



(86) Date de dépôt PCT/PCT Filing Date: 2020/04/17
(87) Date publication PCT/PCT Publication Date: 2020/12/03
(45) Date de délivrance/Issue Date: 2023/08/15
(85) Entrée phase nationale/National Entry: 2021/09/24
(86) N° demande PCT/PCT Application No.: US 2020/028620
(87) N° publication PCT/PCT Publication No.: 2020/242628
(30) Priorités/Priorities: 2019/05/31 (US62/855,445);
2020/03/31 (US16/836,496)

(51) Cl.Int./Int.Cl. *E21B 33/14* (2006.01),
E21B 23/08 (2006.01), *E21B 43/26* (2006.01)

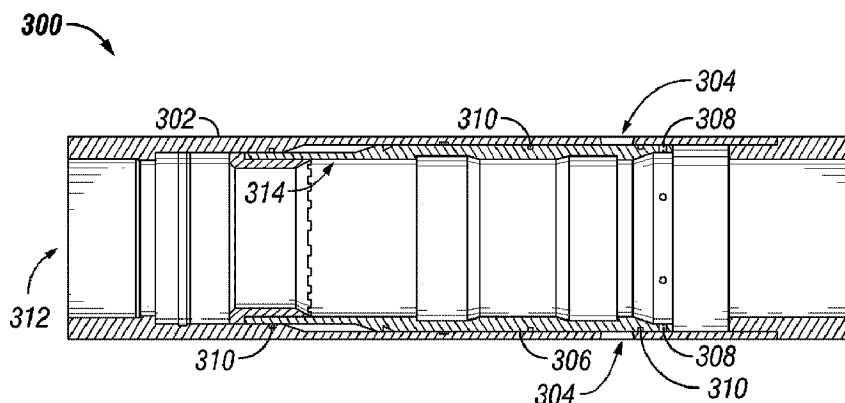
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(54) Titre : OUTIL DE FOND DE TROU POUR CIMENTER UN TROU DE FORAGE

(54) Title: DOWNHOLE TOOL FOR CEMENTING A BOREHOLE



(57) Abrégé/Abstract:

A downhole tool. The downhole tool may include a tubular body and an inner sleeve that is slidable within the tubular body. The tubular body may include a port that allows fluid flow between a bore of the downhole tool and an area outside of the tubular body.

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(57) **Abrégé(suite)/Abstract(continued):**

The downhole tool may be sequentially positionable in a run-in position that blocks fluid flow through the port in the tubular body, then in an open position that allows fluid flow through the port in the tubular bod, and then in a closed position that blocks fluid flow through the port in the tubular body.

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

(19) World Intellectual Property

Organization

International Bureau

(43) International Publication Date

03 December 2020 (03.12.2020)



(10) International Publication Number

WO 2020/242628 A1

(51) International Patent Classification:

E21B 33/14 (2006.01)*E21B 23/08* (2006.01)*E21B 43/26* (2006.01)

(21) International Application Number:

PCT/US2020/028620

(22) International Filing Date:

17 April 2020 (17.04.2020)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/855,445 31 May 2019 (31.05.2019) US

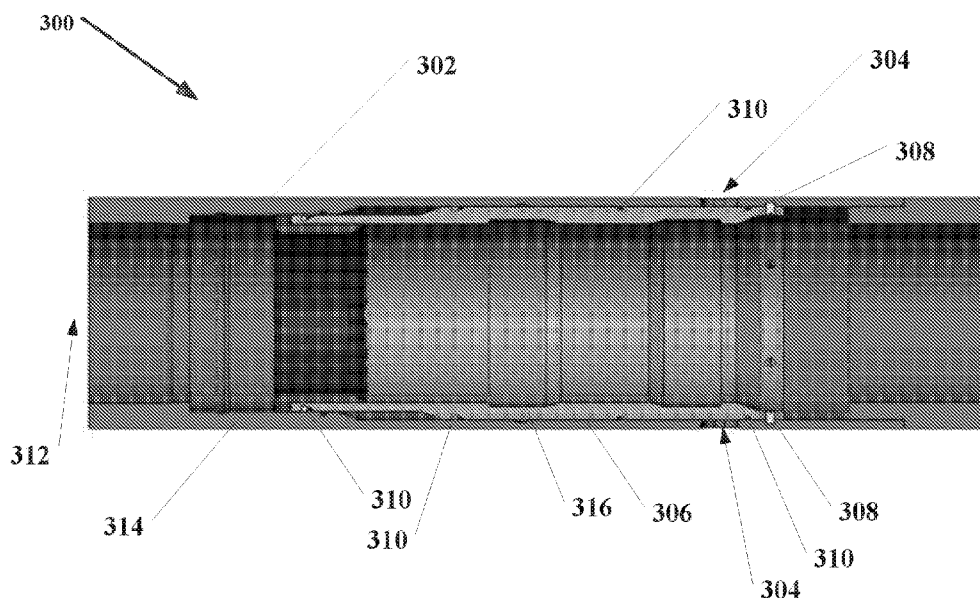
16/836,496 31 March 2020 (31.03.2020) US

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(54) Title: DOWNHOLE TOOL FOR CEMENTING A BOREHOLE

**FIG. 3**

(57) Abstract: A downhole tool. The downhole tool may include a tubular body and an inner sleeve that is slidable within the tubular body. The tubular body may include a port that allows fluid flow between a bore of the downhole tool and an area outside of the tubular body. The downhole tool may be sequentially positionable in a run-in position that blocks fluid flow through the port in the tubular body, then in an open position that allows fluid flow through the port in the tubular body, and then in a closed position that blocks fluid flow through the port in the tubular body.

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WO 2020/242628 A1

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(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, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,
KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR,
TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

DOWNHOLE TOOL FOR CEMENTING A BOREHOLE

BACKGROUND

[0001] This section is intended to provide relevant background information to facilitate a better understanding of the various aspects of the described embodiments. Accordingly, these statements are to be read in this light and not as admissions of prior art.

[0002] Hydraulic cement compositions are commonly utilized in subterranean operations, particularly subterranean well completion and remedial operations. For example, hydraulic cement compositions are used in primary cementing operations where pipe strings, such as casings and liners, are cemented in well bores.

[0003] In typical primary cementing operations, hydraulic cement compositions are pumped into the annulus between the wall of a borehole and the exterior surface of the pipe string disposed within the borehole. The cement composition is permitted to set in the annulus, forming an annular sheath of hardened, substantially impermeable cement that supports and positions the pipe string in the borehole and bonds the exterior surface of the pipe string to the wall of the borehole. The cement composition may be pumped down the inner diameter of the pipe string, out through a casing shoe and/or circulation valve at the bottom of the pipe string and up through the annulus to its desired location.

[0004] In some scenarios, the conventional cementing operations may be performed in two or more stages, where casing is placed within a borehole and a portion of the casing is cemented. Thereafter, one or more cementing operations are performed to cement the remaining portion(s) of the casing into place.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Embodiments of the downhole tool for cementing a borehole are described with reference to the following figures. The same numbers are used throughout the figures to reference like features and components. The features

depicted in the figures are not necessarily shown to scale. Certain features of the embodiments may be shown exaggerated in scale or in somewhat schematic form, and some details of elements may not be shown in the interest of clarity and conciseness.

