The invention lies in structure and techniques for moving heavy load-supporting frameworks such as drilling rigs over relatively short distances. Included are a pair of horizontally slideable supporting platforms and a plurality of lifting jacks, making it possible to "walk" the assembly by a sequence of lifting, sliding and lowering operations.

10 Claims, 10 Drawing Figures
WALKING PLATFORM FOR DRILLING RIGS AND OTHER HEAVY MACHINERY

FIELD OF INVENTION

The present invention lies broadly in the field of structures which support very heavy loads, including the drilling platforms which support earth drilling tools.

More particularly, the invention concerns apparatus and methods for supporting and moving such structures from one site to another through relatively short increments of distance.

Since the apparatus moves on feet which are extended to touch the ground during a movement and are retracted during drilling or other operations at the sites, it may appropriately be called a walking platform.

PRIOR ART

Any drill rig or other heavy equipment may be moved by the time-honored technique of disassembly into small components, loading the components onto trucks manually or with the aid of truck-mounted winches, driving the truck to a new location, and laboriously reassembling the rig. While such techniques are justified when the move is over a distance of several miles or more, the present invention is concerned more with techniques for moving the drill rig through relatively short distances, a matter of feet rather than miles, as when drilling holes for piling and the like. The technique used heretofore was to hire a barge-mounted crane to move the rig, even though it be but a matter of ten feet or less. Such technique is prohibitively expensive, as the crane time involves a charge of hundreds or thousands of dollars per hour, and use of the barge must be scheduled well in advance; if the barge is not available on short notice when needed, the drilling rig and its crew may sit idly by, incurring overhead and labor charges that produce nothing.

The nearest prior art known to applicant is a truck-mounted drilling rig which makes use of jacks located at the corners of the truck bed or framework. These jacks are used primarily to prevent vertical loading of the truck springs and shock absorbers, and are not used at all in moving the drill rig from one location to another. Once the jacks are extended to support the drill rig on such a truck-mounted apparatus, the jacks serve no other function. If the drilling platform, mast and other equipment must be moved to another nearby location to drill a second hole, the jacks must be retracted and the truck driven to such second location. Such a rig is not truly a walking drill rig, but is rather a drill rig supported on a mobile platform, specifically the bed of an automotive vehicle.

While such truck-mounted drill rigs are admirable for their purposes, they are limited in capacity by the weight-supporting capacities of the vehicles that may be used to support them. The present invention is concerned with drill rigs of much greater capacity, weighing tons or hundreds of tons. Such heavy rigs cannot be supported by conventional trucks of even the largest capacity, and their use in such a conventional fashion would require the design of unusually heavy, very special mobile platforms, probably so large that they could not be used on most highways and roads.

SHORT STATEMENT OF THE INVENTION

The invention is concerned primarily with supplying automation to the working platform of a drilling rig or other rig which includes heavy mechanized equipment. It employs three platforms or bases disposed one on top of the other, a lower base or skid, an intermediate base, and the upper base or working platform. The lower base or skid sits on the ground, floor or pier; the intermediate base is supported on the skid so that one mode of motion is possible between them, either rotation or linear movement of the intermediate base with respect to the skid; and the upper or working platform is mounted on the intermediate platform so that the other mode of motion is possible between them, the drilling platform either rotating or being linearly movable with respect to the intermediate platform. A set of lifting jacks are secured to the working platform to operate below it, being extensible to reach the ground or other supporting surface and lift the entire weight of the three platforms off the ground. In fully retracted position, these jacks are clear of the ground and do not interfere with drilling or other operations; however, in an intermediate position they may help the base support the weight of the rig, if desired.

If the working platform is not headed in the right direction for a straightaway movement, this structure is operated first by rotating the working platform until it points in the direction of the next working site; this direction, of course, is parallel to the direction of linear motion between two of the platforms. Thereafter a linear actuator which has opposed ends secured to the pair of linearly slidable platforms is operated so that the drilling platform extends forwardly of the skid, carrying the retracted jacks with it. The next step is to extend the jacks downwardly until they support the weight of the rig, lifting the intermediate platform and skid up off the ground. The linear actuator is then operated in the reverse direction, the result being that the intermediate platform and skid are brought into their original positions relative to the drilling platform, directly under it. Thereafter the jacks are retracted to allow the weight of the rig to rest on the ground. This cycle is repeated as necessary to bring the rig to its next operating position, e.g., centering the drilling mast directly over the hole to be drilled. Fine adjustments in both linear movement and rotation are possible, of course, to center the drill string directly over the hole; these are accomplished without the necessity of another cycle of walking.

