Feb. 17, 1953 A. L. STONE 2,628,725

APPARATUS FOR RACKING PIPE IN DERRICKS

Filed Nov. 3, 1951 4 Sheets-Sheet 1

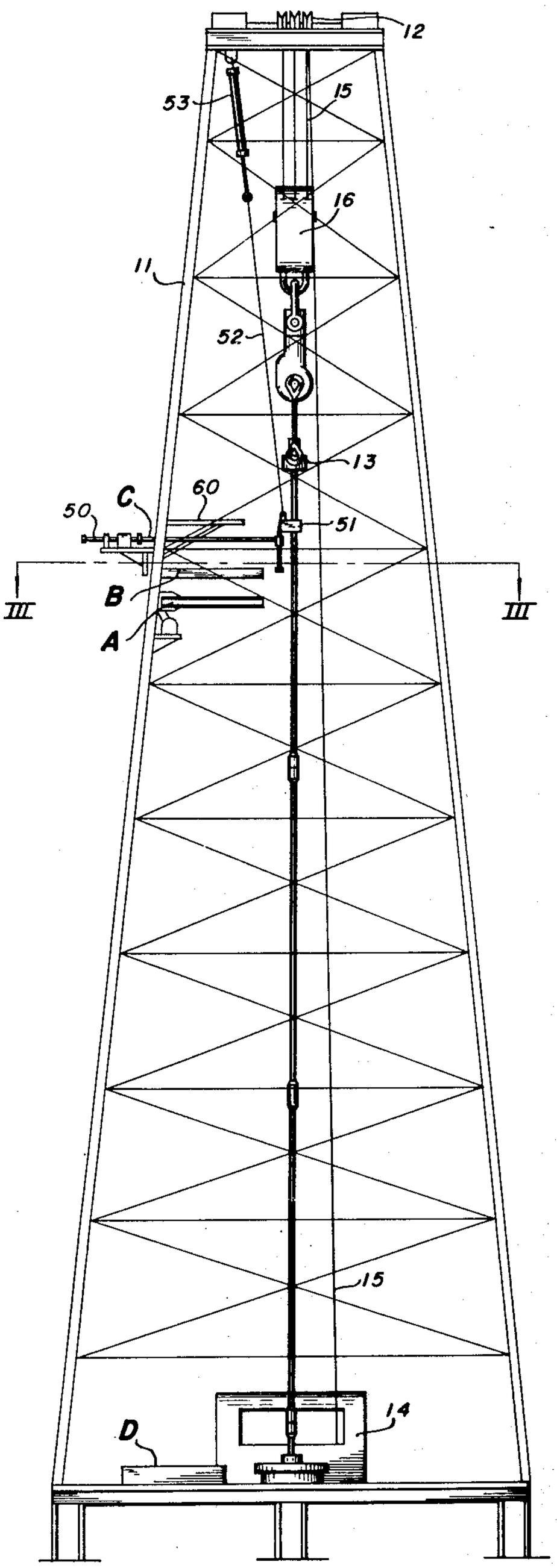

FIG. 1.

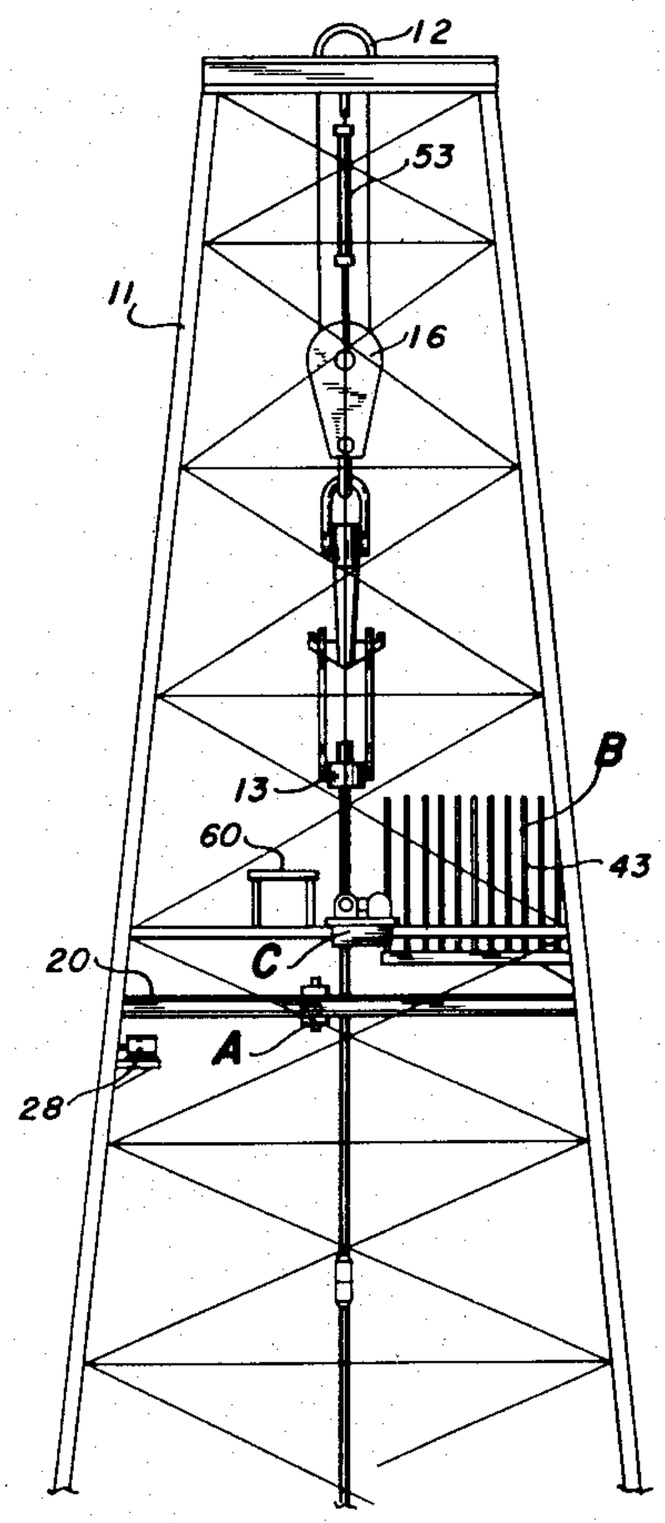

FIG. 2.

