United States Patent

Sizer

[15] **3,677,345**

[45] **July 18, 1972**

[54] PIPE HANDLING APPARATUS AND METHOD

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[73] Assignee: **Otis Engineering Corporation**, Dallas, Tex.

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[52] **U.S. Cl.** **166/315**, 166/77, 175/85, 175/103

[51] **Int. Cl.** **E21b 43/00**, E21b 19/00

[58] **Field of Search** 166/315, 77; 175/85, 202, 203, 175/220, 103; 29/208, 240

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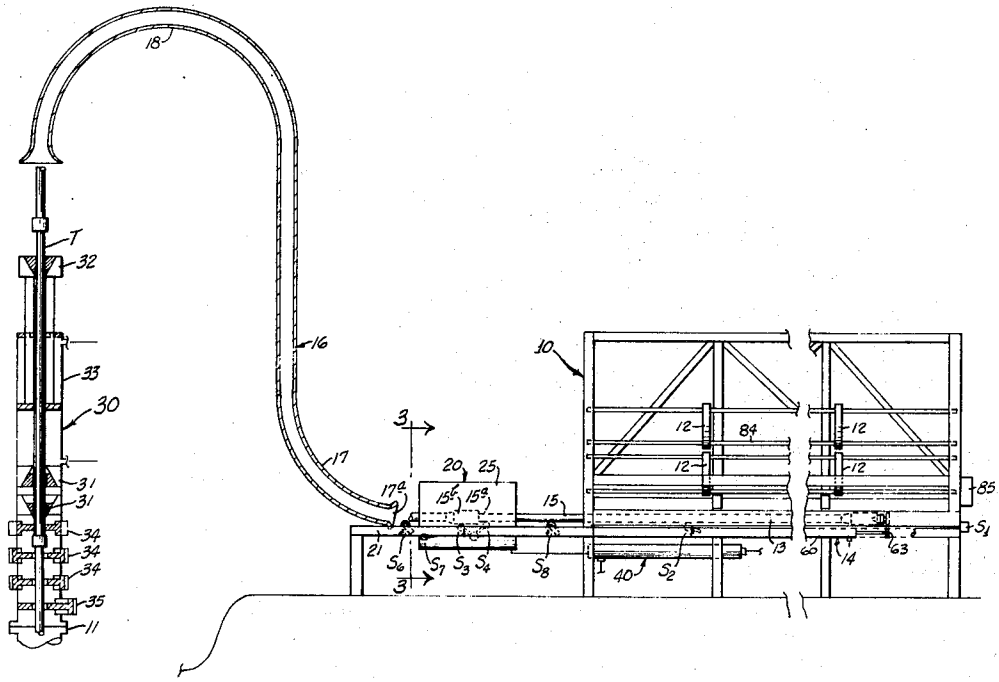
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[57] **ABSTRACT**

Apparatus for handling pipe, making up joints of pipe into an elongate string, inserting the string into a well and removing it from the well with a minimum of manual handling. Pipe joints are racked in units which are made up in a substantially horizontal position and flexed around curves into a well bore and out of a well bore, without the use of conventional hoisting equipment. A basket type circular receiving vessel or receptable is provided for coiling the string of pipe as it is removed from the well bore and for insertion into the well bore if the pipe string is not to be broken into separate lengths or sections. Means is provided for storing the pipe in either the horizontal racks or in the basket in a coil. The pipe handling equipment is in one form mounted on a conveyance such as a barge or the like.

22 Claims, 12 Drawing Figures



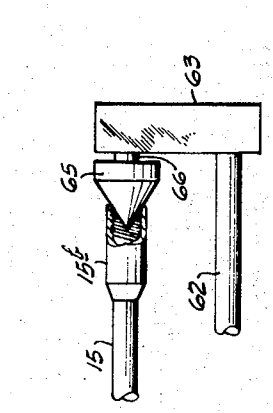


FIG. 5

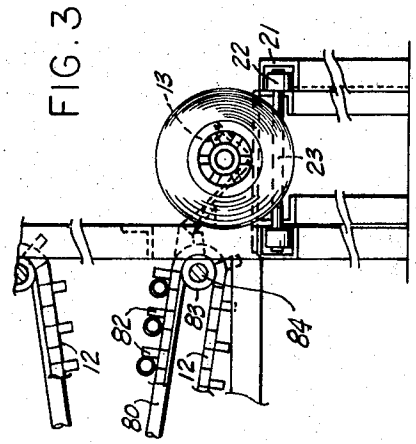
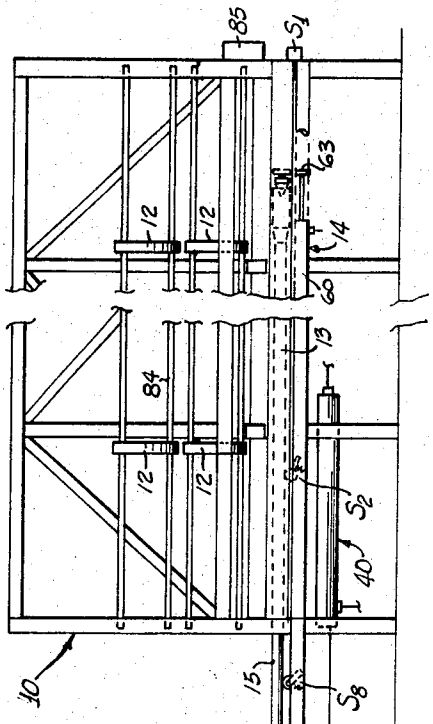


