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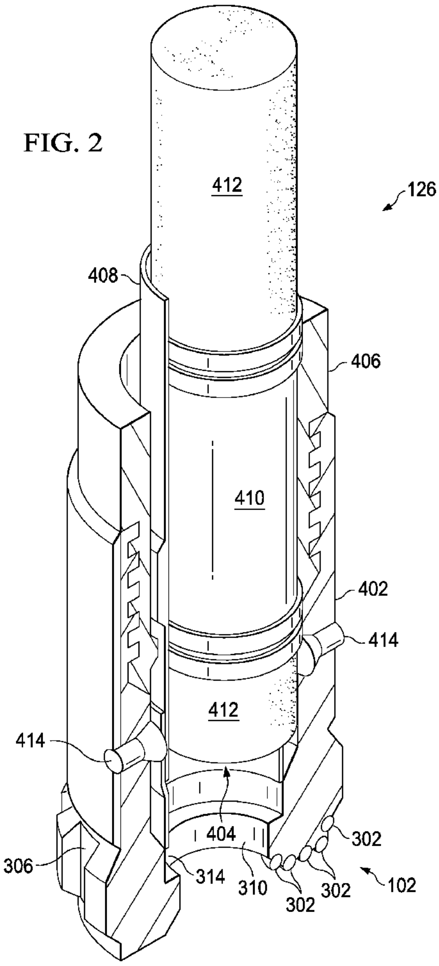
(54) Title: OBTAINING A DOWNHOLE CORE SAMPLE MEASUREMENT USING LOGGING WHILE CORING

FIG. 2



(57) Abstract: A drilling tool and method are disclosed for obtaining a downhole core sample measurement using logging while coring. A drilling tool includes a coring bit that is configured to obtain a core sample from a wellbore. A coring mandrel is coupled to the coring bit and includes an inner gage bore. An inner barrel is disposed inside the inner gage bore and an inner sleeve configured to receive the core sample is disposed inside the inner barrel. Coring bit electronics are coupled to the coring mandrel.

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OBTAINING A DOWNHOLE CORE SAMPLE MEASUREMENT USING LOGGING WHILE CORING

TECHNICAL FIELD

The present disclosure relates generally to coring operations of downhole drilling and, more particularly, to a drilling tool and method for obtaining a downhole core sample measurement using logging while coring.

BACKGROUND

Conventional logging techniques, such as wireline and logging while drilling (LWD), employ tools that use dedicated sensors to collect data from the surrounding formation of a wellbore. The signal between the transmitters and receivers passes through a very complicated and open environment that is susceptible to noise, multipath propagation, washout, mud cake, and invasion problems. These borehole conditions add tremendously to the cost and complexity of the tool, and affect its reading accuracy. Along with the inherent geometrical layout of the tool, this puts a limit on the class of measurements/sensors that can be used, the data acquisition resolution, and the direction of measurement

Conventional tools for obtaining a core from the bitface at the end of a wellbore use dedicated coring drill bits to collect cylindrical core samples. Core samples are subsequently inspected and analyzed at the surface by various equipment and techniques depending on the type of information to be collected. For example, core samples can provide indications of formation properties such as porosity, permeability, and other physical or petrophysical properties of the downhole formation.

In typical operations, a coring drill bit may be used to collect a continuous core sample at the bitface during the drilling operation. Multiple core samples may be collected and stored in proximity to the coring drill bit. After collection of the desired number of samples, the core samples are lifted to the surface to measure properties of the samples. Most laboratories extract only small plugs from the core samples and provide a relatively small number of data points across the whole well.

The core samples, however, can be damaged or compromised in the process of lifting the core samples to the surface. Thus, conventional systems typically include components to support and protect the core sample while lifting it to the surface. Contact between drilling fluids and the core sample may compromise later measurements made to the core sample. Furthermore, mechanical forces during removal and lifting of the core sample may cause the core sample to fracture, which may complicate the ability to gather information from the core sample. Core samples can further degrade when they are transported to a laboratory, or otherwise handled to study. Incorrect or inconsistent values from core samples may have severe implications for wellbore drilling operations.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present disclosure and its features and advantages, reference is now made to the following description, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 illustrates a schematic diagram of a drilling apparatus for a logging while drilling or a coring tool in a wellbore, in accordance with some embodiments of the present disclosure;

FIGURE 2 illustrates a perspective view of a coring bit assembly, in accordance with some embodiments of the present disclosure;

FIGURE 3 illustrates a perspective view of coring bit electronics associated with a coring bit assembly for performing measurements transversely across a core sample, in accordance with some embodiments of the present disclosure;

FIGURE 4 illustrates a cross-sectional view of the coring bit electronics in the coring bit assembly of FIGURE 3 for performing measurements transversely across a core sample, in accordance with some embodiments of the present disclosure;

FIGURE 5 illustrates a cross-sectional view of coring bit electronics in a coring bit assembly for performing measurements to detect anisotropic properties across a core sample, in accordance with some embodiments of the present disclosure;

FIGURE 6 illustrates a perspective view of coring bit electronics in a coring bit assembly for performing measurements transversely and longitudinally across a core sample, in accordance with some embodiments of the present disclosure; and

FIGURE 7 illustrates a flow chart of an example method for performing measurements on a core sample during LWC operation with coring bit electronics, in accordance with some embodiments of the present disclosure.

DETAILED DESCRIPTION

Embodiments of the present disclosure and its advantages are best understood by referring to FIGURES 1–7, where like numbers are used to indicate like and corresponding parts.

FIGURE 1 illustrates a schematic diagram of a drilling apparatus 100 for a logging while drilling or a coring tool in wellbore 106, in accordance with some embodiments of the present disclosure. Drilling tool 116 may be suspended by drill pipe 104 in wellbore 106 defined by sidewall 108.

Drill pipe 104 may include one or more electrical conductors and a multi-strand cable. Drill pipe 104 may include an armored logging cable and may encompassing the cables and conductors. In some embodiments, drill pipe 104 may include drilling tool 116 and may be extended into wellbore 106.

In some embodiments, drilling tool 116 may include any device or combination of devices suitable for drilling wellbore 106 and/or extracting core samples from wellbore 106. Drilling tool 116 may rotate by the operation of drill pipe 104 to extract a core sample or drill into wellbore 106.

