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March 4, 1975 N. D. DYER Re. 28,351

PIPE HANDLING APPARATUS

Original Filed Sept. 15, 1967 8 Sheets-Sheet 1

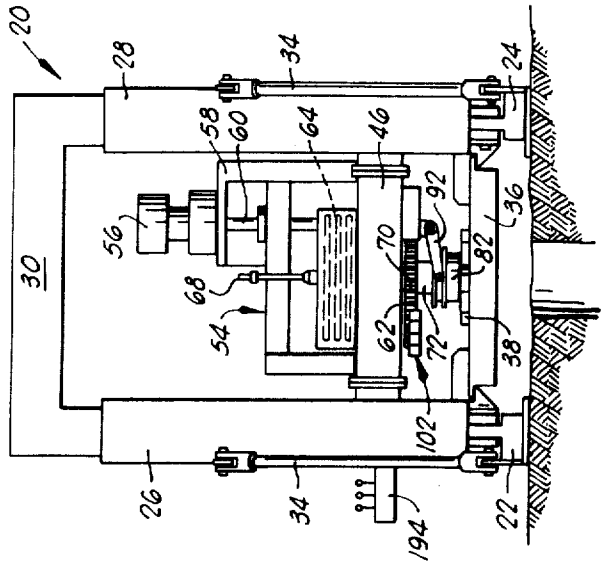


Fig. 2

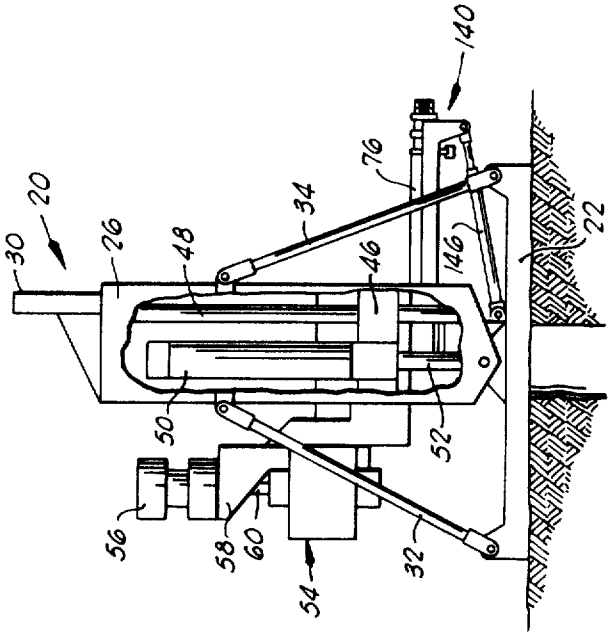


Fig. 1

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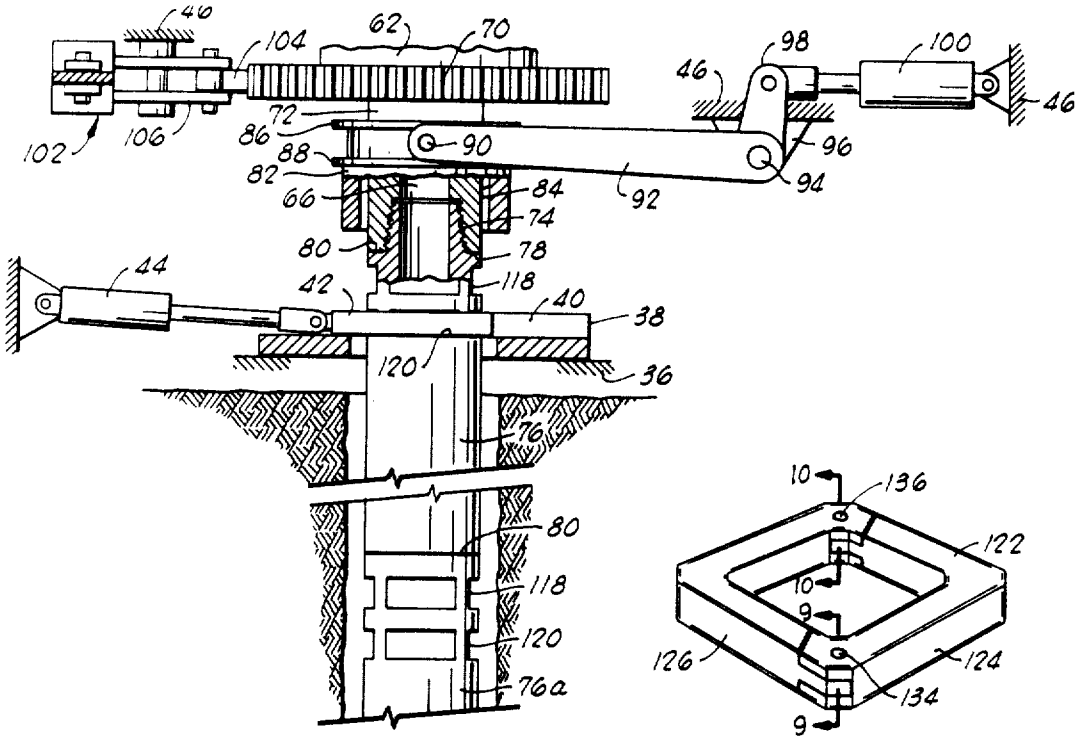


Fig. 3

Fig. 8

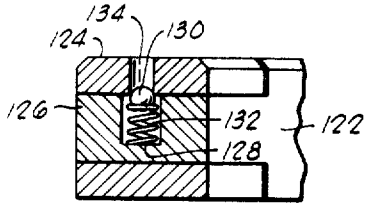


Fig. 9

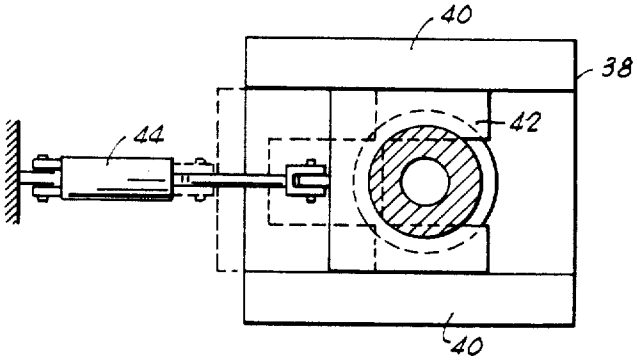


Fig. 6

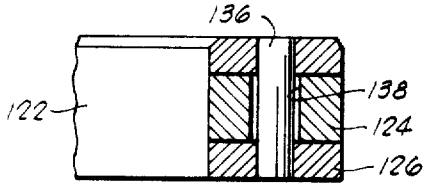


Fig. 10

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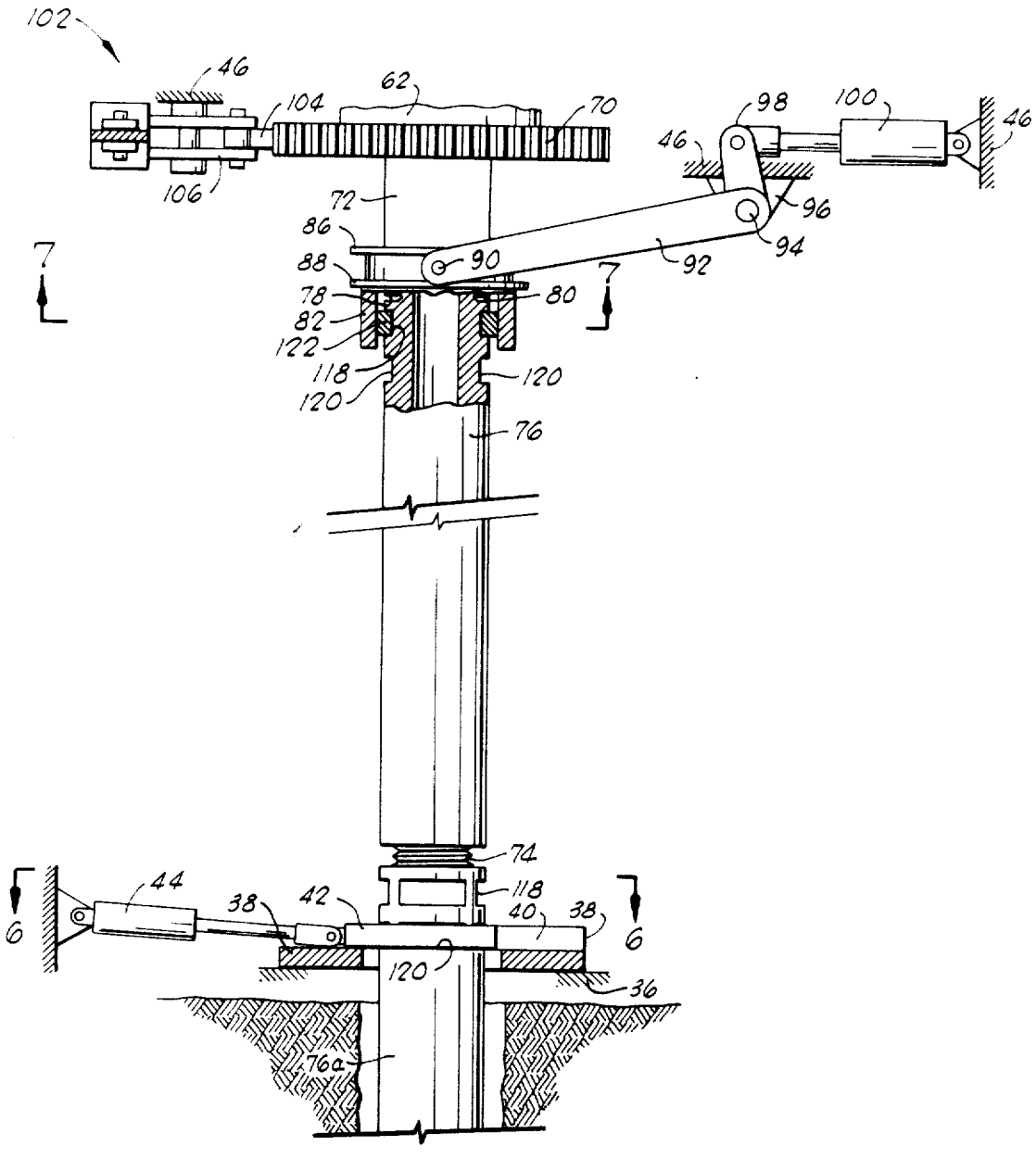


Fig. 4

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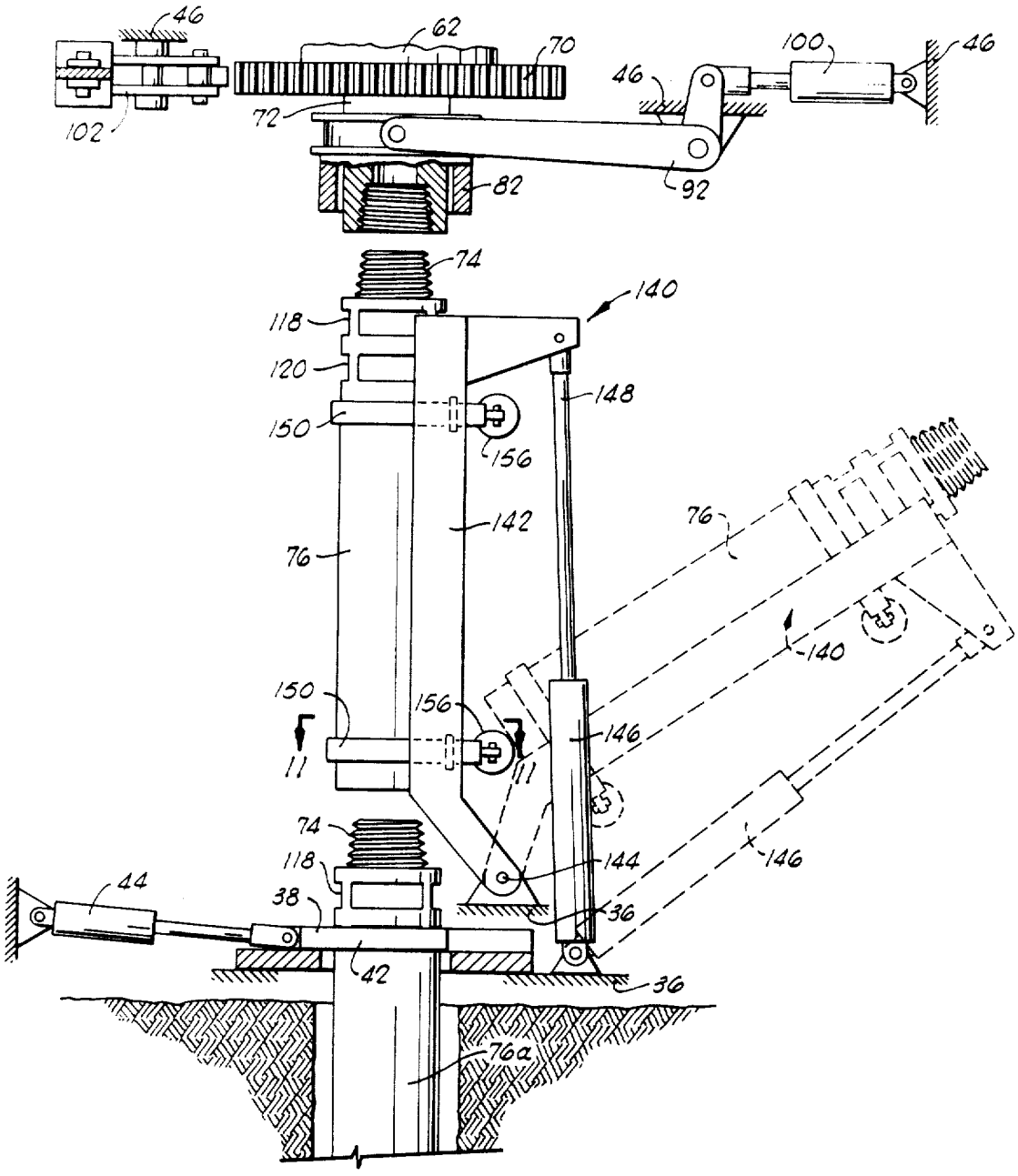


Fig. 5

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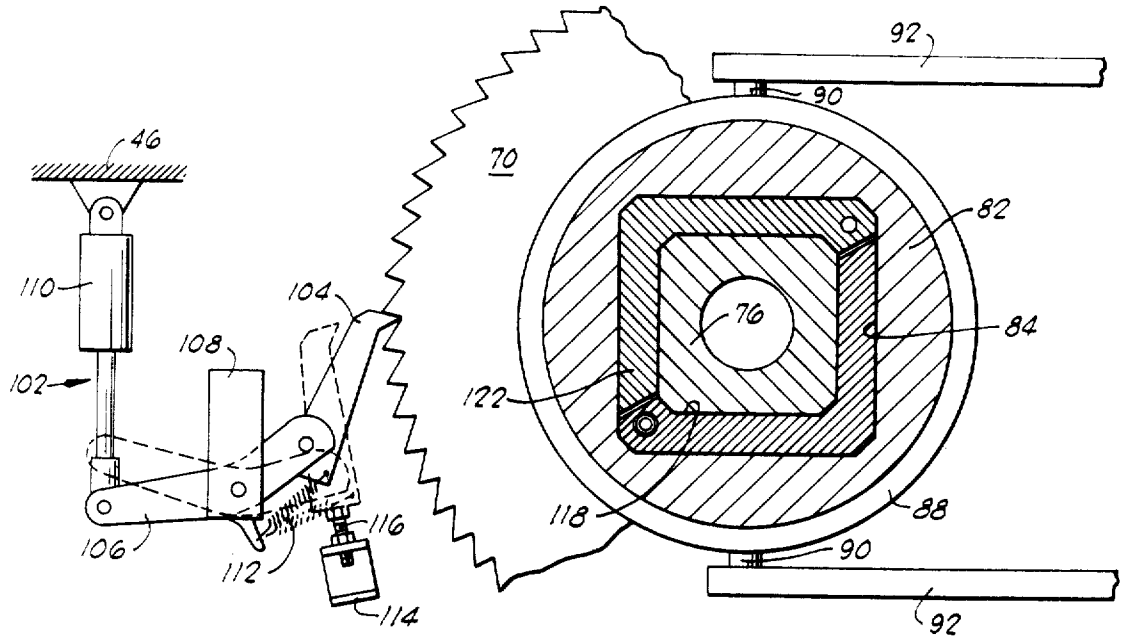


Fig. 7

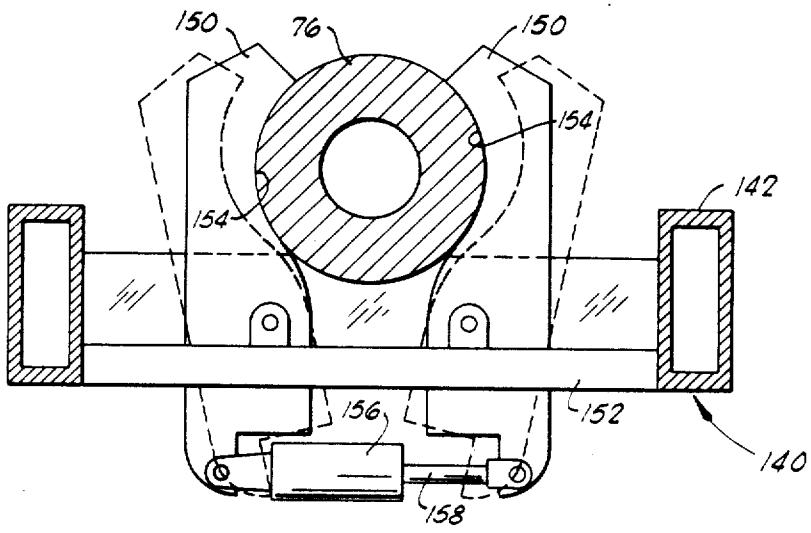


Fig. 11

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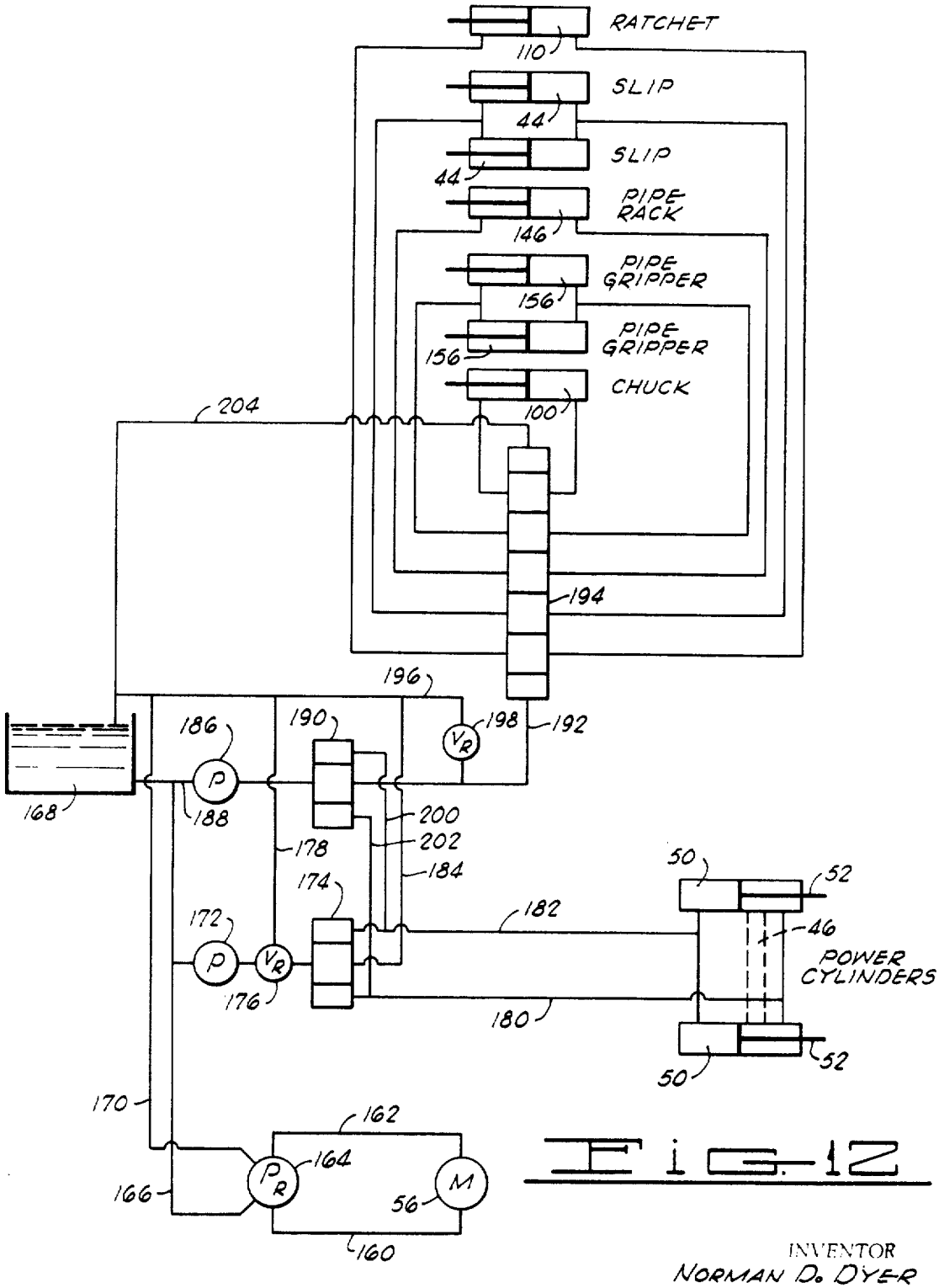


Fig. 12

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Original Filed Sept. 15, 1967 8 Sheets-Sheet 7

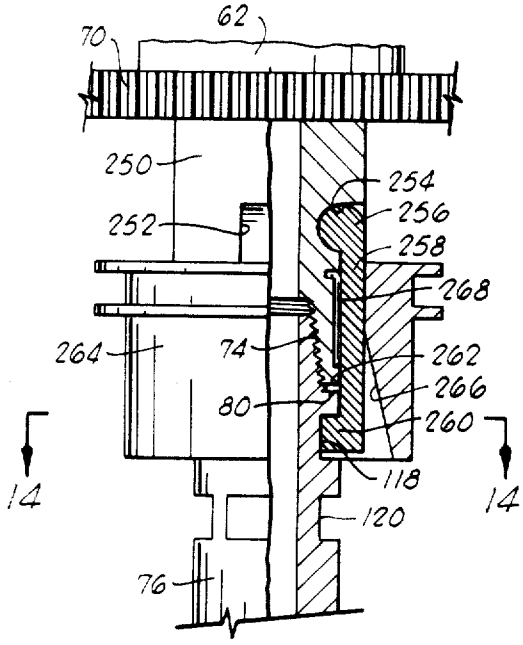


Fig. 13

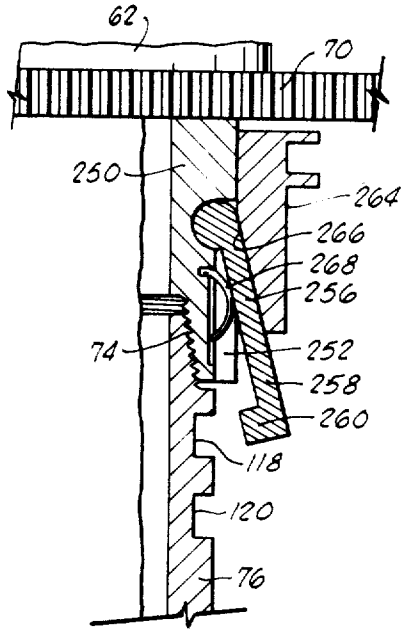


Fig. 15

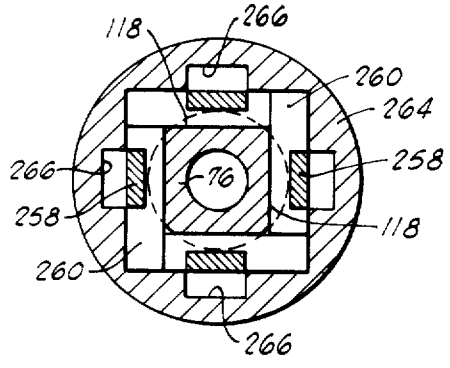


Fig. 14

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PIPE HANDLING APPARATUS

Original Filed Sept. 15, 1967 8 Sheets-Sheet 8

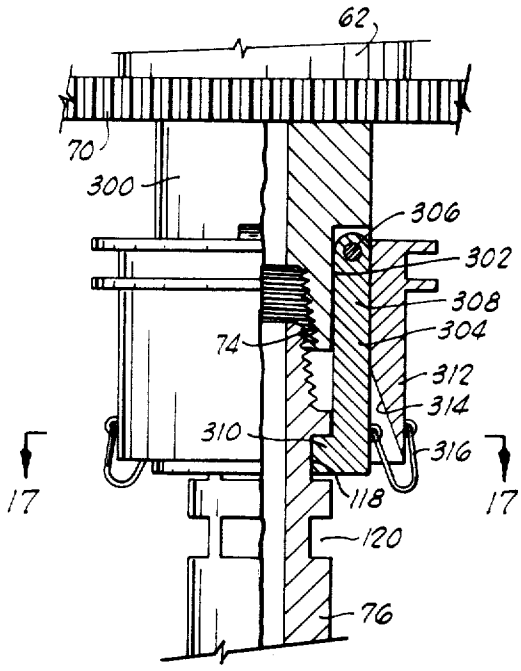


Fig. 16

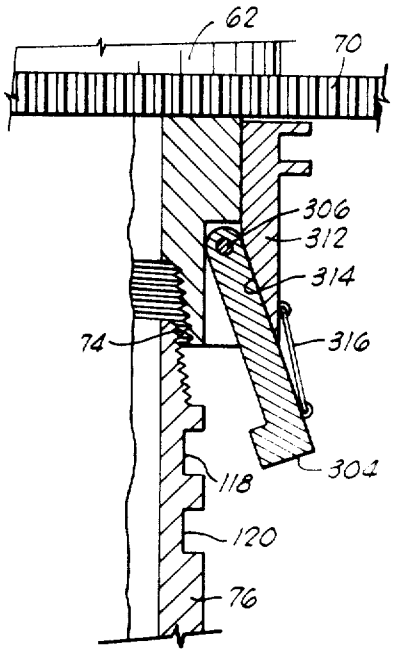


Fig. 18

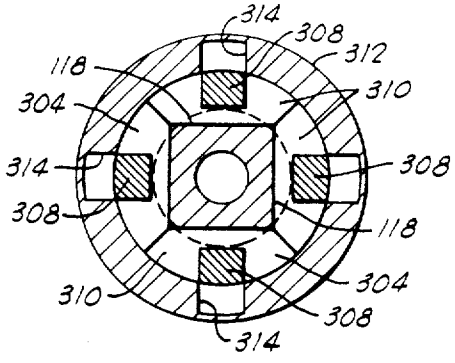


Fig. 17

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United States Patent

Re. 28,351
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28,351

PIPE HANDLING APPARATUS

Norman D. Dyer, Beaumont, Tex., assignor to Dresser Industries, Inc., Dallas, Tex.

Original No. 3,446,284, dated May 27, 1969, Ser. No. 667,957, Sept. 15, 1967. Application for reissue Dec. 5, 1969, Ser. No. 888,182

Int. Cl. E21b *19/16*

U.S. Cl. 173—164 14 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

Apparatus for unscrewing selected threaded connections between sections of pipe and the like. Each pipe section having flats on the exterior thereof that are engaged by a wrench whereby torque can be applied to the pipe. Rotation is applied to one of the pipe sections through the wrench and flats while a subjacent pipe section is being held against rotation by a slip device that engages the flats on the subjacent pipe section, whereby the threaded connection therebetween is broken.

Background of the invention

This invention relates generally to pipe handling apparatus. More particularly, but not by way of limitation, this invention relates to apparatus for unscrewing selected threaded connections between sections of pipe and the like wherein the apparatus is incorporated in rotary drilling machines of the top drive type.

In the top drive rotary drilling machine, the uppermost section of the drill pipe is generally connected to a rotary drive mechanism that imparts rotation to the drill string. The rotary drive mechanism is usually carried on a cross head which is raised and lowered in a mast to either raise or lower the pipe sections in a well bore or the like.

In using the top drive machines in drilling well bores and particularly in drilling raises between drifts in mines, the pipe sections forming the pipe string connecting the drill bit with the rotary drive mechanism are subjected to extremely high torque loads. The result of the loads imposed on the pipe sections, which are interconnected by threads is that the threaded connections become extremely tight and require a very high torque to break the connection. Therefore, it is necessary to provide some means for imposing the required torque on the threaded connections and it is highly desirable, if not essential, that such torque be applied only to the connection that is to be separated. In addition to the foregoing, any device utilized to break the connections must also permit transmission of torque to the pipe from the rotary drive during drilling operations; it must be sufficiently strong to permit the imposition of the required torque for breakout; and, at the same time, it must be of a size and weight that can be readily handled by personnel operating the drilling machine. Due to the conditions under which the drilling machines operate, it is also highly desirable that the device utilized for breaking the threaded joints be extremely rugged and, yet, as simple in construction and operation as possible to reduce both cost and maintenance.

Summary of the invention

This invention provides improved apparatus for unscrewing selected threaded connections between sections of pipe or the like wherein each pipe section has flats on the exterior thereof. The apparatus includes means for rotating the pipe and means for displacing the rotating means along the axis of the pipe. A chuck member is slidingly mounted on the rotating means and is engageable with a wrench that is positioned in the flats. When the chuck is moved into engagement with the wrench, the rotating means is positively connected with the pipe section whereby the pipe section and rotating means are connected for common rotation. The apparatus also includes slip means that are movable into holding engagement with the flats on the pipe section to permit loosening of the connection between the rotating means and the pipe section. The slip means are then engaged with the flats on a subjacent pipe section whereby rotation of the rotating means with the wrench and first pipe section unthreads the threaded connection between the pipe sections.

It is one object of the invention to provide improved pipe handling apparatus for unscrewing selected threaded connections between sections of pipe and the like.

Another object of the invention is to provide improved pipe handling apparatus that is relatively uncomplicated in structure and yet provides the extremely high torque required to unscrew the threaded connections.

Still another object of the invention is to provide improved pipe handling apparatus for unscrewing selected threaded connections between sections of pipe that is positive in operation and is relatively maintenance free.

The foregoing and additional objects and advantages of the invention will become more apparent as the following detailed description is read in conjunction with the accompanying drawings.

Brief description of the drawing

FIG. 1 is a side elevation partially broken out, of a top drive drilling machine incorporating apparatus constructed in accordance with the invention.

FIG. 2 is a front elevation view of the drilling machine of FIG. 1 with certain portions removed for clarity of illustration.

FIG. 3 is a schematic view, partly in elevation and partly in cross-section, of portions of the top drive drilling machine illustrating the use of the apparatus during removal of pipe sections from the well bore.

FIG. 4 is a view similar to FIG. 3, but showing the apparatus in another stage of operation.

FIG. 5 is another view similar to FIGS. 3 and 4, but showing the apparatus in still another operating position.

FIG. 6 is a view illustrating the operation of the slip mechanism taken generally along the lines **6—6** of FIG. 4.

FIG. 7 is an enlarged view taken along the line **7—7** of FIG. 4 illustrating the operation of a torque applying mechanism that is also constructed in accordance with the invention.

FIG. 8 is a pictorial view of one embodiment of a wrench utilized in the apparatus constructed in accordance with the invention.

FIG. 9 is an enlarged cross-sectional view taken along the line **9—9** of FIG. 8.

FIG. 10 is an enlarged cross-sectional view taken along the line **10—10** of FIG. 8.

FIG. 11 is an enlarged cross-sectional view taken along the line **11—11** of FIG. 5 and illustrating the operation of a portion of the pipe handling mechanism.

FIG. 12 is a schematic drawing of the hydraulic circuit utilized in the drilling machine of FIG. 1.

FIG. 13 is a fragmentary view, partially in elevation and partially in cross-section illustrating another embodiment of apparatus that is also constructed in accordance with the invention.

FIG. 14 is a cross-sectional view taken along the line **14—14** of FIG. 13.

FIG. 15 is a cross-sectional view similar to the right hand portion of FIG. 13, illustrating the apparatus of FIG. 13 in another operating position.

FIG. 16 is a fragmentary view, partly in elevation and partly in cross-section, illustrating still another embodiment of apparatus constructed in accordance with the invention.

FIG. 17 is a cross-sectional view taken along the line 17—17 of FIG. 16.

FIG. 18 is a cross-sectional view similar to the right hand portion of FIG. 16 and illustrating the apparatus of FIG. 16 in another operating position.

Description of one embodiment

Referring to the drawing and to FIGS. 1 and 2 in particular, shown therein and generally designated by the reference character **20** is a top drive rotary drilling machine designed to be utilized in the drilling of raises and mines. The drilling machine **20** includes a pair of parallelly disposed spaced base members **22** and **24**, side frame members **26** and **28** that are pivotally connected with the base members **22** and **24**, respectively, and a top frame member **30** that extends between and connects the upper ends of the side frame members **26** and **28**.

Although not shown, the side frame members **26** and **28** can be tilted with respect to the base members **22** and **24** through their pivotal connection. As illustrated, the side frame members **26** and **28** are held in the vertical position by links **32** and **34** which extend between the side frame members **26** and **28** and their respective base members **22** and **24**. Manifestly, if the side frame members **26** and **28** are to be tilted, the links **32** and **34** will have to be either adjusted in length or replaced by links of a different length.

A lower cross member **36** extends between the lower ends of the side members **26** and **28** as shown in FIG. 2. The lower cross member **36** supports a slip device **38**. As shown in FIG. 6, the slip device **38** includes a pair of guide members **40** supported by the cross member **36** that are arranged to slidingly receive a generally U-shaped slip **42**. The slip **42** is connected with a double-acting, hydraulic cylinder **44** so that the slip **42** can be reciprocated for reasons that will be pointed out more fully hereinafter.

A cross head **46** extends between the side frames **26** and **28** as shown in FIG. 2. The ends of the cross head **46** extend into the side frames **26** and **28** and are slidingly disposed on a guide rod **48** that is mounted in and extends vertically in the side frames **26** and **28**. Each end of the cross head **46** is also connected with a double-acting hydraulic cylinder **50**. As shown in FIG. 1, each of the double-acting, hydraulic cylinders **50** includes a piston **52** that has its lower end connected with one of the side frames **26** and **28** so that a reciprocating motion is transmitted to the cross head **46** through the cylinders **50**.

Mounted on the cross head **46** is a rotary drive mechanism generally designated by the reference character **54**. The rotary drive mechanism **54** includes a hydraulic motor **56** that is mounted on a suitable frame **58** connecting the rotary drive mechanism **54** with the cross head **46**.

The hydraulic motor **56** has an output shaft **60** that is connected through a suitable power transmission system to a rotary member **62**. The power transmission system may include a chain drive mechanism **64** as shown in dash lines in FIG. 2.

As shown in FIG. 3, the rotary member **62** has a bore **66** extending therethrough. The bore **66** is in fluid communication with a conduit **68** having a swivel mounted thereon for connection with a source of drilling fluid (not shown) for reasons that are well known in the drilling art.

The rotary member **62** has a ratchet gear **70** mounted thereon for purposes that will become more apparent hereinafter and also includes a generally rectangular rotary drive member **72** having female threads **74** formed in the lower interior end thereof that are adapted to mate with the male thread formed on the upper end of a drill pipe section **76** as shown in FIG. 3. The rotary drive member **72** has a lower end surface **78** that engages an upwardly facing shoulder **80** on the drill pipe section **76** when the threads **74** are in full mating engagement.

Slidingly positioned on the rotary drive member **72** is a chuck **82** having a generally rectangular opening **84** extending therethrough (see also FIG. 7) so that the chuck **82** rotates with the rotary drive member **72**. The chuck **82** is provided at its upper end with a pair of spaced flanges **86** and **88** that encircle the exterior thereof to receive a pair of bearings **90** (only one is shown in FIG. 3) that are carried by a pair of lever arms **92**. The chuck **82** is rotatable relative to the arms **92**.

The lever arms **92** are interconnected by a shaft **94** that extends in pivoting relationship through a bracket **96** mounted on the cross head **46**. An actuating lever **98** connects the lever arms **92** with a double-acting, hydraulic cylinder **100** that is also mounted on the cross head **46**. The arrangement of the linkage described provides a positive means through which actuation of the double-acting, hydraulic cylinder **100** can move the chuck **82** relatively along the axis of the pipe **76**.

Also mounted on the cross head **46** is a torque applying mechanism generally designated by the reference character **102** that operates in conjunction with the ratchet gear **70**. As shown most clearly in FIG. 7, the torque applying mechanism **102** includes a ratchet dog **104** that is engageable with the ratchet gear **70**. The ratchet dog **104** is pivotally mounted on a lever arm **106** that is pivotally carried by a bracket **108** mounted on the cross head **46** (see FIG. 3). The opposite end of the lever arm **106** from the ratchet dog **104** is pivotally connected with a double-acting cylinder **110** that is also mounted on the cross head **46**. A spring **112** extends between the ratchet dog **104** and the lever arm **106** to bias the ratchet dog **104** toward a position in which it will engage the ratchet gear **70**.

The torque applying mechanism **102** is intended to provide additional torque which may be necessary to unscrew the mating threads **74**. Consequently, its direction of actuation will be in a direction opposite to the normal rotation of the device during drilling. Normal rotation of the pipe sections **102** tends to make the threads **74** tighter.

To positively maintain the ratchet dog **104** out of engagement with the ratchet gear **70** during drilling operations, a bracket **114** is mounted on the cross head **46** and adjustable cam **116** mounted therein. The cam **116** is positioned to engage the ratchet dog **104** when the cylinder **110** is in the retracted position. When the cam **116** is in engagement with the ratchet dog **104**, the force of the spring **112** is overcome and prevents the ratchet dog **104** from being biased into engagement with the ratchet gear **70** by the spring **112**.

As may be seen in FIGS. 3, 4 and 5, the drill pipe string, which as previously mentioned, connects the rotary drive mechanism with the drill bit (not shown) is composed of a plurality of identical pipe sections **76**, **76a**, etc. Each of the pipe sections **76**, **76a**, etc. includes a pair of spaced flats **118** and **120** located near the upper ends thereof. Each of the flats **118** and **120** is formed on the drill pipe section to form a substantially rectangular surface thereon (see FIG. 7) to receive a wrench member **122** or to receive the U-shaped slip **42** depending upon the operation to be performed. It should also be pointed out that the drill pipe sections are interconnected by the mating threads **74**. Between each section **76**, **76a**, etc., there is provided a downwardly facing surface corresponding to the surface **78** on the drive member **72** and an upwardly facing shoulder **80** which mate very tightly when the thread **74** is fully engaged. While each of the pipe sections is illustrated as having two sets of flats, only one is required to perform the unscrewing of the threaded connections as will be described hereinafter.

The wrench **122** is illustrated more clearly in FIGS. 8, 9 and 10. As shown therein, the wrench **122** is constructed from two L-shaped members **124** and **126** having each

pair of ends mating in a tongue and groove arrangement.

As illustrated in FIG. 9, a releasable latch is provided whereby the wrench **122** may be opened when desired. To form the releasable latch, a recess **128** is formed in the mating portion of the L-shaped section **126** and a ball **130** and spring **132** are disposed therein. The spring **132** is arranged to urge the ball **130** relatively toward a hole **134** that is drilled in the mating portion of the L-shaped section **124**. The hole **134** serves as a detent, partially receiving the ball **130** whereby the members are releasably connected.

The opposite mating ends of the members **124** and **126** are formed into a similar tongue and groove arrangement. However, these mating end portions are preferably hinged together by a pin **136** that extends therethrough substantially as shown in FIG. 10. Preferably, the hole **138** extending through the tongue portion of the L-shaped member **124** is enlarged so that the hinging arrangement between the members **124** and **126** is relatively loose, permitting slight movement between the members **124** and **126** other than pivotal movement about the hinge pin **136**. The movement is desirable so that the wrench **122** can be easily positioned in the opening **84** and on the flats **118** and **120**, so that the chuck **82** will slide relatively easily thereover and so that the wrench **122** can move to accommodate the forces applied thereto during unscrewing of the threads **74**. If desired, the pin **136** can be constructed from a resilient material that will permit the desired relative movement without the necessity of having the enlarged hole **138**.

Referring to FIG. 5, shown therein is a pipe handling divice designated generally by the reference character **140**. The pipe handling device **140** includes a frame **142** that is connected with the cross member **36** by a pivot **144** and a double-acting, hydraulic cylinder **146** that is also pivotally connected with the cross member **36**. The cylinder **146** includes a piston **148** that is pivotally connected with the frame **142** so that relative telescoping movement between the piston **148** and the cylinder **146** pivots the frame **142** about the pivot **144**. A pair of spaced sets of pipe gripping members **150** are carried by the frame **142**.

As shown more clearly in FIG. 11, the pipe gripping members **150** are pivotally mounted on cross members **152** located in the frame **142**. The innermost sides of the pipe gripping members **150** have radii **154** that are sized and arranged to encircle a portion of the pipe section **76** when the members **150** are in engagement therewith. A double-acting, hydraulic cylinder **156** is pivotally connected with one of the pipe gripping members **150** of each set and a piston **158** contained in the cylinder **156** is pivotally connected with the opposite gripping member **150** of each set whereby telescoping action between the piston **158** and cylinder **156** pivots the gripping members **150** relatively into and out of engagement with the pipe section **76**.

It will be appreciated that the various hydraulic components previously described can be replaced by equivalent pneumatic or electrical apparatus. However, to more clearly describe the preferred hydraulic embodiment, reference is now made to FIG. 12 wherein the hydraulic circuit is shown schematically. Manifestly, the circuit includes many well known components that have been omitted for clarity of illustration.

As shown therein, the hydraulic motor **56** is connected by conduits **160** and **162** with a reversible hydraulic pump **164**. The hydraulic pump **164** is of the variable volume type wherein the output volume of the pump is varied to vary the speed of the motor **56**. It will be noted that the circuit between the pump **164** and motor **56** is a closed circuit. However, a makeup line or conduit **166** connects the pump with the outlet from a reservoir **168** and a relief line or conduit **170** connects the pump **164** with the discharge into the reservoir **168**.

A second pump **172** is connected with the reservoir **168** through the conduit **166** and with a control valve **174** that is located on the output side of the pump **172**. The pump **172** may be generally described as a high volume, low pressure pump. A relief valve **176** is disposed between the control valve **174** and the pump **172** to protect the circuit and pump in the event that the pressure should reach a predetermined value that could damage the pump **172**. The relief valve **176** is connected by a conduit **178** with the discharge into the reservoir **168**.

The control valve **174** is a four-way valve having a conduit **180** extending therefrom that is connected with one end of each of the double-acting, hydraulic cylinders **50** and a conduit **182** extending therefrom that is connected with the opposite end of each of the double-acting, hydraulic cylinders **50**. A discharge conduit **184** extends from the control valve **174** to return fluid to the reservoir **168**. The arrangement is such that hydraulic fluid can be pumped through the conduit **180** to lower the cross head **46** (shown in dash lines in FIG. 12) and pumped through the conduit **182** to raise the cross head **46**. The use of the high volume, low pressure pump with the cylinders **50** provides for very rapid movement of the cross head **46** without a great deal of power and is intended to be used primarily during movement of the pipe section **76** into and out of the hole being drilled by the machine **20**.

A third pump **186** is connected with the outlet from the reservoir **168** by a conduit **188**. The pump **186** is of the low volume, high pressure type. A control valve **190** is connected with the outlet of the pump **186** and the control valve **190** is connected by a conduit **192** with a stack of control valves **194**. A conduit **196** connects the conduit **192** with the reservoir **168** for the return of fluid to the reservoir **168**. A pressure relief valve **198** is interposed in the conduit **196** and is set to relieve the pressure in the conduit **192** should it exceed a predetermined value.

One of the primary functions of the pump **186** is to provide relatively high pressure fluid to the double-acting, hydraulic cylinders **50** for drilling. To perform this function, the control valve **190** is connected by a conduit **200** with the conduit **182** which leads to one side of the cylinders **50**. Similarly, the conduit **180**, which leads to the opposite side of the cylinders **50**, is connected with the control valve **190** by a conduit **202**. The control valves **174** and **190** are arranged so that the hydraulic cylinders **50** can either be actuated by the high volume, low pressure pump **172** for rapid movement during tripping of the pipe **76** into and out of the bore or by the low volume, high pressure pump **186** for relatively slow but controlled high pressure movement of the cylinders **50** during drilling.

The opposite end of the stacked control valves **194** is provided with a conduit **204** for the return of fluid to the reservoir **168**. Contained within the control valves **194** is a pressure relief valve (not shown) that is set to open at a predetermined pressure to prevent the imposition of unduly high pressure on the hydraulic cylinders with which the control valves **194** are connected.

As clearly shown in FIG. 12, each of the individual valves contained within the stack of control valves **194** is connected with a respective double-acting cylinder **44**, **100**, **110**, **146** or **156**. The arrangement is such that the double-acting cylinders can be actuated to drive the pistons contained therein in the appropriate direction to affect the desired operation of the devices actuated by the cylinders.

Operation

As the bit (not shown) penetrates the formation in the bore, it is necessary to continually add pipe sections **76** to interconnect the drilling machine **20** with the bit. To accomplish this, a pipe section **76** is placed on the pipe handling device **140** as illustrated in FIG. 1. The pipe handling device **140** is then raised to the vertical position,

as illustrated in FIG. 5, with the pipe section **76** securely retained therein by the gripping members **150**. The cross head **46** is lowered by actuating the hydraulic cylinders **50** in the proper direction until the rotary drive member **72** engages the thread **74** on the pipe section **76**. When this occurs, the gripping members **150** are released, and the cross head **46** is lowered until the threads **74** on the lower end of the pipe section **76** engage the mating threads on the upper end of the subjacent section **76a**. The rotary drive **62** is actuated through the motor **56** tightening the mating threads **74**.

The slip **42**, holding the subjacent section **76a** and all sections of pipe **76** thereinbelow, is then released and the cross head **46** lowered until the bit (not shown) engages the bottom of the bore. As the rotary drive **62** rotates, the upwardly facing shoulder **80** on the pipe section **76** securely engages the downwardly facing surface **78** on the drive member **72** securing the drive member **72** and the various pipe sections **76**, **76a**, etc. together. During drilling, force is applied to the pipe string and bit through the hydraulic cylinders **50** which are actuated by the high pressure, low volume pump **186**.

During the upward reaming of the hole when drilling raises or during a trip out of the hole when drilling downwardly, it is necessary to remove pipe sections from the string whereby the pipe string is shortened. To accomplish this, the slip **42**, through the hydraulic cylinder **44**, is moved into engagement with the flats **120** on the pipe section **76**. The rotary drive member **72** is then rotated in a direction to unscrew the threads **74** until the initial engagement between the shoulder **80** and surface **78** is broken.

Due to the high torque loadings applied to the threads **74** during drilling, the initial torque necessary to separate the shoulder **80** and surface **78** may be extremely high. If the torque required is greater than that available through the motor **56**, the torque applying mechanism **102** can be utilized to provide the additional torque required.

As shown most clearly in FIG. 7, the torque applying mechanism **102** is actuated by applying hydraulic pressure through the appropriate one of the stacked control valves **194** to the hydraulic cylinder **110**. Extension of the piston from the hydraulic cylinder **110** rotates the lever **106** in the bracket **108**, moving the ratchet dog **104** into engagement with the teeth on the ratchet gear **70**. Simultaneously, torque is applied by the hydraulic motor **56** tending to rotate the drive member **72** in the same direction as the force applied by the ratchet dog **104**. Thus, the torque applying mechanism **102** exerts an additional torque that will be sufficient to disengage the shoulder **80** and surface **78** whereby the threads **74** can be parted.

If it is necessary to rotate the drive member **72** more than is available through the initial engagement between the ratchet dog **104** and the ratchet gear **70**, pressure can be applied to the opposite side of the hydraulic cylinder **110**, disengaging the ratchet dog **104** from the teeth on the gear **70**. The pressure is then reapplied to the cylinder **110**, moving the ratchet dog **104** into engagement with the next tooth on the gear **70** to rotate the gear and the attached rotary drive **72** a greater distance until the initial engagement between the shoulder **80** and surface **78** is broken.

After the shoulder **80** and surface **78** have parted slightly, the wrench member **122** is latched about the upper flats **118** in the pipe section **76**. With the wrench **122** in position on the flats **118**, the hydraulic cylinder **100** is actuated to move the chuck **82** downwardly over the wrench **122** as illustrated in FIG. 4.

The slip **42** is removed from the flats **120** on the pipe section **76** and the hydraulic cylinders **50** are actuated to raise the cross head **46** and pipe sections until the subjacent pipe section **76a** is positioned with the lower flats **120** thereon in alignment with the slip **42**. The slip **42** is actuated through the hydraulic cylinder **44**, moving the slip **42** into engagement with the subjacent section **76a**.

With the torque applying mechanism **102** disengaged and the wrench **122** engaged, the hydraulic motor **56** is actuated to rotate the drive member **72** and attached pipe section **76** relative to the subjacent pipe section **76a**, parting the threads **74** therebetween. If necessary, the torque applying mechanism **102** can be actuated to provide additional torque to break the engagement between the pipe sections **76** and **76a** as previously described. As the thread between the section **76** and the subjacent section **76a** part, the cross head **46** is raised until the section **76** is completely free of the subjacent section **76a**, that is, pipe section **76** is raised to the position illustrated in FIG. 5.

