FINGER BOARD AND RACKER APPARATUS AND METHOD

Noel E. Johnson, Humble, and John W. Turner, Jr., Houston, Tex., assignors to Byrom Jackson, Inc., Long Beach, Calif., a corporation of Delaware
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5 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for a drilling rig for oil wells primarily for use on drilling vessels with automated or semi-automated equipment, having a finger board with latch means individually operable automatically or semi-automatically for latching and releasing each stand of pipe or the like sepa-
reably in racked position against displacement by forces created due to roll and pitch of the vessel, high winds, etc., and method and means for handling drill pipe and drill collars in a vertical racking operation on a vessel.

CROSS REFERENCES TO RELATED APPLICATIONS


BACKGROUND OF THE INVENTION

This invention is directed generally to the field of well oil drilling and equipment therefor. More and more activity is being undertaken in the field of offshore drilling wherein stable platforms are used in shallow water but wherein floating platforms are desirable or a necessity for deep water drilling. Such floating platforms are inherently unstable and may comprise a barge or ship on which is mounted the rig or derrick. In the illustration shown here, the disclosure will be with respect to a ship-mounted derrick and the equipment therewith.

Floating platforms and ships are inherently unstable and it is extremely difficult to mount the equipment and perform the operations in a manner which will most efficiently permit drilling from such vessel.

Particularly, for the purposes of this disclosure, the pipe-handling equipment must be devised so that the pipe may be positioned quickly and accurately for placing in the well bore, or may be stacked or racked in such a manner that it cannot yield to the forces created by the roll or pitch of such vessel or by the force of wind or other forces which might normally be no problem in drilling from a stable platform.

In handling the pipe, ordinarily the sections are coupled into what is termed "stands" made up of several sections for handling purposes. It is customary to work a stand of three sections of pipe or drill collars, which stand must be from time to time racked in position away from the center of the derrick so as to be out of the way of the drilling operations, but readily available to be picked up and lowered into the hole or well.

Heretofore, various methods have been devised for placing the pipe over the well opening or for racking the stands. Particular attention has been given to the question of locking the pipe against displacement but the previous methods have been unsuitable or not the most efficient for use on an unstable platform such as a drilling vessel. Such previous methods have most often consisted of laying the stands down in horizontal fashion for racking. However, some attempts have been made to rack the stands of pipe vertically, especially where the drilling platform is stable. Reference is made to Moore, U.S. Patent 2,507,040; Stone, U.S. Patents 2,619,234 and 2,628,725 and to Coon, U.S. Patent 2,703,778 as showing some of the activity in providing equipment for vertical racking. There are other examples.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a pipe handling and racking arrangement and apparatus suitable for vertical racking of pipe on a vessel. In this connection, it is a primary object to provide an arrangement wherein the racking operations may be performed by an automated or semi-automated system and to disclose a method especially suitable for such racking operations.

It is another object of the present invention to provide an improved form of finger board wherein the drill pipe and drill collars racked therein are securely and individually held against displacement but can be individually removed therefrom without disturbing the latching or holding means for the remaining stands in said finger board.

It is an object of the present invention to provide an improved latch.

It is an object of the present invention to provide a latch arrangement wherein each latch strengthens the finger board assembly and contributes to the stability and security of the finger board and the pipe and drill collars mounted therein.

It is a further object of the invention to provide a means and method for positioning and holding stands of pipe and drill collars in an orderly arrangement, easily controlled by a derrick man or by automation or semi-automation.

It is a further object of the invention to provide a latch means which, when the pipe is in the finger board, extends horizontally between two fingers of the finger board forming with the finger board (and in the event such is the case previously lowered latch means) an individual pipe racking enclosure. Such latch means may be moved vertically by hydraulic or other power means to be out of the way of the pipe to release the pipe and permit its removal from the finger board.

Other objects and advantages will be hereinafter described, and the novel features of the invention will be defined in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a drilling ship having a derrick assembly illustrating an installation of apparatus exemplary to the present invention;

FIG. 2 is an enlarged side elevational view of the derrick assembly shown in FIG. 1 taken on the line 2—2 of FIG. 1 looking in the direction of the arrows;

FIG. 3 is a plan view illustrating some of the racking equipment forming the subject matter of the present invention, the view being fragmentary and taken on the line 3—3 of FIG. 2 looking in the direction of the arrows;

FIG. 4 is a fragmentary plan view on an enlarged scale showing details of the finger board and racking equipment of FIG. 3.

