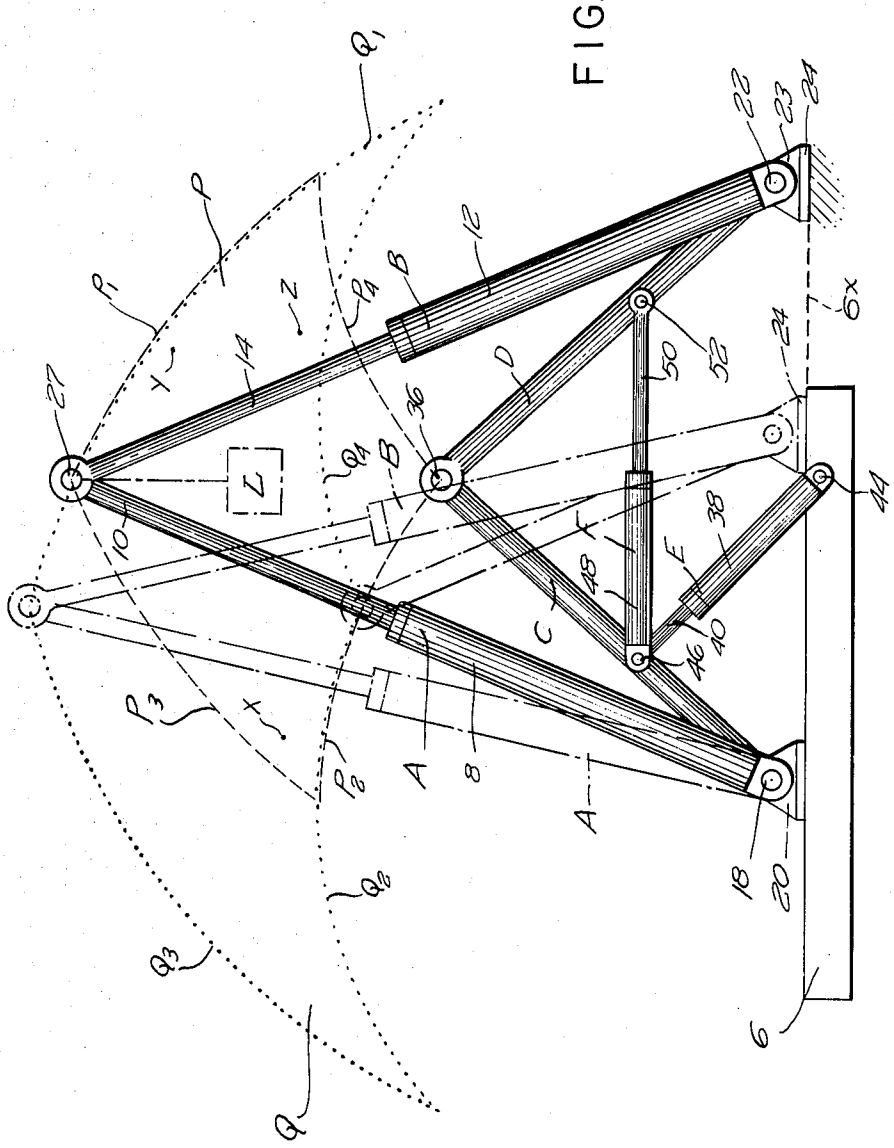
May 3, 1966 R. ROBERTS 3,249,235

VARIABLE BASE A- FRAME HOIST

Filed March 25, 1964 3 Sheets-Sheet 1

FIG. 1



INVENTOR.
REX ROBERTS

BY
Emery, Booth, Miller & Townsend

ATTORNEYS

VARIABLE BASE A- FRAME HOIST

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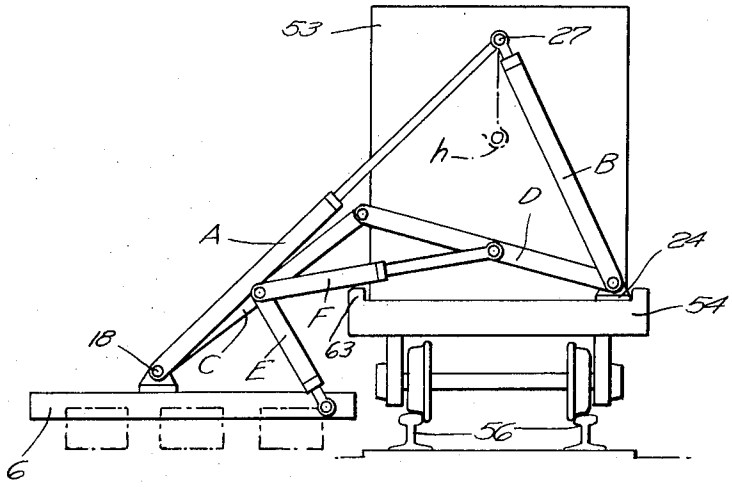

