United States Patent

Langowski et al.

[15] **3,655,071**

[45] **Apr. 11, 1972**

[54] HORIZONTAL PIPE RACKING AND HANDLING APPARATUS

[72] Inventors: **Faustyn C. Langowski; John W. Turner, Jr.**, both of Houston, Tex.

[73] Assignee: **Byron Jackson, Inc.**, Long Beach, Calif.

[22] Filed: **May 27, 1970**

[21] Appl. No.: **40,986**

[52] **U.S. Cl.** ..... **214/2.5**, 214/1 P

[51] **Int. Cl.** **E21b 19/14**

[58] **Field of Search** ..... 214/2.5, 1 P; 175/85, 63

[56] **References Cited**

UNITED STATES PATENTS

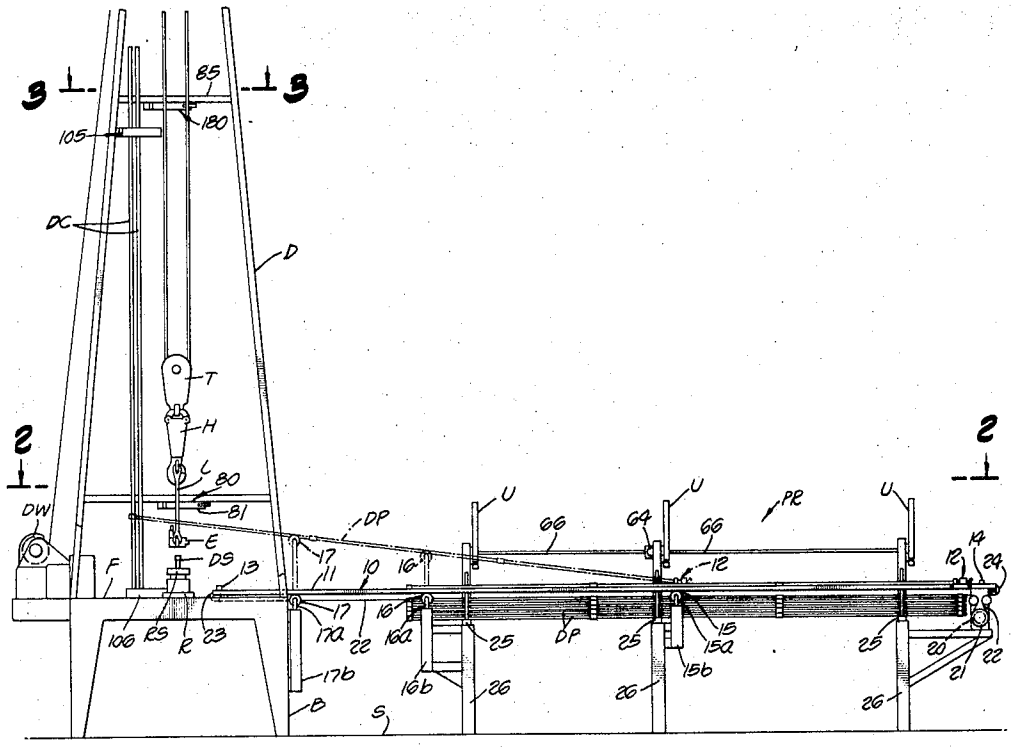
3,499,498	3/1970	Bromell et al.	214/2.5 X
3,083,842	4/1963	Bauer et al.	214/1 P X
3,533,516	10/1970	Guier	214/2.5
3,561,811	2/1971	Turner, Jr.	214/2.5 X
2,730,246	1/1956	Stone	214/2.5
1,884,874	10/1932	Ross	214/2.5 X
3,095,048	6/1963	O'Neill et al.	214/2.5 X
3,145,786	8/1964	O'Neill et al.	214/2.5 X
2,615,585	10/1952	Menhall	214/2.5

Primary Examiner—Gerald M. Forlenza
Assistant Examiner—Frank E. Werner
Attorney—Donald W. Banner, William S. McCurry and John W. Butcher

[57] **ABSTRACT**

Horizontal pipe racking and handling apparatus in which stands of drill pipe are moved between horizontal racked positions and a position suspended at the center of a well drilling derrick, the horizontal rack supporting the pipe in vertical rows at opposite sides of line leading to the center of the derrick, and in which pipe stand racking and unracking apparatus includes a plurality of relatively shiftable pipe gripping and hoisting devices spaced longitudinally of the racked pipe so as to be operative to transfer pipe stands consisting of two joints or three joints of pipe. Each of the pipe transfer devices consists of a frame structure including a horizontally extended arm on which a carriage is shiftable, the carriage carrying vertically shiftable pipe stand engaging heads, and the carriages of all of the pipe transfer devices being driven by a common drive. In addition, the pipe handling apparatus includes a combined catcher and positioner for the lower end of the pipe stand as it approaches a vertical position in the derrick whereby to confine the lower end of the stand against undesired movement and to position the stand above the drill string supported in the rotary table; the catcher and positioning device also being operable to engage and move the lower end of the drill collar between a position above the rotary table and a vertically racked position. The apparatus also includes an upper racker device for engaging and moving the upper end of the drill collars between a position above the rotary table and an offset vertically racked position.

3 Claims, 16 Drawing Figures



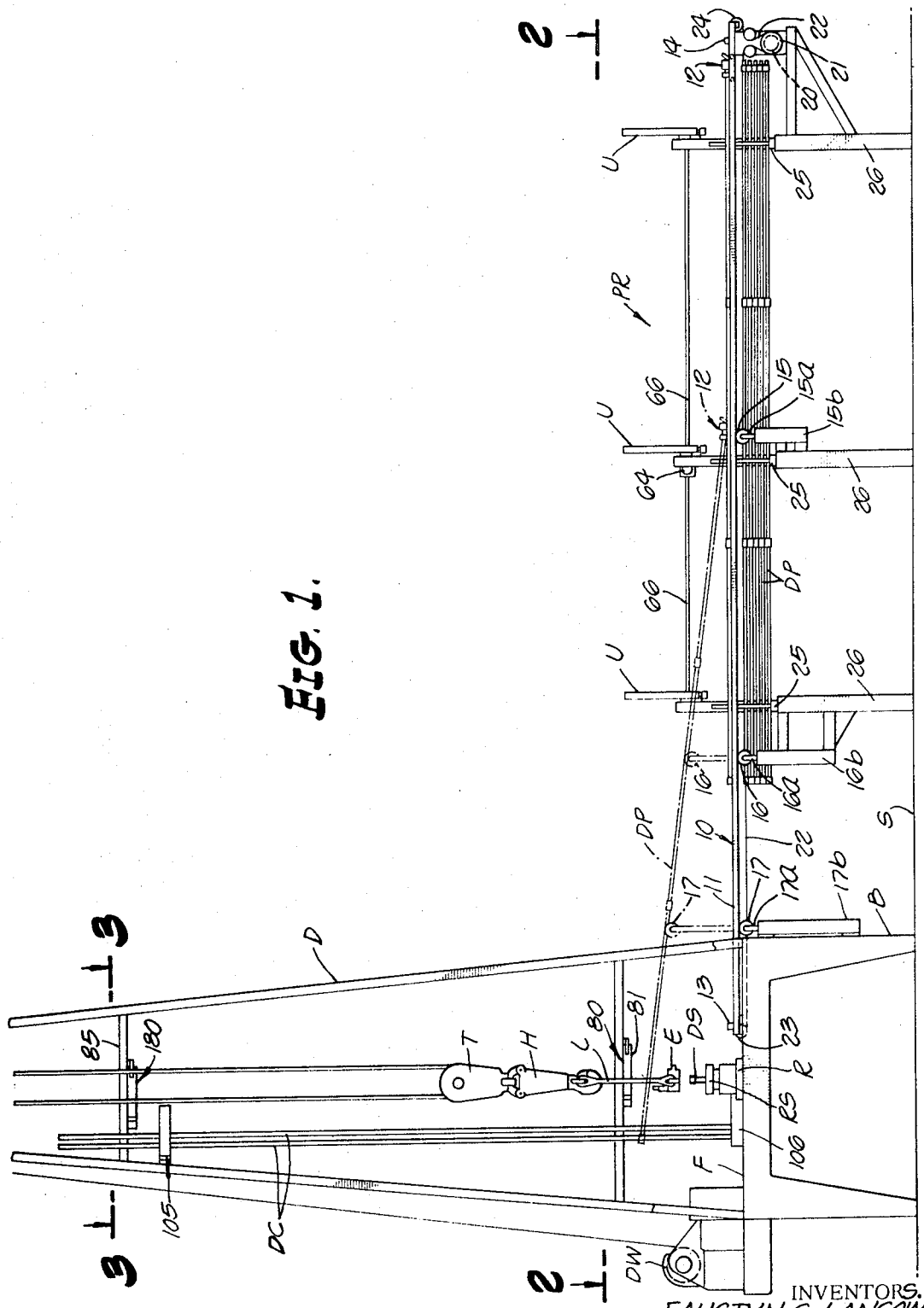


Fig. 1.

