United States Patent [19]

Lang et al.

[11] **3,844,547**

[45] **Oct. 29, 1974**

[54] **TOOL WRENCH**

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[73] Assignee: **Bucyrus-Erie Company**, South Milwaukee, Wis.

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[21] Appl. No.: **430,469**

[52] **U.S. Cl.**..... **269/25**, 81/57.34, 81/57.19, 173/164

[51] **Int. Cl.**..... **B23q 3/08**, B25b 13/50, E21b 3/00

[58] **Field of Search**..... 81/57.33, 57.34, 57.35, 81/57.40, 57.41, 57.19; 173/164; 269/25, 26, 27; 279/4

[56] **References Cited**

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3,270,823	9/1966	Buehler	81/57.3 X
3,727,772	4/1973	Pauls	269/25

Primary Examiner—James L. Jones, Jr.

Attorney, Agent, or Firm—Quarus & Brady

[57] **ABSTRACT**

A tool wrench for holding and locking sections of a drill string of a drilling apparatus has a pivotable mounting arm on which a pair of chuck sleeves and accompanying clamping jaws are attached for slidable movement along and pivotable movement around the longitudinal axis of the mounting arm. A clamp actuator is connected intermediate the chuck sleeves to provide opening and closing operation of the clamping jaws around the drill string section and a swing actuator is employed to pivot the mounting arm from a storage position towards the drill string.

