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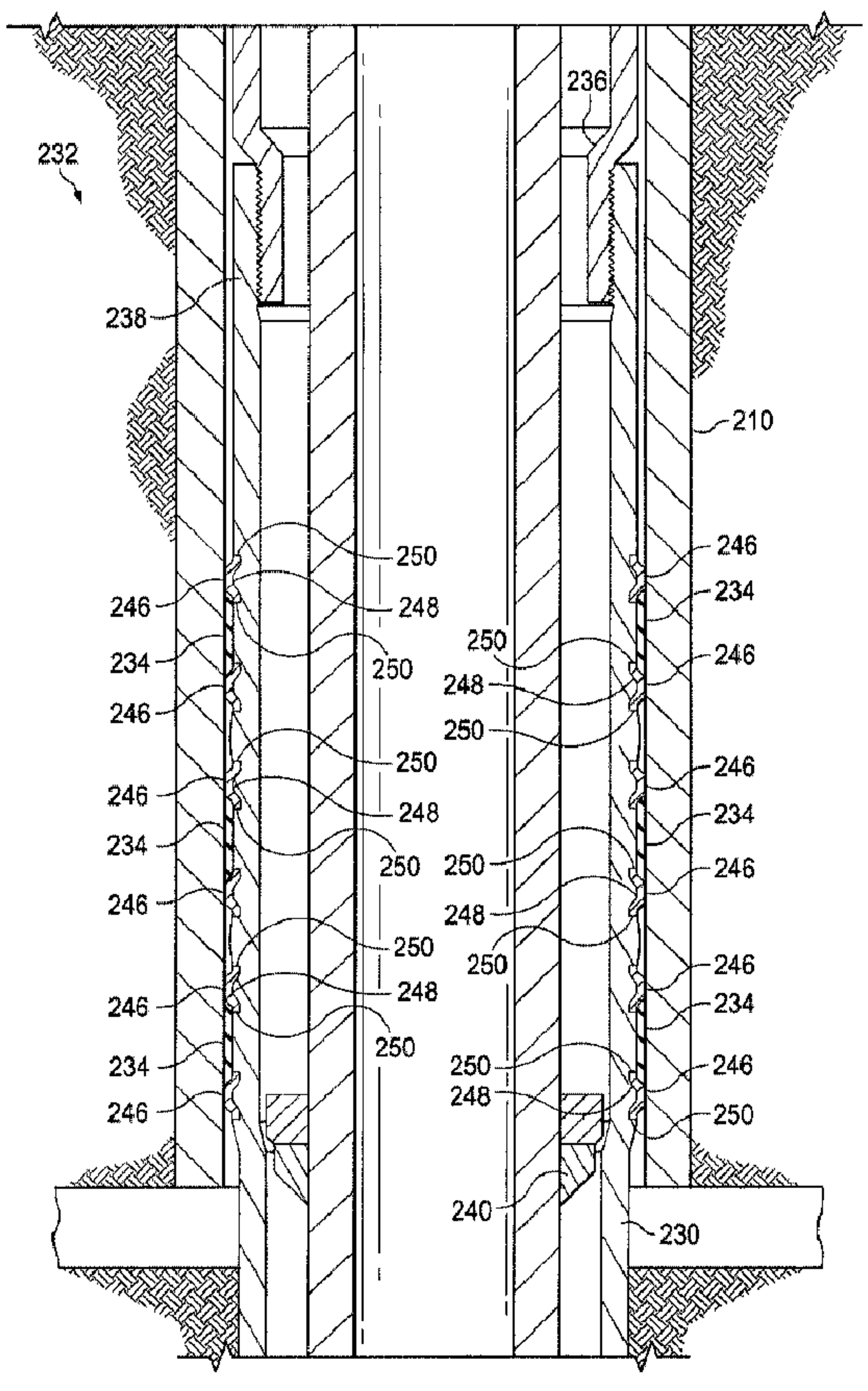
(54) **Titre : BAGUE DE PREVENTION D'EXTRUSION POUR UN SYSTEME DE SUSPENSION DE COLONNE PERDUE**
(54) **Title: EXTRUSION PREVENTION RING FOR A LINER HANGER SYSTEM**



(57) **Abrégé/Abstract:**
In accordance with some embodiments of the present disclosure, an extrusion prevention ring for a liner hanger system is disclosed. The liner hanger includes an elongate body, a first groove in the elongate body, a first extrusion prevention ring disposed

(57) **Abrégé(suite)/Abstract(continued):**
about the elongate body and selectively deformable between a first configuration, where the first extrusion prevention ring is moveable along the length of the elongate body, and a second configuration, where the first extrusion prevention ring is deformed to be received within the first groove, and a seal member disposed about the elongate body and adjacent to the first extrusion prevention ring when the first extrusion prevention ring is in the second configuration, the first extrusion prevention ring configured to prevent movement of the seal member along the length of the elongate body.

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(54) **Title**: EXTRUSION PREVENTION RING FOR A LINER HANGER SYSTEM

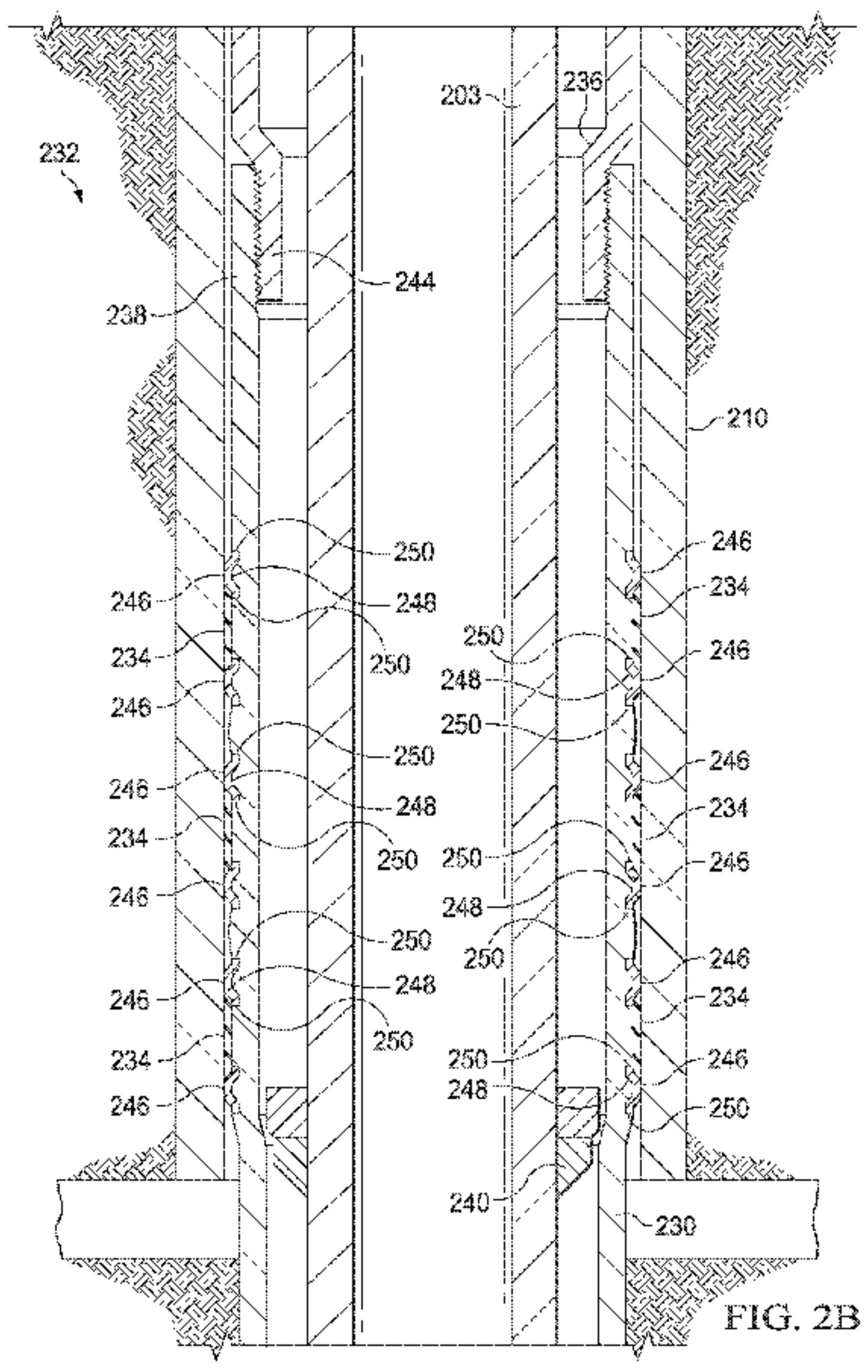

FIG. 2B

(57) **Abstract**: In accordance with some embodiments of the present disclosure, an extrusion prevention ring for a liner hanger system is disclosed. The liner hanger includes an elongate body, a first groove in the elongate body, a first extrusion prevention ring disposed about the elongate body and selectively deformable between a first configuration, where the first extrusion prevention ring is moveable along the length of the elongate body, and a second configuration, where the first extrusion prevention ring is deformed to be received within the first groove, and a seal member disposed about the elongate body and adjacent to the first extrusion prevention ring when the first extrusion prevention ring is in the second configuration, the first extrusion prevention ring configured to prevent movement of the seal member along the length of the elongate body.

