July 6, 1965 R. F. BAUER ETAL 3,193,084

PIPE HANDLING APPARATUS

Original Filed March 28, 1957 4 Sheets-Sheet 1

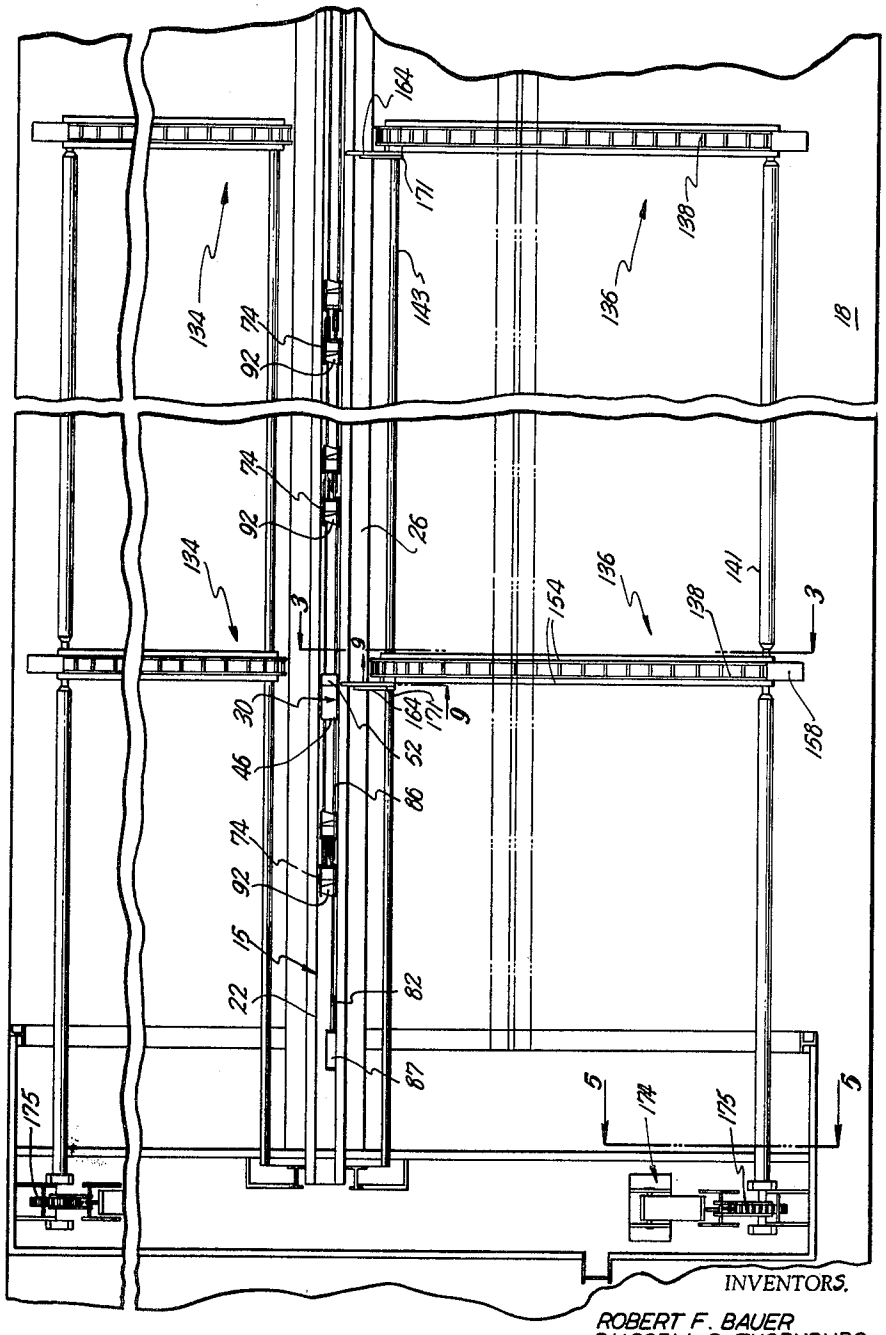

FIG. 1

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PIPE HANDLING APPARATUS

Original Filed March 28, 1957 4 Sheets-Sheet 2