FIG. 2

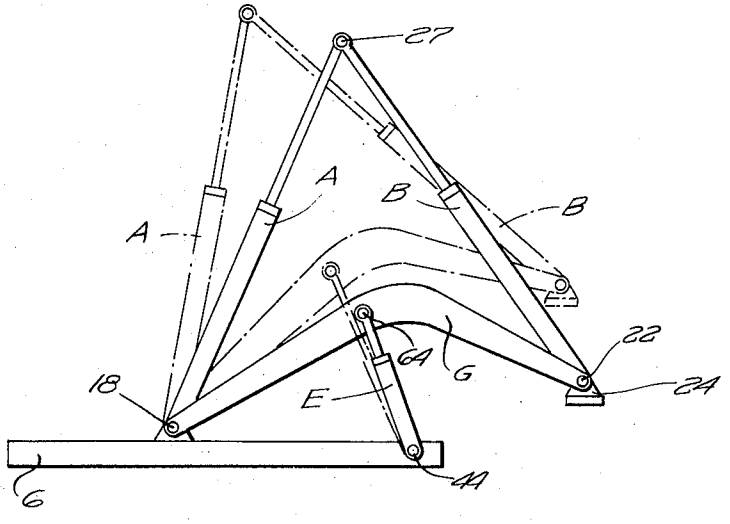

FIG. 3

INVENTOR.
REX ROBERTS
BY
Emery, Booth, Miller & Townsend
ATTORNEYS

May 3, 1966 R. ROBERTS 3,249,235

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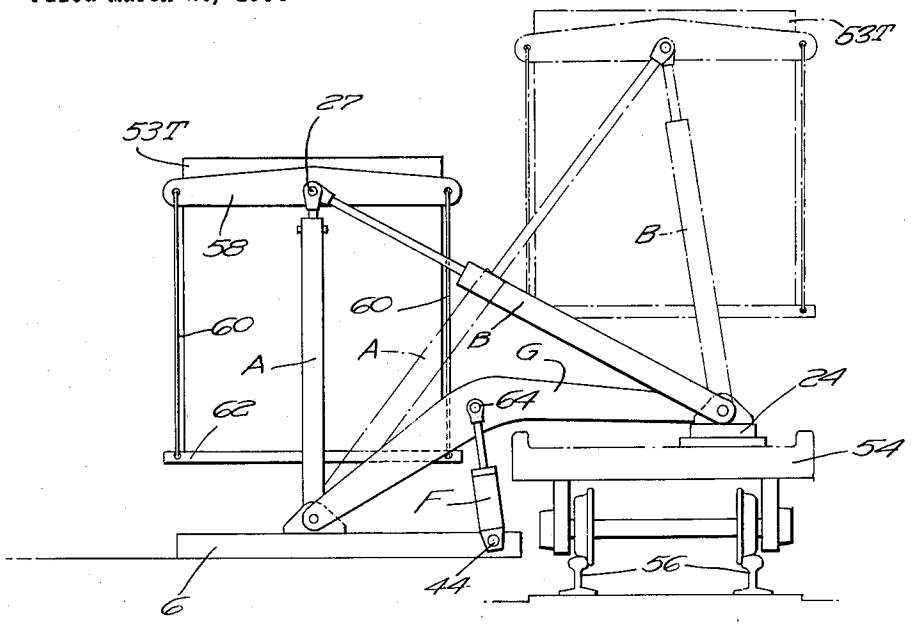

