April 23, 1963 W. A. POZNIK 3,086,751

HYDRAULIC JACK

Original Filed Feb. 2, 1961 2 Sheets-Sheet 1

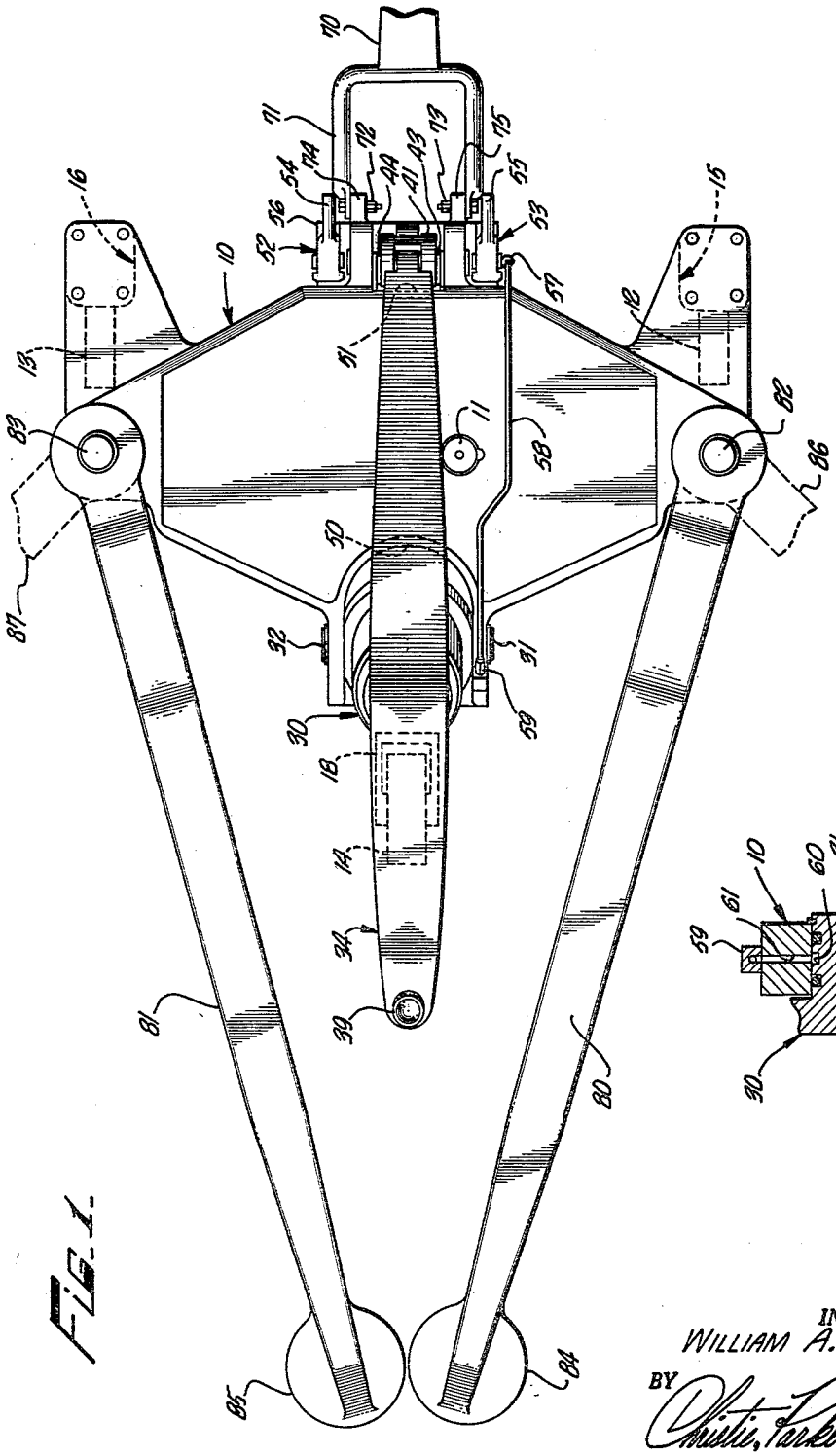

FIG. 1.