FIG. 5 is an enlarged fragmentary side elevational view taken on the line 5—5 of FIG. 4 looking in the direction of the arrows;
FIG. 6 is a side elevational view taken on the line 6—6 of FIG. 4 looking in the direction of the arrows; FIG. 7 is a fragmentary side elevational view taken on the lines 7—7 of FIG. 4 looking in the direction of the arrows;

FIG. 8 is a fragmentary plan view illustrating a portion of the finger board with a drill collar in place thereon; and

FIG. 9 is a fragmentary side elevational view taken on the line 9—9 of FIG. 8 looking in the direction of the arrows, and illustrating a means of fastening a latch to an adjacent finger of a finger board.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, there is shown a drilling ship 21 afloat in the water, the surface of the water being designated 22. The ship has an elevated platform 23 positioned amidships. Erected on the platform is a drilling derrick 24. The ship has a moon hole 25 through which a string of drill pipe 26 extends from above the platform 23 into the water and thence into the earth (not shown) below. As this type of drilling ship with a platform and a derrick is widely known in the field to which the invention pertains, it need not be described here in further detail. Turning to FIG. 2, the derrick 24 is shown somewhat schematically, sway braces, guy wires and similar structural members being omitted to enable working apparatus to be shown more clearly. The derrick has generally vertical corner posts 27 and 28 supported on the platform 23 on base members 29 and 31. A water table 32 near the top of the derrick carries the usual crown block 33 which is aligned with the vertical center line of the derrick. Suspended from the crown block by cable 34 is a travelling block 35. As is usual, one end (not shown) of the cable 34 is anchored to the ship's structure, and the other end is led to the spool 36 of a draw works 37 for raising and lowering the travelling block and the load supported thereby.

A hook structure 38 is swingably suspended from the bottom of the travelling block 35 by inter-engaged balls 39 on the hook and 41 on the block. An elevator link 42 is swingably suspended from an arm 43 on the hook structure, and the link has an elevator 44 swingably attached to another arm 45 to the lower end of the link 42. A second elevator link (not shown in FIG. 2) on the other side of the hook structure 38 similarly connects the elevator 44 to the hook structure 38.

The general reference numeral 46 denotes apparatus for positioning and guiding the block and hook structure. An elevator link stabilizing device is designated by the general reference numeral 47. The general reference numeral 48 designates apparatus for supplying compressed air to the elevator 44 to actuate it.

A stand 49 of drill pipe is shown as being supported by pipe-handling equipment including rackers 51 and 52. Other stands 53 of drill pipe and a stand 54 of drill collars are shown at rest in a pipe rack having a finger board 55, a base 56, and an intermediate rack member 57. The upper end of the string of drill pipe 26 is shown projecting above the power tongs 58, the slips 59, and the rotary table 61. Casing manipulating apparatus is shown at 62. A swivel and Kelly assembly 63 is disposed in the rack hole 64.

Extending outwardly from the derrick and positioned under the rack 51 is a horizontal stage 65 upon which an operator may stand to adjust or repair the rack.

Associated with the racker 52 is a cable 66 actuated by a fluid-powered piston-and-cylinder motor 67 for raising and lowering a component of the racker.

Referring next primarily to FIG. 3, the finger board 55 is shown as being in two sections; one, 68, located on the right-hand side and the other, 69, located on the left-hand side of central opening 71 extending laterally with respect to the center of the well between the rack sections 68 and 69. It is noted that this finger board assem-
As is clearly evident from FIGS. 4, 5 and 7, the latches 97 are mounted in trunnions 131 for rotary movement between a horizontal and vertical position. In FIG. 5, for example, the latch 97 on the left is shown in horizontal or latched position and the latch on the right in open position at 98, in which latter position it will be vertical with respect to the top of the finger 86. The latches are all equipped with a pair of spaced ears 132 and 133 at the rear thereof and which extend upwardly from the surface of the latch 97 and receive the end of the plunger 134 of the hydraulic cylinder 135 between the ears. A bolt 136, the like rotatably attaches the ears to the plunger 134 whereby movement of the plunger, in what may be termed a crank arm action, under the influence of the hydraulic cylinder 135 to move the plunger 134 outward from the cylinder, will push the latch to a horizontal position in which position it will be held by the hydraulic fluid in the cylinder. Retraction of the plunger 134 into the cylinder by reversal of the hydraulic pressure therein will pull the ears 132 and 133 backward and downward, resulting in the latch 97 being raised to a vertical position. Here again it will be held in vertical position so long as the fluid pressure in the cylinder acts to retract the plunger 134 or hold it retracted. Mounted in the finger 86, as in the case of all of the fingers, is a series of the hydraulic cylinders 135 extending vertically and mounted for rotary movement on a bracket 136 in the well-known manner. Hydraulic lines to each end of the cylinder are provided and as here illustrated, are the hydraulic line 137 to the upper end of the cylinder and the hydraulic line 138 to the lower end of the cylinder, the lines being connected through the manifold 115 having thereon valve and valve actuation means to be later described. Preferably, the hydraulic lines pass through an opening 139 in the bottom of the finger 86. Similar openings are provided for each of the hydraulic cylinders, there being one hydraulic cylinder for each latch. Likewise, lines similar to hydraulic lines 137 and 138 lead from each cylinder to the manifold 115 and a source of fluid pressure.

