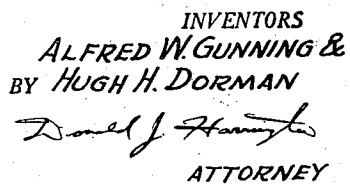


A. W. GUNNING ET AL

HYDRAULIC LIFT FOR INDUSTRIAL TRUCKS AND TRACTORS

4 Sheets-Sheet 1



March 17, 1959

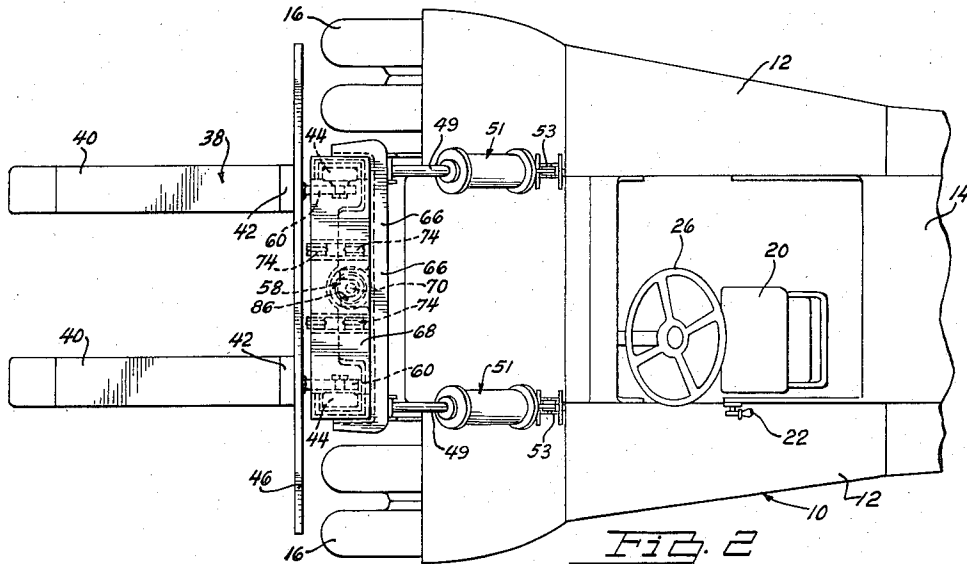
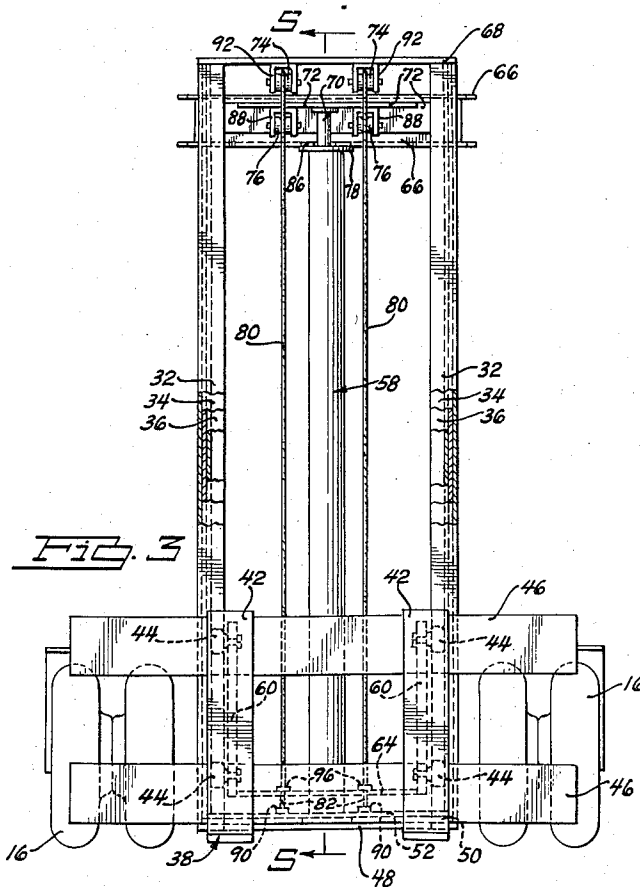
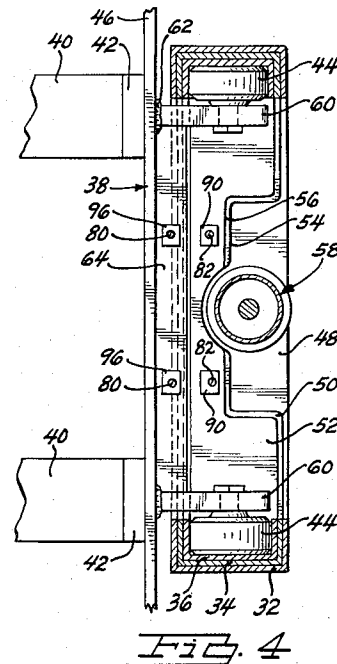
A. W. GUNNING ET AL

