

April 16, 1940.

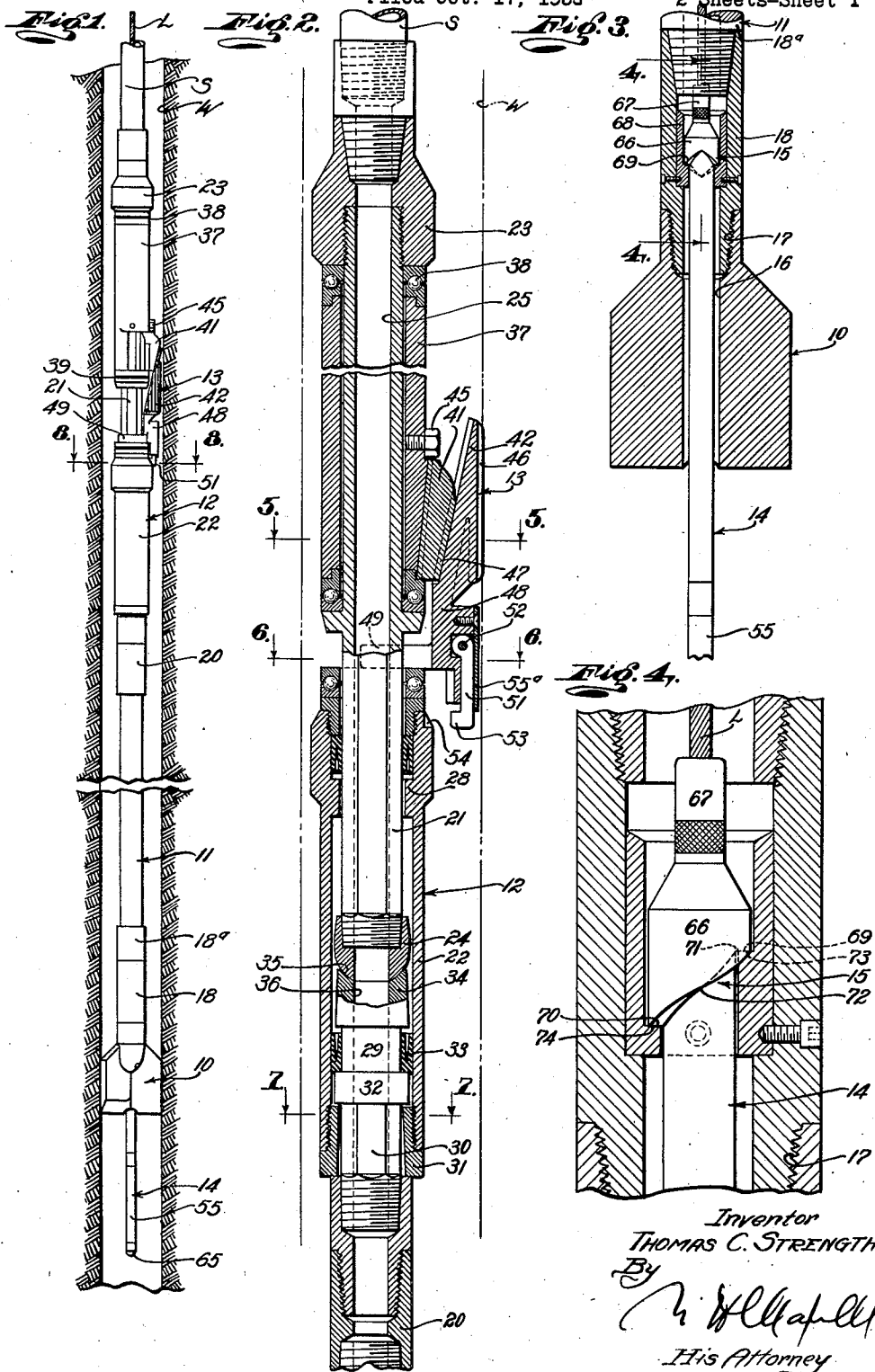
T. C. STRENGTH

2,197,227

DIRECTIONAL WELL DRILLING TOOL

Filed Oct. 17, 1938

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 5.

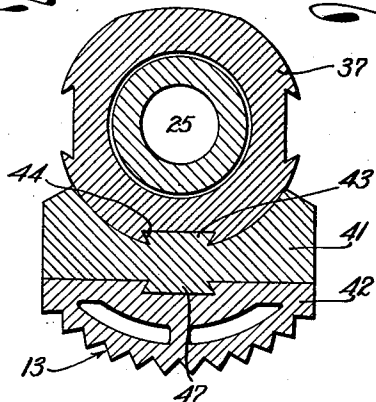


Fig. 6.