FIG. 3



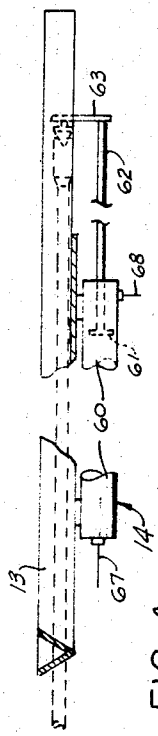


FIG. 4

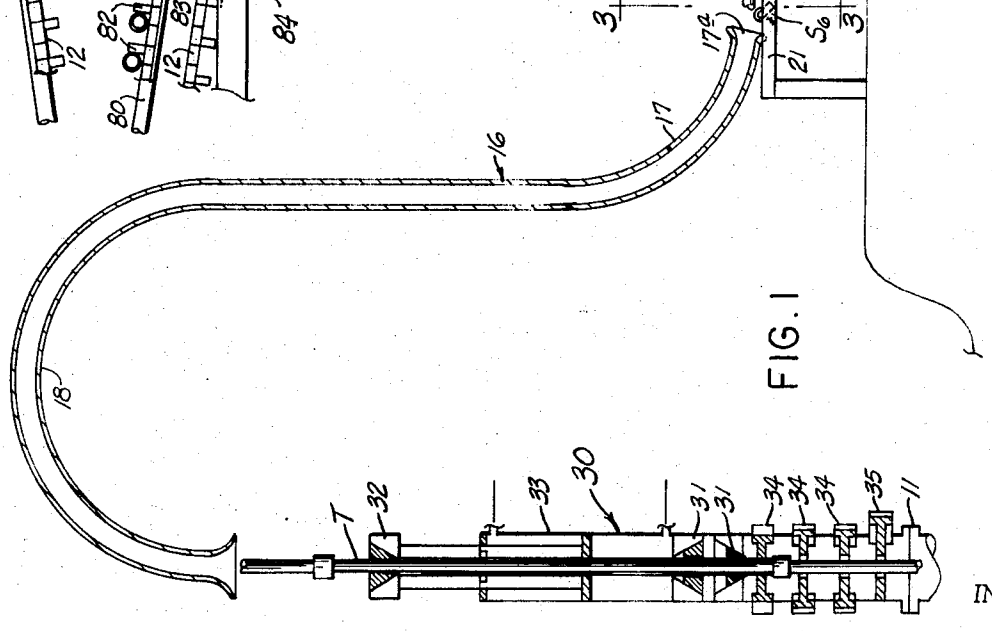


FIG. 1

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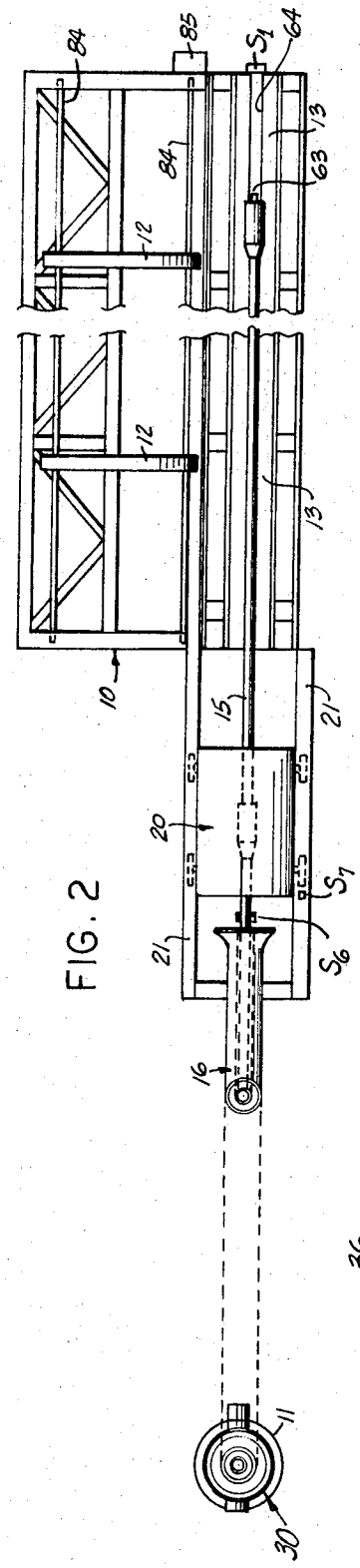


FIG. 2

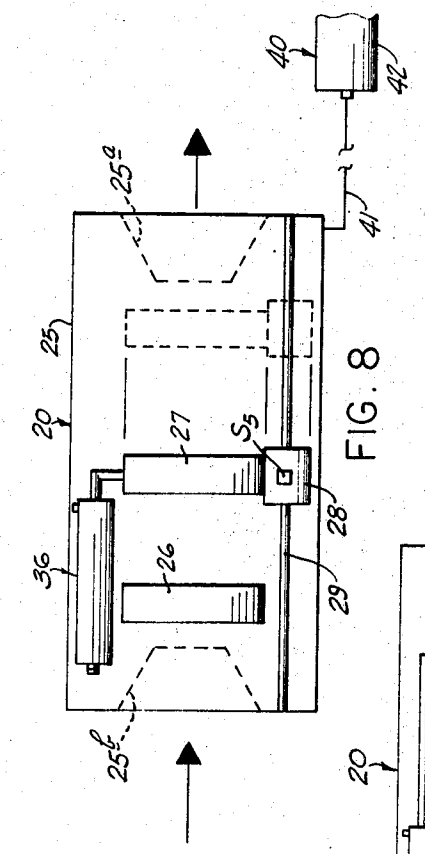


FIG. 8

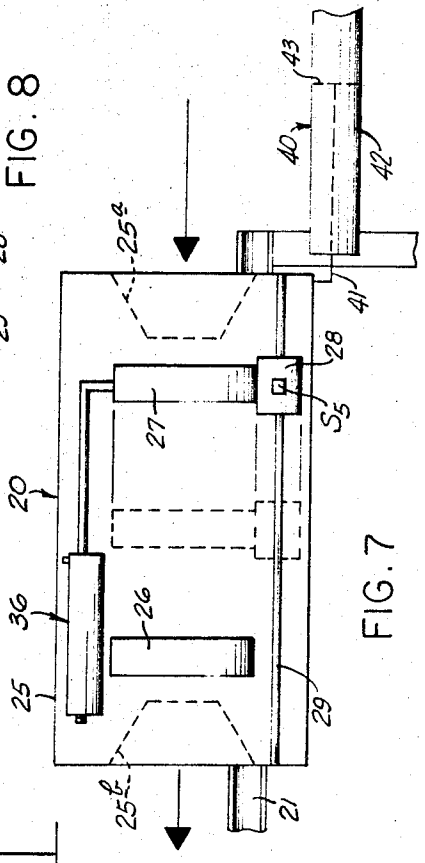


FIG. 7

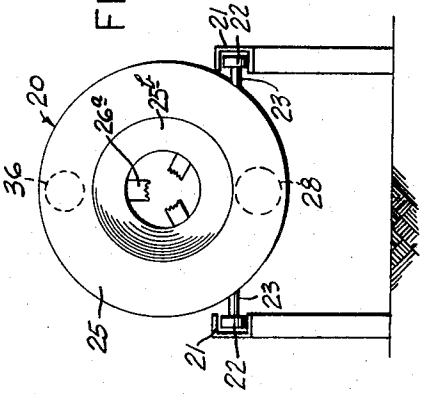


FIG. 6

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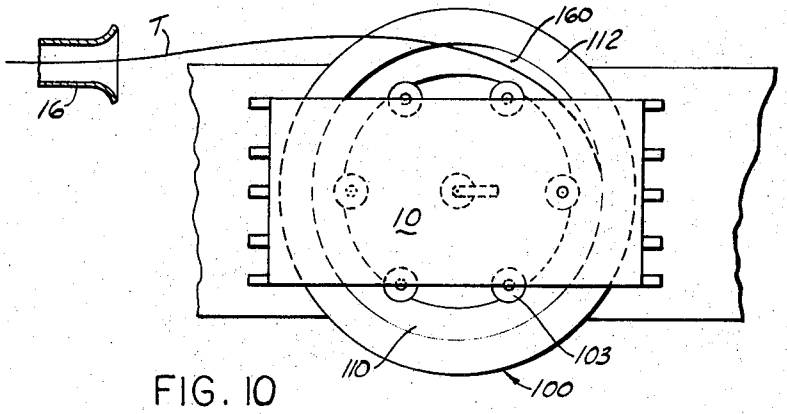


