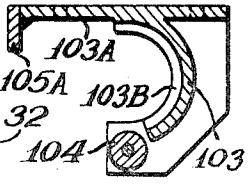
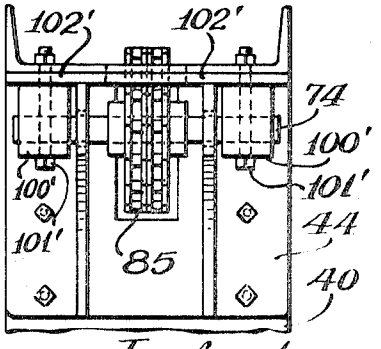
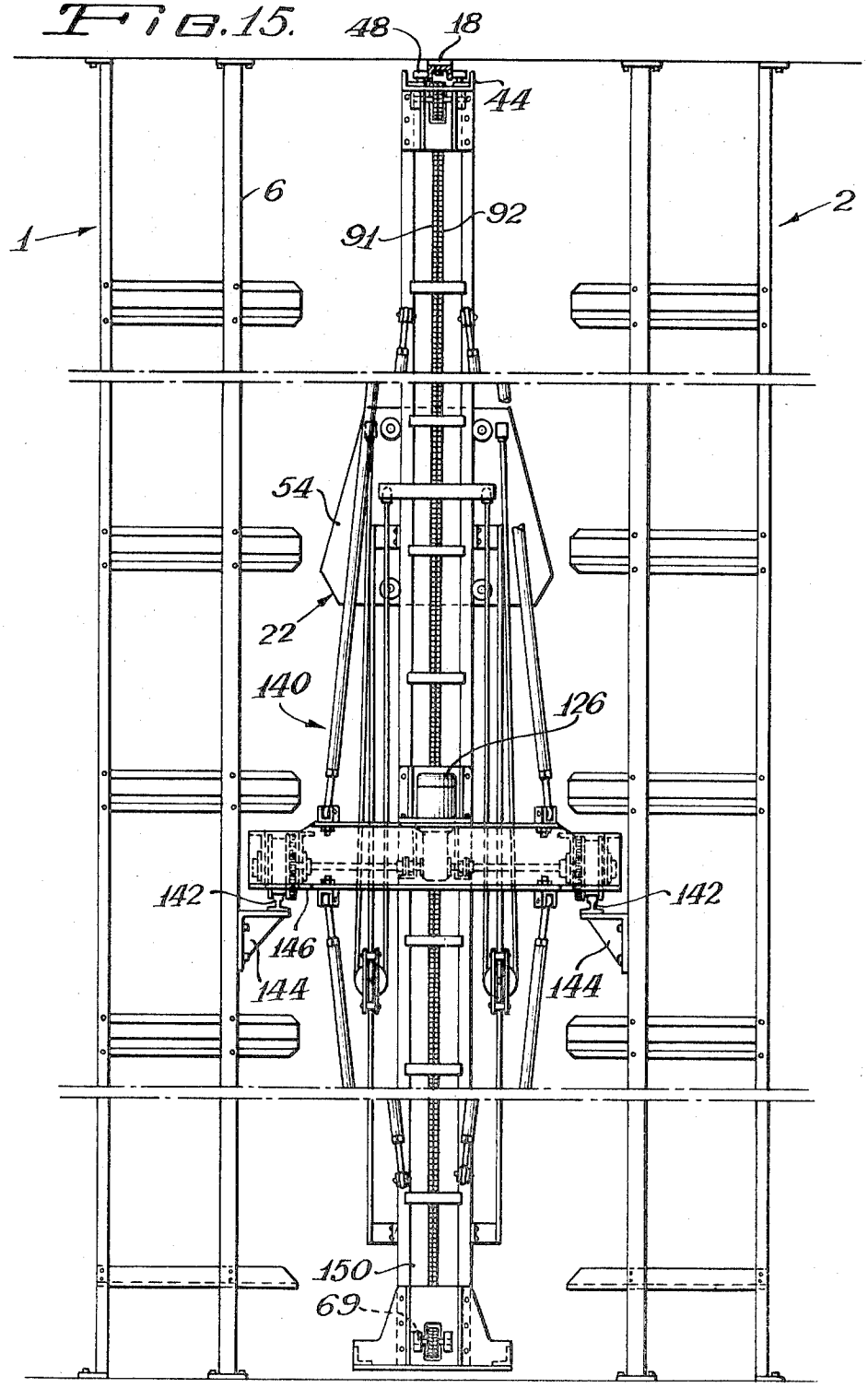


FIG. 14.



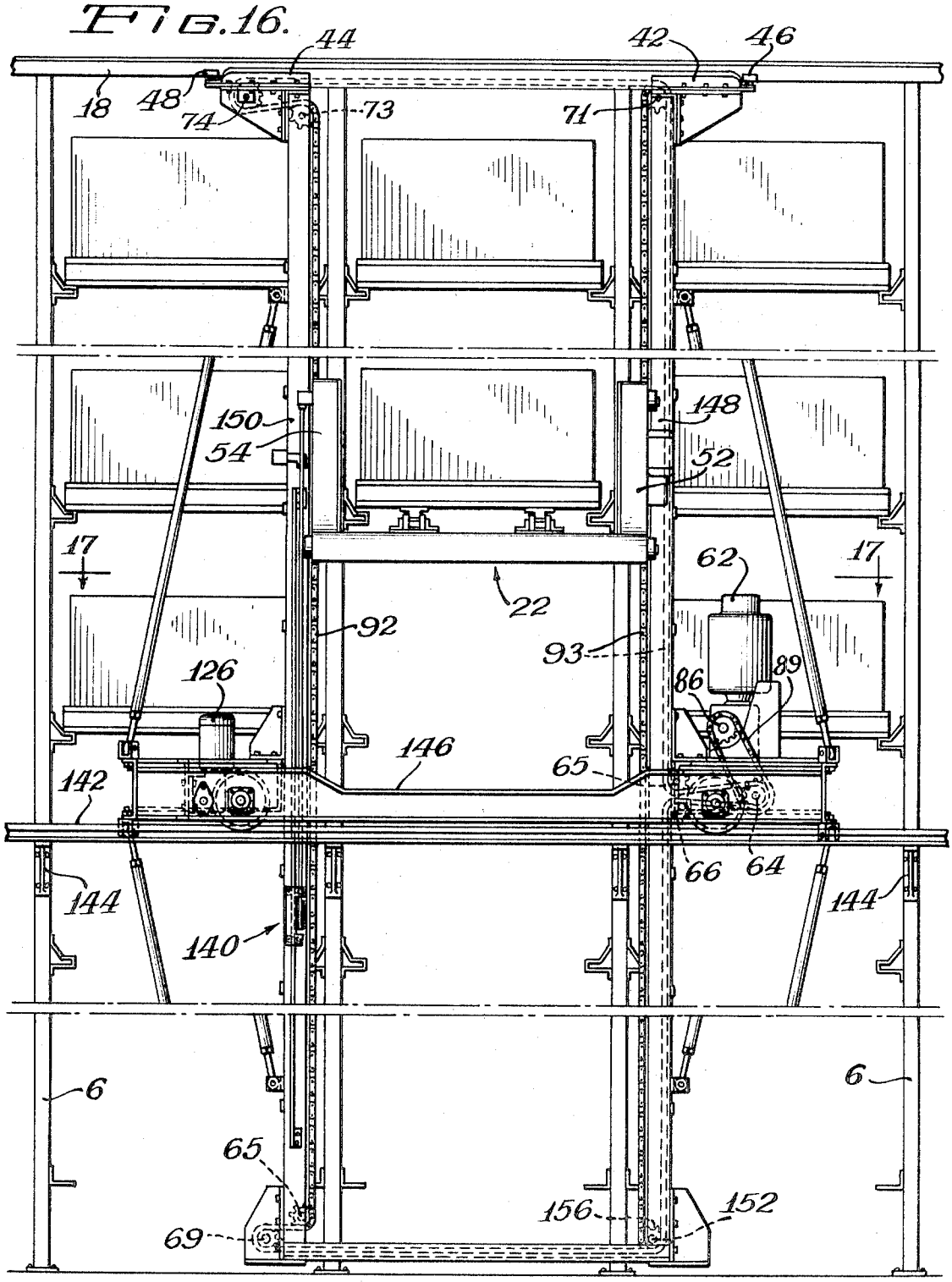
Inventor:
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

Fig. 15.



Inventor
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

FIG. 16.