INVENTORS.
FAUSTYN C. LANGOWSKI
JOHN W. TURNER, JR.
BY
John O. Evans, Jr.
ATTORNEY

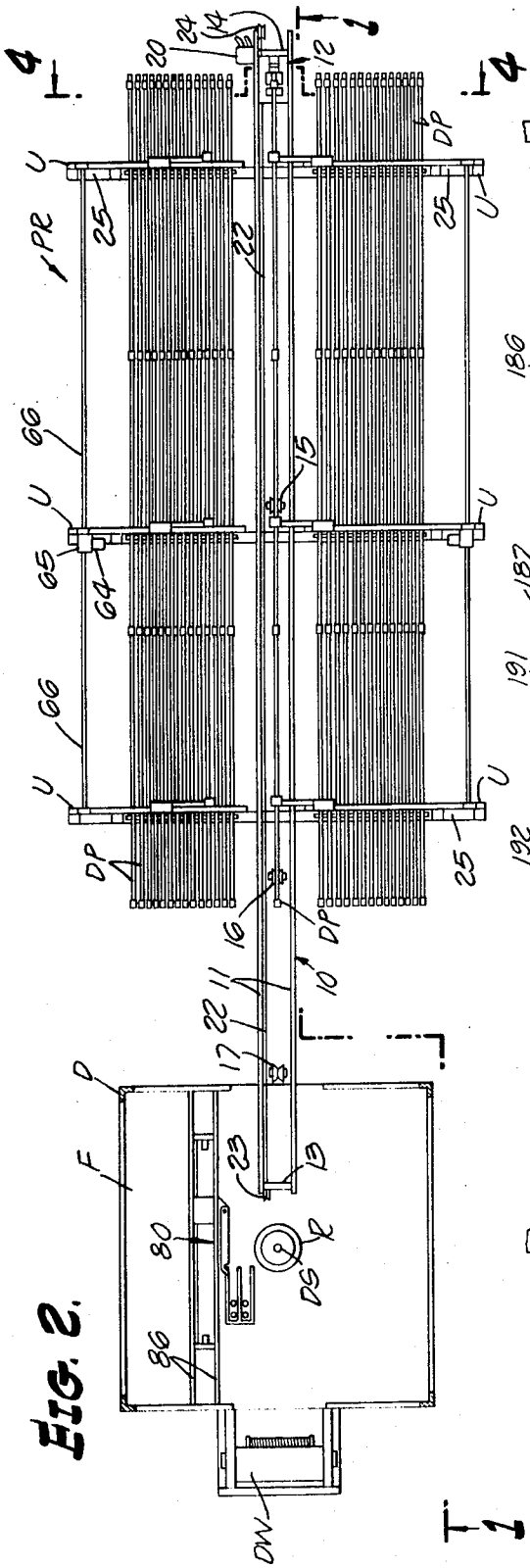


FIG. 2.

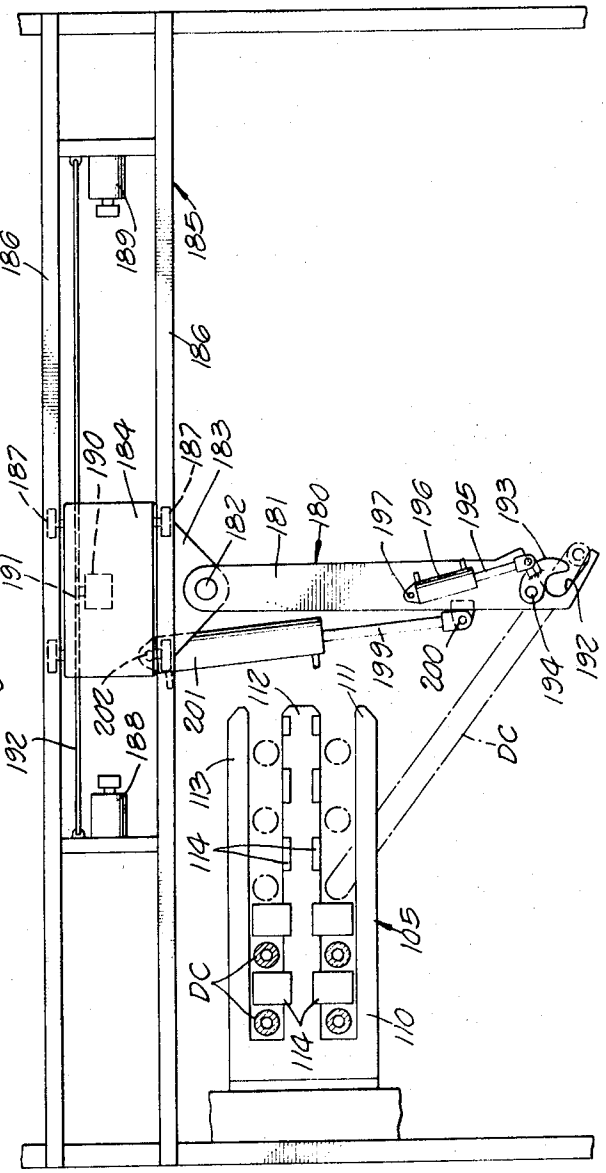


FIG. 3.

INVENTORS.
FAUSTYN C. LANGOWSKI
JOHN W. TURNER, JR.
BY
John O. Evans, Jr.
ATTORNEY

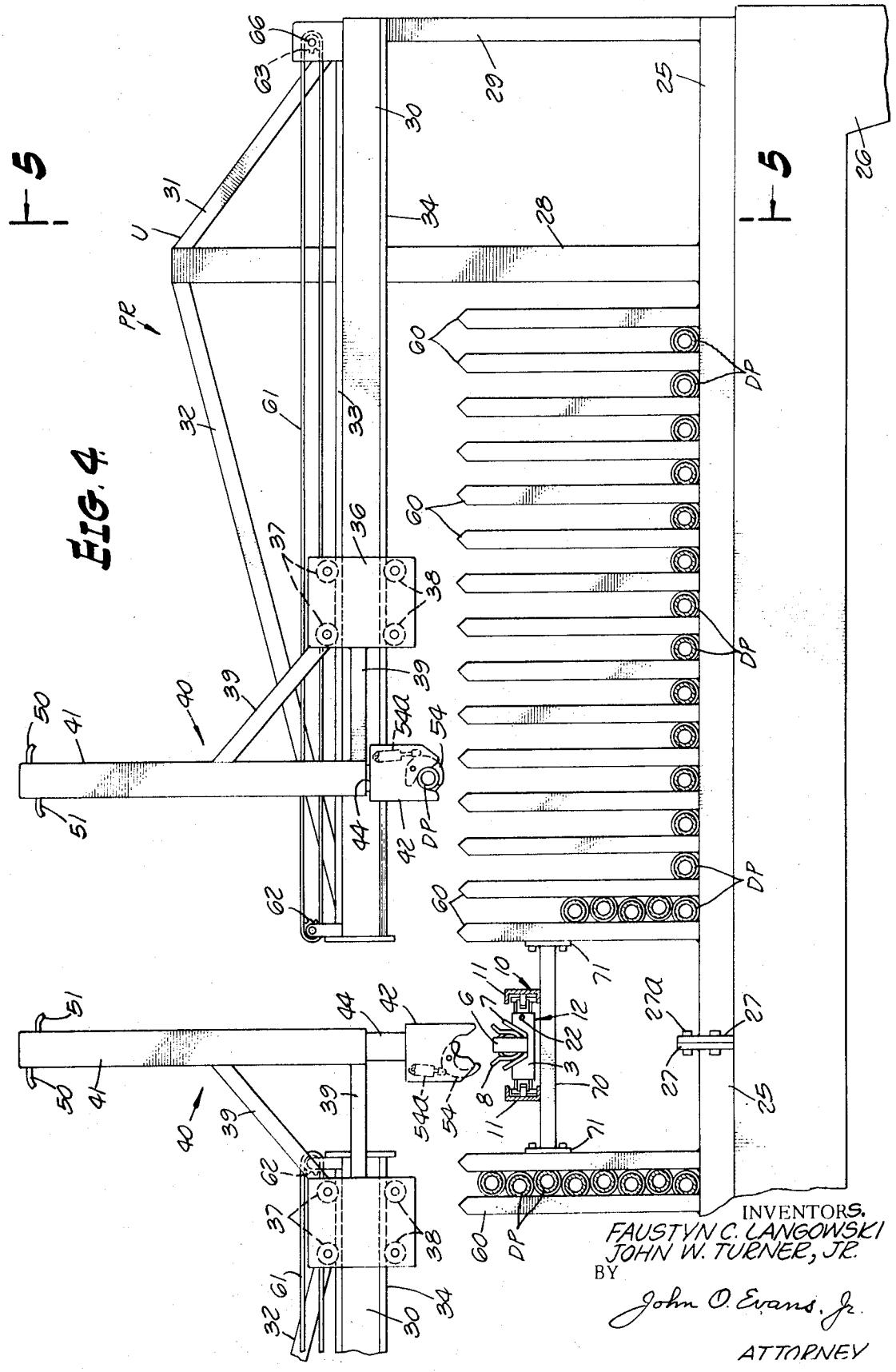


FIG. 4.

INVENTORS,
FAUSTYN C. LANGOWSKI
JOHN W. TURNER, JR.
BY
John O. Evans, Jr.
ATTORNEY

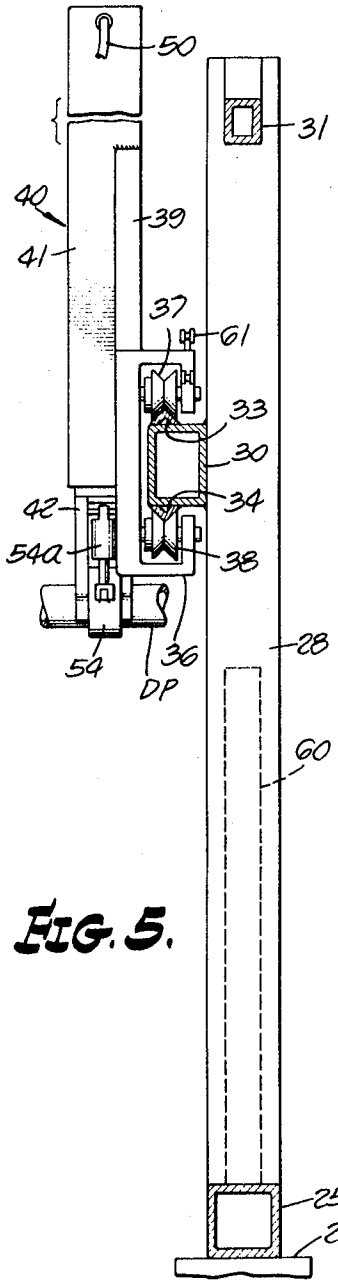


FIG. 5.

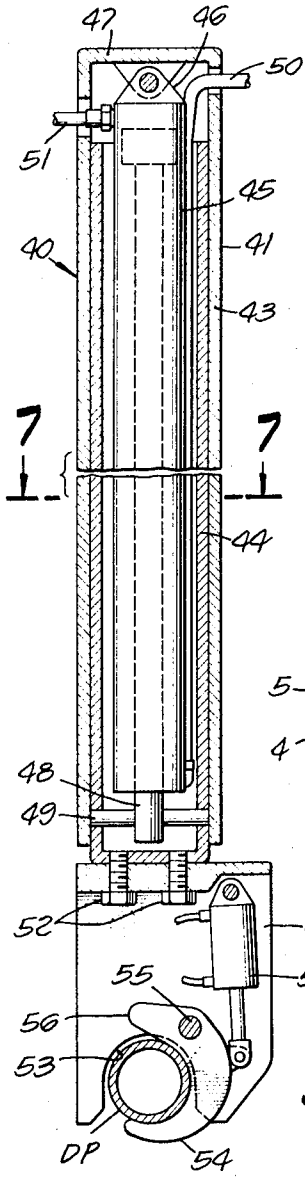


FIG. 6.

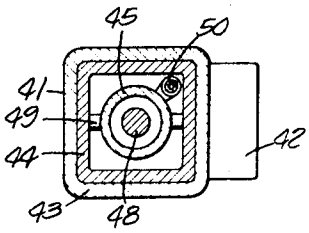


FIG. 7.

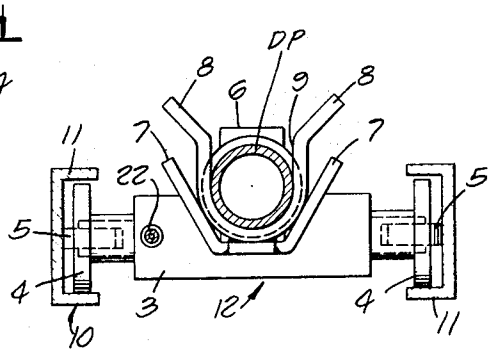


FIG. 9.

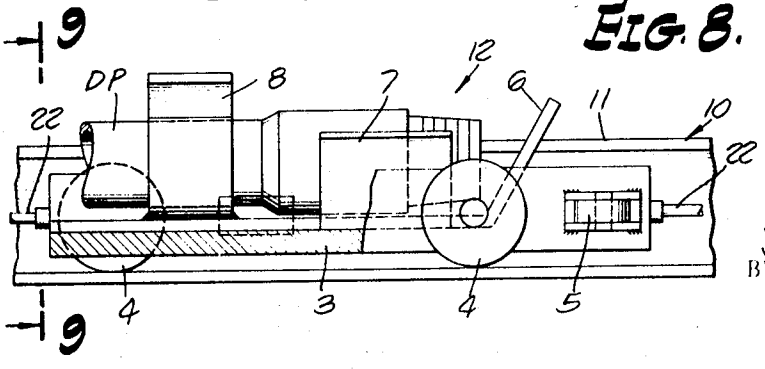


FIG. 8.

INVENTORS.
FAUSTYN C. LANGOWSKI
JOHN W. TURNER, JR.
BY
John O. Evans, Jr.
ATTORNEY

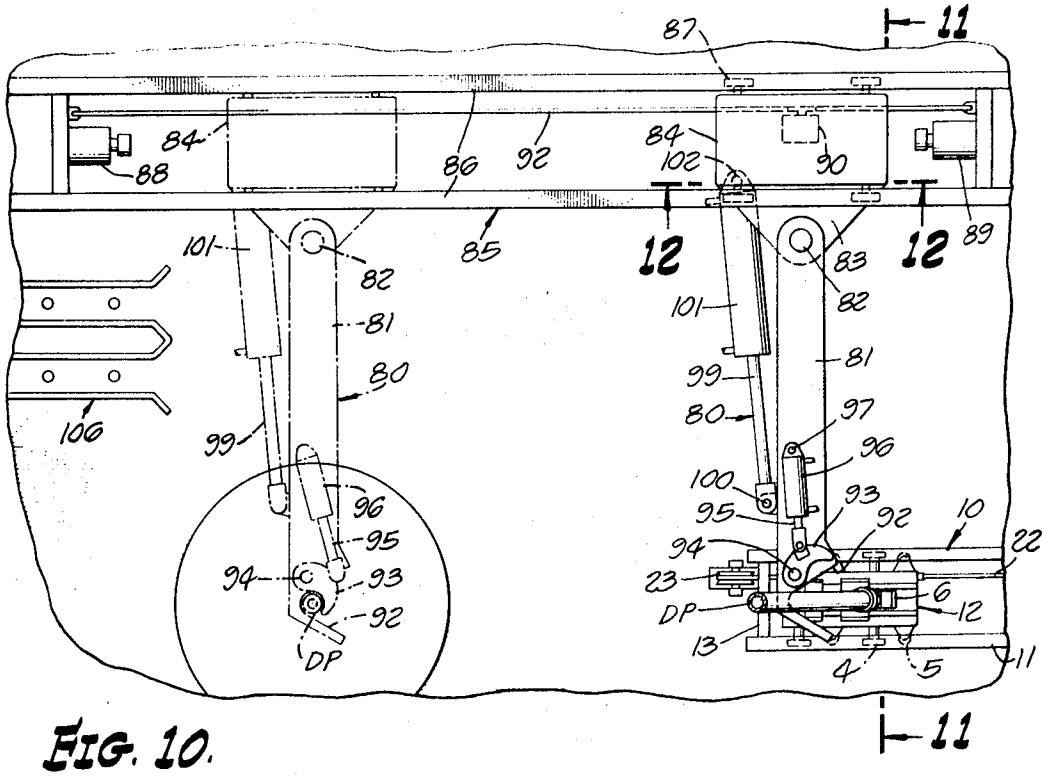
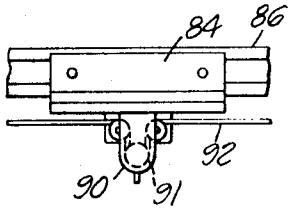


FIG. 10.

FIG. 12.



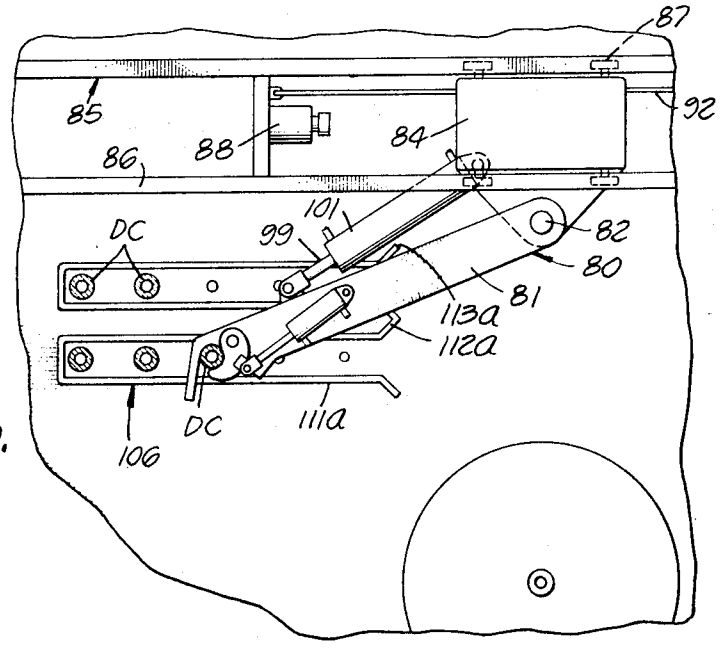
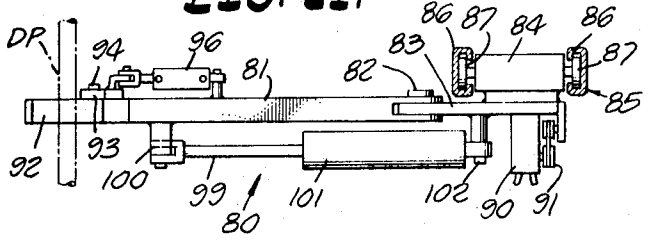


FIG. 13.

FIG. 11.



INVENTORS.
FAUSTYN C. LANGOWSKI
JOHN W. TURNER, JR.
BY
John O. Evans, Jr.
ATTORNEY

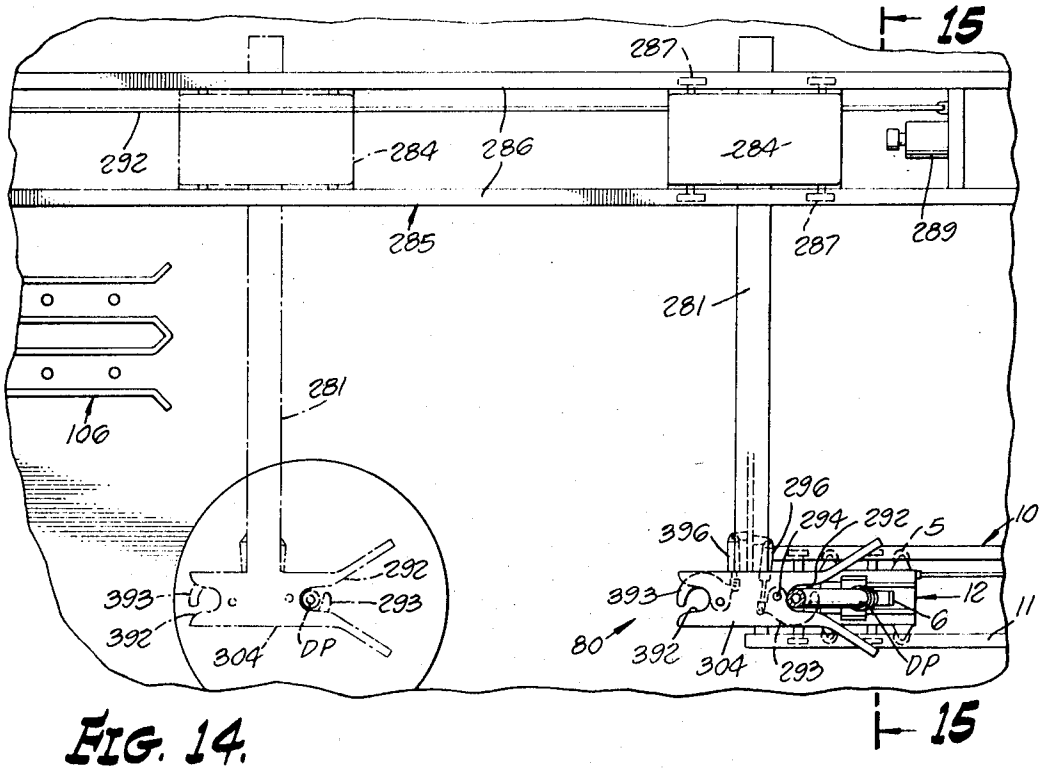


FIG. 14.

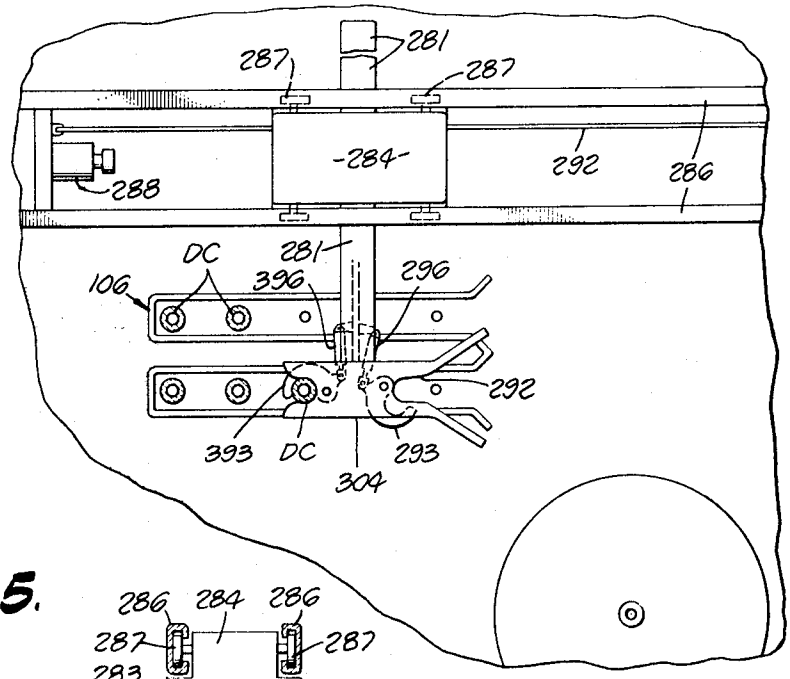
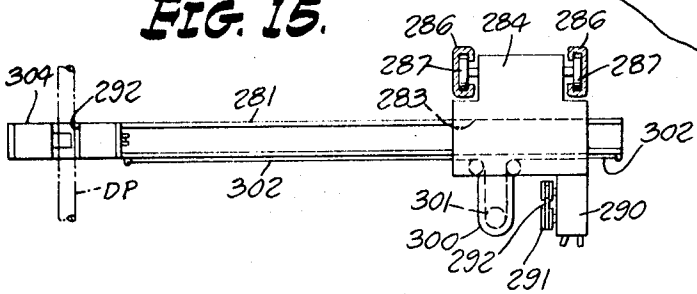


FIG. 16.

FIG. 15.



INVENTORS.
FAUSTYN C. LANGOWSKI
JOHN W. TURNER, JR.
BY
John O. Evans, Jr.
ATTORNEY

HORIZONTAL PIPE RACKING AND HANDLING APPARATUS

BACKGROUND OF THE INVENTION

In the handling of drill pipe and drill collars in the drilling of wells, such as oil or gas wells, particularly where the drill pipe and drill collars must be stored in an immovable condition during round tripping of the drill string, for example, to change bits, and during the time that additional lengths of drill pipe must be available for addition to the drill string as the drilling progresses, the provision at a reasonable expense of suitable apparatus for handling the drill pipe and drill collars, which apparatus is also capable of properly manipulating the pipe or collars, has long posed problems.

Various systems have been heretofore proposed whereby the drill pipe is racked horizontally at a location to one side of the floor of the drilling derrick, and individual stands of the pipe are successively moved between substantially vertical positions supported in the derrick by the usual elevator and traveling block and a racked position. Such systems have involved conveyor type storage means for the stands of pipe as well as the use of transfer devices adapted to move a stand of pipe between a racked position and a position aligned with the center of the derrick by physically engageing and lifting the stand of pipe as it is moved between such positions.

Such prior devices have posed significant problems in a number of respects, for example, if the pipe stands are racked in a conveyor type system and fed to the position aligned with the center line of the derrick, problems are encountered in the physical movement of the conveyors, and additional problems are presented in that all of the stored pipe must be moved in unison resulting in the need for high powered and expensive drive mechanisms. In addition, while in the handling of "singles" of drill pipe, having an average length on the order of 30 feet, it is a fairly simple matter to transfer the pipe in a horizontal position by engaging and lifting the pipe adjacent its ends, but the lifting devices which can reasonably support a drill pipe single may experience difficulties in supporting a "double" which consists of two singles, and which averages about 60 feet in length, due to the tendency of the pipe to sag. Obviously further problems involving sagging of the drill pipe stand would be encountered if an effort is made to support a "treble" consisting of three singles, and averaging about 90 feet in length. These problems combine to render very difficult the provision of apparatus for horizontally racking drill pipe to one side of a derrick without resorting to extensive and extremely costly installations.

One of the common modes of moving the pipe stand from an unracked position aligned with the center line of the derrick to a position at which the box end of the stand is adapted to be engaged by the elevator whereby to lift the stand to a vertical position, has been the use of a dolly rollable on tracks leading to the floor of the derrick and in which the pin end of the stand rests. The dolly is stopped short of the center line of the derrick, with the stand supported in the upwardly moving elevator, and the lower end of the stand must travel from the point at which motion of the dolly is arrested, a number of feet to the center line of the derrick, in order for the pin end to be stabbed into the box end of the drill pipe supported in the rotary table. Particularly in the case where the derrick is on a floating vessel, it is hazardous for a floorman on the derrick floor to manually control such movement of the lower end of the stand supported in the elevator, and the rougher the sea, the more hazardous is such a manual operation, due to the tendency of the pipe to swing. A similar problem exists when the pipe stand is being removed from the drill string and moved to the racked position, since the lower end of the pipe stand, following disconnection from the drill string, must be moved laterally onto the dolly.

A somewhat similar problem exists in the movement of drill collars between positions aligned with the center of the derrick and a laterally displaced racked position in the usual drill collar rack. If the lower end of a drill collar is free to swing during its travel between these two positions, it becomes a hazardous operation, particularly when the great mass of a drill collar is compared with the relatively lesser mass of a stand of drill pipe.

Moreover, if the above described handling operations are not manually performed by a crew, the functions must be accomplished mechanically, say from a remote control location by an operator who can continually maintain control of the drill collars or drill pipe stand. Thus, the provision of suitable apparatus has heretofore been extremely expensive, on one hand, and inadequate, on the other hand.

SUMMARY OF THE INVENTION

In order to obviate the above problems and to provide an economically feasible pipe and drill collar handling apparatus, the present invention provides novel pipe transfer apparatus for use in moving stands of drill pipe, either doubles or trebles between horizontally racked positions and a position aligned with the center line of the derrick, wherein the pipe transfer apparatus comprises a plurality of similar support and arm structures, each arm having a carriage shiftable thereon and each carriage having a vertically shiftable pipe engaging head for picking up the pipe at either position and supporting the pipe as it is moved between such positions. Associated with each pipe transfer structure are laterally spaced posts between which the pipe stands are confined in vertical rows. The plurality of pipe transfer devices are all spaced relative to one another so that three such transfer devices are adapted to engage and support a treble drill pipe stand at such locations that the sag of the pipe stand between points of support is minimized, and therefore the pipe will not be overly stressed. Moreover, since the posts are associated with the pipe transfer devices, it is not possible for the pipe transfer heads to place the engaged portions of the pipe stand between one pair of posts while an intermediate portion of the pipe is placed between another pair of laterally spaced posts, notwithstanding the existence of some sag in the unsupported section of pipe stand, and notwithstanding the tendency of the sagging portion of the stand to swing relative to the fixed rack, for example, in response to vigorous rolling of a floating vessel.

In order to minimize the complexity of the drive mechanism for the pipe transfer devices, they are driven as a unit from a single power source, resulting in not only a reduction in the necessity for drive mechanism, but also minimizing the necessity for control devices whereby the pipe is moved into or from selected racked positions.

In addition to the foregoing, the present invention provides means located above the derrick floor to engage and confine the lower end of a stand of drill pipe against undesired swinging movement as it is being moved between a position aligned with the center line of the derrick and a position on the dolly. More particularly, such means provides a throat into which the lower end of the pipe stand moves as the dolly approaches the center line of the derrick during the addition of a pipe stand to the drill string, and a latch is closed about the drill string to confine it in the throat against swinging movements. Thereafter, the lower end of the stand, while confined against undesired lateral movement in any direction, is positively positioned substantially in alignment with the drill string supported in the rotary table, and the stand is slidable in the throat to allow the stand to be stabbed into the upper end of the drill string. Thereafter, the pipe engaging and positioning means is shiftable to an out-of-the-way position and thence to a standby position for receiving the next stand. Alternatively, the pipe engaging and positioning means may be engaged with the lower end of the stand of drill pipe supported by the usual elevator, as the stand is broken out of the drill string, and while the stand is confined against undesired lateral swinging movement, the lower end of the stand is positively positioned above the dolly, so that the stand may be lowered onto the dolly, for movement towards the rack, whereupon the pipe engaging and positioning means is opened to allow such movement of the pipe stand.

Since, as previously indicated, undesired swinging of the drill collars also poses a problem, the present invention also contemplates the provision of pipe engaging and positioning means which is also engageable with the lower end of a drill collar as the latter is positively moved between a position aligned with the center line of the derrick and a vertically racked position.

In accomplishing the foregoing, the invention contemplates in one form, the provision of a pipe engaging and positioning head having a common throat and a latch for holding therein either a drill pipe stand or drill collar; and in another embodiment of the invention, the pipe gripping means comprises a compound head adapted at one side to engage and confine a drill pipe stand, and adapted at the other side to engage and confine a drill collar, the head being mounted for movement to the necessary location for receiving and confining and for releasing both the drill pipe stand and the drill collar.

Since the dolly which is employed for moving a stand of drill pipe between the derrick floor to a location adjacent the rack may be power driven, as is well known in the art, the invention also contemplates the provision of a dolly which is so constructed as to interfit with the tool joint of the pipe stand, so that motion of the dolly is positively transmitted to the pipe stand to cause it to accelerate and move with the dolly at the desired rate and in the desired direction, notwithstanding inertia tending to preclude such acceleration and movement and notwithstanding other forces resulting from the movement of a vessel on which the rack and pipe handling apparatus will be employed.

This invention possesses many other advantages, and has other purposes which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view showing horizontal pipe racking and handling apparatus made in accordance with the invention, with certain parts broken away along the line 1—1 of FIG. 2;

FIG. 2 is a view in horizontal section through the derrick, but showing the pipe racking apparatus in plan, as taken on the line 2—2 of FIG. 1;

FIG. 3 is a fragmentary view in horizontal section as taken on line 3—3 of FIG. 1, showing the upper drill collar racker;

FIG. 4 is an enlarged fragmentary view in vertical section, as taken on the line 4—4 of FIG. 2;

FIG. 5 is a view in vertical section, as taken on the line 5—5 of FIG. 4;

FIG. 6 is an enlarged detailed view showing a pipe transfer head and 7—7 of FIG. for the head with parts broken away;

FIG. 7 is a view in horizontal section, as taken on the line 7137 of FIG. 6;

FIG. 8 is an enlarged fragmentary detailed view partly in side elevation, and with parts broken away, illustrating the pipe supporting dolly and the track therefore;

FIG. 9 is a view in vertical section, as taken on the line 9—9 of FIG. 8 and showing the dolly in end elevation;

FIG. 10 is an enlarged fragmentary detail view showing a combined drill pipe and drill collar positioning mechanism, the 2 mechanism being shown in full lines in position for engagement by a stand of drill pipe and being shown in broken lines positioning the stand of drill pipe at the center of the derrick;

FIG. 11 is a view in vertical section, as taken on the line 11—11 of FIG. 10;

FIG. 12 is a view in vertical section, as taken on the line 12—12 of FIG. 10;

FIG. 13 is a fragmentary view illustrating the mechanism of FIG. 10 positioning the lower end of a drill collar in a drill collar rack on the derrick floor;

FIG. 14 is a fragmentary view illustrating a modified combined drill pipe and drill collar positioning mechanism, the mechanism being shown in full lines in position for engagement by a stand of drill pipe and being shown in broken lines positioning the stand of drill pipe at the center of the derrick;

FIG. 15 is a view in vertical section, as taken on line 15—15 of FIG. 14; and

FIG. 16 is a fragmentary view illustrating the mechanism of FIG. 14 positioning the lower end of a drill collar in a drill collar rack on the derrick floor.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2, there is generally illustrated a well drilling derrick D having a base structure B providing a floor F which is elevated above the deck S of a ship, for example, but it will be understood that the apparatus hereinafter to be described has application to land based drilling derricks. The rig includes a drawworks DW for raising and lowering a traveling block T from which is suspended the usual hook H adapted to support a drilling swivel (not shown) and adapted to support on links L a tilting elevator E. This elevator E may be constructed in accordance with the disclosure U.S. Letters Pat. No. 3,494,484, issued Feb. 10, 1970, in the name of McFadden, although a power operated elevator may also be employed for engaging pipe stands and closing thereon, as will be well recognized in the art. In any event, the elevator E is adapted to engage a drill string DS at its upper end to elevate the drill string upwardly to expose a stand of drill pipe, for example, a treble which is to be disconnected from the drill string DS while the drill string is supported in the rotary table R by the usual rotary table slips RS or otherwise. Alternatively, the elevator E is adapted to support a stand of drill pipe above the drill string DS at the center line of the derrick, while the traveling block T is lowered to stab the pipe stand into the box at the upper end of the drill string DS. In addition, the elevator E is adapted to similarly support lengths of drill collars as they are being made up in or broken out of the drill string.

The present invention involves the provision of a horizontal pipe rack PR adapted for the storage of a suitable number of stands of drill pipe and including pipe transfer means in the form of a pluralty of pipe transfer units generally denoted at U and arranged in opposing pairs at the left hand side and the right hand side of a track 10 leading from the derrick floor F outwardly therefrom in alignment with the center line of the derrick. The track 10 comprises a pair of laterally spaced rails 11 between which is supported a dolly, generally denoted at 12, the dolly being as will hereinafter be described movable between a stop 13 at a location spaced from the rotary table R and an outer tail stop 14 at the outer end of the track 10. Spaced along the path of the track 10 and disposed between the rails 11 are suitable V rollers 15, 16 and 17 suitably mounted on the deck S of a ship or on the derrick substructure D and being revolvably mounted at the upper ends of the respective ends of actuator rods 15*a*, 16*a* and 17*a* of vertically disposed actuator cylinders 15*b*, 16*b* and 17*b*.

Stands of drill pipe DP are adapted to be moved between the racked positions in the racks PR, and the position shown in broken lines in FIG. 1 with one end of a pipe stand DP engageable with or releasable from the elevator E and with the other end of the stand resting in the dolly 12.

The dolly 12, the details of which are best seen in FIGS. 8 and 9, comprises a body 3 having rollers 4 at its opposite sides engaged in the opposing rails, as well as side rollers 5 which engage the sides of the rails 11. At the outer end of the dolly body 3 remote from the derrick D is an upstanding end wall 6 adapted to engage the end of a stand of pipe DP disposed in the dolly. Inwardly from the end wall is a pair of upwardly divergent side walls 7 providing a seat for the tool joint for the

stand of drill pipe. At the opposite end of the body from the end wall **6** is another pair of upwardly divergent side walls **8** at the apex of which is an arched key seat **9** of a size smaller than the tool joint but adapted to receive the body of the drill pipe. Thus, when the end of the pipe stand is placed in the dolly, it is positively engageable with the end wall **6** of the dolly and in the key seat **9**, so that the dolly may be powered toward the derrick to position the pipe stand DP for engagement by the elevator E. On the other hand, when a stand of drill pipe DP is lowered onto the dolly from the derrick and is to be returned to the rack, the tool joint will be positively engaged to assure that the pipe stand can be accelerated and moved to the racking position.

In order to drive the dolly in opposite directions, a cable drive, as seen in FIG. **2**, may be provided, comprising a drive motor **20** for effecting rotation of a drum **21**, as seen in FIG. **1**, in opposite directions. The cable **22** has a portion frictionally engaged with the drum **21** and extends about a sheave **23** at the inner end of the track and about another sheave **24** at the other end of the track, and the cable is connected to the dolly so as to effect powered movement of the dolly in either direction longitudinally of the track **10**.

The respective pipe transfer devices U previously referred to are typified by a transfer device as illustrated in FIG. **4**. These transfer devices are adapted to be made up in units. Each unit comprises a lower supporting beam **25** adapted to be mounted upon a substructure **26**. At its inner end, the beam is provided with a flange **27** for connecting it as by fasteners **27a** in endwise relation to the corresponding beam of the opposing unit. Adjacent its outer end, the beam supports a vertical post **28**. Preferably, another vertical post **29** is provided at the outer extremity of the beam. Suitably affixed to the posts **28, 29** is an arm **30**, preferably in the form of a rectangular tube for rigidity, which extends horizontally in substantially parallel relation above the beam **25**. The posts **28, 29** extend above the arm **30** to facilitate the connection of suitable struts **31, 32** to the posts and to the arm to fortify the connection of the arm to the posts. On its upper and lower faces, the arm **30** has welded thereon inverted angle irons providing longitudinally extended tracks **33, 34** (See FIG. **5**). Shiftable on the arm is a carriage **36** which is provided with a plurality of rollers **37** engaged with the upper track and an opposing plurality of rollers **38** engageable with the lower track, whereby rocking of the carriage on the arm is precluded, but the carriage is freely shiftable longitudinally on the arm. Mounted in spaced relation to the carriage **36** by suitable connecting members **39** is a pipe transfer device generally indicated at **40** and including an actuator **41** and a head **42**.

As best seen in FIGS. **5** and **6**, the actuator structure **41** comprises an outer rectangular hollow body **43** in which is reciprocably disposed an inner rectangular body **44**. Internally of the inner body **44** is the cylinder **45** of a fluid pressure actuator. The upper end **46** of the cylinder is suitably connected to the upper end **47** of the outer body **43**. Extending from the lower end of the cylinder **45** is the actuator rod **48** which is pinned, as at **49**, or otherwise suitably connected at the lower end of the inner body **44**, whereby extension of the rod from the cylinder will effect downward movement of the inner body and retraction of the rod will effect upward movement of the inner body. Fluid under pressure is adapted to be supplied to the opposite ends of the cylinder through conduits **50** and **51** which extend into the inner body and are connected to the ends of the cylinder, the conduit **50** extending downwardly in the space between the cylinder **45** and the inner body **44** for connection to the lower end of the cylinder.

The pipe transfer head is suitably affixed to the lower extremity of the inner body **44** as by fasteners **52** and includes a downwardly opening and upwardly flared throat **53**. The head has a latch **54** pivotally connected thereto by a pivot pin **55** and adapted in one position to engage and retain the pipe stand DP in the throat **53** of the head and adapted in the other position to allow the head to move downwardly onto the pipe stand and to allow a pipe supported in the head to be released. Preferably, the latch **54** has an arm **56** which will partially block the throat **53** when the latch is open, so that when the latch is closed by an actuator cylinder **54*a***, the opening for the pipe is larger than the pipe.

Forming a part of the unit is a plurality of laterally spaced pipe retainer posts **60**, each fixed to and projecting upwardly from the beam in parallel spaced relation for receiving therebetween vertical rows of pipe stands DP. In order to shift the carriage **36** along the arm **30** so as to dispose the head **42** above a selected row of pipe stands DP or above a selected space into which a pipe stand should be placed, drive means are provided comprising a chain **61** extending about a pair of sprockets **62, 63** mounted at the opposite ends of the arm **30** and connected to opposite ends of the carriage.

Referring to FIG. **2**, it will be noted that one of the sprockets **63** is driven by a power source or motor **64**, say through a reduction gear box **65**, and the other sprockets **63** of the other units U are connected to jackshafts **66** which extend from the power source to the other two units U. It will be understood at this point that the position of the head **42** of all of the units U, whether at a desired location to pick up a stand of pipe DP from one of the rows or to deposit a stand of pipe between the adjacent posts, as well as the positioning of the head **42** to pick up a pipe from the central position between the opposing racks or to deposit a stand of pipe in such central location may be controlled from a remote location or may be automatically controlled by suitable position sensing control devices, not shown, which can control the drive motor **64** either in response to the longitudinal position of the carriages **36** on the arms **30** or in response to the angular position of the jackshafts **66**, but in any event, all of the carriages on all arms **30** of each of the unit U at either side of the racking assembly will be driven in unison and will correspondingly position the respective heads **42**.

As previously indicated, the units U are pre-fabricated and are adapted to be interconnected with other similar units so as to provide right hand and left hand pipe racks disposed at opposite sides of track **10**. In order to further simplify the construction and facilitate installation of the apparatus in the field or on a vessel, means are provided for supporting the rails **11** of the track **10** between the opposing units U, which can be readilly assembled in the field. Thus, as seen in FIG. **4**, the tracks **10** are suitably supported on horizontal support members **70** having mounting flanges **71** adapted to be suitably connected to the innermost posts **60** of a pair of pipe rack units U. Accordingly, the rails **11** may be transported to the installation site in comparatively short lengths and assembled with the rack units U so as to extend radially of the center line of the derrick D. Thereafter, the cable **22** may be extended about the sheaves **23** and **24** and the cable drum **21** and connected to the opposite ends of the dolly **12**.

Referring to FIG. **1**, it will be noted that in the placement of the pipe transfer or racking units U relative to the derrick D, they may be conveniently arranged or spaced so as to support a treble stand of drill pipe at locations spaced inwardly from the extremities of the stand and at an intermediate location notwithstanding approximately at the middle of the intermediate joint of pipe in the stand. However, the pipe transfer or racking units U are preferably so spaced that an adjacent pair of units U, the outermost pair in the illustrative arrangement, are adapted to handle a double length stand of drill pipe, the spacing of the transfer or racking units being such that both treble and double stands are supported at spaced locations whereby to limit the sagging of the intermediate unsupported portion of the stand beyond the elastic limit of the pipe. Moreover, since the pipe racking posts **60** are located substantially beneath the pipe engaging heads **42** of the respective units U, the pipe stands can only be placed between posts which are aligned in the respective units, notwithstanding that substantial sag may exist between the supported points in the pipe stand and that such sagging portions may tend to swing responsive to the roll of the vessel.

It will be apparent from the foregoing that the apparatus, as thus far described, is operable to move pipe stands DP between racked positions, between the posts **60**, and a position at which one end of the stand is supported on the rollers **15** and **16** located between rails **11** of the track **10**. In addition, the apparatus is operable to move the dolly **12**, elevate the rollers **16** and **17**, and lower such rollers, so that a pipe stand DP is shiftable between the aforementioned position supported on the dolly and rollers **15** and **16** and the position shown in broken lines in FIG. **1**, at which one end of the pipe stand DP extends into the derrick so as to be either engaged by or released from the elevator E. When a pipe stand DP is being added to the drill string DS, the elevator E will be either manually or automatically closed about the portion of the pipe stand disposed between the elevator links L. As the traveling block T is elevated, the dolly **12** will be moved further inwardly and the rollers **16** and **17** retracted to allow the dolly to move into engagement with the inner stop **13**, at which time the upper end of the pipe stand is substantially at the center line of the derrick, but the lower end of the pipe stand is located on the dolly **12** to one side of the center line of the derrick, as seen in FIG. **10**. On the other hand, when the pipe stand DP is being removed from the drill string DS, the pipe stand will initially be suspended in the derrick by the elevator E, and the lower end of the suspended pipe stand DP must be swung off to the side so as to be placed into the dolly **12**, and thereafter, the dolly may be actuated to move outwardly on the track **10** as the upper end of the pipe stand DP is lowered by the suspension apparatus including the traveling block T, until the pipe stand assumes the broken line position of FIG. **1**.

