Dec. 11, 1956 F. D. DE JARNETT 2,773,605

PIPE RACKING APPARATUS

Filed Nov. 12, 1953 6 Sheets-Sheet 1

Fig. 1

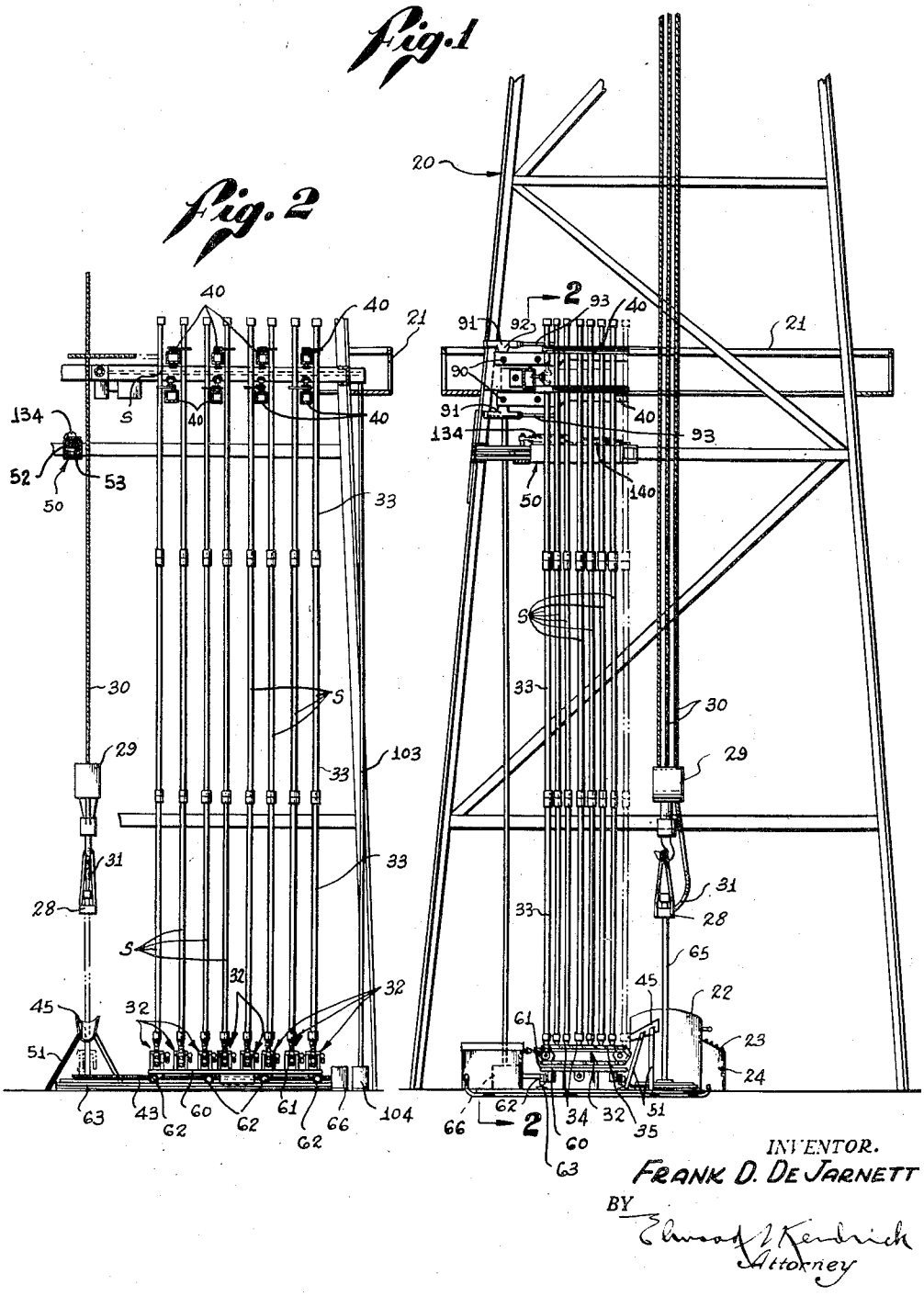



Fig. 2




INVENTOR.
FRANK D. DE JARNETT
BY
Edward J. Kenbrick
Attorney

Dec. 11, 1956 F. D. DE JARNETT 2,773,605

PIPE RACKING APPARATUS

Filed Nov. 12, 1953 6 Sheets-Sheet 2

Fig. 3

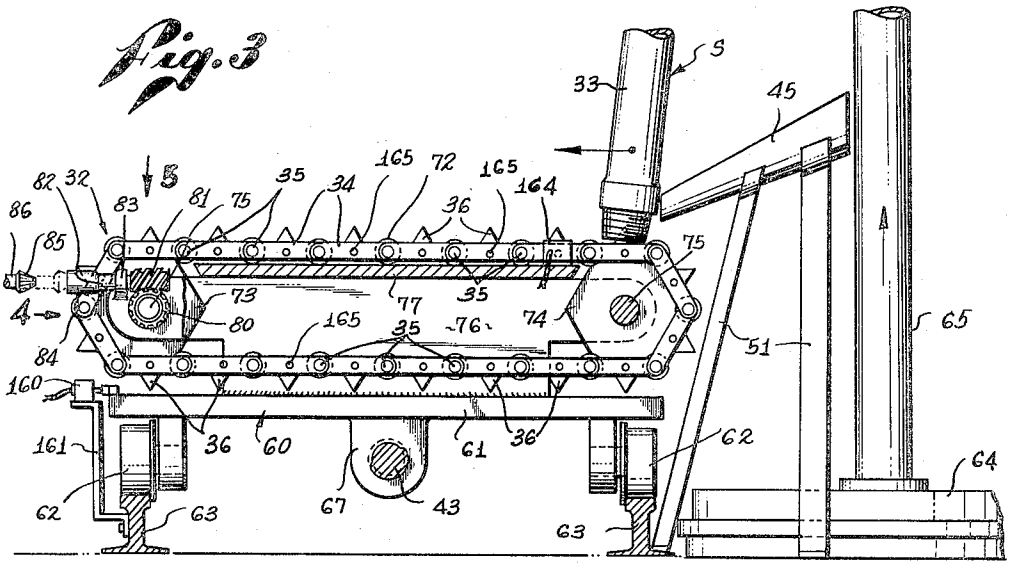



Fig. 5

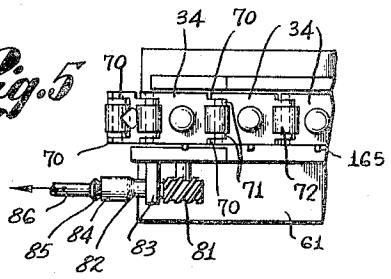
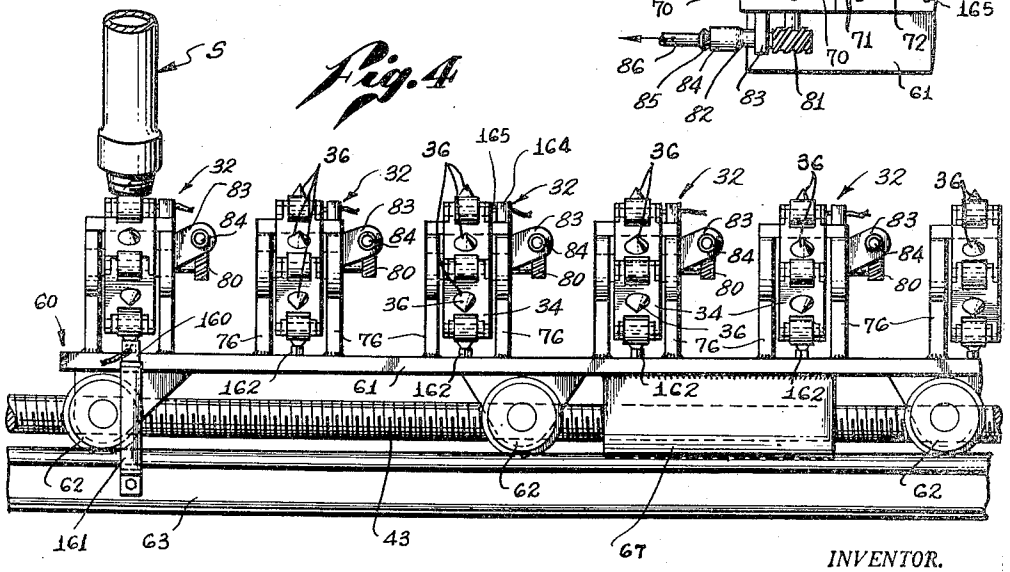