Inventor:
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

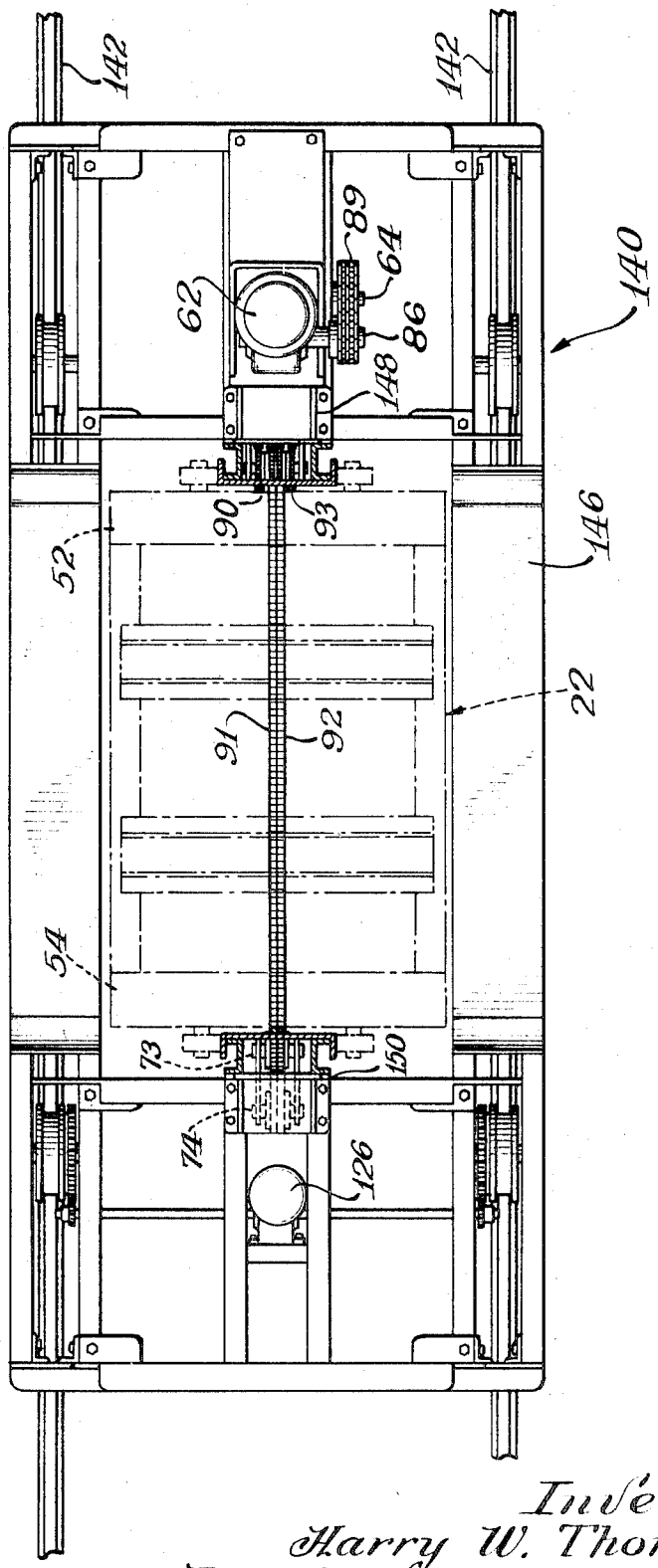
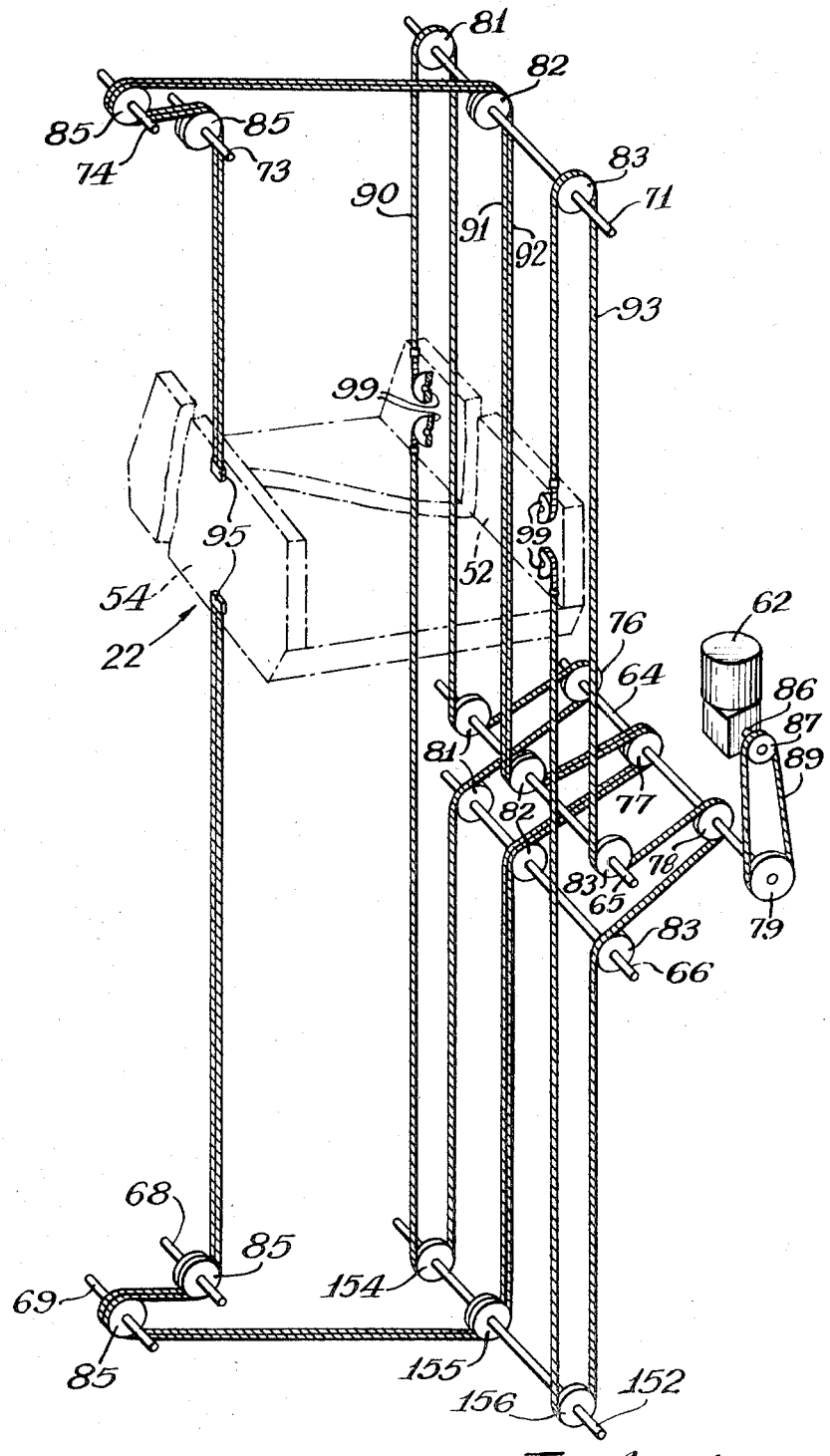


FIG. 17.

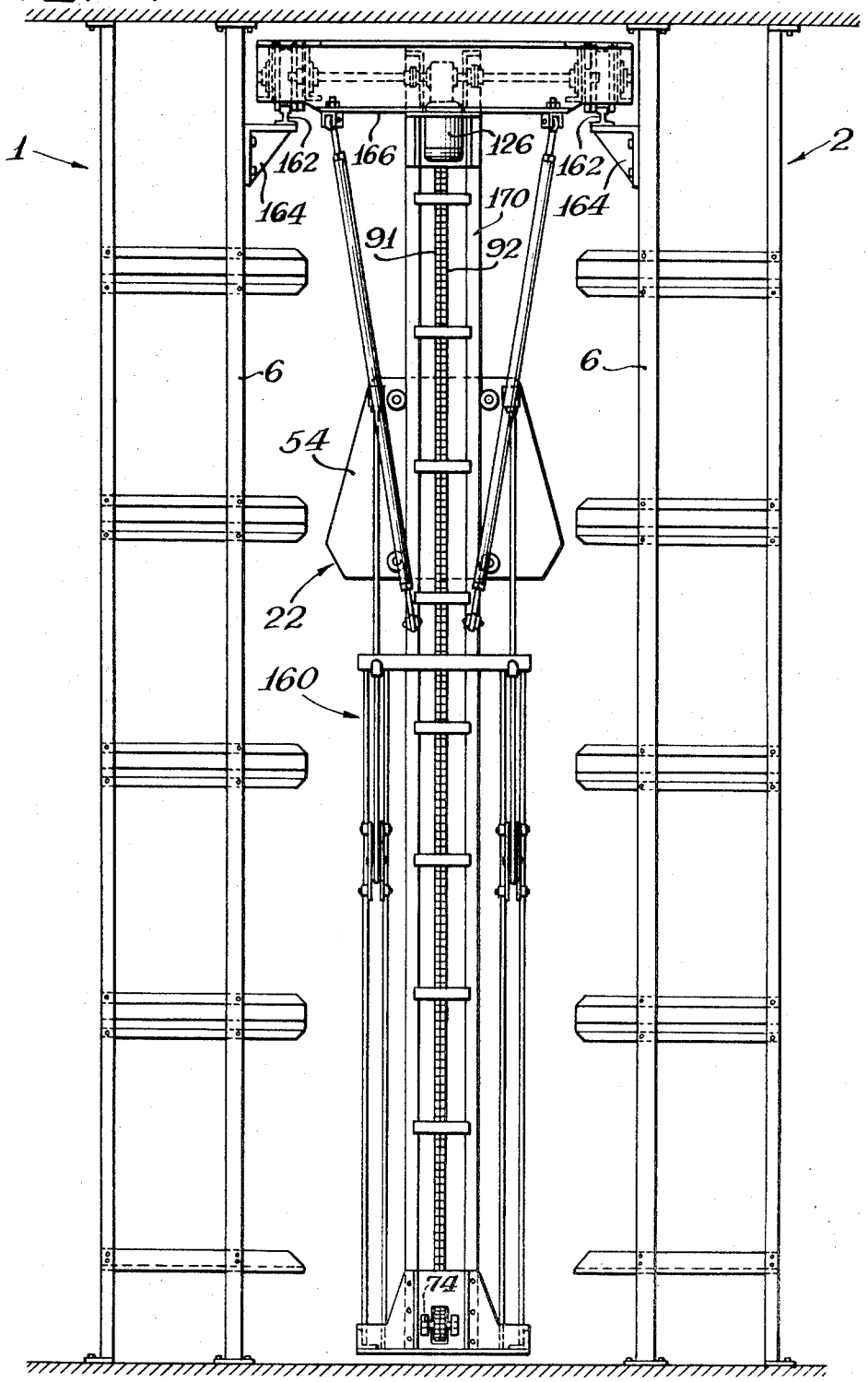
Inventor:
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

FIG. 18.



