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(71) Demandeur/Applicant:
WEATHERFORD/LAMB INC., US
(72) Inventeurs/Inventors:
LOGIUDICE, MICHAEL, US;
SYMMS, JOSHUA VERNON, US;
LIRETTE, BRENT J., US;
SCOTT, THAD JOSEPH, US;
RING, LEV, US
(74) Agent: DEETH WILLIAMS WALL LLP

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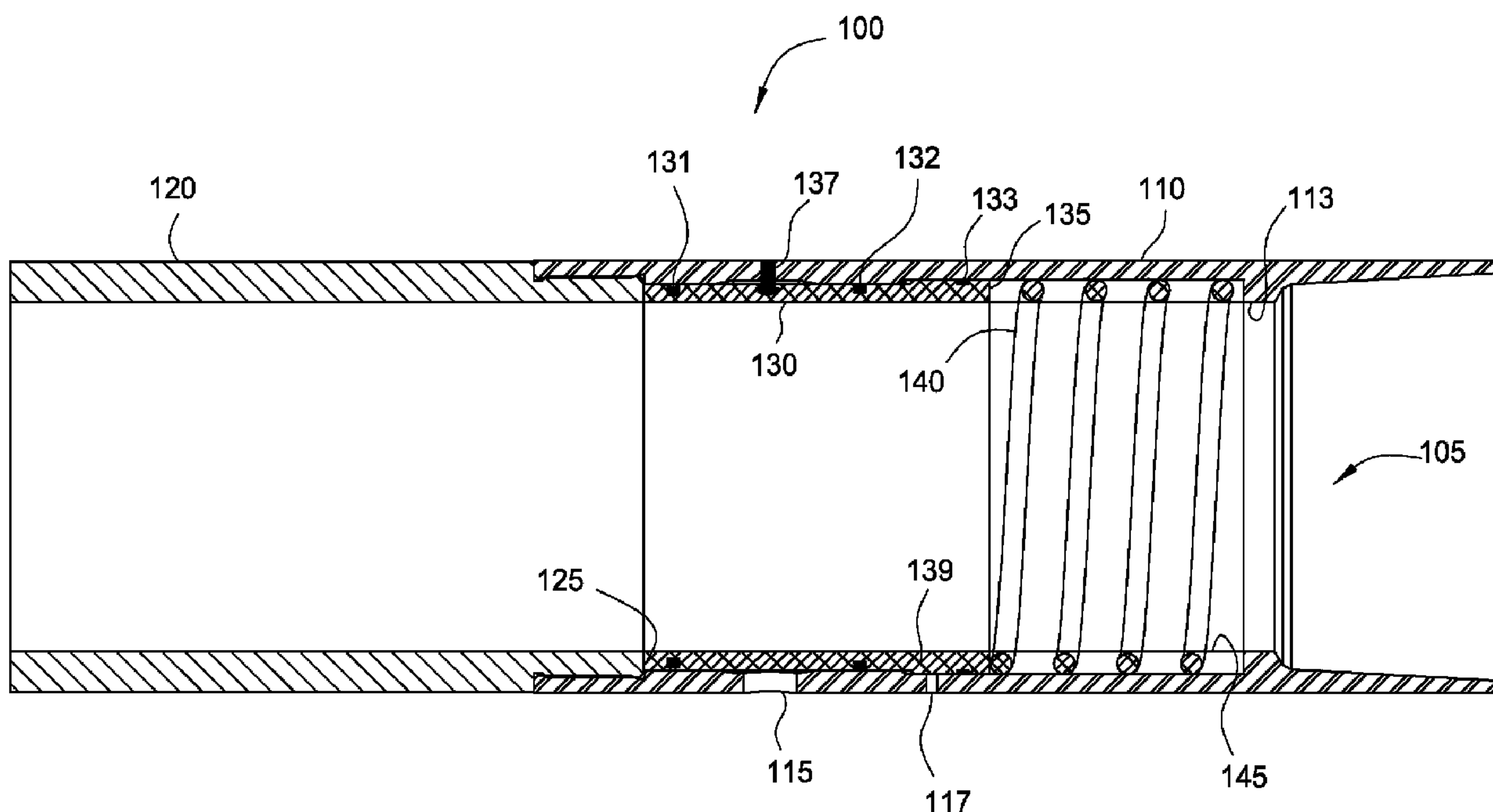
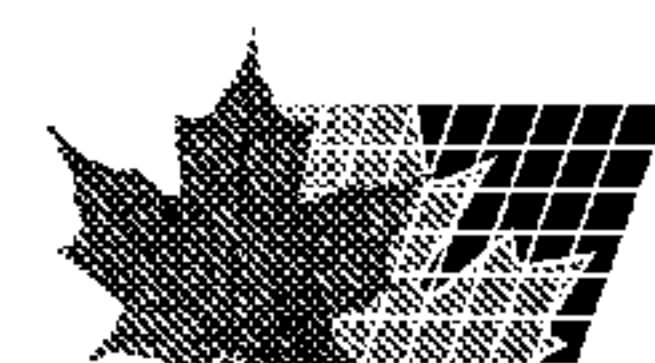


FIG. 2

(57) **Abrégé/Abstract:**

A method and apparatus for a pressure relief valve assembly. The valve assembly may be coupled to one or more casings and/or tubular members to control fluid communication therebetween. The valve assembly is a one-way valve assembly that relieves pressure within an annulus formed between adjacent casings and/or tubular members to prevent burst or collapse of the casings and/or tubular members. The valve assembly is resettable downhole.