Fig. 4

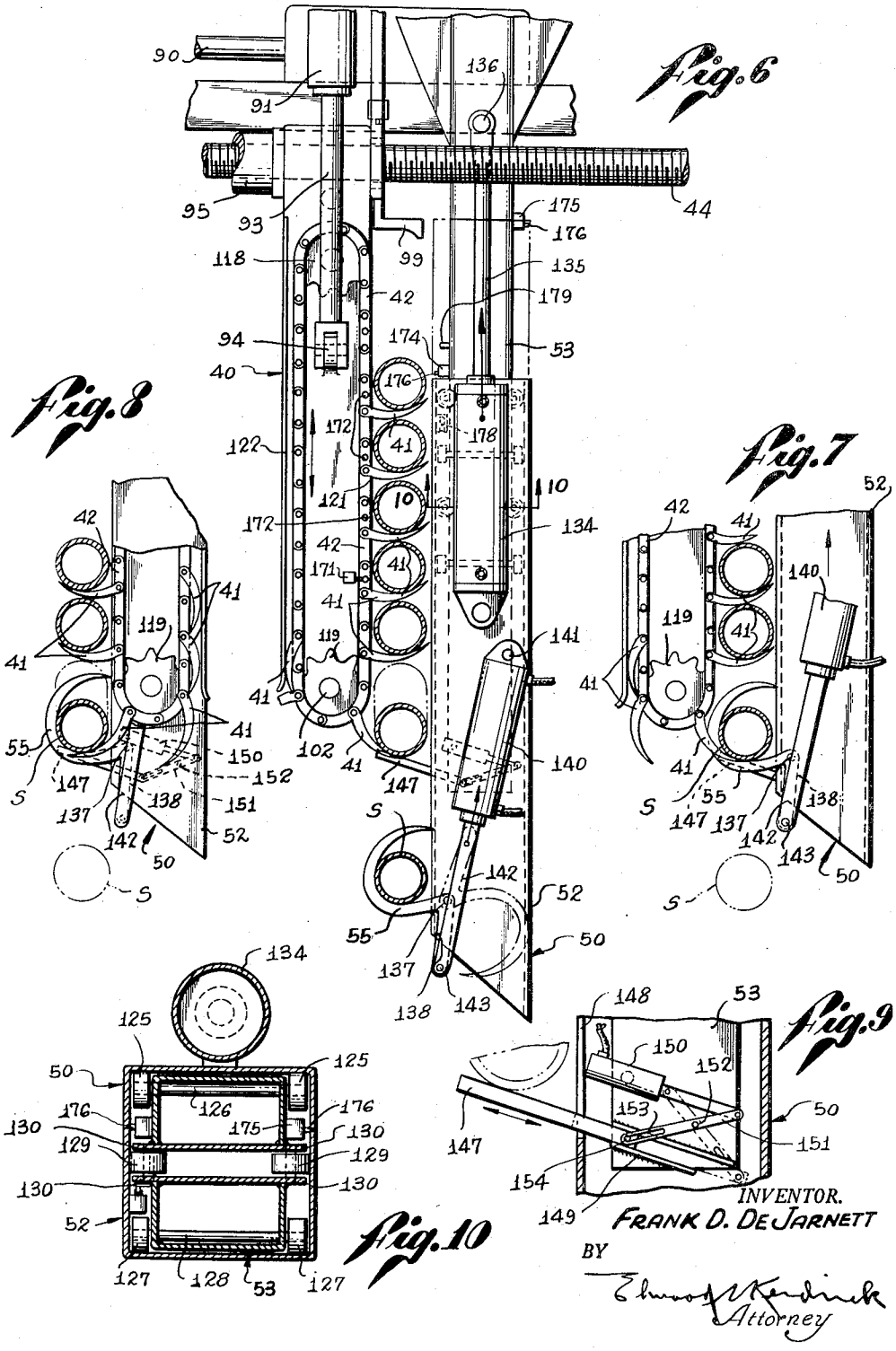



INVENTOR.
FRANK D. DE JARNETT
BY
Elmer J. Kendrick
Attorney

Dec. 11, 1956 F. D. DE JARNETT 2,773,605

PIPE RACKING APPARATUS

Filed Nov. 12, 1953 6 Sheets-Sheet 3

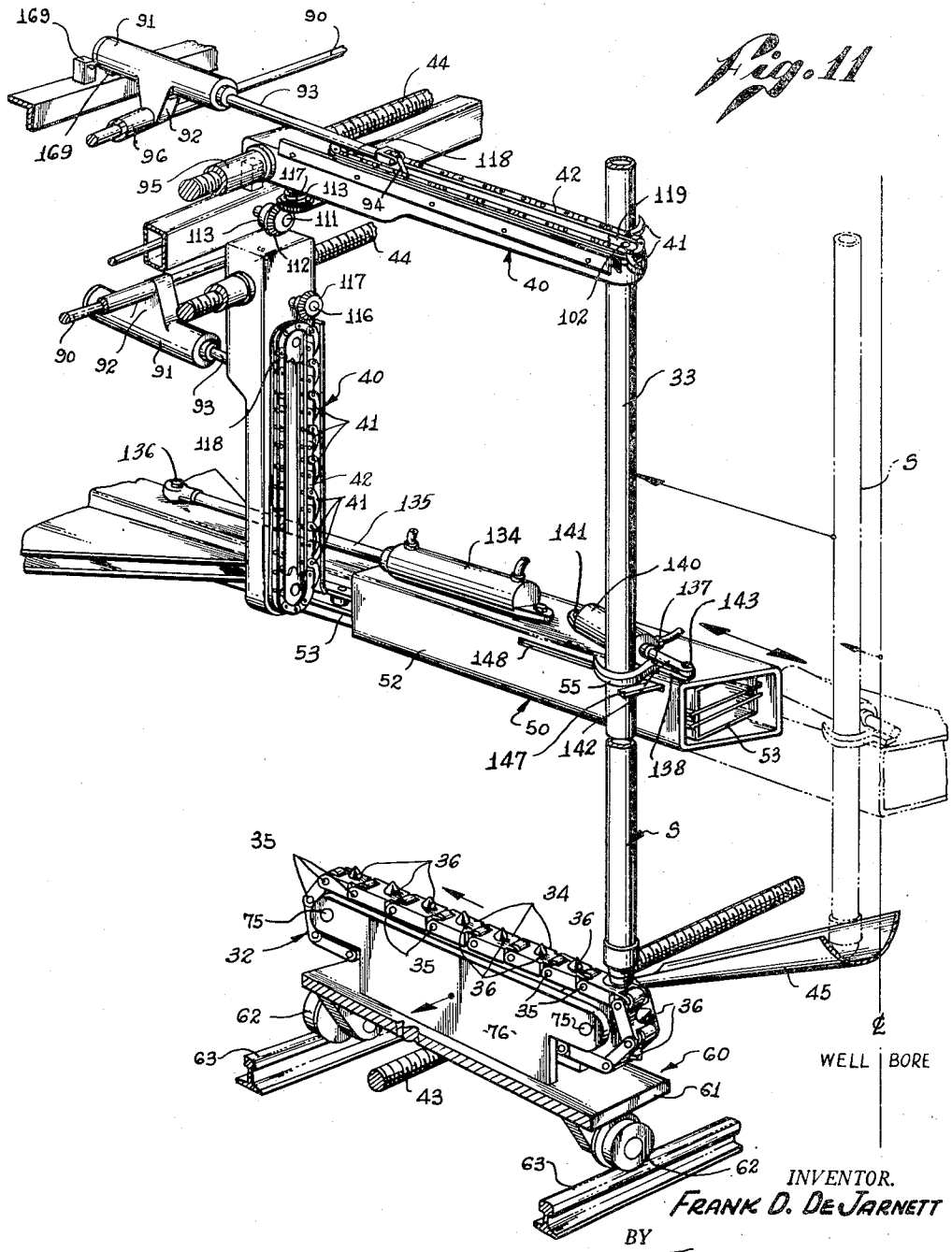


Dec. 11, 1956 F. D. DE JARNETT 2,773,605

PIPE RACKING APPARATUS

Filed Nov. 12, 1953 6 Sheets-Sheet 4

Fig. 11




INVENTOR.
FRANK D. DE JARNETT
BY
Edmund McKendrick
Attorney

Dec. 11, 1956 F. D. DE JARNETT 2,773,605

PIPE RACKING APPARATUS

Filed Nov. 12, 1953 6 Sheets-Sheet 5

Fig. 12

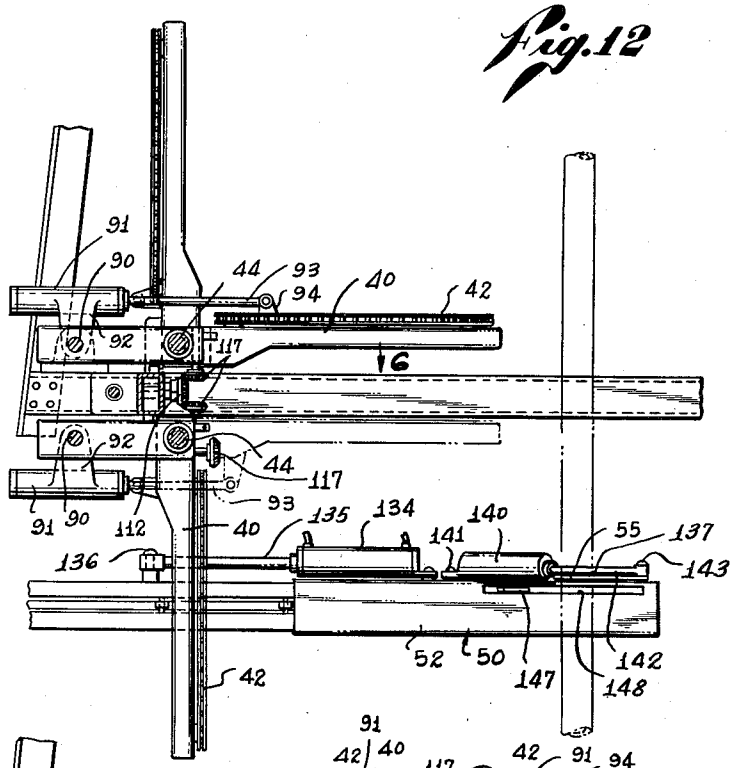
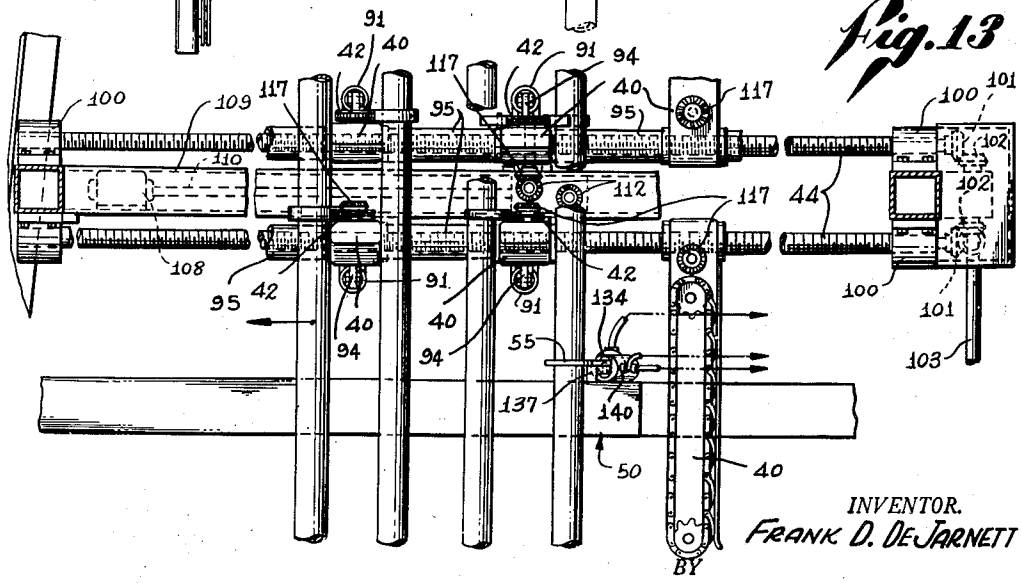



Fig. 13




INVENTOR.
FRANK D. DE JARNETT
BY
Edmund Kendrick
