(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 June 2009 (11.06.2009)

PCT

(10) International Publication Number
WO 2009/073414 A2

(51) International Patent Classification:
E21B 41/00 (2006.01) *E21B 17/02* (2006.01)

(21) International Application Number:
PCT/US2008/084383

(22) International Filing Date:
21 November 2008 (21.11.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/991,151 29 November 2007 (29.11.2007) US
12/274,922 20 November 2008 (20.11.2008) US

(71) Applicant *(for all designated States except US)*: **BAKER HUGHES INCORPORATED** [US/US]; P.O. Box 4740, Houston, TX 77210-4740 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **JAHN, Robert** [US/US]; 9715 Slate Field Dr., Houston, TX 77064 (US).

(74) Agents: **CARSON, Matt, W.** et al.; Baker Hughes Incorporated, P.O. Box 4740, Houston, TX 77210-4740 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

[Continued on next page]

(54) Title: MAGNETIC MOTOR SHAFT COUPLINGS FOR WELLBORE APPLICATIONS

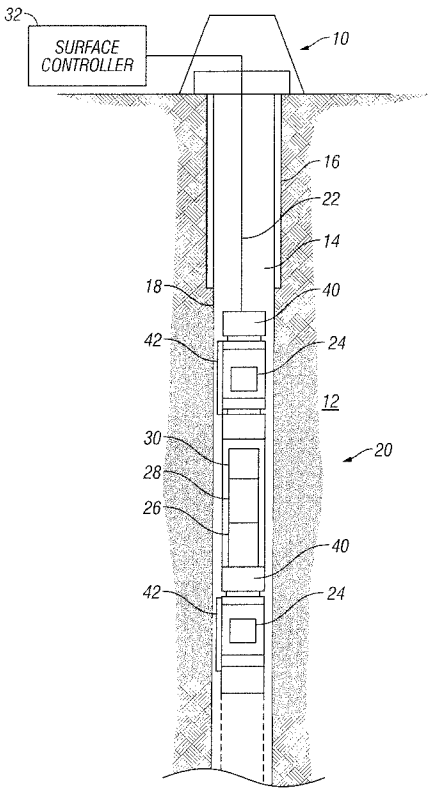


FIG. 1

32 unité de commande en surface

(57) Abstract: An actuator for operating downhole tools includes a tool body and one or more members configured to perform a wellbore task. The tool may include a sealed power and a driven section in pressure communication with the wellbore. A magnetic coupling magnetically connects the power section to the driven section. The power section may include an electric motor; and the driven section may include a speed reducer / torque increaser. In some embodiments, the member may be a positioning member. The positioning member may be manipulated to position a sensor that is configured to measure a parameter of interest. In other embodiments, the member may be an element such as cutting elements that cut wellbore tubulars. In aspects, a method for actuating or operating downhole tools includes using an actuator that utilizes a magnetic coupling to convey energy across a pressure boundary.

WO 2009/073414 A2

European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *without international search report and to be republished upon receipt of that report*

MAGNETIC MOTOR SHAFT COUPLINGS FOR WELLBORE APPLICATIONS

INVENTOR: JAHN, Robert

BACKGROUND OF THE DISCLOSURE

1. Field of the Disclosure

[0001] The disclosure relates generally to systems and methods for actuating downhole tooling.

2. Description of the Related Art

[0002] Oil or gas wells are often surveyed to determine one or more geological, petrophysical, geophysical, and well production properties ("parameters of interest") using electronic measuring instruments conveyed into a wellbore by an umbilical such as a wireline, slickline, drill pipe or coiled tubing. Tools adapted to perform such surveys are commonly referred to as formation evaluation tools. These tools may use mechanical, electrical, acoustical, nuclear and/or magnetic energy to stimulate the formations and fluids within the wellbore and measure the response of the formations and fluids. The measurements made by downhole instruments are transmitted back to the surface. In many instances, these tools may have to be oriented in a pre-determined position in order to obtain accurate measurements. Exemplary positions may include a concentric position in a wellbore, an eccentric position in the wellbore, and an abutting or contacting relationship between the tool and a wall of the wellbore.

[0003] The present disclosure addresses the need for actuator systems suitable for such tools as well as actuator systems that address other needs of the prior art.

SUMMARY OF THE DISCLOSURE

[0004] In aspects, the present disclosure provides an actuator that permits power sources, such as electric motors, to operate at lower temperatures and deliver power at sufficient magnitude to perform useful work even in high pressure and high temperature wellbore environments.

[0005] In embodiments, the apparatus includes a tool body and one or more one positioning members associated with the tool body. The positioning member or members may be configured to engage a surface associated with the wellbore. For example, a positioning member may include an arm configured to radially extend and retract. The apparatus further includes an actuator operably coupled to each positioning member. The actuator may have a power section, a driven section, and a magnetic coupling magnetically connecting the power section to the driven section. In one arrangement, the power section includes a sealed chamber and the driven section includes a chamber in pressure communication with the wellbore. The power section may include an electric motor; and the driven section may include a speed reducer / torque increaser. In embodiments, the apparatus may include a sensor that is configured to measure a parameter of interest. The sensor may be positioned in the tool body and / or on a positioning member.

[0006] In other embodiments, the apparatus may be configured to rotate one or more elements that perform tasks by engaging or

contacting a wellbore object such as a wellbore wall or a wall of a wellbore tubular. For example, the elements may be cutting elements that are configured to cut into objects such as metal casings or drill string. An apparatus configured for such tasks may include a sealed motor section, a driven section, and a magnetic coupling magnetically connecting the power section to the driven section. In one arrangement, the sealed motor section includes a motor in a sealed chamber and the driven section may be positioned in a chamber in pressure communication with the wellbore. The rotary power of the motor is transferred across a pressure boundary between the sealed motor section and the driven section to rotate the cutting elements.

[0007] In aspects, the present disclosure provides a method for actuating or operating downhole tools by using an actuator that utilizes a magnetic coupling that permits a motor to operate at lower temperatures and to deliver power to perform useful work in high pressure and high temperature wellbore environments.