It may be noted in connection with the illustration of FIG. 5 that a stand of drill pipe 53 is in the first compartment and is held and latched therein by the positioning of the latch 97 in the horizontal position to close the opening between the finger 86 and the finger 85 (not shown in this illustration). On the other hand, a drill pipe stand 53 shown in phantom is indicated as being in the compartment next illustrated, but the compartment is still open and the stand may be moved thereby to the latch 97 lowered to the horizontal position retaining the stand in place. For illustrative purposes, the finger 86 is shown as broken away between the first and second latch means to make it comparable with FIG. 3 where several drill pipes are racked before coming to an open compartment.

In referring to “compartment” herein, the reference is intended to be illustrative for the space for one drill pipe (or, as the case may be, one drill collar) between two latches, for example, as shown for illustrative purposes in FIG. 3 at 141.

Referring now primarily to FIGS. 4 and 7, it will be noted that the finger 87 on its side facing the side rail 72, has welded thereto, or otherwise attached, a reinforcing section 143 running the full length of the finger 87. The same is true in connection with the drill collar finger 112 in the right-hand section 68 of the racking board. This reinforcing section is to give added strength to the drill collar finger 87 to withstand the force on the drill collar stand 54 shown in position in FIG. 7. Also, there is an upwardly extending angle iron attached to the top of the reinforcing section 143, here shown as angle iron 144. The principal purpose of this angle iron is to form a strike-plate for the drill collar latches 101 and the end drill collar latch 104. As illustrated, the drill collar latch 104 is thickened by the addition of a layer of metal to the bottom layer of the latch, and the angle iron 144 is drilled to receive a bolt 145 attaching the
nd drill collar latch in each section of pipe rack to the adjacent finger, that is, to finger 87 in the left-hand section of pipe rack (FIG. 3), and the finger 112 in the right-hand section. This bolt is only used in extremely rough weather conditions where the vessel or ship would roll or pitch. The bolt is intended to strengthen the means holding the drill collars firmly in place. Ordinarily, such an arrangement would not be necessary in connection with the retention of the drill pipe in the other fingers. As shown in FIG. 7 (and reference may also be had to FIG. 3), a metal housed eccentric 146 in connection with the drill collar racking means in the right-hand racking section and 147 for the left-hand racking section is attached to the top of the side rail 72, one on each side of the derrick man A, and the mechanism for manipulating the drill collar latches 101 and 104 is located in these housings. The drill collar latches 101 has upwardly extending arms 148 and 149 between which is journaled the end of the plunger 151 of the hydraulic cylinder 152. The cylinder 152 is rotatably journaled to the back of the housing 147 as shown at 153. Hydraulic lines 154 and 155 lead into the respective ends of the plunger and are, in the example shown in FIG. 7, led to the manifold 111 on the side rail 72. This arrangement is similar in its operation to the arrangement for operating the latches previously described or opening and closing the drill collar compartments, except that the plunger acts in a more or less horizontal position. The drill collar finger, here shown as 101-G, is in its open position by dotted lines where it extends through a slot 157 in the top forward edge of the housing 147.

Referring briefly to FIG. 3, there is indicated as visible between the fingers of the racks, standing base pipe rackers 158 which comprises a hemispherical washer located on the derrick base 56 on which the lower end of the stand of drill collars is placed to rack the stand properly aligned. As shown in FIG. 3, these are directly below racker sections and the stand of pipe would be positioned vertically in such arrangement. However, as a practical matter, these base rackers may be offset from the vertical outward of the adjacent fingers, thus reinforcing the fingers. The end fingers, that is, the drill pipe finger 81 and the drill collar finger 87 in the left-hand section, would be reinforced by the end latch of the finger 81 hitting the front rail 76 and by the reinforced latch 104 hitting the drill collar finger 87 in the event of distortion of those fingers. Thus, latches and fingers are operative to reinforce against distortion or bending due to extraneous forces.

