Jan. 6, 1953 A. E. JACKSON 2,624,543

LIFTING DEVICE

Filed Jan. 26, 1950 3 Sheets-Sheet 1

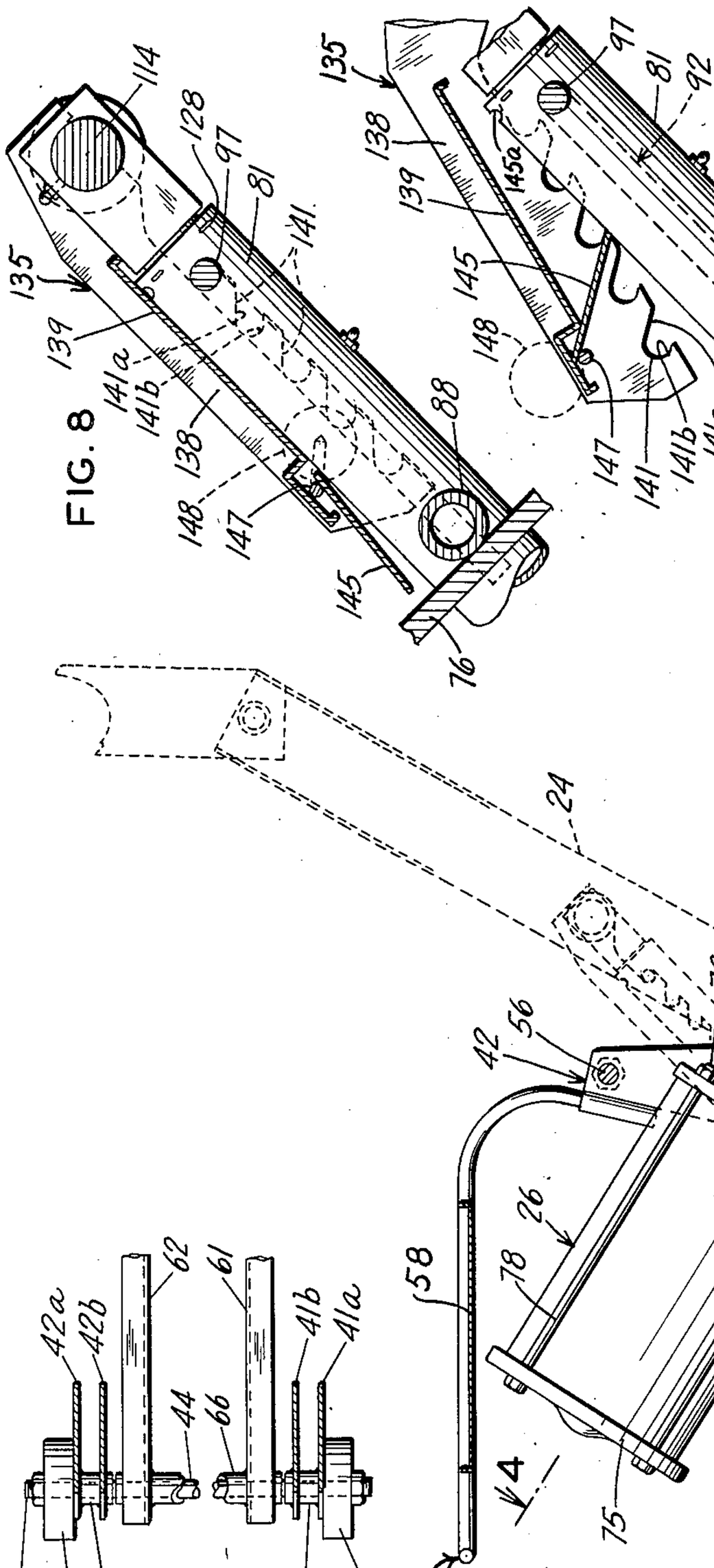

FIG. 8

FIG. 9

FIG. 1

FIG. 10

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LIFTING DEVICE

Filed Jan. 26, 1950 3 Sheets-Sheet 2

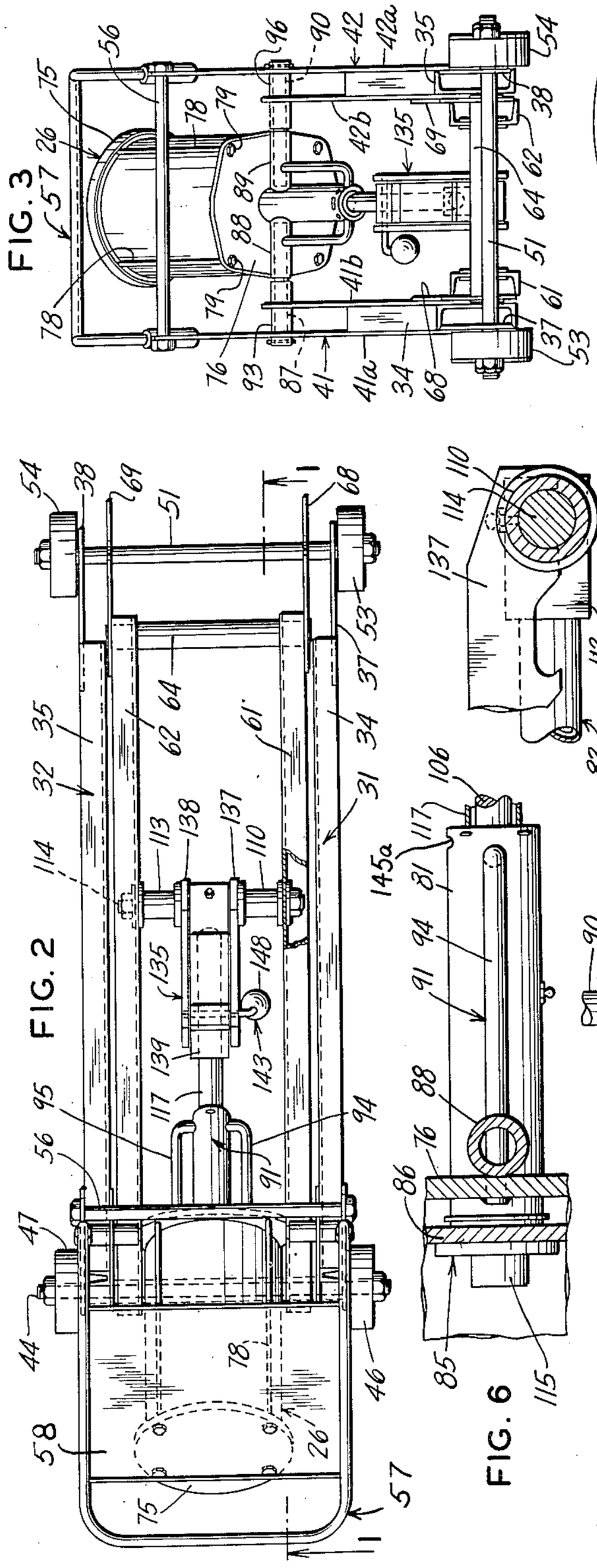

FIG. 2

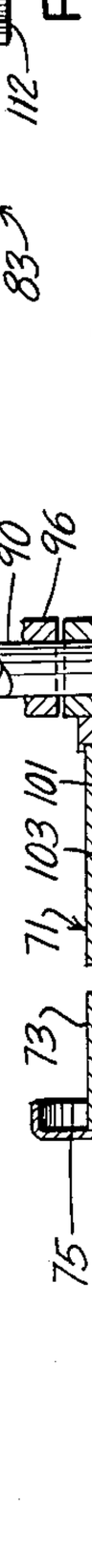

FIG. 6

FIG. 7

FIG. 5

FIG. 4

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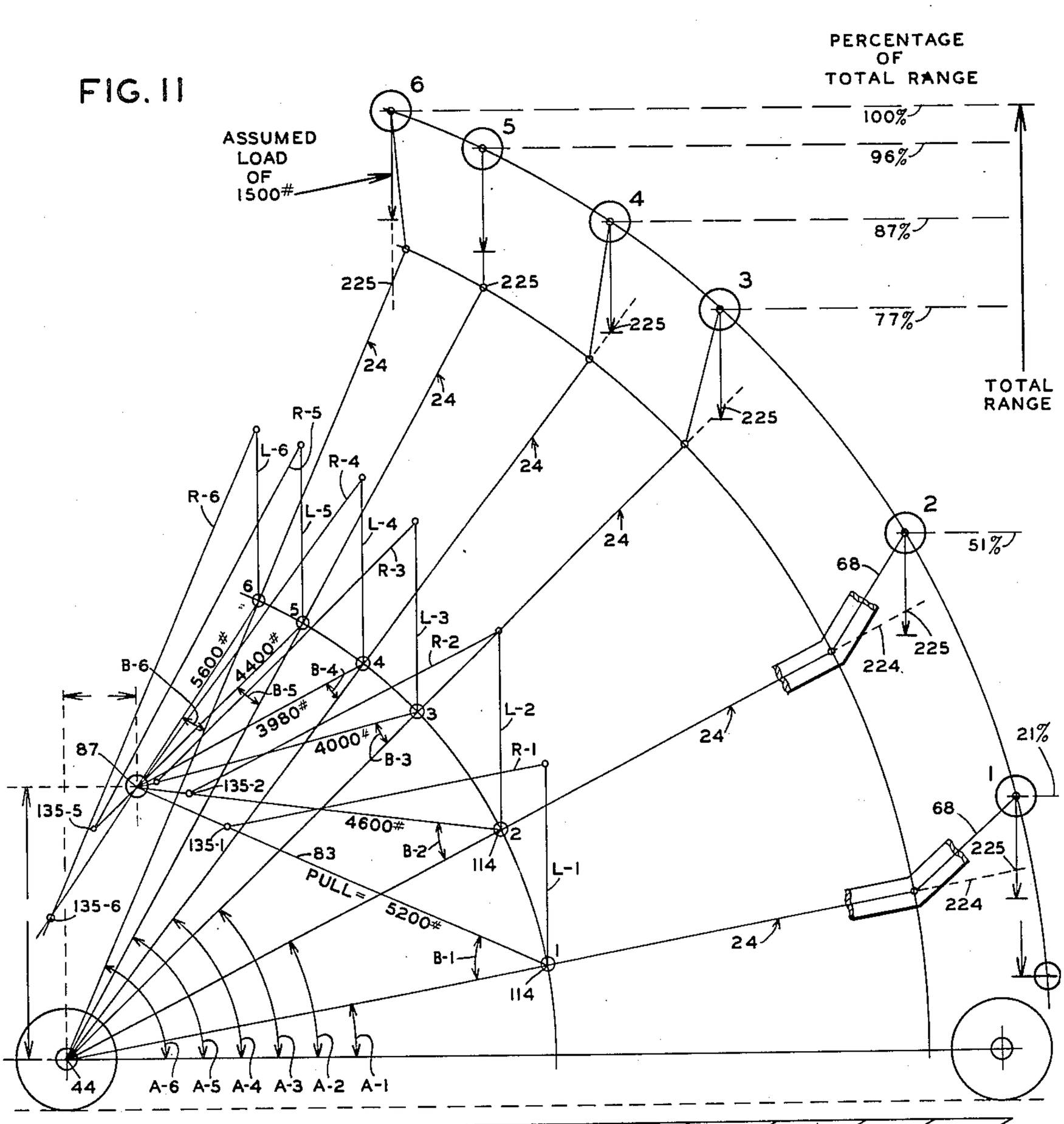
LIFTING DEVICE

Filed Jan. 26, 1950 3 Sheets-Sheet 3

FIG. 11



POSITION	ANGLE A	EFFECTIVE VERTICAL LOAD AT PIVOT 114	ANGLE B	GRAPHICALLY COMPUTED PISTON PULL	LOAD ELEVATION IN PERCENTAGE OF RANGE	SIN B	COS A	COS A / SIN B	MATHEMATICALLY COMPUTED PISTON PULL
1	10°	2950#	34°	5200#	21%	.5592	.9848	1.76	5200
2	27	2900	34	4600	51	.5592	.8910	1.60	4600
3	44	2800	30	4000	77	.5000	.7193	1.44	4040
4	52½	2740	25	3980	87	.4226	.6157	1.41	3980
5	61	2630	17	4400	96	.2924	.4848	1.66	4350
6	67	2540	10⅓	5600	100	.1794	.3907	2.18	5500

FIG. 11A

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Patented Jan. 6, 1953

2,624,543

UNITED STATES PATENT OFFICE

2,624,543

LIFTING DEVICE

Alexis Eugene Jackson, Norwalk, Conn., assignor, by mesne assignments, to American Brake Shoe Company, Wilmington, Del., a corporation of Delaware

Application January 26, 1950, Serial No. 140,739

13 Claims. (Cl. 254—8)

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This invention relates to lifting devices of the kind employed for raising automobiles and the like, and particularly this invention relates to such lifting apparatus of the kind wherein the lifting action is attained by means including a pivoted lifting frame that supports the load on the free end thereof and which effects lifting movement by upward pivotal movement of such frame.

In lifting devices of the aforesaid character, the upward pivotal movement is imparted to the lifting frame in many different ways and through the uses of different sources and kinds of operating power, and it is an important object of the present invention to materially improve the way in which the operating power is applied between the pivoted lifting frame and the supporting base upon which such lifting frame is mounted. More specifically, it is an object of the present invention to so relate the power driven operating means to the base and the lifting frame in such a device that the application of the lifting power is not only accomplished in an efficient manner, but is effective in such a way that the device is particularly convenient and safe in its operation.

The operating power is in many instances applied to lifting devices of the aforesaid character in the form of compressed air, and since compressed air in every instance will expand until a balance is attained between the air pressure and the load that is being applied, it is well recognized that there may be instances where an excess of compressed air may be applied so as to cause a lifting device of this kind to go beyond the limit of movement that is desired. In this respect it should be observed that lifting devices of the kind to which the present invention relates are designed and adapted in each instance for operation through a predetermined maximum lifting range, and it is important to arrange such lifting devices so that the load will not be inadvertently lifted beyond such range, and to enable this to be accomplished in a simple and effective manner is another important object of the present invention. More specifically it is an object of this invention to apply the lifting power to the lifting frame in such a device in such a way that as the lifting frame approaches the upper limit of its normal operating range, the necessary force that must be applied to the lifting frame to support or move the load will be suddenly increased, thereby to guard against the inadvertent overthrow in the operation of the lifting device.

A primary object of my invention is to afford a lifting device for raising one end of an object

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such as an automobile, or the like, in a novel and expeditious manner, and wherein the parts are so constituted and arranged that lifting of the object is accomplished efficiently and in a manner whereby the parts of the lifting device will not interfere with the efficient work of a repairman working on the automobile, or the like, supported on the device.

Another object of my invention is to construct a lifting device having pivotally mounted lifting arms and a motor constituted and arranged relative to each other in a novel and expeditious manner whereby the motor is connected in tention to the lifting arms and is effective during operation of the device to pivot the arms upwardly by pulling thereon.

A further object is to enable a novel lifting device of the aforementioned type to be constructed which embodies novel latching devices for positively, but releasably, holding the lifting arms of the device in raised position.

Yet another object of my invention is to construct a novel lifting device which embodies a supporting frame, lifting arms, a motor for raising the arms, and latching means for releasably holding the arms in raised position, constituted and arranged in a novel and expeditious manner, and which affords a novel, efficient, and practical lifting device which may be economically manufactured, and is efficient and practical in operation.

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, show a preferred embodiment of the present invention and the principles thereof and what I now consider to be the best mode in which I have contemplated 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 and the purview of the appended claims.

In the drawings:

Fig. 1 is a longitudinal sectional view of a lifting device illustrating a preferred embodiment of my invention, the view being taken substantially along the line 1—1 in Fig. 2;

Fig. 2 is a top plan view of the lifting device shown in Fig. 1;

Fig. 3 is a front elevational view of the lifting device shown in Fig. 1;

Fig. 4 is a detail sectional view taken substantially along the line 4—4 in Fig. 1;

Fig. 5 is a detail sectional view taken substantially along the line 5—5 in Fig. 1;

Fig. 6 is a detail sectional view taken substantially along the line 6—6 in Fig. 4;

Fig. 7 is a detail sectional view taken substantially along the line 7—7 in Fig. 4;

Fig. 8 is a detail sectional view of the latching mechanism shown in Fig. 1, showing the mechanism in a latched position;

Fig. 9 is a detail sectional view similar to Fig. 8, but showing the latching mechanism in released position;

Fig. 10 is a detail sectional view taken substantially along the line 10—10 in Fig. 1;

Fig. 11 is a schematic force diagram illustrating the forces required to operate the present lifting device in different operating positions; and

Fig. 11A is a table of values relating to the application of the operating forces.

For the purpose of illustrating a preferred embodiment of my invention, a lifting device 20 is shown in the accompanying drawings which comprises, in general, Figs. 1, 2 and 3, a supporting frame 22, a lifting frame 24, a motor 26, and latching mechanism 28, the motor 26 being operable during an operation of my device to pivot the lifting frame 24 on the supporting frame 22 from the normal, lowered position shown in solid lines in Fig. 1 to the raised position shown in broken lines therein, and the latching mechanism 28 being operable to releasably, but positively, hold the lifting frame in such raised position, all of which will be discussed in greater detail presently.

The supporting frame 22, Figs. 1, 2 and 3, comprises two elongated side beams 31 and 32 preferably comprising two elongated, upwardly inclined channel members 34 and 35 having plates 37 and 38 projecting from, and forming a longitudinal extension on the front ends thereof, respectively, and having two upwardly projecting posts 41 and 42 mounted on, and extending transversely across the rear end portions thereof. The posts 41 and 42 each comprise an outer plate 41*a* and 42*a* and an inner plate 41*b* and 42*b*, respectively, the plates 37, 38, 41*a*, 42*a*, 41*b* and 42*b* being connected to the respective channels 34 and 35 by any suitable means such as welding.

As is best seen in Figs. 1 and 10, the lower end portion of the posts 41 and 42 are connected together by a rod 44 which extends through sleeves 48 and 49 mounted between and connected to the plates 41*a* and 41*b*, and 42*a* and 42*b*, respectively, two wheels 46 and 47 being journaled on the opposite end portions of the rod 44 for supporting the rear end portion of the supporting frame 22. A rod 51, similar to the rod 44, is mounted in, and interconnects, the plates 36 and 37 on the front end portion of the side beams 31 and 32, and two wheels 53 and 54 are journaled on the outer end portions of the rod 51 to thereby afford supports for the front end portion of the supporting frame 22. The posts 41 and 42 are also interconnected at their upper end portions by another rod 56, Figs. 1 and 3, to thereby complete a relatively solid frame structure.

