

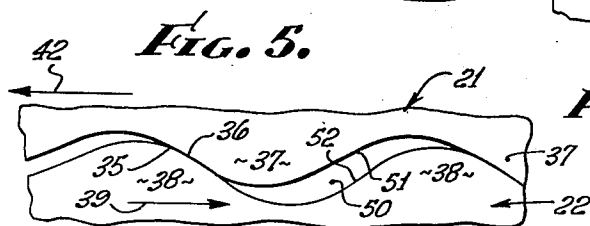
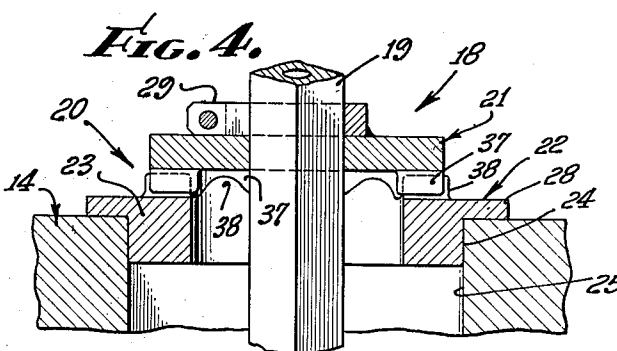
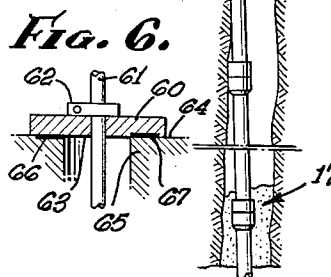
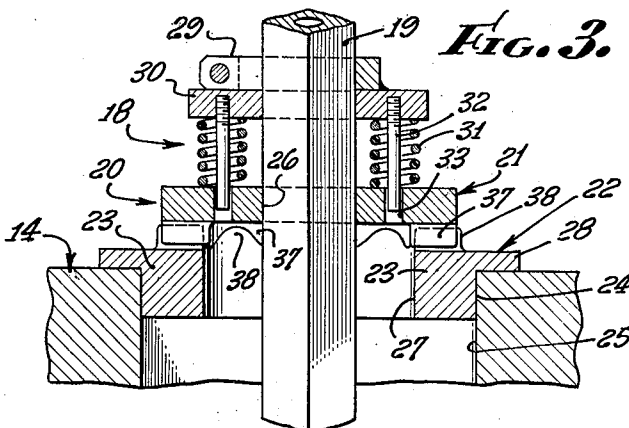
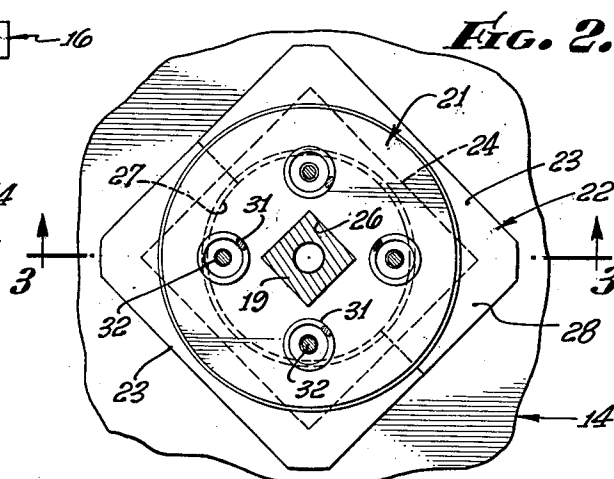
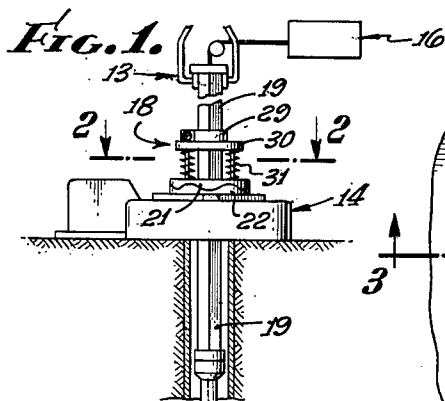
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QUICK RELEASE ROTARY DRIVE FOR WELL PIPE

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3,092,181 QUICK RELEASE ROTARY DRIVE FOR WELL PIPE

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This invention relates generally to the manipulation of well pipe at the well head to produce pipe displacement in the well. The invention is particularly useful in the method of locating the depth at which a pipe string is stuck in a well, wherein pipe displacement capacity at different depths in the well is determined. More specifically, the present invention is directed to the method of and apparatus for rotating and counter-rotating a kelly so as to cause the pipe string in the well to rapidly untwist at different depths in the well.

