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[54] **PARALLEL BAR LINKAGE LOAD TRANSFER APPARATUS**

6 Claims, 5 Drawing Figs.

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B65g 1/06

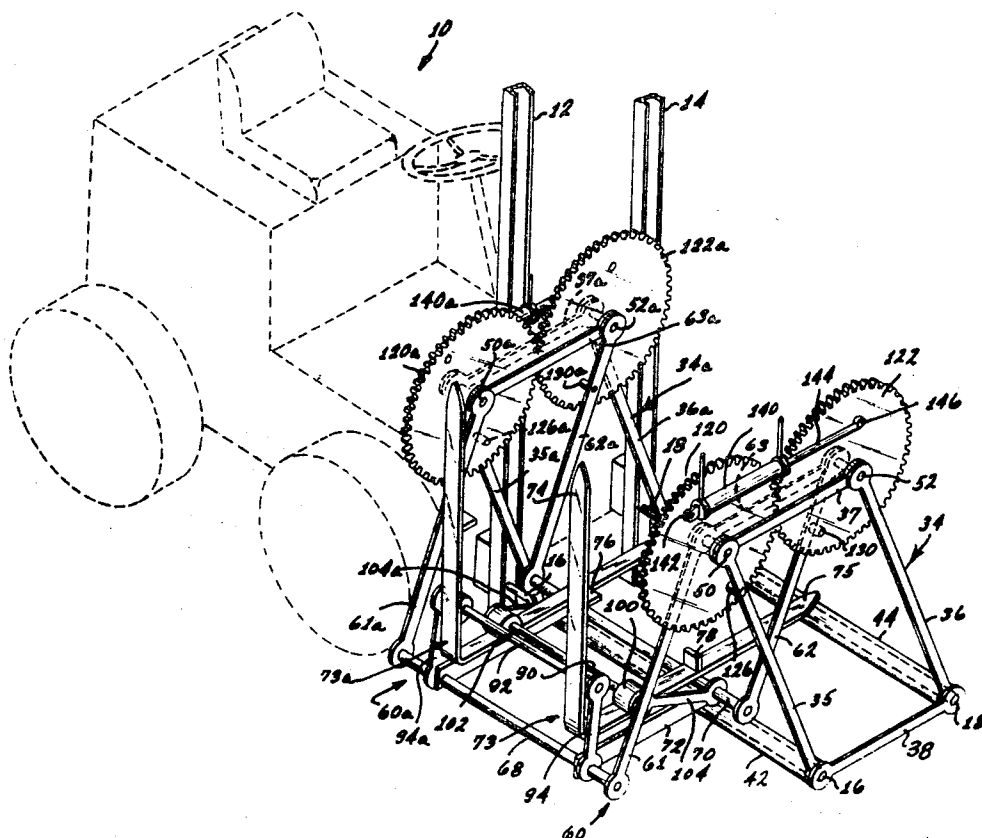
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731, 77, 16.4;