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(71) Applicant (for all designated States except US):
WEATHERFORD/LAMB, INC. [US/US]; 2000 St. James Place, Houston, Texas 77056 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **LOGIUDICE, Michael** [US/US]; 18631 Mosshill Estates Lane, Cypress, Texas 77429 (US). **SYMMS, Joshua Vernon** [US/US]; 13607 Northpointe Ridge Ln., Cypress, Texas 77429 (US). **LIRETTE, Brent J.** [US/US]; 15935 Clipper Pointe Drive, Cypress, Texas 77429 (US). **SCOTT, Thad Joseph** [US/US]; 5315 Hidalgo Street, Houston, Texas 77056 (US). **RING, Lev** [US/US]; 14122 Barnhart Boulevard, Houston, Texas 77077 (US).

(74) Agents: **PATTERSON, William B.** et al.; Patterson & Sheridan, LLP, 3040 Post Oak Blvd., Suite 1500, Houston, Texas 77056 (US).

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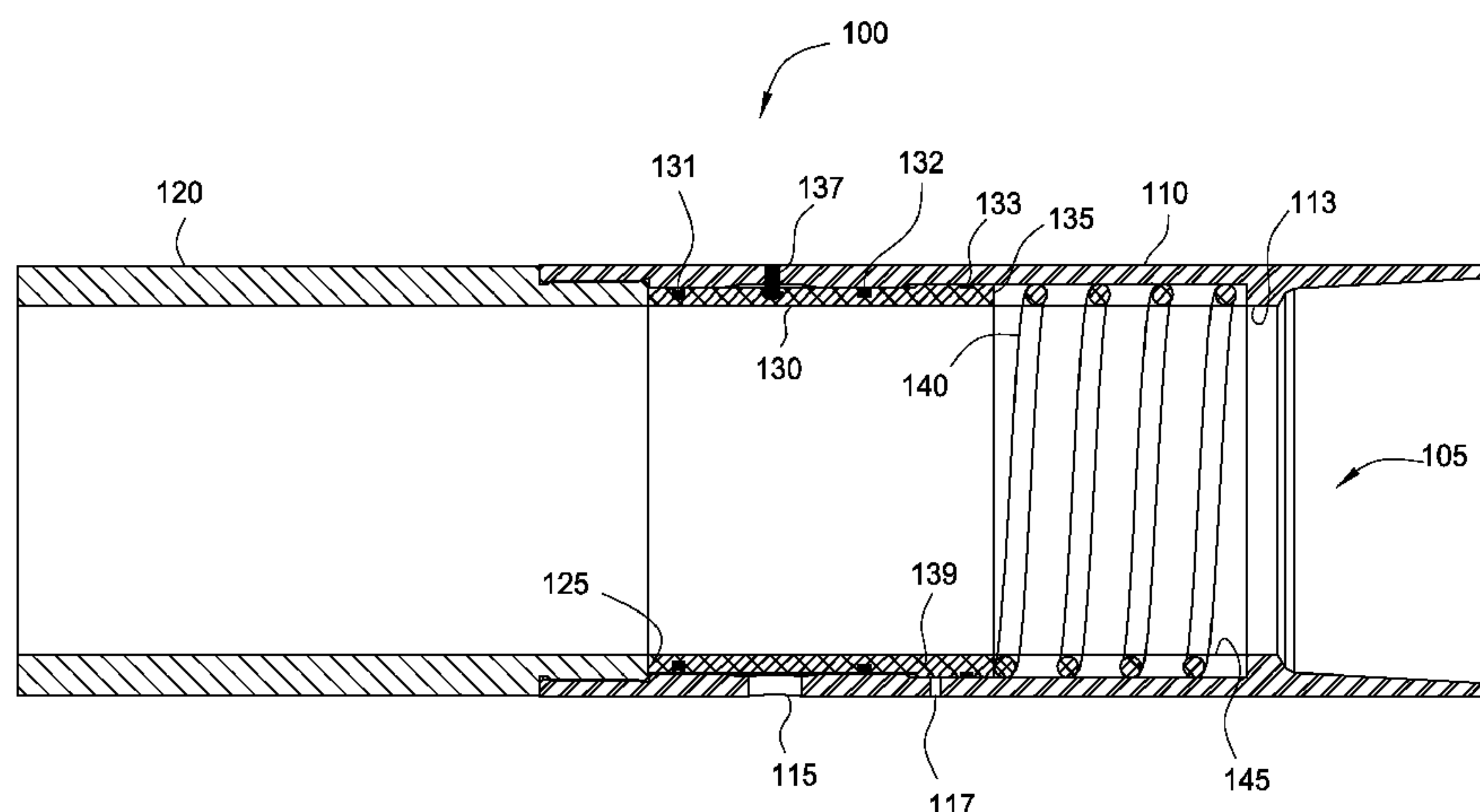
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(57) Abstract: A method and apparatus for a pressure relief valve assembly. The valve assembly may be coupled to one or more casings and/or tubular members to control fluid communication therebetween. The valve assembly is a one-way valve assembly that relieves pressure within an annulus formed between adjacent casings and/or tubular members to prevent burst or collapse of the casings and/or tubular members. The valve assembly is resettable downhole.

