June 18, 1963 J. B. McALPINE 3,094,192

PLATFORM OPERATING SYSTEM

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Fig. 2.

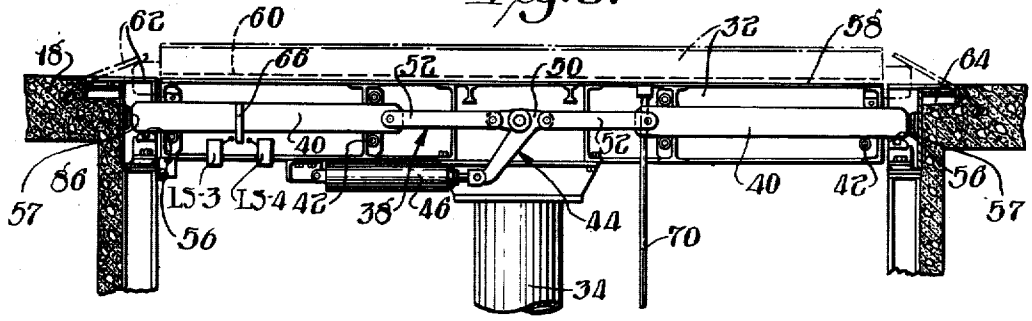
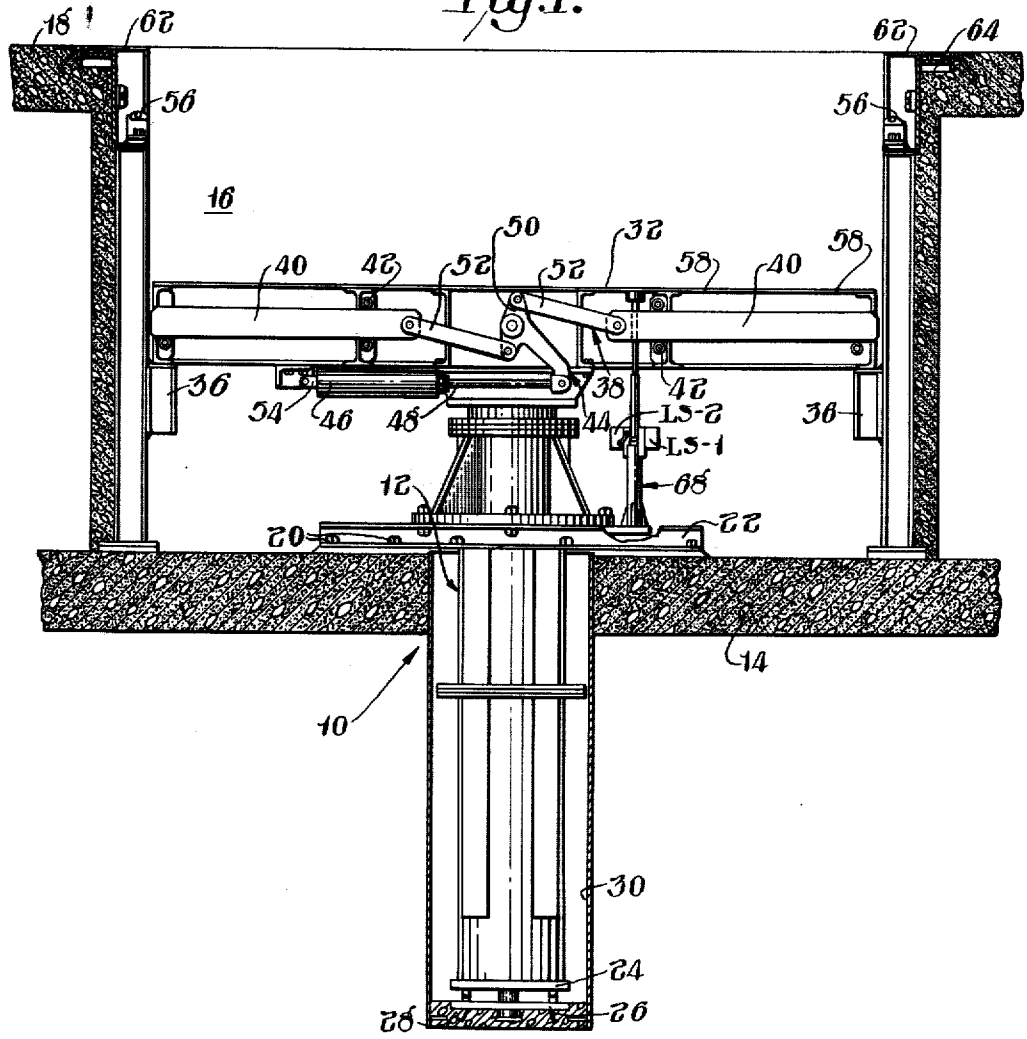


Fig. 1.



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Fig. 3.

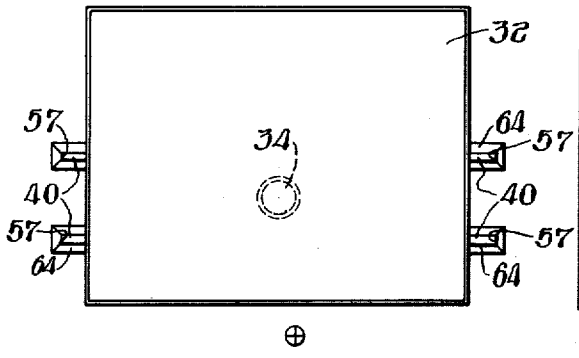


Fig. 9.

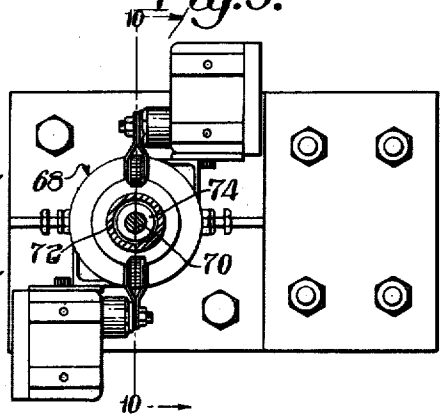


Fig. 8.