2,877,868

HYDRAULIC LIFT FOR INDUSTRIAL TRUCKS AND TRACTORS

Filed May 31, 1956

4 Sheets-Sheet 2



INVENTOR.
ALFRED W. GUNNING &
BY HUGH H. DORMAN
Donald J. Harrington
ATTORNEY

March 17, 1959

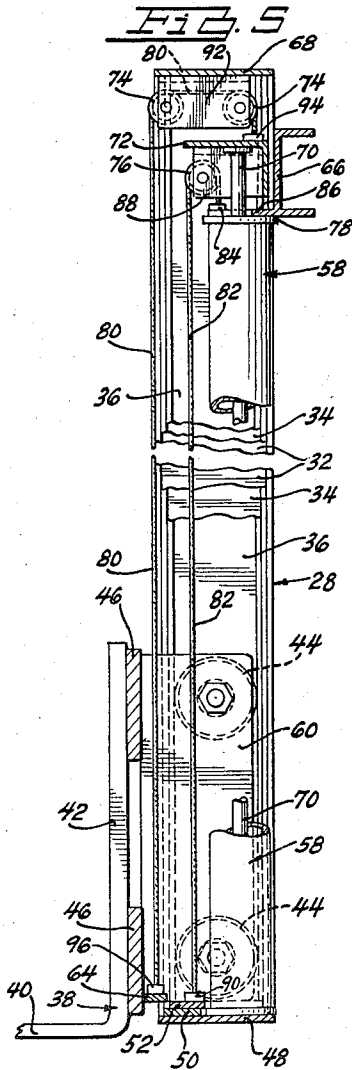
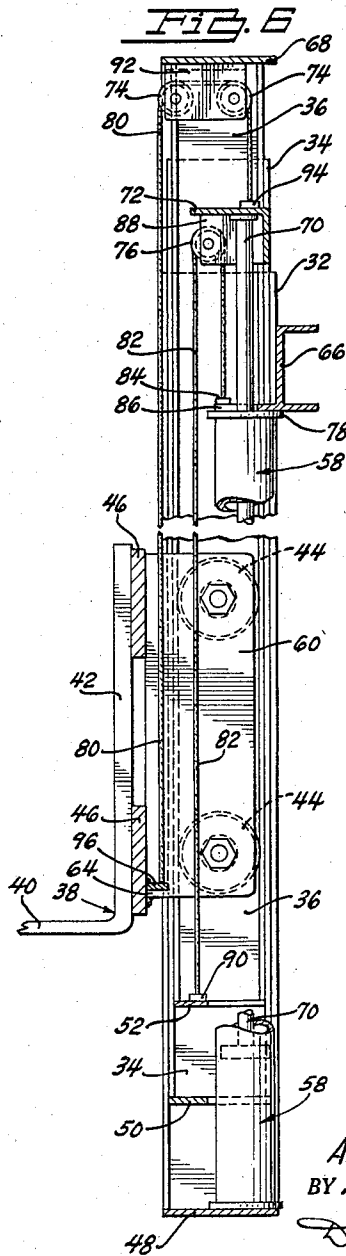
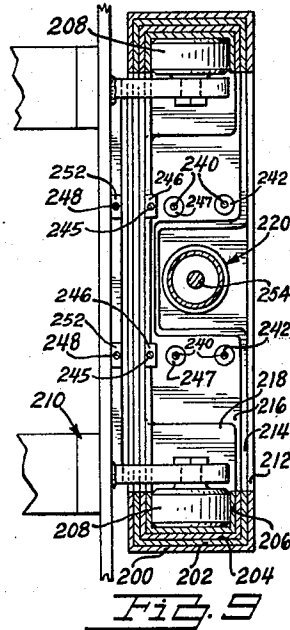
A. W. GUNNING ET AL

