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METAL-TO-METAL SEALING ARRANGEMENT FOR
TELESCOPING CASING JOINT

BACKGROUND

[0001] In the oil and gas industry, tubular members designed for high pressure and high temperature applications, such as casing strings, generally include seals. A casing string is a long section of connected metal pipes (tubulars) generally used as a conduit for flowing fluid to and from a well. The inner diameter of a first upper casing segment (or joint) is large enough to concentrically pass a subsequent lower casing segment through the first casing segment in order to position the subsequent lower casing segment below the first casing segment. A portion of the lower casing segment remains inside the first upper casing segment such that the lower and upper casing segments overlap axially. The space between the two casing segments is sealed. This process of passing and positioning casing segments continues to the bottom of the well, where the inner diameter of the bottommost casing segment is smaller than the inner diameter of the previous casing segments.

[0002] The seals are positioned along the outer circumference of the inner or smaller subsequent casing segments. The seals are squeezed between the two concentric casing segments. The seals prevent drilling fluid, production fluid, stimulation fluid, or any other fluid that may flow in or out of the wellbore, from leaking into the formation surrounding the wellbore. Fluid leaks, such as from casing strings, can lead to production losses, environmental pollution, and blowouts.

[0003] Despite the efforts of seal manufacturers, service companies, and operators, many seals for use in casing strings and other tubular members weaken and fail over time. Accordingly, there exists a continuing need for effective seals between concentric tubular members.

SUMMARY

[0004] In one aspect, embodiments of this disclosure are directed to an apparatus including an outer tubular member having an inner diameter, wherein at least a portion
of the inner diameter may include a first sealing surface. An inner tubular member having an outer diameter may be disposed within the outer tubular member. At least a portion of the outer diameter of the inner tubular member may include a second sealing surface. A self-energized seal may be located around the inner tubular between the first sealing surface and the second sealing surface. The self-energized seal may include at least two protrusions, one located on an outer surface of the self-energized seal and one located on an inner surface of the self-energized seal.

[0005] In another aspect, this disclosure is directed to an apparatus including an outer tubular member having an inner diameter, wherein at least a portion of the inner diameter includes a first sealing surface. The apparatus also includes an inner tubular member having an outer diameter disposed within the outer tubular member, wherein at least a portion of the outer diameter includes a second sealing surface. The apparatus further includes a seal assembly. The seal assembly includes at least two self-energized seals, wherein a first self-energized seal is disposed axially above a second self-energized seal, each of the self-energized seals disposed between the first and second sealing surfaces, wherein each self-energized seal is annular and comprises at least two protrusions, one on an inner surface and one on an outer surface. The apparatus further includes at least one metallic stabilization ring disposed between the at least two self-energized seals.

[0006] In yet another aspect, embodiments of the present disclosure are directed to a method including interference fitting a self-energized seal with a substantially U-shaped cross-section between a first sealing surface of an inner tubular member and a second sealing surface of an outer tubular member. An adjustable sleeve disposed around the inner tubular member may be rotated. The rotation of the adjustable sleeve may cause the inner tubular member to stroke from an initial sealing position to a final sealing position while maintaining the interference fit of the self-energized seal with the first sealing surface and the second sealing surface.
BRIEF DESCRIPTION OF DRAWINGS

[0007] FIG. 1 illustrates a side view of a self-energized seal arrangement in a casing joint, the left side of the figure showing an initial sealing position and the right side of the figure showing a final sealing position in accordance with embodiments disclosed herein.

[0008] FIG. 2 illustrates a detail cross-sectional view of modular sealing components taken from within region A of FIG. 1 in accordance with embodiments disclosed herein.

[0009] FIG. 3 illustrates a cross-sectional view of a self-energized seal assembly in accordance with embodiments disclosed herein.

[0010] FIG. 3A illustrates an isometric view of the self-energized seal shown in FIG. 3.

[0011] FIG. 4 illustrates a cross-sectional view of a self-energized seal in accordance with embodiments disclosed herein.

[0012] FIG. 4A illustrates an isometric view of the self-energized seal shown in FIG. 4.

[0013] FIGS. 5-7 illustrate cross-sectional views of self-energized seal assembly arrangements in accordance with embodiments disclosed herein.

