United States Patent

[11] 3,633,767

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[54] **PIPE-RACKING APPARATUS FOR OIL WELL DERRICKS OR THE LIKE**
7 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **214/2.5**
[51] **Int. Cl.** **E21b 19/14**
[50] **Field of Search** ..... 175/85; 214/2.5, 1 CM, 514

[56] **References Cited**

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2,616,578	11/1952	Dunhane	214/514 UX
2,730,246	1/1956	Stone	214/2.5
3,145,786	8/1964	O'Neill et al.	214/2.5 X
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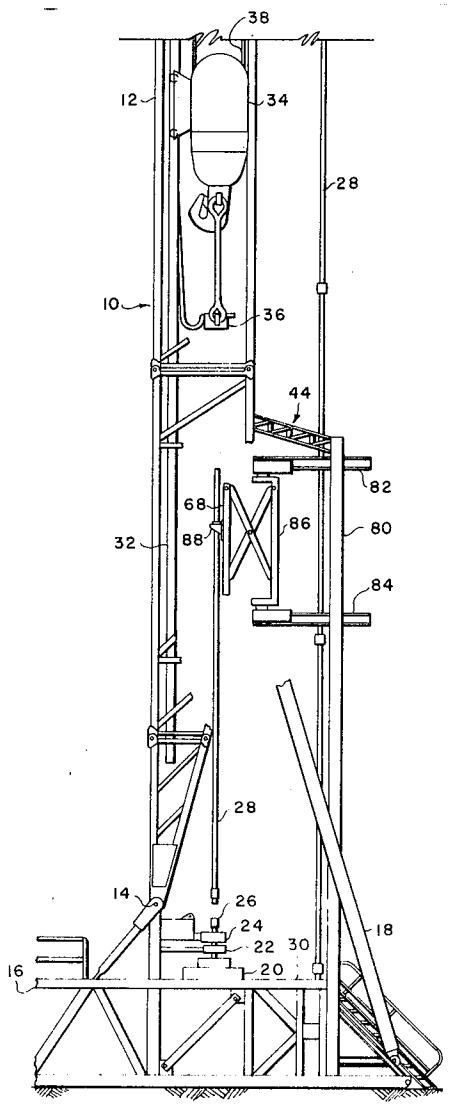
ABSTRACT: The pipe-racking apparatus disclosed in detail hereinafter is intended for use in a derrick during the drilling of oil and gas wells or the like. During trips into and out of the wellbore, drill pipe is removed or added in the form of stands made up of a plurality of short pipe sections. This pipe-racking apparatus includes a transfer arm that consists of a pantograph mechanism carrying a pipe engaging and supporting member. The transfer arm is movable on tracks whereby the stands of pipe can be moved in the vertical position between the pipe-racking area and the centerline of the wellbore.



