US 20240052711A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2024/0052711 A1**

ROGOZINSKI et al. (43) **Pub. Date: Feb. 15, 2024**

(54) **PERCUSSION DRILLING APPARATUS AND TORQUE TRANSFER METHOD**

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(21) Appl. No.: **18/278,420**

(22) PCT Filed: **Feb. 23, 2022**

(86) PCT No.: **PCT/AU2022/050147**

§ 371 (c)(1),
(2) Date: **Aug. 23, 2023**

(30) **Foreign Application Priority Data**

Feb. 23, 2021 (AU) 2021900487

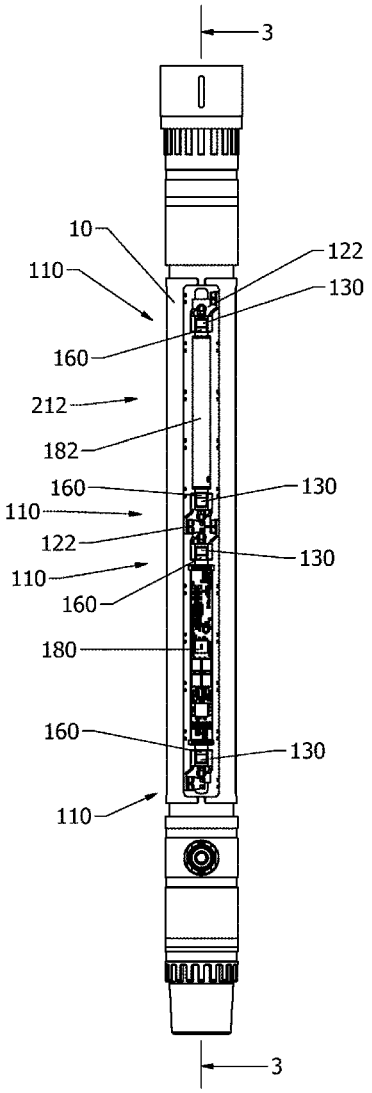
Publication Classification

(51) **Int. Cl.**
E21B 17/046 (2006.01)

(52) **U.S. Cl.**
CPC ***E21B 17/046*** (2013.01); *E21B 1/00* (2013.01)

(57) **ABSTRACT**

A drill rod for transferring torque comprises a casing for connection in a drill string. The casing is coupled to an internal body by a torque transferring mechanism at each end of the casing such that torque applied to an end of the drill rod is transferred through both of the casing and the body.



