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A. ARUTUNOFF

2,709,574

DIAMOND DRILL

Filed April 16, 1953

FIG. 1.

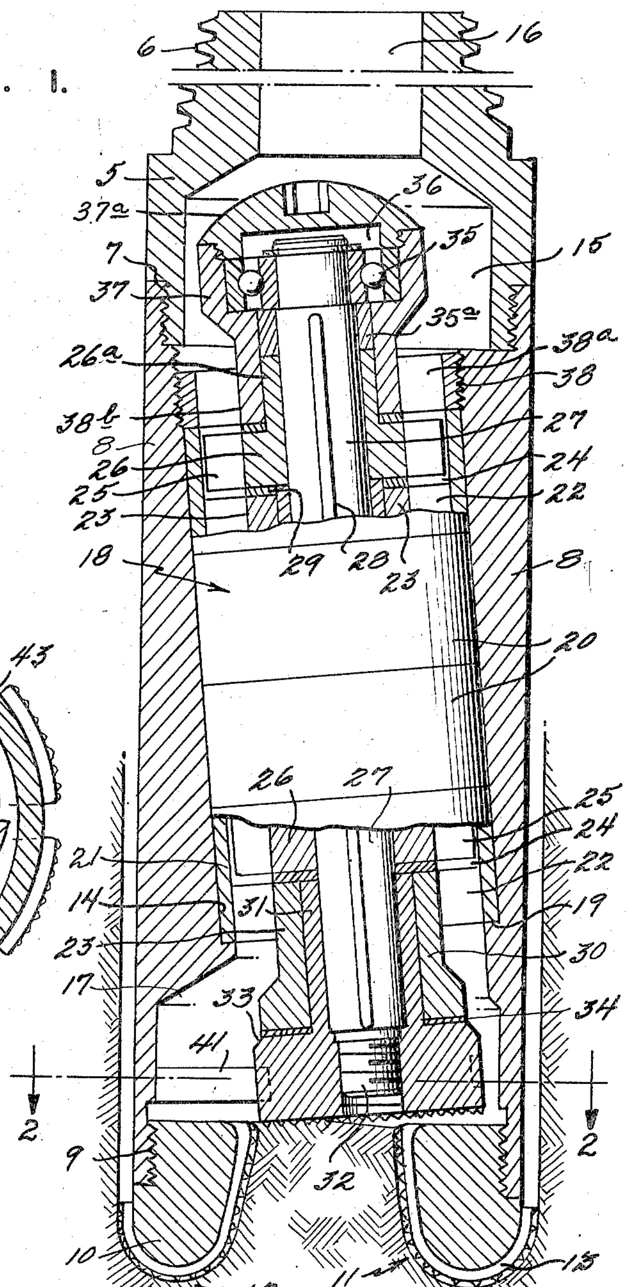
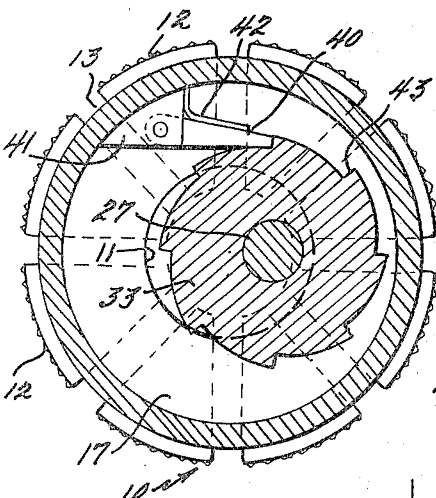


FIG. 2.



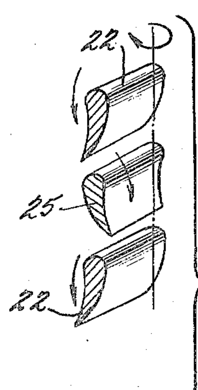


FIG. 3.

INVENTOR

ARMAIS ARUTUNOFF

BY

ATTORNEY

United States Patent Office

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DIAMOND DRILL

Armais Arutunoff, Bartlesville, Okla.