[0008] It should be understood that examples of certain features of the disclosure have been summarized broadly in order that detailed description thereof that follows may be better understood, and in order that the contributions to the art may be appreciated. There are, of course, additional features of the disclosure that will be described hereinafter and which will form the subject of the claims appended hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The advantages and further aspects of the disclosure will be readily appreciated by those of ordinary skill in the art as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings in which like reference characters designate like or similar elements throughout the several figures of the drawing and wherein:

Fig. 1 is a schematic elevation view of an exemplary well that is being investigated with a formation evaluation tool configured in accordance with one embodiment of the present disclosure;

Fig. 2 is an isometric view of a formation evaluation tool using a magnetic coupling in accordance with one embodiment of the present disclosure;

Fig. 3 is a schematic cross-sectional view of the **Fig. 2** embodiment that shows the magnetic coupling in greater detail;

Fig. 4 is a schematic view of a formation sampling tool using a magnetic coupling in accordance with one embodiment of the present disclosure;

Fig. 5 is a schematic view of a caliper device using a magnetic coupling in accordance with one embodiment of the present disclosure;

Fig. 6 is a schematic view of a formation evaluation tool conveyed along a drill string and that uses a magnetic coupling in accordance with one embodiment of the present disclosure;

Fig. 7 is a schematic sectional view of a bottomhole drilling assembly that includes a steering device that uses a magnetic

coupling in accordance with one embodiment of the present disclosure; and

Fig. 8 is a functional block diagram of a cutting tool uses a magnetic coupling in accordance with one embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[00010] The present disclosure relates to devices and methods for actuating downhole tooling. The present disclosure is susceptible to embodiments of different forms. There are shown in the drawings, and herein will be described in detail, specific embodiments of the present disclosure with the understanding that the present disclosure is to be considered an exemplification of the principles of the disclosure and is not intended to limit the disclosure to that illustrated and described herein. Further, while embodiments may be described as having one or more features or a combination of two or more features, such a feature or a combination of features should not be construed as essential unless expressly stated as essential.

[00011] As will be discussed in greater detail below, embodiments of the present disclosure enable a power source in a first pressure environment to transmit power to a driven unit in a second pressure environment without the use of seals along the power transmission path. In many, but not all embodiments, the power transmission path will be configured to transmit rotary power. However, in certain embodiments, a translation motion or other motion may also be utilized to transmit power. The driven unit converts the power supplied by the power source into a mechanical action that can be used to apply a force to a wellbore or casing wall. The applied force may be used to move, position, displace, anchor, steer or orient a tool or housing in a wellbore. Exemplary embodiments are described below.

[00012] Referring initially to **Fig. 1**, there is shown a rig **10** on the surface that is positioned over a subterranean formation of interest **12**. The rig **10** can be a part of a land or offshore a well production/construction facility. A wellbore **14** formed below the rig **10** includes a cased portion **16** and an open hole portion **18**. In certain instances (*e.g.*, during drilling, completion, work-over, etc.), a logging operation may be conducted to collect information relating to the formation **12** and the wellbore **14**. Typically, a tool assembly **20** is conveyed downhole via an umbilical **22** to measure one or more parameters of interest relating to the wellbore **14** and/or the formation **12**. The term "umbilical" as used hereinafter includes a cable, a wireline, slickline, drill pipe, coiled tubing and other devices suitable for conveying a tool into a wellbore. The tool assembly **20** can include one or more tools **24** adapted to perform one or more downhole tasks. The tools may be positioned in a sonde or sub that is suited to enclose, house, or otherwise support a device that is to be deployed into a wellbore. While two proximally positioned tools **24** are shown, it should be understood that a greater or fewer number may be used.

[00013] In embodiments, the tool **24** may be formation evaluation tool adapted to measure one or more parameters of interest relating to the formation or wellbore. It should be understood that the term formation evaluation tool encompasses measurement devices, sensors, and other like devices that, actively or passively, collect data about the various characteristics of the formation, directional sensors for providing information about the tool orientation and direction of movement, formation testing sensors for providing information about the characteristics of the reservoir fluid and for evaluating the reservoir conditions. The formation evaluation sensors may include resistivity sensors for determining the formation resistivity, dielectric constant and

the presence or absence of hydrocarbons, acoustic sensors or receivers for determining the acoustic porosity of the formation and the bed boundary in formation, nuclear sensors for determining the formation density, nuclear porosity and certain rock characteristics, nuclear magnetic resonance sensors for determining the porosity and other petrophysical characteristics of the formation. The direction and position sensors preferably include a combination of one or more accelerometers and one or more gyroscopes or magnetometers. The accelerometers preferably provide measurements along three axes. The formation testing sensors collect formation fluid samples and determine the properties of the formation fluid, which include physical properties and chemical properties. Pressure measurements of the formation provide information about the reservoir characteristics. The above-listed sensors and parameters should be considered illustrative and not exhaustive of the types of sensors that may be used in the tool **20** and or the parameters measured by the tool **20**.

[00014] In certain embodiments, the tool assembly **20** can include communication equipment **26**, a local or downhole controller **28** and a downhole power supply **30**. The communication equipment **26** provides two-way communication for exchanging data signals between a surface controller **32** and the tool assembly **20** as well as for transmitting control signals from the surface processor **32** to the tool assembly **20**. It should be appreciated that the above-described components and equipment merely illustrate one arrangement that may utilize the teachings of the present disclosure. The above-described components or equipment, therefore, are considered only optional and not necessary to the present teachings.