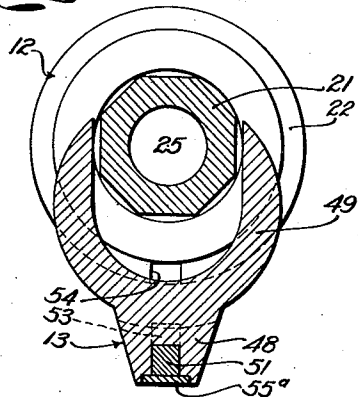


Fig. 7.

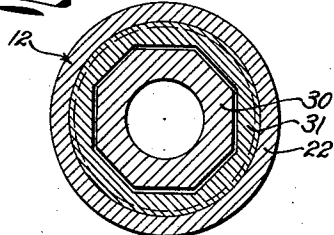


Fig. 8.

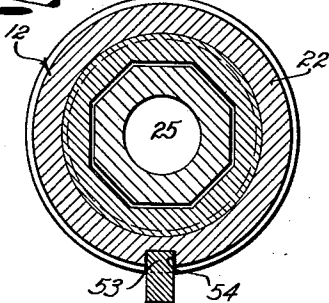


Fig. 9.

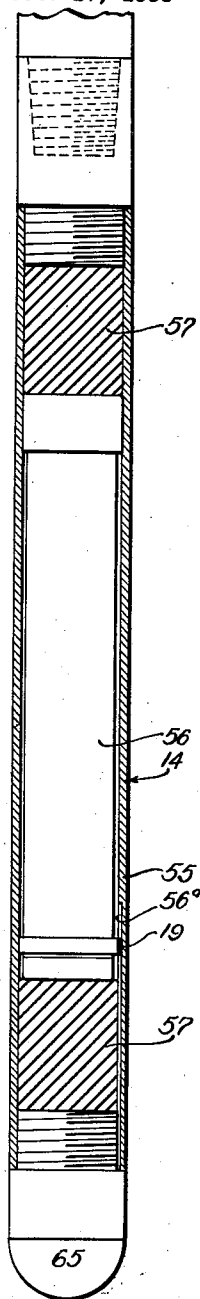
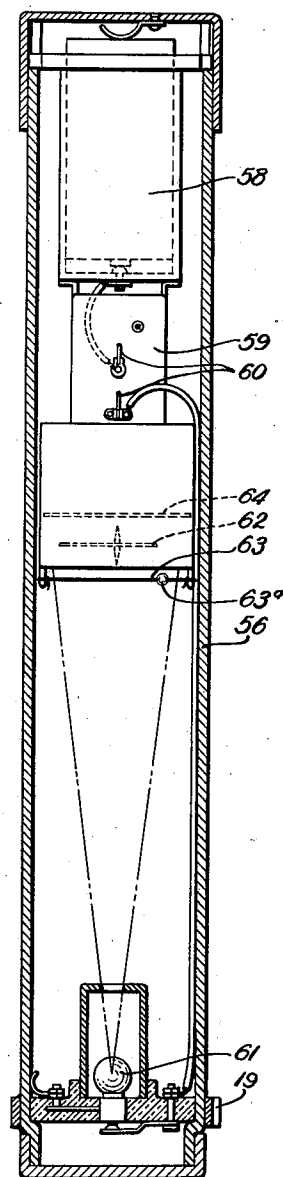


Fig. 10.



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UNITED STATES PATENT OFFICE

2,197,227

DIRECTIONAL WELL DRILLING TOOL

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Application October 17, 1938, Serial No. 235,312

17 Claims. (Cl. 255—1)

This invention relates to the art of well drilling and relates more particularly to controlled directional well drilling devices. A general object of this invention is to provide a simple, practical and dependable deflecting drilling tool.

Well drilling tools have been introduced having diverting or deflecting means capable of deflecting the bit from the longitudinal axis of the drilling string and well bore for the purpose of drilling the well toward certain earth formations or away from certain earth formations. These prior directional drilling tools have proved to be of little value because it is not practical to accurately determine the position of the bit and the direction of its deflection by means of the string of drill pipe, there being no orienting means associated with the tool. The patent to Brack et al., No. 2,061,316, November 17, 1936, discloses a directional drilling tool of the character just referred to.

An important object of this invention is to provide a well drilling tool having means for deflecting the drilling bit and means for accurately orienting the tool to have the deflected bit drill in the selected direction.

Another object of this invention is to provide a drilling tool of the character mentioned embodying an effective deflecting means that is easily set or actuated and that may be easily and quickly released and then reactuated in the event that it is found necessary to orient or change the position of the deflecting means.

