OIL DERRICK ERECTION AND SUPPORT SYSTEM

Norman D. Dyer and Burton W. French, Beaumont, Tex., assignors to Dresser Industries, Inc., Dallas, Tex., a corporation of Delaware

Filed Nov. 24, 1967, Ser. No. 685,668

Int. Cl. E21c 9/00, 11/00; B66c 23/60

U.S. Cl. 173—39

12 Claims

ABSTRACT OF THE DISCLOSURE

A reeling oil well derrick mast is coupled at a pivot to a base and extends away from the base along the ground. An A-frame is mounted on the base rearward of the pivot and supports spaced apart pulleys at a level above the pivot. Three additional pulleys are spaced along each side of the mast. A cable is anchored at each end to the A-frame and is threaded over the top-most of the pulleys on the mast and thence to the pulleys on the A-frame. The cable then passes to the middle pulley on the mast and thence to the lowermost pulley and then to a traveling block which is movable from the lower extremity of the mast to the crown block for erection of the mast in one traverse of the traveling block. Set-back structure is connected to the A-frame and independent of the mast to support a rotary table below the traveling block.

FIELD OF THE INVENTION

This invention relates to oil well drilling apparatus of extended height, and more particularly to a system for the erection and support of the mast, associated structure and mechanical equipment. In a further aspect, the invention involves a structure in which a rotatory table is isolated from the mast, with arrangement for the convenient erection and assembly of drilling system components.

THE PRIOR ART

It has become necessary for the oil well drilling industry to utilize extremely tall masts and high substructures in order to economically and efficiently drill deep oil wells. Due to the extreme height of these masts and substructures, which for instance may comprise a total height of about 170 feet, severe problems are presented in the transportation, erection and subsequent disassembly of the structures.

One type of system previously employed to erect tall masts has required high gin poles which swing the drilling mast into an upright position by means of the traveling block, crown block and drawworks normally used in the drilling operations on the rig. Such a system is disclosed in U.S. Patent No. 2,963,124, issued Dec. 6, 1960. The erection of masts with such prior systems is often expensive and time consuming. Further, safety hazards arise with these prior systems, as the mast must be independently supported in an inclined position during erection because the traveling block reaches its upper limit of travel before the mast has been fully erected.

Derricks having extremely tall substructures have often required multiple gin pole substructures to attain the desired height, thereby requiring extensive use of gin pole trucks during erection, in addition to increasing the weight of the system during transportation. Further, after the erection of the high substructure, expensive and bulky truck ramps have often been required in order to raise the drawworks and associated structure up to the drilling floor.

Systems have thus been heretofore developed wherein drawworks may be mounted on the floor of the substructure when the substructure is in a lowered position, whereas after the substructure is raised into an elevated position.

The mast is then pivoted to a vertical position and connected to the floor of the substructure for support thereof. U.S. Patent No. 3,288,151, issued Jan. 11, 1966, discloses such a system. While this type of oil derrick erection system has been found to be advantageous in some respects, problems still arise due to the fact that the extremely heavy drawworks and associated structure are required to be elevated a considerable distance above ground, thereby necessitating an extremely strong and heavy substructure. Additionally, the rotary table and setback loads on such systems are interconnected to the substructure and the mast, thereby imparting vibration and strain to the mast structure.

SUMMARY OF THE INVENTION

In accordance with the present invention, a reclining mast is coupled at a pivot to a low profile base. A drawworks is mounted to the low profile base. Spaced apart pulleys are mounted on the A-frame and three pulleys are mounted on each side of the mast. A cable is anchored at two ends to the A-frame and threaded over the topmost of pulleys and thence to the pulleys on the A-frame. The cable then runs to the middle pulley on the mast and over the lowermost pulley to the traveling block. A single upward traverse of the traveling block to the crown block of the system erects the mast.

In accordance with a further aspect of the invention, the set-back structure is pivotally mounted on the base on the side of the mast opposite the drawworks. When erected, supporting beams extend from the set-back structure through the mast above the base and are secured to the A-frame. A rotary table is mounted on the beams, wherein the mast is not subjected to the weight or vibration of the rotary table.