A handle 57 is mounted on the upper end portion of the posts 41 and 42, Fig. 1, and projects rearwardly therefrom to afford means for readily pushing or pulling the device 20 across a floor surface on the wheels 46, 47, 53 and 54. A tray

53 may be mounted on the handle 57 for supporting tools and the like.

The lifting frame 24 comprises two lifting arms 61 and 62 normally disposed in substantially horizontal position between the side beams 31 and 32 of the supporting frame 22, as shown in solid lines in Fig. 1, and having the front end portions thereof interconnected by a rod 64 rearwardly of the rod 51. The other, or rear end portions of the arms 61 and 62 are welded to, or otherwise suitably secured to, a sleeve 66 rotatably mounted on the rod 44 between the collars 48 and 49, Figs. 2 and 10. Two axle-receiving hooks or forks 68 and 69 are mounted on the front end portions of the arms 61 and 62 of the lifting frame 24, respectively, and are secured thereto by suitable means such as welding, the hooks 68 and 69 being adapted to supportingly engage an object such as, for example, the axle of an automobile, or the like.

In the operation of my novel device, the lifting frame 24 may be pivoted upwardly and downwardly on the rod 44 between the positions shown in solid lines and in broken lines in Fig. 1, to thereby raise and lower the hooks 68 and 69, and for this purpose I provide a motor such as the motor 26 which may be of any suitable type but which I prefer to be of the pneumatically operated type.

The motor 26 includes a cylinder 71 comprising a cylindrical-shaped side wall 73 and two end walls 75 and 76. The end walls 75 and 76 are clamped on the side wall 73 by studs 78, Figs. 1, 3 and 5, extending through the peripheral edge portions of the end walls 75 and 76 exteriorly of the side wall 73 and held therein by nuts 79.

A cylindrical-shaped guide sleeve 81 is mounted in the central portion of the lower end wall 76 of the cylinder 71 and projects therethrough to afford a guide for the piston rod 83 of a piston 85 having a piston head 86 reciprocably mounted in the cylinder 71 as will be discussed in greater detail presently. Two bosses 88 and 89 project laterally outwardly from the guide sleeve 81 in opposite directions and abut the lower face of the end wall 76 of the cylinder 71, the bosses 88 and 89 being rotatably mounted on studs 87 and 90 projecting through sleeves 93 and 96 mounted in the intermediate portions of the posts 41 and 42, respectively, Figs. 3 and 4. The posts 41 and 42 are preferably inclined forwardly from the vertical so that the studs 87 and 90 are disposed forwardly of the rod 44 for purposes which will be discussed in greater detail presently.

Two substantially L-shaped rods 91 and 92 extend through and are welded to the bosses 88 and 89 and have one leg 94 and 95, respectively, extending through the end wall 76 on opposite sides of the guide sleeve 81 and have the other legs, 97 and 98 abutting and welded to the outer face of the sleeve 81. The upper end portions of the legs 94 and 95 of the rods 91 and 92 are welded to the end wall 76 of the cylinder 71 to thereby secure the rods 91 and 92 and the guide sleeve 81 in fixed position relative thereto.

The piston head 86 comprises a substantially circular shaped flat plate having suitable leathers 101 mounted on the peripheral edge portion thereof by bolts 103 and nuts 104 in position to wipingly engage the inner surface of the side wall 73. The piston rod 83 comprises a rod member 105 having one externally threaded end portion 108 extending through the center of the

head 86 in threaded engagement therewith and the other end portion 109, which is also externally threaded, screwed into a tapped opening 111 in a connecting block 112 rotatably mounted between suitable spacing sleeves 110 and 113 on a shaft 114 extending between, and connected to, the lifting arms 61 and 62 between the rods 44 and 64. A lock nut 115 is mounted on the end 108 of the rod member 106 to hold the head 86 in threaded engagement therewith.

A sleeve member 117, forming a part of the piston 85, and having an externally threaded end 118 mounted in a threaded opening 119 in the block 112, is mounted on the rod 106 in spaced relation thereto and is slidably mounted in the guide sleeve 81, suitable packing 121 and 122 is disposed in the opposite end portions of the guide sleeve 81 in engagement with the outer surface of the sleeve member 117. Bushings 124 and 125, and cotter pins 127 and 128, Figs. 4 and 5, afford means for retaining the packing 121 and 122 in position between the sleeves 81 and 117. A suitable lubricant such as, for example, grease may be packed into the sleeve 81, exteriorly of the sleeve 117, between the bushings 124 and 125 to afford lubrication of the sleeve 117 during reciprocation of the sleeve 117 and the sleeve 81 relative to each other.

As previously mentioned, it will be seen, Fig. 4, that the rod 106 is mounted in the sleeve 117 in spaced relation to the latter. By this construction, a certain amount of flexibility is imparted to the rod 106, the rod 106 being capable of movement laterally in the sleeve 117 whereby the position of the rod 106 in the sleeve 117 may be automatically adjusted to accommodate the piston head 86 in the cylinder 73 to eliminate side thrust between the piston head 86 and the cylinder 83 which might result from relatively minor irregularities in construction or assembly if the piston rod 106 were rigid in the sleeve 117.

From the foregoing, it will be seen that movement of the piston 85 upwardly into the cylinder 71, as viewed in Fig. 1, is effective through the connecting rod 83 to apply tension between the studs 87 and 90 on the supporting frame 22 and the rod 114 on the lifting frame 24 to thereby effect upward swinging movement of the lifting frame 24 around the rod 44 disposed at the lower rear end portion of the supporting frame 22. Upon such movement of the lifting frame 24, the motor 26 rotates therewith on the studs 87 and 90 from the position shown in solid lines in Fig. 1 toward the position shown in broken lines therein, and it will be seen that the positioning of the studs 87 and 90 forwardly of the rod 44 so positions the motor 26 relative to the pivot point of the lifting frame 24 that efficient lifting of the frame 24 is effected.

It will be seen, of course, that when it is desired to lower the lifting frame 24 from raised position, the piston 85 is moved outwardly in the cylinder 71 to thereby permit the frame 24 to pivot downwardly about the rod 44. Thus, it will be seen that reciprocation of the piston 85 into and out of the cylinder 71 is effective to pull the lifting frame 24 into raised position and to permit the frame 24 to be lowered from raised position, respectively.