FIG. 10

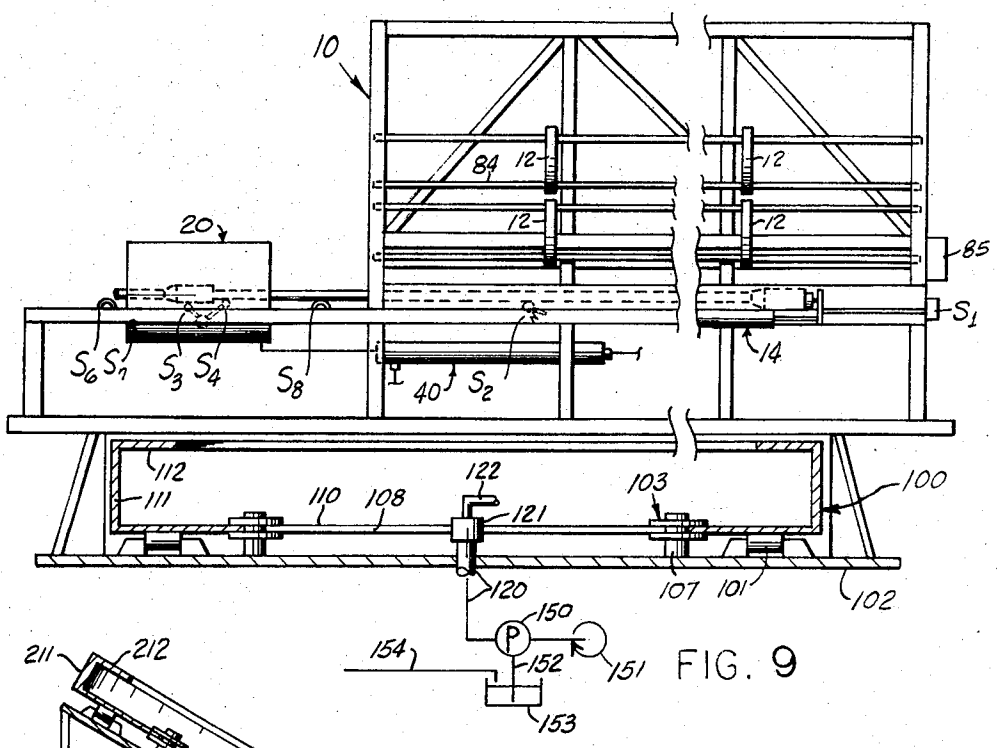


FIG. 9

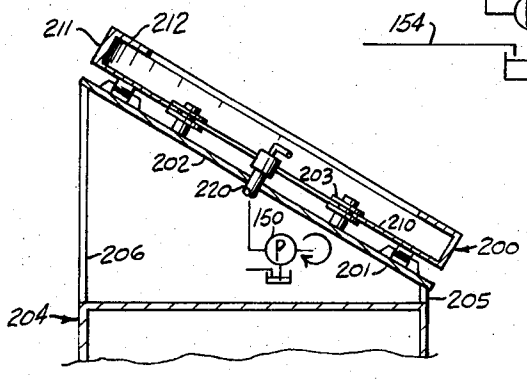


FIG. 12

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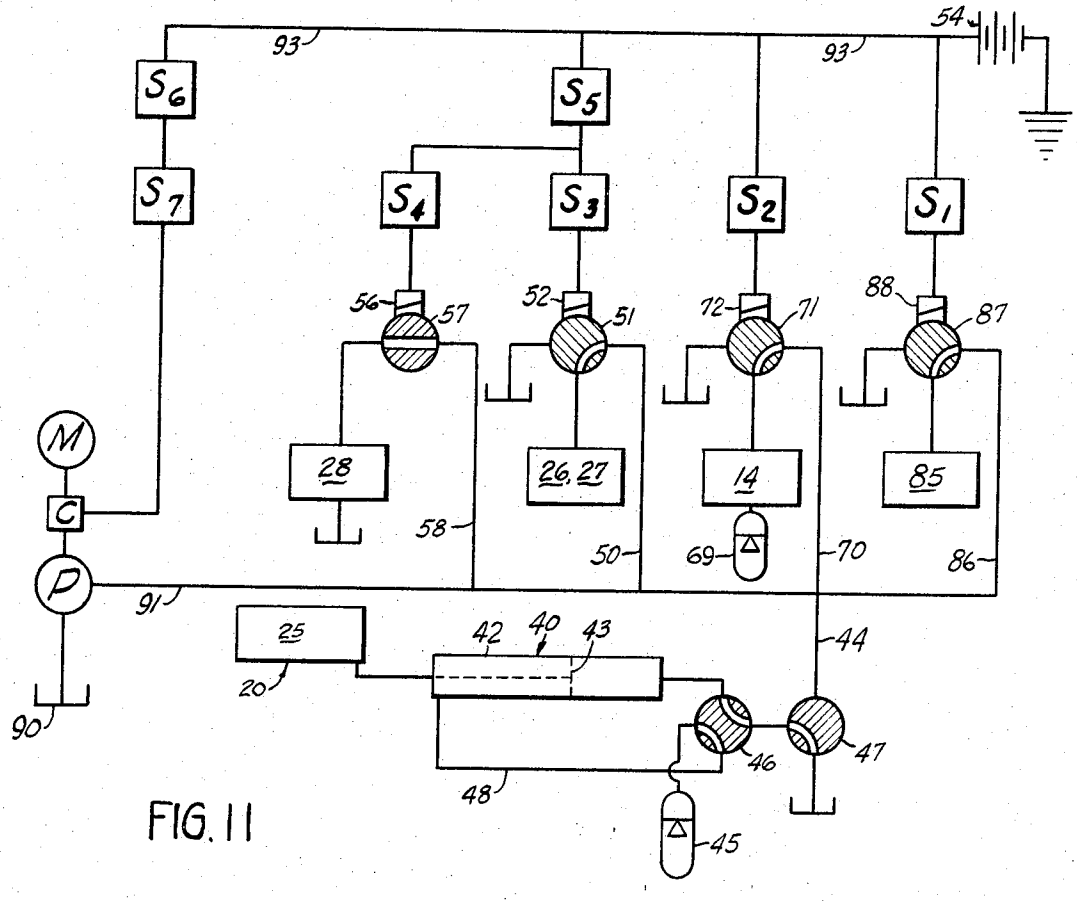


FIG. 11

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PIPE HANDLING APPARATUS AND METHOD

This invention relates generally to pipe handling apparatus and methods, and more particularly to means and a method of assembling, manipulating and disassembling pipe strings with a minimum of manual handling.