FIG. 4.

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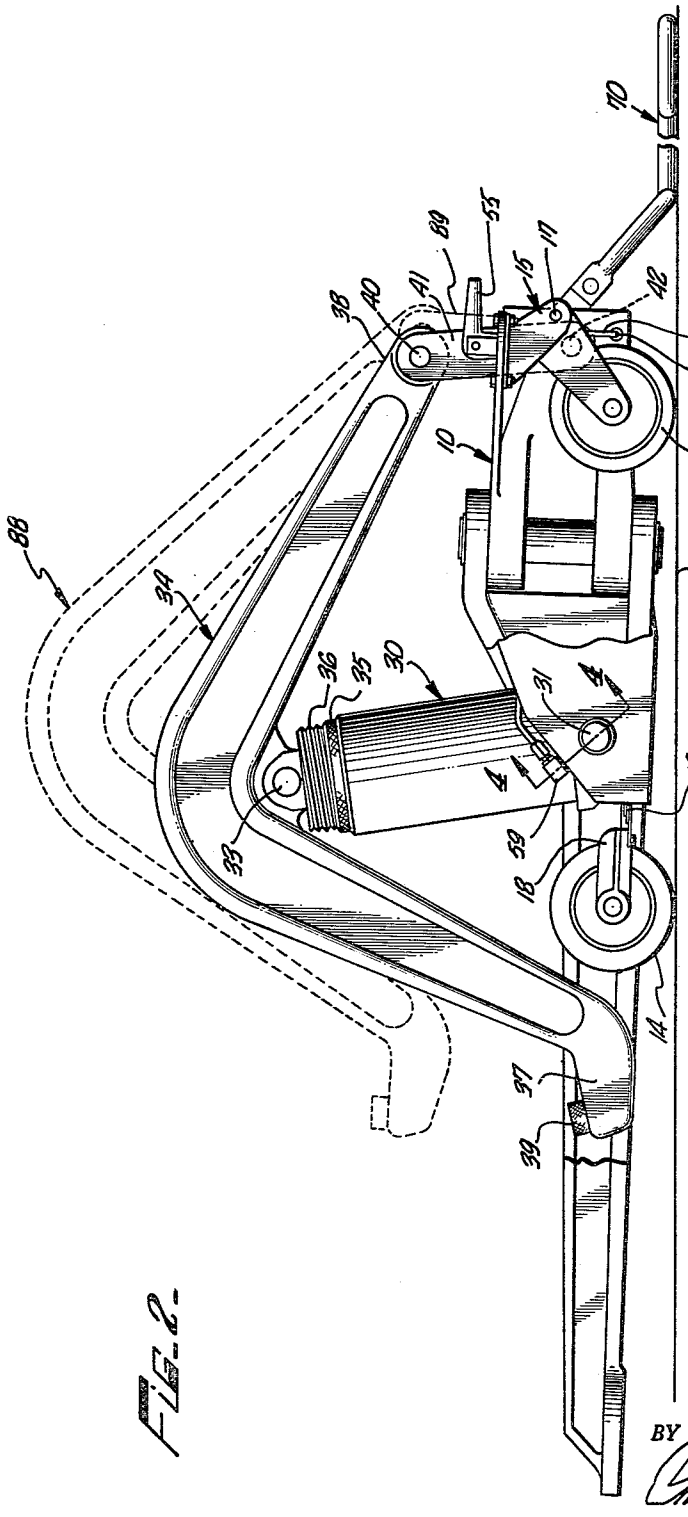

FIG. 2.

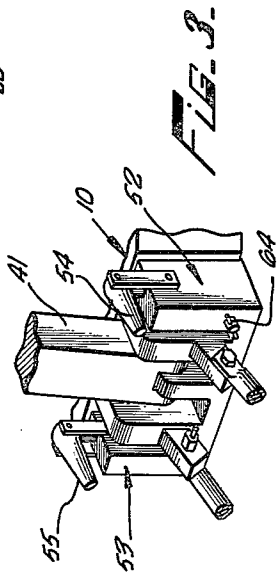

FIG. 3.

