US 20100032167A1

(19) **United States**

(12) **Patent Application Publication**

Adam et al.

(10) **Pub. No.: US 2010/0032167 A1**

(43) **Pub. Date: Feb. 11, 2010**

(54) **METHOD FOR MAKING WELLBORE THAT MAINTAINS A MINIMUM DRIFT**

(76) Inventors: **Mark K. Adam**, Houston, TX (US); **Dennis G. Jiral**, Katy, TX (US); **Lance M. Rayne**, Spring, TX (US); **Michael E. McMahan**, Humble, TX (US)

Correspondence Address:
DUANE MORRIS LLP - Houston
3200 SOUTHWEST FREEWAY, SUITE 3150
HOUSTON, TX 77027 (US)

(21) Appl. No.: **12/511,804**

(22) Filed: **Jul. 29, 2009**

Related U.S. Application Data

(60) Provisional application No. 61/087,269, filed on Aug. 8, 2008.

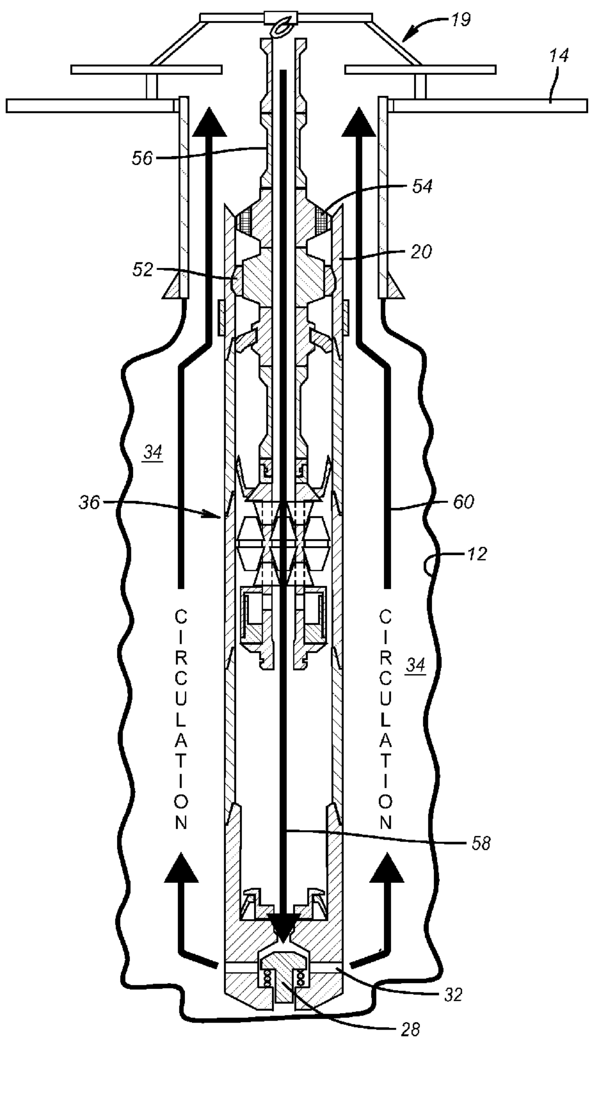
Publication Classification

(51) **Int. Cl.**
E21B 23/00 (2006.01)

(52) **U.S. Cl.** **166/382**

(57) **ABSTRACT**

A well having a minimum drift between or among strings is provided using strings that have a recessed segment and a hanging segment. The length of the recessed segment in the lower end of the upper string is substantially longer than the hanging segment of the lower string that is passed through it. The hanging segments define the drift dimension. In the event the lower string gets stuck in the open hole before it is fully advanced, the hanging segment of the lower string may still be in the recess of the upper string so that the drift dimension can be preserved. Preferably the recess segment is the substantial length of the tubular string apart from its hanging segment near its top end. One or more laterals can be extended through the recessed segments while retaining the drift dimension.