Attorney

Dec. 11, 1956 F. D. DE JARNETT 2,773,605

PIPE RACKING APPARATUS

Filed Nov. 12, 1953 6 Sheets-Sheet 6

Fig. 14

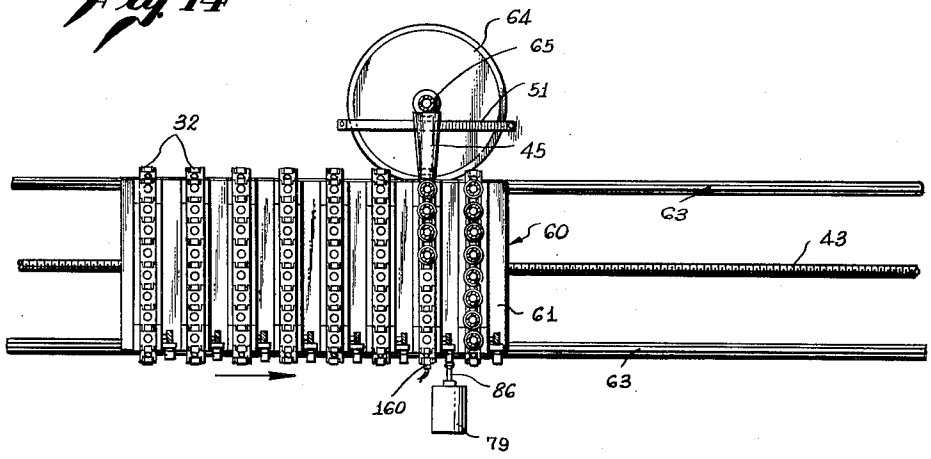
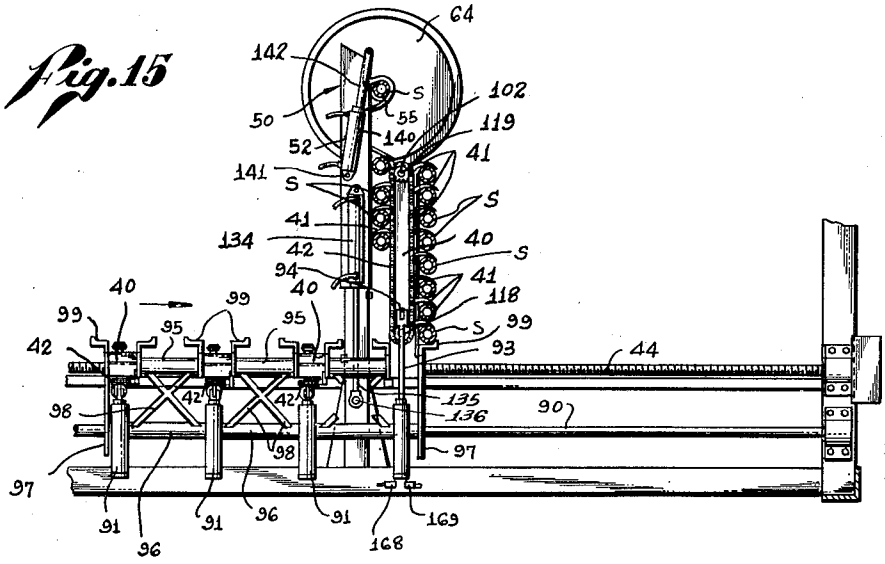



Fig. 15




INVENTOR.
FRANK D. DE JARNETT
BY
Elwood V. Kendrick
Attorney

United States Patent Office 2,773,605 Patented Dec. 11, 1956



2,773,605

# PIPE RACKING APPARATUS

Frank D. De Jarnett, Barcelona, Venezuela, assignor of one-half to Paul A. Medearis

Application November 12, 1953, Serial No. 391,682

33 Claims. (Cl. 214—2.5)

This invention relates to devices for handling pipe at an oil well and more particularly pertains to apparatus for racking sections or stands of pipe.

