United States Patent [19]

Klein

[11] **3,768,579**

[45] **Oct. 30, 1973**

[54] **DRILL PIPE BREAKOUT MECHANISM**

[75] Inventor: **Harold T. Klein,** Bellevue, Wash.

[73] Assignee: **The Robbins Company,** Seattle, Wash.

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[21] Appl. No.: **212,113**

[52] **U.S. Cl.** **173/164,** 81/57.2

[51] **Int. Cl.** **E21b 19/16**

[58] **Field of Search** 173/164; 175/85; 81/57.15–57.21, 57.33–57.35, 58.2; 64/23.5

[56] **References Cited**

UNITED STATES PATENTS

3,446,284	5/1969	Dyer et al.	173/164
2,758,493	8/1956	Goldwater	82/58.2

Primary Examiner—Ernest R. Purser

Attorney—John O. Graybeal et al.

[57] **ABSTRACT**

First and second collar like wrench members having radially outwardly directed peripheral teeth are respectively locatable about a turning wrench flat region of an upper section of drill type and a holding wrench flat region of the next lower section of drill pipe. The lower wrench member is held by a holding wrench having inwardly directing teeth for engaging complementary teeth on the holding wrench member. A drill head includes a breakout wrench having radially inwardly directed teeth which are engageable with the teeth on the upper wrench member. The upper section of pipe is thread connected to a collet internally of the drill head which is free to float axially relative to the breakout wrench on the drill head. The collet is spline connected to the drill head so that it rotates along with the drill head. The axial float permits the drill head to be hydraulically raised and lowered relative to the collet. The drill head is raised to provide room below the breakout wrench for installation of the upper wrench member, and is lowered to bring the teeth of the breakout wrench into engagement with the teeth of the upper wrench member. The collet is supported within the drill head for sideways pivotal movement in all directions, so that bending stresses are not transmitted from the drill pipe to the rotary drive mechanism for the drill head.

9 Claims, 11 Drawing Figures

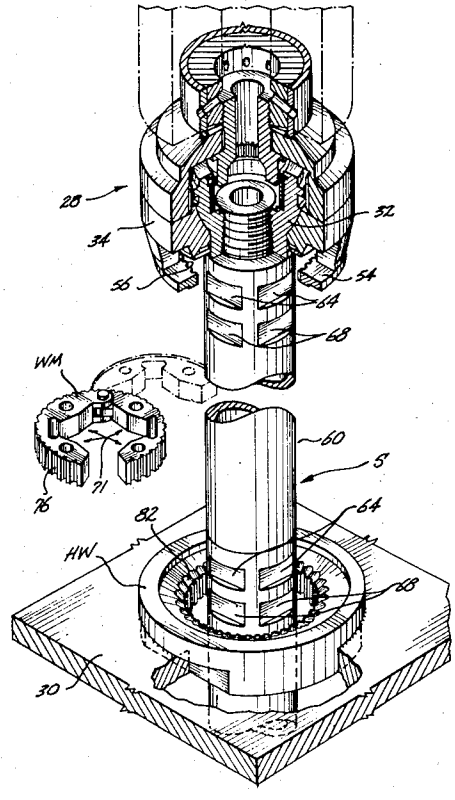
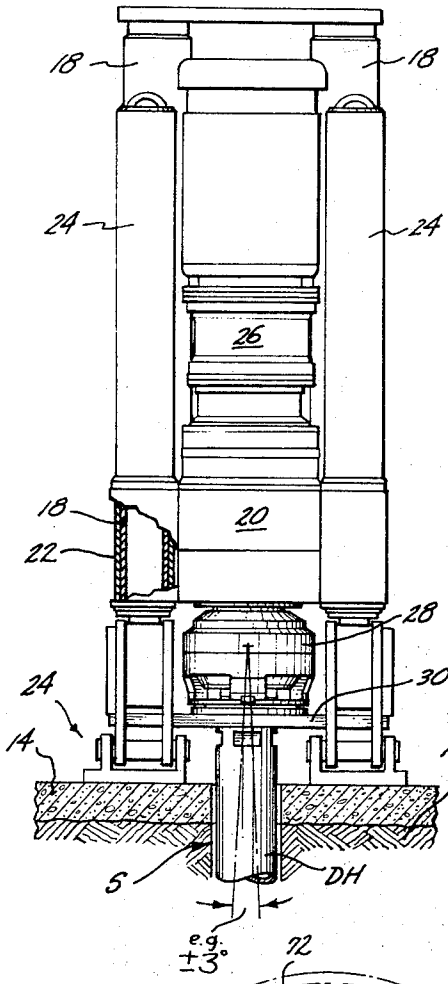


Fig. 1.