Another object of this invention is to provide a directional drilling tool of the character mentioned embodying or employing a surveying tool and having effective means for accurately positioning the surveying tool in a given relation to the deflecting means whereby the record or indication produced by the surveying tool fully and accurately reflects or indicates the rotative or compass position of the deflecting means, the inclination of the bit, etc.

Another object of this invention is to provide an orientatable directional drilling tool of the character referred to in which the deflecting means is initially retained in a given rotative position with respect to the bit so that the surveying instrument may accurately record its rotative position in the well and is freed from the bit and the drilling string when set or actuated against the wall of the well to allow for free rotation of the drilling string.

Another object of this invention is to provide a tool of the character mentioned in which the deflecting means bears on the wall of the well

at one side only to obtain or produce a maximum deflection of the bit.

Another object of this invention is to provide a tool of the character mentioned embodying a novel and particularly effective means for coupling the bit with the drilling string to provide for or permit deflection of the bit and yet preserve full circulation to the bit.

A further object of this invention is to provide a directional drilling tool of the character mentioned that is simple and easy to control and operate.

The various objects and features of my invention will be fully understood from the following detailed description of a typical preferred form and application of the invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is a side elevation of the tool provided by this invention in position in a well, showing the deflecting means retracted and showing the surveying tool in its operative position. Fig. 2 is an enlarged fragmentary vertical detailed sectional view of the upper portion of the tool illustrating the deflecting means in its actuated or expanded state. Fig. 3 is an enlarged vertical detailed sectional view of the bit showing a portion of the surveying tool in position therein. Fig. 4 is an enlarged fragmentary vertical detailed sectional view illustrating the means for definitely locating the surveying tool in the bit. Figs. 5, 6 and 7 are enlarged transverse detailed sectional views taken as indicated by lines 5—5, 6—6 and 7—7, respectively, on Fig. 2. Fig. 8 is an enlarged transverse detailed sectional view taken as indicated by line 8—8 on Fig. 1. Fig. 9 is an enlarged longitudinal detailed sectional view of the surveying tool showing the internal cartridge in elevation and Fig. 10 is an enlarged longitudinal detailed sectional view of the cartridge showing the mechanism contained therein.

The drilling apparatus or tool of the present invention may be said to comprise, generally, a bit 10 carried on a stem 11, means 12 connecting the stem 11 with the drilling string S for longitudinal and angular movement with respect thereto, deflecting means 13 associated with the string S and means 12, a surveying tool 14 and means 15 for orienting the surveying tool 14 in the bit 10 whereby the device may be oriented to obtain deflection of the bit in the desired direction.

The bit 10 incorporated in the directional drilling apparatus may be any selected type or form of well drilling bit that is adapted to receive

or pass a surveying tool of the single shot type. In the drawings the bit 10 is in the form of a typical fish-tail bit, it being understood that other forms of drill bits may be employed if desired. The bit 10 has a central vertical opening 16 for handling the circulation fluid and for admitting or passing the surveying tool 14. I have illustrated a threaded socket 17 in the upper end of the bit 10 receiving the pin of a sub or tool joint section 18. The stem 11 is a tubular member or structure extending upwardly from the drilling bit 10. The lower end of the stem 11 may be connected with a bit sub or tool joint section 18^a. In practice the stem 11 may be formed of one or more lengths of drill pipe which may be limber to flex during drilling with the deflected bit 10. A tool joint section 20 may be provided on the upper end of the stem 11.

The means 12 connecting the stem 11 with the lower end of the drilling string S is in the nature of a universal joint that allows limited angular or universal movement and relative longitudinal movement between the stem 11 and the string S. The coupling means 12 includes an elongate upper section or mandrel 21 connected with the drilling string S and a tubular lower section 22 connected with the bit stem 11 and receiving the mandrel 21. The mandrel 21 may have its upper end threaded in a suitable sub 23 on the lower end of the string S. The upper portion of the mandrel 21 carries the deflecting means 13 and is preferably cylindrical or round in transverse cross section. The lower portion of the mandrel 21 enters the section 22 and is flat sided or polygonal in transverse cross section. A head 24 is secured to the lower end of the mandrel 21. The head 24 has a partially spherical or convex lower face and its outer surface slopes downwardly and inwardly. The head 24 has substantial clearance with the internal wall of the section 22. A central longitudinal opening 25 extends through the mandrel 21 from one end to the other and is provided to handle the circulation fluid and to pass the surveying tool 14.