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HYDRAULIC JACK

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Continuation of application Ser. No. 86,674, Feb. 2, 1961. This application Mar. 26, 1962, Ser. No. 183,991
8 Claims. (Cl. 254—8)

The invention relates to hydraulic jacks, and particularly to hydraulic jacks for lifting wheel assemblies of aircraft landing gears wherein access to the jack point on the landing gear is limited, loads are large, and lateral displacement of the landing gear during jacking is likely.

This application for United States Letters Patent is a continuation of my earlier application, Serial No. 86,674, filed February 2, 1961, now abandoned, for Hydraulic Jack.

The large and heavy aircraft prevalent today often have landing gears which utilize a bogie assembly having four or more wheels. These multiple wheeled bogie assemblies present unique problems when it is desired to lift the landing gear vertically with a jack for removal or repair of the wheels thereon, particularly when one or more of the pneumatic tires on the wheels is flat.

The jack point of the landing gear is usually on the bogie assembly between the wheels. Consequently, access to this jack point is limited, and it is not possible to position properly a conventional relatively bulky hydraulic jack under the jack point on the bogie assembly. This is particularly true when the tires on the bogie assembly are flat, because the flat tires spread laterally toward the jack point on the bogie assembly and thus severely limit access to such jack point. It is thus necessary that the jack have a lifting head which can be positioned properly under the jack point on a bogie assembly despite very limited access to such jack point.

Another problem inherent in existing devices is the fact that normally only one landing gear is jacked, which consequently tilts the aircraft and imposes lateral loads on the lifting head of the jack. These lateral loads tend to disengage the jack point from the lifting head of the jack and thereby drop the aircraft with consequent hazard to life and property.

An example of such lateral loading is observed in a typical existing jack. Normally the lifting head moves in an arc which is concave toward the carriage of the jack. The arc lies in a vertical plane. As the lifting head is engaged with a lifting point on a landing gear bogie and the bogie is raised, the lifting point tends to move along an arcuate path which is concave away from the jack. This movement of the bogie lifting point is especially present when the bogie has a front pair of wheels and a rear pair of wheels disposed on opposite sides of a vertical landing gear strut. If one or both of the front tires are flat and are to be removed, the jack is engaged with the forward lifting point of the bogie, and to accomplish this engagement the jack must be placed in front of the bogie. As the front wheels leave the ground, the bogie member and the lifting point pivot about the axles of the rear wheels of the landing gear. The forward lifting point therefore moves along an arc which is concave away from the jack. Simultaneously, the lifting head of the jack moves toward the jack carriage. If both the jack carriage and rear landing gear wheels are stationary, there is inherent relative movement between the lifting end of the jack beam and the lifting point of the bogie such that the jack may become disengaged from the bogie.

The invention effectively solves the above problems through apparatus which includes a lifting head on a forwardly extending finger-like jacking beam in order that

the lifting head can be efficiently positioned at the jack point of a bogie assembly under conditions of very limited access to such jack point, and which permits limited lateral movement of the lifting head in the plane of jacking motion during jacking in order that such head will follow any lateral displacement of the jack point and thus prevent imposition of lateral loads tending to cause disengagement of the lifting head from the jack point. The inventive apparatus also includes means whereby its stability during jacking is assured and whereby its operation is simple, effective, and rapid.

Generally speaking, the invention provides a cantilever type lever action jacking apparatus comprising a movable carriage and a lifting beam having a lifting end extending from the carriage. Means for movably mounting the beam to the carriage are provided; such means provide two degrees of movement of the beam relative to the carriage. The apparatus also provides means for moving the lifting end of the beam primarily toward and away from the carriage in a plane having a predetermined orientation relative to the carriage. The means for moving the lifting end of the beam permits lateral movement of the beam in the plane relative to the carriage and includes an extensible ram or piston pivotally connected between the carriage and the beam and link means pivotally connected between the beam and the carriage. The link means are spaced apart from the piston along the beam.