In some embodiments, logging while drilling (LWD) may include drilling into the earth and recording information from sensors 120 that may be located proximate the exterior of drilling tool 116 above the drill bit or coring bit 102 to produce a record of various formation parameters. In such configurations, drilling tool 116 may include coring bit assembly 126, drill collar 118, sensors 120, other on-board electronics, telemetry systems, pressure compensators, hydraulic fluid systems, and/or any other suitable devices. Drill collar 118 and sensors 120 may be located above coring bit 102 with respect to drill pipe 104. Drill collar 118 may include electronics that measure sensor 120 outputs and store them as a function of time or transmit them to a surface control unit and/or any other suitable compute. Sensors 120 may provide continuous measurements of downhole parameters, such as, porosity, resistivity, formation pressure, and/or any other suitable measurements. Sensors 120 may be located on the exterior of drilling tool 116 and may be configured to detect downhole parameters as drilling tool 116 descends and/or drills into wellbore 106. However, due to the location of sensors 120, e.g., above coring bit 102 with reference to drill pipe 104, sensors 120 may provide indirect measurements of the current formation being drilled and may be affected by the downhole environment. For example, sensors 120 may be exposed to mud as mud flows past drilling tool 116. Accuracy of sensors 120 may additionally be affected by standoff between drilling tool 116 and sidewall 108. Further, the direction of sensors 120 with respect to sidewall 108 may be oriented such that the direction may also affect accuracy of measurements.

In some embodiments, alternate configurations of drilling apparatus 100 may be arranged for Logging While Coring (LWC) operations. LWC may include extracting a core sample and detecting and/or recording information from sensors that may be located proximate to the interior of drilling tool 116. In such embodiments, LWC may include taking, e.g. logging, measurements of a core sample as the core sample is passing through drilling tool 116. In LWC operation, coring bit assembly 126 (shown in further detail in FIGURE 2) may include coring bit 102 and may operate to extract a core sample from wellbore 106. In some embodiments, coring bit assembly 126 may also include sensors, calipers, electronics, transmitters, receivers, and other elements to perform *in-situ* measurements of a core sample. As discussed below, the measurements may be transmitted to a surface control unit, drill collar 118, and/or other suitable devices for further analysis. The sensors may continuously collect data from a moving string of cores in critical spots of the well. LWC operation may improve measurement accuracy and resolution, add anisotropic capabilities, and introduce new classes of measurements that may not be achievable with LWD operation.

FIGURE 2 illustrates a perspective view of coring bit assembly 126, in accordance with some embodiments of the present disclosure. Coring bit 102 may be any of various types of fixed cutter drill bits, including polycrystalline diamond cutter (PDC) bits, drag bits, matrix drill bits, and/or steel body drill bits operable to extract a core sample from wellbore 106. Coring bit 102 may be designed and formed in accordance with teachings of the present disclosure and may have many different designs, configurations, and/or dimensions according to the particular application of coring bit 102.

Coring bit body 306 may have a generally cylindrical body and inner gage 314. Coring bit 102 may further include throat 310 that may extend longitudinally through coring bit 102. Throat 310 of coring bit 102 may allow a core sample to be cut with a smaller diameter than throat 310. Coring bit 102 may include one or more cutting elements 302 disposed outwardly from exterior portions of bit body 306. For example, a portion of cutting element 302 may be directly or indirectly coupled to an exterior portion of bit body 306 while another portion of cutting element 302 may be projected away from the exterior portion of bit body 306. Cutting elements 302 may be any suitable device configured to cut into a formation, including but not limited to, primary cutting elements, back-up cutting elements, secondary cutting elements or any combination thereof. By way of example and not limitation, cutting elements 302 may be various types of cutters, compacts, buttons, inserts, and gage cutters satisfactory for use with a wide variety of coring bits 102.

Cutting elements 302 may include respective substrates with a layer of hard cutting material disposed on one end of each respective substrate. The hard layer of cutting elements 302 may provide a cutting surface that may engage adjacent portions of wellbore 106. Each substrate of cutting elements 202 may have various configurations and may be formed from tungsten carbide or other materials associated with forming cutting elements for coring bits. Tungsten carbides may include, but are not limited to, monotungsten carbide (WC), ditungsten carbide (W_2C), macrocrystalline tungsten carbide and cemented or sintered tungsten carbide. Substrates may also be formed using other hard materials, which may include various metal alloys and cements such as metal borides, metal carbides, metal oxides and metal nitrides. For some applications, the hard cutting layer may be formed from substantially the same materials as the substrate. In other applications, the hard cutting layer may be formed from different materials than the substrate. Examples of materials used to form hard cutting layers may include polycrystalline diamond materials, including synthetic polycrystalline diamonds.

In operation of embodiments of the present disclosure, coring bit 102 may extract a core sample from a formation of interest approximately the diameter of throat 310. As discussed in detail below, sensors, calipers, electronics, and other elements resident in coring bit assembly 126 may make *in-situ* measurements of the core sample.

Coring bit 102 may be connected to coring mandrel 402. Coring mandrel 402 may have a longitudinal opening 404 that may correspond to throat 310. One end of coring mandrel 402 may be threadably connected to threaded form 406. Inner barrel 408 may pass through coring mandrel 402 and/or threaded form 406. Further, inner barrel 408 may contain inner sleeve 410 that may capture core sample 412. Inner sleeve 410 may be encompassed by inner barrel 408 and/or may extend beyond inner barrel 408. Threaded form 406 may connect inner barrel 408 to coring bit 102 via coring mandrel 402.

Additionally, in some embodiments of the present disclosure coring bit electronics 414 may be contained in coring mandrel 402. Coring bit electronics 414 may also be located in inner barrel 408 (not expressly shown), inner sleeve 410 (not expressly shown), and/or any combination of coring mandrel 402, inner barrel 408, and inner sleeve 410, and/or any other suitable location. Coring bit electronics 414 may include any receivers, transmitters, transceivers, sensors, calipers, and/or other electronic components that may be used in a downhole measurement system. Sensors may include multiple types, including but not limited to, resistivity, dielectric, sonic, nuclear, or nuclear magnetic resonance (NMR). Coring bit electronics 414 may also include any necessary electronics to provide communication between the receivers, transmitters, transceivers, sensors, calipers, and/or other electronic components. The spacing, exact location, and transmitter-receiver arrangement of coring bit electronics 414 may depend on factors including, but not limited to, the direction of measurement and/or the type of sensors, calipers, and/or other types of measurement tools.

Implanting coring bit electronics 414 in coring mandrel 402, inner barrel 408, inner sleeve 410, and/or any other suitable location may allow coring bit electronics 414 to perform direct and/or continuous measurements as core sample 412 moves through coring bit assembly 126. Accordingly, some embodiments of the present disclosure may allow measurements of core sample 412 to be made in drilling tool 116 (as shown with reference to FIGURE 1). Following extraction from wellbore 106, core sample 412 may be stored and later retrieved and lifted to the surface. Core sample 412 may be lifted to the surface by retrieving inner sleeve 410 and/or by extraction of drilling tool 116 from wellbore 106.