THE DRAWINGS

For a more complete understanding of the present invention and for further objects and advantages thereof, reference may now be had to the following description taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a side view of the drilling system forming the present invention fully erected;
FIGURE 2 is a front view of the system fully erected;
FIGURE 3 is a top view of a base portion of the system;
FIGURE 4 is a side view of the base portion system of FIGURE 3 to which there has been added extension bases and drawworks;
FIGURE 5 illustrates the structure of FIGURE 4 with the A-frame erected;
FIGURE 6 illustrates the system of FIGURE 5 to which the mast and the raising lines have been attached;
FIGURE 7 is a diagrammatic view of the raising line assembly;
FIGURE 8 illustrates the mast partially erected;
FIGURE 9 illustrates the mast erected and set-back structure in position for erection;
FIGURE 10 is a detailed view of the coupling between the A-frame, the mast and the set-back structure;
FIGURE 11 is an enlarged view of a portion of the connection between the A-frame and the mast shown in FIGURES 1 and 2;
FIGURE 12 is a sectional view of a position of the structure shown in FIGURE 11; and
FIGURE 13 is an enlarged view of a portion of the set-back structure extending through the mast.

THE PREFERRED EMBODIMENT

Referring now to FIGURES 1 and 2, the drilling structure has been illustrated wherein a mast 10 having legs 11 and 12 is pivotally supported on a base 13.
3,483,933

3 side boxes 13 and 14 at pivotal axis 15. A drawworks hoist 16 is mounted on two extension boxes 17 and 18 which are aligned with and coupled to boxes 13 and 14. The hoist 16 is provided with a cable 20 which passes over a pulley 21 in the crown of the mast 10. The cable extends down to a traveling block 22 and then over a crown block 23. The traveling block 22 is provided with a supporting hook 20. A racking platform 25 is connected about midway along the length of legs 11 and 12.

A catwalk unit 30 is mounted on a platform 31 supported on each side by a leg 32, a supporting post 33, and a leg 34. The leg 32 and post 33 are pinned at point 35 so that during erection they may be coupled to the side boxes 13 and 14 by pins at a pivot axis 41. The set-back structure includes a platform section 42 in front of the mast 10 and is also provided with beams 43 extending through the mast between the legs 11 and 12 to a coupling to the platform 31 immediately above pivot 37. The platform section 42 is supported by two support structures each including front legs 44 and 45 pivotally connected at pivot axis 41. Each of the support structures also includes rear legs 46 and 47. The two support structures are pinned together at pin points 48 (FIGURE 2).

While not shown in FIGURES 1 and 2, the rotary table employed in drilling operations is mounted on the beams 43. By this means, the drawworks, the catwalks and the rotary table are all supported by structures other than the mast. Further, in accordance with the invention a coupling between the mast 10 and the platform 31 is such as to transmit horizontal forces only, so that the sole vertical support for the mast 10 is transmitted to the side boxes 13 and 14 through the pins at axis 15. Furthermore, the drawworks hoist 16 is supported at a low level on the structure formed by the side boxes 13 and 14 and serves to maintain the floor for the rotary assembly free from much equipment which is normally located on the upper level rather than at the ground level.

FIGURES 3–10 illustrate the sequential steps of erection of the derrick structure of the present invention. Referring to FIGURE 3, side boxes 13 and 14 have been positioned and leveled. A center spreader structure 50 and a rear spreader member 52 are affixed between the side boxes to maintain the desired spacing between the boxes. The platform is placed on the boxes 13 and 14 in a reclining position and a pair of the supporting posts 33 are pinned to each side box 13 and 14 at pin points 35. A catwalks spreader 54 is attached between the platforms 31. Each of the platforms 31 supports a pair of rigid A-frame members 56. A pair of spaced pulleys 57 are carried by two of the A-frame members at the apexes thereof.

FIGURE 4 illustrates a side view of the invention showing the drawworks platform in the reclining position. Extension boxes 17 and 18 (not shown) are next installed and are connected to the rear of boxes 13 and 14. Suitable spreaders (not shown) are installed between the extension boxes 17 and 18 and a drawworks hoist 16 is secured on top of the extension boxes. Legs 34, only one of which is shown, are temporarily attached at point 58 to each of the legs 32. The legs 34 are pivotally attached to the platform 31 by pins 37. Projections 60 extend from each of the legs 34.