[0006] FIG. 1 is a drilling system, according to one or more embodiments;

[0007] FIG. 2 is a cementing system for performing a multi-stage cementing operation, according to one or more embodiments;

[0008] FIG. 3 is a cross-sectional view of a downhole tool in a run-in position, according to one or more embodiments;

[0009] FIG. 4 is a cross-sectional view of the downhole tool of FIG. 3 in an open position;

[0010] FIG. 5 is a cross-sectional view of the downhole tool of FIG. 3 in a closed position;

[0011] FIG. 6 is a cross-sectional view of a downhole tool in a run-in position, according to one or more embodiments;

[0012] FIG. 7 is a cross-sectional view of the downhole tool of FIG. 6 in an open position;

[0013] FIG. 8 is a cross-sectional view of the downhole tool of FIG. 6 in a closed position;

[0014] FIG. 9 is a cross-sectional view of a downhole tool in a run-in position, according to one or more embodiments;

[0015] FIG. 10 is a cross-sectional view of the downhole tool of FIG. 9 in an open position; and

[0016] FIG. 11 is a cross-sectional view of the downhole tool of FIG. 9 in a closed position.

DETAILED DESCRIPTION

[0017] The present disclosure describes a downhole tool for cementing a borehole. The downhole tool is used in a multi-stage cementing operation to be conducted within the borehole.

[0018] A main borehole may in some instances be formed in a substantially vertical orientation relative to a surface of the well, and a lateral borehole may in some instances be formed in a substantially horizontal orientation relative to the surface of the well. However, reference herein to either the main borehole or the lateral borehole is not meant to imply any particular orientation, and the orientation of each of these boreholes may include portions that are vertical, non-vertical, horizontal or non-horizontal. Further, the term “uphole” refers a direction that is towards the surface of the well, while the term “downhole” refers a direction that is away from the surface of the well.

[0019] FIG. 1 is a drilling system 100, according to one or more embodiments. The well site 102 includes include a drilling rig 104 that has various characteristics and features associated with a "land drilling rig." Various types of drilling equipment such as a rotary table, drilling fluid pumps, and drilling fluid tanks (not shown) may also be located at a well site 102. However, downhole drilling tools incorporating teachings of the present disclosure may be satisfactorily used with drilling equipment located on offshore platforms, drill ships, semi-submersibles and drilling barges (not shown).

[0020] The drilling system 100 includes a drill string 106 associated with a drill bit 108 that is used to form a borehole 110. Specifically, FIG. 1 depicts a rotary steerable system (RSS) 112 that may be used to perform directional drilling. The term "directional drilling" may be used to describe drilling a wellbore or portions of a wellbore that extend at a desired angle or angles relative to vertical. The desired angles may be greater than normal variations associated with vertical wellbores. Directional drilling may be used to access multiple target reservoirs

within a single borehole or reach a reservoir that may be inaccessible via a vertical wellbore. The RSS 112 may use a point-the-bit method to cause the direction of the drill bit 108 to vary relative to the housing of the rotary steerable drilling system 112 by bending a shaft running through the rotary steerable drilling system 112.

[0021] The drilling system 100 also includes a bottom hole assembly (BHA) 114. The BHA 114 may include a wide variety of components, such as components 116 and 118, configured to form the borehole 110. Such components may include, but are not limited to, drill bits (e.g., the drill bit 108), coring bits, drill collars, rotary steering tools (e.g., the RSS 112) or other directional drilling tools, downhole drilling motors, reamers, hole enlargers or stabilizers. The number and types of components included in the BHA 114 may depend on anticipated downhole drilling conditions and the type of wellbore that is to be formed. The BHA 114 may also include various types of well logging tools and other downhole tools associated with directional drilling of a wellbore such as so-called measurement-while-drilling (MWD) or logging-while-drilling (LWD) tools. Examples of logging tools and/or directional drilling tools may include, but are not limited to, acoustic, neutron, gamma ray, density, photoelectric, nuclear magnetic resonance, rotary steering tools and/or any other available well tool. Further, the BHA 114 may also include a rotary drive (not expressly shown) that rotates at least part of the drill string 106 together with components 116 and/or 118.

[0022] The drill bit 108 includes one or more blades 120 disposed outwardly from exterior portions of a rotary bit body 122. The drill bit 108 rotates with respect to a bit rotational axis 124 in a direction defined by directional arrow 126. The blades 120 include one or more cutting elements 128 disposed outwardly from exterior portions of each blade 120. The blades 120 may also include one or more depth of cut controllers (not shown) configured to control the depth of cut of the

cutting elements 128. The blades 120 may further include one or more gage pads (not expressly shown) disposed on blades 120.

[0023] Various types of drilling fluid may be pumped from the surface of the well site 102 downhole through the drill string 106 to the attached drill bit 108. The drilling fluids may be directed to flow from the drill string 106 to respective nozzles passing through the drill bit 108. The drilling fluid may be circulated uphole to the well surface through an annulus 130 surrounding the drill string 106.

[0024] The borehole 110 is defined in part by a casing string 132 extending from the surface of the well site 102 to a selected downhole location. Portions of the borehole 110 that do not include the casing string 132 may be described as "open hole," while portions of the borehole 110 that include the casing string 132 may be referred to as a "cased hole." In open hole sections, the annulus 130 is defined in part by an outside diameter 134 of the drill string 106 and an inside diameter 136 of the borehole 110. In cased hole sections, the annulus 130 is defined in part by an outside diameter 134 of the drill string 106 and an inside diameter 138 of the casing string 132.

[0025] To case the borehole 110, casing string 132 is run into the borehole 110 (e.g., using a running tool) and hung on a casing hanger (not shown). Cement is pumped through the casing string 132 and into the annulus 130 between the casing string 132 and the borehole wall 118 (or a previously run casing string) in order to cement the casing string 132 into place. In one or more embodiments, the cementing process may be done in stages in which multiple sections of cement are pumped behind the same casing string. For example, when a casing string 132 is too long to cement by only pumping cement into the annulus from a distal end of the casing string 132, a multi-stage cementing operation may be performed. To avoid drilling through the casing string 132 and cement at that location, a first stage of a multi-stage cementing operation may be performed to cement the portion of the casing string 132 below the predetermined location and a second

stage of a multi-stage cementing operation may be performed to cement the casing string 132 above the predetermined location.

[0026] FIG. 2 depicts a cementing system for performing a multi-stage cementing operation in accordance with one or more embodiments. The system 200 includes a downhole tool 202 interconnected in a casing string 204 having an upper casing portion 206 and a lower casing portion 208, the upper casing portion 206 being located above the downhole tool 202 and the lower casing portion 208 being located below the downhole tool 202. The downhole tool 202 is interconnected in the casing string 204 at a location determined based on the operation, borehole conditions, operating equipment, and/or predetermined well plans, among other factors, and is used to perform a multi-stage cementing operation in which a first stage of cementing is performed followed by one or more additional stages of cementing.

[0027] As shown, the casing string 204 is run into a borehole 210 that includes a previously run casing string 212 which was cemented into place using cement 214. The casing string 204 may be run into the borehole 210 using a running tool (not shown) connected to a rig, such as drilling rig 104 in FIG. 1, and/or other operating equipment known in the art.

[0028] Once the casing string 204 is run into the borehole 210, a first stage of a multi-stage cementing process may be performed. Cement is pumped along a flow path through a bore 216 inside of the casing string 204 and the downhole tool 202 as indicated by arrows 218 and out a distal end 220 of the casing string 204. Cement may then flow into an annulus 222 between the casing string 204 and a borehole wall 224 and uphole along a length of the casing string 204. Pumping may be stopped when the cement slurry reaches a predetermined depth 226 along the length of the casing string 204. Once the cement slurry has set, the downhole tool 202 is opened and additional cement slurry is pumped downhole and enters the annulus 222 through the downhole tool. Once the cement slurry pumped

through the downhole tool 202 is set, the process can be repeated with additional downhole tools 202 as necessary until the multi-stage cementing process is completed.