In oil well drilling operations, a drill stem or string of drill pipe is progressively lowered into the well bore by adding successive sections or stands of pipe to the upper end of the string and the drill stem is withdrawn progressively by removing successive sections or stands of pipe from the upper end. The sections or stands of pipe that are out of the well bore are stored or racked in a manner to make them readily available for reassembly to the drill stem. The drill stem must be assembled and disassembled in this manner repeatedly in the course of drilling an oil well for the purpose of changing drill bits and for other purposes. Since actual progress in drilling must be suspended at such times, it is highly desirable to carry out the procedure with the greatest rapidity.

The general object of the invention is to provide power-actuated apparatus for racking stands of pipe of any desired length in upright position and in an orderly and expeditious manner with minimum labor cost. A further object is to provide such apparatus that is largely automatic for simplified operation and control of the apparatus.

With a power-actuated racking apparatus having automatic features, the time required to change a drill bit may be drastically reduced and, in addition, the crew required for the operation may be greatly reduced. Under prevailing practices, a minimum crew of five men is required but the apparatus of the invention makes it possible to reduce this minimum to two men, namely, the driller and the operator of the racking apparatus.

Broadly described, the objects of the invention are attained by a plurality of power-actuated lower support units to support the lower ends of the stands of pipe, in combination with a corresponding plurality of power-actuated upper rack units to engage upper portions of the stands, each pair of lower and upper units holding one row of pipe. Each unit has one end adapted either to receive pipe withdrawn from the well bore or to relinquish pipe that is to be returned to the well bore, and each unit is adapted to shift the stands of pipe successively from said receiving end to the opposite end and vice versa. Thus, a row of pipe may be accumulated progressively by feeding successive stands of pipe to the receiving ends of a pair of lower and upper units, and, subsequently, the row of pipe may be unracked progressively by successive removal of the stands of pipe from the same ends of the units.

To rack pipe in such pluralities of paired lower and upper units and subsequently to unrack the pipe, it is merely necessary to provide means to shift the pipe back and forth between the region of the axis of the well bore and the receiving ends of the cooperating pairs of upper and lower units. Various expedients may be used for this purpose in various practices of the invention.

For example, the combination disclosed in my Patent 2,643,005 (which is hereby included in the present disclosure by reference), may be used to shift stands of pipe back and forth between the region of the axis of the well bore and the receiving ends of the cooperating pairs of units. This combination comprises a laterally shiftable crown block, a stabilizer and a transfer crane. The crown block is first aligned with the axis of the well bore to lift pipe from the bore and then is shifted laterally away from the axis for the down trip of the elevator. In pulling a drill stem, the stabilizer holds the elevated stand of pipe released by the elevator with the stand positioned substantially on the axis of the well bore and the transfer crane shifts the stand from this position to a stored or racked position while the traveling crown block is moving downward to lower the elevator. In like manner, in reassembling the drill string, the transfer crane shifts the racked stands of pipe laterally out of racked positions to the stabilizer for joining to the drill stem and for subsequent engagement by the elevator to lower the drill stem. The crown block takes a position on the axis of the well bore for lowering the drill stem into the well bore and shifts laterally away from the axis for the return upward trip of the elevator, thus avoiding interference with the concurrent functioning of the stabilizer and transfer crane.

In the preferred practice of the present invention, I simplify the problem of transferring pipe to and from the receiving ends of the cooperating pairs of lower and upper units by providing power means to move the units relative to a position or station conveniently near the axis of the well bore. Thus the cooperating pairs of the lower and upper units move successively to a station for receiving or relinquishing pipe and this station is so close to the axis of the well bore that only relatively simple means is required to shift stands of pipe back and forth between the station and the well bore axis. A further object of the preferred practice of the invention is to provide such pipe shifting means.

The various features, objects and advantages of the invention will be understood from the following detailed description of the presently preferred practice of the invention, this description being considered with the accompanying drawings.

In the drawings, which are to be regarded as merely illustrative:

Fig. 1 is a side elevation of the lower portion of an oil well derrick illustrating the preferred practice of the invention;

Fig. 2 is a similar elevation as viewed from the line 2—2 of Fig. 1;

Fig. 3 is a view of one of the lower support units, the view being partly in section and partly in side elevation;

Fig. 4 is an elevation of the plurality of lower support units as viewed in the direction of the arrow 4 of Fig. 3;

Fig. 5 is a plan view of a portion of a lower support unit, the portion being indicated by the arrow 5 in Fig. 3;

Fig. 6 is a plan view of one of the upper rack units together with an associated pipe shifting means;

Fig. 7 is a fragmentary view similar to Fig. 6 showing the mechanism at a different stage of operation;

Fig. 8 is a similar fragmentary view illustrating the manner in which the pipe shifting means cooperates with some of the operating upper rack unit;

Fig. 9 is an enlarged fragmentary view showing an auxiliary retractable part associated with the operation of the pipe shifting means;

Fig. 10 is a transverse section on an enlarged scale of a portion of the pipe shifting means taken as indicated by the line 10—10 of Fig. 6;

Fig. 11 is a perspective view of selected parts of the apparatus showing a cooperating pair of lower and upper units and associated means for shifting stands of pipe

between the receiving ends of the two units and the region of the axis of the well bore;

Fig. 12 is a side elevation of the plurality of upper rack units and the pipe shifting means that cooperates therewith;

Fig. 13 is an elevation of the same upper rack units and associated pipe shifting means viewed as indicated by the arrow **13** in Fig. 12;

Fig. 14 is a plan view of the plurality of lower support units; and

Fig. 15 is a plan view of the upper rack units together with the pipe shifting means associated therewith.

*General arrangement*

Figs. 1 and 2 show an oil well with the usual derrick **20** having the usual elevated catwalk **21**. Fig. 1 shows the usual housing **22** for the power plant that actuates the rotary drill and adjacent thereto shows a panel **23** on a control cabinet **24** for the convenience of the operator of the racking apparatus of the present invention. Also shown in Figs. 1 and 2 is an elevator **28** suspended in the usual manner from a traveling block **29**.

It is contemplated that the elevator **28** will be of the power-actuated type, that is remotely controlled from the derrick floor. Preferably the elevator **28** and the associated traveling block **29** will be constructed as taught in my co-pending application Serial Number 245,898, entitled, Power-Elevator for Oil Wells, filed September 10, 1951, and now Patent No. 2,684,166 (which prior disclosure is hereby included in the present disclosure by reference). In accord with that disclosure, the movement of the traveling block **29** relative to the cable **30** stores power in the form of compressed air and the compressed air is transmitted to the elevator **28** through an air hose **31** for actuation of the elevator under remote control.

At a low level inside the derrick **20** is a plurality of lower support units **32** each of which is capable of supporting a row of stands S of pipe, there being in this instance eight stands per row. Each of the stands S of pipe is shown as comprising three lengths or sections of pipe **33** screwed together.

As best shown in Fig. 11, each of the lower support units **32** may have a series of support elements **34** pivotally interconnected by pins **35** in the manner of a sprocket chain. Each support element **34** may be provided with a conical boss **36** to enter and thereby engage the lower end of a stand of pipe. Fig. 11 shows in full lines a stand S on the first support element **34** at what may be termed the receiving end of the support unit. This is the end of the support unit **32** at which stands of pipe are received successively from the well bore in the course of withdrawing the drill stem and also is the end at which the racked stands of pipe are relinquished successively for return to the well bore in the procedure of reassembling the drill stem. When a stand S of pipe has been received by a support element **34** at the receiving end of a support unit **32**, the chain of support elements is advanced one step away from the receiving end to bring the next support element in position to receive the succeeding stand of pipe. In this manner, each of the lower support units **32** is loaded progressively to accumulate a complete row of the stands of pipe. Subsequently, the stands of pipe of the row are unloaded from the support unit in a similar step-by-step manner, the chain of support elements being shifted towards the receiving end of the support unit one step each time a stand of pipe is removed from the receiving end.

At a higher level on the derrick, in this instance at approximately the level of the catwalk **21**, is a plurality of upper rack units **40** corresponding to the lower support units **32**, there being one upper rack units paired with each lower support unit to cooperate therewith in the racking of one row of the stands of pipe.

As shown in Fig. 6 each of the upper rack units **40** has a series of pipe-engaging members **41** in the form of curved fingers to engage the individual stands of pipe. The curved fingers **41** are carried by a sprocket chain **42**. In racking pipe in the course of pulling a drill stem, each succeeding stand of pipe is shifted to the receiving end of a rack unit **40** and the sprocket chain **42** of the unit is advanced one step to cause one of the fingers **41** to engage the newly presented stand of pipe. Thus each of the upper rack units **40** is loaded and unloaded progressively in similar manner to the corresponding lower support unit **32**.