In the usual situation, where pipe is inserted into a well bore, it is customary to join sections of pipe together in the elongate well string and lower the pipe into the well by means of hoisting equipment at the surface, and then to remove the pipe from the well by such hoisting equipment and break the string into separate sections for stacking or storage. This is an expensive and time consuming method and apparatus, since a large amount of manual handling is required in most cases in making the pipe string up and breaking the pipe string down into sections and moving the pipe into and out of the racks or stacks.

It is, therefore, one object of this invention to provide an improved apparatus and method of handling pipe.

An important object of the invention is to provide an improved apparatus and method for storing pipe, assembling pipe sections into an elongate string, handling the string of assembled pipe sections as by inserting into and removing from a well bore, storing the pipe as an elongate continuous string in a coiled form between operations in the well, and disassembling the string of pipe into sections for storage or replacement or repair, and wherein the means for handling the pipe in accordance with the method is effectively operated and performed with a minimum of manual handling of the pipe sections and with a minimum number of workmen.

Still another object of the invention is to provide an apparatus and method of the character described which is particularly adapted for use in connection with offshore well installations or locations.

A particular object of the invention is to provide means for assembling sections of pipe into an elongate string and disassembling sections of pipe from the elongate string into sections for storing and other handling is accomplished while the pipe is moving, to effect a substantial saving of time in such handling.

It is still another object of the invention to provide an apparatus and method of assembling and handling and storing pipe in which the string of assembled pipe may be stored in the assembled condition, whereby the string of assembled pipe may be removed from a well bore and reinstalled in place in the well without the necessity of disassembling and reassembling the sections of pipe, and so reduce the cost and handling time required in such operation.

A further object of the invention is to provide an apparatus for handling pipe of the character set forth which is readily portable from location to location and is particularly for marine type installations.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIG. 1 is a schematic view of pipe handling apparatus constructed in accordance with the invention and used for moving the pipe from a rack into assembled condition and then into a well bore;

FIG. 2 is a top view, partly in elevation and partly in section, of the pipe handling apparatus of FIG. 1;

FIG. 3 is a fragmentary sectional view of the pipe rack and pipe handling mechanism of FIG. 1 taken on the line 3—3 of FIG. 1;

FIG. 4 is a fragmentary view, partly in elevation and partly in section, of the means for moving the joints of pipe from the rack into the coupling device;

FIG. 5 is a fragmentary view, partly in elevation and partly in section, of the propelling mechanism of FIG. 4;

FIG. 6 is an enlarged fragmentary end elevation of the pipe coupling mechanism of FIG. 1;

FIG. 7 is a schematic side view of the pipe coupling mechanism of FIG. 6, showing the elements thereof in position for assembling sections of pipe into an elongate string;

FIG. 8 is a view similar to FIG. 7 showing the elements of the coupling device in position for disassembling the string of pipe into sections;

FIG. 9 is a fragmentary view, partly in elevation and partly in section, showing the pipe rack and coupling mechanism of FIG. 1 combined with a rotary basket type receptacle storage device for receiving the string of joined sections of pipe in a coiled form;

FIG. 10 is a reduced schematic plan view of the device of FIG. 9;

FIG. 11 is a schematic of the electric and hydraulic control system for the apparatus of FIG. 1; and,

FIG. 12 is a fragmentary cross-sectional view of a slightly modified form of the rotating receiving basket of FIG. 9 showing the same tilted at an angle to permit mounting on a barge or like vehicle with less lateral overhang.

In the drawings, the numeral **10** designates generally a frame structure or rack, shown in FIG. 1 to be supported on the ground or earth surface adjacent a well head **11** of a well. The rack is used for supporting a number of lengths or joints of tubular flow conductor or pipe **15** which are to be made up into a continuous string of flow conductor or tubing T for insertion into the well through the well head **11**. The individual joints of pipe are moved in separate joints from the rack **10** by means of a spacer chain **12** into a guide trough **13**, and each joint is then moved along the trough by a hydraulic pressure operated drive ram or feeder **14** to a hydraulic power operated coupling device or tong assembly **20** where the single joints are connected to the string of previously connected joints of pipe, and are then directed through a tubular guide **16** around an arc **17** and upwardly to a point above the well where they are then directed downwardly toward the well head **11** by a reverse curve **18** in the tubular guide. From the tubular guide the string T of joints of pipe **15** are directed into a pipe moving or inserting and removing mechanism **30** of the type illustrated in U.S. Letters Pat. No. 3,215,203, issued Nov. 2, 1965, to Phillip S. Sizer, by means of which the pipe is mechanically forced into or lifted out of the well bore by means of the hydraulic fluid pressure operated stationary gripping members **31** and the hydraulic fluid pressure operated movable gripping members **32** moved by the hydraulic fluid pressure actuated piston and cylinder operating mechanism **33** to move the string of pipe T in the manner set forth in the patent through a plurality of blow out preventers or strippers **34** and a valve **35** mounted on the upper end of the well head **11**.

It will be seen, therefore, that the pipe moving assembly **30** may be used to grip the tubing string T and force the same downwardly into the well through the well head **11**. The pipe moving assembly will also serve to move the tubing string T by pulling the sections of pipe through the tubular guide **16** under tension without the likelihood of causing deformation or kinking of the pipe, which might result from a pushing type movement. Also, the string of pipe T extending out of the open mouth **17*a*** of the guide tube **16** to the coupling assembly **20** will, when the coupling assembly is engaged therewith, cause the coupling assembly to move along a track **21** formed by a pair of opposed channel members in which wheels **22** are disposed on a shaft **23** which supports the coupling assembly **20**, as also shown in FIGS. **2**, **3** and **6**, whereby the coupling assembly moves along the tracks **21** with the tubing string as it is drawn through the tubular guide **16** by the pipe moving mechanism **30**.

The coupling device **20** includes a housing **25** mounted on the shafts **23** so as to be supported thereby and providing an enclosure and support for a stationary fluid pressure operated pipe engaging member or stationary tong **26** having a plurality of gripping members **26*a*** carried thereby for engaging the pipe as it moves therethrough, and a movable fluid pressure operated rotatable power tubing tong or gripping member **27** having gripping members similar to the gripping members **26*a*** for gripping the pipe, and provided with a fluid pressure operated rotator motor mechanism **28** for rotating the rotatable gripping member **27** to turn the pipe gripped thereby in the

usual manner of power operated tubing tongs. Power operated tubing tongs such as those manufactured by Byron Jackson, Model R 5, by Foster Cathead Company, Model 74–92, or those shown in the U.S. Pat. No. 3,312,294, to Wilson, dated Apr. 4, 1967, may be used for gripping, holding and rotating the pipe.

The movable tong or gripping member **27** is slidably mounted on one or more supporting ways **29** carried by the housing **25** of the coupling assembly so as to be slidable toward and away from the stationary or fixed gripping member or back up tong **26**, whereby the rotatable power tong **27** may move toward the back up tong **26** as the pipe is rotated to thread the pin end of the joint of pipe **15** into the box end of the previously connected joint at the end of the tubing string T in the coupling assembly. The rotatable power tong **27** is biased away from the stationary tong by springs or other suitable means **36** connected thereto and to the housing.