For the purpose of reciprocating the piston 85 in the cylinder 71, a suitable working fluid such as, for example, compressed air may be fed into and out of the cylinder 71 through suitable means such as a coupling member 131 and a flexible hose 132, Figs. 1 and 5, the flow of the working fluid into and out of the cylinder 71,

through the hose 132, being controlled by suitable valve means, not shown.

A latching mechanism 135, Figs. 1, 2, 8 and 9, which is releasably engageable with the legs 97 and 98 of the rods 91 and 92 is mounted on the rod 114 and movable with the piston 85 to thereby afford a releasable, positive means for latching the lifting frame 24 in raised position to insure against accidental or unintentional lowering of the lifting frame 24.

The latching mechanism 135 comprises two elongated plates 137 and 138 pivotally mounted at one end on the rod 114 on opposite sides of the connecting block 112 and extending toward the head 86 of the piston 85. A plate 139 extends between, and is connected to the upper edge portions of the plates 137 and 138 and is adapted to normally rest on the upper surface of the piston sleeve 117, Fig. 1, to normally support the latching plates 137 and 138 in rearwardly extending position, in substantially parallel alignment with the piston rod 85. A plurality of notches 141, Figs. 1, 8 and 9, are formed in the lower edge portions of each of the plates 137 and 138 and open toward the piston 85. The notches 141 are complementary to the legs 97 and 98 of the rods 91 and 92, and the legs 97 and 98 are engageable therein during movement of the piston 85 into the cylinder 71, the notches 141 each having a tapered wall 141*a* under which the legs 97 and 98 of the rods 91 and 92 will freely slide during inward movement of the piston 85, and a concave wall 141*b* which is engageable with the legs 97 and 98 of the rods 91 and 92 when the latter are disposed in the slot 141 to prevent outward movement of the piston 85.

A release lever 143, Figs. 1, 2, 8 and 9, is embodied in the latching mechanism 135, the release lever 143 comprising a lifting plate 145 pivotally mounted between the plates 137 and 138 on a rod 147 journaled in the plates 137 and 138, and a handle 148 connected to the end of the rod projecting outwardly from the plate 137. The lifting plate 145 is mounted between the piston rod 83 and the plate 139 of the latching mechanism 135, and normally projects from the rod 147 toward the piston head 86 in substantially parallel alignment with the piston rod 83, in the position shown in Fig. 8, the handle 148 being weighted so as to tend to retain the plate 145 in that position. With the plate 145 disposed in this position, it will be seen that during movement of the piston into the cylinder 71, the latching mechanism 135 slides upwardly over the legs 97 and 98 of the rods 91 and 92 with the tapered side walls 141*a* of the successive notches 141 in the plates 137 and 138 sliding freely over the legs 97 and 98 of the rods 91 and 92. Full movement of the piston 85 into the cylinder 71 disposes the rods 91 and 92 in the notches 141 closest to the connecting block 112 as shown in Fig. 8. Thus it will be seen that the latching mechanism is effective to positively hold the piston 85 against accidental withdrawal from the cylinder in any one of a plurality of positions wherein the rods 91 and 92 are latchingly engaged in notches 141 in the plates 137 and 138.

When it is desired to move the piston 85 outwardly from the cylinder 71 from a position such as that shown in Fig. 8 wherein the rods 41 and 42 are disposed in notches 141, the operator may, first, feed a small additional amount of working fluid into the cylinder 71 to thereby move the piston 85 into the cylinder sufficiently

to move the tapered walls 141A out of engagement with the legs 97 and 98 and dispose the legs 97 and 98 in registration with the openings of the notches 141, and then, the operator may turn the handle 148 in a counterclockwise direction, as viewed in Fig. 8, to thereby swing the plate 145 down into camming engagement with the guide sleeve 81 and thereby force the plates 137 and 138 to pivot in a clockwise direction into the released position shown in Fig. 9 wherein the plates 137 and 138 are disposed in raised position above the rods 91 and 92, in which position the notches 141 are held out of latching engagement with the legs 97 and 98.

Thus, it will be seen that, in the operation of my novel device, the lifting device 20 with the lifting frame 22 thereof disposed in the normal, lowered position shown in solid lines in Fig. 1, may be moved on the wheels 46, 47, 53 and 54 into position wherein the hooks 68 and 69 are disposed below an article to be lifted, such as the axle of an automobile. Compressed air or the like may then be fed through the hose 132 into the cylinder 71 to thereby cause the piston 85 to move into the cylinder 71. Movement of the piston 85 into the cylinder 71 is effective to pull the lifting frame 22 upwardly around the rod 44 toward the position thereof shown in broken lines in Fig. 1, to thereby raise the hooks 68 and 69 and, therefore, raise the article disposed thereon. It will be seen that, because of the manner in which the parts of my novel lifting device are constituted and arranged, a compact, practical and efficient lifting device is afforded wherein the lifting frame 22 is raised in a novel and expeditious manner by the motor 26, tension being applied to the piston 85 to thereby effect the raising movement of the lifting frame.

It will be remembered that during movement of the lifting frame 22 from the normal position shown in solid lines in Fig. 1 toward the raised position shown in broken lines therein, the motor 26 pivots on the studs 87 and 90 from the solid line position toward the broken line position shown in Fig. 1. However, it will be seen that during a complete movement of the lifting frame 22 from the lowered to raised position, the latching plates 137 and 138, remain disposed in position over the piston rod 83 so that they are urged by gravity toward the piston rod 83 in all operative positions of the motor 26 so that they are always urged by gravity toward the position in which they may latchingly engage the rods 91 and 92 when moved thereacross. Engagement of the latching mechanism 135 is effective to insure against accidental or unintentional lowering of the lifting frame 22, the latching plates 137 and 138 automatically riding into latching engagement with the rods 91 and 92 during movement of the piston 85 into the cylinder 71. However, when it is desired to lower the lifting frame from raised position, this may readily be accomplished by, first, feeding a small additional amount of air into the cylinder 71 to thereby cause the piston 85 to move a slightly greater distance thereinto, and, then, actuating the handle 148 to thereby lift the plates 137 and 138 out of latching engagement with the rods 91 and 92 and then, by permitting the air to escape from the cylinder 71 through the line 132, permitting the lifting frame 24 to move downwardly.