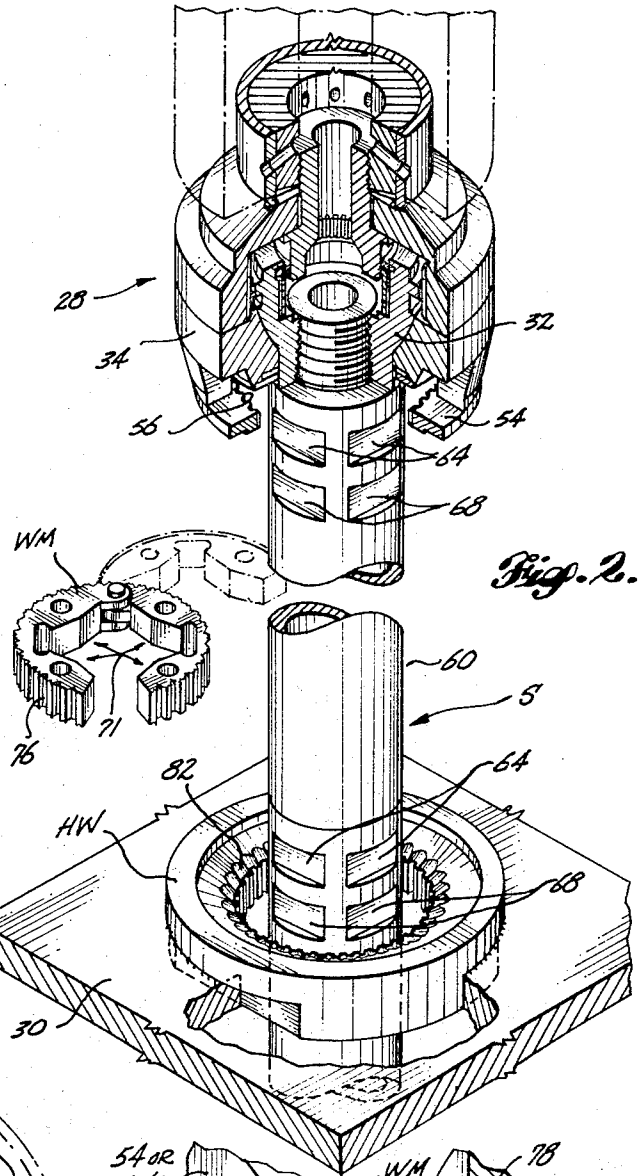


Fig. 2.

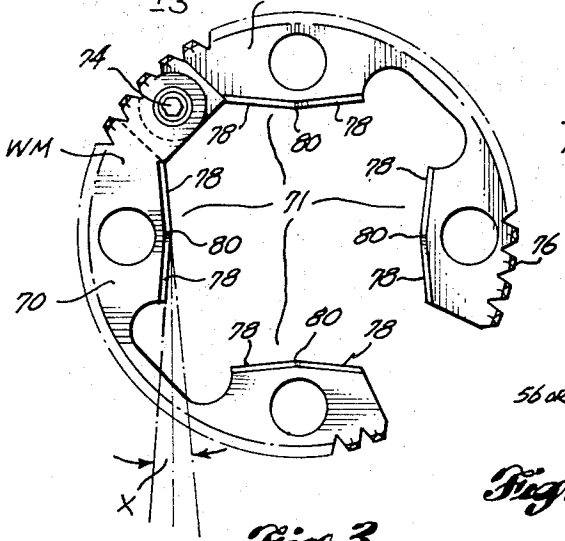


Fig. 3.

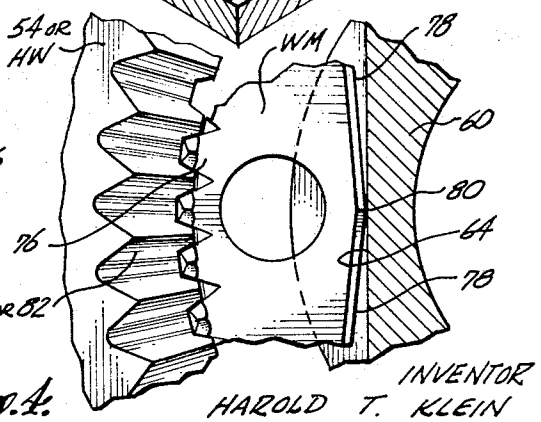


Fig. 4.

INVENTOR
HAROLD T. KLEIN
BY Strayhead, Cole & Barnard
ATTORNEYS

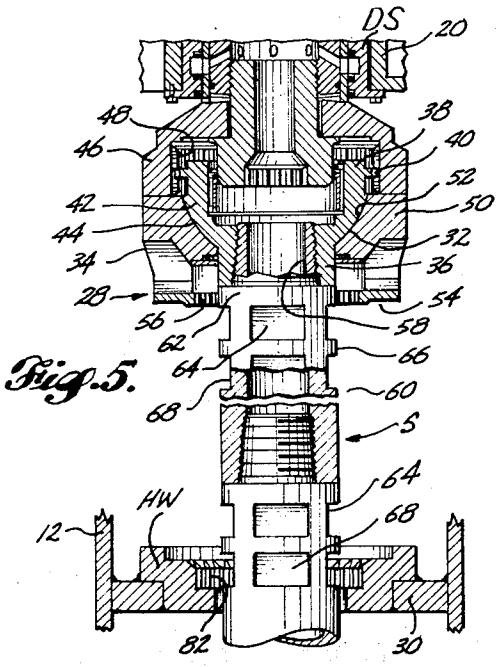


Fig. 5.

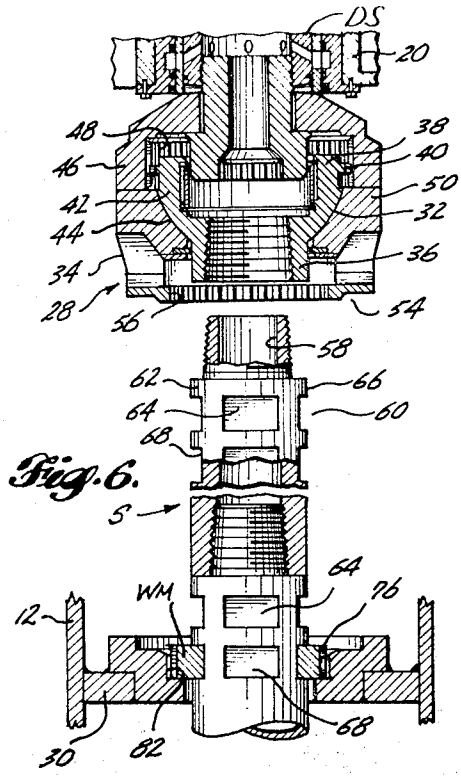


Fig. 6.