The tubular lower section 22 of the coupling means 12 receives the polygonal lower portion of the mandrel 21 and has a packing means for sealing about the mandrel. A nut 26 is threaded in the upper portion of the section 22 and an expansible sealing ring 27 bears upwardly against the nut 26 to seal about the mandrel 21. The opening in the nut 26 is cylindrical and is proportioned to pass the polygonal portion of the mandrel 21 with substantial clearance. An internal flange 28 is provided on the section 22 below the sealing ring 27 and is adapted to cooperate with the polygonal portion of the mandrel 21 to provide for the transmission of rotation between the mandrel and the section 22. The internal surface of the flange 28 is shaped to conform to the polygonal portion of the mandrel 21 and has some clearance with the mandrel. The opening through the tubular section 22 receives the mandrel 21 and its head 24 with substantial clearance to allow for the desired angular movement between the mandrel and the section.

A member 29 is threadedly connected with the tool joint section 20 on the upper end of the bit stem 11 and extends upwardly into the lower portion of the tubular section 22. The member 29 has a polygonal part 30 and a tubular nut 31 is threaded in the lower end of the section 22 to cooperate with the polygonal part 30. The nut 31 has a polygonal opening whose walls co-

operate with the surfaces of the polygonal part 30 to transmit the turning forces from the section 22 to the stem 11. The walls of the polygonal opening in the nut 31 have clearance with the part 30 and slope downwardly and outwardly to permit angular or universal movement between the section 22 and the member 29. A shoulder 32 is provided on the member 29 and an expansible sealing ring 33 bears downwardly against the shoulder 32. The ring 33 is adapted to seal between the member 29 and the internal surface of the section 22. A head 34 is provided on the upper end of the member 29 and a concave seat 35 is formed in the head 34 to receive the lower portion of the above described head 24. The wall of the seat 35 is shaped to seal with the surface of the head 24 and the head 24 is adapted to bear against the seat for the transmission of weight or downward forces from the mandrel 21 to the bit stem 11, the head 24 and seat 35 forming a fluid directing ball and socket connection or assembly. An opening 36 is provided in the member 29 to handle the circulation fluid and to pass the surveying tool 14. During the drilling operations the head 24 bears in the seat 35 of the head 34 for the transmission of the downward force or weight from the string S to the stem 11 and the cooperation of the head 24 with the seat 35 seals off between the heads 24 and 34 to prevent the leakage of fluid from the registering passages or openings 25 and 36. The packing rings 27 and 33 prevent the loss and leakage of fluid under pressure that may leak from the cooperating head 24 and seat 35. In Fig. 2 of the drawings the parts are shown in the contracted or acuated positions where the head 24 bears in the seat 35. The mandrel 21 is shiftable through the flange 28 and the nut 26 and is movable to an up or extended position where the head 24 is above the head 34. It will be seen that the connecting means 12 just described transmits rotation, provides for relative angular or universal movement between the string S and the bit stem 11 and permits relative longitudinal movement between the string S and the stem 11.

The deflecting means 13 is engageable with the wall of the well W to provide for the deflection of the bit 10 from the former or original course of the well. The means 13 is preferably, though not necessarily, associated with the coupling means 12 and is above the universal connection between the mandrel 21 and the member 29. In the preferred form of the invention illustrated in the drawings the means 13 includes a sleeve 37 surrounding the upper portion of the mandrel 21. The sleeve 37 is rotatably supported on the mandrel 21 by upper and lower bearings 38 and 39, respectively. The bearing 38 is adapted to engage upwardly against the lower end of the sub 23 and the bearing 39 engages against a flange 40 on the mandrel 21. The bearings 38 and 39 are in the nature of anti-friction bearings and operate to support the sleeve 37 against axial thrusts as well as radial thrusts.

In accordance with the broader aspects of the invention the deflecting means 13 may be in the nature of a whipstock means or any other suitable form of deflecting means. In the drawings the deflecting means 13^a of the type described and claimed in my co-pending application hereinafter referred to, it being understood that the invention is not to be construed as limited to this form of deflecting means.

The deflecting means 13 illustrated includes a wedge element 41 secured to the sleeve 37 and

a wedge element or slip 42 shiftable on the element 41 and engageable with the wall of the well W. The wedge element 41 is preferably secured to the lower portion of the sleeve 37. The wedge element 41 has a dove-tailed tongue 43 fitting a correspondingly shaped groove 44 in the sleeve 37. The lower end of the wedge element 41 engages downwardly against the bearing 39 and a lock screw 45 is provided on the sleeve 37 at the upper end of the element to hold the element in place. The outer side of the element 41 slopes downwardly and inwardly relative to the longitudinal axis of the tool.