In accordance with the invention, means are provided to confine the lower end of the pipe stand as it is moved between the center line of the derrick and the dolly **12** so as to prevent undesired motion of the lower end of the pipe stand and so as to eliminate the need for manually handling of the lower end of the pipe stand, such means also being operable to position the lower end of the suspended pipe stand DP either on the dolly **12** or at the center line of the derrick. Such confining and positioning means for the lower end of the pipe stand DP is generally indicated at **80** in the embodiment shown in FIGS. **1** through **13**.

More particularly, the means **80** for confining the lower end of the pipe stand DP against undesired movement and for positioning the lower end of the pipe stand comprises, as best seen in FIGS. **10** through **12**, an arm **81** pivotally supported by a vertical pin **82** on a flange **83** which projects outwardly from a carriage **84**, the carriage **84** being shiftably supported for horizontal movement from side to side of the derrick at a connecting side of the derrick by a track **85** comprising a pair of rails **86**.

The rails **86** are suitably supported at their opposite ends on structural members of the derrick and the carriage **84** has rollers **87** at its opposite sides engageable in the rails **86**, so that the carriage is movable between suitable shock absorbing stops **88** and **89** disposed between the rails **86**. In order to move the carriage **84**, suitable drive means are provided including in the illustrative embodiment, a reversible motor **90** mounted beneath the carriage **84** and adapted to drive a sprocket **91** engaged with a chain **92** which extends longitudinally between the rails **86** and which is anchored at its opposite ends on the stops **88** and **89**. At its outer or free end, the arm **81** has a generally V-shaped throat **92** opening laterally so as to receive the lower end of a drill pipe stand DP. In order to confine the pipe stand DP in the throat **92**, a gate **93** is pivotally mounted on the arm **81**, as at **94**. The gate **93** is connected to the rod **95** of a double acting actuator cylinder **96** which is pivotally connected, as at **97**, to the arm **81** and to which pressure fluid can be supplied from an appropriate source (not shown).

When the pipe stand confining and positioning means is being employed to move the lower end of a drill pipe stand from a position on the dolly **12**, as shown in full lines in FIG. **10**, to the center line of the well, as shown in broken lines in FIG. **10**, the gate **93** is closed by the actuator cylinder **96** and its rod **95** to confine the lower end of the pipe stand DP against lateral displacement from the throat **92**. When the pipe stand DP is elevated to free it from the dolly **12**, the positioning carriage **84** may then be actuated by the motor **90** to drive the carriage to the broken line position of FIG. **10** at which the lower end of the pipe stand DP is positioned at the center line of the derrick. Conversely, when it is desired to position the lower end of the pipe stand DP in the dolly, when the pipe stand is removed from the drill string DS, the arm **81** is adapted to be disposed in the broken line position of FIG. **10**, at which position the gate **93** may be closed to confine the pipe stand in the throat **92** so that the carriage **84** may then be actuated to the full line position of FIG. **10**, at which position the lower end of the pipe stand DP may be lowered into the dolly **12** before the gate **93** is opened.

It will be appreciated that during the addition of pipe stands to the drill string DS, it is necessary that the arm **81** be retracted to allow its outer end to pass the previously positioned stand of pipe as the arm **81** is being returned to a position for receiving the next stand. Accordingly, actuator means including a rod **99**, connected as at **100**, to the arm **81**, and reciprocable in a double acting actuator cylinder **101**, pivotally connected, as at **102**, to the carriage **84**, are provided for effecting retraction of the arm **81**, in response to the application of pressure fluid to the cylinder **101** to either retract or extend the rod **99**.

The ability of the positioning arm **81** to be retracted enables the confining and positioning means **80**, just described above, to also be employed in the racking of drill collars vertically in the derrick. Illustratively, a number of drill collars DC are shown in FIG. **1** as being racked in an upper finger board **105**, the lower ends of the drill collars DC being disposed in a receptacle **106** on the floor of the derrick. The drill collars are moved at their lower ends between racked positions and a position at the center line of the derrick by the confining and positioning means **80**, and the upper ends of the drill collars are moved by a similar structure **180**, shown more particularly in FIG. **3**, and located aloft in the derrick above the finger board **105**.

The finger board is shown in general to include a frame **110** suitably affixed to the derrick structure and providing a plurality of parallel, spaced arms **111**, **112** and **113** defining elongated openings adapted to receive the upper ends of the lengths of drill collars DC. Typically, at least one of the arms, the arm **112** in the illustrated structure, has a number of retainer fingers **114** thereon, actuatable between closed positions defining compartments for the drill collars DC and open positions enabling drill collars to be moved into and from the spaces between the fingers **111**, **112** and **113**. The details of the finger actuators need not be elaborated upon herein, but they may be hydraulically opened and closed, as is well known.

The means **180** for controlling and positioning the upper ends of drill collars either in the finger board **105** or at the center line of the derrick comprises an arm **181** pivotally supported by a vertical pin **182** on a flange **183** which projects outwardly from a carriage **184** which, like the previously described carriage **84**, is shiftably supported for movements from side to side of the derrick on a track **185** comprising a pair of rails **186**. These rails **186** are suitably connected to the derrick structure, and the carriage **184** has rollers **187** engaged in the rails **186**. Opposing shock absorbing stops **188** and **189** are provided to limit movement of the carriage, and a reversible motor **190** is mounted beneath the carriage **184** and adapted to drive a sprocket **191** which engages a chain **192** connected at its opposite ends to the stop **188** and **189**.

At its outer or free end, the arm **181** has a generally V-shaped throat **192** opening laterally so as to receive the upper end of a drill collar DC. In order to confine a drill collar in the throat **192**, a gate **193** is pivotally mounted on the arm **181**, as at **194**. The gate **193** is connected to the rod **195** of a double acting actuator cylinder **196** which is pivotally connected, as

at **197**, to the arm **181** and to which pressure fluid can be supplied from an appropriate source (not shown).

When the drill collar confining and positioning means **180** is being employed to move the upper end of the drill collar to a racked position in the finger board **105** from the center line of the derrick or alternatively to move the upper end of the drill collar from the racked position to the center line of the derrick. It is necessary that the carriage **184** be shifted laterally in the derrick on the track **185** and in addition, that the arm **181** be pivoted between the extended position shown in FIG. **3** and a range of angular positions, whereby to place the drill collars DC in the spaces between the racking arms **111**, **112** and **113** as well as to be retracted to a position substantially parallel with the track **185** so as to clear drill collars racked in the space between the rack arms **112** and **113**. Accordingly, actuator means, including a rod **199** connected, as at **200**, to the arm **180** and reciprocable in a double acting actuator cylinder **201**, pivotally connected, as at **202**, to the carriage **184**, are provided for effecting angular positioning or retraction of the arm **181**, in response to the application of pressure fluid to the cylinder **201** to either retract or extend the rod **199**.

The racking of drill collars DC will now be described. Referring to FIG. **13**, it will be noted that the lower ends of the drill collars DC are to be placed in the receptacle **106**, or other conventional means for holding the lower ends of the drill collars in racked positions, by the positioning means **80** which is also employed to position the lower ends of the drill pipe stands DP. Thus, in the progressive racking of drill collars, as they are being removed from the drill string DS, the lower end of a drill collar will be engaged and confined against lateral movement by the positioning means **80**, while the drill collar is suspended in the hoisting apparatus at the center line of the derrick. With the drill collar so suspended, the lower end thereof is shifted laterally with respect to the center of the derrick by retracting the rod **99** into the cylinder **101** until the lower end of the drill collar is in alignment with the parallel spaces between the compartment walls **111a**, **112a** and **113a**. Then, the carriage **84** may be shifted along the track **85** to dispose the lower end of the drill collar DC in the selected racked position. While the positioning means **80** holds the lower end of the drill collar DC, the upper positioning means **180** is operated to engage the upper end of the drill collar which is still located at approximately the center line of the derrick and which is still engaged in the elevator E which will be disengaged from the drill collar after the upper end of the drill collar is confined against lateral movement in the throat **192**, as seen in FIG. **3**. Thereafter, the positioning means **180** may be operated, for example, as required by the illustrative upper rack **105**, to move the carriage **184** to the right, as seen in FIG. **3**, to enable the arm **181** to be pivoted upon retraction of the actuator rod **199** to a position at which the upper end of the drill collar is aligned with one of the spaces between the rack arms **111**, **112** and **113**; whereupon the carriage may be actuated to the left, as seen in FIG. **3**, to move the drill collar to a substantially vertical position, with its upper end in a location to be confined by closure of one of the rack fingers **114**. Following this, the positioning means **180** is further retracted to clear racked drill collars and moved back to a position for engaging a subsequent drill collar. During this operation of the upper positioning means **180**, the lower positioning means **80** may either remain in engagement with the lower end of the drill collar undergoing positioning by the upper positioning means **180**, or, if the lower receptacle **106** is capable of positively preventing movement of the lower end of the drill collar, the lower positioning means **80** may be returned to a standby position for engagement with the next drill collar in the drill string. Without requiring further specific description, it will be understood that the movement of drill collars from racked positions to the center line of the well for connection in the drill string essentially involves operations which are substantially the reverse of the operations employed to remove the drill collar drom the drill string and rack the same.