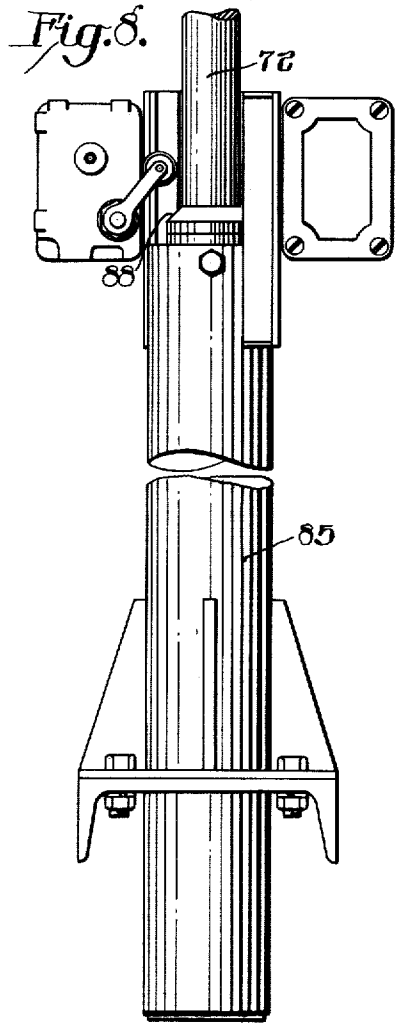
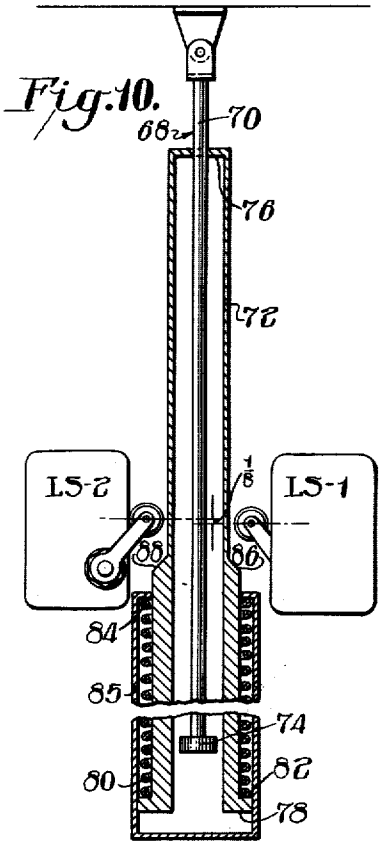


Fig. 10.



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Fig. 5.

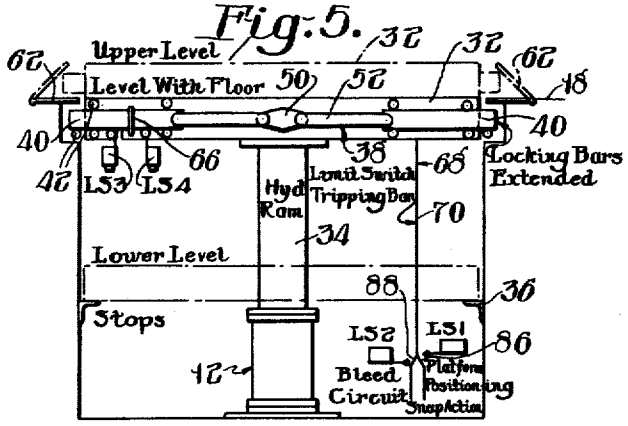


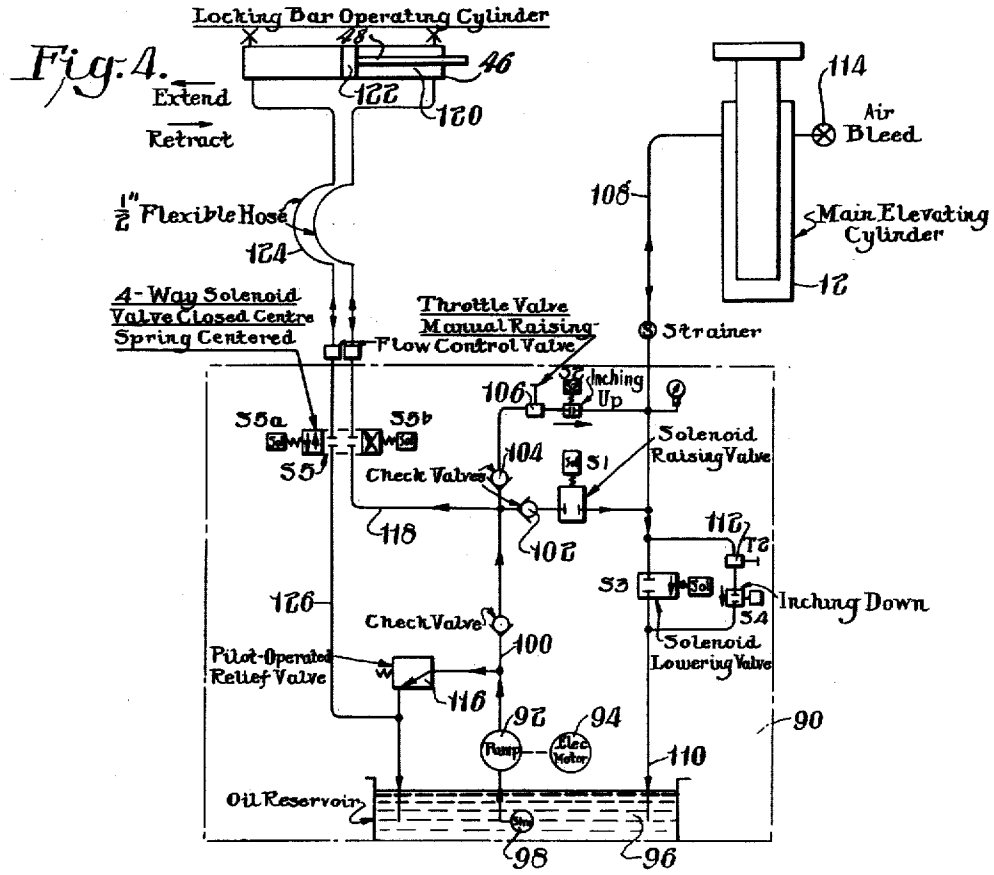
Fig. 7.