The slip 42 has a downwardly and inwardly inclined inner surface cooperating with the sloping face of the element 41 and has vertical teeth 46 on its outer side for biting into the wall of the well W to prevent turning or rotation of the deflecting means 13. A sliding dove-tailed tongue and groove connection 47 is provided between the wedge element 41 and the slip 42 to provide for relative vertical movement between the element and slip. A tail 48 is provided on the lower end of the slip 42 and carries an inwardly projecting yoke 49. The yoke 49 projects inwardly to engage about the mandrel 21 with clearance and an anti-friction thrust bearing 50 is provided on the nut 26 to cooperate with the under side of the yoke 49. The engagement of the yoke 49 with the bearing 50 is operable to hold the slip 42 against downward movement when the string S is moved downwardly to actuate the deflecting means 13 as will be subsequently described. When the means 13 is expanded or actuated the slip 42 contacts or bears against the wall of the well W to move the mandrel 21 and adjacent parts of the apparatus to a position out of alignment with the longitudinal axis of the well and thus provide for the deflection of the bit 10.

In accordance with the invention means is provided for holding the deflecting means 13 in a given or non-rotative position relative to the string S and bit 10 prior to and during operation of the surveying tool 14 so that the record or reading of the tool 14 gives the position of the deflecting means 13. The means for releasably holding the deflecting means 13 in a given rotative position relative to the string S and the bit 10 includes a latch 51 supported by a horizontal pivot pin 52 on the tail 48. The latch 51 is preferably received in a suitable recess in the tail 48 of the slip 42. The latch 51 depends from the tail 48 and has an inwardly projecting finger 53 adapted to engage in a notch 54 in the section 22. A leaf spring 55^a carried by the tail 48 yieldingly holds the latch 51 inwardly so that its finger 53 engages in the notch 54 when the deflecting means 13 is in the retracted position. The engagement of the finger 53 in the notch 54 retains the means 13 in a known rotative position relative to the string S, bit 10, stem 11, etc., so that it may be turned or oriented in the well by means of the string S. The latch finger 53 is free to move radially out of the notch 54 when the means 13 is actuated. The deflecting means 13 just described is fully described and claimed in my co-pending application Ser. No. 235,311, entitled Deflecting device for well drilling tools.

The surveying tool 14 is provided to determine, indicate or record the position of the tool in the well W and more specifically to determine, indicate or record the rotative position of the deflecting means 13. The surveying tool 14 is preferably a well surveying tool of the single shot class. The tool 14 is adapted to be run or dropped

through the drilling string S to a position where it is within or protrudes from the bit 10. The tool 14 includes an elongate, hollow body 55 proportioned to move or fall through the opening in the string S, the openings 25 and 36, the opening in the stem 11, etc. The body 55 contains a cartridge 56 which in turn contains the direction indicating and recording mechanism. Suitable shock absorbing blocks 57 are provided in the body 55 above and below the cartridge 56 to protect the cartridge and its contents against shocks and jars. The present invention is not primarily concerned with the details of the indicating and recording mechanism within the cartridge 56 it being apparent that any of the well known direction and inclination recording mechanisms may be employed.

In the particular case illustrated in the drawings the recording mechanism of the instrument 14 includes an electric battery 58, a clock works 59 controlling a contact mechanism 60 which in turn governs the circuit of an electric lamp 61. The lamp 61 is adapted to illuminate a compass device 62 and a fixed arrow 63 to record the images of the compass device and arrow on a sensitized record 64. The arrow 63 may be in the nature of a hair line thickened at one end or provided at one end with a ball 63^a. In practice the arrow 63 extends diametrically across the interior of the cartridge 56. In accordance with the invention the line or arrow 63 is in a known or given rotative position in the cartridge 56. The cartridge 56 in turn is in a given and known rotative position in the body 55. A key and slot connection may serve to maintain the cartridge 56 in the given rotative position in the body 55. This connection may comprise a key 19 on the cartridge 56 cooperating with a groove or slot 56^a in the wall of the body 55. The cartridge 56 or the body 55, or both, are preferably formed of non-magnetic material so that the compass means 62 is unaffected by them and by the surrounding earth formation.

The clock works 59 is such that the lamp 61 is energized momentarily a predetermined period after the lowering or dropping of the tool 14 into the well and energization of the lamp 61 results in the recordation of the positions of the compass device 62 and the arrow 63 on the record 64. The lower end of the body 55 is provided with a rounded head 65 to readily pass down through the drilling string. A head 66 is provided on the upper end of the body 55 and carries a rope socket 67. The rope socket 67 serves to connect a cable or line L with the body 55. The line L is provided to lower the surveying tool 14 through the string S and to remove the tool 14 from the string.