DETAILED DESCRIPTION

[0014] Embodiments disclosed herein relate to an apparatus and method for sealing concentric tubular members. Specifically, embodiments disclosed herein relate to an apparatus and method for using self-energized seals for sealing concentric tubular members, such as in a telescoping casing string. The self-energized seals may provide a dynamic seal in the absence of fluid pressure.

[0015] Referring initially to Figure 1, a casing joint 100 in accordance with embodiments of the present disclosure is shown. The casing joint 100 includes at least an outer tubular member 1, an inner tubular member 2, and a seal assembly 200 located between at least a portion of the outer tubular member 1 and the inner tubular member 2. An upper portion of inner tubular member 2 may be connected to a mandrel/thread type
casing hanger (not shown). The bottom of outer tubular member 1 may be connected to a lower casing segment (not shown). Mechanisms to connect the outer tubular member 1 to a casing string may include hangers and/or threads to suspend the casing string in the well.

[0016] The casing joint 100 may be a telescoping casing joint such that the inner tubular 2 member strokes within the outer tubular member 1. For example, left side 18 of Figure 1 illustrates the casing joint 100 before stroking of the inner tubular member 2. The right side 19 of Figure 1 illustrates casing joint at the end of the stroke of inner tubular member 2. Telescoping casing joints may be used during production tieback or contingency operations, where maintaining an instantaneous and continuous seal is important.

[0017] The seal assembly 200 provides a metal-to-metal seal between the outer tubular member 1 and the inner tubular member 2. Specifically, the seal assembly 200 provides an instantaneous seal, i.e., provides a seal without the application of fluid pressure or the use of a mechanical means (i.e., tool or motion of the seal assembly), at an initial position (as shown on left side 18), maintains the seal during the stroking of inner tubular member 2, and maintains the seal once the seal assembly 200 is in a final position (as shown on right side 19). Seal assembly 200 provides a dynamic seal, as seal assembly 200 maintains a seal during relative movement of the outer and inner tubular members 1, 2. Although the seal assembly 200 is shown in telescoping casing joint 100, one skilled in the art will understand that a seal assembly in accordance with embodiments disclosed herein may be used in a non-telescoping casing joint, a casing sub, and any sealable connection between two tubular members.

[0018] An adjustable sleeve 3 may be included in the casing joint 100 to stroke the inner tubular member 2, i.e., adjust the position of inner tubular member 2 relative to the outer tubular member 1. The adjustable sleeve 3 may be a tubular sleeve disposed between the outer tubular member 1 and the inner tubular member 2. An inner diameter surface of the adjustable sleeve 3 may be threadedly engaged with a portion of an outer diameter surface of the inner tubular member 2. A portion of the adjustable sleeve 3 may interface with at least a portion of the outer tubular member 1, such that rotation of adjustable sleeve 3 (e.g., as the sleeve 3 is rotated through the threaded engagement)
causes the inner tubular member 2 to move downhole or up hole relative to the outer tubular member 1 depending on the direction the sleeve 3 is rotated, i.e., clockwise or counterclockwise. In other words, the adjustable sleeve 3 causes the inner tubular member 2 to stroke within the outer tubular member 1. The adjustable sleeve 3 may be rotated with various downhole mechanical tools known in the art, such as setting tools. The setting tool (not shown) may also include a mechanical device that sets and positions casing or tubing on wellhead shoulders.

Figure 2 shows a detail view of region A of Figure 1. Region A illustrates a partial cross-sectional view of one side of assembled outer and inner tubular member 1, 2 with sealing assembly 200 disposed therebetween. One of ordinary skill in the art will appreciate that the assembled outer and inner tubular members 1, 2 with sealing assembly 200 are symmetrical, such that the other side (not shown) mirrors the one side shown. The sealing assembly 200 is located radially between a first sealing surface 16 of the outer tubular member 1 and a second sealing surface 17 of the inner tubular member 2. The first sealing surface 16 is located on an inner circumference surface of the outer tubular member 1 and the second sealing surface 17 is located on an outer circumference surface of the inner tubular member 2. The outer tubular member 1 and the inner tubular member 2 may be, for example, casing joints and/or a telescoping casing joint.