Limit Switch Operations

	LS1 &R6	LS2 N/C	LS3 &R6	LS4 N/O	LS4 N/C
Upper Level					
1" 8 Above Floor					
Level With Floor			Contacts Closed		
Lower Level					

Note-R6 Deenergized Pressure Switch

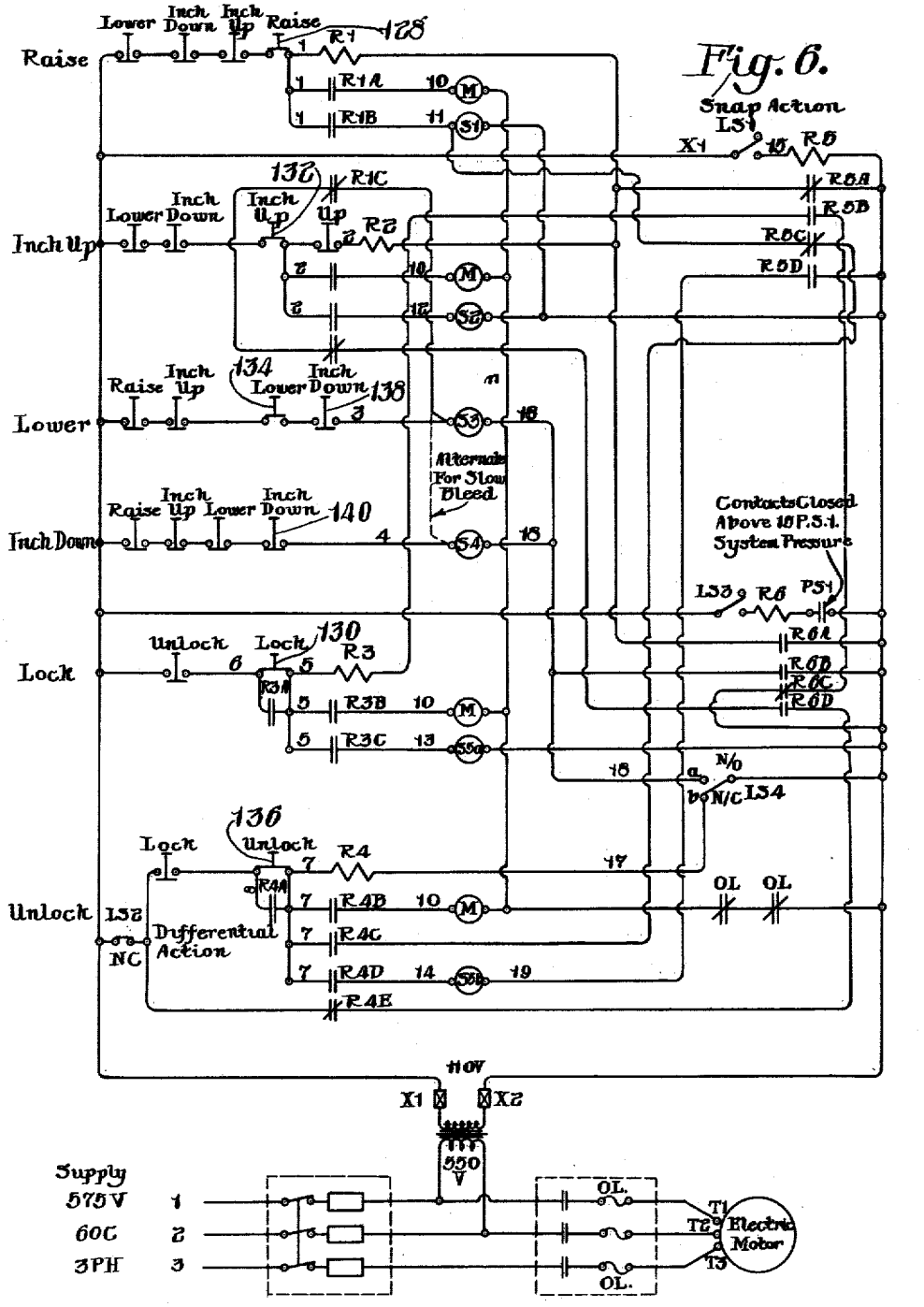
Fig. 4.



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United States Patent Office 3,094,192 Patented June 18, 1963

3,094,192

PLATFORM OPERATING SYSTEM

John B. McAlpine, Scarborough, Ontario, Canada, assignor to Symington Wayne Corporation, Salisbury, Md., a corporation of Maryland

Filed Oct. 21, 1960, Ser. No. 64,076
16 Claims. (Cl. 187—28)

This invention relates to a system for operating a vertically-movable platform, and it more particularly relates to such a system for lowering the undercarriage of an aircraft within a pit.

Modern aircraft, such as jet transports, have become quite large and heavy; and it has, therefore, become quite difficult to repair and test their undercarriage through its operating range. Proposals have, therefore, been made to drop the wheels within pits while an aircraft is supported in a raised position upon jacks. In dropping the undercarriage, the wheels are positioned upon platforms raised substantially to ground level over the pits, and then the platforms are raised a short distance to permit supporting jacks to be placed under the airplane's jacking points. Then the platforms are lowered far enough into the pit to allow full extension, maintenance, testing and replacement of the wheel assemblies if necessary.

Suitable platforms for such operation should be relatively large in area for accommodating the large and rather spread out wheel assemblies of big airplanes, and they must move upwardly and downwardly through a stroke of considerable length. This imposes severe loads upon suitable raising and lowering devices such as hydraulic piston and cylinder assemblies, particularly when the load is eccentrically applied to the platforms in rolling the wheels on and off them.

These severe roll-on and roll-off loads can be resisted by supporting such platforms upon several piston and cylinder assemblies as described in U.S. Letters Patent 2,803,360. However, this complicates the manufacture, operation and maintenance of the lifting system as well as making it necessary to synchronize operation of the individual lifting assemblies. Furthermore, even when several lifting elements are utilized, they might all fail simultaneously, or failure of one element might disasterously tilt the platform or damage the operative lifting element.

An object of this invention is to provide a safe, simple and economical arrangement for operating a vertically-movable platform.

Another object is to provide such an arrangement for installation within a pit which accommodates the undercarriage of an aircraft.

In accordance with this invention a platform is mounted upon a piston and cylinder assembly installed, for example, within a pit. An actuating device extends and retracts locking bars laterally from the platform for engagement upon a supporting surface disposed at the side of the pit adjacent ground or loading level. Hydraulic pressure bleeding means is connected with the piston and cylinder assembly for gently lowering the platform onto the supporting surface, and this pressure bleeding means is actuated by the platform control system to lower the extended locking bars onto the supporting surface when the platform is substantially at ground level. The supporting surface may also include vertical surfaces between which the locking bars engage to prevent any horizontal as well as vertical movement of the platform. This insures that any roll-on and roll-off forces imposed upon the platform are resisted by the supporting surfaces and not imposed upon the piston and cylinder assembly.