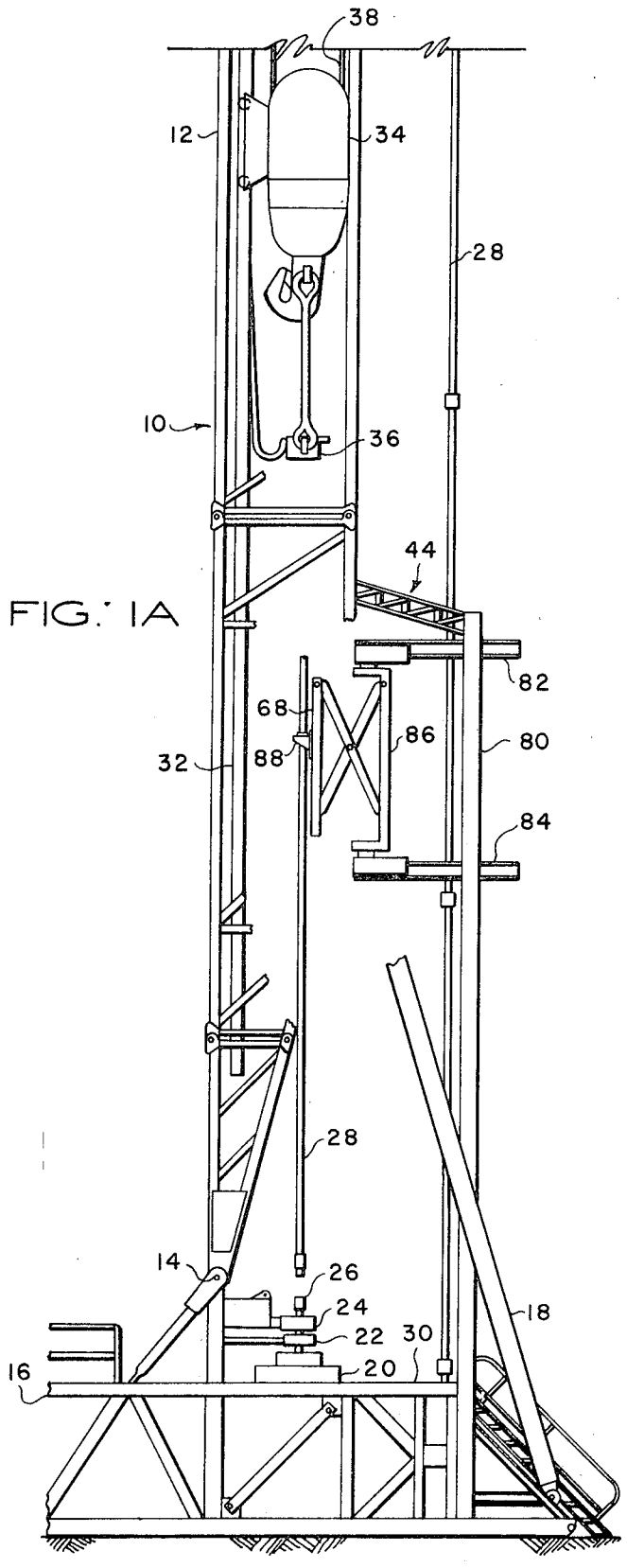


FIG. 1A

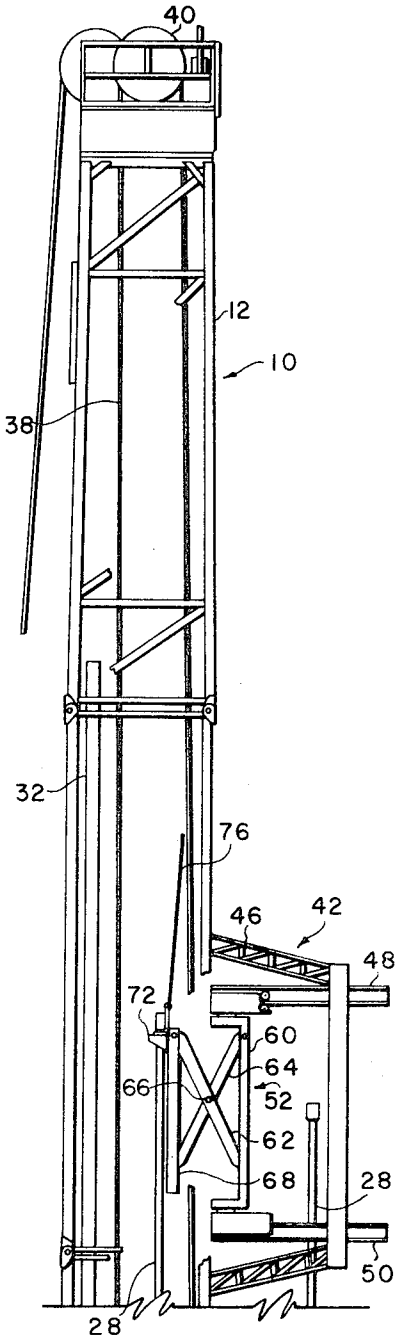