7 Claims, 6 Drawing Figures

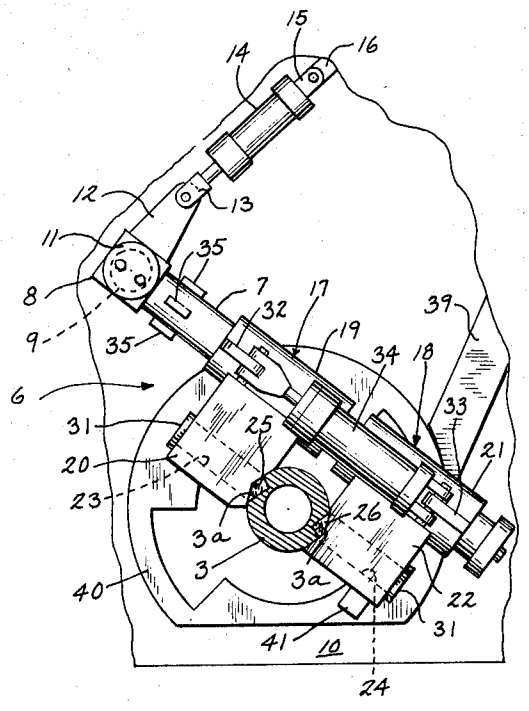


Fig. 1

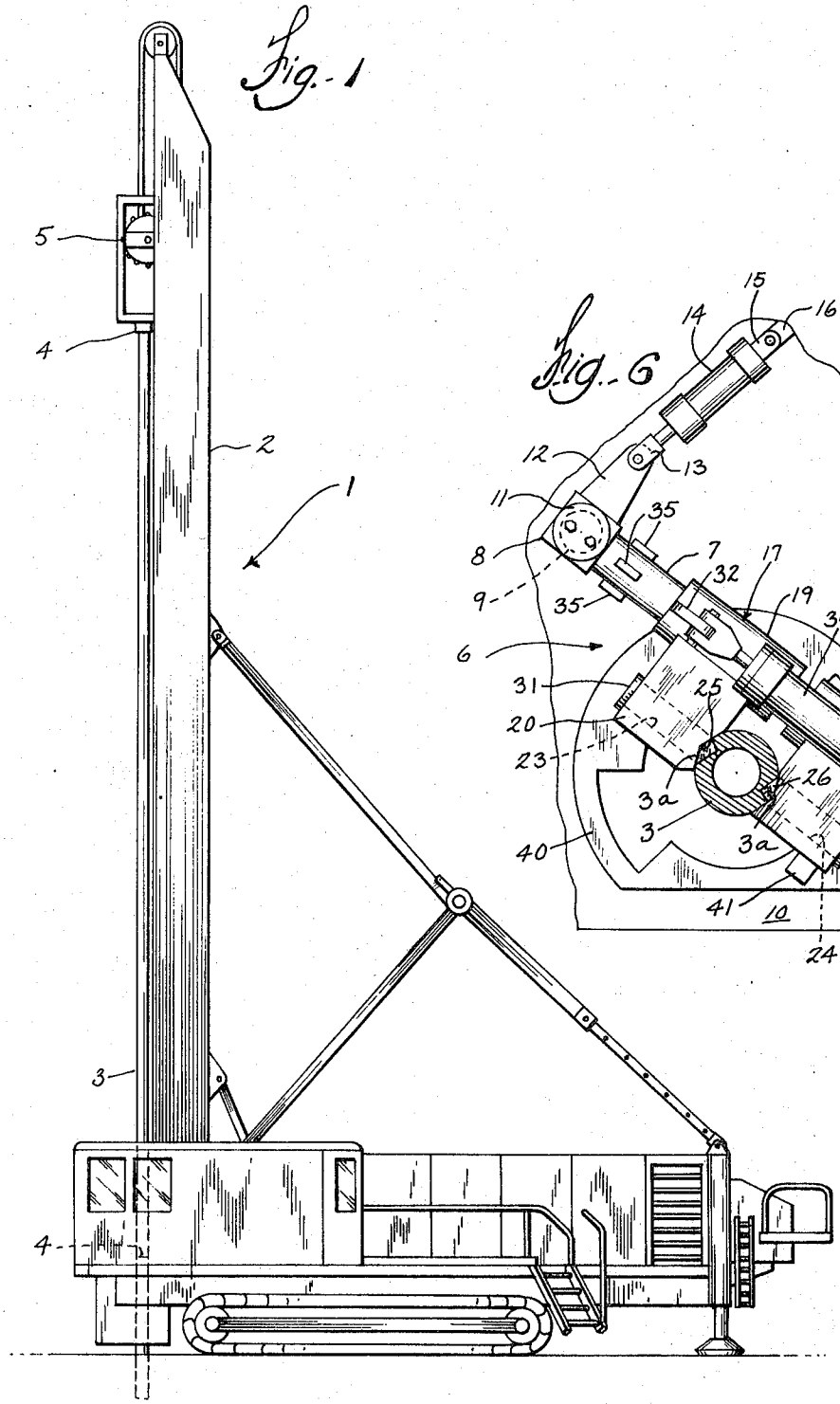

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Fig. 6

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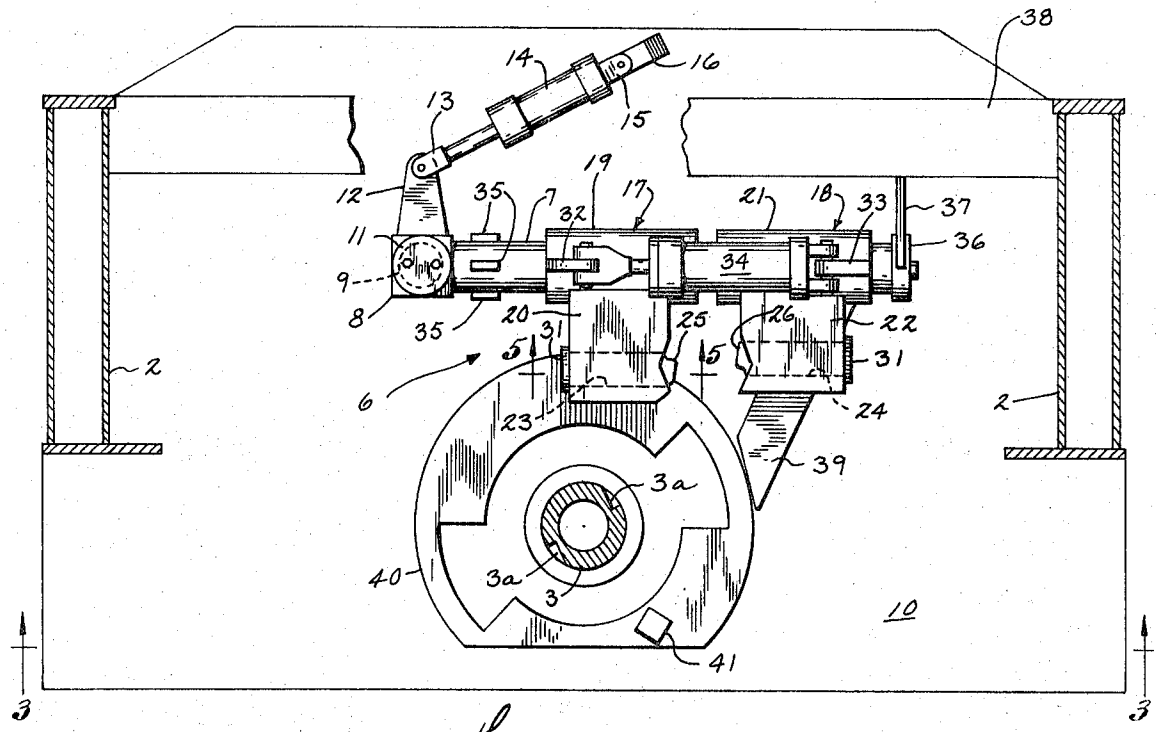

