Joint Structure Between Flexible Shafting and Drill Bit Structure for Drilling Lateral Bore
JOINT STRUCTURE BETWEEN FLEXIBLE SHAFTING AND DRILL BIT STRUCTURE FOR DRILLING LATERAL BORES

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Application January 21, 1952, Serial No. 267,401

2 Claims. (Cl. 255—1.6)

This invention relates to the drilling of bores in the earth and more particularly to the drilling of so-called lateral bores from main bores of oil wells to increase oil production and for other purposes, which lateral bores will generally be at a high angle to the main bore.

One of the objects of my invention is to provide in lateral bore drilling apparatus, universal joint means between the drill bit and tubular drill pipe in order to permit the bit to be deflected off from the main bore without being lost and to be still in a possible position to drill lateral bores in such a manner as to continue to build angle, notwithstanding the lateral bore being directed or otherwise controlled by the angular deflecting surface of the deflecting tool.

A further object is to produce a universal joint means in lateral bore drilling apparatus which will permit circulation of fluid to the drilling bit, which will be simple and rugged in construction, and further which will have such relation in size and position with respect to the drilling bit that the drilling bit will continue to drill in the desired lateral direction after being started in a lateral direction by a deflecting tool positioned in a main well.

A still further object is to produce an improved drilling apparatus for use with a deflecting tool in a main well bore to thereby drill a lateral bore therefrom and wherein said apparatus embodies a combination involving a drilling bit, and a flexible drill pipe together with a universal joint interposed therebetween and associated therewith in a particular manner.

One further object of my invention will become apparent from the following description taken in connection with the accompanying drawings in which:

Figure 1 is a longitudinal cross sectional view of deflecting apparatus embodying my invention and being shown associated with a deflecting tool and conditioned for placing in a main well prior to the beginning of drilling operations to make a lateral bore;

Figure 2 is an enlarged longitudinal sectional view showing details of the universal joint;

Figure 3 is a view showing the bit being deflected off the angular surface of the deflecting tool shortly after the beginning of drilling operations; and

Figure 4 is a view showing the drilling apparatus drilling the lateral bore at a point remote from the deflecting tool and illustrating the bit is forced to "build" angle as drilling continues.

Referring to the drawings in detail and first to Figure 1, there is shown a drilling structure for drilling lateral bores from a main well bore, which structure embodies my invention. The purpose of lateral bores is to increase oil production from oil bearing strata into which the main well bore has been drilled. These lateral bores may be drilled after the main bore is drilled into the oil bearing strata, or they may be drilled off from the main bore at some later date after the main bore has been drilled so that this so-called "old" well may be employed to obtain the additional recovery of oil from the oil bearing strata or oil bearing formation. The lateral bores may be drilled off from the main bore at or near a single depth of the main bore for they may be drilled at different depths along the main bore and the direction therefrom may be at various points of the compass. The lateral bores have a high angle with respect to the axis of the main bore in order that they may enter into the oil bearing formation and reach points a considerable distance in a general lateral direction from the main bore.

As shown in Figure 1, there is provided a deflecting tool D which has a tubular upper end 10 and a window 11 at its lower end. Mounted in the lower end of the tubular member opposite the window is a plug or a obturator 12 provided with a surface 13 angularly positioned with respect to the axis of the deflecting tool, which surface is ordinarily called the deflecting surface, said surface being opposite the window 11 so that the tool may be deflected toward a direction which is at an angle to the axis of the tubular part of the deflecting tool. At the lower end of the deflecting tool there is secured thereto a so-called tail pipe 14 having at its lower end, the purpose of which will be to anchor the deflecting tool D in the main bore and at the desired distance above the bottom of the main bore. The length of the tail pipe will be selected so that when the anchor member 15 is on the bottom of the main bore the deflecting surface 13 will be at the point in the main bore where it is desired to begin drilling off the lateral bore.

