Dec. 26, 1967 F. P. HOPFELD 3,360,078

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Fig. 1

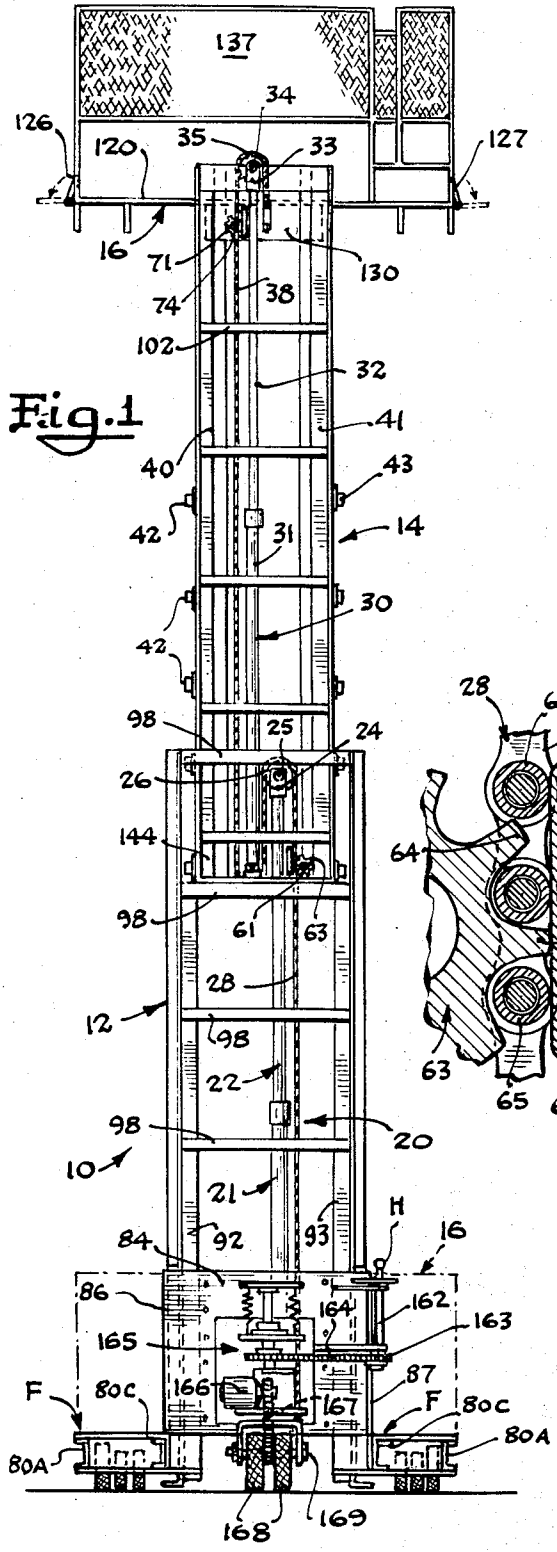


Fig. 2

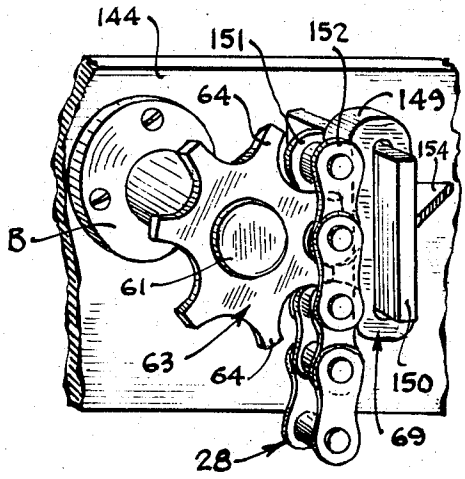


Fig. 4

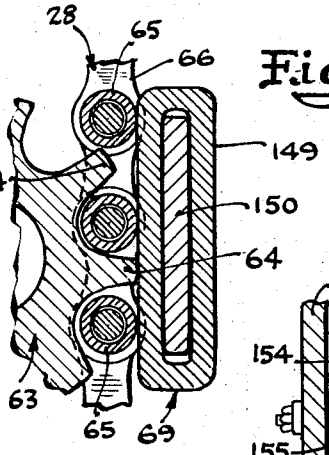
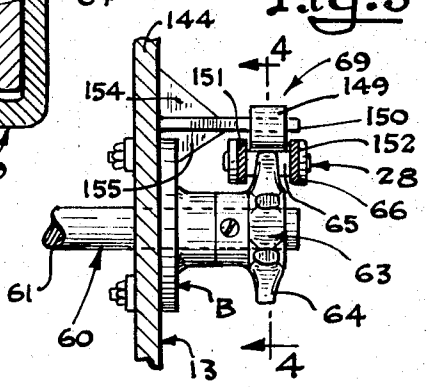


