

Sept. 8, 1953

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2,651,499

STABILIZED APPARATUS FOR DRILLING CURVED BORES
DEVIATING FROM EXISTING VERTICAL WELL BORES

Filed July 18, 1951

2 Sheets-Sheet 1

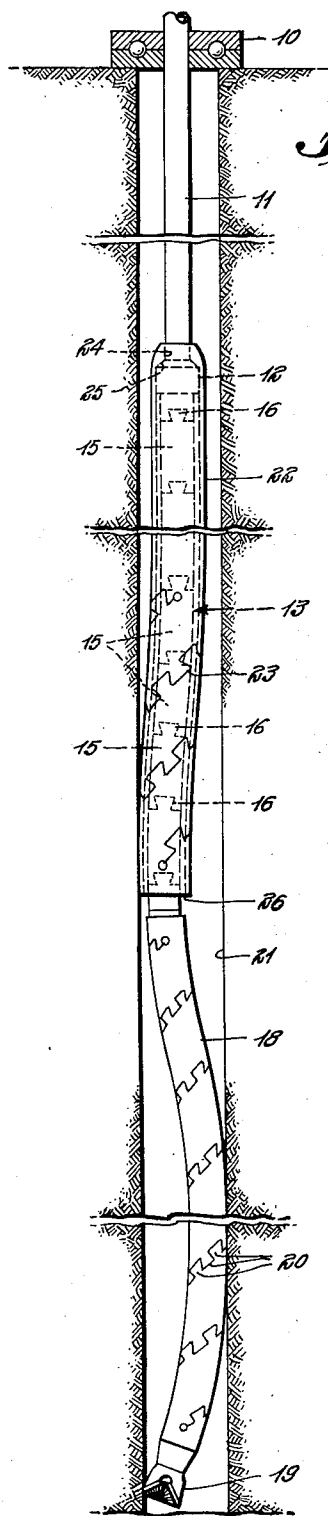


Fig. 1.

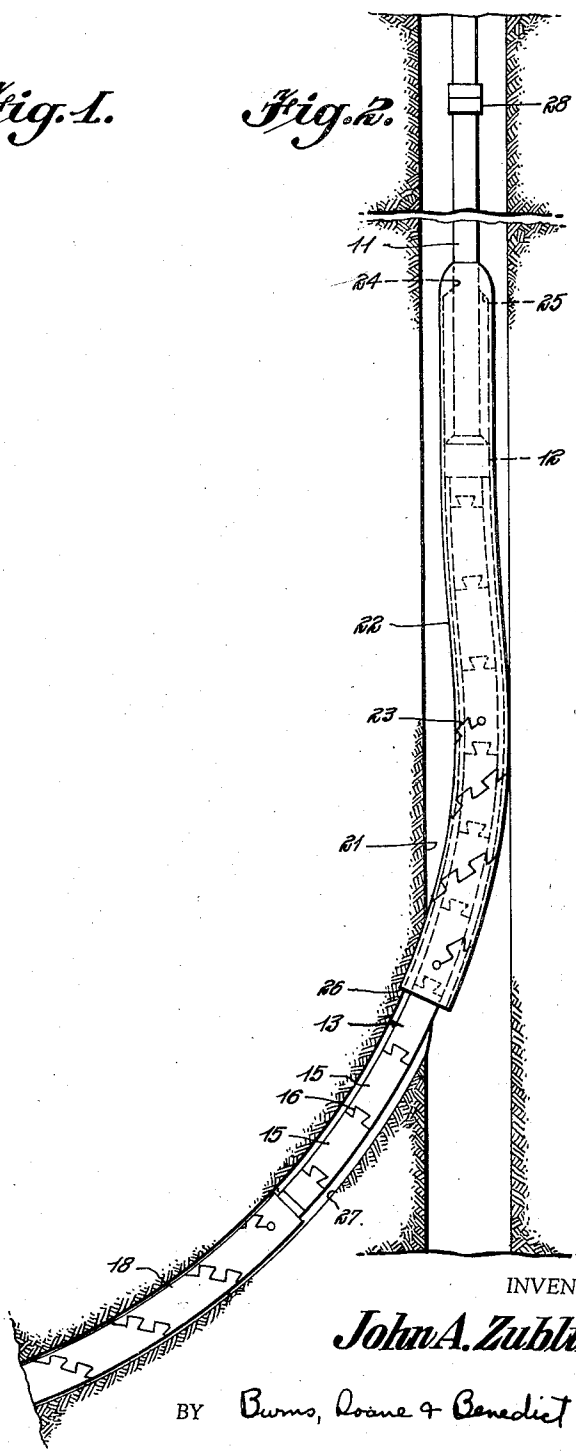


Fig. 2.