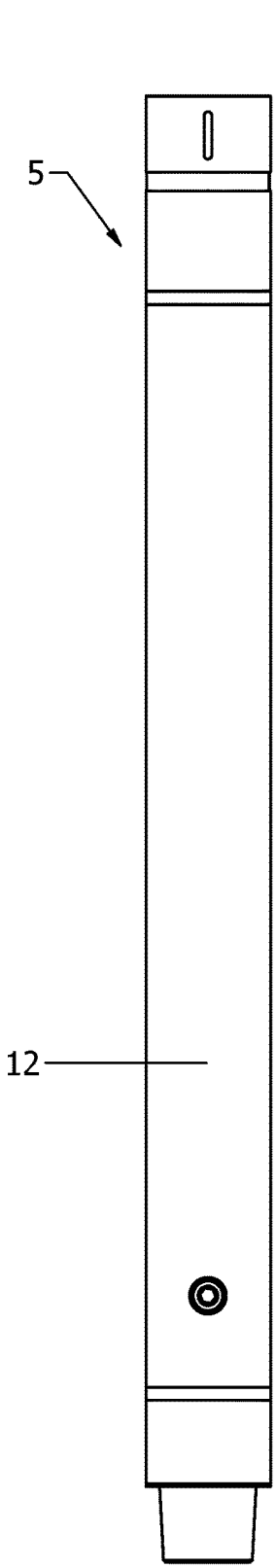


FIGURE 1

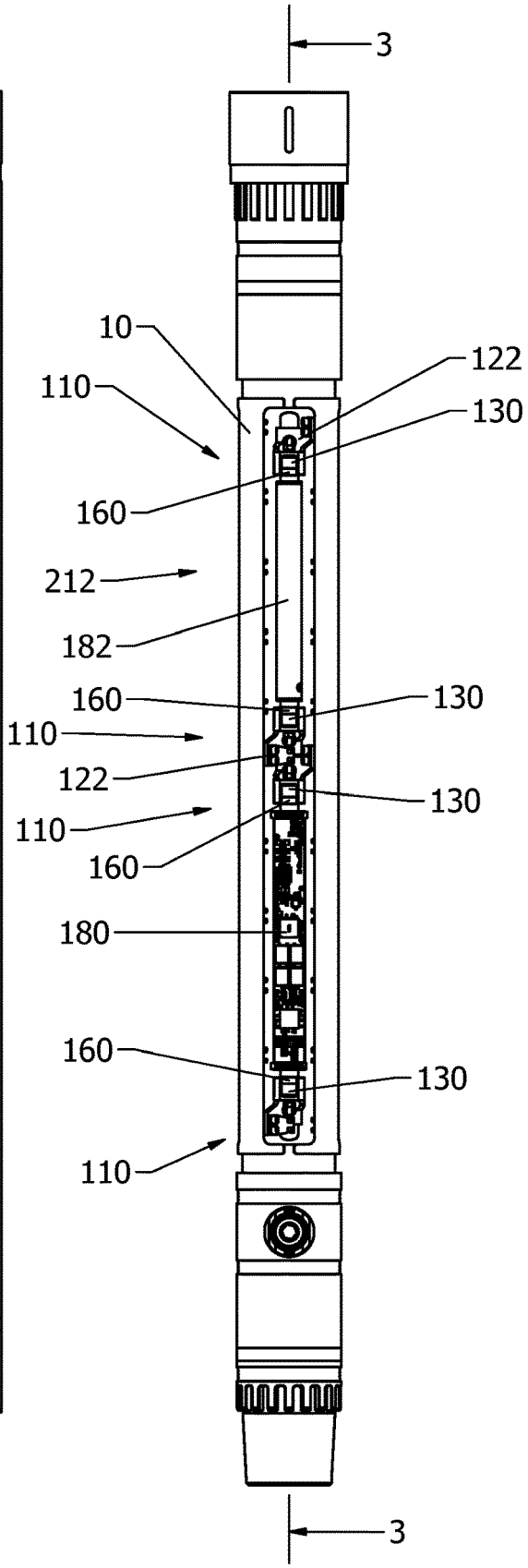


FIGURE 2

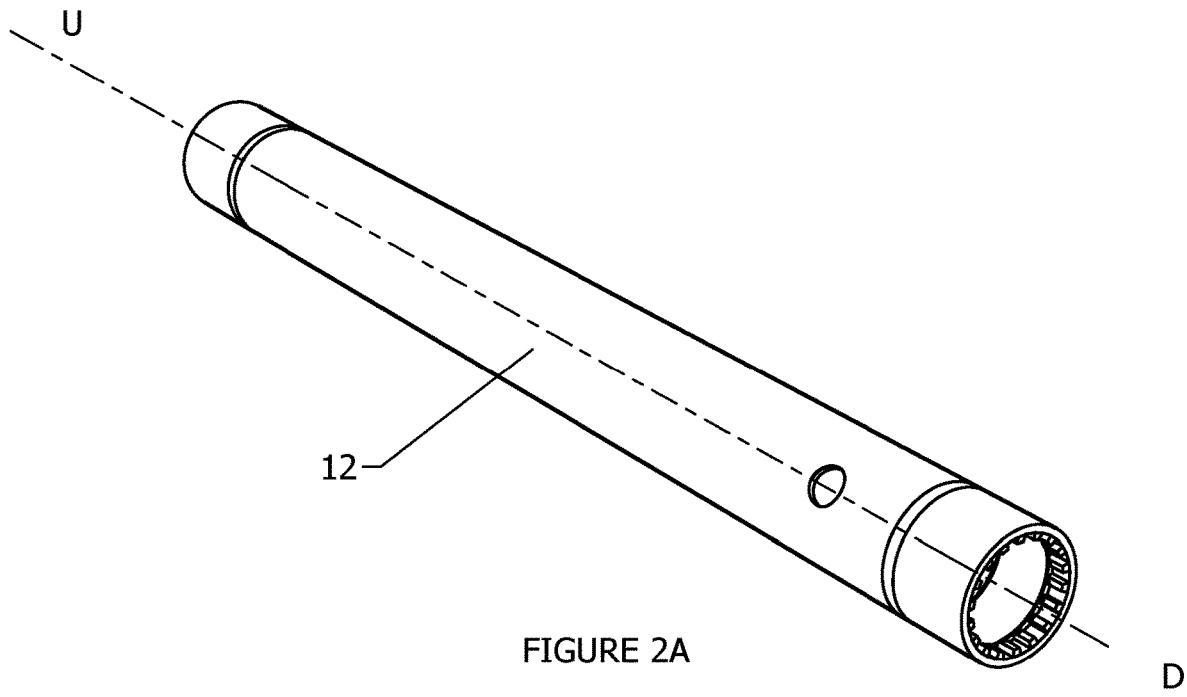


FIGURE 2A