The sealing assembly 200 may be positioned between two axial restricting members. The axial restricting members may be, for example a shoulder 24 of the inner tubular member 2, a shoulder of the outer tubular member (not shown), and/or a threaded retaining nut 15 threaded to at least one of the outer tubular member 1 or the inner tubular member 2. In still other embodiments, the sealing assembly may be located in a groove located on an outer circumference of the inner tubular member 2 or an inner circumference of the outer tubular member 1. As shown in Figure 2, the sealing assembly 200 may be located axially between a shoulder 24 of the inner tubular member 2 and a threaded retainer nut 15 threaded around an outer diameter surface of the inner tubular member 2. In such an embodiment, the sealing assembly 200 moves axially with the inner tubular member 2. In other words, when the inner tubular member 2 is stroked within the outer tubular member 1, the sealing assembly 200 moves (i.e., translates) with the inner tubular member 2. In other embodiments, two
threaded retaining nuts or a shoulder of the outer member 1 and a threaded nut may be used as axial restricting members, such that the sealing assembly 200 is located axially between a first and second threaded retaining nut. The two threaded retaining nuts may be threaded to, for example, the outer tubular member 1, as such, the sealing assembly 200 remains stationary with respect to outer tubular member 1 while the inner tubular member 2 is stroked with respect to the outer tubular member 1 and the seal assembly 200.

[0021] The sealing assembly 200 includes at least one annular self-energized seal, *e.g.*, seal 6. The seal assembly 200 may also include at least one stabilization ring, *e.g.*, ring 10. The seal(s) and stabilization ring(s) act as a "modular components." In other words, the seal(s) and stabilization rings(s) are modular and may be positioned in a variety of configurations, utilizing different numbers of seals and/or stabilization rings, to adapt to a variety of sealing requirements and situations. The annular self-energized seal 6 is positioned between the first sealing surface 16 and the second sealing surfaces 17, such that the self-energized seal 6 is positioned around an outer circumference of the inner tubular member 2. In certain embodiments, the sealing assembly 200 may include at least two self-energized seals located between the first sealing surface 16 and the second sealing surface 17. As shown in Figure 2, four seals 6, 7, 8, 9 may be located between the first sealing surface 16 and the second sealing surface 17, wherein each seal is located axially above one another in a stacked configuration. One skilled in the art will understand that the number of seals included in the seal assembly 200 is not intended to limit the scope of the present disclosure.

[0022] Figure 3 and 4 each show a partial cross-section of a seal 6 in accordance with embodiments of the present disclosure, while Figures 3A and 4A show an isometric view of the seal 6 according to Figures 3 and 4, respectively. As noted above and shown in Figures 3A and 4A, the seal 6 is substantially annular in shape while the cross-section of the seal 6 (*i.e.*, the cross-section of one side of the seal) is substantially horseshoe shaped or U-shaped. The self-energized seal 6 includes a first substantially straight portion 22 and second substantially straight portion 23 and an arcuate portion 30 including an internal arcuate portion 20 and an external arcuate portion 21 disposed between the first and second substantially straight portions 22, 23.
[0023] Each substantially straight portion 22, 23 includes at least one protrusion 5 located on an outer perimeter thereof. In other words, protrusion 5 is an annular protrusion, such that the seal 6 has an annular protrusion 5 along an outer circumference and a second annular protrusion 5 along an inner circumference. The protrusion 5 is located at the maximum and/or minimum diameters of the seal 6. The interference of the protrusion 5 with the first and second sealing surfaces 16 and 17 provides the seal. The protrusion 5 may provide a pivot point. The protrusion 5 may have a bulbous or rounded cross-section as shown in Figure 3. In other embodiments, the protrusion 5 may have a cross-section that is, for example hemispherical, elliptical, triangular, or polygonal. The seal 6 may include a multi-protrusion design such that more than one protrusion 5 is located on the seal, 6 as shown in Figure 4. Accordingly, the shape of the protrusion and number of protrusions is not intended to limit the scope of the present disclosure. Although, the shape of the seal is described with respect to seal 6, one skilled in the art will understand that the present description applies to, for example, seals 7, 8, and 9. The self-energized seal 6 may be constructed from various metals, alloys, and elastomeric materials, for example, but not limited to alloy steel, stainless steel, and nickel alloy. The seals may be formed by any method known in the art including, for example, machining or sheet metal forming. The design and the materials used to construct the self-energized seals may provide flexibility of the seal 6 so that the self-energized seal may effectively seal between the outer and inner tubular members 1, 2.