FIG. 1B

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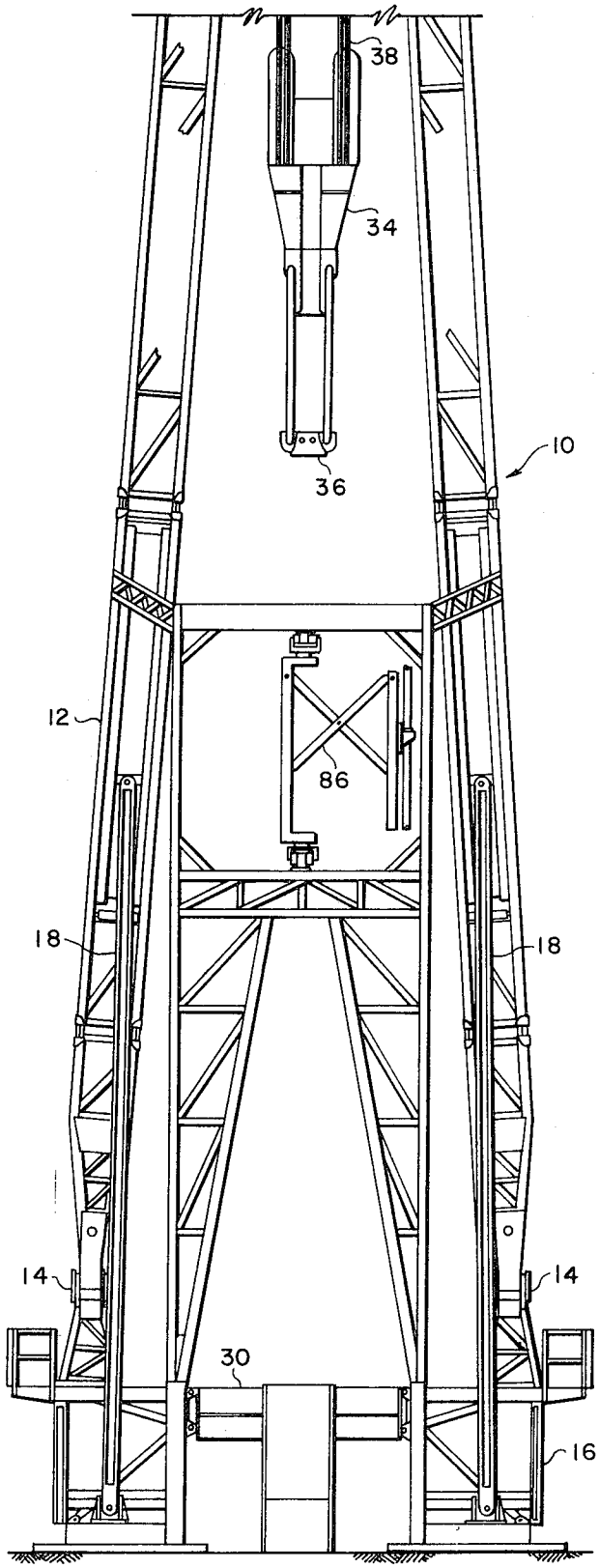