The pressure bleeding means may be inactivated when the platform is raised a predetermined distance above the loading level to permit it to lift and maintain a load

above this level. Furthermore, interlocking means may be provided in the control system for preventing movement of the platform a substantial distance above the loading level unless the locking bars are extended and for preventing movement of the platform below the loading level unless the locking bars are retracted. The locking bar assembly may be hydraulically actuated from the main source of hydraulic pressure, and the hydraulic system may utilize solenoid-operated valves for controlling the raising, lowering and bleeding of the piston and cylinder assembly.

Novel features and advantages of the present invention will become apparent to one skilled in the art from a reading of the following description in conjunction with the accompanying drawings wherein similar reference characters refer to simlar parts and in which:

FIG. 1 is a cross-sectional view in elevation of one embodiment of this invention in the lowered condition;

FIG. 2 is a cross-sectional view in elevation of the upper portion of the embodiment shown in FIG. 1 with the platform substantially at ground level shown in full outline and above ground level partially illustrated in phantom outline;

FIG. 3 is a plan view of the embodiment shown in FIG. 2;

FIG. 4 is a schematic diagram of a hydraulic system for operating the embodiment shown in FIG. 1;

FIG. 5 is a schematic diagram of the embodiment shown in FIG. 1 together with portions of its control system;

FIG. 6 is a schematic electrical diagram for operating the embodiment shown in FIGS. 1–4, including its hydraulic and control system;

FIG. 7 is a schematic chart of the operational phases of portions of the electrical and mechanical control system described in FIG. 5 with particular reference to sensing devices;

FIG. 8 is an enlarged view in elevation of a portion of the control system shown in FIG. 1;

FIG. 9 is a plan view of the portion shown in FIG. 8; and

FIG. 10 is a cross-sectional diagrammatic view taken through FIG. 9 along the line **10—10**.

In FIGS. 1 and 2 is shown a vertically-movable platform arrangement **10** including a hydraulic piston and cylinder assembly **12** mounted upon the base or foundation **14** of a pit **16** which is, for example, of rectangular plan, and extends downwardly from the floor or ground level **18**. Piston and cylinder assembly **12** is of the hydraulic ram type, and it is, for example, rigidly and economically made in the manner described in copending application for U.S. Letters Patent Serial No. 57,325, filed September 20, 1960. Cylinder and piston assembly **12** is secured to foundation **14** by anchor bolts **20** through supporting beams **22**, and the lower end **24** of assembly **12** rests detachably upon a base plate **26** which is anchored within a concrete floor **28** which fills the bottom of casing **30** accommodating piston and cylinder assembly **12**. Details of the aforementioned portions of piston and cylinder assembly **12**, its mode of construction and installation are fully described in the aforementioned copending application for U.S. Letters Patent.

A platform **32** is mounted upon piston **34** which has a stroke sufficient to raise platform **32** from the lower position shown in FIG. 1 resting upon stops **36** to a position above ground level **18** shown in phantom outline in FIG. 2 in which, for example, the upper surface of platform **32** is nine inches above ground level **18**. A locking bar assembly **38** is connected to platform **32** by installation within its structural frame. Locking bar assembly **38** includes locking bars **40** which are mounted to laterally reciprocate through the sides of platform

32 upon sliding bearings 42 which are, for example, anti-friction bearings of the ball bearing type. An actuating device 44 is connected to locking bars 40, and it includes an actuating cylinder 46 from which a rod 48 extends. Rod 48 is rotatably connected to bell crank 50 which is pivoted upon a shaft within platform 32. A pair of connecting rods 52 connect crank 50 with locking bars 40 to extend and retract them in response to the rotational movement of bell crank 50 imparted by movement of rod 48 by actuating cylinder 46. The end 54 of actuating cylinder 46 remote from rod 48 is also rotatably mounted to permit actuating device 44 to move through its operative position. A pair of actuating devices 44 are provided in conjunction with the two locking bars 40 that each operate to provide the four locking bars 40 in all associated with platform 32 as shown in FIG. 3. However, it is also possible to utilize a single actuating device 44 for operating both pairs of locking bars 40.

In FIG. 1 locking bars 40 are shown in the retracted condition to permit platform 32 to be lowered within pit 16. In FIG. 2 locking bars 40 are extended and resting upon horizontal supporting surfaces 56 to maintain the upper surface 58 of platform 32 substantially at ground level 18. Platform 32 is thereby supported by horizontal surfaces 56 to prevent any eccentric loads transmitted to the platform at ground level, for example, by the wheels of the aircraft rolling across the platform from being transmitted to cylinder and piston assembly 12. Furthermore, the vertical ends of bars 40 in FIG. 2 are extended into contact with vertical stop surfaces 57 to prevent platform 32 from shifting horizontally as a load is moved across it. The straight line disposition of bars 40, the connected links of bell crank 50 and connecting rods 52 in this extended condition rigidly align these elements to resist any horizontal shifting forces.

A position of the platform slightly above ground level which is designated by dashed line 60 in FIG. 2 is a control position at which locking and unlocking of the platform occurs, and the various events which occur at this position are later described in detail in conjunction with the electrical and mechanical control system. Platform 32 can also be raised to an extreme upper position designated in phantom outline in FIG. 2. As platform 32 rises to this highest position which is, for example, nine inches or more above ground level, extended locking bars 40 lift pivoted plates 62 covering recesses 64 upwardly. Plates 62 cover recesses 64 when platform 32 is below ground level.

Also shown in FIG. 2 and schematically in FIG. 5 are a pair of electrical limit switches LS–3 and LS–4 which are actuated by a projection 66 mounted on one of locking bars 40 to detect whether locking bars 40 are in the retracted or extended condition. In FIG. 1 together with FIGS. 8–10 are shown another pair of limit switches LS–2 and LS–1 associated with a telescopic tripping rod assembly 68. Limit switches LS–1 and LS–2 actuate the control circuit in accordance with the vertical position of platform 32 in a manner later described in detail. Telescopic assembly 68 as shown in FIGS. 8–10, includes a rod 70 connected to a lower portion of platform 32. Rod 70 slides within a sleeve 72 and includes a projection 74 at its lower end which engages the upper end 76 of sleeve 72 when rod 70 is lifted sufficiently. The lower end 78 of sleeve 72 is resiliently urged downwardly by coil spring 80 which reacts between shoulder 82 upon enlarged end 78 and the upper end 84 of pedestal 85 which is secured to supporting beams 22. Limit switches LS–1 and LS–2 are respectively actuated by surfaces 86 and 88 of sleeve 72 in the sequence and manner later described in detail in conjunction with the control system.