The return movement of the coupling assembly **20** from a position adjacent the receiving end of the tubular guide sleeve **16** toward the guide trough **13** is effected by means of a carriage return **40** connected by a link arm **41** to the housing **25**. The carriage return comprises a cylinder **42** in which a piston **43** is slidable, as is shown in dotted lines in FIGS. **7** and **11**. As is shown in FIG. **11**, the cylinder **42** is connected with a supply line **44** for pressure fluid and through a conduit **48** with a gas charged accumulator **45** by means of a four-way valve **46** connected in series with a three-way valve **47**, whereby movement of the coupling assembly **20** to the left in FIGS. **1** and **2** moves the piston **43** to the left in the cylinder **42** and moves the pressure fluid in the cylinder into the accumulator to compress the gas therein to provide a force for returning the coupling assembly to the right to its position for receiving another joint of tubing for connecting the same to the tubing string T. The manner in which the carriage return is charged and the direction of movement thereof is controlled will be explained more fully hereinafter.

The gripping members **26***a* of the back up or stationary tong or gripping member **26** are moved into gripping engagement with the tubing string in response to fluid pressure from a supply conduit **50** controlled by a suitable three-way valve **51** which is operated by a solenoid **52** controlled by a sensing device **53**, as will be hereinafter more fully explained.

The gripping members of the rotatable power tongs **27** are likewise moved into gripping engagement with the pin end of the joint of pipe to be made up to the tubing string T by fluid pressure controlled by the valve **51** and the sensing device **S3**, whereby the gripping members of both the back up tong **26** and the power tong **27** are moved into engagement with the tubing joints simultaneously.

The sensing device **S3** is mounted on one end of a bell crank support **55** pivotally mounted between the tracks **21**, and a sensing device **S4** is mounted on the other end of the bell crank support and is swung upwardly toward the joint of tubing **15** by the bell crank support when the sensing device **S3** engages the coupling **15***b* and is depressed thereby. Shortly after the engagement of the gripping members with the pipe, the sensing device **S4** is engaged by the pin end **15***a* of the tubing joint **15** to energize the solenoid **56** of the valve **57** which controls flow of pressure fluid from a supply line **58** to the motor **28** to cause rotation of the power tong **27** and the pipe joint **15** to make up the pin end **15***a* of the joint of pipe **15** in the box **15***b* at the rear end of tubing string T. The telescoping movement of the pin **15***a* of the tubing joint **15** as a result of the threading of the pin into the box **15***b* of the tubing string T will cause movement of the power tong **27** along the ways **29** against the biasing force of the biasing means **36**, which may be a spring or a reversible gas charged accumulator.

A torque sensing device and switch **S5** is connected in series circuit between the power supply **54** and the sensing devices **S3** and **S4**, so that when the pipe joint **15** has been made up in the box at the rear end of the tubing string to a predetermined desired degree, the torque sensing device and switch **S5** will actuate to break the circuit from the power source to the sensing devices **S3** and **S4** and to the solenoid **52** of the valve **51** and the solenoid **56** of the valve **57** to stop operation of the rotator motor **28** and to release the gripping members of the stationary back up tong **26** and of the rotating or power tong **27**, so that the pipe joint is then free to be moved with the tubing string T through the guide tube **16** by means of the pipe moving mechanism **30**.

The joint of pipe which is dropped into the trough **13** from the rack **10** is moved toward the coupling device **20** by the fluid pressure operated drive ram or feeder member **14**, which includes a cylinder **60** in which a piston **61** is slidable. A push rod shaft **62** is connected at one end to the piston **61** and extends through a suitable packing gland at the end of the cylinder **60** and has its opposite end connected with an actuator arm or push arm **63** which extends upwardly through a longitudinal slot **64** in the bottom of the trough **13**. The arm **63** is provided at its upper end with a conical centering and drive head **65** which is rotatably mounted on a shaft **66** extending from the support or push arm **63** to the conical drive head. As shown in FIG. **5**, the conical end of the drive head is adapted to enter the box **15***b* of the joint of tubing **15** to push the same along the trough **13** toward the coupling assembly **20**. The head **65** is rotatable on the shaft so that the tubing may be made up while said head is in engagement therewith, if desired.

For moving the piston **61** to move the feeder push rod **62**, fluid conduit lines **67** and **68** are connected to opposite ends of the cylinder **60** and conduit **67** at the left hand end of the cylinder **60** is connected to a gas charged pressure accumulator **69** which biases the piston **61** toward the right end of the cylinder **60** and biases the rod **62** and drive head **65** to the right hand end of the trough **13** beyond the location at which a joint of tubing **15** will enter the trough. Thus, the drive head **65** may engage the box **15***b* of the joint of pipe **15** when fluid pressure is applied through a supply line **70** and a three-way valve **71** to the cylinder **60** on the right hand side of the piston **61** to move the piston to the left and draw the rod **62** and the drive head to the left to engage the drive head with the coupling member. The control of actuating fluid pressure to the cylinder **60** of the feeder mechanism is effected by the valve **71** which is actuated by means of a solenoid **72** energized in response to a signal generated by a sensing device **S2** connected to the solenoid and disposed in the trough **13** adjacent the pin end of the rack and positioned to be engaged by the joint of tubing which is moved into the trough from the rack to energize the valve to admit fluid pressure into the cylinder **60** to move the piston **61** to the left and feed the tubing joint toward the coupling assembly **20**. When the pressure is relieved from the cylinder **60** by movement of the valve **71** to drain position, the gas pressure charge in the accumulator **69** will move the piston **61** back to the right to position the drive head **65** in place to engage the next joint of pipe which is later deposited in the trough to feed the same toward the coupling assembly to add that joint to the string of tubing being made up.

In the pipe rack **10**, a plurality of inclined rails or supports **80** extend from the rear to the front of the rack for supporting the joints of pipe **15** thereon and for permitting the joints to move by gravity toward the trough **13**. The end of the lower rails or guides **80** extend to a point adjacent the side of the trough **13** nearest the rack, whereby the joint of pipe moving off the rails will be deposited on that inclined side of the trough and move downwardly in the trough to engage the opposite side thereof for guiding movement toward the coupling device. The joints of pipe **15** are separated by means of a flexible chain **12** having a plurality of upstanding stop members **82** carried thereby and which move around a pulley or sprocket **83** with the chain as successive joints of pipe are moved out of the rack into the trough. The lower sprockets **83** are mounted on a shaft **84** which has a ratchet escapement mechanism **85** at its end opposite the coupling assembly for controlling movement of the chain and the stops **82**, and thereby controlling the movement of the pipe joints off the rack into the trough.