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APPARATUS FOR RACKING PIPE IN DERRICKS

Filed Nov. 3, 1951 4 Sheets-Sheet 2

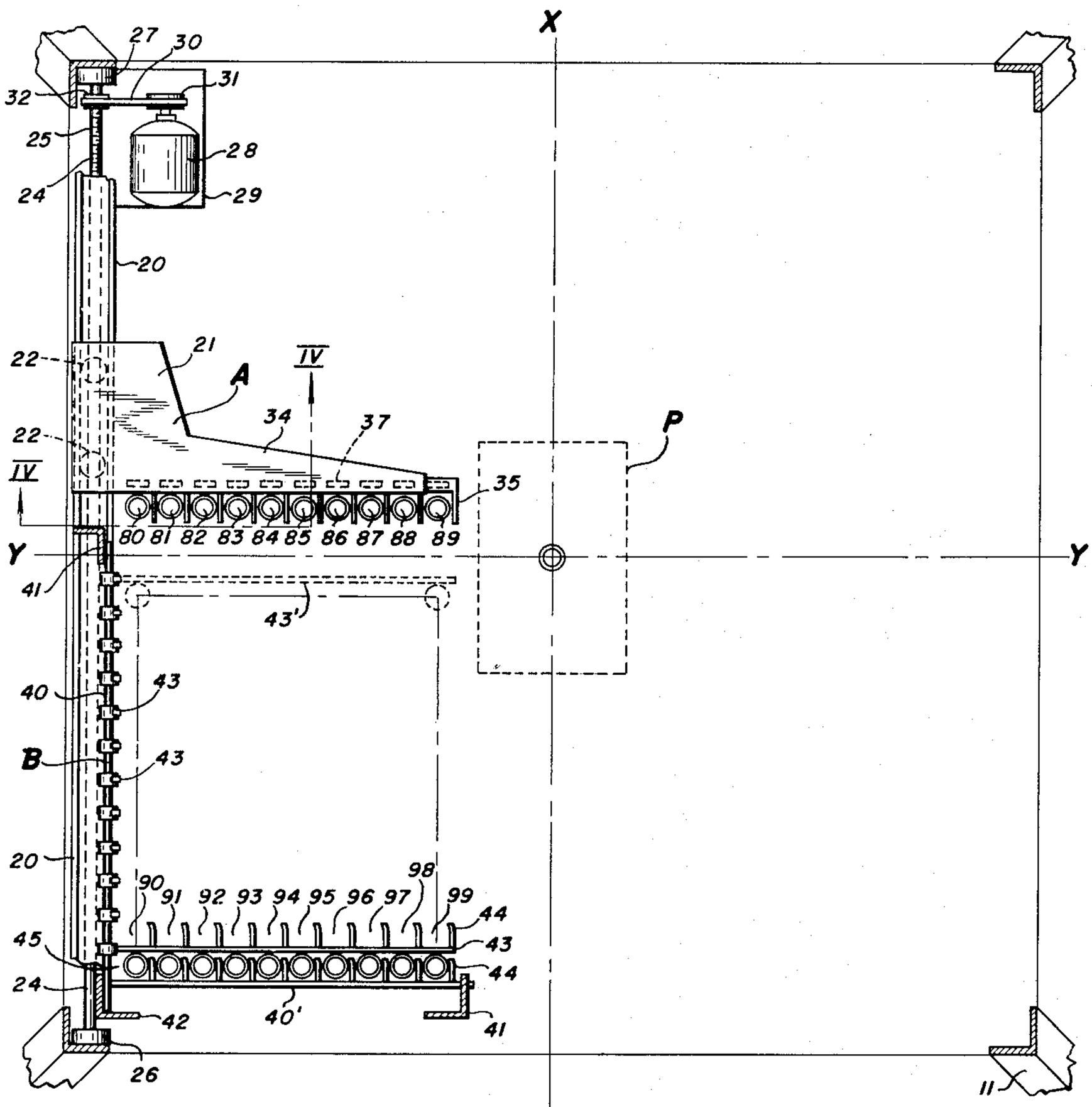

FIG. 3.