In FIG. 4 is shown a schematic diagram of the hydraulic system 90 for operating piston and cylinder assembly 12 and locking bar actuating cylinder 46. Hydraulic system 90 includes a pump 92 driven by electric motor 94 with its suction connected to oil reservoir 96 through a strainer 98. Pump 92 discharges through pressure piping 100, which is also connected to cylinder and piston assembly 12, through a paralleled pair of solenoid-operated valves S–1 and S–2 and check valves 102 and 104 in front of them. Solenoid-operated valve S–1 has a greater flow capacity than valve S–2. Valve S–1 is used as the main piston raising valve, and S–2 as an auxiliary or inching-up valve. A manually adjustable valve 106 is connected in front of valve S–2 to restrict flow through S–2 by bypassing through relief valve 116.

Lowering of the piston and platform is accomplished through another pair of paralleled solenoid-operated valves S–3 and S–4, which are connected to piping 108 directly connected to cylinder and piston assembly 12. Valve S–3 is the main valve and valve S–4 is a smaller capacity auxiliary valve for controlling the return flow of oil through pipe 110 to oil reservoir 96. A manually operated valve 112 is connected in front of valve S–4 to permit manual determination of the lowering speed of the platform for inching down. Valve 114 at the top of cylinder and piston assembly 12 permits air to be bled from the highest point of the system during installation. A relief valve 116 is also connected between discharge line 100 and reservoir 96 to recirculate the discharge from pump 92 when the pressure in discharge line 100 is above a predetermined maximum and during the inching up operation.

Auxiliary pipe line 118 connects locking bar actuating cylinder 46 to pressure line 100 through solenoid-operated valve S–5 which is a four-way solenoid-operated valve including sections S–5*a* and *b*. Pressure line 118 is connected through section S–5*b* to the closed end 120 of piston 122 within cylinder 46 to move it in a direction to retract locking bars 40. The other side of piston 122 to which to rod 48 is attached is connected through return line 124 to valve section S–5*a* from which return line 126 is connected to reservoir 96. Valve section S–5*a* accordingly controls the return of fluid from the rod side of cylinder 46, and valve section S–5*b* controls the flow of oil to the blank side of cylinder 46. This causes the speed of retraction controlled by valve section S–5*b* to be greater than the speed of extension of locking bars 40 controlled by valve section S–5*a* because of the greater area of the blank side of piston 122 in comparison with the side to which rod 48 is attached.

FIG. 5 is a schematic diagram showing the relative positions of cylinder and piston assembly 12, platform 32 and portions of the control system including limit switches LS–1–4, actuating rod assembly 68 including surfaces 86 and 88, and actuating projection 66 upon one of locking bars 40. In FIG. 5 the position of platform 32 substantially in line with ground level 18 is shown in full outline together with the fully raised position of platform 32 shown in phantom outline. Reference is made to FIG. 5 in conjunction with the following description of FIG. 6.

In FIG. 6 is shown a schematic diagram of the electrical portions of the control circuit for raising and lowering platform 32 both at full and inching speeds and for extending and retracting locking bars 40. FIG. 6 also describes a provision for bleeding hydraulic pressure from cylinder and piston assembly 12 through lowering valve S–3 or alternatively through smaller capacity lowering valve S–4. This hydraulic pressure bleeding means is actuated when platform 32 is raised within a predetermined distance above ground level with locking bars 40 extended for insuring that the weight of the platform and any loads thereon are supported by stationary supporting surfaces 56 and not transmitted to the cylinder and piston assembly 12 by roll-on and roll-off loads when the platform is substantially at ground level. The bleeding means is energized when platform 32 is in condition for raising above ground level 18 and is, for example, actuated when

locking bars **40** are extended. However, limit switch LS–**2** provides a means for de-activating the bleeding means when platform **32** rises above a predetermined distance above ground level such as ¼ inch to permit the platform and loads imposed upon it to be raised and maintained distances above ground level such as between ¼ inch and 9 inches. Even though the bleeding means is operative up to ¼ inch positions of platform **32** above ground level, the flow of pressure oil to cylinder and piston assembly **12** is sufficiently greater than the amount of oil being bled to raise platform **32** while a small amount of oil is continuously bleeding back to reservoir **96**. The other portions of the control circuit will be described in conjunction with the various events that they control.

In FIG. 7 is shown a diagram of the phases of operation of the various limit switches and relays controlling the events controlled by the diagram shown in FIGS. 4–6.

In describing the circuit shown in FIG. 6, the sequence of operation of the system is described assuming that platform **32** is first disposed at its lowest position as shown in FIG. 1. The following outline describes the operation of each of the buttons and control elements in accordance with its mode of connection through all of the operational conditions of platform **32**. FIG. 6 includes relays R1—R6 which control various contactors designated by alphabetical suffixes to perform the described operations.

OPERATION OF PLATFORM CONTROL SYSTEM

(1) *Raise Button*

The raise button **128** controls the vertical position of the platform over the full travel of the hydraulic plunger, however the platform will not rise above ground level until locking arms **40** have been extended. Contact must be sustained on this button, otherwise platform motion will stop.

Depressing raise button **128** initiates the following:

(*a*) Energizes R1 through N.C. (normally closed contacts R5A (LS–1 unactuated) with platform below floor and N.O. (normally open) contacts R6A (LS–3 actuated) above floor;
(*b*) Starts motor through R1A;
(*c*) Opens solenoid S–1 through R1B; and
(*d*) Prevents automatic bleeding by opening contacts R1C.

This feeds pressure fluid to the plunger, causing the platform to rise until LS–1 is actuated at a point ⅛" above floor level.

(2) *Limit Switch LS–1*

Limit switch LS–1 is set to be tripped at a point ⅛" above the floor level by surface **86**, and this energizes relay R5 initiating:

(*a*) De-energizing R1 (and R2) through N.C. R5A;
(*b*) Unlocking circuit with R3 (to extend arms) through R5B;
(*c*) Breaking circuit with S–1 on unlocking cycle through R5C;
(*d*) Energizing solenoid S–5*b* on unlocking cycle through R5D.

Platform has now reached its maximum height of travel with the arms retracted.

(3) *Lock Button*

Depressing lock button **130** momentarily causes locking arms **40** to extend to their limit and the platform **32** to settle on its stops **56** level with the hangar floor. Momentary pressure on lock button **130**:

(*a*) Energizes relay R3 through contacts R5B (closed by LS–1 being actuated) R6C (normally closed with LS–3 unactuated);
(*b*) Locks in R3 through contact R3A;
(*c*) Starts motor through contacts R3B; and
(*d*) Energizes S–5*a* through contacts R3C.