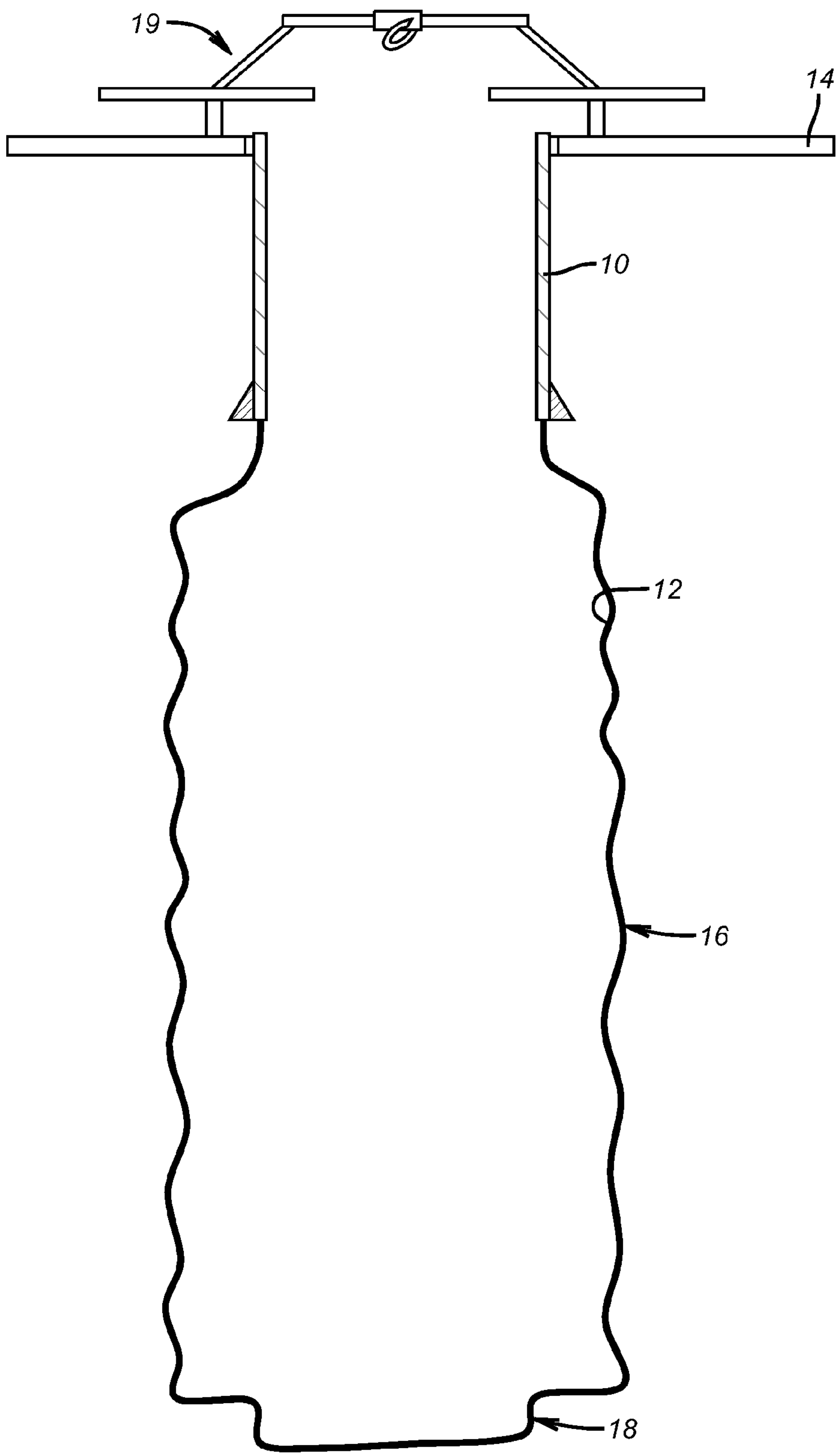


FIG. 1

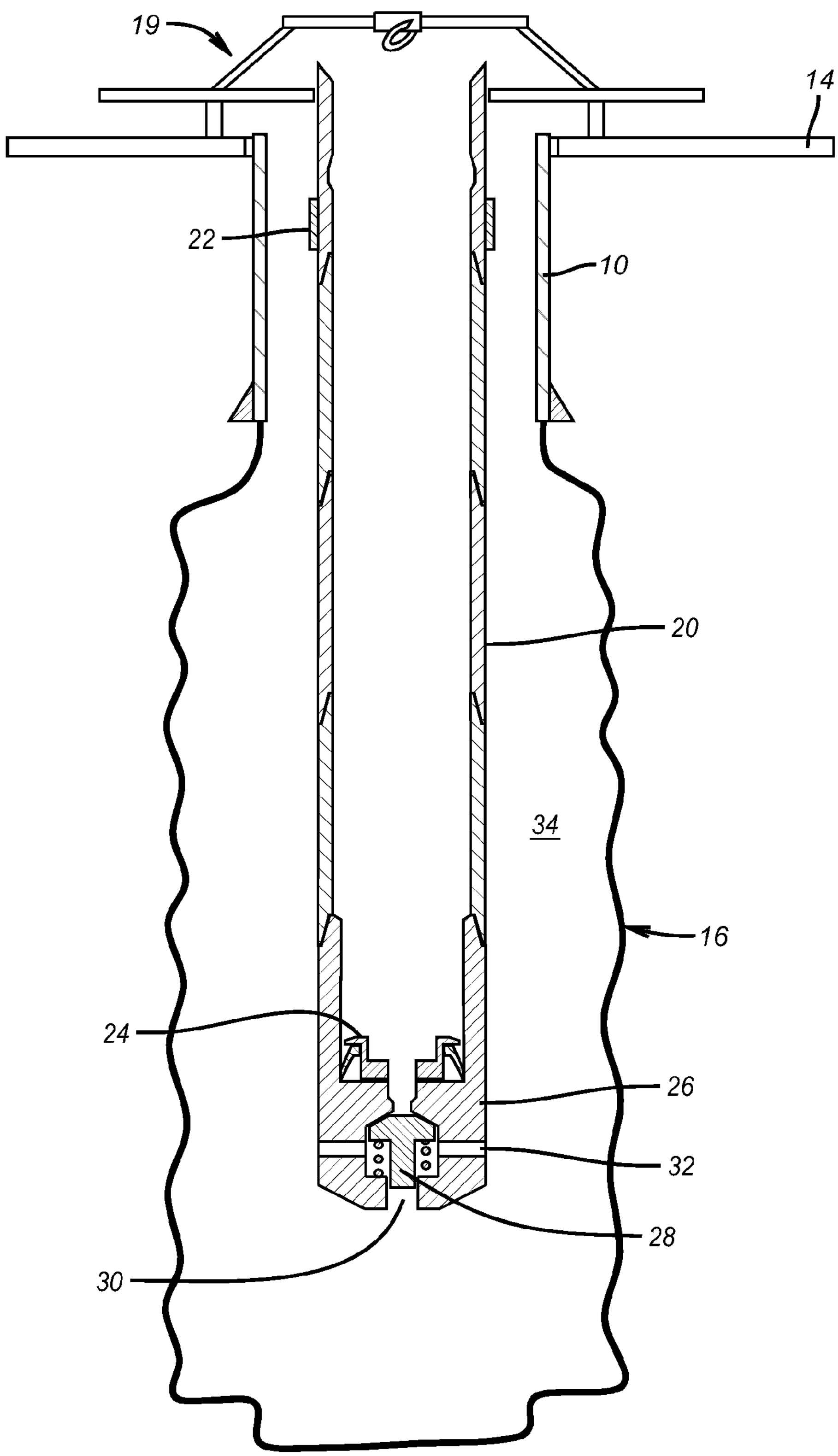


FIG. 2

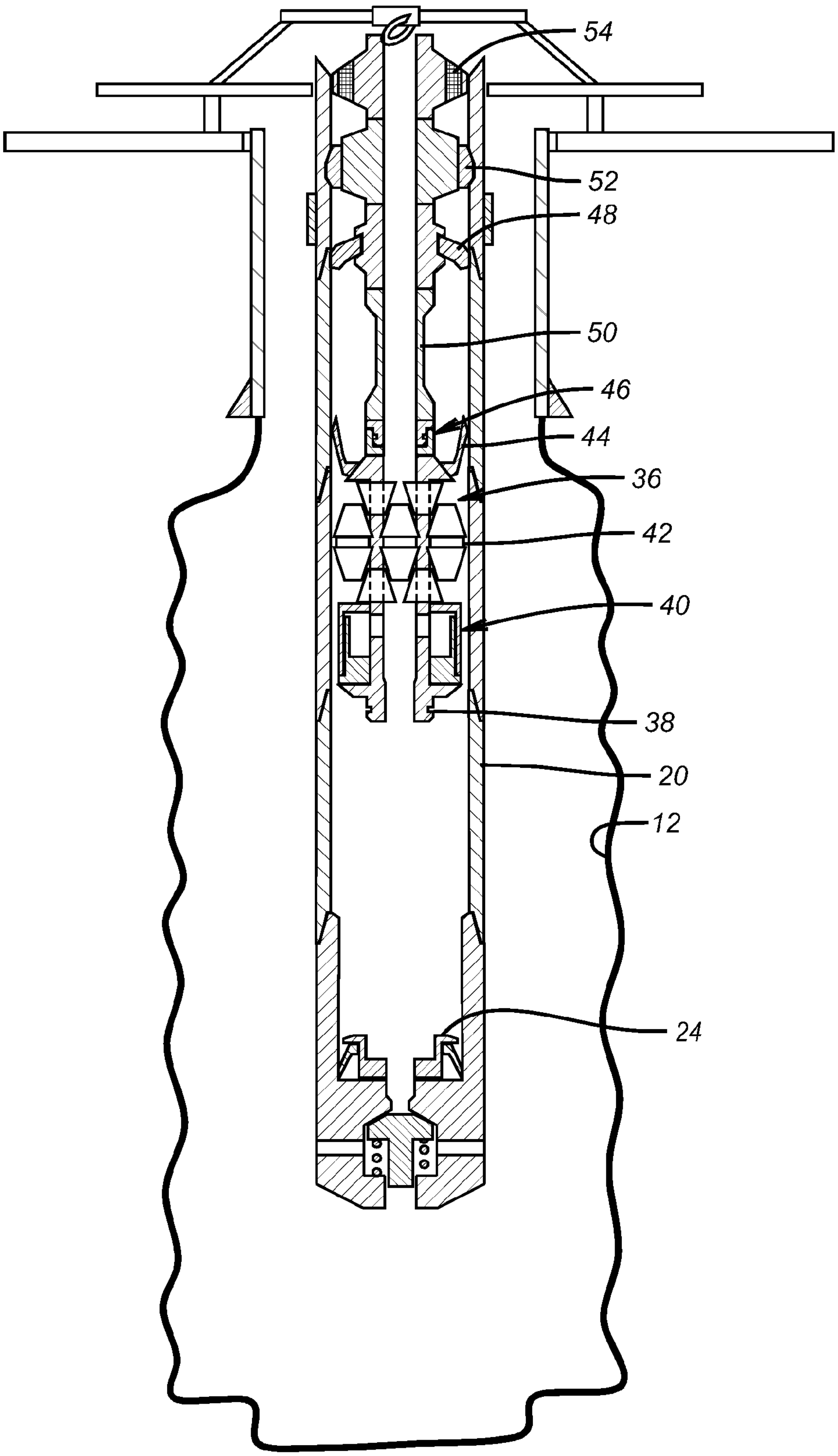


FIG. 3

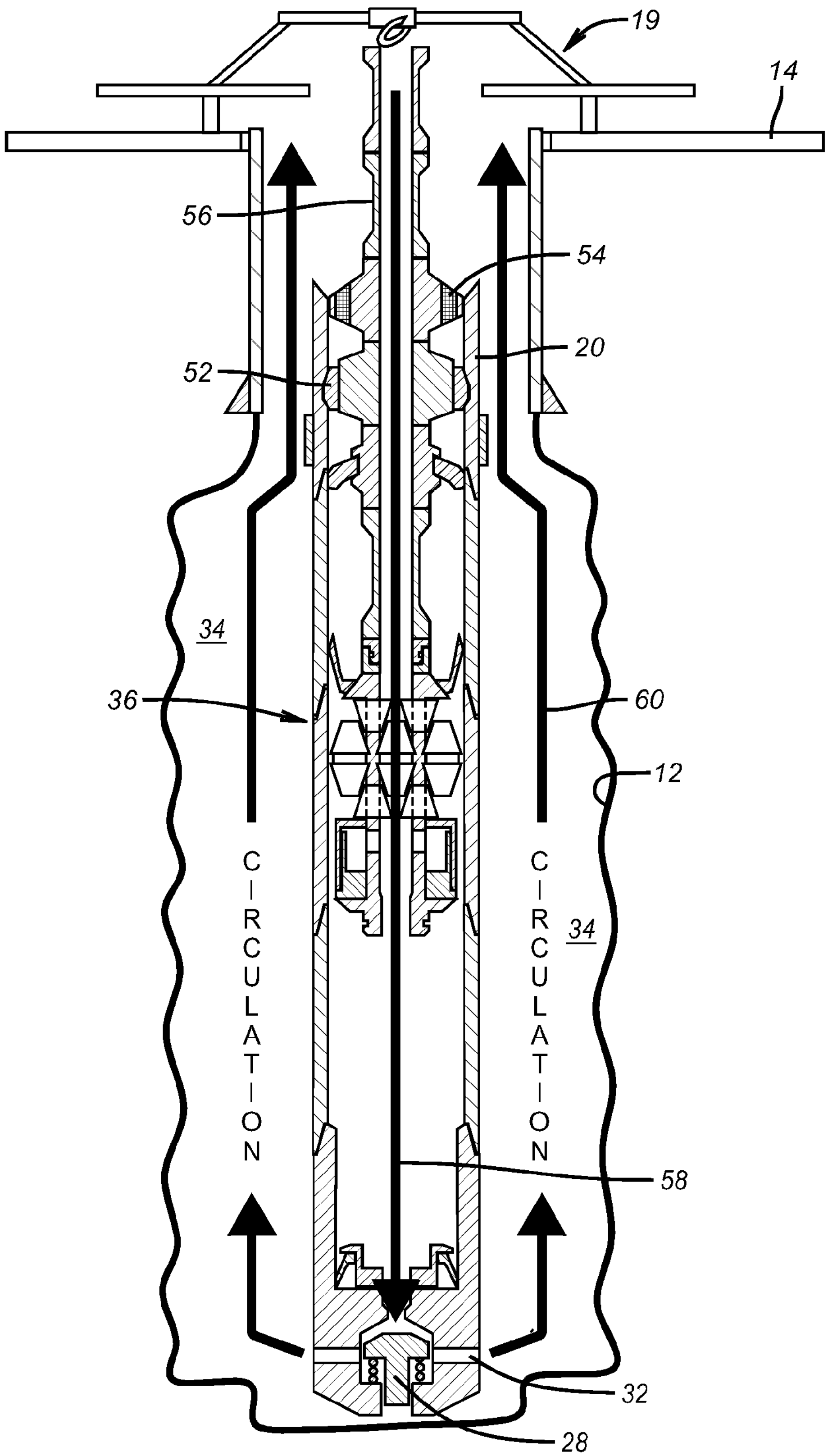

19
14
56
54
20
52
34
36
60
12
CIRCULATION
CIRCULATION
34
58
32
28

FIG. 4

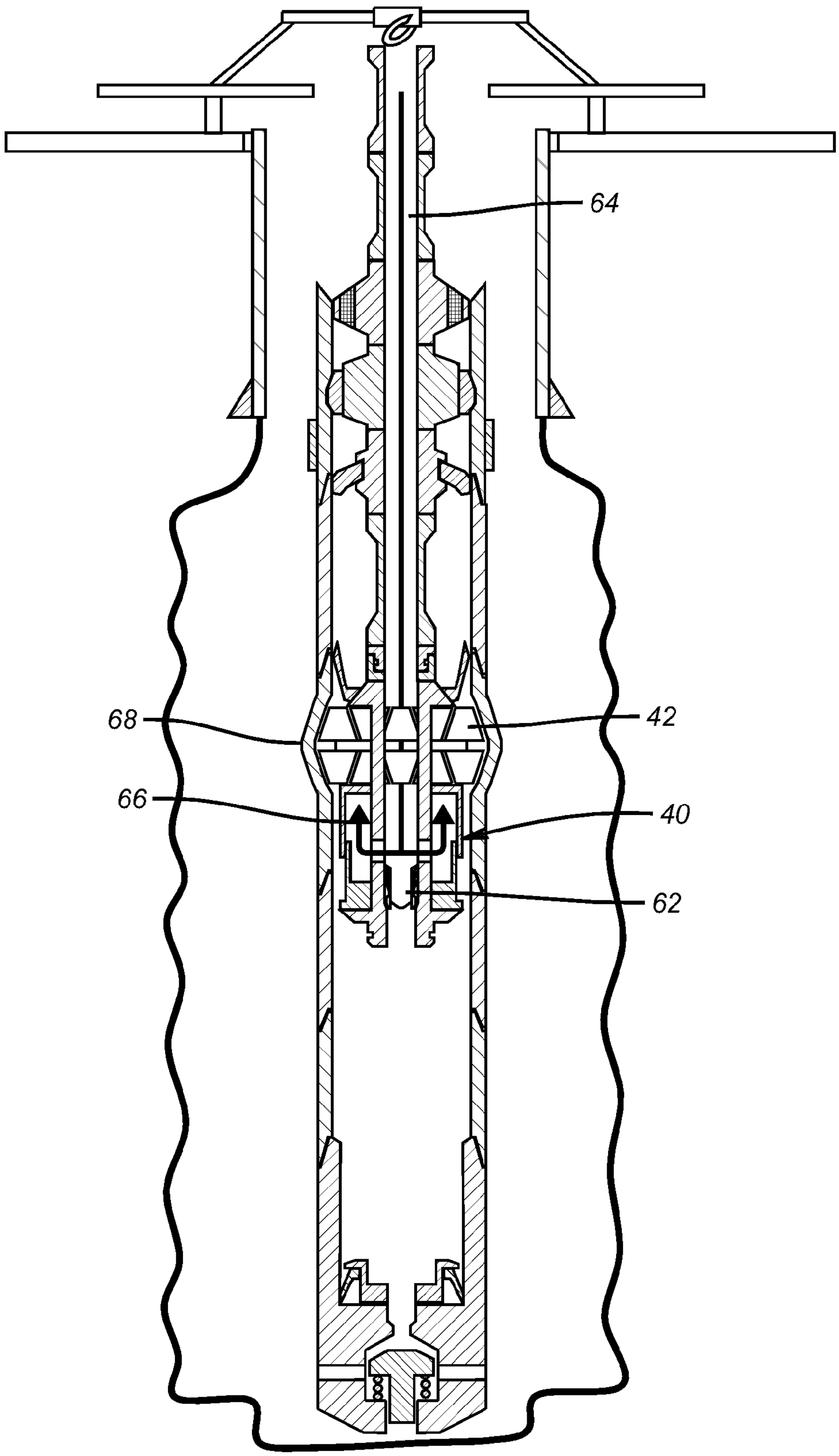


FIG. 5

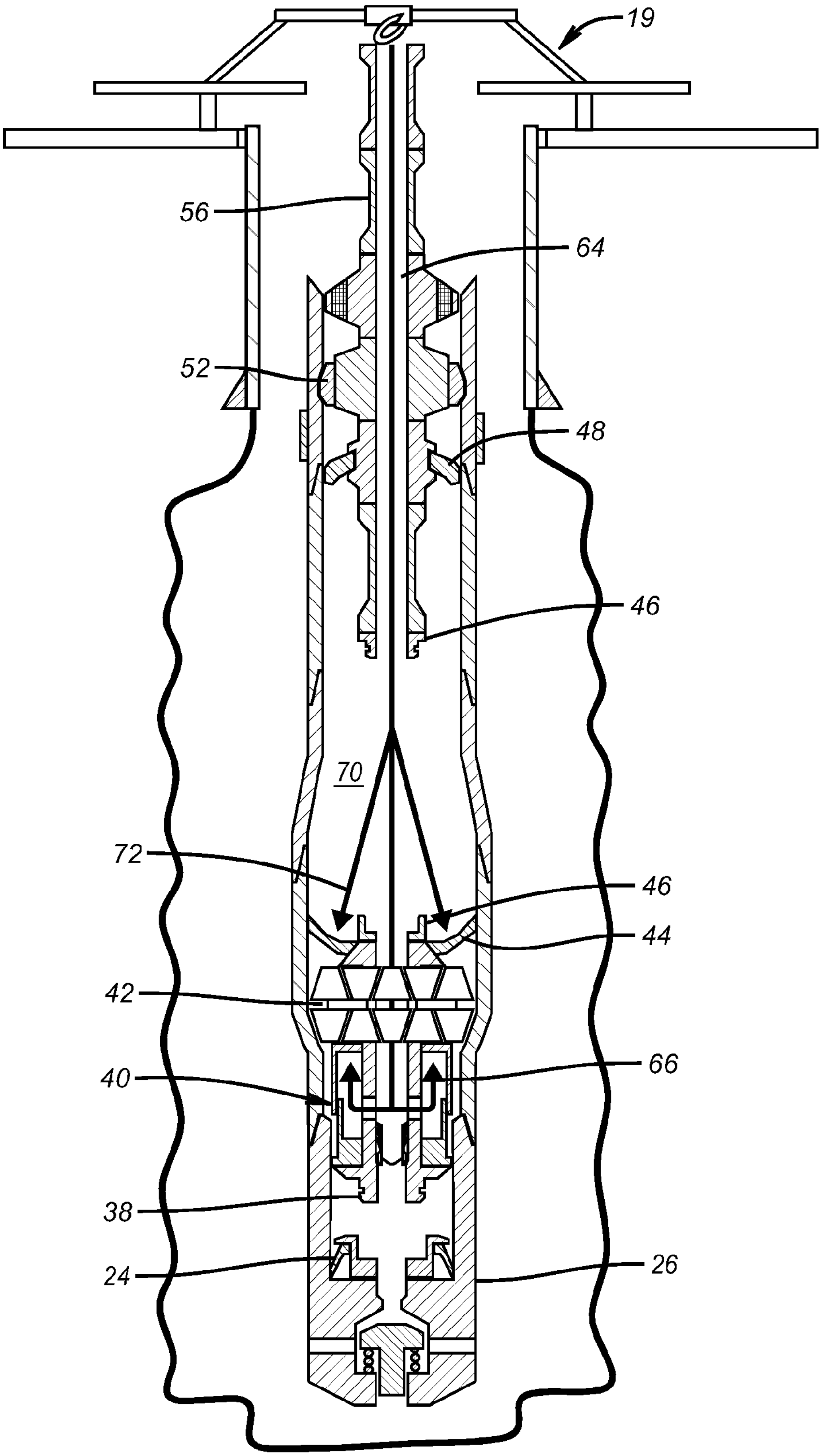