FIG. 2A

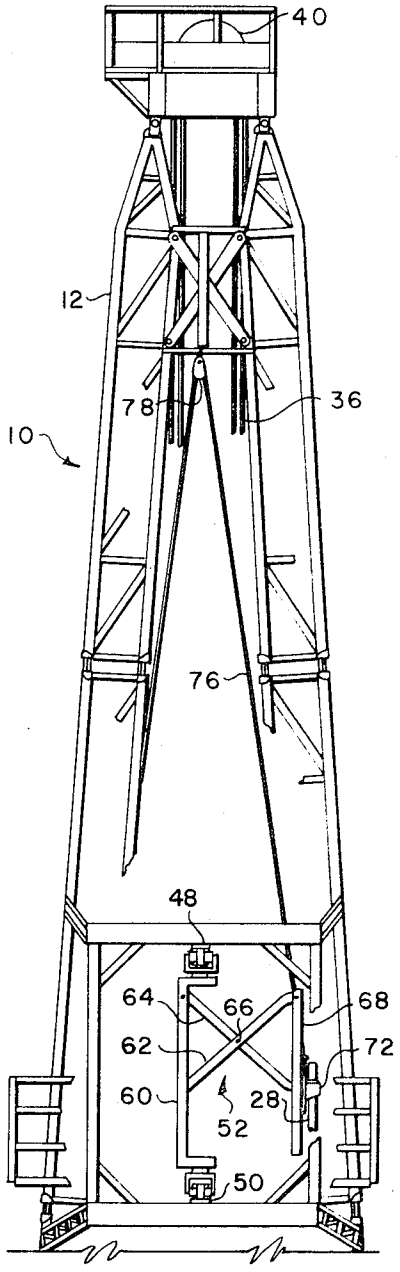

FIG. 2B

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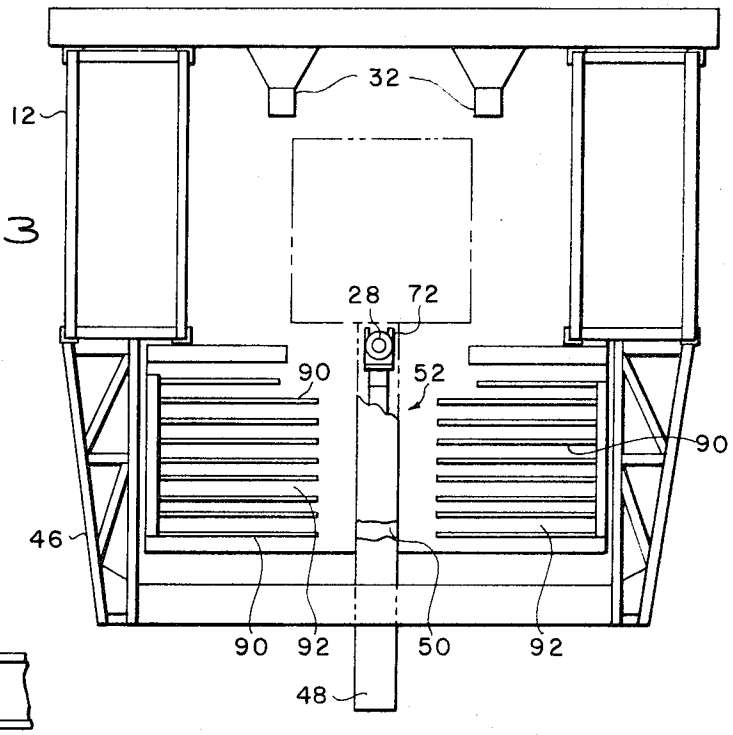
FIG. 3



