

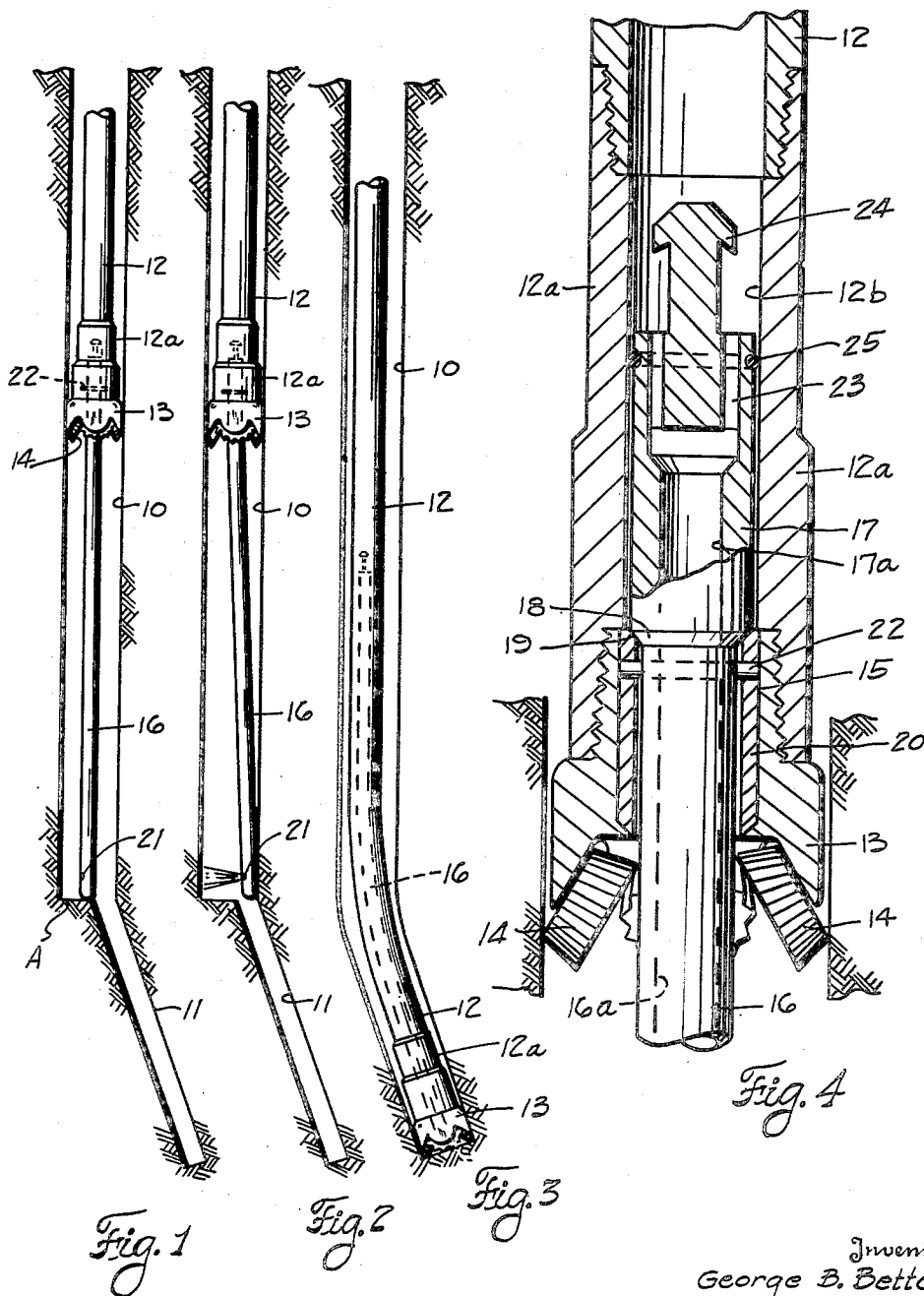
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DIRECTIONAL DRILLING APPARATUS

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DIRECTIONAL DRILLING APPARATUS

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This invention relates to new and useful improvements in directional drilling apparatus.