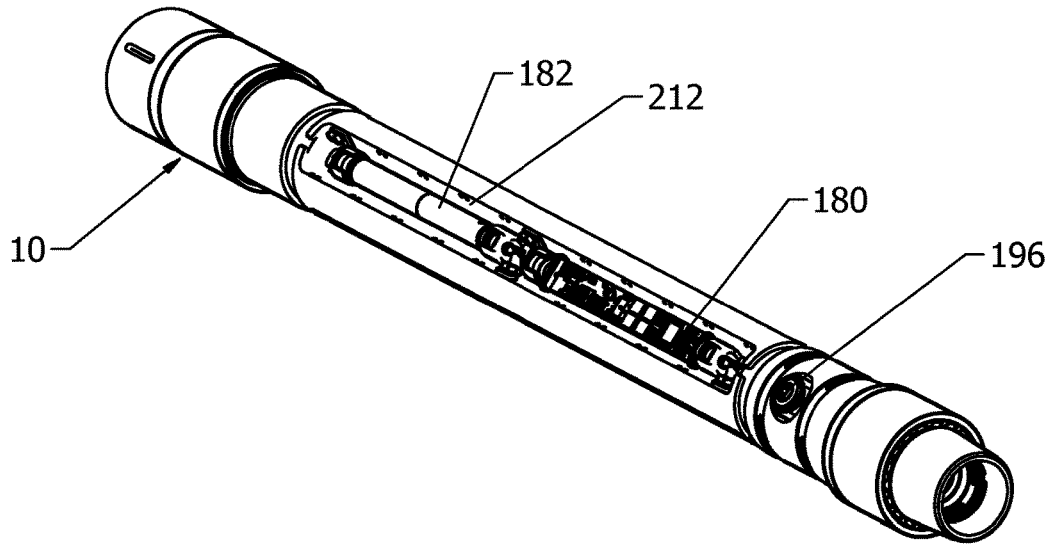


FIGURE 2B

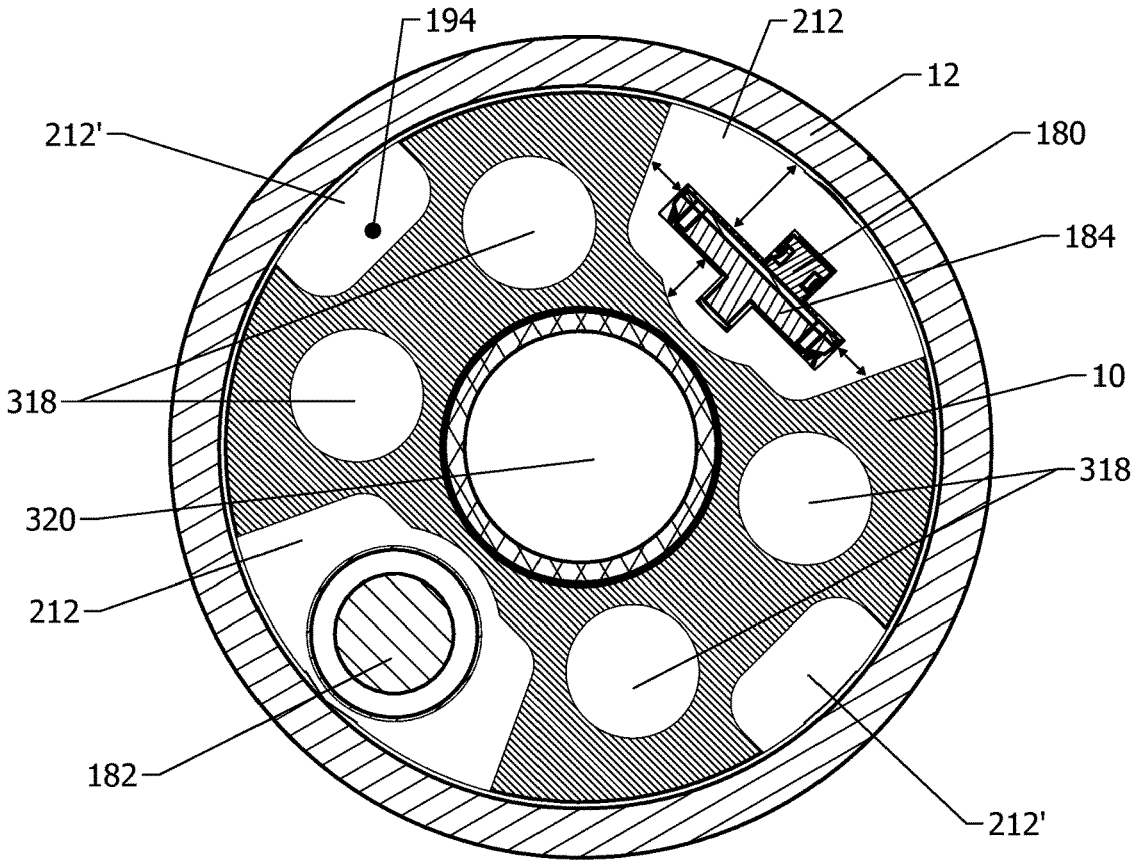


FIGURE 3

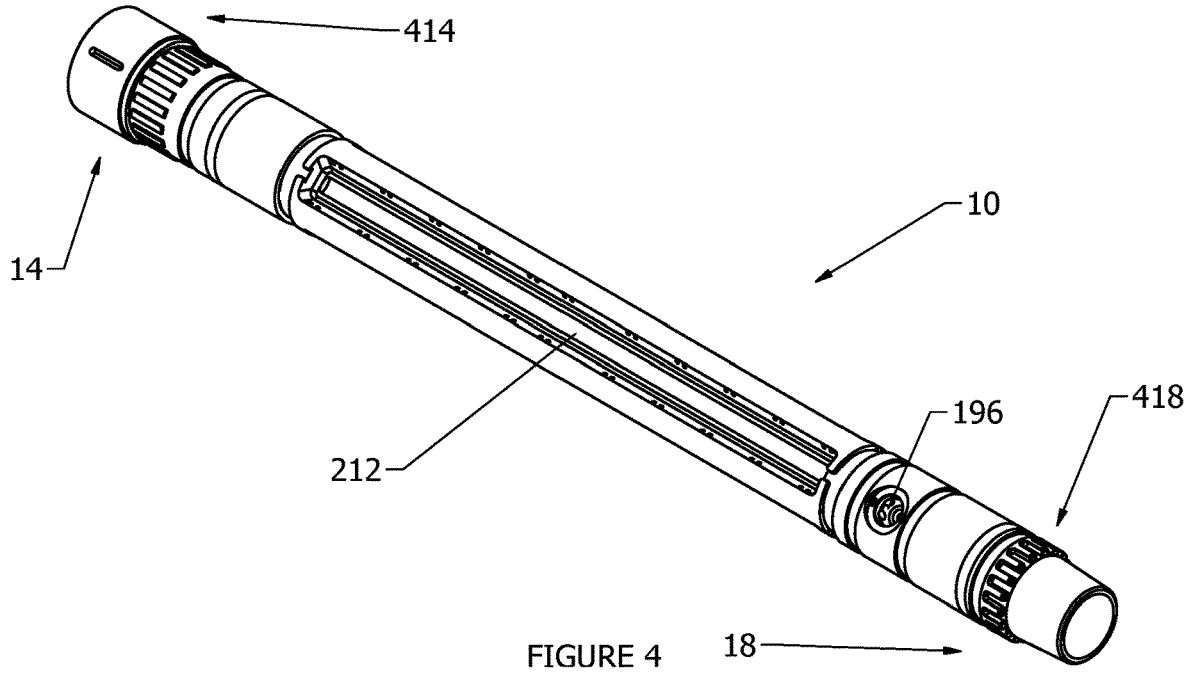


FIGURE 4

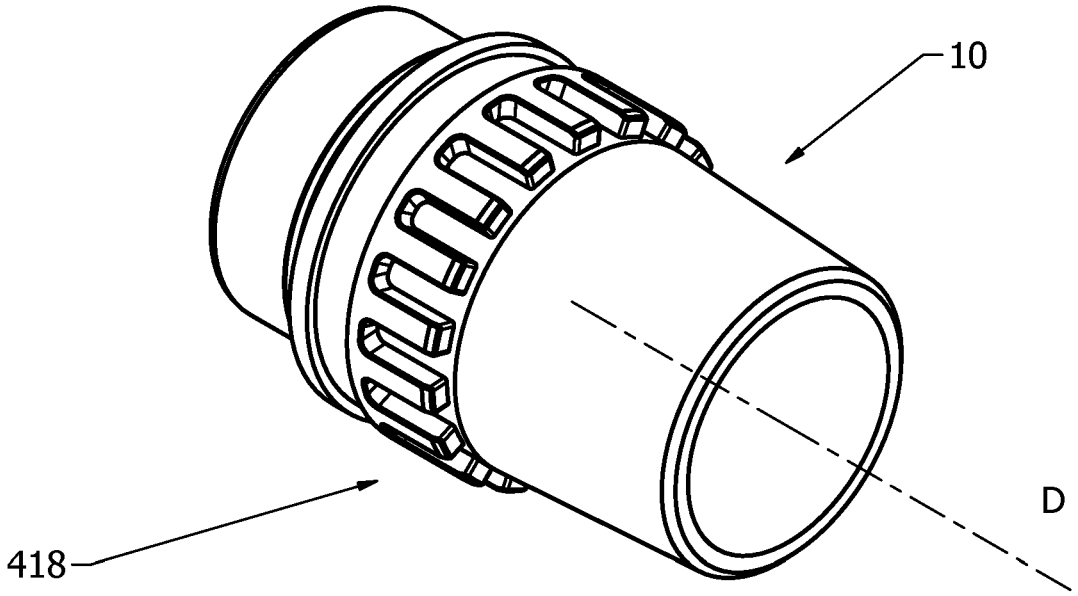