The ratchet escapement **85** is actuated in response to a sensing device S1 disposed in position to be engaged by the push arm **63** when said push arm reaches the right hand extremity of its path of movement. When the push arm engages the sensing device S1 the ratchet escapement mechanism **85** is actuated to permit the shaft **84** to turn a distance equal to the distance between two of the adjacent stops **82** carried by the chain, and so permit a single joint of pipe **15** to move off the rack into the trough.

As shown in FIG. **11**, the ratchet escapement mechanism **85** is connected to a fluid pressure supply line **86** through a three-way valve **87** which is operated by a solenoid **88** energized by the sensing device S1. A pump P, driven by motor M through a clutch C supplies fluid pressure from a tank **90** to a fluid supply conduit **91** to which the supply lines **44, 50, 58, 70** and **86** are connected. The clutch C is actuated by means of sensing and switch members S6 and S7 which are normally closed and are operable to move to open position to break the circuit from the power supply **54** to the clutch to release the clutch and disengage the motor from the pump and so stop operation of the system, in case such is desired, as will be hereinafter more fully set forth.

The fluid pressure from the pump travels through the main supply line **91**, and a branch leads to the valve **87** which controls operation of the ratchet escapement mechanism. A branch **70** leads to the three-way valve **71** which controls operation of the feeder ram mechanism **14**. A branch **50** leads to the valve **51** which controls actuation of the gripping elements in the power tong **27** and the stationary back up tong **26**, and a branch **58** leads to the valve **57** which controls operation of the rotator motor **28** which rotates the power tong or griping member **27** to rotate the pipe joints **15**. The outlet side of the valve in each case leads to a sump, or to the tank **90** if desired, from which the fluid may be recirculated through the system. The sensing devices control actuation of the solenoids which operate the valves and the source of electric power **54** is shown to be a battery, but may be a supply of alternating or desired current, if desired. The power source is connected by means of a main conductor **93**, and branches therefrom to the sensing devices S1, S2, S5, and through S5 to S3 and S4, and to the sensing devices S6 and S7, as shown in FIG. **11**.

The housing **25** of the coupling assembly **20** is provided at its opposite ends with funnel cone shaped guide members **25*a*** on the right hand end and **25*b*** on the left hand end for guiding pipe into the coupling assembly and into the gripping members therein. Obviously, when the pipe is moving from the rack toward the well head, the conical guide member **25*a*** will guide the pin end of the joint of pipe **15** into position in the powered rotating tongs or gripping member **27**. Similarly, conversely, when pipe is moving out of the well to the rack, the box end of the string or tubing T will be guided by means of the conical guide surface **25*b*** into the stationary or fixed back-up tong or gripping member **26** in position to be engaged by the gripping elements **26*a*** therein.

While an accumulator has been described as used in connection with operation of the piston in the cylinders **60** and **42**, it is obvious that a suitable spring system may be utilized to bias the pistons in the same direction as the gas pressure charge of the accumulator will move the piston.

The sensing member or device S3 is positioned at a point at which it will be engaged by the box **15*b*** of the joint of pipe **15** last connected to the tubing string T as such box is moved through the coupling assembly toward the guide tube. This position is so located that the stationary gripping member or back up tong **26** will grip the end of the pipe near the box when the coupling assembly **20** is in its right hand position and before the box passes through the back up tong toward the guide tube. Simultaneously, the feeder mechanism **14** has pushed the next joint of pipe **15** toward the coupling device a distance sufficient that the pin **15*a*** engages the box **15*b*** so that the pin end of **15*a*** of the joint of pipe **15** is at least disposed in a position in which the pin end **15a** of the pipe extends through the power tong or gripping member **27**. Thus, when the sensing member S3 is engaged by the box section **15*b*** at the rear end of the tubing string T, the sensing member S3 energizes the solenoid **52** controlling the valve **51** which moves the valve to a position to feed fluid pressure to the gripping members of the power tong rotating device **27** and to the back up device **26** to move the gripping elements thereof into gripping engagement with the respective pipe joints therein. The sensing member S3 and the sensing member S4 being mounted on the bell crank support **55**, the engagement of the sensing member S3 with the box **15*b*** will pivot the sensing member S4 into position to be engaged by the pin end **15*a*** of the pipe joint being forced toward the tubing string T to then energize the solenoid **56** of the valve **57** to cause fluid pressure to be delivered to the rotator motor **28** to rotate the power tong **27**, and so to rotate the pipe joint **15** to thread the pin into the box at the rear end of the tubing string T. After this rotary action has taken place and the pin is made up in the box sufficiently tightly, the torque limit transducer sensing switch device S5 is actuated to break the circuit to the valve controlling the gripping members and to the valve controlling the rotator motor and so effect release of the gripping members and discontinuance of rotation of the power tong.

The pipe moving device **30** continues to move the pipe string T to move the coupling **15*b*** past the sensing device S3 and so moves the sensing device S3 out of engagement with the coupling and permits the bell crank to move the sensing device S4 out of contact with the pipe, and therefore reestablish the circuitry in a condition for a subsequent operating cycle.

The sensing device S6 is located adjacent but spaced from the entrance or mouth **17*a*** of the guide tube **16** a distance sufficient to be freed for movement to break the circuit to the clutch C should the end of the tubing string move past the sensing device S6 without an additional joint of pipe connected thereto. Thus, the sensing device S6 would break the circuit to the clutch C and disconnect the motor from the pump P to cut off further operation of the pump and the power fluid system, which would at the same time stop delivery of power fluid to the pipe moving device **30** and so terminate all operation of the system.

The sensing device S7 is mounted on the track **21** at a point at which it will be engaged either by the housing **25** of the coupling assembly or by the wheels **22** on which the coupling assembly moves on the track **21**. When the sensing device **57** is engaged by the housing **25**, or the wheels **22**, as the case may be, it will be operated to disengage the clutch and disconnect the motor from the pump to terminate further operation of the entire system. The sensing devices S6 and S7 are thus safety devices for shutting down all operation in the event of the occurrence of an undesirable condition.

In FIG. **9** is shown a rack **10** which is mounted above a rotatable receptacle or cage **100** mounted on a plurality of circumferentially spaced roller bearings **101** carried on a base **102**. Guide roller sheaves **103** are mounted on anti-friction bearings on supports **107**, also spaced circumferentially around the interior of the receptacle, the sheaves having flanges which engage above and below the inner edge **108** of the annular bottom **110** of the receptacle **100**. The annular side wall **111** of the receptacle extends upwardly from the annular bottom **110**, and an inturned retainer flange **112** extends inwardly from the upper end of the annular side wall **111** and provides means for retaining coiled pipe in the receptacle. The roller sheave members **103** which engage the inner edge **108** of the inturned bottom flange of the container or receptacle maintain the receptacle centered on the base **102** and prevent lateral movement of the receptacle or basket with respect ot the central conduit or pipe **120** having a swivel **121** at its upper end providing a connection by means of a goose neck **122** with the surface end of the string of tubing T. Mud or other well operating fluid may be driven or forced into or out of or circulated through the tubing string T by means of a pump **150** driven by a suitable motor or power source **151** and

having an intake **152** communicating with a tank **153** to which a return **154** supplies fluid, either by circulation from the well or from another source.

