

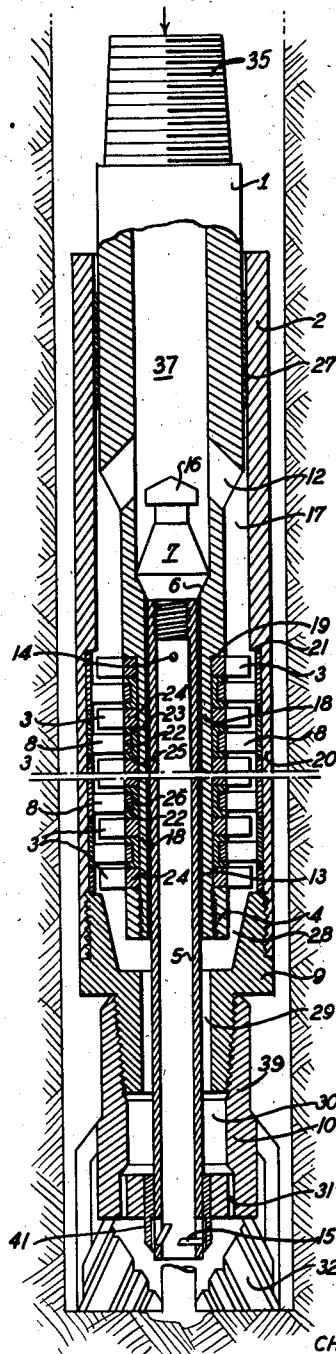
July 12, 1960

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2,944,792

TURBINES FOR DRILLING AND CORING

Filed May 16, 1957



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2,944,792

TURBINES FOR DRILLING AND CORING

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Filed May 16, 1957, Ser. No. 659,635

Claims priority, application France May 28, 1956

6 Claims. (Cl. 255—4)

This invention relates to turbine driven units for drilling wells and more particularly to improvements in the turbines of drilling units constructed to produce cylindrical cores of the earth or rock formations penetrated thereby.

A coring drill turbine or turbo-corer usually includes a sleeve-like body member which carries the stationary turbine blades and which constitutes the stator thereof. The body member is constructed to be directly connected to the lowermost pipe section of a drill string and to be supported in depending relation thereby. While the body member is securely connected to the drill string, it cannot be considered as a truly stationary member because it is actually subject to a certain variable torsion due to the force applied to the drilling bit and to the elasticity of the drill string. Further, it may be found desirable under certain drilling conditions to impart a rotation, in one direction or the other, to the drill string itself. Therefore, it is believed more accurate to state that the stator of the usual turbo-corer is quasi-fixed or fixed with relation to the drill string.

Located concentrically with such body member is a hollow shaft which bears the rotor elements of the turbine and the drilling bit. Usually the shaft is rotatably supported by the body member through a system of bearings which are independent of the rotor and stator elements and are axially spaced relative to these elements. Mounted within the turbine shaft is a removable coring tube designed to receive and to retain the drilled core and to hold the latter when the coring tube is removed from the turbine. Because of the danger of possible breakage of the core, the coring tube is not permitted to rotate with the shaft, but is connected to the body member. According to one known method of accomplishing this, the coring tube is provided at its upper end with a plug which has a tapered body and which seats in a conical seat provided in a fixed member connected to the body member. The plug is maintained securely in place on the seat during the operation of the turbine by the pressure of the circulating and power transmitting fluid which drives the drilling tool, through the turbine, and which usually consists of a drilling mud flowing under pressure. As a result of this arrangement, the coring tube, like the body member of the turbine, is fixed with relation to the drill string during the operation of the turbine.

The present invention has for its primary object to provide a more simply constructed turbo-corer in which the coring tube is mounted on a hollow turbine shaft that is stationary with relation to the outer sleeve-like body member or casing which is rotated about such shaft by the action of the power transmitting fluid on the rotor and stator blades of the turbine. This is accomplished by directly connecting the shaft to the drill string so that it is fixed with relation to such string. The coring tube in this construction is mounted within and directly supported by the shaft. The stator elements are mounted

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on the shaft along an exterior portion opposite the contacting rotor elements of the turbine which are secured to the sleeve-like body member which is rotatably mounted upon the shaft. Because of this construction, the two stationary parts of the turbine, namely, the stator and the coring tube, are both arranged concentrically within the movable part, the rotor. Thus, the part of the turbine that is rotating at a high speed, is only directly associated with one stationary part. This arrangement therefore is less complicated and less costly to maintain and service than prior known constructions in which the rotating part is located between and directly associated with two stationary parts of the turbine.