The inventive apparatus includes, more specifically, a frame on which supporting wheels are mounted with spring means yieldably biasing the frame upwardly in spaced position from the ground but permitting vertical shiftability of the frame to engagement with the ground. An upwardly extending hydraulic piston and cylinder assembly is pivotally connected at its lower end to the frame and at its upper end to a jacking beam. The jacking beam has a lift end extending beyond the frame adjacent to the ground. In addition to the piston, the beam is pivotally connected to the frame with a substantially vertically extending link. The arrangement of the jacking beam, piston and cylinder, and link is such that the jacking beam is free to move laterally in its plane of vertical movement. Suitable stop means are provided to limit the extent of such lateral movement of the jacking beam to a predetermined maximum amount. Conventional hydraulic pumps are mounted on the frame and operatively connected to the piston and cylinder and to a fluid reservoir on the frame for actuation of the piston through operation of the hydraulic pump from a location remote from the lift end of the jacking beam.

The invention will be fully understood from a reading of the following description taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a plan view of the inventive apparatus;

FIGURE 2 is a fragmentary elevation view of the inventive apparatus;

FIGURE 3 is a fragmentary perspective view of a portion of the inventive apparatus; and

FIGURE 4 is a sectional view to enlarged scale along the line 4—4 in FIGURE 2.

Referring to FIGURE 1, **10** designates a frame. Frame **10** is a hollow fluid-tight structure with internal webbing for torsional and bending rigidity. The fluid-tight interior chambers defined within frame **14** serve as a fluid reservoir for operation of the apparatus, as explained below. A screw-cap **11** provides access to the internal chambers in frame **10**.

Frame **10** is mounted on rotatable ground engaging wheels. Wheels **12, 13** are located one on each side of frame **10** at the rear end thereof. A third wheel **14** is mounted at the front end of frame **10** equidistant from wheels **12, 13**. Wheels **12, 13** are connected to frame **10** with conventional knee action casters **15, 16**, respective-

ly. Each caster 15, 16 has a pivotal knee, indicated at 17 for caster 15, and is yieldingly biased against upward movement of the wheel mounted thereon in conventional manner, as by means of a spring on the caster acting between the two portions of the caster pivotally connected together at pivotal knee 17, in order that the wheel is biased downwardly but able to move vertically through pivotal movement about such knee of the caster. Third wheel 14 is rotatably mounted in conventional manner in a fork 18 which is connected to frame 10 by means of a leaf spring 19 fixed to fork 18 and to frame 10. Leaf spring 19 biases wheel 14 downwardly in ground engaging position but is yieldable to permit wheel 14 to displace upwardly. It is apparent that wheels 12, 13, and 14 are yieldably biased to support frame 10 in spaced relation from the ground, indicated at 20, and that application of downward forces on frame 10 will result in the wheels displacing upwardly and frame 10 displacing downwardly to engagement with ground 20. It is within the scope of the invention, however, that wheel 14 may be mounted by casters as mount wheels 12 and 13.

A conventional extensible hydraulic ram or piston and cylinder assembly 30 is pivotally connected about a horizontal axis at its lower end to the frame 10 by means of trunnions 31, 32 fixed on the cylinder and rotatably carried in frame 10. Piston and cylinder assembly 30 extends upwardly, and at its upper end its piston is pivotally connected about a horizontal axis by means of pivot pin 33 to a jacking beam or lifting member 34. As stated above, piston and cylinder assembly 30 is a conventional hydraulic jacking unit and its details will not be further described. As illustrated, piston and cylinder assembly 30 is secured to the forward portion of frame 10. A safety lock nut 35 is threadedly received on the movable ram portion 36 connected to the piston in order that the lock nut may be seated on the cylinder when the ram and piston are in extended position to prevent premature retraction through unexpected loss of fluid pressure within piston and cylinder assembly 30.