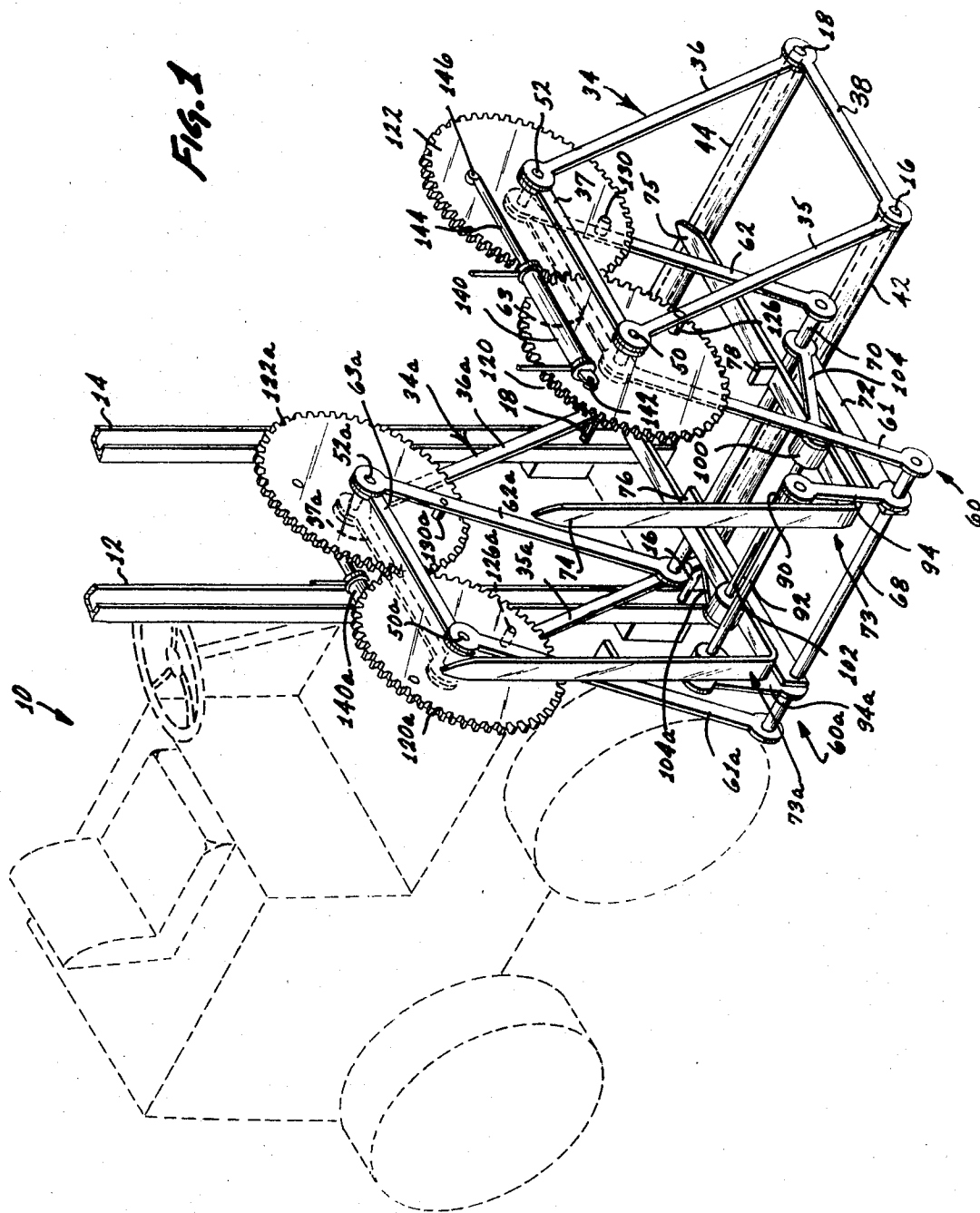
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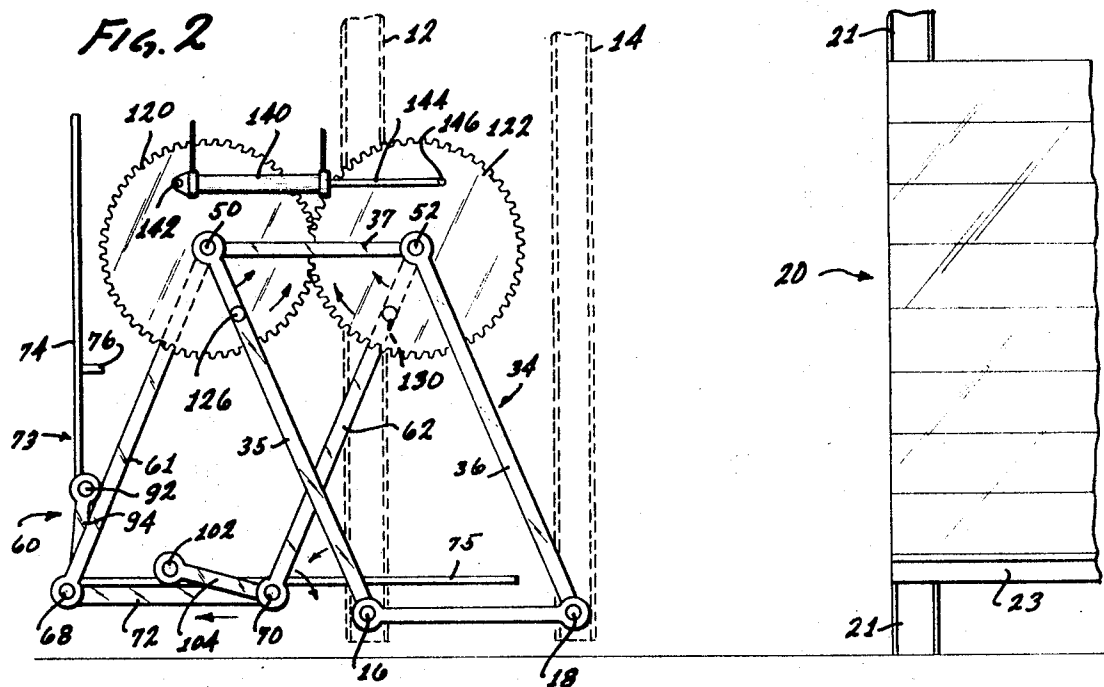
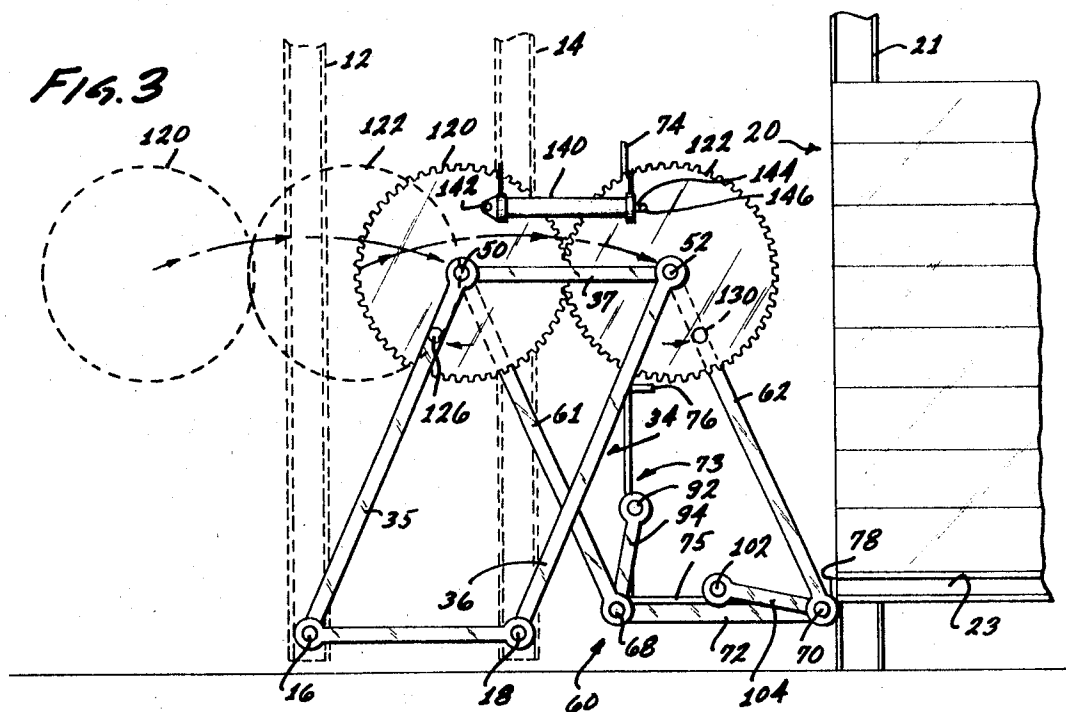
ABSTRACT: The invention is an apparatus or equipment adapted particularly for transferring palletized loads to and from warehouse storage racks. The equipment is provided with forks like a fork lift which are swingable between two positions to adapt the equipment for loading and unloading laterally to and from either side of the equipment to eliminate the need of turning the transporter equipment in an aisle. The load support means for the fork members is suspended like a pendulum by means of parallel bar linkage frames whereby the load can be translated horizontally at the same level. Inter-meshing gears with hydraulic drive means are provided for deforming or warping the suspension frames and to effect the lateral transfer of the load.