This causes pressure fluid to extend locking arms **40**. As locking arms **40** leave their retracted positions, LS–4 relaxes, breaking the continuity of the lowering circuit through LS–4*a* and making the contact LS–4*b* in series with the unlocking circuit. Locking arms extend to their limit where switch LS–3 is actuated, causing:

(*a*) Relay R6 to energize;
(*b*) Contacts R6A to close for further raising of platform **32**;
(*c*) Contacts R6B to close for lowering platform **32**;
(*d*) Contacts R6C to open, thereby de-energizing R3; and
(*e*) Contacts R6D to close in series with bleed circuit.

Contacts R6C de-energize R3 stopping motor and closing solenoid valve S–5, and since the bleed circuit is operative through R6D, the platform slowly settles on stops **56** coming to rest.

Since the platform may remain in this position for prolonged periods, a pressure switch P.S.1 is placed in series with R6 to de-energize the same when the system pressure drops below 15 lbs./sq. inch. LS–3, however, remains depressed, and any increase in system pressure such as caused by thermal expansion, will close contacts P.S.1 to open the bleed circuit as before.

Up to this point limit switch LS–2 has not been actuated, and its normally closed contacts have been in series with the unlocking circuit and the bleed circuit. It is not used in conjunction with a relay and provides the simple function of preventing automatic bleeding and unlocking the arms after the platform is raised approximately ¼" above the floor.

(4) *Raising and Lowering From ¼ Inch to an Upper Level*

Platform **32** is level with hangar floor with arms extended and resting on stops **56**. The system is bled and entire electrical circuit de-energized through pressure switch P.S.1 being released. Platform **32** may now be raised or lowered between this position and its upper limit. Pressure on the raise button will:

(*a*) Energize R1 through contactor R5A;
(*b*) Energize S–1 through contactor R1B.

As soon as pressure is generated, the pressure switches contacts will close making circuit for Relay R1 through contacts R6A. At ⅛" above floor level LS–1 is actuated to open contacts R5A; but since continuity has already been established through R6A, platform **32** will continue to rise. At this point relay R5 will pull in.

At ¼" above floor level limit switch LS–2 will be actuated isolating the bleed circuit and arms unlock circuit. The platform will rise to its upper limit against the internal mechanical stop. Continued pressure on raise button **128** will cause the pump to discharge its full capacity through relief valve **116** without damage to the system.

(5) *Inching Up*

The inch up circuit is paralleled with the Raise circuit, and it is governed by the same interlocks and limit switches. Inching up is achieved by creating sufficient back pressure through solenoid valve S–2 and its associated needle valve to bypass a variable proportion of the pump delivery to the tank.

Constant pressure on inch up button energizes R2, and substituting S–2 for S–1, R2A, R2B and R2C for R1A, R1B and R1C, the same conditions prevail as previously described. At any point between floor level and ¼" above floor level, the automatic bleed system will be operative, and the platform will slowly settle to rest on its stops. At any point above ¼", the platform will hold its position. The platform can now be raised to its upper limit of travel against internal mechanical stop.

(6) *Lowering Platform*

A constant pressure on lowering button **134** will:

(*a*) Energize solenoid valve S–**3** through contacts R**6**B;
(*b*) Stop at any point when button is released; and
(*c*) Automatic bleed circuit will become operative at ¼" above the floor level causing the platform coming to rest on rocking arms.

(7) *Unlocking Platform*

A momentary pressure on unlock button **136** will cause the platform to rise ⅛" and retract locking arms **40**, provided LS–**2** is released. Pressing unlock button **136** will:

(*a*) Energize relay R**4** through LS–4*b*;
(*b*) Close contactor R4A to "lock in" R**4**;
(*c*) Close contactor R4B to start motor;
(*d*) Close contactor R4C to energize solenoid S–**1**;
(*e*) Close contactor R4D to energize solenoid S–5*b*, when continuity is made through contact R5D.

This causes platform **32** to rise until LS–**1** is actuated, when:

(*a*) Solenoid S–**1** is de-energized stopping platform **32** by opening contactor R5C;
(*b*) Solenoid S–5*b* is energized by closing contacts R5D.

Arms start to retract, relaxing limit switch LS–**3** causing:

(1) Relay R**6** to trip;
(2) Opening of contact R6A to prevent raising platform;
(3) Opening contact R6B to prevent lowering platform;
(4) Closing contacts R6C in lock circuit; and
(5) Opening contacts R6D in bleed circuit.

When arms **40** are fully retracted, limit switch LS–**4** is actuated making a circuit with S-**3** and S–**4** to allow further lowering of platform and tripping relay R**4**.

(8) *Lowering Platform Below Floor Level*

A constant pressure on lower button **134** energizes S–**3** through limit switch LS–**4**, causing the platform to descend to its lower limit where it comes to rest on external mechanical stops.

(9) *Inch Down*

The inch down button **138** is paralleled with Lower button **134**. Constant pressure on inch down button **138** produces a slower descending speed through its smaller solenoid valve S–**4** and associated adjustable throttle valve **112**.

(10) *Bleed Circuit*

The bleed circuit is incorporated to insure that when the platform is level with the floor and locked, any roll-over loads will be supported on the locking arms and not on the hydraulic plunger. This circuit is operative between floor level and ¼" above floor level, and for continuity requires:

(*a*) Limit switch LS–**2** relaxed;
(*b*) Relay R**4** relaxed;
(*c*) Relay R**6** relaxed;
(*d*) Relay R**2** relaxed;
(*e*) Relay R**1** relaxed; and
(*f*) Pressure switch P.S.**1** actuated (above 15 p.s.i.)

OPERATION OF HYDRAULIC SYSTEM

The mode of operation of hydraulic system **90** described in FIG. 4 in conjunction with the connection shown in FIGS. 5 and 6 is described in the following under the various headings which are related to the various phases of operation of the hydraulic system.

(1) *Raising the Platform*

Depressing raise button **128**:
(*a*) Starts the electric motor; and
(*b*) Opens solenoid valve S–**1**.

(2) *Oil Flow*

(*a*) Rotation of the pump will cause a negative pressure or partial vacuum at the intake side, allowing the atmospheric pressure in reservoir **96** to force oil through strainer **98** and up to the pump gears where it is forced by meshing gear teeth around the outside periphery to the pump discharge. Since the pump is of the positive displacement type, the maximum pressure at the outlet will equal the minimum total resistance at any instant, and since relief valve **116** has a setting 25% higher than the maximum resistance to overcome, it should not bypass normally.
(*b*) Solenoid S–**1** is open making a passage for the oil through the two check valves and strainer to the hydraulic cylinder.
(*c*) Oil entering the hydraulic cylinder will cause the plunger to ascend by displacement. The maximum lifting capacity will be the product of the relief valve setting and the effective area of plunger. A small pressure drop will be experienced between the pump outlet and cylinder due to friction, however for practical purposes, this may be neglected.

(3) *Inching Up the Platform*

(*a*) Flow conditions are similar to those when raising the platform, only passage is through the manual throttle valve **106** and solenoid valve S–**2**.
(*b*) Adjustment of throttle valve **106** varies the proportioning of the flow through S–**2** and the relief valve. Should the throttle valve be fully closed, the total discharge of the pump would bypass through the relief valve and no motion of the plunger would take place.

(4) *Support of the Platform at Intermediate Positions*

(*a*) The back pressure of the oil due to weight of moving mass is contained by check valves and normally closed solenoid valves.
(*b*) Electrical failure at any time would cause all valves to close, containing the hydraulic medium in the cylinder assembly and pipe line, thus causing the system to fail safe.

(5) *Lowering the Platform*

(*a*) The lower button controls solenoid S–**3** which when opened allows a passage for the oil contained in the cylinder back to the reservoir.
(*b*) This is a form of controlled gravity lowering, and the speed of lowering is a function of the total line and component losses.

(6) *Inching Down*

(*a*) The inch down button **140** controls small solenoid S–**4** which increases the total losses mentioned above.
(*b*) Further speed control is obtained by adjusting manual throttle valve **112**.

(7) *Locking the Platform*

(*a*) The platform is raised to a point ⅛" above the floor (the point at which limit switch LS–**1** actuates and arrests the upward movement of the platform).
(*b*) The lock button is depressed momentarily, starting the motor and energizing S–5*a*.
(*c*) Pressure fluid finds a passage from the pump through solenoid S–5*b* to the rod side of the double acting piston **122** extending arms **40**. Fluid from the blank side of the cylinder is returned to the reservoir **96** through a flow control valve and solenoid S–5*a*.
(*d*) When the arms are fully extended, limit switch LS–**4** is actuated opening solenoid valve S–**4**. Oil from the cylinder is bled to the reservoir **96** through S–**4** relaxing the system pressure.

(8) *Unlocking the Platform*

(*a*) Momentary contact on the unlock button automatically raises the platform ⅛" and retracts the locking arms.

(*b*) The following sequence takes place:

(1) The motor starts up, and solenoid S–1 is energized lifting the platform ⅛";

(2) Limit switch LS–1 is actuated de-energizing solenoid S–1 and energizing solenoid S–5, the motor still running;

(3) Pressure fluid finds a passageway through solenoid S–5*a* to the blank side of the double-acting piston **122** retracting the arms;

(4) Fluid in the rear side of the cylinder is returned to the reservoir **96** through a flow control valve and solenoid S–5*b*.

(*c*) Speed of retraction is higher than extension due to the differential effect of the piston rod.

(9) *Bleed Plug*

A bleed plug **114** is provided to release entrapped air during initial charging, however in operation, the cylinder is self-purging and should not require attention.

(10) *Emergency Lowering of Platform*

(*a*) Manual lowering valves are not fitted to the power unit to eliminate the possibility of the interlocks being defeated.

(*b*) Solenoid valve S–1 is provided with a manual lowering adjustment. Turning this anti-clockwise allows the main valve to open, lowering the platform. This adjustment should only be used in cases of emergency.

What is claimed is:

1. A vertically-movable platform arrangement comprising a hydraulic piston and cylinder assembly, a platform mounted upon said piston, said piston and cylinder assembly having a stroke sufficient to raise said platform through a series of levels including a loading level, a locking bar assembly connected to said platform including locking bars which are extendable to project laterally from said platform, an actuating device connected to said locking bar assembly for extending said bars laterally from said platform and for retracting them, supporting surface means disposed at the side of said platform adjacent said loading level for engagement by said locking bars when they are extended, hydraulic pressure bleeding means connected to said piston and cylinder assembly for lowering said platform at a slow speed, control means for actuating said pressure bleeding means when said locking bars are extended above said supporting surface means and said platform is substantially aligned with said loading level to lower said platform upon said supporting surface means whereby any forces imposed by a load moving across said platform are resisted by said supporting surface means and said hydraulic piston and cylinder assembly is relieved of any loads and pressures, said control means being arranged for actuating said pressure-bleeding means when said platform is disposed within a predetermined distance above said loading level, and said control means being also arranged for inactivating said pressure bleeding means when said platform is more than said predetermined distance above said loading level to permit said platform to raise and maintain a load above said predetermined distance.

2. An arrangement as set forth in claim 1 wherein said control means includes switching means for stopping the upward movement of said platform when it is substantially disposed in alignment with said loading level, and interlocking means are provided for preventing movement of said platform above said position substantially aligned with said loading level until said locking bars are extended.

3. An arrangement as set forth in claim 2 wherein said interlocking means is connected to relay means for energizing further raising of said platform when said locking bars are extended, and said relay means including contactor means bypassing said switching means to permit raising of said platform above said position substantially disposed in alignment with said load level when said locking bars are extended.

4. An arrangement as set forth in claim 3 wherein locking bar circuit control means is connected to said actuating device for causing it to retract said locking bars, and said locking bar circuit control means being connected to actuate said relay means to inactivate said bypassing of said switching means when said locking bars are retracted.

5. An arrangement as set forth in claim 2 wherein said pressure bleeding means and said switching means include switches which are actuated in accordance with the vertical position of said platform, and said interlocking means comprise switches which are actuated in accordance with the extended and retracted conditions of said locking bars.

6. A vertically-movable platform arrangement comprising a hydraulic piston and cylinder assembly, a platform mounted upon said piston, said piston and cylinder assembly having a stroke sufficient to raise said platform through a series of levels including a loading level, a locking bar assembly connected to said platform including locking bars which are extendable to project laterally from said platform, an actuating device connected to said locking bar assembly for extending said bars laterally from said platform and for retracting them, supporting surface means disposed at the side of said platform adjacent said loading level for engagement by said locking bars when they are extended, hydraulic pressure bleeding means connected to said piston and cylinder assembly for lowering said platform at a slow speed, control means for actuating said pressure bleeding means when said locking bars are extended above said supporting surface means and said platform is substantially aligned with said loading level to lower said platform upon said supporting surface means whereby any forces imposed by a load moving across said platform are resisted by said supporting surface means and said hydraulic piston and cylinder assembly is relieved of any loads and pressures, said actuating device for said locking bar assembly comprising an auxiliary hydraulic piston and cylinder assembly which together with said hydraulic piston and cylinder assembly upon which said platform is mounted are supplied with pressure from a central hydraulic pressure generating system, said actuating device for said locking bar assembly includes an operating linkage employing a number of lever elements, said supporting surface means includes horizontal and vertical supporting surfaces which are engaged by said extended locking bars for resisting both vertical and horizontal shifting of said platform, and said operating linkage being arranged to align said lever elements in a substantially straight line when said locking bar assembly is extended for causing said linkage to rigidly resist any horizontal forces in their disposition between said vertical supporting surfaces.