[0024] The self-energized seal, e.g., seals 6-9, may be positioned in either an anticline or a syncline configuration. In other words, each seal may be positioned such that that the U-shaped configuration of the seal opens upwardly, with the arcuate portion 30 axially below the substantially straight portions 23, 24 (syncline configuration) or such that the U-shaped configuration of the seal opens downwardly, with the arcuate portion 30 axially above the substantially straight portions 23, 24 (anticline configuration). For example, referring to Figures 2 and 5, seals 6 and 7 are positioned in a syncline configuration and self-energized seals 8 and 9 are positioned in an anticline configuration.

[0025] As seals 6 and 7 are positioned in a syncline configuration and seals 8 and 9 are positioned in an anticline configuration, seal assembly 200 has a bidirectional
configuration. A bi-directional configuration includes at least two seals such that at least one self-energized seal is positioned in the anticline configuration and at least one self-energized seal is positioned in the syncline configuration. The bidirectional configuration may allow for the seal assembly 200 to effectively seal from both pressures below and above the self-energized seals. In other words, the bidirectional configuration allows holding of pressurized fluid above and below the self-energized seals.

As shown in Figures 6 and 7, the seal may have a unidirectional configuration. For example referring to Figure 7, the seal assembly 200 includes a single seal 6 configured in a syncline position. A unidirectional configuration refers to a seal configuration where each self-energized seal is positioned in either the anticline or the syncline configuration. For a unidirectional seal assembly including at least two or more seals as shown in Figure 6, all seals are positioned in the same configuration, i.e., in only a syncline or only an anticline configuration.

Referring to Figures 2 and 5-7, at least one stabilization ring, e.g., 10-14, may be included in the seal assembly 200 to provide sealing assistance to the at least one self-energized seal, e.g., seals 6-9, by preventing axial and/or radial movement of the at least one self-energized seal, e.g., seals 6-9, with respect to at least one tubular member, e.g., inner tubular member 2. The at least one stabilization ring 10 may be disposed above or below the self-energized seal 6 between the first and second sealing surfaces 16, 17, such that the stabilization ring 10 is positioned around the outer circumference of the inner tubular member 2. The stabilization ring 10 may be metallic or made from elastomeric materials, and assist in supporting the self-energized seal 6. For example, the stabilization ring 10 may help maintain the self-energized seal 6 in place between the outer tubular member 1 and inner tubular member 2 during pressure applications, e.g., when high pressure and high temperature turbulent fluid flows through the tubular members.

A stabilization ring may be positioned between adjacent seals and/or between a seal and an axial restricting member, e.g., shoulder 24 of the inner tubular member 2 or nut 15. For example, stabilization ring 11 is located between seals 6 and 7 while ring 10 is located between shoulder 24 and seal 6. In order to accommodate a variety of
configurations of a seal or seals, e.g., seals 6-9, the stabilization rings may include a plurality of stabilization ring types. Referring specifically, to Figure 2, the types of the stabilization rings may include, a central ring, e.g., ring 12, an intermediate ring, e.g., rings 11 and 13, and an end retainer ring, e.g., rings 10 and 14. Depending on the desired configuration or number of seal(s), e.g., seals 6-9, a variety of stabilization rings, e.g., 10-14, may be used to provide sealing assistance and maintain a relative axial and radial position of the seal(s).

The end retainer rings, 10, 14 may be positioned between at least one seal, seals 6 and 9, respectively, and an axial restricting member, e.g., shoulder 24 of inner tubular member and/or threaded nut 15. End retainer rings 10 and 14 are substantially annular and may include a surface configured to engage a profile of the seal 6 and a second surface configured to engage a profile of the axial restricting member. For example, as shown in Figure 2, the end retainer rings 10, 14 are annular and include at least one substantially planar surface, e.g., planar surface 26, opposite an extension, e.g., extension 25. When end retainer ring 10 is positioned between shoulder 24 and seal 6, the planar surface 26 abuts the shoulder 24, while the extension 25 protrudes into the seal 6 and abuts the internal arcuate portion (20 in Figure 3) of seal 6. By abutting and protruding into an adjacent seal 6, the extension 25 may axially and radially stabilize a position of the seal, e.g., seal 6.