GENERAL DESCRIPTION OF PREFERRED EMBODIMENT

The preferred embodiment of the present invention takes the form of a digger or drilling rig utilizing three horizontal platforms which are generally disposed one on top of the other, and by a multiplicity of jacks secured to and depending from the upper or drilling platform. The bottom platform or skid rests on the ground or substitute therefor, e.g., a floor or pier. To make the rig movable from any given location to another, preselected location, two of the platforms are provided with means whereby the upper platform can be moved linearly with respect to the other. In the appended drawing and in the description thereof, the intermediate base is pivoted on the lower base or skid, the drilling platform being linearly movable with respect to the intermediate platform, but it is to be understood that the opposite type of arrangement is entirely feasible and lies within the scope of the invention. As illustrated in the drawing and in the following description, the apparatus of the invention is employed.
first by rotating the upper pair of platforms relative to the skid so that the drilling platform is pointed in the direction of movement desired, i.e., toward the new location to be drilled. This step is unnecessary, of course, in drilling a series of holes at sites located in a line directly ahead of the hole already drilled. Having made sure of circumferential alignment, the next step is to actuate a linear actuator having its cylinder secured to the drilling platform and the free end of its piston rod secured to the intermediate platform (or vice versa) to extend the drilling platform, relative to both intermediate platform and skid, a distance limited by the stroke of such piston. The jacks dependent from the drilling platform are then extended until pads on the ends of the pistons contact the ground, and they are then further actuated to raise all three platforms, until the skid is well clear of the supporting surface on which it had rested.

This leaves the intermediate platform and skid in the same vertical relationship to the drilling platform as at the start, but they are in a trailing position from a plan view. Thereafter the linear actuator connecting the drilling platform to the intermediate platform is operated in the reverse direction, pulling the intermediate platform and skid underneath the drilling platform, in the same position relative thereto as at the start. The final step is merely one of retracting the four corner jacks until the skid of the assembly rests on the ground again. The jacks may either be raised to clear their pads, or they may be used in contact with the ground, to provide whatever additional drilling support may be desired from them.

Prior to such final step, while the jacks are still supporting all three platforms in the air, an extra step may be performed to close up any angular difference between the starting position of the skid and its position just before lowering the jacks. In such extra step, the rotating mechanism may be operated in reverse to rotate the skid to its circumferential starting position relative to the upper pair of platforms. This step is optional, as the structure illustrated is designed for drilling operation when the drilling platform is disposed at an angle to the skid. However, the entire structure will be more stable when the platforms are brought back to the parallel relationship from which they started, as indicated in the plan view of FIG. 9.

If the described cycle of movement is insufficient to locate the drill string above the spot where it is desired to form a hole, the cycle as outlined may be repeated as often as necessary. Both the rotary means and the linear actuating means may be actuated for whatever fine adjustments may be necessary to accurately position the drilling mast; such fine adjustments may be made without walking the rig, as they are within the reach of the rig in less than a complete stroke of the linear actuator.

The preferred embodiment is described in greater particular in the detailed description which follows. It is believed that those skilled in the art will better appreciate the present invention by reading such description, together with a scrutiny of the drawing figures.

SHORT DESCRIPTION OF THE DRAWING FIGURES

A drawing is enclosed with the present application as an illustration of the present invention. In such drawing:

FIG. 1 is a schematic side view of the apparatus of the present invention disposed at the end of a pier and showing the drilling mast and associated drilling equipment in phantom, both in transport position and drilling position.

FIG. 2 is a schematic side view of the same apparatus with the drilling mast and associated equipment removed, this figure representing the first in a series of steps illustrating the movement of the drill rig from one location to another. In this figure, all components and elements are shown as they would be at the completion of a hole-drilling operation, with the exception that the arrows in the figure symbolize the rotation of the intermediate platform and upper or drilling platform to point in the direction of travel necessary to reach the next drilling site.

FIG. 3 is like FIG. 2 and illustrates the next step, operation of the linear actuator to slide the drilling platform to the left in the figure, the intermediate platform and skid remaining fixed.

FIG. 4 is like FIG. 3 and follows thereafter, the change being extension of the four corner jacks into contact with the ground, and further operation of the jacks to lift the entire rig vertically upward, until the skid is no longer supported on the pier.

FIG. 5 is like FIG. 4 and follows thereafter, the change being a reverse operation of the linear actuator to move the intermediate platform and skid to the left in the figure, returning them to their original positions directly under the drilling platform. While not illustrated, the one remaining step would be to reverse the operation of the four corner jacks, retracting them until the skid rests on the ground once again, this time at a new location.