As heretofore indicated, preferably the problem of transferring pipe from the region of the axis of the well bore to the receiving ends of the cooperating pairs of lower and upper units is simplified by providing for the two pluralities of units to be shifted in succession to corresponding receiving stations for racking or unracking a row of stands of pipe. For this purpose, all of the lower support units **32** may be moved in unison by means including a long screw **43** and the upper rack units **40** may be moved in unison by an upper pair of parallel screws **44**.

Any suitable means may be provided for shifting the stands S of pipe back and forth between the region of the axis of the well bore and the receiving ends of a pair of units, with the receiving end of the lower unit at the lower receiving station and the receiving end of the upper unit at the upper receiving station. In the present embodiment of the invention, for example, what may be termed a guide chute **45** is provided to displace the lower ends of the stands of pipe from the region of the well bore axis to the lower receiving station and what may be termed a pipe shifting means **50** is associated with the upper plurality of rack elements **40** to shift the upper portions of stands of pipe to the upper receiving station.

The guide chute **45** is a suitably inclined trough member supported by legs **51**, the trough member being relatively wide at its upper end and narrowing somewhat at the lower end that is adjacent the lower receiving station.

The pipe shifting means **50** includes a box-like housing **52**, best shown in Fig. 11, which is mounted on a cantilever beam **53** for longitudinal reciprocation thereon. The reciprocative housing **52** carries a pipe engaging means in the form of hook **55** which may be actuated by remote control to engage and release the successive strands of pipe. When the housing **50** is moved outward on the beam **53** to the dotted line position in Fig. 11, the hook **55** may be operated to engage a stand of pipe at the axis of the well bore and then the housing **50** may be retracted under power to draw the stand of pipe towards the upper receiving station for the upper rack units **40**.

In a typical operation of the apparatus for racking stands of pipe in the course of withdrawing a drill stem from the well bore, the elevator **28** is used to lift the drill stem in the manner shown in Fig. 1 and when three sections of the drill pipe are above ground, the drill stem is engaged by slips in the usual manner to permit the exposed stand of pipe to be unscrewed. The stand of pipe released from the drill stem is then lifted by the elevator **28** to bring the lower end of the stand slightly above the guide chute **45**.

The pipe shifting means **50** is then extended to permit the hook **55** thereon to engage the suspended stand of pipe at the axis of the well bore and to displace the stand of pipe towards the two receiving stations. As the pipe shifting means **50** causes this lateral displacement of the stand of pipe, the elevator **28** is lowered to bring the bottom end of the stand of pipe into contact with the guide chute **45** and the lower end of the stand of pipe slides down the chute to be guided thereby. The lower end of the pipe slides into engagement with the conical boss **36** of the support element **34** at the receiving end of the particular lower support unit **32** that

is at the lower receiving station. As the upper portion of the laterally moving stand of pipe approaches the upper rack of unit **40** at the receiving station, the sprocket chain **42** of the rack unit is advanced one step to cause one of the fingers **41** at the receiving end of the rack unit to engage the stand of pipe. The hook **55** of the pipe shifting means **50** is then released from the stand of pipe in preparation for repeating the cycle of operation to rack the next succeeding stand of pipe.

When a lower support unit **32** and the corresponding upper rack unit **40** are completely loaded with a row of stands of pipe in this manner, the lower screw **43** is actuated to bring the next empty lower support unit **32** to the lower receiving station and in like manner the upper pair of screws **44** are actuated to bring the next empty upper rack **40** to the upper receiving station.

The unracking of the stands of pipe in the reassembling of the drill stem is carried out by substantially the same steps in reverse sequence. With the drill stem in the well bore supported by slips, the pipe shifting means **50** is retracted to the receiving end of an upper rack unit **40** at the upper receiving station and the hook **55** is actuated to engage the stand of pipe. The sprocket chain **42** of the rack unit is actuated one step to release the stand of pipe from the rack unit and simultaneously the pipe shifting means **50** is extended outward to swing the upper end of the stand of pipe into the region of the axis of the well bore to permit the remotely controlled elevator **28** to engage the stand of pipe. The hook **55** is then released from the stand of pipe and the elevator **28** is raised to bring the lower end of the pipe upward sufficient to clear the guide chute **45**. During this upward movement of the stand of pipe, the lower end of the stand rides frictionally up the guide chute so that the guide chute serves as means to stabilize the suspended stand of pipe and to minimize the tendency of the suspended stand to swing like a pendulum. The elevator **28** is then lowered to permit the stand of pipe to be screwed to the drill stem and is again lowered to lower the drill stem in accord with the newly added pipe.

*The lower support units*

As shown in Figs. 3, 4 and 14, the plurality of lower support units **32** may be mounted on a carriage, designated as a whole by numeral **60** which comprises a platform **61** supported by a series of flanged wheels **62** on a pair of rails **63**. The path of the carriage **60** along the rails **63**, relative to the bore hole of the well may be understood by reference to Fig. 14 where it can be seen that the carriage is movable to bring any one of the lower support units **32** into position at the lower receiving station adjacent the lower end of the guide chute **45**. It will be noted that the receiving station is immediately adjacent the periphery of the rotary table **64** and is positioned radially across the table from the region of the drill stem **65** in the well bore.

The previously mentioned screw **43** that controls the movements of the plurality of lower support units **32** is suitably journaled in a position extending longitudinally under the carriage **60** and is energized by a suitable motor **66** (Fig. 2). On the under side of the carriage **60** is welded a threaded body **67** in engagement with the threads of the screw **43**. The threaded body **67** serves as a traveling nut to control the position of the carriage.

Each of the series of linked support elements **34** carried by each support unit **32** is a flat metal body which, as best shown in Fig. 5, is formed at one end with a pair of relatively widely spaced ears **70** and is formed at the other end with two ears **71** at lesser spacing. The more widely spaced ears **70** at the end of each support element **34** straddles the less widely spaced ears **71** of the next adjacent support element, both pairs of ears engaging the same connecting pin **35**. Preferably a sleeve **72** is journaled on each pin **35** between the two inner ears **71**. Thus the series of support elements **34** form a continuous sprocket chain with the conical bosses **36** thereon turned outward. This sprocket chain is looped around the two spaced hexagonal sprocket wheels **73** and **74** that are mounted on shafts **75** journaled in two parallel upright side plates **76**. The side plates **76** are welded to the platform **61** and are interconnected by a top plate **77** which serves as a support for the upper run of the series of interlinked support elements **34**.



Any suitable arrangement may be provided for actuating the series of support elements **34** on each lower support unit **32**. For example, a motor **79** may be positioned adjacent the path of the carriage **60**, as shown in Fig. 14, and adapted to make releasable operative connection with the sprocket wheel **73** of each support unit when the support unit is at the receiving station. For this purpose the shaft **75** that carries the hexagonal sprocket wheel **73** of each support unit **32** may be provided with a worm wheel **80** (Figs. 3, 4 and 5) in mesh with a worm gear **81**. The bevel gear **81** is on one end of a short shaft **82** journaled in a bearing **83** on the side of the lower support unit and the other end of this small shaft forms a ribbed clutch socket **84** to receive and cooperate with a conical clutch member **85** on the end of a drive shaft **86**. The drive shaft **86** extends horizontally from the motor **79** and is adapted to shift longitudinally between a retracted disengaged position shown in full lines in Fig. 3 and an extended position shown in full lines in Fig. 5 at which extended position the conical clutch member is engaged in the clutch socket **84** to actuate the hexagonal sprocket wheel **73** and thereby actuate the series of interlinked support elements **34**.

*The upper rack units*

The plurality of upper rack units **40** are arranged in a first upper row pivotally mounted on the upper screw **44** and a second lower row pivotally mounted on the lower screw **44**, the rack units being freely pivotal without engagement with the threads of the screws. Positioned on substantially the same level as the upper screw **44** and parallel thereto is a fixed rod **90** to support a series of power cylinders for the upper row of rack units and in like manner a second fixed rod **90** is positioned parallel to the lower screw to carry a second series of power cylinders for the lower row of rack units.