Fig. 3



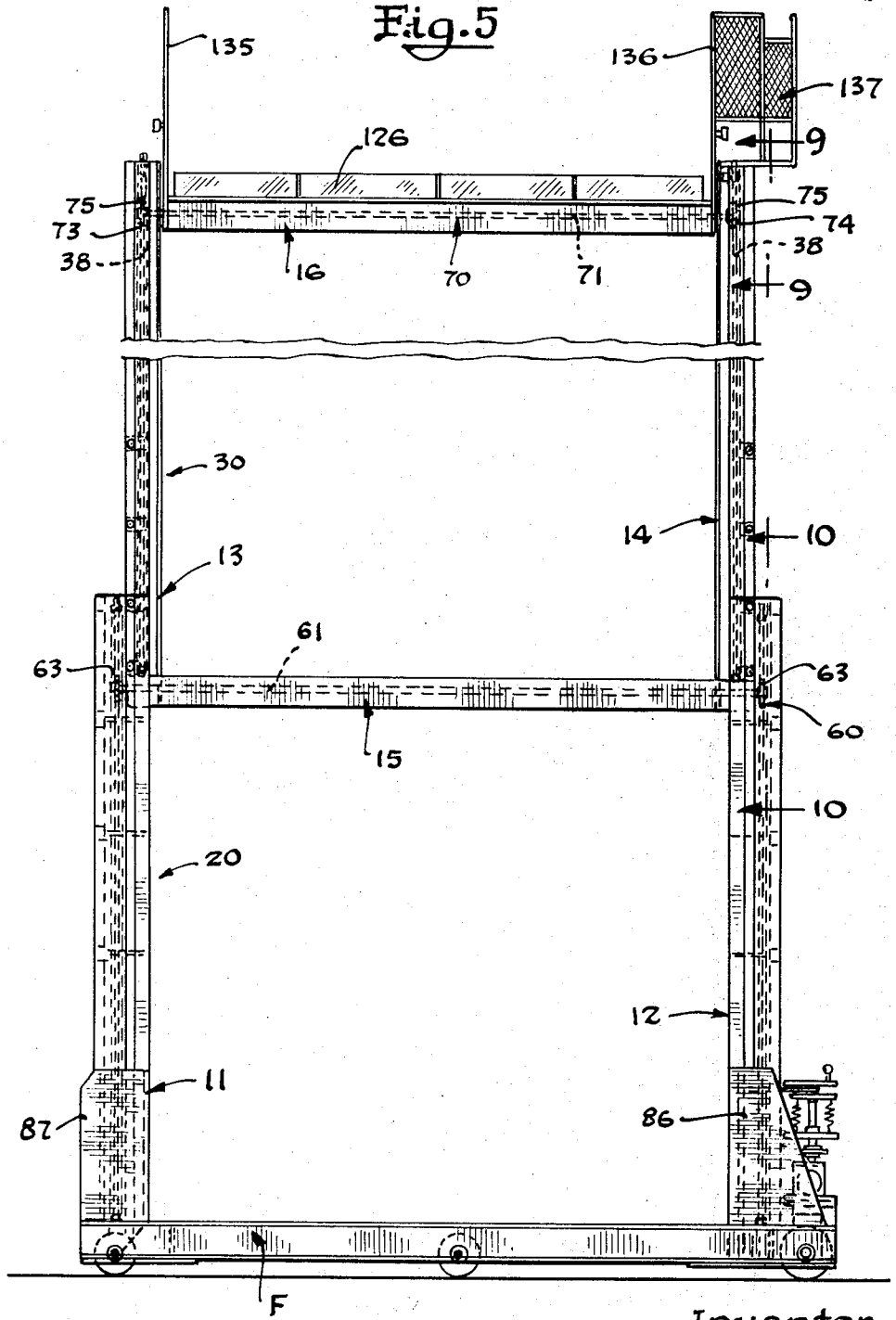
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Fig.5