In the directional drilling and side-tracking of bore holes, it has become the general practice to drill a deflected or offset bore which extends at an angle from the main well bore. Because this deflected bore is of a smaller diameter than the diameter of the main well bore, it is sometimes difficult to follow up with a reaming operation. The deflected or offset bore is of a smaller diameter because the drilling is performed off of the face of a whipstock or by means of a deflecting tool which must obviously be under gauge as compared to the main well bore. It has become the practice to enlarge the smaller deflected bore by means of a reamer, such as any of the well known pilot reamers now in general use. Because of the small diameter of the deflected bore, difficulty has been experienced in causing the pilot of the reamer to enter said bore.

It is one object of the present invention to provide an improved directional drilling apparatus which is so constructed that reaming out of a previously formed deflected bore of relatively small diameter may be efficiently carried out.

An important object of the invention is to provide an improved directional drilling apparatus which includes an elongate pilot stem or pipe which is combined with a reaming bit and which functions to accurately guide said reaming bit downwardly along the smaller diameter deflected bore, whereby efficient follow up reaming of said bore may be accomplished.

Another object of the present invention is to provide an improved apparatus, of the character described, wherein an elongate pilot element is detachably connected with the reaming bit and is arranged to be urged toward one side of the main well bore by means of fluid pressure, whereby a rotation of the drill pipe will cause the guide element to find the deflected bore which has been previously formed and which is of a smaller diameter than the main well bore; the detachable connection between the elongate element and the reaming bit permitting said bit to be detached from said element after the latter is disposed in the deflected bore, whereby it subsequently functions as a guide for guiding the bit within such deflected bore.

A still further object of the invention is to provide an improved reaming apparatus, of the character described, which is so constructed that when the reaming bit and drill pipe move downwardly along the guide stem, a clearance between

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the bore of the drill pipe and said stem is provided to provide free circulation through the drill pipe and reaming bit.

A particular object of the invention is to provide an improved apparatus, of the character described, wherein the elongate guide or pilot element or stem may be removed by a suitable retrieving tool at any time following its disconnection with the reaming bit so that a well survey instrument or other tool may, if desired, be run downwardly through the drill pipe and extend outwardly through the bit to allow a survey operation to be performed.

The construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawing, wherein an example of the invention is shown, and wherein:

Figure 1 is a view of a well bore illustrating the improved apparatus, constructed in accordance with the invention, lowered within a well bore,

Figure 2 is a similar view illustrating the pilot or guide element of the apparatus moved radially to one side of the well bore by means of the fluid pressure,

Figure 3 is a similar view illustrating the reaming operation which is performed within the deflected well bore, and

Figure 4 is an enlarged, transverse, vertical, sectional view of the lower portion of the drill pipe and the upper portion of the pilot or guide element and illustrating the connection therebetween.

In the drawings, the numeral 10 designates a main well bore which has been drilled in the usual manner. A deflected or angular well bore 11 which has a diameter smaller than the diameter of the main well bore extends from the lower end of said main bore and is ordinarily disposed at an angle thereto. The smaller or deflected bore 11 has been formed by means of a drill bit which has been deflected off of a whipstock or other deflecting tool; it is possible that said bore may have been formed by means of any of the well known knuckle joint deflecting tools which are in general use.

After the smaller deflected bore 11 has been formed, it is necessary that said bore be reamed to substantially the same size as the main well bore 10 and it is for this purpose that the improved apparatus is designed. This apparatus includes the usual tubular drill pipe 12 which has

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a reaming bit 13 connected to its lower end. The reaming bit includes the usual cutters 14 and is provided with an axial bore 15 which extends entirely through its shank. The bit shank is externally threaded whereby it may be connected through the usual tool joint 12a with the drill pipe 12.