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EXTRUSION PREVENTION RING FOR A LINER HANGER SYSTEM

TECHNICAL FIELD

The present disclosure relates generally to hydrocarbon recovery operations and, more particularly, to an extrusion prevention ring for a liner hanger system.

BACKGROUND

When performing subterranean operations, a wellbore is typically drilled and completed to facilitate removal of natural resources (e.g., hydrocarbons or water) from a subterranean formation. Often, once a wellbore is drilled, a casing string may be inserted into the wellbore. Cement may be used to install the casing string in the wellbore and prevent migration of fluids in the annulus between the casing string and the wellbore wall. In certain implementations, the casing string may be made of heavy steel.

Once an upper portion of the wellbore has been drilled and cased, it may be desirable to continue drilling and to line a lower portion of the wellbore with a liner lowered through the upper cased portion of the wellbore. Liner hangers may be installed in the lower end of a previously installed casing string and may be used to mechanically support an upper end of the liner. Additionally, liner hangers may be used to seal the liner to the casing string.

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 an elevation view of an example embodiment of a drilling system;

FIGURE 2A illustrates a cross-sectional view of an example embodiment of a liner hanger featuring seal members and extrusion prevention rings;

FIGURE 2B illustrates a cross-sectional view of the liner hanger shown in FIGURE 2A in an expanded configuration;

FIGURE 3A illustrates a side view of an exemplary extrusion prevention ring;

FIGURE 3B illustrates a section view of the exemplary extrusion prevention ring shown in FIGURE 3A; and

FIGURE 3C illustrates a cross-sectional view of the profile of the exemplary extrusion prevention ring shown in FIGURE 3A.

DETAILED DESCRIPTION

The present disclosure describes an extrusion prevention ring for use with a liner hanger system. During a subterranean operation, a liner may be placed in a wellbore to line a portion of the wellbore. The liner may be suspended from a liner hanger coupled to a casing string in the wellbore. The liner hanger may include seal members surrounding the outer perimeter of the body of the liner hanger that anchor the liner hanger to the casing string and provide an annular seal between the liner hanger and the casing string. Additionally, the liner hanger may have extrusion prevention rings located adjacent to each seal member that encircle the outer perimeter of the body of the liner hanger. The extrusion prevention rings may provide additional anchoring capacity between the liner hanger and the casing string and provide a seal between the liner hanger and the casing string. The extrusion prevention rings may also maintain the position of the seal members. For example, when the liner hanger is in contact with the casing string, the seal members may spread due to the compression of the seal members between the casing string and the liner hanger. The extrusion prevention ring may prevent the spread and maintain the thickness of the seal members. The extrusion prevention rings may be coupled to the outer perimeter of the liner hanger without requiring an increase in the weight or the thickness of the walls of the liner hanger. Accordingly, a system and method of use may be designed in accordance with the teachings of the present disclosure to increase the anchoring and sealing capacity of the liner hanger, improve the efficiency, and reduce the cost of the subterranean operation. Embodiments of the present disclosure and their advantages are best understood by referring to FIGURES 1 through 3, where like numbers are used to indicate like and corresponding parts.

FIGURE 1 illustrates an elevation view of an example embodiment of a drilling system. Drilling system 100 may include well surface or well site 106. Various types of drilling equipment such as a rotary table, drilling fluid pumps and drilling fluid tanks (not expressly shown) may be located at well site 106. For example, well site 106 may include drilling rig 102 that has various characteristics and features associated with a "land drilling rig." 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 expressly shown).

Drilling system 100 may also include drill string 103 associated with drill bit 101 that may be used to form a wide variety of wellbores or bore holes such as generally vertical wellbore 114a or generally horizontal wellbore 114b or any combination thereof. Various directional drilling techniques and associated components of bottom hole assembly (BHA) 120 of drill string 103 may be used to form horizontal wellbore 114b. For example, lateral forces may be applied to BHA 120 proximate kickoff location 113 to form generally horizontal wellbore 114b extending from generally vertical wellbore 114a. 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. Direction drilling may also be described as drilling a wellbore deviated from vertical. The term "horizontal drilling" may be used to include drilling in a direction approximately ninety degrees (90°) from vertical.

BHA 120 may be formed from a wide variety of components configured to form wellbore 114. For example, components 122a, 122b, and 122c of BHA 120 may include, but are not limited to, drill bits (e.g., drill bit 101), coring bits, drill collars, rotary steering tools, directional drilling tools, downhole drilling motors, reamers, hole enlargers, or stabilizers. The number and types of components 122 included in BHA 120 may depend on anticipated downhole drilling conditions and the type of wellbore that will be formed by drill string 103 and rotary drill bit 101. Drill bit 101 may include one or more blades 126 that may be disposed outwardly from exterior portions of rotary bit body 124 of drill bit 101. Drill bit 101 may rotate with respect to bit rotational axis 104 in a direction defined by directional arrow 105. BHA 120 may also include various types of well logging tools (not expressly shown) and other downhole tools associated with directional drilling of a wellbore. 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 commercially available well tool.

Wellbore 114 may be defined in part by casing string 110 that may extend from well surface 106 to a selected downhole location. Portions of wellbore 114, as shown in FIGURE 1, that do not include casing string 110 may be described as "open hole." Various types of drilling fluid may be pumped from well surface 106 downhole through drill string 103 to attached drill bit 101. "Uphole" may be used to refer to a portion of wellbore 114 that is closer to well surface 106 and "downhole" may be used to refer to a portion of wellbore 114 that is further from well surface 106. The drilling fluids may be directed to flow from drill string 103 to respective nozzles passing through rotary drill bit 101. The drilling fluid may be circulated uphole to well surface 106 through annulus 108. In open hole embodiments, annulus 108 may be defined in part by outside diameter 112 of drill string 103 and inside diameter 118 of wellbore 114. In embodiments using casing string 110, annulus 108 may be defined by outside diameter 112 of drill string 103 and inside diameter 111 of casing string 110.

Casing string 110 may be made of any suitable material that is compatible with the conditions in wellbore 114, such as steel. In some embodiments, open hole portions of wellbore 114 may be lined with liner 130. Liner 130 may be used to line or case the open hole portion of wellbore 114. In some embodiments, cement may be placed between liner 130 and inner diameter 118 of wellbore 114. Liner 130 may be installed in wellbore 114 through the use of drill string 103. Drill string 103 may include a releasable collet (not expressly shown) by which drill string 103 can support and rotate liner 130 as liner 130 is placed in wellbore 114.

Liner hanger 132 may be attached to the upper end of, or formed as an integral part of, liner 130. Liner hanger 132 may have an elongate body that may include one or more seal members 134 surrounding liner hanger 132 along the axial length of liner hanger 132. When liner hanger 132 is installed in wellbore 114, seal member 134 may anchor liner hanger 132 to casing string 110 and may create a fluid-tight and pressure-tight seal between liner hanger 132 and casing string 110. Seal members 134 may be made of any suitable elastomeric material. The elastomeric material may be formed of compounds including, but not limited to, natural rubber, nitrile rubber, hydrogenated nitrile, urethane, polyurethane, fluorocarbon, perflurocarbon, propylene, neoprene, hydrin, etc. While three seal members 134 are depicted for illustrative purposes, any number of seal members 134 may be used.

As described in further detail in FIGURES 2A and 2B, liner hanger 132 may be designed such that it may be plastically deformed downhole in wellbore 114 from a contracted position to an expanded position. In the contracted position, the outer diameter of liner hanger 132, defined by the outer diameter of seal members 134, may be smaller than inner diameter 111 of casing string 110 such that liner hanger 132 may be lowered into wellbore 114. As described in further detail with respect to FIGURES 2A and 2B, when liner hanger 132 is positioned downhole in wellbore 114, expansion cones located on drill string 103 may expand liner hanger 132 into the expanded configuration, where the outer diameter of liner hanger 132 expands such that seal members 134 are in contact with inner diameter 111 of casing string 110. When seal members 134 are in contact with casing string 110, seal members 134 may provide a seal against casing string 110 and support the weight of liner 130.