[0029] In one or more embodiments, the predetermined depth 226 may be determined based on the total length of the casing string 204, borehole conditions, operating equipment, and/or predetermined well plans, among other factors. It should be understood that the predetermined depth 226 may be at any location along the length of the casing string 204 and may extend into the annulus 222 between the casing string 204 and the previously run casing string 212. In addition, although not shown, it should be understood that other equipment such as guide shoes, float collars, flapper valves, stage plugs, and the like, may be included and used in the multi-stage cementing process without departing from the scope of the present disclosure.

[0030] In another embodiment, a packer (not shown), such as, but not limited to, an inflatable packer or a swellable packer, may be set or a fluid barrier of fluid denser than the cement slurry may be created downhole the downhole tool 202. A packer may be used to isolate the formation downhole of the downhole tool 202 prior to pumping cement slurry into the annulus. A packer or fluid barrier may be used when the formation downhole of the downhole tool 202 is weak and will not allow the cementing operation to be completed.

[0031] Turning now to FIGs. 3-5, FIGs. 3-5 illustrate a downhole tool 300 that may be used in place of downhole tool 202 when performing a multi-stage cementing process. The downhole tool 300 is sequentially positionable between a run-in position, an open position, and a closed position, as described in more detail below. The downhole tool 300 includes a tubular body 302 that includes one or more ports 304 and an inner sleeve 306. The inner sleeve 306 is initially held in the run-in position that blocks the port 304, as shown in FIG. 3, via one or more shear pins 308. The inner sleeve and/or tubular body 302 also include multiple

seals 310 to prevent fluid from flowing out from the bore 312 of the downhole tool 300 to an area radially outside of the downhole tool 300 when the inner sleeve 306 is in the run-in position.

[0032] When it is desired to open the downhole tool 300, a pressurized fluid is flowed through the bore 312 of the downhole tool 300 in the indicated direction 314. The geometry of the sleeve and positions of the seals 310 is such that the pressure applies an unbalanced force on the inner sleeve 306. The unbalanced force on the inner sleeve 306 causes the inner sleeve 306 to shift into an open position, as shown in FIG. 4. The open position exposes the ports 304 and allows fluid to pass from the bore 312 of the downhole tool, through the ports 304, and into an annulus surrounding the downhole tool 300. In at least one embodiment, the inner sleeve 306 is retained in the open position via a locking mechanism (not shown) such as, but not limited to a ratcheting mechanism, a lock ring, or a collet.

[0033] Once the cementing operation has been completed, a plug 500 is pumped downhole and engages with a shoulder 502 coupled to or formed in an uphole end portion 504 of the inner sleeve 306. The pressure applied to the plug 500 is great enough that the locking mechanism holding the inner sleeve 306 in the open position is overcome and the inner sleeve 306 shifts into a closed position, as shown in FIG. 5. The movement to the closed position blocks the ports 304 in the tubular body 302 and prevents fluid from flowing out from the bore 312 of the downhole tool 300. In at least one embodiment, the inner sleeve 306 is retained in the closed position via a second locking mechanism such as, but not limited to a ratcheting mechanism, a lock ring, or a collet.

[0034] In at least one embodiment, the interior surface 316 of the inner sleeve 306 includes a profile 318 as shown in FIGs. 3-5 shaped to receive a setting tool (not shown). The setting tool engages with the profile to shift the inner sleeve 306 to the open and closed positions. In other embodiments, the profile may be omitted.

[0035] Referring now to FIGs. 6-8, FIGs. 6-8 illustrate a downhole tool 600 that may be used in place of downhole tool 202 when performing a multi-stage cementing process. FIGs. 6-8 include many features that are similar to the features described above with reference to FIGs. 3-5. Accordingly, such features will not be described again in detail, except as necessary for the understanding of the downhole tool 600 shown in FIGs. 6-8.

[0036] Similar to the downhole tool 300 described above, downhole tool 600 includes a tubular body 302 having one or more ports 304 and an inner sleeve 602 that is slidable within the tubular body 302 to control flow from the bore 312 of the downhole tool 600 through the ports 304 in the tubular body 302. As shown in FIG. 6, the inner sleeve 602 includes one or more ports 604 that are aligned with the ports in the tubular body 302 when the inner sleeve is positioned in the run-in position. The downhole tool 600 also includes a seat 606 positioned within the inner sleeve 602. When positioned in the run-in position, shown in FIG. 6, the seat 606 and associated seals 608 block the flow of fluid from the bore 312 through the ports 304, 604 in the tubular body 302 and the inner sleeve 602. Similar to the inner sleeve, the seat is retained in the run-in position via one or more shear pins 610.

[0037] When it is desired to open the downhole tool 600, an opening plug 700 is pumped downhole and engages with a shoulder 702 coupled to or formed in the seat 606, as shown in FIG. 7. The opening plug 700 shifts the seat 606 as shown, allowing fluid to flow from the bore 312 of the downhole tool, through the ports 304, 604 in the tubular body 302 and the inner sleeve 602, and into an annulus surrounding the downhole tool 600. In at least one embodiment, the seat 606 is retained in the open position via a locking mechanism such as, but not limited to a ratcheting mechanism, a lock ring, or a collet.

[0038] Once the cementing operation has been completed, a plug 500 is pumped downhole and engages with a shoulder 502 coupled to or formed in an uphole end

portion 504 of the inner sleeve 602. The pressure applied to the plug 500 is great enough that the shear pins 308 holding the inner sleeve 306 in the open position are sheared and the inner sleeve 602 shifts into a closed position, as shown in FIG. 8. The movement to the closed position blocks the ports 304 in the tubular body 302 and prevents fluid from flowing out from the bore 312 of the downhole tool 300. In at least one embodiment, the inner sleeve 602 is retained in the closed position via a second locking mechanism such as, but not limited to a ratcheting mechanism, a lock ring, or a collet.

[0039] Turning now to FIGs. 9-11, FIGs. 9-11 illustrate a downhole tool 900 that may be used in place of downhole tool 202 when performing a multi-stage cementing process. FIGs. 9-11 include many features that are similar to the features described above with reference to FIGs. 3-8. Accordingly, such features will not be described again in detail, except as necessary for the understanding of the downhole tool 900 shown in FIGs. 9-11.

[0040] Similar to the downhole tools 300, 600 described above, downhole tool 900 includes a tubular body 302 having one or more ports 304 and an inner sleeve 902 that is slidable within the tubular body 302 to control flow from the bore 312 of the downhole tool 900 through the ports 304 in the tubular body 302. As shown in FIG. 6, the inner sleeve 902 includes one or more ports 904 that are offset from ports in the tubular body 302 when the inner sleeve is positioned in the run-in position. The downhole tool 900 also includes a seat 606 positioned within the inner sleeve 902. When positioned in the run-in position, shown in FIG. 9, the inner sleeve 902 blocks the flow of fluid from the bore 312 through the ports 304 in the tubular body 302.

[0041] When it is desired to open the downhole tool 900, an opening plug 700 is pumped downhole and engages with a shoulder 702 coupled to or formed in the seat 606, as shown in FIG. 10. The opening plug 700 shifts the seat 606 as shown, allowing fluid to flow from the bore 312 of the downhole tool, through the ports

304, 904 in the tubular body 302 and the inner sleeve 902, and into an annulus surrounding the downhole tool 900. In at least one embodiment, the inner sleeve 902 is retained in the open position via a locking mechanism such as, but not limited to a ratcheting mechanism, a lock ring, or a collet.