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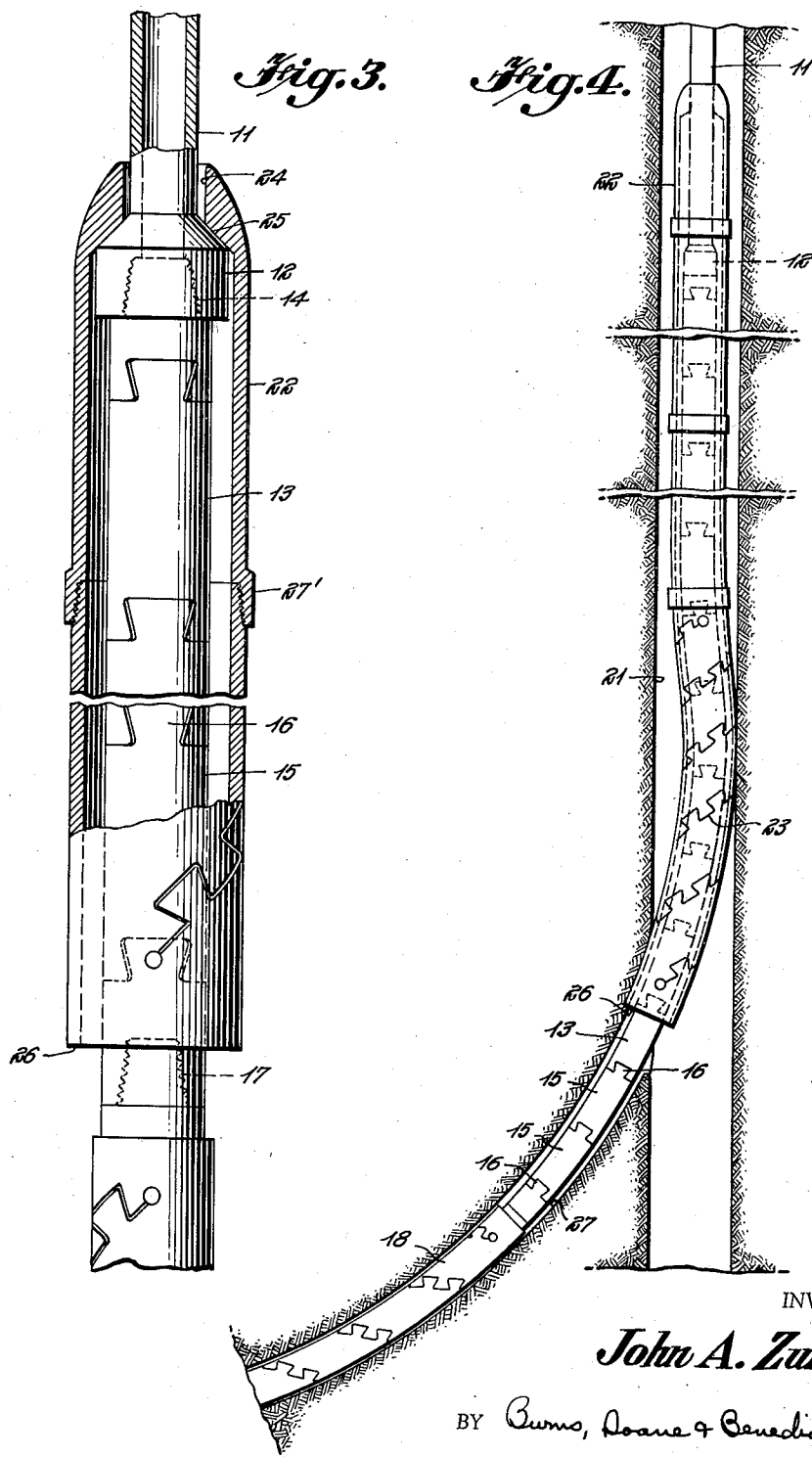
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UNITED STATES PATENT OFFICE

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STABILIZED APPARATUS FOR DRILLING
CURVED BORES DEVIATING FROM EX-
ISTING VERTICAL WELL BORES

John A. Zublin, Los Angeles, Calif.

Application July 18, 1951, Serial No. 237,406

4 Claims. (Cl. 255—1.6)

1

This invention relates to improved, stabilized apparatus for drilling curved bores deviating from existing vertical well bores and has for its object the provision of apparatus embodying means for stabilizing the same against unwanted and objectionable deformation when in use.

The drilling of curved bores into the producing formations of oil wells extending thereinto from the existing vertical well bore and apparatus for effecting the drilling of such deviating bores have been the subject matter of a number of prior patents issued to me and of applications filed by me.

One advantageous form of apparatus for use in the drilling of curved bores deviating from existing vertical well bores embraces a helically dovetail slotted, normally curved, flexible, resilient drill guide, a flexible, nonresilient, sectional, metallic, tubular drive member extending through and rotatable within the helically slotted, normally curved, flexible, resilient drill guide, the said flexible nonresilient drive member projecting upwardly from the normally curved drill guide for a distance adequate to insure the drilling of a curved bore of the desired length. The flexible nonresilient drive member is connected at its upper end to a substantially rigid, tubular drill string that extends to the top of the well to be driven by the usual rotary drilling mechanism. The flexible nonresilient drive member carries for rotation therewith a drill bit at its lower or free end.

In the operation of the deviating bore drilling apparatus just above briefly described, there is often a substantial length that is from 40 to 80 feet or more of nonresilient flexible, sectional, metallic drill pipe disposed above the normally curved, helically slotted, resilient, flexible drill guide at the time drilling of a deviating bore from the existing well bore is initiated. It has been found that when the drilling of a deviating bore is initiated through the employment of such apparatus and excessive weight, due to inadvertence or otherwise, is imposed on the drill string at the surface of the well, there is a tendency for the flexible nonresilient drill pipe sections of the drive member to buckle in the vertical well bore above the normally curved, flexible, helically slotted, resilient drill guide. When such buckling of the flexible nonresilient drive member occurs, the elbow produced by the joints thereof is brought into contact with the wall of the vertical bore and, as the drill pipe is rotated, digs into the formation, forming what has come to be known as a key-seated cutout. When the key-

2

seated cutout is deepened, the more pressure put on the drill string the worse the situation becomes and will sometimes result in breaking the flexible driving member which, because of its hardened surface and peculiar position, is very difficult to fish from the well.

It is the specific purpose and object of the present invention to obviate the objections and difficulties hereinbefore recited by embodying a stabilizing element in the drilling apparatus. Further and more specific purposes and objects of the invention will become apparent as the description proceeds which will be made by reference to the accompanying drawings forming a part hereof and wherein

Figure 1 is a view in side elevation of the drilling apparatus of the invention showing the position of the same in an existing vertical well bore ready to initiate the drilling of a curved, deviating bore.

Figure 2 is a fragmentary, detailed view disclosing the relationship of parts of the apparatus after the drilling of the curved bore has been initiated.

Figure 3 is a detailed view, partly in section, illustrating the relation of the stabilizer member to the associated elements of the apparatus, and

Figure 4 is a view similar to Figure 2 disclosing a sectional stabilizer construction applicable to the drilling of long, curved, deviating bores.

Referring to Figure 1, a conventional rotary drill table is diagrammatically illustrated at 10 and the normally rigid drill string section 11 extends downwardly from the surface of the well. It will be understood that the drill string 11 is of conventional form made up of sections of steel pipe and may well be several thousands of feet in length. The lower section of the tubular drill string 11 may suitably be provided with an annular enlargement 12 (see Figure 3). The upper end of the flexible nonresilient drill string drive member indicated generally at 13 is adapted to be threadedly connected to the annular enlargement 12 of the rigid drill string 11 as indicated at 14 in Figure 3. The flexible nonresilient drive member is preferably constructed in accordance with the teachings of my Patent 2,515,366 and is made up of the individual sections 15 having the intermeshing dovetailed teeth 16. It will be appreciated that where a very long deviating bore is desired the flexible nonresilient drive member 13 may be made up of a plurality of sectional units much the same as the normally rigid, tubular drill string is made up. Such sections are adapted to be interconnected by threaded joints

such as indicated at 17 (Figure 3). The lowermost portion of the flexible nonresilient drive member 13 projects downwardly through and is rotatable within the normally curved, flexible, resilient, drill guide 18, the bit 19 being carried at the extreme lower end of the flexible nonresilient drive member 13 and is mounted for rotation therewith. Thus, when the normally rigid drill string 11 and the flexible nonresilient drive member 13 are rotated from the rotary table 10 at the surface of the well the bit 19 will be positively driven. The normally curved, flexible, resilient, helically slotted drill guide 18 is preferably constructed pursuant to the teachings of my United States Patent 2,515,365, there being provided intermeshing dovetailed teeth 20 along the helical slot of this drill guide.

The drill guide 18 may desirably have a curvature in completely unstressed configuration of a radius of about 16 feet with the pitch of the spiral being about nine inches for a four and one-half inch diameter drill pipe. The drill guide 18 is adapted to be forcibly flexed to less than its normal curvature to permit of its introduction into the vertical well bore indicated at 21, the forcible flexing of the drill guide 18 to this lesser curvature being adequate to store sufficient potential energy therein to force the guide and the rotating drill bit 19 from the existing bore in the desired oriented direction, similar to the method set forth in some detail in my United States Patent 2,336,338.

While the equipment thus far described in this specification is highly effective for the drilling of curved bores deviating from existing vertical well bores in many types of formation, caution must be employed in the handling of the apparatus so as to avoid imposition of too great weight on the drill bit. In the practical operation of rotary drilling equipment, however, oftentimes through inadvertence, miscalculation or otherwise, greater weight is imposed on the drill bit than can be accommodated by previously described apparatus with the result that the flexible nonresilient drive member 13 is caused to buckle at one or more of its joints formed by the intermeshing dovetailed teeth 16. Such buckling creates a rather sharp angle with the hardened edges of the adjacent sections constituting real cutting or shearing instrumentalities which bite into and cut out a V-shaped groove in the formation which tends to lock the apparatus against further downward movement and presents so much friction to the rotation of the apparatus as to sometimes result in the severance thereof through twisting off or breaking of some of the intermeshing dovetailed teeth 16 of the flexible drive member 13. To obviate this buckling action I have, pursuant to the present invention, encased the flexible nonresilient drive member for that portion thereof which projects above the normally curved resilient drill guide 18 with a stabilizer tube 22, the lower end of which may desirably be helically slotted as indicated at 23 to give adequate flexibility thereto to permit the same to assume the necessary position in the vertical bore to facilitate the free movement of the remaining portions of the apparatus into the deviating bore. The upper end of the encasing stabilizer tube 22 is preferably swaged or otherwise formed with an opening 24 of considerably smaller diameter than the inside diameter of the main portion of the stabilizer tube 22 to thus provide the annular shoulder 25 which is adapted to engage the upper face of the enlarged portion

12 at the lower end of the normally rigid, tubular drill string 11. It will be understood that the drill string 11 is free to move downwardly through the opening 24 in the stabilizing tubular member 22. When, however, the drill string 11 is drawn upwardly the enlarged portion 12 engages the shoulder 25 and the tubular stabilizer member 22 will be drawn upwardly with the apparatus.

It will be noted that the exterior diameter of tubular stabilizer member 22 is substantially greater than the exterior diameter of the normally curved, resilient drill guide 18 as more particularly indicated at the lower end 26 of the tubular stabilizer member 22. The arrangement is such that when the bit 19 and the normally curved, resilient drill guide 18 have passed into a deviating bore such as 27 (Figure 2) the shoulder 26 of the tubular stabilizer member 22 is adapted to lodge against the formation at the point of juncture of the deviating curved bore 27 with the vertical bore 21. Because the curved bore 27 is of less diameter than the exterior diameter of the tubular stabilizer member 22, the latter will not pass into the curved deviating bore 27 but will be held in the position substantially shown in Figure 2. The normally rigid, tubular drill string 11 will pass down through the opening 24 and the flexible nonresilient drive member 13 will be fed downwardly through the tubular stabilizer member 22, the curved lower end of which may assume substantially the configuration shown in Figure 2, allowing the flexible nonresilient drive member 13 to advance into the curved bore while the lower end thereof rotates within the normally curved, flexible, resilient drill guide 18. The tubular stabilizer member 22 functions to prevent unwanted buckling of the flexible drive member 13 and maintains the latter in substantially straight form in the vertical bore while facilitating ease of rotation thereof.

If desired, antifricition means may be interposed between the tubular stabilizer member 22 and the flexible drive member 13 to further facilitate ease of rotation thereof.

Inasmuch as the curved bore 27 is of much less diameter than the vertical bore 21 of the existing well, no objectionable buckling of the flexible nonresilient drive member 13 can occur in the curved bore since the walls of the latter serve in and of themselves to stabilize the flexible drive member.

If desired, the tubular stabilizer member 22 may be made up of several sections interconnected as indicated at 27' in Figure 3. In Figure 4 the stabilizer member 22 is illustrated as made up of a series of interconnected sections only the lower one of which is provided with a helical slot 23 to give the necessary flexibility thereto. An enlarged stop ring 28 which may take the form of a pipe coupling is desirably positioned in the drill string 11 a distance above the annular enlargement 12 approximately equal to the over-all length of the flexible drive member 13. The stop ring 28 thus functions to limit upward movement of the tubular stabilizer member 22. Normally, the weight of the tubular stabilizer member 22 will be adequate to keep the same in its lowermost position during insertion of the apparatus into a well bore, that is, with the shoulder 25 in engagement with the enlarged portion 12. If, for any reason such as contact with the wall of a crooked well bore, the tubular stabilizer member 22 is temporarily pulled upwardly on the drill string 11 its upward movement will be limited by the stop ring 28

and as soon as the frictional contact with any irregularity in the vertical bore has been passed, the weight of the member 22 will again return it to its normal position with the shoulder 25 in engagement with the enlarged portion 12. In this way it is possible to stabilize a very substantial length of flexible nonresilient drive section of the apparatus against undesired buckling under all conditions of operation.

Having thus described my invention, what I claim is:

1. An apparatus for drilling curved deviating bores from existing vertical well bores comprising a combination unit adapted to be suspended from the lower end of a conventional rotary drill string, said unit embracing a flexible sectional metallic tubular nonresilient drive member, means for connecting the upper end of said drive member to the lower end of a rotary drill string to rotate in unison therewith, a drill bit carried at the lower end of said drive member for rotation thereby, a normally curved flexible resilient helically slotted metallic tubular drill guide surrounding a substantial portion of said drive member extending immediately above said drill bit and a separate tubular stabilizer member surrounding a further portion of said drive member and extending for a substantial distance above said drill guide, said drill guide being free to advance with said bit upon projection of said drive member through said stabilizer member.

2. An apparatus for drilling curved deviating bores from existing vertical well bores comprising a combination unit adapted to be suspended from the lower end of a conventional rotary drill string, said unit embracing a flexible sectional metallic tubular nonresilient drive member, means for connecting the upper end of said drive member to the lower end of a rotary drill string to rotate in unison therewith, a drill bit carried at the lower end of said drive member for rotation thereby, a normally curved flexible resilient helically slotted metallic tubular drill guide surrounding a substantial portion of said drive member extending immediately above said drill bit, a separate tubular stabilizer member surrounding a further portion of said drive member and extending for a substantial distance above said drill guide, the inner diameter of said tubular stabilizer member being larger than the exterior diameter of said drive member to permit free rotation and longitudinal movement of said drive member therein, the exterior diameter of said stabilizer member being greater than the exterior diameter of said drill guide to preclude entry of said stabilizer member into a curved deviating bore drilled by the apparatus, said drill guide being free to advance with said bit upon projection of said drive member through said stabilizer member.

3. An apparatus for drilling curved deviating bores from existing vertical well bores comprising a combination unit adapted to be suspended from the lower end of a conventional rotary drill

string, said unit embracing a flexible sectional metallic tubular nonresilient drive member, means for connecting the upper end of said drive member to the lower end of a rotary drill string to rotate in unison therewith, a drill bit carried at the lower end of said drive member for rotation thereby, a normally curved flexible resilient helically slotted metallic tubular drill guide surrounding a substantial portion of said drive member extending immediately above said drill bit, a separate tubular stabilizer member having an upper relatively rigid section and a lower relatively flexible section surrounding a further portion of said drive member and extending for a substantial distance above said drill guide, the inner diameter of said tubular stabilizer member being larger than the exterior diameter of said drive member to permit free rotation and longitudinal movement of said drive member therein, the exterior diameter of said stabilizer member being greater than the exterior diameter of said drill guide to preclude entry of said stabilizer member into a curved deviating bore drilled by the apparatus, said drill guide being free to advance with said bit upon projection of said drive member through said stabilizer member.

4. An apparatus for drilling curved deviating bores from existing vertical well bores comprising a normally curved flexible resilient helically slotted drill guide, a flexible nonresilient tubular drive member rotatable within and extending a substantial distance above said normally curved resilient drill guide, a drill bit carried at the lower end of said flexible nonresilient tubular drive member, means for connecting the upper end of said flexible tubular drive member to the lower end of a substantially rigid rotatable drill string, a tubular stabilizer member surrounding a portion of the flexible nonresilient tubular drive member above said normally curved resilient drill guide, said tubular stabilizer member being constructed to permit projection of the flexible nonresilient drive member downwardly therethrough, the exterior diameter of said tubular stabilizer member being substantially greater than the exterior diameter of the said normally curved drill guide to provide a shoulder at the lower end of said tubular stabilizer member adapted to prevent entry of said stabilizer member into a curved deviating bore drilled by the apparatus, said drill guide being free to advance with said bit upon projection of said drive member through said stabilizer member.

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