COLLAPSE SENSING CHECK VALVE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims benefit of United States Provisional Patent Application serial number 61/481,088, filed April 29, 2011, which is herein
5 incorporated in its entirety.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] Embodiments of the invention generally relate to a pressure relief valve assembly.

10 Description of the Related Art

[0003] Traditional well construction, such as the drilling of an oil or gas well, includes a wellbore or borehole being drilled through a series of formations. Each formation, through which the well passes, must be sealed so as to avoid an undesirable passage of formation fluids, gases or materials out of the formation and
15 into the borehole. Conventional well architecture includes cementing casings in the borehole to isolate or seal each formation. The casings prevent the collapse of the borehole wall and prevent the undesired inflow of fluids from the formation into the borehole.

[0004] In standard practice, each succeeding casing placed in the wellbore has an
20 outside diameter significantly reduced in size when compared to the casing previously installed. The borehole is drilled in intervals whereby a casing, which is to be installed in a lower borehole interval, is lowered through a previously installed casing of an upper borehole interval and then cemented in the borehole. The purpose of the cement around the casing is to fix the casing in the well and to seal the borehole
25 around the casing in order to prevent vertical flow of fluid alongside the casing towards other formation layers or even to the earth's surface.

[0005] If the cement seal is breached, due to high pressure in the formations and/or poor bonding in the cement for example, fluids (liquids or gases) may begin to migrate up the borehole. The fluids may flow into the annuli between previously
30 installed casings and cause undesirable pressure differentials across the casings.

The fluids may also flow into the annuli between the casings and other drilling or production tubular members that are disposed in the borehole. Some of the casings and other tubulars, such as the larger diameter casings, may not be rated to handle the unexpected pressure increases, which can result in the collapse or burst of a casing or tubular.

[0006] Therefore, there is a need for apparatus and methods to prevent wellbore casing and tubular failure due to unexpected downhole pressure changes.

SUMMARY OF THE INVENTION

[0007] In one embodiment, a valve assembly comprises a tubular mandrel; a sleeve member disposed within the tubular mandrel; and a biasing member disposed within the tubular mandrel and operable to bias the sleeve member against a shoulder of the tubular mandrel. The sleeve member is movable between a closed position where fluid communication is closed between a bore of the valve assembly and a port disposed through the tubular mandrel, and an open position where fluid communication is open between the bore of the valve assembly and the port disposed through the tubular mandrel.

[0008] In one embodiment, a method of controlling fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular comprises providing a valve assembly for coupling to the wellbore tubular, wherein the valve assembly includes a tubular mandrel, a sleeve member movably disposed in the tubular mandrel, and a biasing member for biasing the sleeve member into a closed position; and moving the sleeve member to an open position to open fluid communication between the exterior of the wellbore tubular and the interior of the wellbore in response to a pressure differential exceeding a first predetermined value.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] So that the manner in which the above recited features of the invention can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to

be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

[0010] Figure 1 is a schematic view of a wellbore.

[0011] Figure 2 is a cross sectional view of a valve assembly in a closed position.

5 [0012] Figure 3 is a cross sectional view of the valve assembly in an open position.

DETAILED DESCRIPTION

[0013] Figure 1 illustrates a wellbore 5 formed within an earthen formation 80. The walls of the wellbore 5 are reinforced with a plurality of casings 10, 20, 30 of varying diameters that are structurally supported within the formation 80. The casings 10, 20, 10 30 are fixed within the formation 80 using a sealing material 15, 25, 35, such as cement, which prevents the migration of fluids from the formation 80 into the annuli between the casings 10, 20, 30. One or more tubular members 40, 45, such as drilling or production tubular members, may also be disposed in the wellbore 5 for conducting wellbore operations. An annulus "A" is formed between the casing 10 and 15 the casing 20, and an annulus "B" is formed between the casing 20 and the tubular member 40. It is important to note that the embodiments described herein may be used with other wellbore arrangements and are not limited to use with the wellbore configuration illustrated in Figure 1.

[0014] The wellbore 5 may intersect a high pressure zone 50 within the formation 20 80. Fluids within the high pressure zone 50 are sealed from the annulus A and B by the sealing material 25 that is disposed between the casing 20 and the wellbore 5 wall. In the event that the sealing material 25 is breached or otherwise compromised, pressurized fluids may migrate upward into the annulus A and cause an unexpected pressure increase. The pressure rise may form a pressure differential across the 25 casings 10, 20 that (if unchecked) may result leakage through or burst of casing 10, and/or leakage through or collapse of the casing 20. A valve assembly 100 is provided to relieve the pressure in the annulus A prior to failure of one or both of the casings 10, 20.