During the downward movement of the lifting frame 24, the plate 145 is retained in the angular position shown in Fig. 9 to thereby hold the plates 137 and 138 out of latching engagement

with the legs 97 and 98 of the rods 91 and 92. However, as is best seen in Figs. 1, 8 and 9, a notch 145A is afforded in the top surface of the sleeve 81, adjacent the end thereof disposed closest to the connecting block 112, and is disposed in the path of travel of the free end of the plate 145 so that, as the lifting frame 24 nears its lowered position, the free edge of the plate 145 drops into the notch 145A and is stopped thereby, so that, during the remaining downward movement of the lifting frame 24, the plate 145 is forced around toward the position shown in Fig. 8 to thereby permit the plates 137 and 138 to drop down into operative position for engaging the rods 91 and 92 during the next raising actuation of the lifting frame 24. Thus, it will be seen that after having been actuated to lift the plates 137 and 138 out of engagement with the rods 91 and 92, the plate 145 is automatically restored to normal position during downward movement of the lifting frame 24 to thereby permit the plates 137 and 138 to be automatically restored to normal lowered position in preparation for the next raising movement of the lifting frame 24.

Under and in accordance with the present invention, the power actuating means as afforded by the motor 71 and the piston rod 83 are associated with the base and the lifting frame 24 in such a way that the operation of the lifting apparatus is rendered unusually safe and advantageous in use. Thus, it will be observed that a lifting apparatus of the kind to which the present invention pertains is in every instance designed and intended for lifting movement throughout a predetermined range, and that when the load is approaching the maximum or highest position in this range, it is important that the lifting action of the mechanism be controlled and controllable in an effective and safe manner. As shown in the following description, and the force calculations set forth therein, such a safe mode of operation is attained under the present invention.

In respect to one factor that enters in a minor way into the calculation of the forces involved in the present structure, it will be noted that where a pivoted lifting frame is utilized with upwardly extended load engaging arms 68—69, as in the present instance, that as the lifting frame pivots from a generally horizontal relation and toward its maximum angle with respect to the horizontal, the effective load that must be overcome by the operating mechanism becomes gradually less, this effective reduction in the involved forces being brought about by reason of the angular relationship of the load engaging members 68 and 69 with respect to the lifting frame. In the present embodiment of the invention, the operating power is applied to the lifting frame at the cross shaft 114, which is located substantially midway between the mounting axis 44 and the center line of the load supporting seat that is afforded in the end of each of the load engaging arms 68 and 69. The load, of course, acts downwardly along a vertical line at all times, and this line intersects a continuation 224, Fig. 11, of a line that is extended through the axes of the shafts 44 and 114. This point of intersection is identified at 225 in Fig. 11, and this point of intersection 225 in each position of the lifting frame 24 determines the effective lever arm through which the load is applied about the mounting pivot 44.

For illustrative purposes, the force diagram of

Fig. 11 has been constructed on the assumption that a 1500 lb. load is applied to the frame **24** at the load supporting end thereof, and the frame **24** has been shown in six different positions, numbered as positions 1 to 6 in Fig. 11. For each of these six positions, the vertical load L that is effective at the cross shaft **114** has been computed and is shown in the table of values that has been identified as Fig. 11A. The vertical force that is effective at each position of the cross shaft **114** has in each instance been plotted vertically as load vectors L–1 to L–6, inclusive. In each instance the lower end of the load vector is located at the related position of the shaft **114**, while the upper end of the load vector constitutes the starting point of a second vector R–1 to R–6, inclusive. The second vector R–1 to R–6 is, in each instance, extended parallel to the longitudinal axis of the corresponding position of the lifting frame **24** and the second vector will thus, in each instance, intersect the axis of the piston rod **83**, or an extension thereof. This point of intersection has been indicated in respect to the vector R–1 by the reference character **135–1**, and the distance between the point **135–1** and the cross shaft **114** may then be scaled to indicate the amount of pulling force that must be exerted by the motor **71** to lift or support a load of 1500 lbs. in the particular location of the lifting frame **24**. In the table that constitutes Fig. 11A, it will be evident that in position 1, as shown in Fig. 11, the pull that must be exerted is 5200 lbs.; in position 2, 4600 lbs.; in position 3, 4000 lbs.; and in position 4, 3980 lbs. In position 4, the load will have been lifted throughout a substantial portion of the vertical range of the present lifting apparatus, or to be exact, 87 percent of the intended maximum range, and during this lifting movement, the amount of pressure required in the cylinder **71** will have been gradually reduced to some extent. To prevent overthrow, and insure proper control of the lifting apparatus as it moves beyond position 4 and into the final portion of its lifting range, the present apparatus requires an increased air pressure or pull in the operating cylinder **71** as this final movement of the lifting frame **24** takes place, and it will be observed in this connection that in position 5 the pull required has increased to 4400 lbs., while at position 6 a relatively great increase has raised the required pull to 5600 lbs.

This advantageous mode of operation is attained under the present invention by so relating the pivot points **44**, **114** and **87** that as the angle A between the lifting frame **24** and the base gradually increases, the included angle B between the frame **24** and the piston rod **83** is reduced rather gradually until the load has reached what may be termed the final portion of the lifting range and so that this angle B becomes quite small and reduces quite rapidly as the load moves into and through this final or upper portion of the lifting range of the apparatus. Thus, in the table that forms Fig. 11A of the drawings, the included angles between the frame **24** and the piston rod **83** in the several selected positions of the frame **24** are indicated as angles B–1 to B–6, inclusive, and it will be observed that these angles B do not reduce very rapidly until the load has entered the upper or final portion of its movement.

In Fig. 11 the piston pull required for the assumed load in the various positions has been determined graphically, but this may also be determined mathematically since this piston pull

is related according to a definite formula to the angles A and B and the load L, this formula being

$$\text{Required piston pull} = L \frac{\cos A}{\sin B}$$

Thus, in Fig. 11A, the sines of the various angles B and the cosines of the angles A are set forth together with the values of the required piston pull calculated according to the above formula, and while some differences may be noted between the graphically and mathematically determined values, this is, of course, due to the difficulty of determining the precise angular relationship of the elements.