The means 15 is provided to hold or support the surveying tool 14 in a given or known rotative position at the bit 10 so that the arrow 63 and the deflecting means 13 are in a given and known relation when the surveying tool 14 is operated to make a record and so that the record thus produced indicates the actual rotative position of the deflecting means 13 in the well. The means 15 includes a socket 68 provided to support or suspend the tool 14. In the construction illustrated the socket 68 is provided in the tool joint section 18 on the upper end of the bit 10. The socket 68 is adapted to freely pass the surveying tool 14 when the same is dropped or run to the operative position. The socket 68 has an upwardly facing internal seat or shoulder 69. The shoulder 69 has a depression 70 and a peak 71. The depression 70 and peak 71 are diametrically

opposite and their pitched walls merge together.

The means 15 further includes a downwardly facing shoulder 72 on the head 66 of the surveying tool 14. The shoulder 72 has a depression 73 for receiving the peak 71 and a peak 74 for fitting the depression 70. The surfaces or walls of the depression 73 and peak 74 slope sharply and merge one with the other. The inclination of the surfaces of the depression 70, peak 71, depression 73 and peak 74 is such that the peaks and depressions automatically mesh or move into mating engagement under the action of the weight of the tool when the tool 14 lands in the joint section 18. The shoulder 69 of course bears a given rotative relation to the deflecting means 13. For example, its peak 71 may be 90° from the central vertical plane of the deflecting means 13 and the shoulder 72 bears a given relation to the line or arrow 63, for example, it may be 90° from the rotative position of the arrow. Accordingly, when the shoulder 72 is in its final position on the shoulder 69 the line or arrow 63 is in a given and known relation or rotative position with respect to the central vertical axis of the deflection means 13. The above described relationship is such that an observation of the record 64, showing the relative positions of the arrow 63 and the compass device 62, indicates or shows the rotative position or the compass position of the deflecting means 13 in the well W.

In the use or operation of the apparatus provided by this invention the drilling tool is secured to the lower end of the string S and is lowered into the well. The tool is lowered to a position where its bit 10 is some distance above the bottom of the well. In lowering the drilling equipment into the well W it may be preferred to attempt to orient the deflecting means 13 to assume the desired position in the well using the orienting methods known to those skilled in the art. When the drilling tool has reached the selected position the surveying tool 14 is lowered or dropped down in the string S on the line L. The tool 14 lands in the joint section 18, that is, the shoulder 72 engages against the shoulder 69 to stop the downward travel of the instrument 14 and to support the instrument. As described above, the shoulders 69 and 72 are such that the instrument 14 automatically assumes the position where the peak 74 is received in the depression 70 and the peak 71 is received in the depression 73. This meshing or mating of the peaks and depressions holds and supports the tool 14 in a known and given rotative position with respect to the other elements of the apparatus. As illustrated in Fig. 1 of the drawings the surveying tool 14 may extend some distance downwardly beyond the bit 10 when landed. It is to be understood that the deflecting means 13 is unactuated or in its normal position when the surveying tool 14 is operated. The latch finger 53 cooperating with the notch 54 holds the deflecting means 13 in a given rotative position and, therefore, in a known rotative position with respect to the arrow 63, assuming the tool 14 to be landed as above described. The clock-works 59 provides for the energization of the lamp 61 a given period after the lowering or dropping of the surveying instrument through the string S. When the lamp 61 is energized the images of the line 63 and the compass device 62 are recorded on the record 64.

When it is known that the surveying instrument 14 has operated to produce the record the

instrument 14 is withdrawn from the string S on the line L and the record 64 is examined. This examination of the record 64 discloses the relationship between the arrow 63 and the compass device 62 at the time of exposing the record 64. As above described, the line 63 is aligned with or bears a given relationship to the deflecting means 13 when the record is made and the relationship between the images of the arrow 63 and the compass device 62 on the record 64 therefore indicates the rotative or compass position of the deflecting means 13. In the event that the record 64 shows that the deflecting means 13 is in an incorrect position the string S may be turned to move the deflecting means 13 to the desired position. The tool 14 may again be dropped or lowered through the string S to make a record 64, as above described, and this second record may be examined to determine if the means 13 has been moved to the correct position. The above operations may, if necessary, be repeated until the means 13 is brought to the correct position.