[0015] Figure 2 illustrates the valve assembly 100 in a closed position. The valve 30 assembly 100 is shown coupled to the casing 20 in Figure 1, but each of the casings

10, 20, 30 and/or the tubular members 40, 45 may similarly include one or more of the valve assembly 100 as described herein. The valve assembly 100 may be coupled to the casings 10, 20, 30 and/or the tubular members 40, 45 using a threaded connection, a welded connection, and/or other similar connection arrangements.

5 [0016] The valve assembly 100 may comprise a top sub 110, a bottom sub 120, a sleeve member 130, and a biasing member 140. The bottom sub 120 is coupled to the top sub 110, such as by a threaded connection. In one embodiment, the top sub 110 and the bottom sub 120 may be integrally formed as a single tubular mandrel. The sleeve member 130 is movably disposed within the top sub 110, and may be
10 biased against a shoulder 125 or upper end of the bottom sub 120 by the biasing member 140. The biasing member 140 may be a spring or other similar biasing mechanism. The biasing member 140 is also disposed within the top sub 110, and may be positioned between the sleeve member 130 and a shoulder 113 of the top sub 110. A cover member 145 optionally may be provided to secure the biasing
15 member 140 within the top sub 110 and to protect the biasing member 140 from interference with any component(s) that pass through the bore 105 of the valve assembly 100. The inner diameters of the top sub 110, the bottom sub 120, the sleeve member 130, and/or the cover member 145 may be equal to provide a substantially uniform inner diameter surface throughout the length of the valve
20 assembly 100. In one embodiment, the inner diameter of the bore 105 of the valve assembly 100 (including the top sub 110, the bottom sub 120, and/or the sleeve member 130) may be substantially equal to or greater than the inner diameter of the casings 10, 20, 30 and/or the tubular members 40, 45 to which it is attached when assembled.

25 [0017] As illustrated in Figure 2, the sleeve member 130 is biased into the closed position. When in the closed position, sealing members 131, 132, 133, such as o-rings, close fluid communication between the bore 105 of the valve assembly 100 and the annulus surrounding the valve assembly 100. In particular, the sealing members 131, 132, 133 seal fluid communication to a first port 115 and a second port 117 that
30 are disposed through the body of the top sub 110. The first port 115 is sealed on opposite sides by sealing members 131 and 132. The second port 117 is sealed on opposite sides by sealing members 132 and 133.

[0018] An external piston area 139, such as a shoulder portion, is provided on the sleeve member 130 between sealing members 132 and 133 and is in fluid communication with the second port 117. An internal piston area 135 is formed by an end of the sleeve member 130, which is in contact with the biasing member 140 and is in fluid communication with the bore 105 of the valve assembly 100. When the force on the internal piston area 135 is greater than the force on the external piston area 139, the valve assembly 100 is moved to the closed position as shown in Figure 2. When the force on the external piston area 139 is greater than the force on the internal piston area 135, the valve assembly 100 is moved to the open position as shown in Figure 3.

[0019] In an optional embodiment, the sleeve member 130 may be initially coupled to the top sub 110 and/or the bottom sub 120 by one or more shearable members, such as shear pins 137 illustrated in Figure 2. The shear pins 137 may retain the sleeve member 130 in a closed position to prevent inadvertent actuation of the sleeve member 130 by a component(s), such as a drilling or production string, that is moved through the bore 105 of the valve assembly 100 during a wellbore operation. The shear pins 137 may be sheared by pressurizing the annulus surrounding the valve assembly 100 to force the sleeve member 130 into the open position as described herein. The force required to shear the shear pins 137 may be greater than the force required to subsequently move the sleeve member 130 to the open position. In one embodiment, a tool or other downhole device may be lowered into the bore 105 of the valve assembly 100 and into engagement with the sleeve member 130 to apply a force sufficient to shear the shear pins 137.

[0020] Figure 3 illustrates the valve assembly 100 in the open position, where the bore 105 of the valve assembly 100 is in fluid communication with the annulus surrounding the valve assembly 100 via the first port 115. The pressure in the annulus surrounding the valve assembly 100 may generate a force on the external piston area 139 sufficient to overcome the force on the internal piston area 135. The force on the internal piston area 135 may include the force from the biasing member 140, such as a spring force, plus the force generated by any pressure within the bore 105 acting on the internal piston area 135. The force on the external piston area 139 may move the sleeve member 130 to a position such that the first port 115 is open to

fluid communication with the bore 105 of the valve assembly 100. In particular, the sealing member 131 is moved across the first port 115 to open fluid communication.

[0021] Referring back to Figure 1, the valve assembly 100 may be operable to control fluid communication between the annulus A and the annulus B. The annulus A surrounds the valve assembly 100, and the annulus B is in fluid communication with the bore 105 of the valve assembly 100. Pressure in the annulus A may act on the external piston area 139 via the second port 117 to move the sleeve member 130 against the force of the biasing member 140 and any pressure force in the annulus B acting on the internal piston area 135. When the valve assembly 100 is open, pressurized fluid may flow from the annulus A to the annulus B through the first port 115 of the valve assembly 100. The valve assembly 100 is thus operable to relieve a pressure that may cause burst of a casing exterior to the casing to which the valve assembly 100 is attached, and/or collapse of a casing to which the valve assembly 100 is attached.