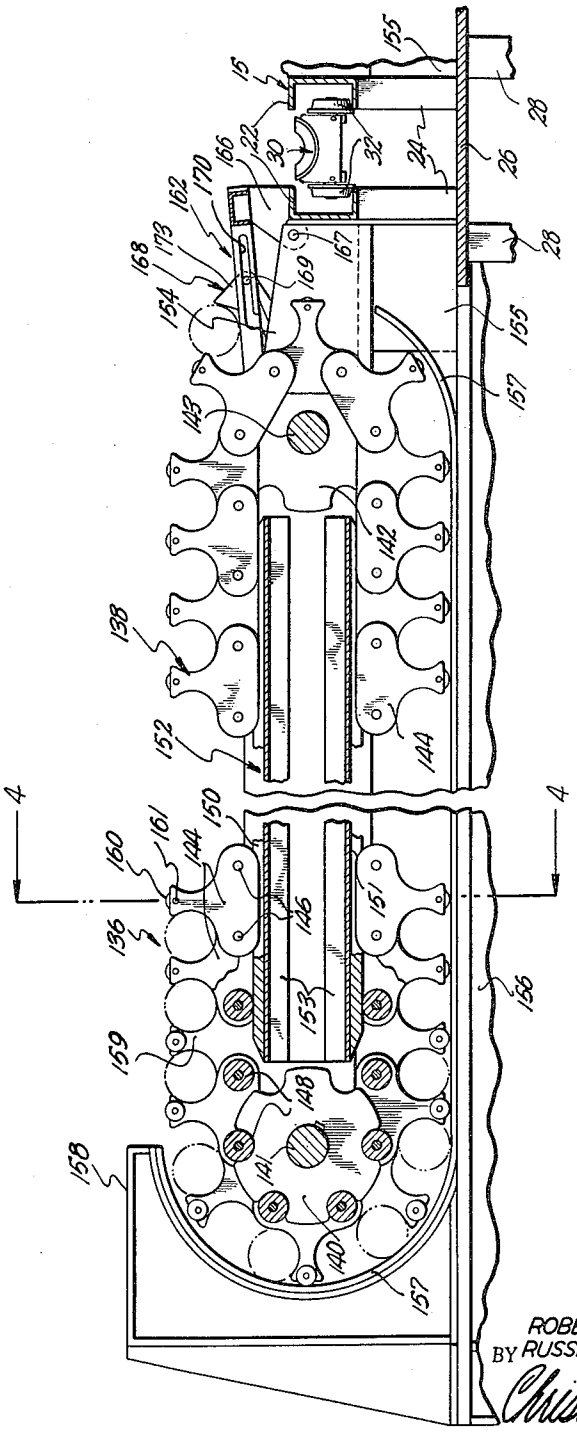

FIG. 2.

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PIPE HANDLING APPARATUS

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FIG. 6.

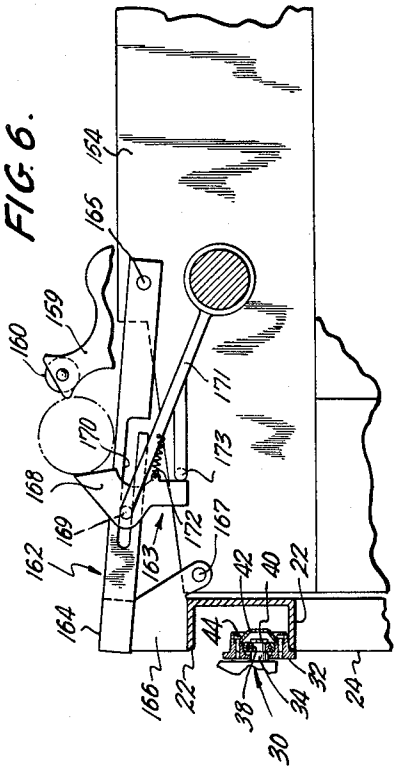


FIG. 7.

