

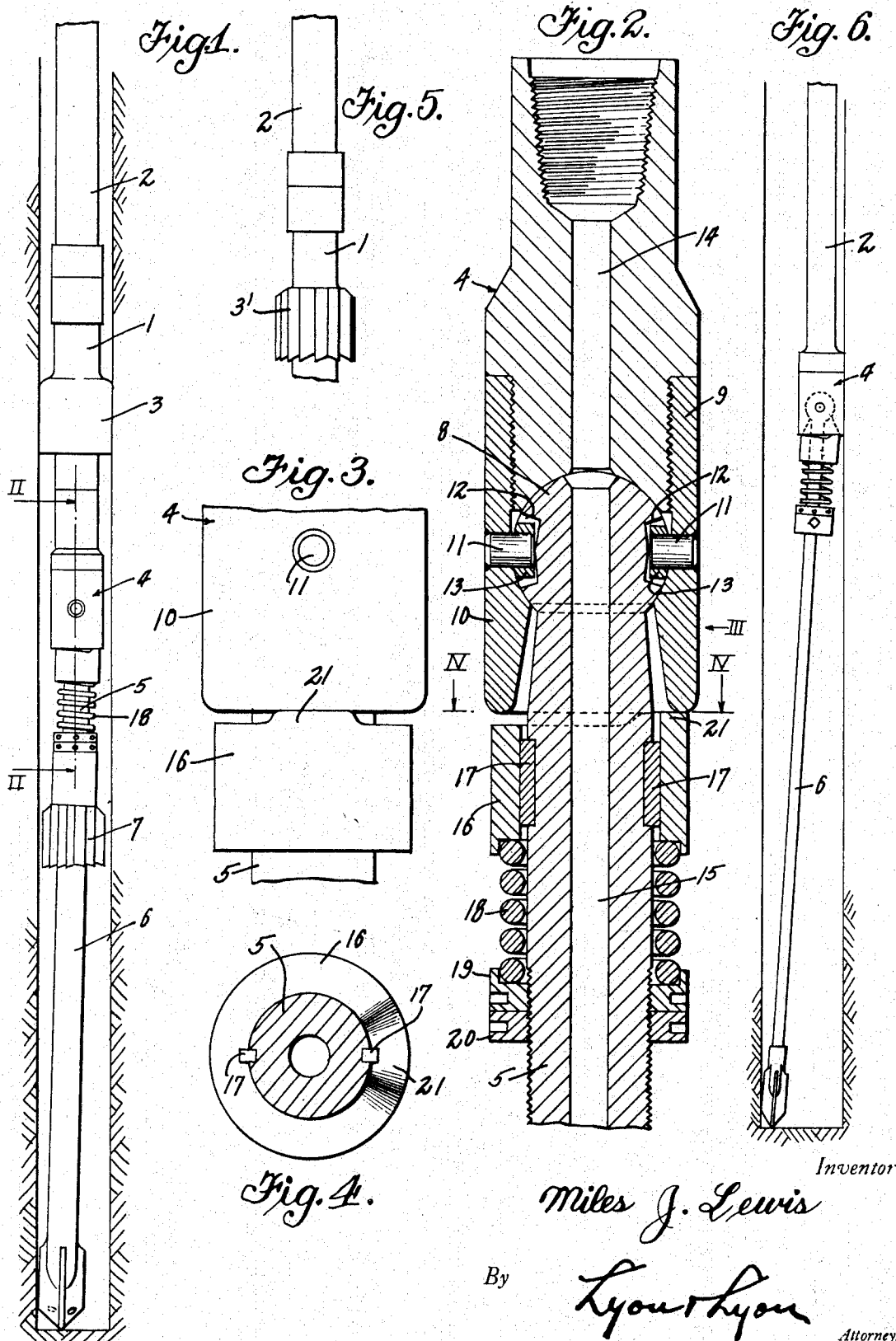
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M. J. LEWIS

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WELL BORE DEFLECTING TOOL

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Inventor

Miles J. Lewis

By

Lyon & Lyon

Attorneys

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WELL BORE DEFLECTING TOOL

Miles J. Lewis, Long Beach, Calif.

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This invention relates to well drilling apparatus and particularly to tools to be used at the bottom of a well hole for extending the hole in a new direction.

For various reasons, it often happens that it is desirable to change the direction of a well hole while it is being drilled. Thus it may be necessary to side-track lost tools and parted strings of casing or drill pipe or to drill off from a bridge or a plug in a desired direction. The present invention makes it possible to extend a hole in a desired new direction at an angle to the pre-existing portion of the hole.