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Fig. 4

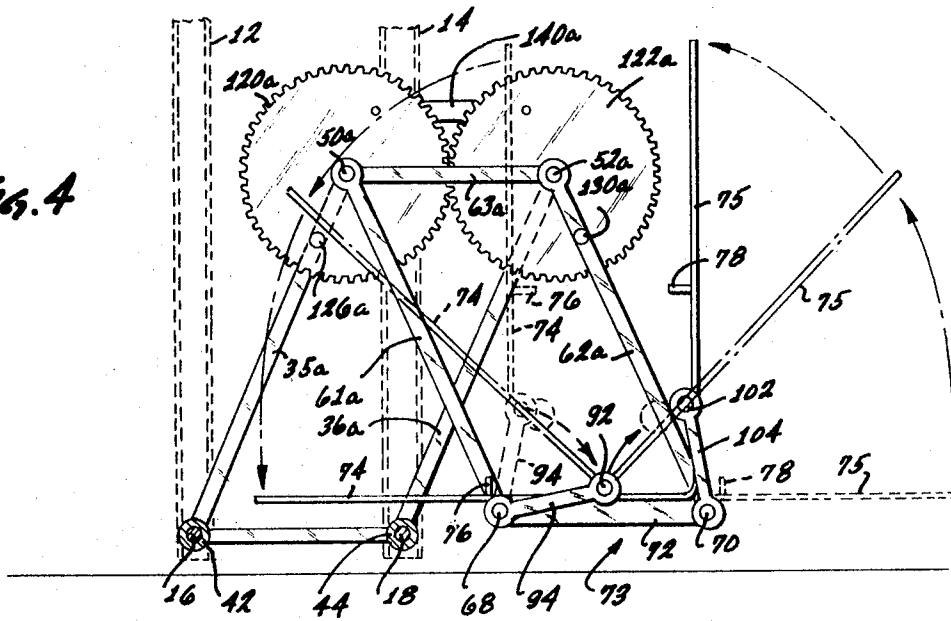
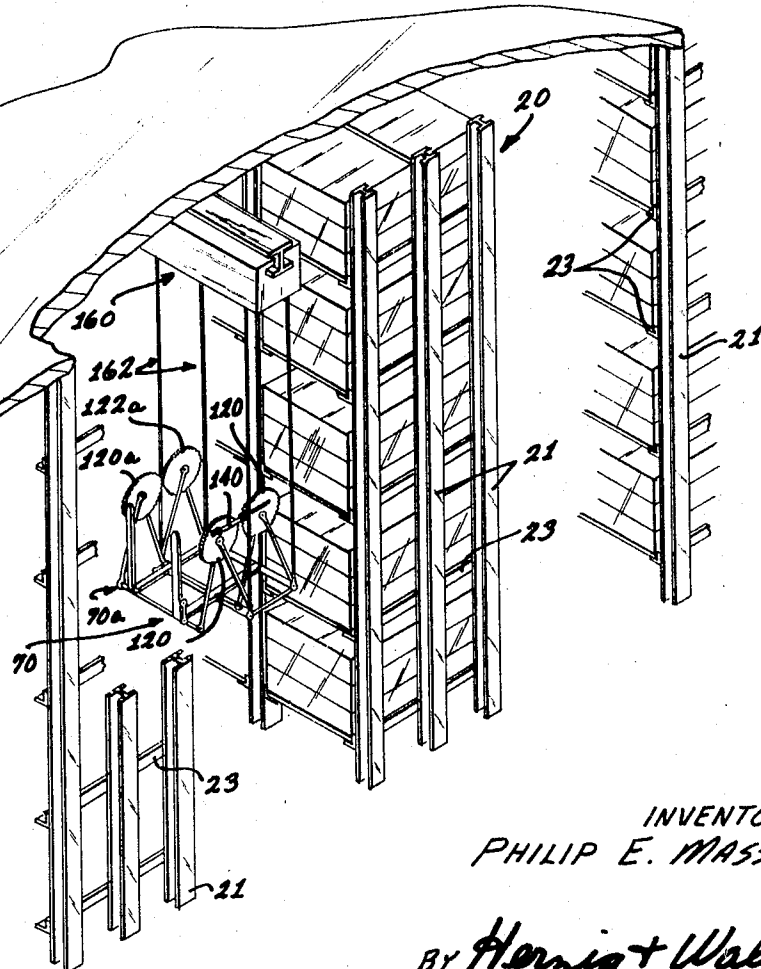