[00015] In accordance with one embodiment of the present disclosure, the tool assembly **20** may include an actuator assembly **40** that extend and /or retract one or more positioning members **42** on the tool **24**. The members **42** may be adapted to independently move between an extended position and a retracted position. The extended position can be either a fixed distance or an adjustable distance. Suitable positioning members **42** include ribs, pads, pistons, cams, arms or other devices adapted to engage a surface such as a wellbore wall or casing interior. In certain embodiments, the positioning members **42** may be configured to temporarily lock or anchor the tool **20** in a fixed position relative to the wellbore and/or allow the tool **20** to move along the wellbore. The actuator assembly **40** and the members **42** may be configured to provide a fixed or adjustable amount of force against the wellbore wall. For instance, in a positioning mode, the members **42** may position the tool **20** in a selected radial alignment or position relative to a wellbore wall or an axial centerline of the wellbore. The force applied to the wellbore wall during that mode, however, is not so great as to prevent the tool from being moved along the wellbore. In a locking or anchoring mode, the members **42** may generate a sufficiently high frictional force on the wellbore wall as to prevent substantial relative movement between the wellbore wall and the tool **20**. In certain embodiments, a biasing member (not shown) can be used to maintain the positioning members **42** in a pre-determined reference position.

[00016] In embodiments, the actuator **40** may utilize a power section that generates power and a driven section that actuates the positioning member or members **42**. As will be described in greater detail below, the power section may be positioned in a sealed chamber at controlled pressure, such as atmospheric pressure. The driven section for

conveying the power from the electric motor to the positioning members **42**, however, may be positioned in a chamber that is substantially at an ambient wellbore pressure. Advantageously, a magnetic coupling positioned at a bulkhead or other physical interface between the controlled pressure and the ambient wellbore pressure may be used to transmit rotary power from the power section to the driven section.

[00017] Referring now to **Fig. 2**, there is shown in greater detail one exemplary formation evaluation tool assembly **200** made according to the present disclosure. The formation evaluation tool assembly **200** may include an actuator **202** for selectively extending and / or retracting one or more arms **204**. The actuator **202** may include an electric motor **206** that drives a drive train **208**. The drive train **208** may include a speed reducer / torque increaser **210**, one or more thrust bearings **212** and a shaft **214**. In embodiments, the arm **204** is extended and retracted using a mechanical linkage **215**. For instance, the shaft **214** may include a threaded section **228** on which is mounted a ball nut **230**. Rotation of the shaft **214** causes the ball screw **230** to translate linearly along the shaft **214**. The linear motion of the ball screw **230** causes linkage **215** to extend or retract the arm **204** in a known manner.

[00018] It should be understood that the drive train **208** may also utilize other power transmission mechanisms. For example, the drive train **208** may utilize cams that may extend or retract pads.

[00019] In one arrangement, the tool assembly **200** may include a sealed section **216** that is maintained at substantially atmospheric pressure and a high pressure section **218** that may have a pressure that approximates a pressure in a surrounding wellbore. Disposed

within the sealed section **216** is the electric motor **206**. Disposed within the high pressure section **218** is the drive train **208**. The sealed section **216** and the high pressure section **218** may be separated by a pressure bulkhead **220**. A magnetic coupling **222** may be used to transmit rotary power across the bulkhead **220**. In embodiments, the magnetic coupling **222** magnetically couples the rotating shaft of the electric motor **206** to the drive train **208** to thereby allow the transmission of rotary power without a physical connection between the electric motor **206** and the drive train **208**.

[00020] Referring now to **Fig. 3**, there is shown in greater detail the arrangement used to convey rotary power from the electric motor **206** (**Fig. 2**) to the drive train **208** (**Fig. 2**). In the non-limiting arrangement shown, the magnetic coupling **222** includes an outer section **240** positioned in the sealed section **216** and an inner section **242** positioned in the high-pressure section **218**. Referring now to **Figs. 2** and **3**, the outer section **240** is fixed to the electric motor **206** whereas the inner section **242** is fixed to the input side of the speed reducer / torque increaser **210**. The electric motor **206** may be a DC motor or an A/C motor. The electric motor **206** may also be a reversible motor. Moreover, the sealed section **216** may be filled with a fluid that is at or near atmospheric. The speed reducer / torque increaser **210** converts the high rotary speed of the electric motor **206** into a torque of sufficient magnitude to displace the arm **204** via the shaft **214**, ball screw **230**, and mechanical linkage **226**. The reaction forces caused by the arm **204** engaging an adjacent wall may cause an axial loading along the shaft **214**, which is borne by the thrust bearing **212**.

[00021] It should be appreciated that the transmission rotary power from the electric motor **206** to the shaft **214** does not necessarily require the use of seals along any portion of the rotary power

transmission path. For instance, there are no seals along the shaft **214** or at the speed reducer / torque increaser **210** that encounter a pressure differential between a wellbore pressure and a low pressure environment associated with the sealed section **216**. This pressure differential may be as great as to cause seals, if present, to apply a significant gripping force onto a rotating shaft. Advantageously, the elimination of such seals also eliminates the loss of rotary power and the loads imposed by such seals on the electric motor **206**. In aspects, the elimination of such losses and loadings permit the electric motor **206** to operate at lower temperatures and permit the delivery of rotary power at sufficient magnitude to perform useful work even in high pressure and high temperature wellbore environments.

[00022] In embodiments, the tool assembly **200** may include one or more instruments **236** for investigating a surrounding formation. In one non-limiting arrangement, the instrument **236** may need physical contact with a casing wall or a wellbore wall during operation. This physical contact may be needed, for example, to acoustically couple an acoustic receiver to an adjacent formation. Thus, in one mode of operation, the actuator **202** is energized to extend the arm **204** outward to engage a wellbore wall and thereafter apply a force needed to radially displace the instrument **236** until the instrument **236** is pressed against the wellbore wall. Due to the physical contact with the wellbore wall, the instrument **236** may detect and measure acoustic energy in the adjacent formation.

[00023] It should be understood, however, that numerous other wellbore applications may also make use of the rotary power supplied by the electric motor **206**. The advantages of the present disclosure may be obtained in those other applications as will apparent in the discussion below.