In well drilling, it frequently happens that the drill string may become stuck at locations that may range from depths near the bit to intermediate depths many pipe stand lengths above the bit, depending upon conditions encountered in a particular well being drilled and the particular reason for the pipe becoming lodged. To illustrate, the pipe may become stuck as a result of a cave-in well, or by key seating of pipe in crooked holes. Also, well casing may become stuck in the hole.

In keeping with presently prevailing practices in the determination of the stuck point location, the pipe is manipulated at the well head by lifting and lowering of the kelly. These practices produce rather slow pipe displacement in the well, which is a disadvantage when detection of pipe movement in the well is dependent upon acceleration undergone by the pipe deep in the hole. For example, in a co-pending application entitled Method and Apparatus for Determining Well Pipe Stuck Point Location, Serial No. 812,178, filed March 11, 1959, by Ford I. Alexander and Ira C. Bechtold, method and apparatus is described whereby accelerated pipe movement may be detected while the detection apparatus is traveling vertically within the pipe, making possible very rapid location of the pipe stuck point. The present application has for one of its major objects the provision of apparatus and method for rapidly displacing the pipe at different depths in the well to produce more rapidly detectable pipe acceleration.

Accordingly, the method broadly contemplates the steps that include rotating the pipe at the well head to twist the pipe string and place it in torsion within the well, and allowing the pipe at the well head to counter-rotate substantially faster than the pipe was rotated whereby the pipe string rapidly untwists at different depths in the well. By carrying out these steps at the well head, it is ensured that the string will be placed in torsion and will accelerate above the stuck point no matter where the latter exists in the well. Also, the energy stored in the pipe during torsional twisting will, upon sudden release, tend to cause transmission of shock torsional loading to the pipe at the stuck point for freeing the stuck pipe. The apparatus which I provide for carrying out this method broadly comprises means connectible with the pipe at the well head for rotating the pipe string in torsion within the well, said means including a coupling releasable to allow counter-rotation of the pipe at the well head substantially faster than pipe rotation of said means.

More specifically, the novel method contemplates rotating the kelly by operation of the rotary table thereby twisting the string and placing it in torsion within the well, intermittently freeing the kelly to counter-rotate relative to the table substantially faster than the kelly is rotated by the table, and suddenly interrupting counter-rotation of the kelly so that the pipe string rapidly and intermittently untwists in the well. The specific apparatus

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for carrying out these steps comprises means connectible with the kelly and rotary table for axially rotating the kelly with the table and twisting the string in torsion within the well, said means including a rotary coupling for keeping the coupling in kelly rotating condition. Further, the coupling has interengaging rotary parts releasable in response to build-up of string torsion acting through the coupling in opposition to string weight loading, to allow counter-rotation of the kelly substantially faster than pipe rotation by the coupling, such counter-rotation occurring when built-up string torsion overcomes the imposed string weight loading.

As will be brought out, the rotary parts have frictionally interengageable cam shoulders through which string torsion acts in opposition to string weight loading, the cam shoulders being adapted to slip for releasing the coupling. Typically, the rotary parts will include an upper part sized for driving connection with the kelly and a lower part sized for driven connection with the rotary table, the upper part being upwardly movable relative to the lower part to release the coupling. Lifting of the kelly as by hoisting apparatus may be carried out during rotation of the rotary coupling to cause release of the coupling and counter-rotation of the kelly at more frequent intervals or after decreased extent of kelly rotation by the rotary table, all for the purpose of varying the rapidity or degree of torsional shock loading associated with untwisting of the string and sudden interruption thereof.