FIGURE 5

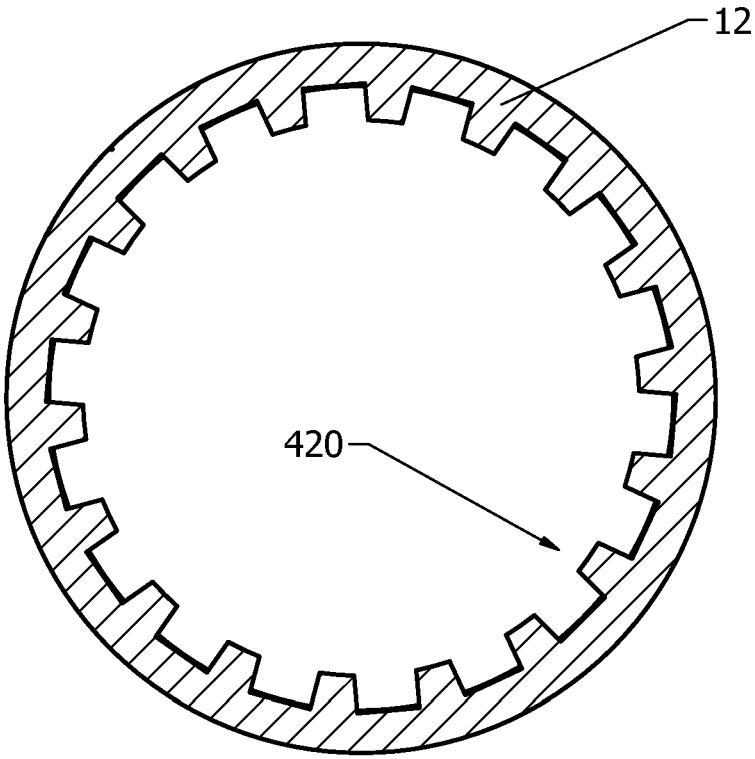


FIGURE 6

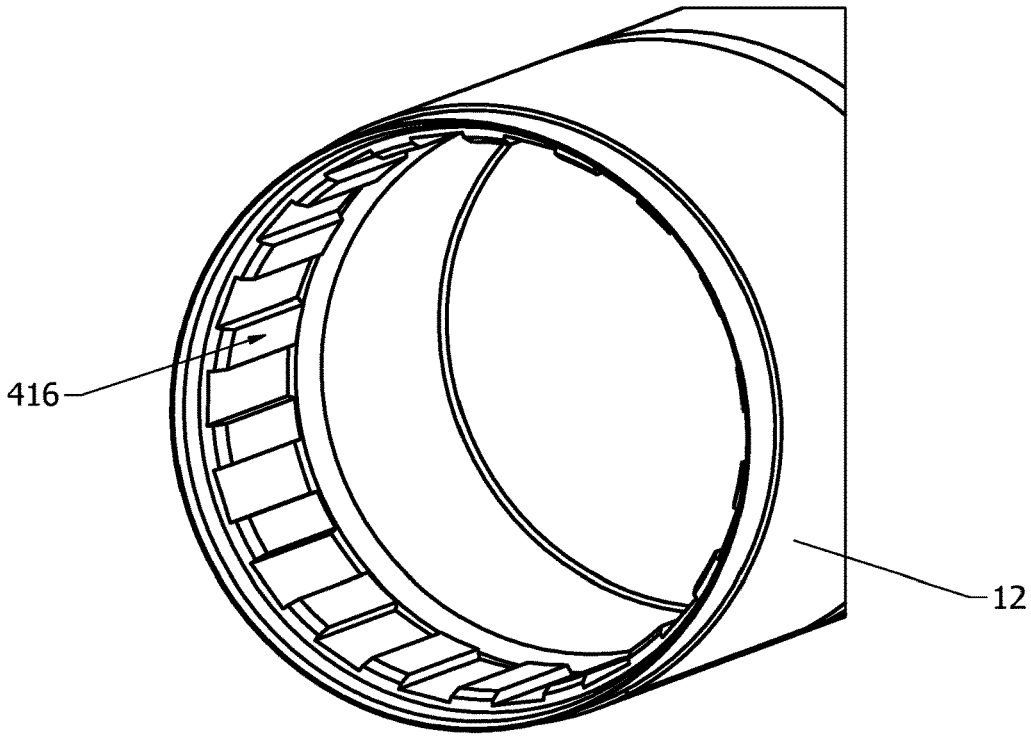


FIGURE 7

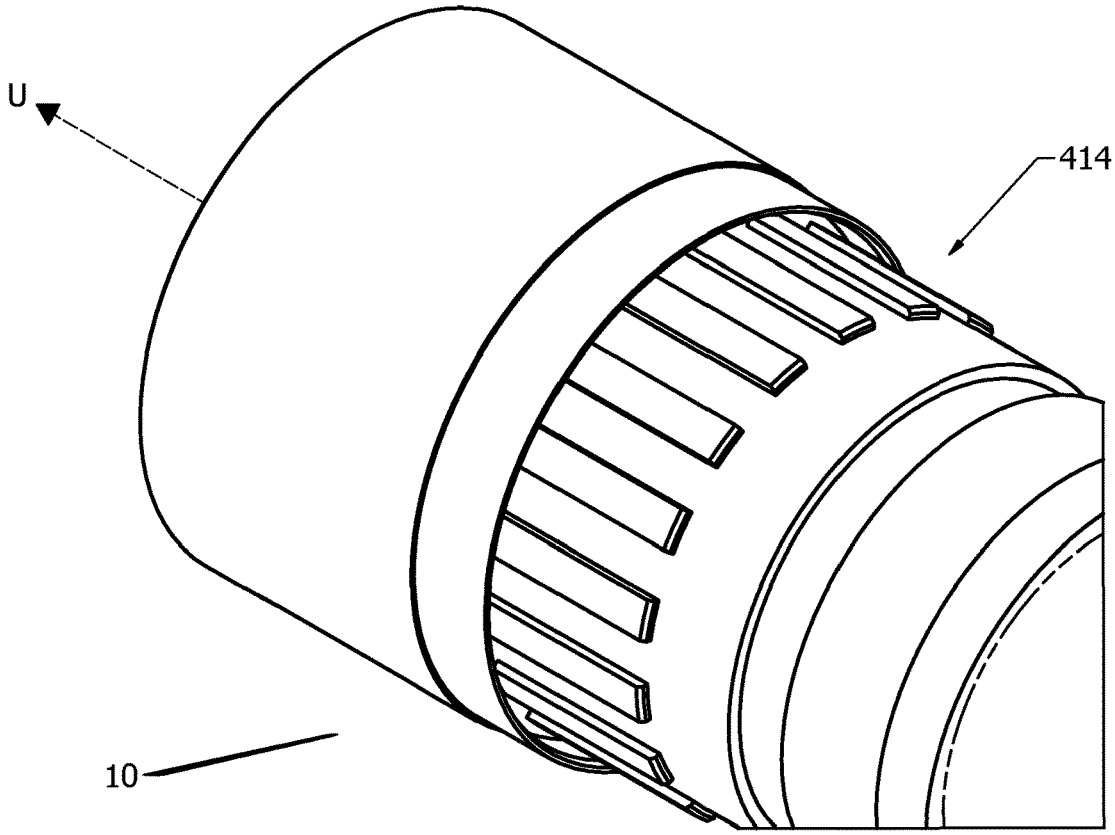


FIGURE 8

PERCUSSION DRILLING APPARATUS AND TORQUE TRANSFER METHOD

FIELD OF THE INVENTION

[0001] The present invention relates to an apparatus and methods used during percussion drilling operations.