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Fig. 2.

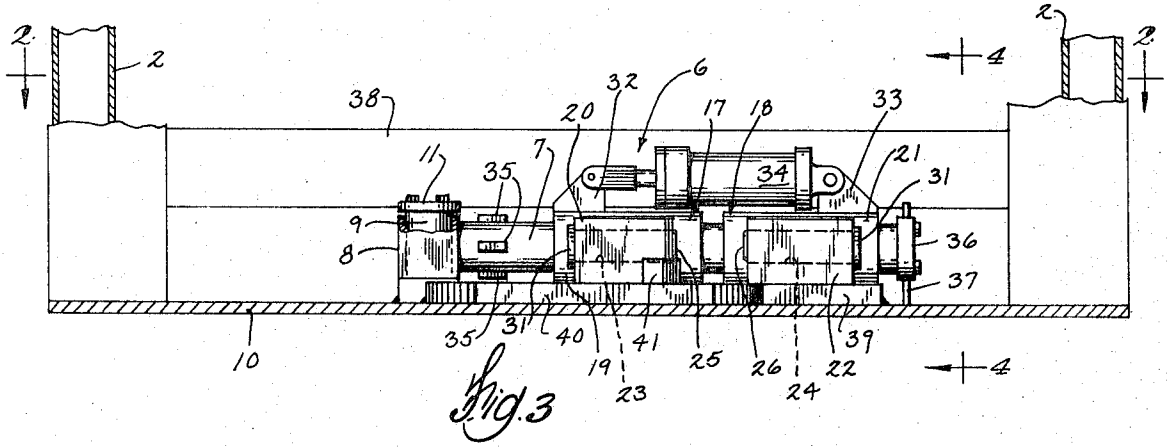
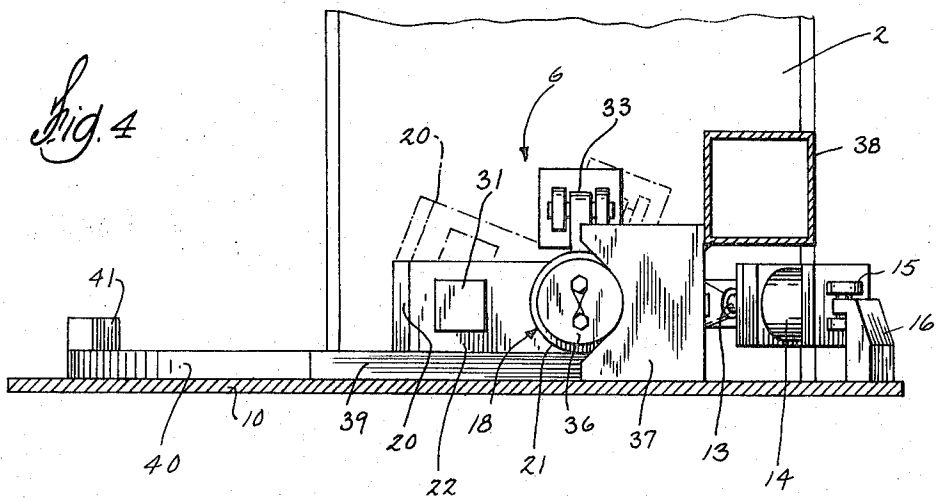