[00024] Referring now to **FIG. 4**, there is schematically illustrated one embodiment of a formation evaluation tool **300** for measuring one or more parameters of interest relating to the formation and / or the wellbore. The tool **300** may include a cable head **302** that connects to the wireline **304**, an electronics module **308**, a hydraulics module **310**, and a formation testing module **312**. The electronics module **308** may provide communication links with the surface and *in situ* control over the tool **300**. The hydraulics module **310** may provide pressurized hydraulic fluid for hydraulically actuated components. The formation testing module **312** may be configured to retrieve and store fluid and / or core samples and, in embodiments, may include analysis tools that perform downhole testing on the retrieved samples. Moreover, the tool **300** can be configured as needed to accomplish specific desired operations and may house additional tools, such as survey tools, formation evaluation tools, reservoir characterization tools, etc. To radially displace the formation testing module **312**, the module **312** may include upper and lower decentralizing arms **314**. The arms **314** can be mounted on the body of module **314** by pivot pins (not shown) and may be configured to extend or retract during operation. In embodiments, an actuator similar to the actuator **40** as described in connection with **Fig. 2** may be used to manipulate the arms **314**. In one non-limiting arrangement, the formation testing module **312** may include a probe **316** or other device configured to engage or even penetrate a wellbore wall to retrieve a desired sample. Thus, in one mode of operation, an actuator (*e.g.*, actuator **40** of **Fig. 2**) may be energized to extend the arm **314** outward to engage a wellbore wall and thereafter apply a force needed to radially displace the module **312** until the probe **316** is pressed against the wellbore wall. Thereafter, the arms **314** may hold the module **312** while the probe **316** retrieves the samples, which may be fluid samples or core samples.

After sampling is complete, the actuator may be energized to retract the arms **314**. In embodiments, the arms **314** may be biased to return to the retracted position once the actuator is deenergized.

[00025] In addition to radially displacing or positioning a tool or sensor, embodiments of the present disclosure may also utilize an actuator having a magnetic coupling as an operative component of the tool or sensor itself. Referring now to **Fig. 5**, there is schematically shown a wellbore caliper device **330** that may be deployed into a wellbore **332**. The caliper device **330** may include known equipment to record wellbore geometry measurements and transmit the measurements to the surface. As shown, the device **330** may include one or more arms **334** that are configured to engage or contact a wellbore wall while the device **330** measures the diameter of the wellbore **332**. The arms **334** may include a biasing element (not shown) that allows the arms **334** to deflect as needed to accommodate the changing diameters of the wellbore as well as to traverse discontinuities and or other obstructions in the wellbore. In one mode of operation, an actuator (*e.g.*, actuator **40** of **Fig. 2**) may be energized to extend the arm **334** outward to engage a wellbore wall. Circuitry in the caliber device **330** may be used to monitor the movement of the arms **334** to determine the diameter of the wellbore **332**. The actuator may be energized to retract the arms **334** or the arms **334** may be biased to a nominal retracted state. Additionally, the caliper device **330** may be either stationary or in motion while the measurements are being taken.

[00026] The above described embodiments may be ordinarily be utilized in connection with non-rigid carriers such as wirelines and slicklines. Embodiments of the present disclosure may also be utilized

in the drilling and completion context as well. Illustrative embodiments are described below.

[00027] Referring now to **Fig. 6**, there is shown a formation evaluation tool **350** that may be positioned along a drill string **352** configured to drill the wellbore. The tool **350** may includes sensors for measuring seismic energy (*e.g.*, geophones G, hydrophones H, and accelerometers A) or any other sensor or device previously described. In one arrangement, sensors **354** that measure data via an acoustical path, the geophone G and the accelerometer A, may be positioned on arms or pads **356** that extend outward from the tool **350** into physical contact or engagement with a wellbore wall **358** such that the sensors **354** are acoustically coupled to the wellbore wall **358** . In one mode of operation, an actuator (*e.g.*, actuator **40** of **Fig. 2**) may be energized to extend the pads **356** outward to engage a wellbore wall in a manner previously described.

[00028] In addition to the positioning of tools, sensors and other devices that are configured to measure one or parameters relating to a formation or borehole, embodiments of the present disclosure may also be utilized in connection with devices that are apply force on a wellbore wall for other wellbore tasks.

[00029] For example, referring now to **Fig. 7**, there is schematically illustrated an embodiment of a bottomhole assembly (BHA) **380** that uses a steering unit **382** for directional drilling. In one configuration, the BHA **380** may include a drill bit **384**, and a drilling motor **386**. The steering unit **382** may include a plurality of ribs or arms **388** that may be selectively actuated to apply a force against a wellbore wall. In embodiments, in a manner as previously described, the steering unit **382** may include a sealed electric motor and rotary transmission device

that includes a magnetic coupling may be used to extend and retract the arm **388**. Each arm **388** may have a separate sealed electric motor and rotary transmission device. Thus, each of the arms **388** may be independently controllable and independently adjustable. To steer the BAH **380** in a desired direction, a force vector to be applied by each of the arms **388** is first computed. Next, each actuator is energized to cause its respective arm **388** to extend a distance that generates the desired force vector. The combination of the side forces applied by the arms **388** will cause the drill bit **384** to drill in a desired direction.

[00030] In still other variants, embodiments of the present disclosure may also be utilized in connection with devices that use one or more rotating elements that perform tasks by engaging or contacting a wellbore object such as a wellbore wall or a wall of a wellbore tubular.

[00031] For example, referring now to **Fig. 8**, there is illustrated in functional block diagram format an embodiment of a pipe cutter **400** for cutting a wellbore tubular **401**. In one configuration, the pipe cutter **400** may include a sealed motor section **402**, a magnetic coupling **404,** a driven section **406,** and one or more cutting elements **408**. The cutting elements **408**, which may be configured to cut metal, cement, or other materials that be in the wellbore, may be expandable; *i.e.*, extend and retract. In a manner previously described, the use of the magnetic coupling eliminates the need for seals or other similar devices along the rotating elements of the driven section **406**. Thus, any loading that would be caused by such seals on the motor are eliminated, which allows the motor to operate more efficiently. The sealed motor section **402** may include a sealed electric motor and the driven section **406** may include suitable shafts, bearings and other components for using the rotary power provided by the motor to rotate

the cutting elements **408**. Thus, in addition to aiding the transmission of rotary power to apply a force on a wellbore wall, embodiments of the present disclosure may be used to aid in transmitting rotary power to rotate cutting elements that cut wellbore tubulars, such as a casing, a drill pipe, a production tubular, a coiled tubing, or a liner.