[0042] Once the cementing operation has been completed, a plug 500 is pumped downhole and engages with a shoulder 502 coupled to for formed in an uphole end portion 504 of the inner sleeve 902. The pressure applied to the plug 500 is great enough that the locking mechanism holding the inner sleeve 902 in the open position is overcome and the inner sleeve 902 shifts into a closed position, as shown in FIG. 11. The movement to the closed position blocks the ports 304 in the tubular body 302 and prevents fluid from flowing out from the bore 312 of the downhole tool 900. In at least one embodiment, the inner sleeve 902 is retained in the closed position via a second locking mechanism such as, but not limited to a ratcheting mechanism, a lock ring, or a collet.

[0043] Further examples include:

[0044] Example 1 is a downhole tool. The downhole tool includes a tubular body and an inner sleeve that is slidable within the tubular body. The tubular body includes a port that allows fluid flow between a bore of the downhole tool and an area outside of the tubular body. The downhole tool is sequentially positionable in a run-in position that blocks fluid flow through the port in the tubular body, then in an open position that allows fluid flow through the port in the tubular body, and then in a closed position that blocks fluid flow through the port in the tubular body.

[0045] In Example 2, the embodiments of any preceding paragraph or combination thereof further include wherein the inner sleeve blocks fluid flow through the port in the tubular body when in the downhole tool is in the run-in position.

[0046] In Example 3, the embodiments of any preceding paragraph or combination thereof further include wherein the inner sleeve is sequentially positionable in a run-in position, then in an open position, and then in a closed position.

[0047] In Example 4, the embodiments of any preceding paragraph or combination thereof further include a seat disposed within the inner sleeve. The seat includes a shoulder shaped to receive a plug to shift the inner sleeve to position the downhole tool in the open position.

[0048] In Example 5, the embodiments of any preceding paragraph or combination thereof further include wherein the inner sleeve and the tubular body are shaped such that the downhole tool is shiftable into an open position via an unbalanced force acting on the inner sleeve, the unbalanced force due to fluid pressure within the downhole tool.

[0049] In Example 6, the embodiments of any preceding paragraph or combination thereof further include wherein the inner sleeve includes a shoulder shaped to receive a plug to shift the inner sleeve to position the downhole tool in the closed position.

[0050] In Example 7, the embodiments of any preceding paragraph or combination thereof further include wherein the inner sleeve comprises a profile on an interior surface of the inner sleeve.

[0051] In Example 8, the embodiments of any preceding paragraph or combination thereof further include a seat slidable within the inner sleeve. Additionally, the inner sleeve further includes a port that, when the downhole tool is positioned in the run-in position, is aligned with the port in the tubular body. Further, the seat is positionable in a run-in position that blocks fluid flow through the port in the inner sleeve and an open position that allows fluid flow through the port in the inner sleeve.

[0052] Example 9 is a cementing system for a borehole. The cementing system includes a casing string positionable within the borehole and including a downhole tool. The downhole tool includes a tubular body and an inner sleeve that is slidable within the tubular body. The tubular body includes a port that allows fluid flow between a bore of the downhole tool and an area radially outside of the tubular body. The downhole tool is sequentially positionable in a run-in position that blocks fluid flow through the port in the tubular body, then in an open position that allows fluid flow through the port in the tubular bod, and then in a closed position that blocks fluid flow through the port in the tubular body.

[0053] In Example 10, the embodiments of any preceding paragraph or combination thereof further include wherein the inner sleeve blocks fluid flow through the port in the tubular body when in the downhole tool is in the run-in position.

[0054] In Example 11, the embodiments of any preceding paragraph or combination thereof further include wherein the inner sleeve is sequentially positionable in a run-in position, then in an open position, and then in a closed position.

[0055] In Example 12, the embodiments of any preceding paragraph or combination thereof further include wherein the downhole tool further includes a seat disposed within the inner sleeve. The seat includes a shoulder shaped to receive a plug to shift the inner sleeve to position the downhole tool in the open position.

[0056] In Example 13, the embodiments of any preceding paragraph or combination thereof further include wherein the inner sleeve and the tubular body are shaped such that the inner sleeve is shiftable into an open position via an unbalanced force acting on the inner sleeve, the unbalanced force due to fluid pressure within the downhole tool.

[0057] In Example 14, the embodiments of any preceding paragraph or combination thereof further include wherein the inner sleeve includes a shoulder shaped to receive a plug to shift the inner sleeve to position the downhole tool in the closed position.

[0058] In Example 15, the embodiments of any preceding paragraph or combination thereof further include wherein the inner sleeve comprises a profile on an interior surface of the inner sleeve.

[0059] In Example 16, the embodiments of any preceding paragraph or combination thereof further include wherein the inner sleeve further comprises a port that, when the downhole tool is positioned in the run-in position, is aligned with the port in the tubular body. Additionally, the downhole tool further includes a seat slidable within the inner sleeve, the seat positionable in a run-in position that blocks fluid flow through the port in the inner sleeve and an open position that allows fluid flow through the port in the inner sleeve.

[0060] Example 17 is a method for cementing a casing string in a borehole. The method includes positioning a casing string comprising a downhole tool within a borehole, wherein the downhole tool is positioned in a run-in position that blocks fluid flow between a bore of the downhole tool and an annulus formed between the casing string and a wall of the borehole. The method also includes shifting the downhole tool to an open position to allow fluid flow between the bore of the downhole tool and the annulus. The method further includes shifting the downhole tool to a closed position to block fluid flow between the bore of the downhole tool and the annulus.

[0061] In Example 18, the embodiments of any preceding paragraph or combination thereof further include wherein shifting the downhole tool to the open position includes shifting an inner sleeve of the downhole tool via an unbalanced force acting on the inner sleeve to shift the downhole tool to the open position, the unbalanced force due to fluid pressure within the downhole tool.

[0062] In Example 19, the embodiments of any preceding paragraph or combination thereof further include wherein shifting the downhole tool to the open position includes pumping a plug downhole to engage with a shoulder of a seat of the downhole tool to shift the downhole tool to the open position.

[0063] In Example 20, the embodiments of any preceding paragraph or combination thereof further include wherein shifting the downhole tool to the closed position includes pumping a plug downhole to engage with a shoulder of an inner sleeve of the downhole tool to shift the downhole tool to the closed position.

[0064] Certain terms are used throughout the description and claims to refer to particular features or components. As one skilled in the art will appreciate, different persons may refer to the same feature or component by different names. This document does not intend to distinguish between components or features that differ in name but not function.

[0065] Reference throughout this specification to “one embodiment,” “an embodiment,” “an embodiment,” “embodiments,” “some embodiments,” “certain embodiments,” or similar language means that a particular feature, structure, or characteristic described in connection with the embodiment may be included in at least one embodiment of the present disclosure. Thus, these phrases or similar language throughout this specification may, but do not necessarily, all refer to the same embodiment.

[0066] The embodiments disclosed should not be interpreted, or otherwise used, as limiting the scope of the disclosure, including the claims. It is to be fully recognized that the different teachings of the embodiments discussed may be employed separately or in any suitable combination to produce desired results. In addition, one skilled in the art will understand that the description has broad application, and the discussion of any embodiment is meant only to be exemplary of that embodiment, and not intended to suggest that the scope of the disclosure, including the claims, is limited to that embodiment.