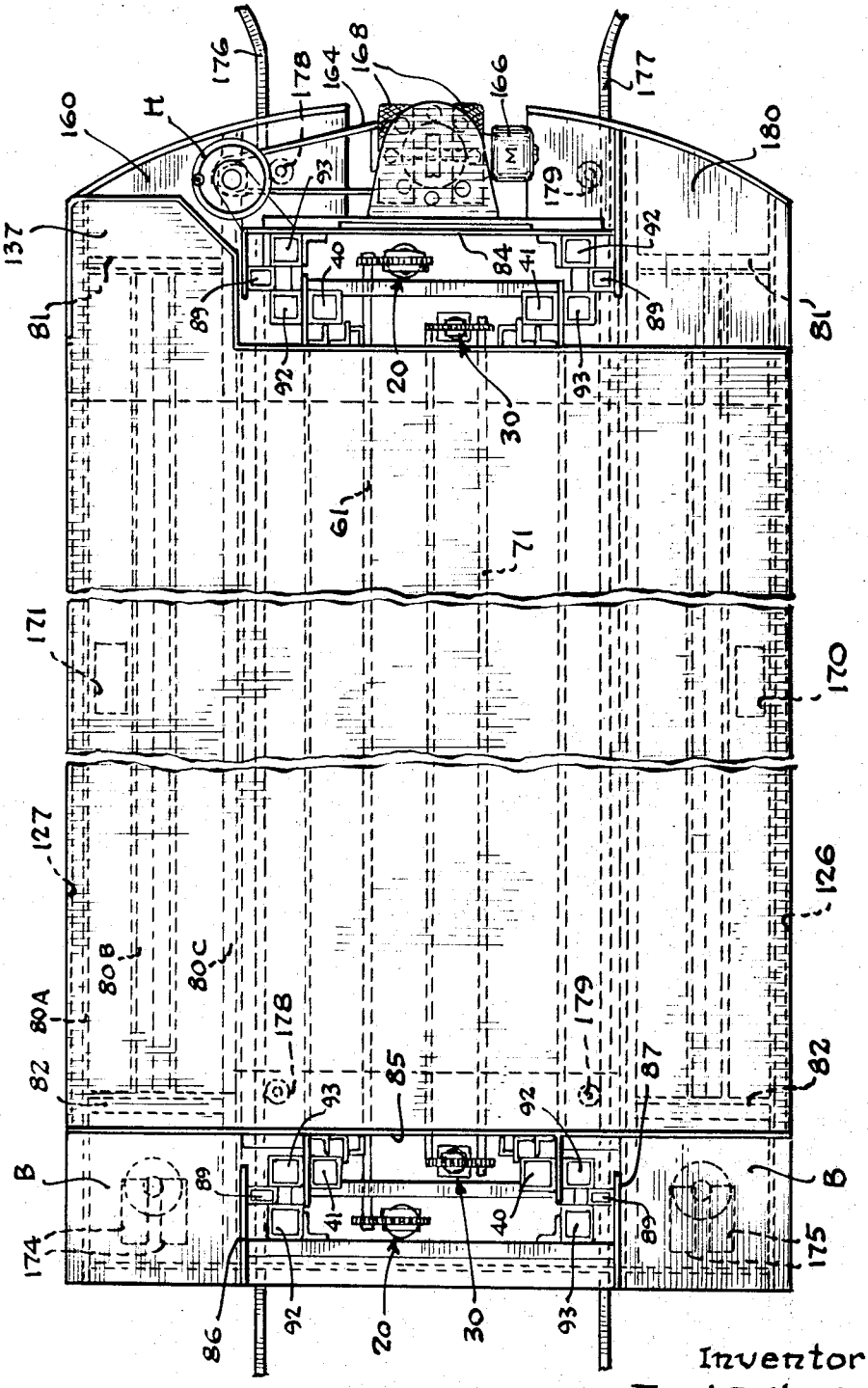
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Fig. 6



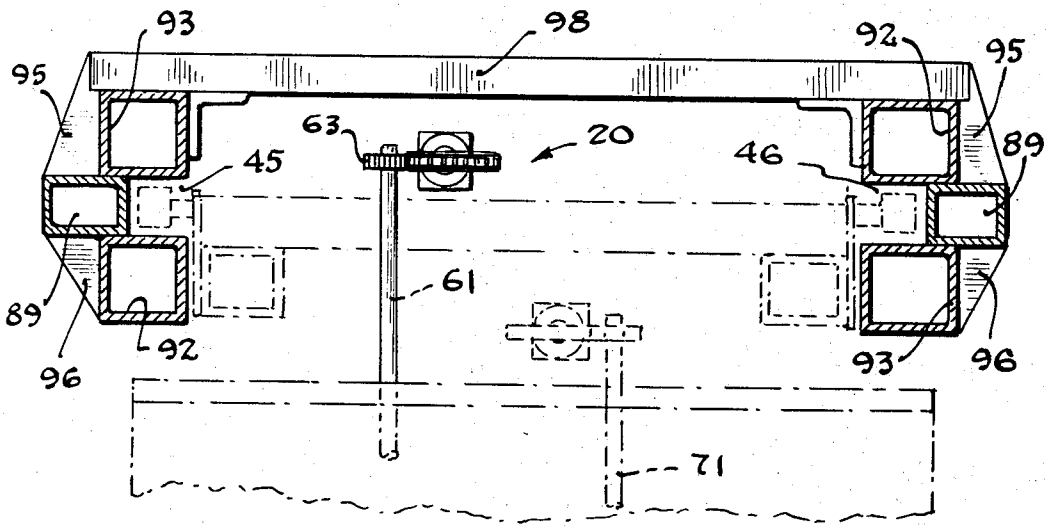
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Fig. 7



