APPARATUS FOR DRILLING AND SAMPLING ROCK FORMATIONS

Inventor: Ronald Oughton, Calgary, Alberta, Canada

Assignee: Shuttle Mountain Holdings Co. Ltd., Letheridge, Alberta, Canada

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Primary Examiner—David H. Brown
Attorney, Agent, or Firm—Stanley G. Ade

ABSTRACT

A double walled drill stem has a fluid driven piston on one end thereof which, by porting, reciprocates and strikes an anvil carrying a bit. The fluid exhausts downwardly around the bit and drives chips and the like upwardly through the inner portion of the drill stem, the fluid to drive the piston passing downwardly between the inner and outer drill stem members, the exhausted fluid carrying chips and dust and the like upwardly to the surface in a continuous manner.

13 Claims, 11 Drawing Figures
APPARATUS FOR DRILLING AND SAMPLING ROCK FORMATIONS

BACKGROUND OF THE INVENTION

Conventionally, percussive drills utilize a fluid such as air or drilling mud passing downwardly of the drill stem to the bit. This picks up debris formed by the bit and drives it upwardly around the outside of the drill stem between the wall of the hole being formed and the drill stem. This often results in dispersing further particles in the wall of the bore and under certain circumstances can cause collapsing of the bore. Conventional devices often use valves or the like to provide the percussive impact needed at the drill bit and these are easily clogged or jammed by particles of rock formed during the drilling operation. This of course means that the entire drill string has to be removed so that the clogging can be cleared.

Also when coring, it is conventional to use a reduced diameter core guide but if the core is not uniform, it will lodge in the reduced section of the inner core passage. This is often prevalent when a small layer of clay, etc., is reached during the drilling operation.

Conventional porting to the outside of the drill bit not only results, under certain circumstances, of caving but also these ports can let in water which can enter the internal mechanism thus making it impossible to continue or to finish a hole when the drilling fluid is shut off in order to add on additional lengths of drill stem.

SUMMARY OF THE INVENTION

The principle object and essence of the invention is to provide a device of the character herewithin described which enables a piston to be reciprocated by fluid under pressure and then the fluid to be exhausted downwardly and internally to the bit whereupon it picks up the chips and the like formed by the bit and exhausts them upwardly through the center of the assembly to the surface in a continuous manner.

Another object of the invention is to provide a device of the character herewithin described which eliminates all contact of the drilling fluid with the wall of the bore formed thus preventing cave-ins from occurring.

Yet another object of the invention is to provide a device of the character herewithin described which eliminates all valves inasmuch as automatic porting is provided for the routing of the pressure fluid.

A yet further object of the invention is to provide a device of the character herewithin described which is easily used for standard coring practices if desired.

Yet another object of the invention is to provide a device of the character herewithin described in which additional sections of the drill stem can easily be added to those already in the bore.

A still further object of the invention is to provide a device of the character herewithin described which, because of the lack of moving parts, does not become inoperative due to interference of the moving parts by chips, dust and the like formed during the drilling operation.

Still another object of the invention is to provide a device of the character herewithin described which is relatively inexpensive in manufacture, economical in operation and otherwise well suited to the purpose for which it is designed.

With the considerations and inventive objects herein set forth in view, and such other or further purposes, advantages or novel features as may become apparent from consideration of this disclosure and specification, the present invention consists of the inventive concept which is comprised, embodied, embraced, or included in the method, process, construction, composition, arrangement or combination of parts, or new use of any of the foregoing, herein exemplified in one or more specific embodiments of such concept, reference being had to the accompanying figures in which:

DRAWINGS

FIG. 1 is a longitudinal sectional view of the invention.

FIG. 2 is a sectional view of the invention shown within a bore hole and reduced in scale with reference to FIG. 1.

FIG. 3 is a cross sectional view of the anvil per se substantially along the line 3—3 of FIG. 1.

FIG. 4 is a cross sectional view of the outer shell or sleeve per se substantially along the line 4—4 of FIG. 1.