[0022] When the pressure in the annulus A and the force acting on the external piston area 139 decreases to a predetermined amount, the biasing member 140 may move the sleeve member 130 back to the closed position where the sealing members 131, 132 close fluid communication to the first port 115. In this manner, the valve assembly 100 is operable as a one-way valve in that it will permit fluid flow into the bore 105 of the valve assembly 100 but will prevent fluid flow out of the bore 105 via the first port 115. The valve assembly 100 is automatically resettable downhole and may be operated multiple times in response to any pressure fluctuations within the wellbore 5. As stated above, any of the casings 10, 20, 30 and/or the tubular members 40, 45 may each be provided with one or more valve assemblies 100 to allow fluid flow from a surrounding casing or tubular member to an inner casing or tubular member, while preventing fluid flow in the opposite direction. The valve assembly 100 vents off collapse pressure from the outside of the casings 10, 20, 30 and/or tubular members 40, 45 but allows internal pressurization of the casings 10, 20, 30 and/or tubular members 40, 45. The internal pressure holding integrity of the casings 10, 20, 30 and/or tubular members 40, 45 is provided by the seal formed between the top sub 110 and the sleeve member 130 with the sealing members 131, 133.

[0023] In one embodiment, a casing 10, 20, 30 and/or tubular member 40, 45 may be provided with multiple valve assemblies 100 that are spaced apart along the length of the casing or tubular member. The valve assemblies 100 may be operable to open and/or close at different pre-determined pressure setting. One or more of the valve assemblies 100 may be operable to open when a first predetermined pressure acts on the external piston area 139, while one or more of the other valve assemblies 100 may be operable to open when a second predetermined pressure acts on the external piston area 139. The first predetermined pressure may be greater than, less than, or equal to the second predetermined pressure.

[0024] In one embodiment, the valve assembly 100 may be operable to open when a pressure differential across the valve assembly 100 exceeds a first predetermined value. The valve assembly 100 may be operable to close when the pressure differential across the valve assembly 100 decreases below a second predetermined value. The first predetermined value may be greater than or equal to the second predetermined value. For example, the valve assembly 100 may include a detent mechanism and/or a collet assembly configured to retain the valve assembly 100 in the open position until the pressure differential across the valve assembly 100 decreases below the second predetermined value. In one embodiment, the detent mechanism may include a c-ring coupled to the sleeve member 130 that engages a shoulder of the top sub 110. When moved to the open position, the sleeve member 130 may move the c-ring across the shoulder with minimal resistance, but when moved to the closed position, the sleeve member 130 may encounter a greater resistance to move the c-ring across the shoulder. Other detent arrangements may be use with the embodiments described herein.

[0025] While the foregoing is directed to embodiments of the invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

Claims:

1. A valve assembly, comprising:
a tubular mandrel;
5 a sleeve member disposed within the tubular mandrel; and
a biasing member disposed within the tubular mandrel and operable to bias the sleeve member against a shoulder of the tubular mandrel, wherein the sleeve member is movable between a closed position where fluid communication is closed between a bore of the valve assembly and a port disposed through the tubular
10 mandrel and an open position where fluid communication is open between the bore of the valve assembly and the port disposed through the tubular mandrel.
2. The valve assembly of claim 1, further comprising a seal member for sealing the port from communication with the bore when the sleeve member is in the closed
15 position.
3. The valve assembly of claim 2, wherein the seal member is coupled to the sleeve member and is movable across the port to open fluid communication.
- 20 4. The valve assembly of claim 1, further comprising an internal piston area and an external piston area, wherein the biasing member contacts the internal piston area, and wherein the external piston area is in fluid communication with an annulus surrounding the valve assembly.
- 25 5. The valve assembly of claim 4, wherein the internal piston area is formed by an end of the sleeve member, and wherein the external piston area is formed by a shoulder of the sleeve member.
- 30 6. The valve assembly of claim 5, wherein the external piston area is in fluid communication with the annulus via a second port disposed through the tubular mandrel.
7. The valve assembly of claim 6, further comprising a seal member for sealing communication between the second port and the bore.

8. A method of controlling fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular, comprising:

providing a valve assembly for coupling to the wellbore tubular, wherein the valve assembly includes a tubular mandrel, a sleeve member movably disposed in the tubular mandrel, and a biasing member for biasing the sleeve member into a closed position; and

moving the sleeve member to an open position to open fluid communication between the exterior of the wellbore tubular and the interior of the wellbore in response to a pressure differential exceeding a first predetermined value.

9. The method of claim 8, further comprising moving the sleeve member to the closed position using the biasing member to close fluid communication between the exterior of the wellbore tubular and the interior of the wellbore tubular.

10. The method of claim 9, further comprising controlling fluid flow through a port in the tubular mandrel using the sleeve member.