During LWD operation, contamination may affect measurements made by sensors 120 due to characteristics of the wellbore environment, including tool standoff, washouts, mud flows and/or other situations that may compromise measurement integrity of sensors 120. Similar conditions may apply during wireline operations, which may include lowering sensors into a wellbore after removal of a drilling tool. However, during LWC operation the measurements made by coring bit electronics 414 of a core sample may not be affected by such wellbore situations. Measurements by coring bit electronics 414 may have the advantage of a measurement environment confined around core sample 412 being relatively small. The distance between multiple sensors and/or other elements may also be relatively small in the confined environment of coring bit assembly 126. Noise and multi-path effects that may be present in the wellbore and may affect measurements made by sensors 120 may not be present around coring bit electronics 414 during LWC operation. Therefore, coring bit electronics 414 may be simpler in configuration and design than sensors 120. For example, the confined space may minimize the transverse movement of core sample 412 in coring mandrel 402, inner barrel 408, and/or inner sleeve 410 allowing for less eccentricity related impact and more consistent measurements. Additionally, the power requirements for coring bit electronics 414 may be less than the power requirements for sensors 120. Further, as discussed in detail below with reference to FIGURES 5 and 6, LWC operation utilizing coring bit electronics 414 may include measuring parameters of core sample 412 in multiple directions, e.g., x-axis, y-axis, and z-axis. Resolution of measurements may also be improved since resolution may be a function of the distance between sensors. LWC operation utilizing coring bit electronics 414 may provide a minimum distance between a transmitter and a receiver, and thus, may provide enhancements to resolution than may be achieved with LWD.

Additionally, when compared with the conventional logging methods (e.g., wireline and LWD), LWC may provide real-time formation measurements that may have better correlation with the core laboratories measurements. LWC may further overcome issues regarding core porosity and mechanical properties that may occur after a core sample is removed from the wellbore to a laboratory for measurement.

The LWC tool may be operated as the sole logging tool or in conjunction with other logging techniques. This may be done in order to obtain increasingly accurate, high-resolution and anisotropic data in the critical spots of the wellbore. The collected data may also be used to calibrate readings from LWD or wireline sensors outside the cored range to enhance their accuracy without the need to wait for laboratory data.

FIGURE 3 illustrates a perspective view of the coring bit electronics in a coring bit assembly for performing measurements transversely across a core sample, in accordance with some embodiments of the present disclosure. In the illustrated embodiment, a portion of coring mandrel 402 containing a portion of core sample 412 is shown. Coring mandrel 402, inner barrel 408, inner sleeve 410 (shown in FIGURE 2), and/or any other suitable location may include coring bit electronics 414. Coring bit electronics 414 may include transmitter 502, receiver 504, sensors, calipers, and/or other electronics or elements suitable for measurement of core sample 412. This configuration may allow the measurement of properties across core sample 412 in the transverse direction, e.g., the x-axis direction. Additionally, some embodiments of the present disclosure may include receiver 504 without transmitter 502.

In some embodiments, during LWC operation, coring bit 102 may extract core sample 412 from the formation. Core sample 412 may be captured by inner sleeve 410 and pass through inner barrel 408. As the core sample 412 passes through inner barrel 408, coring bit electronics in coring mandrel 402 may make measurements of various characteristics and properties of core sample 412, for example. The measurements may be taken continuously as core sample 412 passes through coring bit assembly, and/or the measurements may be interval based and may be programmed to take a measurement based on either elapsed time and/or length of core sample 412. Additionally, the measurements may be taken as needed based on a pre-defined measurement protocol.

In some embodiments, measurements made by coring bit electronics 414 may be communicated to a surface control unit and/or any other suitable unit for receiving signals from coring bit electronics 414. Logs may be created using information from coring bit electronics 414 and the logs may exhibit improved accuracy than would be achieved by sensors 120 or achieved after core sample 412 is removed to the surface. Further, additional classes of measurements, e.g., computed tomography and/or other scanning techniques may be available to coring bit assembly 126, in accordance with some embodiments of the present disclosure.

FIGURE 4 illustrates a cross-sectional view of coring bit electronics 414 in coring bit assembly 126 of FIGURE 3 for performing measurements transversely across a core sample, in accordance with some embodiments of the present disclosure. Transmitter 502 and/or receiver 504 may be mounted within or attached to coring mandrel 402. Although the present embodiment is illustrated with respect to coring mandrel 402, transmitter 502 and/or receiver 504 may also and/or alternatively be mounted within or attached to inner barrel 408, inner sleeve 410, and/or mounted in any suitable location. Transmitter 502 may be located substantially opposite from receiver 504 with respect to core sample 412. Sensors, calipers, and/or other measurement tools may be included as part of or near to transmitters 502 and/or receivers 504. Further, transmitter 502 and/or receiver 504 may be transceivers in order to transmit and receive from both sides of coring mandrel 402, inner barrel 408, and/or inner sleeve 410. In operation of embodiments of the present disclosure, a signal may be sent from transmitter 502 and received by receiver 504. The characteristics and properties of the signal received by receiver 504 may indicate various properties of core sample 412, e.g., porosity, permeability, and other physical or petrophysical properties of core sample 412. The resultant signals and/or measurements may be communicated to a surface control unit via any suitable method for communicating data.

FIGURE 5 illustrates a cross-sectional view of coring bit electronics 414 in coring bit assembly 126 for performing measurements to detect anisotropic properties across core sample 412, in accordance with some embodiments of the present disclosure. In the illustrated embodiment, coring bit electronics 414 may contain two transmitters 502a and 502b and two receivers 504a and 504b. Transmitter 502a may be arranged substantially opposite from receiver 504a with respect to core sample 412, e.g., along the x-axis. Likewise, transmitter 502a may be arranged substantially opposite from receiver 504b with respect to core sample 412 and approximately ninety degrees rotated from transmitter 502a and receiver 504a, e.g., along the y-axis. Sensors, calipers, and/or other measurement tools may be included as part of or near to transmitters 502 and/or receivers 504. Further, transmitters 502 and/or receivers 504 may be transceivers in order to transmit and receive from both sides of coring mandrel 402 and/or inner barrel 408. In operation of embodiments of the present disclosure, a signal may be sent from transmitter 502a and received by receiver 504a. Additionally, a signal may be sent from transmitter 502b and received by receiver 504b. The characteristics and properties of the signal received by receivers 404 may indicate various properties of core sample 412, e.g., porosity, permeability, and/or other physical or petrophysical properties of core sample 412. The resultant signals and/or measurements may be communicated to a surface control unit via any suitable method for communicating data. The configuration shown in FIGURE 5 may allow the detection of anisotropic properties in core sample 412 (e.g., detection of unequal physical properties along different axes) by measuring core sample 412 properties in both the x-axis and y-axis directions.