BACKGROUND

[0002] The following discussion of the background art is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was part of the common general knowledge as at the priority date of the application.

[0003] Percussion drilling, such as reverse circulation drilling, uses a bit which is repeatedly hammered to fracture rock and progressively drill or bore through the earth. Percussion drilling creates a harsh environment which is not conducive to measuring tools and components which are sensitive to rapid changes in motion and/or repeated impacts with the associated shock/vibration.

[0004] Traditional methods of percussion drilling operations are conducted in at least two stages which include a drilling stage and a logging stage. During the drilling stage a drill string is mechanically operated by drilling machinery. Following which, the second stage requires separately lowering additional equipment to log information about the hole that has been drilled including depth, density and gamma radiation of the drilling formation.

[0005] Devices that can reduce and/or eliminate the need or timing of the second stage are commonly sought. It is against this background that the present invention is presented.

[0006] Throughout the specification unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0007] Throughout the specification unless the context requires otherwise, the word "include" or variations such as "includes" or "including", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

SUMMARY OF INVENTION

[0008] According to a first aspect there is provided a drill rod for transferring torque comprising a casing for connection in a drill string; the casing coupled to an internal body by a torque transferring mechanism at each end of the casing such that torque applied to an end of the drill rod is transferred through both of the casing and the body.

[0009] In an embodiment, the torque transferring mechanism comprises splines and complementary mating portions.

[0010] In an embodiment, the splines are configured to engage with the complementary mating portions, forming a splined connection to transfer torque.

[0011] In an embodiment, the torque applied to the casing is also applied to the internal body.

[0012] In an embodiment, the torque applied to the internal body is also applied to the casing.

[0013] In an embodiment, the casing is separable from the internal body.

[0014] In an embodiment, the internal body has one or more fluid supply channels and a fluid return channel.

[0015] In an embodiment, the casing comprises complementary mating portions at both ends and the internal body comprises splines at both ends.

[0016] In an embodiment, the complementary mating portions of the casing are configured to slidably receive the splines of the internal body.

[0017] In an embodiment, an outer diameter of the splines at a first end of the internal body is smaller than an inner diameter of the complementary mating portion at a second end of the casing, so that the internal body is required to be slidably inserted into the casing from the second end.

[0018] In an embodiment, the torque transferring mechanism extends continuously around an entire annular portion between the internal body and the casing.

[0019] In an embodiment, the torque transfer mechanism comprises a continuous complementary mating profile protruding inwardly from the casing and a continuous splined profile protruding outwardly from the internal body.

[0020] In an embodiment, the or each torque transferring mechanism can be coupled to another drill rod having one or more annuluses.

[0021] In an embodiment, the drill string comprises a percussion drill bit and a measuring instrument.

[0022] In an embodiment, an upper end of the internal body comprises connection means for fluidly connecting to a multi annulus drill rod above the torque transferring mechanism located at the upper end of the internal body as well as to another multi annulus drill rod below the lower torque transferring mechanism located at a lower end of the internal body.

[0023] According to a second aspect there is provided a second aspect there is provided a drill apparatus comprising the drill rod of the first aspect.

[0024] According to a third aspect there is provided a method of transferring torque from one end of a drill rod to another comprising transferring torque via both a casing and an internal body.

[0025] In an embodiment, the method further comprising transferring torque from a first end of the drill rod to the casing and the internal body.

[0026] In an embodiment, the method further comprising transferring torque from the casing and the internal body to a second end of the drill rod.

BRIEF DESCRIPTION OF DRAWINGS

[0027] Preferred embodiments of the invention will now be described with reference to the following drawings, in which:

[0028] FIG. **1** is a side view of a drill rod comprising a damping apparatus according to an embodiment of the present invention;

[0029] FIG. **2** is a side view of the drill rod without the casing showing the damping apparatus according to an embodiment of the present invention;

[0030] FIG. **2**A is an isometric view of the casing which may cover the damping apparatus according to an embodiment of the present invention;

[0031] FIG. **2**B is an isometric view of the measuring instruments coupled to the damping apparatus within the body according to an embodiment of the present invention;

[0032] FIG. **3** is a cross-sectional view of the drill rod having inner compartments with a damper apparatus according to an embodiment of the present invention;

[0033] FIG. **4** is an isometric view of a body of the drill rod having compartments arranged longitudinally around the perimeter of the body according to an embodiment of the present invention;

[0034] FIG. **5** is an isometric view of a lower portion of the body showing a downhole spline according to an embodiment of the present invention;

[0035] FIG. **6** is a cross-sectional view of the lower end of the casing which engages with the spline shown in FIG. **5** according to an embodiment of the present invention;

[0036] FIG. **7** is an isometric view of an upper end of the casing which engages with an upper uphole spline shown in FIG. **8** according to an embodiment of the present invention; and

[0037] FIG. **8** is an isometric view of the upper portion of the body showing the uphole spline according to an embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0038] Referring to FIGS. **1**, **2**, **2**A, and **2**B there is provided drill rod **5** comprising an elongate body **10** within a cylindrical casing **12** having ends suitable for connection into a percussion drilling drill string in place of a standard drill rod. Typically, this will be immediately behind the bottom hole assembly including the drill head in the drill string since the measurements are desired to be taken from a position immediately behind the drill head.