[00032] In still other embodiments (not shown), an actuator having a magnetic coupling may be used in connection with deployment of a sensor. For example, the actuator may be coupled to a transducer or sensor positioned in a wellbore environment. The power source, such as an electric motor, may be positioned in a sealed or otherwise controlled environment. Advantageously, the magnetic coupling can transfer power across the pressure boundary between the wellbore environment and the sealed environment. The transferred power may be used to rotate or otherwise move the sensor. In addition to a sensor or transducer that measures parameters of interest, the transferred power may be used to operate sources or other devices that emit energy into a wellbore environment.

[00033] Thus, it should be appreciated that what has been described includes, in part, an apparatus for use in a wellbore in an earth formation that may include a tool body; a movable member associated with the tool body and that engages an object in the wellbore; an actuator operably coupled to the movable member, the actuator having a power section and a driven section; and a magnetic coupling magnetically connecting the power section to the driven section. The power section may include a sealed chamber; and the driven section may include a chamber in pressure communication with the wellbore. The movable member may include an arm configured to radially extend and retract. A sensor measuring a parameter of interest may be positioned on the arm and / or in the tool body. The power section may include an electric motor; and the driven section may include a

speed reducer / torque increaser. The magnetic coupling may convey power across a pressure barrier. The movable member may include a cutting element. The object may be a wellbore wall, a casing, a production tubular, a liner, a drill string, and coiled tubing.

[00034] It should be also appreciated that what has been described includes, in part, a method for use in a wellbore in an earth formation. The method may include engaging an object in the wellbore using at least one movable member associated with a tool body; coupling an actuator to the at least one movable member, the actuator having a power section and a driven section; and magnetically connecting the power section to the driven section. The method may also include disposing an electric motor in a sealed chamber of the power section; and positioning a speed reducer / torque increaser in a chamber of the driven section that is in communication with the wellbore.

[00035] It should be further appreciated that what has been described includes, in part, a system for use in a wellbore in an earth formation that may include a conveyance device; a tool body coupled to the conveyance device; at least one movable member associated with the tool body, the at least one movable member being configured to engage an object in the wellbore; an actuator operably coupled to the at least one movable member, the actuator having a power section and a driven section; and a magnetic coupling magnetically connecting the power section to the driven section.

[00036] The foregoing description is directed to particular embodiments of the present disclosure for the purpose of illustration and explanation. It will be apparent, however, to one skilled in the art that many modifications and changes to the embodiment set forth above are possible without departing from the scope of the disclosure.

CLAIMS

What is claimed is:

1. An apparatus for use in a wellbore in an earth formation, comprising:
(a) a tool body;
(b) at least one movable member associated with the tool body, the at least one movable member being configured to engage an object in the wellbore;
(c) an actuator operably coupled to the at least one movable member, the actuator having a power section and a driven section; and
(d) a magnetic coupling magnetically connecting the power section to the driven section.

2. The apparatus according to claim 1 wherein the power section includes a sealed chamber; and the driven section includes a chamber in pressure communication with the wellbore.

3. The apparatus of claim 1 wherein the at least one movable member includes an arm configured to radially extend and retract.

4. The apparatus according to claim 3 further comprising a sensor configured to measure a parameter of interest, the sensor being positioned on the arm.

5. The apparatus according to claim 1 further comprising a sensor configured to measure a parameter of interest, the sensor being positioned in the tool body.

6. The apparatus according to claim 1 wherein the power section includes an electric motor; and the driven section includes a speed reducer / torque increaser.

7. The apparatus according to claim 1 wherein the magnetic coupling conveys power across a pressure barrier.

8. The apparatus of claim 1 wherein the at least one movable member includes a cutting element.

9. The apparatus of claim 1 wherein the object is one of (i) a wellbore wall, (ii) a casing, (iii) a production tubular, (iv) a liner, (iv) drill string, and (iv) coiled tubing.

10. A method for use in a wellbore in an earth formation, comprising:

- engaging an object in the wellbore using at least one movable member associated with a tool body;
- coupling an actuator to the at least one movable member, the actuator having a power section and a driven section; and
- magnetically connecting the power section to the driven section.

11. The method according to claim 10 further comprising: forming a sealed chamber in the power section; forming a chamber in the driven section that is in pressure communication with the wellbore.

12. The method according to claim 11 further comprising disposing an electric motor in the sealed chamber; and positioning a speed reducer / torque increaser in the chamber of the driven section.

13. The method according to claim 10 further comprising positioning on an extensible arm a sensor configured to measure a parameter of interest.

14. The method according to claim 10 further comprising positioning in the tool body a sensor configured to measure a parameter of interest.

15. The method of claim 10 further comprising positioning a cutting element on the at least one movable member.

16. The method according to claim 10 wherein a magnetic coupling conveys power across a pressure barrier between the power section and the driven section.

17. The method of claim 10 wherein the object is one of (i) a wellbore wall, (ii) a casing, (iii) a production tubular, (iv) a liner, (iv) drill string, and (iv) coiled tubing.

18. A system for use in a wellbore in an earth formation, comprising:

- a conveyance device;
- a tool body coupled to the conveyance device;
- at least one movable member associated with the tool body, the at least one movable member being configured to engage an object in the wellbore;
- an actuator operably coupled to the at least one movable member, the actuator having a power section and a driven section; and
- a magnetic coupling magnetically connecting the power section to the driven section.

19. The system according to claim 18 wherein the power section includes a sealed chamber; and the driven section includes a chamber in pressure communication with the wellbore.