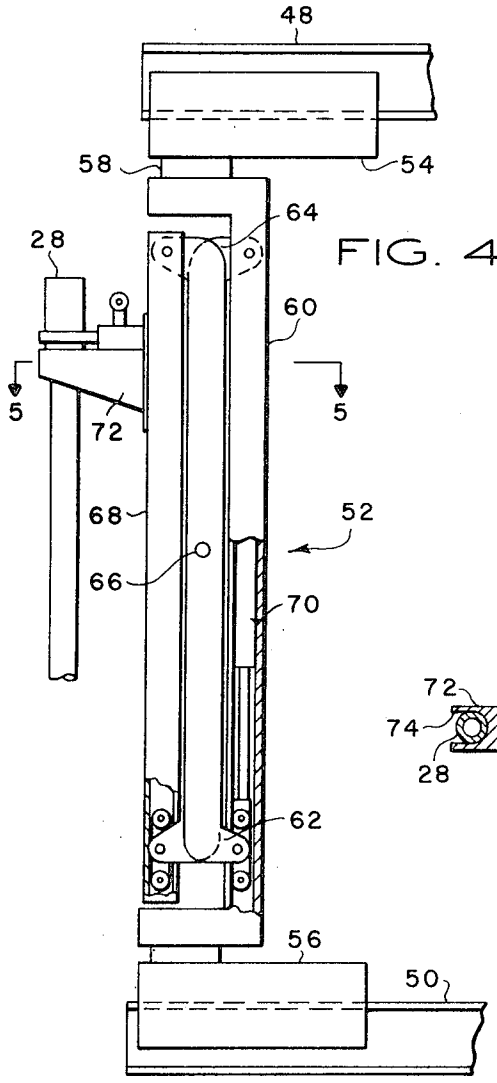


FIG. 4

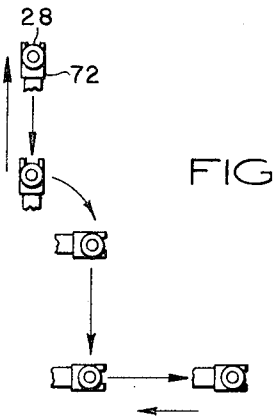


FIG. 6

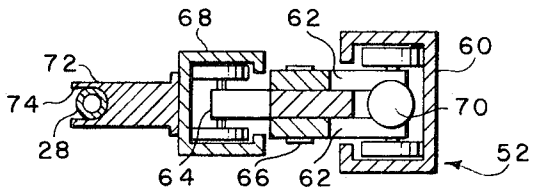


FIG. 5

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PIPE-RACKING APPARATUS FOR OIL WELL DERRICKS OR THE LIKE

BACKGROUND OF THE INVENTION

This invention relates generally to pipe-handling or pipe-racking apparatus. More specifically, but not by way of example, this invention relates to pipe-racking apparatus for handling vertically disposed pipe sections in a derrick used for drilling oil and gas wells or the like.

Various types of pipe-handling or pipe-racking apparatus have been proposed heretofore for the purpose of moving the pipe sections between the centerline of the wellbore and a pipe-racking or setback platform in the derrick. Typical of the apparatus known in the past is the pipe-handling apparatus disclosed in U.S. Pat. No. 2,730,246 issued to A. L. Stone on Jan. 10, 1956.

The Stone patent discloses pipe-racking devices that include track mechanisms or lead screws for manipulating the pipe-engaging portion thereof in a rectilinear fashion so that the pipe stands can be racked in the derrick in the rather small area provided for that purpose. Since the apparatus is limited to rectilinear movements, the pipe racking must follow a prescribed method with each of the stands being necessarily positioned as a result of the limited movements of the pipe-handling apparatus.

SUMMARY OF THE INVENTION

It is one object of this invention to provide improved pipe-racking apparatus for use in a derrick for handling vertically disposed pipe sections that can be used to quickly and efficiently position the pipe sections as desired.

A further object of this invention is to provide an improved pipe-racking apparatus that is extremely rugged, that can be readily installed on existing drilling rigs and that includes the versatility of being able to position the pipe sections in a very compact area of the drilling rig.

Still another object of the invention is to provide an improved pipe-racking apparatus that can be fully automated and thereby reduce the manual labor required in conventional pipe handling.

The foregoing objects are accomplished by improved pipe-racking apparatus for moving and supporting vertical sections of pipe in a derrick wherein the apparatus includes: mounting means for supporting the apparatus in the derrick; transfer arm means carried by the mounting means, the arm means including an outer member positioned substantially vertically and pivotally mounted on the mounting means, an inner member disposed in parallel relationship to the outer member, and connecting means extending between and operably joining the inner and outer members while maintaining the parallel relationship thereof; and, pipe-engaging means positioned on the inner member for engaging and supporting the vertical sections of the pipe in the derrick.

The foregoing and additional objects and advantages of the invention will become more apparent as the following detailed description is read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B taken together comprise a side elevation view of a well-drilling rig including pipe-racking apparatus constructed in accordance with the invention with certain portions of the derricks being removed for clarity of illustration.

FIGS. 2A and 2B taken together comprise a front elevation view of the rig having the pipe-racking apparatus of the invention located therein.

FIG. 3 is a view taken transversely of the derrick above and showing the pipe-racking area.

FIG. 4 is an enlarged, elevation view of the transfer arm of the pipe-racking apparatus.

FIG. 5 is a cross-sectional view taken substantially along the line 5—5 of FIG. 4.

FIG. 6 is a schematic view illustrating the path of movement of the pipe sections between the centerline of the wellbore and a position in the racking area of the derrick.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring to the drawings and FIGS. 1A and 1B in particular, shown therein and generally designated by the reference character 10 is a drilling rig that includes a derrick 12 pivotally mounted at 14 on a base or platform 16. Struts 18, which have their lower ends connected with the base 16, are suitably attached to the derrick 12 to maintain the derrick 12 in the vertical or erect position as illustrated.