An object of the invention is to provide a simple, rugged and inexpensive tool adapted to be used on the end of the usual rotary drill string for changing the direction of a well hole. The invention is particularly useful in deflecting a vertical hole so that it extends at an angle from the vertical but it is equally well adapted for use in extending an inclined hole at a different inclination.

A full understanding of the invention may be had from the following detailed description when read in connection with the accompanying drawing, in which

Fig. 1 is an elevation view, partly in section, showing a tool in accordance with the invention as it appears in a well bore;

Fig. 2 is a detail elevational section through the deflecting mechanism of the tool;

Fig. 3 is a detail elevation of a portion of the tool looking in the direction of the arrow III in Fig. 2;

Fig. 4 is a cross section in the plane IV—IV of Fig. 2;

Fig. 5 is a detail elevation view of the upper portion of the device showing a modified form of construction to that shown in Fig. 1; and

Fig. 6 is a schematic view showing the device used in a relatively large bore to permit deflection of the bore at a relatively sharp angle.

Referring to Fig. 1, my device comprises a collar 1 adapted to be secured at its upper end to the lower end of a drill string 2, the connection being preferably made by suitable, cooperating screw threads on the respective elements. The collar 1 is preferably enlarged at substantially its mid portion, as shown at 3, to act as a guide within the well bore to properly center the collar 1. This enlarged portion 3 is therefore preferably dimensioned to fit snugly within the well bore.

Attached to the lower end of the collar 1 as by thread connections is the socket member of a ball and socket universal joint 4. The ball mem-

ber of the universal joint is attached to the upper end of a downwardly depending shaft 5, which in turn is secured to the upper end of a pilot bit 6. A reamer 7 is preferably mounted upon the upper portion of the pilot bit 6 to enlarge the small hole drilled by the bit.

Referring now to Fig. 2, it will be observed that the ball member 8 of the universal joint fits snugly within the socket member 9 and is substantially enclosed thereby. However, the skirt portion 10 of socket member 9 is cut away sufficiently to leave space about the shank of the shaft 5 immediately below the ball 8 to permit the desired oscillation between the ball and socket members. To permit the transfer of rotary motion between the socket member 9 and the ball member 8, the socket member 9 is provided with inwardly projecting pins 11 which project into vertical slots 12 in the ball 8 in registry with the pins 11. To reduce friction the pins 11 may be provided with rollers 13 on the inner ends thereof.

To permit the supplying of drilling fluid from the drill pipe 2 to the drill bit 6, a central aperture 14 is provided in the socket member 9 and a corresponding central aperture 15 is provided in the ball member 8 and its associated shaft 5. The passage 15 in the shaft 5 registers with a similar passage in the center of the pilot bit 6. This construction of universal joint for supplying drilling fluid therethrough is particularly desirable as it eliminates the necessity of using a flexible hose to conduct the fluid through or past the universal joint. It is to be understood, however, that other forms of universal joint may be employed, such as the form of construction shown in my prior Patent 1,902,174, issued March 21st, 1933, on a Well bore straightening tool.

As shown clearly in Figs. 2, 3 and 4, the skirt portion 10 of the socket member 9 extends some distance below the ball member 8 in the form of an annular ridge surrounding the shaft 5. This skirt 10 is utilized in combination with a cam element next to be described for deflecting the bit 6 in a desired direction with respect to the collar 1 and the drill string 2 to which the collar is secured in use.

The aforementioned cam mechanism comprises a slidable collar 16 slidably mounted for longitudinal movement along the shaft 5 but keyed thereto as by keys 17 to prevent relative rotational movement between the collar and the shaft. Slidable collar 16 is normally forced into contact with the lower edge of the skirt 10 on the socket member 9 by a spiral spring 18 which surrounds the shaft 5 below the slidable collar 16

and is supported at its lower edge by a retainer 19 threaded upon shaft 5. A lock nut 20 is preferably provided below the retainer 19 to lock the latter in a desired position.

5 The upper end face of slidable collar 16 instead of being flat, whereby it would lie completely in a plane perpendicular to the axis of shaft 5, is raised on one side as shown at 21. Therefore, if the spring retainer 19 is adjusted to cause the
10 spring 18 to exert substantial pressure against the slidable collar 16, the raised portion 21 of the latter will be forced into contact with the lower edge of the skirt 10 on the socket member 9 and will tend to bend the universal joint and deflect
15 the bit 6 at an angle to the collar 1, as shown in Fig. 1. By making the spring 18 sufficiently stiff and adjusting the retainer 19 to exert substantial pressure against the spring, this deflecting force can easily be made sufficient to overcome the weight of the bit 6 and hold the latter
20 at a desired angle with respect to the collar 1 even when the latter is extending horizontally instead of vertically as shown in Fig. 1.