Other objects and advantages of the invention, as well as the novel details of construction thereof will become apparent from the following description when read in connection with the accompanying drawing which shows by way of example, in longitudinal section, a turbo-corer embodying the features of the invention.

As shown in the drawing, the shaft 1 of the turbine is tubular in shape and has associated therewith an outer casing or sleeve member 2 which rotates freely about the shaft 1. A set of stator blades 3 is mounted on the shaft 1 near the lower end thereof, being held in assembled relation thereon by the locking nut 4. A coring tube 5 is supported by and positioned within the shaft 1, such support being provided by the inwardly inclined annular shoulder 6 and the cooperating plug member 7 which is provided with a complementary seating surface, this plug being secured in tube 5 as by welding or by being threaded therein. The rotor blades 8 are assembled within casing 2 in stacked and interleaved relation with the stator blades and are supported by this casing, being held in place by the ring nut 9 which in turn carries threads on the exterior surface on its lower end to which the sleeve extension 39 of the drilling tool 10 is attached. The shaft 1 is provided with an externally threaded portion 35 at the upper end thereof for attaching the shaft 1 in fixed relation to the drill string and for supporting the turbine assembly on the drill string. The further details of the embodiment shown will be described in connection with the following description of the operation of the device.

The drilling mud flowing down through the drill string under pressure continues through the upper end of the hollow shaft 1 and through the bore 37 of the upper portion to the outlet ports 12 leading to the space 17 between the hollow shaft and the casing 2 which leads to the turbine proper. The drilling mud flowing down through the hollow shaft 1 exerts pressure on the plug 7 to maintain the latter fixed in position within the shaft. As is shown in the drawing, the plug 7 has an annular tapering seating surface adapted to seat in a correspondingly shaped seat 6 provided in the shaft below the ports 12. When so seated under the pressure of the drilling mud, the plug 7 prevents any passage of the circulating fluid into the portion of the shaft bore 37 above the tapered seat. It will be noted that the shaft bore 37 above the seat is of uniform diameter and that below such seat it has a uniform reduced diameter. The seat may therefore be considered as dividing the shaft into upper and lower portions. The plug 7 is secured to and supports in depending relation the coring tube 5 which extends axially of the turbine within the lower portion of the shaft. The coring tube has an external diameter less than the internal diameter of the lower portion of the shaft so as to provide an axially extending, annularly-shaped space 13 between such tube and the shaft from the plug seat down to the lower end of such shaft. The coring tube 5 is provided with one or more openings 14 in its side wall adjacent its upper end for the purpose of relieving the pressure on

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drilling mud entrapped in the tube 5 as the core advances upwardly in the tube and to permit the mud to escape into the annular space 13 from which it discharges into an area where the mud is under a pressure corresponding to the pressure at the outlet of the turbine section.

The coring tube 5 extends downwardly beyond the lower end of the shaft 1 to a point adjacent the rotary cutters of the drilling tool 10. The tube 5 at this lower end bears in a bushing 41 which is secured in the drilling tool 10 and is rotatable with this tool. The bottom end of the coring tube 5 is provided with spring pressed ratchets 15 which are biased inwardly toward the core and aid in severing the core from the earth formation upon upward movement of the coring tube when the core is to be severed and withdrawn. The upper end 16 of the coring tube supporting plug 7 is formed to enable it to be engaged by a suitable tool and withdrawn upwardly through the shaft 1 together with the coring tube and the core that has been formed in the tube during the coring operation. It will be understood that the plug 7 and coring tube 5 may be withdrawn upwardly through both the upper portion of the shaft and the drill string without detaching the turbo-corer unit, and likewise, if desired, the coring tube may be returned to its position within the shaft for obtaining a further core section without raising the drill string. During the lifting of coring tube 5 the core is retained inside the same by the ratchets 15.