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Fig. 3

Fig. 4


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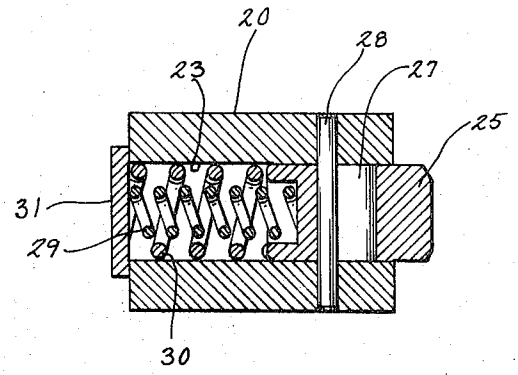

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Fig. 5

TOOL WRENCH

BACKGROUND OF THE INVENTION

The invention pertains to rotary drilling apparatus and more particularly to a tool wrench used in supporting and gripping a drill string to which pipe sections are connected or disconnected. The preferred embodiment is especially applicable in the joining and disjointing of pipe sections in a rotary blast hole drill, but the invention is not confined exclusively to this area and may be utilized wherever it is desirable to couple and uncouple drill string sections in drilling apparatus.

In typical blast hole drilling operations, it is customary procedure to drive a drill string formed by several joined sections of drill pipe, each having a typical length of 60 feet, into the earth forming a deep elongated hole within which a blast or dynamite charge may be implanted subsequent to removal of the drilling apparatus from the site. When inserting or withdrawing the drill string, it is necessary to utilize a tool wrench in association with a conventional breakout wrench and/or pipe handling apparatus for adding individual pipe sections to or detaching sections from themselves and a rotary head mechanism which imparts rotation to the drill string. These operations upon the threaded pipe joints of the formed drill string are accomplished through the use of clamping jaws which grasp the drill string when an upper pipe section or the rotary head mechanism is broken free of or connected into the drill string. In addition, the tool wrench functions to hold the disconnected drill string from falling back into the hole previously drilled.

It is particularly desirable to provide a tool wrench which positively locks the drill string against rotation during loosening yet permits rotation during supplementation of drill pipe sections. Furthermore, since errant raising operation of the drill string sometimes occurs, it is advantageous to furnish a tool wrench which allows for limited longitudinal movement of the drill string without disengagement of the tool wrench therefrom. If safe, effective drilling is to be maintained, design features of automatic operation and adjustability should also be incorporated into the device.

A typical tool wrench for making and breaking threaded pipe joints is disclosed in U.S. Pat. No. 2,972,388 issued to H. W. Thornburg on Feb. 21, 1961. In this patent, hook-shaped pawls mounted below the platform of the drilling apparatus are pivoted inwardly by fluid motors to engage notches at the upper end of a drill pipe section, thereby preventing left hand rotation but allowing right hand rotation of the drill pipe. While selective rotational locking is included in this tool wrench, no structural provision is made to allow the drill string to move longitudinally without disconnecting the hook-shaped pawls.

Another well known tool wrench is shown in U.S. Pat. No. 3,212,593 granted to K. E. Reischl on October 19, 1965. This device consists of two opposing hydraulic rams extending toward each other and adapted to clinch the drill string similar to a vise gripping action. Locking of this tool wrench is accomplished due to the pointwise engagement of the rams with the drill string. As a result of this structure, the ram components are highly susceptible to wear and breakage, and upkeep costs prove to be unduly expensive.