An elongate tubular pilot or guide element 16 which is illustrated as a section of pipe or tubing 16 has its upper end connected with a sub 17, the latter having an external diameter which is slightly larger than the external diameter of the element or stem 16, whereby an external, annular shoulder 18 is formed at the upper portion of the guide element or stem. The tubular pilot or guide element 16 is adapted to extend downwardly through the reaming bit 13 and the external shoulder 18 is adapted to engage an annular seat 19 which is formed at the upper end of a removable landing ring 20 which is removably mounted within the bore 15 of the shank of the bit 13. This landing ring has a tight press fit in the reaming bit so as to be rotatable with the bit, but may be removed by hammer blows when the bit is disconnected. This disposes the sub 17 within the bore 12b of the tool joint 12a and the lower end of the element 16 extends a considerable distance below the reaming bit 13. The lower end of the pilot or guide element or stem 16 is closed and spaced slightly above this lower end, a radial port 21 is provided in the wall of said element. Thus, any fluid flowing downwardly through the tubular element or pipe 16 will be ejected through the relatively small port or orifice 21. The pressure of this ejecting fluid striking the wall of the well bore will tend to urge the lower end of the pilot or guide element in a direction opposite to that side on which the port 21 is located.

The pilot or guide element 16 is arranged to be connected in its seated position to the drill bit 13 by means of a frangible shear pin 22. As is clearly shown in Figure 4, the shear pin extends through the upper portion of the element and has its ends engaged within openings formed in the landing ring 20 press fit mounted within the shank of the bit 13. The bore 16a of the pilot or guide element 16 has its upper end communicating with the bore 17a of the upper sub 17. The bore 17a terminates short of the upper end of the sub and is in communication with longitudinal passages 23 which extend from the top of the sub to said bore. A fishing or retrieving neck 24 is preferably formed integral with the upper end of the sub 17 and the longitudinal passages 23 are disposed around the shank of said neck. A suitable packing ring 25, preferably of the O ring type is mounted on the sub 17 and seals the joint between the exterior of said sub and the bore 12b of the tool joint 12a.

In the operation of the apparatus, the assembly is made up as illustrated in Figures 1 and 4 with the elongate pilot or guide element or stem 16 extending downwardly a substantial distance below the reaming bit 13. The external shoulder 18 at the upper end of the guide or pilot element is engaged with the seat 19 of the landing ring 20 and the shear pin 22 is connecting the element with the bit, whereby the pilot or guide element may be lowered and raised within the main well bore 10 by means of the drill pipe 12. At this time the sub 17 at the upper end of the guide element 16 is disposed within the bore 12b of the tool joint 12a and the packing ring 25 forms a seal between said sub and the bore of said joint.

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The assembly or apparatus is lowered to the bottom of the main well bore and because the guide element is disposed substantially axially of the drill pipe, the lower end of the pilot or guide element will engage the shoulder A which has been formed between the main well bore and the smaller deflected bore 11. Upon reaching this position, a pump pressure is applied through the drill pipe and drilling fluid is pumped downwardly through said drill pipe. This fluid under pressure will flow through the longitudinal passages 23, then through the bore 17a of the sub 17 and finally into the bore 16a of the tubular pilot or guide element 16. As has been noted the lower end of this element is closed with the result that the fluid under pressure is directed outwardly in a forcible stream through the restricted radial port or passage 21 and the force or pressure of this fluid striking the wall of the main well bore 10 will deflect the lower end of the pilot or guide element into contact with the opposite wall of the well bore. Deflection will readily take place because the tubular pilot is of considerable length, such as ten feet or more. This length permits considerable flexibility at the lower end of the tube, at least enough to move the few inches to one side of the main bore. In a well where the main bore is, say, 9 inches in diameter, the deflected bore will be 5½ or 6 inches. Thus, the end of the tubular pilot need only be moved, at the most, only 3¼ inches to reach the side of the main bore if the pilot is about 2½ inches in diameter. There will also be some "sloppiness" at the frangible pin, but this is not a necessity although it may be of some assistance where the deflection must be greater than noted. The drill pipe 12 is then slowly rotated and a slight downward pressure is applied thereto and it will be evident that as soon as the lower end of the pilot or guide element 16 moves opposite the smaller deflected bore 11, the pilot or guide element will immediately enter said bore. The drill pipe is then lowered until the lower end of the guide stem or element 16 is engaged with the lower end of the deflected bore 11. The weight of the drill pipe is then imposed on the shear pin 22 to fracture or shear said pin and thereby disconnect the reaming bit 13 from the pilot or guide element.