Fig. 5



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PARALLEL BAR LINKAGE LOAD TRANSFER APPARATUS

SUMMARY OF THE INVENTION

This invention relates to warehouse storing and warehouse storage systems, and more particularly to equipment of a fork lift type especially constructed for side loading or unloading. The improved side loading and unloading equipment, or transport equipment is particularly adapted to the concept embodied herein of a rack storage system utilized in warehousing for palletized loads in which each pallet is supported by the rack structure and not by the loads underneath the pallet. The fork lift type of equipment, that is, the transporter is especially constructed to provide for sidewise rack loading and unloading, the equipment having forks like a fork lift. The equipment is able to load left or load right or similarly unload left or right and without turning. The side loading equipment may be embodied on a lift truck or it may be embodied in overhead cable lift systems or floor based lift systems.

The particular equipment and system of the invention envisions a warehouse in which the aisle width is approximately equal to the storage rack depth. The aisle may be slightly wider depending on the allowable amount of load overhang on the lift forks as will be made clear hereinafter. The storage racks other than at the wall are double width to be loaded from two adjacent aisles. The warehouse is provided with a feeder aisle across the end of the building for bringing loads to a central point.

The preferred form of the storage rack is described in detail hereinafter. The transporter or fork lift type of equipment is of particular construction to adapt itself to forks associated with mechanism for raising and lowering the lifting forks. A unique feature of the equipment is that referred to in the foregoing that the forks are able to load and unload sideways either to right or left. In other words, the forks of the transporter are movable (swingable) either to right or left with respect to the transporter itself (which may be a fork lift truck) to be inserted under a load. That is, a load can be delivered sideways from the transporter onto a storage rack or retrieved in this manner from a storage rack back onto the transporter. The forks are movable vertically as necessary for moving the load to the correct elevation for storage or removal from storage.

The invention provides unique mechanism to make possible the lateral, that is, the sidewise movement of the forks for side loading and unloading from either side. A preferred form of the invention is disclosed and described in detail herein as applied to or associated with a generally conventional fork lift truck or transporter.

The mechanism for loading and unloading to or from the side is supported on a platform or support means of the fork lift that is movable vertically by the fork lift. In a preferred form of the invention the side loading means is provided by way of parallel bar linkages that form articulated frames that are so organized as to make possible the sidewise movement to either side of the forks. The parallel bar linkages form articulated rectangular frames. In the preferred form of the invention there are provided a pair of horizontal bar members which are the means or members that are moved vertically by the fork lift. Supported from the ends of these members are two of the parallel bar linkages or articulated frames. Two similar parallel bar linkages forming additional rectangular articulated frames are provided, and these additional parallel bar linkages or frames are supported from the upper ends of the first two parallel bar linkages or articulated frames. The lower ends or parts of the second two parallel bar linkages or articulated frames support or carry the fork lift members which themselves are right angle members connected to their supporting means by linkages so that the fork lift members themselves can be rotated or swung through 90° into right- and left-hand symmetrical positions for right- and left-hand loading and unloading, as will be made clear in detail hereinafter.