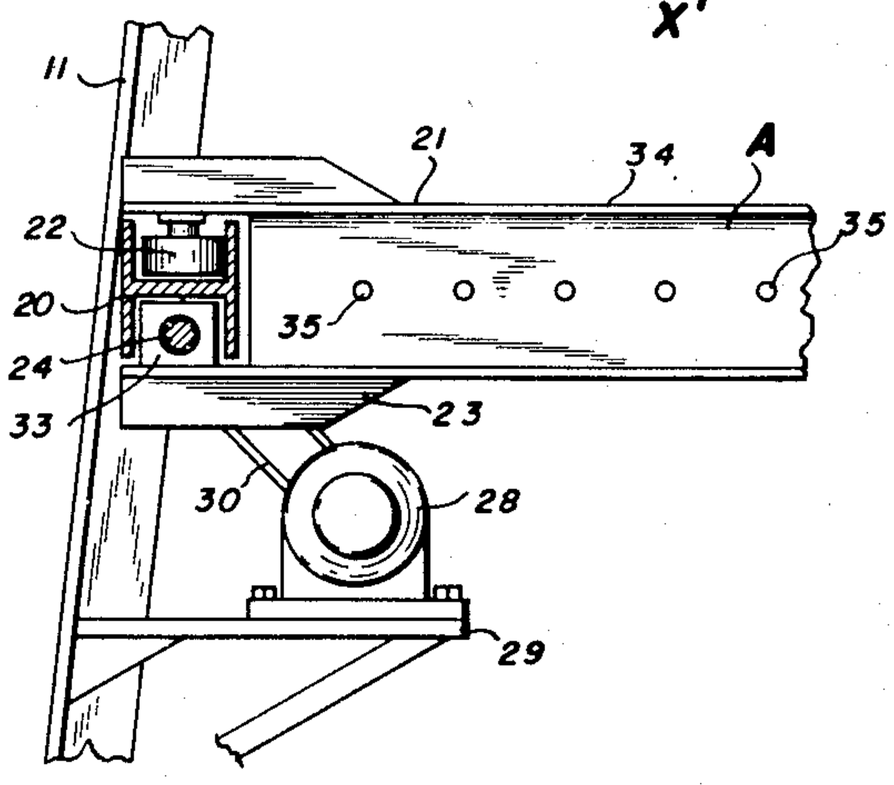

FIG. 4.

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APPARATUS FOR RACKING PIPE IN DERRICKS

Filed Nov. 3, 1951 4 Sheets-Sheet 3

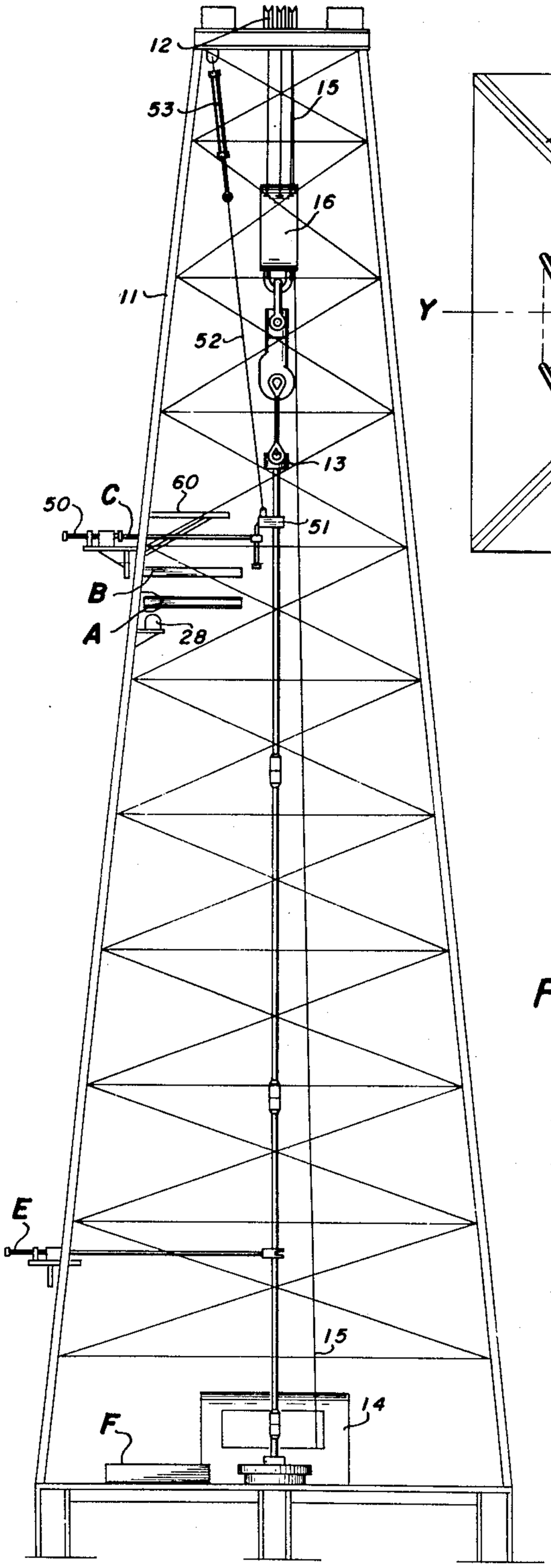

FIG. 5.