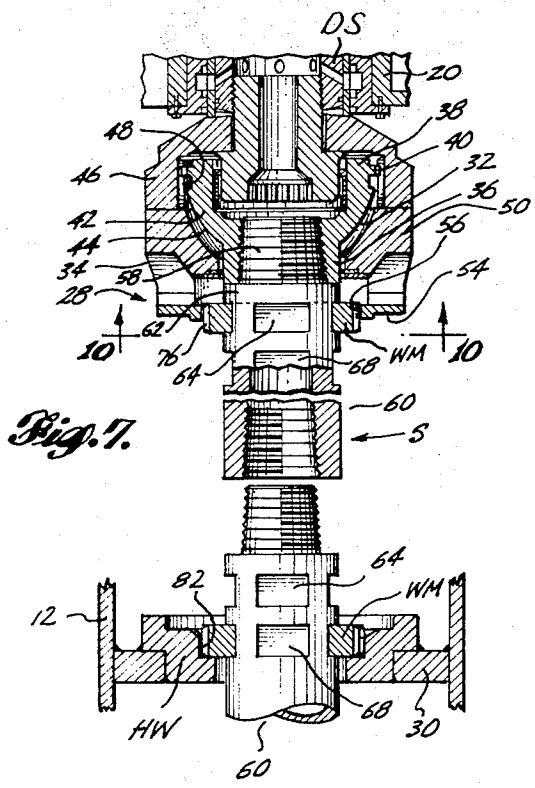


Fig. 7.

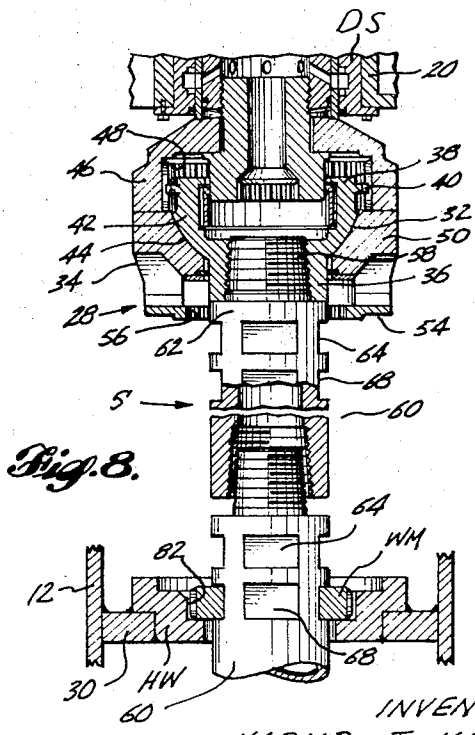


Fig. 8.

INVENTOR
HAROLD T. KLEIN

BY Graybeal, Cole & Barnard

ATTORNEYS

Fig. 9.

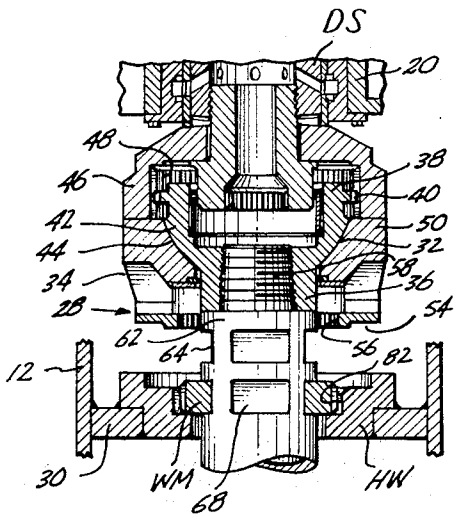
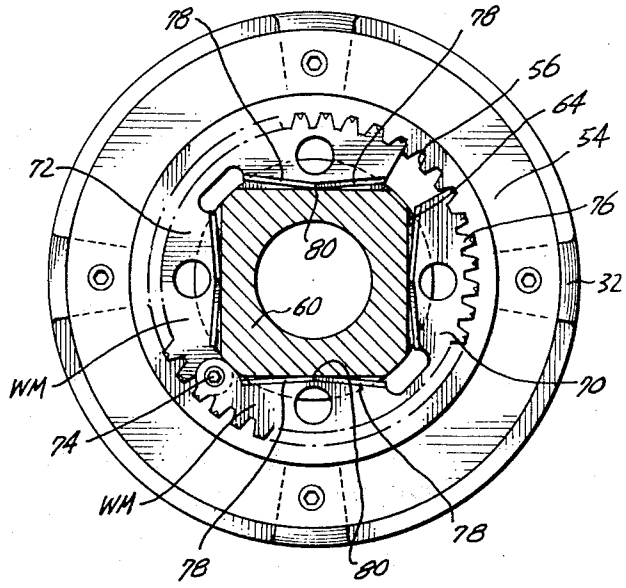


Fig. 10.