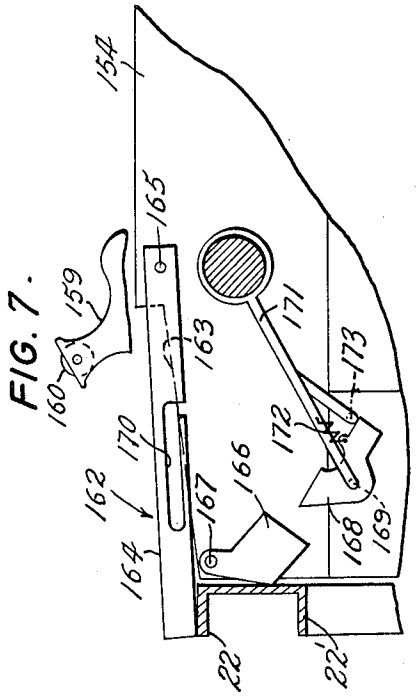
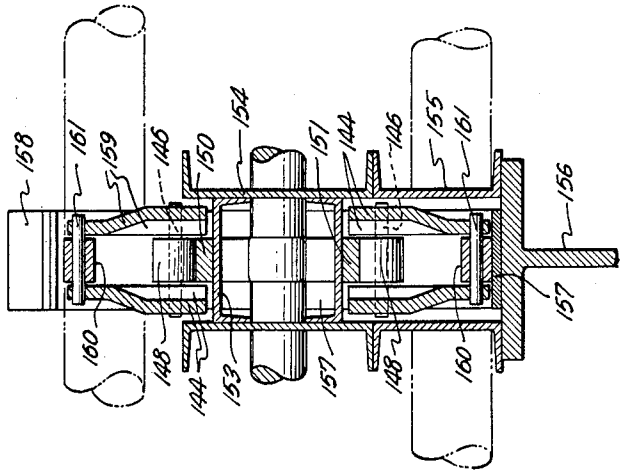


FIG. 3.



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PIPE HANDLING APPARATUS

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FIG. 4.

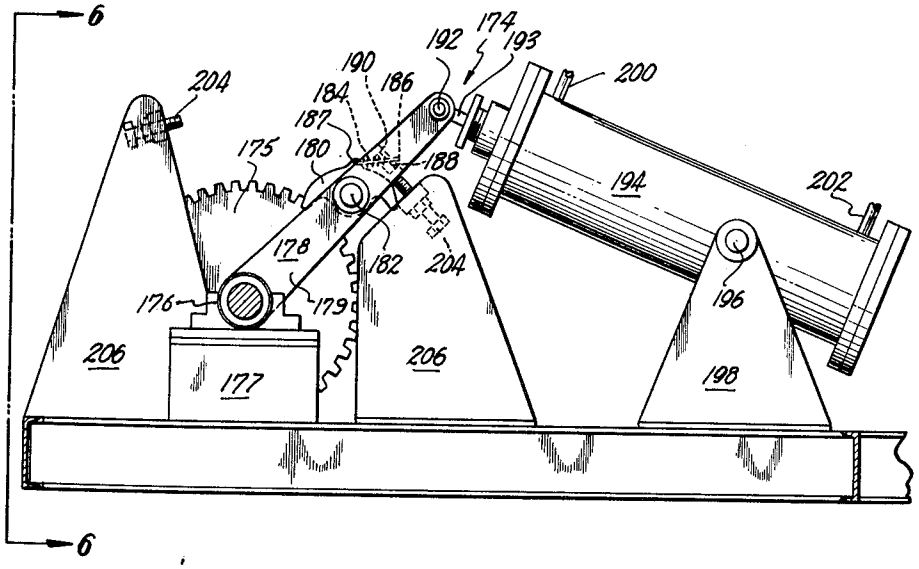
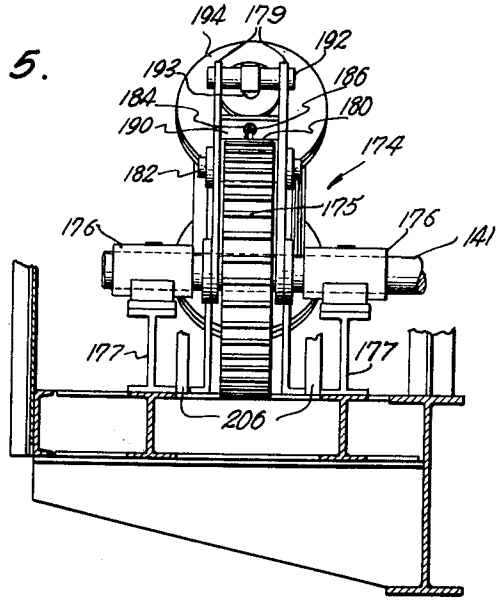


FIG. 5.