FIG. 4

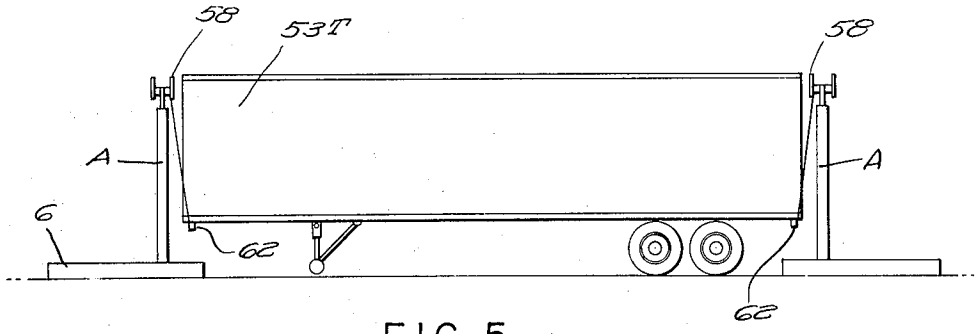

FIG. 5

INVENTOR.
REX ROBERTS
BY
Emery, Booth, Miller & Townsend
ATTORNEYS

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VARIABLE BASE A-FRAME HOIST

Rex Roberts, Groton, Mass., assignor to Ames Shovel and Tool Company, North Easton, Mass., a corporation of New Jersey

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9 Claims. (Cl. 212—8)

This invention relates to apparatus and methods for the transfer of loads between positions which may be at a common level or at different levels and may be variously spaced horizontally.

More particularly, the invention resides in the provision of novel load lifting, transferring and lowering means and methods having general utility with respect to loads of variant size, form and weight, including weights up to many tons according to the designed range for the given apparatus. Among the numerous uses to which the invention is applicable are the loading and unloading of vehicles and conveyances including trucks, railway cars, ships and various other carriers and the like, as well as the transfer of loads between substantially any more or less closely adjoined locations, as in stacking heavy items and materials, moving them to and from storage and such.

In the accompanying drawings illustrating largely diagrammatically or schematically embodiments of means of the invention and whereby the methods thereof may be practiced:

FIG. 1 is an end elevation of one load-handling device or crane showing in full line and in broken line different operative positions thereof;

FIG. 2 is a corresponding view on a smaller scale representing action of a modified form of my load-handling device at different operative levels;

FIG. 3 shows on a scale similar to FIG. 2 another embodiment of the apparatus and whereby the methods of the invention may be practiced;

FIG. 4, corresponding to FIG. 3, illustrates two stages in a load-transferring operation such as that of a large body as for example a semi-trailer to or from a platform such as that of a railway car; and

FIG. 5 is a schematic side view illustrating the use of two lifter or crane units of the invention as for example in an operation as for FIG. 4.

Considering the drawings in more detail, and referring first more particularly to FIG. 1, an operational lifter and transfer unit or crane device as a whole comprises a mounting platform or primary base **6**, presenting a generally horizontal supporting area of suitable size and shape to accommodate the operative elements to be described. The platform **6** preferably is of a character adapting it and the parts mounted thereon to be shifted between different points of use, and to that end it may be equipped with "road" wheels, rolls, casters or the like (not shown) or otherwise be constituted as a mobile platform or transportable frame for the active support of the operative elements.

The latter comprise a primary pair of elongated longitudinally extensible and retractable legs, each designated generally at A and B and which together may be described as a bipod or two-legged boom, the pivotally correlated legs of which are variably relatively positionable in the general manner of those of a human being. The leg A is illustrated herein as comprising a long double-acting fluid cylinder **8** and piston assembly **10**. Leg B comprises a similar double-acting cylinder **12** and piston assembly **14**. For the purposes of this invention, however, legs A and B may comprise other known mechanically extensible and retractable or telescoping structures.

The head or cylinder end of leg A is pivotally connected at **18** to a stationary pedestal or anchor plate **20** fixedly mounted on the base **6**. The head end of leg B

is similarly pivotally connected at **22** to the upright flange **23** of a foot-plate or foot **24** separate from and movable relative to the platform proper **6**. The foot **24** preferably is provided with a bottom face adapted for firm contact with the particular underfooting and adapted for operative positioning on or in the working vicinity of said platform **6** as an extension thereof. Thus the total platform or base **6** including the foot **24** as in effect an active element thereof constitutes an operative common base for the bipod, whether at a given time the foot **24** be set on the platform as in broken line in FIG. 1, or be offset from the platform so as to extend the then operative base.