From the foregoing it may be observed that the two sets of parallel bar linkages, that is the rectangular articulated frames, may be swung to one side or the other with the two sets of frames deforming (or warping) similarly and symmetrically with the load supported by the second two sets of frames moving transversely at a uniform level. There are of course two pivots at the upper ends of the first two sets of frames and the second two sets of frames, one frame of each set being pivoted to one frame of the other set, and carried on these same pivot axes are intermeshing gears, there being a pair of intermeshing gears at each end of the assembly. Means are provided which may be hydraulic cylinders for example, to simultaneously rotate each of the gears of the two pairs in opposite directions. Having reference to one of the pairs of gears, one gear is attached to one of the bars of one of the parallel bar linkages and the other gear is attached by a stem to one of the bars of the other parallel bar linkage. The effect of this is that when the gears of a pair are rotated as described, in opposite directions, one parallel bar linkage swings (while deforming) to one side about its mounting support at the lower end of the linkage frame, and the other parallel bar linkage swings in the same direction but about its pivots or pivotal supports at the upper end. This type of motion takes place symmetrically at both ends of the assembly so that the members supporting the forks swing laterally with respect to the transporter at a uniform level. The exact manner in which the transporter is utilized for loading and unloading will be made clear hereinafter.

From the foregoing those skilled in the art will readily be able to appreciate the objects of the invention. A primary object is that the necessity of turning the transporter for loading or unloading is eliminated. With a conventional means, of course, the entire transporter has to be turned in order to load from a position in an aisle into a rack adjacent the aisle.

A further object is to greatly economize in warehouse space in that it makes it unnecessary to have aisles wide enough for the fork lift or other transporter to turn in the aisle.

Another object is to provide a simplified equipment as described which is capable of moving or transferring loads transversely or horizontally as well as vertically.

A further object is to provide simplified but very effective and positive acting means whereby loads may be moved or transferred horizontally while kept at the same elevation.

A further object is to provide a load moving means as referred to in the foregoing comprising of parallel bar linkages including a pair of parallel bar linkages suspended in the manner of a pendulum whereby to be operable to swing laterally while carrying the supporting means at substantially the same level.

Another object is to provide equipment of the type referred to in the foregoing for moving or transferring loads horizontally as well as vertically, the equipment being provided with forks so constructed that they can be swung between symmetrical positions adapting them for side loading and unloading either to right or left.

Another object is to provide drive means for equipment of the type referred to embodying sets of parallel bar linkages which constitute deformable frames mounted to swing laterally and provided with intermeshing gears attached to the respective frames so that by driving the gears in opposite directions, the frames swing to one side or the other with a load supported in the manner of a pendulum.

Further objects and additional advantages of the invention will become apparent from the following description and annexed drawings, wherein:

FIG. 1 is a perspective view of a preferred form of the invention adapted in a fork lift truck;

FIG. 2 is an end view of the side loading mechanism of FIG. 1;

FIG. 3 is a view similar to that of FIG. 2 showing the mechanism moving to the opposite side;

FIG. 4 is a view similar to that of FIGS. 2 and 3 illustrating the movement of the fork members between their positions for loading or unloading to opposite sides;

FIG. 5 is a perspective schematic view of a modified form of the invention adapted in overhead cable lift systems.

Referring to FIG. 1 of the drawings there is shown in broken lines a conventional fork lift truck 10 having vertical rails or tracks 12 and 14 with respect to which the mechanism to be described can be raised and lowered by conventional or typical means forming part of the fork lift truck or transporter itself.

The load support means or platform that is raised and lowered by the fork lift comprises a pair of bar members 16 and 18, the inner ends of which are capable of being raised and lowered by the fork lift truck or transporter. The side loading mechanism is supported from the bars or support members 16 and 18.

The side loading mechanism will be best understood from FIGS. 1, 2, 3 and 4. FIGS. 1 and 2 show the side loading mechanism moved or articulated to the left while FIGS. 3 and 4 show it moved or articulated to the right. FIGS. 2 and 3 show a rack structure which is also shown more in detail in FIG. 5. The racks are of course in a warehouse as illustrated in FIG. 5. Each load in the rack is palletized, that is supported on a pallet, each pallet being supported by the rack structure rather than by the loads underneath the pallet. In the warehouse the aisle width is approximately equal to the storage rack depth. The aisle may be slightly wider depending on the allowable amount of load overhang on the lift forks as will be made clear. The storage racks other than at the wall are double width to be loaded from the two adjacent aisles as illustrated in FIG. 5. Then there is a feeder aisle across the end of the building by which loads may be brought to a central point. The equipment as shown in FIGS. 1 to 4 may of course be used in the type of warehouse shown in FIG. 5. Pallet supports are spaced on vertical columns unit distances apart. Loads may have a height greater than one unit since the front of the storage rack is clear from floor to ceiling as may be seen in FIG. 5. Preferably the racks are supported by vertical H columns as designated at 21 with angles 23 attached to act as pallet supports. The angles run full length from aisle to aisle. The pallets rest on the angle brackets as may be seen in FIG. 5. The supports of the storage rack can be fabricated like ladders on the ground and erected for assembly. The combined columns in all of the storage racks support the walls and ceiling of the building and the overhead trollies or tracks as illustrated in FIG. 5.