FIGURE 6 illustrates a perspective view for coring bit electronics 414 in coring bit assembly 126 for performing measurements transversely and longitudinally across core sample 412, in accordance with some embodiments of the present disclosure. Transmitters 502 and/or receivers 504 may be mounted within or attached to coring mandrel 402. Although the present embodiment is illustrated with respect to coring mandrel 402, transmitters 502 and/or receivers 504 may also and/or alternatively be mounted within or attached to inner barrel 408, inner sleeve 410, and/or mounted in any suitable location. In the illustrated embodiment, coring bit electronics 414 may include two receivers 504a and 504b and transmitter 502a. Transmitter 502a may be arranged substantially opposite from receiver 504a with respect to core sample 412, e.g., along the x-axis. Receiver 504b may be arranged axially with transmitter 502b, e.g., along the z-axis. Sensors, calipers, and/or other measurement tools may be included as part of or near to transmitter 502a and/or receivers 504a and 504b. Further, transmitter 502a and/or receivers 504a and 504b may be transceivers in order to transmit and receive from both sides of coring mandrel 402, inner barrel 408, and/or inner sleeve 410. In operation of embodiments of the present disclosure, a signal may be sent from transmitter 502a and received by receiver 504a and/or receiver 504b. The characteristics and properties of the signal received by receivers 504 may indicate various properties of core sample 412, e.g., porosity, permeability, and/or other physical or petrophysical properties of core sample 412. The resultant signals and/or measurements may be communicated to a surface control unit via any suitable method for communicating data. The configuration shown in FIGURE 6 may allow both transverse measurement (e.g., between transmitter 502a and receiver 504a) and longitudinal measurement (e.g., between transmitter 502a and receiver 504b).

As exemplified by FIGURES 2–6, many arrangements may exist for coring bit electronics 414 to enable different types of measurements of core sample 412. Other suitable configurations of components may be used as part of the coring bit electronics without departing from the scope of the present disclosure. For example, coring bit electronics 414 may include more or fewer components, including transmitters 502 and receivers 504, than shown in FIGURES 2–6. As another example, coring bit electronics 414 may allow for measurements based on electromagnetic radiation or a light spectrum, such as visible light, infra-red, ultraviolet, and/or x-ray. In designing a configuration in embodiments of the present disclosure, consideration may be made of the type of components, placement of components, corrections for polarization of transmitted waves, and other considerations. For example, continuity of the core string may become a challenge that may be corrected by the addition of an internal mechanical or electronic caliper to the coring bit electronics.

FIGURE 7 illustrates a flow chart of example method 700 for performing measurements on core sample 412 during LWC operation with coring bit electronics (e.g., 414 of FIGURES 2–6), in accordance with some embodiments of the present disclosure. The steps of method 700 may be performed by various computer programs, models or any combination thereof, configured to operate a drilling tool, perform measurements, and log/analyze results. The programs and models may include instructions stored on a computer readable medium and operable to perform, when executed, one or more of the steps described below. The computer readable media may include any system, apparatus or device configured to store and retrieve programs or instructions such as a hard disk drive, a compact disc, flash memory or any other suitable device. The programs and models may be configured to direct a processor or other suitable unit to retrieve and execute the instructions from the computer readable media. Collectively, the computer programs and models used to operate a drilling tool, perform measurements, and log/analyze results may be referred to as a “drilling engineering tool” or “engineering tool.” For illustrative purposes, method 700 is described with respect to drilling tool 116 of FIGURE 1; however, method 700 may be used to perform measurements, and log/analyze results using any suitable drilling tool.

Method 700 may start and at step 706, the engineering tool may direct a drilling tool to extract a core sample from a wellbore. For example, coring bit 102 may be directed to operate and cut core sample 412 from wellbore 106. Once core sample 412 has been extracted from wellbore 106, method 700 may continue to step 708.

At step 708, the engineering tool may direct the coring bit assembly to obtain measurements of the core sample using the coring bit electronics and log results. For example, coring bit electronics 414 contained in coring bit assembly 126 may perform transverse measurements using transmitter 502 and/or receiver 504. The measurements may be transmitted to a surface control unit and logged and/or analyzed.

At step 710, the engineering tool may determine if all measurements have been successfully captured and logged. If more measurements are required, method 700 may return to step 708 to perform additional measurements. If no additional measurements are required, method 700 may proceed to step 712.

At step 712, the engineering tool may direct the drilling tool to remove the core sample. For example, core sample 412 may be removed to the surface or core sample 412 may be deposited into a storage compartment for later removal. For example, drilling tool 116 may deposit core sample 412 in a storage tube (not shown).

At step 714, the engineering tool may determine if more core samples are required. If more core samples are required, method 700 may return to step 706. For example, if more measurements are required, another core sample 412 may be obtained from wellbore 106. This cycle may be repeated until all of core samples 412 are collected, after which, at step 716 drilling tool 116 may be removed from wellbore 106. Following removal of drilling tool 116, method 700 may end.

Modifications, additions, or omissions may be made to method 700 without departing from the scope of the present disclosure. For example, the order of the steps may be performed in a different manner than that described and some steps may be performed at the same time. Additionally, each individual step may include additional steps without departing from the scope of the present disclosure.

Although the present disclosure and its advantages have been described in detail, it should be understood that various changes, substitutions and alternations can be made herein without departing from the spirit and scope of the disclosure as defined by the following claims.

WHAT IS CLAIMED IS:

1. A drilling tool, comprising:

a coring bit configured to obtain a core sample from a wellbore;

a coring mandrel coupled to the coring bit, the coring mandrel including an inner gage bore;

an inner barrel disposed inside the inner gage bore;

an inner sleeve disposed inside the inner barrel, the inner sleeve configured to receive the core sample; and

coring bit electronics coupled to the coring mandrel.

2. The drilling tool of Claim 1, wherein the coring bit electronics are configured to measure a property associated with the core sample.

3. The drilling tool of Claim 2, wherein the property comprises a petrophysical property.

4. The drilling tool of Claim 1, wherein the coring bit electronics comprise a receiver and a transmitter configured to obtain a transverse measurement of the property of the core sample.

5. The drilling tool of Claim 1, wherein the coring bit electronics comprise a receiver and a transmitter configured to obtain a longitudinal measurement of the property of the core sample.

6. The drilling tool of Claim 1, wherein the coring bit electronics comprise a plurality of receivers and a plurality of transmitters configured to obtain an anisotropic measurement of the property of the core sample.

7. The drilling tool of Claim 1, wherein the coring bit electronics comprise a sensor.

8. The drilling tool of Claim 1, further comprising a caliper disposed on the coring mandrel.

9. A drilling tool, comprising:

a coring bit configured to obtain a core sample from a wellbore;

a coring mandrel coupled to the coring bit, the coring mandrel including an inner gage bore;

an inner barrel disposed inside the inner gage bore;

an inner sleeve disposed inside the inner barrel, the inner sleeve configured to receive the core sample; and

coring bit electronics associated with the inner barrel.

10. The drilling tool of Claim 9, wherein the coring bit electronics are configured to measure a property associated with the core sample.

11. The drilling tool of Claim 10, wherein the property comprises a petrophysical property.

12. The drilling tool of Claim 9, wherein the coring bit electronics comprise a receiver and a transmitter configured to obtain a transverse measurement of the property of the core sample.

13. The drilling tool of Claim 9, wherein the coring bit electronics comprise a receiver and a transmitter configured to obtain a longitudinal measurement of the property of the core sample

14. The drilling tool of Claim 9, wherein the coring bit electronics comprise a plurality of receivers and a plurality of transmitters configured to obtain an anisotropic measurement of the property of the core sample.