The tail or outer piston rod ends of legs A and B are pivotally interconnected as through a pivot or hinge connection **27** common thereto and forming the apex of the bipod which extends vertically up from the aforementioned common base in the manner of a two-legged boom of the novel dual form and capacities as herein disclosed.

Means are provided at the inter-leg pivot **27** marking the apex of the bipod for suspending a load. Such load suspension means, of which one example appears in FIGS. 4 and 5, may be a hook, grapple, cable or any known or preferred device for detachable securement to the load or object to be lifted or to a suitable fixture thereon. The supporting means at pivot **27** may comprise, for example, a rigid horizontal arm with depending sling as at **58** in said mentioned FIGS. 4 and 5. Or it may even comprise a chain-fall or a winch (not shown) hung on the pivot **27** and having the free end available for engagement with the load. Any known or preferred means (not shown) may be provided for controlledly supplying fluid under pressure to the cylinders **8** and **12** selectively at one or the other side of their respective pistons so that either or both legs A and B can be extended or retracted positively and independently of each other.

Thus under the invention, the pivot **27** and hence the load suspension means may be moved both vertically and horizontally by variously changing the length of one or the other or of both the boom elements, i.e., the leg A and/or leg B and/or the position of foot **24** relative to pivot **18** along an infinite number of different paths within an area determined by the maximum and minimum limits of those lengths, so long as maximum allowable overturning moments are not exceeded.

More specifically, for a given positioning of foot **24**, the common pivot **27** and the load suspension means may be moved in the plane containing legs A and B and through an area of that plane common to the maximum and minimum extensions of legs A and B. To illustrate, when the foot **24** is positioned as indicated by solid lines in FIG. 1, the common pivot **27** and load suspension means may be moved anywhere within the dashed-line spatial envelope labelled P, and, practically, within limits of maximum allowable overturning moments. Envelope P is bounded by the arcs P^1 and P^2 swept out by leg A when that is at its maximum and minimum lengths respectively and by arcs P^3 and P^4 swept out by leg B when that is at its maximum and minimum lengths respectively. In other words envelope P is the overall area of locus of the pivot **27** common to both legs.

Thus by manipulating the lengths of legs A and B, the load suspension means located at pivot **27** may be made to engage a load at a point *x* within envelope P, lift the load and move it laterally to the right to a point *y* and then lower it to a point *z*. Furthermore, to avoid obstacles that may be present, the suspension means may be moved between points *x*, *y* and *z* along any number of different paths within the envelope P.

It is important to realize that my apparatus is able to lift and move extremely heavy loads suspended at the apex of the bipod between points in the envelope P without requiring counterweights, struts or stays for stability.

This is because during the entire load transferring operation, the crane is able to keep the center of mass of the load between the vertical projections of the load bearing legs A and B, or in other words between the basal support points at **18** and **22** of the apparatus as a whole. Thus the forces acting on legs A and B due to the load are substantially all compressive and there is no tendency to tip the crane. And due to the nature of the stresses on legs A and B, the legs may be of a relatively light weight construction and still lift these heavy loads.

Further under this invention, means are provided for moving foot **24** relative to pivot **18** and operatively positioning the foot on a solid footing at different levels on or around the platform **6** and on the operatively extensible base defined by said platform and by the appropriately positioned foot **24** as dictated by the particular load transferring problem encountered. The positioning means illustrated in FIG. 1 comprises a pair of similar arms C and D. These adjusting arms C and D need not be as large as or as rugged as legs A and B since they are not primary load bearing elements, but are used primarily for positioning the leg B and its foot **24**.

The lower end of arm C is pivotally connected at **18**, in the same manner as leg A, to the anchor plate **20**. The lower end of arm D is pivotally connected as at **22** along with the leg B to ear **23** on foot **24**. The opposite ends of arms C and D are pivotally interconnected above the working base **6** as by means of a pivot **36** common thereto.

An extensible and retractable arm E comprising, for example, a double-acting cylinder **38** and piston assembly **40**, is provided to control the elevation of arm C with respect to base **6**. The head end of cylinder **38** is pivotally connected as at **44** to platform **6** while the tail end of piston **40** is pivotally connected to arm C as at a point **46** therealong. As shown, arm E may have the head or basal end offset from the plane containing legs A and B to lend added stability to the crane device, the pivotal connection as at **44** being of a universal form enabling the load suspension means at **27** to be shifted to some extent in a direction perpendicular to the plane of the legs for more accurate positioning of the apparatus with respect to the load.