These and other objects and advantages of the present invention, as well as the details of an illustrative embodiment, will be more fully understood from the following detailed description of the drawings, in which:

FIG. 1 is a general view showing the pipe string in the well with instrumentation therein for detecting pipe acceleration;

FIG. 2 is an enlarged plan view taken on line 2-2 of FIG. 1;

FIG. 3 is a vertical section taken on line 3-3 of FIG. 2;

FIG. 4 is a view similar to FIG. 3 showing a modified form of the apparatus;

FIG. 5 is a linear extension showing of the rotary parts as they are engaged during rotation of the kelly by the rotary table; and

FIG. 6 is a vertical section showing another modified form of the apparatus.

Referring first to FIGS. 1 through 3, the carrier body for the pipe acceleration detector is shown generally at 10, run down into the well open hole 11 within a standard drill pipe string 12 suspended by a conventionally illustrated elevator 13. The surface equipment is shown also to include a rotary table 14 which is used in rotating and torsionally winding or twisting the drill string as and for the purposes later described. Carrier body 10 is suspended in the drill string and typically within fluid contained therein by means of a line or cable 15 shown in broken lines, which may be raised or lowered by means of apparatus generally indicated at 16. The latter also includes instrumentation useful for receiving a signal from the acceleration detector within the body 10, and for recording the signal, all as described in the copending application previously referred to.

It will be understood that it is desirable to determine pipe displacement capacity at different depths in the well in order that the depth at which the drill pipe string is stuck in a well may be ascertained, the stuck point location being indicated at 17. Typically a cave-in as shown causes the pipe to become stuck in the well. Generally speaking, the pipe is subject to varying degrees of movement above the stuck point as by manipulation at the well head but is not subject to movement below the stuck point so that the location of the latter may be determined by

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traveling an acceleration detector vertically within the pipe while the latter is accelerated.

Coming now to a description of the apparatus by means of which the pipe string may be rapidly displaced or untwisted in accordance with the novel method to be described, reference to FIGS. 2 and 3 will show that means generally indicated at 18 is provided for rotating the kelly 19 by operation of the rotary table 14 to twist the string and place the latter in torsion within the well. The means 18 includes a rotary coupling 20 having interengaged upper and lower rotary parts 21 and 22. Referring first to the part 22, it typically comprises a split master bushing, the respective halves 23 of which are sized at their periphery 24 for fitted reception within the square opening 25 in the rotary table. As a result, the lower rotary part 22 is connected in driven relation with the rotary table.

The upper rotary part 21 typically comprises a plate having a central square opening 26 sized for fitted reception on the kelly 19, so that the rotary part 21 is connected in driving relation with the kelly although it is typically free to slide up and down axially thereof. The lower rotary part 22 has an enlarged opening 27 which freely passes the kelly, and it also includes a flange 28 which seats on the top surface of the table for limiting downward displacement relative to the table, and also for transferring imposed string loading to the table.

String weight loading is imposed downwardly on plate 21, as controlled by the elevator mechanism 13 shown in FIG. 1, through a clamp 29 tightened on the kelly and rigidly connected thereto, a plate 30 engaging the underside of the clamp and extending about the kelly, and through compression springs 31 equally spaced about the kelly and between plates 30 and 21 as seen in FIG. 3. Vertical pins 32 threaded into plate 30 extend through the springs 31 and into drilled openings 33 in plate 21 for locating the compression springs and for retaining them between the two plates 30 and 21. Thus, a desired amount or degree of string weight loading may be imposed upon the rotary part 21 by manipulating the elevator 13 to lower the kelly 19 and thereby compress springs 31 to desired extent.

The rotary parts 21 and 22 have formed thereon cam shoulders 35 and 36 which are respectively downwardly and upwardly presented for frictional engagement. These shoulders are formed on undulating lugs or teeth 37 and 38 which are respectively downwardly and upwardly presented on the parts 21 and 22 and are also circularly arranged around the axis of the kelly, which is common to the axes of parts 21 and 22.

Referring to FIG. 5, as part 22 is driven in the direction of arrow 39 it tends to drive part 21 in the direction of arrow 39 for rotating the kelly with the rotary table. However, such rotation twists the drill string in the well and places it in torsion acting through part 21 to resist rotation by part 22. As a result, during such rotation by the rotary table the torsion forces build-up and tend to cause slippage at the interengaged cam shoulders 35 and 36, FIG. 5 showing that some slippage has occurred, by virtue of the gaps 50 between the reverse shoulders 51 and 52 on lugs 37 and 38. Such slippage is resisted by friction forces exerted at the interengaging shoulders 35 and 36 and arising from imposed string weight loading acting downwardly through plate 30, springs 31 and rotary part 21, the degree of imposed string weight loading being of course under the control of the elevator 13.

Assuming that the imposed string weight loading remains constant, the torsion forces in the drill string will build-up during rotation of the kelly until they overcome the string weight loading acting at the interengaged shoulders 35 and 36, at which time the rotary part 21 will have lifted relative to part 22 to the extent that the parts will release and slippage will occur, part 21 counter-rotating in the direction of arrow 42 as shown in FIG. 5. This counter-rotation will occur at a rate substantially faster

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than rotation by the rotary table in the direction of arrow 39 and will, accordingly, rapidly untwist the pipe string in the hole imparting a sharp or high degree of torsional acceleration to the pipe. Therefore, the instrument 10 will more readily detect pipe acceleration above the stuck point.

Furthermore, the counter-rotation of the rotary part 21 will be suddenly interrupted, depending upon the amount of string weight loading imposed downwardly on the part 21 as controlled by the elevator 13. Thus, when the counter-rotation of part 21 has carried that part sufficiently in reverse that the torsion loading of the string is diminished below the point at which imposed string weight loading causes frictional interlocking of parts 21 and 22 and shoulders 35 and 36, counter-rotation of part 21 will cease. At this time, shoulders 35 and 36 will engage vertically and vertical shock loading on the pipe will produce a horizontal wave traveling vertically along the pipe and detectable as pipe acceleration above the stuck point. The amount of counter-rotation in the direction of arrow 42 may be controlled by increasing or decreasing the imposed string weight loading, as by lowering or lifting the elevator mechanism 13. After frictional engagement at shoulders 35 and 36 is re-established the rotary table effects rotation of the kelly to build up increased string torsion, with resultant repetition of counter-rotation of the kelly and the string followed by sudden interruption of such counter-rotation as previously described. Moreover, this torsional and vertical shock loading may be caused to occur as rapidly and repeatedly as is desirable so as to vibrate the pipe accelerating in the hole above the stuck point, both in torsion and longitudinally.

Turning to FIG. 4, the springs 31 are eliminated and string loading is transferred directly from 29 to the plate 21. Therefore, as the part 21 is rotated by the part 22, string torsion acts through the part 21 to resist such rotation and builds up to the point where slippage between parts 21 and 22 occurs, lifting part 21 and the string in the well. The amount of torsion required to cause such lifting and eventual relative slippage of parts 21 and 22 associated with counter-rotation of part 21 in the direction of arrow 42, is controlled by adjustment of the elevator mechanism 13. Thus less build up of string torsion is required to cause or bring about counter-rotation of part 21 if the imposed string loading is decreased as by raising or elevating the string by mechanism 13, and similarly greater string torsion is required to effect release of the coupling as the elevating mechanism 13 is lowered.

For loosening the pipe at the stuck point, rotary torque is continuously applied to the string at the well head to place the string in torsion within the well. The pipe portion above the stuck point is then freed to counter-rotate in the well and such counter-rotation is suddenly interrupted by re-engagement of coupling parts 21 and 22 to transmit shock torsional loading to the pipe at the stuck point, these operations being carried out repeatedly and alternately. Also, circulation of drilling fluid is maintained downwardly through the string and upwardly about the string to soften the formation at the stuck point. Such softening and lubrication may also be produced by "spotting" oil in the key seat formation by perforating the pipe at that location and then pumping oil into the string.

While vibration of the pipe string has been described in connection with the kelly 19, it will be understood that the invention also contemplates vibration of the string pipe at the well head, as for example would be carried out when the string becomes stuck as it is being run out of the hole. In such a case, the plate 21 would be appropriately clamped to the string pipe itself at the well head. This arrangement is specifically shown in FIG. 6 wherein a large heavy plate 60 is clamped to the pipe string 61 at 62.

Plate 60 has a flat underside 63 seating directly on the

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flat upper surface 64 of rotary part 65, which may comprise the rotary table or a part carried by the table to rotate therewith. Plate 60 and the stuck string 61 are rotatable by the part 65 when sufficient string weight is let down to create sufficient driving friction between surfaces 63 and 64. However, as the string is twisted, the back-torque builds up to the point where it overcomes the static friction forces resisting relative slippage of surfaces 63 and 64, at which time such slippage occurs. The string then unwinds until the back torque therein is reduced sufficiently in relation to the string weight loading in part 65 to permit re-establishment of driving friction at surfaces 63 and 64. This sequence of twisting and untwisting of the string may be controlled as to frequency and degree of twisting and untwisting by varying the string weight loading imposed on parts 60 and 65. Also, means such as circularly interrupted high-friction "shoes" 66 and 67 may be imbedded in surfaces 64 and 63 to engage during relative slippage of parts 60 and 65, for suddenly interrupting such slippage. Such shoes may for example comprise an abrasive material as carborundum. Finally, the surfaces 63 and 64 may have slight downward inward taper for centering the string 61.

I claim:

1. The method of rapidly accelerating a pipe string stuck in a well, that includes applying torque at the well head for rotating the string to twist the string and place the string in torsion within the well, applying string weight at the well head to resist said torque application, and allowing the pipe at the well head to counter-rotate freely substantially faster than the string was rotated, whereby the pipe string rapidly untwists at different depths in the well.

2. The method of rapidly accelerating a pipe string stuck in a well, that includes applying torque at the well head for rotating the string to twist the string and place the string in torsion within the well, applying string weight at the well head to resist said torque application, and freeing the string at the well head to counter-rotate freely substantially faster than the string was rotated whereby the pipe string rapidly untwists at different depths in the well.

3. The method of rapidly accelerating a pipe string stuck in a well, that includes applying torque at the well head for rotating the string to twist the string and place the string in torsion within the well, applying string weight at the well head to resist said torque application, intermittently allowing the string at the well head to counter-rotate freely substantially faster than the string is rotated, and suddenly interrupting counter-rotation of the string at the well head, whereby the pipe string rapidly untwists at different depths in the well.

4. The method of rapidly accelerating a drill pipe stuck in a well, that includes applying torque at the well head for rotating the string to twist the string and place the string in torsion within the well, applying string weight at the well head to resist said torque application, elevating the string at the well head during said rotation thereof, intermittently allowing the string at the well head to counter-rotate freely substantially faster than the string is rotated, lowering the string at the well head during said counter-rotation thereof, and suddenly interrupting said lowering and counter-rotating movement of the string at the well head, whereby the pipe string is rapidly displaced at different depths in the well.

5. In the method of locating the depth at which a drill pipe string is stuck in a well wherein pipe displacement capacity at different depths in the well is determined, said string including a kelly adapted to be rotated at the well head by a rotary table, the steps that include applying torque at the well head for rotating the kelly by operation of said rotary table thereby twisting the string and placing the string in torsion within the well, applying string weight at the well head to resist said torque application, intermittently freeing the kelly to counter-rotate

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freely relative to said table and substantially faster than the kelly is rotated thereby, and suddenly interrupting counter-rotation of the kelly, whereby the pipe string rapidly and intermittently untwists at different depths in the well.

6. The method of rapidly accelerating a drill pipe string stuck in a well, said string including a kelly adapted to be rotated at the well head by a rotary table, the steps that include supporting at least some of the weight of the pipe string at the well head, applying torque at the well head for rotating the kelly by operation of said rotary table thereby to twist the string and place the string in torsion within the well, applying string weight loading at the well head to resist said torque application, elevating the kelly during said rotation thereof, intermittently freeing the kelly to counter-rotate relative to said table and substantially faster than the kelly is rotated thereby, lowering the kelly during said counter-rotation thereof, and suddenly interrupting said lowering and counter-rotation of the kelly, whereby the pipe string is rapidly displaced at different depths in the well.