Jacking beam 34 is generally V-shaped opening downwardly and has a lift end 37 and an anchored end 38. In a preferred embodiment of the invention, the pivotal connection effected between the upper end of piston and cylinder assembly 30 and jacking beam 34 by means of pivot pin 33 is located intermediate the lift end 37 and anchored end 38 of the jacking beam at the apex of the beam. Lift end 37 of jacking beam 34 extends forwardly from the forward end of frame 10 and from wheel 14 in spaced relation therefrom to lie closely adjacent to ground 20 when the beam 34 is in its retracted position. The clearance between the under side of lift end 37 and ground 20 is, as illustrated, relatively small in order that lift end 37 can be maneuvered into locations of limited access close to ground 20. A suitable lifting head 39 is fixed to lift end 37 and has a surface, conventionally hemispherical, which is similar to the shape of a jack point on a bogie assembly for engagement of lifting head 39 with such jack point.

The jacking beam 34 further is pivotally connected to the carriage by rigid link means. A pivot pin 40 having a horizontal axis hingably mounts jacking beam 34 to a connecting link 41 which has its lower end pivotally connected about a horizontal axis to frame 10 with a pivot pin 42. Connecting link 41 extends upwardly from pivot pin 42 to pivot pin 40. The axes of pivot pins 33, 40, 42 and trunnions 31, 32 are each horizontal and all are parallel to each other and extend at right angles to jacking beam 34. Spiral springs 43, 44 each have one end connected to frame 10 and the other end connected to connecting link 41 and are prestressed to yieldingly bias link 41 in a counterclockwise direction about pin 42 toward the lift end of the jacking beam. This holds the jacking beam in proper position while the apparatus is being moved and positioned for use.

Since piston 30 and the link means 41 are connected to beam 34, beam 34 is mounted for movement in a plane having a predetermined orientation relative to frame 10. Because the pivot pins 31, 33, 40 and 42 are horizontal, the movement of beam 34 is in a vertical plane, that is, the primary movement of beam 34 is toward and away from frame 10 in a vertical plane. Secondary lateral movement of beam 34 in the vertical plane may occur longitudinally of frame 10 since piston 30 and link means 40 are pivoted to the beam 34 and to the frame 10. Because the link 41 is rigid and because the ram 30 is located between the anchored end and the lifting end of the beam, the beam rotates or changes its attitude relative to the chassis as the ram 30 is operated.

Stop means are provided to limit to a predetermined amount the maximum lateral movement of jacking beam 34 in its vertical plane. In the illustrated embodiment, these stop means take the form of a predetermined horizontal clearance of yoke 50 in frame 10 from cylinder and piston assembly 30, which limits such lateral movement of jacking beam 34 rearwardly or to the right in FIGS. 1 and 2. A similar predetermined horizontal clearance of recess 51 in frame 10 from link 41 limits such lateral movement of jacking beam 34 forwardly or in a direction to the left in FIGS. 1 and 2.

Normally the lifting end 37 of beam 34 follows an arc which is concave toward the frame 10 as piston 30 is extended. This is because springs 43 and 44 normally bias the link member forwardly of frame 10 in a counterclockwise direction. The resiliently biased pantograph linkage between the beam and the carriage guides the lifting head 39 along a preselected path during unloaded movement of beam 34. The combination of springs 43 and 44 with the link member 41 comprises means for guiding the lifting head 39 along the preselected path. The configuration of the apparatus, consistent with the lifting head 39 being close to ground 20 when the beam 34 is in its retracted position, provides that the chord of the arc normally traversed by lifting head 39 is substantially vertical. The normal arc refers to the path along which the lifting head moves when the jack is unloaded. It was mentioned above, however, that the path of the lifting point on a landing gear is an arc which is concave away from the carriage 10. Even though the normal arc of travel of lifting head 39 is concave toward carriage 10, head 39 follows the arc of travel of the bogie lifting point since beam 34 is permitted to move longitudinally of carriage 10 as it moves vertically. The biasing effect of springs 43 and 44 on beam 34 is inconsequential when compared with the loading imposed on the beam by the landing gear. Since the arc actually followed by lifting head 39 is dictated by the path of a bogie lifting point, lateral loading of the lifting head is avoided and undesired disengagement of lifting head 39 and the jack point is prevented. It is apparent that without this freedom of movement of jacking beam 34 in its plane of vertical motion, as, for example, would be the case if pin 40 connected anchored end 38 of the jacking beam directly to frame 10, lifting head 39 would be constrained to follow only an arc when elevated and would thereby tend to disengage itself from the jack point on the load unless either the jack as a whole or the load as a whole displaced horizontally to accommodate such arcuate movement of lifting head 39.