Intermediate rings 11 and 13 are positioned between two unidirectional seals, e.g., seals 6 and 7 or seals 8 and 9. In other words, intermediate rings are located between two seals where both seals are positioned in the same configuration, i.e., in either an anticline (seals 8 and 9) or syncline (seals 6 and 7) configuration. As such, an intermediate ring 11 includes an arcuate surface 28 to receive an external arcuate portion (21 in Figure 3) of a seal 6. An extension 28 may be located opposite the arcuate surface 28 and abut an inner arcuate portion (20 in Figure 3) of the adjacent seal 7. By abutting the external arcuate portion of seal 6 and protruding into an adjacent seal 7, the intermediate ring 11 assists in axially and radially stabilizing a position of seals 6 and 7.

A middle ring, e.g., ring 12, may be located between two seals that are positioned in different configurations, i.e., one is in a syncline configuration and the other is in the
anticline configuration. As shown in Figure 2, the middle ring 12 is located between seal 7, which is in a syncline position, and seal 8, which is in an anticline position. The middle ring 12 includes a first arcuate surface 29 located opposite a second arcuate surface 29, such that both arcuate surfaces 29 receive an external arcuate surface (21 in Figure 3) of the seals 7 and 8. By abutting the external arcuate surfaces of seals 7 and 8, the middle ring 12 may axially and radially stabilize a position of seals 7 and 8.

Although described primarily with respect to Figure 2, one skilled in the art will understand that a seal assembly 200 may include a variety of seal configurations and consequently, stabilization ring configurations. The above description of the seals 6-9 and stabilization rings 10-14 as well as the various geometries of the stabilization rings 10-14 is not intended to limit the scope of the present disclosure. For example, in some embodiments, the middle ring may include a first extension surface located opposite a second extension surface, such that the first extension surface extends to abut an inner arcuate surface of a seal configured in an anticline position and the second extension surface extends to abut an inner arcuate surface of an adjacent seal configured in a syncline position. Accordingly, the geometries and configurations of seals, e.g., 6-9, and stabilization rings, e.g., 10-14, are provided as examples and are not intended to limit the scope of the present disclosure.

The sealing assembly 200 provides at least one self-energized seal 6 to provide a seal between first and second sealing surfaces 16, 17. A stabilization ring may be provided to the sealing assembly 200 to provide sealing support to the seal 6. A seal between the outer tubular member 1 and the inner tubular member 2 is formed by an interference fit between the protrusions 5 on the outer and inner surfaces of the seal 6 and the first and second sealing surfaces 16, 17, respectively. The self-energized seal, e.g., at least one of seals 6-9, unlike pressure or mechanical energized seals, may seal against the sealing surfaces 16, 17 before the application of fluid pressure and/or movement of the seal assembly 200, thereby providing an instantaneous seal. Pressure energized seals maintain sealing capabilities when fluid flows within tubular members, e.g., inner and outer tubular members 1, 2, and forces the pressure energized seals to press against a sealing surface in order to maintain the seal.
In contrast, a self-energized seal 6 maintains sealing capabilities due to an interference fit against first and second sealing surfaces 16, 17. The protrusions 5 provide interference with the first and second sealing surfaces 17, 16. The protrusions 5 provide a pivot point and allow the seal, e.g., at least one of seals 6-9, to pivot, flex, or bend radially inward or radially outward at the pivot point. The flexibility of the seal provided by the protrusions 5 allows said seal to conform against the first and second sealing surfaces 16, 17 to create an interference fit. The interference fit provides an effective seal without the application of fluid pressure. The interference between the seal, e.g., seals 6-9, and the first and second sealing surfaces 16, 17, may be in the range of 0.001 inch to 0.010 inch. Positioning a stabilization ring 10 above or below the seal 6 allows the seal 6 to pivot, flex, or bend, but helps to maintain the interference fit against the first and second sealing surfaces 16, 17, as discussed above.

Referring collectively to Figures 1 and 3, the sealing assembly 200 may be initially placed between the outer and inner tubular members 1, 2 of the telescoping casing string 100 at an initial sealing position 18. The sealing assembly 200 may include at least one seal, e.g., one of seals 6-9. At the initial sealing position 18, the sealing assembly 200 creates an effective initial and instantaneous seal between the first and second sealing surfaces 16, 17 of the outer and inner tubular members 1, 2. The initial and instantaneous sealing effectiveness may be attributed to the self-energizing capabilities and features of the seal, such as, for example, the interference fit provided by protrusions 5 (Figure 2). The self-energized seals are initially placed into the telescoping casing joint via various mechanical tools known in the art, such as a setting tool. For example, the seals may be installed between the outer and inner sleeves 1, 2 by engaging setting tool or other seal installation tool with the threads on the inner sleeve 2. The seal installation tool may be rotated thereby advancing components of the seal assembly 200 to a final location. For example, rotation of the seal installation tool may advance the seal assembly 200 toward the shoulder 24 of inner sleeve 2. Components of the seal assembly 200, e.g., seals 6-9 and stabilization rings 10-14 may be advanced separately or together as a seal assembly 200. To operate a telescoping casing joint or sub with the sealing assembly 200, the adjustable sleeve 3 is rotated with, for example, a setting tool. The rotation of the adjustable sleeve 3 strokes the
inner tubular member 2 downward from the initial sealing position 18 within the outer tubular member 1.