FIG. 5 is a cross sectional view along the line 5—5 of FIG. 1.

FIG. 6 is a side elevation of the anvil per se.

FIG. 7 is a fragmentary cross sectional view of one end of the outer shell or sleeve shown secured to one end of the outer casing.

FIG. 8 is a cross sectional view of the bit substantially along the line 8—8 of FIG. 1.

FIGS. 9, 10 and 11 show fragmentary side elevations of the three methods for providing rotation to the drill stem.

In the drawings like characters of reference indicate corresponding parts in the different figures.

PRELIMINARY DESCRIPTION

The device consists of outer and inner concentrically spaced drill stem section 10 having an outer casing 11 screw threadably secured to the outer section of the drill stem section 10 with a piston and cylinder assembly 12 mounted within the casing so that the piston can reciprocate and strike an anvil 13 which in turn has a drill bit assembly 14 secured to the outer end thereof and beyond the end of the casing 11. The piston reciprocates and strikes the anvil which in turn reciprocates with the bit in a percussive manner.

DETAILED DESCRIPTION

In detail, reference should first be made to FIG. 2 which shows the assembly within a bore 15 formed within rock bearing formations 16 and extending downwardly from ground level 17.

The drill string sections 10 terminate at an air swivel assembly 18 which is conventional in construction and includes an air intake 19 which is connected to a source of fluid under pressure. This fluid may, of course, be drilling mud or air but under normal circumstances is usually air.

An extension 20 extends upwardly from the inner portion of the drill stem sections and terminates in a discharge 21 through which chips and fluid are discharged in a continuous basis as will hereinafter be described.

A conventional collar assembly or ground seal 22 mounts the device at ground level in the usual way, to seal any fluid (air) which may otherwise escape to the
outside of the drill pipe. It permits proper return flow of the jet air through the inner bore.

The drill stem sections in this invention include an outer cylindrical tube or drill stem section 23 and an inner cylindrical tube or section 24 mounted concentrically within the outer section and being maintained in the desired concentric relationship by means of a spider 25 situated at either end thereof. These sections can therefore be added one to the other as a complete unit rather than individual inner and outer sections.

Under normal circumstances, the air intake 19 enters through the air swivel assembly 18 to the annular space 26 formed between the inner and outer sections 24 and 23, it being understood that the spiders 25 are apertured to permit passage of the fluid under pressure thereby.

Means collectively designated 27 are provided to connect the outer casing 11 with the lowermost drill stem section 10 and takes the form of a cylindrical adaptor sleeve 28 being screw threaded externally to the one end of the outer section 23 as clearly shown in FIG. 1 so that the outer wall of the sleeve 28 and the section 23 are flush.

The lower end 29 of the adaptor sleeve is reduced in diameter and screw threaded to receive the end 30 of the outer casing 11 which screw threadably engages same so that the outer wall of casing 11 is flush with the outer wall of the sleeve 28.

Forming part of the adaptor sleeve 28 is a compression head 31 which is cylindrical and an inner cylindrical casing 32 is shouldered as at 33 to engage within a shouldered portion 34 of the compression head. It then engages the end 35 of the inner section 24 of the lowermost drill stem section 10 as clearly shown. In this connection split rings 36 secure the inner casing 32 to the end 35 of the drill stem section 24 and also to the end 37 of the compression head 31.

The cylinder 38 of the piston and cylinder assembly 12 is in turn secured by the means of a rubber ring 39 to the other end of the compression head and extends downwardly therefrom as clearly shown.

Longitudinally extending ports or channels 40 are formed within the compression head and extend from the end 37 thereof to radially extending ports 42 formed adjacent the other end of the compression head and extending outwardly to the outer wall thereof. These ports and channels 40 and 42 communicate between the annular space 26 of the drill stem sections and a longitudinally extending annular channel 43 formed between the cylinder 38 and the inner wall of the outer cylindrical casing 30, said annular channel extending from adjacent ports 42 to a location indicated by reference character 44.

The piston 45 of the piston and cylinder assembly 12 is cylindrical in configuration and engages around the inner cylindrical casing 32 and within the cylinder 38.

Conventional anti-frictional means (not illustrated) are provided to reduce the sliding friction between the piston and the casing on the one hand and the piston and the cylinder on the other.

This piston is provided with a plurality of longitudinally extending channels or ports 46 extending from the head 47 thereof, along the length thereof to external radially situated ports 47 which extends through the outer wall of the piston as clearly shown.

Also provided on the piston 45 is an annular open ended channel 48 formed by a reduction of the diameter of the cylinder below the head 47, this reduced diameter and the cylinder wall 38 defining this channel 48. A plurality of ports 49 are formed through the cylinder wall 38 adjacent the lower end 50 thereof.

The outer casing 11 is provided with an annular shoulder 51 adjacent the end 50 of the cylinder which is retained therein by means of a rubber ring 52 in the usual manner and this annular shoulder acts as a fluid pressure seal at this point.

However, the casing increases in diameter below this shoulder to form an annular fluid passageway 52 which extends to adjacent the internally screw threaded end 53 of the outer casing 11.

Describing the operation of the piston and cylinder assembly, fluid under pressure is supplied downwardly through the outer annular space 26 between the outer and inner sections of the drill stem assembly 10. It is then routed through the passageways 40 and ports 42 in the compression head 31, to the annular channel 43 between the cylinder 38 and the outer casing 11.

It then passes through the radially extending ports 49 formed in the cylinder wall adjacent the end 50 and enters the annular chamber 48 between the wall and the piston, reacting between the shoulder 51 of the outer casing and the underside of the head 47 of the piston thus driving it in the direction of arrow 54 towards the compression head 31.

The piston moves in this direction, exhausting air through ports 46 and 47 until ports 47 are covered by the annular shoulder 51 at which time air in front of the piston head is compressed between the head and the compression head 31. This compressed air acts as a buffer and prevents the head of the piston striking the compression head 31. However, the piston moves towards the compression head 31 a distance sufficient to permit ports 47 to align with ports 49 in the cylinder wall at which time the fluid will be routed from the annular space 43, through ports 49, through ports 47 and channels 46 to the upper side of the piston head within the compression chamber between the piston head and the compression head 31. This immediately reverses the action of the piston reinforced by the compression of the air between the piston and the compression head and drives the piston downwardly or in a direction opposite to arrow 54 until it reaches the position shown in FIG. 1 whereupon the sequence repeats.

It has been found that with approximately 150 psi fluid pressure, a reciprocating rate for the piston can be obtained of approximately 3,200 strokes per minute.

Each time the position reaches the position shown in FIG. 1, the end 55 thereof strikes the anvil assembly 13.

A cylindrical anvil sleeve or outer shell 56 is screwed threadably engaged within the end 53 of the outer casing 11 and the anvil 13, which is cylindrical in configuration, is mounted between this shell and the inner casing 32 for percussive reciprocation thereon.

The anvil is shown in detail in FIGS. 3 and 6. It consists of a cylinder 57 having a plurality of radially extending bearing lugs 58 formed on one end thereof and a screw threaded portion 59 formed on the other end. A plurality of closed ended longitudinally extending slots 60 are formed within the wall of the cylindrical portion 57 intermediate the ends thereof.

The outer shell or anvil sleeve 56 is also cylindrical and a plurality of longitudinally extending portions 61 are formed on the inner surface thereof also having longitudinally extending slots 62 closed at one end thereof,
formed within these portions 61 as clearly shown in FIGS. 4 and 7.

A plurality of ball bearing 63 engages slots 60 and 62 which are complimentary, thus providing reciprocal bearing support for the anvil within the anvil sleeve 56.

The spaces between the bearing shoulders 58 and the portions 61 form an annular fluid passageway between the annular fluid passageway 52 and a further passageway 63' formed adjacent the end 64 of the anvil shell 56.

A bit assembly 65 screwed threadably engages the screw threaded end 59 of the anvil and is a sliding fit within the end 64 of the anvil sleeve as clearly shown in FIG. 1.

An annular flexible seal 66 extends between the anvil shell 56 and the anvil adjacent the annular space 63' and this seal is engaged with the wall of the anvil in such a manner that fluid under pressure can pass thereby downwardly towards the bit assembly 65 but fluid or debris cannot pass upwardly.

The bit assembly is conventional in construction insofar as the material and attachment of the bit inserts 67 are concerned. However, it is provided with a plurality of longitudinally extending channels 68 extending from the inner end of the bit to cross channels 69 which extend inwardly to the inner bore 70 of the bit. The channels 68 also communicate with a plurality of further channels 71 which extend to the face of the bit.

It will of course be understood that the hollow center 70 of the bit communicates with the interior of the inner casing 32 and thence to the inner section 24 of the drill stem component 10.

In operation, air reciprocates the piston as aforesaid and is exhausted downwardly through the annular channel 52, past the anvil 13 to the annular channel 63' whereupon it passes through the bit assembly 65 whereupon part of the air or fluid enters the inner bore 70 of the bit and moves upwardly therefrom forming a jet action. Other air or fluid passes through the longitudinal drilling 71 to the face of the drill bit and picks up chips or debris and drives them towards the inner bore whereupon they are picked up by the jet action of the air passing upwardly through the assembly to the surface to be discharged through the discharge 21 in a continuous manner.

Under these circumstances, there is no chance of the fluid disturbing the walls of the bore being formed thus eliminating the majority of causes of cave-ins and the like. Furthermore, due to the fact that the only moving part is the reciprocating piston and the percussively reciprocating anvil, there is no chance of dust or debris interfering with the operation of the device inasmuch as no moving valves are required.

If it is desired to core, a coring bit of special design is placed on the end of the anvil and coring can be undertaken in the conventional manner.

Under certain circumstances, a single wall drill stem section may be used. If this is so, then the anvil would be solid at the lower end thereof so that the fluid would pass outwardly of the drill bit and then upwardly between the drill bit and the drill stem in the conventional manner.

However, the preferred embodiment provides for the passageway of the fluid and the chips centrally through the drill stem to be discharged externally as hereinbefore described.
ing including a plurality of balls engaging between said anvil and said casing, longitudinal channels formed in the wall of said anvil and in said casing, said balls being mounted in said channels, and fluid passageway means between said anvil and said casing communicating between each side of said anvil.

2. The assembly according to claim 1 which includes an anvil sleeve screw threadably engageable with the lower end of said casing and forming part thereof, said anvil reciprocating within said sleeve.

3. The assembly according to claim 1 in which said means securing said casing by one end thereof to one end of the outer section of said drill stem section including an adaptor sleeve screw threadably engaging said outer sleeve and screw threadably engaging said casing, a ported compression head forming part of said adaptor sleeve and being secured by one end thereof to one end of the inner section of said drill stem section, the cylinder of said piston and cylinder assembly being secured by one end thereof to the other end of said compression head, and by other end thereof internally to said casing, ports formed between the inner wall of said casing and said cylinder communicating with said ported compression head.

4. The assembly according to claim 3 which includes an inner cylindrical casing secured within said compression head and to said one end of the inner section of said drill stem section, said piston being cylindrical and reciprocating upon said inner casing and within said cylinder, said cylinder and said compression head defining an annular compression chamber.

5. The assembly according to claim 4 in which said piston includes fluid connecting means extending from the head thereof along the length thereof to exterior ports in the wall of said piston, further ports formed in the wall of said cylinder adjacent one end thereof, said ports in said cylinder and in said piston aligning when said piston is at one end of the stroke thereof.

6. The assembly according to claim 1 which includes means routing internally the exhausted fluid from said piston and cylinder assembly to said bit assembly, and means communicating between said bit assembly and the inner section of said drill stem section whereby said exhausted fluid picks up chips and the like formed by said bit assembly and exhausts same through said inner drill stem section.

7. The assembly according to claim 6 in which said means securing said casing by one end thereof to one end of the outer section of said drill stem section includes an adaptor sleeve screw threadably engaging said outer section and screw threadably engaging said casing, a ported compression head forming part of said adaptor sleeve and being secured by one end thereof to one end of the inner section of said drill stem section, the cylinder of said piston and cylinder assembly being secured by one end thereof to the other end of said compression head, said cylinder being secured by the other end thereof internally to said casing, ports formed between the inner wall of said casing and said cylinder communicating with said ported compression head.

8. The assembly according to claim 1 which includes an inner cylindrical casing secured within said compression head and to said one end of the inner section of said drill stem section, said piston being cylindrical and reciprocating upon said inner casing and within said cylinder, said cylinder and said compression head defining an annular compression chamber.

9. The assembly according to claim 8 in which said piston includes fluid connecting means extending from the head thereof along the length thereof to exterior ports in the wall of said piston, further ports formed in the wall of said cylinder adjacent one end thereof, said ports in said cylinder and in said piston aligning when said piston is at one end of the stroke thereof.

10. A drilling assembly including outer and inner concentrically spaced drill stem sections and a source of fluid under pressure supply to said drill stem section between the outer and inner walls thereof; comprising in combination an outer casing, means securing said casing by one end thereof to one end of the outer section of said drill stem section, a piston and cylinder assembly mounted within said casing, an anvil reciprocal within said casing, the piston of said piston and cylinder assembly adapted to strike one end of said anvil, and a drill bit assembly operatively secured to the other end of said anvil beyond the other end of said casing, means cooperating between said casing and said piston and cylinder assembly to route fluid under pressure to each side of said piston alternately to reciprocate same whereby said piston strikes said anvil successively, and means mounting said anvil within said casing for percussive reciprocation therein, said means securing said casing by one end thereof to one end of the outer section of said drill stem section including an adaptor sleeve screw threadably engaging said outer section and screw threadably engaging said casing, a ported compression head forming part of said adaptor sleeve and being secured by one end thereof to one end of the inner section of said drill stem section, the cylinder of said piston and cylinder assembly being secured by one end thereof to the other end of said compression head, and by the other end thereof internally to said casing, ports formed between the inner wall of said casing and said cylinder communicating with said ported compression head, an inner cylindrical casing secured within said compression head and to said one end of the inner section of said drill stem section, said piston being cylindrical and reciprocating upon said inner casing and within said cylinder, said cylinder and said compression head defining an annular compression chamber, said means mounting said anvil for percussive reciprocation within said casing including an anvil sleeve secured to said casing at one end thereof and forming part thereof, said anvil being of cylindrical configuration and reciprocating upon said inner casing and within said sleeve, at least one closed ended longitudinally extending channel formed in the inner wall of said sleeve, corresponding channels formed in the outer wall of said anvil and ball bearings mounted in said channels for journaling said anvil within said sleeve as aforesaid, and fluid passage means between said anvil and said sleeve communicating upon each side of said anvil.

11. The assembly according to claim 10 which includes means routing internally the exhausted fluid from said piston and cylinder assembly to said bit assembly, and means communicating between said bit assembly and the inner section of said drill stem section whereby said exhausted fluid picks up chips and the like formed by said bit assembly and exhausts same through said inner drill stem section.

12. The assembly according to claim 10 in which said piston includes fluid connecting means extending from
the head thereof along the length thereof to exterior ports in the wall of said piston, further ports formed in the wall of said cylinder adjacent one end thereof, said ports in said cylinder and in said piston aligning when said piston is at one end of the stroke thereof.

13. The assembly according to claim 10 in which said means mounting said anvil for percussive reciprocation within said casing including a plurality of balls engaging between said anvil and said casing, longitudinal channels formed in the wall of said anvil and in said casing, said balls being mounted in said said channels, and fluid passageway means between said anvil and said casing communicating between each side of said anvil.

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