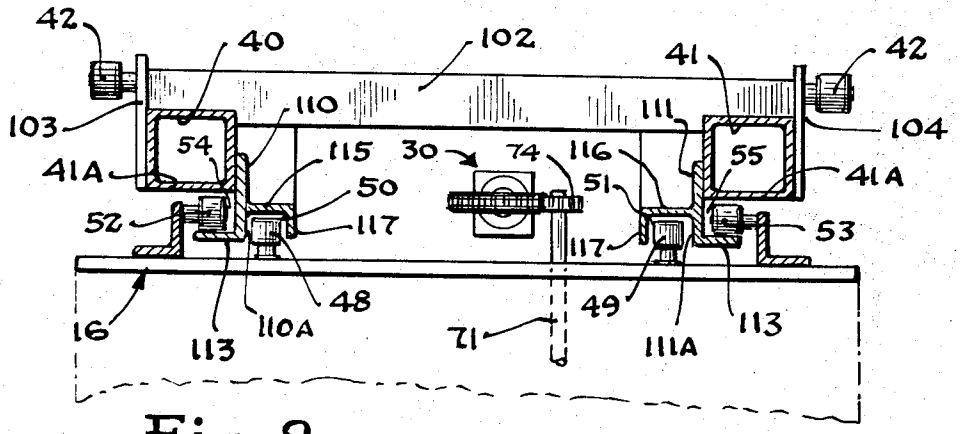


Fig. 8

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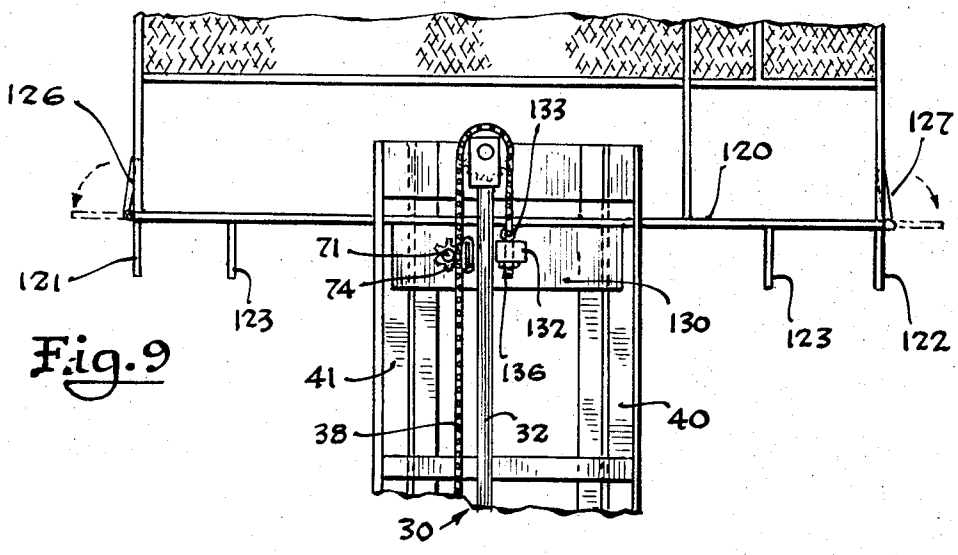


Fig.9

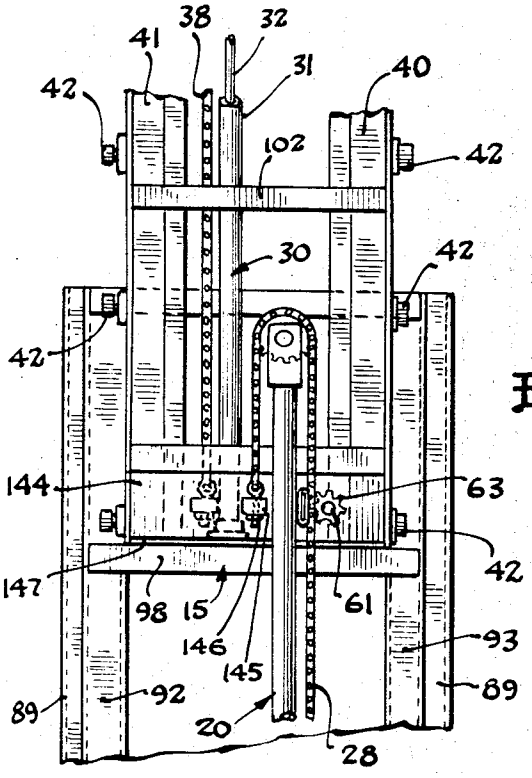


Fig.10

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Filed Apr. 5, 1966, Ser. No. 540,409
7 Claims. (Cl. 187—9)

ABSTRACT OF THE DISCLOSURE

A platform in a lift is raised by chains operated by a piston. The platform, or other vertically movable part, is equipped with a shaft having sprockets at the ends thereof. These sprockets are engaged with the chains, so that chains in effect lay a track for the sprockets during vertical movement, assuring equalized or level movement of the platform.

This invention relates to lifts, platforms or supports movable by a plurality of fluid actuated cylinder and piston devices.

The present invention is particularly directed to lifts having a vertically movable platform or support for equipment of various kinds. The platform of such a lift may be relatively large and movable by a pair of opposed fluid actuated cylinders which are connected to a common source of fluid under pressure.

Such platforms are typically guided during movement by rollers or slides; but even with guiding by such rollers, slides or the like, a problem sometimes exists in preventing tilting of the platform because of the uneven distribution of weight on the platform or because of uneven lifting forces being generated by one lifting cylinder relative to another lifting cylinder.

With the weight on the platform disposed in a noncentered position, the lifting force from the cylinder or cylinders closest to the weight should be greater than that supplied by the opposite cylinder in order to maintain the platform on a level keel. This division of lifting forces is particularly difficult when the cylinders are connected to a common source of fluid under pressure. Moreover, after considerable use of the cylinders, it sometimes occurs that the cylinders do not develop an equal amount of force. For example, one cylinder might have a slight leak, or a slight binding of piston movement may be encountered. Accordingly, an object of the present invention is to assure level movement of a platform or the like by opposed fluid operable piston and cylinder devices by a simple and inexpensive apparatus.