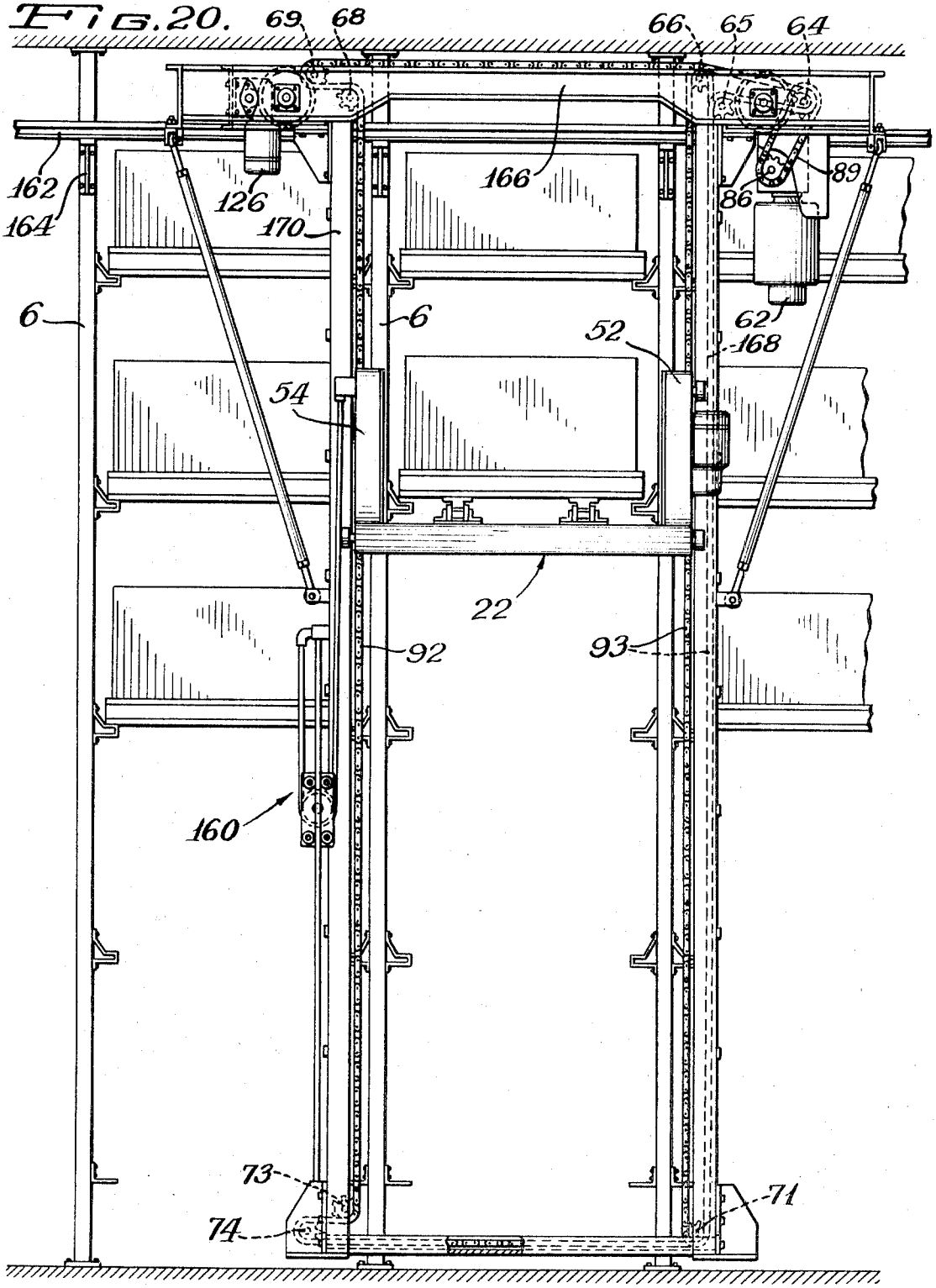
Inventor:
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

Fig. 19.



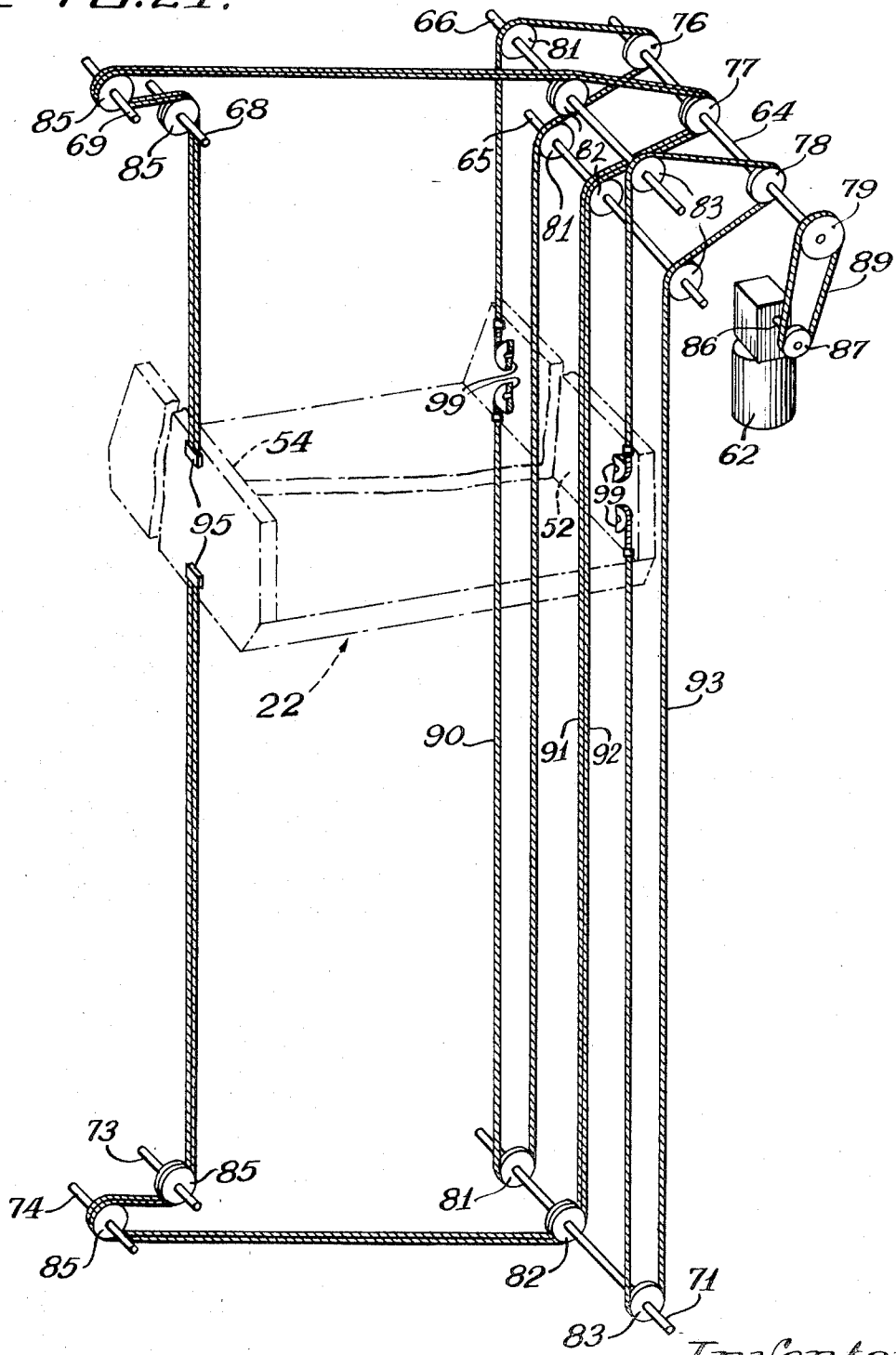
Inventor:
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

FIG. 20.



Inventor:
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

FIG. 21.



Inventor:
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

FIG. 22.