As best shown in Figs. 11 and 12, each of the power cylinders **91** is formed with an integral supporting bracket **92** that is slidingly mounted on one of the fixed rods **90**. Each power cylinder has a forwardly extending piston rod **93** which is pivotally connected to an integral wing **94** of the corresponding rack **40** so that extension and retraction of the piston rod will swing the rack unit between a horizontal racking position and a substantially vertical idle position. As may be seen in Fig. 12, the rack units of the upper row on the upper screw **44** swing upward to their retracted idle positions and the rack units of the lower row swing downward to their retracted idle positions.

The rack units **40** of the upper row are confined laterally by what may be termed a carriage assembly and in like manner the rack units of the lower row are confined by a second carriage assembly. Each of the two carriage assemblies includes a series of sleeves **95** on the corresponding screw **44** spacing the rack units apart and a corresponding plurality of sleeves **96** on the associated fixed rod **90** to serve as spacers for the corresponding power cylinders. At each end of each carriage assembly is an end member **97** having apertures to receive the corresponding screw **44** and fixed rod **90**. The series of sleeves **95** on the screw and the corresponding series of sleeves **96** on the rod, together with the two end members **97**, are interconnected in a unitary manner by frame work that includes diagonal frame members **98** (Fig. 15). United with this framework is a guard arm **99** adjacent each rack unit **40** to protect the corresponding screw **44** from accidental impact by the racked stands of pipe. At

least one of the sleeves **95** is internally threaded for engagement with the threads of the corresponding screw **44** to serve as a traveling nut for moving the carriage assembly and thereby moving the corresponding row of rack units **40** in unison.

As shown in Fig. 13, the two screws **44** are journaled in bearings **100** on the derrick and are provided with bevel gears **101**. The two bevel gears **101** mesh with corresponding bevel gears **102** that are actuated by an upright drive shaft **103**. The lower end of the drive shaft **103** is actuated by a motor **104** (Fig. 2) on the derrick floor. Thus energization of the motor **104** causes both of the carriage assemblies to move in unison.

For energization of the racking mechanism of the rack units **40** when the rack units are at the upper receiving station, a suitable motor **108** may be mounted on a horizontal hollow beam **109** that extends parallel to the two screws **44** between the two levels of the two carriage assemblies. The motor **108** is operatively connected to a longitudinal shaft **110** inside the hollow beam and this shaft in turn is operatively connected to two short counter shafts **111** each of which carries a driving bevel gear **112** outside the hollow beam. One of these driving bevel gears **112** is positioned to actuate the mechanism of an upper row rack unit **40** at the receiving station and the other positioned to actuate the corresponding lower row racking unit **40** at the receiving station. Each of the two driving bevel gears **112** is operatively connected with the corresponding counter shaft **111** by means of an electrically actuated clutch **113** which effects an operative connection only when desired. When the motor **108** is not energized, each of the driving bevel gears **112** is freely rotatable.

Each of the rack units **40** has a shaft **116** with a bevel gear **117** thereon positioned to cooperate with the corresponding driving bevel gear **112** that is driven by the motor **108**. Thus, as may be seen in Fig. 11, when a rack unit **40** of the upper row is swung downward from its idle vertical posistion to its horizontal racking position, the bevel gear **117** of the unit is brought into mesh with the corresponding driving bevel gear **112** for actuation of the rack mechanism of the rack unit. The shaft **116** of each rack unit that carries the bevel gear **117** is operatively connected by irreversible worm gearing to a sprocket **118** for actuating the sprocket chain **42** of the unit. As best shown in Fig. 6, the sprocket chain **42** passes around the drive sprocket **118** and also around an idler sprocket **119** which is mounted on a shaft **102** at the outer receiving end of the rack unit.

The various pipe engaging fingers **41** carried by the sprocket chain **42** are continually urged outward away from the sprocket chain by concealed springs so that each finger tends to take an extended position at which a stop shoulder **121** of the finger backs against the sprocket chain, the sprocket chain serving as a stop to limit the outward movement of the finger.. Each of the rack units **40** has an operating side where the fingers **41** are fully extended to engage stands S of pipe and has a blind side where the fingers are retracted. On the blind side of each rack unit is guard plate **122** positioned adjacent the sprocket chain **42** to serve as means to cause the fingers **41** to be folded back against the sprocket chain in opposition to the concealed springs that are associated with the fingers.

The two rows of upper rack units **40** differ with respect to their operating sides. Thus, as viewed in Fig. 2, the fingers **41** of the upper row of rack units **40** extend to the right, the left sides of the units being the blind sides, and the fingers **41** of the lower row extend to the left, the right sides of the lower row of units being the blind sides.

*The pipe shifting means*

As heretofore stated, the pipe shifting means **50** includes a box-like housing **52** that is mounted on a cantilever beam **53** for longitudinal reciprocation thereon. As



shown in Figs. 10 and 11, the cantilever beam **53** may be of hollow construction and may incorporate suitable rollers for supporting the surrounding housing **52** in a freely movable manner. In the construction shown, the rollers for cooperation with the housing **52** include upper pairs of rollers **125** on spaced axles **126**, lower pairs of rollers **127** on lower spaced axles **128** and spaced pairs of side rollers **129** journaled in side flanges **130** of the hollow beam.

The longitudinal movements of the housing **52** on the beam **53** are controlled by a power cylinder **134** that is suitably mounted on the upper side of the housing. The power cylinder **134** has a rearwardly extending piston rod **135** which is connected to a fixed pin **136** at the fixed end of the beam **53**.

The previously mentioned hook **55** that is adapted to releasably engage stands S of pipe is mounted on a pivot **137** and has an integral operating arm **138**. For actuation of the hook **55**, a power cylinder **140** is pivotally mounted on the upper side of the housing **52** by suitable pivot means **141**. The power cylinder **140** has a forwardly extending piston rod **142** that is pivotally connected by a pin **143** to the end of the operating arm **138**. Extension of the piston rod **142** will cause the hook **55** to swing around a stand S of pipe and hold the stand in confinement against the side of the housing **52** as shown in full lines in Fig. 6; and retraction of the piston rod **142** will swing the hook out of the way into the retracted position shown in dotted lines in Fig. 6.

Preferably the cantilever beam **53** is provided with a retractable bar or auxiliary finger **147** which serves a purpose to be explained later. The auxiliary finger **147** extends through a slot **148** in the side of the reciprocative housing **52** and at its inner end is slidingly mounted in a guide channel **149** inside the beam **53**. The finger **147** is controlled by a pivotally mounted solenoid **150** inside the beam which may be energized to cause the finger to retract. A concealed spring inside the solenoid structure urges the finger to its normal outward position when the solenoid is not energized. The solenoid is operatively connected to one arm of a lever **151** that is mounted on a suitable pivot means **152**. The other arm of the lever **151** has a slot **153** to slidingly engage a headed pin **154** on the inner end of the finger **147**. It is apparent that energization of the solenoid to retract its pivotal connection with the lever **151** will cause the finger **147** to be drawn into the beam **53**.

The various power cylinders associated with the rack units **40** and the two power cylinders of the pipe shifting means **50** may be either pneumatic or hydraulic and may be remotely controlled in various ways well known in the art. Preferably the various power cylinders are operated by compressed air.

*Operation*

When a stand of pipe is unscrewed from the drill stem in the procedure of withdrawing the drill stem from the well bore, the elevator **28** is raised by the traveling block **29** to bring the lower end of the stand of pipe to an elevation just clear of the upper end of the guide chute **45**. The power cylinder **134** of the pipe shifting means **50** is actuated to shift the reciprocative housing **52** outward on the cantilever beam **53**, the hook **55** on the housing being in its retracted position. The outward movement of the housing **52** carries the hook **55** alongside the unscrewed stand of pipe suspended from the elevator **28** and the power cylinder **140** is actuated to extend the piston rod **142**, thereby to cause the hook **55** to swing around the stand of pipe and confine the stand of pipe against the side of the reciprocative housing **52**.

The power cylinder **134** is then energized to cause retraction movement of the reciprocative housing **52** and thus cause the suspended stand of pipe to be displaced towards the receiving stations of the lower support units **32** and the upper rack units **40**. As the pipe shifting means **50** retracts in this manner to displace the suspended

stand of pipe, the elevator 28 is lowered to bring the bottom end of the stand of pipe into contact with the guide chute 45 and with continued lowering of the elevator the lower end of the pipe slides down the guide chute onto the upwardly directed boss 36 of the first support element 34 on the particular lower support unit 32 that is at the receiving station.