The base 16 will support a drawworks (not shown) and a rotary table 20 that is located on the centerline of the wellbore. Power slips 22 and power tongs 24 are provided for the purpose of supporting the drill string 26 in the wellbore and for assembling the drill string 26 from stands 28 of drill pipe or for breaking the drill string 26 down into stands 28.

A stand 28 consists of one or more joints of drill pipe. Each joint will be between 20 and 40 feet long. The drill string 26 is made up of a plurality of the stands 28 screwed together.

The drilling rig 10 also includes an area for racking the stands 28. The area, which will be referred to herein as the setback 30, is illustrated in FIG. 1A as being a portion of the base 16. The setback 30 will be offset from the centerline of the wellbore so that the stands 28 can be racked in the drilling rig 10 out of the way of operations being performed along the wellbore centerline.

Elongated tracks or guides 32 are attached to the derrick 12 and extend along a substantial portion of the derrick 12. The tracks 32 are provided to control the position of a travelling block 34 and an elevator 36 which is connected to the lower end of the travelling block 34.

The travelling block 34 is connected with the drawworks (not shown) through a cable system 38 that extends upwardly from the travelling block 34 over a crown block 40 mounted on the upper end of the derrick 12. The cable system 38 permits the travelling block 34 to be raised and lowered in the derrick 12 along the tracks 32.

The drilling rig 10 includes upper pipe-racking apparatus designated generally by the reference character 42 and a lower pipe-racking apparatus designated generally by the reference character 44. As shown in FIG. 1B, the upper pipe-racking apparatus includes a frame 46 supporting a pair of spaced track members 48 and 50. Movably mounted on the tracks 48 and 50 is an upper transfer arm assembly 52 that is shown in more detail in FIGS. 4 and 5.

Upper and lower carriers 54 and 56 movably connect the transfer arm 52 with the tracks 48 and 50. The carriers 54 and/or 56 may be provided with a motor or similar device for propelling the transfer arm 52 along the tracks 48 and 50. In addition, either the upper or lower carrier 54 or 56 will include a servomotor 58 for pivoting the transfer arm 52 relative to the tracks 48 and 50. If desired, the carriers 54 and 56 can be connected with the tracks 48 and 50 and the tracks moved relative to the frame 46.

Extending between the carriers 54 and 56 is an outer member 60. The outer member 60 is in the form of a hollow beam and is arranged to movably support the lower end of a pair of links or connecting members 62 and to pivotally support the upper end of a second connecting member 64. The connecting members 62 and 64 are pivotally joined by a pin 66.

The upper end of the members 62 are pivotally connected with the upper end of an inner member 68 that is disposed substantially parallel to the outer member 60. The inner member 68 is also a hollow beam and is arranged to movably support the lower end of the connecting member 64.

The transfer arm 52 is of a geometric construction sometimes referred to as a pantograph. That is, the construction is such that movement of the lower ends of the connecting members 62 and 64 causes the connecting members to pivot about

the pin 66, moving the inner member 68 relatively toward and away from the outer member 60.

To cause the movement of the ends of the connecting members 62 and 64, a linear actuator 70, such as a hydraulic cylinder, is mounted in the outer member 60 with its lower end connected with the lower end of the connecting members 62. Actuation of the linear actuator 70 moves the lower ends of the connecting members 62 and 64 relatively toward the pivoted upper ends thereby moving the inner member 68 relative to the outer member 60.

Movably mounted on the inner member 68 is a pipe-engaging member 72. The pipe-engaging member 72 has a recess 74 in its outer end portion that is sized to receive the drill pipe. The recess 74 is arranged to fit over the pipe, but is sufficiently small so that the enlarged couplings joining the pipe sections to form the stands 28 will not pass therethrough. Thus, the pipe-engaging member 72 can be raised into engagement with the collars to exert an upward force on the pipe stands 28.