15. The drilling tool of Claim 9, wherein the coring bit electronics comprise a sensor.

16. The drilling tool of Claim 9, further comprising a caliper disposed on the inner barrel.

17. The drilling tool of Claim 9, wherein the coring bit electronics are disposed on the inner barrel.

18. The drilling tool of Claim 9, wherein the coring bit electronics are disposed on the inner sleeve.

19. A method for performing measurements on a core sample, comprising:

extracting a core sample from a wellbore with a coring bit coupled to a coring mandrel;

measuring a property associated with the core sample using coring bit electronics coupled to the coring mandrel; and

transmitting the measurement from the coring bit electronics to a surface.

20. The method of Claim 19, wherein the coring bit electronics comprise a receiver and a transmitter configured to obtain a transverse measurement of the property of the core sample.

21. The method of Claim 19, wherein the coring bit electronics comprise a receiver and a transmitter configured to obtain a longitudinal measurement of the property of the core sample

22. The method of Claim 19, wherein the coring bit electronics comprise a plurality of receivers and a plurality of transmitters configured to obtain an anisotropic measurement of the property of the core sample.

23. The method of Claim 19, wherein the coring bit electronics comprise a sensor.

24. The method of Claim 19, wherein the property comprises a petrophysical property.

25. The method of Claim 19, further comprising a caliper disposed on the coring mandrel.

26. A method for performing measurements on a core sample, comprising:

extracting a core sample from a wellbore with a coring bit coupled to a coring mandrel, the coring mandrel including an inner barrel;

measuring a property associated with the core sample using coring bit electronics associated with the inner barrel; and

transmitting the measurement from the coring bit electronics to a surface.

27. The method of Claim 26, wherein the coring bit electronics comprise a receiver and a transmitter configured to obtain a transverse measurement of the property of the core sample.

28. The method of Claim 26, wherein the coring bit electronics comprise a receiver and a transmitter configured to obtain a longitudinal measurement of the property of the core sample

29. The method of Claim 26, wherein the coring bit electronics comprise a plurality of receivers and a plurality of transmitters configured to obtain an anisotropic measurement of the property of the core sample.

30. The method of Claim 26, wherein the coring bit electronics comprise a sensor.

31. The method of Claim 26, wherein the property comprises a petrophysical property.

32. The method of Claim 26, further comprising a caliper disposed on the inner barrel.

33. The method of Claim 26, wherein the coring bit electronics are disposed on the inner barrel.

34. The method of Claim 26, wherein the coring bit electronics are disposed on the inner sleeve.

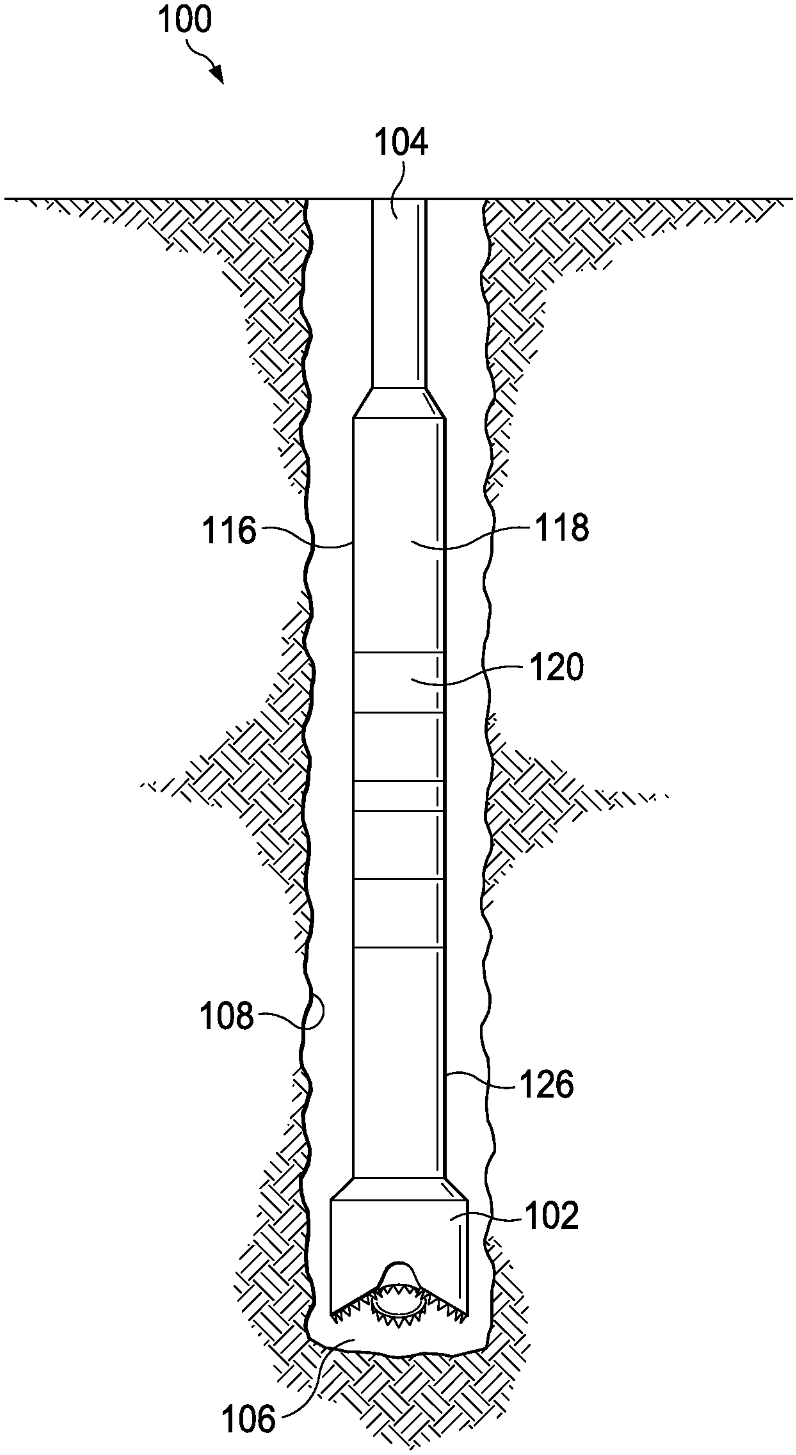
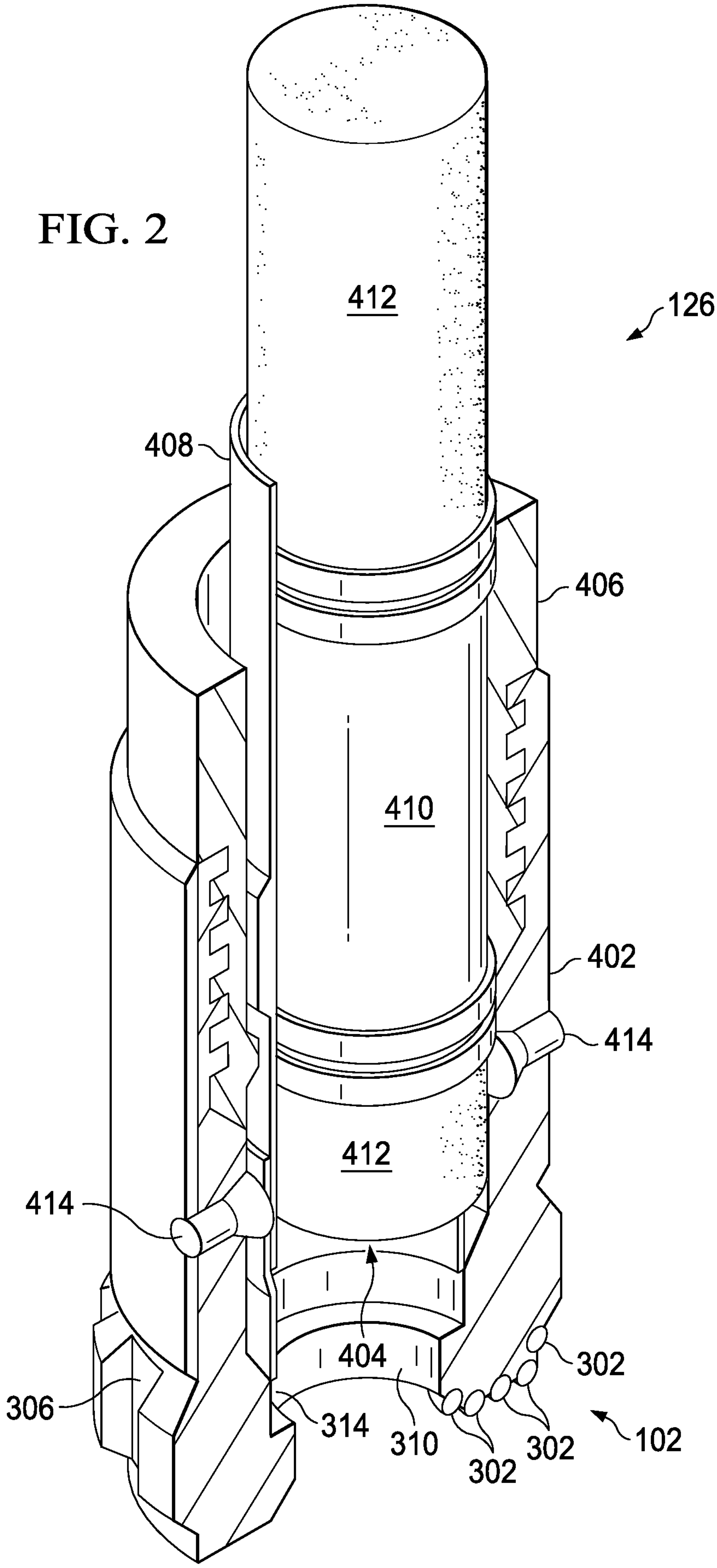