It is against this background of the art that the present invention has been conceived, and a principal purpose of the invention is to improve upon prior tool wrenches which furnish strictly rotational and longitudinal locking of a drill string.

SUMMARY OF THE INVENTION

The present invention provides a tool wrench for drilling apparatus having a pivotably connected mounting arm, a pair of chucks slidably attached to the mounting arm for retractable movement along and pivotable movement around the longitudinal axis of the mounting arm, a clamp actuator joined between the chucks and a swing actuator on the drilling apparatus secured to the mounting arm. The swing actuator moves the mounting arm from a storage position towards and into engagement with the drill string whereupon the slidable chucks are operated by the clamp actuator to positively grip and lock the drill string from rotation during loosening but permit rotation during tightening of an additional pipe section. The chucks are upwardly pivotable about the mounting arm to accommodate for marginal upward movement of the drill string in the event of misoperation of the drilling apparatus.

It is a general objective of the invention to provide a tool wrench which supports and effectively holds a drill string section from impacting free during coupling and uncoupling of an upper pipe section or the rotary head mechanism regardless of rotational or longitudinal movement of the drill string. This behavior is attained by utilizing a pair of adjustable chucks each axially slidable along the mounting arm to firmly grip the upper portion of any size drill pipe section, and also upwardly pivotable about the longitudinal axis of the mounting arm to maintain engagement of the tool wrench despite any inadvertent raising of the drill string.

In prior devices, as referred to above, there has been adequate holding forces for firmly gripping a section of a drill string and assuredly holding it in suspended position within a hole, as is particularly necessary when removing the drill string section by section from the hole. However, if an operator mistakenly commences to vertically shift a drill string at an improper time, the gripping forces may be lost. The present invention has, as one objective, the unique provision of allowing the chuck jaws of a tool wrench to rotate about their mounting in a vertical plane to retain the gripping forces upon the drill string. In this manner the function is introduced into a tool wrench of allowing some vertical disposition of the chuck jaws to enhance reliability.

Another objective is to provide a tool wrench which can be operated automatically when joining pipe to and removing pipe from the drill string without manual handling of the individual pipe or drill string. Such goal is accomplished by employing a swing actuator which pivotably moves the tool wrench from a non-obstructing storage position into engagement with the drill string and a clamp actuator which moves the chucks into positive interlock with suitable recesses on the pipe section. Due to this structure, there is a marked reduction in manual labor cost and an accompanying improvement in the safety factors related to handling of drill pipes.

The foregoing and other objects and advantages of the invention will appear from the following description. In the description reference is made to the accom-

panying drawings which form a part hereof, and in which there is shown by way of illustration and not of limitation a preferred embodiment of the invention. Such embodiment does not represent the full scope of the invention, but rather the invention may be employed in many different embodiments, and reference is made to the claims for interpreting the breadth of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in elevation of a rotary blast hole drill incorporating a tool wrench of the present invention,

FIG. 2 is a top view of the tool wrench located on the base platform of the mast of the blast hole drill, which view is taken in the plane 2—2 designated in FIG. 3 and shows the invention swung away from the drill pipe in a storage position,

FIG. 3 is a front view in elevation of the tool wrench taken in the plane 3—3 indicated in FIG. 2,

FIG. 4 is a side view in elevation of the tool wrench taken in the plane 4—4 indicated in FIG. 3 and illustrating, in phantom, a pivotable movement of a pair of chucks forming a part of the tool wrench,

FIG. 5 is a view in cross section of a clamping jaw of one of the chucks of the tool wrench taken in the plane 5—5 designated in FIG. 2, and

FIG. 6 is a top view of the tool wrench, similar to FIG. 2, showing the wrench pivoted towards a drill string to indicate the manner in which clamping jaws of the device engage the drill string.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a rotary blast hole drill, generally designated by the reference numeral 1, includes a tiltable mast 2 pivotably movable between a horizontal transporting position and a series of variable, raised drilling positions one of which is vertical, as illustrated. A number of drill pipe sections 3 are joined together by threaded pipe joints 4, and the uppermost section 3 is connected by a joint 4 to a rotary head driving mechanism 5. The drill string thus formed is driven into the earth by means, not shown, that force the rotary head driving mechanism 5 downward along the mast 2. This downward movement is accompanied by rotation of the drill string in conventional manner. Since a blast hole drill of the character above outlined is well known and does not per se comprise substance of the present invention, further description thereof is unnecessary. While the invention is suitable for such drills, however, it should be understood that it is applicable to any oil, gas or water drilling rig as well as any other equipment which requires coupling and uncoupling of drill pipe sections.

As depicted in FIGS. 2-4 and 6, the improved tool wrench, generally indicated by the reference numeral 6, includes a circular, cylindrical mounting arm 7 secured at one end to a rectangular shaped post 8 which pivots on an upstanding, stationary spindle 9 anchored to the platform 10 of the mast 2. A round cap 11 on the top of the spindle 9 holds the post 8 in place, so that it will not rise and jump the spindle 9 during operation of the tool wrench 6. The arm 7 thus presents its longitudinal length in a horizontal plane substantially vertical to the drill pipe sections 3, and it is cantilevered for pivot around one end.

A transfer link 12 is secured to and extends rearward from the post 8, so that they will rotate together about the spindle 9. The free end of the transfer link 12 is connected to the rod end 13 of a hydraulic cylinder 14, which serves as a swing actuator, and the casing end 15 of the cylinder 14 is pivotally secured to a mounting bracket 16 fixed upon the mast platform 10. As a result of these linkages, pressurization of the swing actuator 14 causes the cylindrical mounting arm 7 to pivot towards and away from the drill pipe section 3.

A pair of chucks 17 and 18 are slidably mounted upon the mounting arm 7 for both longitudinal movement therealong and pivotable movement thereabout. The chuck 17 includes a tubular sleeve 19 encircling the arm 7 to which is welded a radially extending clamping jaw 20. Correspondingly, the chuck 18 includes a tubular sleeve 21 to which is welded a second clamping jaw 22, the forward extent of the clamping jaw 22 being somewhat less than that of the clamping jaw 20. The clamping jaws 20, 22 are formed with cylindrical openings 23 and 24, respectively, which have axes that parallel one another with a slight lateral offset. Jaw teeth 25, 26 reside in the openings 23, 24 and protrude from the openings in facing relation to one another.

Turning now to FIG. 5, the tooth 25, which is structurally identical to the tooth 26, fits snugly within the opening 23 for reciprocal motion therein, and it has a vertical slot 27 formed therethrough. A transverse retainer pin 28 is inserted through the slot 27 and is held in place by its ends extending into closely conforming openings in the jaw 20. Thus, the pin 28 limits the tooth 25 in its sliding movement within the aperture 23. The tooth 25 is normally biased outwardly by a pair of compression springs 29, 30, which work against the tooth 25 at one end and are retained within the aperture 23 by means of a plug cap 31 affixed to the clamping jaw 20.

With further reference to FIGS. 2-4 and 6, a mounting ear 32 is secured at the upper part of the outer end of the tubular sleeve 19, and similarly located on the tubular sleeve 21 is a second mounting ear 33. A hydraulic cylinder 34, acting as a clamp actuator, has its rod end joined to the mounting ear 32 and its casing end connected to the mounting ear 33. As a result of these connections, operation of the clamp actuator 34 slidably moves the chucks 17, 18 back and forth along the longitudinal axis of the cylindrical mounting arm 7. These longitudinal movements comprise converging and diverging excursions of the chucks 17, 18 so that the jaws 20, 22 are closed and opened. The outermost movement of chuck 17 is limited by a number of stop elements 35 circumferentially spaced around the periphery of the arm 7, and the outermost movement of the chuck 18 is limited by a bearing collar 36 fastened to the outer, cantilevered end of the arm 7. It should be appreciated that the entire assembly of the chucks 17, 18 and the clamp actuator 34 are pivotable upward about the longitudinal axis of the mounting arm 7, as indicated in phantom in FIG. 4, as well as being slidable longitudinally therealong.

