

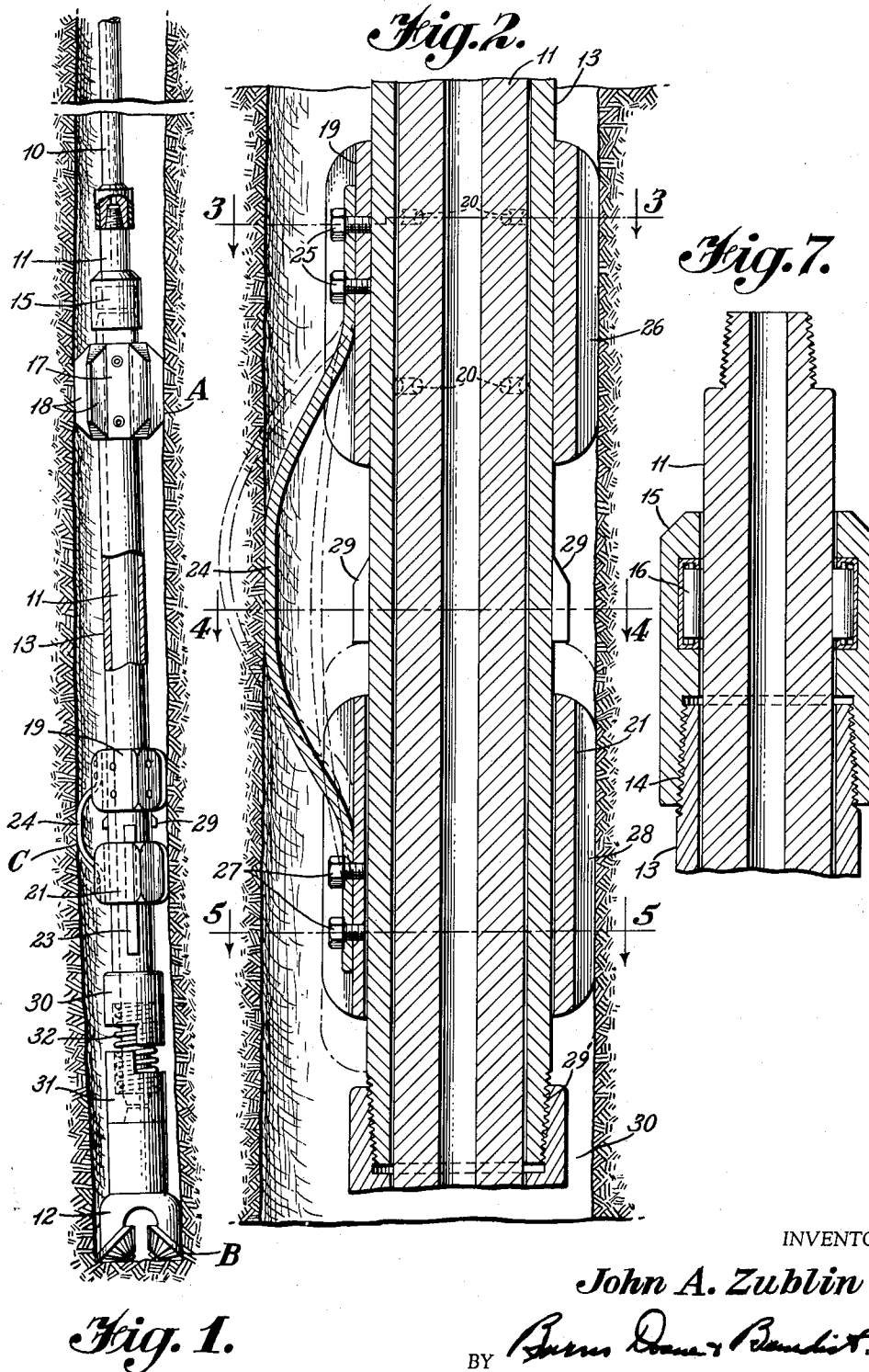
Feb. 14, 1956

J. A. ZUBLIN
APPARATUS FOR DRILLING WELLS WITH ORIENTED
CURVED BORES OF LARGE RADII

2,734,720

Filed Dec. 30, 1952

2 Sheets-Sheet 1



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Fig. 3.

