

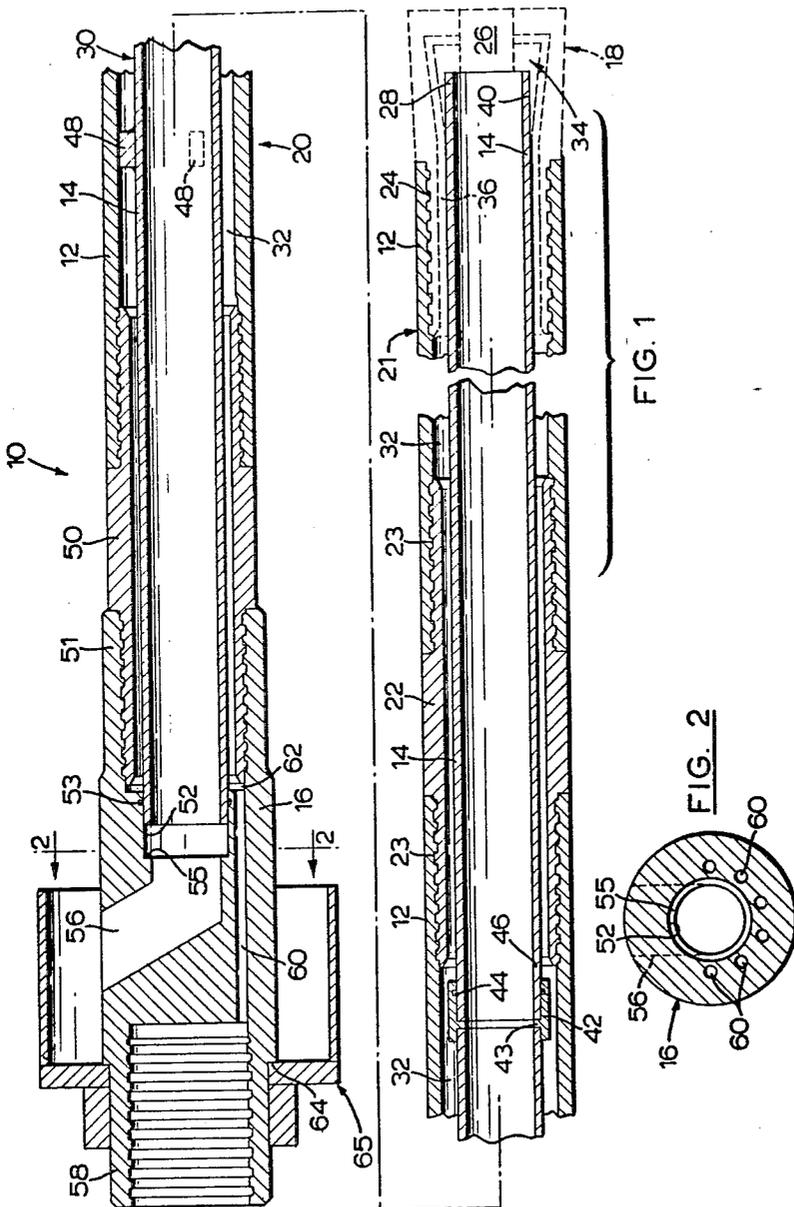
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ROTARY-PERCUSSION DRILL APPARATUS

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ROTARY-PERCUSSION DRILL APPARATUS

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7 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus for sinking a borehole by rotary-percussive means and collecting the earth fragments. The apparatus comprises a drill pipe having a bit end, a drive end and an interior tube in the drill pipe which defines an annular space between the drill pipe and the interior tube. Means for maintaining the interior tube in coaxial relation while permitting axial movement includes radially aligned spacer blocks and a spout stock secured to the drill end of the drill pipe. A bit secured to the bit end of the drill pipe has an annular portion adapted to seat the interior tube; an opening through the annular portion and passages communicating the opening with the annular space defined by the interior tube and drill pipe.

This invention relates to the rotary-percussive piercing of earth formations, and has to do particularly with an apparatus adapted to sink a bore hole through both overburden and bedrock, while permitting immediate collection of fragments of the earth formation penetrated as the fragments are loosened, to enable continuous monitoring and exact logging of the bore hole.

Conventional rotary-percussive drilling apparatus usually includes a hollow drill-pipe, a rotary-percussive drill mechanism from which extends a coupling through which rotation, percussion and pressurized fluid are transmitted to the drill-pipe, and a drill bit at the bottom end of the drill-pipe. The drill bit is of a size whereby it cuts a bore hole appreciably larger than the drill-pipe, and the annular space between the drill-pipe and the walls of the bore hole provides a passage for the return of the pressurized fluid, usually air, which is forced down the inside of the drill-pipe. As the drill bit chips away the earth formation, the pressurized air or other fluid takes up the chips and cuttings and carries them up between the drill-pipe and the bore hole to the surface of the earth where they can be either collected for testing or discarded.