[0036] The seal assembly 200 maintains an effective seal between the first and second sealing surfaces 16, 17 of the outer and inner tubular members 1, 2, respectively, as the inner tubular member 2 strokes. As the inner tubular member 2 moves downhole, the seal assembly 200 may move with the inner tubular member 2, maintaining a sealing contact with the first and second sealing surfaces 16, 17. This enables the seal assembly 200 to effectively seal from and including the initial sealing position 18 ("pre-stroked" position) to and including the final sealing position 19 ("stroked" position). In other words, the stroking causes the self-energized seals to move from the initial sealing position 18 to a final sealing position 19. For example, shoulder 24 of inner tubular member 2 may provide a downward acting force on the seal assembly 200, thereby causing seal assembly 200 to stroke downward with the inner tubular member 2.

[0037] In other embodiments, the sealing assembly 200 may remain stationary as the inner tubular member 2 strokes downward. For example, inner tubular member 2 may stroke downward with respect to outer tubular member 1 and the sealing assembly 200 is axial restricted by outer tubular member 1. In such embodiments, the seal assembly maintains an effective seal between the first and second sealing surfaces 16, 17, as the inner tubular member 2 strokes downward.

[0038] Once the inner tubular member 2 has reached a final stroke position 19, as shown by the right side of Figure 1, the seal assembly 200 including at least one self-energized seal 6 will be in a final sealing position. The setting tool may then attach the casing joint to a well head assembly.

[0039] Accordingly, embodiments disclosed herein provide self-energized seals that may include an instantaneous seal without the application of fluid pressure, unlike pressure energized seals which require fluid pressure to seal. The self-energized seals may be effective where pressure energized seals fail; for example, pressure energized seals may lose sealing effectiveness when fluid pressure diminishes. Further, the modular sealing components may allow for multiple effective and efficient configurations to seal between the sealing surfaces of concentric tubular members, such as those within a telescoping casing joint or sub.
Embodiments of the present disclosure may include an outer tubular member having an inner diameter, where a portion of the inner diameter includes a first sealing surface, and an inner tubular member having an outer diameter disposed within the outer tubular member, where a portion of the outer diameter includes a second sealing surface. A self-energized seal may be disposed around the inner tubular between the first sealing surface and the second sealing surface. The self-energized seal may include a first and second substantially straight portion and an arcuate portion disposed therebetween forming a substantially U-shaped cross-section. The self-energized seal may also include at least two protrusions, one located on an outer surface of the self-energized seal and one located on an inner surface of the self-energized seal.

Other embodiments of the present disclosure include an outer tubular member having an inner diameter, where a portion of the inner diameter includes a first sealing surface, and an inner tubular member having an outer diameter disposed within the outer tubular member, where a portion of the outer diameter includes a second sealing surface. A seal assembly may be positioned between the first and second sealing surfaces. The seal assembly includes at least two self-energized seals, wherein a first self-energized seal is disposed axially above a second self-energized seal and each annular seal is disposed between the first and second sealing surfaces. Each of the self-energized seals are annular and comprises at least two protrusions, one on an inner surface and one on an outer surface. Each of the annular seals are. The seal assembly may also include at least one metallic stabilization ring disposed between the at least two self-energized seals.