As mentioned above, in bad weather, the end drill collar latch 104 is bolted to the finger 87 for added reinforcement against displacement of the drill collars.

The same arrangement holds true for the right-hand section.

As noted in FIGS. 5 and 6, the manifold 115 is shown as mounted on the top of the end rail 74 by means of bolts 142 extending through the base of the manifold and into the end rail. The views in FIGS. 5 and 6 of the manifold 115 show thereon stacked valve and solenoid assemblies 159, such manifolds being available to the trade from commercial sources and not per se forming a part of this invention. It may be noted, however, that FIG. 6 shows a valve and solenoid as available for each latch, and each latch is independently connected to a two-way valve with solenoid actuating means on a manifold for the particular finger on which the manifold is located. A manifold is available for each finger and for each drill collar latch assembly for each section of the racking board. As will be apparent, the manifold has fluid inlet conduit 161 and fluid outlet conduit 162, conduit 161 being attached to a source of fluid pressure and conduit 162 leading to the sump. These conduits are in communication with the valves.

Each of the valves has two hydraulic lines 137 and 138 connected to the hydraulic cylinders 135, as above described, for each of the latch means. Thus, fluid pressure is always maintained on each manifold valve from a common line, and actuation of the valve to open the circuit to hydraulic line 137 will divert the pressure into that line and into the plunger end of the cylinder 135. At the same time the valve will open the fluid circuit in line 138 to dump fluid pressure therein into the fluid outlet conduit 162 and return the excess fluid to the sump. Reversal of the valve by the solenoid arrangement will place the fluid pressure in the hydraulic line 138 and relieve the line at the actuator by means of the fluid toward the plunger end and extending the plunger, thus, lowering the latch 97. Each drill collar latch 101 may be similarly operated by reversing the flow of operating fluid in conduits 154 and 155. Actuation of the solenoids for the manifold valve may be done automatically (by a computer) but is done by the derrick man A moving a toggle switch 163 indicated schematically on the console 117 in either the forward or reverse direction.

After the latch has moved, the switch is released and the valve being actuated in the manifold will move to a locked position holding the latch in the desired attitude.

The manifold 115 has a conduit 164 through which electrical leads are brought from the console toggle switch 163 into a terminal box 165. From there the individual electrical connections are made to the solenoids for each valve.

**METHOD OF OPERATION**

The operation of this device will be described in connection with the showing of a semi-automated arrangement, it being understood that the device can be fully automated.

Ordinarily, the drill pipe 26 will be pulled from the well (assuming that the operation calls for removing the pipe from the hole) through the rotary table 61 and tong 58 by means of the block 35 and the elevator 45, until three sections of pipe have cleared the slip 59 and the block 35 is in its uppermost position. The pipe will be locked in the rotary table 69 by the slip 59 against downward movement, and the elevator will be removed from the pipe while it is being grasped by the racker head 119 on the top racker arm 118 for steadying the upper portion of the pipe. This operation is under control of the derrick man A.

At the same time, the intermediate head on the racker 52 will be in its lowest position and will grasp the lower section of pipe at its upset or collar, as the case may be. While this is happening, the racker 52 will be operated to spin out and disconnect the stand 49 from the pipe 26 and the floor man B will actuate the hydraulic cylinder 67 to move the racker head on the intermediate racker arm 52 to its upper position as shown in FIG. 2. This will lift the stand of pipe 49 clear of the derrick man A, as it was previously connected.

The derrick man A and the floor man B will then act in concert by energizing the racker arms on the rackers 51 and 52, respectively, moving the pipe back towards the finger board 55 in the space 71 but clear of the ends of the fingers. As to pipe 26, it has reached the space between the fingers into which it is to be placed, the latches 97 therein having been placed in their vertical or raised position 98 by the derrick man A. Flipping the toggle switch 163 to energize the latch-lifting means, the derrick man A will move the racker 51 laterally to move the pipe 49 into the space between

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the racking fingers and the floor man B will move the intermediate racker 52 laterally to bring the bottom of the stand 49 over the spherical base 158 thereon. When this has been done, the floor man B then energizes the cylinder 67 to lower the racker head on the intermediate racker 52 to set the pipe 49 on the base 158 thereon. The derrick man A then operates the toggle switch 163 for the proper latch 97 causing the latch to be energized and to move into the horizontal position 99 retaining the pipe in the compartment 141 selected therefor.