Still referring primarily to FIG. 1, the positioning means desirably comprises also an additional extensible and retractable arm F for moving arm D with respect to arm C. For this purpose I have shown a double-acting cylinder **48** and piston assembly **50** connected between the aforementioned pivot **46** and a pivot **52** located on arm D preferably at an intermediate point along it. Each of arms E and F likewise have means (not shown) for controlledly supplying fluid under pressure selectively to the cylinders thereof at one and the other side of their respective pistons so that arms E and F can be extended or retracted independently of one another.

Thus by suitably variably adjusting the lengths of arms E and F, foot **24** may be raised, lowered or moved laterally. For example, extending arm E and retracting arm F moves foot **24** from its solid line position in FIG. 1 to or toward the dotted line position wherein it rests on the primary platform **6**.

It will be appreciated that the re-positioning of foot **24** on and adjacent the platform **6** changes the overall locus of pivot **27** to a different circumscribing envelope. The locus now becomes a spatial envelope Q bounded by the arcs Q^1, Q^2 and Q^3, Q^4 swept out by the legs A and B at their maximum and minimum extensions respectively. Similar envelopes indicating the range of movement of the common pivot **27** and the load suspension means secured thereto may easily be visualized when the foot **24** is operatively positioned at other locations on or within or above or below the total operative base **6***x* of the apparatus.

Referring now to FIG. 2 wherein is shown a crane apparatus similar to that of FIG. 1 positioned to lift one

end of a long load **53** from a flat car **54** standing on railroad tracks **56**. Of course, where the load is of considerable length in the direction of the tracks, similar apparatus adapted to operate in unison with the illustrated device is stationed at the other end of load **53**.

In this operational example the base **6** has been stationed on the ground or other substructure adjacent the flatcar **54**, with the extensible foot **24** of the leg B operatively positioned solidly on the top of the flat car adjacent the end of the load **53** by suitably manipulating arms E and F as aforesaid. Load suspension means comprising a diagrammatically indicated hook *h* depending from the common pivot **27** engages the end of load **53**, or both ends of a relatively short load. The crate, container or other load body **53** is off-loaded from the flatcar **54** simply by extending both of legs A and B slightly to lift the load to above the level of the guard rail **63** of the flatcar and then simultaneously retracting leg A and extending leg B until the load has swung over to the left as viewed in FIG. 2 to a point above the platform **6** or whatever lateral location within the capacity of the apparatus is desired. The load may then be lowered by further retracting the legs A and B as requisite to deposit the load on the ground or on a truck undercarriage or other such support (not shown). During the entire offloading operation, the center of mass of load **53** will remain between the vertical projections of the fixed head ends of legs A and B. Thus any need for resort to additional stays, jacks, counterweights or such is obviated in maintaining the stability of the crane.

FIG. 3 shows a modified form of my apparatus having a somewhat more limited range of movement than that of FIGS. 1 and 2, but which is particularly adapted to load and unload semitrailers as during railroad piggyback operations. It has the similar primary platform **6**, primary lifting legs A and B and variably positionable foot **24** for one of them, herein again the leg B. As before, the load suspension means (not shown) is located at the common pivot **27**.

The FIG. 3 device differs from the prior example mainly in that the arms C, D and F are replaced by a single rigid non-extensible bowed positioning arm G which extends from the fixedly anchored pivot **18** on platform **6** to the pivot **22** on the movable foot **24**.

As before, an extensible and retractable arm E for controlling the elevation of arm G is connected between the pivot **44** on platform **6** and a pivot **64** located at or near the bow in arm G. The movements of foot **24** in response to changes in the length of arm E are limited to those in an arc about pivot **18**. However, for a given positioning of foot **24**, the pivot **27** is movable within a given spatial envelope as previously described in connection with the FIGS. 1 and 2 embodiment of my invention.