Some embodiments of the present disclosure may include interference fitting a self-energized seal with a substantially U-shaped cross-section between a first sealing surface of an inner tubular member and a second sealing surface of an outer tubular member. An adjustable sleeve disposed around the inner tubular member may be rotated. The rotation of the adjustable sleeve may cause the inner tubular member to move from an initial sealing position to a final sealing position while maintaining the interference fit of the self-energized seal with the first sealing surface and the second sealing surface.
Although the preceding description has been described herein with reference to particular means, materials, and embodiments, it is not intended to be limited to the particulars disclosed herein; rather, it extends to all functionally equivalent structures, methods, and uses, such as are within the scope of the appended claims.
CLAIMS

What is claimed is:

1. An apparatus comprising:
   an outer tubular member having an inner diameter, wherein at least a portion of the inner diameter includes a first sealing surface;
   an inner tubular member having an outer diameter disposed within the outer tubular member, wherein at least a portion of the outer diameter includes a second sealing surface; and
   a self-energized seal disposed around the inner tubular between the first sealing surface and the second sealing surface, the self-energized seal including:
      first and second substantially straight portions and an arcuate portion disposed therebetween forming a substantially U-shaped cross-section, and
      at least two protrusions, one located on an outer surface of the self-energized seal and one located on an inner surface of the self-energized seal.

2. The apparatus of claim 1, further comprising at least one stabilization ring disposed above and/or below the self-energized seal.

3. The method of claim 2, wherein the at least one stabilization ring includes an extension, the extension protruding into the arcuate portion of the self-energized seal to provide sealing assistance.

4. The apparatus of claim 1, wherein the inner tubular member and the outer tubular member are portions of a telescoping casing joint.

5. The apparatus of claim 1, wherein the at least two protrusions create an interference fit with the first and second sealing surfaces.

6. The apparatus of claim 4, wherein the interference is in the range of about 0.001 inches to about 0.010 inches

7. An apparatus comprising:
   an outer tubular member having an inner diameter, wherein at least a portion of the inner diameter includes a first sealing surface;
an inner tubular member having an outer diameter disposed within the outer tubular member, wherein at least a portion of the outer diameter includes a second sealing surface;

a seal assembly including:

at least two self-energized seals, wherein a first self-energized seal is disposed axially above a second self-energized seal, each of the self-energized seals disposed between the first and second sealing surfaces, wherein each self-energized seal is annular and comprises at least two protrusions, one on an inner surface and one on an outer surface; and

at least one metallic stabilization ring disposed between the at least two self-energized seals.

8. The apparatus of claim 7, wherein a cross-section of the at least two self-energized seals is substantially U-shaped.

9. The apparatus of claim 7, wherein the at least two self-energized seals are configured in an anticline configuration.

10. The apparatus of claim 7, wherein the at least two self-energized seals are configured in a syncline configuration.

11. The apparatus of claim 7, wherein one of the at least two self-energized seals is configured in a syncline configuration and the other of the at least two self-energized seals is in an anticline configuration.

12. The apparatus of claim 7, wherein the at least two self-energized seals are made from a metal or elastomeric material.

13. A method comprising:

interference fitting a self-energized seal with a substantially U-shaped cross-section between a first sealing surface of an inner tubular member and a second sealing surface of an outer tubular member;

rotating an adjustable sleeve disposed around the inner tubular member;
stroking the inner tubular member from an initial sealing position to a final sealing position while maintaining the interference fit of the self-energized seal with the first sealing surface and the second sealing surface.

14. The method of claim 13, further comprising interference fitting a metallic stabilization ring between the first sealing surface and the second sealing surface, the metallic stabilization ring disposed axially above or below the self-energized seal.

15. The method of claim 14, further comprising preventing relative axial and radial movement of the at least one self-energized seal with the metallic stabilization ring.

16. The method of claim 13, wherein the at least one seal strokes downward with the inner tubular member.

17. The method of claim 16, further comprising providing a downward force with a shoulder of the inner tubular member to stroke the at least one seal downward with the inner tubular member.

18. The method of claim 13, further comprising configuring the at least two self-energized seals into a multi-directional configuration.

19. The method of claim 18, further comprising providing a seal while stroking the inner tubular member from an initial sealing position to a final sealing position.

20. The method of claim 13, wherein the providing the seal occurs without an application of fluid pressure.
FIG. 2
# INTERNATIONAL SEARCH REPORT

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. E21B33/04 E21B17/07 E21B/08

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
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<tbody>
<tr>
<td>X</td>
<td>US 5 997 003 A (TURNER EDWIN C [US]) 7 December 1999 (1999-12-07) figures 1,2,8,9</td>
<td>1-3,5-12</td>
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**Date of the actual completion of the international search**

29 September 2015

**Date of mailing of the international search report**

09/10/2015

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