7. For use in the method of rapidly accelerating a pipe string stuck in a well, means connectible with the string at the well head and for rotating the pipe to twist the string and place the string in torsion within the well, said means including a coupling releasable to allow counter-rotation of the pipe at the well head substantially faster than pipe rotation by said means, whereby the pipe string may be caused to untwist rapidly at different depths in the well, said means including structure integrally connectible to the string to move vertically therewith and located at the well head proximate said coupling to transmit string imposed loading thereto.

8. For use in the method of locating the depth at which a pipe string is stuck in a well wherein pipe displacement capacity at different depths in the well is determined, means connectible with the pipe at the well head and for rotating the pipe to twist the string and place the string in torsion within the well, said means including a coupling having interengaged shoulders releasable from interengagement to allow counter-rotation of the pipe at the well head substantially faster than pipe rotation by said means, said means including structure integrally connectible to the string to move vertically therewith and located at the well head proximate said coupling to transmit string imposed loading thereto to effect interengagement of said shoulders after said pipe counter-rotation whereby the pipe string may be caused to untwist rapidly at different depths in the well.

9. For use in the method of locating the depth at which a pipe string is stuck in a well wherein pipe rotary displacement capacity at different depths in the well is determined, means connected with the pipe at the well head for rotating the pipe to twist the string and place the string in torsion within the well, said means including a coupling outside the string and to which said pipe weight loading is transmissible for keeping the coupling in pipe rotating condition, said coupling having interengaged parts releasable in response to build-up of string torsion acting through the coupling in opposition to said pipe weight loading to allow counter-rotation of the pipe at the well head substantially faster than pipe rotation by said means, whereby the pipe string may be caused to untwist rapidly at different depths in the well, said means including structure a portion of which is integrally connected to the string to move vertically therewith, said structure being located at the well head proximate said coupling to transmit string imposed loading thereto.

10. For use in the method of rapidly accelerating a pipe string stuck in a well, said string including a kelly adapted to be rotated at the well head by a rotary table and master bushing, means connected with the kelly and rotary table for axially rotating the kelly with said table to twist the string and place the string in torsion within the well, said means including a rotary coupling outside the string and to which string weight loading is trans-

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missible for keeping the coupling in kelly rotating condition, said coupling having interengaged rotary parts releasable in response to build up of string torsion acting through the coupling in opposition to said string weight loading to allow counter-rotation of the kelly substantially faster than pipe rotation by said means, whereby the pipe string may be caused to untwist rapidly at different depths in the well, said means including structure integrally connected to the kelly to move vertically therewith and located at the well head proximate said coupling to transmit string imposed loading thereto.

11. The invention as defined in claim 10 in which said rotary parts have frictionally interengageable cam shoulders through which string torsion acts in opposition to said string weight loading, said shoulders being adapted to slip for releasing the coupling.

12. The invention as defined in claim 11 in which said rotary parts are upper and lower and are respectively sized for driving connection with said kelly and driven connection with said master bushing, said upper part being upwardly movable relative to said structure and said lower part to release the coupling, said lower part interfitting said master bushing.

13. The invention as defined in claim 12 in which said structure includes a clamp rigidly connected with the kelly above said upper rotary part.

14. The invention as defined in claim 13 in which said structure includes a compression spring through which string weight loading is transmitted to said upper part

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and against which said upper part is adapted to move upwardly to release the coupling.

15. The method of rapidly accelerating a pipe string stuck in a well, that includes applying torque at the well head for rotating the string to twist the string placing it in torsion within the well, applying string weight at the well head to resist said torque application, freeing the pipe to counter-rotate rapidly in the well, suddenly interrupting said pipe counter-rotation at the location at which the pipe was freed to transmit shock torsional loading downwardly to the pipe at the stuck point, and repeating the steps of freeing and interrupting the pipe to transmit repeated shock torsional loading to the pipe at the stuck point.

16. The method of claim 15 including maintaining circulation of drilling fluid downwardly through the string and upwardly about the string to soften the formation at the stuck point.

17. The method of claim 15 including passing oil through the pipe wall into the key seat formation to lubricate the pipe at the stuck point.

References Cited in the file of this patent

UNITED STATES PATENTS

2,495,364	Clapp	Jan. 24, 1950
2,550,964	Brookes	May 1, 1951
2,609,674	Groat	Sept. 9, 1952
2,689,710	Page	Sept. 21, 1954