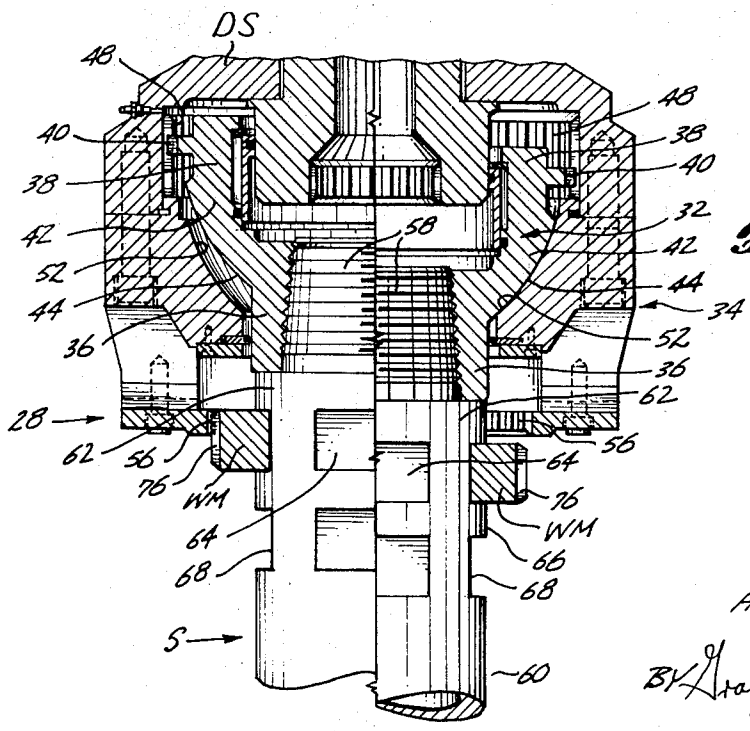


Fig. 11.

INVENTOR
HAROLD T. KLEIN
BY Graybeal, Cole & Barnard
ATTORNEYS

DRILL PIPE BREAKOUT MECHANISM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to sectional drill stems or shafts comprising a plurality of pipe sections joined together by threaded pin and box type tool joints. More particularly, it relates to auxiliary apparatus for rotatably coupling the drill head to the drill stem at a time when the upper threaded tool joint between the two is loose, so that the drill head can be rotated in a reverse direction to in turn rotate the section of drill pipe threaded to it, for breaking or loosening the lower tool joint of such pipe section without unscrewing the upper tool joint. The invention also relates to various details of holding and turning wrenches, collar like turning and holding breakout wrenches.

2. Description of the Prior Art

The most conventional practice of breaking drill stem threaded tool joints involves the use of tongs or manually applied portable power wrench mecanisms which require hard manual work, and in addition they made the breakout operating both hazardous and time consuming.

U.S. Pat. No. 3,239,016 granted on Mar. 8, 1966, to Emmett L. Alexander discloses a breakout method and apparatus in which neither tongs nor manually applied power mechanisms are used. Instead, the pipe sections are constructed to include a square headed extension at the pin end thereof and a square socket of complementary shape internally of the pipe at the box end. In use, the portion of the drill stem portion below the uppermost section is secured against both rotary and axial movement and the drill head is reversed to cause a random loosening of either the upper or lower threaded tool joints of the upper section of drill pipe. If the lower joint loosened first, the upper section of pipe is rotated until the threads are completely decoupled. Then, the drill head and the upper section of pipe attached thereto are raised until the square head of the extension is engaged within the square socket of the second section. Then, the drill head is again reversed to cause first a loosening and then a complete decoupling of the tool joint at the upper end of the upper section. If the upper tool joint is the first to loosen, the drill head is reversed until the threads of such joint are entirely disengaged, and then the drill head is moved axially upwardly to place a square headed depending section of an axial extension of the drill head inside the square socket within the upper end of the upper section of drill pipe. Then, the drill head is reversed to first loosen and then entirely disengage the threads of the lower tool joint.

Applicant's prior U.S. Pat. Nos. 3,463,247 and 3,554,298 disclose a system in which the drill head is provided with an auxiliary wrench having jaws which during use are spaced radially outwardly from opposed depressions or flats in the upper section of drill pipe. Insert elements are inserted laterally into the spaces between depressions and the jaws, to substantially completely fill such spaces. A horseshoe type holding wrench or the like is used for engaging the second pipe section at a holding table. Breakout torque is transferred to the upper pipe section from the jaws, to the insert elements, to the depressions, during reverse drive of the drill head.

U.S. Pat. No. 3,446,284, granted May 27, 1969, to Norman D. Dyer and Roy L. VanWinkle, discloses apparatus similar to that shown by applicant's prior U.S. Pat. Nos. 3,463,247 and 3,554,298, except that the drill head is provided with an external axially moveable sleeve and mechanism for moving it axially downwardly relative to the drill head and the frame on which the drill head is supported, and auxiliary mechanism for rotating it in the breakout direction. The sleeve is moveable downwardly into surrounding engagement with a wrench member installed about a surface depression region on the drill pipe.

SUMMARY OF THE INVENTION

The drill pipe of the present invention is like the drill pipe disclosed by applicant's aforementioned U.S. Pat. Nos. 3,463,247 and 3,554,298. Such pipe comprises a threaded pin at one end, a threaded box at the other end, and external auxiliary torque transfer means at one end only, located axially inwardly of the tool joint component at such end.

A disadvantage of the known drill head carried breakout apparatuses of the prior art is that they all require rotation of the drill head relative to the surface depressions of the pipe before the wrench surfaces of the breakout wrench can be brought into engagement with the wrench members received in the surface depressions. Also, in apparatuses of the type shown by applicant's aforementioned U.S. Pat. Nos. 3,463,247 and 3,554,298, wherein a wrench member is slipped laterally into place between the recesses and the turning wrench jaws, the lateral through openings which are required structurally weaken the drill head and results in a wrench which can only apply torque to opposed sides of the drill pipe.