20. The system according to claim 19 wherein the power section includes an electric motor disposed in the sealed chamber; and the driven section includes a speed reducer / torque increaser in the chamber.

21. The system according to claim 18 wherein the magnetic coupling conveys power across a pressure barrier.

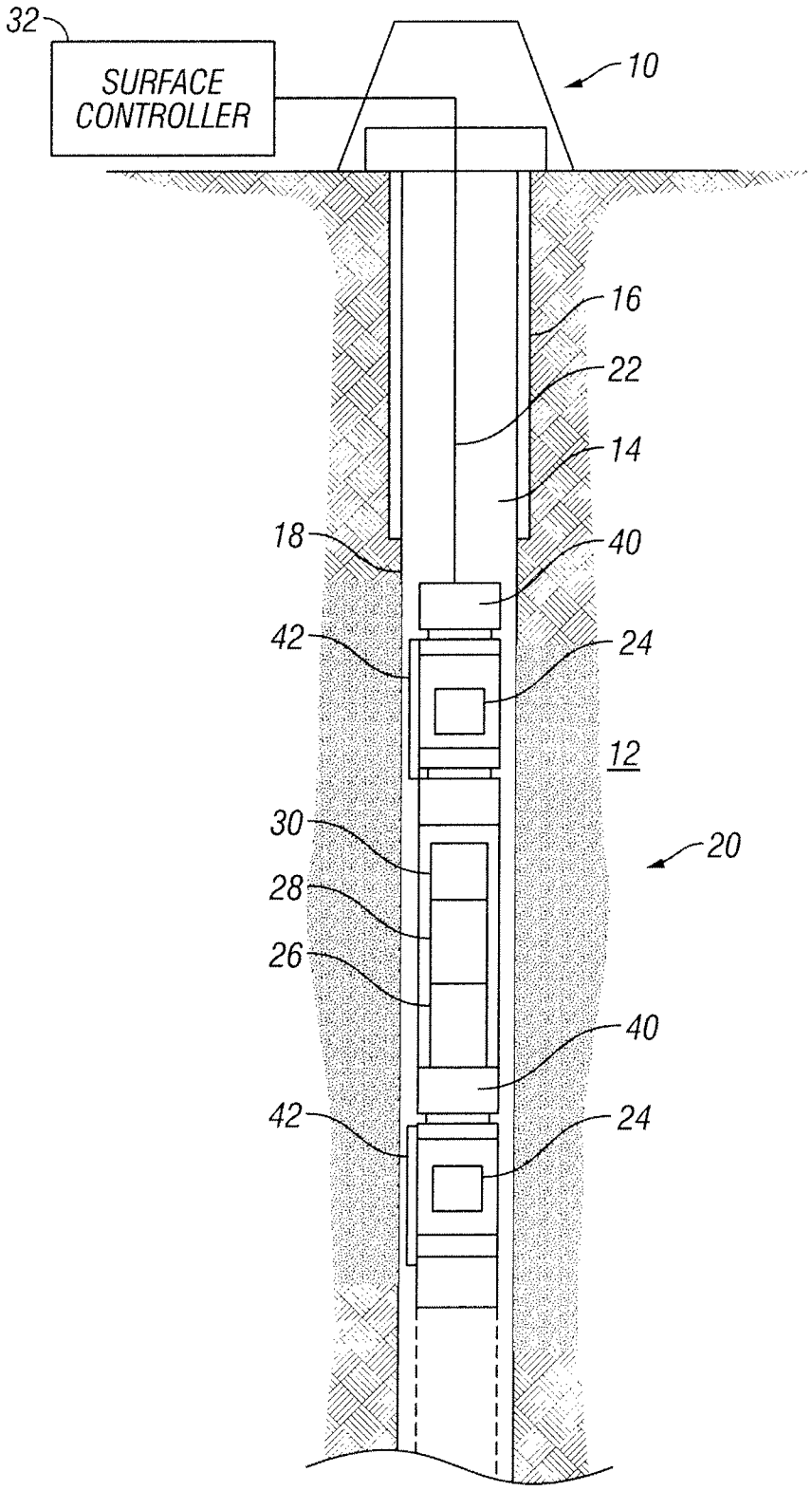

32
SURFACE CONTROLLER
10
16
22
14
18
40
42
24
12
30
20
28
26
40
42
24

FIG. 1

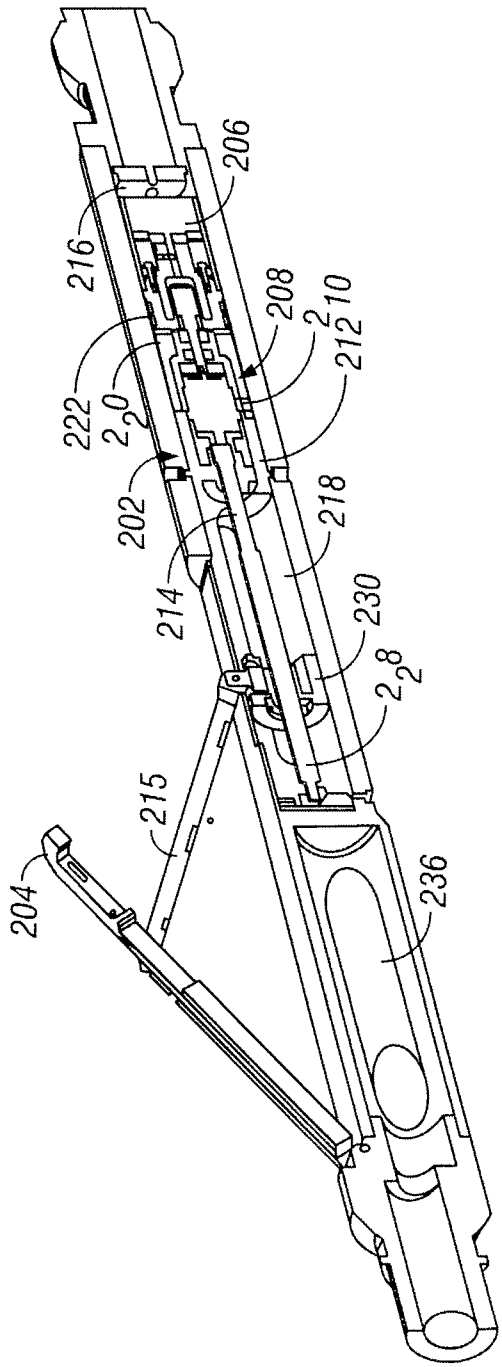


FIG. 2

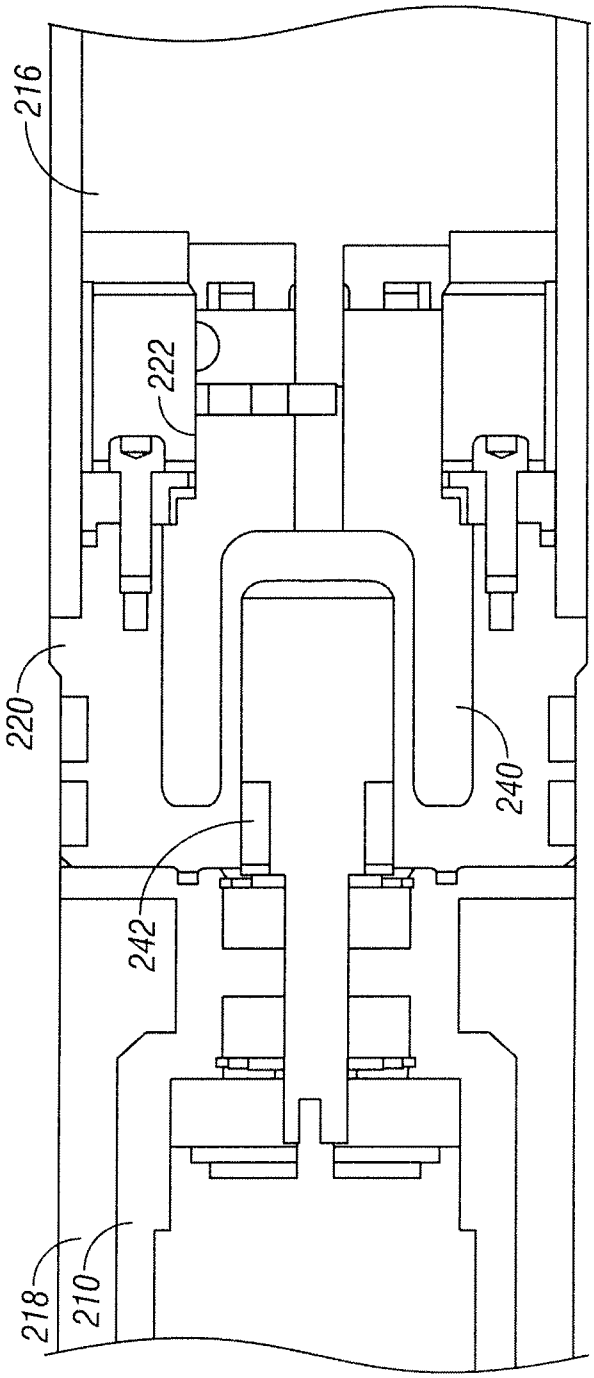


FIG. 3

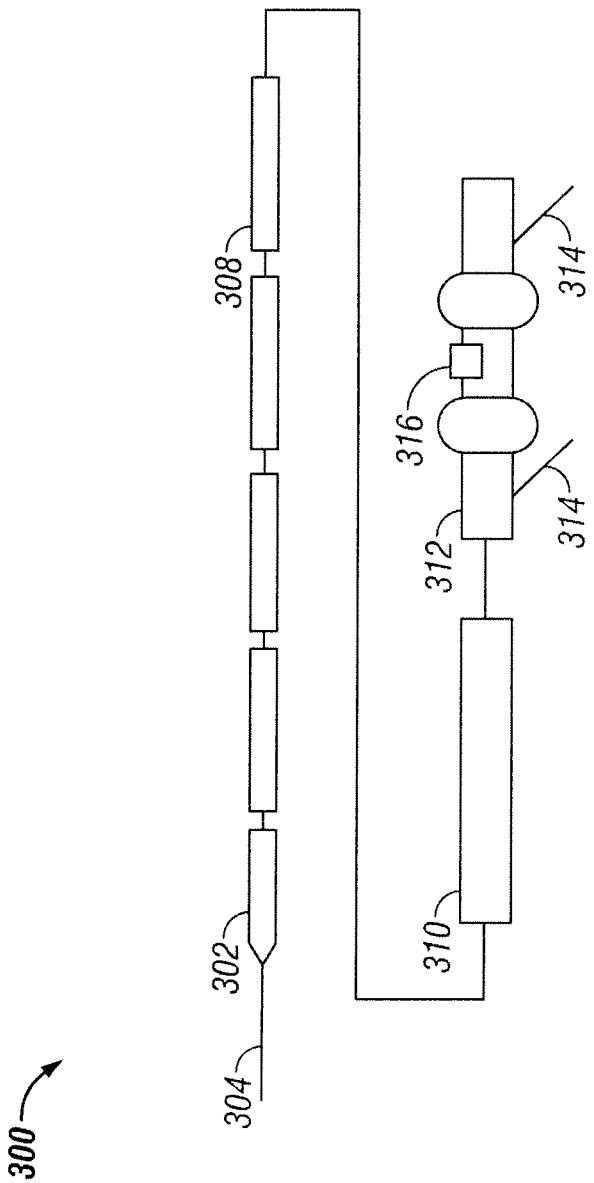


FIG. 4