It is to be observed that ordinarily the pipe 53 will be racked first into the end compartments nearest the end rails 73 and 74 starting with the first space 88 if the racking is on the left-hand finger board section 69 and next proceeding with the second stand to rack the end compartment in the space 89 and so on, until there is a single row of stands in the finger board section 69 at the left-hand end thereof. Next, they will fill the second compartment in each of the spaces, moving the latch 97 from its vertical 98 to its horizontal position 99 in each instance to hold the pipe 53 therein.

As mentioned above, release of the toggle switch locks the latch 97 in the position selected.

When the left-hand section 69 has been filled, then the derrick man A racks the right-hand section 68 in the same way.

Since it is last to come out of the hole and first to go into the hole, the drill collars 54 will then be racked in the same way in their respective sections.

It is noted that, should the operators A and B prefer, they can rack to fill the space 88 completely before starting on the space 89. However, due to the possible interference of the racked stands 53 with the racker head 119, it is possible only to rack from the outside toward the derrick man or from the left toward the center of the left-hand section 69. Similarly, the same principal holds true to the right-hand section 68 where the right-hand row of compartments will be filled first or the space furthest from the operator will be filled first.

It is understood that reference herein is made to fluid under pressure. A pump or other source of said fluid is not disclosed but is believed to be a common expedient. The same holds true for a sump into which the excess fluid is dumped.

No point has been made of the paths and location of the various electrical and fluid lines, it merely being necessary that they are usually located in a trough below the fingers and underneath the walkaround, or any other convenient location where they are out of the way.

While we have herein shown and described various embodiments of our present invention, including a method for racking stands of pipe and drill collars, still we do not wish to be limited thereto except as may be required by the limitations in the claims.

What is claimed is:

1. In a pipe racking apparatus for the vertical racking of stands of drill pipe and drill collars used in oil wells and the like, comprising:
   (a) a finger board having at least one finger board section;
   (b) a plurality of inwardly extending horizontal fingers spaced apart a distance to accommodate the diameter of a drill pipe or drill collar to be racked therein;
   (c) a plurality of latch means spaced longitudinally of each said finger, each latch being spaced a distance from any adjacent latch at least the diameter of a drill pipe or drill collar to be racked, thereby forming between said latches and said fingers a compartment to receive such drill pipe or drill collar;
   (d) each latch means being hinged at one end to the finger on which it is mounted for pivotal movement between a vertical position and a horizontal position with respect to said finger, the arrangement being such that when the latch means is in the horizontal position it extends laterally at right angles to said finger and when it is in the vertical position it extends vertically with respect to said finger on which it is mounted, the former being the closed position and the latter being the open position for said latch means; and
   (e) power-actuated means selectively operable to move each said latch means independently of each other said latch means between its vertical and horizontal positions and to hold it in the position to which it is moved.

2. A pipe racking apparatus as claimed in claim 1, wherein the racker board sections are mounted in a framework comprising a rear rail, an end rail on the end of which one section of a finger board is mounted, and a front rail, said rear rail forming one side of a compartment for racking drill collars and having thereon a latch means for each compartment, and fluid actuated means for each such latch means.

3. A pipe racking apparatus as described in claim 2, wherein there are two finger board sections and a rear rail, two end rails and two front rails, the latter having an opening therebetween, each finger board section being mounted on one of the end rails, and each finger board section having latch means on the rear rail for the racking of drill collars.

4. A pipe racking apparatus as claimed in claim 3, wherein each racking board section includes a drill collar finger, and wherein each racking board section has a latch movable horizontally to extend between the rear rail and the end of the drill collar finger, and means for locking the drill collar finger to the last-mentioned latch means for stabilizing the drill collar finger.

5. Pipe racking apparatus as defined in claim 1, including a racker base disposed below said finger board and having rows of protruberances adapted to receive the lower end of each of said drill pipe or drill collar, said protruberances being in spaced relation aligned beneath the spaces between said fingers.

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JAMES A. LEPPINK, Primary Examiner U.S. Cl. X.R.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,501,017 Dated March 17, 1970

Inventor(s) Noal E. Johnson and John W. Turner, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Sheets 1, 2, 3, 4, 5, and 6 of drawings, line 2, cancel "AND METHOD.
Column 1, line 3, cancel "AND METHOD"; line 29, after "Turner," should be --Jr.--; line 32, after "Turner," should be --Jr.--.

Column 4, line 51, "flingers" should be --fingers--.
Column 5, line 47, "end" should be --and--.
Column 7, line 15, "manipulating" should be --manipulating--.
Column 8, line 47, "slip" should be --slips--; line 49, "69 should be --61--; "slip" should be --slips--.

SIGNED AND
AUXILIARY

OCT 27 1970

(SEAL)

Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents