United States Patent [19]

Besijn

[11] **3,870,165**

[45] **Mar. 11, 1975**

[54] **RACKING BOARD**

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[22] Filed: **Feb. 1, 1973**

[21] Appl. No.: **328,887**

[52] **U.S. Cl.** .... **214/2.5,** 211/60 S

[51] **Int. Cl.** **E21b 19/00**

[58] **Field of Search** .... 214/2.5, 1 P; 175/85; 211/60 R, 60 S; 254/105

[56] **References Cited**

UNITED STATES PATENTS

1,887,901	11/1932	Dodson	214/2.5 X
2,628,725	2/1953	Stone	214/2.5

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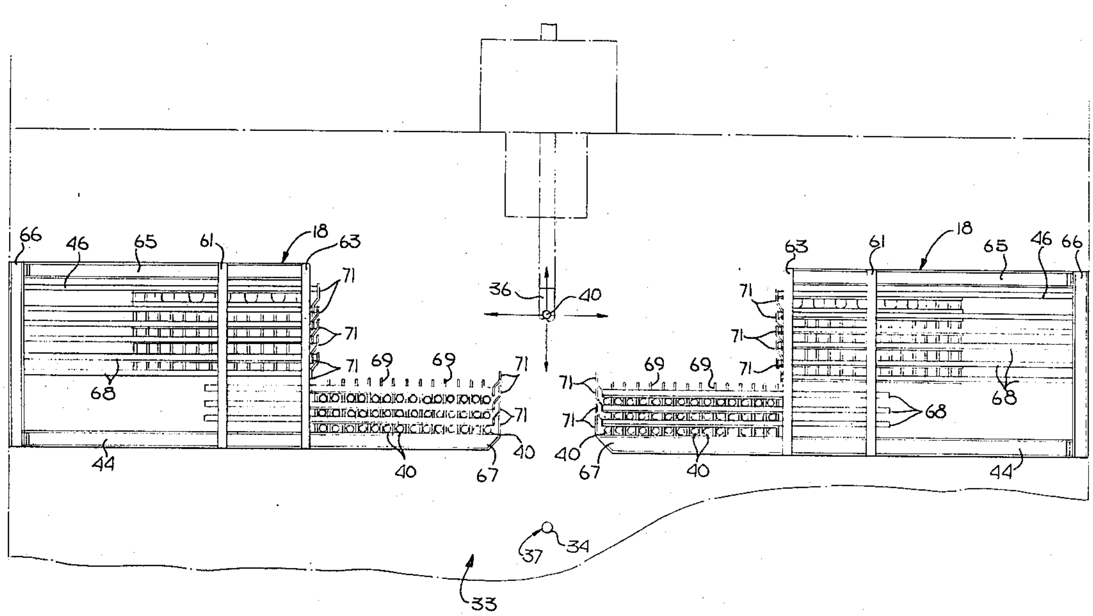
Attorney, Agent, or Firm—Spensley, Horn and Lubitz

[57] **ABSTRACT**

Drilling pipe racking apparatus for use on drilling rigs for controllably engaging and retaining a plurality of stands of pipe adjacent the tops thereof for racking purposes. The system is comprised of: a plurality of slideable racking arms, each having a plurality of spaced transversely extending members defining a plurality of open racking cells at one side thereof which members are slideably engageable with the adjacent side of the next racking arm; one stationary racking arm having a plurality of spaced transversely extending members similar to the sliding racking arm; and one sliding racking arm without transverse extending members. Control of the position of one racking arm controllably opens and closes the racking cell in the adjacent racking arm in an orderly progression. Upon full extension of a racking arm so as to close all racking cells in an adjacent racking arm, the extended racking arm itself defines a new plurality of racking cells. Means are provided for driving, interlocking and indexing the racking arms from one to another predetermined position with a safety interlock operable at all positions of the racking arms. Support structure as well as operating mechanism and safety interlock system are described.