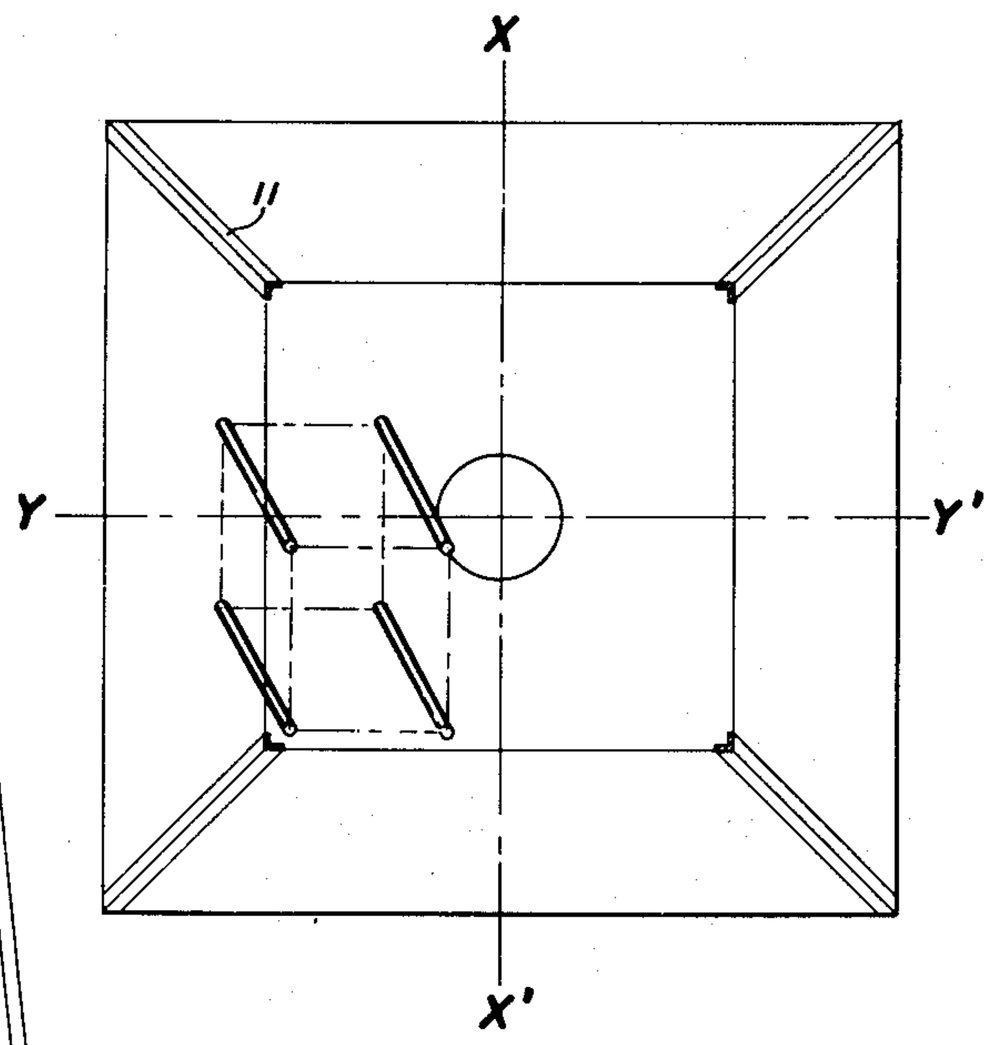

FIG. 8.

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APPARATUS FOR RACKING PIPE IN DERRICKS

Filed Nov. 3, 1951 4 Sheets-Sheet 4

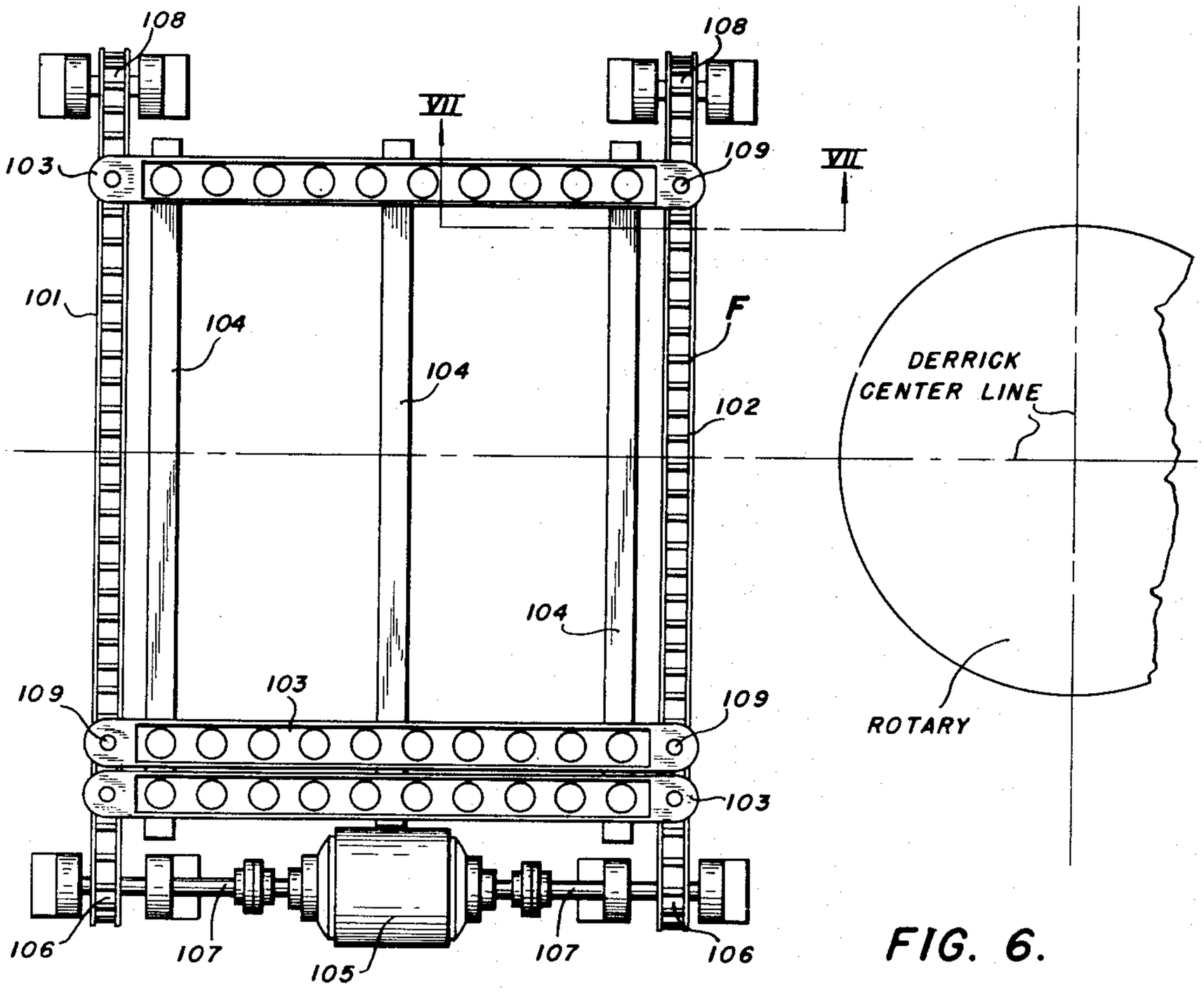

FIG. 6.