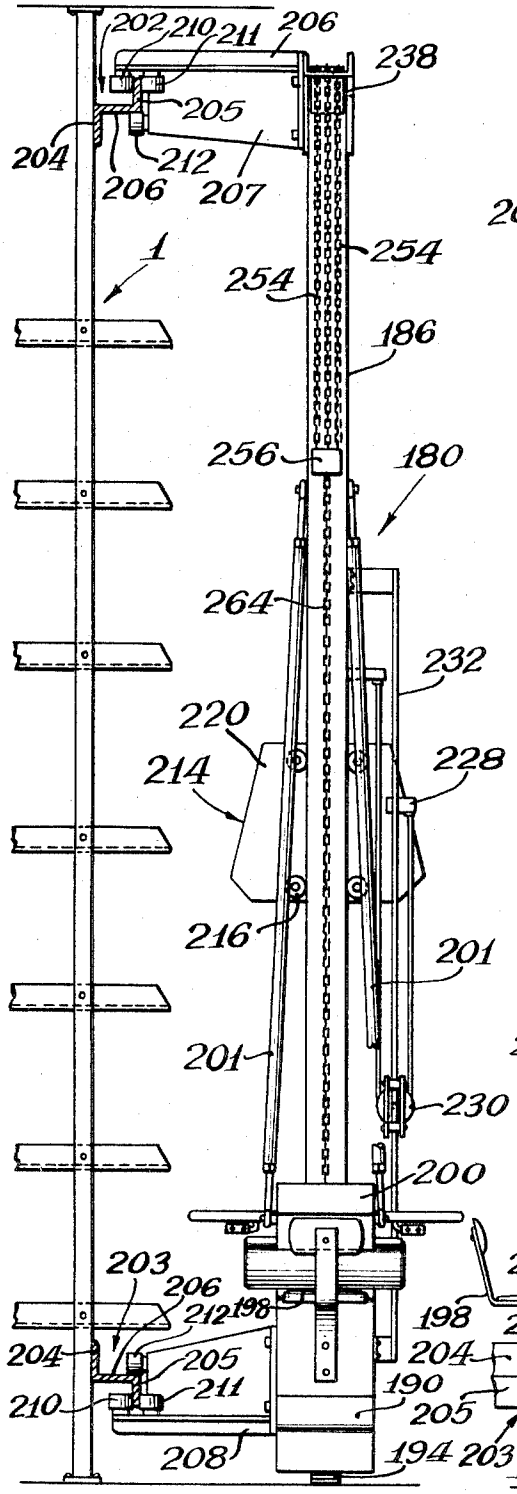
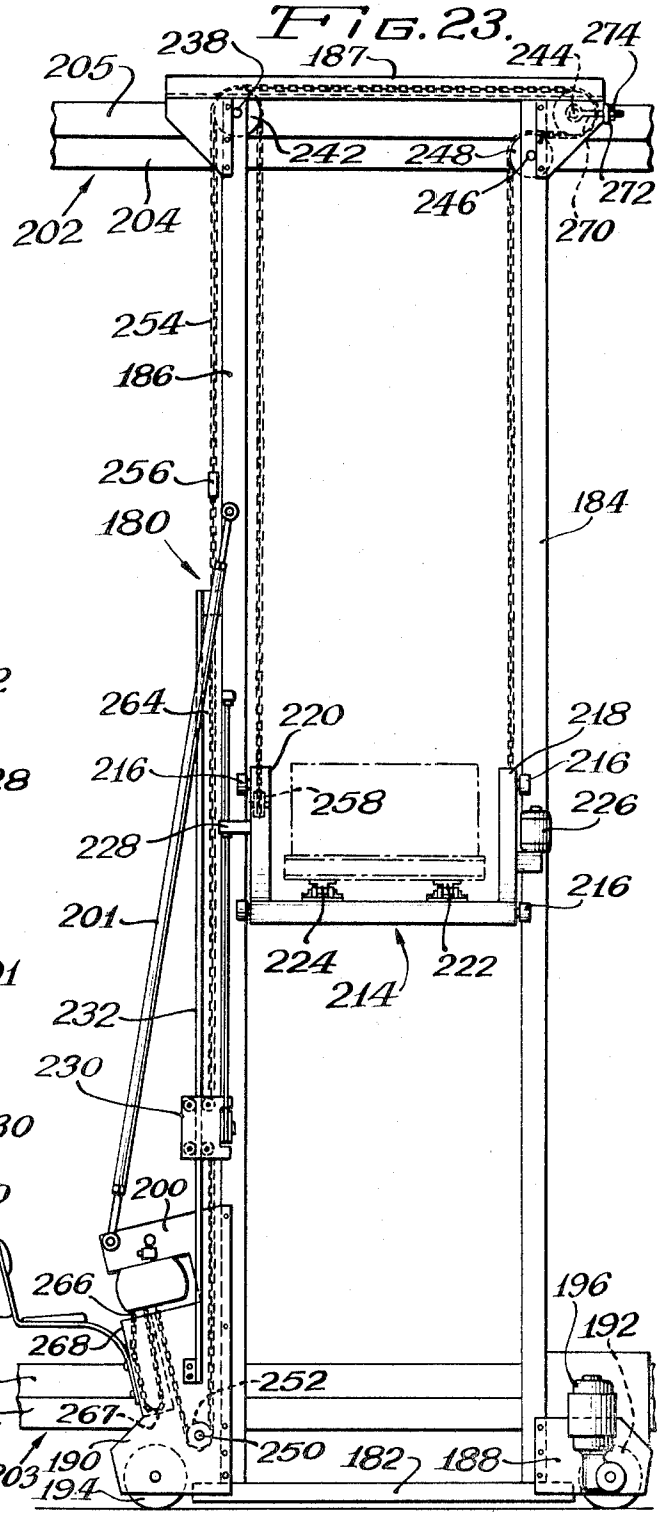
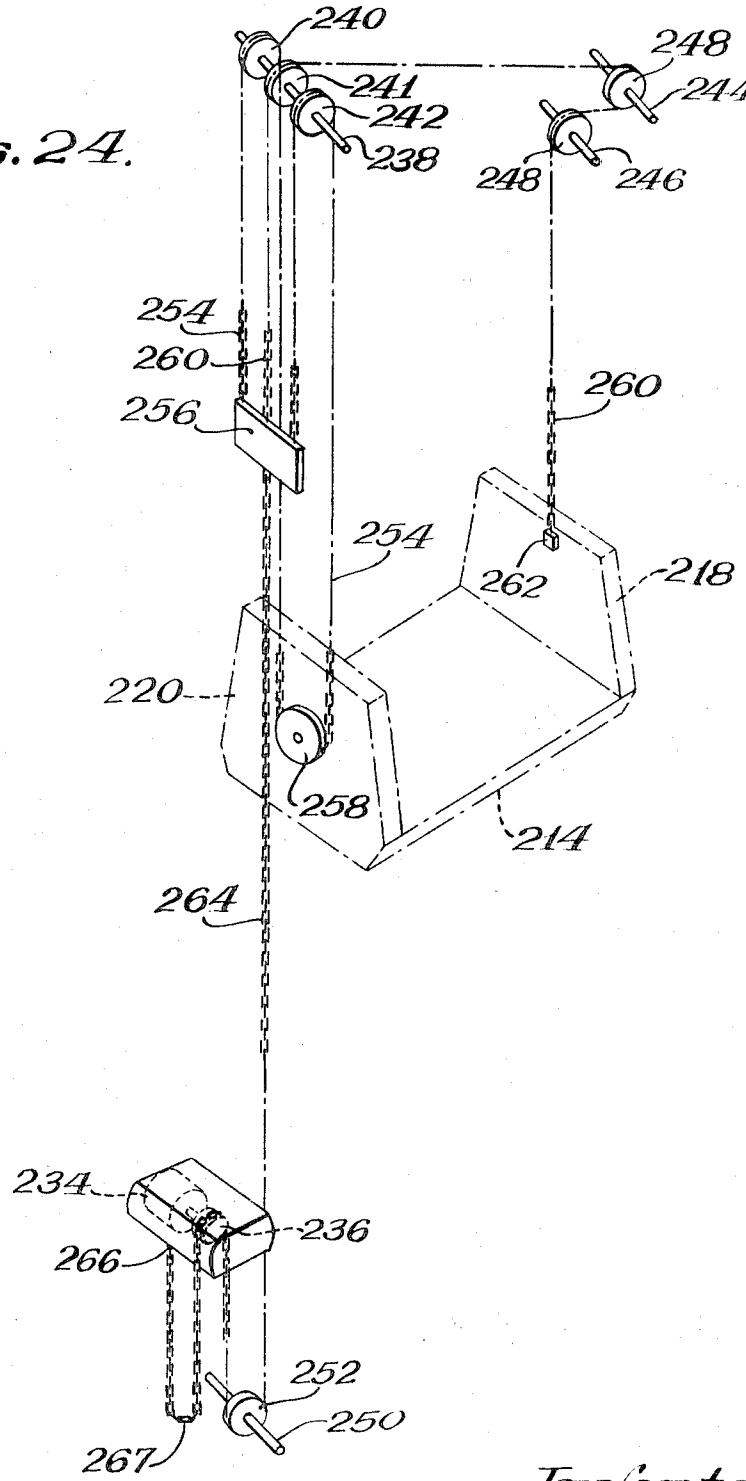


FIG. 23.



Inventor:
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

FIG. 24.



Inventor:
Harry W. Thompson
By Bair, Freeman & Molinare Attys.

LOAD CARRIERS

RELATED APPLICATIONS

This application is a continuation-in-part of my copending application entitled "Storage and Retrieval Arrangement," Ser. No. 737,199, filed June 14, 1968. BACKGROUND OF THE INVENTION

This invention relates to a load carrier for storing and removing articles from storage bins and, more particularly, to a new and improved load carrier and hoist arrangement for the lift platform of such carrier.

In the past load carriers have been provided for the storage and removal of articles from selected vertically arranged storage bins. These load carriers generally include a platform which is adapted to be moved both horizontally and vertically until it is located adjacent the open face of the storage bin and each platform generally has forks or the like mounted thereon which are adapted to be extended into the bin to either insert or remove a selected article from the bin. The previous load carrier arrangements were somewhat susceptible to malfunction during operation due to twisting of the lift platform hoisting apparatus as well as jumping of the hoist apparatus chains from their associated drive wheels, pulleys, or sprockets. Moreover, in the previous arrangements, the hoisting chains were generally connected off center or diagonally to opposite corners of the platform resulting in unequal loading stresses in the cables. Such unequal stresses frequently resulted in increased cable wear and twisting of the hoist cables as well as jumping of the cables or chains from their pulleys or sprockets.

The load carriers constructed in accordance with the principles of my invention, in general, obviate these disadvantages. Such load carriers are capable of storing and removing extremely heavy articles from storage bins and the possibility of twisting or jumping of the cables or chains is substantially reduced. Moreover, the load carriers of my invention minimize the unequal and unsymmetrical loading of the hoist cables or chains due to the novel reeving of the hoist arrangement and attachment to the platform. The hoist arrangements of my load carriers are rugged in operation and the tension of the hoist cables or chains as well as the level of the platform may be easily and rapidly adjusted without extensive adjustment procedures or disassembly of the load carrier. Moreover, the hoist arrangements of my invention may be readily adapted for use with various size load carriers and may, in general, be readily employed in floor running as well as center or overhead running load carriers. Also such arrangements allow chain guard coverage over at least 180° of the drive sprockets to virtually eliminate the possibility of the jumping of the hoist chains from the teeth of their drive sprockets.

SUMMARY OF THE INVENTION

In the load carrier constructed in accordance with the principles of my invention, first and second rotatable wheel means are provided and first flexible hoist means, connected to one end of a platform, are trained about both of the wheel means and second flexible hoist means, connected to the opposite end of the platform, are trained about one of the wheel means. A drive means moves both flexible hoist means in one direction to raise the platform and in the other direction to lower the platform.

These and other objects, features and advantages of the present invention will be more clearly understood through a consideration of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

In the course of this description, reference will frequently be made to the attached drawings in which:

FIG. 1 is an isometric view of a storage and retrieval arrangement including one preferred embodiment of floor-running load carrier of the present invention;

FIG. 2 is an end elevation view of the storage frames and the load carrier of FIG. 1;

FIG. 3 is a side elevation view of the load carrier of FIG. 1;

FIG. 4 is a cross-sectioned plan view of the load carrier taken along line 4–4 of FIG. 3;

FIG. 5 is a plan view of the load carrier lift platform of the present invention;

FIG. 6 is a cross-sectioned end elevation view of the lift platform taken along line 6–6 of FIG. 5;

FIG. 7 is a schematic view of the chain hoist and sprocket arrangement of the load carrier embodiment shown in FIG. 1;

FIG. 8 is a view of an arrangement for anchoring some of the hoist chains to the lift platform taken along line 8–8 of FIG. 5;

FIG. 9 is a view of an arrangement for anchoring the remainder of the hoist chains to the lift platform taken along line 9–9 of FIG. 5;

FIG. 10 is a side elevation view of an adjustable chain hoist drive shaft and chain cover arrangement;

FIG. 11 is a plan view of the adjustable drive shaft and chain cover taken along line 11–11 of FIG. 10;

FIG. 12 is a cross-sectioned side elevation view of the chain cover of FIG. 10;

FIG. 13 is a side elevation view of an adjustable chain hoist idler shaft arrangement;

FIG. 14 is an end elevation view of the adjustable arrangement taken along line 14–14 of FIG. 13;

FIG. 15 is a broken end elevation view of the storage frames and a center-running embodiment of load carrier;

FIG. 16 is a broken side elevation view of the center-running load carrier of FIG. 15;

FIG. 17 is a cross-sectioned plan view of the center-running load carrier taken along line 17–17 of FIG. 16;

FIG. 18 is a schematic view of the chain hoist and sprocket arrangement of the center-running load carrier;

FIG. 19 is an end elevation view of the storage frames and an overhead-running embodiment of load carrier;

FIG. 20 is a side elevation view of the overhead-running load carrier of FIG. 19;

FIG. 21 is a schematic view of the chain hoist and sprocket arrangement of the overhead-running load carrier;

FIG. 22 is an end elevation view of a storage frame and another embodiment of floor-running load carrier;

FIG. 23 is a side elevation view of the load carrier of FIG. 22; and

FIG. 24 is a schematic view of the hoist and pulley arrangement of the load carrier of FIG. 22.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

General Description

An overall general arrangement including one of the preferred embodiments of load carrier of the present invention is shown in FIG. 1. In general, the arrangement includes a plurality of storage frames 1, 2 and 3 comprising a plurality of horizontal 4 and vertical 6 support members. The horizontal members 4 directly support stored articles 8. These articles may either be large individual items spanning the distance between the horizontal support members 4 of each bin or they may be palletized as shown. The vertical support members 8 rest upon the floor 10 of the storage area and may extend to the ceiling thereof. Each of the banks of storage frames 1 and 2, 2 and 3 are spaced apart from each other by an aisle 12 and 14. In the floor-running load carrier embodiment shown in FIG. 1, a pair of spaced parallel rails 16 are mounted upon the floor 10 and an overhead rail 18 is mounted in the center of each aisle adjacent the tops of the storage frames. The load carrier 20 operates between the respective storage frames 1, 2 and 3 in either of the aisles 14 or 16. The load carrier 20 is adapted to move longitudinally up and down either of the aisles 12 and 14 and a lift platform 22 is provided on the load carrier which is adapted to move in a vertical direction. The lift platform is equipped with forks 24 and 25 which are moveable to either side of the lift platform and are adapted to extend into the bins to deposit or remove selected articles from storage. For a detailed description of the construction of the

forks and their operation, the aforementioned copending application is referred to.