The deflecting apparatus in which I have embodied my invention for use with the deflecting tool to accomplish the efficient drilling of a lateral drain hole comprises several structures and these are all attached to the lower end of the usual drill pipe P. Among these structures are the flexible shaft S, the universal joint J, a reamer B and a drill bit D, as illustrated in Figure 1 and connected together as shown. The use of the reamer B as part of the drilling apparatus does not constitute a combination part of my invention and may or may not be employed, as desired. The combination of reamer with a universal joint as part of the drilling structure is the separate invention of Eric L. Sanders and is covered by co-pending application Serial No. 267,377, filed January 21, 1952, for "Reaming Bit Structure for Oil Bore." The flexible shafting S may be of any suitable construction which will permit the shaft to follow a drill bit into a lateral hole which is being drilled off from the main bore and yet be capable of transmitting torque to the drill bit. The particular shaft shown comprises a number of tubular sections 16 joined together by means of inter-engaging lobes and sockets. One end of each section will have, for example, a number of sockets 17 and the other end of each section will have a corresponding number of lobes 18. In order that the various sections may be properly connected together in a permanent manner, all the sections comprising the flexible shafting may be constructed from a single piece of suitable drill pipe which will be cut through by a cutting torch at different points along its length. If it is desired to have the sections of a length, say eight inches, then the pipe which is going to be cut to form the flexible shafting will be cut completely around circumferentially at every eight inches along its length. The cut accomplished by the cutting torch will be such as to produce the sockets and the received lobes at adjacent ends of the sections 16 in inter-engaging relation. The direction of cutting of the torch will always be toward the axis of the tube and at right angles to said axis. Thus, the sockets and lobes will have such a configuration that it will be impossible for the sections produced to become disengaged from each other, yet each section is capable of a limited movement in any direction with respect to its adjacent section, either above or below. For any drill pipe which is cut to produce the flexible shaft S, the upper end thereof will have a suitable threaded socket and the lower end will have a suitable threaded extension so that these flexible shafting lengths can be connected together as desired, or to the usual drill pipe or old well known manner. The length of the flexible shafting S may vary as desired, but it should be long enough to allow for the drilling of the desired length of lateral bore.

The joint J which is a primitive form of universal is mounted in the drilling structure at the lower end of the flexible shaft S and forms a connecting joint between said shafting and the drill bit B, together with the reamer which is connected at the reamer B. The joint J provides a universal connection and is so constructed that drilling torque can be transferred from the flexible shafting to the drill bit to accomplish drilling operations. One form of universal 13 at whatever point can be used is shown in detail in Figure 2. Referring now
to this figure, it will be seen there is a member 19 having a bore 20 so constructed that adjacent its upper end is passed a spherical surface 21 from which the remainder of the bore is flared upwardly, as indicated at 22. The lower end of the bore is provided with internal threads 23. Positioned in the member 19 is a member 24 provided with a ball 25 at one end and having a blank portion 26 provided with external threads 27 adjacent its end. The ball portion of the member 24 is arranged to be received in the bore 20 of the member 19 and connected thereto by the spherical surface 21 and the shank extends on through the flared part of the bore. In order that the ball 25 will be held in the member 19, there is provided a third member 28 having a reduced portion 29 provided with internal threads 30. The end of the reduced portion is formed with a semi-spherical recess 31. Thus, by threading the reduced portion 29 into the internally threaded section of the bore 20, the end recess 31 will be brought into engagement with the ball and thus hold it in position and yet permit the ball to have limited movement in any direction in the member 19. The lower end of the member 25 will be provided with an internally threaded socket 32 so that the joint can have connected thereto the externally threaded end 33 of the reamer bit if such is chosen to be used.

It is desired that the joint be so constructed as to permit fluid to circulate therethrough and to accomplish this the member 28 will have an axial passage 37 and the member 24 carrying the ball will have an axial passage 38. The lower end of this passage 38 is flared adjacent the ball surface so that upon movement of the ball to any position there will always be a direct connection with the passage 37.

To attach the upper end of the joint structure to the lower end of the flexible shafting 8 there is provided a sub 39 having a passage therethrough. The threaded extension on the member 26 is screwed into the sub as shown in Figure 1.