To insure that the tool wrench 6 does not obstruct the drill string during normal drilling operations, provision is made to store the mounting arm 7 clear of the drilling region. In particular, a storage bracket 37, which is best shown in FIG. 4, is fastened to the mast platform 10 and a hollow crossbeam 38 interconnect-

ing the uprights of the mast 2. When the swing actuator 14 is in its extended position, as shown in FIG. 2, the mounting arm 7 lies substantially parallel to the crossbeam 38 and the storage bracket 37 functions to seat the bearing collar 36 of the mounting arm 7.

Assuming that a drill pipe section is to be added to the drill string comprised of pipe section 3, the swing actuator 14 is retracted to pivot mounting arm 7 from its storage position of FIG. 2 to an operative position of FIG. 6. The mounting arm 7 swings towards the drill pipe sections 3 joined to the rotary head mechanism 5 with the chuck jaws 20, 22 sliding across a flat rail bar 39 and a generally circular drill plate 40, both of which are secured to the mast platform 10. When the front portion of the clamping jaw 22 abuts a check bar 41 fastened on the drill plate 40, clamp actuator 34 is operated to slide the clamping jaws 20, 22 and spring biased teeth 25, 26 into locking engagement with the recesses 3*a* on the drill pipe section 3 at a point below the threaded joint 4 coupling the drill pipe section 3 to the rotary head mechanism 5. The disposition of the biased teeth 25, 26 with the recesses 3*a* of the drill pipe section 3 allows a right hand rotation of the drill pipe 3, but positively locks the drill pipe 3 against left hand rotation. With the drill pipe 3 locked against left hand rotation, the rotary head mechanism 5 may be reversed to uncouple the upper joint 4 between the rotary head mechanism 5 and the drill pipe 3, which remains suspended by the clamping jaws 20, 22. Should the operator of the drilling apparatus 1 mistakenly raise the drill string while unthreading of the joint 4 occurs, the chucks 17, 18 will pivot upwardly around the mounting arm 7 and the clamping jaws 20, 22 will maintain their positive locking engagement with the drill pipe section 3. Upon complete disconnection and subsequent raising of the rotary head mechanism 5, conventional pipe handling apparatus, not shown, is employed to align an additional pipe section 3 between the rotary head mechanism 5 and the drill pipe section 3 held by the tool wrench 6. The rotary head mechanism 5 is then lowered and rotated to couple the pipe section into the top of the drill string suspended in the hole, the suspended drill pipe section 3 being permitted to rotate once threading of the joint 4 becomes tight, since the teeth 25, 26 are forced inwardly by the inner surface of the recesses 3*a* on the rotating drill pipe section 3. Upon addition of the pipe section, the clamping jaws 20, 22 are released and the tool wrench 6 is automatically swung back to its storage position of FIG. 2.

In withdrawing the drill string, the rotary head mechanism 5 is raised until a full length of drill pipe lies above the base of the drilling apparatus 1. The tool wrench 6 is operated as aforedescribed to grip the upper end of the next lower pipe section 3 in the drill string and the rotary head mechanism 5 is reversed to disconnect the lower threaded joint 4 of the raised drill pipe section whose upper joint remains secured to the rotary head mechanism 5. Pipe handling apparatus is utilized to unfasten and transfer the raised drill pipe section whereupon the rotary head mechanism 5 is lowered and rotated for connection to the suspended drill pipe section 3 held by the tool wrench 6, which is thereafter retracted and stored.

The tool wrench 6 may also be employed for supplementing and removing drill pipe sections in conjunction with a conventional breakout wrench (not shown) which acts to impart a wrenching torque for loosening and uncoupling a section of drill pipe immediately above a drill pipe length engaged by the tool wrench 6.

In the invented structure one of the salient features is the rotatable motion the chucks 17, 18 may make about the axis of the circular, cylindrical surface of the mounting arm 7. An operator may inadvertently raise the drill string, and it is essential that the tool wrench 6 does not then lose its grip upon the drill string, for a prime function of the wrench 6 is to hold the drill string from falling back into the drilled hole. To achieve this purpose, the chucks are mounted for a limited rotational movement that ensures positive engagement of the clamping jaws 20, 22 with the drill pipe section 3 during all coupling and uncoupling procedures. The slidable chuck construction also allows the tool wrench 6 to accommodate various sizes of drill pipes. In addition, the swing actuator 14 and clamp actuator 34 provide for complete automatic operation of the tool wrench 6 thereby alleviating the possibility of injury due to handling and improving safety throughout drilling operation.

We claim:

1. In a tool wrench for holding sections of a drill string of a drilling apparatus, the combination comprising:

a mounting arm pivotably connected at one end to the drilling apparatus and swingable about an axis parallel to a drill string axis of the drilling apparatus;

a pair of chucks slidably attached upon said mounting arm for movement towards and away from each other and adapted to close around a section of a drill string, said chucks being upwardly pivotable about the longitudinal axis of said mounting arm;

a first hydraulic cylinder pivotal with said mounting arm and having ends each being fixed to one of said chucks for moving said chucks along said mounting arm; and

a second hydraulic cylinder associated with the drilling apparatus and having one end joined to said mounting arm for swinging said mounting arm towards and away from a drill string.

2. A tool wrench as in claim 1, wherein said mounting arm comprises a cylinder having stop elements affixed thereto for limiting the outermost movement of said chucks.

3. A tool wrench as in claim 2, wherein each of said chucks includes a tubular sleeve slidably engageable with said mounting arm and a jaw secured to said tubular sleeve.

4. A tool wrench as in claim 3, wherein each said jaw has a tooth biased outwardly and engageable with recesses formed on the sections of a drill string to prevent loosening thereof.

5. A tool wrench as in claim 4 having a hinge coupling which comprises an upright spindle joined to the drilling apparatus, a post connected with said mounting arm and having a transfer link extending therefrom, said post being disposed on said spindle for rotation thereabout and said transfer link being connected to one end of said second hydraulic cylinder.

6. In a tool wrench for holding sections of a drill string of a drilling apparatus, the combination comprising:

a circular, cylindrical mounting arm pivoted at one end to swing about an axis parallel to a drill string axis of the drilling apparatus;

a hinge coupling connecting the one end of said mounting arm to the drilling apparatus;

a swing actuator associated with the drilling apparatus and having one end joined to said hinge coupling for swinging said mounting arm towards and away from a drill string;

a pair of chucks slidably attached upon said mounting arm for movement towards and away from each other and adapted to clamp around a section of a drill string, said chucks being pivotable about the longitudinal axis of said mounting arm; and

a clamp actuator pivotal with said mounting arm and having ends each being fixed to one of said chucks for moving said chucks along said mounting arm.

7. In a tool wrench for holding sections of a drill string in a drilling apparatus, the combination comprising:

a mounting arm with a circular, cylindrical surface extending longitudinally of its length, and pivoted at one end for swinging movement toward and away from a drill string of the drilling apparatus, such movement being in a plane substantially perpendicular to said drill string;

a pair of sleeves encircling and slidable along said circular, cylindrical surface in converging and diverging movement with respect to one another, which sleeves are also free to rotate about said surface;

a pair of chuck jaws, one on each of said sleeves, extending radially outward from said mounting arm and positioned in a facing relation to converge upon and diverge from one another in unison with sleeve movements, said jaws also being swingable upward upon a rotation of said sleeves; and

an extendable and retractable clamp actuator connected between said sleeves for imparting said converging and diverging movements, such movements tightening said jaws upon and releasing them from said drill string when said jaws are positioned on opposite sides thereof by a pivoted movement of said mounting arm, said upward swinging of said jaws permitting maintenance of jaw engagement with said drill string upon occurrence of an upward displacement of the drill string.

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