FIG. 6

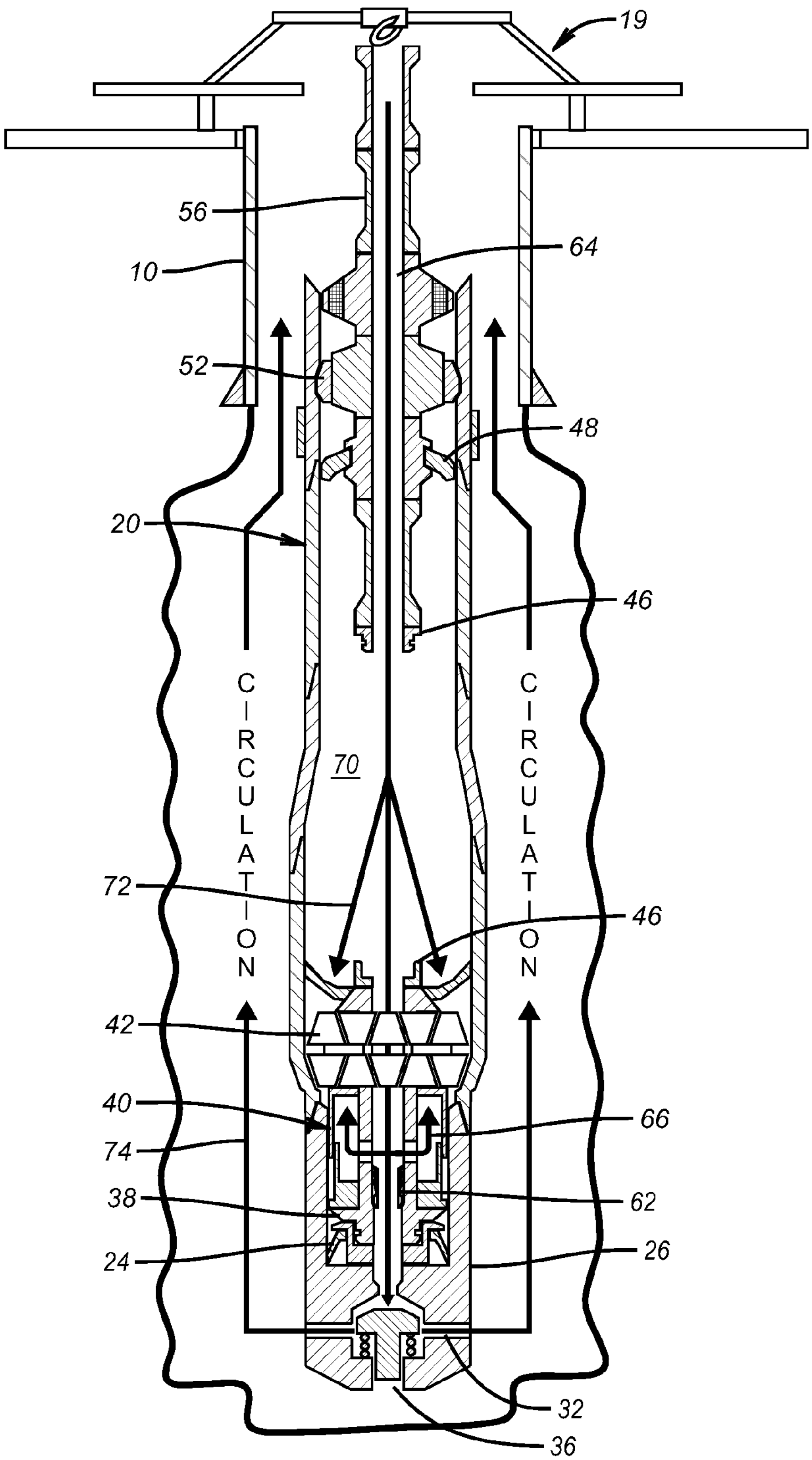

19
56
64
10
52
48
20
46
C I R C U L A T I O N
C I R C U L A T I O N
70
72
46
42
40
66
74
38
62
24
26
32
36

FIG. 7

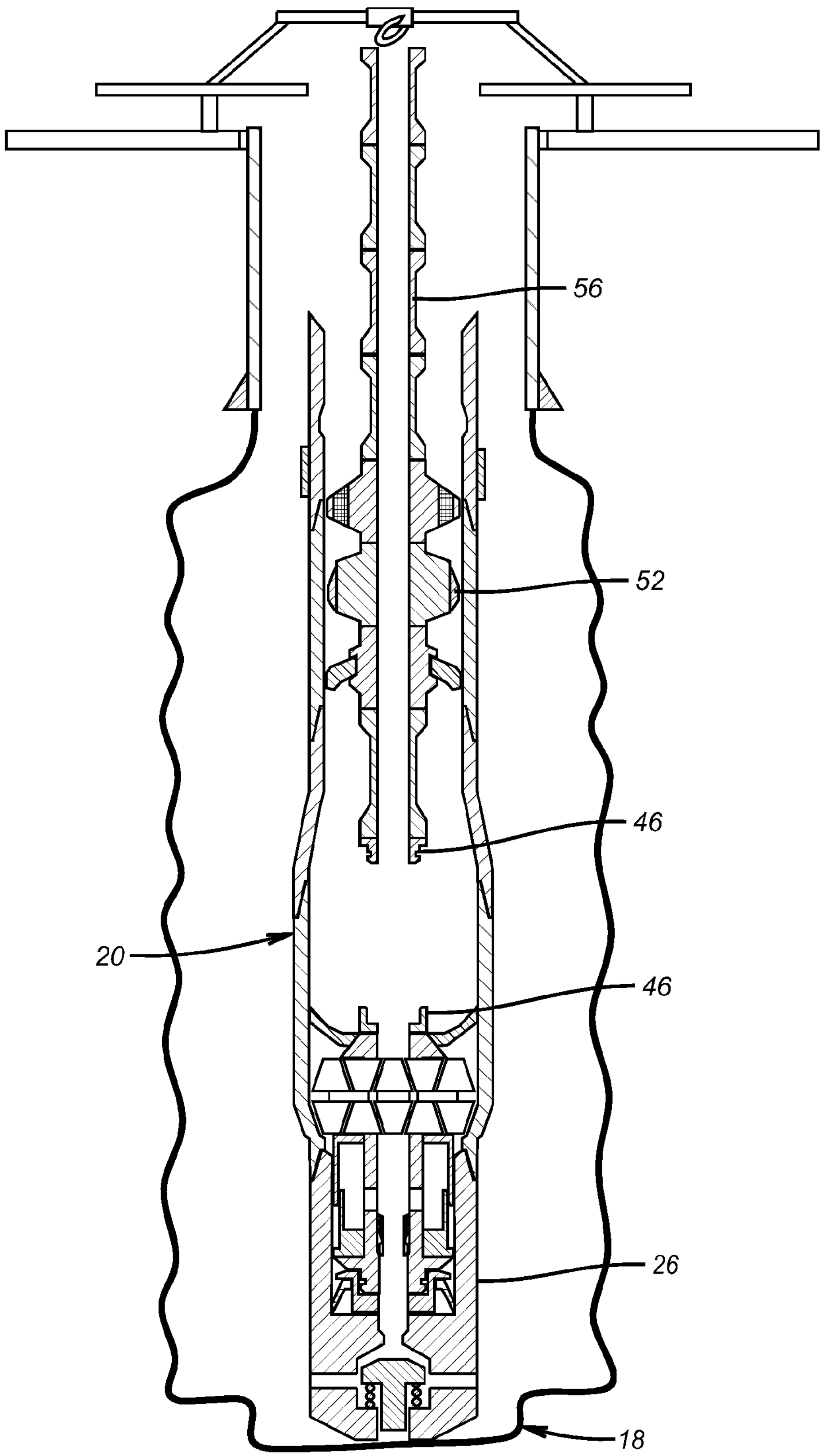


FIG. 8

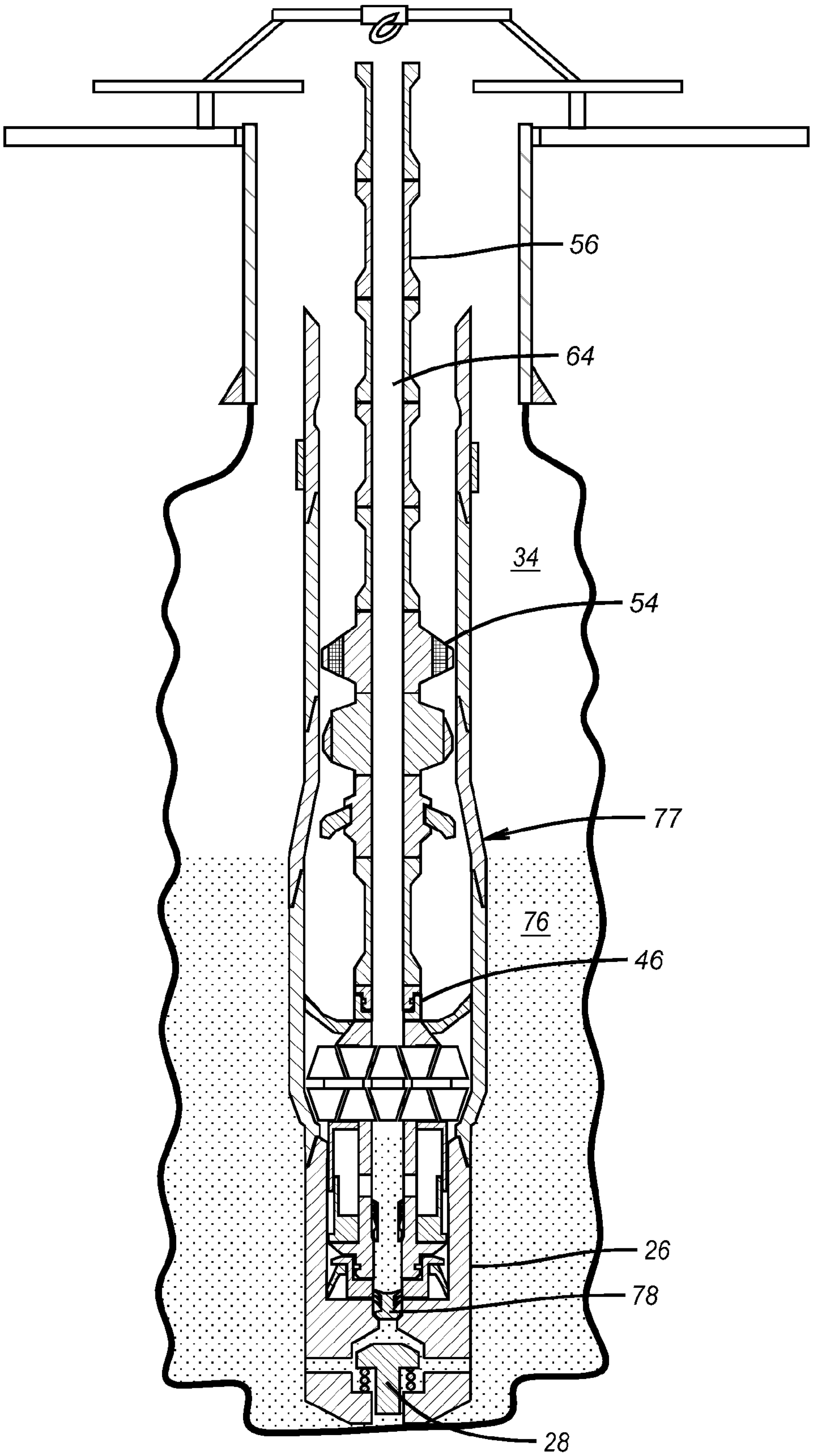


FIG. 9

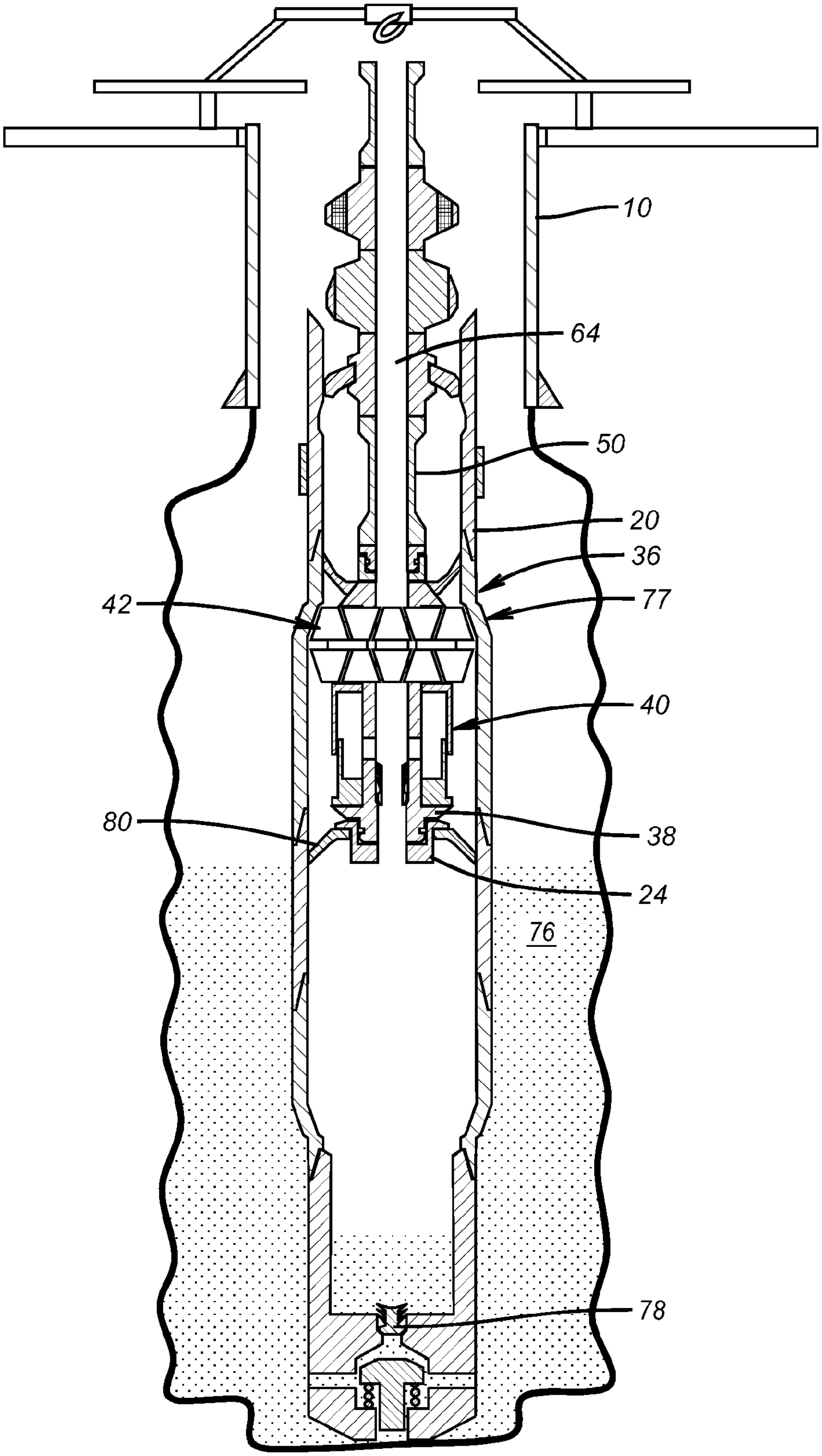


FIG. 10

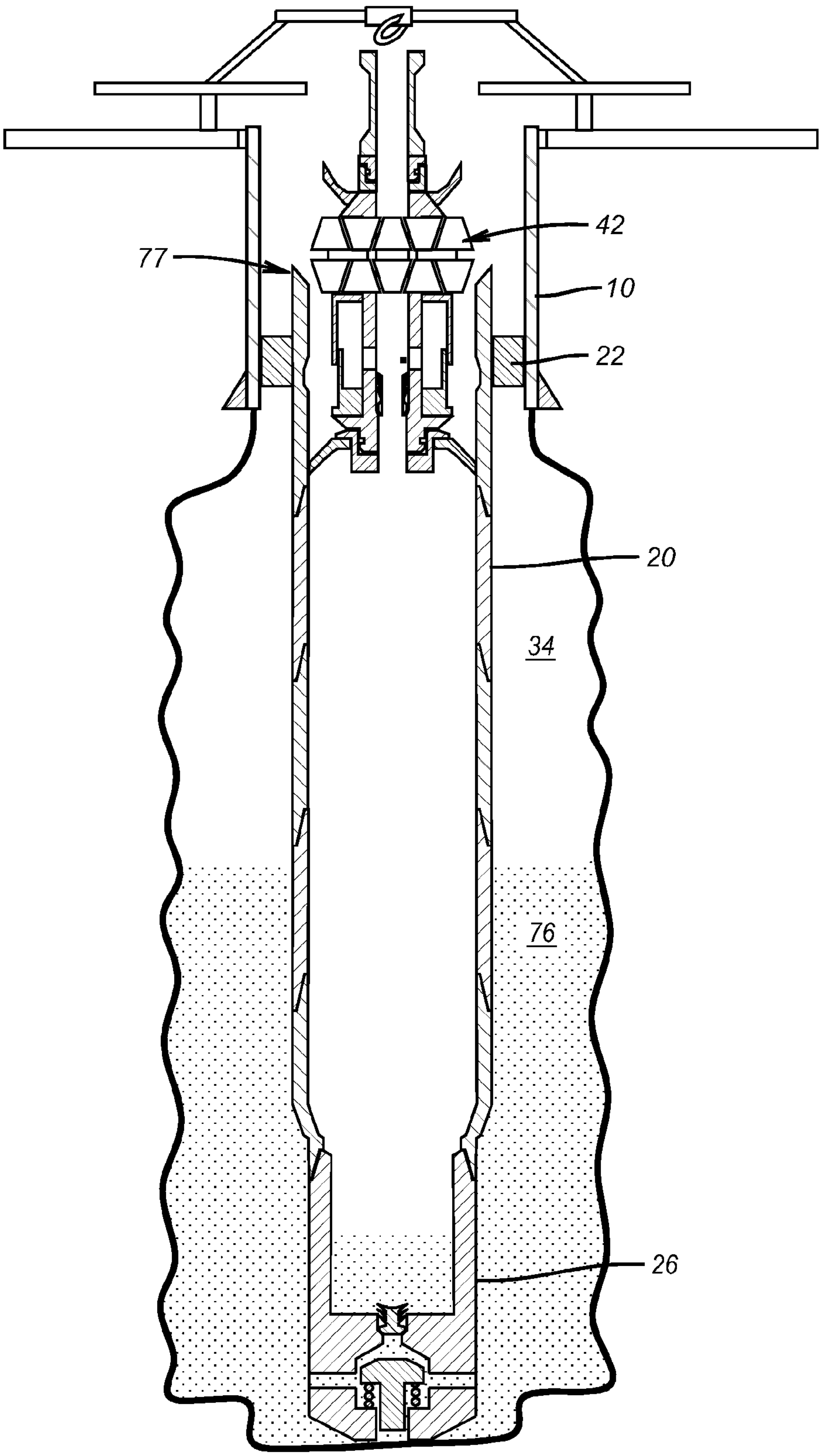


FIG. 11