The basket receptacle **100** is rotatable freely about the center of the conductor **120**, and when the string of tubing T is removed from the well through the well head **11** by means of the pipe moving device **30** and directed back toward the rack **10** through the guide tube **16**, as shown in FIG. **10**, the surface end of the pipe may be directed downwardly through a space **160** between the rack **10** and the upper cover flange **112** of the basket **100**, so that the pipe may enter the basket and be confined between the upper flange cover **112** and the lower flange bottom **110** of the basket and will be coiled against the annular side wall **111** of the basket in the well known manner, while connected in flow communication with the central conduit or pipe **120** and the pump **150**. This permits circulation through the tubing string T at all times.

The rotatable basket or receptacle **100** is freely movable by the pipe as it is moved thereinto out of the well, but may also be driven by a suitable power unit, if desired, to assist in moving the pipe from the well into the basket. The pipe when so coiled in the basket remains in a continuous string of the desired length for use in the well and is readily available for reinsertion into the well by means of the pipe moving mechanism **30** when desired. Also, if desired, at any point, the tubing string may be cut to remove a defective joint, if desired, and a joint replaced, as by welding. Also, the rotatable basket or receptacle provides for quick continuous movement of the pipe into and out of the well when desired without the necessity of breaking the string of pipe into separate joints. However, it is to be noted that, if desired the pipe string may be broken into joints and stacked on the rack **10** by reversing the movement of the pipe through the mechanism. In this event, the location of the sensing elements would be altered so that the rotating or power tong **27** may break the joint of pipe **15** out of the box **15***b* of the surface end of the string of tubing while moving toward the right. Similarly, the carriage return **40** will be reversed in operation by changing the application of the pressure of the accumulator to the opposite side of the piston to provide for return of the carriage to a position near the guide tube **16** after it has moved toward the rack while disconnecting a joint of pipe from the tubing string. Likewise, the feeder mechanism **14** will be disconnected and rendered inoperative to remain in its rightmost position, and the ratchet mechanism will be reversed in operation and provided with a source of power (not shown) to move the stop members in a reverse direction to move the pipe joints up the inclined rails or carrier members on the rack.

The sensor **S3** will be engaged by the box connected to the pin end of a joint being disconnected from the string of tubing T to cause the gripping elements to grip the pipe, and swing the bell crank to move the sensing element **S4** into engagement with the tubing joint extending through the coupling device to energize the rotator motor in a reverse direction to cause the joint of pipe to be broken out and disconnected from the tubing string T. While the joint is being disconnected, movement of the coupling assembly to the right will move the body or wheels into engagement with a sensing device **S8** connected in series circuit between the power source **54** and the sensors **S3** and **S4** to break the circuit thereto, and de-energize the rotating mechanism motor valve and disengage the gripping elements from the pipe to permit the pipe joint to be pushed along the trough **13** into a position to be returned to the rack **10**. Also, the limit stop sensing member **S7** will be disposed adjacent the right hand end of the limit of travel of the coupling assembly on the track **21** to be engaged by the housing **25** of the coupling assembly or by the wheels **22** riding along the track **21** to disengage the clutch and disconnect the motor from the pump to terminate operation of the system until the disconnected joint of pipe has been moved out of the trough and the accumulator gas pressure acting on the reversed carriage return for the coupling assembly returns the coupling assembly to its position adjacent the mouth **17***a* of the guide tube for receiving another joint of pipe for disconnection from the string of tubing in the manner just described.

In FIG. **12** is shown a basket type receptacle **200** in which the base **202** for supporting the bearings **201** and the roller sheaves **203** is mounted at an angle on a support or vehicle **204** by means of upright support members **205** and **206** of different lengths, whereby the basket may be disposed on a narrower lateral support and does not overhang the support or vehicle **204**. Obviously, the central conduit **200** will be longer and extend downwardly to the support or vehicle **204**. The open upper end wall **212** is adapted to receive the pipe to be coiled against the annular side wall **211** and supported by the bottom wall **210** in the same manner as in the form of FIGS. **9** and **10**. However, this arrangement of the basket conserves lateral space and provides storage space beneath the basket. In this installation the pipe rack **10** and the feed trough **13** and coupling assembly **20** may be disposed to feed the pipe beneath the elevated portion of the basket, if desired, or the lower side of the basket may be disposed substantially tangent to the coupling assembly and the pipe guiding feed trough.

From the foregoing it will be seen that a method and an apparatus and system have been disclosed which are substantially automatic in operation and require a minimum of attendance by operators or manual manipulation of the pipe or operating mechanism. The pipe moving device **30** coacts with the pipe handling mechanism at the rack, including the coupling mechanism, and is preferably supplied with power from the same source of fluid pressure as the pipe coupling mechanism and other equipment at the rack, and is subject to the same safety controls in the event of an undesirable condition arising. Also, the sensing mechanisms controlling operation of the system may obviously be disposed at other positions or consist of other structures than those described without changing the results obtained in use of the system and method.

The foregoing description of the invention is explanatory only, and changes in details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. Apparatus for handling pipe including: storage means for a plurality of separate pipe joints; means for delivering pipe joints individually from the storage means; guide means for receiving and guiding the joints of pipe for longitudinal movement therethrough; means for moving an individual joint of pipe in said guide means to engagement with the end of a previously delivered joint moved through said guide means; coupling means for joining said joint of pipe from the guide means to a string by rotating said joint of pipe to thread the same to the previously assembled string; means for moving said assembled string of pipe while the joint is being coupled to the string; and a rotatable basket-like storage container for receiving the assembled pipe string therein, said pipe string being deposited in coiled form as said pipe string is moved into said rotatable storage container, said rotatable storage container being rotatable by said pipe string as said pipe string is moved thereinto.

2. Apparatus of the character set forth in claim **1** wherein: said means for coupling said joint of pipe to the assembled string of pipe and said moving means are reversible to uncouple the individual joints from said string of pipe while said string of pipe is being moved by the reversed moving means.

3. Apparatus of the character set forth in claim **1** wherein: a supplemental rotatable basket-like storage container is provided adjacent the said first storage container for receiving the assembled string of pipe in a coiled form for storage therein.

4. The apparatus of claim **1** wherein said storage means includes: means for delivering individual joints of pipe one at a time to said guide means correctly aligned to be received in said guide means.

5. The apparatus of claim 2 wherein said means for moving said pipe joint longitudinally through said guide means includes: fluid pressure operable means for moving said means for moving said joint of pipe into engagement with the previous joint already made up in said string of pipe.

6. The apparatus of claim 1 wherein said coupling means includes: first and second gripping means for gripping the pipe and means for rotating one of said first and second gripping means relative to the other of said first and second gripping means about their common longitudinal axes for joining said one pipe joint to the previously delivered pipe joint.

