

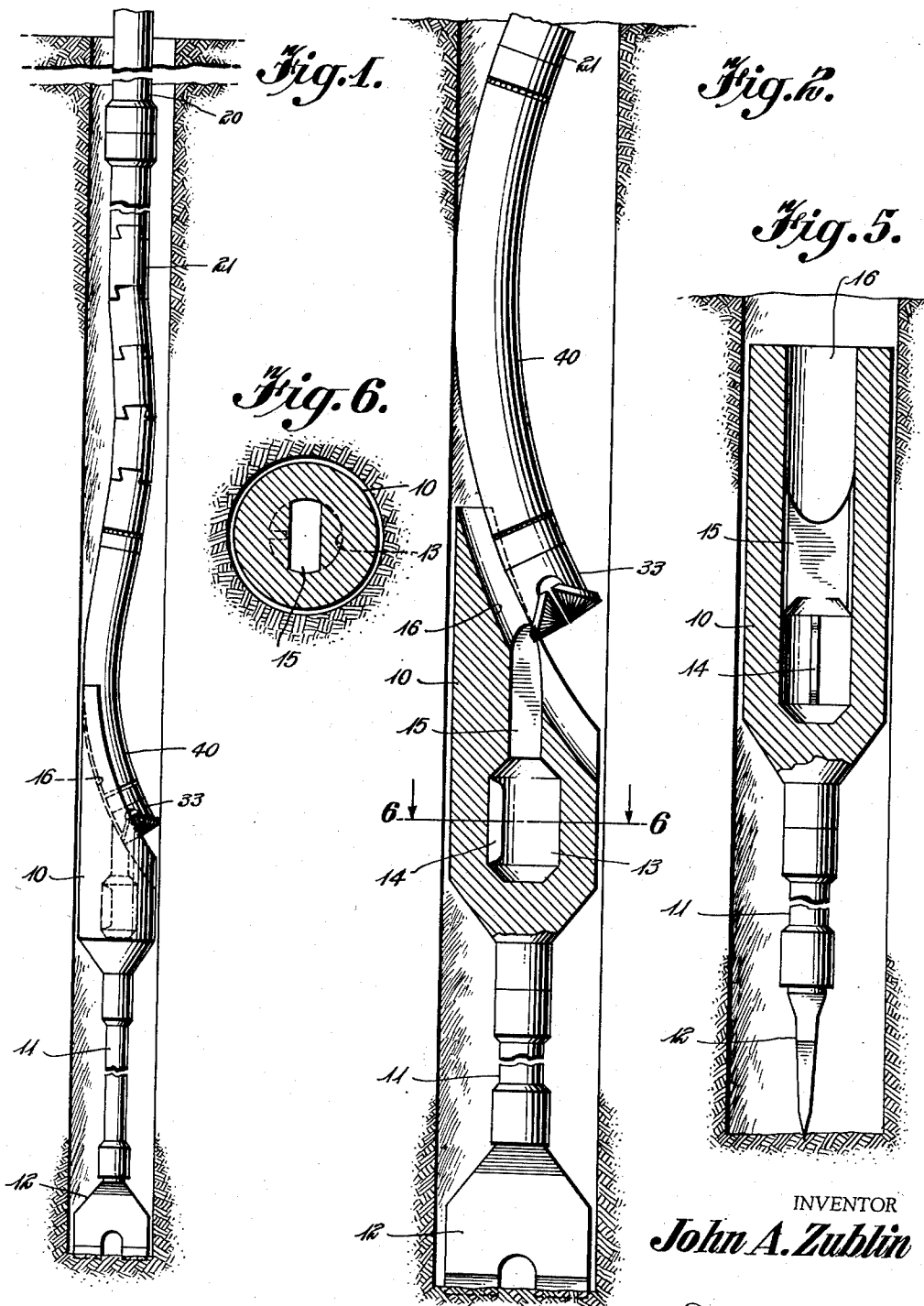
Feb. 16, 1954

Filed Jan. 17, 1951

J. A. ZUBLIN
APPARATUS FOR DRILLING LATERAL BORES
DEVIATING FROM VERTICAL WELL BORES

2,669,428