The device is used as follows:

25 Assume that a well bore has been extended to a desired depth and it is desired to continue the hole at an angle to the existing portion and in a certain direction. The bottom of the existing hole is squared off, as shown in Fig. 1, by means
30 of a squaring off tool mounted upon a drill string. Thereafter the drill string and squaring off tool are removed from the hole and the tool comprising the collar 1, universal joint 4 and bit 6 attached to the drill string 2 and lowered into the
35 hole. Before insertion the spring retainer 19 is adjusted to exert substantial pressure against the spring 18 so that as the device is lowered into the hole the bit 6 is deflected to one side as shown in Fig. 1, and, when the bottom of the
40 hole is reached, the point of the drill comes to rest at one edge of the hole, as shown in Fig. 1. The enlarged portion 3 of the collar 1 may be dimensioned to fit snugly in the well bore, as shown in Fig. 1, to align the collar 1 substantially
45 with the axis of the hole. If the hole has been previously drilled or reamed to fit the enlarged portion 3 of the collar 1, then the angle at which the bit 6 can be deflected will be accurately known since it will be determined by the diameter of the
50 hole. Furthermore, by suitably orienting the drill string 2 as it is lowered into the hole, the bit 6 can be made to come to rest pointing in a desired direction in which the hole is to be extended.

When the point of the bit 6 has been set down on the bottom of the squared off hole in the manner described, power is applied to the drill string and the latter rotated. This rotary motion is applied through the collar 1 and the universal joint 4 to the bit 6, causing the latter to drill into
60 the bottom of the hole at the point where it was set down. The drill bit is preferably of a type that will cut in wherever it is set down instead of "walking around" in the hole. Of course, there will be a natural tendency for the bit to "walk
65 around" in the hole because of the angle at which it is maintained with respect to the collar 1 and drill string 2 by the raised portion 21 on the slidable collar 16. This tendency is insufficient, however, to overcome the friction of the drill
70 point to horizontal movement with respect to the formation at the bottom of the hole and, as the universal joint 4 rotates with the drill string and bit, the slidable collar 16 is forced downwardly along the shaft 5 against the pressure of the
75 spring 18 during the first half revolution and

then moves upward again during the second half revolution. This motion continues, the slidable collar 16 oscillating up and down along the shaft 5 as the device rotates. The net result is that while the slidable collar 16 exerts a force tend-
8 ing to deflect the bit 6 in a predetermined direction with respect to the collar 1, it yields in response to outside forces to permit the bit 6 to be turned by the drill string 2 through the uni-
9 versal joint 4 while maintaining the original position in which it was set down on the bottom of the hole.

After the pilot bit 6 has drilled a sufficient distance in the desired direction, the reamer 7 reaches the bottom of the hole and enlarges the
15 hole made by the pilot bit to a desired size. The reamer 7 in the case of the assembly shown in Fig. 1 would originally be of lesser diameter than the guide portion 3 of the collar 1 so that the depth to which the hole can be drilled in the new
20 direction with the assembly shown in Fig. 1 is limited. When this limit is reached, the device may be removed from the well and the drilling continued with a conventional bit since in most instances the angle of the hole drilled by the pilot
25 bit 6 with respect to the direction of the original hole is relatively small and the drill string can yield laterally sufficiently to follow around the bend in the hole.

A reamer 3', as shown in Fig. 5, may be substituted for the smooth guide 3 in Fig. 1, the reamer 3' simultaneously enlarging the well hole to a desired diameter and at the same time centering the collar 1 within the hole.

The angle of the extended hole with respect to
35 the original hole may be varied by varying the diameter of the original hole and also by varying the length of the bit 6. Thus the larger the hole the greater the lateral displacement between the tip of the pilot drill 6 and the center
40 of the collar 1 and likewise the shorter the pilot bit 6 the greater the angle it will take with respect to the drill string.

The angle may also be increased by reducing the size of or eliminating the enlarged guide portion 3 of the collar 1, in which case the universal joint assembly will bear against one side of the hole and the tip of the pilot drill will bear against the opposite side of the hole, as shown in Fig. 6.