CLAIMS

What is claimed is:

1. A downhole tool operable by an opening plug and a closing plug, the downhole tool comprising:

- a tubular body comprising a first port that allows fluid flow between a bore of the downhole tool and an area outside of the tubular body;

- an inner sleeve slidable within the tubular body and comprising a second port and a profile on an interior surface of the inner sleeve, wherein the inner sleeve is positionable in a run-in position, an open position, and a closed position;

- a seat disposed within the inner sleeve, the seat comprising a first shoulder shaped to receive the opening plug, wherein the inner sleeve is movable in a downhole direction to the open position by the opening plug engaging with the first shoulder; and

- a second shoulder coupled to or formed in an uphole end portion of the inner sleeve, the second shoulder shaped to receive the closing plug, wherein the inner sleeve is movable in a downhole direction to the closed position by the closing plug engaging with the second shoulder;

- wherein the inner sleeve blocks fluid flow through the first port in the tubular body when positioned in the run-in position,

- wherein the second port in the inner sleeve is aligned with the first port in the tubular body when the inner sleeve is positioned in the open position to allow fluid flow through the first port and the second port, and

- wherein the inner sleeve blocks fluid flow through the first port in the tubular body when positioned in the closed position.

2. The downhole tool of claim 1, wherein the inner sleeve is sequentially positionable in a run-in position, then in an open position, and then in a closed position.

3. The downhole tool of claim 1, wherein the inner sleeve is retained in the open position via a locking mechanism.
4. The downhole tool of claim 3, wherein the locking mechanism is configured such that a pressure applied to the closing plug when the closing plug engages with the second shoulder overcomes the locking mechanism to shift the inner sleeve to the closed position.
5. The downhole tool of claim 3 or claim 4, wherein the locking mechanism comprises a ratcheting mechanism, a lock ring, or a collet.
6. The downhole tool of claim 1, wherein the inner sleeve is retained in the closed position via a locking mechanism.
7. A cementing system for a borehole, the cementing system comprising:
 - a casing string positionable within the borehole, the casing string comprising a downhole tool comprising:
 - a tubular body comprising a first port that allows fluid flow between a bore of the downhole tool and an area radially outside of the tubular body; and
 - an inner sleeve slidable within the tubular body and comprising a second port and a profile on an interior surface of the inner sleeve, wherein the inner sleeve is positionable in a run-in position, an open position, and a closed position;
 - a seat disposed within the inner sleeve, the seat comprising a first shoulder shaped to receive an opening plug, wherein the inner sleeve is movable in a downhole direction to the open position by the opening plug engaging with the first shoulder; and
 - a second shoulder coupled to or formed in an uphole end portion of the inner sleeve, the second shoulder shaped to receive the closing plug, wherein the inner sleeve is movable in a downhole direction to the closed position by the closing plug engaging with the second shoulder;

wherein the inner sleeve blocks fluid flow through the first port in the tubular body when positioned in the run-in position,

wherein the second port in the inner sleeve is aligned with the first port in the tubular body when the inner sleeve is positioned in the open position to allow fluid flow through the first port and the second port, and

wherein the inner sleeve blocks fluid flow through the first port in the tubular body when positioned in the closed position.

8. The cementing system of claim 7, wherein the inner sleeve is sequentially positionable in a run-in position, then in an open position, and then in a closed position.

9. The cementing system of claim 7, wherein the inner sleeve is retained in the open position via a locking mechanism.

10. The cementing system of claim 9, wherein the locking mechanism is configured such that a pressure applied to the closing plug when the closing plug engages with the second shoulder overcomes the locking mechanism to shift the inner sleeve to the closed position.

11. The cementing system of claim 9 or 10, wherein the locking mechanism comprises a ratcheting mechanism, a lock ring, or a collet.

12. The cementing system of claim 7, wherein the inner sleeve is retained in the closed position via a locking mechanism.

13. A method for cementing a casing string in a borehole, the method comprising:

positioning a casing string comprising a downhole tool within a borehole, the downhole tool comprising an inner sleeve and a seat, the inner sleeve comprising a profile on an interior surface of the inner sleeve and wherein the inner sleeve is positioned in a run-in position that

blocks fluid flow between a bore of the downhole tool and an annulus formed between the casing string and a wall of the borehole; then shifting the inner sleeve to an open position to allow fluid flow between the bore of the downhole tool and the annulus by pumping an opening plug downhole to engage with a first shoulder of the seat of the downhole tool to move the inner sleeve in a downhole direction and shift the inner sleeve to the open position; and then shifting the inner sleeve to a closed position to block fluid flow between the bore of the downhole tool and the annulus by pumping a closing plug downhole to engage with a second shoulder of the inner sleeve of the downhole tool to shift the inner sleeve to the closed position.

14. The method of claim 13, wherein:

positioning the casing string wherein the inner sleeve is positioned in a run-in position comprises the inner sleeve comprising a port not being aligned with a port of a tubular body of the downhole tool so as to block the fluid flow between the bore of the downhole tool and the annulus; shifting the inner sleeve to the open position comprises pumping the opening plug downhole to engage with the first shoulder of the seat to slide the inner sleeve to align the port of the inner sleeve and the port of the tubular body and allow fluid flow between the bore of the downhole tool and the annulus; and shifting the inner sleeve to the closed position comprises pumping the closing plug downhole to engage with the second shoulder of the inner sleeve of the downhole tool to slide the inner sleeve so that the port of the inner sleeve is not aligned with the port of the tubular body so as to block the fluid flow between the bore of the downhole tool and the annulus.

15. The method of claim 14, wherein shifting the inner sleeve to the open position comprises retaining the inner sleeve in the open position via a locking mechanism.

16. The method of claim 15, wherein shifting the inner sleeve to the closed position comprises overcoming the locking mechanism by pumping the closing plug downhole to engage with the second shoulder of the inner sleeve of the downhole tool to shift the inner sleeve to the closed position.

17. The method of claim 15 or 16, wherein the locking mechanism comprises a ratcheting mechanism, a lock ring, or a collet.

18. The method of claim 14, wherein shifting the inner sleeve to the closed position comprises retaining the inner sleeve in the closed position via a locking mechanism.