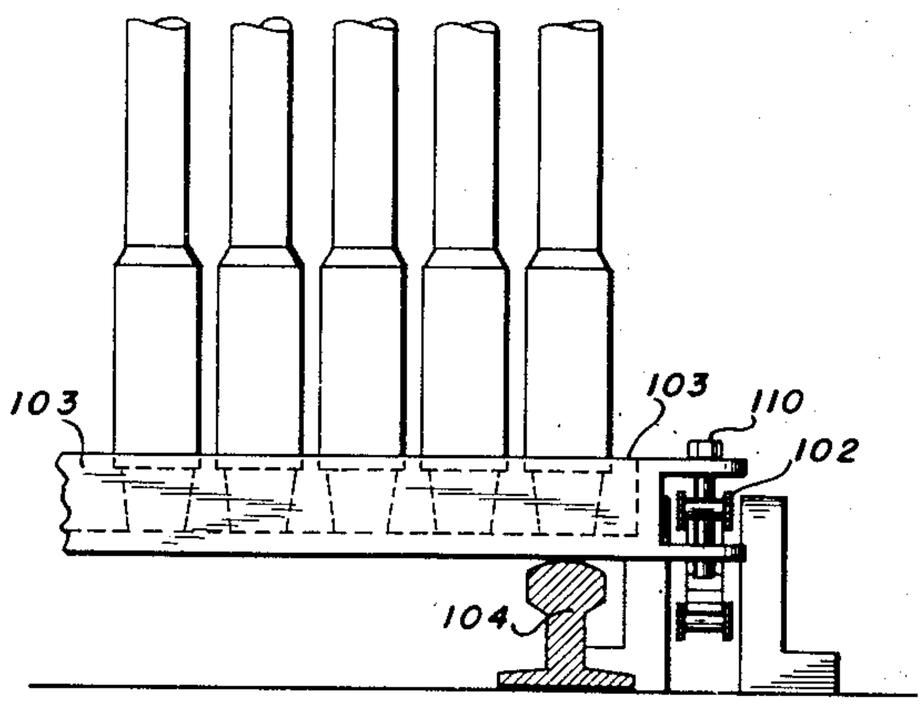

FIG. 7.

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Patented Feb. 17, 1953

2,628,725

UNITED STATES PATENT OFFICE

2,628,725

APPARATUS FOR RACKING PIPE IN DERRICKS

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Application November 3, 1951, Serial No. 254,782

4 Claims. (Cl. 214—2.5)

1

This application is a continuation-in-part of Serial No. 692,201, filed August 22, 1946, now abandoned.

The present invention is directed to apparatus adapted for handling pipe in a derrick.

In some commercial operations it is necessary to handle lengths of pipe or conduit in a derrick in a rapid, efficient manner. As an example, when drilling boreholes by the rotary drilling method, it is necessary to remove and replace the drill stem into the borehole a number of times during the course of the drilling operation. The drill stem is made up of joints of pipe with the ends fastened together by screw joints and in removing the drill stem from the hole it is customary to raise the drill stem until several connected joints (for example, three) of the drill pipe, which is called a stand, are above the derrick floor, to disengage the screw thread attaching the lower end of the stand to the remainder of the drill stem, to raise up the disconnected stand and move it over to one side of the derrick with its axis substantially vertical during the moving and racking operation, then to raise the drill stem until another stand of pipe is above the derrick floor, and to repeat the operation. In returning the drill pipe into the borehole the reverse procedure is used, with the pipe taken from its racking position a stand at a time, the stand moved over with its axis substantially vertical until its axis coincides with that of the borehole, the lower end of the stand connected with the portion of the drill stem in the hole, the drill stem then lowered until the upper end of the last connected stand is just above the derrick floor, and the operation repeated.

It will be understood that in drilling deep boreholes having a depth of the order of 10,000 to 15,000 feet, 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 satisfactory portion of the total time involved to be used in the operation of deepening the borehole.

The present application is directed to apparatus which enables pipe to be handled with its axis substantially vertical in an efficient and rapid manner.

The present invention may be described more specifically as involving an improved apparatus adapted to be employed in conventional drilling apparatus involving derrick drawworks, crown block and travelling block which enables this conventional apparatus to be employed in a more efficient manner and which also allows stands of

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pipe to be handled in a derrick conveniently and without requiring difficult manual labor.

The improved apparatus of the present invention may be described briefly as involving a lateral trackway, a transfer assembly mounted on a lateral trackway and a racking assembly. The lateral trackway is adapted to be mounted substantially horizontally in the drilling derrick substantially parallel to a side of the derrick. The transfer assembly is mounted on the trackway for movement between pipe receiving and pipe transferring positions. The transfer assembly has an arm extending horizontally and perpendicularly to the trackway, this arm having pipe receiving recesses for holding a row of stands of pipe. The racking assembly is adapted to be mounted in the derrick adjacent the trackway and perpendicular thereto and has a plurality of laterally spaced fingers which define open ended pipe receiving recesses. Each pipe receiving recess in the racking assembly is adapted to receive a stand of pipe from the row of stands in the transfer assembly upon movement of the transfer assembly along the trackway into pipe transferring relation to the racking assembly.