The drill pipe and reaming bit are then moved downwardly with the pilot or guide element 16 remaining stationary because of its engagement with the lower end of the deflected bore 11. Upon reaching the shoulder A, the drill pipe is rotated to rotate the bit 13 and thereby ream out the smaller deflected bore 11 to substantially full gauge or the same size as the main well bore 10. It will be evident that during the reaming operation, the pilot or guide element functions to guide the reaming bit throughout the length of the smaller deflected bore. It is also pointed out that as the drill bit and drill pipe move downwardly with respect to the pilot or guide element and its connected sub 17, the sub moves upwardly into the drill pipe which has a slightly larger bore than the bore of the tool joint 12a. This means that the drilling fluid which is circulated downwardly through the drill pipe may freely by-pass the sub 17 and may also by-pass around the exterior of the tubular pilot or guide element 16, whereby there is substantially no obstruction to the necessary drilling fluid must be circulated during the reaming operation.

After the smaller deflected bore 11 has been drilled out to full size, as shown in Figure 3, it may be desirable to obtain a survey of the de-

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deflected bore to determine or check its direction and inclination. If such survey is desirable or necessary, a suitable retrieving or fishing tool (not shown) is lowered through the well pipe and is engaged with the retrieving or fishing neck 24 and the entire pilot or guide element 16 is retrieved through the drill pipe. The pipe and bit are then raised slightly off bottom and a suitable well surveying instrument may be dropped or lowered through the drill pipe so as to extend outwardly below the reaming bit 13. It is noted that the shoulder 19 on the landing ring 20 provides a support for such instrument. In this manner a survey of the inclination and deviation of the deflected bore may be accomplished before the drill pipe and reaming bit are removed. The survey instrument may be recovered either with the drill pipe or by means of a wire line or cable, as desired.

If it is not desired to obtain a survey, the pilot and guide element 16 will be removed when the drill pipe and reaming bit are brought to the surface. From the foregoing it will be seen that a simple and efficient apparatus for reaming a smaller diameter deflected bore is provided. The elongate pilot or guide stem or element 16 is normally attached to the drill pipe so as to be lowered therewith through the main well bore. Upon reaching bottom, the pressure fluid which is pumped downwardly through the drill pipe is utilized to deflect the lower end of the pilot element into a position where it will readily enter the deflected bore 11. Upon its entry into said bore, the pilot element is readily detached from the drill pipe, whereby the drill pipe and its reaming bit may move downwardly with reference to said element. During the reaming operation, the pilot or guide element forms an axial guide to assure that the reamer will follow the deflected bore 11. The pilot or guide element may be retrieved either with the drill pipe when the latter is removed or may be recovered and brought to the surface by means of any well known retrieving or fishing tool. The removability of the pilot element independently of the drill pipe makes it possible to accomplish a well surveying operation before the drill pipe and reaming bit are brought to the surface.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. A drilling apparatus including, a drill pipe adapted to be lowered within a well bore, a reaming bit having an axial bore secured to the lower end of the drill pipe, an annular support within the drill pipe, a tubular pilot element extending through the drill bit and projecting a substantial distance therebelow, the upper end of said element being enlarged and supported upon the support within the drill pipe, whereby said element cannot pass completely through the pipe and bit in a downward direction, and releasable means normally securing the element to the drill pipe and bit so that the element may be lowered therewith, said element comprising a tubular conductor having a radial port in its lower portion and having its lower end closed, whereby pressure fluid pumped downwardly through the drill pipe and conductor will be ejected outwardly through said port and will function to

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deflect said conductor radially against the wall of the well bore so that subsequent rotation of the drill pipe, bit and conductor will rotate the lower end of the conductor in a path adjacent the wall of the bore.

2. A drilling apparatus including, a drill pipe adapted to be lowered within a well bore, a reaming bit having an axial bore secured to the lower end of the drill pipe, an annular support within the drill pipe, a tubular pilot element extending through the drill bit and projecting a substantial distance therebelow, the upper end of said element being enlarged and supported upon the support within the drill pipe, whereby said element cannot pass completely through the pipe and bit in a downward direction, releasable means normally securing the element to the drill pipe and bit so that the element may be lowered therewith, said element comprising a tubular conductor having a radial port in its lower portion and having its lower end closed, whereby pressure fluid pumped downwardly through the drill pipe and conductor will be ejected outwardly through said port and will function to deflect said conductor radially against the wall of the well bore so that subsequent rotation of the drill pipe, bit and conductor will rotate the lower end of the conductor in a path adjacent the wall of the bore, detachment of the releasable means permitting downward movement of the drill pipe and bit with respect to the conductor, whereby said bit is guided by the conductor during a reaming operation, and means for circulating a drilling fluid downwardly through the drill pipe and around the exterior of the pilot conductor during the reaming operation.

3. A drilling apparatus as set forth in claim 1, wherein the releasable means connecting the pilot element with the drill bit is a shear pin which may be fractured when the pilot element is engaging the lower end of the bore and the weight of the drill pipe is imposed thereon.

4. A drilling apparatus including, a drill pipe adapted to be lowered within a well bore, a reaming bit having an axial bore secured to the lower end of the drill pipe, an annular support within the drill pipe, a tubular pilot element extending through the drill bit and projecting a substantial distance therebelow, the upper end of said element being enlarged and supported upon the support within the drill pipe, whereby said element cannot pass completely through the pipe and bit in a downward direction, releasable means normally securing the element to the drill pipe and bit so that the element may be lowered therewith, means for deflecting the lower end of the pilot element radially into engagement with one side of the well bore, whereby rotation of the drill pipe and bit with the element attached thereto rotates the lower end of the element in a path adjacent the wall of said bore, and means on the upper portion of the pilot element adapted to be engaged by a retrieving tool, whereby when the connecting means between the element and drill pipe and bit is detached, said element may have a line connected therewith by a retrieving tool and be removed from the well bore independently of the drill pipe and bit.

5. A drilling apparatus attachable to the lower end of a drill pipe for enlarging an earth bore smaller than a main earth well bore and which has been drilled off therefrom at an angle, said apparatus comprising a reaming bit having an axial bore and being of a size to drill a bore of greater diameter than the said small bore, means

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securing the bit to the lower end of the drill pipe, an elongated pilot element extending through the bit bore and having its lower end projecting below the bit a substantial distance and being of a size to be received in the smaller bore, means comprising a frangible element for securing the upper end of the pilot element to said bit whereby the element may be lowered with the drill pipe and bit and caused to extend into the smaller bore an appreciable distance and when so positioned permitting the element to be detached from the bit by application of weight of the drill pipe sufficient to shear the frangible means and thereby allow for movement of the bit and pipe with respect to said pilot element so that the bit when rotated can be guided by the portion of the element in the smaller bore and enlarge said smaller bore without any appreciable change in its direction, and means for causing the lower end of pilot element when it is in the main bore to assume a position where it can enter the smaller bore when the drill pipe is rotated.

6. A drilling apparatus attachable to the lower end of a drill pipe for enlarging an earth bore smaller than a main earth well bore and which has been drilled off therefrom at an angle, said apparatus comprising a reaming bit having an axial bore and being of a size to drill a bore of greater diameter than the said small bore, means securing the bit to the lower end of the drill pipe, an elongated pilot element extending through the bit bore and having its lower end projecting below the bit a substantial distance and being of a size

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to be received in the smaller bore, means for releasably securing the upper end of the pilot element to said bit, said releasable means being of a type maintaining the element connected to the bit so the element may be lowered with the drill pipe and bit and caused to extend into the smaller bore an appreciable distance and when so positioned permitting the element to be released from the bit by such manipulation of the drill pipe as to allow for downward movement of the bit and pipe with respect to said element so that the bit when rotated can be guided by the portion of the element in the smaller bore and enlarge said smaller bore without any appreciable change in its direction, and means for deflecting the lower end of the pilot element when it is in the main bore so it can be caused to enter the smaller bore and then be subsequently released, said last named means comprising a conduit through the element from its upper end toward the lower end with a radial port whereby fluid pumped down the drill pipe can be laterally discharged from the radial port and thereby deflect the element.

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