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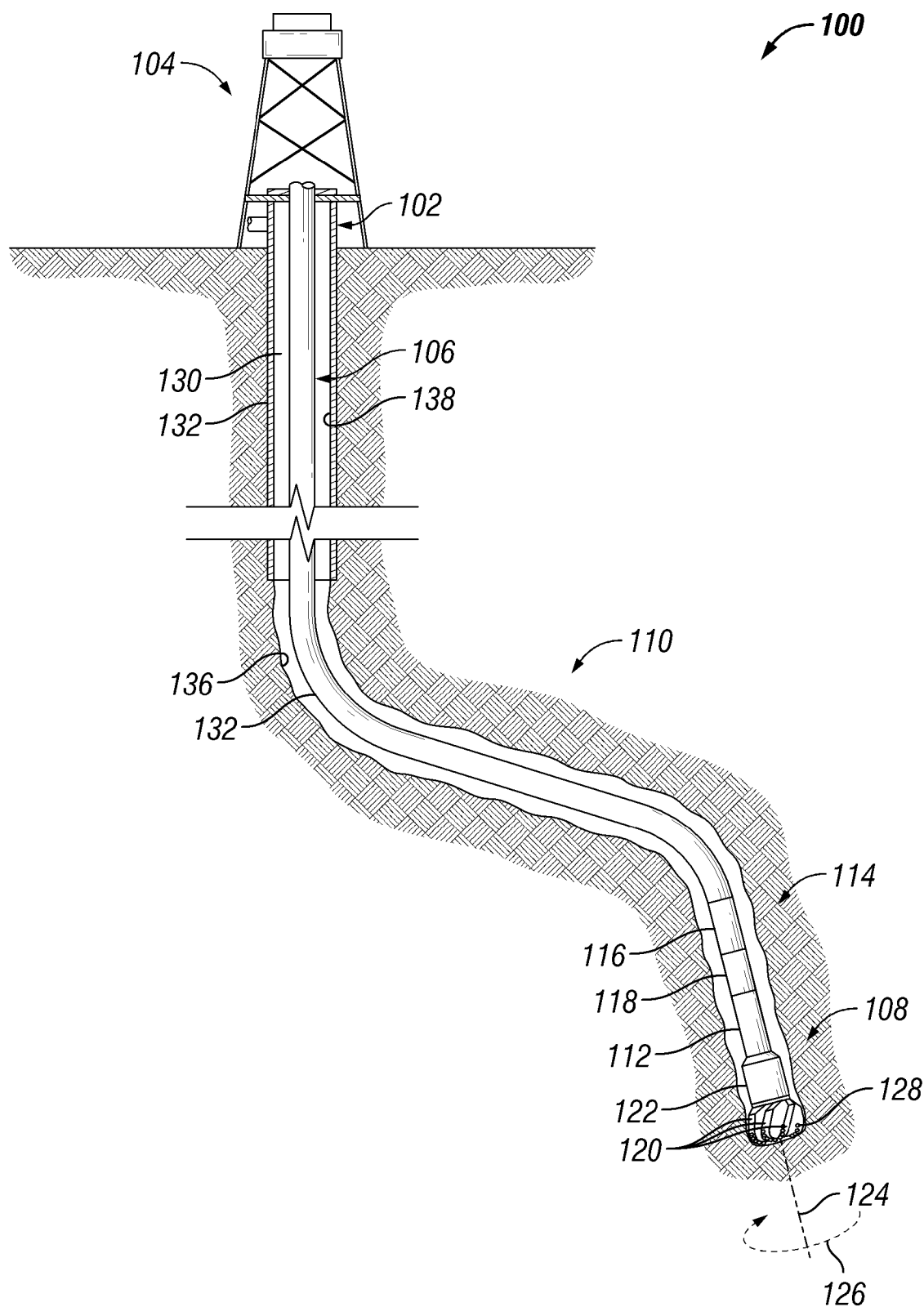


FIG. 1

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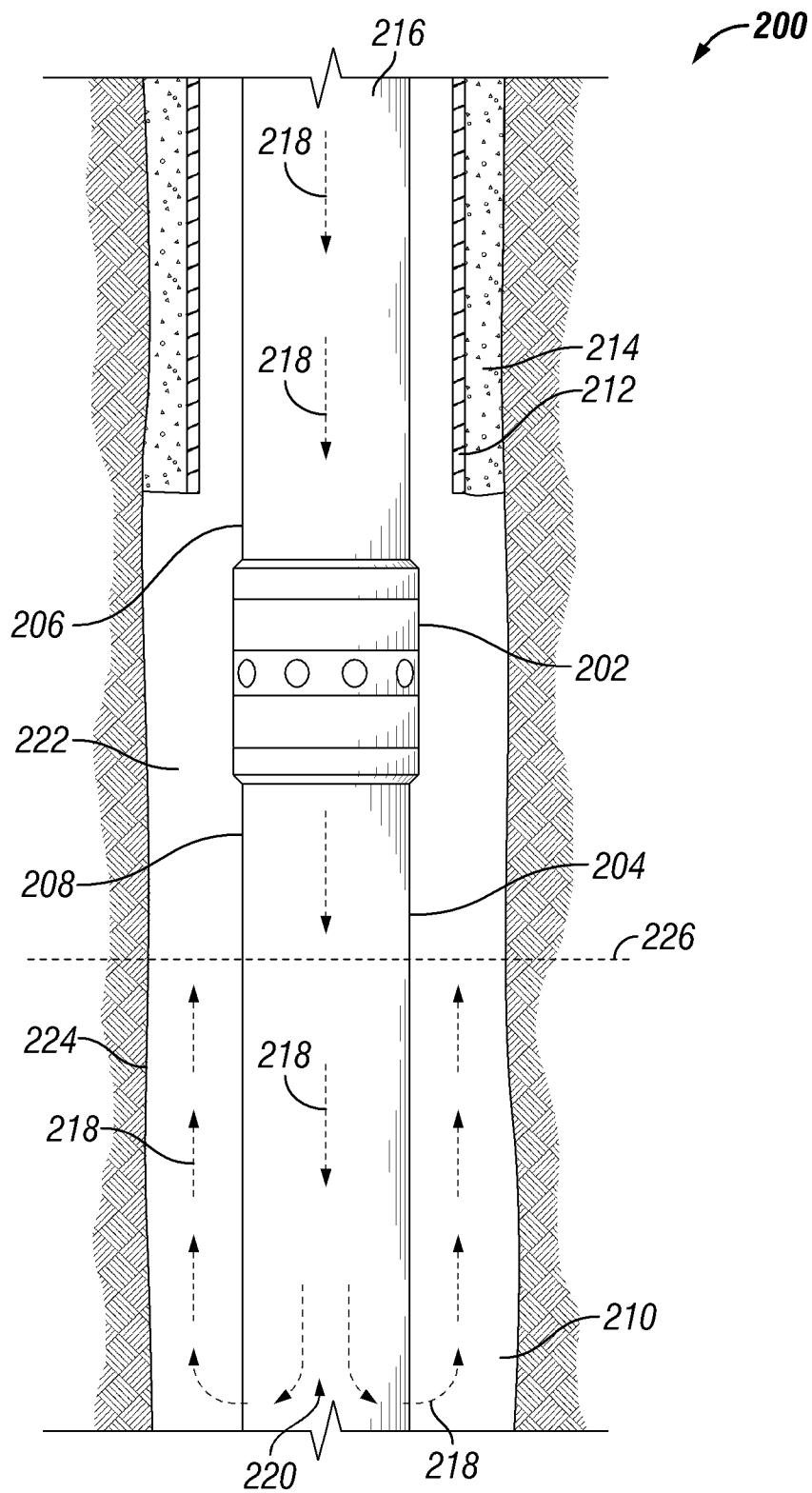


FIG. 2

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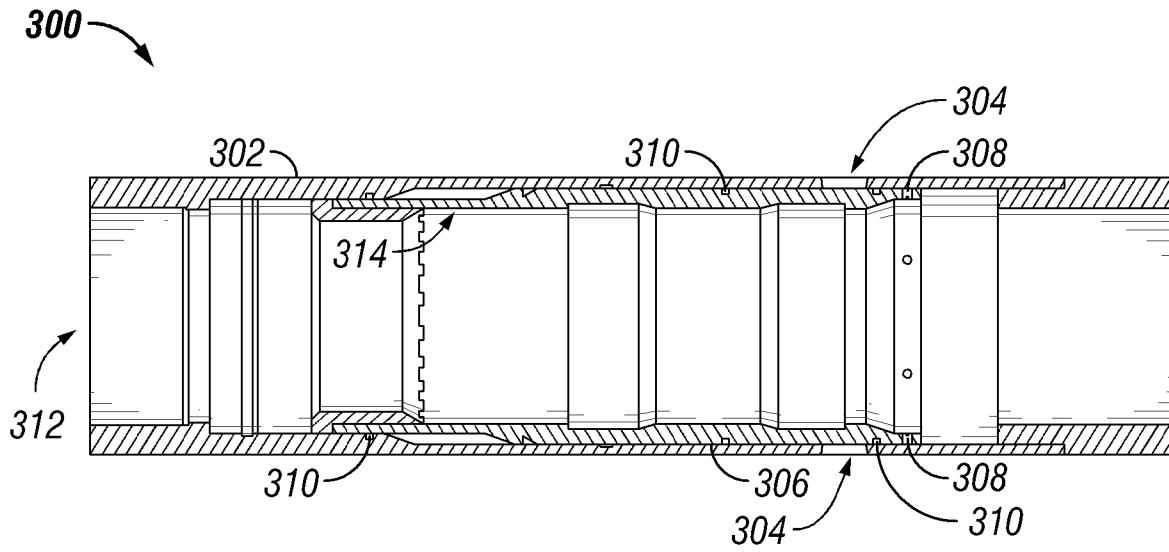