FIGURE 5 illustrates the erection of the drawworks platform from the reclining position indicated by the dotted lines to a vertical position by a cable 62 passing over a gin pole 64 to a suitable winch (not shown). Platform 31 and the rigidly connected A-frames 56, posts 32 and legs 33 are carried by the cable 62 to the upright position shown in FIGURE 5. The pins at points 58 are removed prior to erection of the drawworks platform, and thus the legs 34 swing to a vertical position as the drawworks structure is erected. The bottom ends of the legs 34 are then pulled forward and secured to the projections 60 by pins 36.

FIGURE 6 illustrates the assembly of the mast 10 along the ground in front of the erected drawworks structure. The mast 10 is assembled in several sections, with the base portion of the mast being first laid upon boxes 13 and 14 and pinned at the pivotal axis 15. The remainder of the sections of the mast are then assembled and the traveling block 22 is provided with the associated cables in the usual manner. A sheave 66 is connected to the platform 31 over which the fast line 20 passes drawworks 16.

After the mast 10 is assembled as shown in FIGURE 6, mast erection lines are installed in the mast in the manner shown in FIGURE 7. Three pulleys 70, 72 and 74 are spaced along each of the mast legs 11 and 12, the outlines of which are shown, with the pulleys 70 being mounted closely adjacent the pivotal axis 15. A cable is then anchored at two ends on spaced apart A-frames 56, and threaded over the topmost pulleys 74 to define the cable segments 76. The cable is then passed to spaced pulleys 57 mounted on the A-frames 56 to form cable run segments 77 and thence to the middle pulleys 72 to form cable run segments 78. The cable then passes to the lowermost pulleys 70 located on the mast to form cable segments 79 and thence to the hook 24 on the traveling block 22 to form cable segments 80. It will be seen that pulleys 70 pass the cable from the outside of the legs 11 and 12 into the inside of the legs 11 and 12. As traveling block 22 is pulled upwardly by cables 81 due to the winching action of the drawworks 16, the cable lengths 80 are lengthened and the cable lengths 78 are shortened, thereby tending to erect the mast 10 as shown in FIGURE 8.

Mounting of the pulleys 70 closely adjacent to the pivotal axis 15 allows the traveling block 22 to be connected to the mast erection cable at the lowermost part of the mast 10. A long traverse of the traveling block 22 from the bottom of the mast 10 to the crown block of mast 10 10 is thus provided. This long traverse enables mast 10 to be erected in only one upward traverse of the traveling block 22, instead of the requirement of two or more traverses of the traveling block as herebefore required. Additionally, the positioning of the pulleys 70 in the low position on the mast 10 keeps the weight of the traveling block 22 relatively low when the lever arm acting on the mast is short, thereby putting less strain on the erection system and on the mast structure.

Additionally, as is clearly shown in FIGURES 6–8, the drawworks 16 is mounted low on the extension boxes 17 and 18, and therefore is not required to be raised high upon the elevated floor of the derrick structure as in previous systems.

When the mast 10 is finally vertically erected, the mast is pinned to the platform 31 at pin point 82, as shown in FIGURE 9. FIGURES 11 and 12 illustrate in greater detail the connection between platform 31 and the mast 10. Projections 83 extend rigidly outward from mast 10 and are received between a pair of extension members 84, with the ends of projections 83 resting against vertical surface on support structures 87. A link 85 connects the ends of members 84 together, but is bent upwardly to allow projection 83 to move between the members 84 to be pinned at 82. Members 84 are connected to the platform 31 at the pivot axis 86, and the members 84 may be swung to a vertical position when not being utilized. Platform 31 has slots through which the members 84 extend. As best shown in FIGURE 12, the members 84 are normally disposed at a slight angle to the horizontal, with pin points 82 being above axes 86, whereby vertical loads on the mast 10 pivot members 84 without imposing any vertical loading on the drawworks 16.

Hence, the connection between the mast 10 and the platform 31 is such that forces are transferred between the
What is claimed is:

1. A mast erection system for an oil well derrick structure having a base and a reclining mast coupled by a pivot to the base and extending away from the base along the ground and a traveling block movable from the lower extremity of the mast to a crown block which comprises:

(a) a support structure mounted on said base rearward of said pivot,
(b) spaced apart pulleys mounted on said support structure at a level above said pivot,
(c) three pulleys mounted on each side of said mast spaced apart along the lower region of the mast with the lowermost of said pulleys being closely adjacent said pivot, and
(d) cable anchored at two ends and threaded over the topmost of said pulleys and thence to said pulleys on said support structure, thence to the middle of said pulleys on said mast and thence to the lowermost of said pulleys and to said traveling block whereby movement of said traveling block when engaged by said cable in the region of said lowermost of said pulleys will erect mast in one upward traverse of the traveling block.