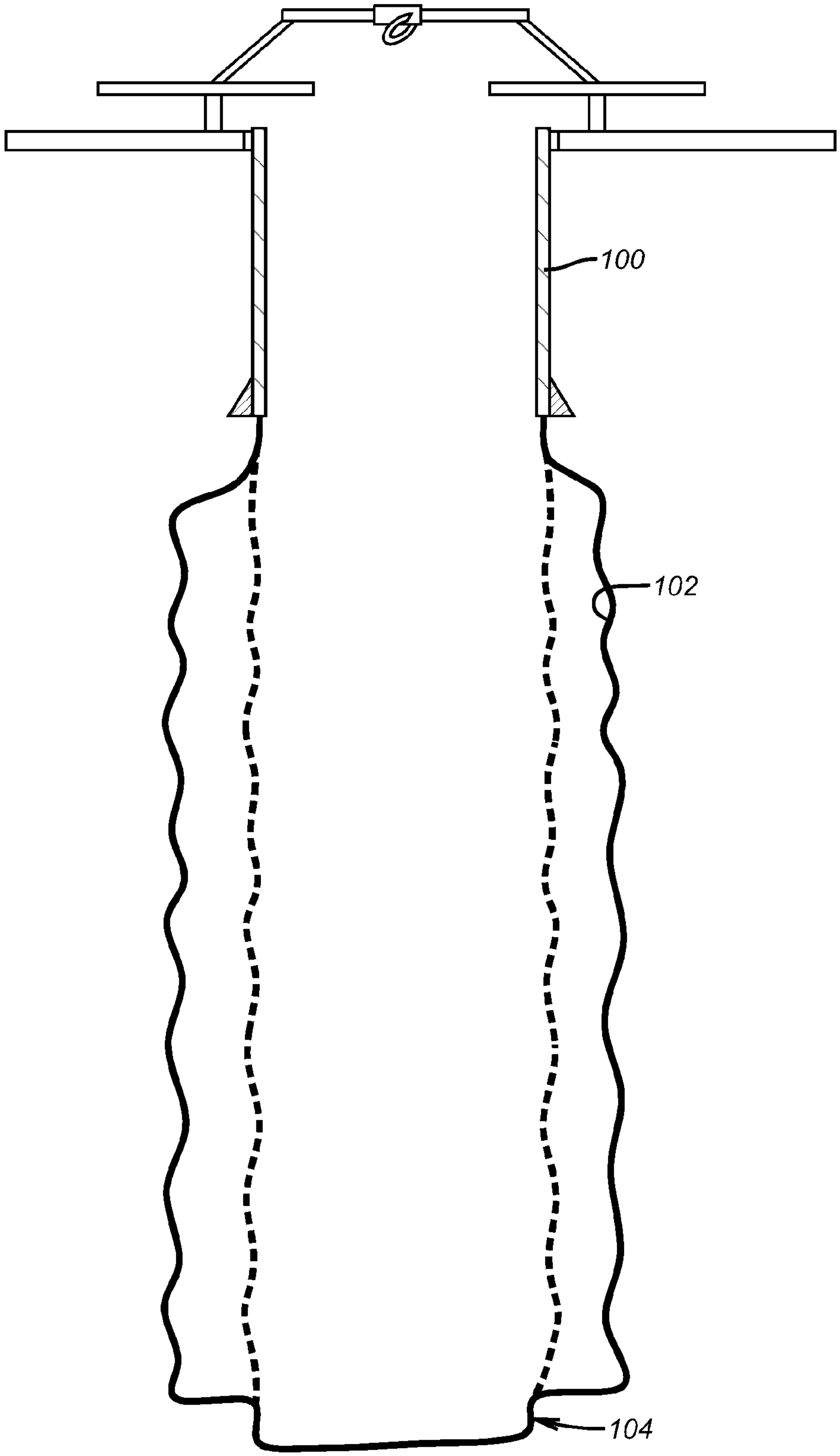


FIG. 12

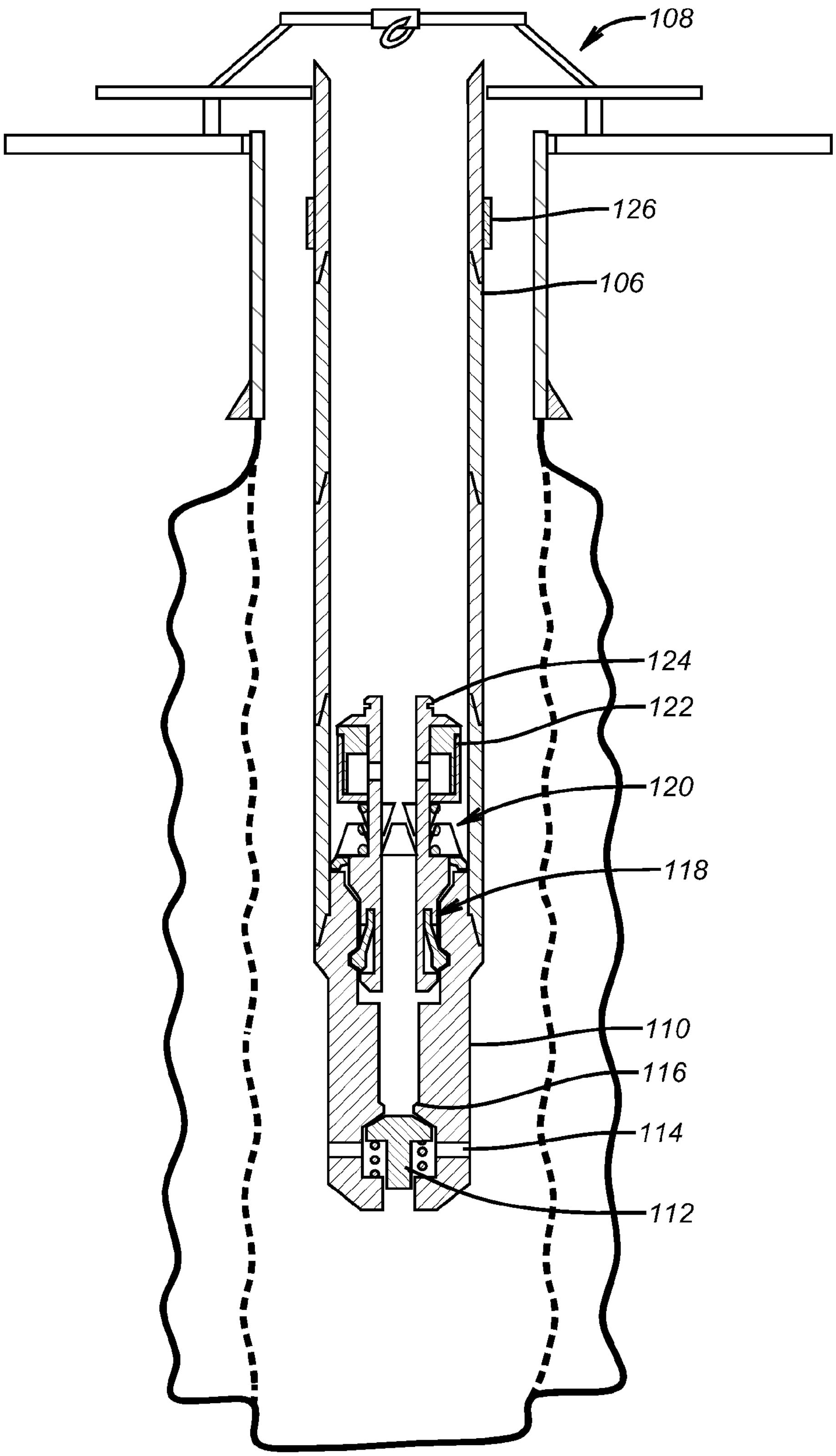


FIG. 13

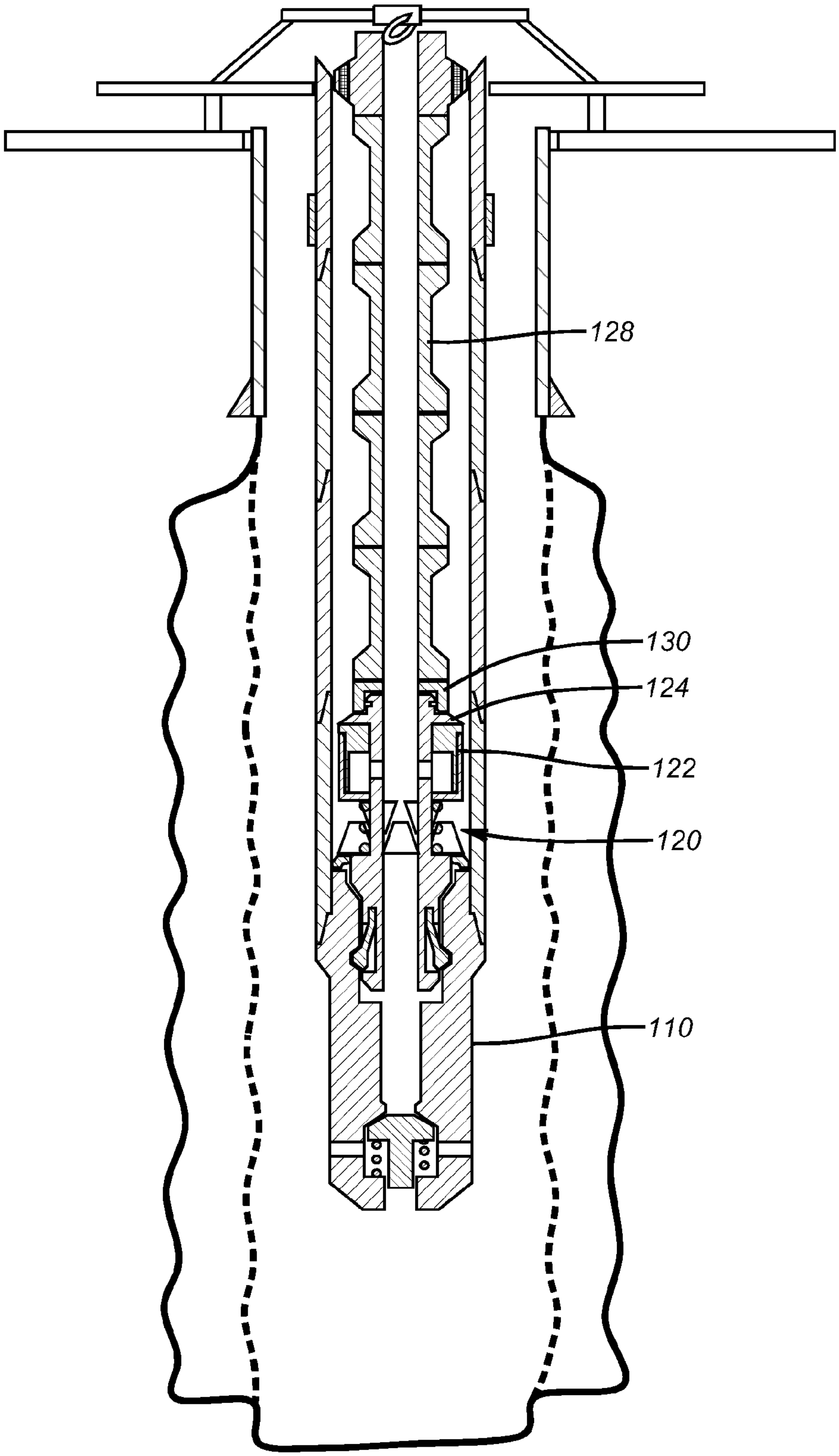


FIG. 14

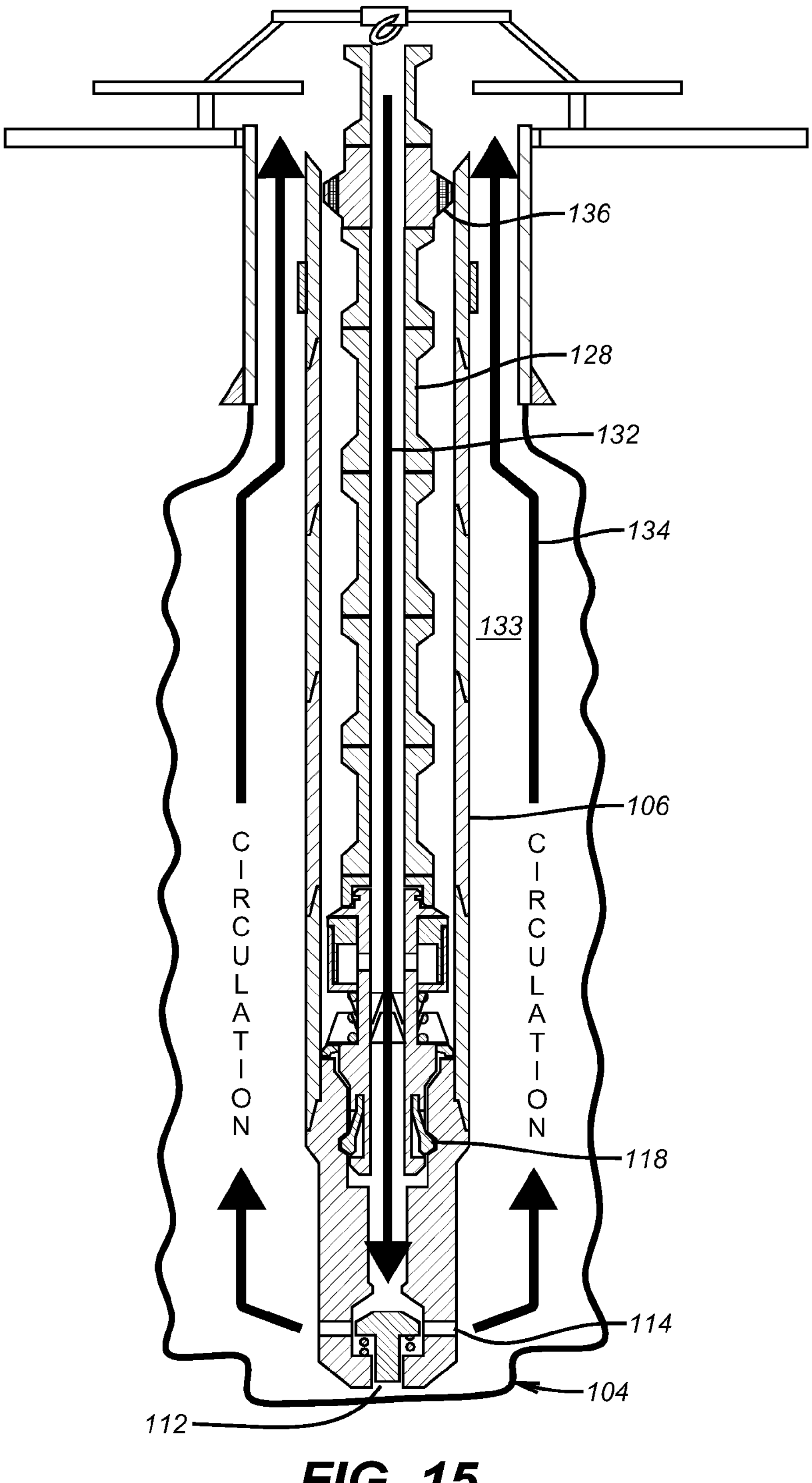

136
128
132
134
133
106
CIRCULATION
CIRCULATION
118
114
104
112

FIG. 15

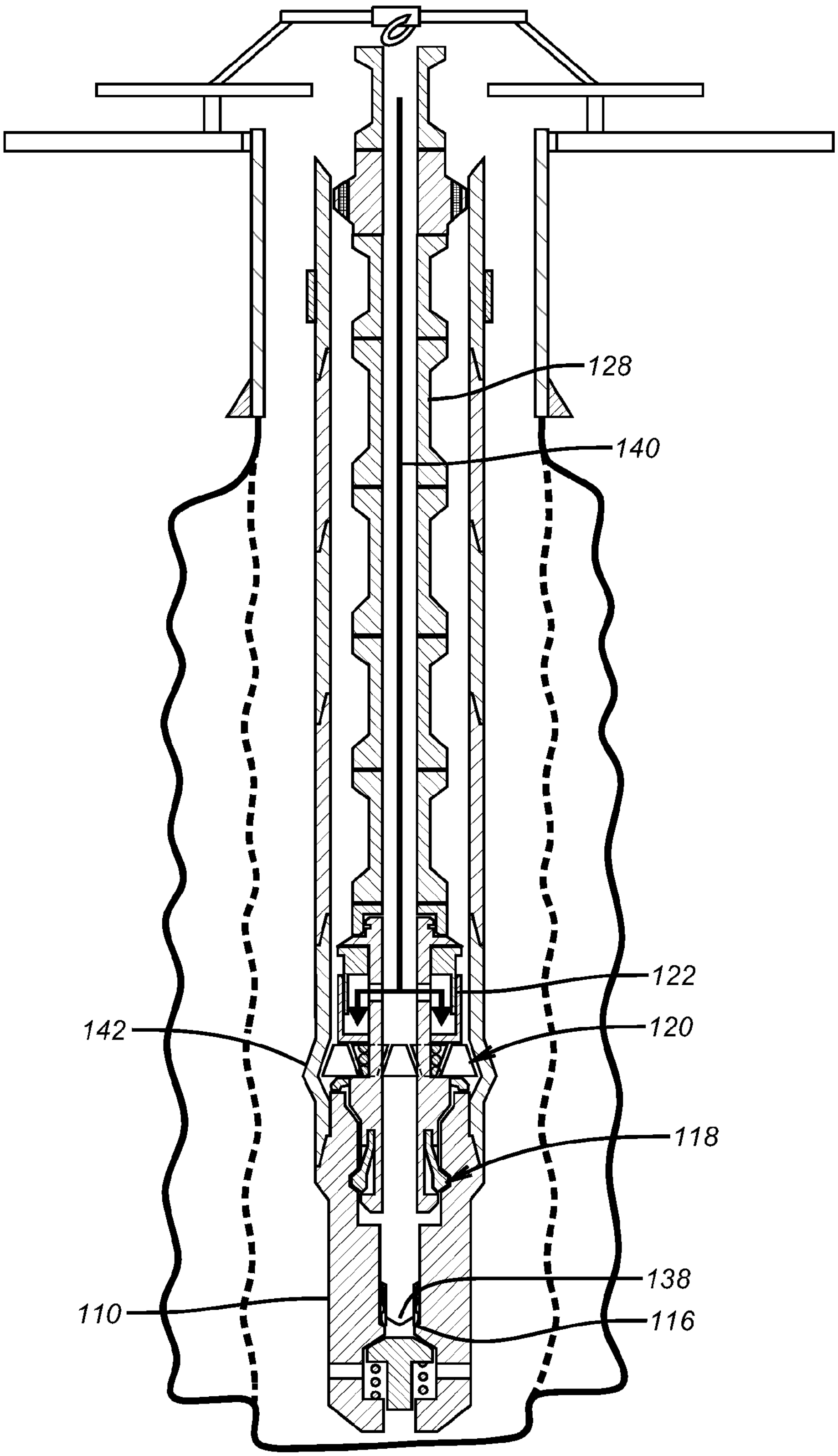


FIG. 16

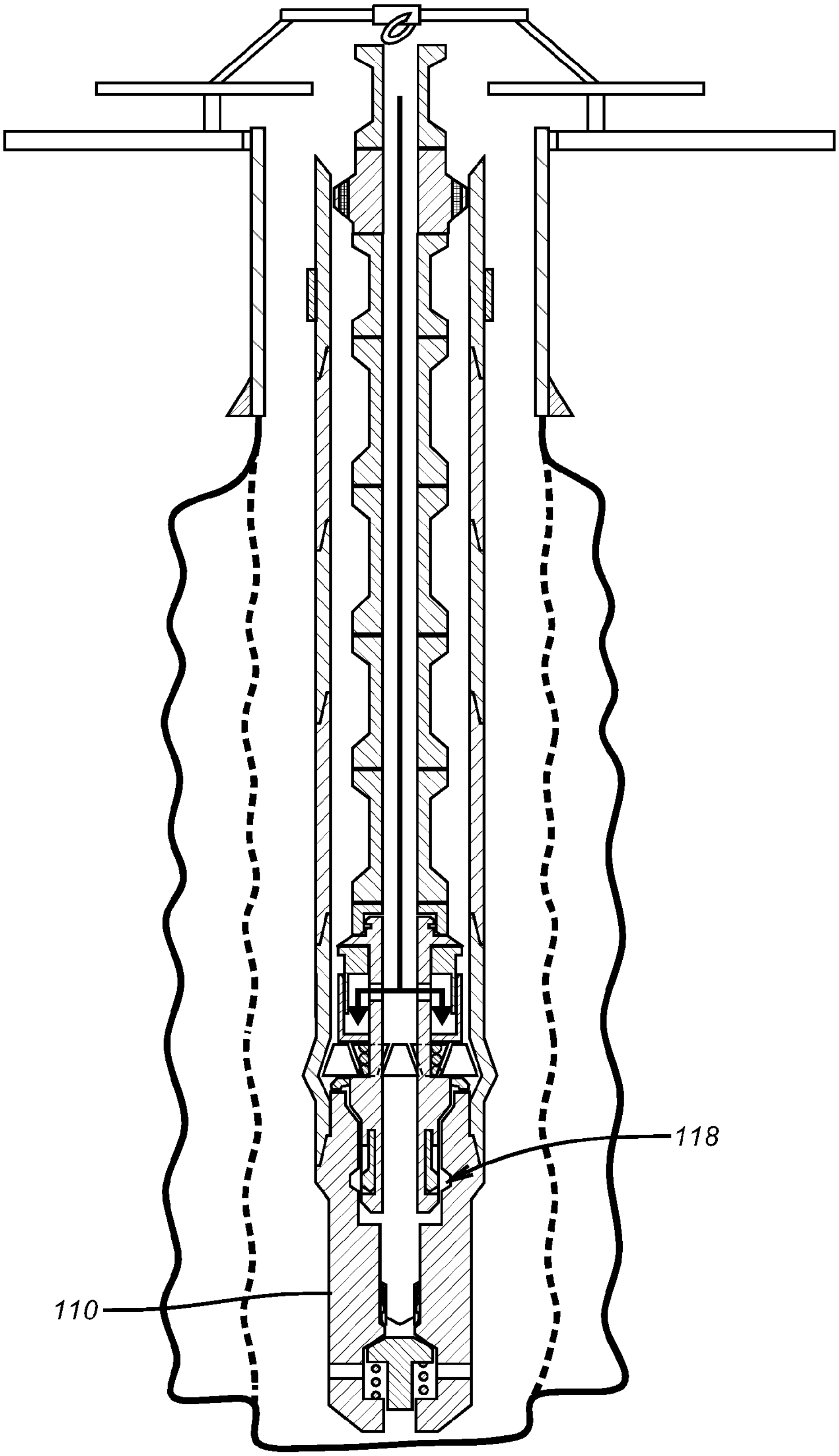