FIG. 3

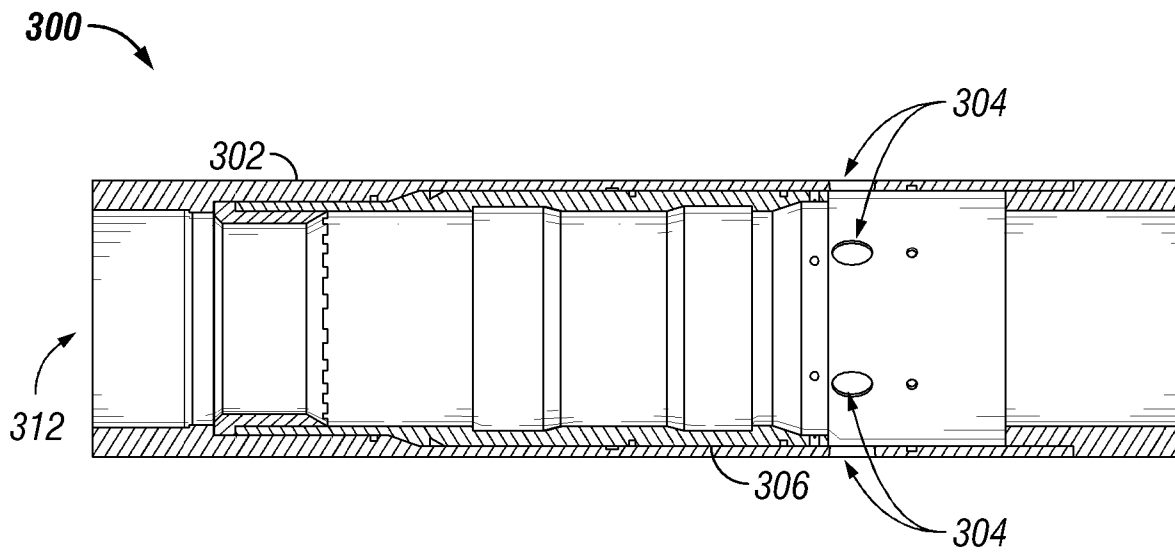


FIG. 4

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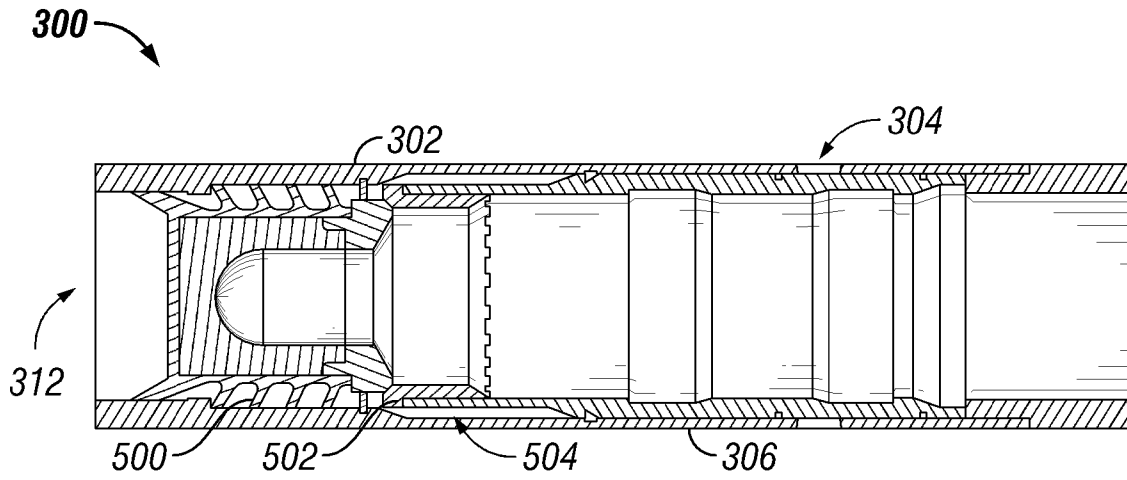


FIG. 5

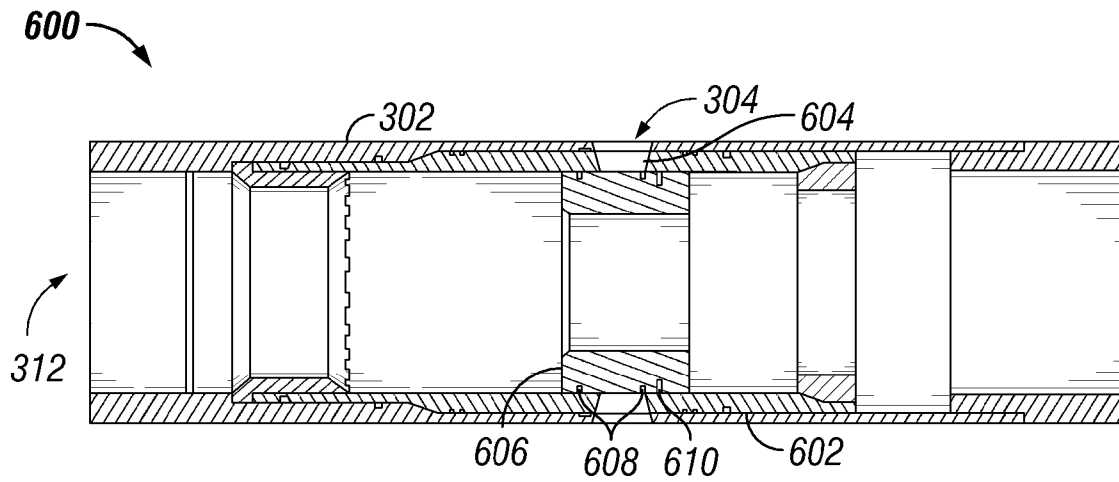


FIG. 6

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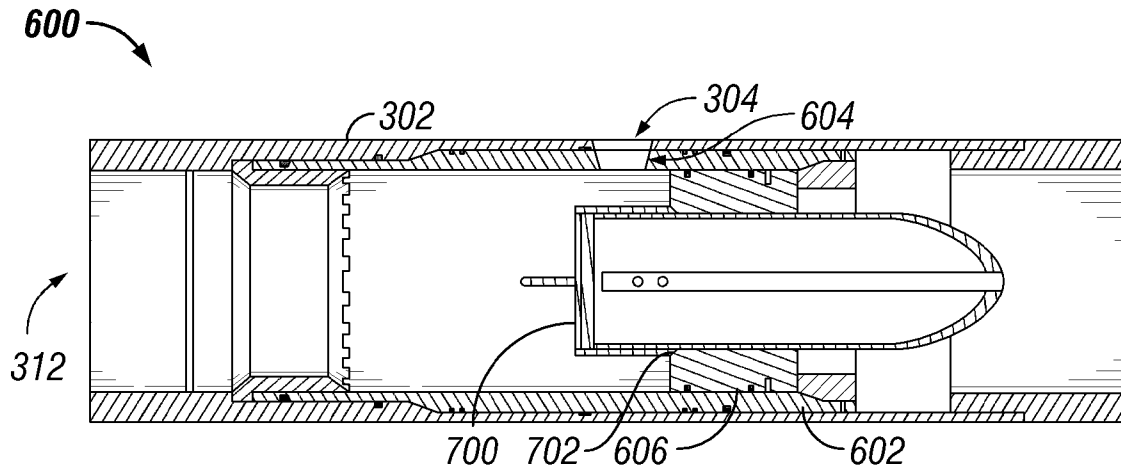