In FIG. 4, showing the FIG. 3 form of my apparatus positioned adjacent one end of a semitrailer **53T** which it is desired to place on a flatcar **54**, a similar device is assumed to be simultaneously positioned at the other end of such trailer **53T**, for operation in unison with the first one as described with reference to FIG. 3. At the outset, the feet **24** of both end-located cranes are moved to a raised position such as indicated by dotted lines in FIG. 3. A flatcar **54** is positioned on tracks **56** beside and generally paralleling the semitrailer **53T**. Thereupon the feet **24** are lowered by retracting the corresponding arms E to step the feet firmly down onto the flatcar near the respective ends thereof, into the foot position as in full-line in FIGS. 3 and 4. The legs A of the two cranes are contracted and the legs B extended until the slings **60**, **62** comprising the load suspension means at each end of the semitrailer **53T** are brought to appropriate level to be engaged under the respective ends of the semitrailer as seen at the left in FIG. 4. Then the legs A are operatively manipulated in extension and contraction cooperatively as appropriate to elevate the semitrailer **53T** and to shift it laterally to the dotted-line posi-

tion as at the right in FIG. 4. Both legs A and B may then be slowly retracted to lower the semitrailer 53T and deposit it on the flatcar 54. Finally, the feet 24 will be raised sufficiently, as to the dotted-line position of FIG. 3, by extending arm E, whereupon the platform 6 and the entire crane apparatus thereon are pulled back away from the flatcar 54 which then is free to move away with the semitrailer 53T loaded on it.

In the FIGS. 3 and 4 embodiment of my apparatus the maximum and minimum extensions of legs A and B and the length of and bow of arm G may be so proportioned and correlated that the locus of the load-supporting common pivots 27 of the leg pairs A–B and hence the center of mass of the load 53 will never extend laterally out beyond the operative basal locations of the head ends of legs A and B, respectively. Thus it is ensured that the full weight of the trailer or other load is borne by the primary lifting elements A and B and that the stresses on the secondary and permissibly less substantial arms E and G are kept to a minimum.

FIG. 5 shows two of my side loading cranes of the type illustrated in FIGS. 2 to 4 as they would be positioned at the opposite ends of a load 53 such as a semitrailer and operated in unison as explained in connection with FIGS. 3 and 4.

It will thus be seen from the foregoing description in conjunction with the drawings that my load transferring apparatus and method facilitates loading operations particularly including those of the piggyback variety. With my invention extremely heavy loads can be moved very rapidly and efficiently with a relatively lightweight piece of equipment, and with no danger of the load unbalancing or tipping over the equipment.

It will be seen also that objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in carrying out the above method and in the construction set forth without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limting sense. By way of example, those skilled in the art will find it obvious that pivotal connection of leg A to the base 6 (in the various figures) may be of a limited universal type in which common stabilizers limit the extents to which the assembly can tilt to the side.

It will be understood that my invention, either as to means or method, is not limited to the exemplary embodiments or steps herein illustrated or described, and I set forth its scope in my following claims:

1. A load-handling device comprising a base, a pair of variably extensible and contractile main legs, means pivotally anchoring one end of one of said legs to said base, one end of the other of said legs being movably positionable relative to the anchored end of said one of said legs, means for adjusting the positions of the positionable end of said other of said legs relative to said anchored end of said one of said legs, means pivotally interconnecting the ends of said legs opposite said anchored and positionable ends of said legs, load attaching means connected with said legs at the site of the pivotal interconnection between their said opposite ends, means for positively extending and contracting the legs independently while said load attaching means is connected with a load, whereby, upon extension and contraction of said main legs, said load attaching means with a load attached is movable through paths of movement the limits of which are established by the maximum and minimum lengths of said legs and by the spacings between said anchored and positionable ends of said legs.

2. A load-handling device according to claim 1 wherein said means for adjusting the positionable end of said other of said legs includes two independently operable members, means connecting one of said members in a lateral force-transmitting relationship with said positionable end and said one leg to move said positionable end laterally toward and from said one leg, and means connecting the other of said members in a heightwise force-transmitting relationship with said positionable end and said anchored end of said one leg to move said positionable end to different levels in relation to said pivotally anchored end of said one leg.

3. A load-handling device according to claim 1 wherein said means for adjusting the positionable end of said other of said legs includes means for variably spacing the lower ends of the legs so that they span the horizontal length of said paths of movement of a given load to be handled by said load attaching means.