The use of the present apparatus for racking pipe stands DP or unracking them and moving the stands between the derrick and the racked positions involves the following operations. If it is assumed that the drill string is being run into the well, either during the drilling operation or during round tripping of the drill string, a stand of drill pipe DP will be moved from the racked position between a pair of posts **60** of the respective rack units U at either the left or right hand side of track **10** which leads between the rack apparatus PR and the derrick floor F. To accomplish this, the motor **64** is operated to drive the jackshafts **66** so as to move all of the pipe transfer carriages **36** on one side to a position at which all of the heads **42** are above a selected space between the pipe rack posts **60**. The actuators **40** for the heads are operated to lower the heads into positions at which closure of the latches **54** will enable the pipe stand to be lifted upon upward movement of the heads **42**. Following such upward movement, carriages **36** are further actuated to move the heads **42** to positions above the track **10**, at which positions the heads are lowered and the latches **54** opened so that the stand will be deposited on the supporting rollers **15** and **16** and on the dolly **12**. The dolly is actuated and the rollers **16** and **17** progressively elevated until the pipe stand DP is in the position illustrated in FIG. **1**, at which its upper end is engageable by the elevator E. The elevator E is latched about the pipe stand DP and the drawworks operated to lift the pipe stand into the derrick the dolly **12** traveling inwardly and supporting the lower end of the pipe stand until the dolly **12** is in the position shown in FIG. **10**, in engagement with the inner stop **13**. The confining and positioning means **80** may have previously been moved to the standby position during elevation of the pipe stand DP, but in any event, is now positioned as shown in FIG. **10** to engage the pipe stand DP above the dolly **12**, and when the gate **93** is closed, the pipe stand will be positively controlled against lateral movement, while being free for longitudinal movement. Thereupon, the positioning means **80** is shifted to the broken line position of FIG. **10**, and the pipe stand DP stabbed into the upper end of the drill string for connection thereto by the usual tonging apparatus (not shown). The gate **93** is then opened and the arm **81** is retracted so that the arm will clear the pipe stand now in the drill string and the positioning means **80** may be returned to the standby or full line position of FIG. **10**, in readiness for a repetition of the cycle.

In the reverse operation, when pipe stands are being removed from the drill string and racked in the rack PR, the stand is suspended by the elevator E, and controlled to prevent undesired lateral movement by the positioning means **80** which engages the pipe stand before the stand is broken out of the drill string. Then, after breaking out the stand with the usual tongs, the lower end of the stand is moved positively to the position over the dolly **12**. The pipe stand is lowered to engage the dolly, and the gate **93** opened to allow the pipe to move with the dolly as the stand is lowered by the hoisting mechanism, including the elevator E, to the broken line position of FIG. **1**, where the elevator is released, freeing the pipe stand for movement with the dolly to the location between the rack units U for transfer to the racked position, as previously indicated.

FIGS. **14** through **16** illustrate a modified positioning means which may be employed in lieu of either or both of the positioning means **80** and **180**, and which is depicted in the position of the positioning means **80**.

In this embodiment, the carriage **284** is supported by a track **285**, the rails **286** of which are engaged by rollers **287** carried by the carriage **284**. The arm **281**, in this embodiment, is reciprocable, as distinguished from the pivoted arms **81** and **181** previously described, and is preferably of rectangular form, slidably disposed in a complemental way **283** in the carriage, as seen in FIG. **15**. The carriage is actuated along the rails **286** between shock absorbing stops **288** and **289** by a reversible motor **290** and a drive sprocket **291** which drivingly engages the chain **292** extending between the stops **288** and **289**. Similarly, the arm is reciprocated through the carriage by

a reversible motor **300** which drives a sprocket **301**, the sprocket engaging a chain **302** which is anchored adjacent to the ends of the arm **281**, as also seen in FIG. **15**.

At the inner end of the arm **281** is a head **304** adapted to confine and position drill pipe stands and adapted to confine and position drill collars. In this embodiment, as in the previously described embodiment, the drill pipe stand DP engages in a throat **292** and is confined by a gate **293** which is pivotally mounted at **294** and actuatable between open and closed positions by a double acting actuator **296** which is supplied with pressure fluid from an appropriate source.

The head **304** also has at its opposite side from the throat **292**, a throat **392** adapted to receive drill collars, and a gate **393** is pivoted on the head so as to be actuated between open and closed position by a double acting actuator **396**.

It is now apparent from the foregoing that the head **304** will receive a pipe stand DP in its throat **292** when the pipe stand is elevated in the derrick and rests at its lower end on the dolly **12**, as shown in full lines in FIG. **14**, and that the carriage **284** and arm **281** can then be shifted to the broken line position. Thereafter, when the pipe stand DP is connected to the drill string, the gate **293** can be opened to allow the head to be retracted and to clear the pipe stand as the head is returned to the standby position, awaiting the next pipe stand. The carriage **284** and arm **281** can also be reversely operated to move the pipe stand DP from the broken line position to the full line position.

It is also apparent from the foregoing that the head **304** can be manipulated or shifted in the compound directions necessary to move the lower end of a drill collar between the receptacle **106** at a selected location and the center of the derrick, while the upper end of the drill collar is suspended by the hoist equipment or is engaged in the finger board **105**.

We claim:

1. In well drilling derrick apparatus having hoisting apparatus for stands of drill pipe and drill collars, a horizontal drill pipe rack to one side of the derrick, pipe moving means for moving stands of drill pipe between said rack and a position with the upper end of a stand of drill pipe disposed above the derrick floor to be engaged by or released from the hoisting apparatus, a rack for vertically racking drill collars in the derrick at one side of the derrick, means for engaging and confining the lower ends of said stands of drill pipe and said drill collars when they are suspended in the derrick by said hoising apparatus operable to move the lower end of said stands of drill pipe between a position on said pipe moving means and a position at the center of the derrick and to move the lower end of said drill collars between a position in said rack and a position at the center of the derrick, said means for engaging said stands of drill pipe and drill collars comprising support means extending laterally of said derrick to one side of the center of the derrick and parallel to the line of movement of said stands of drill pipe by said pipe moving means, a carriage shiftable on said support means, means for actuating said carriage in opposite directions, an arm pivotally mounted on said carriage, means providing a throat at the outer end of said arm for receiving said stands of drill pipe and said drill collars, a gate for closing said throat, actuator means for said gate, and actuator means for said arm to pivot the same between a position at which said throat is aligned between said pipe moving means and the center of the well and positions at which said throat is disposed in said drill collar rack.

2. In well drilling derrick apparatus having hoisting apparatus for stands of drill pipe and drill collars, a horizontal drill pipe rack to one side of the derrick, pipe moving means for moving stands of drill pipe between said rack and a position with the upper end of a stand of drill pipe disposed above the derrick floor to be engaged by or released from the hoisting apparatus, a rack for vertically racking drill collars in the derrick at one side of the derrick, means for engaging and confining the lower ends of said stands of drill pipe and said drill collars when they are suspended in the derrick by said hoisting apparatus operable to move the lower end of said stands of drill pipe between a position on said pipe moving means and a position at the center of the derrick and to move the lower end of said drill collars between a position in said rack and a position at the center of the derrick, said means for engaging said stands of drill pipe and drill collars comprising support means extending laterally of said derrick to one side of the center of the derrick and parallel to the line of movement of said stands of drill pipe by said pipe moving means, a carriage shiftable on said support means, means for actuating said carriage in opposite directions, an arm reciprocably carried by said carriage for longitudinal movement in a direction normal to the direction of movement of said carriage, a head having opposed oppositely opening throats for respectively receiving stands of drill pipe and drill collars, a gate for closing each throat, actuator means for closing each gate, and actuator means for retracting and extending said arm to align said throats between the center of the derrick and said pipe moving means and a position in said drill collar rack.

3. In well drilling derrick apparatus having hoisting apparatus for stands of drill pipe and drill collars, a horizontal drill pipe rack to one side of the derrick, pipe moving means for moving stands of drill pipe between said rack and a position with the upper end of a stand of drill pipe disposed above the derrick floor to be engaged by or released from the hoisting apparatus, a rack for vertically racking drill collars in the derrick at one side of the derrick, means for engaging and confining the lower ends of said stands of drill pipe and said drill collars when they are suspended in the derrick by said hoisting apparatus operable to move the lower end of said stands of drill pipe between a position on said pipe moving means and a position at the center of the derrick and to move the lower end of said drill collars between a position in said rack and a position at the center of the derrick, said means for engaging said stands of drill pipe and drill collars comprising support means extending laterally of said derrick to one side of the center of the derrick and parallel to the line of movement of said stands of drill pipe by said pipe moving means, a carriage shiftable on said support means, means for actuating said carriage in opposite directions, an arm movably mounted on said carriage, means providing a throat at the outer end of said arm for receiving said stands of drill pipe and said drill collars, a gate for closing said throat, actuator means for said gate, and actuator means for said arm to move the same between a position at which said throat is aligned between said pipe moving means and the center of the well and positions at which said throat is disposed in said drill collar rack.

* * * * *

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,655,071 Dated April 11, 1972

Inventor(s) Faustyn C. Langowski 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:

Col. 3, line 55, delete entire line and substitute --head and the telescopric actuator for the head with parts broken away;--;
line 57, "7137" should be --7-7--;
line 65, delete "2".
Col. 6, line 60, delete "notwithstanding".

Signed and sealed this 13th day of February 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents