

[54] **APPARATUS FOR THREADING AND UNTHREADING VERTICAL LENGTHS OF DRILL PIPE**

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[51] Int. Cl. **B25b 17/00, B25b 13/50**

[58] Field of Search **81/57.16, 57.2, 57.34, 81/54**

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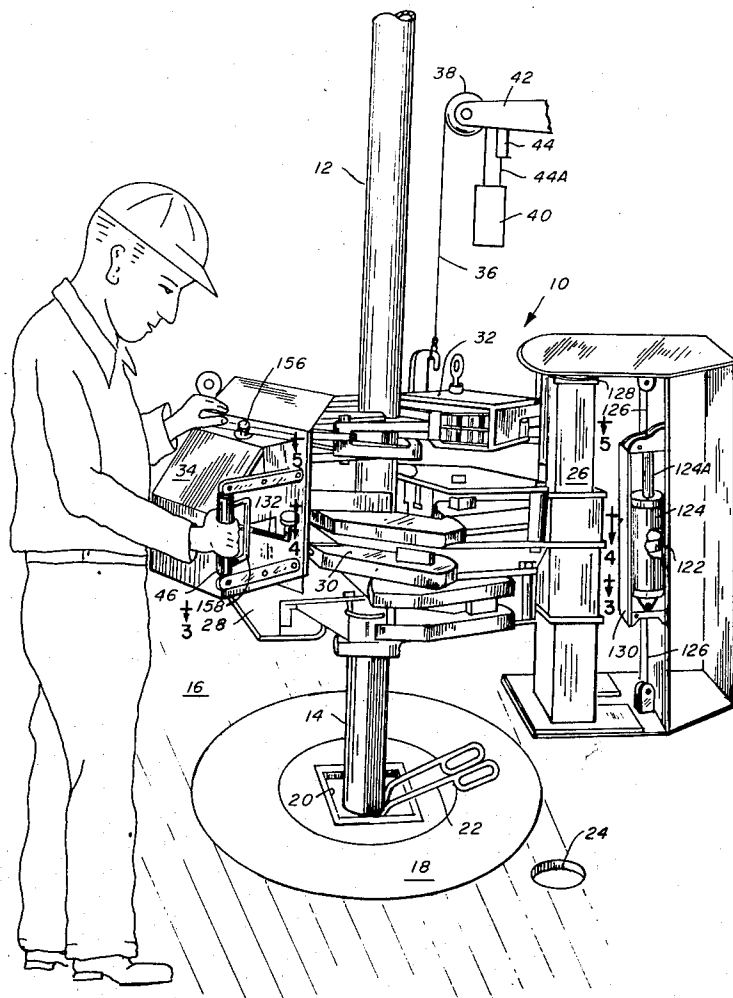
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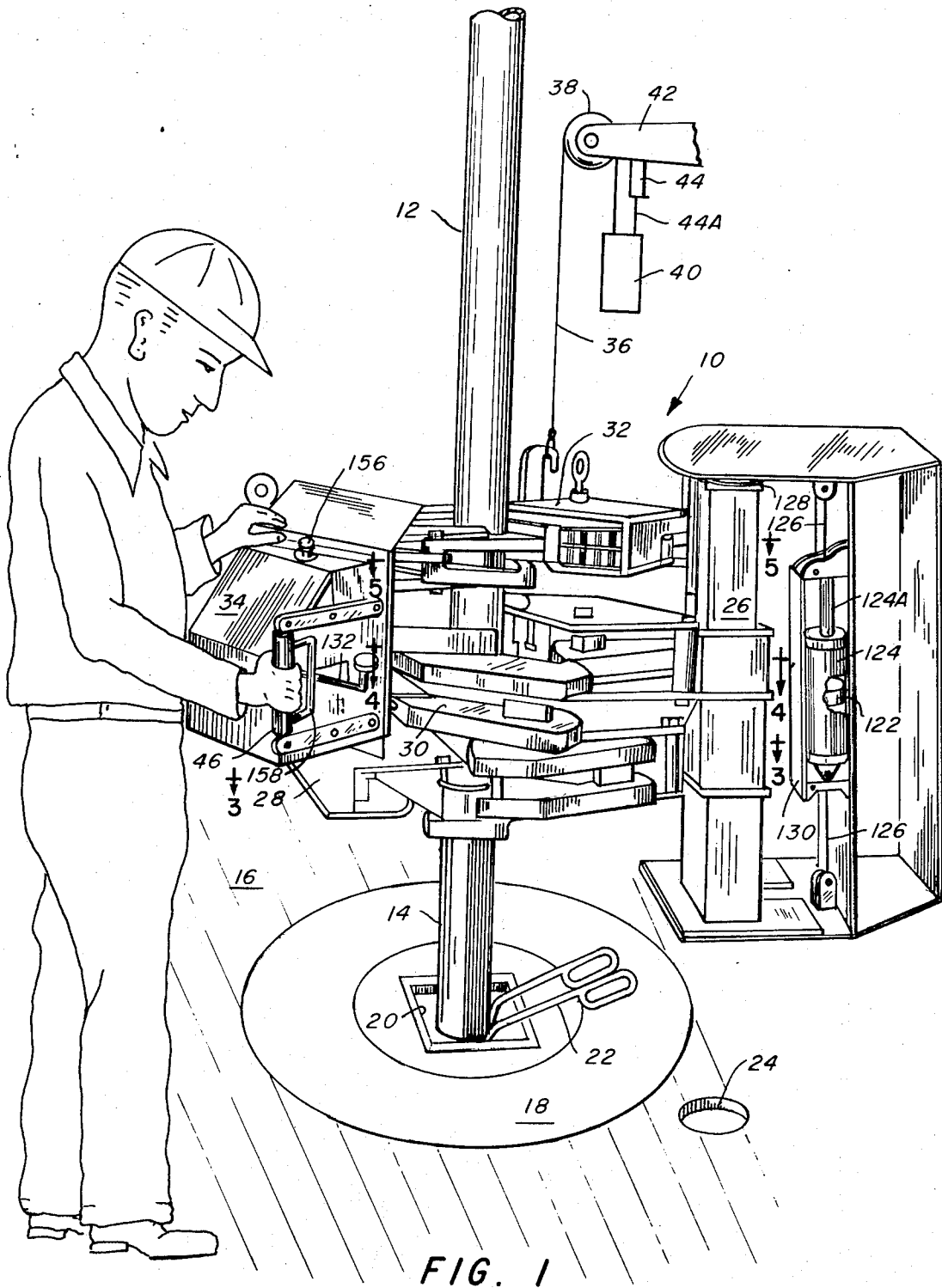
Primary Examiner—James L. Jones, Jr.
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[57] **ABSTRACT**

An apparatus for threading together two vertical lengths of drill pipe, one having a female thread and the other having a male thread at the ends to be threaded, including a backup tong removably positioned around the lower drill pipe having means of grasping and holding the lower drill pipe, a spinner removably positioned around the upper drill piping including means of rotating the upper drill pipe to threadably engage it with the lower drill pipe, and a lead tong removably positioned around the upper drill pipe including means of grasping the upper drill pipe and rotating it relative to the lower drill pipe to securely threadably set the upper to the lower drill pipe.

11 Claims, 10 Drawing Figures





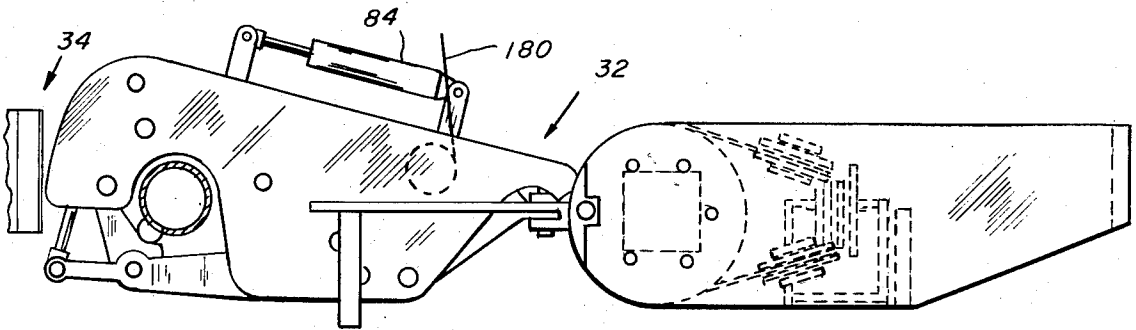


FIG. 2

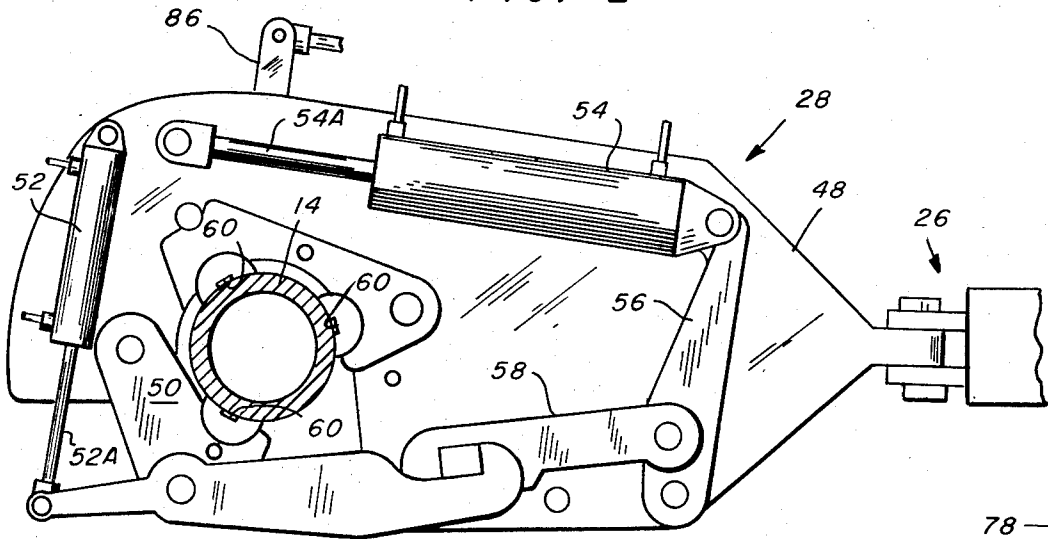


FIG. 3

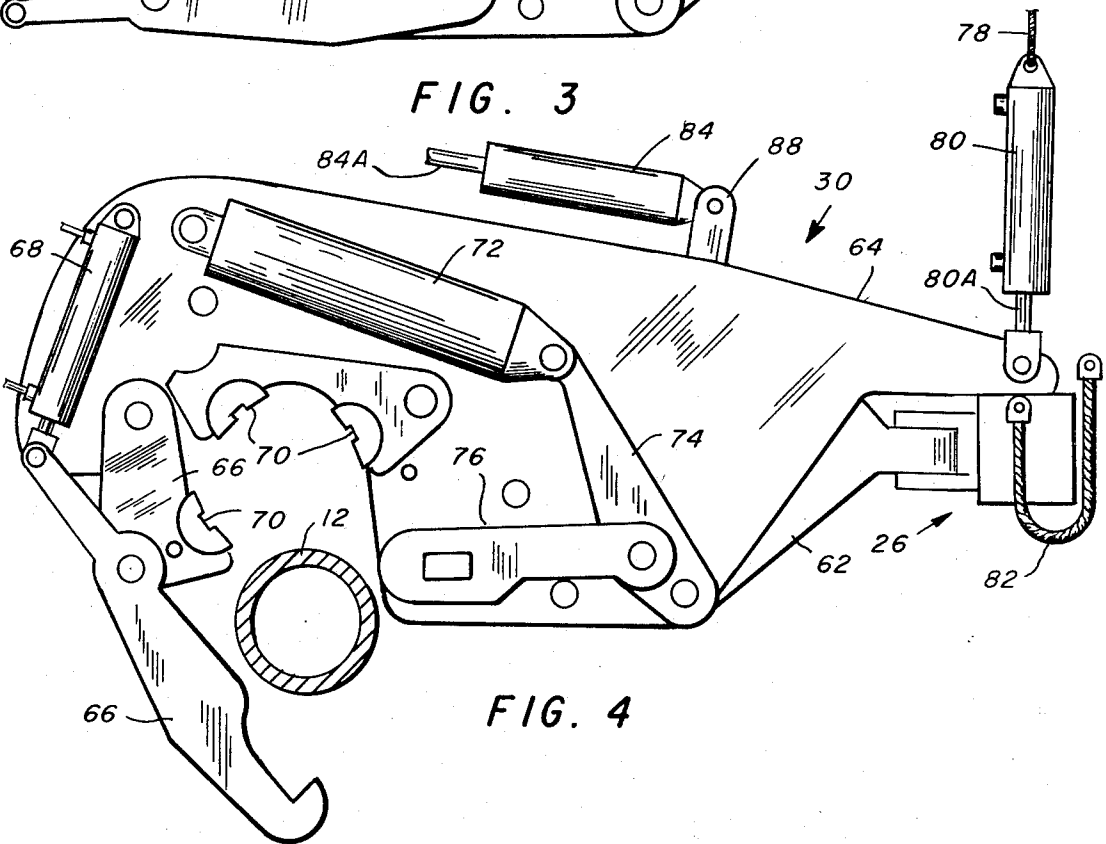


FIG. 4

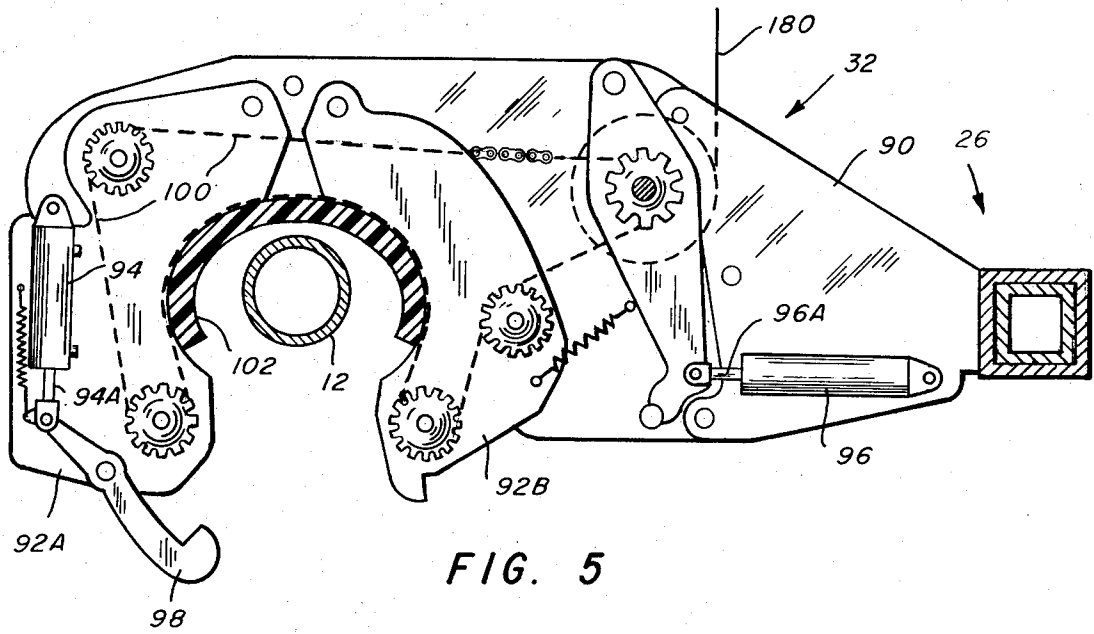


FIG. 5

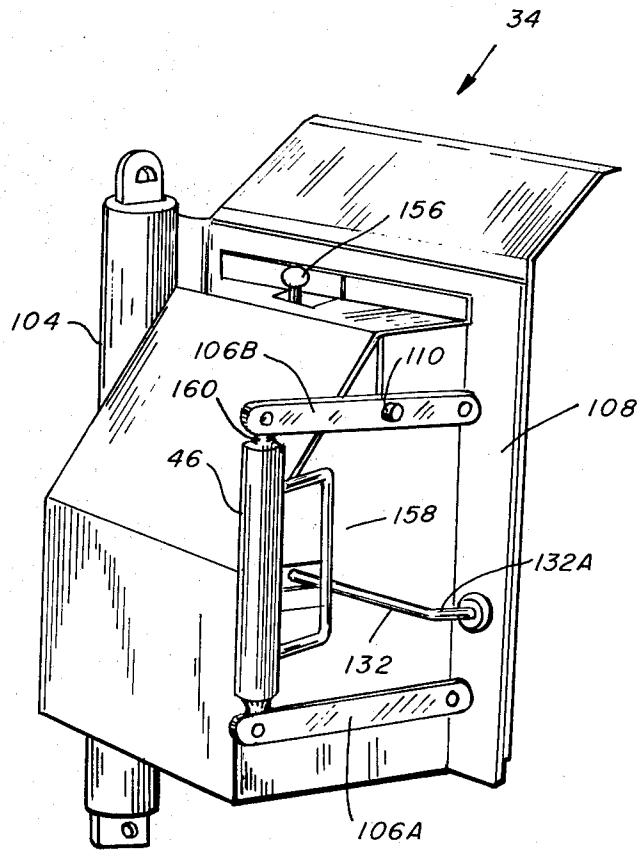


FIG. 6

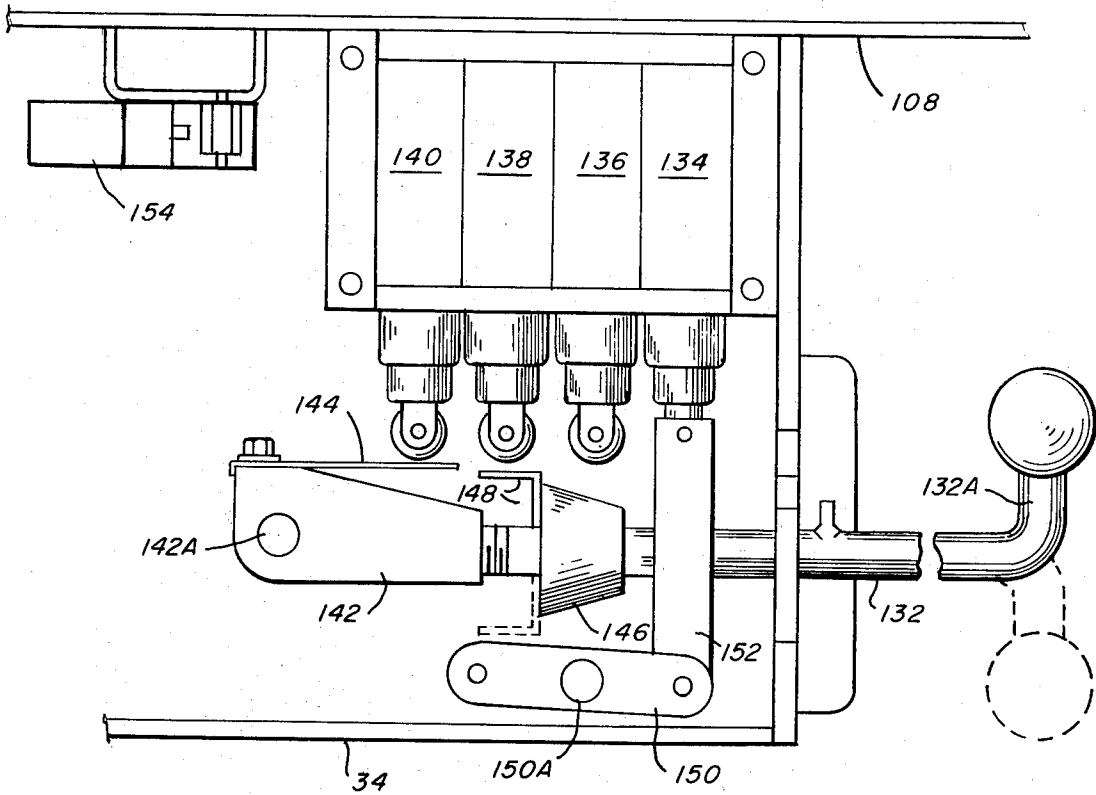


FIG. 7

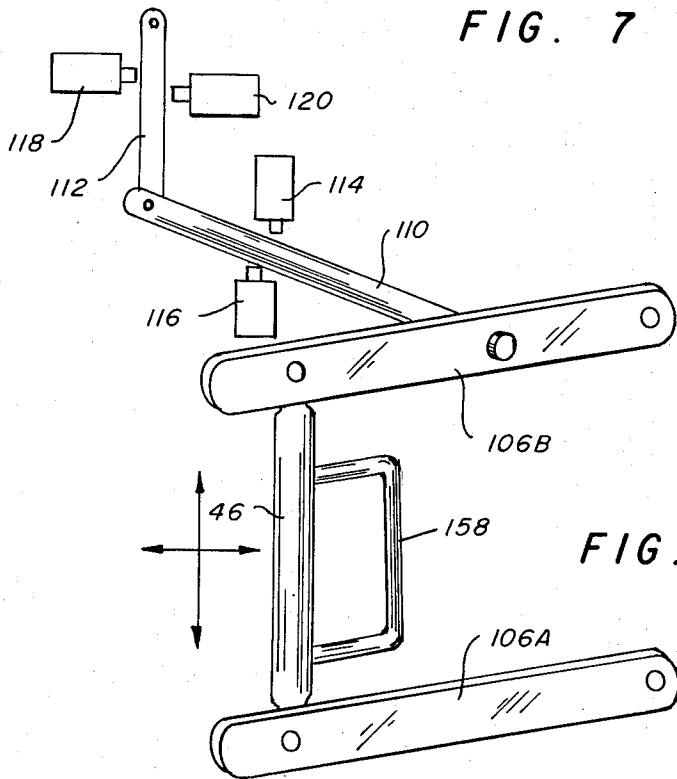


FIG. 9

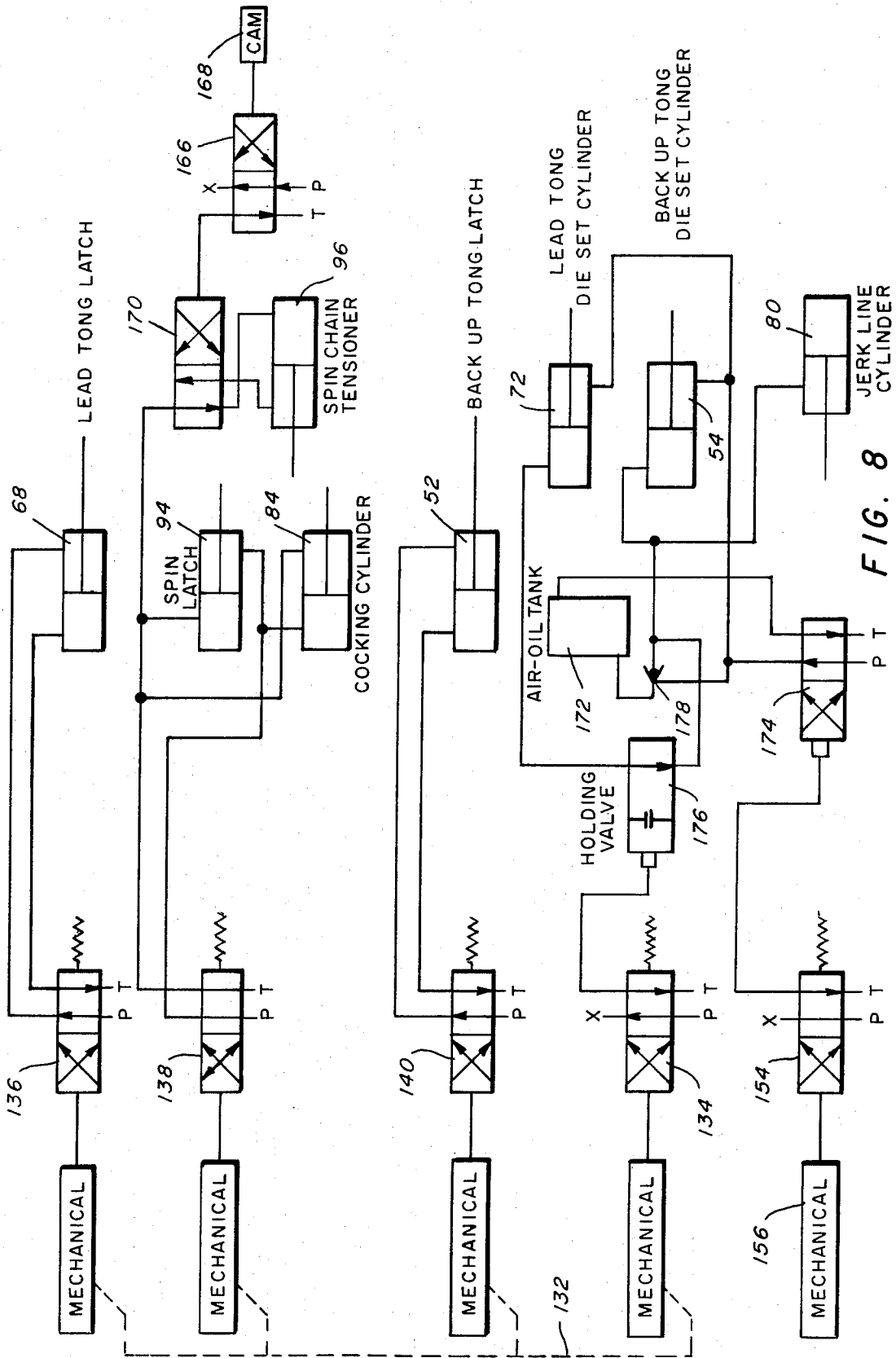


FIG. 8

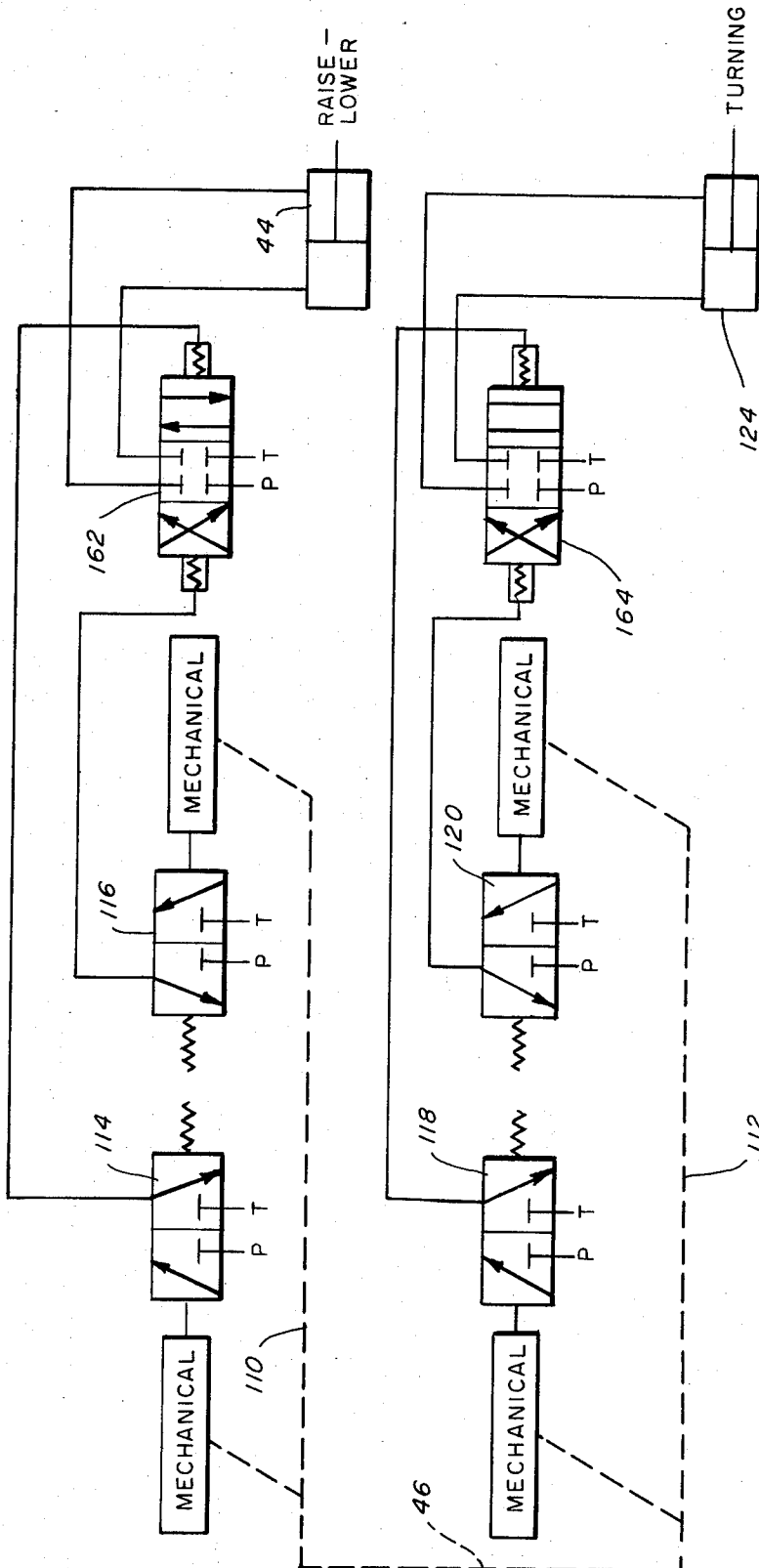


FIG. 10

APPARATUS FOR THREADING AND UNTHREADING VERTICAL LENGTHS OF DRILL PIPE

BACKGROUND, SUMMARY AND OBJECTS OF THE INVENTION

The present techniques utilized in rotary oil and gas well drillings have changed very little since rotary drilling was first introduced. The present practice still utilizes a driller and at least two workmen on the drilling floor to handle tongs and a spinning chain for wrenching up and breaking out a drill pipe. The work is tiring and inherently dangerous. The spinning of the chain about rotating drill pipe and the manual handling of tongs to thread up or break out the lengths of drill pipe frequently produce serious injury.

The number of workmen required to operate a rotary drilling rig has not been essentially reduced since rotary drilling was established. Commonly used type of drilling rig equipment still requires, as a minimum, a driller and two floormen to operate the manual tongs and spinning chain. While significant advancements have been made in other facets of drilling, including improved drill bits, drilling muds, and so forth, the means of handling the assembly and disassembly of lengths of the drill pipe have not basically changed. Thus, the safety of rotary drilling has not significantly improved since its introduction in the early 1900's nor has the labor efficiency been materially improved.

This invention is directed to an apparatus for connecting and disconnecting lengths of drill pipe on a drilling rig having as its basic objects improved safety and efficiency of workmen.

More particularly, an object of this invention is to provide an apparatus for threading and unthreading vertical lengths of drill pipe in an arrangement wherein a driller and a single workman on the drilling floor may constitute a complete drilling crew.

Another object of the invention is to provide an apparatus for threading and unthreading vertical lengths of drill pipe including the use of the backup tongs for retaining the lower drill pipe in non-rotatable position, a spinner for rotating the upper drill pipe to threadably engage it with the lower drill pipe, and a lead tong for grasping the upper drill pipe and rotating it to threadably set the upper to the lower drill pipe.

Another object of the invention is to provide an apparatus for threading together and breaking out vertical lengths of drill pipe including control means for hydraulically actuating the apparatus.

Still more particularly, an object of this invention is to provide an apparatus for threading and unthreading vertical lengths of drill pipe having hydraulic controls and including composite control means wherein all hydraulic signal actuations are accomplished from an easily operated control mechanism.

These objects, as well as others, will be fulfilled in the following description and claims, taken in conjunction with the attached drawings.

DESCRIPTION OF THE VIEWS

FIG. 1 is an isometric view of apparatus forming an embodiment of the invention for threading and unthreading vertical lengths of drill pipe and showing an operator handling the control portion.

FIG. 2 is a top view of the apparatus of this invention, the operator not being shown.

FIG. 3 is a cross-sectional view taken along the line 3—3 of FIG. 1 showing the basic elements of the backup tong portion of the apparatus.

FIG. 4 is a cross-sectional view taken along the line 4—4 of FIG. 1 showing the basic elements of a lead tong portion of the apparatus.

FIG. 5 is a cross-sectional view taken along the line 5—5 of FIG. 1 showing the basic elements of a spinner portion of the apparatus.

FIG. 6 is an isometric view of the control box portion of the apparatus.

FIG. 7 is a partial internal view of the control box of FIG. 6 showing the relationship between a valve actuating lever and a valve manifold utilized to control the apparatus.

FIG. 8 is a diagram of a hydraulic system incorporating the valves and cylinders of the various pieces of equipment making up the apparatus of the invention.

FIG. 9 is a diagrammatic view of the arrangement of the swing and elevational control handle portion of the control box showing the means of actuation of control valves to position and elevationally control the apparatus.

FIG. 10 is a diagram of the hydraulic system actuated by the swing and elevational control handle of FIG. 9 to control the position and elevation of the apparatus.

DETAILED DESCRIPTION

Referring to the drawings, and first to FIG. 1, an operator is shown utilizing the apparatus of this invention, the apparatus being generally indicated by the numeral 10. The apparatus is used to threadably connect and disconnect vertical lengths of drill pipe, such as upper drill pipe 12 and lower drill pipe 14. Drill pipes 12 and 14 are of the type utilized in rotary drilling of oil and gas wells. The workman stands on drilling floor 16 in which is positioned a rotary table 18 through which the lower drill pipe 14 extends. Drilling table 18 includes a cup 20 which receives slips 22.

Adjacent to the rotary table 18 is a mouse hole 24 which is drilled to a depth sufficient to support one length of drill pipe and to position the upper end of the drill pipe at a height so that the drilling kelly (not shown) may be attached to it. The drilling kelly is a length of pipe which has an irregular exterior cross-section, usually of a square configuration, which fits in a kelly bushing positioned in the drilling table cup 20. The drilling bushing permits the kelly to slide up and down to permit downward advance as the drilling bit penetrates to deepen the well hole but nevertheless drilling bushing rotatably connects the kelly to table 18.

The elements 12 through 24 are standard items of a rotary drilling rig. This invention is made up of apparatus 10 which has, as its major components, a pivot post 26, a backup tong 28, a lead tong 30, a spinner 32, and a control box 34. The weight of the tongs 28 and 30, spinner 32 and control box 34, is supported by a cable 36 which extends over a pulley 38 to a counterweight 40. The pulley 38 is secured to an arm 42 extending from the drilling derrick (not shown). A hydraulic elevational cylinder 44 is affixed to the arm 42 and has a piston rod 44A extending therefrom and attached to weight 40. By controlling the extension or retraction of

piston rod 44A the elevation of the apparatus 10 is controlled so that the apparatus may be properly elevationally positioned to engage the upper end of lower drill pipe 14 and the lower end of upper drill pipe 12. The cylinder 44 is controlled by the up or down movement of handle 46 which is a part of the control box 34. The means by which handle 46 controls elevational cylinder 44 will be described subsequently.

Referring to FIG. 3, the arrangement of backup tong 28 is shown. The tong 28 is shown as clamped to lower drill pipe 14. For detailed information on the construction and operation of backup tong 28 and lead tong 30, reference may be had to copending application Ser. No. 104,865 filed Jan. 8, 1971, now U.S. Pat. No. 3,703,111, entitled: Pipe Tongs. Generally, the backup tong 28 includes a base portion 48 which is affixed at one end to turning post 26. A jaw portion 50 pivots relative to base portion 48 and, when in the opened position, the backup tong 28 may be pivoted in position to encompass pipe 14. A backup tong latch cylinder 52, having piston rod 52A extending therefrom, is positioned between the base portion 48 and jaw 50. By hydraulic pressure to cylinder 52 the opening and closing of jaw 50 is controlled. When the backup tong jaw 50 is in closed position the tong may be made to securely grasp pipe 14 by means of a backup tong die set cylinder 54. Generally, the die set cylinder 54, having piston rod 54A extending therefrom, functions by imposing force relative to base plate 48 to jaw portion 50 by levers 56 and 58. Securely closing the jaw portion 50 cause dies 60 to set upon pipe 14.

Referring to FIG. 4, lead tong 30 is generally illustrated and is substantially identical to backup tong 28. As with backup tong 28, detailed information as to the arrangement, construction and operation of a lead tong which may be used in the construction and operation of the present invention is fully described in the above referenced copending application. Lead tong 30 includes a sub-base portion 62 upon which a base portion 64 is pivotally supported. The sub-base portion 62 is attached to pivot post 26 and, by rotation of the pivot post, may be swung to engage upper drill pipe 12 or swung away from it as desired. Lead tong 30 includes a pivoted jaw 66 which may be swung open to receive the upper drill pipe 12 and closed by means of lead tong latch cylinder 68. When in the closed position dies 70 may be securely set on pipe 12 by means of lead tong die set cylinder 72 which move levers 74 and 76 and causing the jaw portion to securely force the dies into pipe 12. The lead tong base portion 64 may be pivoted relative to the backup tong 28 to threadably set or break out the upper length of drill pipe 12 relative to the lower length of drill pipe 14. When the ends of pipes 12 and 14 are engaged the pipes are threaded together by rotation of spinner 32 detachably connected to drill pipe 12. The final act of securely setting the threads of the drill pipe requires the upper drill pipe 12 to be rotated only a relatively few degrees, such as 20° or less. In like manner, when it is desired to break out or unthread the upper drill pipe from the lower, the upper drill pipe need be rotated only approximately 30° to break the threads loose. This is accomplished by rotation of the lead tong 30 relative to the backup tong 28 which is held in a stationary position. In breaking out, once the threads of the pipe have been unset from each other, the lower drill pipe may be spun by rotary

table 18 to finish unthreading the lower from the upper drill pipe.

Various means may be provided for rotating the lead tong 30 relative to the backup tong 28. One means includes the use of a cable 78 (See FIG. 4) which extends to wrap around a cat head portion of the drilling rig drawworks (not shown). The cable 78, having one end wrapped around the cat head, extends to connect to lead tong 30. When it is desired to pull the lead tong 30 to rotate it relative to backup tong 28 the driller actuates the drawwork to cause the cat head to rotate withdrawing cable 78.

In the illustrated arrangement cable 78, rather than being attached directly to lead tong 30, is attached to one end of a pressure intensifying cylinder 80 with the piston rod 80A extending from the cylinder being affixed to lead tong 30. The purpose of cylinder 80 is to apply increased hydraulic pressure on lead tong die set cylinder 72 and backup tong die set cylinder 54 as force is applied on cable 78 to set or break out drill pipe. The means whereby pressure from the intensifier cylinder 80 is applied to the lead tong die set cylinder 72 will be described subsequently.

The arrangement of FIG. 4 is utilized in breaking out drill pipe, that is, threadably separating the upper from the lower drill pipe. When making up drill pipe it is obvious that the upper drill pipe must be rotated in the opposite direction relative to the lower drill pipe to firmly set the threads. When making up drill pipe the pressure intensifier cylinder piston 88 is attached to one end of a cable 82 which loops around a pivot post with the other end attached to lead tong base portion 64. In making up the lead tong portion 64 is cocked relative to the backup tong 28 by means of a cocking cylinder 84 having piston 84A extending therefrom. The piston rod 84A is connected to a bracket 86 extending from backup tong base portion 48 (See FIG. 3). Cylinder 84 is attached to a bracket 88 extending from the lead tong base portion 64 (See FIG. 4). When the lead tong is cocked counterclockwise relative to backup tong 28, pull applied by cable 78, to intensifier cylinder 80, to cable 82, pulls the lead tong clockwise to apply torque to the upper drill pipe 12 to threadably lock it to the lower drill pipe 14.

Referring to FIG. 5 the basic concept of the spinner 32 is illustrated. For a more detailed explanation of the construction and operation of a spinner apparatus reference may be had to U.S. Pat. No. 3,308,691 and to my copending application Ser. No. 189,689, filed Oct. 15, 1971, entitled "Apparatus For Rotating A Member." Essentially the spinner 32 includes a base portion 90 which is affixed at one end to the pivot post 26. Pivotaly secured to base portion 90 are jaw portions 92A and 92B, although it can be seen that in the simplest embodiment a single jaw portion may be employed. With the jaws 92A, 92B opened the spinner 32 may be pivoted by pivot post 26 to encompass the upper drill pipe 12. By actuation of spinner latch cylinder 94 having piston rod 94A extending therefrom, jaw portion 92A is moved into closed position. By actuation of spin chain tensioning cylinder 96 having piston rod 96A extending therefrom jaw portion 92B is moved to the closed position. In the closed position the jaws are held together by lever 98. When in the closed position a chain 100 is caused to grip the exterior surface of upper drill pipe 12. Tension is applied to chain 100 against pipe 12 by the spin chain tensioning cylinder 96 operating

in the opposite direction, that is, by withdrawing piston 96A. Thus the spin chain tension cylinder 96 serves the dual function of closing jaw 92B when piston rod 96A is extended and, after lever 98 locks the jaws together, the withdrawal of piston rod 96A applies tension to chain 100. To increase the torque applied by chain 100 on the drill pipe 12 a resilient pipe engaging bushing 102 may be employed.

The purpose of spinner 32 is to rotate the upper drill pipe 12 relative to the lower drill pipe 14 during makeup operation to threadably engage the upper and lower pipe together. The final step of setting the upper to the lower drill pipe is accomplished by the use of the tongs 28 and 30 as previously described.

CONTROL BOX

Supported to the mechanism, such as on a post 104 (See FIG. 3) extending between the backup tong 28 and spinner 32, is a control box generally indicated by the numeral 34. The control box contains all of the actuating mechanisms to enable an operator working on the drilling floor to control the mechanism for making up or breaking out successive lengths of drill pipe. The operator utilizing the control box 34 works in conjunction with a driller which controls the drawworks to raise and lower drill pipe and operate the cat head to pivot the lead tongs relative to the backup tong as previously described.

The control box 34 includes swing and elevational control handle 46 which is rotatably supported at the outer end between yoke arms 106A and 106B. The inner end of arms 106A and 106B are pivotally supported to a plate 108 extending from post 104. Attached to upper arm 106B is the outer end of a control rod 110. Referring to FIG. 9, the relationship between the swing and elevational control handle 46, yoke arms 106A and 106B, and control rod 110, is diagrammatically illustrated. Rod 110 is pivotally affixed at one end to a pivot rod 112. The other end of pivot rod 112 which is pivotally secured to the interior of box 34. Positioned above and below the control rod 110 are elevational control valves 114 and 116. When handle 46 is pushed upwardly the control rod 110 engages upper control valve 114 to move the entire mechanism upwardly, and correspondingly, when handle 46 is moved downwardly valve 116 is actuated to move the mechanism downwardly, in an arrangement to be described subsequently.

Positioned to one side of the pivot rod 112 is a clockwise turning valve 118 and to the other side is a counterclockwise turning valve 120. When the operator moves handle 46 to the right, pivot rod 112 engages valve 120 to cause the pivot post to rotate counterclockwise, that is, to move the spinner and tongs towards engagement with drill pipes 12 and 14. Correspondingly when the operator moves handle 46 to the left the pivot rod 112 engages clockwise turning valve 118 to cause the entire mechanism to be rotated clockwise, that is, away from drill pipe 14. Turning control valves 118 and 120 function to cause rotation of the pivot post 26 by the control of fluid pressure above and below a piston 122 (See FIG. 1) in a turning control cylinder 124. The piston rod 124A extending from cylinder 124 is connected to one end of a cable 126 while cylinder 124 is held in a steady position. Cable 126 loops about a pulley 128 at the upper end of post 26. The other end of cable 126 is attached to a yoke 130

which in turn is attached to piston rod 124A. As the piston 122 is caused to move in cylinder 124 in one direction cable 126 moves around the pulley 128 to rotate post 26 in the clockwise direction, and as fluid pressure is applied to the cylinder 124 in the other direction piston rod 124A is withdrawn to cause cable 126 and pulley 128 to rotate post 26 in counterclockwise direction. Means whereby turning valves 118 and 120 are employed to control turning cylinder 124 will be described subsequently.

For more detailed information on the construction and arrangement of a pivot post which functions in as an example of apparatus employed to practice this invention. Reference may be had to copending application entitled: "Pipe Tongs."

Thus it can be seen that the operator, by manipulation of swing elevational control handle 46, can, with one hand, control the elevational positioning of the apparatus to properly align the apparatus so that the backup tong closes upon and grasps the upper end of the lower drill pipe 14 and the lead tong closes upon and grasps the lower end of upper drill pipe 12, and at the same time, by moving the handle to the operator's right or left, the apparatus can be swung into position to engage the drill pipe, or swung out of the way so as not to interfere with other drilling operations.

Extending from control box 34 is a valve actuating lever 132. The outer end of lever 132 has a 90° bend, being designated as portion 132A. The purpose of end portion 132A is to give an indication of the rotational position of lever 132 to the operator. Valve actuating lever 132 is utilized to control the successive steps in threading together or unthreading vertical lengths of drill pipe. The sequence of steps is governed by the rotational position of the lever 132. In the position as indicated in solid outline in FIG. 7 wherein the portion 132A is pointed towards plate 108 the lever functions to control making up, that is, threadably connecting joints of drill pipe. When the lever 132 is rotated 180° to the position shown in dotted outline it functions to control the breaking out or unthreading of lengths of drill pipe.

Positioned in the control box are the following hydraulic actuating control valves: (See FIG. 7) a holding control valve 134; a lead tong latch valve 136; a spinner control valve 138; and a backup tong latch valve 140. A lever block 142 is pivoted at 142A and threadably receives the inner end of lever 132. The threads between the lever and the block 142 enables the lever 132 to be rotated 180°. Extending from block 142 is a leaf spring 144 which engages backup tong latch valve 140 when lever 132 is moved forwardly, that is, towards plate 108. Affixed to lever 132 is a block 146 which supports a valve actuating clip 148. Clip 148 engages spinner control valve 138 when lever 132 is moved towards plate 108 when the lever 132 is rotated to the makeup position, as shown in solid outline in FIG. 7. Further forward movement of lever 132 causes block 146 to engage lead tong latch valve 136. When lever 132, when in the makeup position, is moved rearwardly, away from the plate 108, valves 136, 138 and 140 are deactivated in the enumerated sequence.

When lever 132 is rotated 180° to the breakout position, as shown in dotted outline, forward movement causes the actuation of backup tong latch valve 140 by spring 144, followed by actuation of lead tong latch valve 136. When the lever 132 is moved in the rear-

ward direction while in break-out position, valve 136 and 140 are deactuated followed by the actuation of holding control valve 134. This is accomplished by means of a rocker arm 150 pivoted at 150A connected by a linkage 152 to the holding control valve 134. Clip 148 engages rocker arm 150 when the lever 134 is moved rearwardly while in the break-out position to actuate the holding control valve 134.

Positioned in the control box 34 is a die set valve 154. A lever 156 extends through an opening at the top of the control box 34 (See FIG. 6) to provide a means for the convenient control of the die set valve by the operator.

The swing and elevational control handle 46 is preferably provided with a bail 158 (See FIG. 6) extending from the rotatable handle 46. Handle 46 is formed about a bolt 160. The function of bail 158 is to maintain lever 132 in the forward position to hold the backup tong latched in the closed position.

In addition to the control valves described to this point, the control system of the apparatus includes a hydraulically actuated valve, the physical position of which is not shown since such may be located any place in the system, such as in the structure supporting pivot post 26. Referring to FIG. 10 a three-position spring centered hydraulic actuated valve 162 is utilized to control elevational control cylinder 44. In all cases in the hydraulic control diagrams of FIGS. 8 and 10 the letter P stands for the pressure source and the letter T stands for tank or reservoir. As lever 46 (FIG. 9) is raised and lowered control rod 110 actuates valves 114 or 116 which in turn actuates the hydraulic control valve 162 to apply fluid pressure to one side or the other the piston of elevational control cylinder 44 to raise or lower the mechanism. In a similar arrangement, the actuation of handle 46 to the right or left pivots pivot rod 112 to engage valve 118 or 120 to hydraulically actuate control valve 164 to apply fluid pressure to one side or the other of the piston 122 in turning cylinder 124 to rotate pivot post 26 to move the mechanism towards or away from the drill pipe.

Referring to FIG. 8, a spin chain control valve 166 is actuated by a cam (not shown) on the drilling rig. Cam 168 is automatically actuated when the driller engages the mechanisms on the drilling rig to rotate the cat head which, as previously described, rotates the chain 100 of the spinner to threadably engage the pipe. Spinner chain tensioning valve 170 is hydraulically controlled by the spinner chain control valve 166 to apply hydraulic fluid pressure to one side or other of the spinner chain tensioning cylinder 96 depending upon the position of the spinner control valve 138 as determined by lever 132.

The tong die set cylinders 54 and 72 are controlled by hydraulic pressures applied from an air-oil tank 172. Air pressure to the top of the air-oil tank 172 is controlled by a tank pressurizing valve 174 which in turn is controlled by the die set control valve 154.

A die set cylinder holding valve 176 is hydraulically actuated by the holding control valve 134 to hold the lead tong die set cylinder in closed position. A pilot operated check valve 178 controls the flow of hydraulic fluid from air-oil tank 172 to the die set cylinders 54 and 72.

OPERATION

With the apparatus in position as shown in FIG. 1, the

sequence of steps employed for making up, that is, threading together two contiguous vertical lengths of drill pipe are the following:

1. With valve actuating lever 132 rotated to the makeup position as shown in solid outline in FIG. 7, the operator moves it forward, that is, towards plate 108, to the first position wherein leaf spring 144 actuates backup tong control valve 140 which applies hydraulic fluid pressure to backup tong latch lever 52 (FIG. 3) latching the backup tong in closed position.

2. Further forward motion on valve actuating lever 132 actuates spinner control valve 138 applying hydraulic fluid to the spinner latch cylinder 94 latching the jaws of spinner in closed position, and pressure is also applied to cocking cylinder 84 which cocks the lead tong counterclockwise relative to the backup tong.

3. The driller engages the cat head on the drilling rig to pull on cable 180 causing chain 100 to rotate to spin the upper drill pipe 12. This action by the driller automatically actuates cam 168 to actuate spin chain control valve 166 applying fluid pressure to the spin chain tensioning cylinder 96, applying tension on the chain 100 so that it securely grasps the exterior of drilling string 12. Bushing 102 ensures a secure frictional engagement of the chain 100 to rotate pipe 12. The upper drill pipe 12 is spun into the lower drill pipe 14.

4. Further forward motion of valve actuating lever 132 actuates lead tong latch valve 136 to apply hydraulic force to lead tong latch cylinder 68, latching the lead tong to the upper drill pipe 12.

5. The operator pushes lever 156 on the top of the control box 34 to actuate die set control valve 154 which in turn actuates the tank pressurizing valve 174 so that air pressure is applied to air-oil tank 172. This applies hydraulic fluid through pilot operated check 178 to the tong die set cylinders 154 and 172 securely setting the tongs on pipes 12 and 14. At the same time, hydraulic pressure is applied to pressure intensifier cylinder 80. Pressure is trapped by the pilot operated check valve 178 in die sets cylinders 54 and 72 and in the pressure intensifying cylinder 80.

6. A driller actuates the cat head pulling on cable 78, and thus on intensifying cylinder 80, piston rod 80A, and cable 82, to rotate lead tong 30 in a direction to securely threadably set the upper drill pipe 12 to the lower drill pipe 14. As increased force is applied on cable 78 the hydraulic pressure in intensifier cylinder 80 increases, the increased pressure is automatically applied to die set cylinders 54 and 72. Thus, as the force tending to rotate the lead tong 22 relative to the backup tong 28 increases the force applied by the dies to grip the pipe is increased to ensure that the dies do not slip on the pipe. This ensures positive threaded locking of the upper to the lower drill pipe. The upper drill pipe has now been threaded into and securely threadably set to the lower drill pipe.

7. The operator moves lever 156 atop the control box 34 to deactuate the die set control valve 154. This deactuates the pressurizing valve 174, removing hydraulic pressure to the die set cylinders 54 and 72 and the pressure intensifier cylinder 80. At the same time, pressure is applied to open the pilot control valve 178 to allow hydraulic fluid in the die set cylinders and pressure intensifier cylinder to return to the air-oil tank 172.

8. The operator moves valve actuating lever 132 to full rearward position releasing valves 138 and 140 which releases all engagement of the apparatus with the

upper and lower drill pipes. The apparatus may then be moved off the pipe by the operator moving handle 46 to the left.

The steps which take place to threadably disengage or break out adjacent vertical lengths of drill pipe will now be described:

1. The operator moves the apparatus from stored position to engage the drill string by moving handle 46 to the right, actuating counterclockwise turning valve 120 which applies pressure to hydraulic control valve 164 and thereby to turning cylinder 124.

2. The operator rotates valve actuating lever portion 132A 180° to the position shown in dotted outline in FIG. 7.

3. The operator pushes lever 132 forward, towards plate 108. Spring 144 engaging and actuating backup tong latch valve 140 applying hydraulic pressure to backup tong cylinder 52, latching the backup tong in position about lower drill pipe 14.

4. The operator pushes lever 132 forward to the next position wherein lead tong latch valve 136 is engaged applying hydraulic pressure to lead tong latch cylinder 68, latching the lead tong about the upper drill pipe 12. (Note that in the break-out mode spinner control valve 138 is not actuated since the spinner is not utilized in breaking out the upper length from the lower length drill pipe)

5. The operator actuates lever 156 on top of the control box to engage the die set control valve 154 which applies pressure to die set cylinders 72 and 84 in the same manner as described in step 5 of the makeup sequence.

6. The piston 80A of the pressure intensifier cylinder 80 is attached directly to the base portion 64 of lead tong 30 (See FIG. 4). The operator rotates the cat head on the drilling rig (not shown) withdrawing cable 78, and thereby causing the lead tong 30 to rotate counterclockwise relative to backup tong 28, threadably breaking out the upper drill pipe 14 from the lower drill pipe 12.

7. The operator moves lever 132 to the full reverse position. This deactuates backup tong latch valve 140 and lead tong latch valve 136. Clip 148 engages rocker arm 150 actuating the holding control valve 134 which in turn actuates the die set cylinder holding valves 176. This traps hydraulic pressure in lead tong die set cylinder 72.

8. Operator moves lever 156 to open die set valve 154. This deactuates the tank pressurizing 174 relieving pressure from backup tong die set cylinder 54. Note, however, that pressure is not relieved from the leading tong die set cylinder 72 because it is blocked by holding valve 176. At the same time air pressure is applied to operate check valve 178 to upset the check and apply pressure on the front side of backup tong die set cylinder 54 to make sure that the backup tong is fully released from the lower drill pipe 14.

9. The driller rotates the rotary table 18. Slips 20 cause the lower drill pipe 14 to rotate clockwise relative to the upper drill pipe 12, unthreading the lower drill pipe from the upper drill pipe.

10. The operator releases valve actuating lever 132 to the neutral position, deactuating the holding control valve 134 which permits the die set cylinder holding valve 176 to return to normal position, allowing hydraulic fluid pressure to flow from lead tong die set cylinder 72 and air pressure to be applied to the rearward

side of the piston forcing the dies to the open position. With the die set cylinder relieved the lead tong 28 opens, releasing the apparatus from engagement with the drilling string. The operator then may move the apparatus off the drill string if required.

The sequence of steps had been described which are involved, in the first instance, to threadably connect the upper to the lower drill pipe and in the second instance to breaking out or threadably disconnecting the drill pipe. In normal drilling operations when a trip is being made into or out of the hole, such as is required when necessary to change bits, successive lengths of drill pipe are threaded together in the instance of going into the hole, and contrarily, successive lengths of drill pipe are unthreaded from each other in coming out of the hole. In all instances the operator of the apparatus completely controls the threading together and unthreading successive lengths of drill pipe in a manner requiring only a floor operator and a driller. The use of the spinning chain is completely eliminated and the use of a manually operated tong is eliminated, thus, reducing the minimum requirement of men on the drilling floor from two to one and at the same time substantially increasing workmen safety. The exact hydraulic control system required to operate the mechanisms of this invention may greatly vary in detail. Auxiliary devices such as flow controls to slow down certain operations relative to others may be employed in the hydraulic system to control the exact timing of the sequence of operation of various components, all employing known hydraulic control technology. The means of rotating the spinning chain 100 may vary in many ways. The illustrated arrangement wherein a cable 180 actuated by the drilling rig drawworks is only one example. It can be seen that hydraulic pneumatic or electric motors may be equally as well employed. The same applies to the use of cable 78 as a means of setting or breaking out the pipe by rotation of the lead tong relative to the backup tong. Such may be accomplished utilizing hydraulic cylinders or other arrangements rather than the cable-cat head arrangement as described.

Many other aspects of the invention may vary in considerable detail without departing from the spirit and scope of this disclosure. It is understood that the invention has been described by reference to an exemplified embodiment for purposes only of illustrating one arrangement of the invention. The invention is not limited to the exemplified embodiment set forth herein but is encompassed only by the attached claim or claims, including the full range of equivalency to which each element or step thereof is entitled.