When the record 64 indicates that the deflecting means 13 is in the correct and desired position the string S may be lowered until the bit 10 engages the bottom of the well and the downward movement of the string S may be continued until the head 24 engages the seat 35. During downward movement of the mandrel 21 with respect to the section 22 the wedge element 41 slides down on the slip 42 to expand the slip against the wall of the well W. The engagement of the yoke 49 with the bearing 50 holds the slip 42 against downward movement during actuation of the slip against the wall of the well. The engagement of the slip 42 with the wall of the well W operates to move the drilling device to a position where it is off center in the well. Accordingly, when drilling is started the bit 10 is deflected and made to follow a course deviating from the former path of the well. The coupling means 12 is such that the stem 11 and the bit 10 may assume an angular position with respect to the string S and the stem 11 may flex to aid this action.

The directional drilling tool of the present invention is such that the drilling bit 10 may be oriented to drill in the proper or selected direction, that is, the bit 10 may be oriented and directed to take the selected deflected course. The tool is simple and easy to operate and control and is inexpensive to manufacture.

Having described only a typical preferred form and application of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. A well tool for use in conjunction with a tubular well string comprising a bit connected with the string, deflecting means connected in the string to be above the bit operable to engage the side wall of the well bore to deflect the bit, and a surveying tool adapted to be run through the string to the bit and operable to record the rotative position of the deflecting means.

2. A well tool for use on a well string including a drilling bit connected with the string, deflecting means connected with the string and spaced above the bit and operable to engage laterally against a side wall of the well to deflect the bit, a surveying tool adapted to be run through the

string to the bit, and means at the bit for supporting the surveying tool in a known rotative position with respect to the deflecting means, the surveying tool being operable to record its rotative position and therefore the rotative position of the deflecting means.

3. A well tool for use on a tubular well string including a drilling bit connected with the string, deflecting means connected with the string to be above the bit and operable to engage laterally against a side wall of the well to deflect the bit, a surveying tool adapted to be run through the string to the bit, the surveying tool being operable to make a record of its rotative position, and means removably supporting the surveying tool at the bit in a given rotative position with respect to the deflecting means whereby said record indicates the position of the deflecting means.

4. A directional well tool for use on a tubular well string including a drilling bit, deflecting means connected with the string above the bit and operable to engage laterally against a side wall of the well to deflect the bit, universal coupling means connecting the bit and deflecting means, a removable surveying tool adapted to be run through the string to the bit and operable to make a record of its rotative position, and means locating the surveying tool at the bit in a given rotative position with respect to the deflecting means whereby said record indicates the position of the deflecting means.

5. A directional well tool for use on a rotary well drilling string comprising a bit connected with the string, deflecting means secured to the string and located above the bit operable to engage laterally against the wall of the well to deflect the bit, a removable surveying tool to be run through the string to the bit and operable to make a record of the rotative position of the surveying tool, and cooperable parts secured to the bit and surveying tool acting to locate the surveying tool in a given rotative position relative to the deflecting means whereby said record indicates the rotative position of the deflecting means in the well.

6. A directional well drilling tool for use on a rotary well drilling string comprising a bit connected with the string, deflecting means connected above the bit operable to engage laterally against the wall of the well to deflect the bit, a removable surveying tool to be run through the string to project below the bit and operable to make a record of the rotative position of the surveying tool, and intermeshing parts secured to the bit and surveying tool acting to locate the surveying tool in a given rotative position relative to the deflecting means whereby said record indicates the rotative position of the deflecting means in the well.

7. A directional well tool for use on a tubular well string comprising a bit on the lower end of the string, deflecting means secured to the string and positioned above the bit to engage laterally against the wall of the well to deflect the bit, the deflecting means contacting the wall of the well at only one side of its longitudinal axis, a removable surveying tool to be run through the string to the bit and operable to make a record of the rotative position of the surveying tool, and cooperable parts secured to the bit and surveying tool acting to locate the surveying tool in a given rotative position relative to the deflecting means whereby said record indicates the rotative position of the deflecting means in the well.

8. A directional well tool for use on a tubular

well string comprising a bit connected with the string, deflecting means connected above the bit operable to engage laterally against the wall of the well to deflect the bit, a removable surveying tool to be run through the string to the bit and operable to make a record of the rotative position of the surveying tool, a seat at the bit having a depression and a peak, and a part secured to the surveying instrument having a depression receiving said peak and having a peak received in the first named depression, the engagement of the depressions and peaks of the seat and part locating the surveying tool in a known position relative to the deflecting means whereby said record indicates the rotative position of the deflecting means.