The breakout apparatus of this invention is primarily characterized by breakout and holding wrenches which encompass full circles and each includes a large number of torque transferring teeth, and by a pair of collar-like wrench members, one for engaging the turning wrench recesses of an upper section of pipe and a second for engaging the holding wrench recesses of the second section of pipe, and each including peripheral teeth for engaging the teeth of the breakout and holding wrenches, respectively.

In preferred form the collar-like wrench members are provided with wrench surfaces of dihedral form so that several degrees of rotation of the wrench member relative to the drill pipe section it surrounds is possible. The amount of rotational movement is at least the angular width of a gear tooth, so that enough rotational movement of the wrench member can always occur to allow engagement of the breakout or holding wrench teeth with the teeth on a wrench member, without drill head rotation being necessary. The large number of teeth provide even distribution of turning forces substantially all around the wrenches and the pipe, and the full ring nature of the wrenches results in a system which is quite structurally sound.

The circular wrench member has four wrench surfaces which act upon all four wrench surfaces on the pipe, reducing the load on each wrench surface. Additionally, a four point thrust (pipe weight) exists between the wrench member and the pipe.

According to the invention, the drill head of the apparatus includes inner and outer portions which are spline connected together so that they rotate together but each can enjoy some axial movement relative to the other. In preferred form, the inner member is mounted

to "float," axially relative to the outer member and the outer member is axially fixed relative to the traveling cross frame and the rotary drive assembly carried thereby. This arrangement permits use of the hydraulic raising and lowering equipment for the traveling cross frame for also (1) lifting the outer portion of the drill head relative to the inner portion and the pipe section secured thereto to provide sufficient room below it for installing the breakout wrench member; for (2) lowering the outer portion of the drill head to place its teeth into engagement with the teeth of the breakout wrench member; for (3) lowering the drill pipe to place the lower holding wrench member into engagement with the holding wrench; and for (4) raising the drill pipe to remove the holding wrench member from the holding wrench; and (5) to provide axial end play during makeup or breakout so that the derrick does not have to follow accurately the thread pitch.

These and other objects, features, advantages, and characteristics of the present invention will be apparent from the following description of a typical and therefore nonlimited embodiment of the invention, as described below in conjunction with the accompanying illustrations.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing like element designations refer to like parts, and

FIG. **1** is a small scale front elevational view of a traveling head type drilling machine which comprises an embodiment of the invention;

FIG. **2** is a fragmentary perspective view of an upper section of drill pipe interconnected between the drill head and a second length of drill pipe, with some parts in section to better illustrate certain constructional features, and showing one of a pair of splined collar-type wrench members forming a part of the machine, one of which members is used as a holding wrench at the worktable during breakout and makeup of the drill stem, and the other of which is used as a turning wrench at the drive head during certain parts of the breakout operation;

FIG. **3** is a top plan view of one of the wrench members;

FIG. **4** is an enlarged scale fragmentary plan view showing a portion of the holding wrench member engaging the teeth of the worktable holding wrench;

FIG. **5** is a view partially in section and partially in elevation of the components of FIG. **2** but minus the wrench members, and showing the drill pipe in its drilling condition immediately prior to the start of a breakout operation;

FIG. **6** is a view like FIG. **5,** but showing the holding wrench member engaging the second length of drill pipe and being held by the holding wrench at the worktable, and showing the upper end of the upper length of pipe decoupled from the drill head;

FIG. **7** is a view similar to FIGS. **5** and **6,** but showing a loose engagement of the threaded joint at the drill head, showing the breakout wrench in place, and showing the threaded joint at the lower end of the upper length of pipe decoupled;

FIG. **8** is a view similar to FIGS. **4–6,** but typifying a situation wherein on reverse rotation of the drill head, for random breaking of the upper section threaded joints, the lower threaded joint broke first, such view showing said lower joint decoupled for clarity of illustration;

FIG. **9** is a view similar to FIGS. **5–8,** but showing the upper length of drill pipe lowered to a position adjacent the holding wrench table, with the holding wrench engaging the holding wrench surfaces on the upper length of drill pipe, and showing the drill head ready for use to loosen the upper threaded joint;

FIG. **10** is a cross-sectional view taken substantially along line **10—10** of FIG. **7,** showing the cross-sectional configuration of the drill pipe in the region of the turning wrench receiving surfaces, and showing the turning wrench in its position of use; and

FIG. **11** is an enlarged scale vertical sectional view through the drill head, on the right showing the tool joint member of the drill head down in a position placing the drive wrench surfaces of the drill pipe below the breakout wrench portion of the drive head, and on the left showing the tool joint member "floated" upwardly and the peripheral teeth of the turning wrench collar in engagement with the teeth of the turning wrench.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1,** the drilling machine **10** is shown to comprise a base portion **12** which may be firmly anchored to a concrete pad **14** which in turn is anchored to the ground **16.** Base portion **12** is shown supporting upstanding guide column means **18** for a traveling cross frame **20.** Cross frame **20** includes guide sleeves **22** (FIG. **1**) which surroundingly engage the guide column means **18.** Hydraulic linear motors or thrust rams **24** are provided for moving the cross frame **20** and the drilling equipment carried thereby up-and-down along the guide column means **18.** The drilling equipment carried by the frame **20** includes a drive motor and transmission assembly, indicated generally at **26,** and a drill or drive head **28.** The motor and transmission assembly **25** is adapted to rotate the drill head **28** in either direction at the selection of the operator.

