UNITED STATES PATENT OFFICE

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DIRECTED WELL DRILLING

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7 Claims. (Cl. 255—1.6)

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This invention has to do with directional well drilling, and contemplates within its general scope improved methods and equipment for conducting deflected drilling operations in a manner productive of numerous advantages distinguishing the invention from the past and conventional practices.

The customary procedures and tools used for directional or deflected drilling employ the usual whipsstocks, i.e., deflector barriers set in the well and generally characterized by their open or exposed angular top surfaces which, when engaged by the drill bits, deflect the latter in accordance with the whipsstock orientation. Assuming this orientation to be correct, the accuracy of the bit or bore hole deflection is largely dependent upon the ability of the angular face of the whipsstock to direct and maintain the bit in a certain or predetermined course.

Experience has shown that a given shape, extent or angularity of an open whipsstock deflecting face will not always assure corresponding deflection of the drill bit (or other formation cutting tool), because of the tendency of the bit to follow courses of least resistance in the formation, which may vary from the course directed by the whipsstock. For example, while guided at one side by the whipsstock, the bit may encounter relatively softer formations in one or more different directions, and will tend to penetrate and deflect laterally of the whipsstock, or follow a course above that which the whipsstock is intended to establish.

One of my major objects is to provide not only for deflecting a bit or cutting tool in a predetermined course, but also for so confining the tool or immediate portion of the drill string that the tool is guided and confined in all directions laterally of its intended course of advancement and therefore given positive control with respect to the course which it must follow. Thus, with the guide orientation established, the bit cannot escape its intended course, as for any of the reasons ordinarily responsible for error in the deflection, and the hole can be directed at any angle of deflection with complete accuracy.

More specifically, the invention contemplates providing at the proper location in the well bore, an inclined passage within which the tool or bottom portion of the drill string is received and laterally confined in all directions so that upon advancement in a deflected course determined by the orientation and angularity of the passage, the tool will be positively fed and rigidly guided. Typically the angular guide passage may be formed by a drillable tube contained or embedded in a cementitious body of drillable material.

A further object of the invention is to so combine or associate the above mentioned guide passage with the drill string that setting and orientation of the passage-containing body, and deflected drilling may occur sequentially in a single operation, thus avoiding the expenditure of time, use of various tools, and multiple trips into and out of the well, customarily required for a whipsstocking operation. In this respect the invention contemplates lowering the guide passage body together with the bit (while permitting downward fluid circulation), and after setting and orienting the body, commencing deflected drilling, all in a single course of operation.

Particularly the invention aims to employ a novel association of the guide body with spaced pilot and main drill bits so that the pilot bit first is deflected to drill a bore to be followed by the main drill bit, and the latter then or simultaneously advances to drill away the guide body and enter the pilot bore.

All the objects and advantages of the invention, as well as the details of certain illustrative embodiments, will be fully understood from the following description of the accompanying drawings, in which:

Fig. 1 is a view taken in vertical section to show the guide body lowered in the well on the pipe string to setting position;

Fig. 2 is a similar view showing the progression of the pilot bit through the guide into the formation;

Fig. 3 shows a further stage in the drilling progression after the main bit has cut through the guide body;

Fig. 4 is a view similar to Fig. 1 illustrating a variational aspect of the invention; and

Fig. 5 is a fragmentary enlarged view illustrating a variational form of releasable connection between the guide body and the pipe string.

Referring first to Fig. 1, the guide generally indicated at 10 is shown to be lowered and set in position at the bottom of the bore hole 11 which may be cased or uncased. The drill pipe string 12 is shown to carry an upper or main drill bit 13, which as will be understood may be of any suitable type and form, and a lower relatively small diameter pilot bit 14, connected to bit 13 by a pipe 15, or a section of the string tubing, having the later described length relationship to the guide 10. Where the bore is to be deflected through casing, milling cutters or drills may be
used, or the bits may be made to penetrate casing.

Typically the guide 10 is shown to comprise a body 16 of cementitious or other non-magnetic drillable material having at its lower end an anchor plate or shoe 17 adapted to penetrate the sand or formation at the bottom of the hole, thus preventing turning of the body from oriented position. The body contains a tube 18 of non-magnetic drillable material characterized by its deviation from the vertical, and specifically formed to have a straight upper portion 18a and a lower extent 18b extending angularly at an inclination desired for the intended deflection of the bit. This angle of deflection may vary to serve the purposes of different jobs, and accordingly it will be understood that in any given instance, the guide tube 18 may be preformed to have any particular angularity, or may be selected from a stock of embedded guide tube bodies containing tubes of different angularities.

Any suitable form of connection may be employed for releasably attaching the lower end of the pipe string 28 to the body 16. Merely as illustrative, the pipe 15 is shown to be received within the body a distance permitting reception of the pilot bit 14 in the tube 18, and to be releasably held against downward movement relative to the body by means of shear pins 19 carried by the body and received within openings 20 in the pipe 15. Suitable packing 21 may engage about the pipe to confine the circulating fluid against leakage through the top of the body.

As illustrative of a variational form of releasable connection between the drill string and guide tube body, Fig. 5 shows a threaded joint 22 typically in the form of an insert 23 having right hand thread engagement with the threaded portion 24 of the tube section 15. After the guide tube body is set in oriented position, the joint at 22 may be broken by right-hand rotation of the drill string, permitting downward movement of the bits relative to the guide.

In considering a typical offset drilling operation, assume the guide body assembly to be lowered to the bottom of the well on the pipe string in the described association and relation to the bits 13 and 28 as shown in Fig. 1. It will be observed that the drill string and guide tube are in open condition permitting maintenance of downward fluid circulation during the lowering operation, a feature of advantage in permitting the guide tube body to be circulated into setting position. Ordinarily it is desired to set the plug at a predetermined orientation, i.e., a position at which the inclined portion 18b of the guide tube has a determinable oriented direction. For this purpose it may lower on line 25 through the pipe string and into a non-magnetic tube 18 an appropriate orienting instrument, conventionally indicated at 26 by which readings may be taken to establish the tube orientation.

With the drillable body and guide tube set in oriented position, the drill string may be lowered to release the described shear pin or threaded connections, and advance the pilot bit 14 through the guide tube by deflection by the bit to assume a correspondingly deflected course as illustrated in Fig. 2. The distance between the bits 13 and 14 may be such that the pilot bit is permitted to drill the formation a more or less extended distance before bit 13 reaches the body 16, thus pre-establishing the direction and inclination of the deflected drill hole before bit 13 commences to cut away the body and tube assembly 10. Upon con-

\[ \text{continued drilling, the pilot bit advances the bore 27 as bit 13 progressively cuts away the drillable material 18 and guide tube, circulation at the time being continuously maintained through the drill string to wash away the cuttings. Eventually bit 13 will have drilled through the guide tube body and may be permitted to penetrate the formation in a course following the direction of bore 27, whatever depth desired. As illustrated in Fig. 3, bit 13 may be permitted to drill the diverted bore 28 a distance sufficient to pre-establish the direction of drilling according to the course of the bore, whereupon the pipe string may be pulled to remove the pilot bit and tube 15. Thereafter drilling may be continued using the single bit 13 which will follow the course of bore 28 and the pilot bore 27.}\]

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Fig. 4 illustrates a variational procedure employing essentially the same equipment as previously described, but differing in that the pilot bit is inserted within the angular guide tube body before the assembly is lowered in the well. Here the drillable body 28 is shown to contain the angular guide tube 30 and packing 31 as before. The drill string 32 includes the upper bit 33, a non-magnetic tube section or pilot bit string 34, and the pilot bit 35, the latter in this instance being shown as a closed end bit, though having some circulation openings 36, as distinguished from the core-type bit 14. Before lowering the assembly into the well, tube 34 and the pilot bit 35 may be thrust down into the guide tube 30 to the position illustrated and in which the pilot bit and lower portion of the tube 34 are retracted within the guide. If desirable, a releasable connection may be effected between the guide body and pipe string, as by means of a shear pin 37 interconnecting the pilot bit and guide tube or body. As before, circulation may be maintained through the pipe string in the operation of setting the guide body. The latter may be oriented by lowering on line 38 the instrument 39 to a position within the non-magnetic pilot bit stem and lower angular portion 30a of the guide tube. With the latter oriented, drilling may be commenced to progress in the manner previously described with the condition of the string and guide assuming the relationships illustrated in Figs. 2 and 3.

50 I claim:

1. In combination with a pipe string carrying an upper larger diameter cutting tool and a lower pilot cutting tool, a body releasably connected to said pilot cutting tool and adapted to be lowered therewith to setting position in the well, said body containing a passage which in turn contains said pilot tool and is inclined from the vertical and of sufficient size to pass said pilot cutting tool within the body and cause the tool to be deflected laterally into the formation, and a tubular connection between said pilot tool and said upper cutting tool and positioning the tools so that following deflection of the pilot tool into the formation the upper tool engages and drills away the body as drilling progresses.