When seal member 134 is in contact with inner diameter 111 of casing string 110, seal member 134 may be compressed between liner hanger 132 and casing string 110. The pressure created by the compression of seal member 134 may cause seal member 134 to spread out along the perimeter of liner hanger 132 and the thickness of seal member 134 may decrease. Additionally, the weight of liner 130 may cause seal member 134 to migrate from one location to another along liner hanger 132. The migration and/or spreading of seal member 134 may decrease the ability of seal member 134 to provide sealing and anchoring functions for liner hanger 132. Therefore, liner hanger 132 may include one or more extrusion prevention rings (e.g., extrusion prevention rings 246 shown in FIGURES 2A and 2B) located on the sides of seal member 134 to maintain the position of seal member 134 and prevent seal member 134 from spreading and/or migrating along the outer perimeter of liner hanger 132. FIGURE 2A illustrates a cross-sectional view of an example embodiment of a liner hanger including seal members and extrusion prevention rings. Liner hanger 232 may be used to suspend liner 230 in a wellbore (e.g., wellbore 114 shown in FIGURE 1). Liner hanger 232 may be coupled to casing string 210 via one or more seal members 234 and/or one or more extrusion prevention rings 246. Liner hanger 232 may be made of any suitable ductile material that is compatible with the conditions in the wellbore, such as steel or a suitable corrosion resisting alloy (CRA), that allows liner hanger 232 to be plastically deformed from an original configuration to an expanded configuration.

Liner hanger 232 may further include a polished bore receptacle, or tie back receptacle, 236 coupled to the upper end of liner hanger 232. In one embodiment, polished bore receptacle 236 may be coupled to liner hanger 232 by a connector, such as threaded joint 238. The inner bore of polished bore receptacle 236 may be smooth and machined to close tolerance to permit drill strings, production tubing, and/or any other suitable subterranean tool to be connected to liner 232 with a fluid-tight and pressure-tight connection. For example, production tubing may be connected to polished bore receptacle 236 and used to pump fracturing fluid at high pressure down a without exposing casing string 210 to the fracturing pressure. While polished bore receptacle 236 is shown as above liner hanger 232 in FIGURE 2A, alternatively polished bore receptacle 236 may be located below liner hanger 232.

The outer diameter of liner 230 may be as large as possible while still allowing liner 230 to be lowered through casing string 210. Additionally, while liner hanger 232 is in the original configuration, the outer diameter of liner hanger 232 may be defined by the outer diameter of the seal members 234 such that the outer diameter of liner hanger 232 is approximately the same as the outer diameter of liner 230.

During assembly of liner hanger 232, one or more grooves 248 may be formed in the outer perimeter of liner hanger 232. Groove 248 may be formed by any suitable manufacturing process such as machining. Groove 248 may be placed along the outer perimeter of liner hanger 232 such that the spacing of grooves 248 along the axial length of liner hanger 232 corresponds with the placement of one or more seal members 234. For example a first groove 248 may be machined along the outer perimeter of liner hanger 232 at a first axial position of liner hanger 232 and a second groove 248 may be machined along the outer perimeter of liner hanger 232 at a second axial position along liner hanger 232 where the first and second axial positions correspond to the edges of seal member 234.

Liner hanger 232 may further include one or more extrusion prevention rings 246 placed over one or more grooves 248. Extrusion prevention ring 246 may be made of any suitable ductile material that withstands the conditions in the wellbore and has a high yield strength and a high elongation, such as aluminum, steel, or stainless steel. For example, extrusion prevention ring 246 may be made of a stainless steel, such as AISI 316 stainless steel. Extrusion prevention ring 246 may be designed to provide a predetermined contact stress when expanded into casing 210.

Extrusion prevention ring 246 may be installed on the outer perimeter of liner hanger 232 by sliding extrusion prevention ring 246 over an end of liner hanger 232 until extrusion prevention ring 246 is at a predetermined position (e.g., over groove 248). After extrusion prevention ring 246 is placed over groove 248, extrusion prevention ring 246 may be compressed and plastically deformed to fit snugly against groove 248 along the outer diameter of liner hanger 232. Extrusion prevention ring 246 may be compressed by any suitable means of deforming metal, such as through the use of a piston-pressure device or a crimping tool. Liner hanger 232 may include extrusion prevention rings 246 located over each groove 248. The placement of extrusion prevention rings 246 and grooves 248 may be such that an extrusion prevention ring 246 is placed adjacent to one or both sides of one or more seal members 234 along the axial length of liner hanger 232.

Groove 248 may have edges 250 to maintain the placement of extrusion prevention ring 246 when extrusion prevention ring 246 is placed over groove 248. In some embodiments, the shape of groove 248 may mirror the shape of extrusion prevention ring 246. For example, in FIGURES 2A and 2B, groove 248 is trapezoidal shaped, corresponding to the trapezoidal shape of the inner surface of extrusion prevention ring 246. When the shape of groove 248 mirrors the shape of inner surface 364, groove 248 may provide structural support for extrusion prevention ring 246. In other embodiments, the shape of groove 248 may not mirror the shape of extrusion prevention ring 246 or may be a complementary shape to the shape of extrusion prevention ring 246. While groves 248 are shown in FIGURES 2A and 2B has having a trapezoidal shape, grooves 248 may be any suitable shape such as circular, square, or rectangular. Grooves 248 may be designed to contain extrusion prevention ring 246 to prevent damage to extrusion prevention ring 246 during placement of liner hanger

232 in the wellbore. The design of groove 248 may additionally provide support for extrusion prevention ring 246 to prevent axial movement of extrusion prevention ring 246 during expansion of liner hanger 232 and while liner hanger 232 is used during the subterranean operation.

Once extrusion prevention rings 246 are installed on liner hanger 232, one or more seal members 234 may be formed over the outer diameter of liner hanger 232. Seal member 234 may be positioned such that one or more extrusion prevention rings 246 are located on the sides of seal member 234. Seal member 234 may be made of any suitable elastomeric material that may be compatible with the conditions in the wellbore, such as an elastomeric material (e.g., rubber), ductile metals (e.g., AISI type 316L stainless steel), or other polymeric materials.

Seal members 234 may be spaced along the axial length of liner hanger 232, surrounding the outer perimeter of liner hanger 232 according to the planned use of liner hanger 232. For example, in high temperature, high pressure (referred to as "HPHT") subterranean operations, liner hanger 232 may include a greater number of seal members 234 than the number of seal members 234 used for a non-high temperature, high pressure subterranean operation. The distance between each seal member 234 may be determined such that any deformation induced in casing string 210 by the force exerted by seal members 234 may be minimized and/or isolated and the force of seal member 234 may be distributed along casing string 210. Additionally, the distance between seal members 234 may be selected to maximize the hanging capacity of seal members 234. The hanging capacity is the maximum downward force seal member 234 may carry without causing liner hanger 232 to move relative to casing string 210. The distance between seal members 234 may be based on any suitable factor, such as the outer diameter of liner hanger 234, the thickness of the wall of liner hanger 234, the inner diameter of casing string 210, the thickness of casing string 210, and/or the weight of liner 230. For example, the distance between the seal members may be smaller when the weight of liner 230 is heavier. The length of liner hanger 234 may limit the number of seal members 234 that may be placed on liner hanger 234.

Seal member 234 may be positioned at any axial location along the outer perimeter of liner hanger 232. The placement of one or more seal members 234 may be based on any suitable design parameter such as the weight of liner 230 suspended from liner hanger 232.

FIGURE 2B illustrates a cross-sectional view of the liner hanger shown in FIGURE 2A in an expanded configuration. During installation of liner hanger 232 in the wellbore, liner hanger 232 may be deployed on a setting tool to provide the axial force required to expand liner hanger 232 (e.g., a setting tool on drill string 103 shown in FIGURE 1). When liner hanger 232 is positioned in casing string 210, fluid pressure applied to the drill string and liner hanger 232 may be used to drive expansion cone 240 downward through liner hanger 232 to expand and plastically deform liner hanger 232 to the expanded configuration where one or more seal members 234 are forced into contact with casing string 210. An alternate setting method may be used to deliver the setting force, such as a mechanically or electronically activated tool. The contact between seal member 234 and casing string 210 may anchor liner hanger 232 to casing string 210 and may provide a pressure-tight and/or fluid-tight seal between liner hanger 232 and casing string 210. After liner hanger 232 is expanded, expansion cone 240 may be removed from liner hanger 232, through polished bore receptacle 236 and out of the wellbore.