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8 Claims. (Cl. 255—72)

This invention consists in new and useful improvements in a rotary rock drilling bit and more particularly a diamond studded bit having a main cutting head provided with a supplemental core-removing or disintegrating bit, the present invention being a modification of and improvement on the structures illustrated and described in my former U. S. Patents Nos. 2,587,429 and 2,619,325.

As pointed out in the specifications of my said former patents, diamond bits ordinarily used in connection with hard rock drilling operations by the rotary method, are limited in their penetrating speed by the lack of cutting speed at the central portion of the bit. The lack of cutting speed at the center of the rotary bit materially retards the operation because the rock in the center portion is not actually cut but must be crushed by the weight of the bit before progress is possible. It is therefore, the object of my invention to provide a rotary bit having a main cutting head of the type which provides a central core-receiving recess at its cutting end and is provided with a supplemental core removing bit so arranged with respect to the core receiving recess as to disintegrate the core as the main cutting head progresses.

Another object of the invention is to provide a self-contained drilling tool wherein the supplemental core-removing bit is driven by a fluid operated motor housed in the main body structure and actuated by the circulating drilling liquid. This drilling liquid is at best, considerably laden with abrasive material and it is an object of my invention to provide a fluid-operated motor consisting of an axial-type turbine, which inherently can withstand operation with abrasive liquid for a prolonged period of time.

Another object of the invention is to provide in a diamond bit driving assembly, a turbine driven disintegrator or supplemental core removing bit, the axis of which is eccentric with respect to the axis of the main bit.

Still another object is to provide in an assembly of this type, a core disintegrator wherein the eccentric axis is also inclined with respect to the axis of rotation of the main bit.

A further object of the invention is to provide in an assembly of the type referred to, means whereby the pressure contact area of the core disintegrating tool with the core, is reduced to an extent well within the capacity of the thrust bearings of the driving turbine.

A still further object is to provide a diamond bit assembly including a main cutting head and a supplemental core disintegrating tool driven by an axial turbine located within the main head and provided with auxiliary means such as a ratchet and dog arrangement, for operatively connecting the main cutting head to the core disintegrating tool, for the event that the volume of circulating liquid should become insufficient for revolving the core-disintegrating tool at a higher relative speed than the rotating speed of the mechanically driven main cutting head.

With the above and other objects in view which will appear as the description proceeds, my invention consists in the novel features herein set forth, illustrated in the accompanying drawings and more particularly pointed out in the appended claims.

Referring to the drawings in which numerals of like character designate similar parts throughout the several views,

Figure 1 is a view partly in longitudinal section and partly in elevation, showing my improved bit assembly.

Figure 2 is a transverse sectional view taken on line 2—2 of Figure 1, showing the auxiliary driving means, and

Figure 3 is a diagrammatic view showing the preferred cross-sectional profile and relationship of the fixed and rotary turbine blades.

In the drawings, referring first to Figure 1, 5 represents the base portion of a hollow cylindrical shank or coupling member, reduced and threaded as at **6** to facilitate connection to the usual hollow drill stem (not shown). The cylindrical base portion **5** of the shank is recessed and internally threaded as at **7**, to receive complementary threads at the upper end of a cylindrical body **8** which serves both as a housing for the fluid operated motor to be described, and as a supporting member for the main cutting head.

The lower end of the body **8** is reduced and threaded as at **9**, to engage complementary internal threads on the upstanding connecting flange of the main cutting head **10**, the cutting portion of which is preferably diamond-studded and extends radially beyond the periphery of the cylindrical body **8**. The central portion of the main cutting head **10** is recessed at **11**, to form an annular cutting area which is preferably divided into a series of segmental cutting units **12**, by an intervening series of channels **13** which radiate from and communicate with the central recess **11**. As seen in the drawings, each of these channels extends radially entirely around the cutting surface of the head **10**, so as to establish free communication from the central recess **11** to the periphery of the head.