2. The combination set forth in claim 1 wherein a pivotal link is provided to anchor said support structure to said support structure and adapted for the transfer of forces between said support structure and said mast having horizontal components only.

3. The combination set forth in claim 1 wherein said mast has a pair of legs spaced apart at said pivot and converging at said crown block with reinforcing structure in said legs confined to provide an unobstructed working space between said legs, and wherein the surface of said lowermost pulley over which said cable leads to said traveling block protrudes into said working space.

4. The combination set forth in claim 1 wherein said support structure has a structure facing said mast of configuration corresponding with the configuration of said mast in the region of said pivot.

5. The combination set forth in claim 1 and further comprising:

(a) set-back structure pivotally connected to said base on the side of said pivot opposite said frame and having supporting beams extending through the erected mast above said base to a connection with said support structure, and
(b) a rotary table for said mast mounted on said supporting beams to maintain said mast free of the weight of said rotary table.

6. An oil well derrick structure having a base and a reclining mast with legs pivoted at spaced points on a pivotal axis onto the base and pivoted to a frame above the pivotal axis, the combination which comprises:

(a) a set-back structure pivotally mounted on said base on the side of said pivotal axis opposite said frame and having supporting beams above said base extending through said mast and secured to said frame, and
(b) a rotary table mounted on said beams between the legs of said mast with said mast free of the weight of said rotary table.

7. In an oil well derrick structure wherein a draw-works is mounted on a rearward end of a base and a reclining mast is pivoted at a front portion of the base, the combination comprising:

(a) a draw-works and a-frame platform having back legs rigidly depending from the back of said platform, (b) the lowermost end of said legs being connectable to a pivot axis on said base adjacent the front of said draw-works, (c) front legs pivotally depending from the front edge of said platform and secured at the lowermost ends thereof adjacent the front portion of said base whereby during erection said platform may be swung about said pivot axis to a horizontal position and said front
legs swung forward and secured at the lowermost ends to securely support said platform,
(d) means operated by said drawworks for pivoting said mast to an upright position, and
(e) means for connecting the front edge of said platform to said mast for transmission of horizontal components of force only between said platform and said mast.
8. Oil well derrick structure comprising:
(a) a base having a low profile,
(b) drawwork means mounted on an end portion of said base,
(c) a support platform securable to a central portion of said base at an elevation above said drawwork means,
(d) a mast movable from a horizontal to a vertical position about a pivot axis passing through the lower extremity of the mast and through said base on the side of said support platform opposite said drawwork means,
(e) a traveling block assembly movable along the length of said mast by said drawwork means,
(f) pulleys mounted above said support platform and along the length of said mast,
(g) cable anchored at two ends and threaded over said pulleys to said traveling block in a plurality of cable run segments for vertical erection of said mast in one traverse of said traveling block, and
(h) means for connecting said mast when vertical to said support platform for transmission of horizontal components of force only between said mast and support platform.
9. The structure defined in claim 8 and further comprising:
reclining set-back structure pivoted to said base on the end portion opposite said drawwork means,
support beams extending at right angles from said set-back structure,
means to move said set-back structure to a vertical position parallel to the erected mast with said support beams extending through said mast, and
means to connect the ends of said support beams to said support platform with said mast free of forces on said support beams.
10. The structure of claim 8 wherein said means for connecting said mast to said support platform comprises substantially horizontal link means pivotally connected to said platform at one end and adapted to be pivotally connected to said mast at the other end.
11. The structure of claim 8 wherein spaced apart pulleys are mounted above said support platform and three pulleys are mounted along both sides of the lower portion of said mast, and said cable is threaded over said pulleys in five cable run segments on each side of said mast to a connection with said traveling block.
12. The structure of claim 11 wherein the lowermost pulley on each side of said mast is in the region of said pivot axis passing through said mast and over which said cable passes to a clear zone inside said mast.

References Cited
UNITED STATES PATENTS
3,141,653 7/1964 Jenkins ----------- 254—139
3,228,151 1/1966 Woolslayer et al. --- 173—39 X
3,262,237 7/1966 Jenkins et al. ------ 52—116

ERNEST R. PURSER, Primary Examiner
U.S. Cl. X.R.