FIG. 6 is a side elevation of the same embodiment, showing more detail of the structure.

FIG. 7 is a view from the lefthand end of FIG. 6, as indicated by the sectioning lines and arrows thereof marked 7–7.

FIG. 8 is a righthand end view, also taken on FIG. 6, as indicated by the lines and arrows marked 8–8 thereon.

FIG. 9 is a plan view of the structure of FIG. 6, partially external and partially in longitudinal section, as indicated by the lines and arrows marked 9–9 thereon.

FIG. 10 is an enlarged sectional view of FIG. 8, indicating the structure making it possible to move the drilling platform linearly with respect to the intermediate platform.

DETAILED DESCRIPTION OF THE DRAWING FIGURES

FIGS. 1–5 depict a drill rig 5 of the invention disposed adjacent the end of a pier 2 disposed above a body of water 3. Protuding upwardly out of the body of water 3 near the end of pier 2 are a number of tubes 4 supported in the floor of the sea. Holes are to be drilled downwardly through the earth below the tubes 4, and the drilling mast or derrick 6 is disposed above the tube 4 closest to the end of pier 2. It is to be understood that mast 6 supports a drill string (not shown) having a drill bit 6a secured to its lower end, and that in each drilling operation the drill bit or auger 6a and drill string above it will be lowered through tube 4 until it contacts undrilled earth formations, after which the bit will be rotated to produce a deeper hole. After drilling such hole to the required depth, the rotation of the drill string will be stopped, and the string will be raised until
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At that time, it will be necessary to move the mast 6 further to the left in FIG. 1, and to rotate it to a cocked position so that it can drill the earth below the next outwardly disposed tube 4, slanting as it does from left to right and downwardly in FIG. 1. This figure also shows the mast 6 in its horizontal transport position, together with the associated equipment 7 carried on drilling platform 10 and used to rotate the drill string, crowd it into the earth, etc. Since these components, including the mast, form no part of the present invention, they are omitted from the other figures and will not be further described.

FIGS. 1-5 also show the principal components of the present invention, consisting of drilling platform 10a, intermediate platform 10b, lower platform 10c, skids 12 and 13, pivot ring or rotary table 11 between platforms 10b and 13, and the multiplicity of vertical jacks 8 secured to the drilling platform 10a, of which two are shown in the figures. FIGS. 1 and 2 depict the platforms in the positions they occupied relative to each other and to the pier 2 at the time of drilling a hole in the first location 4 immediately adjacent the end of the pier 2. FIG. 2 differs from FIG. 1 only in illustrating the fact that platforms 10a and 10b may be rotated with respect to skid 13 in the directions indicated by arrows 25; a plan view looking down on top of the apparatus as depicted in FIG. 2 would show this rotation to be in the clockwise direction, although of course the upper and intermediate platforms may be rotated in the opposite direction if required by the location of the next drilling site. Rotation is accomplished by rotating the intermediate base 10b on the pivot ring 11 which joins it to the skid 13, using actuating and control mechanism of a conventional nature, not depicted in the drawing.

FIG. 2 also indicates that the upper base 10a supports the cylinder 14 of a linear hydraulic actuator, having a piston 17 whose rod 15 extends to the right in the figures and has fixed on its outer end an anchor member 16 secured to the intermediate platform 10b. Each jack 8 includes a mount or block 9 joined to the adjacent end of drilling platform 10a by a beam 28; mounted in each block 9 is a hydraulic cylinder from which there protrudes in a downward direction a piston rod 18 which serves as a leg for movement of the drilling rig. Each such leg terminates in a ground pad 19. It should be noted from FIG. 2 that at this time the intermediate platform is disposed directly beneath the drilling platform 10a, and that all the jacks 8 are retracted, with the drilling pads on the ends of piston rods 18 spaced above the pier 2.

In FIG. 3, the piston 17 within cylinder 14 of the linear hydraulic actuator has moved all the way from left to right. Since the piston rod is pinned to the intermediate platform 10b, such hydraulic movement causes the drilling platform 10a to move to the left, from its relative position in FIG. 2 to its position as indicated in FIG. 3, such movement being symbolized by the arrow 26. It should be noted from FIG. 3 that the net result of this step is to move the upper drilling platform 10a to the left in the figure, disposing this drilling platform so that it is no longer centered above the intermediate platform and skid. Movement of the drilling platform carries with it dependent jacks 8, but the fact that the beams 28 supporting the trailing jacks 8 are longer than the similar forward beams 28 prevents these jacks from colliding with the intermediate platform and skid.