A transfer car 26 may be located adjacent the ends of the storage frames 1, 2 and 3 and is adapted to move in a direction normal to the aisles 12 and 14 along rails 27. When it is desired to transfer the floor-running load carrier 20 from one aisle to another aisle, the load carrier is disposed upon the transfer car 26 and the transfer car is moved along rails 27 to the aisle to which it is desired to operate the load carrier. When the transfer car 20 is aligned with the last mentioned aisle, the load carrier is then moved off the transfer car and down the selected aisle. The transfer car 26 also supports and is capable of transferring a pickup conveyor 28 and a delivery conveyor 30 for use in conjunction with the load carrier 20. The conveyors have suitable interruptions 29 to receive the forks 24 and 25 of the lift platform 22. Appropriate sliding bus and conductor arrangements 31 and 31' are provided to supply power to the transfer car and load carrier machinery. The transfer car will not be described in detail since it is not deemed to be part of the present invention. Reference is made to my copending application, Ser. No. 737,199, filed June 14, 1968, for a detailed description of the transfer car construction.

DETAILED DESCRIPTION OF THE FLOOR-RUNNING LOAD CARRIER

Referring to FIGS. 2—4 a preferred embodiment of floor-running load carrier is shown which includes a trolley base 32 of a generally rectangular are Two pairs of rollers 34 and 36 are rotatably mounted upon each end of the base 32, the rollers engaging the parallel rails 16 in the aisle 12 and providing for rolling support of the load carrier 20. Offset toward the center of the base 32 from its ends are a pair of upwardly extending masts 38 and 40 which are rigidly mounted upon the base 32 and are further supported by struts 41 running between the base 32 and each of the masts. Located at the top of each of the masts 38 and 40 is a generally right angled frame member 42 and 44, respectively, extending away from the center of the load carrier and each carrying a pair of spaced horizontal rollers 46 and 48 at their extreme ends. The rollers 46 and 48 are arranged to straddle the overhead rail 18 and prevent lateral movement of the top of the load carrier 20. Such lateral movement might particularly be present due to cantilever effect resulting when an article is being deposited or removed from one of the storage bins by the extended forks 24 and 25.

The lift platform 22 is carried between the masts 38 and 40 and is adapted to be selectively raised and lowered through a series of sprockets and chains which will be described in more detail later. The lift platform 22 includes a generally rectangular bed 50 and a pair of upstanding end panels 52 and 54 to either end of the bed adjacent masts 38 and 40, respectively. Mounted upon the outer side of each of the panels 52 and 54 are a pair of upper rollers 56 and lower rollers 58 which are spaced from each other by a distance such that they straddle the flanges of a component channel 59 on each side of their respective masts as shown in FIGS. 3—5, the flanges acting as guide members during the raising and lowering of the lift platform 22 and preventing the lift platform from swinging in a lateral direction or tilting from cantilever effect. Mounted on the side of end panel 52, is a fork operating motor 60 which is adapted to operate a fork drive shaft 61 via drive chains 61A and sprockets, as shown in FIG. 6. The forks 24 and 25 are arranged on the upper side of the bed 50 and are adapted to be telescopically extended from either side of the bed to carry the selected articles to be deposited or removed from the respective storage bins.

Referring to FIGS. 3, 4, 6 and 7, the lift platform is raised and lowered by a hoist lift motor 62 which is mounted upon one end of the trolley base 32. The hoist chain arrangement includes eight shafts carrying suitable sprockets and mounted at various locations on the load carrier 20. As best seen in FIGS. 3 and 7, shafts 64, 65 and 66 are rotatably mounted at the hoist lift motor end of the trolley base 32 on the trolley base. Shafts 68 and 69 are also rotatably mounted on the trolley base 32 but at the end opposite the hoist lift motor 62; shaft 71 is rotatably mounted to mast 38 at its right-angled frame 42 vertically above shafts 64, 65 and 66; and shafts 73 and 74 are rotatably mounted upon the mast 40 at its upper end vertically above shafts 68 and 69. Shaft 64 carries four sprockets 76, 77, 78 and 79, sprocket 77 being a double sprocket, and shafts 65, 66 and 71 each carry three sprockets 81, 82 and 83, sprockets 82 being double sprockets. Shafts 68, 69, 73 and 74 each carry one sprocket 85, each of the sprockets 85 being a double sprocket. The hoist lift motor 62 includes a drive shaft 86 having a sprocket 87. Five drive chains are provided to raise and lower the platform 22. Drive chain 89 is trained about sprockets 79 and 87. Drive chain 90 extends from end panel 52 of the lift platform, over sprocket 81 on shaft 71, under sprocket 81 on shaft 65, around sprocket 76, around sprocket 81 on shaft 66 and back to the lift platform. A double-strand chain provides a pair of drive chains 91 and 92 which extend from end panel 54 of the lift platform, are trained over double sprocket 85 on shaft 73, around double sprocket 85 on shaft 74, over double sprocket 82 on shaft 71, beneath double sprocket 82 on shaft 65, around double sprocket 77 on drive shaft 64, under double sprocket 82 on shaft 66, around double sprockets 85 on shafts 69 and 68, and back to end panel 54. Drive chain 93 extends from end panel 52 over sprocket 83 on shaft 71, beneath sprocket 83 on shaft 65, around sprocket 78 on drive shaft 64, around sprocket 83 on shaft 66 and back to end panel 52. It will readily be seen when viewing FIGS. 4 and 7 together, that the separation of the sprockets is exaggerated in FIG. 7 for the purpose of clarity. In actuality, the sprockets are located adjacent each other as shown in FIG. 4.

The double chains 91 and 92 are not continuous but are broken in their vertical legs between shafts 68 and 73 and each of the ends are anchored to the top and bottom of panel 54, as shown in FIG. 8, by a pin 94 and a block 95. The block 95 is, in turn, pinned within the end panel 54 at 96 such that the block may pivotally move about the pin 96. The single chains 90 and 93, are also broken, as shown in FIG. 9, and the ends of each of the chains 90 and 93 carry a universal coupling 97, the couplings being connected together by a looped segment of chain 98. The couplings 97 adapt the looped segment 98 to twist independently of the chains 90 and 93. The chain segments 98 are each trained about rollers 99 which are rotatably mounted within the inside of the top and bottom of the end panel 52. It will thus be seen that, in actuality, chains 90 and 93 form one long chain. Although the segments 98 are trained about rollers 99, it is not anticipated that the chains 90 and 93 will move a substantial amount about the rollers during the actual raising and lowering of the lift platform. The rollers 99 merely provide an anchoring structure on the platform for the chains and allow some play in the platform with relation to the chains 90 and 93 during operation.

As an example, the direction of rotation of the various shafts, sprockets, and chains will be described where it is desired to raise the lift platform 22. The hoist lift motor 62 is energized driving drive shaft 86 and its sprocket 87 in a clockwise direction, drive chain 89 in a clockwise direction, sprocket 79 in a clockwise direction, and its associated shaft 64 in a clockwise direction. Rotation of shaft 64 in a clockwise direction, rotates sprockets 76, 77 and 78 in a clockwise direction and chains 90, 91, 92 and 93 also in a clockwise direction. This, shafts 66, 69, 71 and 74 idle in a clockwise direction and shaft 65, 68 and 73 idle in a counterclockwise direction. Since all the chains are moving in a clockwise direction, each of the chains will exert an upward pull on their respective end panels 52 and 54 at their upper anchoring rollers 99 and blocks 95, respectively, and conversely the chains will be slackened at their lower anchoring rollers 99 and blocks 95 and the lift platform 22 will rise. It will be readily apparent that operation of the hoist lift motor 62 in the opposite

direction will drive the chains in a counterclockwise direction lowering the lift platform **22**.

The above described multiple reeving arrangement is effective to distribute the load equally between each of the chains and, in turn, each of the chains exerts a balanced and equal lifting or lowering force on the platform, since the chains each exert their lifting force on symmetrically opposite ends of the platform in a vertical direction and since the same number of chains is provided at both ends of the platform. This, twisting of the chains is avoided and uneven wear is substantially reduced. Moreover, since each of the chains bears a load which is substantially identical to the loads borne by the remaining chains, all the chains may be of the same specifications avoiding unnecessary spare part storage problems and allowing standardization.

It will be platform when considering the disclosed reeving arrangement, that the lift platform is operable over substantially the entire vertical length of the masts. The upper ends of the end panels **52** and **54** of lift platform **22** may be lifted to within only a few inches of the top of each of the masts **38** and **40**, i.e. to the top of the masts less the diameter of sprockets **81**, **82** and **83** on shaft **71** and sprocket **85** on shaft **73**. At the bottom of the masts, bed **50** of the lift platform **22** may be lowered to the recessed bed between the masts **38** and **40**, as shown in FIG. **3**, of the trolley base **32**. It should also be evident that the described reeving arrangement may be readily adapted to load carriers having various length lift platforms without necessitating the replacement of any of the hoist arrangement components. To adapt the above-described reeving arrangement to load carriers of different lengths, it is only necessary to add or remove links from the double chains **91** and **92** to adjust their lengths. Similarly, the reeving arrangement may be readily adapted to load carriers having longer or shorter masts simply by adding or removing links from each of the chains **90**, **91**, **92** and **93**. Thus, the shafts, sprockets, etc., of the reeving arrangement may be prefabricated for and readily interchanged between load carriers of different sizes due to their uniformity.