As can be seen in FIG. 2B, a cable system 76 extends from the pipe-engaging members 72 to a pulley 78 hung in the derrick 12 and then down to a hoist (not shown). The arrangement is such that the cable system 76 can be used to raise and lower the pipe-engaging member 72 along the inner member 68 of the transfer arm 52 thereby raising and lowering the stand 28 engaged thereby.

The lower pipe-racking apparatus 44 includes a frame 80 that is connected with the derrick 12 and with the base 16 to support a pair of spaced tracks 82 and 84. A transfer arm device 86 is movably mounted on the tracks 82 and 84. The transfer arm 86 is identical in almost every respect to the transfer arm 52 previously described. The transfer arm 86 preferably includes a pipe-engaging member 88 that is fixed to the inner arm 68 instead of being movable therealong as previously described in connection with the transfer arm 52.

It can be appreciated from the foregoing, that appropriate power, such as electrical or hydraulic, can be provided to the various motors and actuators utilized in the pipe-racking apparatus 42 and 44. Also, it is preferred that the transfer arms 52 and 86 be controlled for synchronized movement by an operator located on the base 16. Such control apparatus is believed to be conventional and is therefore not described in detail herein.

FIG. 3 is a transverse view of the derrick 12 taken just above the frame 46 and looking downward. The track 50 will be located in the derrick 12 and is in approximately the same position as the monkey board of a conventional derrick. Spaced racking fingers 90 extend from the frame 46 toward the track 50 providing a plurality of racking slots 92. The fingers 90 are positioned directly over the setback 30.

OPERATION PREFERRED EMBODIMENT

The pipe-racking apparatus 42 and 44 of this invention are utilized in the drilling rig 10 during the removal of the drill pipe from the wellbore and replacement of the drill pipe therein. Since the pipe-handling procedure during the replacement of the drill pipe is substantially a reverse of the pipe-handling procedure during removal of the drill pipe, only the removal procedure will be described.

The drawworks is actuated causing the cable system 38 to lower the travelling block 34 and elevators 36 downwardly until the elevators 36 can be attached to the upper end of the drill string 26 extending from the wellbore. The cable system 38 is then actuated to raise the travelling block 34 and elevators 36 in the derrick 12 lifting the drill string 26 therewith. When one stand 28 of the drill string 26 has been raised into the derrick 12, the power slips 22 are set holding the drill string 26 in the wellbore with the stand 28 extending therefrom.

The travelling block 34 is then lowered as the threaded connection joining the stand 28 to the remainder of the drill string 26 is unthreaded. As the stand 28 is being unthreaded, the transfer arms 52 and 86 are moved inwardly toward the centerline of the wellbore until the pipe-engaging members 72 and 88 thereon have engaged the stand 28. As soon as the stand 28 has been unthreaded from the drill string 26, the cable system 76 is actuated, raising the pipe-engaging member 72 to lift the stand 28 free from the remainder of the drill string 26.

When the stand 28 is free, the actuator 70 is energized, collapsing the transfer arms 52 and 86 moving the stand 28 outwardly away from the centerline of the wellbore and toward the pipe-racking area. The transfer arms 52 and 86 and the connected pipe stand 28 are then propelled along the tracks to the appropriate racking position above the setback 30. As shown in FIG. 6, the pipe-engaging member 72 and the stand 28 are then pivoted and the hydraulic actuator energized to move the inner member 68 away from the outer member 60 so that the stand 28 is disposed in the proper slot 92 between the racking fingers 90. The cable system 76 is then utilized to lower the stand 28 and pipe-engaging member 72 until the lower end of the stand 28 is resting on the setback 30. The transfer arms 52 and 86 are then collapsed, returned to the area of the centerline of the wellbore, and turned to a position in substantial alignment with the length of the tracks to pick up subsequent stands 28 of pipe as the drill string 26 is pulled from the wellbore.

Since the angular position of the transfer arms 52 and 86 is controlled by a servomotor, it is not necessary that the travelling block 34 be mounted on the guides 32. The ability to position the pipe-engaging member 72 in various angular positions permits an operator of the pipe-racking apparatus 42 and 44 to seek the stand 28 as it hangs in the derrick 12.