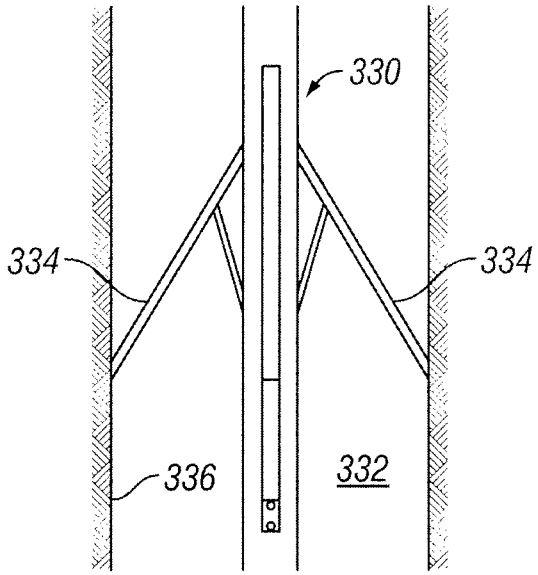


FIG. 5

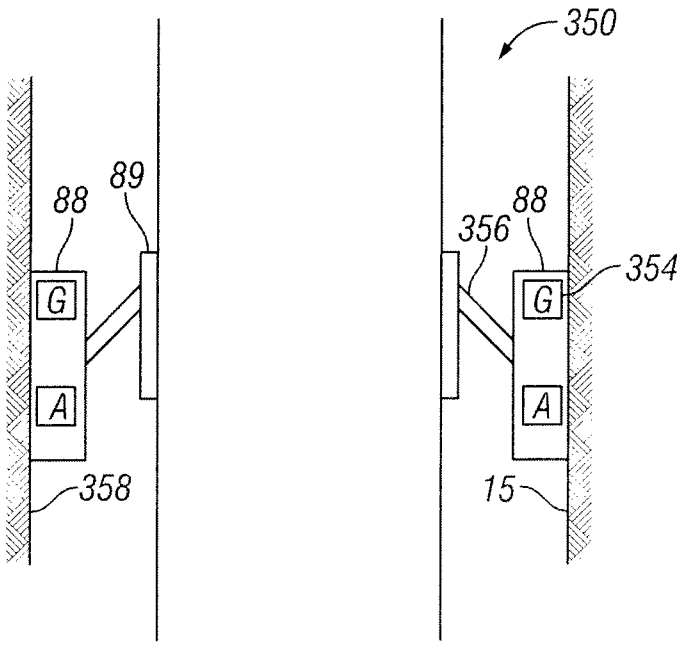


FIG. 6

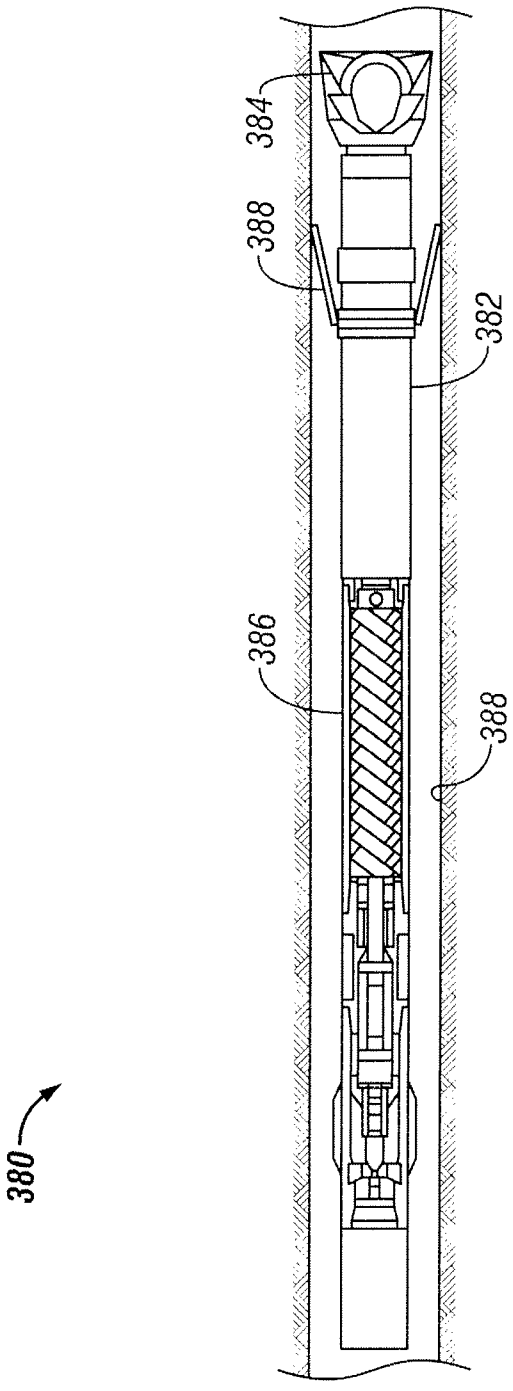


FIG. 7

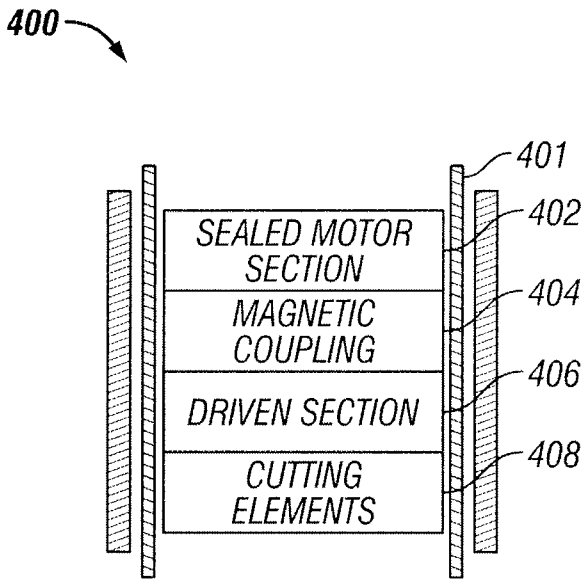

400
401
402
404
406
408
SEALED MOTOR SECTION
MAGNETIC COUPLING
DRIVEN SECTION
CUTTING ELEMENTS

FIG. 8