6 Claims, 12 Drawing Figures



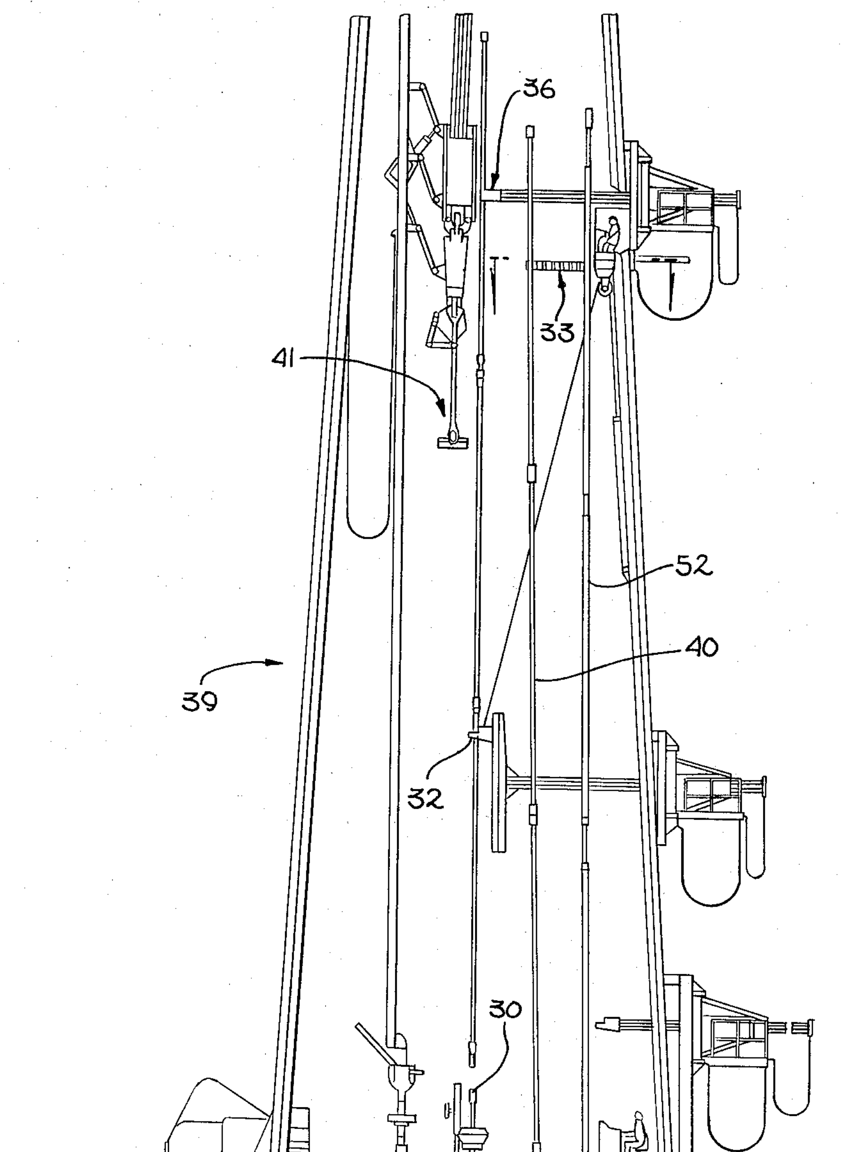


Fig. 1

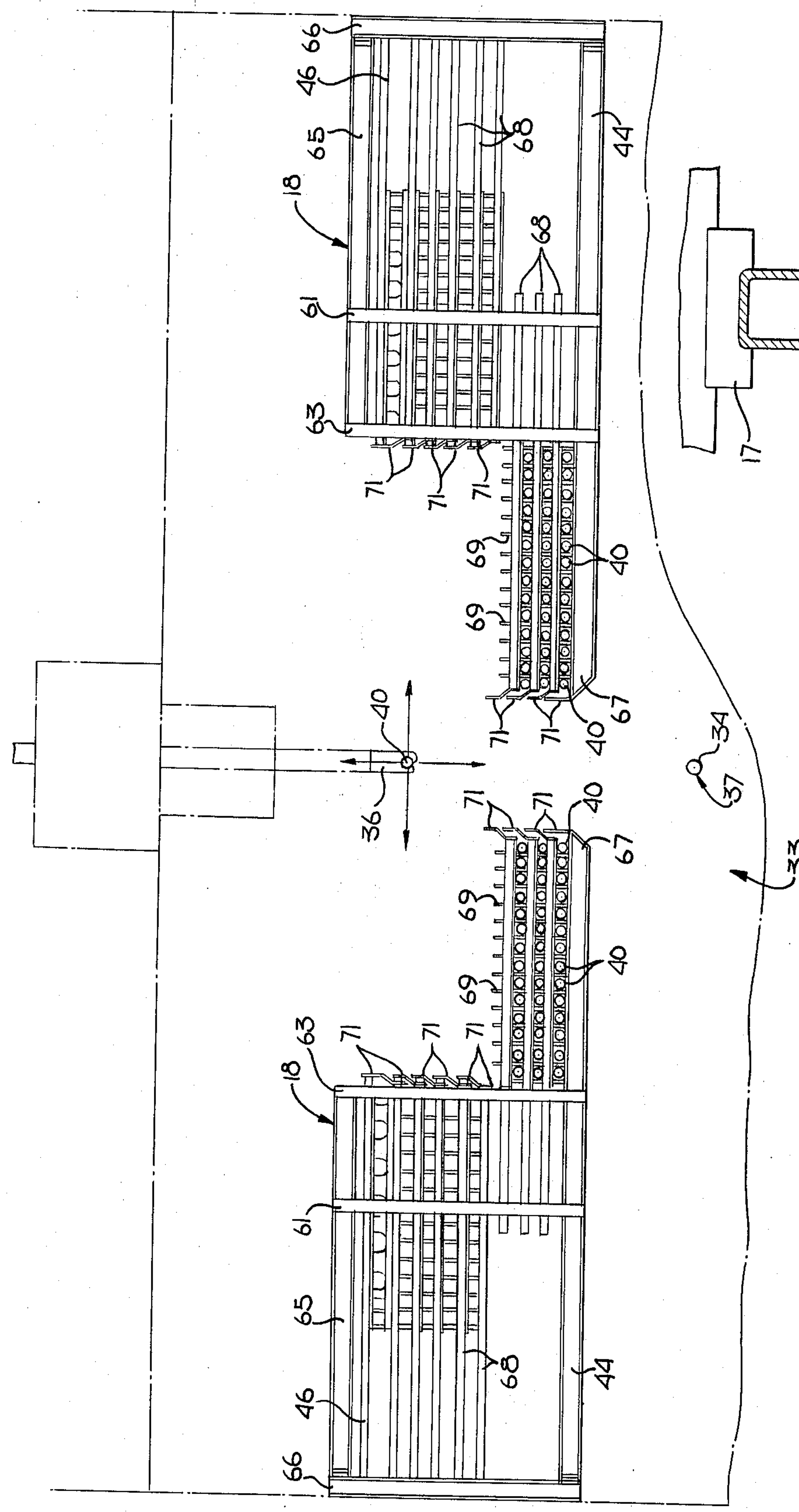


Fig.2

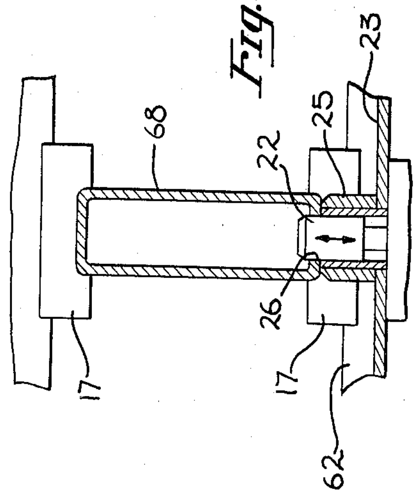


Fig.8

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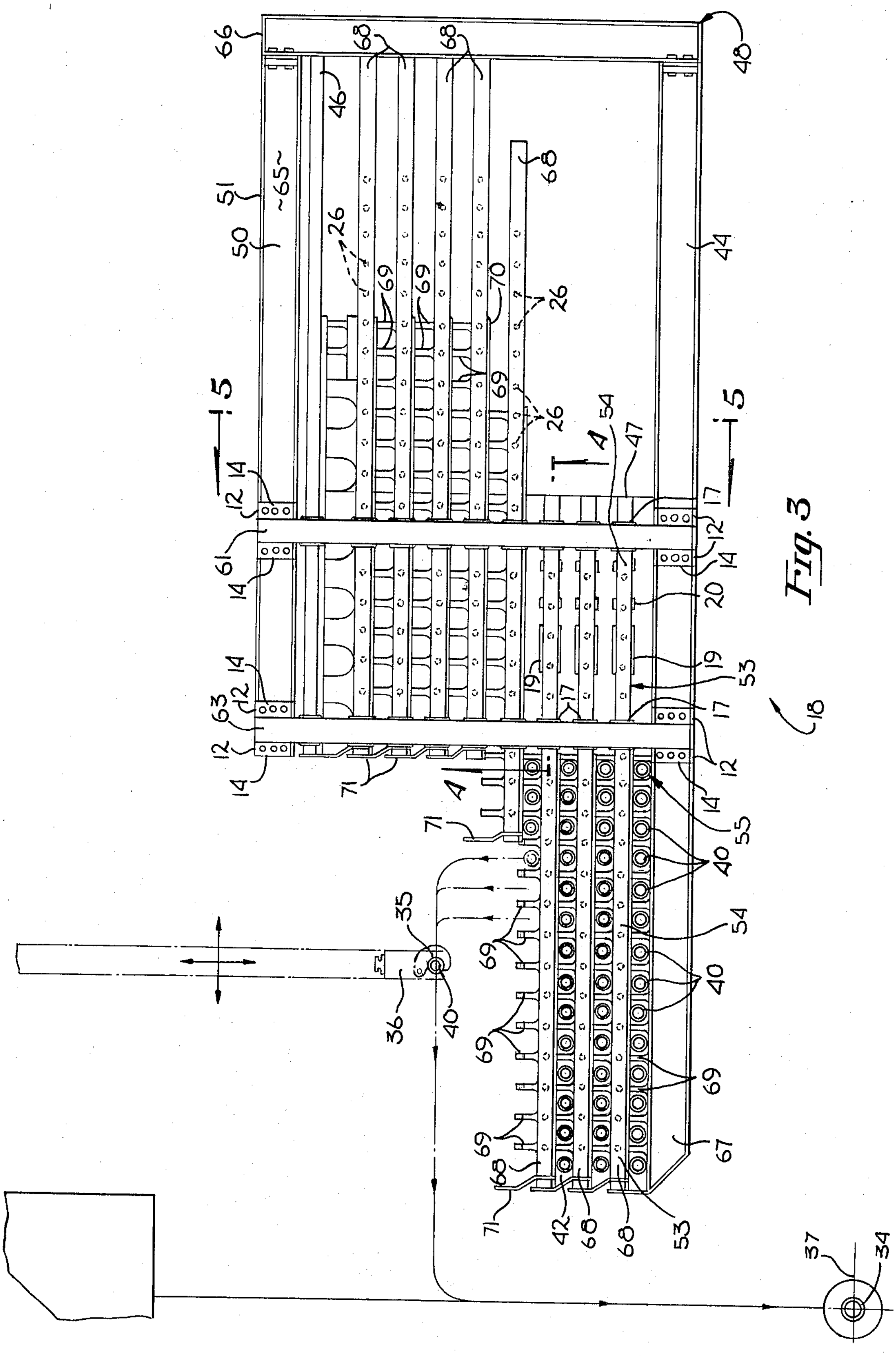