FIG. 1

FIG. 2


126
412
408
406
410
402
414
412
414
404
302
306
314
310
302
302
102

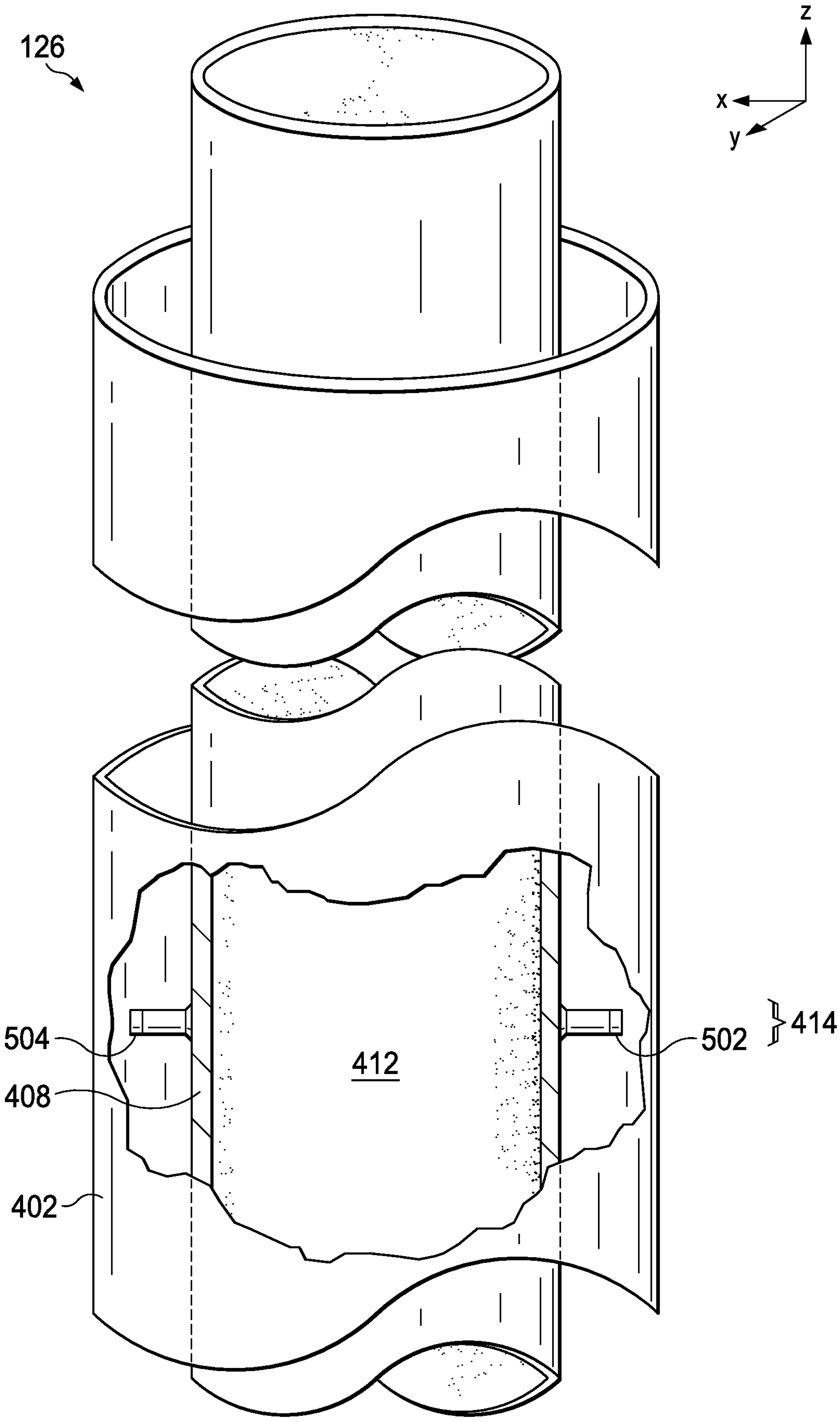


FIG. 3

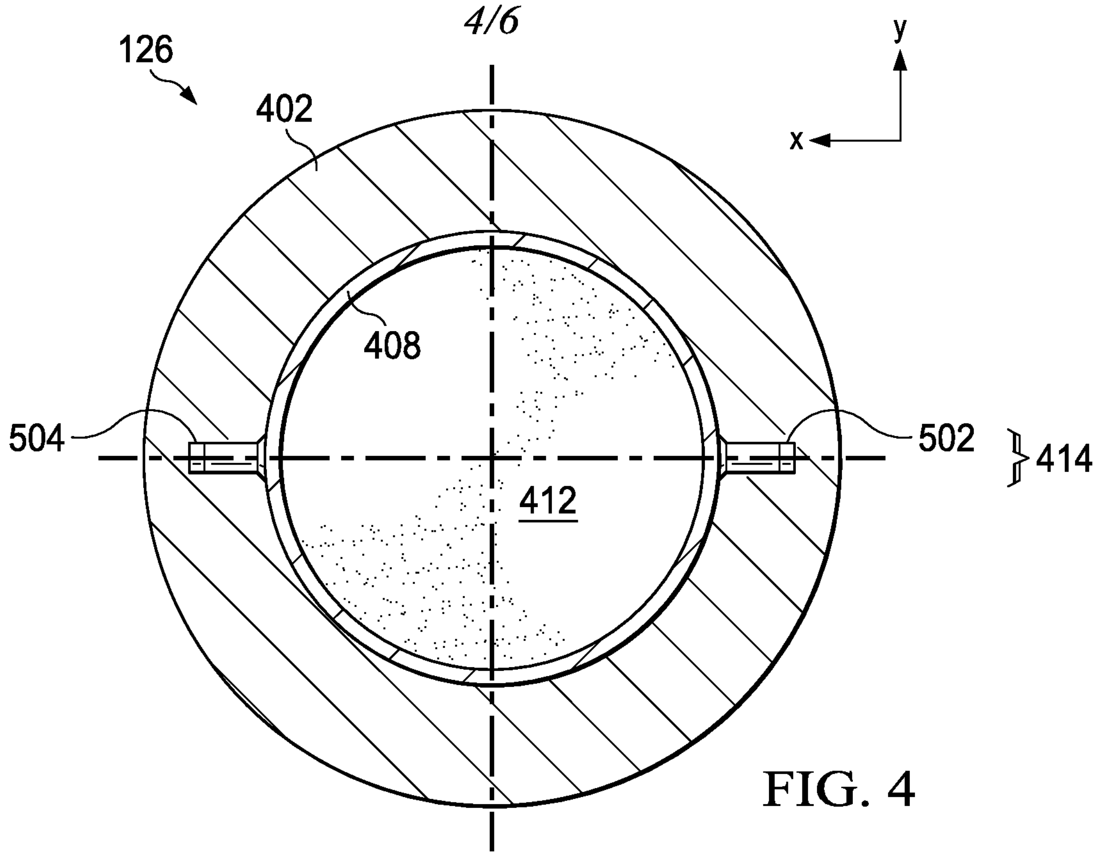

126
402
408
504
502
414
412
x
y

FIG. 4