The drilling mud flowing down through the shaft 1 is discharged through the spaced ports 12 into an annular chamber or passage 17 formed between shaft 1 and the outer sleeve-like casing 2 of the turbo-corer. As previously indicated, the shaft constitutes the stator of the turbine and has mounted upon the blade-carrying section 18 thereof the fixed stator elements which include blades 3. These stator elements are secured by suitable means such as keys and keyways (not shown) on the shaft between a shoulder 19 formed at the juncture of shaft section 18 with the main body of the shaft 1 and the nut 4 which is in threaded engagement with the lower end of shaft section 18. The rotor elements which include blades 8 of the turbo-corer illustrated are similarly mounted on that portion of the rotatable casing 2 that is co-extensive with section 18 of the shaft 1 and which is designated by the numeral 20. The rotor elements and blades 8 are secured in position between a shoulder 21 formed in sleeve or casing 2 at the upper end of section 20 and a ring nut 9 threadedly connected to the lower end of casing section 20. The stator and rotor elements and blades 3 and 8, respectively, are constructed similarly to the stator and rotor elements and blades in the turbine construction disclosed in my copending application Serial No. 660,405, filed May 20, 1957, corresponding to French appln. No. P.V. 3826, filed May 28, 1956, so that in addition to performing the normal turbine functions for which they were designed, they form part of and function in the nature of a multiple collar thrust bearing unit to support and center the rotor casing 2 and to take care of the thrust thereof.

As in the turbine structure described in more detail in my said copending application, the rotor elements which comprise blades 8 of the instant turbine constitute the movable parts of the thrust bearing unit and the stator elements which comprise blades 3 constitute the fixed parts of such unit. Similarly, there are located between the rotor and stator elements of the turbine, stationary annular U-shaped bearing shoes formed of any suitable bearing material such as for example, a suitable bearing metal or a synthetic rubber such as neoprene. The annular U-shape of these bearing shoes is such that each provides an outwardly opening annular groove into which an annularly-shaped portion 22 of a rotor element carried at the end of the blade 8 may be contained. The upper side wall 23 of each U-shaped shoe is located between the annularly-shaped portion 22 of each rotor element 8 and the annularly-shaped portion 24 of the stator ele-

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ment carrying blade 3 positioned adjacently above each such rotor element and its blade 8. The lower wall 25 of each U-shaped shoe is located between such rotor portion 22 and the annularly-shaped portion 24 of the stator element and its blade 3 positioned adjacently below such rotor element and its blade 8. The inner wall 26 of each U-shaped shoe is sandwiched between the portion 22 of its corresponding rotor element 8 and the shaft section 18. The rotor 2 may also be guided and supported at its upper end on shaft section 1 by a radial bearing 27 which is carried by the shaft 1 so as to be disposed in rotative bearing relation to the inner surface of rotatable sleeve or casing member 2.

The drilling mud discharging from the downstream end of the turbine after passing successively through the blades 3 and 8 flows downwardly through a passageway 28 formed between the nut 4 and the ring nut 9 and thence through an annular passage 29 between the coring tube 5 and the inner wall surface of the ring nut 9. This annular passageway 29 opens into an enlarged annular passageway 30 defined by the coring tube and the inner wall surface of the sleeve extension 39 of the drilling tool. The drilling mud after traversing these passageways discharges from the lower end of the passage 30 through a plurality of annularly arranged passages 31 into the vicinity of the rotary cutters 32.

The coring tube 5 at its upper end is provided with a ring of spaced discharge ports 14 which put the top end of the chamber defined by the coring tube into communication with the upper end of the annular space 13 between such coring tube and the shaft. Since the lower end of chamber 13 is in communication with the discharge passageway at the downstream end of the turbine, the pressure in chamber 13 approximates the hydrostatic pressure of the column of drilling mud at the point in the bore hole outside the turbine and at the level of the discharge from the turbine. This pressure is, of course, very substantially below that prevailing within shaft 1 above the turbine. Because of the provision for communication between the interior of the coring tube and a point of relatively low pressure in the flow of the drilling mud, any tendency for the pressure to build up in the drilling mud initially present in the coring tube 5 due to rise of the core of the earth formation into the tube as the drill penetrates the formation is avoided and resistance to such penetration that otherwise might occur is avoided. The expelled drilling mud flows down through the annular chamber 13 to join with the drilling mud being discharged from the downstream end of the turbine.

While I have hereinabove described and illustrated in the drawing a preferred embodiment of my invention, it will be understood that various changes and modifications of the construction thereof may be made without departing from the invention which is not to be deemed as limited otherwise than as indicated by the scope of the appended claims.