FIG. 17

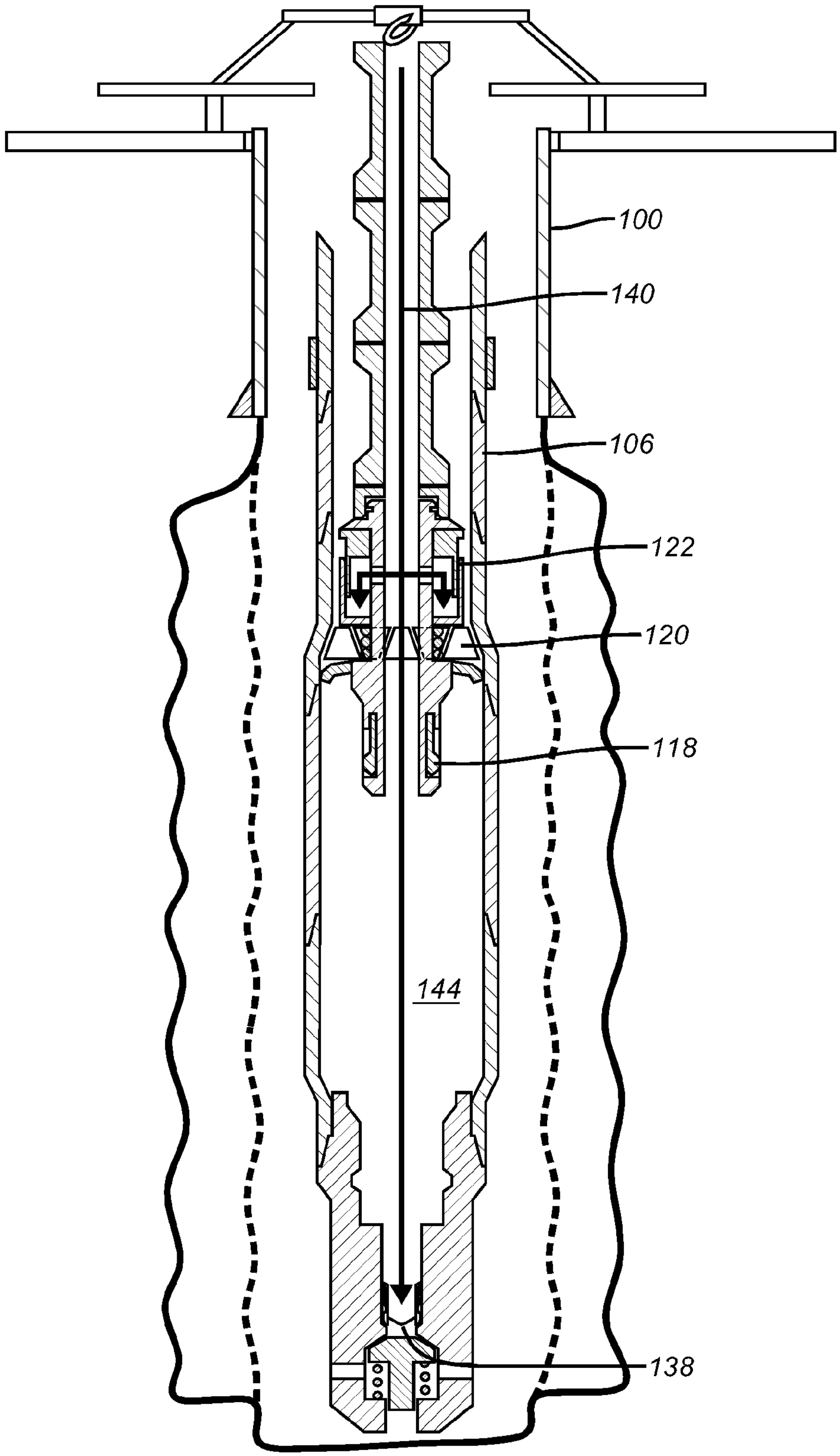


FIG. 18

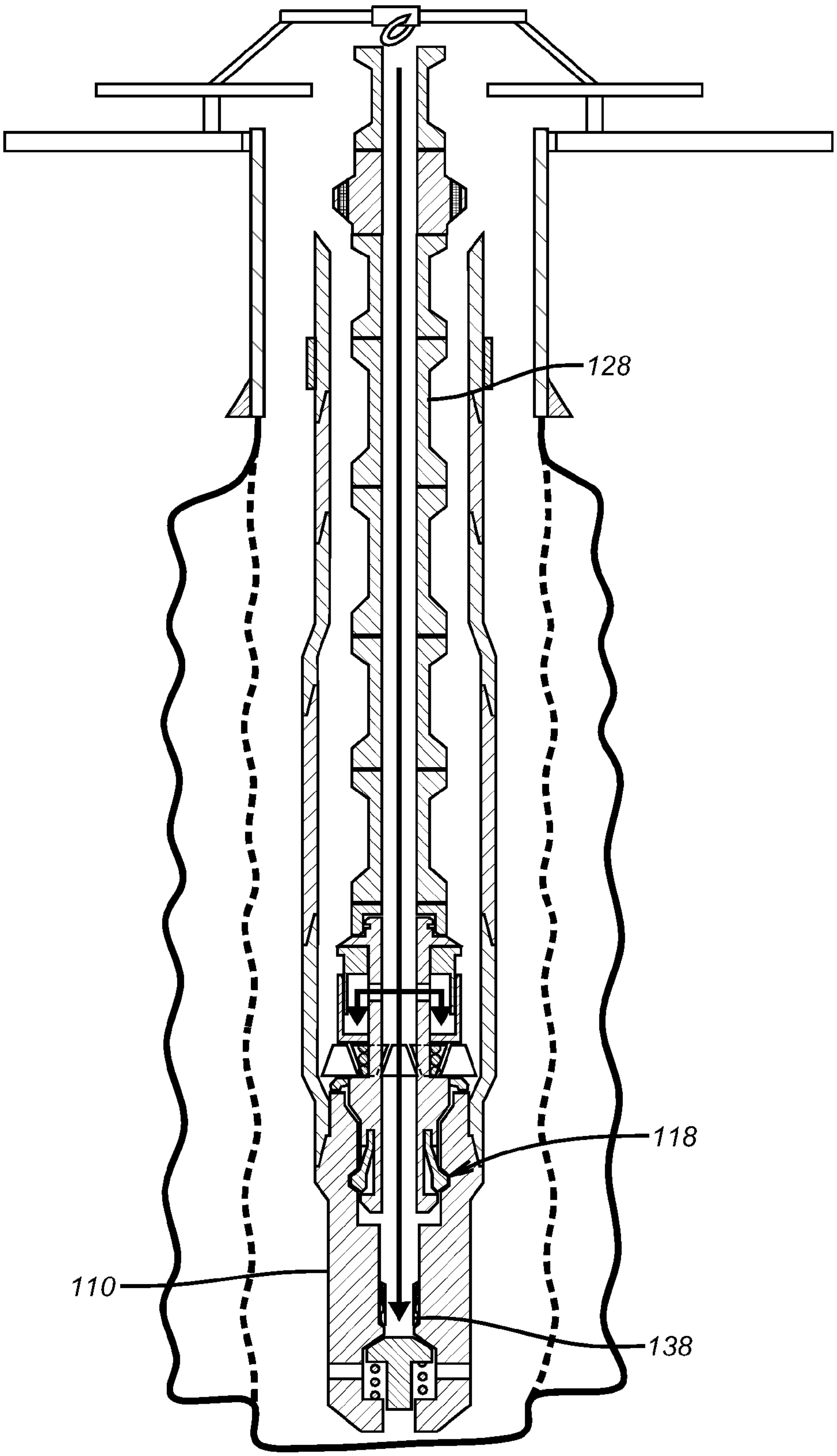


FIG. 19

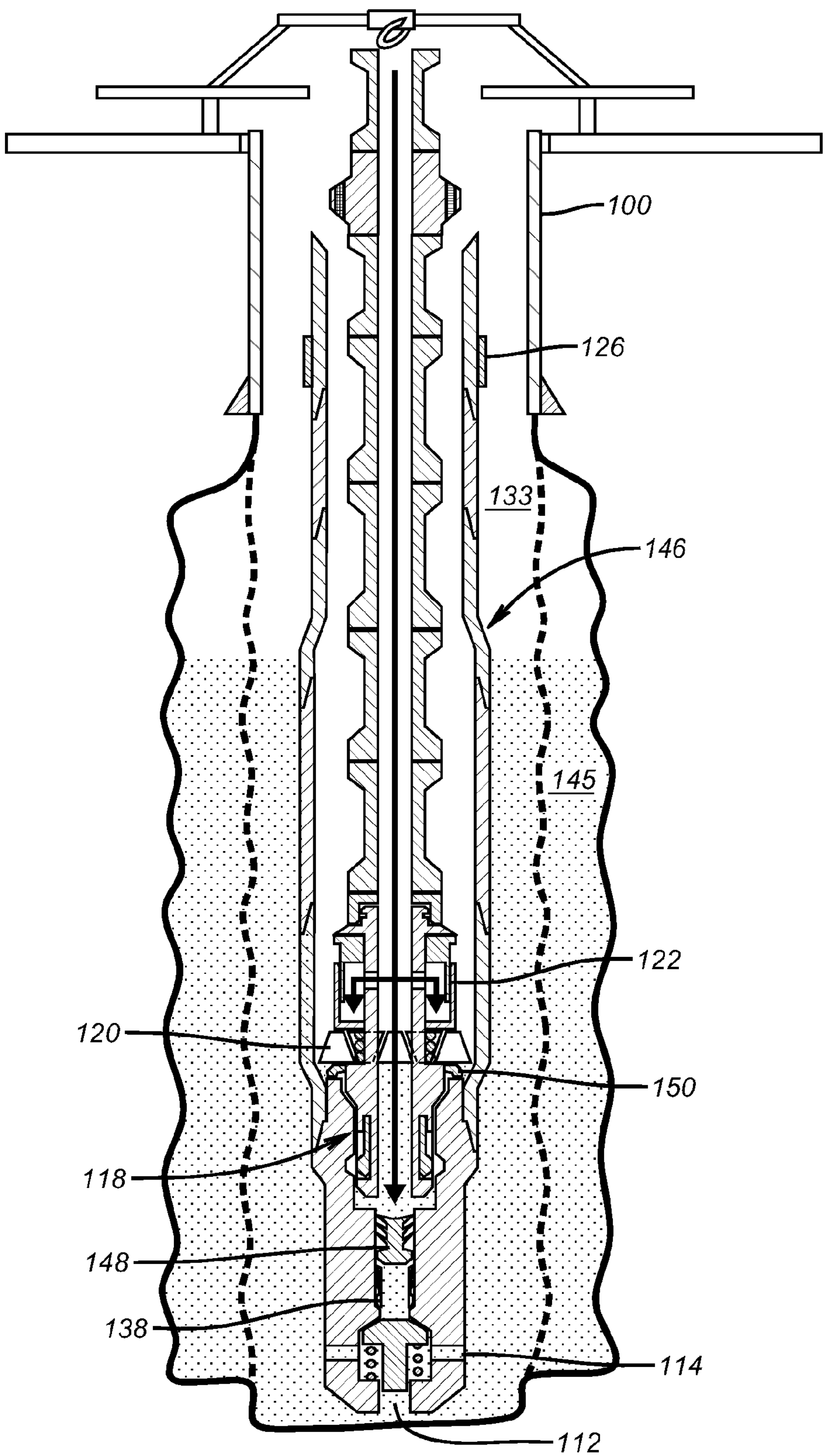


FIG. 20

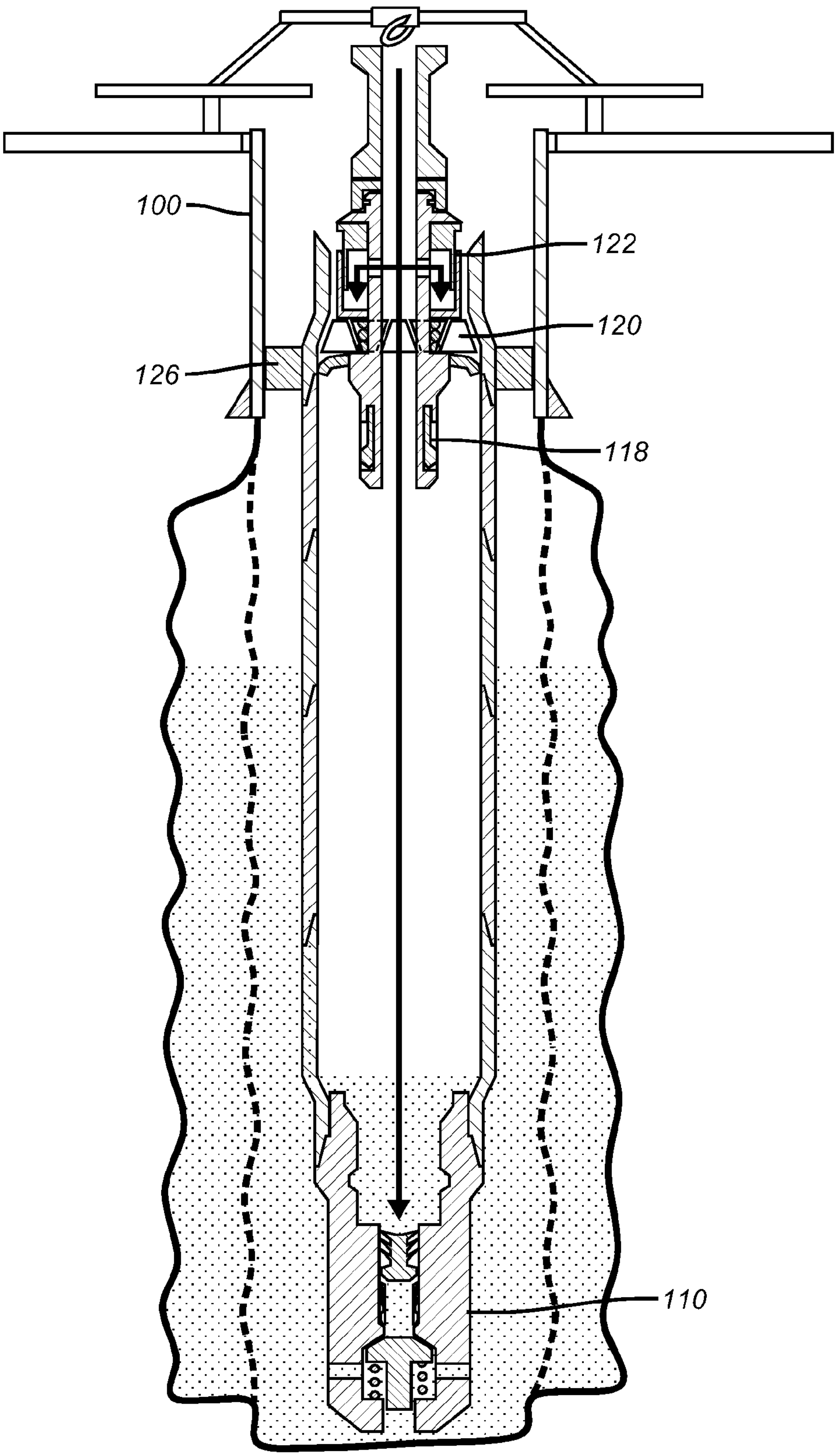


FIG. 21

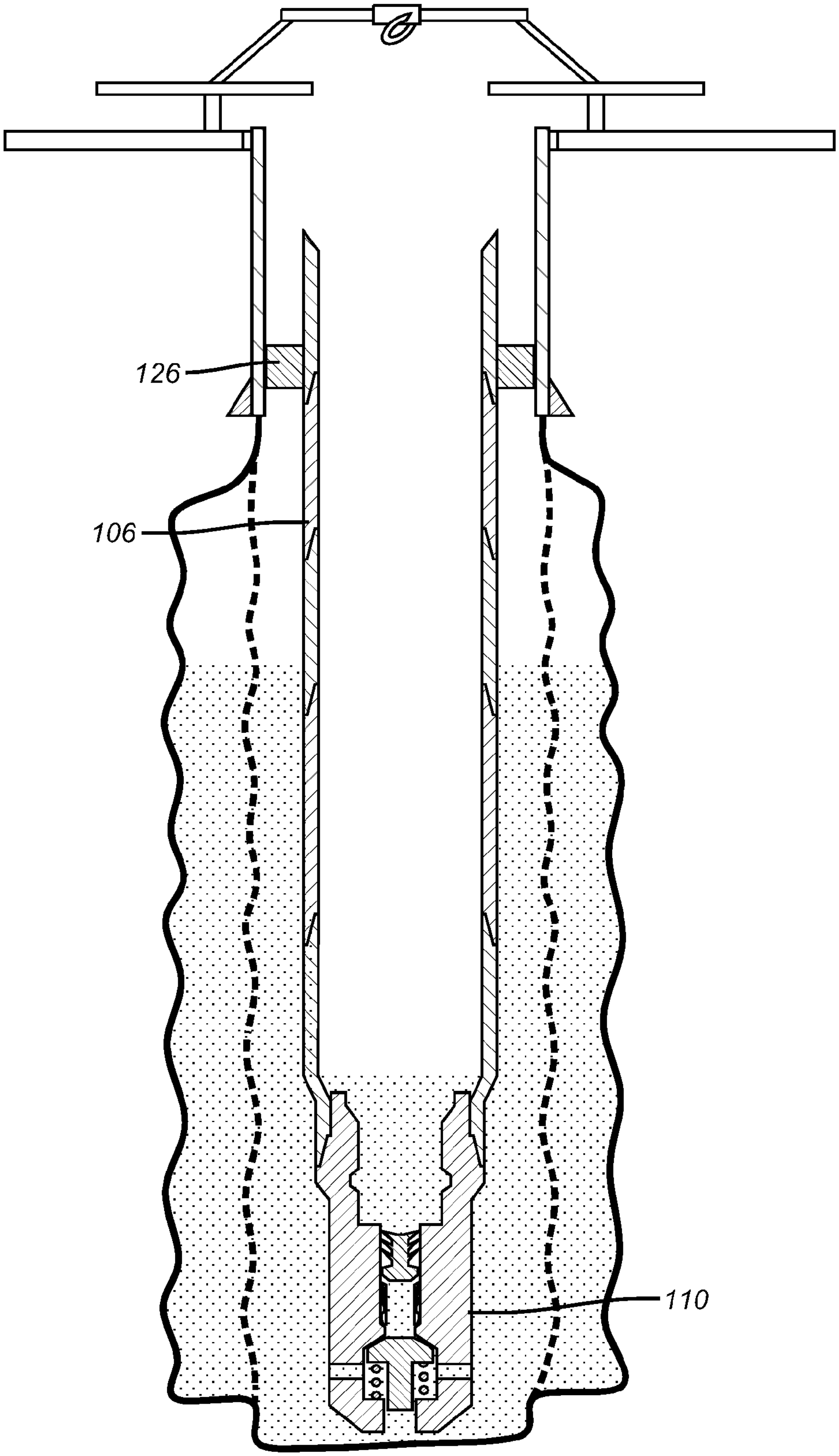


FIG. 22

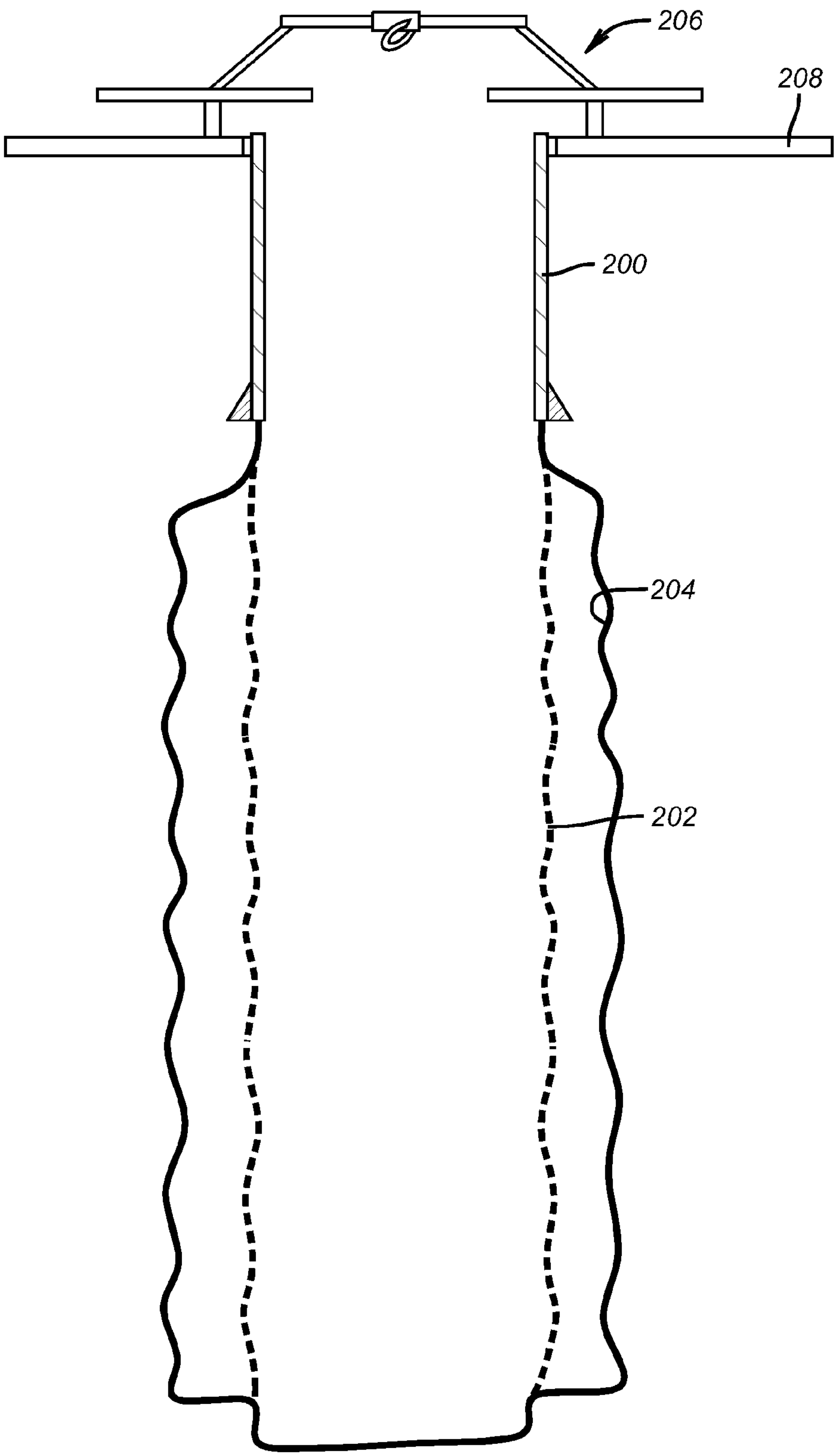


FIG. 23

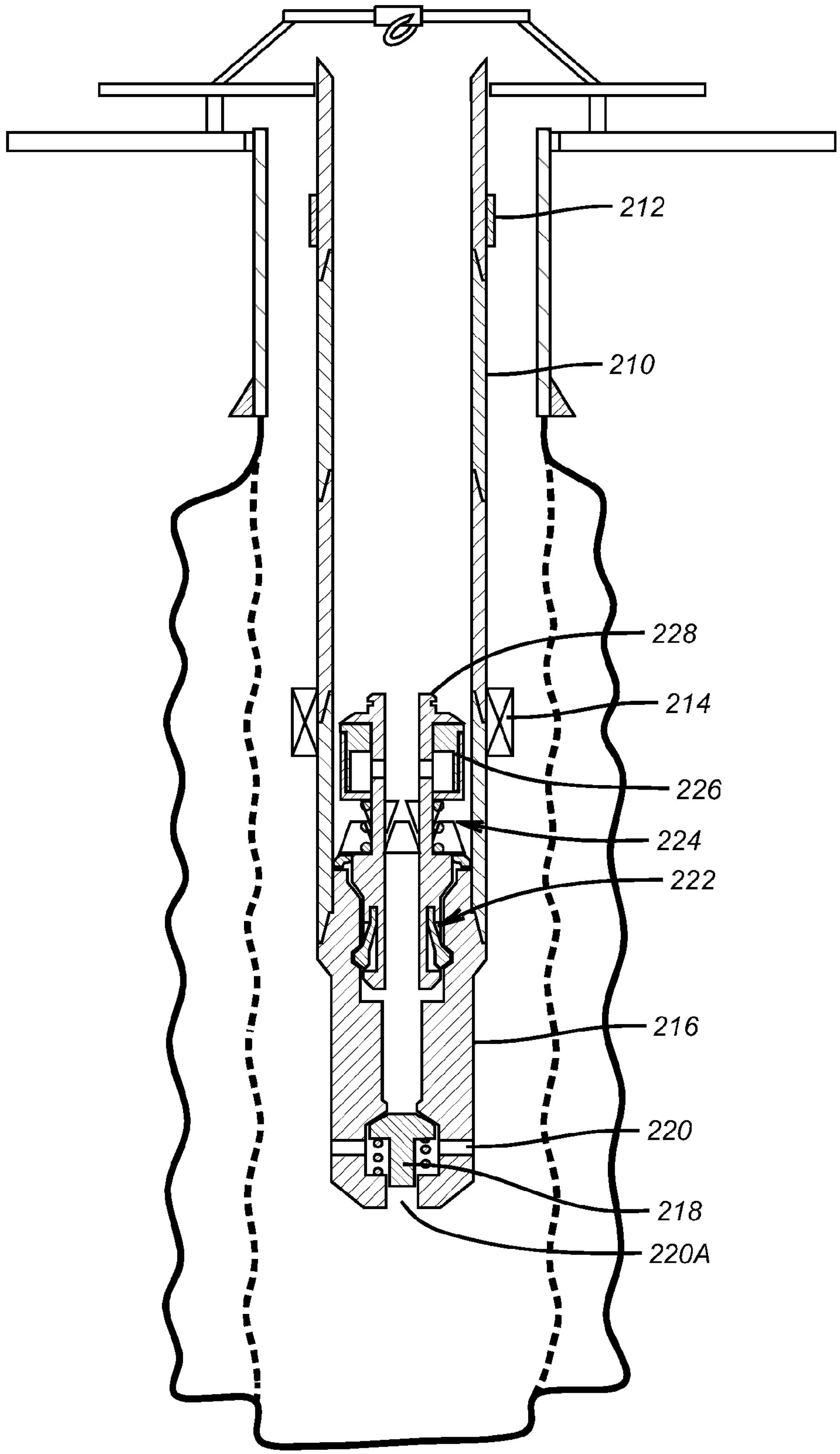