When liner hanger 232 is expanded in the wellbore, seal members 234 may contact casing string 210 and may couple liner hanger 232 to casing string 210. Additionally, extrusion prevention ring 246 may expand with liner hanger 232. During expansion, extrusion prevention ring 246 may be plastically deformed and may maintain the position of extrusion prevention ring 246 relative to seal member 234 to maintain the position of seal member 234 along the axial length of liner hanger 232.

Seal member 234 may be held in place by one or more extrusion prevention rings 246. Extrusion prevention ring 246 may maintain the position of seal members 234 and prevent seal members 234 from migrating along the outer diameter of liner hanger 232 and/or spreading while seal members 234 support the weight of liner 230 and anchor liner hanger 232 to casing string 210. Extrusion prevention ring 246 may be placed at one or both sides of seal member 234. Extrusion prevention ring 246 may be a circular ring that extends along the outer perimeter of liner hanger 232 at a predetermined axial location (e.g., at a side of seal member 234).

In addition to maintaining the position of seal member 234, in some embodiments extrusion prevention ring 246 may provide additional anchoring capability for liner hanger 232 by forming a metal to metal contact with casing string 210. Extrusion prevention ring 246 may also provide a seal between liner hanger 232 and casing string 210. The use of extrusion prevention ring 246 and seal member 234 on liner hanger 232 may enhance the anchoring and sealing of liner hanger 232 with casing string 210 when compared to a liner hanger 232 having seal members 234 alone. Additionally, the use of extrusion prevention ring 246 may provide redundant anchoring and pressure integrity for liner hanger 232 in the event that a seal member 234 is damaged during installation of liner hanger 232 in the wellbore.

While liner hanger 232 is shown in FIGURES 2A and 2B as having three seal members 234, liner hanger 232 may have any number of seal members 234. The number of seal members 234 may be based on the characteristics of the subterranean operation, such as the weight of liner 230 suspended from liner hanger 232. Additionally, while liner hanger 232 is shown as having six extrusion prevention rings 246, liner hanger 232 may have any number of extrusion prevention rings 246. While extrusion prevention rings 246 are shown as having a flat top, extrusion prevention rings 246 may have any suitable shape such as pointed, spiked, or curved.

FIGURE 3A illustrates a side view of an exemplary extrusion prevention ring. Extrusion prevention ring 346 may be placed around the outer diameter of a liner hanger (e.g., liner hanger 232 shown in FIGURES 2A and 2B) and may maintain the position of one or more annular seals. Additionally, extrusion prevention ring 346 may provide metal-to-metal contact between extrusion prevention ring 346 and a casing string (e.g., casing string 210) to anchor and seal the liner hanger to the casing string.

The diameter of extrusion prevention ring 346, shown as "d" in Figure 3A, may be any suitable diameter corresponding to the outer diameter of the liner hanger. Liner hangers may have different sizes depending on the particular application and the size of extrusion prevention ring 346 may correspond to the diameter of a liner hanger. For example, the diameter may be slightly larger than the unexpanded outer diameter of the liner hanger such that extrusion prevention ring 346 may slide over the liner hanger during the assembly process, as described with reference to

FIGURES 2A and 2B. Extrusion prevention ring 346 may be manufactured through any suitable process, such as casting and extruding. Extrusion prevention ring 346 may be made of any suitable ductile material that may allow extrusion prevention ring 346 to be deformed from an original configuration, to a deformed configuration, and to an expanded configuration. Extrusion prevention ring 346 may also be made of a material that withstands the conditions in the wellbore and has a high yield strength and a high elongation, such as aluminum, steel, or stainless steel. For example, extrusion prevention ring 246 may be made of a stainless steel, such as AISI 316 stainless steel.

Extrusion prevention ring 346 may be placed along the outer perimeter of the liner hanger such that extrusion prevention ring 346 protrudes from the outer perimeter of the liner hanger and is slidable along the length of the liner hanger and rotatable about the liner hanger. After extrusion prevention ring 346 is installed over a groove in the liner hanger (e.g., groove 248 shown in FIGURES 2A and 2B), extrusion prevention ring 346 may be deformed, or crimped, against the groove. In the contracted configuration, extrusion prevention ring 346 may be seated in the groove and the diameter of extrusion prevention ring 346 may be decreased relative to an original configuration. Extrusion prevention ring 346 may be deformed by any suitable deformation methods, such as through the use of a piston pressure device or a crimping tool. After the liner hanger is positioned in the wellbore and expanded whereby extrusion prevention ring 346 may also be expanded with the liner hanger. In the expanded configuration, top surface 354 may be in contact with the casing string and the diameter of extrusion prevention ring 346 may be increased relative to a deformed or crimped configuration and/or an original configuration.

FIGURE 3B illustrates a section view of the exemplary extrusion prevention ring shown in FIGURE 3A. Extrusion prevention ring 346 is shown sectioned along section A-A shown in FIGURE 3A. FIGURE 3C illustrates a cross-sectional view of the profile of the exemplary extrusion prevention ring shown in FIGURES 3A and 3B. The profile of extrusion prevention ring 346 may be any suitable profile that maintains the position of a seal member and provides a contact surface between a liner hanger and a casing string of a wellbore.

In some embodiments, extrusion prevention ring 346 may provide a metal-to-metal seal between the liner hanger and the casing string. When extrusion prevention ring 346 is in the expanded configuration, top surface 354 of extrusion prevention ring 346 may be flat to provide a more effective contact surface between the liner hanger and the casing string than an extrusion prevention ring 346 with a pointed or spiked top surface 354. For example, the casing string (e.g., casing string 110 shown in FIGURE 1) may have surface variations such that the surface of the casing string is not even and/or smooth and top surface 354 may provide a larger surface area to contact the casing string to bridge any variations in the surface of the casing string. Additionally, when top surface 354 is flat, top surface 354 may provide a higher load capacity for supporting the weight of the liner hanger and the liner due to the larger contact area between extrusion prevention ring 346 and the casing string provided by top surface 354.

In some embodiments, top surface 354 may be textured to provide a higher coefficient of friction between extrusion prevention ring 346 and the inner diameter of the casing string. For example, top surface 354 may be threaded, knurled, sandblasted, serrated, or otherwise textured to eliminate the smoothness of top surface 354. The texturing of top surface 354 may be such that as extrusion prevention ring 346 is deformed or expanded from the original configuration to the deformed configuration and/or expanded configuration, the texturing of top surface 354 remains intact.

In some embodiments, the profile of extrusion prevention ring 346 may be symmetrical such that angle 356a is approximately the same as angle 356b. In other embodiments, the surface geometry of extrusion prevention ring 346 may be asymmetrical such that angle 356a is different from angle 356b. Angles 356a and 356b may be selected such that after the liner hanger and extrusion prevention ring 346 are expanded in the wellbore, profile 358 of extrusion prevention ring 346 may remain approximately normal to the body of the liner hanger. For example, angles 356a and 356b may be any suitable angle between approximately 30° to approximately 70°.

Top surface 354 may have width 360 that may be selected based on the requirements of the subterranean operation. For example, width 360 may be based on the predetermined surface area designed to contact the casing string to support the weight of the liner hanger and the liner. Width 360 may be selected to maintain a suitable width of extrusion prevention ring 346 such that in the expanded state, extrusion prevention ring 346 maintains the position of one or more seal members along the outer perimeter of the liner hanger.

Height 362 (e.g., the difference between the outer diameter and the inner diameter of extrusion prevention ring 346) may be configured such that the outer diameter of extrusion prevention ring 346 may be similar to the outer diameter of a seal member. For example, as shown in FIGURES 2A and 2B, the outer diameters of extrusion prevention ring 246 and seal member 234 extend from the outer perimeter of liner hanger 232 by approximately the same amount. In other embodiments, height 362 may be such that the outer diameter of extrusion prevention ring 346 may be less than or greater than the outer diameter of the seal members.