It should be pointed out that the wrench **122** can be constructed relatively light so that it can be easily handled. This is possible because the torque is transmitted through the rectangular drive member **72** to the chuck **82**, wrench **122** and to the flats **118**. The wrench **122** serves only as a filler between the chuck **82** and the flats **118** on the pipe section **76** and the load placed thereon is essentially a compressive load.

When the pipe section **76** has been completely separated from the subjacent section **76a**, the chuck **82** is raised and the wrench **122** removed from the flats **118**. The pipe handling mechanism **140** is then raised to the position illustrated in FIG. 5 and the pipe gripping members **150** actuated through the hydraulic cylinder **156** to securely engage the pipe section **76**.

With the gripping members **150** securely holding the pipe section **76**, the hydraulic motor **56** is actuated to rotate the drive member **72**, unthreading the threads **74** between the drive member **72** and the pipe section **76**. At this point, it can be appreciated that the pipe section **76** is completely free of any connection with the drive member **72** or with the subjacent pipe section **76a**. The hydraulic cylinder **146** is then actuated to lower the pipe handling device **140** and the pipe section **76** into a horizontal position whereupon the pipe gripping members are released and the pipe section **76** removed.

The foregoing procedure is repeated until the desired number of pipe sections have been removed. From the foregoing, it can be appreciated that the apparatus described provides a means for breaking the various threaded connections between the pipe sections at selected connections therebetween.

Without the wrench **122** and the chuck **82**, the application of torque to the drive member **72** would result in the separation of a threaded connection, but it is not immediately discernible which threaded connection might part. If the threads **74** between the drive member **72** and the pipe section **76** were to separate, it would be extremely difficult to engage the pipe section **76** to provide sufficient torque to break out the thread between the pipe section **76** and pipe section **76a**. Also, if the lower thread, that is, the thread between the pipe section **76** and the subjacent pipe section **76a** were to part, it would require a massive pipe handling mechanism to grip the pipe section **76** with sufficient force to resist rotation when it is attempted to break the thread **74** between the drive member **72** and the pipe section **76**. However, when utilizing the apparatus constructed in accordance with this invention, the threaded connections can be broken when and where desired.

Embodiment of FIG. 13

FIGS. 13, 14 and 15 illustrate another embodiment of wrenching arrangement that can be utilized in the top drive drilling machine **20**. As shown in FIG. 13, a generally rectangular drive member **250** is connected with the ratchet gear **70** and rotating member **62** as was the rotary drive member **72** of the embodiment of FIG. 1. Circumferentially spaced, longitudinally extending slots **252** are formed in the exterior of the drive member **250**

with the upper ends **254** of the slots **252** radiused inwardly as clearly shown. Each of the slots **252** is arranged to pivotally receive a wrench dog **256**.

Each of the wrench dogs **256** includes an arm portion **258** that extends downwardly through the slots **252**. The lower end of each dog **256** is formed into a wrench lug **260**. The lugs **260** are sized and arranged to be disposed in the flats **118** or **120** of the pipe section **76**.

The drive member **250** is provided interiorly with the mating threads arranged to mate with the threads **74** on the upper end of the drill pipe section **76**. Also, the drive member **250** has a downwardly facing surface **262** on the lower end thereof arranged to engage the shoulder **80** on the drill pipe section **76**.

To hold the wrench dogs **256** in engagement with the pipe section **76**, a chuck **264** having a rectangular opening therein is slideably disposed on the drive member **250**. By comparing the chuck **264** with the chuck **82**, it can be appreciated that the only distinction therebetween lies in the provision of angularly extending slots **266** in the interior of the chuck **264** adjacent the wrench dogs **256**. The slots **266** are provided to reduce the vertical movement necessary in the chuck member **264** to permit the wrench dogs **256** to move to the fully disengaged position as illustrated in FIG. 15.

A spring **268** is carried by the drive member **250** is located between each of the wrench dogs **256** and the drive member **250** in the slots **252**. As can be seen in FIG. 15, the springs **268** are arranged to return to an arcuate configuration biasing the wrench dogs **256** outwardly into the slots **266** when the chuck **264** has been raised.

As illustrated in FIG. 13, the initial engagement between the shoulder **80** on the pipe section **76** and the surface **262** on the drive member **250** has been previously broken as described in connection with the previous embodiment. The chuck **264** is disposed in the lower position holding the wrench dogs **256** in the flats **118**. As can be clearly seen in FIG. 14, the lugs **260** on the wrench dogs **256** are configured so that they entirely fill the rectangular space between the flats **118** and the interior of the chuck **264**. With this arrangement, the torque transmitted through the drive member **250** to the pipe section **76** to break the threads between the pipe section **76** and the subjacent pipe section **76** is transmitted from the chuck **264** to the pipe section **76** through the wrench dogs **256**. As previously described, the load on the lugs **260** is essentially a compressive load since the lugs are completely contained within the chuck **264**.

When it is desired to release the wrench dogs **256** from engagement with the pipe section **76**, the chuck **264** is raised to the position shown in FIG. 15. The springs **268** return to their arcuate configuration, biasing the wrench dogs **256** outwardly and away from the flats **118** on the pipe section **76**. With the wrench dogs **256** in the position shown, power can be transmitted through the rotary member **50** to unscrew the mating threads **74** between the rotary drive member **250** and the pipe section **76**.

As can be appreciated from the foregoing and from viewing FIGS. 13, 14 and 15, the wrenching arrangement shown therein is fully automatic in that it does not require the manual application of the wrench **122** as was true with the previously described embodiment. Also, the lifting force applied to the pipe string when raising the pipe section **76** to a position wherein the mating threads between the pipe sections **76** and the subjacent pipe section **76** can be disconnected is provided by the wrench dogs **256** through the engagement of the lugs **260** with the pipe sections **76**. Depending on the length of the arm portions **258**, the litting force may also be provided by the partially disconnected mating threads **74** between the rotary drive member **250** and the pipe sections **76**. Thus, there is provided an additional safety factor during the lifting of the pipe string from the bore.

Embodiment of FIG. 16

FIGS. 16, 17 and 18 illustrate another embodiment of wrenching means that can be utilized to apply torque to the pipe sections in the drilling machine **20**. As shown therein, a cylindrical rotary drive member **300** is connected with the drive mechanism **62** and with the ratchet gear **70**.

The drive member **300** has female threads formed therein adapted to engage the threads on the drill pipe section **76** and has a plurality of circumferentially spaced slots **302** formed in and extending through the lower end thereof. The slots **302** are sized and arranged to receive a plurality of wrench dogs **304** that are each pivotally connected with the drive member **300** by a pivot pin **306**. The wrench dogs **304** include an arm portion **308** terminating at its lower end in a lug portion **310**. As shown more clearly in FIG. 17, the lug portions **310** have mitered ends so that they completely fill the space between the flats **118** on the pipe section **76** and the interior of a chuck **312**.

The chuck **312** has a circular opening extending therethrough and is slideably disposed on the cylindrical rotary drive member **300**. An angularly extending slot **314** is formed in the chuck **312** adjacent each of the arm portions **308** of the wrench dogs **304** to reduce the vertical movement of the chuck **312** that is necessary to permit the wrench dogs **304** to move to the disengaged position illustrated in FIG. 18.

As shown in FIG. 16, the wrench dogs **304** are securely held in the position engaging the flats **118** of pipe section **76** when the chuck **312** is in the lower position on the drive member. To be certain that the wrench dogs **304** will completely disengage the pipe section **76** as the chuck **312** is moved upwardly, a flexible member **316**, such as a wire cable or strong cord, is attached to the lower end of each arm portion **308** and to the exterior of the chuck **312**. As may be clearly seen in FIG. 16, the flexible member **316** does not interfere with the movement of the wrench dogs **304** into the flats **118** when the chuck **312** is in the lower position. The member **316** is placed in tension, as shown in FIG. 18, when the chuck **312** is raised so that the wrench dogs **304** are positively moved outwardly into the slots **314** formed in the chuck **312** and out of engagement with the pipe section **76**.

In the wrenching arrangement illustrated in FIG. 16, as well as the arrangement illustrated in FIG. 13, the lifting force applied to the pipe sections **76** can be carried by the engagement of the wrench dogs **304** which engage the pipe section **76**. Since it is not necessary to have engagement between the mating threads **74** to provide the lifting force, the mating threads **74** between the rotary member and pipe section can be completely loosened. With the threads completely disengaged, the wrench dogs **304** can be more easily aligned with and inserted into the flats **118**.