A more specific object of the invention is to equalize the rate of movement of opposite sides of a platform movable by fluid operated pistons by means of a common shaft spanning the platform and having sprockets thereon engageable with rack-like means on the lift.

In the preferred embodiment of the invention, the fluid operated pistons each have a sprocket fixed at the upper end thereof about which sprocket is entrained a chain which has one end affixed to the platform and which has the opposite end affixed to a stationary member. Thus, vertical movement of the pistons raises or lowers the sprockets with the chains moving about the sprockets and causing vertical movement of the platform affixed to the chains. A further object of the invention is to assure level movement of a platform by having a shaft journaled on the platform and having sprockets running in tracked engagement with chains movable by fluid operated devices to reciprocate the platform.

Another object of the invention is to stabilize a platform during its vertical movement by means of a sprocket having teeth engaged in the links of a chain with a replaceable guide serving as a backup for the chain as it is engaged by the teeth of the sprocket.

A general object of the invention is an improved self-propelled lift having at least one frame movable relative to a stationary framework with a relatively large platform movable relative to the movable frame, the movement of the platform being equalized by a common shaft and sprocket apparatus.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, shows a preferred embodiment of the present invention and the principles thereof and what is now considered to be the best mode contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention.

In the drawings:

FIG. 1 is an elevational view of a lift constructed in accordance with the preferred embodiment of the invention with the platform raised to its maximum elevation;

FIG. 2 is an enlarged perspective view of an equalizing mechanism including a sprocket enmeshed with a chain;

FIG. 3 is a top view of FIG. 2 showing the equalizing mechanism;

FIG. 4 is an enlarged sectional view taken along the lines 4—4 of FIG. 3 in the direction of the arrows showing sprocket teeth enmeshed with the chain and moving against a backup or guide member.

FIG. 5 is a side elevational view of the lift of FIG. 1;

FIG. 6 is a plan view of the lift of FIG. 1;

FIG. 7 is a plan view of a stationary mast constructed in accordance with the preferred embodiment of the invention;

FIG. 8 is a plan view of a movable mast constructed in accordance with the preferred embodiment of the invention;

FIG. 9 is a perspective view of one end of the pallet constructed in accordance with the preferred embodiment of the invention; and

FIG. 10 is an elevational view of a movable mast constructed in accordance with the preferred embodiment of the invention.

General description

Referring now to the drawings and more particularly to FIGS. 1 and 5, there is illustrated a lift **10** constructed in accordance with the preferred embodiment of the invention with a vertically movable platform or pallet **16**. The lift **10** has a lower and stationary main frame portion F from which are upstanding a pair of fixed opposed masts **11** and **12** with a pair of inner and smaller masts **13** and **14** movable relative thereto. Spanning the smaller masts **13** and **14** is a longitudinal frame member **15** and spanning the upper portion of the smaller masts **13** and **14** is the upper platform or pallet **16**. The pallet **16** is vertically movable relative to the smaller masts **13** and **14** from a position adjacent the frame member **15** to the position near the tops of the movable masts **13** and **14**, as seen in FIG. 5.

The preferred manner of moving the smaller masts **13** and **14** relative to the stationary masts **11** and **12**, is by means of a pair of fluid operated cylinder and piston means **20**, FIG. 6, located within the stationary masts **11** and **12**. As best seen in FIG. 1, the piston cylinder means **20** includes a stationary cylinder **21** and a movable piston member **22**, FIG. 1. The upper end of each piston **22** is formed with a yoke **24** which carries a shaft **25** for mounting a rotatable sprocket **26** about which is entrained a chain **28**. One end of the chain

28 is affixed to the stationary frame F while the other end of the chain 28 is affixed to a movable mast 13 or 14, FIG. 1. Each piston and cylinder means 20 and the chains 28 are identical as are each of the masts 11 and 12. Therefore, a description of one mast 11 or 12 and its associated piston and cylinder means 20 will enable an understanding of the construction of the opposite mast and piston and cylinder means which are identified by identical reference characters.

In a like manner, another set of piston and cylinder means 30, FIG. 6, are secured to the respective small masts 13 and 14 for moving the pallet 16 relative thereto. The piston and cylinder means 30 have a cylinder 31 with a vertically extendible piston 32 which carries a yoke 33 at the upper portion thereof. Each of the yokes 33 has a shaft 34 on which is rotatively mounted a sprocket 35 about which is entrained a chain 38 which has one end affixed to a small mast 13 or 14 and the opposite end affixed to the pallet 16.

Thus, vertical movement of the pistons 32 relative to the cylinders 30 raises and lowers the sprockets 35 resulting in the chains 38 moving to raise and lower the platform 16 relative to the small masts 13 and 14.

For the purpose of guiding the movement of the small masts 13 and 14 during their vertical movement, the masts 13 and 14 have outer, vertical, tubular members 40 and 41, FIG. 1, on which are journaled a plurality of outwardly extending rollers 42 and 43 received in guide channels 45 and 46, FIG. 7, in the main masts 11 and 12. Likewise, the pallet 16 is guided during vertical movement by a series of rollers 48 and 49 sliding in channels 50 and 51, FIG. 8, formed in the inner masts 13 and 14 and by a series of rollers 52 and 53 guided in further channels 54 and 55, FIG. 8.

The present invention has as its primary aspect the assurance of relatively equal vertical movement of the masts 13 and 14 relative to the main masts 11 and 12 and level movement of the pallet 16 relative to the masts 13 and 14.

The problem of equalizing the movement of opposite ends of platforms, pallets, supports or the like can be better appreciated from consideration of the example of a large, heavy load is placed on the right hand side of the platform 16, FIG. 5. Thus, the right hand piston and cylinder means 20 and 30 (FIG. 5) require greater lifting force because of the greater proportion of the weight thereon than on left hand cylinders and piston means 20 and 30. Since the usual practice is to supply the respective pistons and cylinder means 20 and 30 at both the right and left hand sides of the lift 10 with fluid under equal pressure from a common source of pressure such as a pump or compressor, the left hand piston and cylinder means 20 and 30 generate the same lifting force as the right hand piston and cylinder means but have less weight to lift and ordinarily would move more rapidly upward causing canting or tilting of the platform. Manifestly, the unequal movements on opposite sides of guided platform or the like results in the increased friction, or binding of some of the guiding rollers within the guide channels causing undue wear or even destruction of components during attempted further vertical movement of the platform 16.

The problem of equalizing the movement is more acute where the platform is of relatively large size and is adapted to carry quite heavy loads. A consideration of the environment of the invention will illustrate wherein such a problem is relatively acute. Thus, the lift 10 may be employed in a warehouse with the lift platform 16 being twelve feet in length and seven and one-half feet in width. The pallet 16 moves vertically through a distance of approximately fourteen feet relative to the small masts 13 and 14; and, with the small masts 13 and 14 extended, the pallet 16 is approximately twenty-five feet above the floor-level when in position illustrated in FIG. 5. Thus, the imposition of a heavy load on one side of the large pallet 16, which is to move twenty-five feet vertically, renders the problem of level movement through this relative long distance rather acute.

The preferred manner of equalizing the amount of movement by the opposed cylinder means 20 is by an equalizing device 60, which includes a long shaft 61 spanning the masts 13 and 14, FIG. 5. Toothed sprockets 63 are keyed to the opposite ends of the shaft 61. The sprockets 63 have teeth 64, FIGS. 3 and 4, which are adapted for rolling and meshed engagement with rollers 65 spanning and interconnecting chain links 66 of the chains 28. The chains 28 at the location of the sprockets 63 are provided with traveling guide means or backup means 69 which are secured to the respective masts 13 and 14 for vertical movement with the movable masts 13 and 14 as the sprockets 63 roll along the chains 28. It will be appreciated that each sprocket 63 must rotate at the same rate as its attached and common shaft 61. As the sprockets 63 control the rates of movements of the chains 28, the chains 28 must, therefore, also move at the same rate thereby affording an equal and level movement of the attached masts 13 and 14.

In a similar manner, an equalizing means 70 equalizes the movement of the chains 38 and the attached pallet 16 relative to the masts 13 and 14. The equalizing means 70 includes a shaft 71 secured to and journaled in bearings on the underside of the pallet 16 and includes opposed sprockets 73 secured to the shaft 71 and in toothed engagement with the rollers of the chains 38. The sprockets 73 have teeth 75 which mesh in the chain links 38. The opposed sprockets 73 rotate at the same rate because they are fixed to the same shaft 71 and, therefore, limit any attempted movement of one chain 38 relative to the other chain 38, which would tilt the pallet 16.

Detailed description

The stationary frame F at the bottom of the lift 10 has as primary structural elements three longitudinally extending channel members 80A, 80B and 80C, FIGS. 1 and 6, on both the left and right hand side thereof. The intermediate channels 80B are shorter and are joined to cross channels 81 and 82, FIG. 6, which in turn are secured to channels 80A and 80C. The innermost channels 80C are spaced apart sufficiently to permit the frame member 15 to nest therebetween when the movable masts 13 and 14 are lowered. The channels 80A and 80B are spaced apart to permit stiffener plates on the underside of the platform 16 to nest therebetween when the platform 16 is lowered into the dotted line position, shown in phantom lines in FIG. 1.

Upstanding and secured at the fore and aft ends of the opposed channels 80C are central plates 84 and 85. These plates have secured at the ends thereof, as best seen in FIG. 5, truncated, triangular shaped gusset plates 86 and 87. These gusset plates 86 and 87 extend at right angles to the central plates 84 and 85.

The construction of the masts 11 and 12 can be understood in conjunction with FIGS. 1, 5 and 7 and as seen therein, large square-sectional channels 92 and 93 extend vertically upward for the full length of the masts 11 and 12 and are secured at their lower ends to the gusset plates 86 and 87. Disposed between the square-sectional channels 92 and 93 are rectangular cross-sectional channels 89 which likewise extend vertically from the frame F to which the channels 89 are secured. A series af small reinforcing gusset plates 95 and 96, FIG. 7, are welded at spaced locations to the channels 89 and are welded to their respective parallel channels 92 and 93 to form a unitary structure for the masts 11 and 12. Providing crosswise support for the opposed groups of channels 89, 92 and 93, are angles 98, FIGS. 1 and 6, which are secured to the channels 92 and 93, FIG. 7, to add rigidity to the mast structure.

It will be recalled that the smaller masts 13 and 14 each have a pair of square tubular members 40 and 41

extending generally vertically. Cross brace members **102**, FIG. 1, extend lengthwise between the tubular members **40** and **41** and are secured thereto at spaced locations. Secured along the outer sides of the respective tube members **40** and **41** are vertically oriented plates **103** and **104**, FIG. 8, on which are journaled a series of the rollers **42**, FIG. 8, which as mentioned, are disposed to roll in the guide channels **45** and **46** of the stationary masts **11** and **12**, as best seen in FIG. 7.

As best seen in FIG. 8, a mast **13** or **14** has a pair of angles **110** and **111** secured along the inner surface of the tubular members **40** and **41**. The angles **110** and **111** have outwardly directed legs **113** cooperating with the surface **41A** on the tubular members **41** for guiding the rolling movement of the rollers **52** and **53**, which are journaled on posts on the platform **16**. Smaller angle members **115** and **116** are secured to the respective angles **110** and **111** and also extend vertically. The angle members **115** and **116** have legs **117** which cooperate with surfaces **110A** and **111A** on angles **110** and **111**, respectively to define vertical guideways for the rollers **48** and **49** which are journaled on posts on the pallet **16**. The axis of rotation of the respective rollers **48** and **49** is at right angles to the axis of rotation of the rollers **52** and **53**; therefore, the pallet **16** is guided and supported against for and aft motion as welll as sideways motion relative to the masts **13** and **14**.

The construction of the pallet **16** can best be understood from FIG. 9, wherein it is shown as having a flat support plate **120** on the upper surface of which will be disposed the items to be elevated. Along the underside of support plate **120** are secured longitudinal stiffener plates such as outer stiffener plates **121** and **122**. Spaced intermediate the stiffener plates **121** and **122** are additional depending stiffener plates **123** secured to the underside of the pallet plate **120** as by welding. It is preferred that the pallet **16** have hinged, side boards **126** and **127** extending longitudinally across the pallet plate **120** to prevent the sliding of goods from the pallet **16**. The side boards **126** and **127** may be pivoted to a generally horizontal position, FIG. 9, when it is desired to remove the goods from the plate **120** of the pallet **16**.

The pallet **120** has secured to its fore and aft edges, downwardly extending support plates **130** through which extend the opposite ends of the equalizing shaft **71** carrying respective sprockets **73** and **74** for engagement with the chains **38**. Also secured to the support plates **130** are anchor blocks **132** for receiving threaded shafts **133** to which are attached ends of the chains **38**. The threaded shafts allow the adjustment of the chain **38** relative to the pallet **16** and to the respective sprockets **73** and **74**.

It is preferred to have relatively high mesh screens **135** and **136** at the opposite sides of the pallet **16**, as best seen in FIG. 5. A small operator's cage **137** is also secured to the aft end of the pallet **16**. An operator may ride up and down in operator's cage **137** with the pallet **16** and be safe-guarded from falling from the pallet **16** and also protected from being engaged by goods on the pallet **16**, for example due to a shifting of the goods on the pallet **16**.

The mounting of the other equalizing means **60** including the equalizer shaft **61** can best be understood from a consideration of FIG. 10, wherein there is shown a vertically extending plate **144** secured to the respective vertical, tubular members **40** and **41** of the masts **13** and **14**. As seen in FIGS. 3 and 10, the sprockets **63** are secured to the shaft **61** which is journaled for rotation in bearings B mounted on the respective opposed plates **144**. One end of each of the chains **28** is also affixed to a threaded end of an adjustable connector stud **146**, FIG. 10, extending through an aperture in a bracket **145** welded to the plate **144**. A horizontal plate **147** at the bottom of plate **144**, FIG. 10, spans the channels **40** and **41** at the base of the plate **144** and serves as the base for the hydraulic cylinder **31**. The hydraulic cylinder **31** is suitably secured to the angles **102**, FIG. 10, of the small mast **13**.

The respective equalizing means **60** and **70** each employ the same construction of a backup or support **69** for the chain and sprocket teeth, as can be understood in connection with FIGS. 2, 3 and 4. As best seen in FIG. 2, the backup means **69** includes a bracket **150** welded to plate **144** and extending at right angles thereto. Suitable braces **154** are welded to the bracket **150** and plate **144** to afford further rigidity to the bracket **150**. A sleeve-shaped member **149** is slideable on the bracket **150**. That is, the sleeve member **149** has a generally rectangular opening and fits about the bracket **150**, as will be evident in FIG. 4. The width of the sleeve member **149** is sized to fit between the chain link side plates **151** and **152**, FIG. 3. The sleeve member **149** is preferably hardened and is adapted for sliding freely on the bracket **150**. Once the sleeve **149** has its adjacent vertical side portion between the chain links **151** and **152**, the sleeve **159** will remain in this position until replaced. It is preferred that the hardened sleeve **149** not be fastened by retainers or welded in position on the bracket **150** but be freely floating thereon to adjust itself within the chain links **151** and **152**, moving relative thereto. It is to be understood that the sprocket teeth **64** apply considerable force to the chain **28** and thereby to the hardened sleeve **149** when the sprockets **63** or **73** are functioning to hold their respective chains on one side of the pallet **16** against faster movement than the chains on the opposite side of the pallet **16**. This considerable force of the teeth on the chain and sleeve **149**, which force is necessary to hold one side of the pallet **16** level, would cause excessive wear of the sleeve **149** but for the hardening of the sleeve **149** to render it wear resistant.

It is preferred that the movable lift **10** be self-propelled and also contain its own pumps and motors for supplying a fluid under pressure, which is preferably a hydraulic fluid, to the respective cylinders **21** and **31** to cause movement of the masts **13** and **14** and movement of the pallet **16**.

As can best be understood from FIGS. 1, 5 and 6, a conventional steering handle H is provided on the right hand side of the lift and at the aft end thereof for manipulation by an operator standing on a suitable platform **160**, FIG. 6. The steering handle H is connected to a shaft **162**, FIG. 1, which is in turn connected to a drive sprocket **163** for turning a chain **164** to turn a wheel supporting shaft mechanism **165**, FIG. 1. The operator also controls a suitable electric motor **166**, FIG. 1, which is connected by a chain drive **167** to a pair of drive wheels **168** mounted on an axle **169**. The particular manner of mounting the wheels **168** relative to the frame F is not described in detail hereinafter but is generally of the same kind as described in U.S. Patent No. 2,997,721.

In addition to the central drive wheels **168**, it is preferred that a pair of central wheels **170** and **171**, FIG. 6, be disposed intermediate the channel members **80A** and **80B** and that pairs of forward castors **174** and **175**, FIG. 6, be provided at the forward end of the frame F for rolling engagement with the floor. The frame F is also adapted to be guided along a pair of opposed parallel tracks **176** and **177** which are adapted to be engaged by small rollers such as **178** and **179**, FIG. 6, secured to the frame F and spaced for engagement with the floor guide tracks **176** and **177**. However, it is to be understood that the lift **10** can be steered by the steering wheel and handle H so as to move without the guidance of such floor tracks **176** and **177**, if it is so desired. Disposed in covered spaces immediately above the castor **174** and **175** are batteries B for the electric motor drive. Opposite the steering wheel H on the forward side of the frame F is a compartment **180**, FIG. 6, in which are disposed suitable motors and pumps for the hydraulic cylinders **21** and **31**.

From the foregoing, it will be seen that the present invention affords a unique lift in which the fluid operated devices for lifting a platform or the like are mechanically

interlocked so as to afford equal movement to opposite sides of the platform. In the preferred form of the invention, the equalizing device includes a common shaft having sprockets thereon for engagement with chains, racks or the like to assure that the sprockets turn at the same rotational speed. Preferably, the sprockets engage the rollers of the chain which is backed up by a traveling guide bar which has a wear hardened means thereon against which the chain slides as the teeth of the sprockets are inserted in the spaces between the chain links.

Hence, while preferred embodiments of the invention have been described and illustrated, it is to be understood that they are capable of variation and modification.

I claim:

1. In a lift of the character described wherein a horizontal platform is to be raised and lowered by a pair of vertically extendible and retractible elements, a base on which said elements are supported, a pair of chains connected to said platform and having portions trained over said elements so that vertical movement of said elements is accompanied by vertical movement of the platform, and an equalizer for assuring that movement of one of said elements through a predetermined distance is accompanied by movement of the other of said elements through substantially the same distance, said equalizer including a horizontally disposed shaft carried by said platform, a sprocket at each end of said shaft, and each sprocket being meshed with a related one of said chains so that the chains become a track for the sprockets during vertical movement of said platform.

2. A lift according to claim 1 wherein said elements are fluid operated pistons each having a sprocket to the free end thereof over which said chains are trained.

3. The lift of claim 1 wherein said platform has chain backup means thereon for supporting said chains against movement out of the teeth of said sprockets.

4. The lift of claim 3 wherein each of said backup means includes a detachable wear-hardened member guiding said chain links.

5. In a lift of the character described, a vertically movable platform, opposed vertically movable masts supporting said platform, said platform and masts having cooperating guide elements to guide the platform during vertical movement independent of said masts, stationary masts and cooperating guide means on the stationary masts and the movable masts, means for moving the movable masts including opposed fluid actuated piston and cylinder means, equalizing means for equalizing movement of the platform by the opposed fluid actuated cylinder and piston means, said equalizing means including a shaft member carried by said platform, toothed means secured at spaced positions on said shaft member, rack-like means at spaced positions on the lift and receiving a respective one of said toothed means to equalize the vertical movement of said shaft member and platform, additional equalizing means carried by said movable masts relative to said stationary masts, additional piston and cylinder means to move the movable masts, said additional equalizing means including another shaft member, toothed means secured at spaced locations on said other shaft member, and additional rack-like means at spaced locations on the lift and receiving a respective one of the last-mentioned toothed means to equalize the vertical movement of said movable masts.

6. The lift of claim 5 wherein both of said rack-like means are chains and wherein both of said toothed means are sprockets having their respective teeth meshed in the respective chains.

7. The lift of claim 6 wherein said chains are operated by the piston and cylinder means to lift the platform and to lift the movable masts.

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