An adjustable pillow block arrangement is also provided to mount certain of the aforementioned shafts on the load carrier. As shown in FIGS. **10** and **11**, the drive shaft **64** extends between and is journaled through a pair of blocks **100** which are adjustably suspended by bolts **101** from a stationary member **102** fixed to each side of the frame of the trolley base **32**. A chain guard **103** is fixed to and extends below a horizontal plate **103A**, the plate being sandwiched between the block **100** and stationary member **102**. The bolts **101** extend through the plate **103A**. The chain guard **103** carries ribs **103B** which are aligned with sprockets **76**, **77** and **78** and extend into the center of each chain to confine and urge the chains **90**, **91**, **91** and **93** into engagement with their respective sprocket teeth. An elongated roller **104** may also be carried between the ends of the chain guard **103** to engage the chains and urge them into engagement with their respective sprocket teeth. An adjusting screw **105** is threaded through a downwardly extending flange of the stationary member **102** and is arranged to bear against a tab **105A** which extends downwardly from the plate **103A** to adapt the arrangement for horizontal adjustment. It should be noted that the previously described multiple chain reeving arrangement allows chain guard protection around at least 180° of the drive sprockets **76**, **77** and **78**, thus substantially eliminating the possibility of the chains jumping from the drive sprockets.

In FIGS. **13** and **14**, a second adjustable pillow block arrangement is shown for adjusting shaft **74** at the top of mast **40**. Although not shown, another adjustable arrangement, like that shown in FIGS. **13** and **14**, is provided on the frame of the base **32** for allowing adjustment of shaft **69**. Referring to FIGS. **13** and **14**, a pair of blocks **100'** are provided which are suspended from the right angled frame member **44** at the top of mast **40** by bolts **101'** extending through a horizontal portion **102'** of the right angled member **44**. A tab **104'** extends downwardly from beneath the horizontal portion **102'** and an adjusting screw **105'** is carried by the tab **104'**. The horizontal position of the shaft **74** is adjusted horizontally in substantially the same manner as previously described with respect to the pillow block arrangement shown in FIGS. **10** and **11**.

The adjustable mounting arrangements of shafts **64**, **69** and **74** provide a ready means of adjusting the tension of the chains **90**, **91**, **92** and **93** without necessitating the removal of links. For example, to remove slack from the chains, the bolts **101** are loosened and the adjusting screw **105** is turned bearing on tab **105A** and urging the plate **103A** to the right, as viewed in FIGS. **10** and **11**. As the plate **103A** moves to the right, the chain guard **103**, roller **104**, the block **100** and the shaft **64** with its associated sprockets also moves horizontally to the right, increasing the tension on chains **90**, **91**, **92** and **93**. When the shaft **64** has been moved to a location where the chain tension desired obtains, the bolts **101** are again tightened locking the block **100**, plate **103A** and shaft **64** in place.

The provision of the adjustable arrangement on shafts **69** and **74** provides a means whereby the platform may easily be leveled. If, for example, the lift platform **22** is out of level such that its panel **54** is lower than panel **52**, the bolts **101'**, shown in FIGS. **13** and **14**, are loosened freeing the block **100'** at the top of mast **40**. Similarly the corresponding block rotatably mounting shaft **69** at the bottom of mast **40** is also loosened. Shaft **74** is now moved to the left and shaft **69** to the right, as viewed in FIG. **7** lifting end panel **54** until it is disposed at the same level as end panel **52**. The shaft-mounting blocks are then secured in their desired position by tightening the bolts **101'**. It will again be evident that the lift platform **22** may readily be leveled without requiring the removal of links from the lift chains or the expenditure of excessive time or effort.

Although the hoist chain arrangement is shown employed in a load carrier having a floor-running trolley base, it is contemplated that the hoist chain arrangement may be utilized in a load carrier in which the trolley base is either overhead running or center running, embodiments of which are described in more detail later.

Since a suitable electric connector must be electrically connected to the fork-operating motor **60** to provide a power source for the motor, an arrangement is provided to prevent fouling of the electrical connection during the raising and lowering of the lift platform. As best shown in FIGS. **2** and **3**, a pair of appropriate conductor wires **106** are attached at one of their ends to a connector **108** on end panel **54** and at their other ends to connectors **110** on mast **40**. The mast **40** carries a pair of vertical guide members **112** and a pair of weighted pulleylike members **114** which are adapted to ride up pulleylike down the guide members via rollers **116** which straddle the guide members **112**. Each conductor wire **106** is looped beneath a roller **118** on each of the pulleylike members **114**. Thus as the platform **22** is raised, the loop of the conductors **106** is moved in an upward direction drawing each of the pulleylike members **114** with it upwardly along its guide member **112**, the pulleylike member **114** continuing to exert a downward force maintaining the conductors **106** in a substantially taut condition. As the lift platform **22** is lowered, the loops are also lowered lowering each of the pulleylike members **114** continuing to maintain the conductors **106** taut to prevent fouling.

Referring again to FIGS. **2**, **3** and **4**, the end of the trolley base **32** opposite the hoist lift motor **62** includes a suitable drive motor **126** for driving the load carrier **20** horizontally along its aisle rails **16**. The drive motor **126** is connected to a pair of transverse drive shafts **128** via an appropriate gear box arrangement **130**. A drive gear **132** is located at the terminal end of each of the drive shafts **128** drivingly engaging a suitable gear **134** rigidly affixed to the side of each of the pair of rollers **36**.

The trolley base **32** also carries a pair of bumpers **136** for positioning the load carrier on the transfer car **26** during transfer of the load carrier between the aisles. The positioning of the load carrier on the transfer car during transfer is fully

described in the aforementioned copending application Ser. No. 737,199.

Also disposed at the drive motor end of the trolley base 32 is a control switchboard 138 for controlling, via appropriate electrical circuitry (not shown), the drive motor 126, hoist lift motor 62 and fork operating motor 60 of the load carrier. Such circuitry is not shown as it is not deemed to be the subject matter of the present invention. Although, the control switchboard is shown as being mounted upon the load carrier 20, it may be remotely located.

DETAILED DESCRIPTION OF OPERATION OF THE FLOOR-RUNNING LOAD CARRIER

At the commencement of operation it will be assumed that the load carrier 20 and transfer car 26 are properly aligned with an aisle in which it is desired to store and retrieve articles, for example aisle 12 as shown in FIG. 1. Let us also assume that a palletized article has been delivered from the right, as viewed in FIG. 1, has moved by gravity or otherwise down the rolls of pickup conveyor 28, and has come to rest adjacent the end of the storage frame 2 and the load carrier 20. The load carrier 20 is partially disposed upon the transfer car 26 such that its lift platform 22 is disposed between the pickup conveyor 28 and the delivery conveyor 30 at their storage frame ends. Also before commencing operation, the lift platform 22 has been lowered to the level of the pickup conveyor 28 in preparation for picking up the article to be removed therefrom and stored in the appropriate storage bin.

An appropriate order is now entered by the operator in the control switchboard 138, informing the load carrier 20 where to store the article now located upon the pickup conveyor 28. At the same time an order may be given to the load carrier 20, via the control switchboard 138, telling the loaded carrier 20 where to go to retrieve a stored article for the purpose of bringing the article out to the delivery conveyor 30 after the article which is now on the pickup conveyor has been stored. These orders might be given to the control switchboard at the same time or individually at different times.

Assuming that both a storage and a retrieval order are given simultaneously to the load carrier 20 for purposes of describing the full mechanical operation of the arrangement, the lift platform forks 24 and 25 are telescopically extended from the lift platform 22 beneath the article resting upon the pickup conveyor 28. Referring particularly to FIGS. 5 and 6, when the forks 24 and 25 are to be extended, an electrical signal, via appropriate circuitry (not shown), energizes the fork-operating motor 60 to rotate the sprockets and chain 61A and the fork-operating drive shaft 61 to extend the forks 24 and 25 into the interruptions 29 in the pickup conveyor 28. When the forks 24 and 25 have been fully extended beneath the article on the pickup conveyor 28, the fork-operating motor 60 is deenergized and the hoist lift motor 62 is energized to lift the platform 22 to engage the forks 24 and 25 with the bottom of the article and lift the article free of the pickup conveyor 28. To lift the lift platform 22 and its associated forks 24 and 25, the hoist lift motor 62 is energized in a direction to rotate the sprocket 87, chain 89, and sprocket 79, and shaft 64 in a clockwise direction, referring particularly to FIG. 7. Rotation of the shaft 64 in a clockwise direction causes rotation, in a clockwise direction, of sprockets 76, 77 and 78, which in turn causes rotation, also in a clockwise direction, of chains 90 and 93 and double chains causes and 92. As described earlier, the clockwise rotation of the chains 90 and 93 causes a lifting force to be exerted upon the upper rollers 99 mounted on the end panel 52 of the lift platform, the chains 90 and 93 being slacked about the lower roller 99 and beneath the lift platform. The clockwise rotation of double chains 91 and 92 causes a lifting force to be exerted upon the upper block 95 mounted on the end panel 54 of the lift platform, the double chains 91 and 92 being slacked at the lower block 95 and beneath the platform. As the forks 24 and 25 come into contact with the bottom of the article during the aforementioned lifting of the lift platform, the article is lifted free of the pickup conveyor 28 and the forks are now retracted onto the lift platform by operation of the fork-operating motor 60 in a direction opposite to that previously described.

When the forks 24 and 25 have been fully retracted and the article to be stored is disposed upon the lift platform 22, the drive motor 126 may now be energized to move the load carrier 20 longitudinally down the aisle 12 to the desired storage location. As the load carrier 20 is moving horizontally down the aisle, operation of the hoist lift motor 62 may continue until the lift platform 22 is properly vertically positioned with respect to the location of the bin in which it is desired to store the article. Referring in particular to FIGS. 3 and 4, the drive motor 126, upon being energized, drives the rollers 36 in the appropriate direction, via the gear box 130, drive shafts 128, drive gears 132, and gears 134, to move the load carrier 20 longitudinally into the aisle 12. When the load carrier 20 is properly horizontally positioned and its lift platform 22 is vertically positioned with respect to the bin in which it is desired to store the article, the forks 24 and 25 are again extended in the appropriate direction into the proper bin and the article to be stored is carried into the bin. The lift platform 22 is then slightly lowered by the hoist lift motor 62 disposing the article upon the supporting horizontal members 4 in the bin and disengaging the forks from the bottom of the article. The forks 24 and 25 are then retracted onto the platform 22, and the load carrier is ready to proceed to the bin from which it is desired to retrieve an article.