FIG. 24

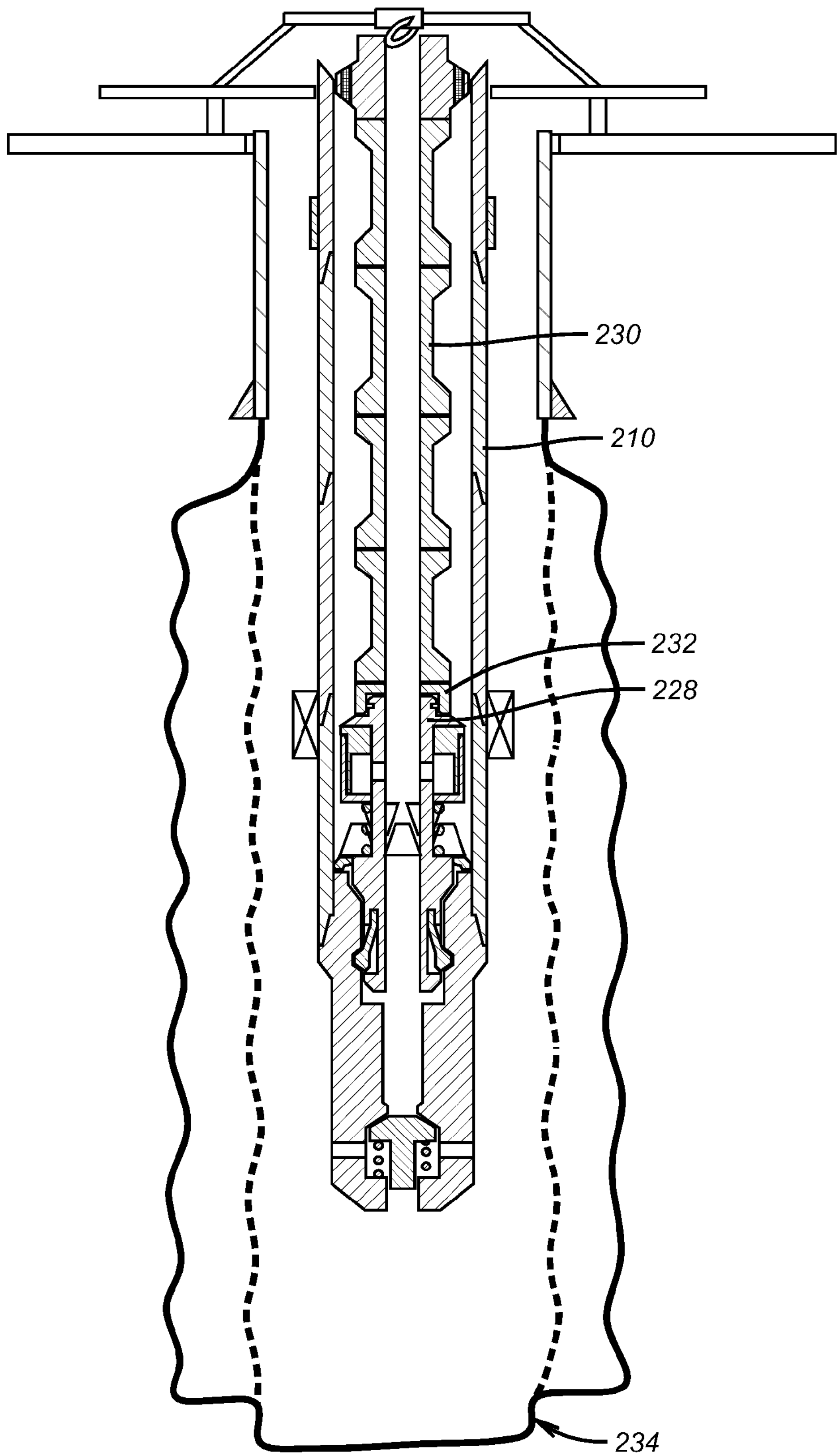


FIG. 25

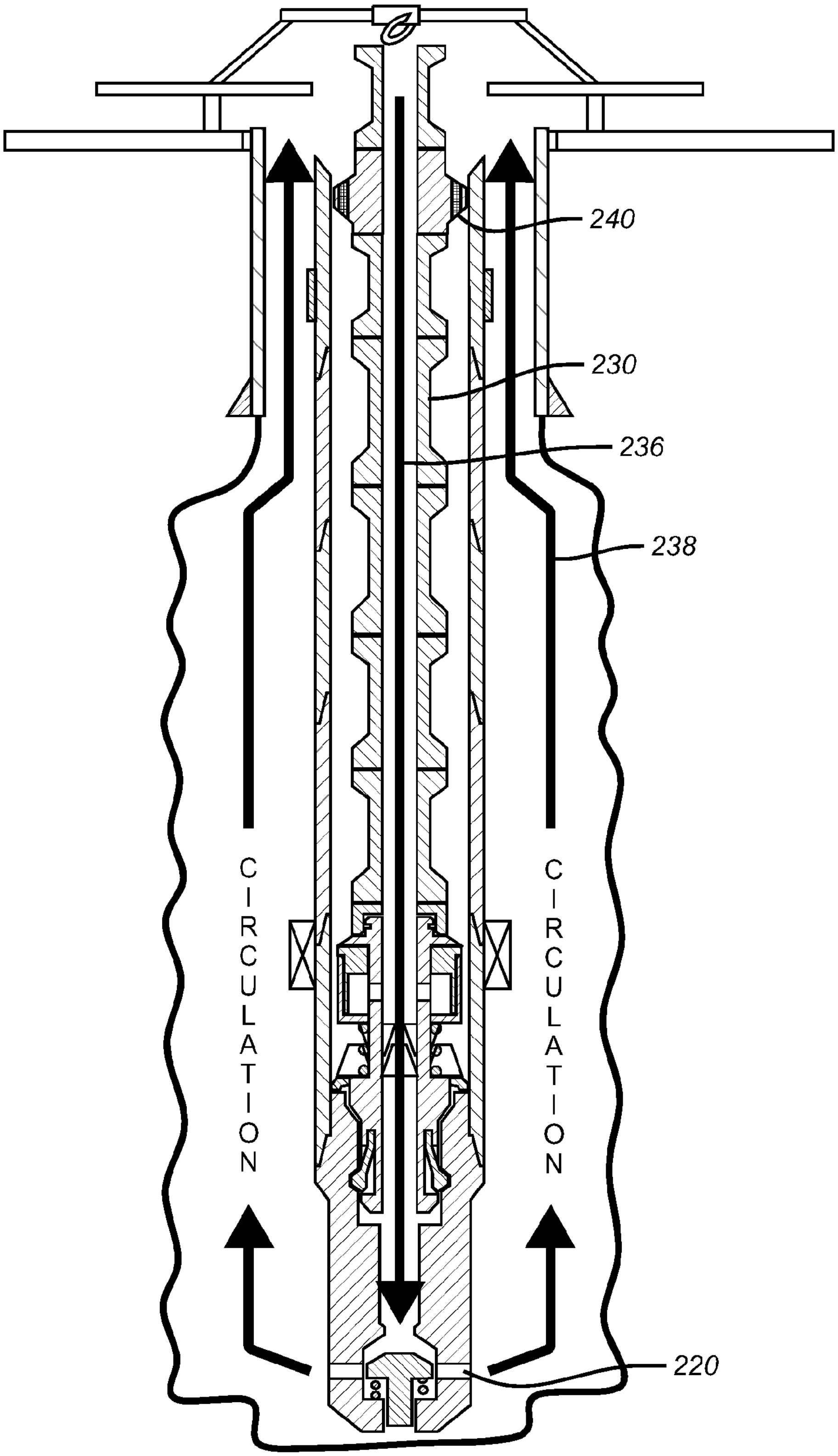


FIG. 26

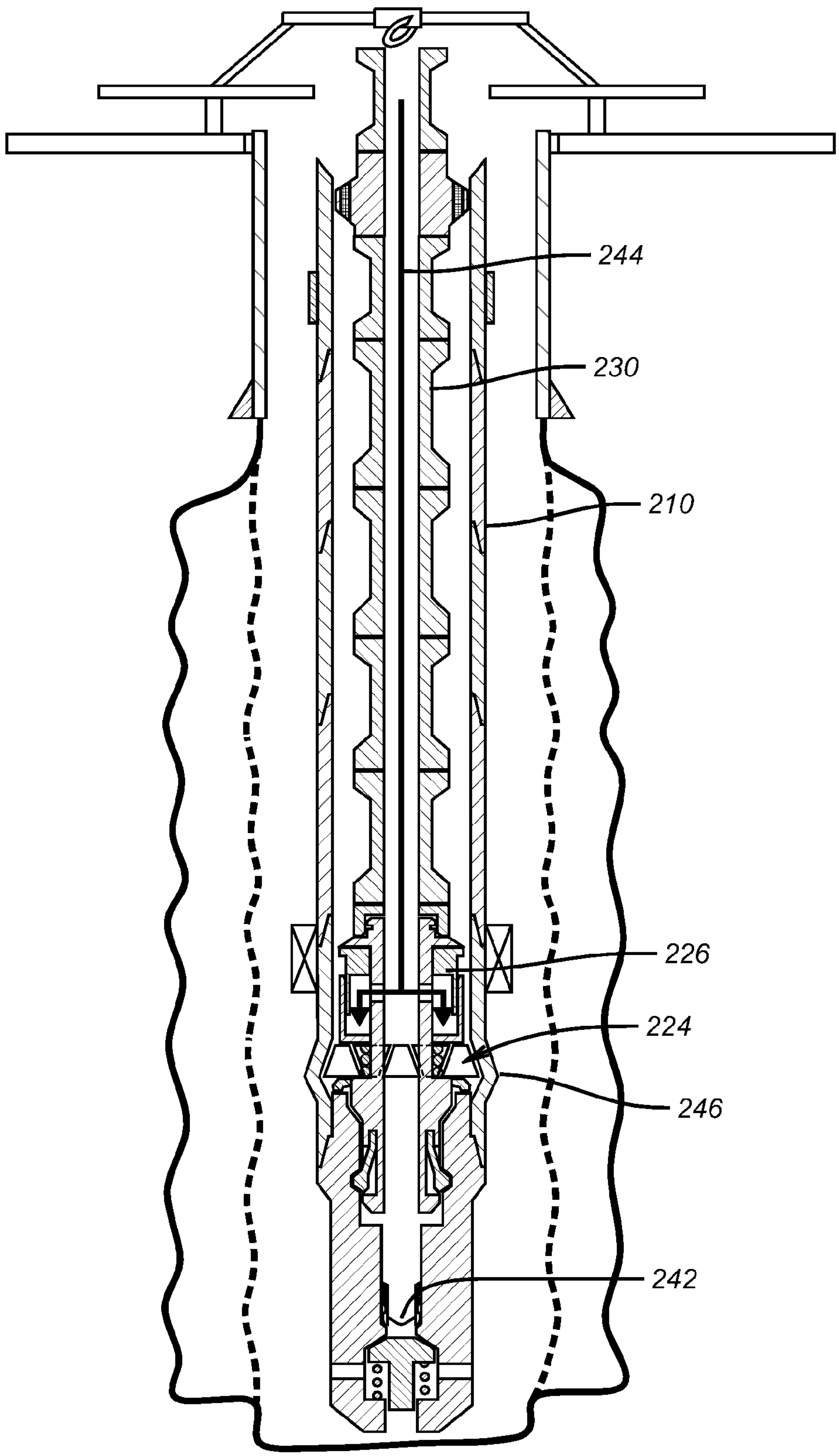


FIG. 27

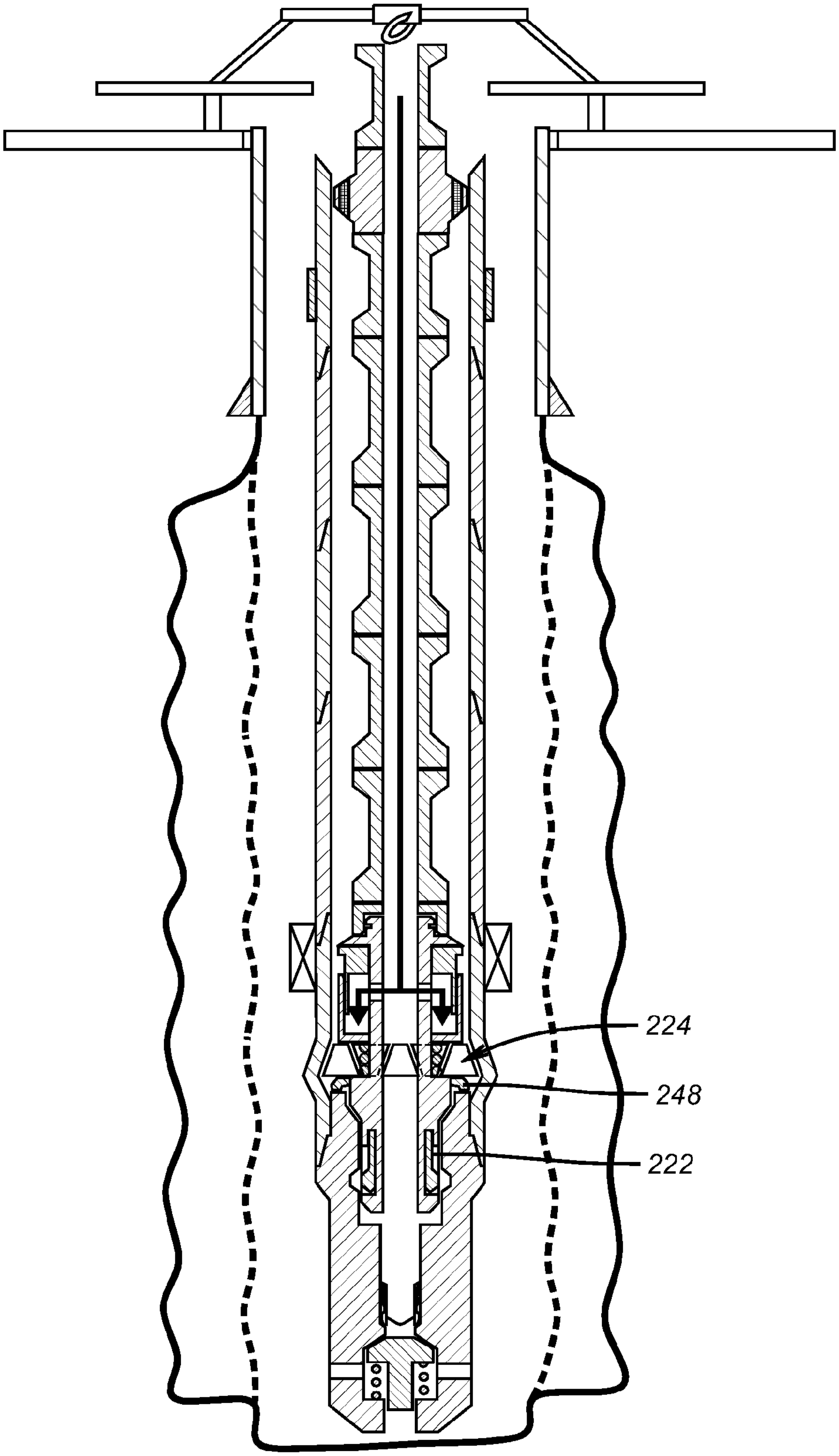


FIG. 28

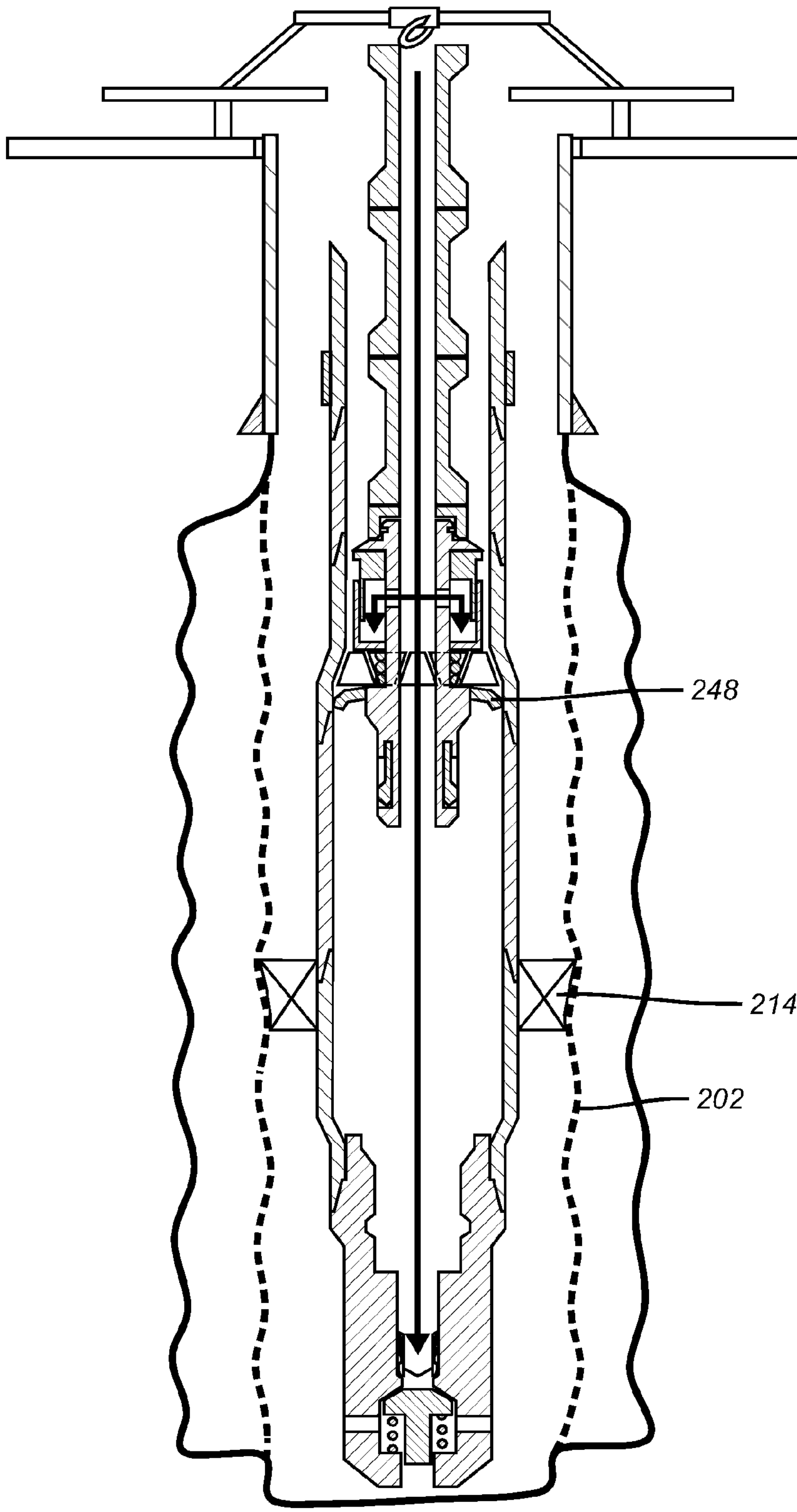


FIG. 29

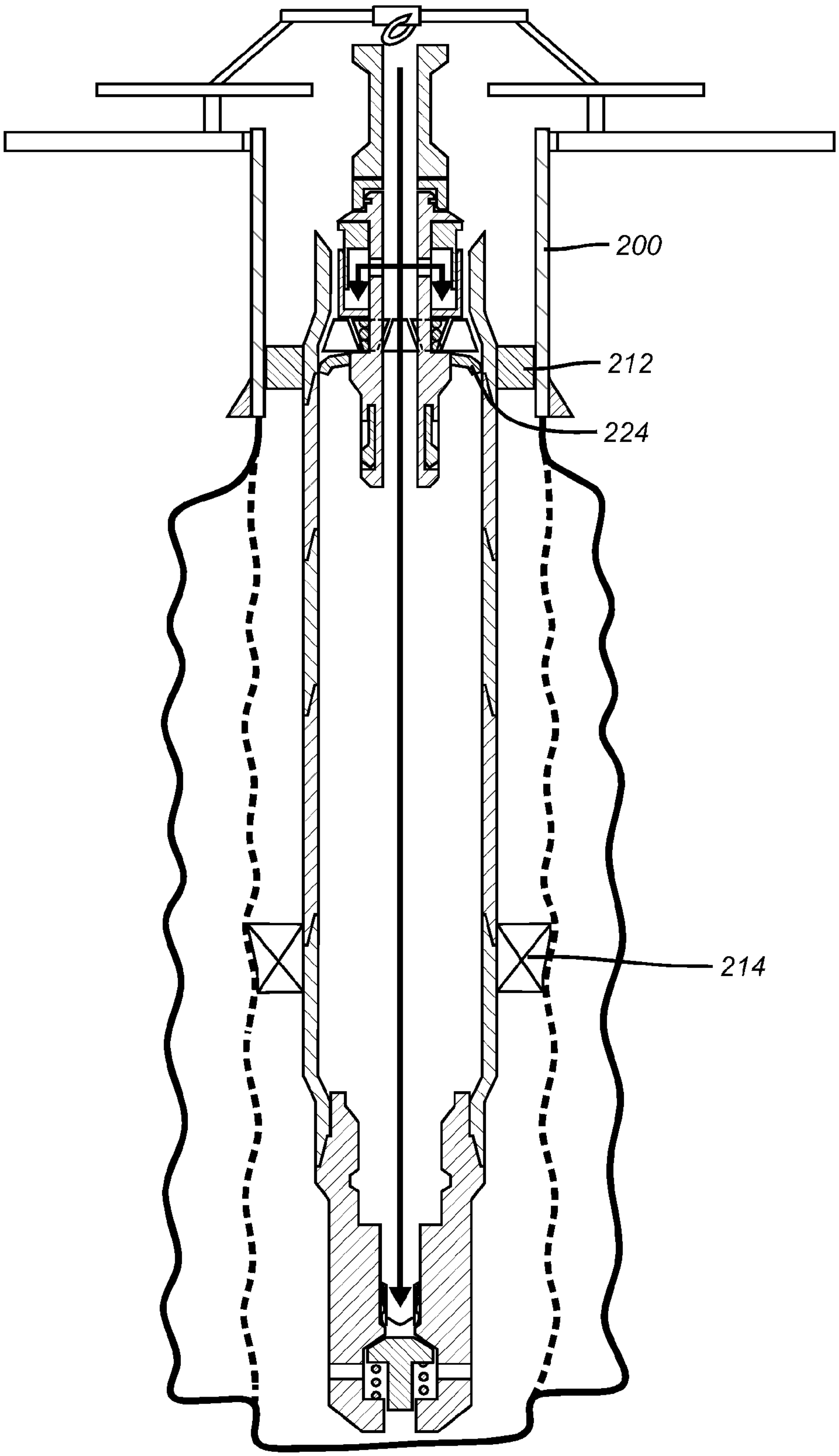


FIG. 30

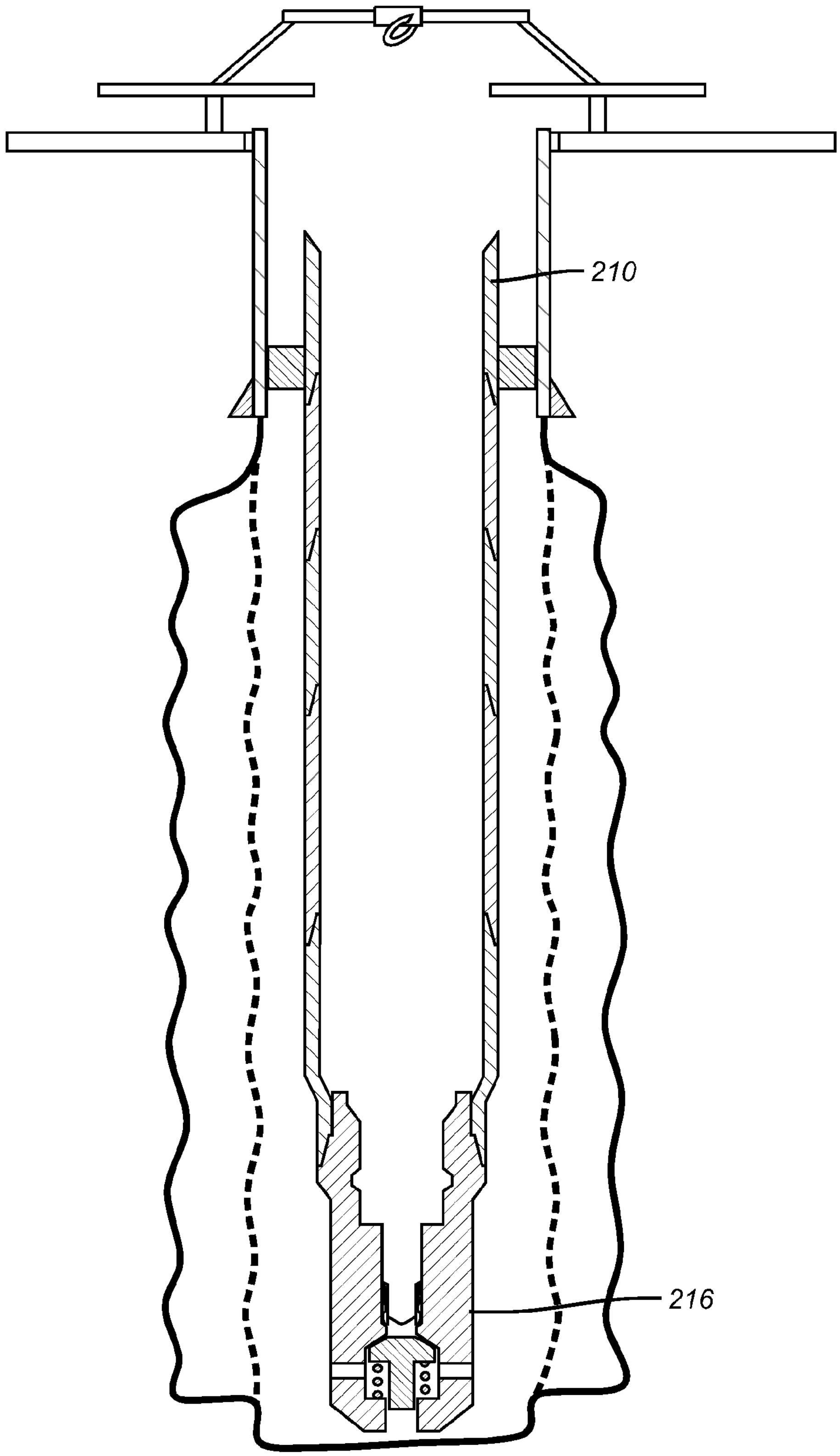