Height 362 may be based on a function of an amount of possible compression of the seal member when the seal member is in contact with the casing string. For example, height 362 may be a distance from the outer perimeter of the liner hanger such that when the seal member is compressed, the outer diameter of extrusion prevention ring 346 may be approximately the same as the outer diameter of the compressed seal member. Height 362 may result in both the seal member and extrusion prevention ring 346 contacting the casing string which may allow the liner hanger to support a greater weight than a liner hanger where only the seal member contacts the casing string or a liner hanger where only extrusion prevention ring 346 contacts the casing string. Extrusion prevention ring 346 may provide mechanical support for the liner and the liner hanger.

Any number of extrusion prevention rings 346 may be placed along the axial length of the liner hanger. The number of extrusion prevention rings 346 placed along the axial length of the liner hanger may be based on any suitable consideration, such as the number of seal members placed on the liner hanger, the weight of the liner suspended from the liner hanger, or the predetermined anchor and/or sealing capacity of extrusion prevention rings 346. Each of extrusion prevention rings 346 may provide anchor capability and sealing capability for the liner hanger, as well as act as a retainer for the seal member when the seal member is compressed between the casing string and the liner hanger.

Extrusion prevention ring 346 may provide a metal to metal seal with the casing string which may be desirable for use in certain high temperature and/or high pressure subterranean operations where the effectiveness of an elastomer seal member may be reduced. Additionally, the degradation of extrusion prevention ring 346 may be less than the degradation of the seal members under such extreme conditions, resulting in a longer lasting liner hanger which may reduce the costs and improve the efficiency of the subterranean operation.

Embodiments disclosed herein include:

A. A liner hanger including an elongate body; a first groove in the elongate body; a first extrusion prevention ring disposed about the elongate body and selectively deformable between a first configuration, where the first extrusion prevention ring is moveable along the length of the elongate body, and a second configuration, where the first extrusion prevention ring is deformed to be received within the first groove; and a seal member disposed about the elongate body and adjacent to the first extrusion prevention ring when the first extrusion prevention ring is in the second configuration, the first extrusion prevention ring configured to prevent movement of the seal member along the length of the elongate body.

B. A method for coupling a liner to a casing string of a wellbore including coupling a liner hanger to a liner. The liner hanger includes an elongate body; a first groove in the elongate body; a first extrusion prevention ring disposed about the elongate body and selectively deformable between a first configuration, where the first extrusion prevention ring is moveable along the length of the elongate body, and a second configuration, where the first extrusion prevention ring is deformed to be received within the groove; and a seal member disposed about the elongate body and adjacent to the first extrusion prevention ring when the first extrusion prevention ring is in the second configuration, the first extrusion prevention ring configured to prevent movement of the seal member along the length of the elongate body. The method further includes lowering the liner and the liner hanger into a wellbore through a casing string; and expanding the liner hanger such that the seal member is in contact with the casing string.

C. A system for performing subterranean operations including a liner hanger positioned within a casing string of a wellbore and a liner coupled to the liner hanger.

The liner hanger includes an elongate body; a groove in the elongate body; a first extrusion prevention ring disposed about the elongate body and selectively deformable between a first configuration, where the first extrusion prevention ring is moveable along the length of the elongate body, and a second configuration, where the first extrusion prevention ring is deformed to be received within the first groove; and a seal member disposed about the elongate body and adjacent to the first extrusion prevention ring when the first extrusion prevention ring is in the second configuration, the first extrusion prevention ring configured to prevent movement of the seal member along the length of the elongate body.

Each of embodiments A, B, and C may have one or more of the following additional elements in any combination: Element 1: wherein a height of the first extrusion prevention ring is based on an outer diameter of the seal member. Element 2: wherein a surface of the first extrusion prevention ring is textured. Element 3: the elongate body is selectively deformable from a first configuration, where the elongate body is moveable along a casing string of a wellbore, and a second configuration where the elongate body is expanded such that the seal member is in contact with the casing string; and the first extrusion prevention ring is deformable to a third configuration where the first extrusion prevention ring is in contact with the casing string. Element 4: wherein the first extrusion prevention ring has a flat surface contacting the casing string. Element 5: wherein a width of the first extrusion prevention ring is based on a weight of a liner attached to the elongate body. Element 6: wherein a shape of the first groove corresponds to a shape of the first extrusion prevention ring. Element 7: a second groove in the elongate body; and a second extrusion prevention ring disposed about the elongate body and selectively deformable from a first configuration, where the second extrusion prevention ring is moveable along the length of the elongate body, and a second configuration, where the second extrusion prevention ring is deformed to be received within the second groove, the second extrusion prevention ring located adjacent to the seal member on an opposite side of the seal member from the first extrusion prevention ring.

Although the present disclosure and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the disclosure as defined by the following claims. For example, while the embodiment discussed describes a extrusion prevention ring with a flat top surface, the extrusion prevention ring may also have a pointed or spiked top surface and may be made of any suitable material and in any suitable shape. Additionally, while the liner hanger is shown as being used with drilling equipment, the liner hanger may be used in any suitable subterranean operation. It is intended that the present disclosure encompasses such changes and modifications as fall within the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A liner hanger, comprising:

an elongate body;

a first groove in the elongate body;

a seal member disposed about the elongate body; and

a first extrusion prevention ring disposed about the elongate body and selectively deformable between a first configuration and a second configuration;

wherein in the first configuration, the first extrusion prevention ring is movable along the length of the elongate body;

wherein in the second configuration, the first extrusion prevention ring is received within the first groove and adjacent to the seal member to prevent movement of the seal member along the length of the elongate body.

2. The liner hanger of claim 1, wherein a height of the first extrusion prevention ring is based on an outer diameter of the seal member.

3. The liner hanger of claim 1, wherein a surface of the first extrusion prevention ring is textured.

4. The liner hanger of claim 1, wherein:

the elongate body is selectively deformable from a first configuration, where the elongate body is moveable along a casing string of a wellbore, to a second configuration where the elongate body is expanded such that the seal member is in contact with the casing string; and

the first extrusion prevention ring is deformable to a third configuration where the first extrusion prevention ring is in contact with the casing string.

5. The liner hanger of claim 4, wherein the first extrusion prevention ring has a flat surface contacting the casing string.

6. The liner hanger of claim 1, wherein a width of the first extrusion prevention ring is based on a weight of a liner attached to the elongate body.

7. The liner hanger of claim 1, wherein a shape of the first groove corresponds to a shape of the first extrusion prevention ring.

8. The liner hanger of claim 1, further comprising:

a second groove in the elongate body; and

a second extrusion prevention ring disposed about the elongate body and selectively deformable from a first configuration, where the second extrusion prevention ring is moveable along the length of the elongate body, to a second configuration, where the second extrusion prevention ring is deformed to be received within the second groove, the second extrusion prevention ring located adjacent to the seal member on an opposite side of the seal member from the first extrusion prevention ring.

9. A method for coupling a liner to a casing string of a wellbore, comprising:

coupling a liner hanger to a liner, the liner hanger including:

an elongate body;

a first groove in the elongate body;

a seal member disposed about the elongate body; and

a first extrusion prevention ring disposed about the elongate body and selectively deformable between a first configuration and a second configuration;

wherein in the first configuration, the first extrusion prevention ring is movable along the length of the elongate body;

wherein in the second configuration, the first extrusion prevention ring is received within the first groove and adjacent to the seal member to prevent movement of the seal member along the length of the elongate body;

lowering the liner and the liner hanger into a wellbore through a casing string; and

expanding the liner hanger such that the seal member is in contact with the casing string.

10. The method of Claim 9, wherein a height of the first extrusion prevention ring is based on an outer diameter of the seal member.

11. The method of Claim 9, wherein a surface of the first extrusion prevention ring is textured.

12. The method of Claim 9, wherein the first extrusion prevention ring is deformable to a third configuration where the first extrusion prevention ring is in contact with the casing string of a wellbore.

13. The method of Claim 9, wherein a shape of the first groove corresponds to a shape of the first extrusion prevention ring.

14. The method of Claim 9, wherein the liner hanger further includes:

a second groove in the elongate body; and

a second extrusion prevention ring disposed about the elongate body and selectively deformable from a first configuration, where the second extrusion prevention ring is moveable along the length of the elongate body, to a second configuration, where the second extrusion prevention ring is deformed to be received within the second groove, the second extrusion prevention ring located adjacent to the seal member on an opposite side of the seal member from the first extrusion prevention ring.

15. A system for performing subterranean operations, comprising:

a liner hanger positioned within a casing string of a wellbore, the liner hanger including:

an elongate body;

a first groove in the elongate body;

a seal member disposed about the elongate body; and

a first extrusion prevention ring disposed about the elongate body and selectively deformable between a first configuration and a second configuration;

wherein in the first configuration, the first extrusion prevention ring is movable along the length of the elongate body;

wherein in the second configuration, the first extrusion prevention ring is received within the first groove and adjacent to the seal member to prevent movement of the seal member along the length of the elongate body; and

a liner coupled to the liner hanger.