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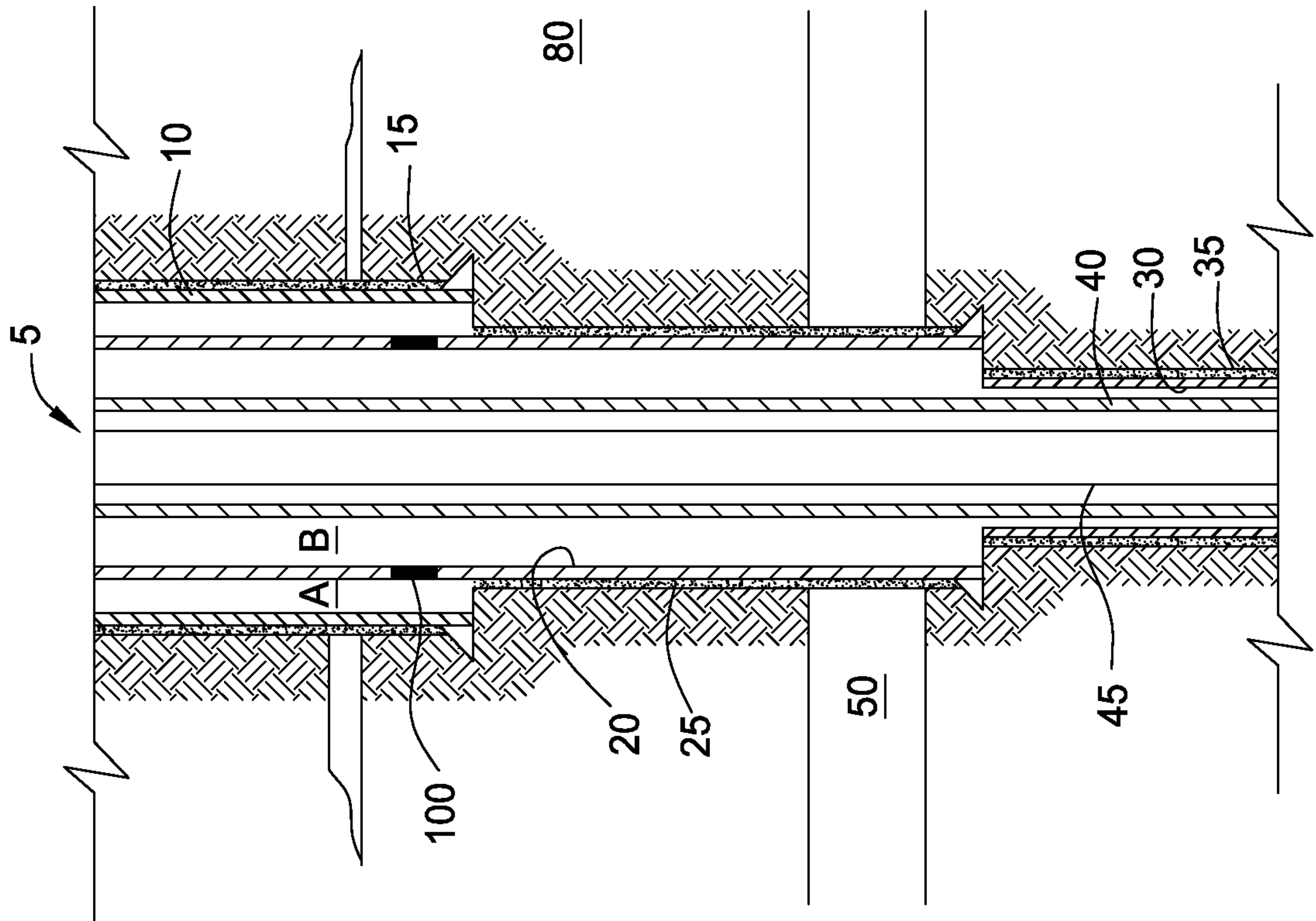