2,877,868

HYDRAULIC LIFT FOR INDUSTRIAL TRUCKS AND TRACTORS

Filed May 31, 1956

4 Sheets-Sheet 3



INVENTORS
ALFRED W. GUNNING &
BY HUGH H. DORMAN

Donald J. Harrington
ATTORNEY

March 17, 1959

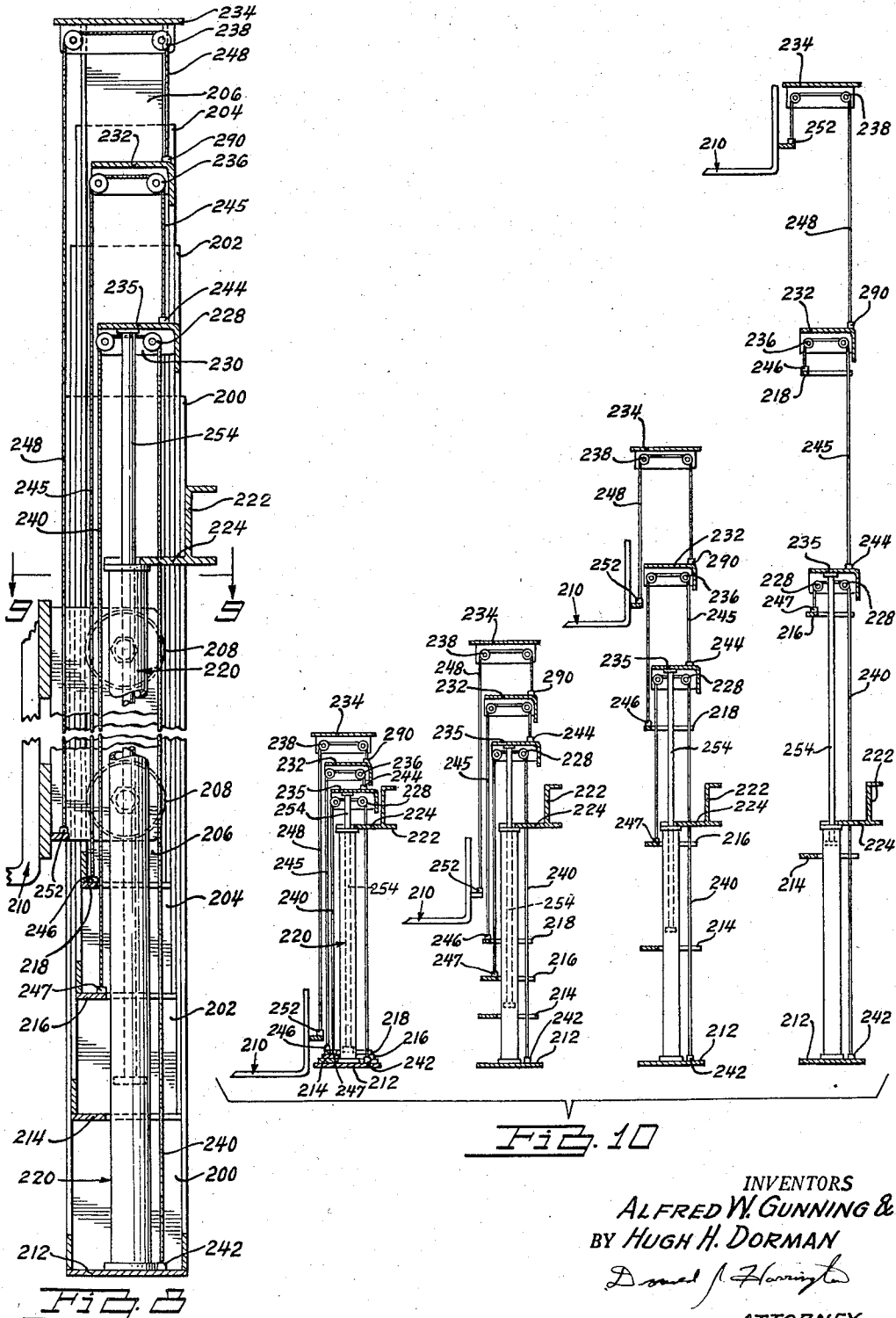
A. W. GUNNING ET AL

2,877,868

HYDRAULIC LIFT FOR INDUSTRIAL TRUCKS AND TRACTORS

Filed May 31, 1956

4 Sheets-Sheet 4



INVENTORS
ALFRED W. GUNNING &
BY HUGH H. DORMAN
Donald J. Harrington
ATTORNEY

1

2,877,868

HYDRAULIC LIFT FOR INDUSTRIAL TRUCKS AND TRACTORS

Alfred Wayne Gunning, Richland, and Hugh H. Dorman, Olivet, Mich., assignors, by direct and mesne assignments, to Multi-Lift Co., a corporation of Michigan

Application May 31, 1956, Serial No. 588,438

9 Claims. (Cl. 187—9)

Our invention relates generally to industrial trucks of the load-lifting and transporting type, and more particularly to a new and improved hoisting mechanism capable of being adapted for use with industrial trucks or tractors.

Our present invention comprises an improvement in the earlier structure disclosed in U. S. Patent No. 2,514,052, issued to Alfred W. Gunning as sole inventor.

According to a principal feature of our invention, we have provided a lifting mechanism which may be readily adapted for use with a wide variety of vehicles of known construction, and which is capable of lifting a load from floor level to a height greatly exceeding the normal inoperative height of the lifting mechanism. Such a feature greatly simplifies the problems associated with storing the vehicle when not in use, and it greatly facilitates load-handing operations in those instances when the operating environment includes low ceilings and passageways.

We are aware of various lifting mechanisms, including that of the above-mentioned patent to A. W. Gunning, one of the instant joint inventors, which are capable of hoisting a load from one level to another. These mechanisms are characterized by a hydraulic lifting cylinder and piston for actuating the mechanism, and the total distance traveled by the load during operation exceeds the total movement of the actuating piston.

By way of illustration, the prior art lifting mechanism described in the above-mentioned patent to A. W. Gunning comprises a pair of telescopically related, vertically positioned sections defined by channels or rails between which is mounted a hydraulic cylinder and piston mechanism. A lifting fork is carried at one side of the channels, and it is adapted to ride therealong during load-lifting operations. A complex chain and pulley arrangement is employed in the prior art arrangement for drivably connecting the lifting fork, one of the sections and the movable piston, the other section remaining fixed to the truck and serving as a reaction member. During the initial stages of operation, the lifting fork is raised to the top of the channels by the hydraulic piston as both of the sections remain stationary. Upon further movement of the hydraulic piston, the lifting fork remains stationary with respect to the relatively movable sections while the latter is being moved with respect to the fixed section. The maximum height to which the load may be lifted is thus twice the height of the channels when the mechanism is in the retracted position, but the lifting force exerted by the hydraulic piston is three times the weight of the load since the mechanical lifting ratio is three to one.

When the above described patented structure is lowered or retracted, the reverse sequence is followed; i. e., the lifting fork is first lowered conjointly with the movable channels as the cylinder and piston is retracted, and then the lifting fork is lowered with respect to the fixed channels as the hydraulic piston is further retracted to the original starting position.