16. The system of claim 15, wherein a height of the first extrusion prevention ring is based on an outer diameter of the seal member.

17. The system of claim 15, wherein a surface of the first extrusion prevention ring is textured.

18. The system of claim 15, wherein:

the elongate body is selectively deformable from a first configuration, where the elongate body is moveable along a casing string of a wellbore, to a second configuration where the elongate body is expanded such that the seal member is in contact with the casing string; and

the first extrusion prevention ring is deformable to a third configuration where the first extrusion prevention ring is in contact with the casing string.

19. The system of claim 18, wherein the first extrusion prevention ring has a flat surface contacting the casing string.

20. The system of claim 15, where in the liner hanger further includes:

a second groove in the elongate body; and

a second extrusion prevention ring disposed about the elongate body and selectively deformable from a first configuration, where the second extrusion prevention ring is moveable along the length of the elongate body, to a second configuration, where the second extrusion prevention ring is deformed to be received within the second groove, the second extrusion prevention ring located adjacent to the seal member on an opposite side of the seal member from the first extrusion prevention ring.

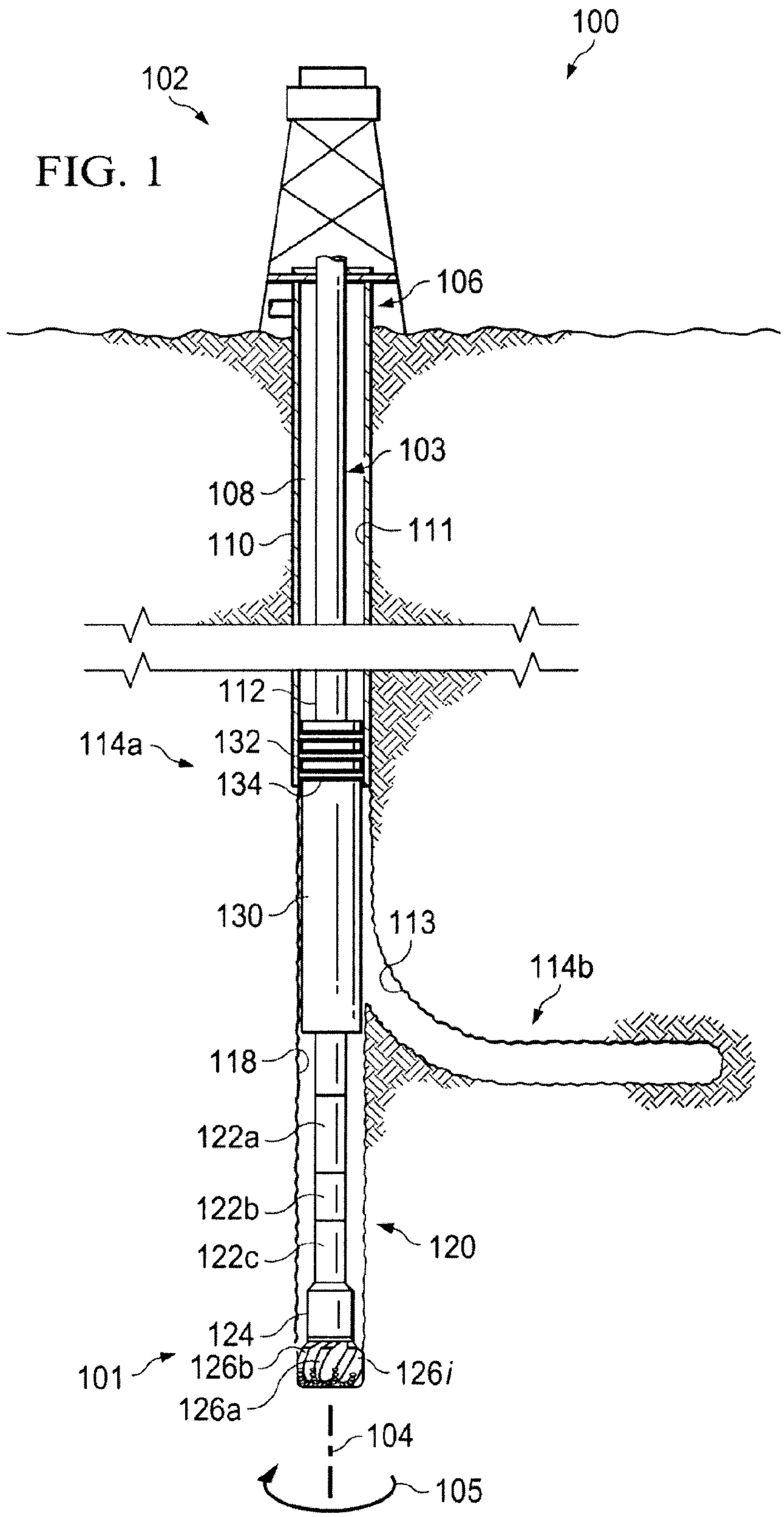
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FIG. 1
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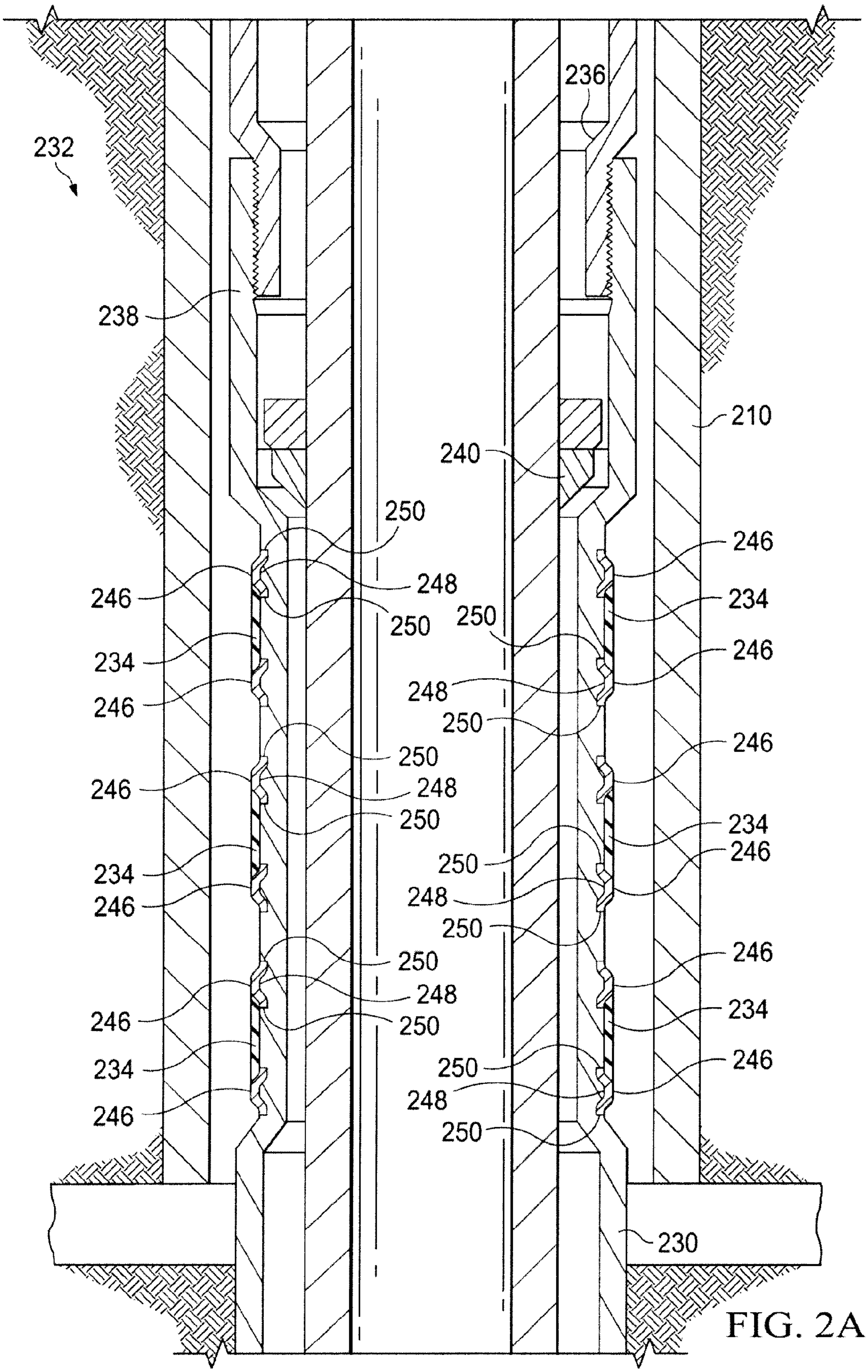
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FIG. 2A