FIG. 1

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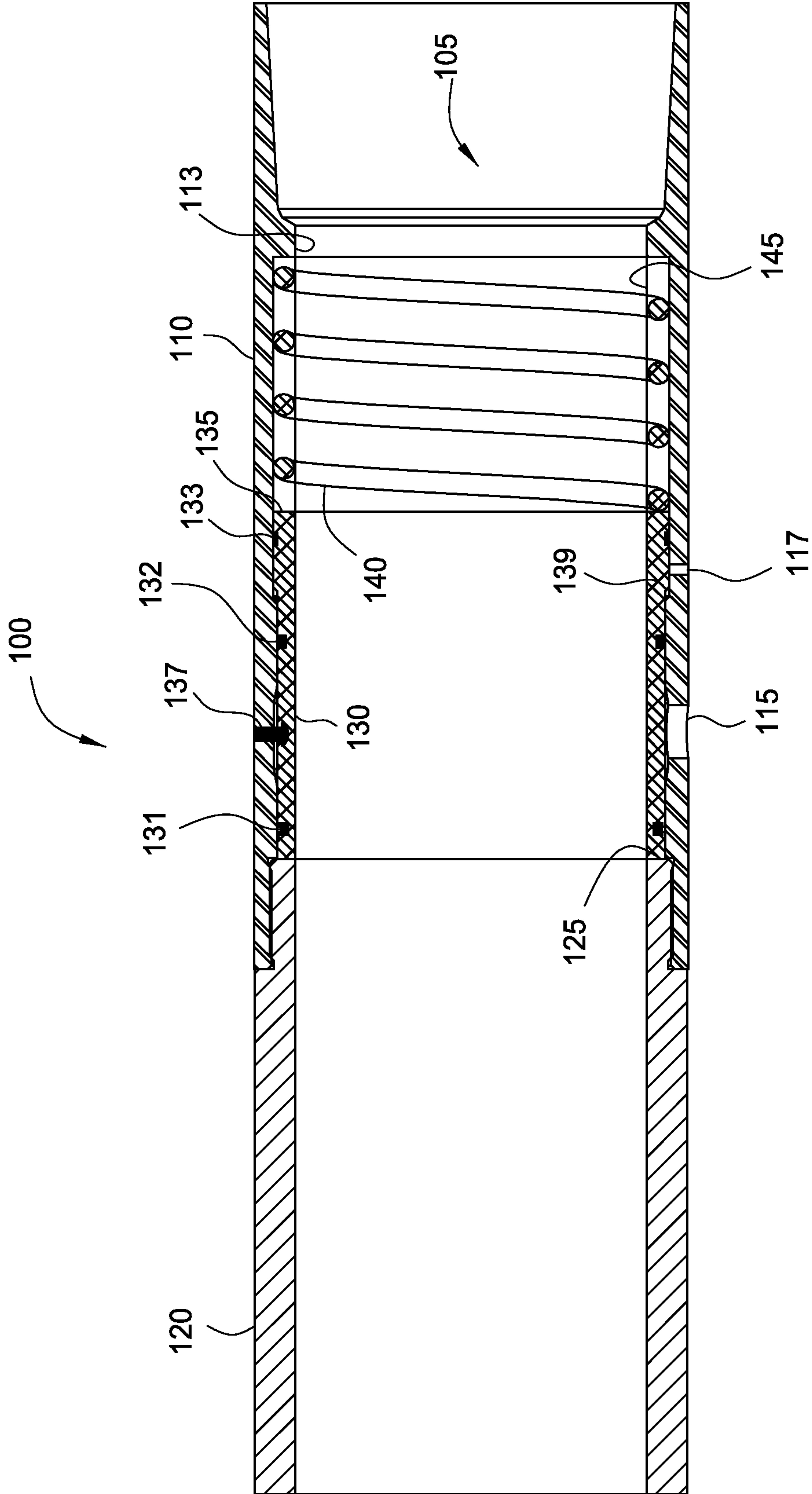


FIG. 2

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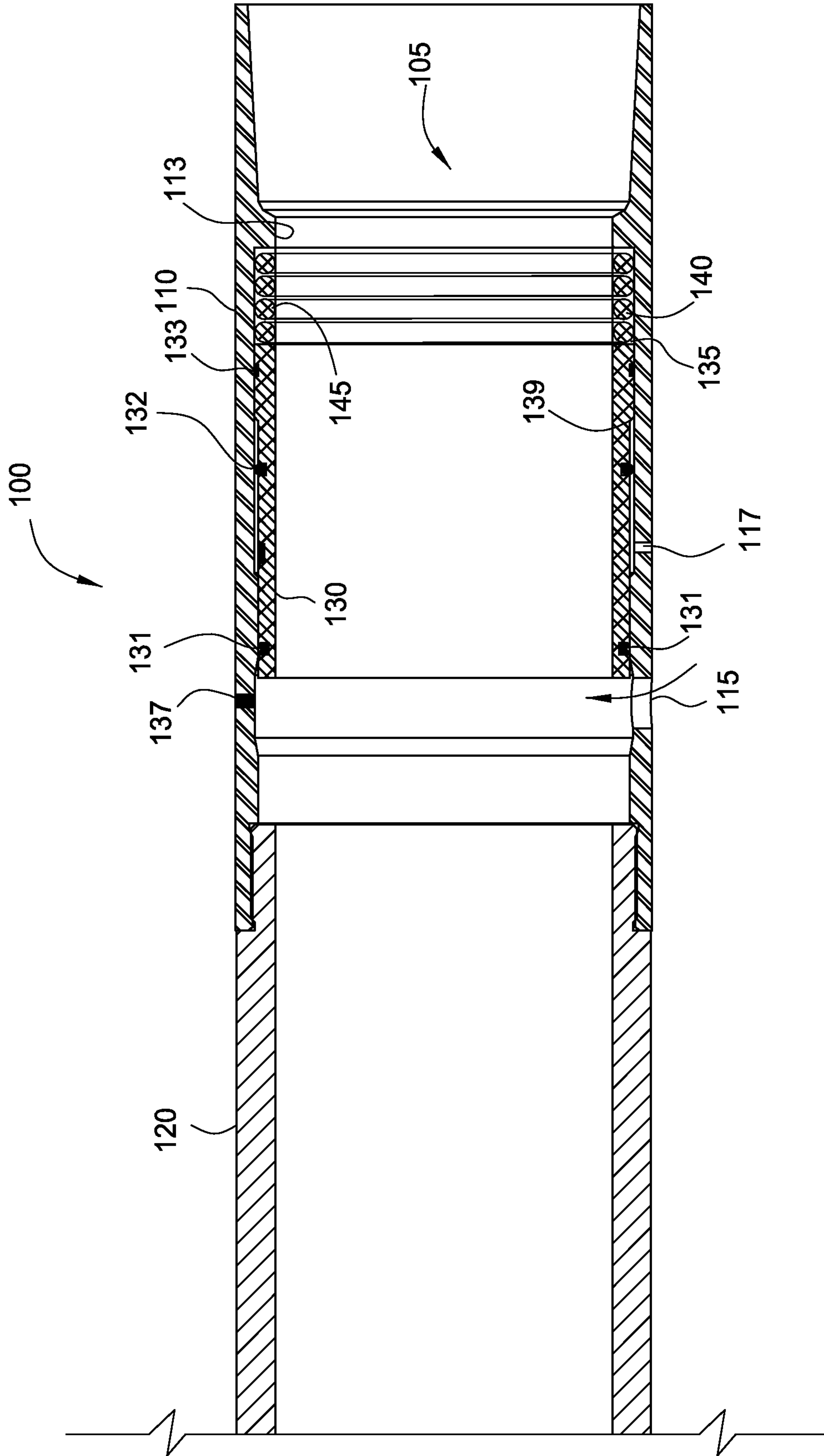


