

May 22, 1951

C. W. SPAULDING ET AL
DIRECTIONAL DRILLING APPARATUS

2,553,874

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2 Sheets-Sheet 1

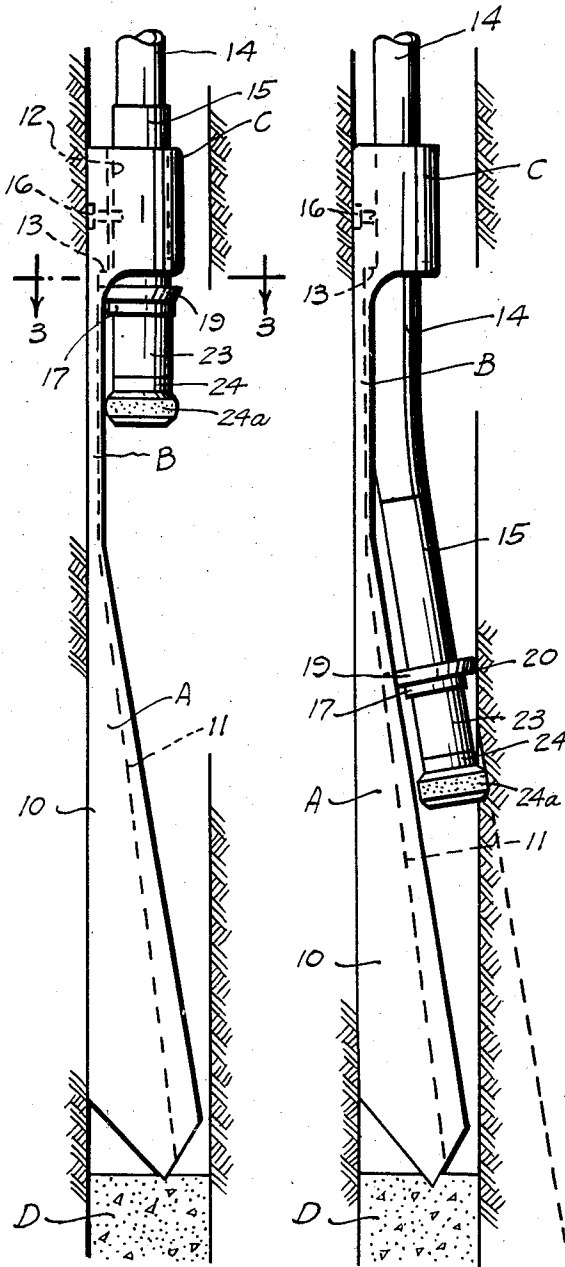


Fig. 1

Fig. 2

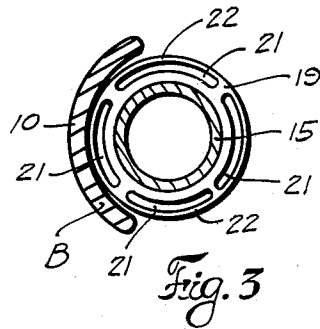


Fig. 3

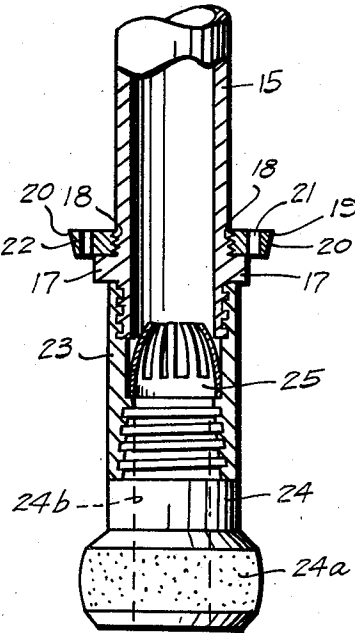


Fig. 4

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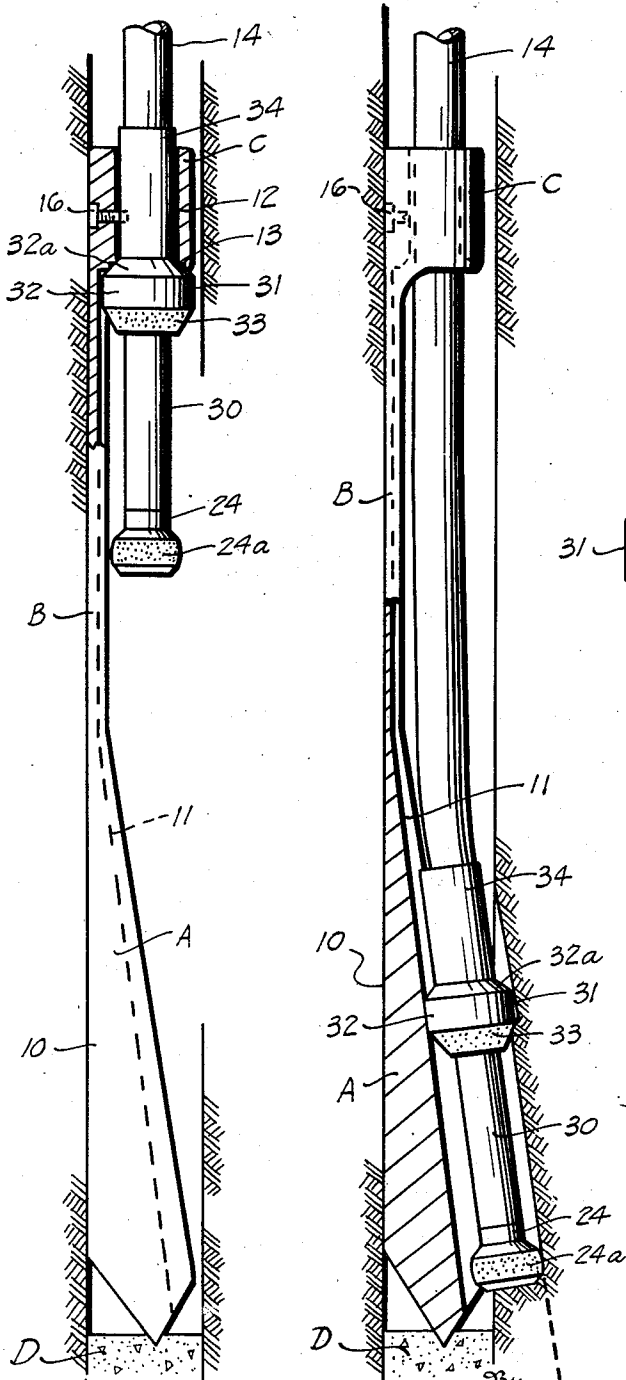