3 Sheets-Sheet 1



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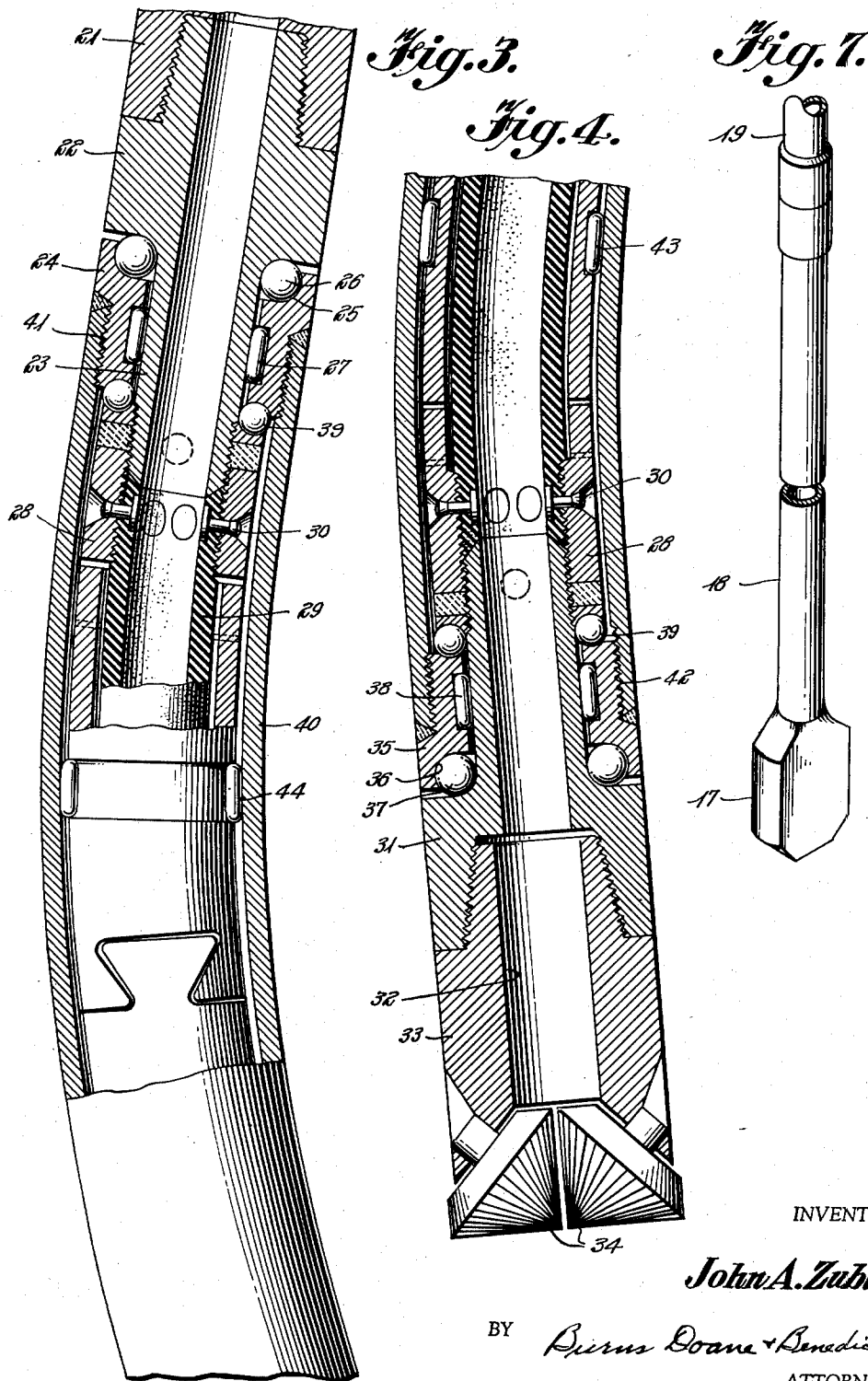
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Fig. 8.