Conventional hydraulic pumps, schematically illustrated at 52, 53, are mounted on frame 10 at its rear end and have operating handles 54, 55, respectively, which, through a suitable conventional handle extension (not illustrated) permit the pumps to be operated from a position remote from the lift end 37 of jacking beam 34. Two pumps are illustrated, pump 52 being a low pressure high displacement pump for moving lifting head 39 into engagement with a jack point on the apparatus to be lifted, and pump 53 is a high pressure low displacement pump for lifting of large loads after engagement of lifting head 39 with the jack point on such loads. Pumps 52, 53 are connected

together and to the fluid reservoir defined within frame 10 in conventional manner by means of a manifold 56 in order that the pumps receive fluid from the fluid reservoir within frame 10. Pumps 52 and 53 may be used alternately or simultaneously to discharge such fluid under pressure through a conventional fitting 57. The arrangement of manifold 56, provided in order to perform the above described functions, is conventional and within the province of those skilled in the art and hence will not be described in detail. Fitting 57 is connected to a fluid conduit 58 which is connected to a second fitting 59 at the forward end of frame 10. As illustrated in FIG. 4, fitting 59 communicates through a passage 61 in frame 10 to an annular recess 60 defined by trunnion 31 in its exterior surface. Annular recess 60 communicates through a radial passage 62 and an axial passage 63 to the interior of the cylinder of piston and cylinder assembly 30. In this manner, fluid under pressure is transported from discharge fitting 57 of pumps 52, 53 to the piston and cylinder assembly 30 for hydraulic actuation of the piston within such piston and cylinder assembly responsive to operation of the hydraulic pumps. A conventional release valve on the rear end of frame 10 is schematically indicated at 64 (FIG. 3) and is operative through manifold 56 to permit selective communication of conduit 58 to the fluid reservoir within frame 10 via a by-pass of pumps 52, 53 in order that when it is desired to release fluid pressure within piston and cylinder assembly 30, release valve 64 may be manipulated to effect same. The manner in which release valve 64 is provided to perform the above functions is within the province of those skilled in the art and will not be described in detail.

A suitable towing handle 70 is yoked at 71 and pivotally connected with pins 72, 73 to lugs 74, 75 fixed to frame 10.

Outrigger arms 80, 81 are each pivotally connected about a vertical axis to opposite sides of frame 10 with pins 82, 83, respectively. Outrigger arms 80, 81 are elongated and have jack pads 84, 85 at their outer ends for ground engagement.

This apparatus is illustrated in solid lines in the drawings in its condition when not in use or being towed. As illustrated, outrigger arms 80, 81 are rotated about their vertical pivot axes defined by pins 82, 83, respectively, toward frame 10 with their jack pads 84, 85 adjacent. Also, as illustrated in FIG. 2, wheels 12, 13, and 14 support frame 10, lift end 37 of jack beam 34, and the outrigger arms above ground level so that the entire apparatus can be easily moved. In operation, outrigger arms 80, 81 are rotated outwardly to the position indicated with phantom lines 86, 87 to straddle the outside of the bogie assembly to be jacked. Lift end 37 of jacking beam 34 is maneuvered between the wheels of the bogie assembly and lifting head 39 positioned under the jack point on such bogie assembly. Hydraulic pumps 52, 53 are then operated in conventional manner in order to actuate the piston within piston and cylinder assembly 30 and extend same to raise jacking beam 34 to an elevated position, as indicated in FIG. 2 with phantom lines 88. As illustrated, link 41 displaces to the position indicated with phantom lines 89 in order that jacking head 39 displaces upwardly vertically or arcuately concave away from frame 10 rather than arcuately toward frame 10. Upon engagement of lifting head 39 with the jack point of the bogie assembly being jacked, further elevation of jacking beam 34 results in wheels 12, 13, and 14 yieldably displacing in order that frame 10 and jack pads 84, 85 of outrigger arms 80, 81, respectively, engage the ground. Further operation of the hydraulic pumps elevates the bogie assembly, and when sufficient elevation thereof has been obtained, safety lock nut 35 is screwed down to engage the cylinder of piston and cylinder assembly 30 for safety. When the bogie assembly is to be lowered, safety lock nut 35 is screwed upwardly away from the cylinder of piston and cylinder assembly 30 and release valve 64 is opened, thereby retracting piston and cylinder assembly 30 and lowering jacking beam 34 and the bogie assembly lifted thereby.

The apparatus of this invention provides a hydraulic jack in which the lifting head follows a predetermined path when the jack is operated with no load imposed thereon. This feature allows the operator of the device to preposition the jack under a load such that the lifting head will engage the load at a preselected point. Also, the apparatus is such that the lifting head is capable of moving to accommodate limited displacement of the load when the jack is subjected to a load.

While the invention has been described above in terms of specific apparatus, this has been by way of example and illustration and should not be considered as limiting the scope of the invention to the illustrated embodiment.

What is claimed is:

1. A jack comprising a frame, a substantially vertical hydraulic piston and cylinder assembly, means for pivotally connecting the lower end of the piston and cylinder assembly to the frame for pivotal movement thereof about a horizontal axis, a jacking beam having a lift end and an anchored end, said lift end of the jacking beam extending beyond the frame and being adjacent to the ground, pin means for directly connecting the upper end of the piston and cylinder assembly to the jacking beam at a point intermediate its lift end and anchored end such that the jacking beam and the piston and cylinder assembly pivot relative to each other about a horizontal axis, a substantially vertical link having its lower end pivotally connected about a horizontal axis to the frame and having its upper end pivotally connected about a horizontal axis to the anchored end of the jacking beam, the upper end of the link being connected to the jacking beam at a location spatially intermediate the upper and lower ends of the piston and cylinder assembly, the upper and lower pivot axes of the piston and cylinder assembly and of the link all being substantially parallel to each other and transverse to the jacking beam, the beam being movable longitudinally of the frame independently of the condition of actuation of the piston and cylinder assembly, stop means on the frame between the link and the piston and cylinder assembly for limiting to a predetermined extent the degree of pivotal movement of the piston and cylinder assembly and the link about their respective lower pivot axes, a hydraulic pump on the frame operable from the end of the frame remote from the lift end of the jacking beam, and means operatively connecting the hydraulic pump to the piston and cylinder assembly for hydraulic actuation of the piston responsive to operation of the hydraulic pump.

2. Apparatus in accordance with claim 1 wherein the jacking beam is substantially V-shaped opening downwardly and the pin means connecting the piston and cylinder assembly to the jacking beam is located at approximately the apex of the jacking beam.

3. Apparatus in accordance with claim 2 wherein the lower end of the link is pivotally connected to the rear end of the frame, the means for pivotally connecting the lower end of the piston and cylinder assembly to the frame is located at the forward end of the frame, and the lift end of the jacking beam extends forwardly from the forward end of the frame.

4. A jack comprising a frame, rotatable ground engaging wheels, means for yieldably connecting the wheels to the frame for vertical shiftability of the frame to engagement with the ground and for biasing the frame in spaced position from the ground, an upwardly extending hydraulic piston and cylinder assembly, means for pivotally connecting the lower end of the piston and cylinder assembly to the frame for pivotal movement thereof about a horizontal axis, a jacking beam having a lift end and an anchored end, said jacking beam being substantially V-shaped opening downwardly, said lift end of the jacking beam extending beyond one end of the frame and being adjacent to the ground, a single upwardly ex-

tending link having its lower end pivotally connected about a horizontal axis to the other end of the frame and its upper end pivotally connected about a horizontal axis to the anchored end of the jacking beam, pin means for directly connecting the upper end of the piston and cylinder assembly to the jacking beam at a point intermediate its left end and anchored end and located approximately at the apex of the jacking beam such that the jacking beam and the piston and cylinder assembly pivot relative to each other about a horizontal axis, the upper and lower pivot axes of the piston and cylinder assembly and of the link all being substantially parallel to each other and transverse to the jacking beam, stop means for limiting to a predetermined extent the degree of pivotal movement of the piston and cylinder assembly and the link about their respective lower pivot axes, a hydraulic pump on the frame operable from the end of the frame remote from the lift end of the jacking beam, and means operatively connecting the hydraulic pump to the piston and cylinder assembly for hydraulic actuation of the piston responsive to operation of the hydraulic pump, the jacking beam having two degrees of freedom of movement relative to the frame, the first degree being substantially vertical relative to the frame, the second degree being longitudinally of the frame, the movement of the beam in its second degree of freedom being independent of movement of the beam in the first degree of freedom.

5. A hydraulic jack engageable with a point on a load, the point moving along an arc convex to the jack during lifting of the load, the jack comprising:

(*a*) a carriage movable over a supporting surface,

(*b*) a lifting beam movably mounted to the carriage and having a lifting end engageable with a load and an opposite end, and

(*c*) means for mounting the beam to the carriage so that the beam is movable in two degrees of freedom relative to the carriage and for moving the lifting beam lifting end primarily toward and away from the supporting surface in a vertical plane, said means for mounting and moving providing for limited longitudinal movement of the lifting beam relative to the carriage to accommodate movement of the lifting end of the lifting member when the lifting end is engaged with the point and the point moves along said convex arc, said means for mounting and for moving including

(1) an extensible hydraulic ram pivotally connected to the carriage and pivotally connected to the beam, and

(2) a rigid link member spaced from the ram along the beam pivotally connected to the carriage and pivotally connected to the beam,

(*d*) and means for limiting the longitudinal movement of the lifting end relative to a preselected path, the path being a circular arc having a chord oriented substantially perpendicular to the supporting surface.

6. A hydraulic jack according to claim 5 including resilient means for biasing the lifting beam and the lifting end thereof toward one of two limits of longitudinal movement of the beam whereby the lifting end follows a preselected path during movement toward and away from the supporting surface.

7. A jack for lifting a load of the type which has a path of movement in a vertical plane when lifted that is convex with respect to the jack, said jack comprising: a movable carriage having a front and rear end, a lifting beam having a load engaging head at a first end disposed adjacent the front end of the carriage for lifting a load and a second end disposed adjacent the rear end of the carriage, a fluid motor pivotally connected to the carriage and pivotally connected to the lifting beam for raising the load engaging head of the lifting beam relative to the carriage, a link spaced from the fluid motor and pivotally connected at one end to the carriage and pivotally connected at the other end to the lifting beam, the fluid motor and the link providing for longitudinal movement of the lifting beam with respect to the carriage, spring means for biasing the lifting beam toward a predetermined starting position, and stop means for limiting the longitudinal movement of the lifting beam with respect to the carriage and providing for limited longitudinal movement of the second end of the lifting beam from said predetermined starting position away from the front end of the carriage so that the load engaging head in lifting said load moves vertically along an arc which is convex with respect to the jack and substantially the same as the arc defined by said load.

8. A jack comprising a movable carriage, a lifting beam having a load engaging head for lifting a load, a fluid motor pivotally connected at one end to the carriage and pivotally connected at the other end to the lifting beam, a link spaced from the fluid motor and pivotally connected at one end to the carriage and pivotally connected at the other end to the lifting beam, whereby said lifting beam has longitudinal movement with respect to the carriage, and stop means for limiting longitudinal movement of the lifting beam, whereby the load engaging head may follow an arc which is convex with respect to the jack.

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