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3,193,084

PIPE HANDLING APPARATUS

Robert F. Bauer, Whittier, and Russell B. Thornburg, Torrance, Calif., assignors to Shell Oil Company, a corporation of Delaware, Continental Oil Company, a corporation of Delaware, The Superior Oil Company, a corporation of California, and Union Oil Company of California, a corporation of California, all of Los Angeles, Calif.

Original application Mar. 28, 1957, Ser. No. 649,099, now Patent No. 3,083,842, dated Apr. 2, 1963. Divided and this application Sept. 24, 1962, Ser. No. 225,744

4 Claims. (Cl. 198—137)

This invention provides pipe handling apparatus which is particularly suitable for use on a floating drilling vessel, and is a division of our co-pending patent application Serial No. 649,099, filed March 28, 1957, now U.S. Patent No. 3,083,842.

One of the problems in drilling an underwater well from a floating vessel is the handling of the large quantities of drill pipe necessary for the drilling operation, particularly in making trips in and out of the well with drill pipe. In conventional onshore drilling, the drill pipe is stacked in vertical sections or "stands" inside the derrick as trips are made in and out of the well. However, this procedure is not practical in drilling from a floating vessel because of the hazards presented by the pitching and rolling of the vessel due to wave action which is almost invariably present. Not only is there the danger of vertically stacked pipe shifting and causing injury or damage, but the vertical stacking of large quantities of drill pipe inside a derrick on a floating vessel would decrease the stability of the vessel.

This invention provides pipe handling apparatus for an almost fully automatic operation for racking and securely storing the drill pipe sections in a stable horizontal position when the pipe is not in use for drilling.

The apparatus permits successive sections of drill pipe to be moved quickly and safely from a horizontal position to a vertical position when drill pipe is being lowered into the well, and, conversely, permits successive sections of drill pipe to be lowered quickly and safely from a vertical to a horizontal position when drill pipe is being taken from the well.

Briefly, the invention contemplates pipe handling and racking apparatus which comprises a track adapted to extend from an inner end adjacent a drilling rig to an outer end remote from the rig. A carriage is adapted to travel on the track between an outer and an inner position to support a section of pipe. The apparatus also includes means to displace a section of pipe from a rest position along the track to a laterally displaced position.

In the preferred form, a pipe racking conveyor is disposed adjacent the track so that individual sections of pipe may be successively fed in a horizontal position from the racking conveyor on to the track, or conversely, from the track into the racking conveyor.

The pipe racking conveyor includes a pair of rotatable supports with an endless belt disposed around the supports. A plurality of pipe storage spaces are formed between adjacent pipe retainers which extend outwardly from the belt. Means are provided for moving the belt in either direction so that sections of pipe may be carried to or from the track.

When the apparatus is used on a floating vessel, the track preferably lies on the longitudinal center line of the vessel and a separate pipe racking conveyor is disposed on each side of the track. Means are provided for displacing a section of the pipe from the track to either racking conveyor. Also in the preferred form, each racking conveyor includes a pair of longitudinally spaced

belts and supports so that sections of pipe are supported at spaced locations.

These and other aspects of the invention will be more fully understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a plan view of the pipe racking apparatus mounted for use with pipe handling apparatus described and claimed in U.S. Patent No. 3,083,842.

FIG. 2 is a fragmentary transverse elevation, partly in section, taken on line 2—2 of FIG. 1 of one pipe racking conveyor, the track, and the carriage;

FIG. 3 is a view taken on line 3—3 of FIG. 2;

FIG. 4 is a side elevation taken on line 4—4 of FIG. 1 of the drive arrangement for the racking conveyor shown in FIG. 2;

FIG. 5 is a view taken on line 5—5 of FIG. 6;

FIG. 6 is a view taken on line 6—6 of FIG. 1 showing a ramp pipe stop used in transferring pipe from the track to the conveyor;

FIG. 7 is a view similar to FIG. 6, showing the ramp pipe stop used in transferring pipe from the conveyor to the track.