The present invention will now be described in greater detail in conjunction with the drawing in which

Fig. 1 is an elevation showing a drilling derrick with an embodiment of the present invention mounted therein;

Fig. 2 is a view of the upper portion of the apparatus of Fig. 1 taken at right angles to the view of Fig. 1;

Fig. 3 is a view taken along line III—III of Fig. 1;

Fig. 4 is a view taken along line IV—IV of Fig. 3;

Fig. 5 is an elevation showing another embodiment of the present invention;

Fig. 6 is a fragmentary top view showing on a larger scale a portion of the device of Fig. 5;

Fig. 7 is a view taken along line VII—VII of Fig. 6; and

Fig. 8 is a top view showing the relation of the pattern of racked pipe and the derrick in both the embodiment of Fig. 1 and that of Fig. 5.

Turning now specifically to the drawing and first to Fig. 1, a conventional derrick 11 has mounted at the upper end thereof a conventional crown block 12, elevators 13, a drawworks 14, a drilling line 15 connected to the drawworks to be moved thereby, and a travelling block 16 supported from the crown block by the drilling line and arranged to be raised and lowered along

the central vertical axis of the derrick by the operation of the drawworks. In the drawing the path of the travelling blocks is identified by dashed lines designated by letter P. In the plan views, one center line of the derrick is designated as X—X' and the center line at right angles thereto is designated as Y—Y'.

By way of illustration, but without intending it as a limitation of the invention, it may be stated that conventional derricks of a height of 136 feet are employed for drilling boreholes and the stands of the pipe handled in the derrick consist of there joints with a total length of approximately 90 feet. It may be mentioned that the stands of pipe are not uniform in length and the different stands of pipe being handled may have a variation of several feet in length. It may also be mentioned that the drawworks, crown block and travelling block must be of sufficient strength to raise the entire length of the drill stem, while the separate stands of pipe conventionally used, each weigh less than 2,000 pounds.

Mounted on derrick **11** is a pipe transfer assembly A, a permanent racking assembly B and a pipe handling and auxiliary elevator assembly C and a means for receiving the lower ends of the drill pipe when racked designated as D.

The pipe transfer assembly A has a track **20** extending horizontally along one side of the derrick with ends secured to corner members of the derrick by suitable means, not shown. A carriage **21** is provided with wheels **22** engaging with the upper edge of member **20** whereby the carriage may move in a direction parallel with the longitudinal axis of member **20**. A rod member **24** having its outer surface defining a screw thread **25** is mounted with its axis adjacent to and parallel with member **20**; the ends of rod member **25** are secured to corner members of the derrick by suitable journals **26** and **27**. A motor **28** is mounted on a stand **29** secured to the derrick by suitable means, not shown, and is arranged to rotate rod **24** through a suitable means, such as a belt **30**, driving pulley **31** and driven pulley **32**. A threaded nut **33** having threads arranged to mate with threads **25** of rod member **24** is mounted on rod **24** and is secured to carriage **21** by structural member **23** to prevent rotation thereof. It will be obvious that the arrangement of carriage **21**, track **20**, rod **25** and threaded nut **33** is similar to the conventional arrangement of a lathe carriage and that rotation of the drive pulley **31** in a given direction will cause lateral movement of carriage **21** in one direction, while reversal of the direction of rotation of the drive pulley **31** will cause lateral movement of carriage **21** in the reverse direction.

The carriage **21** includes an elongated member **34** which extends horizontally with its axis parallel to the center line Y—Y' and defines an edge parallel with the aforesaid center line, in which are arranged pin members **35** which are spaced and extend at right angles to the longitudinal axis of portion **34**; it will be seen that the arrangement of members **34** and **35** resembles somewhat the appearance of a rake or comb. The spaces defined by members **34** and **35** are designated as **80** to **89**, inclusive, and are each adapted to receive a single stand of drill pipe; the embodiment in the drawing will be seen to provide spaces for receiving 10 stands of drill pipe.

The carriage **21** is provided with means for retaining the separate stands of drill pipe within

storage spaces **80** to **89**. By way of example, the carriage is shown as provided with a plurality of electromagnets **37**, with each electromagnet mounted on member **34** and adjacent a storage space; the use of electromagnets is well known to the art and it will be obvious that a stand of drill pipe may be maintained within a storage space by the electromagnet when desired and may be released from the space when desired. It is to be understood that the showing of electromagnets for this purpose is solely for the purpose of illustrating a suitable embodiment, and that other means, such as permanent magnets or mechanical linkages, may be employed for releasably retaining stands of drill pipe within the storage spaces.

The permanent racking assembly B for receiving stands of drill pipe from pipe transfer assembly A includes a horizontally extending member **40** attached to structural member **41** and to the corner **42** of the derrick. In addition, it includes horizontally extending member **40'** also secured to a structural member **41** and corner **42** of the derrick. Spaced rod members **43** are mounted on member **40** and are adapted to pivot on member **40** from a horizontal to a vertical position. Member **40'** and each member **43** is provided with a plurality of prongs **44**. It will be seen that the spaced prong members **44** form storage spaces. These spaces correspond to those defined by the pipe transfer assembly A. The storage spaces defined by member **40'** are designated **90** to **99**, inclusive, while those defined by members **43** are designated as **45**. In the drawing, the members **43** are shown of such dimensions as to define 12 storage spaces **45** and member **40'** defines 10 storage spaces; a member **43'** is arranged to hold the last row of pipes in member **43** to prevent accidental displacement of the stands in the last row. The 11 members **43** and member **40'** define storage spaces capable of storing a total of 120 stands of drill pipe. The pipe in storage will be seen to be clear of the path P followed by the travelling blocks as they are moved vertically in the derrick.