7. The apparatus of claim 6 wherein said coupling means includes: sensing means for detecting the presence of the enlarged box end connection of the pipe and means for energizing said first and second gripping means to grip the pipe string on opposite sides of said box whereby subsequent rotation of one of said gripping means relative to the other of said gripping means produces the connection to attach the newly delivered joint of pipe to said previously delivered joint of said pipe string.

8. The apparatus of claim 7 including: sensing means operatively associated with said first and second gripping means and with said means for energizing said rotating means operable to automatically stop rotation of the pipe and to release said gripping means when the pipe connection has been produced.

9. The apparatus of claim 3 wherein said supplemental basket-like storage means comprises a receptacle body having an annular upright sidewall with upper and lower inwardly extending annular flanges at the upper and lower ends of said side wall, respectively, and means for supporting said receptacle body for free rotational movement.

10. The device of claim 9 wherein said receptacle body is provided with swivel flow conductor means connectable to the upper end of said pipe string to permit the circulation of fluids through said pipe string at all times.

11. The device of claim 10 including: deck means for supporting said storage means; and means supporting said deck means in position over said rotatable basket, said deck support means being spaced from said basket.

12. The device of claim 10 wherein said basket is disposed at an angle relative to a horizontal plane whereby it occupies less space and provides storage space therebeneath.

13. Apparatus of the character set forth in claim 1 including first stationary gripping means in said coupling means for gripping said string of coupled joints of pipe to prevent rotation thereof about its longitudinal axis; second gripping means on said coupling means for gripping said individual pipe joint to be joined to said string; means for rotating said second gripping means to rotate said individual joint of pipe to couple said joint to said string; first sensing means sensing the presence of said string of pipe in said coupling means and activating said first gripping means and said second gripping means; second sensing means sensing the presence of said individual joint of pipe in said coupling means and activating said rotating means; and third sensing means sensing the completion of the coupling of said individual joint to said string and deactivating both said gripping means and said rotating means.

14. Apparatus of the character set forth in claim 13 including: fourth sensing means for sensing movement of the end of said string of coupled joints of pipe as said string is moved out of said coupling means to stop movement of said string of pipe when said end of said string passes said fourth sensing means without another joint coupled thereto.

15. A pipe handling system for inserting pipe into and removing pipe from a well and including: fluid pressure operated pipe gripping and moving means connected with the well at the surface for moving pipe into and out of said well; means for guiding a string of coupled sections of pipe to said pipe gripping and moving means; horizontally disposed coupling means for joining sections of pipe together in an elongate string of pipe for insertion into said well; means for receiving and guiding separate sections of pipe in correct axial alignment to said coupling means; means for moving said separate sections of pipe in said receiving and guide means to direct said separate sections to be connected to the end of the string of joined sections of pipe being moved into the well; storage rack means for supporting a plurality of separate sections of pipe in position to be delivered individually to said receiving and guide means; and means for moving an individual separate section of pipe from said rack storage means into said receiving and guide means; said coupling means for joining said section of pipe with said string being operable to effect such joining while said string of connected sections is being moved toward the well by said pipe gripping and moving means, said guide means being curved for guiding said string of joined sections from a horizontal position along said coupling means into a vertical position for movement into the well by said gripping and moving means.

16. A system of the character set forth in claim 15 including: first sensing means for sensing the presence of said separate section of pipe in said receiving and guide means and activating said means for moving said section of pipe toward said coupling means; and second sensing means on said coupling means for sensing the movement of the string of joined sections of pipe through said coupling means and the movement of said separate sections of pipe into said coupling means to activate said coupling means to join said separate section of pipe to said string of joined sections of pipe.

17. A system of the character set forth in claim 16 including: first stationary gripping means on said coupling means operable to hold said string of joined sections of pipe against rotation about its longitudinal axis; second gripping means on said coupling means for gripping said separate section of pipe; means for rotating said second gripping means to rotate said section of pipe to connect said section to said string; said second sensing means activating said rotating means for rotating said second gripping means to rotate said separate section of pipe to couple said section of pipe to said string of joined sections of pipe; and sensing means on said coupling means sensing the force applied by said rotating gripping means to said separate section of being coupled with said string to deactivate said rotating means and said gripping means to free said coupled joint and string for movement through said coupling means.

18. A method of handling pipe for moving the same into and out of a well comprising: racking individual joints of pipe in a storage rack; moving said individual joints of pipe automatically one at a time from said rack into position horizontally to be coupled with a previously moved joint into a string; coupling said last moved joint of pipe automatically to the previously moved joint into a string of coupled joints; curvedly guiding the pipe string from a horizontal position to a vertical position for entering said well; and moving said string of pipe automatically into the well.

19. The method of handling pipe for moving the same into and out of a well comprising: racking individual joints of pipe in a storage rack; moving said individual joints of pipe automatically one at a time from said rack into position to be coupled with a previously moved joint into a string; coupling said last moved joint of pipe automatically to the previously moved joint into a string of coupled joints; moving said string of pipe automatically into a well; automatically removing said string of pipe from said well; moving said string of pipe automatically into a rotatable receptacle; coiling said string of pipe in said receptacle and rotating said receptacle while said pipe is being moved into said receptacle to store the pipe in said receptacle in a coiled condition; removing said pipe automatically from said receptacle; guiding said string of pipe to said well; and moving said string of pipe automatically into said well.

20. The method of claim 19 including the additional steps of again removing said string of pipe automatically from said well; moving said string of pipe automatically toward said rack; breaking said string of pipe automatically into individual sections; and storing said individual sections in said rack.

21. The method of handling pipe for moving the same into and out of a well comprising: racking individual joints of pipe in a storage rack; moving said individual joints of pipe automatically one at a time from said rack into position to be coupled with a previously moved joint into a string; coupling said last moved joint of pipe automatically to the previously moved joint into a string of coupled joints; moving said string of pipe automatically into a well; removing said string of pipe automatically from said well; moving said string of pipe automatically into a rotatable receptacle; coiling said string of pipe in said receptacle and rotating said receptacle while said pipe is being moved into said receptacle to store the pipe in said receptacle in coiled condition; moving said receptacle to another well; removing said string of pipe automatically from said receptacle; guiding said string of pipe to said another well; and moving said string of pipe automatically into said another well.

22. The method of handling pipe for moving the same into and out of a well comprising: racking individual joints of pipe in a storage rack; moving said individual joints of pipe automatically one at a time from said rack into position to be coupled with a previously moved joint into a string; coupling said last moved joint of pipe automatically to the previously moved joint into a string of coupled joints; guiding the moving string of pipe to a well; moving said string of pipe automatically into the well; removing said string of pipe automatically from said well; moving said string of pipe automatically into a rotatable receptacle; coiling said string of pipe in said receptacle and rotating said receptacle while said pipe is being moved into said receptacle to store the pipe in said receptacle in coiled condition; removing said string of pipe automatically from said receptacle; guiding said string of pipe to another well; and moving said string of pipe automatically into said another well.

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