In addition to its use as described for extend-
50 ing a well hole in a different direction, regardless of the direction of the original hole, my device may be used for straightening crooked holes substantially as described in my prior Patent 1,902,174. When the device is to be used for the
55 latter purpose, the lock nut 20 is loosened and the spring retainer 19 backed off until the spring 18 exerts no pressure at all between the sliding collar 16 and the skirt 10 on socket member 9. Therefore, when the device is lowered into a
60 crooked well hole on the end of a drill string, the pilot bit 6 being freely suspended by the universal joint 4, will seek a vertical position regardless of the inclination of the original hole and the drill string 2. By setting down the pilot drill 6 on the
65 bottom of the hole while it is freely suspended in vertical position and continuing the hole vertically by rotating the drill string, the hole will be continued in a vertical direction.

Although the invention has been specifically described with reference to a few preferred embodiments, it is understood that various departures may be made from the structure shown without departing from the spirit of the invention
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and that the scope of the invention is to be limited only as set forth in the appended claims.

I claim:

1. A well boring tool comprising a drill bit, means including a universal joint for operatively connecting said bit to the lower end of a drill string and spring means for yieldingly directing said bit in a fixed predetermined direction with respect to said drill string, said spring means permitting flexure of said universal joint and deflection of said bit in response to external forces of predetermined magnitude acting upon said bit and drill string, respectively.

2. A well boring tool comprising a drilling bit, a reamer adapted to be secured to the lower end of a drill string, a universal joint operatively connecting said bit to said reamer whereby said bit can be rotated about its own axis by the reamer while positioned at an angle to the reamer, and means for yieldingly deflecting said bit at an angle with respect to said reamer.

3. A well boring tool comprising a drilling bit, means including a universal joint for operatively connecting said bit to the lower end of a drill string, said universal joint comprising a ball member and a socket member, one of which members is rigidly secured to said bit and the other of which is rigidly secured to said drill string, said socket member, at least in part, enclosing said ball member and having an annular thrust face, a shaft secured to and extending from said ball member, a collar slidable along said shaft and having an annular thrust face juxtaposed to the thrust face on said socket member, a spiral spring surrounding said shaft back of said collar, means on said shaft for compressing said spring to force said collar against said socket member with the annular thrust faces on said collar and socket member in contact, said thrust faces being shaped to bend said universal joint when forced together by said spring.

4. A well boring tool as described in claim 3 in which the means on said shaft for compressing said spring is adjustable along said shaft for varying the spring pressure on said collar.

5. A well boring tool as described in claim 3, in which cooperating guide means are provided on said slidable collar and said shaft on which it slides for preventing relative rotation between said slidable collar and said shaft.

6. A well boring tool comprising a drill bit having a shaft extending upwardly therefrom, a bit rotating member having a downwardly extending shaft, universal joint means for connecting said shafts for simultaneous rotation for permitting lateral flexing therebetween, a hollow member on one of said shafts and rigid there-

with, having an annular thrust face adjacent said universal joint means, a collar longitudinally slidable on said other shaft, and having an annular thrust face juxtaposed to the thrust face on said hollow member, and spring means for resiliently compressing said collar against said hollow member, at least one of said annular faces being higher on one side than on another to flex said universal joint means in one direction in response to the compression of said spring while permitting said joint to flex in the opposite direction in response to external forces acting on said bit and bit rotating member when such forces are of sufficient magnitude to compress said spring.

7. A well boring tool comprising a drill bit, means including a universal joint for operatively connecting said bit to the lower end of a drill string, whereby said bit can be rotated about its own axis by the drill string while positioned at an angle to the drill string, and yieldable means for normally directing said bit in a fixed predetermined direction with respect to said drill string, said yieldable means permitting flexure of said universal joint and deflection of said bit in response to external forces of predetermined magnitude acting upon said drill bit and drill string, respectively.

8. A well boring tool comprising a drill bit, means including a universal joint for operatively connecting said bit to the lower end of a drill string, whereby said bit can be rotated about its own axis by the drill string while positioned at an angle to the drill string, and means for yieldingly deflecting said bit at an angle with respect to said drill string.

9. A well boring tool comprising a drill bit, means including a universal joint for operatively connecting said bit to the lower end of a drill string, whereby said bit can be rotated about its own axis by the drill string while positioned at an angle to the drill string, and means for yieldingly deflecting the bit at an angle to and in a fixed direction of orientation with respect to said drill string.

10. A well boring tool as described in claim 8, in which said drill string comprises a guide member on the lower end thereof substantially cylindrical in shape and dimensioned to fit snugly within the well bore to center itself and said universal joint within the well bore.

11. A well boring tool as described in claim 8, in which a reamer is mounted upon said drill bit between the point of the drill bit and said universal joint.

MILES J. LEWIS.