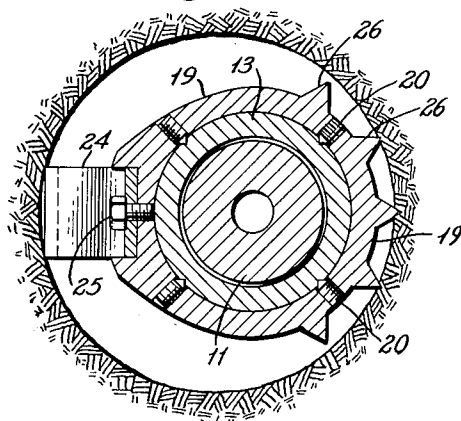


Fig. 4.

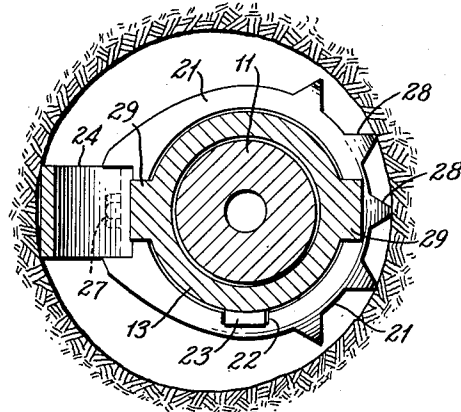


Fig. 5.

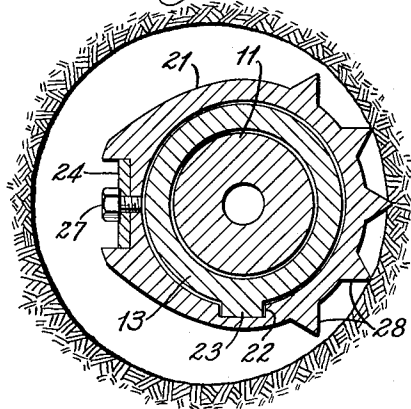
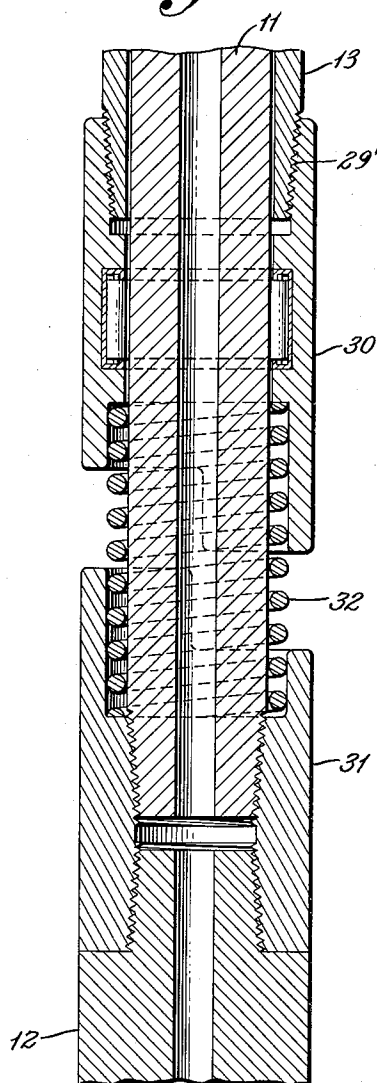


Fig. 6.



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APPARATUS FOR DRILLING WELLS WITH ORIENTED CURVED BORES OF LARGE RADII

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4 Claims. (Cl. 255—1.6)

The present invention relates to a method and apparatus for drilling oil wells with oriented curved bores of large radii. It is the purpose and object of the invention to provide a method and apparatus by which oriented curved bores of large radii may be effectively drilled with but one round-trip of the drilling equipment.