Fig. 5

Fig. 6

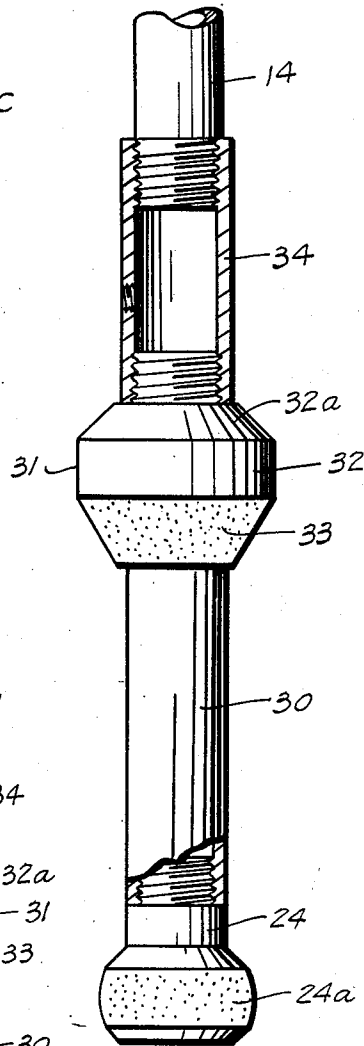


Fig. 7

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UNITED STATES PATENT OFFICE

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DIRECTIONAL DRILLING APPARATUS

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This invention relates to new and useful improvements in directional drilling apparatus.