Referring to FIGS. 1 and 2, a racking conveyor 136 includes a pair of fore and aft spaced endless conveyor chain belts 138 which are each adapted to move in a direction perpendicular to the track. A plurality of sections of drill pipe (shown only in phantom line) extend horizontally and longitudinally across the belts and are supported and held securely on them. The upper and lower sections of each of the belts are adapted to be moved, as described in detail below, toward and away from the track so that horizontal sections of pipe may be carried either toward or away from the track. Since the construction and mounting of the conveyor belts in the racking conveyors are identical, only the aft chain in the starboard racking conveyor will be described in detail.

Referring to FIG. 2, the aft belt has its outboard portion disposed around a starboard drive sprocket 140 which is keyed to a rotatable starboard drive shaft 141 extending from the aft end of the track to the forward racking conveyor belt. The inboard end of the belt is disposed around an idler sprocket 142 adjacent the track and mounted on a longitudinal and horizontal idler shaft 143 which extends from the aft end of the track to the forward racking conveyor chain. The belt is made up of pairs of spaced links 144 pivotally connected end to end by link pins 146. A link pin roller 148 is mounted on each link pin between the link pairs. The link pin rollers are adapted to roll on upper and lower wearing strips 150, 151, respectively, mounted on the upper and lower surfaces of a transverse divider 152 which extends from the inner periphery of the idler sprocket to the inner periphery of the drive sprocket. Preferably, the structural divider is a pair of vertically spaced channel beams 153 opening toward each other and secured at each side to structural runners 154 which are a pair of spaced channel beams which each open outwardly away from the divider proper, and extend inwardly from the outer end of the divider past the idler sprocket to terminate adjacent the track. The structural runners are attached adjacent the track by a pair of support beams 155 to the upper flange of an I-beam 156 which extends across the floating vessel to support the aft chain belts for both the starboard and port racking conveyors.

An outside wearing strip 157 begins adjacent the track just below the idler shaft and is spaced from and curved to fit the contour of the belt around the lower portion of the idler sprocket. The outside wearing strip extends along and is welded to the top of the flange of I-beam 156 and is curved at its outboard end around the aft chain

drive sprocket and terminates at its upper end over the drive shaft. The outer end of the outside wearing strip is supported by a pipe conveyor cage **158**, which is secured to the outer end of the upper flange of I-beam **156**.

Each link of the belt has an outwardly extending pipe retainer **159** which has concave sides to fit the curvature of the drill pipe. A separate pipe retainer support roller **160** is mounted on a separate transverse shaft **161** secured at each end to each pair of pipe retainers. The pipe retainer support rollers are adapted to bear against the outside wearing strip.

Thus, adjacent pipe retainers form a storage space in which a section of drill pipe may be stored and securely held. As the chain belt moves around each sprocket, the adjacent links are pivoted with respect to each other and the pipe retainers are spread apart. The drill pipe is prevented from falling out of the outboard end of the chain belt by the outside wearing strip. As the chain is rotated so that its upper portion moves outboard and around the idler sprocket, the pipe retainers are successively spread and then closed, picking up successive sections of drill pipe which roll outboard after being displaced by the pipe throw-out arms on to an adjustable ramp **162**, which is set as shown in FIGS. 3 and 9. To move pipe in the other direction, the ramp is set as described below so that its inner end is lower than its outer end, and as the conveyor belt is moved so that its upper portion moves inboard and around the idler sprocket, the pipe retainers are successively spread open, permitting successive sections of pipe to roll inboard on the ramp and into the track where the aft end of the drill pipe comes to rest on the carriage at the rear of the track, and the forward portion of the drill pipes rests on the lifter roller.

The detailed construction and operation of the ramp can best be understood from reference to FIGS. 2, 6, and 7. The upper portion of the inner end of each runner **154** is cut away to form a notch **163** which has a transverse surface that extends outwardly and upwardly from adjacent the carriage track. The outboard end of a ramp arm **164** is connected by pivot **165** to the aft side of the upper portion of the aft runner **154** at the outboard end of notch **163**.