7. A vertically-movable platform arrangement comprising a hydraulic piston and cylinder assembly, a platform mounted upon said piston, said piston and cylinder assembly having a stroke sufficient to raise said platform through a series of levels including a loading level, a locking bar assembly connected to said platform including locking bars which are extendable to project laterally from said platform, an actuating device connected to said locking bar assembly for extending said bars laterally from said platform and for retracting them, supporting surface means disposed at the side of said platform adjacent said loading level for engagement by said locking bars when they are extended, hydraulic pressure bleeding means connected to said piston and cylinder assembly for lowering said platform at a slow speed, control means for actuating said pressure bleeding means when said locking bars are extended above said supporting surface means and said platform is substantially aligned with said loading level to lower said platform upon said supporting surface means whereby any forces

imposed by a load moving across said platform are resisted by said supporting surface means and said hydraulic piston and cylinder assembly is relieved of any loads and pressures, said piston and cylinder assembly being provided with pressurized hydraulic fluid from a pressure generating system, an electrically-operable lowering valve being connected in said system for controlling the return flow of fluid from said cylinder assembly to said system when said piston is being lowered, and said pressure bleeding means incorporating electrical control means which opens said electrically-operable valve when said platform is disposed above ground level.

8. An arrangement as set forth in claim 7 wherein low pressure switching means are connected to said system for closing said lowering valve and inactivating said pressure bleeding means when a minimum pressure exists in said cylinder.

9. An arrangement as set forth in claim 7 wherein additional switching means are provided for inactivating said pressure bleeding means when said platform is disposed above a predetermined distance from said loading level to permit said platform to raise and maintain a load above said predetermined distance.

10. A vertically-movable platform arrangement comprising a hydraulic piston and cylinder assembly, a platform mounted upon said piston, said piston and cylinder assembly having a stroke sufficient to raise said platform through a series of levels including a loading level, a locking bar assembly connected to said platform including locking bars which are extendable to project laterally from said platform, an actuating device connected to said locking bar assembly for extending said bars laterally from said platform and for retracting them, supporting surface means disposed at the side of said platform adjacent said loading level for engagement by said locking bars when they are extended, hydraulic pressure bleeding means connected to said piston and cylinder assembly for lowering said platform at a slow speed, control means for actuating said pressure bleeding means when said locking bars are extended above said supporting surface means and said platform is substantially aligned with said loading level to lower said platform upon said supporting surface means whereby any forces imposed by a load moving across said platform are resisted by said supporting surface means and said hydraulic piston and cylinder assembly is relieved of any loads and pressures, and the capacity of said pressure bleeding means being maintained slight enough to permit a normal supply of pressure fluid to said cylinder to raise said piston even while a slight amount of pressure is bleeding therefrom.

11. A vertically-movable platform arrangement comprising a hydraulic piston and cylinder assembly, a platform mounted upon said piston, said piston and cylinder assembly having a stroke sufficient to raise said platform through a series of levels including a loading level, a locking bar assembly connected to said platform including locking bars which are extendable to project laterally from said platform, an actuating device connected to said locking bar assembly for extending said bars laterally from said platform and for retracting them, supporting surface means disposed at the side of said platform adjacent said loading level for engagement by said locking bars when they are extended, hydraulic pressure bleeding means connected to said piston and cylinder assembly for lowering said platform at a slow speed, control means for actuating said pressure bleeding means when said locking bars are extended above said supporting surface means and said platform is substantially aligned with said loading level to lower said platform upon said supporting surface means whereby any forces imposed by a load moving across said platform are resisted by said supporting surface means and said hydraulic piston and cylinder assembly is relieved of any loads and pressures, a hydraulic system incorporating control valves being connected to said piston and cylinder assembly for operating it, an auxiliary portion of said hydraulic system being connected to operate said actuating device for said locking bar assembly, said control means being connected to operate said control valves and including detecting elements associated with said platform arrangement, said control elements including detecting switches associated with said locking bar assembly for ascertaining when they are extended and retracted, and said control elements also including platform detecting switch means operated in accordance with the vertical position of said platform.

12. An arrangement as set forth in claim 11 wherein said platform detecting switch means includes a switch for preventing movement of said platform through a predetermined control position substantially aligned with said loading level until the condition of said locking bars is changed by extension when rising up through said position and retraction when lowering through said control position.

13. An arrangement as set forth in claim 12 wherein said platform detecting switch means prevents said platform from rising through said control position until said locking bars are extended, and said extended locking bars prevent said platform from dropping below said loading level.

14. An arrangement as set forth in claim 13 wherein said control means is arranged to lift said platform slightly above said loading level to said control position when said locking bars are being retracted to facilitate their movement.

15. A vertically-movable platform arrangement comprising a hydraulic piston and cylinder assembly, a platform mounted upon said piston, said piston and cylinder assembly having a stroke sufficient to raise said platform through a series of levels including a loading level, a locking bar assembly connected to said platform including locking bars which are extendable to project laterally from said platform, an actuating device connected to said locking bar assembly for extending said bars laterally from said platform and for retracting them, supporting surface means disposed at the side of said platform adjacent said loading level for engagement by said locking bars when they are extended, hydraulic pressure bleeding means connected to said piston and cylinder assembly for lowering said platform at a slow speed, control means for actuating said pressure bleeding means when said locking bars are extended above said supporting surface means and said platform is substantially aligned with said loading level to lower said platform upon said supporting surface means whereby any forces imposed by a load moving across said platform are resisted by said supporting surface means and said hydraulic piston and cylinder assembly is relieved of any loads and pressures, locking bar control circuit means being connected to said actuating device for energizing it to extend said locking bars, and said locking bar control circuit means being connected to said pressure bleeding means for actuating it as said locking bars are extended.

16. An arrangement as set forth in claim 15 wherein pressure-operated switch means is connected to said locking bar control circuit means for de-energizing it and preventing said locking bars from being retracted while the pressure in said locking bar control circuit is below a predetermined minimum.

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