The pattern of the racked drill pipe in the derrick is shown in Fig. 8 where a pipe is shown at each corner of the pattern with the upper ends of the pipes connected by dashed lines to form a rectangle and the lower ends are similarly connected. It will be seen that each stand of drill pipe has its upper end leaning toward the center of the derrick along a line parallel to center line Y—Y' of the derrick and away from the center of the derrick in a direction parallel to the center line X—X'. The leaning of the pipe in the manner shown allows the drill pipe to be secured to the assembly A by electromagnets **37** and upon release of the drill pipe from assembly A, they lean in such a position that they are retained within the racking assembly B by the force of gravity. Similarly, when removing pipe from racking assembly B by pipe transfer assembly A, a row of stands of pipe may be locked to assembly A with electromagnets **37** and moved parallel with center line X—X'.

The assembly C for supporting and guiding stands of drill pipe in the derrick consists of a pipe racker arm **50** which is provided with pipe engaging means in the form of an auxiliary elevator **51** which grips the pipe to support the weight thereof. The auxiliary elevator **51** is supported by a cable **52**, the upper extremity of which is connected to the piston of a fluid ac-

tuated cylinder 53. It will be evident that assembly C is capable of supporting these connected stands of pipe while they are being moved between transfer assembly A and the center line of the derrick and while they are being made up or broken out from the drill string. While a stand of drill pipe is being supported and moved by assembly C, it is necessary that the movement of its lower end be controlled. In the embodiment of Figs. 1 to 4 the lower end of the pipe may be controlled by a man on the derrick floor. Pipe handling apparatus of the type described forms the subject matter of my copending application Serial No. 5,843, entitled "Apparatus for Racking Pipe in a Derrick," filed February 2, 1948, which has been replaced by application Serial No. 254,781, filed November 3, 1951.

It is conventional to the art to provide means for steadying the upper end of each stand of pipe as it is being disconnected from the remainder of the drill stem in a hole and also when it is being connected to the drill stem in a hole. This steadying force may be supplied by assembly C. However, if desired, such a force may be applied by a derrickman stationed on monkeyboard 60 which may be secured to the derrick by conventional means not shown. This arrangement of the monkeyboard places the derrickman in convenient position for releasing elevators 13 in the drill stem, and for engaging elevators 13 with the drill stem.

It will be apparent that after the stand of drill pipe has been disconnected from the drill stem, it is necessary to move the disconnected stand of pipe from the center line of the derrick to a position adjacent pipe transfer assembly A. This is accomplished by the use of assembly C. In disconnecting a stand, the joint may be broken and then spun out by conventional tongs and spinner, not shown in the drawing. After the joint is spun out, the weight of the stand is taken through auxiliary elevator 51, cable 52 and cylinder 53 and the stand is raised until the lower end of the stand clears the string of pipe in the hole. Assembly C may then move the stand of pipe laterally until it is adjacent that pipe receiving space of assembly A in which the stand of drill pipe is to be placed. The stand is then lowered until its lower end rests on mat D and the derrickman guides the upper end of the pipe the short distance necessary to place it into the selected pipe receiving space of assembly A. After a row of stands of pipe has been placed in position in pipe transfer assembly A, the assembly A is moved so as to place the upper ends of the pipe in the permanent racking assembly B.

In the operation of coming out of the hole the pipe transfer assembly A will initially be empty as will the permanent racking assembly B. The first stand of pipe disconnected from the drill stem will be moved over by means of pipe handling assembly C and the stand set adjacent position 80 of assembly A with its lower end resting on rack D. The derrickman will then hold the upper end of the pipe and upon its being released by assembly C will move it into position 80. The next stand of pipe set over will be placed in position 81 and the subsequent stands in positions 82, 83, 84, 85, 86, 87, 88, and 89 in sequence. When the assembly A has been filled with stands of pipe the carriage 21 will be moved to place the drill pipe into spaces 90, 91, 92, 93, 94, 95, 96, 97, 98, and 99, respectively, of racking assembly B.

After these spaces have been filled, the member 43 adjacent member 40' is placed in position

to receive the drill pipe, the pipe transfer assembly A filled with another row of pipe and again moved over to place the stands of pipe in spaces 45 of this member and the operation subsequently repeated.

When going into the hole with the drill stem, the procedure described will be reversed with pipe transfer assembly A receiving stands of drill pipe from storage spaces 45 of member 43 farthest removed from member 40', the assembly A moving these stands laterally until the row approximates center line Y—Y' of the derrick, the stands of the pipe removed from assembly A one at a time and transferred by assembly C to the center of the derrick where the lower end of the stand is screwed to the upper end of the drill stem in the hole. After the stands of drill pipe have been taken from pipe transfer assembly A, assembly A is moved laterally to racking assembly B to receive another row of stands of pipe and the operation repeated.

Another embodiment of the present invention is shown in Figs. 5, 6, and 7. This embodiment differs from that previously described in providing vertically spaced assemblies for controlling the movement of the stand of pipe in the derrick and movable racks for receiving the lower ends of the stand of drill pipe placed in the pipe transfer assembly. Movable stands are adapted to be moved along the derrick floor to a permanent position similar to the movement of the upper end of the pipe produced by pipe transfer assembly A.