The marked and continued increase in the piston pull that is encountered in the present apparatus when the lifting frame **24** enters the final or upper portion of its lifting range is due to the rapid decrease in the angle B as this final portion of the lifting stroke is entered and traversed, and in attaining such reduction in the angle B in this portion of the stroke, the location of the pivot **87** to the right of the vertical plane of the pivot **44** is important, as is the location of the pivot **87** at a distance above the pivot **44** which is less than the spacing of the pivots **44** and **114**. In other words, it is important that the pivot **87** be so located that when the frame **24** is about to enter the final or upper portion of its lifting range, the pivot **87** will be spaced but a short distance laterally of the frame **24**, and the angle B will be relatively small. In this regard, however, the pivot **87** must in every instance be located a substantial distance above the horizontal plane of the pivot **44** so as to attain the required lifting action on the frame **24** throughout the entire range of movement of the frame **24**.

From the foregoing it will be seen that I have afforded a novel lifting device wherein lifting arms are moved upwardly in a novel and expeditious manner by a motor operating under tension, and wherein safe, efficient, and practical operation of the device is insured by the novel and expeditious manner in which the parts are constituted and arranged.

Hence, while I have illustrated and described the preferred embodiments of my invention, it is to be understood that these are capable of variation and modification and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims:

I claim:

1. A lifting device comprising an elongated supporting frame, elongated arms pivotally mounted at one end to said frame and having means at the other end thereof for supporting an object, supporting means on said frame and extending upwardly above said one end of said arms, a cylinder pivotally mounted on said supporting means above said one end of said arms, a piston mounted in said cylinder and pivotally connected in tension to said elongated arms between the ends thereof, said piston being movable into and out of said cylinder and operable upon movement into said cylinder to raise said other ends of said arms, means projecting outwardly from said cylinder, and a latching member pivotally mounted on said piston and having abutments thereon for engaging said last named means in latching engagement therewith during such movement of said piston into said cylinder for holding said piston against movement outwardly from said cylinder.

2. A lifting device comprising an elongated supporting frame including upwardly extending supporting means on one end portion thereof, elongated arms pivotally mounted at one end to said frame and having means at the other end thereof for supporting an object, cylinder means pivotally mounted on said supporting means, a piston mounted in said cylinder means, and pivotally connected in tension to said elongated arms between the ends thereof, said piston being movable into and out of said cylinder means and operable upon movement into said cylinder means to raise said other ends of said arms, means projecting outwardly from said cylinder means, a latching member pivotally mounted between said arms and movable into releasable latched engagement with said outwardly projecting means during such movement of said piston into said cylinder means to thereby positively hold said piston against outward movement relative to said cylinder means, and means mounted on said latching member and engageable with said cylinder means for moving said latching member from said engagement with said outwardly projecting means.

3. A lifting device comprising an elongated supporting frame comprising a pair of upwardly inclined elongated beams disposed in spaced parallel relation to each other, and a pair of upwardly extending posts mounted on the upper end portions of respective ones of said beams and having upper end portions extending thereabove, elongated arms pivotally mounted at one end to said frame and having means at the other end thereof for supporting an object, a cylinder pivotally mounted on said posts above said beams, a piston mounted in said cylinder and pivotally connected in tension to said elongated arms between the ends thereof, said piston being movable into and out of said cylinder and operable upon movement into said cylinder to raise said other ends of said arms, said cylinder including means projecting outwardly therefrom toward said arms and engaged with said piston for guiding the latter, abutment members projecting outwardly from said last named means transversely to said piston, and a latching member pivotally mounted on said piston and extending thereabove, said latching member having a plurality of recesses therein engageable with said abutment members during movement of said piston into said cylinder for holding said piston against outward movement relative thereto, and a lever carried by said latching member and engageable with said outwardly projecting means on said cylinder for moving said latching member out of said latching engagement with said abutment members.

4. A lifting device comprising elongated supporting members, wheels mounted on the end portions of said members for supporting the latter, an elongated lifting frame pivotally mounted at one end to one end of said supporting members and having another end normally disposed adjacent to the other end of said supporting members, said other end of said lifting frame having means for supporting an object, two posts mounted on and extending upwardly from said one end of said supporting members in spaced relation to each other, a cylinder pivotally mounted between said posts above said supporting members, said cylinder including an elongated guide member projecting outwardly therefrom toward said lifting frame and having two rods projecting laterally outwardly therefrom in opposite directions, an elongated piston having one end portion extending through said guide member and slidable therethrough into and out of said cylinder, the other end portion of said piston being fixedly pivoted to said lifting frame between said two ends thereof, a latching member pivoted to said other end portion of said piston and extending thereabove, said latching member having a plurality of notches therein complementary to said rods and in which said rods are latchingly engageable during movement of said piston into said cylinder for holding said piston against outward movement relative to said cylinder, and a lever pivotally mounted on said latching member and manually engageable with said guide member for moving said latching member out of said latching engagement with said rods for freeing said piston for movement outwardly relative to said cylinder.

5. In a lifting apparatus, an elongated base, an elongated lifting frame having a mounting end pivoted on a first horizontal axis disposed transversely of said base adjacent one end of such base and said lifting frame having its other end formed with load engaging means to define a load end on said frame, said frame being shiftable about said first axis from a lower position wherein said frame is substantially horizontal through a limited lifting range to thereby raise said load end of said frame, means affording a second horizontal axis parallel to and substantially above said first axis and spaced horizontally from said first axis toward the other end of said base, means affording a third pivotal axis disposed on and transversely of said lifting frame and intermediate the ends thereof and at a predetermined distance from said first pivotal axis, power operated force applying means connected between and pivoted at spaced points respectively on said second and third axes and operable to apply lifting forces in tension between said second and third axes to raise said lifting frame, said second axis being spaced vertically from said first axis in an amount substantially less than said predetermined dimension so that the included angle between said lifting frame and a line joining said second and third axes reduces rapidly and becomes relatively small when said frame approaches the upper limit of said lifting range.

6. In a lifting apparatus, an elongated base, an elongated lifting frame having a mounting end pivoted on a first horizontal axis disposed transversely of said base adjacent one end of such base and said lifting frame having its other end formed with load engaging means to define a load end on said frame, said frame being shiftable about said axis from a lower position wherein said frame is substantially horizontal through a limited lifting range to thereby raise said load end of said frame, an operating cylinder pivoted on a second horizontal axis parallel to and substantially above said first axis and spaced horizontally from said first axis toward the other end of said base, a piston in said cylinder, a piston rod connected between said piston and a third pivotal axis disposed on and transversely of said lifting frame and intermediate the ends thereof and at a predetermined distance from said first pivotal axis, said second axis being spaced vertically from said first axis in an amount substantially less than said predetermined dimension so that the included angle between said lifting frame and said piston decreases rapidly and becomes relatively small when said frame approaches the upper limit of said lifting range.