What is claimed:

1. Apparatus for use on a rotary drilling rig for threading together and unthreading the vertical lengths of drill pipe, the upper length being rotatably supported above a derrick floor from a drilling mask and the lower length being supported on a rotary table, comprising in combination:

a backup tong having a jaw portion movable between an opened and closed position wherein in the opened position the backup tong may be positioned to engage the lower length of drill pipe and in the closed position the backup tong encompasses the lower drill pipe, and including means when in the closed position of grasping the lower drill pipe to prevent the rotation thereof;

a spinner having a jaw portion movable between an opened and a closed position wherein in the opened position the spinner may be positioned to engage the upper length of drill pipe and in the closed position the spinner encompasses the upper drill pipe, and including means when in the closed position of grasping and rotating the second drill pipe to threadably engage the lower drill pipe;

a lead tong having a jaw portion movable between an opened and a closed position wherein in the opened position the lead tong may be positioned to engage the upper length of drill pipe and in the closed position the lead tong encompasses the upper drill pipe, and including means when in the closed position of grasping the upper drill pipe;

means of rotating said lead tong relative to said backup tong to threadably set the upper drill pipe to the lower drill pipe;

independent hydraulic cylinder means provided for selectively opening and closing the spinner jaw, the lead tong jaw and the backup tongs and for selectively grasping and releasing the backup tongs with said lower drill pipe and grasping and releasing the spinner and lead tong with the upper drill pipe;

a source of hydraulic pressure;

hydraulic actuating valve manifold means between the said source of hydraulic pressure and the said independent hydraulic cylinder means for selectably and sequentially controlling said independent hydraulic cylinder means to sequentially actuate said backup tong jaw and grasping means, said spinner jaw and grasping means, and said lead tong jaw and grasping means for selectably threading and unthreading said lengths of drill pipe; and

valve actuating lever means pivotally connected with said manifold means whereby pivoting of the lever means in one direction actuates the valves of the manifold in sequence to cause said spinner and said tongs to engage said lengths of drill pipes for threadably engaging and setting said upper length of drill pipe to said lower length of drill pipe, and wherein pivoting of the lever means in an opposite direction actuates the independent cylinder means to cause said spinner and said tongs to disengage from said lengths of drill pipe.

2. Apparatus for use on a rotary drilling rig for threading together and unthreading lengths of drill pipe according to claim 1 including:

means of rotating said lead tong relative to said backup tong to threadably break out the upper drill pipe from the lower drill pipe;

means of releasing said backup tong from said lower drill pipe;

and means of rotating said lower drill pipe by said rotary table to unthread said lower drill pipe from said upper drill pipe.

3. Apparatus for use on a rotary drilling rig for threading together and unthreading two vertical lengths of drill pipe according to claim 1 including:

hydraulic cylinder means of closing and unclosing said backup tong jaw portion;

hydraulic cylinder means of closing and unclosing said spinner jaw portion;

hydraulic cylinder means of closing and unclosing said lead tong jaw portion;

hydraulic cylinder means with said backup tongs of grasping and releasing said lower drill pipe;

hydraulic cylinder means with said spinner of grasping and releasing said upper drill pipe;

hydraulic cylinder means with said lead tong of grasping and releasing said upper drill pipe;

a source of hydraulic pressure;

a manifold of hydraulic actuating valves between said source of hydraulic pressure and said hydraulic cyl-

hydraulic cylinder means with said spinner of grasping and releasing said upper drill pipe; and

hydraulic cylinder means with said lead tong of grasping and releasing said upper drill pipe.

4. Apparatus according to claim 3 including hydraulic means of simultaneously selectably positioning said backup tong, said spinner, and said lead tong to engage and to disengage said upper and lower lengths of drill pipe.

5. Apparatus according to claim 3 including:

a source of hydraulic pressure;

a manifold of hydraulic actuating valves between said source of hydraulic pressure and said hydraulic cylinder means for selectably and sequentially controlling said hydraulic cylinder means to sequentially actuate said backup tong jaw and grasping means, said spinner jaw and grasping means, and said lead tong jaw and grasping means for selectably threading and unthreading said lengths of drill pipe.

6. Apparatus for use on a rotary drilling rig for threading together and unthreading the vertical lengths of drill pipe, the upper length being rotatably supported above a derrick floor from a drilling mask and the lower length being supported on a rotary table, comprising in combination:

a backup tong having a jaw portion movable between an opened and closed position wherein in the opened position the backup tong may be positioned to engage the lower length of drill pipe and in the closed position the backup tong encompasses the lower drill pipe, and including means when in the closed position of grasping the lower drill pipe to prevent the rotation thereof;

a spinner having a jaw portion movable between an opened and a closed position wherein in the opened position the spinner may be positioned to engage the upper length of drill pipe and in the closed position the spinner encompasses the upper drill pipe, and including means when in the closed position of grasping and rotating the second drill pipe to threadably engage the lower drill pipe;

a lead tong having a jaw portion movable between an opened and a closed position wherein in the opened position the lead tong may be positioned to engage the upper length of drill pipe, and in the closed position the lead tong encompasses the upper drill pipe, and including means when in the closed position of grasping the upper drill pipe;

means of rotating said lead tong relative to said backup tong to threadably set the upper drill pipe to the lower drill pipe;

hydraulic cylinder means of closing and unclosing said backup tong jaw portion;

hydraulic cylinder means of closing and unclosing said spinner jaw portion;

hydraulic cylinder means of closing and unclosing said lead tong jaw portion;

hydraulic cylinder means with said backup tongs of grasping and releasing said lower drill pipe;

hydraulic cylinder means with said spinner of grasping and releasing said upper drill pipe;

hydraulic cylinder means with said lead tong of grasping and releasing said upper drill pipe;

a source of hydraulic pressure;

a manifold of hydraulic actuating valves between said source of hydraulic pressure and said hydraulic cyl-

inder means for selectably and sequentially controlling said hydraulic cylinder means to sequentially actuate said backup tong jaw and grasping means, said spinner jaw and grasping means, and said lead tong jaw and grasping means for selectably threading and unthreading said lengths of drill pipe; and

a valve actuating lever pivoted at one end and when pivoted in one direction engages said manifold of hydraulic actuating valves, said lever and said actuating valve being arranged such that as said lever is pivoted in one direction said valves are actuated in sequence to actuate said cylinders to cause said spinner and said tongs to engage said lengths of drill pipes, whereby said upper length of drill pipe may be threadably engaged and threadably set to said lower length of drill pipe, and when said valve actuating lever is pivoted in the opposite directions said cylinders are actuated to cause said spinner and said tongs to disengage from said lengths of drill pipe.

7. Apparatus according to claim 6 wherein said valve actuating lever is rotatable 180° to a break out position in which position the pivotation of said lever in one direction engages said manifold of hydraulic actuating valves in a manner such that said valves are actuated in sequence to actuate said cylinders to cause said tongs to engage said lengths of drill pipe, whereby said upper length of drill pipe may be threadably broken out of said lower length of drill pipe, and said lower length of drill pipe unthreaded from said upper length of drill pipe, and when said valve actuating lever is pivoted in the opposite direction said cylinders are actuated to cause said tongs to disengage from said lengths of drill

pipe.

8. Apparatus for use on a rotary drilling rig for threading together and unthreading two vertical lengths of drill pipe according to claim 1 including:

a rotatable vertical pivot post supported on said derrick floor adjacent to and spaced from said upper and lower lengths of drill pipe, said backup tong, said spinner and said lead tong being affixed to and extending from said pivot post; and

means of selectably rotating said pivot post to engage and disengage said backup tong, said spinner, and said lead tong to and from said upper and lower lengths of drill pipe.

9. Apparatus according to claim 8 including hydraulic means of rotating said pivot post and thereby positioning said backup tong, said spinner and said lead tong to and from engagement with said length of drill pipe.

10. Apparatus for use on a rotary drilling rig for threading together and unthreading two vertical lengths of drill pipe according to claim 1 including:

means of rotatably positioning said lead tong relative to said backup tong about said lengths of drill pipe to cock said tongs to grasp said lengths of drill pipe whereby said lead tong may be rotated in the opposite direction relative to said backup tong to threadably set said upper drill pipe to said lower drill pipe.

11. Apparatus according to claim 10 wherein said means of rotatably positioning said lead tong relative to said backup tong including a coching hydraulic cylinder means connected between said backup tong and said lead tong.

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