It will also be noted in the embodiment of FIG. 16 that the circular exterior of the drive member **300** and the circular interior of the chuck **312** will not permit torque to be transmtited therethrough. Torque, in the wrenching arrangement of FIG. 16, is transmitted from the rotary drive member **300** directly through the wrench dogs **304** to the flats **118** of the pipe section **76**. The chuck **312** serves to prevent deflection of the wrench dogs **304** outwardly out of engagement with the pipe section **76**.

The wrenching arrangement of FIG. 16 has the advantages of being fully automatic, that is, nothing, such as the application of the wrench **122** must be applied manually; the mating threads **74** can be completely unscrewed since the lifting force is applied through the wrench dogs **304**, thereby permitting the wrench dogs **304** to be more easily aligned with the flats **118**; and the positive engagement of the wrench dogs **304** with the pipe sections **76** and the flats **118** avoids the exertion of tensile forces on the threads, whereby the wrenching arrangement has a longer and more maintenance-free life.

It will be understood that the embodiments described in detail hereinbefore are presented by way of example only and that many changes and modifications can be

made thereto without departing from the spirit of the invention or from the scope of the annexed claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Apparatus for unscrewing selected threaded connections between sections of pipe and the like wherein each pipe section has flats on the exterior thereof, said apparatus comprising:
- rotating means engageable with one of the pipe sections for rotating the pipe, said rotating means including a chuck member slidingly mounted thereon, said chuck member having an opening extending coaxially therethrough with respect to the axis of said pipe;
- moving means for displacing said rotating means and pipe along the axis of said pipe;
- wrench means adapted to be positioned in the flats and sized to be received within said opening in engagement with said chuck member;
- chuck actuating means for moving said chuck member into engagement with said wrench means holding said wrench means in said flats connecting said one pipe section and rotating means for common rotation; and,
- slip means movable into holding engagement with the flats on said one pipe section, whereby the rotating means is rotated to break the connection between said one pipe section and the rotating means, and said slip means being movable into holding engagement with the flats on the subjecent pipe section upon movement of said pipe sections by said moving means, whereby rotation of the rotating means rotates said one pipe section engaged by the wrench means and unthreads the connection between the pipe sections.

2. The apparatus of claim 1 wherein said wrench means includes:
- a pair of generally L-shaped members having first and second mating end portions, said wrench means being of generally rectangular configuration when said L-shaped members are placed in mating relationship;
- connecting means joining said first and second mating end portions, at least one of said connecting means being releasable whereby said wrench means can be opened for positioning on the flats and closed when placed thereon.

3. The apparatus of claim 2 wherein one of said connecting means includes a hinge pin pivotally connecting one of said first and second mating end portions.

4. The apparatus of claim 2 wherein the releasable connecting means joins said second mating end portion and includes:
- a plunger reciprocally positioned in one end portion of said second mating end portion;
- resilient means biasing said plunger relatively toward the other end portion of said second mating end portion; and,
- said other end portion having a recess therein for receiving said plunger to releasably connect said second mating end portion together.

[5. The apparatus of claim 1 wherein said wrench means include a plurality of wrench dogs pivotally mounted on and rotatable with said rotating means and receivable in the opening in said chuck member, said dogs having a lug portion engageable with the flats on the pipe section in response to movement of said chuck member relatively toward the pipe section.]

[6. The apparatus of claim 5 and also including biasing means engaging said wrench dogs to move said dogs out of engagement with the flats when said chuck member is moved relatively away from the pipe section.]

[7. the apparatus of claim 5 wherein said chuck member includes a substantially flat surface in said opening adjacent each said wrench dog and each said wrench dog includes a mating substantially flat surface, said surfaces being in mating engagement when said chuck member is moved relatively toward the pipe section to lock said rotating means, pipe section and chuck member together for common rotation.]

[8. The apparatus of claim 5 wherein:
- the opening in said chuck member is substantially circular in cross-section;
- said rotating means has a slot for each said wrench dog extending substantially parallel to the axis of the pipe; and,
- each said wrench dog includes
  - an arm portion extending from said lug portion, each said arm portion being pivotally connected with said rotating means and located in a respective one of said slots, whereby said rotating means and pipe section are connected for common rotation, and
  - each lug portion has a surface engageable with the chuck member, whereby said dogs are held in engagement with the flats on the pipe section when the chuck member is moved relatively toward the pipe section.]

9. The apparatus of claim 1 and also including torque applying means engageable with said rotating means to apply additional torque therethrough to aid in disconnecting said threaded connections.

10. The apparatus of claim 9 wherein said torque applying means includes:
- a ratchet gear mounted for rotation with said rotating means;
- a ratchet dog pivotally mounted on said moving means and engageable with said ratchet gear;
- resilient means biasing said ratchet dog toward a position wherein said ratchet dog engages said ratchet gears; and,
- force applying means on said moving means operably connected with said ratchet dog for moving said ratchet dog into engagement with said ratchet gear to apply torque to said rotating means in a direction to unscrew the threaded connections.

11. The apparatus of claim 10 and also including a cam member mounted on said moving means, said cam member being engageable with said ratchet dog to move said ratchet dog out of engagement with said ratchet gear.

12. The apparatus of claim 11 wherein said force applying means comprises a double-acting hydraulic cylinder and piston assembly.

13. The apparatus of claim 1 and also including pipe handling means for engaging said one pipe section after the connection between said one pipe section and said subjacent pipe section has been unthreaded permitting relative rotation between rotating means and said one pipe section disengaging the engagement therebetween.

14. The apparatus of claim 13 wherein said pipe handling means includes:
- a frame movable between a position adjacent and parallel to the axis of said pipe sections and a position relatively remote therefrom;
- means for moving said frame; and,
- pipe gripping means carried by said frame, said gripping means being engageable with said one pipe to hold said one pipe section against rotation.

15. The apparatus of claim 14 wherein said pipe gripping means includes:
- a first set of gripping members pivotally mounted on said frame;
- a second set of gripping members pivotally mounted on said frame in spaced relation to said first set of gripping members; and
- actuating means for each set of gripping members arranged to move said gripping members into and out of engagement with said one pipe section.

16. In rotary drilling apparatus including moving means for raising and lowering elongated, threadedly connected pipe sections into and out of a well bore and the like, each of the sections having flats on the exterior thereof and rotating means engageable with the pipe sections for rotating the pipe sections, the improvement comprising:

a chuck member carried by the rotating means, said chuck member being rotatable therewith and slidable thereon along the axis of the pipe sections, said chuck member having a generally rectangular opening extending coaxially therethrough relative to the axis of the pipe sections;

a wrench member adapted to be removably located in said flats and sized to be received within said rectangular opening for engagement with said chuck member;

chuck actuating means for moving said chuck member into engagement with said wrench member when said wrench member is located in said flats connecting the pipe section, wrench member and rotating means for common rotation; and,

slip means movable into holding engagement with the flats on one pipe section, whereby the rotating means is rotated to break the connection between said one pipe section and the rotating means, and said slip means being movable into holding engagement with the flats on the subjacent pipe section when said pipe sections are raised, whereby rotation of the rotating means rotates the pipe section engaged by the wrench member and unthreads the connection between the pipe sections.

17. The apparatus of claim 16 and also including:

torque applying means including

a ratchet gear mounted for rotation with said rotating means;

a ratchet dog pivotally mounted on said moving means and engageable with said ratchet gear;

resilient means biasing said ratchet dog toward a position wherein said ratchet dog engages said ratchet gear;

force applying means on said moving means operably connected with said ratchet dog for moving said ratchet dog into engagement with said ratchet gear to apply torque on said rotating means in a direction to unscrew the threaded connections; and

a cam member mounted on said moving means, said cam member being engageable with said ratchet dog to move said ratchet dog out of engagement with said ratchet gear; and,

pipe handling means including

a frame movable between a position adjacent and parallel to the axis of said pipe sections and a position relatively remote therefrom,

means for moving said frame, and

pipe gripping means carried by said frame, said gripping means being engageable with said one pipe section to hold said one pipe section against rotation.

18. The apparatus of claim 17 wherein said wrench member comprises:

a pair of generally L-shaped members having first and second mating end portions, said wrench member, when said L-shaped members are placed in mating relationship, having a generally rectangular configuration;

hinge means pivotally connecting said first mating end portion; and,

latch means releasably connecting said second mating end portion, whereby said wrench member can be opened for positioning on the flats and latched closed when placed therein, said latch means including

a plunger reciprocally positioned in one said end portion of said second mating end portion,

resilient means biasing said plunger relatively toward the other end portion of said second mating end portion, and

said other end portion having a recess therein for receiving said plunger to releasably latch said second mating end portion together.

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