The need for the drilling of deflecting bores, having as their purpose the recovery of oil from points in a producing formation horizontally spaced a substantial distance from the point of initiation of the vertical well bore, has become increasingly pronounced with attempts to recover oil, for example from under water formations. Indeed there are many instances where real need for the drilling of a deflecting bore in a given azimuth is apparent.

It is the purpose and object of the present invention to provide a method and apparatus by which such a deflecting bore may be produced through conventional rotary drilling technique as a direct continuation of an initiated vertical well bore.

The present invention is not concerned with the production of curved deviating bores of small radii, such as drain holes drilled directly from a vertical well bore laterally into the producing formation, but is rather concerned with the production of a deflecting bore as a continuation of an initially straight well bore, in the original drilling of which the bore is deflected in a curved path of large radius of the order of 1,000 to 2,000 feet.

In the prior art practice of drilling deflecting bores, the expedient of using whipstocks has been largely resorted to. Generally speaking, the tubular drill strings employed in rotary drilling have sufficient inherent flexibility to permit of their deviation from the vertical in an amount approximating about three degrees per hundred feet of length of drilling string. Again speaking generally, whipstocks set in a vertical well bore for the purpose of causing a deflection of the drill bit usually contemplate a deflection from the vertical of from around three degrees to five degrees. In practice it has been found that when drilling a deflecting bore through the medium of the whipstock, the drill string, after it passes the whipstock, tends to follow the path of least resistance and return to a straight line under the influence of gravity. Because of this inherent tendency of the rotary drill string to follow the path of least resistance it has been the prior art practice in the drilling of deflecting bores through the use of whipstocks to drill a limited distance beyond the point of setting of a given whipstock; to then withdraw the drill string and bit from the well bore and set another whipstock at the lower depth to which the deflecting bore had been drilled, this procedure being repeated throughout the drilling of the deflecting bore. Such practice has entailed the necessity for a complete round-trip each time a whipstock is set. Each round-trip and each setting of the whipstock entails hazards that, quite apart from the sheer loss of time involved, render the drilling of deflecting bores of large radii very costly.

It is the purpose and object of the present invention to provide a greatly simplified method and apparatus for

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the drilling of deflecting bores of large radii through the medium of which it is possible to completely eliminate the use of whipstocks and complete the drilling of the deflecting bore, or even a series of deflecting bores, on one round-trip of the drilling equipment.

More specifically it is the purpose and object of the invention to provide a method and apparatus for initiating and continuing the drilling of a deflecting bore, at substantially the same fixed radius, sufficiently large to lie within the limits of inherent flexibility of the conventional rotary drill string.

From an apparatus stand-point, the purpose and object of the invention is to provide a unit suspendable from the lower end of a rotary drill string susceptible of manipulation in such a manner as to effect the initiation and continued drilling of a curved deflecting bore of large radius without the use of other elements or instrumentalities than those suspended from and carried by and insertable into the well bore through the medium of a conventional rotary drill string.

By the expression "curved bores of large radii" as employed in this application, it is intended to identify and define degrees of curvature attainable through the inherent flexibility of a normal rotary drill string. Generally speaking, the radii of deflecting bores, in the drilling of which the present invention is addressed, lie within the limits of 1,000 to 3,000 feet. The further purposes and objects of the invention will become apparent as the description proceeds which will be given in connection with the accompanying drawings forming a part hereof, and in which:

Figure 1 is a fragmentary view and side elevation with parts broken away and illustrating a position of a drilling unit suitable for practicing the method and exemplifying the apparatus of the present invention.

Figure 2 is a detailed cross-sectional view illustrating the manner in which the deflecting force is applied to the drilling unit.

Figure 3 is a detailed cross-sectional view taken on the line 3—3 of Figure 2.

Figure 4 is a detailed cross-sectional view taken on the line 4—4 of Figure 2.

Figure 5 is a detailed cross-sectional view taken on the line 5—5 of Figure 2.

Figure 6 is a detailed cross-sectional view through the clutch mechanism illustrating operational features of the apparatus, and

Figure 7 is a detailed cross-sectional view illustrating the manner in which the drilling unit may be suspended from a conventional rotary drill string.

Referring to Figure 1, a conventional hollow rotary drill string is indicated at 10 which is adapted to extend to the surface of the well and be rotated by the conventional rotary equipment. Drilling fluid is adapted to be passed down and through the drill string 10 from the lower end of which is suspended a unit assembly embracing an inner tubular rotary drive member 11 which carries the bit 12 at its lower end so that rotation of the rotary drill string 10 and the rotary tubular drive member 11 will effect a positive rotation of the bit 12. Surrounding the rotary drive member 11 is an elongated sleeve 13, the upper end of which is threadably engaged at 14 in a collar 15 carrying anti-friction means 16 for facilitating free rotation of the tubular drive member 11 within the sleeve 13 (see Fig. 7). Adjacent the upper end of the sleeve 13 there is provided a collar 17 having ribs 18. This collar 17 is rigidly secured to the sleeve 13 and acts to center the same in the well bore.

The collar 17 in reality acts as a fulcrum about which the portions of the unit below the collar 17 could normally be moved.

At a point intermediate the collar 17 and the bit 12,

there is provided an anchoring collar 19 fixedly held on the outer sleeve 13 by the set screws 20 (see Fig. 3). Spaced below anchoring collar 19, a slidable collar 21 having the keyway 22 for accommodating the key 23, is mounted for relative vertical movement on the exterior of the sleeve 13 (see Fig. 4). A heavy leaf-spring 24 adapted to exert a predetermined lateral force on the drill unit has its upper end secured as indicated at 25 to the anchor collar 19 opposite the gripping teeth 26 thereof. The lower end of the leaf-spring 24 is secured as indicated at 27 to the slidable collar 21 opposite the gripping teeth 28 thereof. Stop members 29 are carried by the sleeve 13 to limit the upper movement of the slidable collar 21 on the sleeve 13. Secured to the lower end of the sleeve 13 by the threaded connections 29' is the upper member 30 of the two-member clutch, the lower member 31 of which is secured to and carried by the inner rotary drive member 11. The spring 32 normally urges the clutch members 30 and 31 toward disengaged position. When however an upward pull is exerted on the rotary drill string 10, the frictional resistance offered by the collar 17 and the spring 24 engaged with the well bore wall and the weight of attendant mountings carried by the outer sleeve 13, will hold the sleeve 13, permitting limited vertical movement of the inner drive member 11 and engagement of the clutch members 30 and 31 to permit concurrent rotation of the inner drive member 11 and the sleeve 13 to facilitate orientation of the sleeve 13 and insure deflection of the bit 12 in a desired azimuth. It will be appreciated that as the drilling of the deflecting bore continues the spring 24 tends to force the collars 19 and 21 toward the side of the bore of smallest radius. When the teeth 26 and 28 of collars 19 and 21 are pressed against the wall of the deflecting bore the degree of deflection will become stable and the bore will continue with substantially the same radius. The spring 24 continues to maintain proper friction between the collars 19, 21 and the wall of the well bore whereby the member 13 is held against rotation as it advances into the bore. Only the closing of the clutch members 30 and 31 with forced rotation of member 13 will vary the azimuth of the deflecting bore. It will also be appreciated that the weight of the sleeve 13 and parts carried thereby is normally sufficiently in excess of the frictional resistance or drag created by spring 24 and the ribs on collars 17, 19 and 21 engaging with the well bore such that the sleeve will normally move along with the drill collar 11 and drill bit 12.

By reference to Fig. 1, it will be observed that the drilling unit has three points of contact with the well bore. Point A being the contact of the upper collar 17 with the well bore; point B being the contact of the drill bit 12 with the well bore; and point C being the contact of the spring 24 with the well bore. The bit 12 rotates and its sharp teeth cut sidewardly into the well bore under the force supplied through the medium of the spring 24. Thus after a few rotations of the drill string with the parts in the position shown in Fig. 1, the bit initiates the drilling sidewardly under the force of the spring 24. The bit is lowered simultaneously with this sideward drilling tendency with the result that there is initiated the drilling of a curved bore of large radius determined by the three-point contact of the unit with the well bore. In the illustrated embodiment the distance between points A and B is approximately 14 feet. The total pressure applied by the spring 24 through its area of engagement with the well bore wall is of the order of from 100 lbs. to 1,000 lbs. With this construction a deflecting bore having a radius of curvature of about 1,900 feet can be produced and the complete deflecting bore drilled on one round-trip of the drilling unit into and out of the well.

It will be understood that the effective pressure applied to the bit will depend somewhat on the relative location of the points A, B, and C, and that by the variation of the relationship of the points A, B, and C, and the degree of pressure applied by the spring 24 at the point C, the

degree of deflection of the bit can be quite accurately controlled within the limits of elasticity of the rotary drill string 10.

While the invention is primarily intended to effect the drilling of a deflecting bore as a continuation of an initiated vertical bore, it is possible to take off from a vertical bore that has been previously drilled with a deflecting bore in a predetermined azimuth. Indeed it is even possible to drill a second deflecting bore after a first bore in a given azimuth has been drilled. A slight upward pull on the drill string 10 with limited partial rotation will effect engagement of the clutch members 30 and 31, following which the unit may be oriented to a new azimuth.

Having thus described my invention, what I claim is:

1. Apparatus for controlling the direction and extent of deviation of a well bore by the rotary drilling method comprising an elongated relatively inflexible tubular section, an elongated drill collar rotatably mounted in said tubular section, a drill bit carried at the lower end of and rotatable with said drill collar, means at the upper end of said drill collar for connecting same to the lower end of a rotary drill string for rotation therewith, a collar rigidly secured to said tubular section and having outwardly projecting ribs engageable with the well bore wall to provide a fulcrum about which said tubular section can pivot, and well bore engaging deflecting means carried by said tubular section at a point spaced from said collar acting to urge said inflexible tubular section and said drill bit to pivot about said collar in a predetermined radial direction.

2. Apparatus as recited in claim 1 wherein said collar is mounted at the upper end of said tubular section, and said well bore engaging deflecting means is carried by said tubular section at a point spaced below said collar.

3. Apparatus for controlling the direction and extent of deviation of a well bore by the rotary drilling method comprising an elongated relatively inflexible tubular section, an elongated drill collar rotatably mounted in said tubular section and capable of limited longitudinal movement relative to said tubular section, interengaging clutch elements carried by said tubular section and said drill collar respectively, means normally holding said clutch elements in disengaged position while permitting engagement of said clutch elements upon limited longitudinal movement of said drill collar within said tubular section, a drill bit carried at the lower end of and rotatable with said drill collar, means at the upper end of said drill collar for connecting same to the lower end of a rotary drill string for rotation therewith and whereby said drill collar may be moved longitudinally relative to said tubular section by lifting of the drill string for engagement of said clutch elements, a collar rigidly secured to said tubular section and having outwardly projecting ribs engageable with the well bore wall to provide a fulcrum about which said tubular section can pivot, and well bore engaging deflecting means carried by said tubular section at a point spaced from said collar acting to urge said inflexible tubular section and said drill bit to pivot about said collar in a predetermined radial direction.

4. Apparatus as recited in claim 3 wherein said collar is mounted at the upper end of said tubular section and said well bore engaging deflecting means includes a wall engaging spring carried by said tubular section at a point intermediate the ends of said tubular section.

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