Fig. 3

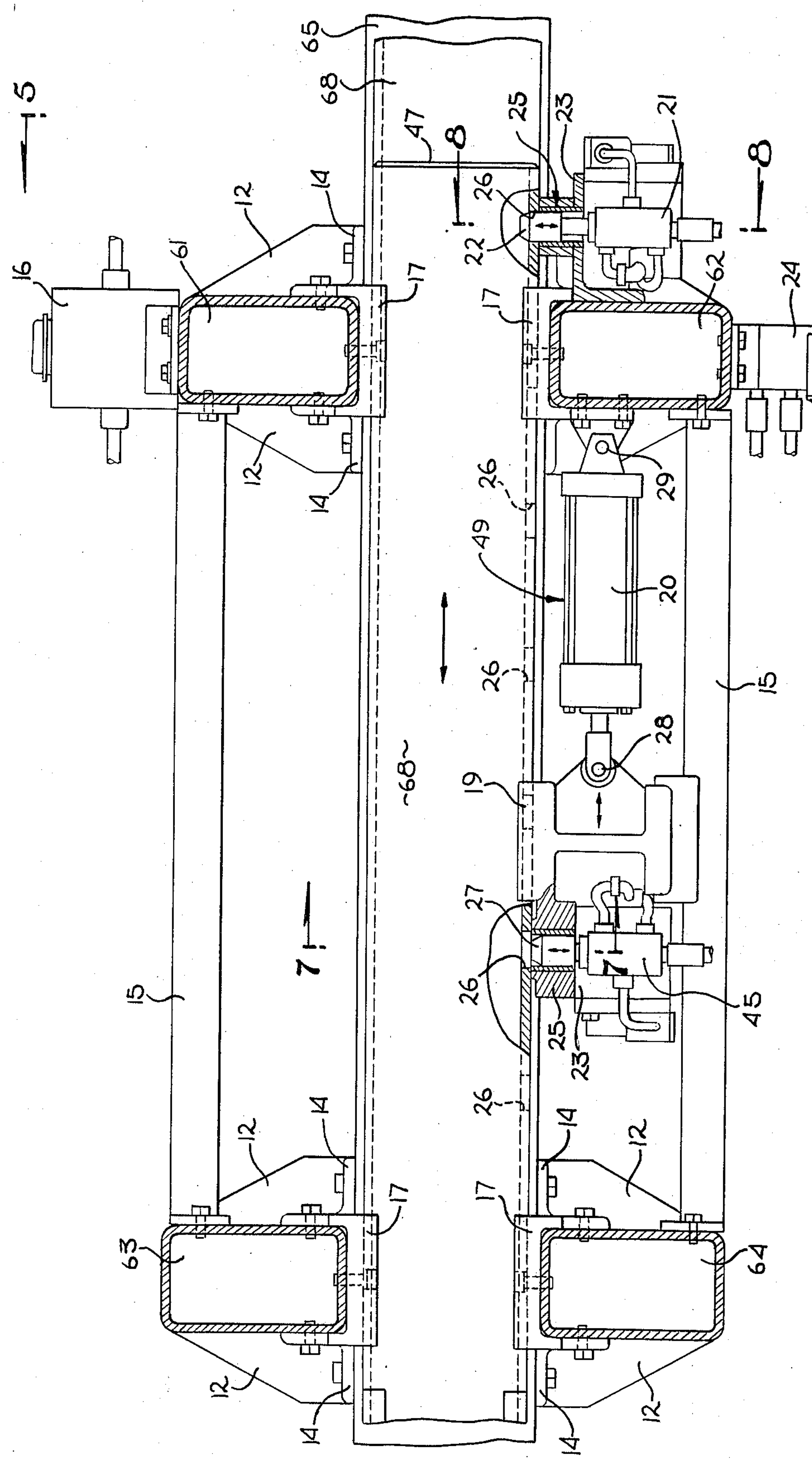


Fig. 4

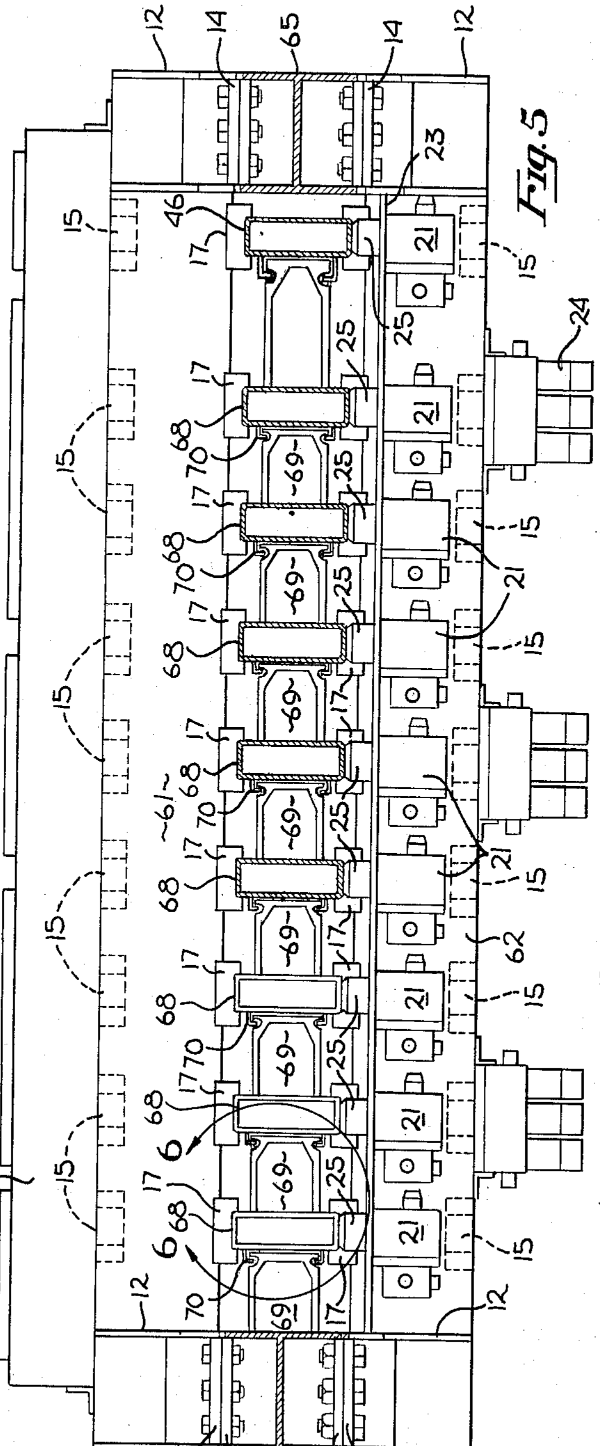


Fig.5

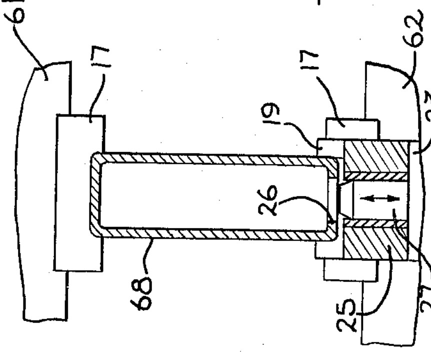


Fig.7

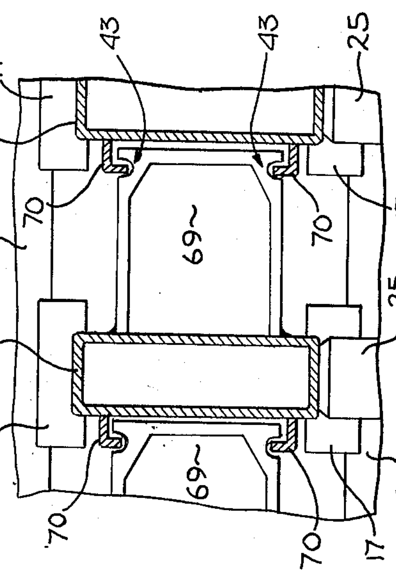


Fig.6

Fig. 9a

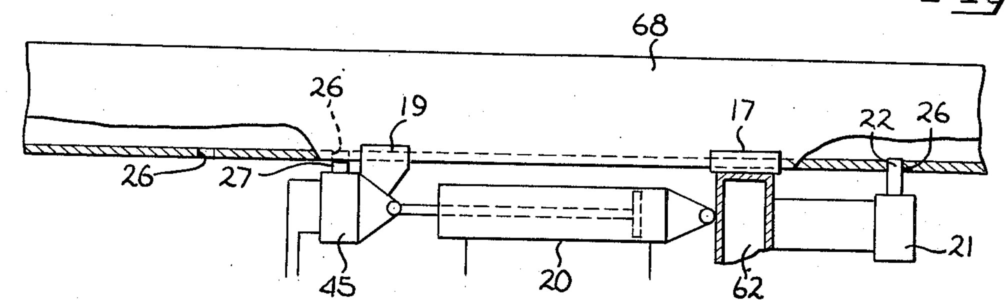


Fig. 9b

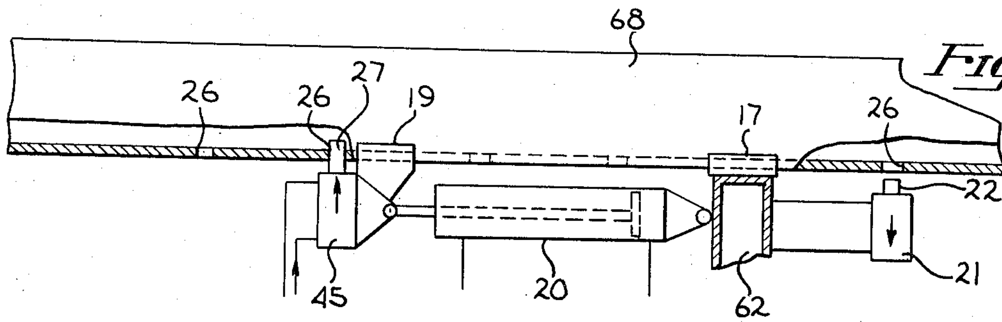


Fig. 9c

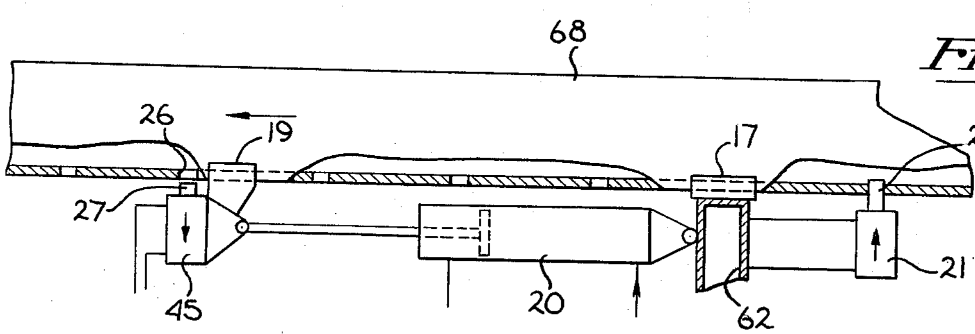
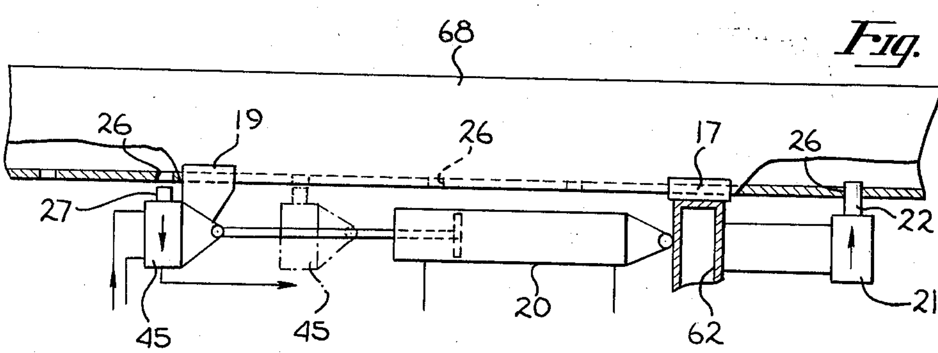


Fig. 9d



RACKING BOARD

BACKGROUND OF THE INVENTION

In well drilling operations it is necessary to handle lengths of pipe or conduit in a derrick in a rapid and efficient manner. For example, when drilling wells by the rotary drilling method, it is necessary to remove and replace the drill stem into the bore hole a number of times during the course of the drilling operation. The drill stem is made up of lengths of pipe with the ends fastened together by threaded joints. In removing the drill stem from the hole, it is customary to raise the drill stem until several connected joints of the drill pipe, which is called a stand, are above the derrick floor. The thread attaching the lower end of the stand to the remainder of the drill stem is disengaged. The disconnected stand is raised and moved over to one side of the derrick where it is racked with its axis substantially vertical. The drill stem is then raised until another stand of pipe is above the derrick floor. In going in hole, i.e., in returning the drill pipe into the well, the reverse procedure is used with the pipe taken from its racked position a stand at a time. The stand is moved from the rack with its axis substantially vertical until its axis coincides with that of the well hole. The lower end of the stand is then connected with the portion of the drill stem in the hole, and the drill stem is lowered until the upper end of the last connected stand is just above the derrick floor and the operation repeated.

With the advent of more complex and sophisticated drilling equipment and with the concomitant cost of the use of such equipment, it is necessary to handle the stands of pipe quickly and effectively in order to minimize the time used for handling pipe and allow a maximization of the total time involved to be used in the operation of deepening the hole. This is particularly true in offshore drilling operations in that equipment must be so designed as to minimize down-time or time in which actual drilling operations are not being performed. Although not limited thereto, the present invention is particularly useful in offshore operations and the presently preferred embodiment is adapted to be used on a semi-submersible drilling platform. Offshore drilling operations, whether conducted from a semi-submersible platform or a floating drilling vessel, present additional problems to those described above in that the action of the sea causing the platform and derrick to pitch and roll makes the provision of a satisfactory apparatus for handling pipe essential. In offshore drilling operations, because of the high cost of the equipment, down-time, i.e., the time in which drilling operations must be suspended by reason of weather or sea conditions, is an important factor in the total cost of the well being drilled. Additionally, safety considerations are involved to an extent not present in most land-drilling operations.

Pipe racking apparatus of the type known to the prior art are not fully satisfactory for offshore drilling operations nor for offshore or land drilling operations where harsh climatic conditions prevail. It can readily be seen that when large amounts of heavy pipe are stacked vertically in a derrick where the platform upon which the pipe rests is somewhat unstable, hazards to personnel and the equipment are presented. The present invention eliminates those hazards and makes the type of operation described above more efficient and safe. By allowing a completely safe operation, the drilling operations can be carried out under circumstances of weather and sea conditions, for example, at which they would otherwise have to be terminated and in this manner the use of the pipe racking apparatus of the present invention maximizes the amount of time during which drilling operations can be performed by the drilling equipment in conjunction with which the present invention is utilized.

The present invention is so constructed that the parts which are required to move are of heavy mass and are driven by relatively strong forces so that any ice formed thereon can be readily broken away by the operation of the equipment itself.

The present invention provides an improved racking apparatus for vertically racking oil well pipe, the apparatus being suitable for the racking of pipe on unstable platforms such as a floating drilling vessel or a semi-submersible platform but also being applicable to the racking of pipe on a stable offshore platform or land rig.

The present invention is also adaptable to receiving different sizes of pipe which may be racked simultaneously.

Another object of the present invention is to provide a pipe racking apparatus which may be readily adapted to partial or fully automated drilling operations.

BRIEF SUMMARY OF THE INVENTION

Drilling pipe apparatus for use on drilling rigs for controllably engaging and retaining a plurality of stands of pipe adjacent to the tops thereof for racking purposes. The system is comprised of a generally horizontally oriented frame assembly, disposed above the floor of the drill rig, with the frame assembly supporting a plurality of slideable racking arms therein. The racking arms are provided with a plurality of spaced protrusions which define open racking cells on one side of the racking arm, with the protrusions defining the racking cells slideably engaging the adjacent side of the next racking arm to define the closed cells. A system of pneumatic or hydraulic cylinders or other suitable driving means, such as is commonly used in the art, is approximately controlled through an electrical system by solenoid valves, to provide for the electrically-controlled selective sliding of each racking arm so as to open and close the racking cells in an adjacent racking arm in an orderly progression. Safety relays appropriately disposed provide an interlock for the solenoid valves so as to insure that positive engagement with each racking arm is provided at all times to that the racking arms are never free to randomly slide and inadvertently release the pipe racked therein. Upon full extension of a racking arm so as to close all racking cells in an adjacent racking arm, the extended racking arm itself defines a new plurality of racking cells for progressively receiving stands of pipe. A specific embodiment of the present invention is shown and described in detail, with various alternate embodiments thereof also described.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevation view, partly cut away, of a drilling rig.

FIG. 2 is a top plan view of the pipe rack embodying the invention shown in relation to the drill hole.

FIG. 3 is an enlarged plan view of one-half of the pipe rack as shown in FIG. 2.

FIG. 4 is a section view of the pipe rack taken along lines 4—4 of FIG. 3.

FIG. 5 is a section view of the pipe rack taken along lines 5—5 of FIG. 3.

FIG. 6 is an enlarged partial view in section of the racking arms and locking means taken along lines 6—6 of FIG. 5.

FIG. 7 is an enlarged partial view in section of a racking arm and locking pin, pin down, taken along lines 7—7 of FIG. 4.

FIG. 8 is an enlarged partial view in section of a racking arm and locking pin, pin up, taken along lines 8—8 of FIG. 4.

FIGS. *9a* through *9d* are schematic progressive step illustrations of the pin locking mechanism operation.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is a system that can be used to contain tubular members in nearly vertical disposition. The preferred embodiment disclosed herein is particularly useful for the racking of drill-pipe in a derrick of a drill rig, such as, by way of example, an offshore drill rig subject to at least some wave motion, as the system controllably and individually locks each pipe in its own individual cell to prevent unexpected motion or tipping thereof. As shall subsequently become apparent, the system is composed of simple, massive moving parts which are not easily fouled by weather or wearing and utilizes a single, positive acting actuating mechanism for each row of pipe to be retained.

Referring now to FIG. **1**, components of a typical drill rig are illustrated, partly diagrammatically to illustrate the environment and operation of the present invention. A drilling derrick **39** is shown on the drilling platform which in the illustrative embodiment is the main deck of an offshore drilling structure. The derrick **39**, in the present embodiment, has mounted at the upper end thereof a crown-block and air operated elevators **41**. The traveling block is supported from the crown blocks by the drilling line and arranged to be raised and lowered along the axis of the derrick by operation of the draw works. However, other apparatus, such as a crown block in a heave compensator, or just hydraulic lifts with no crown block could be used in an alternate embodiment. In FIG. **2**, the axis of the derrick will be coincident with the axis of the rotary table **37** and bore hole shown as **34**. Mounted on the derrick **39** is a pipe transfer assembly comprising a lifting head **32** and racking head **36**. One of the permanent racking assemblies which is the subject matter of the present invention is shown on the derrick as **33**.

Referring now to FIG. **1**, a side view of the presently preferred embodiment of the racking unit **33** is composed of steel members and is fastened to the derrick **39** approximately **80** feet above the main deck **38**. However, the racking unit **33** can be secured to the derrick at any desired elevation above the main deck **38**, and should be installed or adjusted to the desired height determined by the length of stand of the pipe **40** being used. In normal operation, the pipe racking unit **33** will be composed of two individual pipe racking mechanism **18**, although this is not a requirement of this invention. These pipe racking mechanisms **18** can be mirror images of each other, and are situated on the derrick **39** as best shown in FIG. **2** The racking unit **33** is positioned in a horizontal plane approximately parallel the main deck **38**, so that it does not interfere with normal

drilling operations. Each racking mechanism **18** is further positioned so that the sliding arms, described in detail hereafter, slide toward the opposing racking mechanism and the centerline of the rotary table **37** when the rack is being filled, and away from the centerline of the rotary table when being emptied, as best shown in FIG. **2**. Since the racking unit **33** is composed of two racking mechanisms **18** which are right and left sides, only one side will be described in detail hereafter, it being understood that the other is the mirror image of the one described. Other modifications in arrangement, proportions or detail may be made therein by one skilled in the art, as required or advantageous to meet the specific requirements of any particular use of the present invention.

Thus, the racking unit **33** acts as two independent structural pipe racking mechanisms **18**, one the right and the other left side. Each racking mechanism **18** is secured to the derrick **39** by a connecting means fastened to the end and center support beams **61, 62, 63** and **64** and the beams **65, 66** and **44** (see FIGS. **3** and **4**). The racking mechanism **18** is positioned in the derrick, in the present embodiment, so that the end support beams **63** and **64**, end beam **66**, front arm beam **44**, and rear arm beam **65** form a rectangular shape, with the end support beams **63** and **64** forming the side closest the drill hole **37**.

Each pipe rack mechanism **18** is positioned so that the stands of drill pipe **40** can be nested in the rack near the top of each pipe while the bottom of the pipe rests on the main deck preferably upon a platform **38** having patterned indentations to receive and retain the lower ends of the pipes against horizontal movement. The racking mechanism **18** is adapted so the operator can remove the pipes **40** from the rack when going into the hole and place them into the rack when coming out of the hole.

Now referring particularly to FIGS. **3** and **4**, each rack mechanism **18** is framed by an end beam **66**, a rear arm beam **65**, a front arm beam **44** coextensive with the stationary racking arm **67**, end support beams **63** and **64**, and the central support beams **61** and **62**. End support beams **62** and **64** are below beams **61** and **63** respectively as shown in FIG. **4**. In the present embodiment, the end beam **66** and the front and rear arm beams **44** and **65** are steel wide-flange members, while the support beams **61, 62, 63** and **64** are steel rectangular tube sections. The end and arm beams are positioned so that the web is in a horizontal plane and the flanges in a vertical plane. The support beams **61, 62,** 63 and **64** are positioned such that the longest dimension of the cross-section is in a vertical plane and the shortest in a horizontal plane.

The end beam **66** is connected to the rear arm beam **65** and the front arm beam **44**, the end beam and arm beams being coplanar. The rear arm beam **65** is a continuous member terminating at the connection to the end support beams **63** and **64**. The upper end support beam **63** is secured to the top of the flanges **51** of the rear arm beam **65**, and the lower support beam **64** is secured to the bottom of the flanges **51** of the rear arm beam. The upper and lower central support beams **61** and **62** are connected to the rear arm beam **66** in the same manner as the end support beams **63** and **64**. This connection allows the arm beams **44** and **65** to be continuous through the support beams **61, 62, 63** and **64**. The front arm beam **44** is connected to the support beams 61, 62, 63 and 64 in the same manner as the rear arm beam 65. However, the front arm beam 44 continues past the end support beams 63 and 64 and becomes the stationary racking arm 67, as previously mentioned, terminating at the end finger 71. Thus, the stationary racking arm 67 and the rear arm beam 44 are a continuous member.

The connection between the support beams 61, 62, 63 and 64 and the arm beams is best shown in FIG. 4. Steel angles 14 allow bolting to secure the support beams to the arm beams, with stiffeners 12 adding torsional rigidity to the connection. The top of the upper support beams 61 and 63 and the bottom of the lower support beams 62 and 64 are connected by horizontal stiffeners 15 which serve to add torsional rigidity to the support beams and which may contain electrical wiring connections.

The presently preferred embodiment is shown particularly in FIGS. 3 and 5. There are eight sliding racking arm 68, which quantity is generally determined by the storage capacity required, one stationary racking arm 67, and one rear racking arm 46. The sliding racking arms 68, along with the finger locking plates 69, make up individual racking cells 42. The finger locking plates 69 are made of steel plate in the present embodiment, one end being connected to the sliding racking arm 68, with the protruding end having a double finger keyway 43, best illustrated in FIG. 6. The racking arms 68 form the front and back of the racking cells 42 while the finger locking plates 69 form the sides of the racking cells (FIG. 3). Each racking arm 68 interlocks with the two adjacent racking arms by means of the finger locking keys 70 and the finger locking plates 69 cooperatively engaging each other (FIG. 6). The meshing of the keys 70 and the plates 69 serve to limit relative movement of the arms 68 with respect to each other, but allow longitudinal movement of a racking arm 68 with respect to the adjacent arm for extension or retraction thereof. The finger locking keys 70 are made, in the present embodiment, of two steel angles attached to the back of the sliding racking arm 68 (FIG. 6). The finger locking plate 69 is fastened to the front of the racking arm 68 coplanar to the finger locking keys 70. In this embodiment, each of the racking arms 68 has 14 pairs of finger locking plates 69, in addition to one end finger 71. The rear racking arm 46 is generally the same as the sliding racking arms 68, except it has no finger locking plates welded to its front side.

The racking arm 68 adjacent to the rear racking arm 46 may have finger locking plates 69 spaced farther apart than the other racking arms 68. This configuration is shown in the present embodiment (FIG. 3). These extra-wide racking cells can be used to contain drill collars, pipe that is heavier and usually bigger in diameter than normal drilling pipe 40.

The racking arms 68 and rear racking arm 46 are slideably mounted between support beams 61, 62, 63 and 64. The arms are slideable between an extended position where the stub end 47 of the racking arm 68 is adjacent the central support beams, and a retracted position where the end finger 71 is immediately adjacent the end support beams 63 and 64 and the stub end 47 of the racking arm 68 generally engaging the end beam 66. Thus, the racking arms 68 are always slideably supported by the support beams 61, 62, 63 and 64 by means of a bushing 17 at all four contact points, as best illustrated in FIG. 4. The stationary racking arm 67 is designed to resist bending movements due to the loads incurred from the pipe 40 in a first horizontal direction, while the support beams 61, 62, 63 and 64 take the forces encountered in the orthogonal horizontal direction.

The racking arms 68 and 46 are designed to be slideably indexed into predetermined position and then to be locked in place. This is accomplished by means of a driving and indexing mechanism which in the presently preferred embodiment includes vertically moveable driving and locking pins 22 and 27 insertable into racking arm locking holes 26 drilled in the bottom flange of the racking arms 68 (see FIGS. 3 and 4), into which the racking arm locking pins 22 and 27 are insertable.

Now referring more specifically to FIG. 4, a section view showing the locking and sliding mechanism 49 may be seen. It is to be understood that the electrical control system of the driving and indexing means can take various forms as can the driving and indexing system. A principal criteria of the driving and indexing system is that at all times, regardless of position, the racking arms are locked securely so that all motion is prevented. In this embodiment, the locking an sliding mechanism 49 consists of one horizontal hydraulic cylinder 20, two vertical pneumatic cylinders 21 and 45, a slideable racking arm guide 19, and two sets of racking arm locking pins 22 and 27 and locking pin sleeves 25. The vertical pneumatic cylinder 21 with its locking pin sleeve 25 is permanently fastened to the lower central support beam 62 on the side closest the end beam 66. The racking arm locking pin 22 is slideably mounted in the vertical locking pin sleeve 25, and can be extended or retracted by the vertical pneumatic cylinder 21. One end of the horizontal hydraulic cylinder 20 is connected by connection means 29 to the lower central support beam 62 opposite the vertical pneumatic cylinder 21, and the other end is fastened by connection means 28 to the slideable racking arm guide 19. The slideable racking arm guide 19, in the present embodiment, is a preformed steel member that will slide longitudinally along a racking arm 68 without any lateral displacement. The end of the sliding racking arm guide 19 opposite the horizontal hydraulic cylinder is permanently fastened to and supports the vertical pneumatic cylinder 45, and its locking pin sleeve 25 in which the locking pin 27 is slideably mounted. Thus, the vertical pneumatic cylinder 45 and its locking pin sleeve 25 must displace longitudinally along the racking arm 68 as the sliding racking arm guide 19 is forced by the horizontal hydraulic cylinder 20, while the vertical cylinder 45 extends or retracts the locking pin 27 into or out of engagement with the locking pin holes.

In the present embodiment one driving and indexing mechanism is utilized in combination with each slideably moveable racking arm. In view of the present disclosure, it can be seen that a single driving and indexing mechanism can be utilized which could be moved manually or automatically from one racking arm, to the racking arm which is to be moved next in the cycle of operation.

Having now described the structure and mechanism arrangement, a typical manner of use will be described. One normal aspect of usual drilling procedure utilizing the present invention, commonly called coming out of the hole, involves the steps of lifting the drill stem 30 from the drill hole with elevator 41, locking the stem

30 with respect to the rotary table 37, steadying the stand with racking head 36 disengaging the elevator from the drill stem, unscrewing a stand of pipe, and raising the stand of pipe with lifting head 32 and placing the bottom end on the main deck while using the racking head 36 to place the top portion of the pipe stand 40 in the pipe rack 33 and retain it therein as subsequently described. The reverse process is followed if the rack 33 is being emptied, commonly called going into the hole.

Assuming the racking mechanism 18 to initially be empty, the racking procedure may commence with all sliding racking arms 68 and 46 in the retracted position, enclosed within the racking frame 48, and supported by the support beams 61, 62, 63 and 64, i.e., with the racking arm stub end 47 adjacent to the end beam 66. The stationary racking arm 67 is now set to receive the first pipe 40.

The first pipe 40 is placed between the first pair of finger locking plates 69, the pair closest to the end support beams 63 and 64, e.g. in the region generally identified by the numeral 55. The first sliding racking arm 68 (designated 54 for specificity), the racking arm closest to the front arm beam 44, is then moved forward toward the axis of the derrick and rotary table 37 by a distance approximately equal to the width of one pipe cell 42 opening, the movable the pipe 40 that has just been placed, and locking it in that position. The next pipe 40 may be placed in the next adjacent pipe cell 42 and the sliding racking arm 54 is again moved forward to cover that pipe cell 42. This procedure is followed until the last pipe cell 42 in that row has been filled with a pipe 40 and the sliding racking arm 54 moved forward to cover the pipe. At this point the sliding racking arm will have reached the limit of its travel and is now supported by not only the support beams 61, 62, 63 and 64, but also the stationary racking arm 67, due to the system of interlocking finger locking keys 70 and finger locking plates 69 of this sliding racking arm and the stationary racking arm 67. Thus all pipes 40 contained between the stationary racking arm 67 and the first sliding racking arm 54 are firmly secured in place. The process is now repeated using the next sliding racking arm 68 and so on until all the pipe has been racked. This process is best illustrated in FIG. 3, which depicts a rack mechanism 18 partially filled in accordance with the foregoing procedure.

To unrack the pipes, the rear racking arm 46 is moved back into the frame 48 by the width of one cell, one racking cell thus exposing one pipe 40. This pipe can then be pulled out of its racking cell 42. The racking arm 46 is moved back one more racking cell and another pipe is removed. Thus, all pipes can be removed and unracked in succession.

The sliding arms 68 can be moved in their horizontal plane either by a suitable power drive means or manually.

In the preferred embodiment, the power drive means for each racking arm 68 is comprised of the short stroke horizontal hydraulic cylinder 20, two vertical pneumatic cylinders 21 and 45, two racking arm locking pins 22 and 27, two locking pin sleeves 25, and one racking arm guide 19 (FIG. 4). The horizontal hydraulic cylinder 20 is secured to the side of the lower central support beam 62 facing the end support beams 63 and 64 by connection means 29 and is used to produce the horizontal sliding motion of the sliding racking arms 68. One end of the horizontal hydraulic cylinder 20 is connected by pin means 28 to a slideable racking arm guide 19 which is secured to the vertical pneumatic cylinder 21. Pin sleeve 25 and racking arm locking pin 22 are permanently fastened to the side of the lower central support beam 62, opposite the horizontal hydraulic cylinder 20. Both pins 22 and 27 are aligned in the vertical plane of the vertical centerline of the racking arm 68. As previously described, the racking arm locking pins 22 and 27 are movably vertically through the locking pin sleeves 25 by the vertical pneumatic cylinders 21 and 45. Note that the racking arm locking pin 27 and its locking pin sleeve 25, and vertical pneumatic cylinder are slideable by means of the horizontal hydraulic cylinder 20, while the racking arm locking pin 22 and its locking pin sleeve 25 are permanently affixed to the lower central support beam 62.

Referring now to FIGS. 9*a* through 9*d*, there is schematically illustrated the progressive steps of operation of the driving and indexing mechanism 49. With the driving and indexing mechanism 49 in the position shown in FIG. 9*a*, the horizontal hydraulic cylinder 20 is fully retracted and the vertical pneumatic cylinder 45 under the locking pin 27 is fully retracted. Thus the locking pin 27 is not engaged in the racking arm locking hole 26. The vertical pneumatic cylinder 21 is fully extended and consequently engages the racking arm locking hole 26. The vertical pneumatic cylinder 45 is now extended its full stroke, engaging locking pin 27 with locking hole 26. After locking pin 27 is engaged, the vertical pneumatic cylinder 21 is withdrawn, disengaging locking pin 22. This is shown in FIG. 9*b*. The racking arm 68 is now moved into position one racking cell forward by the horizontal hydraulic cylinder extending its full stroke as shown in FIG. 9*c*. Upon completion of the stroke of cylinder 20, the locking pin 22 is then engaged and locking pin 27 disengaged putting the mechanism in the condition shown in FIG. 9*c*. The horizontal hydraulic cylinder 20 is withdrawn in its full stroke, bringing the racking arm locking pin 27 into place under the next adjacent racking arm locking hole 26. (e.g., closer to the central support beams 61 and 62) as shown in FIG. 9*d*, completing the cycle. To empty the pipe rack mechanism 18 the horizontal hydraulic cylinder 20 is extended and then the above steps are merely performed in the reverse order.