Referring again to FIGS. 1 to 4 numeral 34 designates the first parallel bar linkage forming an articulated rectangle, or frame this parallel bar linkage comprising side members 35 and 36 and top and bottom members 37 and 38. The bottom member 38 is pivotally attached to the ends of torsion tubes 42 and 44 through which extend axially the columns or support members 16 and 18. The side members 35 and 36 are preferably rigidly attached to the torsion tubes 42 and 44 so as to rotate the torsion tubes as will be described hereinafter. The upper ends of the side members 35 and 36 are pivotally attached to the shafts 50 and 52. These shafts are parallel to the support members 16 and 18. Pivotally attached to these pivot shafts are the ends of the upper horizontal member 37.

Numeral 34a designates another parallel bar linkage which is like the parallel bar linkage 34 but which is at the other ends of the support members 16 and 18 adjacent to the guide tracks 12 and 14. Since this parallel bar linkage is similar and moves similarly its parts will not be again described in detail. However, the lower ends of links (or bars) 35a and 36a are also secured to the torsion tubes 42 and 44.

Numeral 60 designates a second parallel bar linkage or frame adjacent to the parallel bar linkage 34. Numeral 60a designates another parallel bar linkage which is similar to the parallel bar linkage 60 but which is at the other end of the support members 16 and 18 and is adjacent to the parallel bar linkage 34a.

The parallel bar linkage 60 has side members 61 and 62 and a transverse upper member 63. The lower end of the side member 61 is rigidly attached to shaft 68 and lower end of side member 62 is rigidly attached to a shaft 70 forming torsion bar

couplings between frames 60 and 60a. The shafts 68 and 70 are joined by a link member 72 pivotally connected thereto, this link member being parallel to the top link member 63. Thus it will be seen that these link members form a parallel bar linkage that is, an articulated rectangular frame that is similar to the parallel bar linkage or rectangular frame 34. The upper ends of the side members 61 and 62 are pivotally mounted on their pivot shafts 50 and 52 and the upper transverse member 63 is similarly and pivotally attached to or mounted on the pivot shafts 50 and 52.

The parallel bar linkage or frame 60a is like the frame 60 and it will be observed however that the side member 61a of the frame 60a is also rigidly attached to the shaft 68. The side member 62a of frame 60a is rigidly attached to or mounted on the shaft 70.

Referring again to the frame 34a its side members 35a and 36a are pivotally attached to or mounted on pivot shafts 50a and 52a. The upper frame member 37a of frame 34a has its ends pivotally attached to the pivot shafts 50a and 52a.

The side members 61a and 62a of the frame 60a are pivotally attached to the pivot shafts 50a and 52a. The upper horizontal member of frame 60a that is, 63a has its ends pivotally attached to the pivot shafts 50a and 52a.

From the foregoing those skilled in the art will be able to observe that the two shafts 68 and 70 form a load supporting means or platform for a load that can be moved or transferred laterally by the equipment described as illustrated in FIGS. 2, 3 and 4.

A pair of fork members are carried by this platform, these forks being so configured and so linked that they can be moved between two symmetrical positions adapting them for either right or left side loading or unloading. The two fork members are designated at 73 and 73a. As will be observed the fork member 73 is of right angular configuration having a first fork 74 and the second fork 75.

The arm 74 has on it a lug 76 and the arm 75 has on it a lug 78.

The fork member 73a is like the member 73 and, therefore, will not be described in detail except that its relative position, orientation and operation will be made clear.

The fork member 73 is linked to the support means or platform formed by shafts 68 and 70 by two different links making it possible for the fork member 73 to assume either of two symmetrical positions 90° from each other adapting the equipment for loading or unloading to either right or left. The arm 74 of the fork member 73 carries a lug 90 which is journaled on a transverse shaft 92. Connected between the shaft 92 and the shaft 68 is a swinging link 94 rigidly connected to shaft 92. The arm 75 of the fork member 73 has a similar lug member 100 which is journaled on a shaft 102. Numeral 104 designates another swinging link, one end of which is rigidly connected to the shaft 102 and the other end of which is journaled on the end of shaft 70. Shafts 92 and 102 are both torsion bars. Links 94 and 104 are journaled on shafts 68 and 70.

At the other end of the assembly associated with the other fork member 73a are similar swinging links 94a and 104a which are similarly connected or oriented between the fork member 73a and the shafts 68 and 70.

FIG. 1 shows the assembly swung to the left about pivot shafts 50 and 52 as does FIG. 2 with the fork members 73 and 73a oriented for being swung to the right for loading and unloading with respect to a rack 20 as shown in FIG. 3. On the other hand, FIG. 4 shows the fork members 73 and 73a oriented to their opposite position for loading or unloading to or from the left. The orientation of the assembly of the fork members 73 and 73a between their two positions may be observed from FIGS. 1 and 4. It will be observed that the lower horizontal members 72 and 72a remain horizontal at substantially the same level. It will be observed that when the assembly comprising the fork members 73 and 73a is oriented to its opposite 90° position as shown in FIG. 4 the link members 104 and 104a come up into a generally upright position with the fork arms 75 and 75a in an upright position. On the other

hand the link members 94 and 94a move toward a generally horizontal position as may be seen in FIG. 4 with the arms 74 and 74a coming into a horizontal position as may be seen in FIG. 4. As will be observed all of the parts of the assembly are symmetrical and occupy symmetrical positions or orientations when the fork assembly is in a position at one side or the other. The fork members 73 and 73a in addition to moving through 90° of arc, move laterally to accommodate themselves to the two desired symmetrical positions, that is they translate laterally. Links 104 and 104a are constrained to move together by torsion bar 102, as are links 94 and 94a by bar 92.

It will be observed, of course, that power means are necessary, for the lateral swinging of the support means for the fork assembly which swings in the manner of a pendulum from the pivot shafts 50, 52, 50a and 52a, the supporting means or platform for the fork assemblies being suspended by the parallel bar linkages 60 and 60a which linkages or frames are in turn suspended from the parallel bar linkages 34 and 34a which themselves can swing similarly while deforming.

Journalled on the pivot shafts 50 and 52a are a pair of gears 120 and 122 which mesh with each other. Carried on the pivot shafts 50a and 52a are a similar pair of gears 120a and 122a. The gear 120 is attached to or pinned to the upright link member 35 by a stem 126. The corresponding link member 35a of the frame 34a is pinned to the gear 120a by means of a stem 126a.

Referring to the parallel bar linkage 60 its side member or link 62 is secured to or attached to the gear 122 by a stem or member 130 and the corresponding member 62a of the frame 60a is attached to the gear 122a by a stem or member 130a.

Power means are provided for rotating the gears 120 and 122 and the gears 120a and 122a. Different forms of power means may be utilized. In the form of the invention shown the power means is in the form of a hydraulic cylinder 140 the end of which is pivotally attached to the gear 120 at 142 and the stem 144 of which is pivotally attached to the gear 122 at 146. A corresponding cylinder 140a is provided having similar attachment to the gears 120a and 122a, and hydraulic power can be supplied to the cylinders which are preferably double ended, by conventional hydraulic supply means with appropriate controls of supply and release of the pressure. Power might be applied at the lower ends of links 35 and 36 through columns 16 and 18.

From the foregoing those skilled in the art will understand the nature and operation of the invention. The truck or transporter 10 can be run down aisles between racks of the type shown in FIG. 5 and then loading and unloading can take place without turning the truck or transporter 10. FIGS. 1 and 2 show the fork lift assembly in its position oriented for loading from rack 20 as shown in FIGS. 2 and 3. The fork lift assembly can be oriented manually from one of its symmetrical positions to the other. FIGS. 1 and 2 show the fork lift assembly retracted to the left. This is, of course, accomplished by applying power to the hydraulic cylinders 140 and 140a so as to rotate the gears in directions as shown by the arrows in FIG. 2. It will be observed that when the gear 122 rotates in a clockwise direction as shown in FIG. 2 and the gear 120 rotates in an anticlockwise direction as shown in FIG. 2 the parallel bar linkages 34 and 60 will take positions as shown in FIG. 2. That is, the gear 120 will drive the stem 126 in an anticlockwise direction with respect to axis of shaft 42. The frame 34 will be deformed to the left as shown. Similarly the gear 122 will drive the stem 130 in a clockwise direction causing the link member 62 of frame 60 to move in a clockwise direction relative to shaft 70 with the frame 60 deforming correspondingly. The action is the same relative to the parallel bar linkages or frames at opposite ends of the assembly under the influence of the two pairs of gears 120 and 122 and 120a and 122a. It will be observed that the platform formed by members 72 and 72a and shafts 68 and 70 that support the fork members or fork assembly swings in the manner of a pendulum, being supported from the pivot shafts 50 and 52 and shafts 50a and 52a with the platform remaining at the same

level, the shafts 50, 52, 50a and 52a themselves moving horizontally (arcuately), the gears, of course, moving similarly.

When power is supplied to the hydraulic cylinders 140 and 140a for movement in the opposite direction, the parts now move into a position as illustrated in FIG. 3, the gears, of course, each rotating in an opposite direction and imparting opposite directional movement to the links to which they are pinned. As may be seen in FIG. 3 the fork members 73 and 73a are now in a position to be received in a pallet under one of the loads supported in the rack 20. The load is unloaded, that is, retracted, horizontally, (i.e.) sideways with respect to the transporter by again applying power to the gears to rotate them in the opposite direction to bring the load back into a position aligned with the upright guide tracks 12 and 14. In this position the load can, of course, be raised vertically in the usual manner as done with a fork lift.