As seen in Figure 1, the central portion of the cylindrical body **8** is diagonally drilled to provide a generally longitudinally extending chamber **14**, the longitudinal axis of which is inclined with respect to the axis of rotation of the cylindrical body **8** and head **10**. The chamber **14** opens at its upper end into a fluid inlet cavity **15** which communicates with the central fluid passageway **16** in the shank **6**, its lower end opening into an annular transverse recess **17**, located above the main cutting head **10** and extending radially beyond the core receiving recess **11** in the latter. As will later appear, this lower recess **17** houses the cutting end of the core disintegrating bit and also serves as a fluid discharge cavity.

The chamber **14** houses a fluid operated motor generally indicated by the numeral **18**, with its lower end supported on an annular shoulder **19**, formed at the lower extremity of the chamber **14**. The fluid motor **18** is coaxial with the inclined chamber **14** and consists of a multi-stage turbine assembly comprising a series of superimposed units **20** fitted closely within the cylindrical confines of the chamber **14**.

Each of the turbine units **20** comprises an annular housing **21**, which carries a series of fixed blades **22** which radiate from a central bearing sleeve **23**. The upper half of each housing forms an impeller recess **24** to accommodate the rotary blades **25** of the turbine rotor.

The blades **25** of each rotor radiate from a central annular support **26** which is reduced and extended vertically as at 26^a, to rotatably engage within the sleeve **23** of the housing **21** next above. The central supports **26** are drilled longitudinally so that they may be superimposed on a shaft **27** to which they are operatively connected by means of a spline **28**. The shaft **27** is concentric with the axis of the turbine assembly 18 and the support extension 26[a] of each rotor 25 is of a length to extend sufficiently beyond the respective sleeve 23, to abut the under side of the next impeller, with thrust washers 29 interposed between the end of each sleeve and the corresponding impeller.

As will be seen in the diagrammatic illustration in Figure 3, the fixed blades 22 and the rotary blades 25 of the turbine, are oppositely directed and respectively, of suitable foil profile to enhance the flow of operating fluid through the turbine, for rotating the shaft 27 and the core disintegrating tool to be described.

The sleeve 23 of the lowermost housing 21 is extended downwardly as at 30 to form a radially enlarged annular bearing support for the lower end of the shaft and the core disintegrating tool. The lower extremity of the shaft 27 is reduced as at 32 to engage a central threaded opening in a supplemental core disintegrating tool or disc 33 which is preferably provided with an upwardly directed bearing sleeve 31 adapted to engage shaft 27 between the latter and the bearing support 30, a thrust washer 34 being interposed between the disc 33 and the lower end of the support 30.

The turbine shaft 27, carrying the supplemental bit 33 is maintained in its proper radial position by the bearing surfaces of the supports 26, 26[a] and corresponding sleeves 23. The auxiliary core disintegrating unit 18 is maintained in place in the chamber 14 by means of a retaining member 38 which is screw threaded into the upper end of the chamber 14 as shown in Figure 1 and abuts the upper edge of the uppermost unit 20.

This retaining member 38 is ring shaped and provided with a series of radiating fixed blades 38[a] similar to fixed blades 22 in the series of units 20 which serve as the upper fixed blades of the assembly and its central sleeve portion 38[b] which is coaxial with the sleeves 23, is extended upwardly and enlarged radially, to form a grease filled bearing housing 37. A ball bearing assembly 35 is located in the grease chamber 36 within the housing 37 and supports the upper end of the shaft 27, a threaded closure 37[a] being inserted in the top of the housing 37 to close the chamber 36 and retain the bearing 35. A bushing 35[a] engages the upper end of shaft 27 between the bearing 35 and the upper end of the uppermost support extension 26[a]. The axial position of the shaft 27 and the rotary blades 25 is governed by the thrust washers 29 and will be limited by the bearing 35 after the thrust washers have undergone some wear.

Thus, it will be seen that I have provided an auxiliary unit which may be easily inserted and removed from the chamber 14 for purposes of repair and maintenance.