FIG. 3

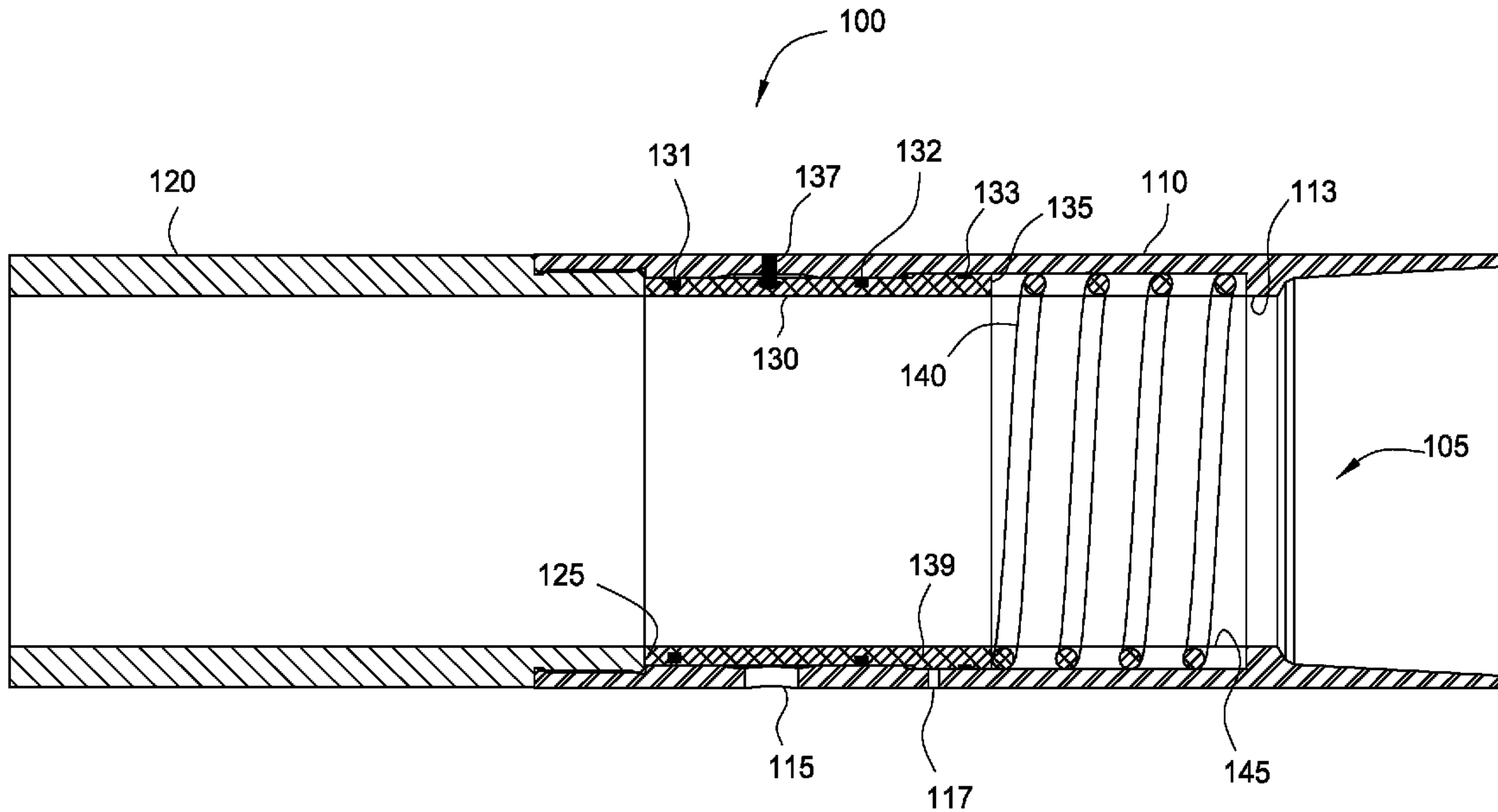


FIG. 2