FIG. 4 illustrates the reorientation of the fork members 73 and 73a for side loading or unloading to or from the left. It will be observed that the arm 75 of the fork member 70 is in a vertical position and the arm 74 is in a horizontal position. The link 104 is in a generally upright position whereas the link 94 now is in a generally horizontal position both of these links have been rotated in a clockwise direction from their broken line positions. Thus, it will be seen that the fork assembly has two similar symmetrical positions one for loading to one side and one for loading to the other side, for unloading, the two positions being symmetrical.

From the foregoing those skilled in the art will readily understand the nature of the construction and the operation of the invention as so far described, and the manner in which it achieves and realize the objects and advantages as set forth in the foregoing. When loading or unloading to the side there is, of course, an overturning moment applied to the transporter, for example, the fork lift truck as shown in FIG. 1. However, ordinarily the mass of the truck itself is sufficient to counterbalance the effect of the load which is off the centerline of the truck. However, various means can be resorted to, to assure against any overturning of the truck or transporter. A hinged drop leg may be used extended to one side to engage with the floor. This leg might be in the form of an I-beam that is extended out to one side and moved down through an angle to engage the floor to thereby operate in the manner of an outrigger. Such outrigger member preferably would be low enough to slide under a load on a standard pallet and might extend into a slot formed in the rack structure to receive such member. The fork system as described is, of course, adaptable to be used with fork lift trucks to load and unload forwardly, that is, the mechanism as described would extend forwardly to engage underneath a load either to retract from a rack or insert it into a rack. Various other modifications are possible. For example, it may be desired to have the mechanism tend to lower the load or raise it during the horizontal transfer to accommodate various conditions relative to the rack structure on which the pallets are stacked. This effect is easily realized by having the pairs of gears of different sizes. The effect of this variation is that the supporting platform for the load does not move horizontally at the same level but will move vertically an amount dependent upon the difference in diameters of the two gears.

FIG. 5 shows a modification or adaptation of the invention adapted to an overhead cable lift system. In the aisle at the top between racks there is an overhead guide track or rail in which a trolley carriage 160 moves and suspended from the carriage by cables as shown at 162 is a side loading assembly like that of the previous embodiment. This assembly as shown comprises the four parallel bar linkage frames, the two sets of intermeshing gears and the fork members 73 and 73a. This assembly provides a platform as in the previous embodiment for the load providing for loading and unloading to either right or left. The fork members 73 and 73a are reversible between their opposite symmetrical positions as in the previous embodiment. Thus the side loading assembly which is suspended

from the trolley can be raised and lowered to any desired height by the cable system which may be powered electrically for example,, and the trolley can be run along the guide track 160 to any desired position for loading and unloading into and out of the rack structure.

The foregoing disclosure is representative of preferred embodiments of the invention and is to be interpreted in an illustrative rather than a limiting sense. Improvements reside in the particular mechanisms for transferring a load laterally while keeping it at the same level or in a modified form for changing the level as it moves. Improvements reside also in the particularly power drive means for bringing about the lateral transfer of the load. Novelty also resides in the adaptation of the mechanisms just referred to, to utilization in transporters such as fork lift trucks, overhead cable lift systems and comparable types of material handling and moving systems.

What I claim is:

1. A load transfer device comprising a vehicle support means mounted on said vehicle, a pair of first sets of parallel bar linkages forming spaced frames each frame having a pair of moving centers and being pivotally supported at spaced points on said support means, a second pair of sets of parallel bar linkages forming second spaced frames means for pivotally attaching said second pair of frames to the first sets of frames at said centers spaced from the supporting means, a load support carried by the second sets of frames in a position between the first and second pair of frames, gear means having centers coinciding with said aforesaid centers and inter-

meshing with each other, and means for applying torque to intermeshing gear members whereby to cause the first and second pair of frames to pivot in a manner whereby to transfer said load support laterally relative to said support.

2. A device as in claim 1 wherein said second set of frames has corners pivot shafts pivotally attaching said corners to corners of frames of said first set, said torque applying means comprising intermeshing gears centered at the axes of said shafts and each gear having attachment to a link of a frame for applying torque to it.

3. A device as in claim 1, comprising fork lift means having spaced forks supported by the load support.

4. A device as in claim 3, wherein the fork lift members comprise right angular members each having two forks which are normal to each other and means for supporting the fork members whereby they can be rotated through 90° so that a pair of forks can extend in either opposite directions from the support means.

5. A device as in claim 4, including means for laterally translating the fork lift members.

6. A device as in claim 5, including four-bar linkage means having moving centers connected between the fork lift members and the support means for simultaneously bringing about rotation of the fork lift members through the 90° while at the same time translating the said members laterally by movement of said moving centers.

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