2. In combination with a pipe string carrying an upper larger diameter cutting tool and a lower pilot cutting tool, a body releasably connected to said pilot cutting tool and adapted to be lowered therewith to setting position in the well, said body containing a passage which in turn contains said pilot tool and has downward and outward curvature from the vertical to pass and deflect said pilot cutting tool laterally into the formation, and a tubular connection be-
between said pilot tool and said upper cutting tool, said upper tool being positioned in the pipe string directly above the pilot tool and being operable to cut away the material of said body after deflection of said pilot tool into the formation.

3. In combination with a pipe string carrying an upper larger diameter cutting tool and a lower pilot cutting tool, a body of drillable material releasably connected to said pilot tool to be lowered therewith to setting position in the well, a drillable tube in said body and inclined from the vertical, said pilot tool being retained within said tube and movable therethrough to be deflected laterally into the formation, and a tubular connection between said pilot tool and said upper cutting tool and positioning the tools so that following deflection of the pilot tool into the formation the upper tool engages and drills away the body as drilling progresses.

4. In combination with a pipe string carrying an upper larger diameter cutting tool and a lower pilot cutting tool, a body of drillable material connected to said pilot tool to be lowered therewith to setting position in the well, a drillable tube in said body and inclined from the vertical, said pilot tool being retained within said tube, means releasably connecting said body and pilot tool against relative downward movement of the pilot tool, and a tube section connecting said cutting tools, said pilot tool being movable upon releasing said connection downwardly through said drillable tube to be deflected thereby laterally into the formation and the upper tool being positioned in the string to then engage and drill away the body.

5. In combination with a pipe string carrying an upper larger diameter cutting tool and a lower pilot cutting tool, a body of drillable material releasably connected to said pilot tool to be lowered therewith to setting position in the well, a drillable tube extending longitudinally inside said body from the top to the bottom thereof and inclined from the vertical, a pipe section interconnecting said cutting tools, downward fluid circulation being maintainable from the pipe string through said cutting tools and inclined tube, said pilot tool being received within and movable through said tube to be deflected thereby laterally into the formation and the upper tool being positioned in the string to then engage and drill away the body.

6. In combination with an oil well pipe string carrying an upper larger diameter bit and a spaced lower pilot bit, tubing interconnecting said bits, a body lowered to setting position in the well on said tubing and containing a longitudinal passage inclined from the vertical and containing said pilot bit, said passage being open to permit fluid circulation downwardly through the pipe string, tubing and body, and means releasably connecting the tubing and pilot bit with the body, said bits being operable to sequentially pass the location of the body first by movement of the pilot bit through said passage and then drilling of the body by said upper bit as the pipe string is lowered and the pilot bit is deflected by said passage laterally into the formation.

7. In combination with an oil well pipe string carrying an upper larger diameter bit and a spaced lower pilot bit, tubing interconnecting said bits, a body of cementitious drillable material lowered to setting position in the well on said tubing and containing a longitudinal passage inclined from the vertical and receiving said pilot bit, said passage being open to permit fluid circulation downwardly through the pipe string, tubing, and body, and means releasably connecting said tubing and pilot bit with the body, said bits being spaced so that upon lowering of the pipe string the pilot bit is deflected by said passage laterally into the formation and the upper bit is then operable to drill away the material of said body while following a course established by the pilot bit deflection.

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REFERENCES CITED

The following references are of record 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>1,424,109</td>
<td>McBride</td>
<td>July 25, 1922</td>
</tr>
<tr>
<td>2,043,381</td>
<td>Lane</td>
<td>June 9, 1936</td>
</tr>
<tr>
<td>2,058,327</td>
<td>Lane</td>
<td>Oct. 20, 1936</td>
</tr>
<tr>
<td>2,081,284</td>
<td>Eastham</td>
<td>May 25, 1937</td>
</tr>
<tr>
<td>2,119,746</td>
<td>Lane</td>
<td>June 7, 1938</td>
</tr>
<tr>
<td>2,227,293</td>
<td>Scott et al.</td>
<td>Dec. 31, 1940</td>
</tr>
<tr>
<td>2,261,414</td>
<td>Clark</td>
<td>Apr. 28, 1942</td>
</tr>
<tr>
<td>2,334,747</td>
<td>Brantley</td>
<td>Nov. 23, 1943</td>
</tr>
<tr>
<td>2,498,159</td>
<td>Gammill</td>
<td>Feb. 21, 1950</td>
</tr>
<tr>
<td>2,498,192</td>
<td>Wright</td>
<td>Feb. 21, 1950</td>
</tr>
</tbody>
</table>