As previously indicated, the axis of the turbine 18 and the supplemental bit 33 is inclined to the axis of rotation of the main cutting head 10, so that the supplemental bit 33 is presented to the core within the recess 11, not only eccentrically but at an inclined angle, as will be apparent from Figure 1. An advantage of this arrangement lies in the fact that the thrust load on the turbine shaft can be kept within very low limits as the pressure contact area of the disintegrator 33, with the core in recess 11, becomes a small portion of what it would be if the axis of the disintegrator were parallel with that of the main drilling head.

Another important advantage of the inclined relationship of the axis of the turbine 18 with respect to the longitudinal axis of the cylindrical body 3, is that it makes possible the use of a turbine of considerably larger diameter, in a main housing cylinder of a given diameter. In other words, if the axis of the turbine were parallel with the axis of the housing cylinder, and offset to one side thereof so as to provide the desired eccentric relation of the supplemental bit 33, the size of the parallel turbine would be restricted to a radius extending from the offset axis of the turbine to the parallel wall of the housing. By inclining the axis of the turbine so that it intersects the longitudinal axis of the housing, as shown in Figure 1, it will be seen that while the eccentric relation of the supplemental bit 33 is maintained, the mass of the turbine is shifted toward the center of the housing so that the diameter of the turbine can be considerably extended, without contacting the wall of the housing. It will of course be understood that the dimensions of the disintegrator bit 33 are sufficient to afford long life and that the cutting surface thereof is preferably diamond studded.

In the operation of the structure thus far described, the cutting head assembly is lowered into the hole on a drill stem attached to the shank 6 and is rotated thereby. As the annular cutting head 10 progresses, an upstanding core is formed in the central recess 11. During this operation fluid under pressure is constantly introduced through the inlet passageway 16, into the inlet chamber 15 and thence to the inlet end of the turbine 18, causing the shaft 27 to constantly rotate at a speed greater than that of the head 10. Rotation of the shaft 27 causes simultaneous rotation of the angularly disposed, eccentric core-disintegrating tool 33, which constantly cuts away the core formed in the recess 11 as the main cutting head descends.

As before stated, the angle of presentation of the cutting face of the rotating core disintegrating tool 33 greatly facilitates this operation as, instead of maintaining an overall cutting engagement within the entire top plane of the core, it travels in a circular path around the core with its cutting engagement eccentric to the core's axis. This arrangement maintains the thrust load on the turbine shaft within very low limits and greatly prolongs the life of the equipment.

Turning now to Figure 2 of the drawings, I have shown an auxiliary drive mechanism adapted to effect rotation of the auxiliary core disintegrating tool through mechanical connection with the main cutting head assembly, in the event the pressure of the operating fluid fails to drive the turbine at a speed in excess of the rotation of the cutting head 10.

This auxiliary drive mechanism comprises a spring-loaded pawl 40, pivotally mounted on a support 41 secured to the inner wall of the cavity 17. A leaf spring 42 normally urges the pawl 40 into engagement with the periphery of the auxiliary cutting tool 33 which is provided with a series of notches or ratchet teeth 43. Thus, the clockwise rotation of the auxiliary cutting tool, in excess of the speed of the main cutting head 10, causes the ratchet teeth 43 to pass idly by the spring loaded pawl 40. However, upon a decrease in the speed of rotation of the auxiliary cutting tool, the clockwise rotation of the main cutting head 10 overtakes the tool and the pawl 40 engages one of the ratchet teeth 43 and causes the tool 33 to rotate with the head 10.

During the entire operation, the pressure fluid which has been utilized to drive the turbine, leaves the turbine through the discharge end of the lowermost unit 20 and enters the discharge cavity 17, from whence it passes over the disc 33 and through grooves 13 to wash away the cuttings both from the main cutting head 10 and the auxiliary disintegrating tool 33.

It will thus be seen that I have provided a relatively simple self-contained drilling tool assembly which is sturdy in construction, efficient and positive in operation, and easily assembled and dismantled for purposes of cleaning and repair. The novel arrangement of the eccentric and inclined supplemental bit which constantly overlies the core and is operated by the same fluid utilized to wash away the cuttings, causes a progressive disintegration of the core without the necessity of withdrawing the drill head from the hole to remove the core whenever a core barrel becomes full.