FIG. 31

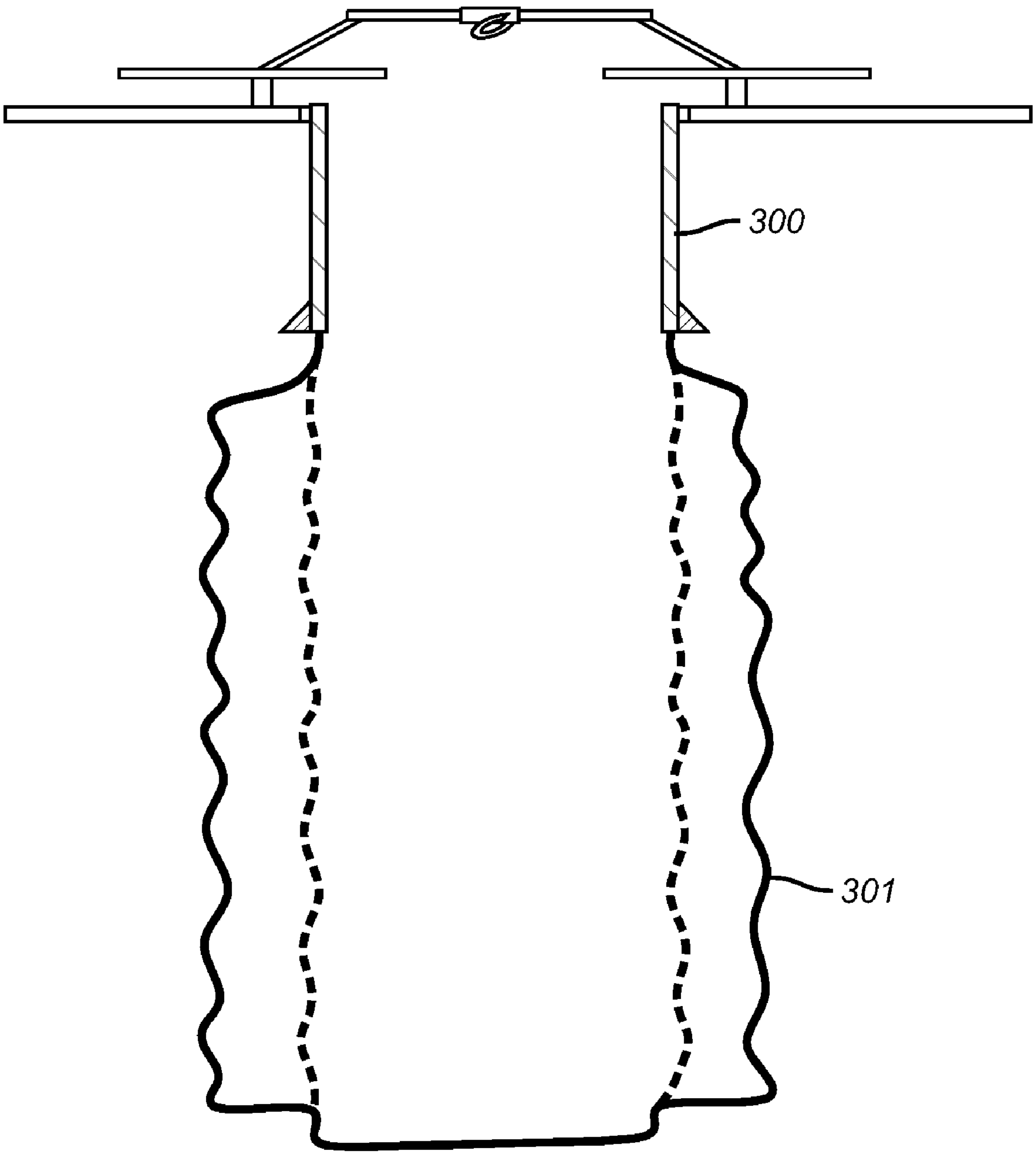


FIG. 32

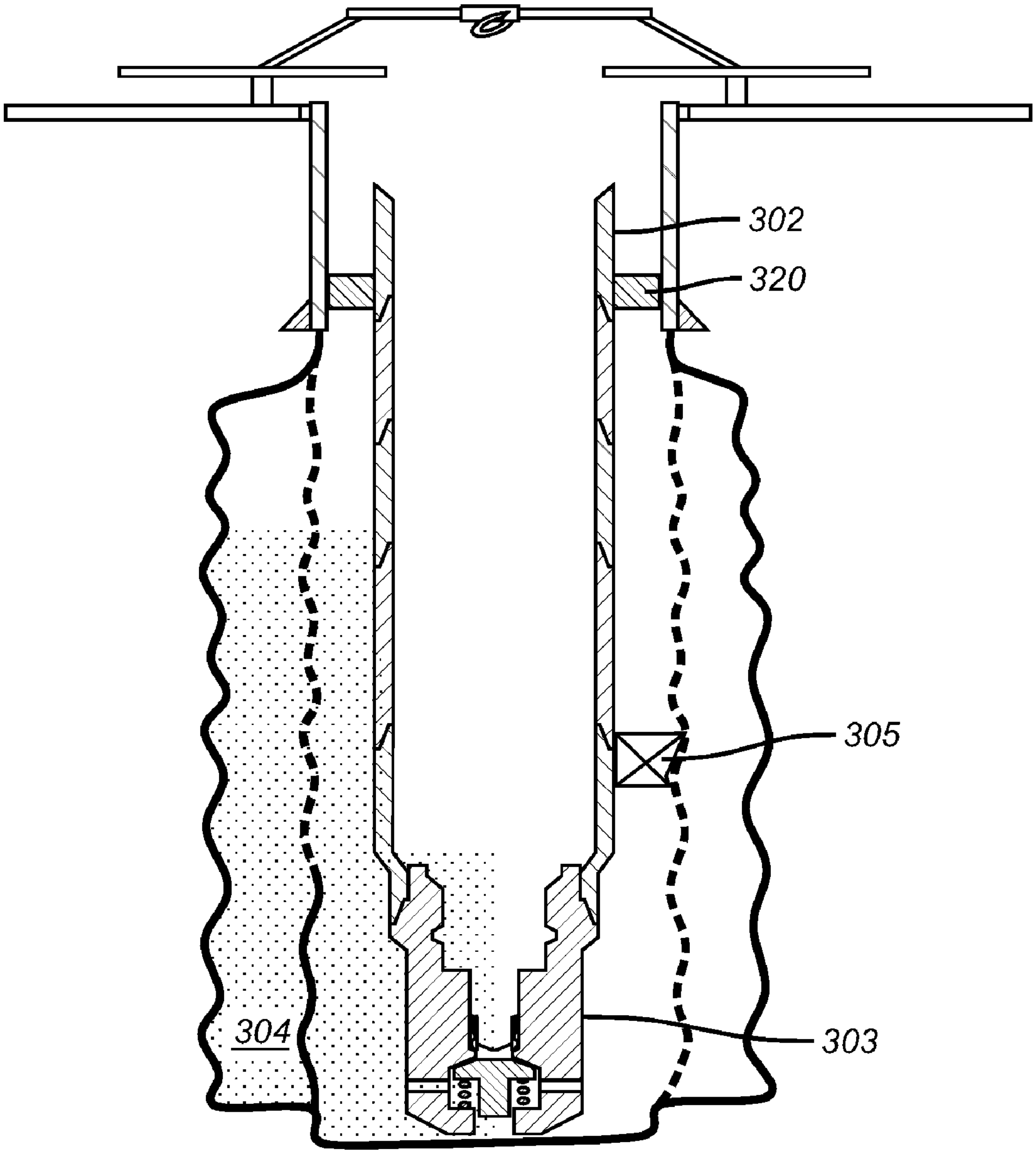


FIG. 33

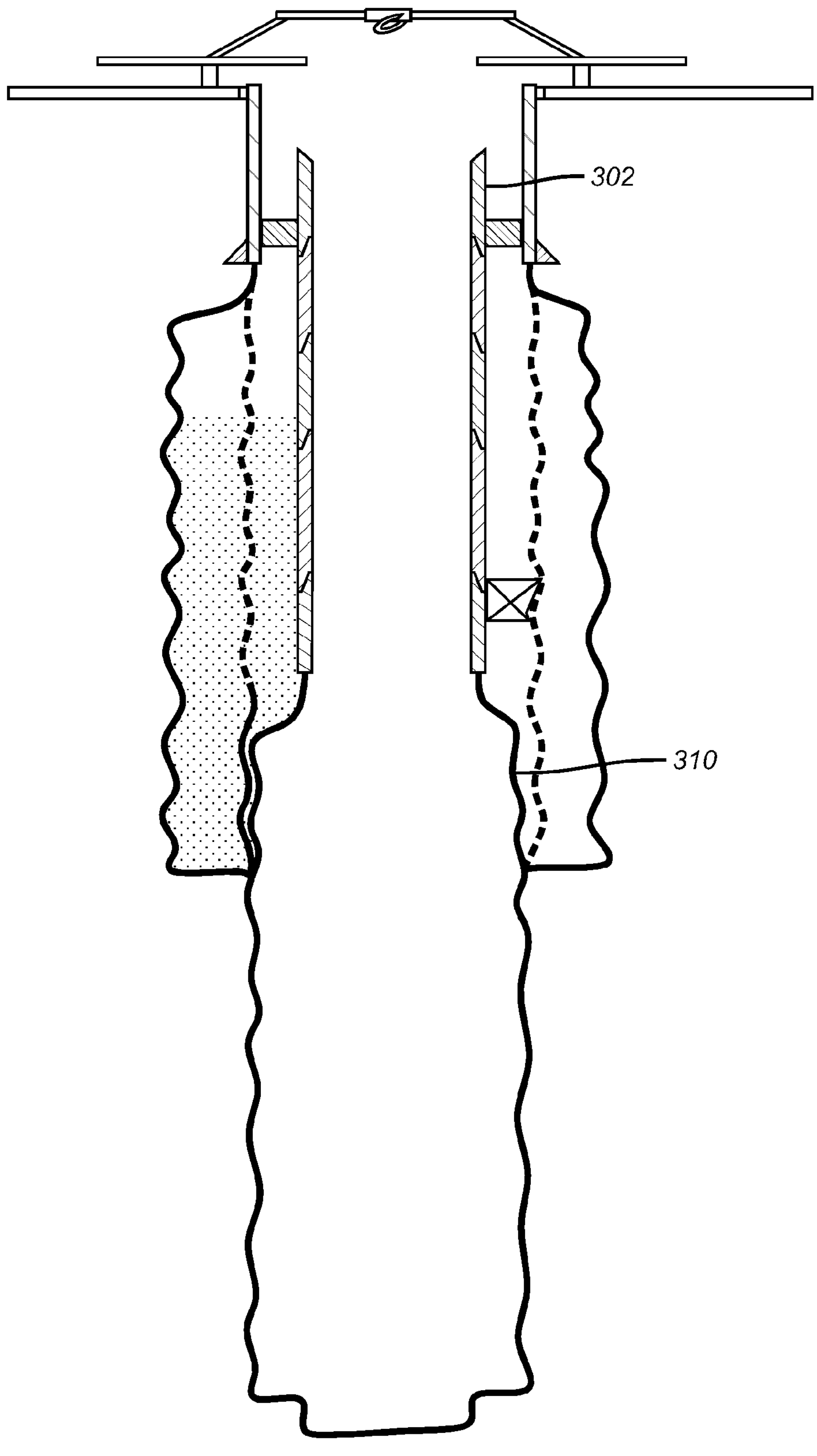


FIG. 34

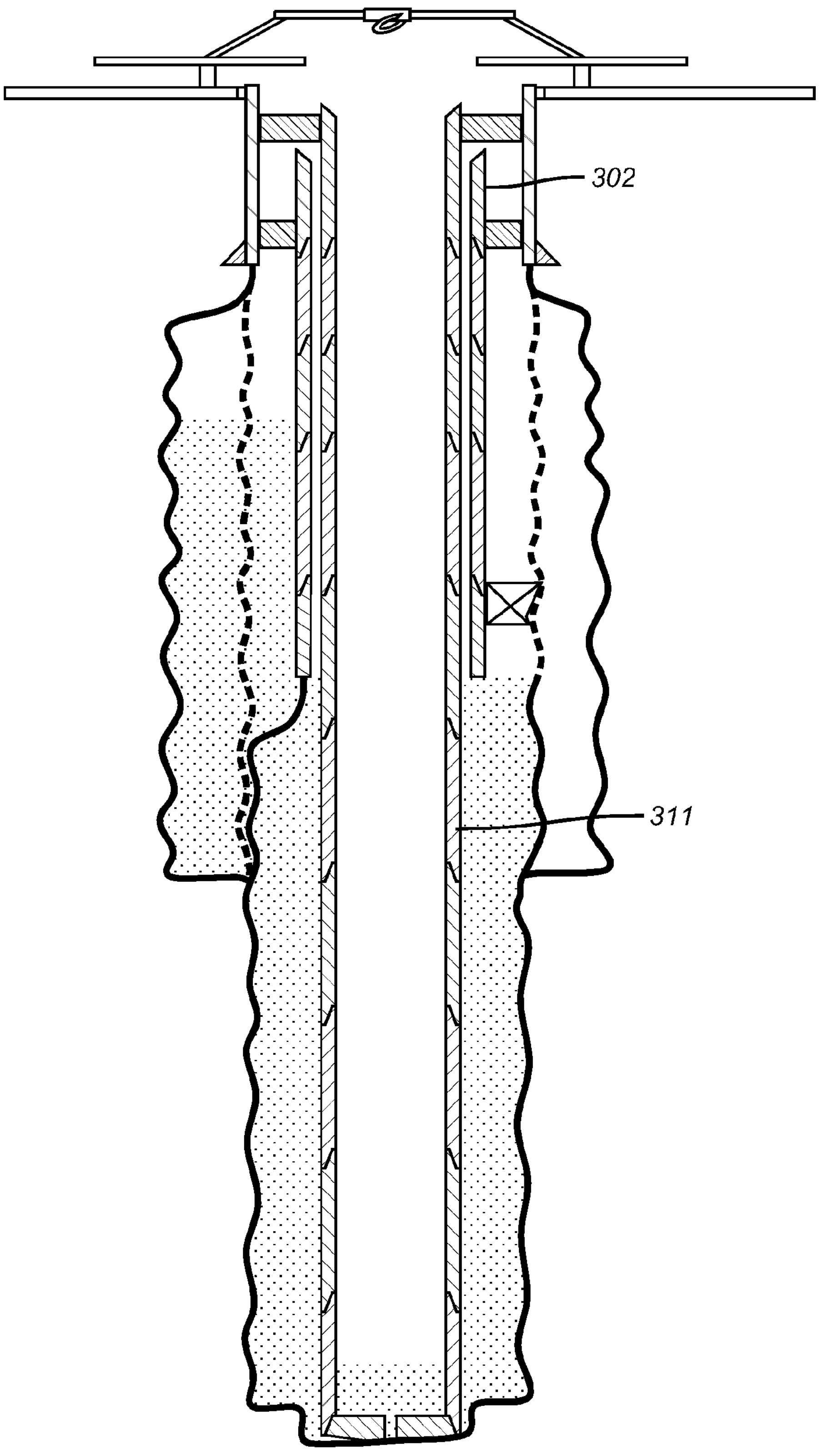


FIG. 35

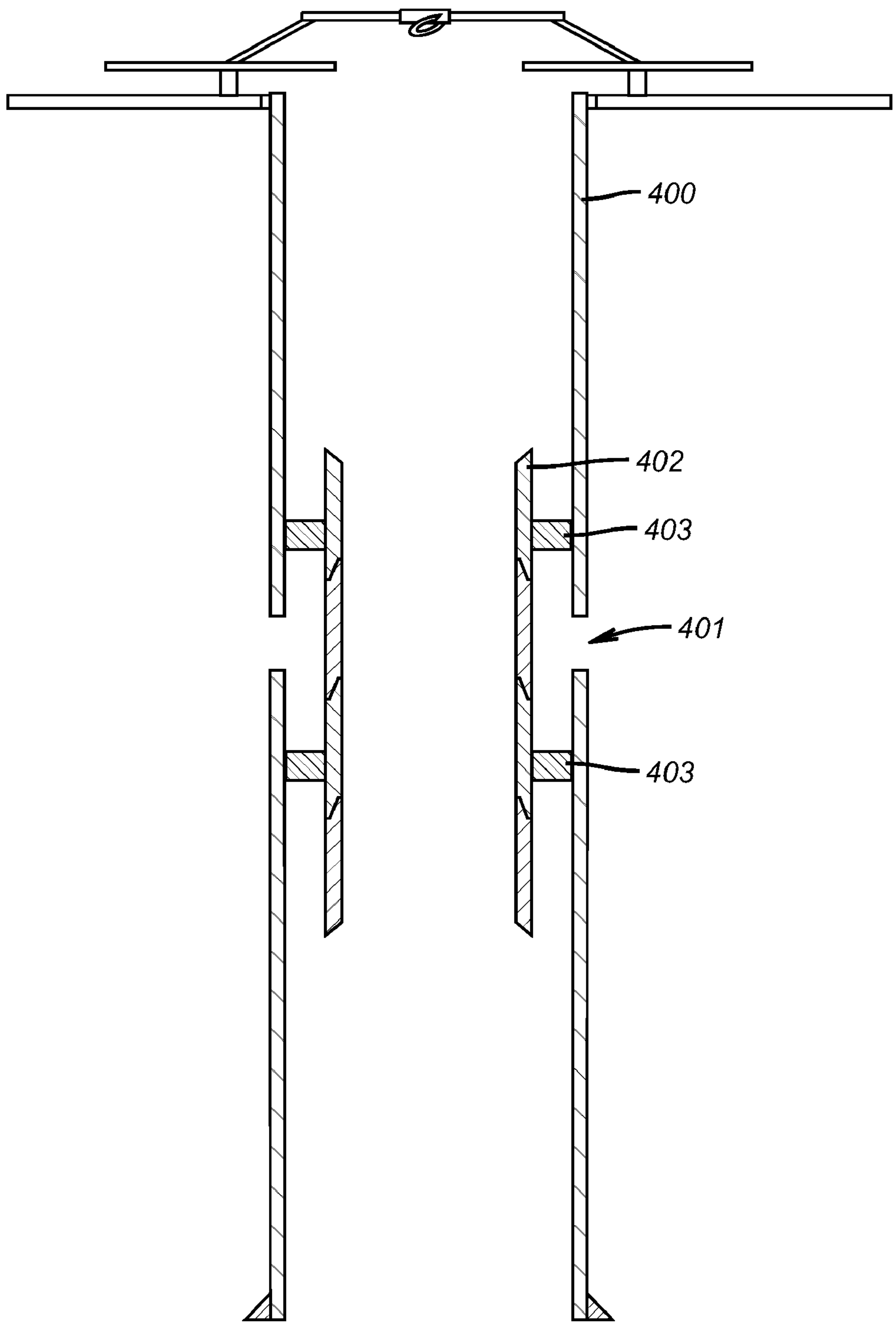


FIG. 36

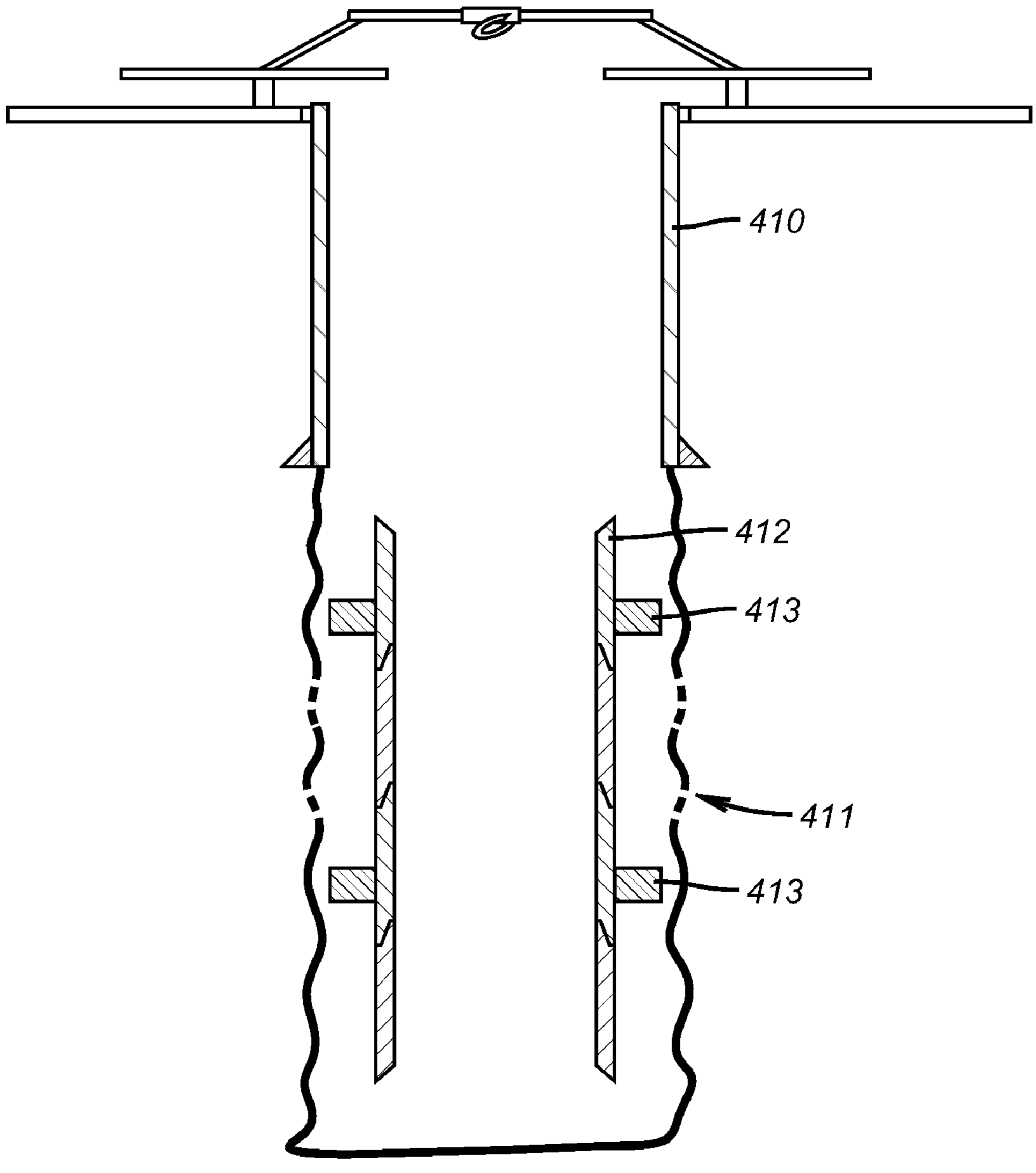


FIG. 37

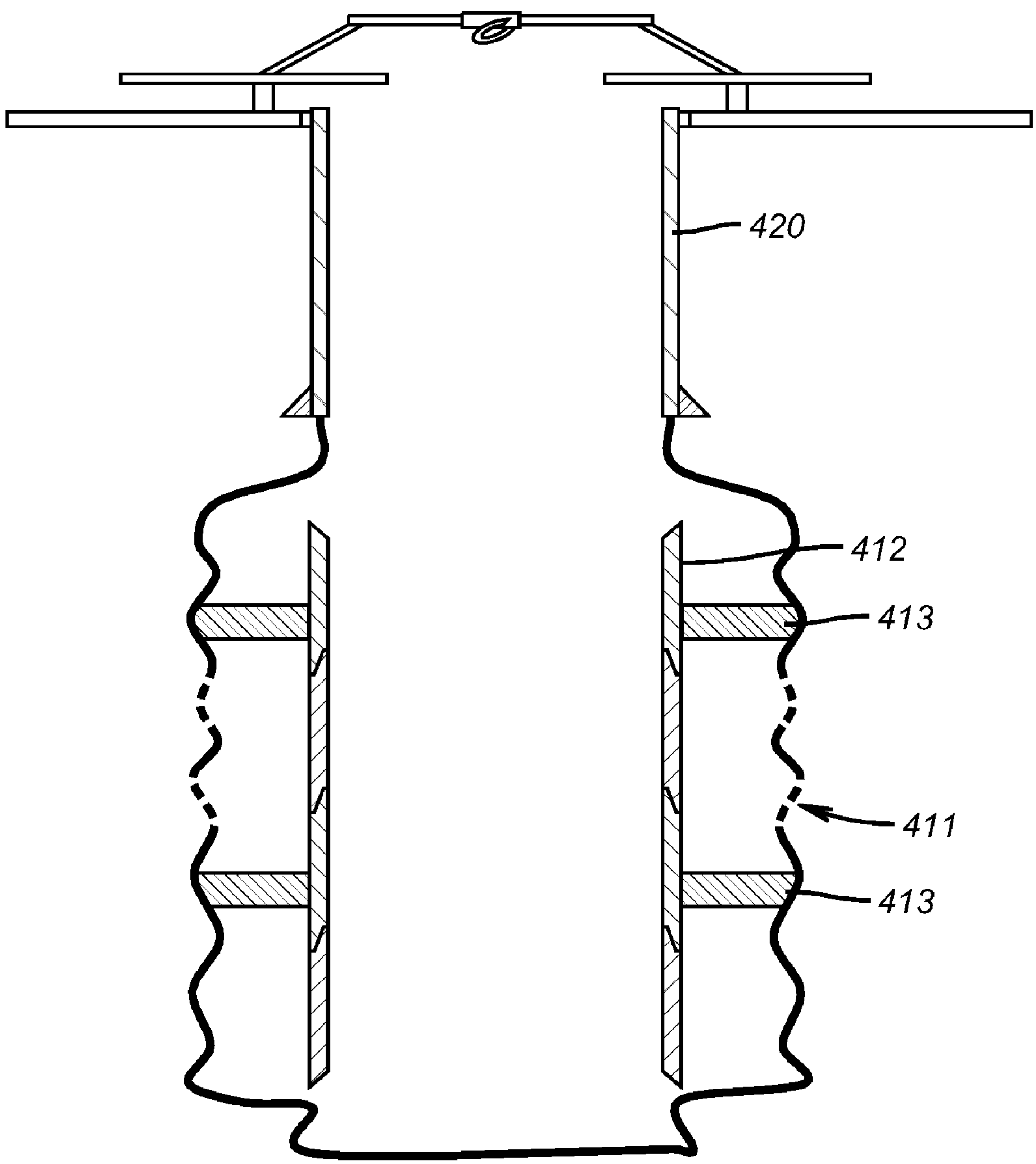


FIG. 38