During horizontal movement of the load carrier 20 to the location of the bin from which it is desired to remove an article, the hoist lift motor 62 operates to raise or lower the lift platform 22 as necessary to position the lift platform vertically with respect to the forthcoming bin. When the load carrier 20 and lift platform 22 are properly positioned in the horizontal and vertical directions with respect to the bin, the forks 24 and 25 are again extended beneath the article desired to be retrieved, and the lift platform 22 is raised slightly again to contact the extended forks with the bottom of the article and lift the article free of its storage bin. The forks 24 and 25 are then retracted until the article is disposed upon the lift platform 22. The drive motor 126 and the hoist lift motor 62 are again energized moving the load carrier 20 longitudinally down the aisle toward the transfer car 26 and lowering the lift platform 22 to the level of the delivery conveyor 30, respectively.

The load carrier 20 moves horizontally down the aisle 12 until its rollers 36 are again partially disposed on the transfer car 26; its rollers 34 still resting upon the rails 16 in the aisle, the lift platform 22 being located adjacent the frame end of the delivery conveyor 30. When the load carrier 20 is so disposed, the lift platform 22 has been lowered to the level of the delivery conveyor 30, and the drive motor 126 and hoist lift motor 62 have been deenergized, the fork-operating motor 60 is again energized extending the forks 24 and 25 into the interruptions 29 of the delivery conveyor 30, carrying the retrieved article from the lift platform 22 and disposing the article vertically above the rollers of the delivery conveyor 30. When the forks 24 and 25 are fully extended, the hoist lift motor 62 is again energized to slightly lower the lift platform 22, causing the forks to drop beneath the surface of the rollers of the delivery platform and deposit the article upon the rollers. As soon as the article is deposited upon the rollers and disengaged from the forks 24 and 25, the article moves to the right, as viewed in FIG. 1, down the delivery conveyor 30 either by power or gravity depending on the construction of the conveyor and the forks may be again retracted as previously described. Thus, the load carrier is now ready to receive another order from the control switchboard 138 to either store and/or retrieve another article as hereinbefore described.

If it is desired to store or retrieve an article in another one of the aisles, the load carrier 20 may be transferred from the aisle in which it is located to the desired aisle via the transfer car 26

as is fully described in my copending application, Ser. No. 737,199.

DETAILED DESCRIPTION OF THE CENTER-RUNNING LOAD CARRIER

Referring to FIGS. **15—18**, a center-running embodiment of load carrier is shown. The center-running load carrier **140** is substantially similar to the floor-running embodiment previously described and therefore like reference numerals will be employed with like components in the drawing. The load carrier rails **142**, rather than being mounted on the aisle floors, are mounted at an intermediate elevation on angled mounting members **144** which, in turn, are attached to the vertical members **6** of the storage frames. The trolley base **146** is rollably located on the elevated rails and is powered by drive motor **126** and a pair of masts **148** and **150** extend both above and below the base. As shown in FIG. **17**, the base **146** includes a rectangular open section **152** in its center to allow vertical movement of the lift platform **22** upwardly and downwardly through the plane of the base between the distal ends of the lower and upper portions of the masts. The tops of the masts **148** and **150** engage an overhead rail through right-angled frame members **42** and **44** and rollers **46** and **48** as previously described. The bottom distal ends of the masts are suspended freely above the aisle floor.

The lift platform **22** is raised and lowered over the length of the masts **148** and **150** by the hoist lift motor **62** which is mounted upon one end of the trolley base. The hoist chain arrangement includes one more shaft than the previously described floor-running load carrier, all the shafts carrying suitable sprockets and being rotatably mounted at various locations on the load carrier **140**. As best seen in FIGS. **16** and **18**, the reeving arrangement is similar to the previously described reeving arrangement but differs in that shafts **68** and **69** are rotatably mounted adjacent the bottom end of mast **150** and thus spaced from the bottom of the trolley base **146** and the additional shaft **152** is rotatably mounted adjacent the bottom end of mast **148**. Shafts **64**, **65** and **66** are rotatably mounted on the trolley base **146** and shaft **71** and shafts **73** and **74** are rotatably mounted at the top of masts **148** and **150**, respectively.

Chains **90** and **93** extend upwardly from the upper roller **99** on the end panel **52** of the lift platform, over sprockets **81** and **83** on shaft **71**, around sprockets **81** and **83** on shaft **65**, around drive sprockets **76** and **78** on shaft **64**, over sprockets **81** and **83** on shaft **66**, around sprockets **154** and **156** on shaft **152** and upwardly around the lower roller **99** on the end panel **52** of the lift platform. Double chains **91** and **92** are connected to the upper pivotally mounted block **95** on the end panel **54** of the lift platform and extend upwardly over double sprocket **85** on shaft **73**, around double sprocket **85** on shaft **74**, over double sprocket **82** on shaft **71**, around double sprocket **82** on shaft **65**, around double drive sprocket **77** on shaft **64**, over double sprocket **82** on shaft **66**, around double sprocket **155** on shaft **152**, around double sprockets **85** on shafts **69** and **68** and upwardly to the lift platform where their ends are connected to the lower block **95** on the end panel **54**.

As an example, the direction of rotation of the various shafts, sprockets, and chains will be described where it is desired to elevate the lift platform **22** of the center-running load carrier. The hoist lift motor **62** is energized driving drive shaft **86** and its sprocket **87** in a clockwise direction, drive chain **89** in a clockwise direction, sprocket **79** in a clockwise direction, and its associated shaft **64** in a clockwise direction. Rotation of shaft **64** in a clockwise direction, rotates its sprockets **76**, **77** and **78** in a clockwise direction and chains **90**, **91**, **92** and **93** also in a clockwise direction. Thus, shafts **69**, **71** and **74** and **152** idle in a clockwise direction and shafts **65**, **66**, **68** and **73** idle in a counterclockwise direction. Since all the chains are moving in a clockwise direction, each of the chains will exert an upward pull on the end panels **52** and **54** of the lift platform **22** at their upper anchoring rollers **99** and blocks **95**, respectively, and conversely the chains will be slackened at their lower anchoring rollers **99** and blocks **95** and the lift platform will rise. Operation of the hoist lift motor **62** in the opposite direction will drive the chains in a counterclockwise direction lowering the lift platform **22**.

The center-running load carrier is particularly useful where the height of the storage frames is substantial and the masts must extend over such height. Since the extension of the masts **148** and **150** in both directions from the trolley base **146** results in improved rigidity of the masts, a substantially greater overall mast length may be realized without the necessity of heavier structural materials.

It is also contemplated that the adjustable mounting arrangements shown in FIGS. **10—14** will be employed in the center-running trolley base **146** to mount shafts **64**, **69** and **74**. Also if desired, a transfer car similar in construction to transfer car **26** may be employed for use with the center-running load carrier **140** to move the load carrier between aisles, such transfer car having its rails **27** elevated substantially to the elevation of the intermediate rails **142** rather than being floor mounted.

DETAILED DESCRIPTION OF THE OVERHEAD-RUNNING LOAD CARRIER

Referring to FIGS. **19—21** a preferred embodiment of overhead-running load carrier is shown. The overhead-running load carrier **160** again is substantially similar to the previously described embodiments and like reference numerals will be employed with like components in the drawings. The load carrier rails **162** are mounted adjacent the tops of the storage frames **1** and **2** on angled mounting members **164** which, in turn are attached to the vertical members **6** of the storage frames. The trolley base **166** is rollably located on the elevated rails and powered by drive motor **126** and a pair of masts **168** and **170** extend in hanging relationship from beneath the trolley base and the lift platform **22** is moveable along the length of the masts. The trolley base **166** is substantially the same as the trolley base **32** described with respect to the floor-running embodiment, except that the trolley base **166** is inverted and the masts **168** and **170** extend from its lower side downwardly toward and closely adjacent the aisle floor of the storage area. A guide rail may be mounted upon the floor, if desired, or the distal ends of the masts may be freely suspended above the floor as shown.

The reeving arrangement of load carrier **160** again is substantially similar to the floor running embodiment, the arrangement being substantially inverted. Referring to FIGS. **20** and **21**, the lift platform **22** is raised and lowered by the hoist lift motor **62** which is mounted upon one end of the trolley base on the bottom side thereof. As in the floor-running embodiment, the hoist chain arrangement includes eight shafts carrying suitable sprockets rotatably mounted at various locations on the load carrier **160**. Shafts **64**, **65** and **66** are rotatably mounted at the hoist lift motor end of the trolley base **166**. Shafts **68** and **69** are also rotatably mounted on the trolley base **166** but at the end opposite the hoist lift motor **62**. Shaft **71** is rotatably mounted at the lower distal end of the mast **168** substantially vertically beneath shafts **64**, **65** and **66**; and shafts **73** and **74** are rotatably mounted on the mast **170** at its lowermost end substantially vertically beneath shafts **68** and **69**. Chains **90** and **93** extend upwardly from the upper roller **99** on end panel **52** of the load carrier, over sprockets **81** and **83** on shaft **66**, around sprockets **76** and **78** on shaft **64**, over sprockets **81** and **83** on shaft **65**, around sprockets **81** and **83** on shaft **71** and upwardly around the lower roller **99** on the end panel **52** of the lift platform. Double chains **91** and **92** are connected to the upper pivotally mounted block **95** on the end panel **54** of the lift platform and extend upwardly over double sprocket **85** on shaft **68**, around double sprocket **85** on shaft **69**, over double sprocket **82** on shaft **66**, around the double drive sprocket **77** on shaft **64**, over double sprocket **82** on shaft **65**, around double sprocket **82** on shaft **71**, around dou-

ble sprockets 85 on shafts 74 and 73, and upwardly to the lift platform where their ends are connected to the lower block 95 on the end panel 54.

Again as an example, the direction of rotation of the various shafts, sprockets and chains will be described where it is desired to raise the lift platform 22. The hoist lift motor 62 is energized driving drive shaft 86 and its sprocket 87 in a clockwise direction, drive chain 89 in a clockwise direction, sprocket 79 in a clockwise direction, and its associated shaft 64 in a clockwise direction as viewed in FIG. 21. Rotation of shaft 64 in a clockwise direction, rotates its sprockets 76, 77 and 78 in a clockwise direction and chains 90, 91, 92 and 93 in a clockwise direction. Thus, shafts 66, 69, 71 and 74 idle in a clockwise direction and shafts 65, 68 and 73 idle in a counterclockwise direction. Since all the chains are moving in a clockwise direction, each of the chains will exert an upward pull in their respective end panels 52 and 54 at their upper anchoring rollers 99 and blocks 95 respectively, and conversely the chains will be slackened at their lower anchoring rollers 99 and blocks 95 and the lift platform 22 will rise. The operation of the hoist lift motor 62 in the opposite direction will drive the chains in a counterclockwise direction lowering the lift platform.