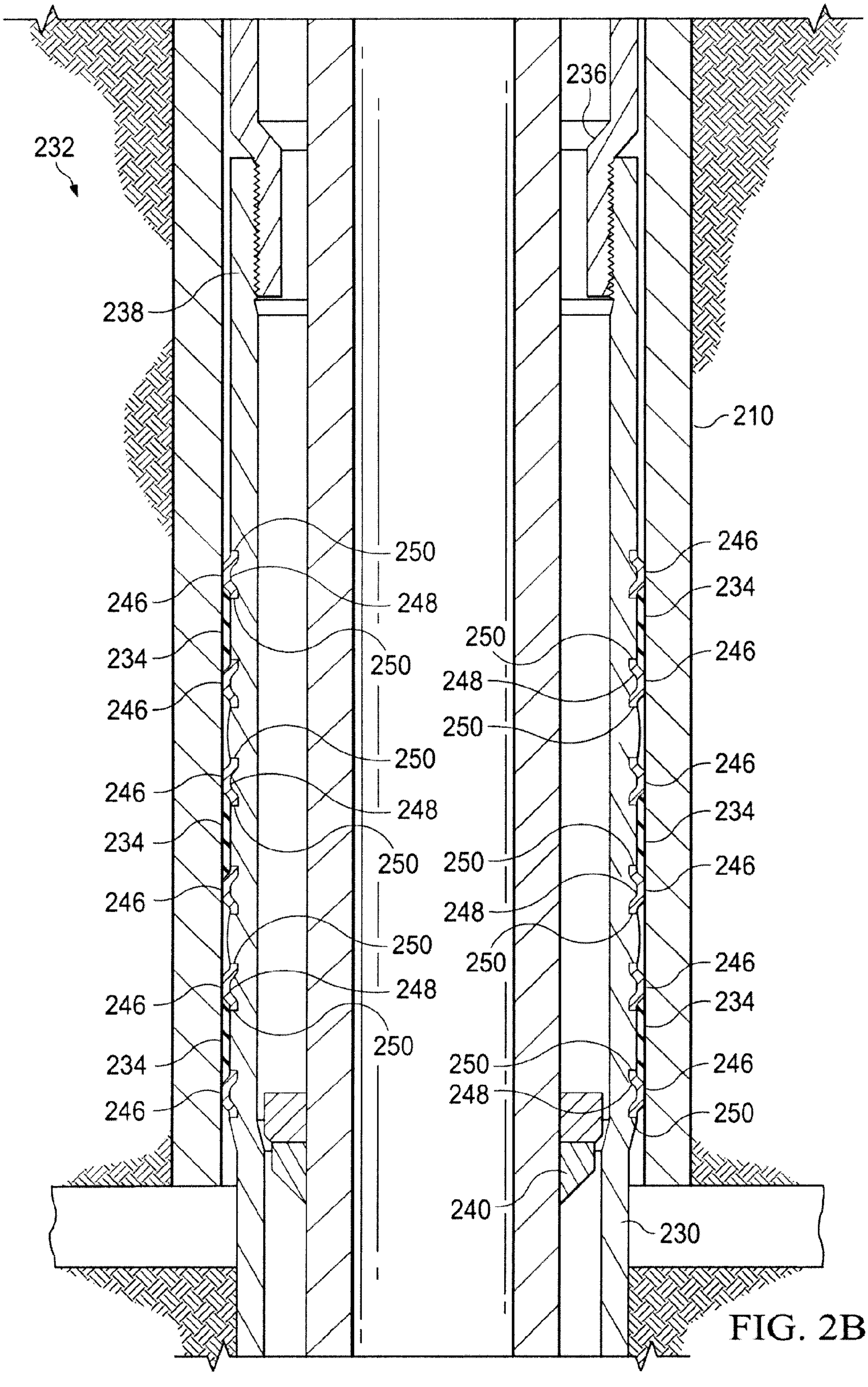

FIG. 2B

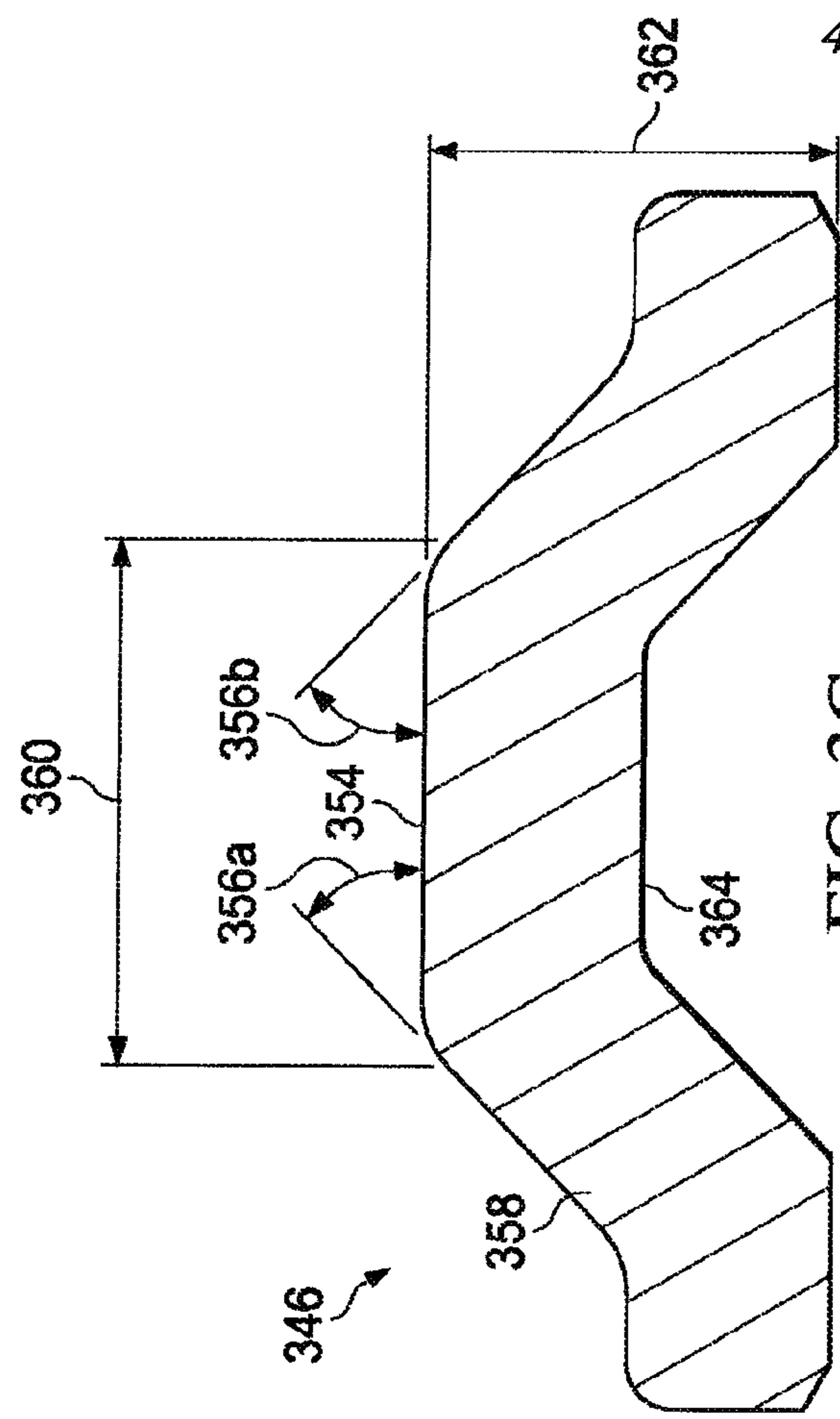

FIG. 3C

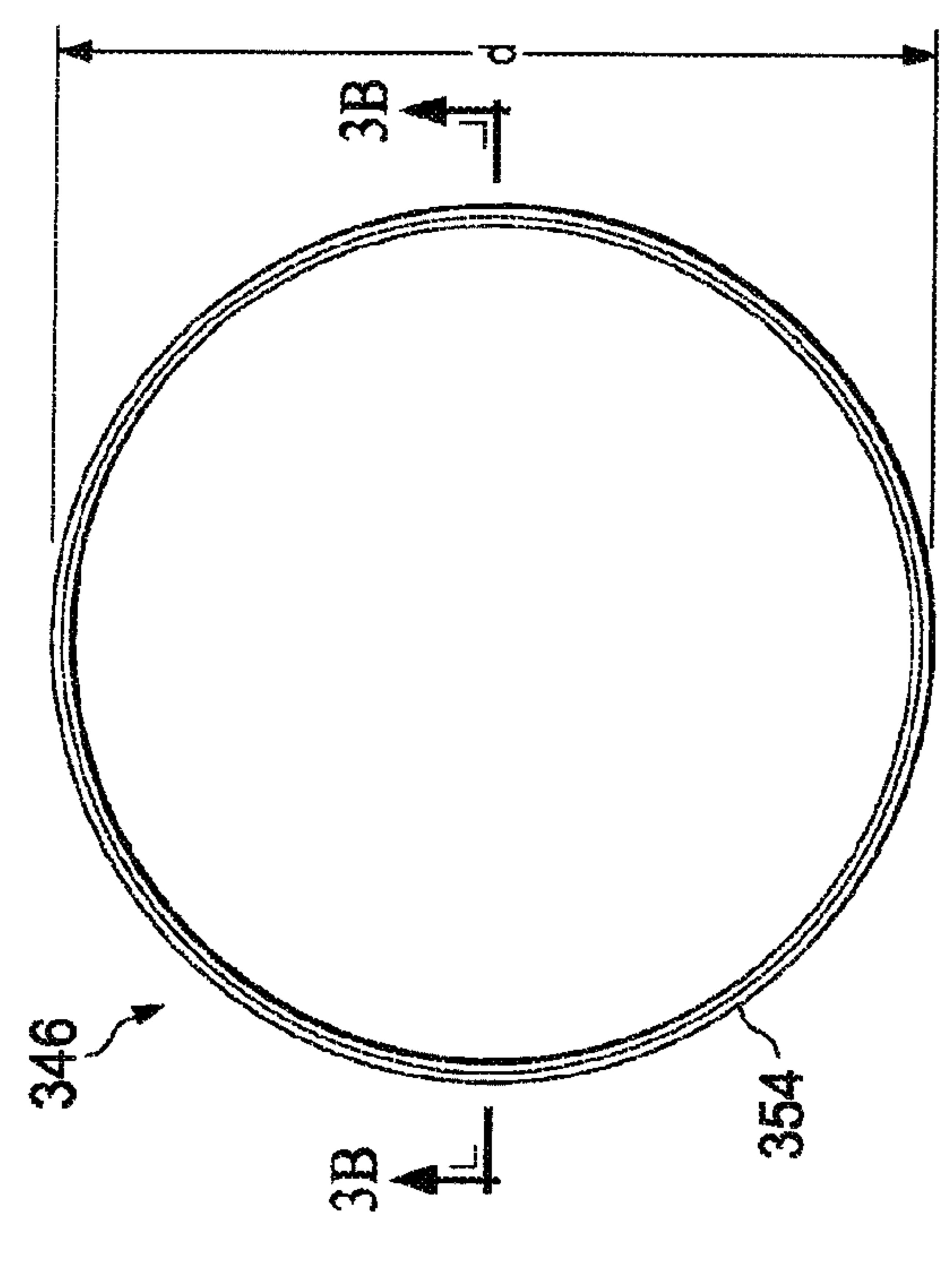