I claim:

1. A coring turbine unit comprising a tubular shaft adapted to be connected at a given end thereof to a drill string in fixed relation to said drill string, a sleeve disposed coaxially with the axis of said shaft and providing a wall of the sleeve extending about said shaft along a length of said shaft and in spaced relation thereto to define between said shaft and said sleeve an annular passage for flow of driving fluid through said passage generally along said axis in the direction from said given end of the shaft toward the other end thereof, means supporting said sleeve on said shaft for rotation of said sleeve on said shaft axis, stator elements carried by said shaft, rotor elements carried by said sleeve for rotation therewith, said stator and rotor elements respectively providing stator and rotor turbine blades disposed in said passage in cooperative relation to each other and so as to be engaged by said driving fluid for effecting

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movement of said rotor blades and elements with respect to said stator blades and elements to produce rotation of said sleeve about said shaft on said shaft axis, said sleeve at the end thereof along said axis from said given end of said shaft being adapted to carry a core forming bit, and a core tube disposed within said tubular shaft coaxially therewith and supported by said shaft adjacent the end of said core tube disposed toward said given end of said shaft, said core tube extending to the opposite end thereof disposed adjacent said bit for receiving into said opposite end the core formed by said bit.

2. A coring turbine unit as defined in claim 1 in which said core tube is disposed with the exterior surface thereof in spaced relation to the interior surface of said tubular shaft to provide an annular chamber about said core tube extending therealong, means within said tubular shaft engaging said end of said tube disposed toward said given end of said shaft and engaging said shaft internally for closing against fluid flow from said tubular shaft to said annular chamber, said core tube being provided with an opening communicating between the interior of said core tube and said annular chamber, said annular chamber at a portion thereof disposed along said shaft axis from said opening toward said bit communicating with said driving fluid passage at a point downstream in the flow of said fluid through said passage from said rotor and turbine blades.

3. A coring turbine unit as defined in claim 1 in which said shaft comprises a first portion adapted to be connected to the drill string in said fixed relation thereto and providing a bore of given cross section and a second portion disposed along said axis from and connected to said first portion and providing a bore of reduced cross section with respect to said given cross section of said first portion of said shaft, said shaft providing an annular seat adjacent the juncture of the bores of said two portions, said core tube being disposed in the bore of said second portion, and a member disposed in the bore of said first portion and secured to said core tube adjacent the end of said core tube disposed toward said first portion, said member removably engaging said annular seat for supporting said member and said core tube on said seat and for closing against flow of driving fluid between said bores of said two portions of said shaft, said core tube having a cross section in relation to the bore of said second portion to provide for axial movement of said core tube together with said member for withdrawing said core tube from said shaft in the direction toward said given end of said shaft.

4. A coring turbine unit as defined in claim 3 in which the exterior surface of said core tube is disposed in

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spaced relation of the bore of said second portion of said shaft to provide an annular chamber about said core tube extending therealong, said core tube being provided with an opening communicating between the interior of said core tube and said annular chamber, said annular chamber at a portion thereof disposed along said axis from said opening toward said bit communicating with said driving fluid passage at a point downstream from said rotor and turbine blades in the flow of said fluid through said passage.

5. A coring turbine unit as defined in claim 1 in which said stator elements at portions thereof disposed inwardly adjacent said shaft provide annular bearing surfaces perpendicular to the axis of said shaft and in spaced relation to each other along said axis, said rotor elements providing at portions thereof disposed inwardly toward said shaft annular bearing surfaces perpendicular to said shaft axis in spaced relation to each other along said axis and respectively in thrust transmitting relation to said annular bearing surfaces of said stator elements to oppose thrust along said axis developed by said driving fluid engaging said stator and rotor blades.

6. A coring turbine unit as defined in claim 1 in which said stator elements at portions thereof disposed inwardly adjacent said shaft provide annular bearing surfaces perpendicular to the axis of said shaft and in spaced relation to each other along said axis, said rotor elements providing at portions thereof disposed inwardly toward said shaft annular bearing surfaces perpendicular to said shaft axis in spaced relation to each other along said axis and in opposed spaced relation to respective annular bearing surfaces of said stator elements, and bearing means disposed between adjacent opposed annular bearing surfaces respectively of said stator and rotor elements and coacting therewith to oppose thrust along said axis developed by said driving fluid engaging said stator and rotor elements.

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