FIG. 7

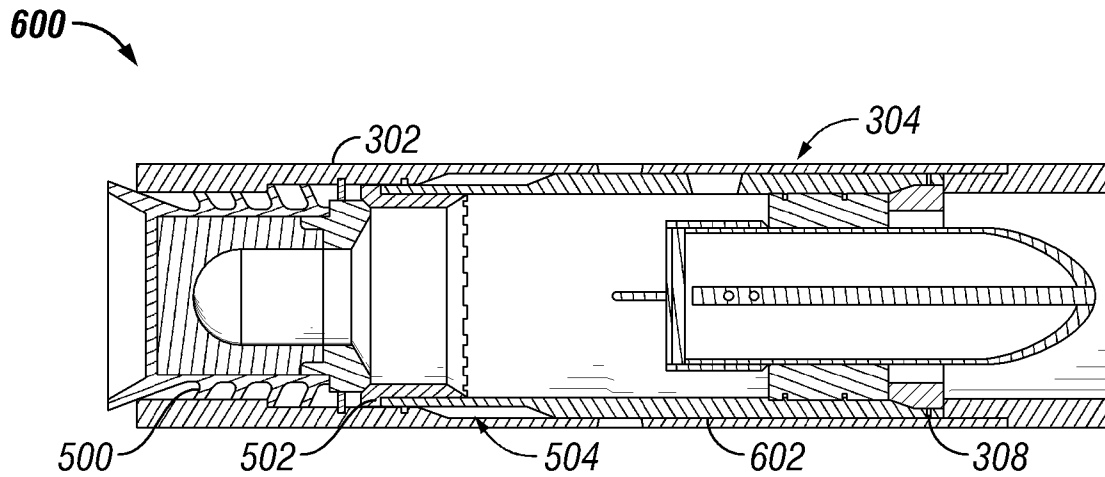


FIG. 8

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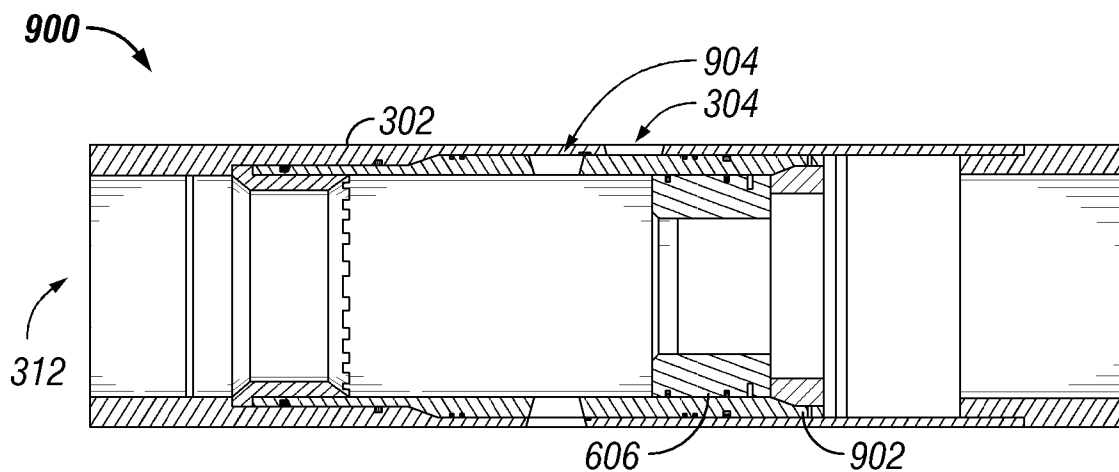


FIG. 9

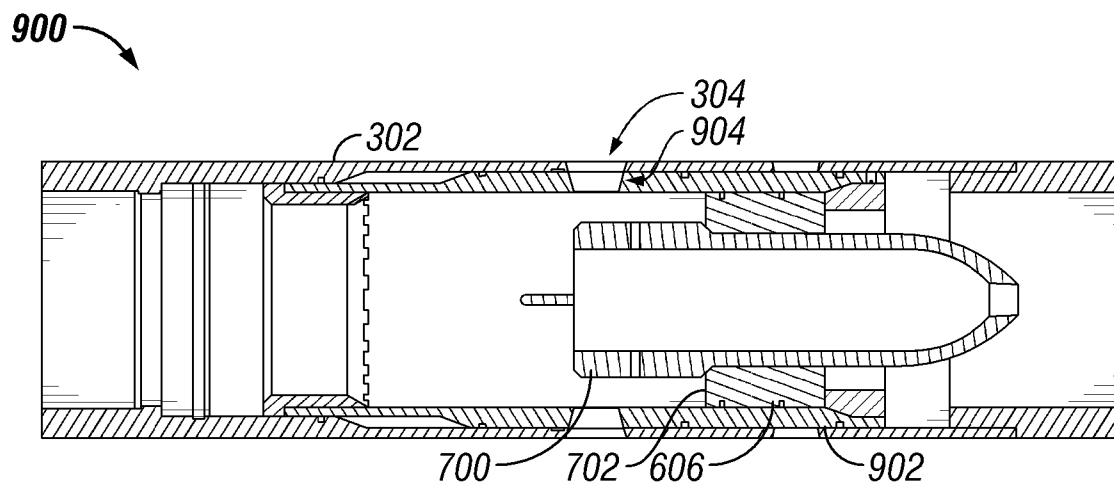


FIG. 10

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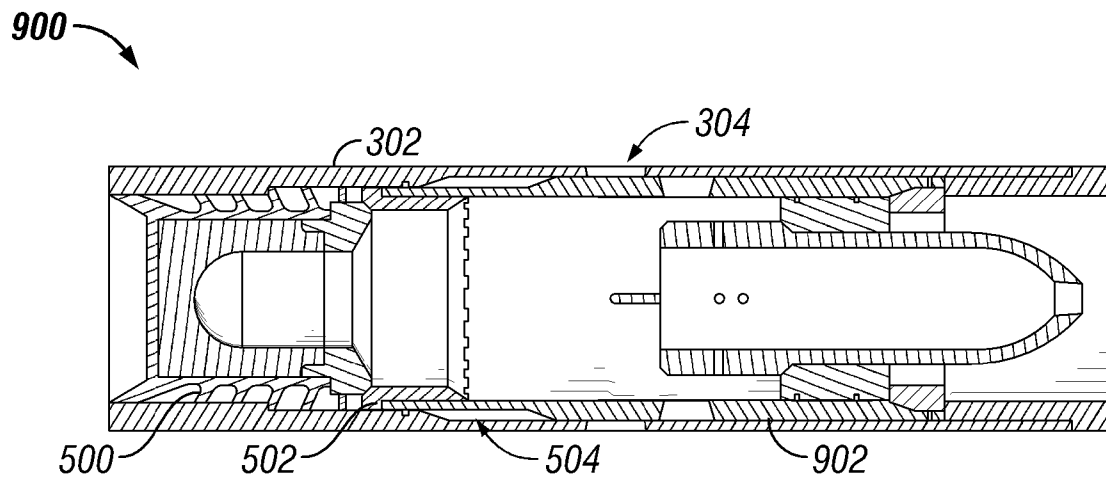


FIG. 11