While FIG. 6 illustrates movement of the pipe-engaging member 72 only toward the right, it will also be apparent that the pipe-engaging member 72 can be pivoted to the left in order to utilize the racking area located to the left of the tracks 48 and 50. The use of the collapsible mechanism built into the transfer arms 52 and 86 permits the arms to be of rugged construction and mounted on heavy tracks that do not interfere with normal operations in the drilling rig 10 since they can be relatively short. Also, the collapsible structure of the transfer arms permits the transfer arms to be pivoted in a relatively small area thereby conserving space in the derrick 12.

The embodiment described in detail hereinbefore is presented by way of example only and it will be understood that many changes and modifications can be made thereto without departing from the spirit and scope of the invention. For example, the terms "derrick" and "rig" as utilized herein shall include all of the various types of apparatus for running conduit into and out of wellbores, such as fixed derricks and collapsible masts.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Pipe-racking apparatus for moving and supporting vertical sections of pipe in a derrick, said apparatus comprising:

mounting means for supporting said apparatus in the derrick;

transfer arm means carried by said mounting means, said arm means including

an outer member positioned substantially vertically and pivotally mounted on said mounting means,

an inner member disposed in parallel relationship to said outer member, and

connecting means extending between and operably joining said inner and outer members for varying the distance between said inner and outer members while maintaining said parallel relationship;

pipe-engaging means positioned on said inner member for engaging and supporting the vertical sections of pipe in the derrick, wherein said connecting means includes:

a first connecting member having one end pivotally connected with said outer member and the other end movably connected with said inner member;

a second connecting member having one end pivotally connected with said inner member and the other end movably connected with said outer member; and,

said connecting members being pivotally connected between said ends.

2. The pipe-racking apparatus of claim 1 wherein said connecting means also includes power means for moving said other ends of said connecting members toward and away from said one ends of said connecting members whereby said inner and outer members are moved apart and together.

3. The pipe-racking apparatus of claim 1 and also including means for pivoting said transfer arm means relative to said mounting means.

4. The pipe-racking apparatus of claim 1 wherein:

said pipe-engaging means is movable along said inner member; and,

said apparatus also includes means for moving said pipe-engaging means for raising and lowering the pipe sections when engaged thereby.

5. The pipe-racking apparatus of claim 4 wherein said means for moving said pipe-engaging means includes hoisting apparatus operably connected with said pipe-engaging means and arranged to be mounted on said derrick.

6. The pipe-racking apparatus of claim 1 wherein

said mounting means includes spaced upper and lower track members;

said transfer arm means includes an upper carriage movable along said upper track member and pivotally supporting an upper end of said outer member, a lower carriage movable along said lower track member and pivotally supporting a lower end of said outer member; and,

at least one of said carriages including means for propelling said transfer arm means along said track members.

7. Pipe-racking apparatus for moving and supporting vertical sections of pipe in a derrick, said apparatus comprising:

mounting means for supporting said apparatus in the derrick,

said mounting means including spaced upper and lower track members;

transfer arm means carried by said mounting means, said arm means including

an outer member positioned substantially vertically and pivotally mounted on said mounting means,

an inner member disposed in parallel relationship to said outer member,

connecting means extending between and operably joining said inner and outer member for varying the distance between the inner and outer members while maintaining said parallel relationship, said connecting means including a first connecting member having one end pivotally connected with said outer member and having the other end movably connected with said inner member, a second connecting member having one end pivotally connected with said inner member and having the other end movably connected with said outer member, and said connecting members being pivotally connected between said ends,

power means for moving said other ends of said connecting members toward and away from said one end of said connecting members whereby said inner and outer members are moved apart and together,

an upper carriage movable along said upper track member and pivotally supporting an upper end of said outer member,

a lower carriage movable along said lower track member and pivotally supporting a lower end of said outer member, and

at least one of said carriages including means for propelling said transfer arm means along said track members;

pipe-engaging means movably positioned on said inner member for engaging and supporting the vertical sections of pipe in the derrick;

means for moving said pipe-engaging means for raising or lowering the pipe sections when engaged thereby; and,

means for pivoting said transfer arm means relative to said mounting means.

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