7. In a lifting apparatus, an elongated base, an elongated lifting frame having a mounting end

pivoted on a first horizontal axis disposed transversely of said base adjacent one end of such base and said lifting frame having its other end formed with load engaging means to define a load end on said frame, said frame being shiftable about said axis from a lower position wherein said frame is substantially horizontal through a limited lifting range to thereby raise said load end of said frame, an operating piston and cylinder device including a piston, a piston rod element and a cylinder element, one of which elements is pivoted on a second horizontal axis parallel to and substantially above said first axis and spaced horizontally from said first axis toward the other end of said base, means connecting the other of said elements on a third pivotal axis disposed on and transversely of said lifting frame and intermediate the ends thereof and at a predetermined distance from said first pivotal axis, said second axis being spaced vertically from said first axis in an amount substantially less than said predetermined dimension so that the included angle between said lifting frame and said piston decreases rapidly and becomes relatively small when said frame approaches the upper limit of said lifting range.

8. A lifting device comprising an elongated supporting frame including upwardly extending supporting means on one end portion thereof, elongated arms pivotally mounted at one end to said frame and having means at the other end thereof for supporting an object, cylinder means pivotally mounted on said supporting means, a piston mounted in said cylinder means and pivotally connected in tension to said elongated arms between the ends thereof, said piston being movable into and out of said cylinder means and operable upon movement into said cylinder means to raise said other ends of said arms, means projecting outwardly from said cylinder means, a latching member pivotally mounted between said arms and movable into releasable latched engagement with said outwardly projecting means during such movement of said piston into said cylinder means to thereby positively hold said piston against outward movement relative to said cylinder means, a releasing member mounted on said latching member and operatively engageable with said cylinder means for moving said latching member from said engagement with said outwardly projecting means, and means comprising an abutment on said cylinder means and engageable with said releasing member during outward movement of said piston relative to said cylinder means for moving said releasing member out of said operative engagement with said cylinder means.

9. A lifting device comprising an elongated supporting frame, an elongated lifting frame pivotally mounted at one end to said supporting frame and having means at the other end for supporting an object, supporting means on said supporting frame and extending upwardly above said one end of said lifting frame, a cylinder pivotally mounted on said supporting means above said one end of said lifting frame, said cylinder including an elongated guide member projecting outwardly therefrom toward said lifting frame, and an elongated piston having a head reciprocably mounted in said cylinder, and a rod extending through said guide member and slidable therethrough into and out of said cylinder, said rod comprising an elongated sleeve having one end portion fixedly pivoted to said lifting frame and the other end portion slidably mounted in said guide member, and an elongated rod member mounted in and slidable with said sleeve in spaced relation thereto, said rod member having one end portion fixedly pivoted to said lifting frame and the other end portion connected to said head.

10. In a lifting device of the type comprising a supporting frame, an elongated lifting frame pivotally mounted at one end to said supporting frame and having means at the other end for supporting an object, supporting means on said supporting frame and extending upwardly above said one end of said lifting frame, and a cylinder pivotally mounted on said supporting means above said one end of said lifting frame, an elongated tubular guide member projecting outwardly from said cylinder toward said lifting frame, bushing members mounted in opposite ends of said guide member, and an elongated piston having a head reciprocably mounted in said cylinder, and a rod mounted in said bushings extending through said guide member and slidable through said guide member into and out of said cylinder, said rod comprising an elongated sleeve having one end pivotally connected to said lifting frame and the other end projecting toward said head, and an elongated rod member laterally loosely mounted in said sleeve and reciprocable therewith, said rod member having one end pivotally connected to said lifting frame and the other end connected to said head for movement therewith.

11. A lifting device comprising an elongated supporting frame, arms pivotally mounted at one end to said frame and having means at the other end for supporting an object, posts on said frame and extending upwardly above said one end of said arms, a cylinder pivotally mounted on said posts on an axis located in a horizontal plane spaced above said pivot mounting of said one end of said arms and located in a vertical plane intermediate the ends of said arms, a latch member associated with said cylinder, a piston slidably mounted in said cylinder and pivotally connected in tension to said arms for raising the latter around said one end, and latch means connected to and movable with said piston and engageable with said latch member when the arms are in raised position to lock the piston to the cylinder against accidental displacement from a position corresponding to the raised position of said arms.

12. A lifting device comprising an elongated supporting frame, an elongated lifting frame pivotally mounted at one end to said supporting frame, the other end of said lifting frame having means for supporting an object, said supporting frame including elongated supporting means mounted on and extending upwardly from the lifting frame pivoting portion of said supporting frame, a motor pivotally mounted on said supporting frame above said one end of said lifting frame, the motor pivot axis being located in a vertical plane nearer said other end of said lifting frame than a vertical plane passing through the pivotal mounting of said one end of said lifting frame, said motor including a member fixed thereto and a reciprocating member, one end of which is movable upwardly relative to said supporting frame during an operation of said motor, said member being pivotally connected in tension to said lifting frame between the ends thereof and being operable upon such movement upwardly relative to said supporting frame during operation of said motor to raise said other end of said lifting frame, and latch means movable with said reciprocating member and en-

gageable with the member fixed to the motor when the lifting frame is in raised position to lock said member against accidental displacement from a position corresponding to a raised position of said lifting frame.

13. A lifting device comprising an elongated supporting frame, an elongated lifting frame pivotally mounted at one end to one end of said supporting frame, the other end of said lifting frame being normally disposed adjacent to the other end of said supporting frame and having means thereon for supporting an object, elongated posts mounted on said first mentioned end of said supporting frame and extending upwardly from, and inclined toward, said other end of said supporting frame, power means including members pivotally and slidably mounted on said posts above said one end of said supporting frame and pivotally connected in tension to said lifting frame between the ends thereof for applying a predetermined tension to said lifting frame to thereby raise said other end of said lifting frame around said one end thereof, the pivotally mounted power means member including a member fixed thereto, and latch means movable with said slidably mounted power means member and engageable with said member fixed to said pivotally mounted power means member when the lifting frame is in raised position to lock the slidably mounted power means member against accidental displacement from a position corresponding to a raised position of said lifting frame.

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The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,552,965	Harris	May 15, 1951

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