As shown most clearly in FIG. 6, the ramp arm extends inwardly and upwardly so that its inner end rests on a ramp support block **166** which in turn rests on the top of track **22**. The ramp support block is secured by a pivot **167** to the inner end and upper edge of aft runner **154**. As shown in FIG. 6, the ramp is set so that pipe will roll from the track to the racking conveyor.

To insure that a section of drill pipe remains in the proper position to be loaded on to the racking conveyor after being delivered on to the ramp from the track, even when the ship is rolling under heavy wave action, a pipe stop dog **168** is secured to a pivot **169** and disposed near an intermediate portion of the ramp arm. Pivot **169** extends perpendicular to the ramp arm and the forward end of pivot **169** is in a longitudinal slot **170** formed in the aft side of the ramp arm. The outboard end of the slot **170** turns downwardly and opens out the bottom of the ramp arm. Thus, pivot **169** can be slipped up into and down out of slot **170**. Pivot **169** is attached at its aft end to the inboard end and forward side of a stop arm **171** which is pivotally secured at its outboard end around the idler shaft. A tension spring **172** is connected at one end to the dog below pivot **169**, and at its other end to an intermediate portion of the stop arm. A dog stop **173** extends from the stop arm at a point just outboard of the outer end of spring **172** and terminates adjacent the lower end of dog **168**. Thus, as shown most clearly in FIG. 6, the upper end of the dog projects above the ramp arm and the lower end of the dog bears against the dog stop. When a section of drill pipe rolls down the ramp arm, the dog pivots in a clockwise direction (as viewed in FIG. 6) to permit the section of pipe to roll into the space between the dog and the adjacent pipe retainer on the racking conveyor belt. The tension spring returns the dog to the position shown in FIG. 6, and the pipe is held snugly in the position shown in phantom line until the pipe retainer conveyor belt can be actuated to move the upper portion of the belt in an outboard direction so that the section of pipe is then held between adjacent pipe retainers. This procedure is repeated until storage of pipe on the conveyor is completed.

When it is desired for pipe to move in the opposite direction, i.e., from the conveyor on to the track, the ramp arm **164** is lifted, the ramp support **166** is pivoted in a clockwise direction (as viewed in FIG. 6) so that it rests below the track, and the ramp arm is then lowered to rest on the upper edge of the track (see FIG. 7) so that pipe will roll from the racking conveyor on to the track and carriage as mentioned above.

When the ramp arm is to be lowered so that pipe can be discharged from the conveyor on to the track, the inner end of the ramp arm is raised sufficiently so that the pivot **169** slides out of slot **170**, and the stop arm and dog, and ramp support block are then lowered out of the way. The ramp arm is then lowered to rest on the track so that pipe can roll freely from the conveyor on to the track (see FIG. 7).

Referring to FIGS. 1, 4 and 5, a starboard conveyor drive **174** at the aft end of the starboard conveyor drive shaft is adapted to rotate the drive shaft and thereby move the racking conveyor belts to carry pipe toward or away from the track. The starboard conveyor drive includes a gear drive wheel **175** keyed to the aft end of the starboard conveyor drive shaft. The aft end of the starboard conveyor drive shaft is journalled in a pair of pillow blocks **176** mounted on each side of the gear drive wheel and supported by braces **177**. A conveyor drive lever **178** includes a pair of laterally spaced, inwardly and upwardly extending lever arms **179** which are pivotally attached at their lower ends on opposite sides of the conveyor drive wheel. A conveyor lever pawl **180** is mounted on a horizontal and longitudinal pivot **182** in an intermediate portion of the lever between the two lever arms. A compression pawl spring **184** is disposed around a pawl pin **186** which is pivotally attached at its outboard end to the upper end of a projection **187** on the center portion of the lever pawl. The inboard end of the pawl pin extends through an opening **188** in a block **190** welded between the two lever arms above the pawl. The pawl spring is compressed between the block and the projection on the pawl.

The upper end of the lever arms are connected by a horizontal and longitudinal pivot **192** to the upper end of a downwardly and inwardly extending conveyor drive piston **193** which is disposed in a pneumatic starboard conveyor cylinder **194** connected by a horizontal and longitudinal pivot **196** intermediate its ends to a pair of supports **198** on opposite sides of the cylinder. Pneumatic lines **200** and **202** are used to supply pressure to the outboard and inboard ends, respectively, of the cylinder so that the piston may be worked back and forth in the cylinder.