2

In order to make certain that the above sequence is followed, a complex latching mechanism must be incorporated in the patented structure to prevent the movable channels from moving until the lifting fork reaches the upper extremity of the channels during a lifting operation and to cause the lifting fork and the movable channel to move in unison during the initial stages of a lowering or retracting operation.

The improved structure of our instant invention eliminates the need for such a latching mechanism and it is substantially less complex and more reliable in operation.

Further, the mode of the operation of the mechanism of our invention embodies a new concept which overcomes the deficiencies inherent in conventional lifts.

The provision of such an improved hoisting mechanism being a principal object of our invention, it is a further object of our invention to provide a hoisting mechanism of the type above described which includes a plurality of telescopically related channel members and a lifting carriage assembly operatively associated therewith and in which a relatively large movement of the lifting carriage will accompany a relatively small movement of the hoisting members of the mechanism, the ratio between the maximum lifting height of the lifting carriage to the normal retracted height of the mechanism being appreciably greater than the corresponding ratio inherent in structures of known construction.

It is a further object of our invention to provide a hoisting mechanism wherein this dimensional advantage may be enjoyed with no increase in the lifting force of the hydraulic piston being required; i. e., for a given ratio between the weight of the load and the force requirements of the hydraulic cylinder and piston, the mechanism of our instant invention is capable of lifting a given load to a considerably greater height than that height which could be obtained with a conventional lifting mechanism of known construction.

A further object is to provide a hoisting mechanism as above set forth wherein an increase in the lifting height can be obtained without a corresponding increase in the height of mechanism when it assumes a retracted position. Indeed, the retracted height of our improved mechanism is substantially less than that of conventional mechanisms in spite of this increased lifting height advantage.

It is a further object of our invention to provide a hoisting structure of the type set forth above wherein relative movement between each of the plurality of channels and the lifting fork takes place simultaneously with an established ratio, each of the relatively movable elements of the mechanism reaching a terminal position simultaneously during a load-lifting operation.

It is a further object of our invention to provide a hoisting mechanism of the type above set forth wherein the above described increased ratio between the maximum load-lifting height and the height of the retracted mechanism may be accomplished with no increase in the lifting ratio and without highly stressing any of the structural members of the mechanism.

It is a further object of our invention to provide a lifting mechanism comprising telescopically related channels, a hydraulic piston and a relatively movable lifting fork, as above described, wherein separate pulley means are associated with each channel, the movable portion of each pulley means being situated at an elevated location thus preventing dirt and foreign matter from fouling the operation of the same. This feature is of considerable significance when the mechanism is used in the field or in warehouses, or the like, where scrap and debris is likely to accumulate.

Other objects and advantages of our invention will readily become apparent from the following description.

3

In carrying forth the foregoing objects, we have provided a load hoisting mast comprising at least three telescopically related sections defined by spaced parallel channels, the lower or base sections being adapted to be secured in a suitable fashion to an industrial truck or tractor and held in fixed relationship with respect to the other sections. A hydraulic piston and cylinder mechanism may be caused to actuate the first relatively movable section or intermediate section and a pulley means is carried at a location proximate to the portion thereof on which the piston and cylinder mechanism acts. A first cable or chain may be trained over the pulley means and one end thereof may be anchored, the other end being connected to a third or upper movable section. The ratio between the movement of the piston and this last-mentioned movable section is therefore two to one.

The third movable section is slidably received within the intermediate section and it also carries a pulley means at the upper end thereof over which a separate cable or chain is trained, one end of this second cable or chain being connected to the top side of the intermediate sections, and the other end of the second cable being connected to the lifting carriage. The ratio between the movement of the lifting carriage and the hydraulic piston is therefore three to one.

According to another embodiment of our invention, a fourth relatively movable section may be received within the third section and the cable or chain associated with the third section may instead be connected to the fourth section. Another pulley means may be carried by the fourth section and a third cable or chain may be trained thereover with one end thereof secured to the third section, the other end being connected to the lifting carriage. The total movement of the lifting carriage which may be obtained with this embodiment will be equal to four times the movement of the piston, but the height of the mechanism in the retracted position is still equal to the height of the above described first embodiment. In each of the embodiments, duplicate pulleys and cables or chains are preferably provided for each of the movable sections and this is the arrangement which will be described in the instant specification.

For the purpose of more particularly describing the principal features of our invention, reference will be made to the accompanying drawings, wherein:

Fig. 1 shows a side elevational view of an industrial truck or tractor utilizing the improved lifting structure of our instant invention, one extreme elevated position being illustrated in Fig. 1 by dotted lines;

Fig. 2 is a plan view of the truck and lifting mechanism shown in Fig. 1;

Fig. 3 is a front elevational view of the truck of Fig. 1, showing in more particular detail the construction of the lifting mechanism of our instant invention;

Fig. 4 is a cross-sectional view of the lifting mechanism taken along section line 4—4 of Fig. 1;

Fig. 5 is a vertical cross-sectional view of the lifting mechanism taken along section line 5—5 of Fig. 3;

Fig. 6 is a vertical cross-sectional view similar to that of Fig. 5 wherein the telescopically related channels are shown in a partly extended position;

Fig. 7 is a schematic representation of the lifting mechanism of our instant invention, showing the three operative positions;

Fig. 8 is a cross-sectional view similar to that of Fig. 5, showing a modified form of our invention;

Fig. 9 is a cross-sectional view of the modified construction of Fig. 8 taken along section line 9—9 of Fig. 8;

Fig. 10 is a schematic representation of four operative positions of the load lifting structure of Figs. 8 and 9.

The first embodiment above described is illustrated in Figures 1 through 7 of the drawings, and the pulley arrangement for interconnecting the relatively movable

4

channels and the lifting fork is more particularly illustrated in Figs. 5 and 6.

Referring first to Fig. 1, numeral 10 is used to generally designate a typical industrial type truck which includes a chassis 12, an engine 14 suitably mounted on the chassis, front wheels 16, preferably of the tandem type, and dirigible rear wheels 18. A driver seat is illustrated at 20, and a portion of the vehicle controls are illustrated at 22 and 24 adjacent the driver seat 20. A steering wheel 26 is mounted at the forward portion of the vehicle and may be pivotally connected to the dirigible wheels 18 through a suitable steering linkage, not illustrated.

The chassis 12 includes a vehicle frame upon which the lifting structure or mast of our instant invention may be mounted, said lifting structure being generally designated in the drawings by the numeral 28. A bracket 30 may be pivotally mounted at a forward portion of the vehicle frame, and a pair of substantially rectangular outer channels 32 of a base mast section may be secured thereto as indicated. A separate intermediate channel may be slidably received within each outer channel 32 and these intermediate channels may move relative to the base mast section to an upper position illustrated in Fig. 1 by means of dotted lines. The intermediate channels define in part an intermediate mast section and they are designated by the numeral 34. A pair of inner or upper channels 36 of an upper mast section may in turn be slidably received within the intermediate channels 34, said channels 36 likewise being adapted to be extended to an upper position. This latter position is also illustrated in Fig. 1 by means of dotted lines.

A lifting fork or carriage assembly is illustrated in the drawings at 38 and it includes a substantially horizontal pair of fork arms 40 and a pair of right-angle mounting plates 42. A pair of rollers is designated by numeral 44, each roller being mounted at a separate vertically spaced position. The rollers 44 are received within the above mentioned inner channels 36, one pair of rollers being associated with each channel 36.

A pair of brackets 47 is secured to the outer channels 32, one bracket 48 being joined to each supporting channel, and a piston rod 49 may be pivotally connected to each bracket 48. The piston rod 49 forms a portion of a hydraulic cylinder and piston mechanism generally designated by numeral 51, the base of the mechanism 51 being pivotally mounted on the structural portion of the chassis 12 as illustrated at 53. One hydraulic piston and cylinder mechanism 51 is provided for each of the channels 32 at transverse locations on the vehicle as best seen in Fig. 2.

The two positions of the lifting fork illustrated in Fig. 1 represent the two extreme lifting positions, the upper extreme position being illustrated by dotted lines. However, it will be appreciated that the lifting fork 38 may assume any of a plurality of intermediate positions as desired between the two extreme positions illustrated. During operation, the mast 28 may be pivoted about the connection between the chassis and the bracket 30 by extending or retracting the piston rod 49. Suitable hydraulic controls may be provided for this purpose to effect such a tilting operation.

Referring next to Figs. 2, 3, and 4, the structural relationship between the channels and the lifting fork may be more fully understood. As best seen in Fig. 4, each of the channels 32, 34, and 36 are formed with progressively decreasing dimensions to accommodate a nesting relationship therebetween. The rollers 44 are adapted to move vertically within the inner channel 36 for the purpose of guiding the lifting fork 38. By preference, the lifting fork 38 includes a pair of horizontally extended bars 46 to facilitate the handling of freight or other bulky merchandise and the plates 42 may be secured thereto as indicated. The lower end of the outer channels 32 may be joined by a lower supporting plate 48 as illustrated.

5

in Fig. 4, and the lower end of the channels 34 and 36 may similarly be joined by supporting plates 50 and 52 respectively, the plates 48, 50 and 52 being situated in vertically stacked relationship when the channels assume the position illustrated in Fig. 3. A central portion of each of the supporting plates 50 and 52 is recessed, as illustrated at 54 and 56 respectively, for accommodating a hydraulic cylinder and piston mechanism generally designated by the numeral 58, said mechanism being vertically mounted on the lower supporting plate 48 of the outer channels 32.

As best seen in Figs. 2 and 4, the carriage assembly 38 includes a pair of roller supporting members 60. The supporting members 60 may be secured to the carriage assembly 38 in any suitable fashion, as by welding 62, and by preference, a supporting plate 64 is interposed between the members 60 to provide transverse support and to provide a means for connecting thereto a lifting cable or chain which will subsequently be described. The upper end of the channels 32 may be interconnected by a hydraulic cylinder supporting bracket 66 and the upper end of the inner channels 36 may be interconnected by a supporting bracket 68.

Referring next to Fig. 3, the hydraulic cylinder and piston mechanism 58 may be seen in more particular detail, and it includes a ram or piston rod 70 which is adapted to engage a bracket 72 which interconnects the upper ends of the second pair of channels 34. It is seen from Fig. 3 that a pair of pulleys 74 is mounted on the upper supporting bracket 68 and a second pair of pulleys 76 is mounted on the bracket 72. A separate flexible member such as a cable or chain 80 may be trained over each of the pulleys 76 and one of the ends of each cable or chain may be anchored to a flange 78 carried by the upper end of the relatively fixed cylinder of the piston and cylinder mechanism 58.