FIG. 4 illustrates the next step, lowering the jacks 8 until they not only contact the pier 2 but lift the entire rig upwardly from the surface of the pier, as depicted. Downward movement of the jacks is symbolized by the arrows 27, and it should also be noted from this figure that the drilling platform 10a is still displaced to the left relative to intermediate platform 10b and skid 13.

FIG. 5 illustrates the next step, retraction of the piston and piston rod 15 to their starting positions. Since the intermediate platform 10b and skid 13 are still suspended, they are the most mobile mass in the system, and move to the left to their original positions relative to the drilling platform 10a directly under it. This movement is symbolized by the arrow 29 drawn in the middle of the space occupied by the intermediate platform.

The described set of motions completes a cycle except for a step of retracting jacks 8 until they permit the skid 13 to rest on the surface of the pier, after which the jacks may be further retracted to clear them of any obstructions. Also, prior to retracting the jacks the skid 12-13 may be rotated to its relative circumferential starting position. If the location of the hole to be drilled is still beyond the drilling mast, the cycle of steps may be repeated as often as necessary to walk the drilling rig to the desired location. Small adjustments may be made as necessary to move the components through a partial step to accurately locate the drill string directly above the hole, and the same is true of rotary motions. The equipment provided to lower and raise the drilling mast between the positions indicated in FIG. 1 in phantom also include means to secure the mast at an angle with respect to the vertical, so that slanted holes may be drilled through the cantilevered tubes 4 indicated in FIG. 1.

It is not essential that the chronology of steps be laid out above be followed exactly. One variant, for instance, would be to extend the drilling platform linearly before rotating it and the intermediate platform with respect to the skid. If the exact distance for the linear movement is known with greater precision and the angle of rotation, this sequence may actually prove advantageous.

Similarly, there are permissible variants in the order in which the platforms are stacked on one another. The intermediate platform could be linearly slidable on the skid, and the drilling platform could be rotatably mounted on the intermediate platform directly under it. As vertical jacks remain attached to the drilling platform. This alternate construction would require an extra extension of the jacks and an extra retraction step, as it would be necessary to follow the sequence of first rotating the drilling platform, second extend jacks to lift the entire rig, third rotate intermediate platform and skid to point in the same direction as the drilling platform, fourth retract jacks, fifth extend intermediate and drilling platforms relative to the skid, sixth extend jacks to lift the rig off the ground, seventh extend skid to bring it under the other platforms, eighth and last retract jacks.

FIGS. 6-10 are intended to convey at least a general idea of the structure of a specific embodiment of the present invention. As can be seen from these figures, the lower platform or skid actually consists of two parts, a skid base 13 and a skid rack 12. The skid base 13 is the platform which rests upon the pier, earth or other flooring. Above skid rack 12 and secured to it is the pivot ring 11 which pivotally mounts the intermediate platform 10b; details of the mounting are not
shown, but they include conventional structure for supporting a heavy load, including appropriate bearings and means to prevent separation of the skid from the intermediate platform when the entire rig is lifted by the jacks. Suitable means (not shown) are included to initiate and control the extent of rotation, including means to obtain small increments and decrements of rotation when the drilling mast is being accurately located over the hole to be drilled.

Rigidly mounted on the top of pivot ring 11 are a pair of parallel rails 30 which constitute the intermediate platform or lower base 10b. As can be seen from the enlarged detail of FIG. 10, each rail 30 is generally U-shaped, the upwardly extending arms of the member defining an upwardly facing groove or trough 34 which receives in slideable relationship one of the two parallel l-beams 31 of the upper or drilling platform 10a. Suitable bearing structure (not shown) between the two members is provided, either a journal bearing or appropriate anti-friction bearing. The possibility that the skid might be left on the ground when raising the intermediate platform is avoided by the structure indicated in FIG. 10, consisting of straps 32 disposed at the top of and on either side of rail 30 to extend over the trough 34, and secured to rail 30 by the indicated bolts 33. The straps 32 cooperate with the bottom of trough 34 to define a slot which receives the lower flange of l-beam 31. Rails 30 are firmly secured to the upper surface of turntable or pivot ring 11, and do not move with respect thereto during any part of the operation of the drilling rig, whether in moving the same or during drilling operations.