One disadvantage of the conventional apparatus just described is that, while it is capable of satisfactory drilling in bed rock where the walls of the bore hole are solid, it does not work well in overburden, where the loose and unconsolidated walls of the bore hole have a tendency to collapse and block up the return passage, so that the cuttings cannot be carried up to the surface. Even when the walls of the bore hole in overburden are sufficiently consolidated to resist collapse, there is a risk that the returning chips will become contaminated with material from the walls of the bore hole during the upward return passage, thereby giving test readings which do not accurately represent the true profile of the earth formation being drilled. The same problem can arise in bedrock, especially when some of the pierced strata are of weaker material, such as sandstones or weak clays.

It is therefore an object of this invention to provide a rotary-percussive drill apparatus wherein the aforementioned disadvantages are overcome.

Essentially, this object is achieved by providing apparatus permitting a "reverse-flow" for the pressurized fluid employed. Instead of the fluid return taking place between the drill-pipe and the bore hole walls, where col-

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lapse or contamination can take place, the return flow of fluid passes upwardly through the centre of a second coaxial tube within the drill-pipe, the down flow of fluid passing down the annular space between the interior tube and the drill-pipe. In order to provide apparatus of this nature, two problems require solution. The first of these relates to the way in which the interior tube should be supported inside the exterior drill-pipe, and the second has to do with the way pressurized fluid is fed to the annular space between the interior tube and the drill-pipe and the way in which the upflowing mixture of fluid and rock chips is exhausted to the outside.

Accordingly, this invention provides, in combination, a drill-pipe having a bit end and a drive end, a bit carried by said bit end, an interior tube positioned within said drill-pipe to define an annular space between the drill-pipe and the interior tube, means for maintaining the interior tube in a substantially coaxial relation to said drill-pipe while permitting axial movement of the interior tube relative to said drill-pipe, said bit having an annular portion against which the lower end of the interior tube is adapted to seat, said bit having an opening extending through the bit within said annular portion, said bit having passage means communicating said annular space with said opening.

One embodiment of this invention is shown in the accompanying drawings, in which like numerals denote like parts throughout the several views, and in which:

FIGURE 1 is an axial sectional view, broken at two axial locations, of a drilling apparatus; and

FIGURE 2 is a cross-sectional view taken at the line 2—2 in FIGURE 1.

A drilling apparatus, generally shown at 10 in FIGURE 1, consists essentially of a drill-pipe 12, an interior tube 14, a spout stock 16 connected to the drive end of the drill-pipe 12, and a bit 18 connected to the bit end of the drill-pipe 12.

The drill-pipe 12 is preferably a high carbon steel pipe of a type readily available on the open market. By way of illustration only, the drill-pipe 12 may have an O.D. of 4 1/16 inches and an I.D. of 3 1/4 inches, and each section of the drill-pipe 12 may be between 9 and 10 feet long. The ends of each section of drill-pipe 12 are internally threaded, the thread shown in the drawings being the box thread type. In FIGURE 1, there is shown an upper drill-pipe section 20 and a lower drill-pipe section 21. The two sections 20 and 21 are linked together by means of a connector pin 22, which is again a standard item available on the open market. The connector pin 22 is made of a material which is weaker than the material of the drill-pipe 12, and this ensures that, under excessive loads, the connector pin 22 will break before the drill-pipe 12. As shown, the connector pin 22 has two male threaded ends 23 adapted to engage the ends of the sections 20 and 21.

The bit 18 has a male threaded portion 24 for threaded engagement with the lower end of the section 21 of drill-pipe 12. The exact tooth shape, etc., of the bit 18 does not form a part of this invention and will not be described in detail in the specification. It is essential to this invention, however, that the bit 18 employed meet the following requirements. Firstly, it should be suitable for use with rotary-percussion drilling apparatus, in which the vibrations or percussions transmitted to the bit cause the bit teeth to chip the rock being traversed. Secondly, the bit must have an opening 26 extending through the bit along the axis of the drill-pipe 12. Thirdly, the opening 26 must have an annular ledge 28 upon which an interior tube 14, later to be described in greater detail, can seat. The fourth requirement relates to the fact that the interior tube 14 is positioned within the drill-pipe

12 to define an annular space 32 between the drill-pipe 12 and the interior tube 14, the fourth requirement being that the bit 18 have passage means communicating the annular space 32 with the opening 26 below the annular ledge 28. In FIGURE 1 passages 34 are shown extending from the opening 26 to a reduced annular space 36 between the interior tube 14 and the male threaded portion 24, the reduced annular space 36 being in communication with the annular space 32. It is also preferable that the bit 18 have a slight downward flare as shown, but this is not considered essential.

It will be noted that the bit 18 has a bore 40 of a larger diameter than the opening 26, and that the difference in these diameters is what defines the ledge 28. Although the interior tube 14 is shown to fit snugly within the bore 40, it is essential that the fit between these two be loose enough to permit unrestrained axial motion of the interior tube 14 with respect to the bit 18.

The interior tube 14 is a relatively thin-walled mechanical tubing, which is preferably a standard steel pipe. By way of illustration only the interior tube 14 may have an O.D. of 2 $\frac{3}{8}$ inches and an I.D. of 2 inches. This invention provides that the interior tube 14 be completely free of any rigid attachment to the drill-pipe 12, and that moreover it be free to move axially with respect to the drill-pipe 12. In FIGURE 1, the connection between two adjacent sections of interior tube 14 is seen to involve the provision, at one end of each section of interior tube 14, of a cylindrical member 42 which is welded or otherwise secured to the end of the section of interior tube 14. The cylindrical member 42 has an interior ridge 43 which abuts against the end of the section to which the member 42 is secured, and also has an internal gallery 44 which receives a circular sealing member such as an O-ring. The end 46 of the other section of interior tube 14 fits snugly within the cylindrical member 42 as shown.

In order to maintain the coaxial relation between the interior tube 14 and the drill-pipe 12 when a large number of sections of drill-pipe 12 is in use, each section of interior tube 14 is provided with three axially aligned but circumferentially distributed spacer blocks 48 which are welded to the outside wall of the interior tube 14. It is preferably, of course, that the spacer blocks be equally spaced around the outside of the interior tube 14. The radial dimension of the spacer blocks is slightly less than the radial dimension of the annular space 32, thereby permitting a small amount of lateral play as between the interior tube 14 and the drill-pipe 12. More importantly, this arrangement permits unimpeded axial movement of the interior tube 14 with respect to the drill-pipe 12.

At the upper end of the section 20 of the drill-pipe 12 is attached a further connector pin 50 identical in all respects to the connector pin 22. The connector pin 50 joins the section 20 of the drill-pipe 12 to the spout stock 16, the latter having at its lower end a female threaded portion 51 for engagement with the connector pin 50. The spout stock 16 has an internal, coaxial, downward-opening bore 52 in which the upper end of the uppermost section of the interior tube 14 is received. The downward-opening bore 52 has an interior gallery 53 adapted to carry a circular sealing ring, such as an O-ring. The sealing rings in the galleries 44 and 53 prevent the passage of fluid, for example air, between the annular space 32 and the inside of the interior tube 14. The downward-opening bore 52 has a step 55 which limits the axial movement of the interior tube 14 in the upward direction. The bore 52 has a lateral extension 56 which opens through the side of the spout stock 16, thereby providing communication between the inside of the interior tube 14 and the outside of the spout stock 16.

Standard rotary-percussion drills usually have, extending therefrom, a threaded, male coupling through which rotation, percussion and pressurized fluid, for example air, are transmitted to the drill-pipe 12. The spout stock 16 is provided, at its upper end, with an internally

threaded female coupling 58 for threadedly receiving the male coupling of a rotary-percussion drill. In order to transmit the pressurized fluid from the male coupling member of the rotary percussion drill to the annular space 32, the spout stock 16 is provided with passage-way means communicating the interior of the threaded female coupling 58 with the annular space 32. More particularly, the spout stock 16 is provided with six passageways 60 extending from the interior of the threaded female coupling 58 to a portion 62 of the spout stock 16 which is intermediate the coupling portion 51 and the downward-opening bore 52. Naturally, there can be more or less of the passageways 60, the only criterion being that the passageway means have sufficient capacity to deliver pressurized fluid in the appropriate quantity.

The spout stock 16 is provided with an upward facing ledge 64 against which a conventional spout shroud 65 is adapted loosely to seat. The purpose of the spout shroud 65 is to avoid material being ejected great distances through the lateral extension 56. The spout shroud 65 directs all such material downwardly along the spout stock 16.

It will now be evident that the pressurized fluid, which is usually air, passes from the female coupling 58 through the passageways 60 and into the annular space 32, from where it passes downwardly to the bit 18, through the passages 34, and into the opening 26. As the bit 18 chips the formation being traversed, the chips produced pass into the opening 26, where they are picked up by the pressurized fluid emerging from the passages 34 and are carried upwardly through the center of the interior tube 14, entrained in the fluid flow. They are then ejected through the lateral extension 56 of the bore 52, impinge against the spout shroud 65, and drop downwardly outside the spout stock 16, there to be either discarded or collected for analysis.

By making the interior tube 14 completely independent of the drill-pipe 12 as far as its axial and rotary motion is concerned, no part of the torque or percussion stress is borne by the interior tube 14. This permits its manufacture as a comparatively weak tube whose only function is to partition the downward flow of fluid from the upward flow of fluid.

The drilling apparatus of this invention is of advantage in what is known as "tie-back" operations, in which, after a vertical or oblique bore hole has been drilled, a tie rod is passed downwardly through the centre of the interior tube 14 until its tip has reached through the bit 18 to the bottom of the bore hole, whereupon the tie rod is grouted with cement while drill-pipe 12 is simultaneously withdrawn. The opening 26 permits the withdrawal of the bit 18 over the tie rod.

While a preferred embodiment of this invention has been disclosed herein, those skilled in the art will appreciate that changes and modifications may be made therein without departing from the spirit and scope of this invention as defined in the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In combination:

- (a) a drill pipe having a bit end and a drive end;
- (b) an interior tube positioned within said drill pipe to define an annular space between the drill pipe and the interior tube, said interior tube having a central passage therethrough;
- (c) a spout stock secured to the drive end of said drill pipe and adapted to transmit impact and rotation to said drill pipe, said spout stock having an internal downwardly-opening bore in which the interior tube is slidably received whereby the said bore is in communication with the central passage of the interior tube, said spout stock including means for connecting said spout stock to a source of pressurized fluid and a passage in said spout stock for direct-

ing said pressurized fluid into the annular space between the drill pipe and the interior tube; and,
 (d) a bit carried by said bit end, said bit having passage means for passing fluid from said annular space into the interior tube and an annular portion against which the lower end of the interior tube is adapted to seat, said bit having a central opening extending therethrough and communicating with the central passage of the interior tube.

2. The combination claimed in claim 1, in which said spout stock is adapted to transmit impact and rotation to said drill-pipe from the threaded male coupling member of a rotary-percussion drill which also delivers pressurized fluid through said male coupling member, the spout stock having a threaded female coupling at its upper end for receiving said male coupling member, the downward-opening bore having a lateral extension opening through the side of the spout stock, the spout stock having passageway means communicating the interior of said threaded female coupling with said annular space, whereby pressurized fluid can pass from said male coupling member into said annular space.

3. The combination claimed in claim 1, in which the drive end of the drill-pipe is threadedly connected to the lower end of a cylindrical connector pin of which the upper end is threadedly connected to said spout stock coaxially with said downward-opening bore, said connector pin being spaced from said interior tube, the spout stock having a threaded female coupling at its upper end for receiving the male coupling member of a rotary-percussion drill which is adapted to deliver pressurized fluid through said male coupling member, the downward-opening bore having a lateral extension opening through the side of the spout stock, the spout stock having passageway means communicating the interior of said threaded female coupling with the space between said connector pin and said interior tube, said connector pin being constructed to fail under excessive loads before the spout stock and drill-pipe are damaged.

4. The combination claimed in claim 3, in which said means for maintaining further includes at least three axi-

ally aligned but circumferentially distributed spacer elements secured to the outside wall of said interior tube intermediate its ends.

5. The combination claimed in claim 4, in which said passageway means comprises a plurality of bore holes.

6. In combination:

a drill-pipe having a bit end and a drive end,

a bit carried by said bit end,

an interior tube positioned within said drill-pipe to define an annular space between the drill-pipe and the interior tube, said bit having passage means by which fluid can pass from said annular space into the interior tube,

and a spout stock secured to the drive end of said drill-pipe and adapted to transmit impact and rotation to said drill-pipe from the threaded male coupling member of a rotary-percussion drill which also delivers pressurized fluid through said male coupling member, the spout stock having a threaded female coupling at its upper end for receiving said male coupling member and having an internal passage communicating the centre of said interior tube with the exterior of the spout stock, the spout stock further having passageway means communicating the interior of said threaded female coupling with said annular space, whereby pressurized fluid can pass from said male coupling member into said annular space.

7. The combination claimed in claim 6, in which said passageway means comprises a plurality of bore holes.

References Cited

UNITED STATES PATENTS

2,657,016	10/1953	Grable	175—215
3,155,179	11/1964	Hunt	175—215
3,198,256	8/1965	Kirby	166—99
3,370,658	2/1968	Jansson	175—215

NILE C. BYERS, JR., Primary Examiner