Referring next to Figs. 5 and 6, the pulley arrangement previously mentioned is illustrated in more particular detail and it will be apparent that each of the pulleys 74 and each of the pulleys 76 are provided with a separate flexible member such as a chain or chains or cables, the cable associated with the pulleys 74 being shown at 80 as above indicated, and the chain or cables associated with the pulley 76 being shown at 82. The above-mentioned connection between the chains or cables 82 and the relatively stationary cylinder of the piston and cylinder mechanism 58 is shown in Figs. 5 and 6 at 84. For convenience, the flexible members will hereinafter be referred to as cables.

By preference, the above-mentioned supporting bracket 66 is formed with an extension 86 situated above the upper end of the piston and cylinder mechanism 58 to provide an anchor support for the cables 82 at 84 and to maintain the piston and cylinder mechanism in a fixed vertical position. Also by preference, the supporting bracket 66 is formed with a substantially channel shape to provide added rigidity to the mechanism.

It may also be seen from Figs. 5 and 6 that the pulleys 76 are mounted at the upper end of the intermediate channels 34 by means of a mounting bracket 88 which may be permanently fixed to supporting bracket 72 in a suitable fashion. The lower ends of cables 82 are connected to the supporting plate 52 at the lower end of the inner channels 36, said connection being designated in Figs. 5 and 6 by the numeral 90.

By preference, the pulleys 74 are situated in tandem at the upper end of the inner channels 36 and are mounted on the supporting bracket 68 by a suitable mounting bracket 92. The cables 80 are drawn over the tandem pulleys 74 and one end of each cable 80 is fixed to the supporting member 72, as shown at 94. The other end of each cable 80 is joined to the supporting plate 64 of the carriage assembly 38 as illustrated at 96.

For purposes of illustration, it will be assumed that the hydraulic piston and cylinder mechanism is moved to a

6

partly extended position as illustrated in Fig. 6. Since the cylinder of the piston and cylinder mechanism is connected to the relatively fixed outer channels 32, and since the movable piston rod 70 engages the supporting bracket 72 of the intermediate channels 34, movement of the piston rod with respect to the stationary fixed channels 32 will cause the channels 34 to move to a partly extended position in telescoping relationship. This relative movement of the channels 34 causes the pulleys 76 to move in an upward direction and this upward movement is transmitted to the inner channels 36 through the cables 82. Since one end of each cable 82 is anchored at 84, the rate of movement of the inner channels 36 will be twice that of the intermediate channels 34. However, the movement of each of the channels 34 and 36 occurs simultaneously although the rates of movement differ by this constant ratio. Therefore, for any given displacement of the piston rod 70, the inner channels 36 will have moved to a height which is twice that of the intermediate channels 34. This upward movement of the inner channels 36 causes a corresponding upward movement of the pulleys 74 and this motion is transmitted to the carriage assembly 38 through the cables 80 since one end of each cable 80 is connected at 94 to the intermediate channels 34 while the other end is connected to the carriage assembly.

The operation of the mechanism and the pulley arrangement may be readily understood by referring to Fig. 7 wherein three operative positions of the lifting mechanism are illustrated. It is emphasized that the pulley arrangement at one transverse side of the vehicle is identical to that on the other side. It is apparent upon an inspection of Fig. 7 that as the piston rod 70 is moved from the first position to the second position, the movement of the intermediate channels 34 will be exactly equal to the displacement of the piston rod. However, since the lifting ratio between the intermediate channels 34 and the inner channels 36 is exactly two to one, the inner channels 36 will be moved a distance which is twice that of the intermediate channels 34. However, the lifting ratio of the intermediate channels 34 with respect to the carriage assembly is not two to one since the cables 80 are connected to a member which moves with respect to the channels 36 at a predetermined ratio. The lifting ratio of the inner channels 36 with respect to the carriage assembly is therefore decreased by the extent of this predetermined ratio, the overall lifting ratio between the carriage assembly and the piston rod therefore being exactly three to one.

The third illustration shown in Fig. 7 shows the piston rod 70 in a fully extended position. Since the lifting ratio is three to one, as previously described, the carriage assembly will assume a position which is exactly three times the distance that the piston rod travels. For the purpose of illustrating the above described lifting advantage, we have developed one working embodiment of our improved mechanism in which the overall retracted height of the mechanism is eighty inches (80") and wherein a total fork height of one hundred and sixty-two inches (162") may be obtained. Similarly, in another operative embodiment of our invention in which the overall height is ninety-two inches (92"), a total fork height of one hundred and ninety-eight inches (198") may be obtained. By way of contrast with the lifting mechanism disclosed in the above mentioned patent to A. W. Gunning, the overall height of the upright structure disclosed in the patent is equal to eighty-three inches (83") in the collapsed position, but the lifting fork can be raised from ground level to only sixty-three inches (63") during the initial stages of the lifting operation, and to a final height of only one hundred and thirty inches, (130").

Referring next to the second embodiment of our invention illustrated in Figs. 8 through 10, four telescopically related rectangular mast sections are provided

7

rather than three mast sections as in the previous embodiment, each section being defined by nested channels and the outermost channels being designated by numeral 200; the second channels being designated by numeral 202; the third channels being designated by numeral 204, and the innermost channels being designated by numeral 206. A pair of rollers is situated within the innermost channels 206 as shown at 208 and they form a portion of a lifting fork structure or carriage assembly similar to that previously described. The carriage assembly of the embodiment of Figs. 8 through 10 is generally designated by numeral 210. The lower ends of the outer channels 200 are joined together by supporting plate 212 and each of the other channels 202, 204 and 206 are joined at the lower ends thereof by similar supporting plates 214, 216 and 218 respectively.

A hydraulic cylinder and piston mechanism 220 is mounted, as in the previous embodiment, on the lower supporting plate 212, the supporting plates 214, 216 and 218 being recessed at an intermediate location thereon to accommodate the piston and cylinder mechanism 220. It is emphasized that the hoisting mechanism of Figs. 8 through 10 may be mounted on an industrial truck or tractor in the manner previously described in connection with the previously described embodiment.

Referring more particularly to Figs. 8 and 10, it may be seen that the outer channels 200 are joined adjacent the upper ends thereof by a supporting member 222, preferably of channel-shape, which includes an extension 224 situated adjacent the top of the piston and cylinder mechanism 220 for supporting the same. The next pair of channels 202 includes a supporting member 235 which bridges the upper ends thereof and which carries pulleys 228 suitably mounted on a pulley bracket 230. Similarly, the channels 204 and 206 are formed with supporting members 232 and 234 respectively, the supporting member 232 having mounted thereon another set of pulleys 236 and the supporting member 234 having mounted thereon a third set of pulleys 238. Each of the pulleys 228, 236 and 238 are preferably of the tandem type.

A first cable 240 may be drawn over each of the pulleys 228 and one end of each cable 240 may be anchored to the relatively stationary channels 200, as shown at 242. The other end of each cable 240 is joined at 247 to the supporting plate 216 of the channels 204. A second cable 245 may be drawn over each of the pulleys 236 and one end of each cable 245 may be joined to the supporting member 235, as shown at 244, the other end thereof being connected to the mounting plate 218, as shown at 246, thereby imparting a lifting motion to the inner channels 206. Finally, a third cable 248 may be drawn over each of the pulleys 238 and one end of each cable 248 may be connected to a mounting plate 232 as shown at 249, the other end thereof being connected to the carriage assembly 210 as shown at 252.

It will thus be apparent that the pulley arrangement of the embodiment of Figs. 8 through 10 is substantially similar to that of the previously described embodiment. However, it is capable of further multiplying the motion of the hydraulic piston and cylinder mechanism 220 by reason of the additional mast section which is provided. The piston rod of the piston and cylinder mechanism 220, shown at 254, acts directly on the channels 202 and the relative motion between the channels 200 and the channels 202 during operation is exactly equal to the relative movement between the piston rod 254 and the relatively stationary portion of the piston and cylinder mechanism.

The operation of the embodiment of Figs. 8 through 10 may best be observed by referring to the schematic representation of Fig. 10. For purposes of clarity, we have illustrated four operative positions of the mechanism in order to provide a more complete understanding of the same.

8

Referring first to the first operative position illustrated in Fig. 10, it will be observed that the overall stacked height of the mechanism is substantially the same as that of the previous embodiment. If it is assumed that the piston rod is extended from the position shown in the first illustration to that shown in the second illustration, the motion imparted to the channels 202 will be exactly equal to the movement of the piston rod.

Since the lifting ratio of the cable 240 and the pulleys 228 is two to one, and since one end of each cable 240 is anchored, the channels 202 will move a distance exactly twice that of the distance traveled by the piston rod. If this latter distance is represented by the symbol "x," the distance traveled by the channels 202 will therefore be "2x." Since the lifting ratio of the cables 245 and the pulleys 236 with respect to the channels 202 is two to one, and since the channels 202 move at a predetermined ratio with respect to the channels 200, the distance traveled by the channels 204 as the piston rod moves a distance "x" will be equal to the quantity $(4x-1x)$ or "3x." Similarly, the lifting ratio of the pulleys 238 and the cables 248 with respect to the channels 204 is two to one. However, as in the previous case, the channels 204 move relative to each of the channels 200 and 202 at separate predetermined fixed ratios. Therefore, the motion which is imparted to the lifting fork by the innermost channels 206 and the associated cable will be equal to the quantity $2(4x-1x)-2x$ or "4x." Therefore, it is seen that the overall lifting ratio of the second embodiment of Figs. 8 through 10 is exactly equal to four to one.

As the piston rod 254 moves to a further extended position, the carriage assembly will continue to rise at a rate four times the rate of movement of the piston rod and each of the channels 200 through 206 will move simultaneously at their own fixed ratios until the ultimate position illustrated in the fourth operative position of Fig. 10 is obtained. The overall height of the lifting fork in this ultimate position will be approximately three times the original stacked height shown in the first illustration.

As previously indicated, the cables illustrated in the drawings may be readily replaced by chains if desired, the extent of the modification required to accomplish this being slight.

We are aware that various changes may be made in certain details of the construction specifically shown herein without departing from the principles of our invention and we therefore do not intend that the scope of our invention should be limited except as defined by the scope and spirit of the appended claims.