As shown in FIG. 4, the spring operated pawl is set to be urged by its spring in a counter-clockwise direction, so that its outboard end engages the teeth of the drive wheel, and as the lever is moved in a counter-clockwise direction, the drive wheel is rotated to carry pipe away from the track. Outboard and inboard adjustable stop screws **204** are mounted in abutments **206** on opposite sides of the lever to limit the amount of travel of the lever arm. As shown in FIG. 4, the stops are arranged so that the gear drive wheel can be rotated from its shown position about 65° in a counter-clockwise direction, which moves the starboard conveyor belts in a direction to carry pipe away from the track. To effect further rotation of the gear drive wheel after the lever abuts the outboard stop, the piston is forced back into

the cylinder and the pawl slides over the gear teeth to permit the lever to return to the position shown in FIG. 4. If the gear drive wheel is to be rotated in the opposite direction, the spring operated pawl is rotated manually in a clockwise direction (as viewed in FIG. 4) so the inboard end of the pawl pin passes through the center line of the pawl pivot, causing the pawl spring to urge the pivot in a clockwise direction so that the inboard tooth of the pawl engages the gear drive wheel teeth. In this position, as the lever piston is reciprocated, the gear drive wheel is turned in the clockwise direction, and the starboard racking conveyor belts are moved to carry pipe toward the track. The port conveyor drive shaft is powered by a port conveyor drive which is identical to that just described for the starboard conveyor.

The operation of the apparatus to move pipe from the racking conveyor to a drilling rig for lowering into a well is described in detail in U.S. Patent No. 3,083,842, and is not repeated here for brevity.

We claim:

1. Pipe handling and storage apparatus comprising a pair of rotatable shafts, a belt disposed around the shafts to form upper and lower sections of the belt, a plurality of spaced outwardly extending pipe retainers on the belt to form pipe storage spaces between adjacent retainers, an outside wearing strip disposed beneath the lower section of the belt, a roller at the outer end of each pipe retainer and adapted to ride on the wearing strip to transfer the pipe load from the lower portion of the belt to the wearing strip, and means for moving the belt.

2. Pipe handling and storage apparatus comprising a pair of rotatable shafts, a separate rotatable sprocket mounted on each shaft, an endless chain belt disposed around the sprocket to form upper and lower sections of the belt, a plurality of spaced outwardly extending pipe retainers on the belt to form pipe storage spaces between adjacent retainers, an outside wearing strip disposed beneath the lower section of the belt, a roller at the outer end of each pipe retainer and adapted to ride on the wearing strip to transfer the pipe load from the lower portion of the belt to the wearing strip, and means for moving the belt.

3. Pipe handling and storage apparatus comprising a pair of laterally spaced rotatable shafts, a first pair of sprockets mounted on one of the shafts, a second pair of sprockets mounted on the other shaft, a first endless chain belt disposed around one of each pair of the sprockets on the shafts, a second endless chain belt disposed around the other sprockets on the shafts, the belts each having upper and lower sections, a plurality of spaced outwardly extending pipe retainers on each belt to form pipe storage spaces between adjacent retainers, an outside wearing strip disposed beneath each lower section of each belt, a roller at the outer end of each pipe retainer and adapted to ride on one of the wearing strips to transfer the pipe load from the lower portion of a said belt to one of the wearing strips, and means for moving the belts together.

4. Pipe handling and storage apparatus comprising a pair of rotatable shafts, a belt disposed around the shafts to form upper and lower sections of the belt, a plurality of spaced outwardly extending pipe retainers on the belt to form pipe storage spaces between adjacent retainers, an outside wearing strip disposed beneath the lower section of the belt, a roller at the outer end of each pipe retainer and adapted to ride on the wearing strip to transfer the pipe load from the lower portion of the belt to the wearing strip, a discharge ramp adjacent the belt where it passes around one of the shafts, and means for moving the belt in either of two directions to move pipe in the storage spaces toward and away from the ramp.

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