[0039] The body **10** comprises longitudinally extending compartments **212** arranged around an outer diameter of the body **10**. Each compartment **212** is in the form of a recess or slot as seen in FIGS. **2**B and **4**. In an embodiment there are two large compartments **212** on opposite sides of the body **10**. The large compartments **212** are able to receive one or more measuring instruments **180**, as described further below. In an embodiment there may be additional compartments, such as smaller compartments **212'** on opposite side of the body **10**, and each between two of the larger compartments **212**.

[0040] Percussion drilling is an umbrella term that includes but is not limited to, reverse circulation drilling and air core drilling. The present invention may be suitable for any form of drilling where the drill string experiences high impact and/or repetitive impact forces. The forces that the measuring instrument **180** experiences may be axial, radial and/or rotational shock/vibration experienced independently, or a combination of the aforementioned. Such forces may impede the measuring instrument **180** from collecting accurate data and/or functioning entirely.

[0041] Referring to FIGS. **5** to **8**, there is provided an upper end of body **10** having a torque transferring mechanism. In an embodiment the torque transferring mechanism comprises a plurality of splines **414** and complementary spline mating portion **416** comprising complementary grooves for receiving the splines **414**. The lower end of the body **10** comprising a torque transferring mechanism, preferably comprising a plurality of splines **418** and complementary spline mating portion **420** comprising complementary grooves. An alternative to the splines includes a sawtooth shaped set of teeth. Each torque transferring mechanism provides a physical connection which, when a torque is applied to a portion of the drill rod **5**, the torque is transferred through each of the body **10** and the casing **12**. The transfer of torque between the body **10** and casing **12** provides additional rigidity and strength during percussion drilling operations and/or operations which impart high and/or repetitive torque loads.

[0042] Again, referring to FIGS. **6** and **7**, there is provided a profile within the upper end of casing **12** and the lower end of casing **12** in the form of respective complementary spline mating portions **416**, **420**, respectively. The complementary spline mating portion **416** receives each of the teeth or splines **414** positioned on the body **10** at the upper portion of the body **10**. The spline mating portion **420** receives each of the teeth or splines **418** located on the lower portion of the body **10**. The splines **414**, **418** mesh with the profile of complementary spline mating portion **416**, **420**, respectively.

[0043] In alternative embodiments, the splines **414**, **418** may be positioned on the casing **12** and the respective complementary spline mating portions **416**, **420** may be located on the body **10**. The splines **414**, **418** may be affixed to the body **10** or integrally formed therein. Alternative embodiments may have the splines **414**, **418** affixed to the casing **12** or integrally formed therein. Complementary spline mating portions **416**, **420** may be affixed to the casing **12** or integrally formed therein. Alternative embodiments may have the complementary spline mating portions **416**, **420** affixed to the body **10** or integrally formed therein.

[0044] The combination of spline **414** and complementary spline mating portion **416** form a torque transferring mechanism which is also able to be separated so as to provide access to the to the interior of the casing, such as to compartments with measuring instrument(s) therein. The interaction of spline **418** and complementary mating portion **420** provide a physical connection for sharing a torque load between the body **10** and casing **12**. Each torque transferring mechanism transfers a torque applied to the body **10** throughout the body **10** and the casing **12**. Conversely, the torque applied to the casing **12** is applied to the casing **12** and the body **10**.

[0045] The casing **12** comprises complementary spline mating portions **416**, **420** which slideably receives the body **10**, the body **10** comprising spline **414**, **418**. To slideably receive the body **10** within the casing **12**, the outer diameter at spline **418** must be smaller than an inner diameter of the complementary spline mating portion **416**. In an embodiment, the casing is separable from the internal body. In an alternative embodiment, the body **10** and casing **12** may each comprise one of the splines **414**, **418** and one of the complementary spline mating portions **416**, **420**. Alternatively, the outer diameter of spline **414** may be smaller than an inner diameter of the complementary spline mating portion **420** requiring the body **10** to be slideably inserted into the casing **12** from the opposite end.

[0046] As discussed above, the upper portion of the body **10** comprises connection means for fluidly connecting to a multi annulus drill rod above the torque transferring mechanism located at the upper end of the body **10** as well as below the lower torque transferring mechanism located at the lower end of the body **10**. The annulus of the drill rod above the body **10** in the drill string fluidly connects with the upper end of the body **10** at or adjacent to the upper torque transferring mechanism. The lower end of the body **10** connects with the annulus of the drill rod or bottom hole assembly below the body **10** at or adjacent to the lower torque transferring mechanism.