Again it is contemplated that the adjustable mounting arrangement shown in FIGS. 10—14 be employed to mount shafts 64, 69 and 74 on load carrier 160. Also if desired, a transfer car similar to transfer car 26 may be employed to move the load carrier 160 between aisles, such transfer car having its rails 27 elevated substantially to the elevation of the rails 162.

DETAILED DESCRIPTION OF SECOND EMBODIMENT OF FLOOR-RUNNING LOAD CARRIER

Referring to FIGS. 22—24, a somewhat simplified second embodiment of floor-running load carrier is shown. The load carrier 180 includes a horizontal trolley base 182 having a pair of masts 184 and 186 extending upwardly from each end thereof and connected to each other at their tops by a cross beam 187. Attached at each end of the base 182 and to masts 184 and 186 are extended housings 188 and 190 formed of relatively heavy plates. Each housing includes a single wheel 192 and 194, respectively, rotatably mounted thereon the wheels being adapted to roll upon the floor of the aisle. Housing 188 also carries a drive motor 196 which powers the wheel 192 through a suitable gear arrangement for moving the load carrier up and down the aisle. An operator's seat 198 and a control switchboard 200 are mounted on housing 190 and a pair of struts 201 are attached between the mast 186 and housing 190 to structurally strengthen the mast arrangement.

A pair of Z-shaped guide rails 202 and 203 are mounted to the top and bottom respectively, of the storage frames for guiding the movement of the load carrier 180 up and down the aisle and for spacing the load carrier from the storage frames. Each of the Z-shaped guide rails 202 and 203 includes a pair of vertical flanges 204 and 205 which are spaced from each other by a bridging web 206, flanges 204 being attached to the storage frames. Horizontally extending angle members 207 and 208 are attached at the top and bottom, respectively, of mast 186 and extend toward the guide rails 202 and 203, angle member 207 extending above guide rail 202 and angle member 208 extending beneath guide rail 203. Each of the angle members carry three rollers 210, 211 and 212 at their distal ends. Rollers 210 and 211 of each of the angle members rollably engage the side faces of the vertical flanges 205 and rollers 212 of angle members 207 and 208 rollably engage the bottom face of the web 206 of rail 202 and top face of the web 206 of rail 203, respectively.

The lift platform 214 is of similar construction to the lift platform previously described and includes a plurality of rollers 216 on its end panels 218 and 220 for guiding and steadying the lift platform during vertical movement, a pair of telescopically extendible forks 222 and 224, and a fork-operating motor 226. An appropriate electrical connector 228 is provided as previously described to supply power to the fork-operating motor and includes a weighted pulleylike member 230 substantially identical to that previously described. The pulleylike member is adapted to ride up and down a guide member 232 which is attached to mast 186 and extends laterally therefrom.

Referring to FIG. 24, the lift platform 214 is raised and lowered by a hoist lift motor 234 and pocketed chain sheave 236 which is located beneath a control switchboard 200. The hoist arrangement includes the sheave 236 and four pulley shafts which are mounted at various locations on the load carrier. Shaft 238 is rotatably mounted at the top of mast 186 and carries three sheave pulleys 240, 241 and 242. Shafts 244 and 246 are rotatably mounted at the top of mast 184 and each carries a single sheave pulley 248. Shaft 250 is rotatably mounted on the housing 190 adjacent the trolley base at the bottom of mast 186 and also carries the single sheave pulleys 252. A chain 254 is attached at one end of a yoke block 256 and extends upwardly over pulley 240, downwardly toward the lift platform 214, around a roller 258 which is rotatably mounted in the end panel 220 of the lift platform, upwardly over pulley 242 and downwardly toward the block 256, its end being attached to the other end of the block. A chain 260 is attached in substantially the center of the block 256 and extends upwardly over pulley 241 across the top of the load carrier, around pulley 248 of shaft 244, over pulley 248 of shaft 246 and downwardly toward the lift platform where its end is attached to a block 262 which is pivotally pinned within the end panel 218 of the lift platform. A third chain 264 is attached to the bottom of the block 256 at substantially its center and extends downwardly around pulley 252 over the powered chain sheave 236, its bitter end 266 being attached to the underside of the hoist power assembly and the dead end loop 267 collecting in a container 268 formed within the housing 190, as shown in FIG. 23.

To raise the lift platform 214, the hoist lift motor 234 is energized rotating the sheave 236 in a counterclockwise direction, as viewed in FIG. 24, taking tension on the chain 264. As the chain 264 moves downwardly, a downward force is exerted on the yoke block 256, pulling chains 254 and 260 toward housing 190. As the chains move downwardly an upward lifting force is exerted upon the roller 258 and block 262 raising the lift platform, the excess chain collecting in the container 268. Operation of the sheave 236 in the opposite direction will tend to slack the chains and the lift platform 214 will move downwardly by gravity, the sheave 236 acting as a brake.

Referring again to FIG. 23, an adjusting bolt 270 is provided attached to shaft 244. The adjusting bolt 270 is journaled through an apertured plate 272 and a nut 274 is threaded on the end of the bolt. To adjust the level of the lift platform 214, the nut 274 is rotated in one direction or the other moving the adjusting bolt 270 and its associated shaft 244 horizontally to the right or left changing the spacing of shaft 244 relative to shaft 246.

It should be understood that the embodiments of the invention which have been described are merely illustrative of some of the applications of the principles of the invention. Numerous modifications may be made by those skilled in the art without departing from the true spirit and scope of the invention.

What I claim is:

1. A load carrier comprising:

a substantially horizontal moveable base,

a pair of masts spaced from each other and extending in a substantially vertical direction from said base,

a substantially rigid horizontal platform disposed between said masts and adapted to move in a vertical direction therebetween,

first flexible hoist means mounted upon both of said masts and connected to one end of said platform,

second flexible hoist means mounted on one of said masts and connected to the other end of said platform,

drive means for moving said first and second flexible hoist means in one direction to raise said platform and in the opposite direction to lower said platform between said masts,

a first wheel means rotatably mounted adjacent an end of said one mast, each of said flexible hoist means being trained about said wheel means, and said second flexible hoist means straddling said first flexible hoist means,

second wheel means rotatably mounted in spaced relationship along said one mast from said first wheel means, said second wheel means comprising a first plurality of wheels and a second plurality of wheels, each of said first and second flexible hoist means being trained about ones of said first and second plurality of wheels, and

means for adjustably moving said second plurality of wheels relative to said first plurality of wheels said last-mentioned means comprising cover means on said moving means upon which said second plurality of wheels are mounted, said cover means being selectively moveable relative to said first plurality of wheels and urging and maintaining each of said flexible hoist means in contact with a major portion of each of said second plurality of wheels.

2. The load carrier of claim 1 wherein said first flexible hoist means comprises a pair of flexible members.

3. The load carrier of claim 1 wherein said first flexible hoist means comprises a pair of chains, said second flexible hoist means are chains and said wheel means comprise a plurality of sprocket wheels engaging said chains.

4. The load carrier of claim 1 including

third and fourth wheel means mounted in spaced relationship along said other mast,

said first flexible hoist means being trained about each of said wheel means and said second flexible hoist means being trained about said first and second wheel means

5. The load carrier of claim 4 wherein one of said wheel means comprises first and second wheels, at least one of said first and second flexible hoist means being trained about said first and second wheels, one of said wheels being adjustably moveable with respect to the other of said wheels.

6. The load carrier of claim 1 wherein said masts extend above and below said base and each of said flexible hoist means extend above and below said base between each end of their respective masts.

7. The load carrier of claim 1 wherein said masts extend below said base and said flexible hoist means extend below said base between the lower ends of their respective masts and the base.

8. The load carrier of claim 1 including means pivotally connecting one of said flexible hoist means to said platform and roller means at the end of said platform opposite said one end, the other of said flexible hoist means comprising a looped member looped about said roller means.

9. The load carrier of claim 1 wherein said first flexible hoist means comprises a single flexible member, said second flexible hoist means comprises a looped flexible member straddling said single member, a flexible drawing member operatively associated with said drive means, and one end of said single member and both ends of said looped member being attached to said drawing member.

10. A hoist arrangement for hoisting a rigid load comprising,

first flexible hoist means adapted to be connected to one end of the rigid load,

second flexible hoist means adapted to be connected to the opposite end of the rigid load,

first and third rotatable wheel means, said first flexible hoist means being trained about both of said wheel means and said second flexible hoist means being trained about said first wheel means,

drive means for moving said first and second flexible hoist means in one direction to raise the rigid load and in the opposite direction to lower the rigid load between said first and second flexible hoist means,

second and fourth wheel means located in vertically spaced relationship with respect to said first and third wheel means, respectively, said first flexible hoist means being trained about each of said wheel means and said second flexible hoist means being trained about said first and second wheel means,

fifth rotatable wheel means adjacent said second wheel means, said first and second flexible hoist means being trained about said fifth wheel means, and means for adjustably moving said fifth wheel means relative to said second wheel means, said last-mentioned means comprising cover means upon which said fifth wheel means are mounted, said cover means being selectively moveable relative to said second wheel means and urging and maintaining each of said flexible hoist means in contact with a major portion of each of said fifth wheel means.

11. The hoist arrangement of claim 10 wherein said second flexible hoist means straddles said first flexible hoist means.

12. The hoist arrangement of claim 11 wherein said first flexible hoist means comprises a pair of flexible members.

13. The hoist arrangement of claim 11 wherein said first flexible hoist means comprises a pair of chains, said second flexible hoist means are chains and said wheel means comprise a plurality of sprocket wheels engaging said chains.

14. The hoist arrangement of claim 10 including sixth rotatable wheel means adjacent at least one of said third and fourth wheel means, said first flexible hoist means being trained about all of said wheel means, said sixth wheel means also being selectively moveable with respect to its adjacent wheel means.

15. The hoist arrangement of claim 10 wherein said first wheel means comprise a pair of rotatable shafts having wheels thereon, one of said shafts being located in a plane above said second wheel means and the other of said shafts being located in a plane below said second wheel means, and said third and fourth wheel means being located in substantially the same plane as each of said shafts, respectively.

16. The hoist arrangement of claim 10 wherein said first flexible hoist means comprises a single flexible member, said second flexible hoist means comprises a looped flexible member straddling said single member, a flexible drawing member operatively associated with said drive means, and one end of said single member and both ends of said looped member being attached to said drawing member.