9. A directional well tool for use on a tubular well string comprising a bit connected with the string, deflecting means connected above the bit operable to engage laterally against the wall of the well to deflect the bit, the deflecting means being operable by vertical movement of the string with respect to the bit, a coupling between the bit and string allowing such vertical movement of the string relative to the bit and providing for angular movement of the bit relative to the string, a removable surveying tool to be run through the string to the bit and operable to make a record of the rotative position of the surveying tool, and cooperable parts secured to the bit and surveying tool acting to locate the surveying tool in a given rotative position relative to the deflecting means whereby said record indicates the rotative position of the deflecting means in the well.

10. A directional well drilling tool for use on a tubular well drilling string comprising a bit connected with the string, deflecting means rotatably supported on the string above the bit and operable to engage the wall of the well to deflect the bit, releasable means initially holding the deflecting means in a known rotative position with respect to the bit, a surveying tool to be run through the string to the bit and operable to make a record of its rotative position in the well, and means removably supporting the surveying tool at the bit in a definite known rotative position relative to the deflecting means whereby said record indicates the rotative position of the bit.

11. A directional well drilling tool for use on a tubular well drilling string comprising a bit connected with the string, deflecting means rotatably supported on the string above the bit and operable upon relative vertical movement between the string and bit to engage the wall of the well and divert the bit, coupling means connecting the string and bit for such relative vertical movement and for relative angular movement, latch means holding the deflecting means against turning in a given rotative position and releasable upon vertical movement between the bit and string, a surveying tool to be run down through the string operable to make a record of its rotative position, and means removably supporting the surveying tool in a given rotative position at the bit whereby said record indicates the rotative position of the deflecting means in the well.

12. A directional well tool for use in conjunction with a tubular drilling string, comprising a bit, a stem on the bit, a slack universal connection between the stem and string, deflecting means rotatably supported on the string and operable upon relative vertical movement be-

tween the string and bit to engage the wall of the well and deflect the bit, releasable latch means holding the deflecting means in a known rotative position released by said relative vertical movement, a surveying tool to be run through the string to the bit and operable to make a record of its rotative position, and engaging parts secured to the surveying tool and body operating to support the surveying tool in a known rotative position relative to the deflecting means whereby the record indicates the rotative position of the deflecting means in the well.

13. A directional well drilling tool for use in conjunction with a tubular drilling string, comprising a bit, a stem on the bit, a slack universal connection between the stem and string, deflecting means rotatably supported on the string and operable upon relative vertical movement between the string and bit to engage the wall of the well and deflect the bit, releasable latch means holding the deflecting means in a known rotative position released by said relative vertical movement, a surveying tool to be run through the string to the bit and operable to make a record of its rotative position, and intermeshing sloping parts secured to the surveying tool and body operating to support the surveying tool in a known rotative position relative to the deflecting means whereby the record indicates the rotative position of the deflecting means in the well.

14. A directional well tool for use on a tubular well string including a drilling bit connected with the string, deflecting means connected with the string above the bit and operable to engage laterally against a side wall of the well to deflect the bit, the deflecting means including a shiftable wedge slip for engaging the wall of the well, a surveying tool adapted to be run through the string to the bit, and means at the bit for supporting the surveying tool in a known rotative position with respect to the deflecting means, the surveying tool being operable to record its rotative position and therefore the rotative position of the deflecting means.

15. A directional well drilling tool for use on a tubular well drilling string comprising a bit connected with the string, deflecting means above the bit secured in the string to engage laterally against the wall of the well to deflect the bit, the deflecting means contacting the wall of the well at only one side of its longitudinal axis, a removable surveying tool to be run down through the string to project beyond the bit and operable to make a record of the rotative position of the surveying tool, the surveying tool including a body, a recording unit in the body, and means keying the unit in a known rotative position in the body, and cooperable parts on the bit and surveying tool body operable to locate the surveying tool in a given rotative position relative to the deflecting means whereby said record indicates the rotative position of the deflecting means in the well.

16. A well tool for use on a well string comprising the combination of two elements, one a drilling tool, the other a deflecting means, means connecting one element with the string for relative movement, means operable by such relative movement to operate the deflecting means against the wall of the well to deflect the bit, a tool adapted to be run down the string and said combination of elements, and means at said combination of elements for locating said tool to project downwardly beyond the drilling tool to record the rotative position of the deflecting means.

17. A well tool for use on a well string comprising the combination of two elements, one a drilling tool, the other a deflecting means for acting on the wall of the well to deflect the drilling tool, a rotatable connection between the said elements whereby the drilling tool may be rotated relative to the deflecting means, a surveying tool adapted to be run through the string and said elements, and means at the elements for stopping and locating the surveying tool to project downwardly beyond the drilling tool where it is operable to record the rotative position of the deflecting means.

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