From the foregoing it is believed that my invention may be readily understood by those skilled in the art without further description, it being borne in mind that numerous changes may be made in the details of construction without departing from the spirit of the invention as set forth in the following claims. So, for example, instead of being diagonally bored, the part 3 may be in the form of a piece of pipe in which the turbine assembly in a cylindrical housing of its own, can be diagonally mounted.

What I claim is:

1. A drilling assembly adapted to be rotated by a drill pipe, comprising a driving member, a housing forming an extension of said driving member, a core bit carried by and coaxial with said housing and having a central core receiving recess, opening into said housing, an axial type, fluid-operated turbine in said housing, having an axis which is inclined and intersects the longitudinal axis of said housing, a shaft concentric with and operated by said inclined turbine, and a cutting head coaxially connected to said inclined turbine shaft and located in said housing in eccentric relation to said core receiving recess.

2. An assembly as claimed in claim 1, including means for introducing a circulating fluid into said housing for driving said turbine.

3. A drilling assembly as claimed in claim 1, including means for preventing the rotation of said cutting head at a speed slower than that of the core bit.

4. A rotary bit comprising a connecting shank, a cylindrical body secured to said shank and depending therefrom, a main core bit carried at the lower extremity of said body and having a central core receiving recess at its cutting end, forming an annular cutting portion, a chamber in said body, housing a fluid actuated motor and motor shaft, the rotary axis of which is inclined and intersects that of said body, a cavity in said body coaxial with the body, located between said motor and main core bit and extending radially beyond the core receiving recess in the latter, a supplemental core removing bit carried coaxially by said inclined motor shaft and lying in said cavity in eccentric relation to the axis of the core-receiving recess, with its radial boundary overlying the axis of the latter, means for admitting fluid under pressure to said motor chamber for operating the motor, and said chamber being in fluid communication with said cavity, whereby said fluid is discharged adjacent the cutting surfaces of the bits.

5. A rotary bit as claimed in claim 4 wherein said fluid actuated motor comprises a multi-stage axial turbine.

6. A rotary bit comprising a connecting shank, a cylindrical body secured to said shank and depending therefrom, a main core bit carried by the lower extremity of

said body and having a central core receiving recess in its cutting end, forming an annular cutting portion, a chamber in said body, housing a fluid actuated motor and motor shaft, the axis of which is inclined and intersects the axis of said body, a cavity in said body coaxial with the body, located between the motor and main core bit and extending radially beyond the core receiving recess in the latter, a supplemental core removing bit carried coaxially by said motor shaft and lying in said cavity in eccentric relation to the axis of the core receiving recess, with its radial boundary overlying the axis of the latter, means for admitting fluid under pressure to the motor chamber for operating the motor, said chamber being in fluid communication with the cavity, whereby said fluid is discharged adjacent the cutting surfaces of the bits, and auxiliary driving means for operatively connecting said body to said supplemental bit upon a reduction in the speed of rotation of said supplemental bit, below that of said body.

7. Apparatus as claimed in claim 6, wherein said auxiliary driving means comprises a pawl and ratchet assembly interposed between said body and said supplemental bit.

8. A self-contained drilling assembly comprising a connecting shank, a cylindrical body secured to said shank and depending therefrom, a main core bit carried at the lower end of said body and having a central core receiving recess at its cutting end, forming an annular cutting portion, a cylindrical chamber in said body, terminating at its lower end in a fluid discharge cavity which extends radially beyond the core-receiving recess, an auxiliary core-disintegrating unit removably housed in said chamber and including a fluid actuated turbine and turbine shaft, the axis of said auxiliary unit being inclined and intersecting the axis of rotation of the main core bit a core disintegrating disc fixed concentrically on said shaft and located in said cavity in eccentric relation to said core receiving recess, with its radial boundary overlying the axis of the latter, means for admitting fluid under pressure to said turbine, and said chamber being in fluid communication with said cavity, whereby fluid is discharged adjacent the cutting surfaces of the bit and disc.

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