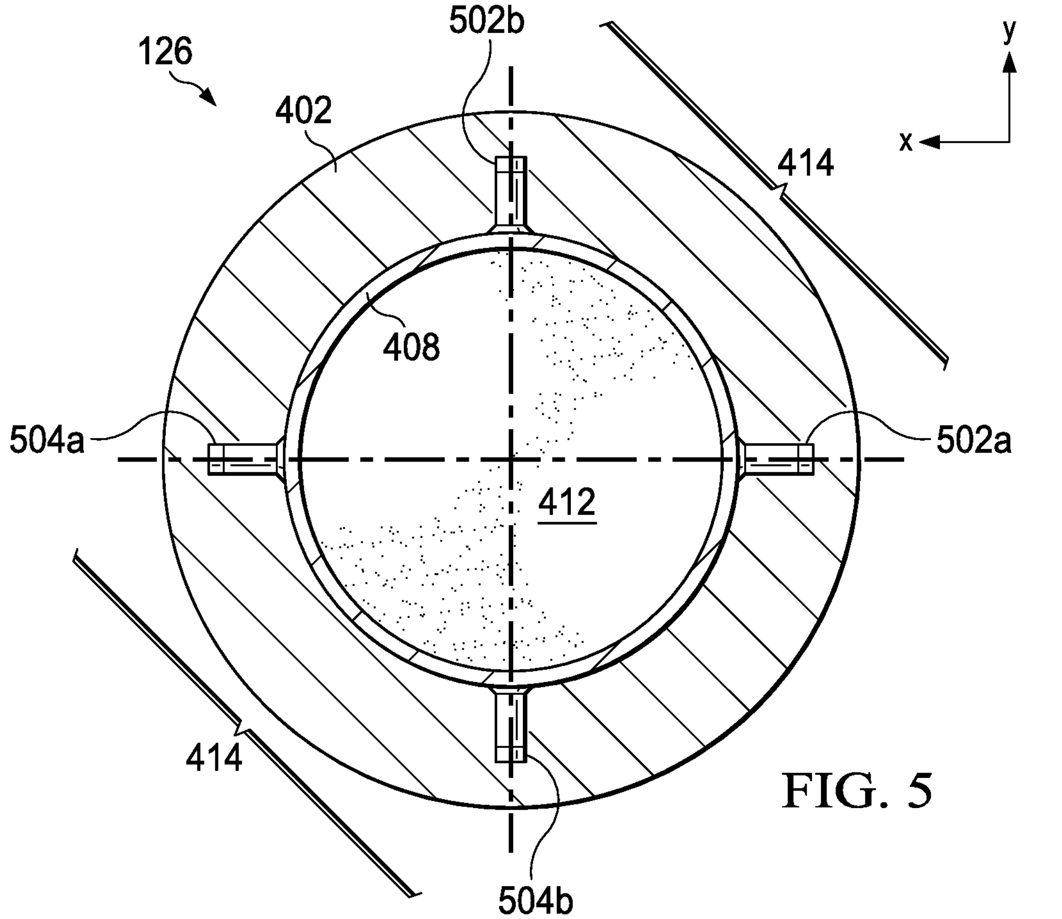

126
402
502b
414
408
504a
502a
412
414
504b
x
y

FIG. 5

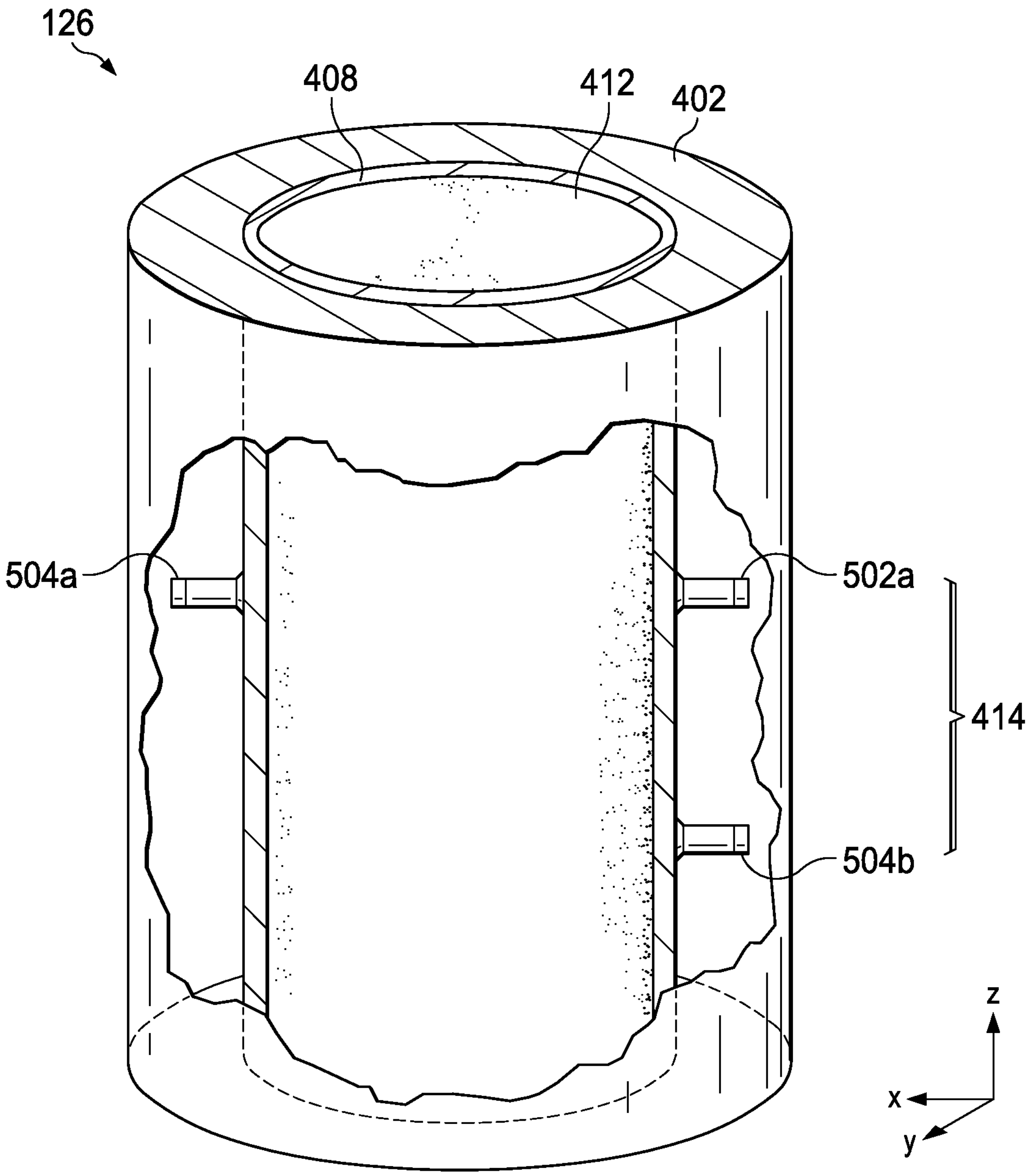


FIG. 6

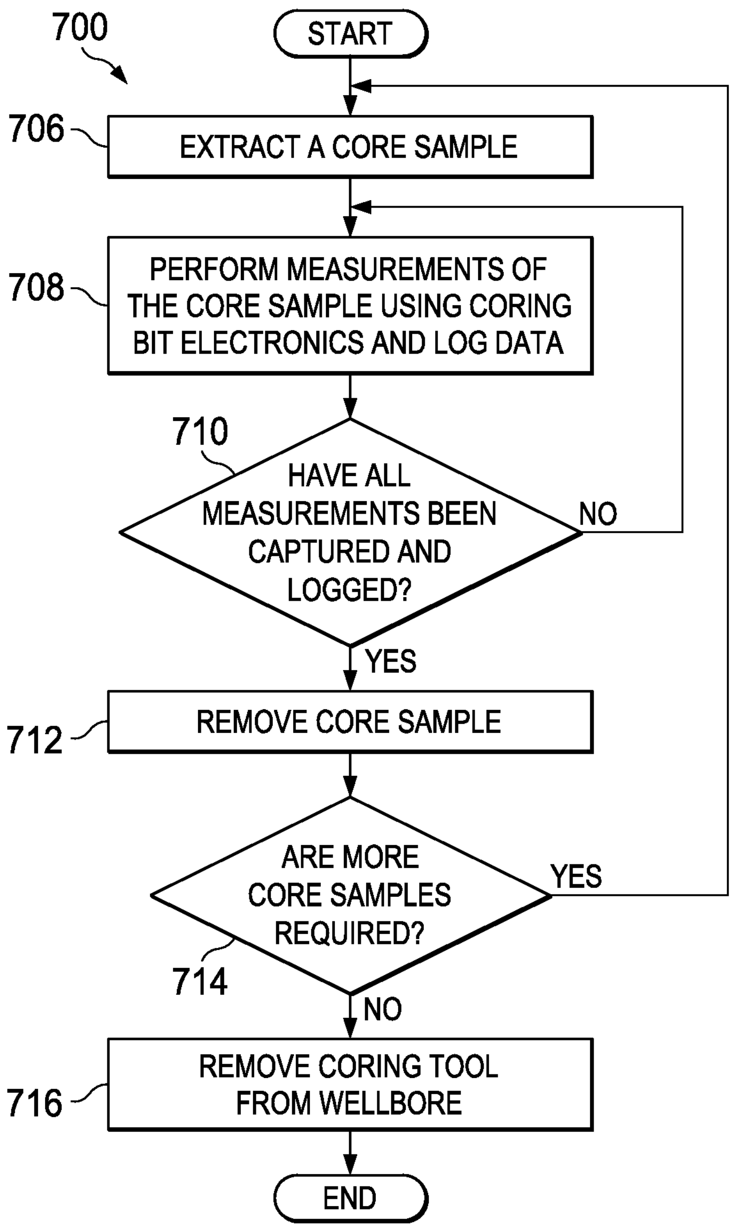

700
START
706
EXTRACT A CORE SAMPLE
708
PERFORM MEASUREMENTS OF THE CORE SAMPLE USING CORING BIT ELECTRONICS AND LOG DATA
710
HAVE ALL MEASUREMENTS BEEN CAPTURED AND LOGGED?
NO
YES
712
REMOVE CORE SAMPLE
ARE MORE CORE SAMPLES REQUIRED?
YES
714
NO
716
REMOVE CORING TOOL FROM WELLBORE
END

FIG. 7