One object of the invention is to provide an improved apparatus for drilling an inclined or directional well which apparatus is constructed so that a core of the formation may be taken simultaneously with the directional drilling operation, whereby accurate information as to said formation is available and also whereby an indication as to whether or not the drilling is proceeding in the desired direction is obtained; the core which is taken simultaneously with the drilling operation, forming an axial guide for the drill bit to insure satisfactory deflection or directional drilling.

An important object of the invention is to provide an improved directional drilling apparatus including a deflecting tool, such as a whipstock, in combination with a core-taking bit such as the usual diamond drilling bit, together with means for protecting said bit against damage due to contact with the face of the deflecting tool or whipstock as said bit is guided outwardly into the formation by said tool or whipstock; the use of the diamond type bit permitting efficient drilling operations to be carried out in excessively hard formations.

Still another object of the invention is to provide an improved directional drilling apparatus including, a deflecting tool having an inclined guide face and a diamond bit arranged to be connected with a drill pipe and movable downwardly of the guide face of the tool, together with an enlargement secured to the drill pipe above the bit which enlargement is adapted to engage and ride upon the guide face of the deflecting tool to space the abrasive cutting surface of the bit away from said deflecting tool face to prevent undue wear or damage to said bit while the bit is guided outwardly by the tool during the directional drilling operation.

A further object of the invention is to provide an improved directional drilling apparatus, of the character described, wherein the enlargement or protective element on the drill pipe for protecting the bit may be an annular element which is constructed of a wearable material, whereby by the time the drill bit has moved off of the deflecting tool face, said element has become worn down to substantially the diameter of the drill pipe and will not interfere with subsequent operations.

A particular object of the invention is to provide an improved directional drilling apparatus, of the character described, wherein the protec-

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tive enlargement may be a reamer located above the bit, whereby said reamer not only functions to hold the bit in a position spaced from the deflecting tool face during the "drilling off" procedure but also subsequently follows the bit in the deflected bore to drill said bore to full size.

Another object of the invention is to provide an improved apparatus, of the character described, wherein a diamond core bit of standard design is combined with a deflecting tool in such a manner that a directional drilling operation may be accomplished simultaneously with the obtaining of a core of the sub-surface formation.

A still further object of the invention is to provide an improved apparatus of the character described, which is readily removable as a unit with the drill pipe after the directional drilling operations are complete.

The construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawing, wherein an example of the invention is shown, and wherein:

Figure 1 is an elevation of an improved directional drilling apparatus, constructed in accordance with the invention, and illustrating the bit in a position connected with the whipstock,

Figure 2 is a similar view showing the bit detached and moved downwardly with respect to the whipstock,

Figure 3 is an enlarged, horizontal, cross-sectional view taken on line 3—3 of Figure 1,

Figure 4 is a view partly in elevation and partly in section of the drill bit assembly,

Figure 5 is a view similar to Figure 1 showing a modified form of the invention,

Figure 6 is a view similar to Figure 5 and illustrating the drill bit in a drilling position, and

Figure 7 is an enlarged view partly in section and partly in elevation showing the bit and reamer assembly of Figures 5 and 6.

In the drawings, the numeral 10 designates a deflecting tool which is illustrated as a whipstock. The whipstock includes a body portion A which is generally wedge shaped and which is provided with an inclined guide face 11 extending longitudinally thereof. The upper end of the body portion A merges into a relatively straight section B which is formed integral therewith and which has its upper end connected with a collar C. It is desirable that the collar C, straight section B and body A be formed of one piece. The

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collar is provided with an axial bore 12 which is formed with an annular shoulder 13 at its lower end.

The usual drill pipe 14 has an elongate sub 15 connected to its lower end and this sub is adapted to extend through the bore 12 of the whipstock collar C and is arranged to be detachably connected with the collar by means of a shear pin 16 which extends through the collar and into the sub. As is clearly shown in Figure 4, the sub 15 is formed with an external flange 17 nearer its lower end and immediately above the flange is provided with external left-hand screw threads 18. A spacing or guide ring 19 is adapted to be screwed onto the threads 18 and this ring has its outer periphery 20 beveled or inclined downwardly. Arcuate slots or openings 21 extend entirely through the ring 19 and extend throughout the major portion of said ring, whereby the wall thickness 22 of said ring is relatively thin.

A coupling sleeve 23 is threaded onto the lower end of the sub 15 with its upper end abutting the annular flange 17 and a diamond core bit 24 is adapted to be threaded into the lower end of said sleeve. A core catcher 25 of any suitable construction is mounted within the sleeve 23. The core taking bit 24 is a standard diamond core bit and, as is well known, includes an abrasive cutting surface 24a.

It will be evident that a whipstock or deflecting tool is not ordinarily practical for the purpose of guiding a diamond bit outwardly into the subsurface formation because the particular contour of the bit would cause its abrasive cutting surface 24a to contact and ride upon the inclined guide face 11 of the whipstock or deflecting tool, with the result that damage to the cutting surface would occur. With the arrangement illustrated, the spacing or guide ring 19 functions to maintain or hold the cutting surface of the bit in spaced relation to the guide face of the whipstock. Therefore, when the bit assembly is moved downwardly along the face of the whipstock, the ring 19 will engage the whipstock face and the abrasive cutting surface 24a of the bit will be maintained out of engagement with the metallic face of the whipstock. The provision of the left-hand threads 18 for mounting the ring 19 prevents the same from becoming disconnected upon rotation of the drill pipe and bit and thus the ring functions to affect positive guiding of the bit out into the formation without said bit actually contacting or rotating against the metallic guide face of the whipstock.

The material of which the ring 19 is constructed is a relatively soft metal which is capable of quickly wearing upon contact with the formation and with the whipstock face. The ring is so designed that it will not become worn until the drilling has proceeded with the bit beyond the lower end of the whipstock; however, by the time that the bit has passed below the lower end of the whipstock, the thin wall 22 of the ring 19 has been worn to the point that the outer portion of the ring beyond the openings 21 is completely removed and the diameter of said ring is substantially the same as that of the flange 17.

The operation of the apparatus is believed to be obvious. The assembly is connected as shown in Figure 1 with the whipstock ring being connected to the drill pipe by means of the shear pin 16. The whipstock may then be lowered through the well bore to the point at which it is to be set. It is usual to set the whipstock upon a cement plug D which has been previously introduced into

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the bore hole at the point where deflection drilling is to occur. After the whipstock is positioned upon the plug or other support within the bore, the weight of the drill pipe is imposed upon the shear pin and fractures said pin, whereby the drill bit 24, sleeve 23 and sub 15, as well as the drill pipe may be lowered with respect to the whipstock. Lowering of the bit causes the same to move downwardly opposite the inclined face 11 of the whipstock and the spacing or guide ring 19 engages the face to deflect the bit outwardly into the formation. The drill pipe is then rotated to impart a rotation to the bit which then begins cutting an inclined bore as indicated by dotted lines in Figure 2. During the initial cutting action, the cutting surface 24a of the bit is maintained in a position spaced away from the whipstock face by the guide and spacing ring 19. Thus, any damage to this surface by a contact with the metallic surface of the whipstock is prevented.

As continued rotation is imparted to the drill pipe and drill bit, the bit functions to drill the inclined or offset bore and during the time that the bit is traversing the length of the whipstock, the guide or spacing ring 19 is subjected to an abrasive or wearing action through its contact with the metallic whipstock face and also with the subsurface formation. The inclined periphery 20 of the ring increases the abrasive action or wearing on the ring. The thin wall 22 of the ring 19 is such that this wall is completely worn through by the time that the bit 24 passes beyond the lower end of the whipstock. Of course, it is understood that the particular point at which the ring becomes worn so that its diameter reduces to substantially the diameter of the flange 17 is not particularly critical except that said ring should not wear until after the bit has passed the lower end of the whipstock since it must function as a spacer until the cutting surface of the bit has cleared said whipstock.

By providing the core bit 24, it will be evident that as the deflected or inclined well bore is formed, a core moves upwardly through the bore 24b of the core bit and into the sub 15 past the core catcher 25. By the time that the bit has drilled the inclined or offset bore a sufficient depth, an ample core of the subsurface formation will have been obtained. This core will be extremely valuable since it will be taken at an angle to the main well bore and will give accurate information with respect to the subsurface formation. The use of a diamond core bit has been found extremely satisfactory in the harder formations. The obtaining of a core is also valuable in providing accurate information regarding whether or not drilling is outside of the cement plug since in some instances the bit tends to drift back into the old bore after it passes beyond the lower end of the whipstock.

After the inclined or deflected bore has been formed, it is only necessary to lift the drill pipe 14 upwardly so as to engage the remaining portion of the ring 19 of reduced diameter, with the internal shoulder 13 within the bore of the collar 12. Continued lifting of the drill pipe after this engagement will, of course, retrieve the whipstock from the bore hole.

In Figures 1 to 4, an ordinary diamond core bit has been illustrated together with a wearable guide collar for maintaining the abrasive cutting surface of the bit out of contact with the whipstock face during the drilling off procedure. In some instances it is desirable that the inclined

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or deflected bore be drilled to substantially full gauge or to the same size as the original well bore and such an arrangement is shown in Figures 5 to 7. In this instance the whipstock or deflecting tool 10 having the body A, the straight section B and the collar C is provided, with the whipstock collar having the bore 12 and shoulder 13. The diamond core bit 24 is connected by means of an elongate sleeve 30 with a diamond reamer 31. This reamer includes a cylindrical body section 32 having an annular cutting surface 33 which is illustrated as inclined or beveled but which may be formed with annular shoulders or steps of gradually reducing diameters toward its lower end. The reaming body is connected through a sub 34 with the drill pipe 14.

The operation of this form of the invention is substantially the same as the first form. After the whipstock has been lowered and set in proper position, the shear pin 16 is fractured and the assembly lowered. Such lowering will cause the cylindrical body 32 of the reamer to engage and contact the guide face 11 of the whipstock and since the reamer body has a diameter larger than the diameter of the cutting surface 24a of the bit 24, said reamer body will function to maintain the bit in spaced relation with respect to the whipstock face. Thus, in effect, the reamer body in the form shown in Figures 5 to 7 functions in substantially the same manner as the spacing collar 19 in the first form so far as maintaining the cutting surface 24a of the bit out of contact with the whipstock face is concerned. It will be evident that as the bit 24 forms the deflected or inclined bore, the beveled or inclined cutting surface 33 of the reamer will follow up to ream the bore to substantially full size or at least to a diameter which will permit an ordinary bit to be inserted in the inclined bore. Just as in the first form, a core of the subsurface formation being drilled will be taken simultaneously with the directional drilling operation.

In removing the tool, the drill pipe is pulled upwardly and an annular shoulder 32a formed at the upper end of the reamer body will engage the internal shoulder 13 within the whipstock collar, whereby the whipstock may be retrieved when the drill pipe is removed.

In both forms of the invention, a positive means is provided for maintaining the cutting surface 24a of the drill bit out of contact or engagement with the face of the whipstock. In this manner, such cutting surface is protected against damage which may be caused by its rotatable contact with the metallic surface of the whipstock. Also in both forms of the invention, a core is taken simultaneously with the deflecting drilling step and said core not only gives information as to the sub-surface formation being drilled but also provides an indication that the drill bit has not drilled back into the cement plug after passing the lower end of the whipstock. Further, the core entering the bit forms an axial guide, particularly in harder formation, which guides the bit outwardly at the starting angle as drilling proceeds to assure proper angular drilling. Although a diamond core bit has been illustrated, it is obvious that the advantages of taking a core during the direction or deflection drilling operation may be obtained with any other standard type of core bit and so far as the improved results which flow from the taking of a core simultaneously with the deflection drilling are concerned, any suitable type of core bit, now in gen-

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eral use, could be employed. It is also apparent that the combination of a core bit with a deflecting tool, such as a knuckle joint, would produce the same advantages of being able to cut a core simultaneously with the drilling operation.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What we claim and desire to secure by Letters Patent is:

1. A directional drilling apparatus including, a deflecting tool having an inclined guide face and having a collar at its upper end, a drill pipe extending through said collar and having a drill bit on its lower end, said bit and pipe being adapted to be moved longitudinally of the guide face of the deflecting tool when said tool is in a set position within a well bore, and bearing means connected in the drill pipe above the drill bit for rotation with the pipe and bit and having a diameter larger than the cutting surface of said bit for engaging the face of the tool and rotating relatively thereto as the drill pipe and bit move longitudinally thereof and functioning to hold the bit in spaced relation to the face of said tool.

2. A directional drilling apparatus as set forth in claim 1, wherein the means for maintaining the bit spaced from the face of the deflecting tool comprises an annular ring element which is located above said bit.

3. A directional drilling apparatus as set forth in claim 1, wherein the means for maintaining the bit spaced from the face of the deflecting tool comprises an annular ring element which is located above said bit, and also wherein the ring element is constructed of a wearable material so that as said ring moves longitudinally along the face of the deflecting tool, it becomes worn to reduce its diameter to substantially that of the drill pipe.

4. A directional drilling apparatus as set forth in claim 1 wherein the enlarged means maintaining the bit spaced from the deflecting tool face is a reamer body which engages and rides upon the face of said tool, together with a cutting surface on said reamer body which functions to follow up and enlarge the bore drilled by the drill bit.

5. A directional drilling apparatus including a whipstock which comprises a body having an inclined guide face throughout its lower portion and having a collar at its upper end with the collar connected to the body by means of a straight wall section, a drill pipe, a sub connected to the drill pipe and extending through the collar, a diamond core bit connected to the lower end of the sub, and an enlarged guide and spacing ring mounted on the sub above the bit for rotation with the bit and sub and having a diameter larger than the diameter of the cutting surface of said bit, whereby when the bit assembly is moved downwardly with respect to the whipstock, said ring engages and rotates relatively to the guide face of said whipstock and maintains the cutting surface of the bit spaced away from the whipstock face.

6. A directional drilling apparatus as set forth in claim 5, wherein the guide and spacing ring is constructed of a wearable material which is capable of being worn to reduce the ring diame-

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ter by the abrasive action of the formation and whipstock face on said ring.

7. A directional drilling apparatus including a whipstock which comprises a body having an inclined guide face throughout its lower portion and having a collar at its upper end with the collar connected to the body by means of a straight wall section, a drill pipe, a sub connected to the drill pipe and extending through the collar, an enlarged reamer connected to the sub and having the outer periphery of its body adapted to engage and ride upon the whipstock face, an elongate sub below the reamer, and a drill bit connected to the lower end of the elongate sub, the diameter of the cutting surface of the drill bit being less than the diameter of the reamer body, whereby said body in riding upon the face of the whipstock maintains the bit in spaced relation to the whipstock face.

8. A directional drilling apparatus as set forth in claim 7, wherein the drill bit is a diamond core bit, whereby a core is obtained as said bit drills through the sub-surface formation.

9. A directional drilling apparatus as set forth in claim 7, wherein the cutting surface of the reamer is of a diameter less than the reamer body so that said cutting surface is protected from contact with the whipstock face as the assembly moves longitudinally thereof.

10. A directional drilling apparatus including a whipstock which comprises a body having an inclined guide face throughout its lower portion and having a collar at its upper end with the collar connected to the body by means of a straight wall section, a drill pipe, a core bit con-

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nected to the lower end of the drill pipe, and means rotatable with the core bit and cooperating with the guide face whereby when the bit is moved downwardly and rotated with respect to the whipstock, said bit is guided outwardly into the formation by the whipstock without contact with the inclined surface to drill an inclined well bore and to simultaneously take a core which moves upwardly within the bit.

11. In a drill bit structure for attachment to a drill stem and association with a whipstock having an inclined guide surface, said structure comprising a drill bit and a bearing means spaced above the drill bit for rotation therewith and for cooperation by relative rotation with the whipstock guide surface, said bearing means being in the form of a ring having a greater diameter than the drill bit so that it will maintain the bit during its drilling out of contact with the guide surface.

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