The drill bit B, already referred to, may be of any suitable construction such as the rock type having rotary cutting members as shown. The reamer bit, which is located directly behind the drilling bit, has its lower end connected to the member 25 of the joint by an end portion 40 of the universal joint, as already mentioned. The reamer bit thus follows the drilling bit as it cuts the lateral bore and reams out the cut bore.

The universal joint I, when assembled in the drilling structure shown, must have a specific relationship with respect to the drilling bit B and this specific relationship is one of diameter and further one of distance at which the pivotal axis of the joint is situated with respect to the drilling end of the drill bit. The diameter of the joint, that is, the diameter of the members 19 and 28 of the joint, must be less than the diameter of the bore with which it is to be used by the drilling bit and if a reamer bit having the same diameter, a joint I having a diameter of four and one-fourth inches and a flexible drilling shaft having a diameter of four and one-fourth inches. This structure a whipstock having a nine degree deflecting angle is employed. The joint is so fashioned that the distance from the face of the drill bit B to the center of the joint is fourteen and one-half inches. The radius of curvature of a lateral bore drilled with the example structure is approximately thirty-nine and one-twelfth inches.

Before inserting the lateral bore drilling structure just described into the well bore to perform the drilling of the lateral bore, the deflecting tool will be connected to the drilling bit and flexible shafting of the example structure as shown in Figure 1. The deflection tool will be positioned in the joint J. The position of the pin will be such as to hold the bit B slightly above the deflecting surface of the deflecting tool, as shown in Figure 1. With this connection, the deflecting tool will be placed at the bottom of the main bore so that the anchor 15 will rest on and press into the bottom of said bore. The distance that the deflecting tool is above this bottom will depend upon the length of the tail pipe 14 to produce the lateral bore. Between the inner ends of the pins and the seats there will be provided pivot plugs 36 which are pivotally mounted on the pins and slidably in the slots. The slots are of sufficient length to permit the use of the pivotl plug movement of the ball.

Drilling operations can now be commenced and these are begun by first applying a downward pressure on the drill pipe P, which will result in severing the frangible pin 40 and disconnection of the lateral bore drilling structure from the deflecting tool. As the drill pipe P is rotated, the drill bit will also be rotated, and upon continued lowering of the drill pipe the drill bit will be deflected by the deflecting surface 13 through the window of the deflecting tool and the drilling bit will then begin to cut a hole off from the side of the main bore and in a direction as determined by the angle of the deflecting surface. The beginning of the cutting of the lateral bore from the main bore is shown in Figure 3, wherein the frangible pin is disclosed as being severed and the bit lowered to the position where it is being deflected by the deflecting surface. Due to the fact that the diameter of the members of the joint is less than the drill bit, the joint, when acted upon by downward forces present during drilling, will be pushed out of the land of the deflecting tool. Consequently, this tendency of the joint to move toward the deflecting surface will result in the positioning of the axial of the drilling bit and also the coinciding axis of the reamer, if such a pin is employed, to be at a slight angle to the deflecting surface.

Thus, as soon as a drilling bit reaches a point slightly below that shown in Figure 3 where it is passing off from the deflecting surface the bit will tend to dig toward the top side of the bottom of the lateral bore being drilled and, as a result, the lateral bore will be drilled in a curve and not in a straight line or substantially straight line. This is referred to as "building" angle. If there were no tendency for the drilling bit to build angle as a result of the structure employed, the lateral bore would be drilled in a straight line substantially the same as that of the deflecting surface as extended, and the axis of the lateral bore would always maintain an angular relation with the main bore which would be substantially the same as the deflecting surface.

With my improved drilling construction embodying the universal joint J having a particular relationship with the drilling bit, both as to diameter and distance rearwardly of the drilling bit, the angle, which is indicated by the line a—d in Figure 4, will be at a slight angle to a line tangent to the lateral bore at a point where the drilling bit is cutting, such tangential figure being indicated in Figure 4 by the line e—f and this angle will be such as to direct the drilling bit toward the high side of the lateral bore as drilling continues. As the drilling bit is rotated and the angle continues to
“build,” the lateral bore cut will have a curvature which will have a substantially uniform radius of curvature. If the lateral bore is continued to be drilled outwardly, it will ultimately reach a horizontal direction with respect to the main bore which is assumed to be vertical. During all the drilling, fluid can be circulated through the flexible shafting, joint J and reamer bit if used to the drill bit. If necessary, the flexible shafting can be lined with a suitable rubber tubing to prevent leakage at the cut.

After the desired length of lateral hole is drilled, the flexible shafting and other drilling structure can be pulled back into the deflecting tool and then the whole structure removed from the bottom of the main bore, or if it is desired to drill additional drain holes off from the main bore, the deflecting tool can be raised off the bottom of the main bore and after turning the drill pipe to a new oriented position it can be again lowered and a lateral bore drilled off in another direction, which will be determined by the direction of the deflecting surface of the deflecting tool. In order that the deflecting tool may be picked up by the drilling structure when the flexible shaft is withdrawn by raising the drill pipe, the top of the tubular portion 10 of the drilling tool is provided with an internal collar 41 which has such small diameter that it can be engaged by the reamer as it moves upwardly toward the top of the tubular portion of the deflecting tool, Other arrangements can be employed, if desired, to permit the deflecting tool to be picked up.

Being aware of the possibility of modification in the particular drilling structure shown without departing from the fundamental principles of my invention, I desire it to be understood that the scope of my invention is not to be limited except in accordance with the appended claims.

What is claimed is:

1. A drilling structure for drilling a lateral curved bore having a substantially uniform radius of curvature from a main earth bore and comprising a deflecting tool for positioning in the main bore, a drilling bit of a size to drill the desired finished lateral bore, a rotatable flexible drill pipe having short sections connected together by flexible joints, and a universal joint structure connecting the drill bit to the lower end of the flexible drill pipe, said joint structure embodying ball and socket parts having limited free universal movement and interengaging means carried thereby for transmitting rotary movement between the parts, one of the parts of the joint structure being connected to the flexible drill pipe and the other part being connected to the drilling bit, said joint structure having an overall diameter less than the drill bit and being positioned closely adjacent to the drill bit, and said flexible drill pipe also being of a diameter less than the drill bit whereby during drilling the drill bit can first be deflected from the main bore by the deflecting tool to start the lateral bore and thereafter the joint will be permitted by the size thereof and the size of the flexible drill pipe to be forced to the low side of the lateral bore being drilled and the bit will be continuously directed toward the high side of the bore bottom and thereby “build angle” to produce the curved bore.

2. A drilling structure for drilling a lateral curved bore having a substantially uniform radius of curvature from a main earth bore and comprising a deflecting tool, a drilling bit of a size to drill the desired finished lateral bore, a rotatable flexible drill pipe having short sections connected together by flexible joints, and a universal joint structure connecting the drill bit to the lower end of the flexible drill pipe, said joint structure embodying ball and socket parts having limited free universal movement and interengaging means, means carried thereby for transmitting rotary movement between the parts, one of said ball and socket parts being connected to the flexible pipe and the other to the drilling bit, said joint structure having an overall diameter less than the drill bit and being closely positioned adjacent to the drill bit, at least within a distance not exceeding four times the diameter of the bit and said flexible drill pipe also being of a diameter less than the drill bit and substantially that of the joint whereby during drilling the joint will be permitted to be forced to the low side of the lateral bore being drilled and the bit will be continuously directed toward the high side of the bore bottom and thereby “build angle” to produce the curved bore.

References Cited in the file of this patent

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,666,383</td>
<td>Quintrell</td>
<td>Dec. 16, 1941</td>
</tr>
<tr>
<td>2,382,933</td>
<td>Zublin</td>
<td>Aug. 14, 1945</td>
</tr>
<tr>
<td>2,402,538</td>
<td>Carpenter</td>
<td>June 18, 1946</td>
</tr>
<tr>
<td>2,515,365</td>
<td>Zublin</td>
<td>July 18, 1950</td>
</tr>
<tr>
<td>2,589,534</td>
<td>Buttolph</td>
<td>Mar. 18, 1952</td>
</tr>
</tbody>
</table>