Base portion **12** also supports a holding wrench table **30,** the function of which will hereinafter be described in greater detail.

As shown by FIGS. **2, 5–9** and **11,** the drill head **28** includes a tubular inner portion or collet **32** surrounded by and contained within a tubular outer portion **34.** By way of example, inner portion **32** comprises a threaded box type tool joint component and its lower end, designated **36** in the drawing. It also includes a larger diameter upper end portion **38** carrying a ring of external splines **40,** and an intermediate portion **42** presenting a convex spherical support surface **44.** The outer portion **34** of drill head **28** includes an upper portion **46** provided with internal splines **48** which mate with the splines **40.** It also includes a lower portion **50** having a concave seat **52** of spherical curvature matching the curvature of the surface **44.** A turning wrench **54** is secured to the lower end of portion **34.** Turning wrench **54** comprises a circular array of teeth **56,** e.g., spur gear or spline teeth.

The outer portion **34** of the drive head **28** is coupled to the motor and transmission drive assembly **26,** to be directly rotated thereby. Drill head portion **34** is also fixed in position axially relative to the traveling cross frame **20.** As a result, for every unit of linear travel of the cross frame **20** there is an equal amount of travel of drill head outer portion **34.** And, when the cross

frame **20** is fixed in position linearly relative to the rest of the machine the head portion **34** is also fixed in position. The splines **40, 48** couple the inner drive head portion **32** to the outer drive head portion **34** so that they both rotate together, with the rotating torque being transmitted through the splines. However, the splines **40, 48** allow the inner drill head portion **32** to "float" or travel axially relative to the outer drill head portion **34** and the traveling cross frame **20.**

During the drilling operation the spline connection of short teeth **40** with long teeth **48** substantially protects the rotary drive equipment from the bending forces imposed on the drill pipe **5.** The spline connection permits enough angular deviation (e.g., plus and minus about 3°) of the collet **32** relative to the rotary drive shaft DS, so that deviation tends to occur between members **32,** DS rather than bending. Initially, actual deviation is prevented by use of a bushing (not shown) at the table **30** for guiding the pipe S. As drilling proceeds deviation is prevented by drill hole guidance of the drill pipe. Pivotal movement at the splines **40,48** occurs regardless of whether the surfaces **44, 52** are together or separated.

The tool joint **36** receives a complementary threaded pin type tool joint component **58** located at the upper end of a length of drill pipe **60,** or at the upper end of some other drill pipe component. Immediately axially inwardly of tool joint component **58** there is a first annular shoulder **62** which abuts against the lower end surface of the drill head box type tool joint **36.** A first set of wrench surfaces **64** (e.g., a set of four, quadrate "flats") is spaced axially inwardly of shoulder **62.** A second shoulder **66** is spaced axially inwardly of the wrench surfaces **64.** And, a second set of wrench surfaces **68** is spaced axially inwardly of shoulder **66.** As will hereinafter be explained in detail, the flats or wrench surfaces **64,68** are snuggly and surroundingly engaged by a collar-like wrench member WM.

The spline connection **40, 48** permits a sufficient amount of axial "float" of the inner drill head member **34** to result in the wrench surfaces **64** being spaced below the turning wrench **54** when the inner drill head member **32** is seated down on the outer drill head member **34.** When the inner drill head member **32** is coupled to a length of drill pipe **60,** or to some other drill pipe member, and the outer drill head member **34** is moved relatively downwardly relative to the pipe section **60** (such as by use of the motors **24** to lower the cross frame **20**), the splines **40, 48** permit the inner head member **32** to float upwardly a sufficient amount to allow engagement of the peripheral teeth **76** on the collar like wrench member WM with the teeth **56** of the drill head turning wrench **54** (FIGS. **7** and **11**).

Referring to FIGS. **3** and **10,** the collar like wrench member WM is adapted to surroundingly engage the drill pipe member **60** in the region of the turning wrench surfaces **64, 68.** The wrench member WM includes inner wrench surfaces which are designed to substantially mate with and transmit torque to the pipe wrench surfaces **64, 68.** In the illustrated embodiment the wrench WM comprises four generally quadrate wrench surfaces **71.** The illustrated wrench member WM is of a two-piece construction, the two pieces **70, 72** being hinged together at **74.** A plurality of splines or teeth **76** are provided on the outer periphery of the wrench member WM. The splines or teeth **76** are engageable by the turning wrench teeth **56** at the lower end of the drill head outer portion **34** when the wrench member WM is installed as a collar around the wrench surface region **64** or **68** of the drill pipe member **60.**

In the illustrated embodiment the pipe wrench surfaces **64** are shown to be planar whereas the wrench member surfaces **71** are of shallow dihedral form. Each surface **71** includes two planar halves **78** meeting together at a radially inwardly pointing apex **80.** The deflection (e.g., about 10°) of each surface **78** relative to the other surface **78** permits some turning of the wrench member WM relative to the drill pipe member **60** before surface-to-surface contact is made between one set of wrench member surface halves **78** and the drill pipe member surfaces **64.** The amount of circumferential adjustment of the wrench member WM relative to the drill pipe member **60** is equal to about at least the circumferential width of a spline tooth **56, 76.** Owing to this arrangement, the operator can locate the wrench member WM about the wrench surface region **64** of the drill pipe member **60** and then move it circumferentially a portion of a tooth width if needed to locate the teeth **76** in position to be engaged by the teeth **56,** with rotation of the drill head **28** being unnecessary.

The worktable **30** is formed to include an annular holding wrench HW which includes a generally radially inwardly directed set of splines or teeth **82** which are of similar size and cut to teeth **56** so that the holding wrench HW can also receive and engage the teeth **76** of **9** wrench member WM if the pipe is not in anal alignment with the machine true center line.

A breakout operation will now be described:

Let it be assumed that in the drilling operation the traveling cross frame **20** and the drill head **28** carried thereby are in the process of being moved upwardly along the guide column **18,** and the drill stem S is being withdrawn from the drill hole DH. When the upper or first pipe section **60** is wholly above the wrench table **30,** and the holding wrench depressions **68** of the second pipe section **60** are in position at the wrench table **30** to receive a wrench member WM, axial movement of the frame **20** is stopped. The holding wrench member WM is then inserted in place, about the holding wrench depression **68** of the second pipe section **60,** and the frame **20** is hydraulically moved downwardly (by rams **24**) to place the teeth **76** of the holding wrench member WM into engagement with the teeth **82** of the holding wrench HW. The axial entrances into the teeth **82** are flared so that the wrench member teeth **76** are cammed into engagement with the teeth **82.** This entrance design between the two sets of teeth will cause about one-half tooth rotation of the pipe member in either direction. This camming action causes a slight amount of rotation of the wrench member WM during hydraulic movement of either wrench member **54** or wrench member WM within the limits allowed by the dihedrally related wrench surfaces **78,** if such rotation is necessary in order for tooth engagement to occur.

The drill head **28** is reversed, i.e., rotated in a tool joint loosening direction, for the purpose of randomly loosening one of the tool joints at opposite ends of the upper pipe section **60.** FIG. **6** shows a situation wherein the upper tool joint has loosened first. For the sake of clearer illustration, FIG. **6** shows the two upper joint components separated. However, in actual practice there is not a complete separation, only a loosening of the threads. FIG. **8** shows the lower tool joint having loosened first. In this figure the lower tool joint compo-

nents are shown to be completely separated. However, again, in actual practice there is no complete separation. Assuming that the random loosening operation caused the upper joint to loosen first. The threads are not totally separated but rather are maintained loosely joined. A turning wrench member WM is placed around the turning wrench region of the upper pipe section, with the wrench surfaces **21** within the recesses **64.** The traveling cross frame **20** is then lowered (by rams **24**) until the drill head breakout wrench teeth **56** engage the wrench member teeth **76.** Here again, the entrances into the two sets of teeth **56, 76** are flared so that there is a slight camming action, including some rotation of the wrench member WM if necessary, to cause meshing of the teeth **56** with the teeth **76.** After this has been done the drill head **28** is again rotated in the thread loosening direction. The portion of the drill stem S below the upper section **60** is still restrained by the holding wrench HW by way of the lower wrench member WM. However, the drill head wrench **54** now transmits torque from the drill head **28** to the upper pipe section **60** by way of the upper wrench member WM. This application of torque results in a loosening of the threads at the lower tool joint. With the tool joints at both ends of the upper pipe section **60** now loosened, the upper section **60** can be easily unscrewed and removed from the drill stem S. After this is done the drill head **28** is lowered and coupled to the next pipe section **60** by loosely screwing together its box and the upstanding pin of the next section **44.** The drill head **28** is then raised, with the weight of the drill stem S being carried by the loosely engaged threads of the loosely made up tool joint, until such next section is wholly above the holding wrench table **30** and in position for removal in the manner described above. The two wrench members WM are again inserted in place. The lower one is lowered into the holding wrench HW (by movement of rams **24**) and the drill head **28** is lowered until the wrench **56** engages the upper wrench member WM (also by movement of rams **24**). Then, the drill head **28** is reversed as before to loosen the threaded tool joint now at the wrench table. This process is repeated with all subsequent sections of the drill stem S until all sections have been removed from the drill hole DH.

If during the initial reversal of the drive head **28** to cause a random loosening of the initially upper tool joint, the lower joint is the first to loosen, then an added stage must be added to the operation in order to effect loosening of the tool joint between the upper section and the drive head **28.** This stage involves maintaining the loosened lower tool joint components coupled, so that their threads may carry the weight of the drill stem S, then removing the holding wrench member WM, and then lowering the drill head **28,** with drill stem attached, downwardly until the holding wrench depressions **68** of the upper pipe section **60** are at the holding wrench station at table **30.** As shown by FIG. **9,** the holding wrench member WM is reset about the depressions **68** and the assembly is lowered (by rams **24**) to place it into engagement with the holding wrench HW, so that the members WM and HW serve to both support the weight of the drill stem S still in the hole, and prevent its rotation. The lowered drill head **28** is then rotated in the joint loosening direction until the threaded tool joint between it and the upper pipe section **60** is loosened. When this happens the joint components are maintained loosely coupled, again so that the threads can carry the weight of the drill stem S, and the drill head **28** is raised to relocate the upper pipe section **60** in a proper position for removal. The holding wrench member WM is reinstalled on the second pipe section **60** and the first section **60,** now having both of its tool joints loosened, is easily unscrewed from the second pipe section **60** and from the drill head **28,** and is removed from the drill stem S.