As the upper portion of the stand of pipe approaches the receiving end of the particular upper rack unit 40 that is at the upper receiving station, the sprocket chain 42 of the rack unit is actuated to advance one step in the racking direction of the chain so that one of the fingers 41 carried by the chain swings into engagement with the approaching stand of pipe as shown in Fig. 7. In the course of this movement of the stand of pipe into position to be engaged by the racking finger 41, the auxiliary finger 147 is momentarily retracted out of the path of movement of the stand of pipe to avoid interference with the movement. The finger 147 then extends again to its normal position. With the laterally shifted stand of pipe effectively secured in racked position, the power cylinder 140 is energized to swing the hook 55 to its retracted position for repetition of the cycle of operation of the pipe shifting means 50.

As may be seen in Fig. 2, the operating side of each of the rack units 40 in the lower row, i. e., the side to which the fingers 41 extend for racking the pipe, is on the side towards the pipe shifting means 50. As may be understood by referring to Fig. 6, in these instances in which the operating side of a rack unit is on the side towards the pipe shifting means 50, the pipe shifting means cooperates with the fingers 41 to retain the stands of pipe in racked positions and the retractable finger 147 on the beam 53 is not necessary. On the other hand, the operating or racking sides of the rack units 40 in the upper row are on the sides away from the pipe shifting means 50. Moreover, when one of these upper rack units is at the upper receiving station, it is positioned directly above the pipe shifting means 50 as may be seen in Fig. 8. The pipe shifting means 50, therefore, does not cooperate with the upper row of rack units 40 to confine the racked stands of pipe. Fig. 8 shows that the extent and curvature of the fingers 41 is such that the fingers adequately support the slightly leaning stands of pipe only after the fingers are advanced a second step from the receiving end of the rack unit. At the first pipe engaging step of a finger 41, a racking finger 41 requires the cooperation of the auxiliary finger 147. Thus, in Fig. 8 the extended auxiliary finger 147 cooperates with the racking finger 41 at the first racking position of the finger to form a cradle for the leaning stand of pipe.

The actuation of the sprocket chain 42 of the rack unit by one step brings a new finger 41 in position to receive the next succeeding pipe that is to be racked in the same row, and the corresponding lower support unit 32 is actuated by energization of the motor 79 to shift the series of support elements 34 one step in preparation for receiving the next stand of pipe.

When a row of stands of pipe has been completed in a pair of cooperating lower support units 32 and upper rack units 40, the drive shaft 86 of the motor 79 is reached to disengage the conical clutch member 85 from the clutch socket 84 of the lower support unit at the receiving station. The motor 66 is then energized to operate the screw 43 for shifting the carriage 70 to bring the next lower support unit 32 to the lower receiving station. In like manner, the motor 104 is energized to actuate the two upper carriage assemblies to shift sufficiently to bring the next rack unit 40 into position at the upper receiving station. When the shifting of the two upper carriage assemblies carries a bevel gear 117 of a loaded rack unit 40 out of engagement with the corresponding driving bevel gear 112 at the receiving station, the driving bevel gear is not clutched and hence rotates freely to permit the disengagement.

The next rack unit 40 is then moved from its vertical idle position to its horizontal racking position by energization of the corresponding power cylinder 91. As a rack unit 40 reaches its horizontal position, the corresponding bevel gear 117 carried by the rack unit is brought into operative mesh with the corresponding driving bevel bear 112.

In the reverse procedure of returning stands of pipe to the drill stem, the pipe shifting means 50 is first retracted to the position shown in Fig. 7 and the power cylinder 140 is actuated to extend the piston rod 142 to swing the hook 55 into position to engage the outermost stand of pipe at the receiving stations. The motor 108 is then energized to actuate the corresponding sprocket chain by one step in the unracking direction and the pipe shifting means 50 is then actuated by the power cylinder 134 to shift outward to move the upper end of the stand of pipe into the region of the axis of the well bore where the upper end may be engaged by the elevator 28. The auxiliary finger 147 is momentarily retracted to avoid interference with the unracking of the stand of pipe. The power cylinder 140 of the pipe shifting means 50 is actuated to retract the hook 55 thereby to release the stand of pipe to the elevator 28 and then the elevator is raised by the traveling crown block. The upward movement of the elevator drags the lower end of the stand of pipe up the guide chute 45 until the lower end of the pipe swings clear of the guide chute. The elevator may then be lowered to permit the suspended stand of pipe to be screwed onto the drill stem in the bore hole.

It will be readily apparent to those skilled in the art that the described steps in the operation of the apparatus may be performed automatically if desired, thereby to relieve the operator of the burden of initiating tahe operation of each component of the apparatus in the sequence. Figs. 3 and 4 show, by way of example, a switch 160 in the circuit of the motor 66 for automatically stopping the carriage 60 as each successive lower supporting unit 32 moves into position at the lower receiving station. The switch 160 is mounted on a fixed bracket 161 adjacent the path of travel of the carriage 60 and an operating finger 162 is positioned on the carriage opposite each of the lower support units 32 to operate the switch 160 and thereby break the motor circuit. Thus the motor may be energized to cause the carriage to travel and the carriage will be automatically stopped when the next lower supporting unit 32 reaches the receiving station.

In like manner, each of the lower support units 32 may be provided with a switch 164 in the circuit of the motor 79 to automatically de-energize the motor when one step in the actuation of the series of support elements 34 has been completed. Each of the support elements 34 has a laterally extending lug 165 (Fig. 3) to operate the switch 164 as the support element reaches the end of one step of advancement of the series of support elements.

For similar control of the upper rack units 40, a pair of stationary limit switches 168 and 169 (Figs. 11 and 15) may be positioned to cooperate with the upper row of power cylinders 91 and a similar pair of limit switches may be positioned in fixed positions to cooperate with the lower row of power cylinders 91. One of the two limit switches 168 and 169 is used for each direction of travel of the corresponding carriage assembly and is positioned and adapted to break the circuit of the motor 104 in response to contact by the rear end of a power cylinder 91.

The step-by-step actuation of the sprocket chain 42 of each rack unit 40 may be controlled by a switch 171 (Fig. 6) which is adapted for actuation by a series of spaced lugs 172 on the sprocket chain 42. When the motor 108 is energized to advance the sprocket chain 42, one of the lugs 172 operates the switch 171 at the end of the step of advance, thereby to break the circuit of the motor.

As shown in Fig. 10, the cantilever beam 53 may be provided with two switches 174 and 175, each having an operating finger 176 positioned in the path of movement of the side wall of the reciprocative housing 52. As shown in Fig. 6, the two switches 174 and 175 are spaced apart longitudinally of the beam 53. When the power cylinder 134 is energized to shift the pipe shifting means 50 outward, eventually the housing 52 clears and releases the switch 174 to cause operation of the valve controlling the power cylinder 140, so that the power cylinder 140 will be energized to swing the hook 55 from its retracted position to a position engaging and confining a stand of pipe. At the end of the return or retracting movement of the housing 52, the housing operates the second switch 175 to cause energization of the power cylinder 140 to retract the hook 55 out of engagement with the pipe. The circuits of these two switches 174 and 175 with respect to the operation of the power cylinder 140 are also suitably adapted also to cause automatic operation of the hook 55 in the unracking operation of the apparatus.

Mounted inside the housing 52 is a concealed switch 178 (Fig. 6) which is adapted to be operated by a fixed pin 179 on the side of the beam 53. In the course of the retraction movement of the housing 52, the switch 178 is operated by the fixed pin 179 to cause momentary energization of the solenoid 150 thereby to retract the auxiliary finger 147 momentarily to clear the path of a stand of pipe being shifted by the hook 55. If desired, the switch 178 may also be given a second function of automatically closing the circuit of the motor 108 to cause the sprocket chain 42 of the unit at the receiving station to initiate operation for advancement by one step of the pipe engaging fingers 41 as the pipe shifting means 50 brings the new stand of pipe to the receiving end of the rack unit.

My description in detail of a selected embodiment of the invention will suggest to those skilled in the art various changes, substitutions and other departures from my disclosure that properly lie within the spirit and scope of the appended claims.

Having described my invention, I claim:

1. Apparatus of the character described for racking and unracking stands of pipe adjacent a well bore, said apparatus having in combination: a plurality of lower support units to support a corresponding plurality of rows of stands of pipe, each of said units having one end adapted to receive the lower ends of stands of pipe, each of said units being adapted to shift the lower ends of the stands of pipe successively to or from its receiving end; a corresponding plurality of upper rack units to engage upper portions of the rows of stands of pipe on said lower support units, each of said rack units having one end adapted to receive stands of pipe from the well bore, each of said rack units being adapted to shift the stands of pipe successively to or from its receiving end; and power means to actuate said support units and said rack units for racking and unracking stands of pipe.