In the preferred embodiment, a control console is provided at a convenient location for observation and control of the racking mechanisms. The console is of conventional construction, providing electrical signals to solenoid valves controlling the flow of hydraulic fluid to the various hydraulic cylinders and air to the various air cylinders in the apparatus herethfore described so as to result in the desired motion and locking of the racking arms. It is to be noted, however, that if both pins 22 and 27 (FIG. 4) for any of the racking arms 68 were simultaneously withdrawn, the corresponding racking arm would be free to slide in a longitudinal direction, thereby opening the racking cells in an adjacent racking arm, releasing the pipe stands stored therein. To prevent such an occurrence, the locking pins 22 and 27 are spring loaded in the locked position and can be withdrawn by engaging switches which control the solenoid valve which control the cylinders 45 and 21 respectively. Note, however, that the solenoid valves are connected so that only one cylinder, 21 or 45, can be withdrawn at any time, i.e., if one is withdrawn, the other is engaged. Thus, neither pin **22** nor pin **27** for any racking arm may be withdrawn unless the other pin is in the extended position, thereby assuring that each racking arm is engaged at all times by at least one of pins **22** or **27.** Accordingly, inadvertent sliding and lack of control in the position of any of the racking arms is prevented either by the locking of the racking arm with respect to the central support beams by pin **22,** or by locking the racking arm by pin **27** to the racking arm locking guide for controllable motion by cylinder **20,** thereby avoiding any possibility of operator error. Furthermore, pin **22** is preferably generally encouraged, in event of any power failure, to the engaged state due to the spring loaded position and is only withdrawn by application of pneumatic pressure, so that all racking arms are locked in the event the pneumatic system is deactivated or fails to properly function.

A manual movement of the racking arms **68** can be accomplished, if for some reason the power drive means will not function. Motion is produced by inserting a special collard crowbar between two finger locking plates **69** and into a special pre-drilled hole in a plate welded to the lower central supporting beam **62.** The sliding racking arm can then be pushed forward or backward using the leverage of the crowbar. The racking arm can be locked in a desired position by inserting the crowbar between the next pair of finger plates **69** and into the special pre-drilled hole.

In addition to the manual movement technique described above, various power drive means, by way of example, may utilize motors, pinion systems and various hydraulic or pneumatic cylinder combinations. However, for the sake of ruggedness and simplicity, a system of hydraulic main cylinders and pneumatic secondary cylinders has been found particularly useful. One such system, not shown in the present embodiment is described below. It uses a long stroke horizontal hydrualic cylinder. The total stroke of the cylinder is equal to the maximum travel of the sliding racking arm. As the racking arm **68** must move only a fraction of its travel per pipe stand **40** stored, the travel of the cylinder must be interrupted for each pipe stand **40.** This can be done by driving the cylinder with an accurately dimensioned stroke volume corresponding to the travel per pipe, or more simply, by putting a choke in the hydraulic lines so that the cylinder moves relatively slowly. The cylinder can then be started and stopped by direct manual control. This system can only be applied where the operator is sufficiently close to the racking system, to see what he is doing.

Now referring to the sliding and locking mechanism shown in FIG. **4,** and used in the present embodiment, each sliding racking arm **68** has one complete locking and sliding mechanism **49** situated under the lower central support beam **62.** However, in an alternate embodiment only one locking and sliding mechanism **49** is employed, there being provided a means to move itself along the lower central support beam locking itself into position under each racking arm **68** until the racking arm is fully extended in either direction and then unlocking itself to move to the next racking arm **68.** This horizontal movement of the locking pin mechanism **49** would be accomplished by a horizontal hydraulic cylinder position along or under the lower central support beam or run about parallel to that beam. This configuration has certain advantages when used in a totally automated system.

Thus, there has been described herein a simple, rugged drill pipe racking mechanism, adapted to be used on any kind of drill derrick or rig, either offshore or on land. This pipe rack serves to contain each stand of pipe in a specific fixed position relative to the drilling derrick while in use. However, while the preferred embodiment of the present invention has been described in detail herein, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. Pipe racking apparatus for use on drilling rigs for controllably engaging and retaining a plurality of stands of pipe in vertical orientation within a drilling derrick comprising:

a frame member positionable on the derrick;

a plurality of racking arms affixed to the frame member, said racking arms being moveable into and out of the frame member;

each of said racking arms having at one side thereof a plurality of transversely extending members spaced along the length of said racking arm by a distance substantially equal to but greater than the diameter of the pipe being racked to define a plurality of open individual pipe receiving cells, said members cooperating with the next adjacent racking arm to provide closed pipe receiving cells;

means for driving and indexing each racking arm through a series of predetermined positions to sequentially expose or cover the pipe cell in the next adjacent racking arm, said driving and indexing means being adapted to move the racking arm to which it is connected by the width of the spacing between transverse members at each indexing step to thereby cover or expose one stand of pipe; and

interlocking means for locking each of said racking arms, said interlocking means including a plurality of locking members, each secured to said adjacent racking arm for engaging said transversely extending members such that said transversely extending members slidingly engage said locking members, preventing transverse movement.

2. Pipe racking apparatus for use on drilling rigs for controllably engaging and retaining a plurality of stands of pipe in vertical orientation within a drilling derrick comprising:

a frame member positionable on the derrick;

a plurality of racking arms affixed to the frame member, said racking arms being moveable into and out of the frame member;

each of said racking arms having at one side thereof a plurality of transversely extending members spaced along the length of said racking arm by a distance substantially equal to but greater than the diameter of the pipe being racked to define a plurality of open individual pipe receiving cells, said members cooperating with the next adjacent racking arm to provide closed pipe receiving cells;

means for driving and indexing each racking arm through a series of predetermined positions to sequentially expose or cover the pipe cell in the next adjacent racking arm, said driving and indexing means being adapted to move the racking arm to which it is connected by the width of the spacing between transverse members at each indexing step to thereby cover or expose one stand of pipe;

interlocking means for locking each of said adjacent racking arms, said interlocking means including a plurality of locking members, each secured to said adjacent racking arm for engaging said transversely extending members such that said transversely extending members slidingly engage said locking members, preventing transverse movement; and

a fail safe locking means for locking each of said racking arms, said fail safe locking means including a plurality of locking pins which are spring loaded in the locked position and are coupled to said frame member, said locking pins being insertable into a plurality of apertures spaced longitudinally along said racking arm.

3. The apparatus of claim **2** wherein said locking pins are electrically coupled such that only one of said pins can be disengaged at any time.

4. Pipe racking apparatus for use on drilling rigs comprising:

a frame;

a plurality of generally elongate coplanar racking arms, each of said racking arms being moveable along its axis with respect to said frame, said plurality of racking arms being transversely spaced in substantially parallel relationship;

said racking arms having a front and back side facing respectively the back and front sides of adjacent racking arms;

a plurality of transverse locking fingers longitudinally spaced along, and affixed to, the front side of said racking arms, said locking fingers being slideably engaged with the back side of the adjacent racking arm whereby the adjacent front and back side of two adjacent racking arms and two adjacent locking fingers define a cell for receiving a stand of pipe; and

drive means for progressively and controllably moving and inter locking each of said racking arms with respect to said frame.

5. The pipe racking apparatus as defined in claim **4** wherein said frame means includes a racking member extending generally parallel to and adjacent to the first of said plurality of racking arms, said racking member having locking fingers for slideably engaging said back side of said first of said plurality of racking arms.

6. Pipe racking apparatus as defined in claim **5** including a sliding member for closing the open cells of the last of said racking arms.

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