[0047] In use measuring the orientation of a measurement tool during percussion drilling operations comprises drilling a hole using a drill string having a percussion drill bit and, preferably, a measuring instrument **180**; transferring torque applied to the drill string to an end of the drill rod through the casing **12** and the body **10** to an opposite end of the drill rod **5**, and preferably, measuring the orientation of the tool as the hole is being drilled. As the drill string progressed into the drilled bore hole the action of the percussion drill bit is paused to add another drill rod, and when the drill string is extracted drill rods are removed. During each pause in drilling the measuring instrument **180** takes a calibration measurement. Because torque transfer is shared by the casing **12** and the body **10**, the casing **12** can potentially be thinner than in a standard drill rod, which allow for greater clearance between the measuring instrument **180** and the casing **12**, or for more space to accommodate the measuring instrument **180**.

[0048] In the context described herein, pneumatic percussion drilling is where there is a hammer actuated by pressurised air that strikes an anvil component of or connected to a drill bit so that the drill bit impacts on rock on the bottom of a drill hole so as to break the rock. The hammer is directly next to the drill bit. This type of percussion drilling is used in rotary air blasting (RAB) and reverse circulation drilling (RC drilling). Pneumatic percussion drilling is used in mineral exploration. It is to be distinguished from hydraulic (often water or mud) powered percussion drilling used in hydrocarbon well drilling. It is also to be distinguished from mechanical percussion drilling where the drill string is lifted and dropped, usually from the surface. In hydraulic and mechanical percussion drilling a casing within which the drill string can move is usually used. However, in pneumatic percussion drilling a casing is usually not used.

[0049] RC drilling will be understood to be where the pressurised air flow is also used to blow the rock broken by the drill bit impact into one or more holes in the drill bit and then up through the drill string. The drill rods have an inner tube through which the air and recovered rock return to the surface and an outer tube, which between this and the inner tube, the pressurised air travels down the drill string to the hammer and the drill bit. This is distinguished from RAB, which is where the broken rock air is blown up the drill hole outside of the drill string. The inner tube is not required in the drill rods for RAB.

[0050] Percussion drilling can be distinguished from air core drilling where the drill bit cuts, rather than breaks from impact, but there is pressurised air that returns the cuttings through the drill string. Percussion drilling can also be distinguished from diamond core drilling where ring is cut by diamond teeth and a core sample can be retrieved.

[0051] Modifications may be made to the present invention within the context of that described and shown in the drawings. Such modifications are intended to form part of the invention described in this specification.

1.-**18**. (canceled)

19. A drill rod for transferring torque comprising a casing for connection in a drill string; the casing coupled to an internal body by a torque transferring mechanism at each end of the casing such that torque applied to an end of the drill rod is transferred through both of the casing and the body.

20. A drill rod according to claim **19**, wherein the torque transferring mechanism comprises a splines and complementary mating portions.

21. A drill rod according to claim **20**, wherein the splines are configured to engage with the complementary mating portions, forming a splined connection to transfer torque.

22. A drill rod for transferring torque comprising a casing for connection in a drill string; the casing coupled to an internal body by a torque transferring mechanism at each end of the casing such that torque applied to an end of the drill rod is transferred through both of the casing and the body, wherein the torque transferring mechanism comprises a splined connection between splines and complementary mating portions to transfer torque.

23. A drill rod according to claim **19**, wherein torque applied to the casing is also applied to the internal body.

24. A drill rod according to claim **19**, wherein torque applied to the internal body is also applied to the casing.

25. A drill rod according to claim **19**, wherein the casing is separable from the internal body.

26. A drill rod according to claim **19**, wherein the internal body has one or more fluid supply channels and a fluid return channel.

27. A drill rod according to claim **19**, wherein the casing comprises complementary mating portions at both ends and the internal body comprises splines at both ends.

28. A drill rod according to claim **19**, wherein the complementary mating portions of the casing are configured to slidably receive the splines of the internal body.

29. A drill rod according to claim **19**, wherein an outer diameter of the splines at a first end of the internal body is smaller than an inner diameter of the complementary mating portion at a second end of the casing, so that the internal body is required to be slidably inserted into the casing from the second end.

30. A drill rod according to claim **19**, wherein the torque transferring mechanism extends continuously around an entire annular portion between the internal body and the casing.

31. A drill rod according to claim **19**, wherein the torque transfer mechanism comprises a continuous complementary mating profile protruding inwardly from the casing and a continuous splined profile protruding outwardly from the internal body.

32. A drill rod according to claim **19**, wherein the or each torque transferring mechanism can be coupled to another drill rod having one or more annuluses.

33. A drill rod according to claim **19**, wherein the drill string comprises a percussion drill bit and a measuring instrument.

34. A drill rod according to claim **19**, wherein an upper end of the internal body comprises connection means for fluidly connecting to a multi annulus drill rod above the torque transferring mechanism located at the upper end of the internal body as well as to another multi annulus drill rod below the lower torque transferring mechanism located at a lower end of the internal body.

35. A method of transferring torque from one end of a drill rod to another comprising transferring torque via both a casing and an internal body.

36. A method of transferring torque according to claim **35**, wherein the method further comprises transferring torque from a first end of the drill rod to the casing and the internal body.

37. A method of transferring torque according to claim **36**, wherein the method further comprises transferring torque from the casing and the internal body to a second end of the drill rod.

* * * * *