The framework for drilling platform 10a consists primarily of the pair of parallel l-beams 31. The solid lines of FIG. 9 indicate the position occupied by these members preliminary to a movement of the drilling platform 10 to the left in the figure (to the new position shown in phantom), from which it will be seen that members 31 are joined at their extremities by cross-braces 36. Joined to cross-brace 36 and extending parallel to sliding beams 31 are a pair of beams 28. At their outer ends, beams 28 are joined to and support a cross member 22, which in turn supports a pair of the components of the jack subassemblies. Each cross member 22 is a hollow beam supporting in slidable relationship a pair of shorter beams 23, the latter being disposed within the beam 22 in nested relationship. On the outer end of each sliding member 23 there is secured a mounting block 9 for one of the jacks 8; the phantom position of these blocks 9, shown most distant from the longitudinal center line 35 in FIG. 9, indicates the preferred operating position of the blocks 9, i.e., when moving the rig from one drilling site to another. They are moved to such laterally extended position by actuation of the hydraulic cylinders 20, secured to the fixed box beam 22, to extend the pistons 21 having their free ends secured to blocks 9. It will be apparent that the sliding box beams 23 and blocks 9 are retracted to their solid line positions when the jacks are not being employed in order to minimize risk to the jacks and possible personnel injuries which are inherent in their extended positions.

As indicated in FIGS. 6, 7 and 8, each jack assembly consists of the block 9 previously described, a vertically disposed hydraulic cylinder 24, the piston rod 18 extending downwardly from the end of the hydraulic cylinder and a foot or pad 19 secured to the free end of the piston rod. The dimension indicated by arrow 40 shows the stroke of the piston or leg 18.

FIG. 8 depicts an operator's seat 37 and, located directly in front of it, one of the control levers 38 utilized by the operator. No attempt is made to depict all of the controls available to the operator, nor the various gauges and dials visible from his position, but it will be understood that suitable such controls and instruments are readily available for all of the various movements previously described. Since these employ only conventional structure and are not involved in the inventive concept herein disclosed and claimed, there is no need to describe them in detail. Similarly, the structure for rotating one platform with respect to another is not shown in detail, for a like reason.

Although the invention has been illustrated and described in connection with a single specific embodiment, it is to be understood that the inventive concept is not limited to the specific structure shown. All forms of the invention embraced within the language of the following claims is within the spirit of the invention and should be so understood.

What is claimed is:

1. A heavy equipment rig capable of walking between adjacent working sites, comprising:
   a lower base means,
   a middle base means,
   an upper base means linearly slideable with respect to said middle base means,
   revolving means interconnecting said middle base means with said lower base means,
   actuating means linearly and slidably interconnecting said middle base means with said upper base means,
   and
   lifting means depending from said upper base means and retractable above the lower portion of said lower base means.

2. The apparatus described in claim 1, wherein said lifting means is also extendable below said lower portion of said lower base means.

3. The apparatus described in claim 2, wherein said revolving means is mounted on said lower base means for revolvably supporting said upper base means.

4. The apparatus described in claim 3, wherein said revolving means includes a turntable mounted on said lower base means and supporting said middle base means thereabove.

5. The apparatus described in claim 4, wherein said actuator means includes a fluid-actuating cylinder having one end anchored to one of said middle and upper base means and a piston means having one end slidably disposed in said cylinder and having the other end anchored to the other of said middle and upper base means.

6. The apparatus described in claim 5, wherein said middle base means further includes a pair of support rail members arranged side-by-side on said revolving means and longitudinally slidably engaging said upper base means.

7. The apparatus described in claim 6, wherein said upper base means further includes a pair of glide rail members aligned with and slidably engaging said support rail members in said middle base means.

8. The apparatus described in claim 7, wherein said support rail members each comprise:
   a generally U-shaped bar member having a longitudi nally recess along its upper surface, and
   and
9. The apparatus described in claim 8, wherein said glide members are each slidably disposed in said recesses in said bar members and are each further provided with a flange portion underriding said strap member.

10. A method of walking a drilling rig having a drilling platform with a longitudinal axis from one drilling site to the next, comprising the steps of:

rotating said drilling platform until its longitudinal axis is generally aligned to point toward the next drilling site, said rotating step also rotating the drilling platform relative to a skid which supports it, sliding said drilling platform relative to an intermediate platform which also supports the drilling platform by the use of a linear actuator having its cylinder secured to one platform and the free end of its piston rod secured to the other, raising said rig by the use of jacks resting on the ground and acting vertically on said drilling platform so that both said platforms and said skid are raised above the ground, sliding said intermediate platform and skid, by reverse use of the linear actuator, to approximately their original positions relative to the drilling platform, and lowering said drilling rig by releasing said jacks until the skid returns to the ground.

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