What we claim is:

1. A load hoisting mast comprising a stationary base mast section, a plurality of movable mast sections said mast sections being arranged in substantially vertical telescopic relationship, a hydraulic cylinder connected to said base section, a piston movably positioned in said cylinder, a piston rod secured to said piston, said piston rod being connected to the lowermost one of said plurality of movable mast sections, plural pulley means carried by each of said movable mast sections at the upper portion thereof, a separate flexible member trained over each pulley means, a first end of each flexible member trained over the pulley means carried by the lowermost one of said plurality of movable mast sections being anchored to a relatively stationary portion of said mast, a first end of each of the other flexible members trained over the pulley means carried by each of the other movable mast sections being connected to the upper portion of the next lower movable mast section, a lifting carriage movably carried by said mast, the second end of each flexible member trained over the pulley means carried by the uppermost one of said movable mast sections being connected to said lifting carriage to effect vertical movement of the same, the second end of each

flexible member trained over the pulley means carried by each of the other movable mast sections being connected to the lower portion of the next upper movable mast section, the movement of said carriage being continuously and directly related to the movement of said piston by a fixed motion transmitting ratio which is equal in magnitude to the number of said telescopically related mast sections.

2. A load hoisting mast comprising a base mast section, an upper mast section and one intermediate mast section, said mast sections being arranged in substantially vertical telescopic relationship, a hydraulic cylinder connected to said base section, a piston movably positioned in said cylinder, a piston rod secured to said piston, said piston rod being connected to said intermediate section, first pulley means carried by said intermediate section at the upper portion thereof, a first flexible member trained over said first pulley means with one end thereof anchored to a relatively stationary portion of said mast and with the other end thereof connected to a lower portion of said upper section, a second pulley means carried by said upper section at the upper portion thereof, a second flexible member trained over said second pulley means with one end thereof connected to said intermediate section, and a lifting carriage movably carried by said mast, the other end of said second flexible member being connected to said lifting carriage to effect vertical movement of the same, the movement of said carriage being continuously and directly related to the movement of said piston by a fixed motion transmitting ratio which is equal in magnitude to the number of said telescopically related mast sections.

3. A load hoisting mast comprising a base mast section, an upper mast section and two intermediate mast sections, said mast sections being arranged in substantially vertical telescopic relationship, a hydraulic cylinder connected to said base section, a piston movably positioned in said cylinder, a piston rod secured to said piston, said piston rod being connected to a first of said intermediate sections, first pulley means carried by said first intermediate section at the upper portion thereof, a first flexible member trained over said first pulley means with one end thereof anchored to a relatively stationary portion of said mast and with the other end thereof connected to a lower portion of a second of said intermediate sections, a second pulley means carried by said second intermediate section at the upper portion thereof, a second flexible member trained over said second pulley means with one end thereof connected to said first intermediate section and with the other end thereof connected to a lower portion of said upper section, a third pulley means carried by said upper section at the upper portion thereof, a third flexible member trained over said third pulley means with one end thereof connected to said second intermediate section, and a lifting carriage movably carried by said mast, the other end of said third flexible member being connected to said lifting carriage to effect vertical movement of the same, the movement of said carriage being continuously and directly related to the movement of said piston by a fixed motion transmitting ratio which is equal in magnitude to the number of said telescopically related mast sections.

4. A load hoisting mast comprising a base mast section, an upper mast section and an intermediate mast section, said mast sections being arranged in substantially vertical telescopic relationship, motor means for imparting relative motion between said base section and said intermediate section, said motor means having two relatively extensible parts, one of said parts being connected to said base section and the other part being connected to said intermediate section, first pulley means carried by said intermediate section at the upper portion thereof, a first flexible member trained over said first pulley means with one end thereof anchored to a relatively stationary portion of said mast and with the other end thereof connected to a lower portion of said upper section, a second pulley means carried by said upper section at the upper portion thereof, a second flexible member trained over said second pulley means with one end thereof connected to said intermediate section, and a lifting carriage movably carried by said mast, the other end of said second flexible member being connected to said lifting carriage to effect vertical movement of the same, the movement of said carriage being continuously and directly related to the relative movement of the parts of said motor means by a fixed motion transmitting ratio during the entire operating time interval.

5. The combination as set forth in claim 2 wherein each mast section comprises a pair of channels, supporting means for maintaining the paired channels of each section in spaced, parallel relationship, the corresponding channels of each mast section being disposed one within the other in nesting relationship.

6. The combination as set forth in claim 5 wherein the outermost channels define in part said base section, wherein the innermost channels define in part said upper section and wherein said one intermediate section is defined in part by the channels situated between the innermost and outermost channels.

7. The combination as set forth in claim 5 wherein said carriage includes rollers disposed within and movable along the innermost channels, said carriage thereby being guided during load hoisting operations.

8. The combination as set forth in claim 5 wherein said cylinder is connected to and supported by the supporting means for the channels of said base section.

9. The combination as set forth in claim 5 wherein the supporting means for said intermediate section and said upper section each comprises a bracket connecting the upper ends of the respective channels thereof, the pulley means for each of said last mentioned sections being connected to the respective bracket thereof.

References Cited in the file of this patent

UNITED STATES PATENTS

1,311,165	Hennessy	July 29, 1919
2,394,458	Lull	Feb. 5, 1946
2,571,858	Garland	Oct. 16, 1951
2,632,530	Wagner	Mar. 24, 1953
2,701,031	Brumbaugh	Feb. 1, 1955
2,787,343	Mitchell	Apr. 2, 1957

FOREIGN PATENTS

722,766	Great Britain	Jan. 26, 1955
---------	---------------	---------------