4. A side-loading crane comprising a base, an outboard positioning foot movable relative to said base, a pair of extensible and retractable legs, means hinging said legs together at one end, means pivotally connecting the other end of one of said legs to said base, means pivotally connecting the other end of the other of said legs to said positioning foot, said legs together constituting an upstanding bipod of operatively variable spread, means at the site of said hinging means for suspending a load; a rigid arm, means pivotally connecting one end of said arm to said base, means pivotally anchoring the other end of said arm with said other end of the other of said legs, an extensible and retractable member, means pivotally connecting one end of said member to said arm at a position between the ends thereof, and means pivotally connecting the other end of said member to said base, whereby extending and retracting of said member are effective to operatively position said positioning foot on solid footings including locations above, below and level with said base in the working vicinity thereof, and whereby extending and contracting of said legs when said foot is on the selected solid footing are effective to move said load suspending means within a spatial envelope bounded by the loci of the maximum and minimum extensions of said legs.

5. A crane apparatus comprising a movable base adapted to be placed at the side of a support such as a railway car platform to or from which a load is to be transferred, a movable arm, means mounting one end of said arm on the base in pivotally anchored relationship thereto, a foot connected with the arm at the other end thereof and adapted by movement of the arm to be set on said support beside said base, and a pair of expansible and contractable legs, means mounting one end of one of said legs on the base in pivotally anchored relationship thereto, means connecting one end of the other of said legs with said foot, means pivotally connecting the other ends of said legs in relationship to one another, means for suspending a load from the site of the pivotal connection between said legs, and means for selectively moving said arm in relation to said base and, thereby, to effect positioning of said foot and said one end of the other of said legs.

6. A pivoting-frame crane comprising a movable base, movable arm means, means mounting one end of said arm means in pivotally anchored relationship to said base, means for pivotally moving the other end of said arm means relative to the base about said mounting means, a pair of extensible and contractable legs each comprising a fluid operated cylinder and piston, means mounting one end of one of said legs on said base in pivotally anchored relationship thereto, means connecting one end of the other of said legs in pivotal relationship with the outer end of said arm means, means pivotally joining said legs together at their other ends, and means for suspending a load substantially at the site of the pivotal joint between said legs, whereby expanding and contracting of said legs is effective to raise and lower the load suspending means and shift it and a load suspended thereby between said base and an elevated support.

7. Apparatus as defined in claim 6 wherein said arm means comprises two pivotally interconnected arms hav-

ing their unconnected ends pivotally anchored with said base and with said one end of said other of said legs, respectively, and wherein said means for pivotally moving said arm means includes an expansible and retractable member, one end of said member being pivotally connected in force transmitting relationship with the end of said arm which is anchored with said one end of said other of said legs and the other end of said member linked in force transmitting relationship with said base.

8. Apparatus as defined in claim 6 wherein said means for pivotally moving said arm means includes an extensible and retractable member, means pivotally connecting one end of said member in force-transmitting relationship with said arm means at a point above said base and pivotally connecting the other end of said member in force-transmitting relationship with said base.

9. A crane for hoisting, transferring and lowering a heavy load, said crane comprising a movable main platform, a template-like foot of substantial supportive area and being movable relative to said platform, a pair of extensible and retractable load bearing legs, hinge means interconnecting said legs at their upper ends, means pivotally interconnecting the lower end of one leg to said platform, means pivotally connecting the lower end of the other end of the other leg to said foot, said platform and said foot together defining a common operative base for the crane as a whole, said legs together constituting an upstanding bipod of operatively variable spread, means at the site of said hinge means for suspending a load; a pair of foot positioning arms hinged together at one end, means pivotally anchoring the other end of one of said arms to the platform, means pivotally anchoring the other end of the other of said arms to said foot, a first extensible and retractable member, means pivotally connecting one end of said member to said one of said arms at a point thereon between its ends, means pivotally connecting the other end of said member to said platform at a point thereon spaced from the pivotal connection of said one leg thereto, a second extensible and retractable member, means pivotally connecting one end of said second member to a point on said one of said arms between its ends, and means pivotally connecting the other end of said second member to a point on the other of said arms between its ends; whereby extending and retracting of said first and second members are effective to position said foot on a solid footing within said common operative base, and whereby extending and retracting of said legs are effective to move said load suspending means within limits established by the maximum and minimum extensions of said legs.

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EVON C. BLUNK, *Primary Examiner.*

SAMUEL F. COLEMAN, *Examiner.*

A. L. LEVINE, *Assistant Examiner.*