In the device of Figs. 5, 6, and 7, inclusive, the derrick and the assemblies A, B, and C are identical with the device previously described so that the description of these parts will not be repeated. Lower racker assembly E controls the lower end of a stand of pipe so that its upper end may be supported and guided by assembly C and its lower end guided by assembly E in moving it between the center of the derrick and to the side thereof. Lower pipe racker assembly E is secured to the same side of the derrick as pipe handling assembly C. Lower pipe racker assembly E, as well as upper pipe handling assembly C, forms the subject matter of my copending application Serial No. 5,843, entitled "Apparatus for Handling Pipe in a Derrick," filed February 2, 1948, which has been replaced by application Serial Number 254,781, filed November 3, 1951. A device F is provided on the floor of the derrick for receiving the ends of a row of sections of drill pipe whose upper ends are to be placed in pipe receiving assembly A. In the embodiment shown in the drawing, assembly F consists of driving chains 101 and 102 with movable trays 103 arranged to be slid along rails 104 mounted adjacent the derrick floor. A prime mover 105 is arranged to drive sprockets 106 through shafts 107. Idler sprockets 108 are arranged to provide a fixed path for the chains. The ends of the trays are provided with openings 109 for receiving pins 110. As will be seen by reference to Fig. 7, the trays 103 are arranged to receive the lower ends of a row of sections of the drill pipe.

When utilizing the apparatus shown in Figs. 5, 6, and 7 when removing a drill stem from a borehole, the pipe receiving assembly A is arranged to receive the upper ends of a row of drill pipe and a tray 103 is arranged to receive the lower ends of said row of pipe. A stand of drill pipe has its upper end supported and guided by assembly C and its lower end guided by assembly E as it is moved from the center

of the borehole over to a position adjacent that identified as pipe 89 in Fig. 3. With its upper end supported by assembly C, its lower end is released from assembly E and is then guided by a man on the derrick floor as it is lowered into position in tray 103. Its upper end is then released and guided by the derrickman into position 89. The process is repeated until a row of pipe is arranged with the upper ends of the section of pipe in the pipe transfer assembly A and the lower ends supported by the tray. Assembly A and the tray are then moved simultaneously or separately to put the row of pipe in permanent racking position at which time assembly A is disengaged from the row while the tray 103 remains in position as the support for the lower ends of the pipe sections. The assembly A is then returned to its initial position and another tray 103 is placed in position to receive another row of pipe and the process repeated until all the pipe has been permanently racked. When returning the drill stem to the borehole the procedure is reversed.

It will be seen that the present invention is directed to an assembly for handling drill pipe including a derrick provided with drawworks, crown block and travelling block. Mounted in the derrick for movement parallel to one side thereof is a pipe transfer assembly adapted for receiving a row of stands of drill pipe. Also mounted in the derrick at approximately the same level as the pipe transfer assembly is a rack adapted to receive rows of stands of drill pipe from the pipe transfer assembly.

The apparatus of the present invention enables pipe to be handled in a derrick in a rapid and convenient manner. When coming out of a borehole the equipment allows stands of drill pipe to be disconnected from the remainder of the drill stem, and the disconnected stand to be moved out of the path of travel of the travelling blocks. The travelling blocks may then be started downwardly to start its cycle of raising the drill stem in the borehole to expose another stand of pipe at the same time the disconnected stand of pipe is being placed in the pipe transfer assembly. After the pipe transfer assembly has been filled it may be moved laterally to place the stands of pipe in the rack in a final position. Similarly, when connecting stands of drill pipe to the drill stem, as when going into the hole, the apparatus of the present invention allows a row of stands in the rack to be moved laterally by the pipe transfer assembly until approximately at the center line of the derrick and then allows each stand of pipe to be moved from the pipe transfer assembly to the center of the derrick and connected thereto while utilizing the several parts of the equipment effectively.

While specific embodiments of the apparatus of the present invention have been disclosed, it will be evident to a workman skilled in the art that various changes may be made without departing from the scope of the invention.

Having fully described and illustrated the practice of the present invention, what is desired to be claimed as new and useful and is to be secured by Letters Patent is:

1. Means for handling pipe in a derrick comprising, in combination, a lateral trackway adapted to be mounted substantially horizontally in the derrick substantially parallel to a side of the derrick, a transfer assembly mounted on said trackway for movement therealong between pipe receiving and pipe transferring positions, said transfer assembly comprising an arm extending substantially horizontally and substantially perpendicular to said trackway, said arm having means adapted to receive and laterally support a row of stands of pipe, means for moving said transfer assembly along said trackway, a racking assembly comprising a plurality of laterally spaced fingers cooperating to define open ended pipe receiving recesses and means supporting said fingers in substantially horizontal positions substantially parallel to said trackway, each of said recesses being adapted to receive a stand of pipe from said row of stands in said transfer assembly upon movement of said transfer assembly along said trackway into pipe transferring relation to said racking assembly.

2. An assembly in accordance with claim 1 in which means adapted to be supported by the derrick floor is arranged for receiving a row of pipe coinciding with that received by the transfer assembly.

3. Means for handling pipe in a derrick comprising, in combination, a lateral trackway adapted to be mounted substantially horizontally in the derrick substantially parallel to a side of the derrick, a transfer assembly mounted on said trackway for movement therealong between pipe receiving and pipe transferring positions, said transfer assembly comprising an arm extending substantially horizontally and substantially perpendicular to said trackway, said arm having a plurality of rods projecting therefrom at right angles thereto substantially parallel to said trackway and spaced to define a plurality of openings each arranged for receiving a single stand of drill pipe, a plurality of magnets mounted on said arm with each magnet adjacent one of the openings defined by the rod members, means for moving said transfer assembly along said trackway, a racking assembly comprising a plurality of laterally spaced fingers cooperating to define open ended pipe receiving recesses and means supporting said fingers in substantially horizontal positions substantially parallel to said trackway, each of said recesses being adapted to receive a stand of pipe from said row of stands in said transfer assembly upon movement of said transfer assembly along said trackway into pipe transferring relation to said racking assembly.

4. An assembly in accordance with claim 3 in which a lower pipe receiving assembly adapted to be supported by the derrick floor is arranged for receiving the lower ends of the row of pipe received by the transfer assembly and for moving them in a direction parallel to the direction of movement of the upper ends by the transfer assembly.

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No references cited.