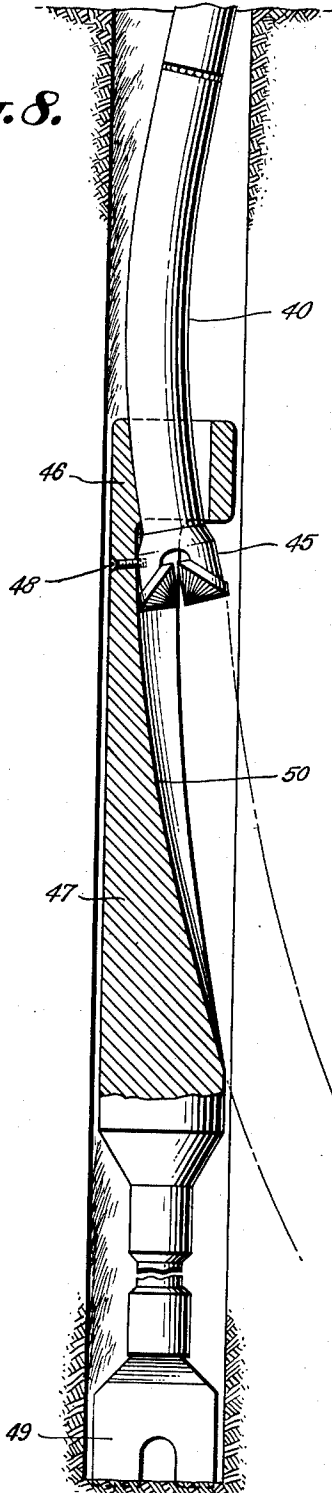


Fig. 9.

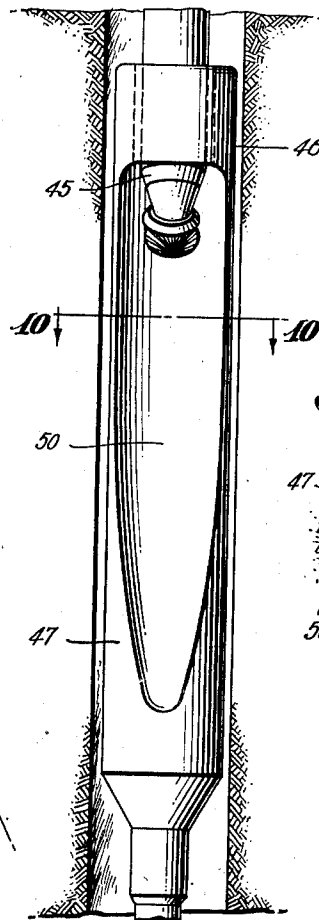
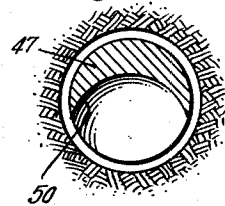


Fig. 10.



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UNITED STATES PATENT OFFICE

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APPARATUS FOR DRILLING LATERAL
BORES DEVIATING FROM VERTICAL
WELL BORES

John A. Zublin, Los Angeles, Calif.

Application January 17, 1951, Serial No. 206,363

3 Claims. (Cl. 255—1.6)

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The present invention relates to apparatus for drilling lateral bores deviating from existing vertical well bores.

It is an object and purpose of the invention to provide a set of apparatus elements that can be employed by drilling crews versed in the art of rotary drilling through the employment of practices with which they are generally conversant.

More specifically, it is the object of the invention to provide a specially related drilling unit and whipstock in which the whipstock and drilling unit effectively cooperate to initiate and insure the drilling of a deviating bore.

In its more specific aspects, the invention contemplates the employment in combination of a relatively short rigid curved drill guide suspended from a flexible drill string section and a specially constructed whipstock arranged to hold the rigid curved drill guide against rotation during the initiation of the drilling of a deviating well bore, while at the same time causing a drill carried by the rigid curved drill guide to be pressed side-wardly against the existing well bore, all in combination with means for positively rotating a drill bit carried by the rigid drill guide through rotation of a drill string extending to the well surface. Further and more detailed objects and advantages of the invention will become apparent as the description proceeds, in which will be given a reference to the accompanying drawings, wherein:

Figure 1 is a view in side elevation disclosing the apparatus of the present invention in the position occupied thereby on the initiation of the drilling of a deviating bore from an existing vertical well bore.

Figure 2 is an enlarged detailed view partly in cross section showing the position of the whipstock and rigid drill guide immediately prior to contact thereof.

Figure 3 is a detailed view partly in cross section showing the manner of connecting the rigid curved drill guide into the drill string and illustrating the internal bit driving member.

Figure 4 is a detailed cross sectional view through the lower end of the rigid curved drill guide illustrating the manner in which the bit is supported.

Figure 5 is a detailed view partially in cross section showing the internal construction of the whipstock and illustrating the same at right angles to the position occupied thereby in Figures 1 and 2.

Figure 6 is a transverse cross sectional view on line 6—6 of Figure 2.

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Figure 7 is a fragmentary detailed view of the tool employed in setting and orienting the whipstock.

Figure 8 is a view similar to Figure 1 but showing a modified form of the invention.

Figure 9 is a detailed view taken at right angles from Figure 8, and

Figure 10 is a cross sectional view taken on line 10—10 of Figure 9.

When it is desired to drill a lateral bore deviating from an existing vertical well bore with the apparatus of the present invention, the first step resides in setting the whipstock which may, if desired, be oriented to insure the drilling of the deviating bore in the desired azimuth and at the proper vertical position in the existing well bore. For this reason the description herein will be initiated with a description of the specially constructed whipstock, its manner of orientation and setting in a well.

At one or more sections of coupling rod 11 carried by the lower end of the body of the whipstock and at the lower end of the coupling rod 11 there is threadedly received therein a fishtail bit 12. The body 10 of the whipstock has a cylindrical cavity 13 into which there projects a rib 14 integral with the whipstock body 10. An open keyway 15 extends from the upper end of the cylindrical cavity 13 through the top of the whipstock. The top of the whipstock is curved and the degree of curvature corresponds to the degree of curvature of the rigid curved drill guide presently to be described and which is received in and seats in the semi-circular saddle 16 which is disposed centrally along a transverse axis of the whipstock.

Referring to Figure 7, the tool for setting and orienting the whipstock embraces a generally rectangular shaped head 17 carried by a vertical shank 18 which is adapted to be secured to a small pipeline 19 that extends to the surface of the well. The rectangular head 17 of this tool passes freely through the open keyway 15 in the body 10 of the whipstock and is accommodated by the cylindrically shaped cavity 13 in which the head 17 of the tool may be given a partial rotation. As soon as the head 17 of the tool is rotated out of alignment with the keyway 15, the whipstock will be suspended thereby and can be lowered into the well. The length of and number of the sections 11 between the body 10 of the whipstock and the fishtail bit 12 will determine the distance above the bottom of the hole at which the deviating bore is to be drilled. When the tool comprised of the small pipeline 19, shank

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18 and head 17 is rotated beyond, say a quarter turn, the head 17 strikes against the rib 14 integral with the body 10 of the whipstock and further rotation of the tool effects rotation of the whipstock, thus the whipstock can be oriented so as to position the curved saddle 16 in relation to the existing well bore to insure the drilling of a deviating bore in the desired azimuth. When the whipstock has been properly oriented, it can be lowered so that the teeth of the fishtail bit 12 dig in slightly into the formation of the bottom of the well and lock the whipstock against rotation to an undesired position. A reverse rotation of the tool, including the head 17, will bring it again into alignment with the open keyway 15 and permit its removal from the whipstock and withdrawal from the well, leaving the whipstock ready to receive the rigid curved drill guide.

Coming next to that portion of the apparatus which is carried at the lower end of the conventional rotary drill string, the lower end of the lower section of the conventional rotary drill string is indicated at 20 in Figure 1. Threadedly attached to the lower end 20 of the lower section of the conventional rotary drill string is a flexible non-resilient drill string section 21 which preferably takes the form of the non-resilient flexible drill pipe more particularly disclosed in my prior U. S. Patent 2,515,366 issued on July 13, 1950. It will be appreciated that, depending upon the length of the deviating bore desired to be drilled, one or more non-resilient flexible pipe sections 21 may be employed in the apparatus.

To the lower end of the flexible non-resilient drill string section 21 there is attached a tubular coupling member 22 (see Figure 3). The coupling member 22 has a relatively long extension 23 on which an annular bearing member 24 is mounted. The bearing member 24 is provided with a ball race 25 in which ball bearings 26 are adapted to ride. Roller bearings 27 are also carried intermediate the annular bearing member 24 and the tubular extension 23 of the coupling 22. The lower end of the tubular extension 23 of the coupling 22 threadedly receives a second flexible non-resilient tubular member 28 which, apart from the fact that it is of somewhat less diameter than the flexible non-resilient tubular drill string section 21, may be of the same construction. Both the flexible non-resilient drill string section 21 and the flexible non-resilient member 28 are made up of small independent units interconnected by the dovetail slots in a manner described in more detail in U. S. Patent 2,515,366 hereinabove referred to. Each of the members 21 and 28 is also provided with an impervious flexible liner such as indicated at 29 in Figure 3 secured at its opposite ends to the flexible metallic tubular member through the medium of a combined threaded and rivet connection such as indicated at 30 in each of Figures 3 and 4. Secured to the lower end of the flexible non-resilient tubular member 28 is a second tubular coupling member 31 which at its lower end threadedly receives the shank 32 of the bit 33 carrying the conical cutters 34. A short annular bearing member 35 surrounds the smaller portion of the tubular coupling member 31 and is provided with ball race 36 in which the ball bearings 37 ride. Roller bearings 38 are also disposed intermediate the short annular bearing member 35 and the smaller portion of the tubular coupling member 31. At either end of the flexible non-resilient tubular member 28 there is disposed a set of ball bearings 39. At the lower

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end of the flexible non-resilient member 28 the said ball bearings 39 rest and ride on the upper end of the short annular bearing member 35. At the upper end of the flexible non-resilient tubular member 28 the set of ball bearings 39 are disposed immediately below and roll against the lower end of the short annular bearing member 24. The arrangement is such that rotation of the drill string including the lower end 20 of the lower section of the relatively rigid drill string, together with the flexible non-resilient drill string section 21 and the flexible non-resilient smaller diameter tubular member 28 effects a positive rotation of the bit 33.

An important feature of the present invention resides in the provision of a short rigid curved drill guide 40 that surrounds the flexible non-resilient tubular member 28 and is connected at its upper end by the threaded connection 41 to the short annular bearing member 24 and at its lower end through the threaded connection 42 to the short annular bearing member 35 (see Figures 3 and 4). Roller bearings 43 and 44 are mounted intermediate the outer relatively short curved rigid drill guide 40 and the inner flexible tubular drill guide member 28. It will be appreciated that in operation the short rigid curved drill guide 40 and the short annular bearing members 24 and 35 at the upper and lower ends respectively of the curved drill guide 40 do not rotate, whereas the tubular coupling member 22, the flexible non-resilient tubular member 28 and the tubular coupling 31 secured to the lower end of the member 28 do rotate in unison when the rotary drill string, including the flexible non-resilient drill string section 21 is rotated. The arrangement is such that substantially all frictional contact between the rotating elements of apparatus and the non-rotating rigid curved drill guide 40 and the associated bearing members 24 and 35 is eliminated.

When the whipstock, including the body 10 and the curved semi-circular saddle 16, has been set in properly oriented position in the bottom of an existing vertical well bore and the portions of the apparatus embracing the flexible non-resilient tubular drill string section 21, the flexible tubular drill guide member 28, the curved rigid drill guide member 40 and the bit 33 are lowered into the well and rotated so that the direction of curvature of the rigid drill guide 40 extends along the same transverse axis as the curvature of the semi-circular seat 16 in the whipstock, the rigid drill guide 40 will move into the seat 16 in the manner indicated in Figure 1. When the elements of the apparatus are in the position shown in Figure 1, rotation of the drill string at the surface of the well effects rotation of the flexible non-resilient drill string section 21, the inner flexible non-resilient drill guide member 28 and the bit 33, while the curved rigid drill guide 40 is held against rotation due to its being seated in the curved semi-circular seat 16 of the whipstock. The pressure imposed on the area of contact between the curved drill guide 40 and the semi-circular seat 16 of the whipstock due to the weight of the drill string causes the bit 33 to be forced against the side of the vertical well bore and rotation of the bit thus initiates drilling of a deviating bore. The rigid curved guide 40 follows the bit under the pressure imposed thereon and when the curved guide 40 has completely entered a deviating bore, the flexible non-resilient drill string section 21 then follows the semi-circular curved seat 16 of the whipstock and progresses into the deviating well bore as the

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same is advanced through continued rotation of the drill bit.

It will be observed that the only non-rotating element entering the deviating bore is the short curved drill guide 40. Thus, no extended non-rotating elements are either in the curved deviating bore or in the vertical well bore about which the mud fluid can set during intervals of cessation in the circulation thereof. It will be additionally observed that the curved guide 40 may progress into a deviating bore many times the length thereof.

The length and degree of curvature of the rigid curved drill guide and the corresponding degree of curvature of the semi-circular seat 16 of the whipstock will be determined by the diameter of the existing vertical well bore from which a deviating bore is to be drilled. Generally speaking, the rigid curved drill guide 40 will be four or five times as long as the diameter of the vertical well bore into which it is to be inserted and the degree of curvature of the rigid curved drill guide 40 will be such that it can pass freely into a vertical well bore having a diameter equal to at least one-fifth of the over-all length of the rigid curved drill guide 40.

Referring to Figures 8 to 10, there is disclosed in these figures a modified form of the invention in which the rigid curved drill guide 40 carries a bit 45 having a body of greater transverse dimension than the diameter of the rigid drill guide 40. In this modification the rigid drill guide 40 extends through the collar 46 of the whipstock 47 and the collar 46, together with the body of the bit 45, act to support the whipstock 47 from the lower end of the drill string during the lowering of the drill string into the well. A shear pin 48 may suitably be passed through the body of the whipstock 47 and received into a suitable opening in the body of the bit 45 as shown in Figure 8. When the elements are in the position shown in Figure 8, the rigid curved drill guide 40, the bit 45 and the whipstock 47 can be lowered into the well as a unit. The cutters of the bit 45 lie within the confines of the periphery of the collar 46 of the whipstock 47 and do not gouge into the sides of the well bore as the bit is lowered into the well. When the fishtail bit 49 strikes the bottom of the well bore and weight is thereafter applied by the drill string to the curved drill guide 40, the pin 48 will be sheared off and the bit will be urged into the side of the well bore, at which time rotation thereof is initiated in the manner described with respect to the other modifications of the invention. The rigid curved guide 40 seats in the cut-out channel 50 of the whipstock 47 which holds the same against rotation and yet continues to urge the bit laterally as the curved guide 40 is lowered to effect the initiation and drilling of a deviating curved bore.

The modification of Figures 8-10 possesses certain advantages in operation in that the whipstock and bit can be lowered into the well at one and the same time, requiring no extra round trip for setting the whipstock. Additionally, the bit is held during the period of insertion into the well in a position out of contact with the wall of the well bore. Further, when the rigid curved drill guide 40 and the bit are withdrawn at the conclusion of the drilling of the curved deviating bore, the whipstock is withdrawn and pulled to the surface of the well, along with the rigid curved drill guide and bit.

While I have disclosed the whipstock as sup-

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ported from the bottom of the well and locked against rotation by a fishtail bit, it will be appreciated that it is within the broader purview of the invention to employ slits associated with the whipstock for locking the same against the walls of the vertical well bore in the desired position.

The foregoing specification has been given by way of exemplification of the invention and not in limitation thereof, the scope of the invention being that defined by the subjoined claims.

What I claim is:

1. A unit attachable to the lower end of a rotary drill string and insertable into a vertical well bore for drilling lateral bores deviating from existing vertical well bores comprising in combination a first non-resilient flexible tubular drill string member, means for securing the upper end of said flexible drill string member to the lower end of a conventional rotary drill string, a second non-resilient flexible tubular member secured to the lower end of said first flexible tubular member and rotatable in unison therewith, a drill bit secured to the lower end of and rotatable in unison with said second flexible tubular member, a short rigid curved drill guide carried on and surrounding said second flexible non-resilient tubular member, said second flexible non-resilient tubular member being free to rotate within said rigid drill guide, means rotatably securing said bit to the lower end of said guide, a whipstock, means carried by the whipstock for seating and holding said rigid curved drill guide against rotation while said flexible non-resilient members and said bit are rotated to initiate drilling of a lateral bore deviating from a vertical bore on a curvature of the same radius as the radius of curvature of said short rigid curved drill guide, whereby said flexible non-resilient members and said rigid curved drill guide follow the bit into a curved deviating bore as drilled thereby.

2. A unit attachable to the lower end of a rotary drill string and insertable into a vertical well bore for drilling lateral bores deviating from existing vertical well bores comprising in combination a first non-resilient flexible tubular drill string member, means for securing the upper end of said flexible drill string member to the lower end of a conventional rotary drill string, a second non-resilient flexible tubular member secured to the lower end of said first flexible tubular member and rotatable in unison therewith, a drill bit secured to the lower end of and rotatable in unison with said second flexible tubular member, a short rigid curved drill guide freely suspendable in a vertical well bore carried on and surrounding said second flexible non-resilient tubular member, said second flexible non-resilient tubular member being free to rotate within said rigid drill guide, means rotatably securing said bit to the lower end of said guide, a whipstock, means carried by the whipstock for seating and holding said rigid curved drill guide against rotation while said flexible non-resilient members are rotated to advance said bit and said rigid curved guide into a lateral bore deviating from a vertical bore on a curvature of the same radius as the radius of curvature of said short rigid curved drill guide and means carried by the whipstock for holding the same against rotation in the well bore when set for the drilling of a deviating bore in the desired azimuth.

3. A unit attachable to the lower end of a ro-

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tary drill string and insertable into a vertical well bore for drilling lateral bores deviating from existing vertical well bores comprising in combination a first non-resilient flexible tubular drill string member, means for securing the upper end of said flexible drill string member to the lower end of a conventional rotary drill string, a second non-resilient flexible drill string tubular member of less outside diameter than said first member secured to the lower end of said first flexible tubular member and rotatable in unison therewith, a drill bit secured to the lower end of and rotatable in unison with said second flexible tubular member, a curved tubular one-piece drill guide carried on and surrounding said second flexible non-resilient tubular member and having a diameter not substantially greater than that of said first member, said second flexible non-resilient tubular member being free to rotate within said curved drill guide, means rotatably securing said bit to the lower end of said guide, said bit being effective to drill a bore of greater diameter than the maximum diameter

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of the unit, a whipstock, means carried by the whipstock for seating and holding said curved drill guide against rotation while said flexible non-resilient members and said bit are rotated to drill a lateral bore deviating from a vertical bore on a curvature of the same radius as the radius of curvature of said curved drill guide.

JOHN A. ZUBLIN.

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