It is to be understood that the exact physical character or construction of the auxiliary torque transfer means, the turning wrench receiving depressions, and the holding wrench receiving depressions, may vary from what is illustrated and described. Although the drive head **28** is shown and has been described as including a threaded box type of tool joint component, in some installations it might be desirable to provide it with a pin type of tool joint component, in which case the box ends of the pipe sections would be directed upwardly towards the drill head, rather than the pin ends of the pipe as is illustrated. Also, it is to be understood that the present invention is applicable to drilling equipment for drilling generally vertically upwardly, horizontally, or at a slant, as well as to equipment which is used for drilling generally vertically downwardly. And, the wrench collars might be made in three or more sections rather than two sections, as illustrated.

What is claimed is:

1. Drilling apparatus comprising:

a rotary drill head comprising an inner portion including a threaded tool joint component, an outer portion surrounding said inner portion and including a circular array of teeth, and means coupling said inner and outer portions together for joint rotation but permitting relative axial movement of such portions;

a drill pipe member including a complementary threaded tool joint component at an end thereof, for mating with the threaded drill pipe component of the drill head, and exterior wrench surface means spaced axially inwardly of said member from said threaded tool joint component;

a wrench member installable onto said drill pipe member, in at least a partially surrounding relationship thereto, said wrench member including an inner part engageable with the wrench surface means on the drill pipe member, and an outer portion including teeth engageable with the teeth on the drill head; and

with the means coupling the inner and outer portions of the drill head together permitting sufficient relative axial movement that the threaded tool joint component of the drill head can be moved relatively axially outwardly of the drive head a sufficient amount to place the wrench surface means of the drill pipe member where the said wrench member can be secured thereto, and can be moved relatively axially inwardly a sufficient amount to place the teeth on the wrench member into engagement with the teeth on the outer portion of the drill head, so that the drill head can be rotated in a direction which would tend to cause loosening of the threaded tool joint and rotational torque would be transferred from the drill head through the teeth on the drill head to the teeth on the wrench member

and from the wrench member to the drill pipe member.

2. Drilling apparatus according to claim 1, wherein said drilling apparatus includes a support frame for the rotary drill head and means for moving said support frame axially during the drilling operation, and the outer portion of the drill head is fixed in position axially with respect to said frame, wehrein said inner portion of the drill head is generally tubular and comprises an outboard end portion which includes said threaded tool joint component and an inboard portion which is exteriorly splined, and the outer portion of the drill head includes complementary splines having spaces between them for receiving the splines of the inner portion.

3. Drilling apparatus according to claim 1, wherein the inner part of the wrench member is sized to make a loose enough engagement with the wrench surface means that the wrench member, when it is on said drill pipe member, can be moved circumferentially an amount at least about equal to the circumferential width of a tooth on the drill head or the wrench member.

4. Drilling apparatus according to claim 1, wherein the entrance portions of the teeth on at least one of the drill head and wrench member are shaped to upon relative axial movement cause a camming of the two sets of teeth into engagement in the event of an initial misalignment.

5. Drilling apparatus for use with a drill pipe member having at one end thereof a threaded tool joint component connectible to a complementary threaded tool joint component carried by a rotary drive head, at its opposite end a threaded tool joint component connectible to a complementary threaded tool joint component on another drill pipe member, and between its ends an exterior wrench surface means, wrenching means comprising:

a wrench including a central opening substantially larger in diameter than the drill pipe member, and a circular array of radially inwardly directed teeth at least partially surrounding said opening; and

a wrench member installable onto the drill pipe member in at least a partially surrounding relationship thereto, said wrench member including an inner part engageable with the wrench surface means on the drill pipe member, and a outer portion including radially outwardly directed teeth engageable with the teeth on said wrench, with the inner part of the wrench member being sized to make a loose enough engagement with the wrench surface means so that the wrench member, when it is on said drill pipe member, is free to move circumferentially an amount at least about equal to the circumferential width of a tooth on the wrench or the wrench member, so that the teeth on said wrench member can be moved into substantial engagement with the teeth on said wrench without rotation of the drill pipe member.

6. Drilling apparatus according to claim 5, wherein the entrance portions of the teeth on at least one of the wrench or the wrench member are shaped to upon relative axial movement cause a camming of the two sets of teeth into engagement in the event of an initial misalignment, attended by circumferential movement of the wrench member.

7. Drilling apparatus according to claim 5, wherein said wrench is a holding wrench which is secured to a worktable portion of a drilling machine.

8. Drilling apparatus according to claim 5, wherein said wrench is a turning wrench which is secured to and rotates with a drill head portion of a drilling machine.

9. Drilling apparatus according to claim 5, comprising both a turning wrench of the type described which is secured to and rotates with a drill head portion of a drilling machine and a holding wrench of the type described which is secured to a worktable portion of a drilling machine.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,768,579 Dated October 30, 1973

Inventor(s) Harold T. Klein

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

FIG. 1, change numeral "24" to -- 12 -- .
Column 4, line 39, change numeral "25" to -- 26 -- .
Column 6, line 29, delete numeral "9".
Column 6, line 29, change "anal" to -- axial -- .
Column 6, line 30, change "machine" to -- machine's -- .
Column 8, line 34, before "means" insert -- spline -- .
Column 8, line 36, after "permitting" insert -- limited --.
Column 8, line 40, change "drill pipe" to -- tool joint --.
Column 8, lines 52/53, change "the means coupling the inner and outer portions of the drill head together" to -- said spline means -- .
Column 8, line 54, after "movement" insert -- so -- .
Column 9, line 8, change "wehrein" to -- wherein -- .
Column 9, line 25, insert a comma after "to".
Column 9, line 26, insert a comma after "movement".
Column 9, line 26, after "cause a" insert -- rotational --.
Column 9, line 27, after "into" insert -- aligned -- .

Signed and sealed this 10th day of December 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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