2. Apparatus as set forth in claim 1, which includes power-actuated means to shift stands of pipe back and forth between the receiving ends of said units and the region of the axis of the well bore.

3. Apparatus as set forth in claim 1 which includes means to guide the lower ends of the stands of pipe from the region of the axis of the well bore to said lower support units whereby the stands of pipe may be lifted from the well bore and then lowered into engagement with said guide means for lateral displacement to said support units.

4. Apparatus as set forth in claim 3 which includes means to displace the upper portions of the stands of pipe away from the region of the axis of the well bore towards said upper rack units.

5. Apparatus as set forth in claim 1 which includes means to move said lower support units selectively to a receiving station near the well bore for receiving the stands of pipe.

6. Apparatus as set forth in claim 5 which includes means to move said upper rack units selectively to a receiving station for receiving the upper portions of stands of pipe.

7. Apparatus of the character described for racking and unracking stands of pipe adjacent a well bore, said apparatus having in combination: a plurality of lower support units, each having one end adapted to receive pipe, said support units being movable in succession to a receiving station to receive pipe from the well bore or to relinquish pipe for return to the well bore; a row of support elements on each of said units to support the lower ends of a corresponding row of stands of pipe, said elements being movable on the unit to and from said receiving end in succession to receive or relinquish the lower ends of said stands of pipe; power-actuated means to move said support units individually to and from said receiving station and to move support elements on each support unit to and from said receiving end of the support unit; and upper rack means to stabilize the stands of pipe on said support units.

8. Apparatus as set forth in claim 7 in which said lower support units are interconnected to move in unison relative to said receiving station.

9. Apparatus as set forth in claim 8 which includes a carriage on which said support units are mounted and which includes a track for said carriage.

10. Apparatus as set forth in claim 7 which includes means to displace the lower end of a stand of pipe from the region of the axis of the well bore to said end of a support at said receiving station.

11. Apparatus as set forth in claim 10 in which said guide means provides a downwardly inclined guide surface for sliding contact by the lower ends of the stands of pipe.

12. Apparatus as set forth in claim 7 in which said upper rack means comprises a plurality of rack units corresponding to said lower support units.

13. Apparatus as set forth in claim 12 in which said upper rack units are movable in succession to an upper receiving station corresponding to said lower receiving station; and which include power means to move said upper rack units to and from said upper receiving station.

14. Apparatus as set forth in claim 7 which includes lower means to displace the lower end of a stand of pipe from the region of the axis of the well bore to the receiving end of a support unit at said receiving station; and includes upper means to displace the upper portions of the stands of pipe from the region of the axis of the well bore into engagement with said upper rack means.

15. In apparatus of the character described for racking and unracking stands of pipe adjacent a well bore, the combination of: a plurality of support units to support a corresponding plurality of rows of stands of pipe, each of said units having one end adapted to receive the lower ends of stands of pipe, said units being movable in succession to a receiving station to receive pipe from the well bore or to relinquish pipe for return to the well bore; a row of support elements on each of said units to support the lower ends of a corresponding row of stands of pipe, said elements being flexibly interconnected for movement in unison to permit movement of the elements successively to or from said receiving end of the support unit; and power means to move said support units in turn to said receiving station and to move said elements on each unit to and from the receiving end of the unit.

16. Apparatus as set forth in claim 15 in which each of said support elements is shaped to extend into the lower end of a stand of pipe.

17. Apparatus as set forth in claim 16 in which each of said support elements has a tapered projection for engagement with the lower end of a stand of pipe.

18. Apparatus as set forth in claim 17 in which said support elements are linked together on each of said lower support units and each unit provides a guideway for movement of the linked elements.

19. Apparatus as set forth in claim 18 in which the series of linked elements on each unit are movable in a path extending longitudinally of the top of the unit and turning downward at the receiving end of the unit.

20. Apparatus as set forth in claim 19 which includes a wheel member journaled at said end of each support unit to engage the linked elements in the manner of a sprocket wheel engaging a sprocket chain.

21. Apparatus as set forth in claim 15 in which said plurality of units are mounted on a carriage and said power means moves said carriage.

22. In apparatus of the character described for racking and unracking stands of pipe adjacent a well bore, the combination of: lower support means to support the lower end of rows of stands of pipe, said means being movable to carry such row of pipe in a path laterally of the row to position the rows successively with one end of each positioned row at a lower receiving station adjacent the bore hole, said means being movable to load and unload each row of pipe progressively from the end of the row at said lower station; upper rack means to engage upper portions of the same rows of stands of pipe to stabilize the rows of stands of pipe on said lower support means, said upper rack means being movable laterally of the rows to shift the upper portions of the rows of pipe to position the rows successively with one end of each positioned row at an upper receiving station corresponding to said lower receiving station, said rack means being movable to load and unload each row of pipe progressively from the end of the row at said upper station.

23. Apparatus as set forth in claim 22 which includes means to displace the lower ends of said stands of pipe from the region of the axis of the well bore to said lower receiving station.

24. Apparatus as set forth in claim 22 which includes power-actuated means to shift upper portions of said stands of pipe from the region of the axis of the well bore to said upper receiving station.

25. Apparatus as set forth in claim 24 which includes means to displace the lower ends of said stands of pipe from the region of the axis of the well bore to said lower receiving station.

26. In apparatus of the character described for racking and unracking stands of pipe adjacent a well bore, the combination of: lower support means to support the lower ends of rows of stands of pipe, said means being movable relative to a lower receiving station near the bore hole to load and unload each row of pipe progressively at the receiving station; a plurality of upper rack units, each corresponding to a row of stands of pipe on said lower support means, said upper rack units being movable relative to an upper receiving station corresponding to said lower receiving station, each of said rack units having one end to receive or to relinquish stands of pipe at said upper receiving station; a series of pipe engagement members movably mounted on each of said rack units to engage or disengage the stands of pipe to progressively rack or unrack the rows of pipe; and power means to move said rack units relative to said upper station and to move said engagement members on each rack unit relative to said end of the rack unit.



27. Apparatus as set forth in claim 26 in which said engagement members on each rack unit are flexibly connected together for movement in unison by the power means.

28. Apparatus as set forth in claim 26 in which said engagement members are incorporated in a sprocket driven chain.

29. Apparatus set forth in claim 28 which includes power-actuated means to displace the stands of pipe from the region of the axis of the well bore to said upper receiving station for engagement by said rack units.

30. In apparatus of the character described for racking and unracking stands of pipe adjacent a well bore, the combination of: a plurality of elevated rack units to engage and stabilize the upper portions of upright stands of pipe, each of said rack units having a receiving end to receive stands of pipe from the well bore and to relinquish the stands of pipe for return to the well bore, each of said units being adapted to shift stands of pipe successively to and from said receiving end; and power means to actuate said rack units and to shift the units successively to an upper receiving station for receiving stands of pipe from the well bore or for relinquishing the stands of pipe for return to the well bore.

31. Apparatus as set forth in claim 30 in which each of said units has a series of pipe engagement members flexibly interconnected for movement in unison to move stands of pipe towards and away from said ends of the unit.

32. Apparatus as set forth in claim 31 in which said rack units are pivotally mounted and are power-actuated to swing between a substantially vertical retracted idle position and a substantially horizontal racking position.

33. In apparatus of the character described for racking and unracking stands of pipe adjacent a well bore, the combination of: a plurality of elevated rack units to engage and stabilize the upper portions of upright stands of pipe, each of said rack units having a receiving end adapted to receive stands of pipe from the well bore and to relinquish the stands of pipe for return to the well bore, each of said units being movable to shift stands of pipe successively to and from said receiving end; means to displace the upper portions of stands of pipe from the region of the well bore to said receiving ends of the rack units; and power means to energize each of said rack units to engage a stand of pipe in response to displacement of the stand of pipe towards the rack unit by said displacement means.


**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,668,995 | Woolever | May 8, 1928 |
| 2,006,844 | Smith | July 2, 1935 |
| 2,423,169 | Bennett | July 1, 1947 |
| 2,628,725 | Stone | Feb. 17, 1953 |