FIG. 3A

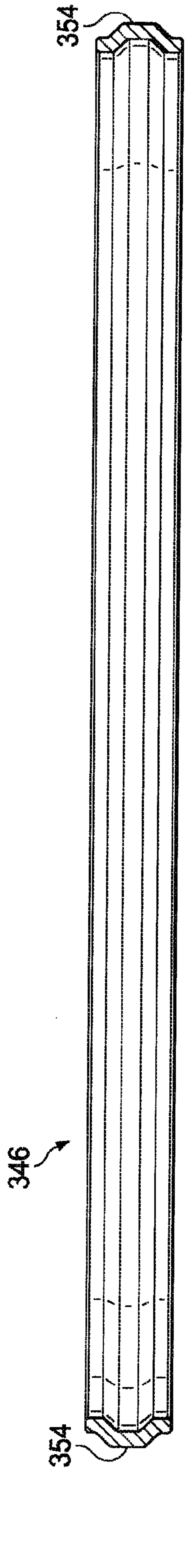

FIG. 3B

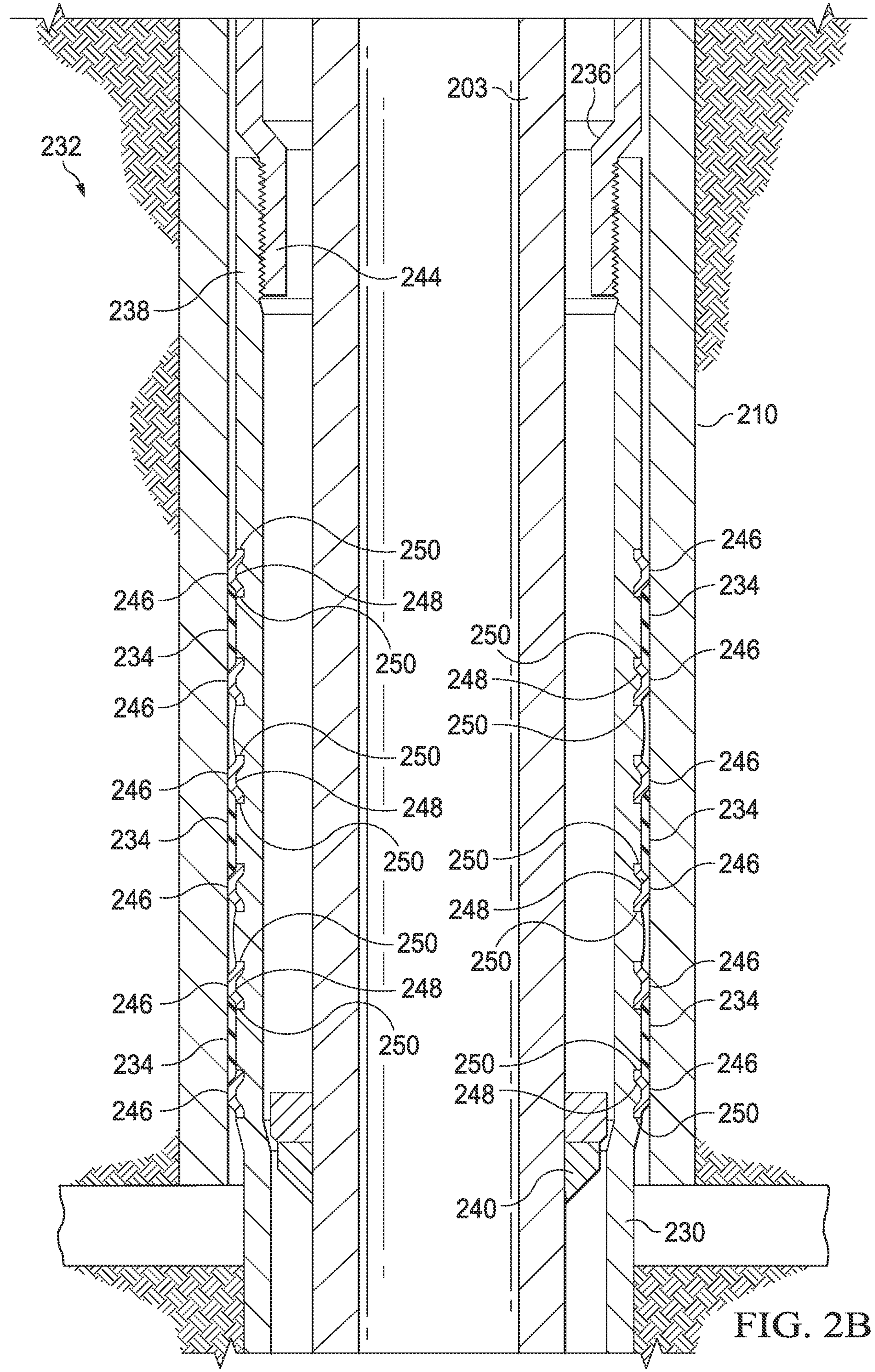

FIG. 2B