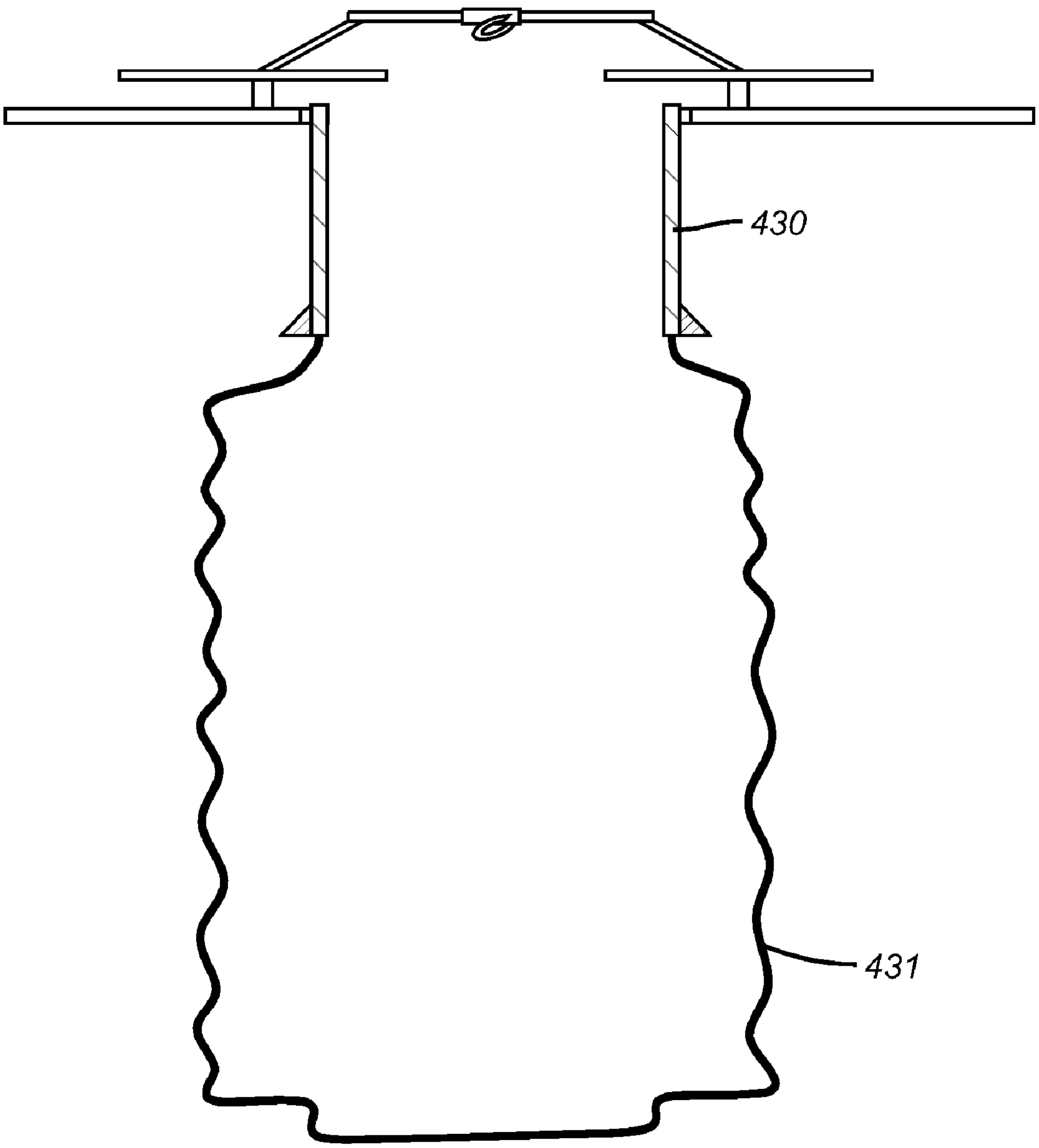


FIG. 39

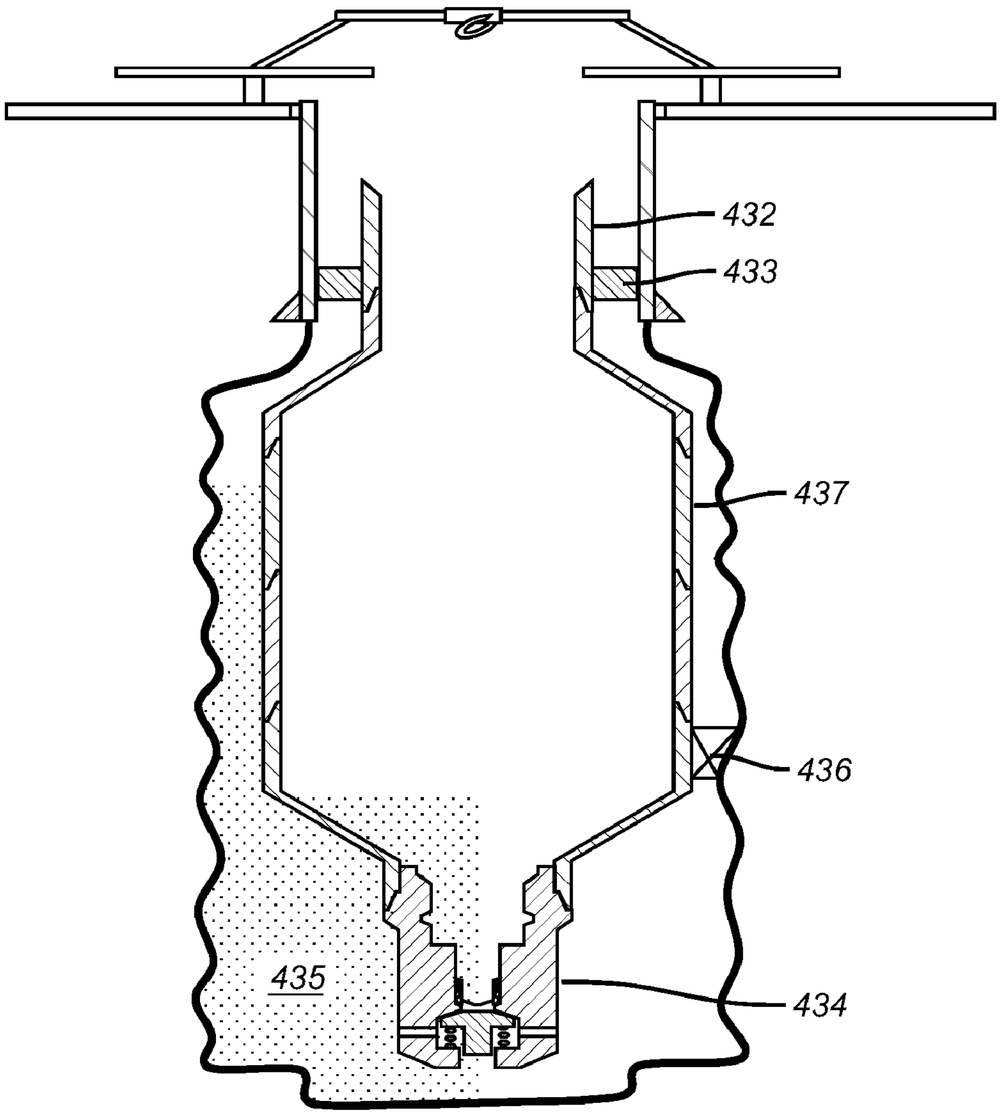


FIG. 40

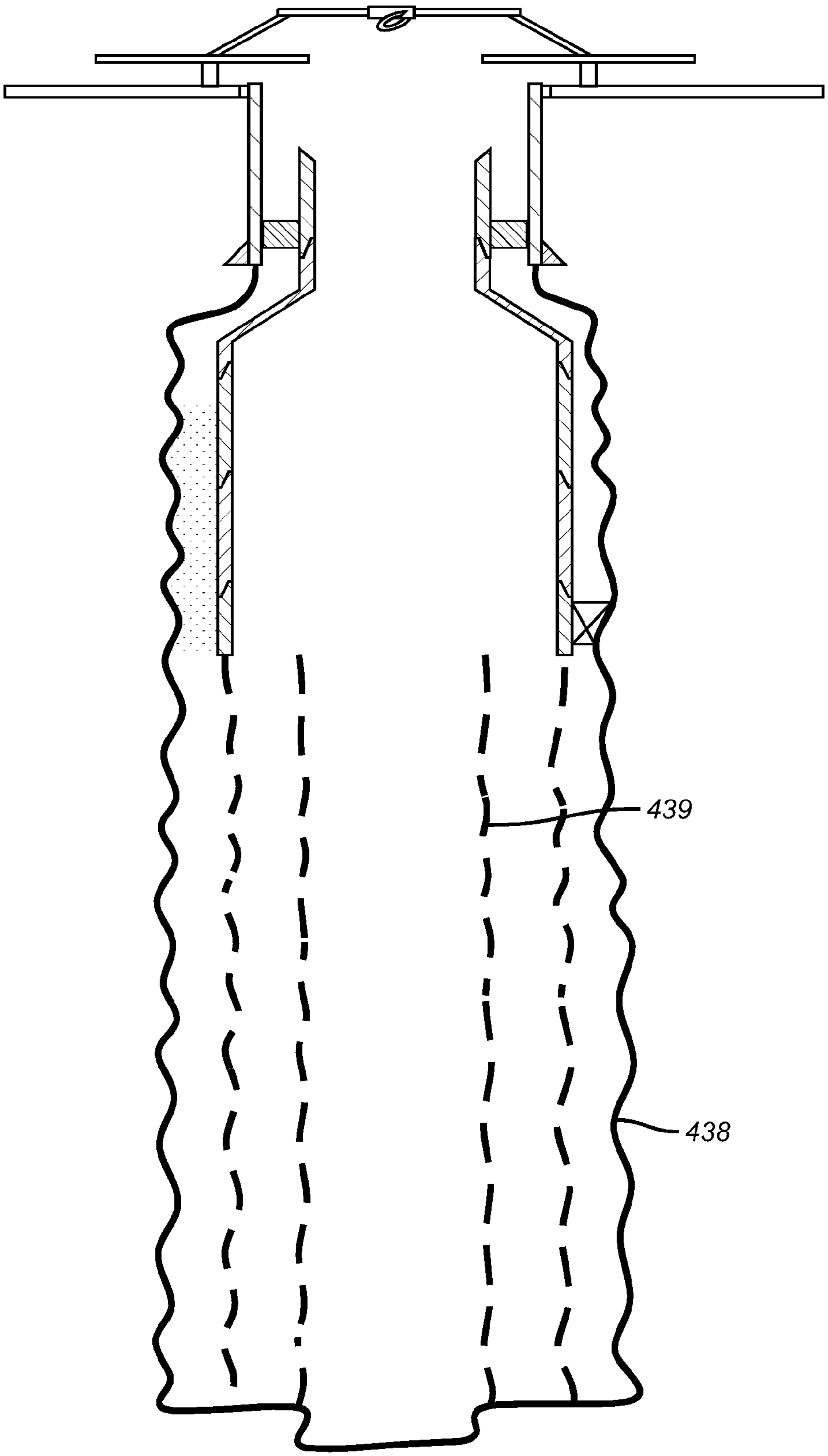


FIG. 41

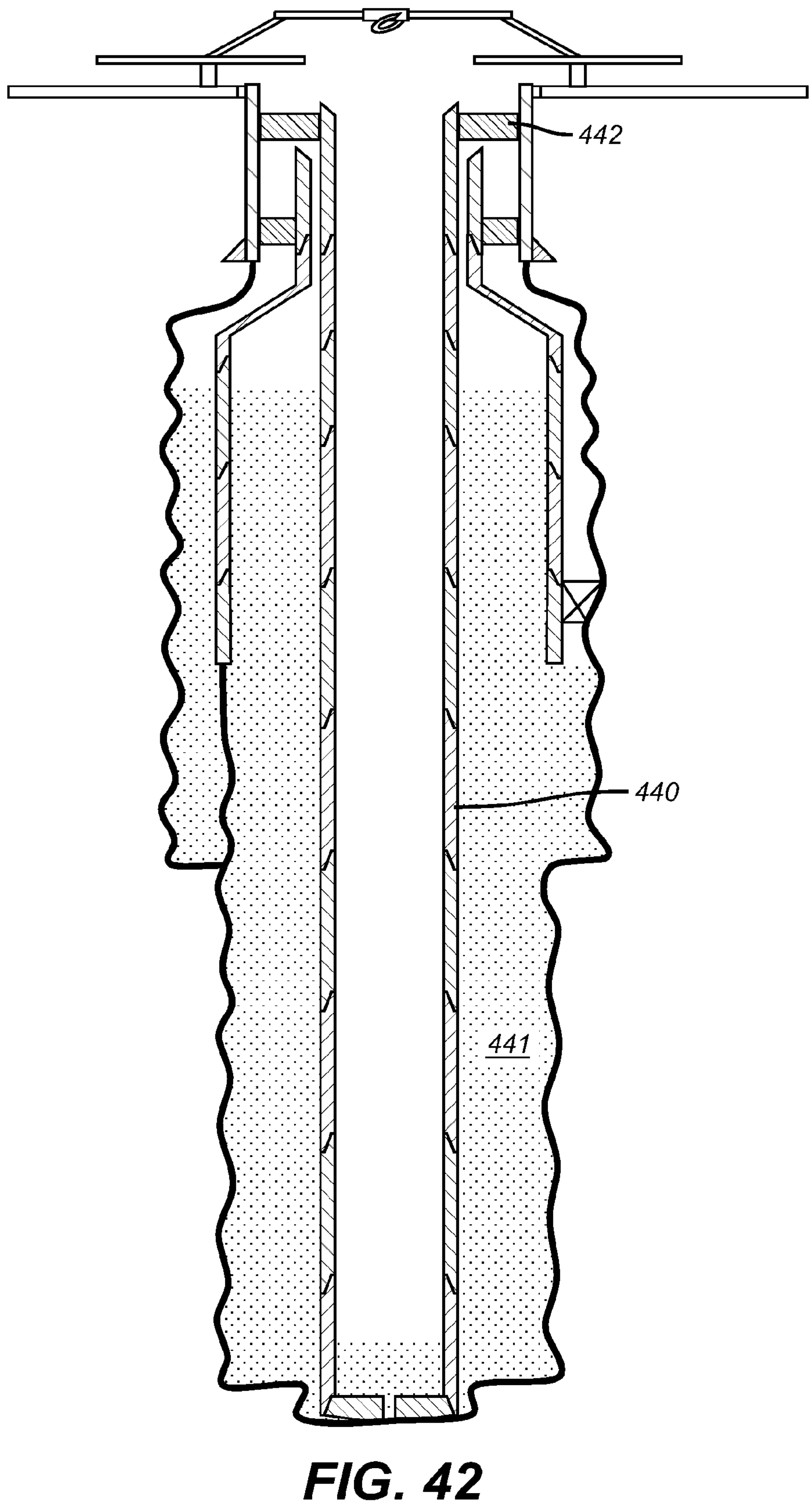


FIG. 42

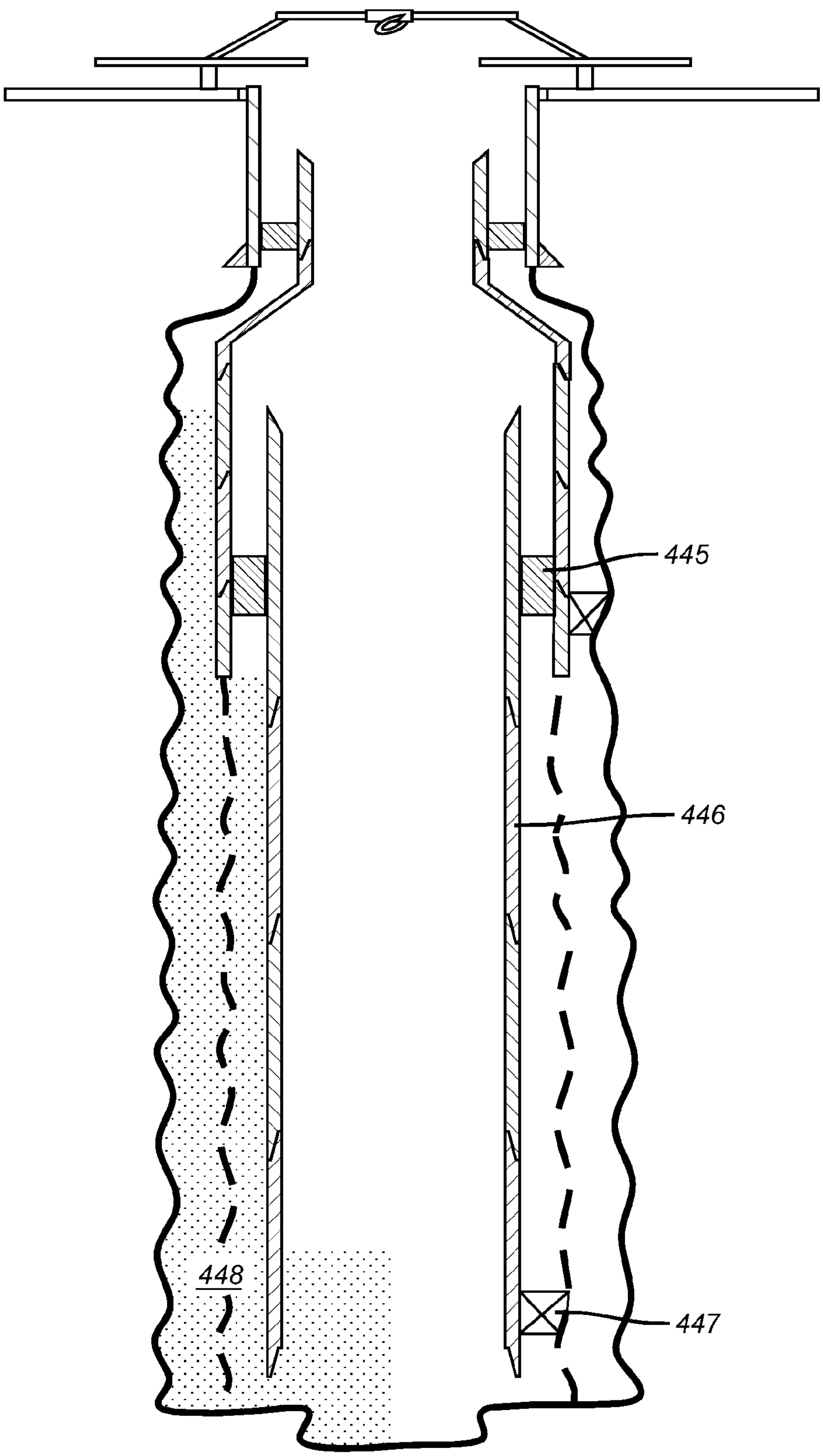


FIG. 43

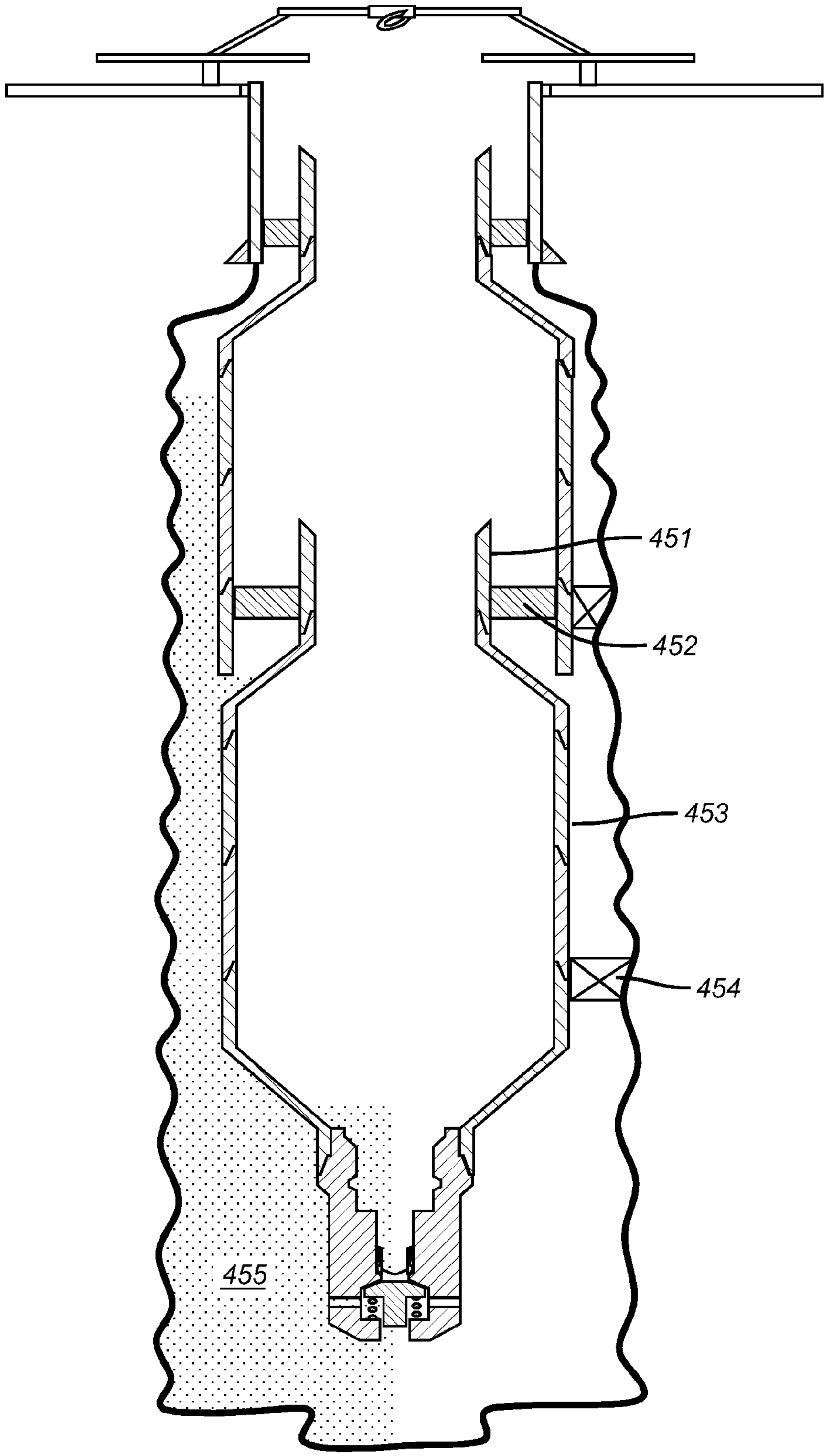


FIG. 44

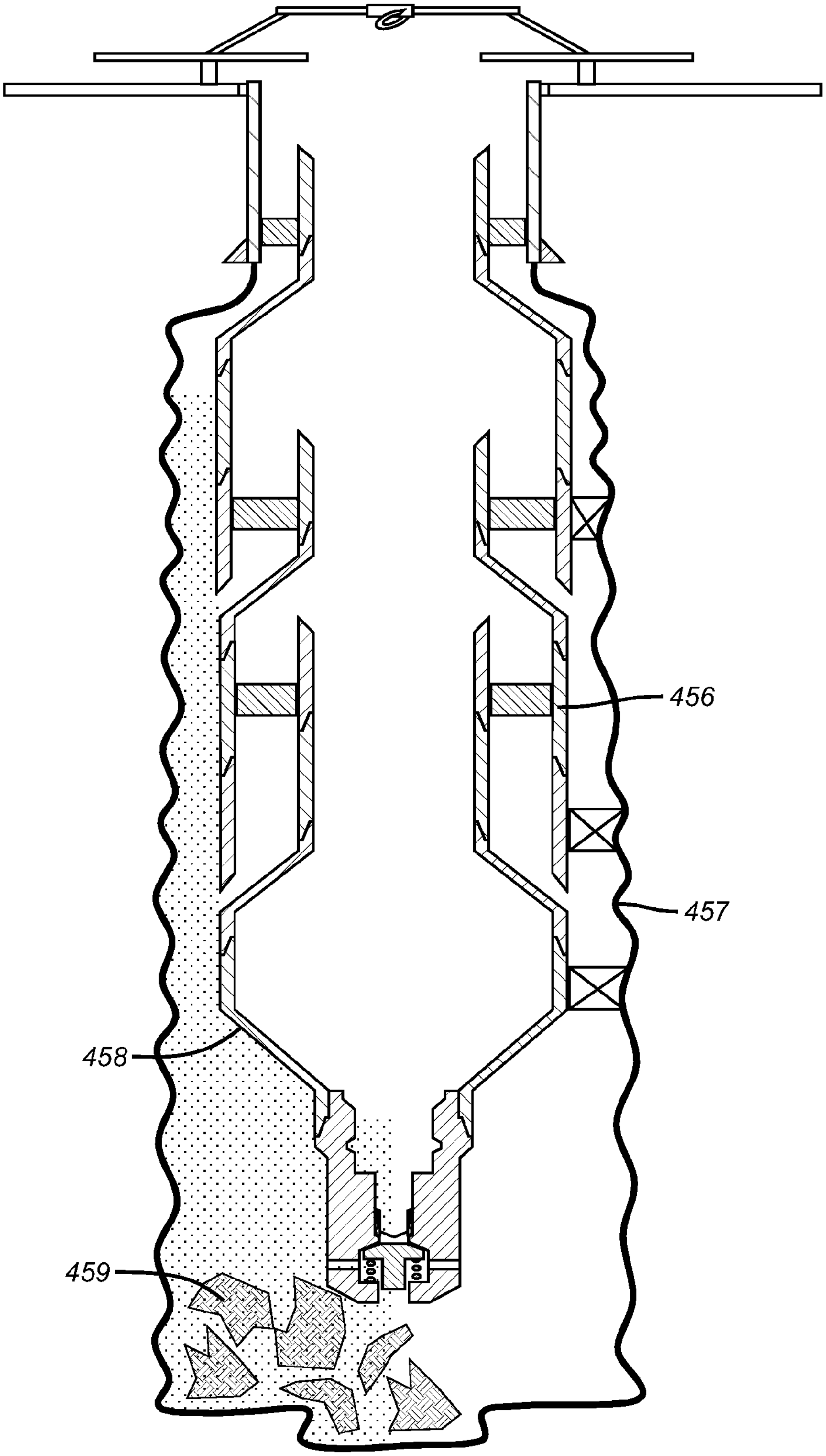


FIG. 45

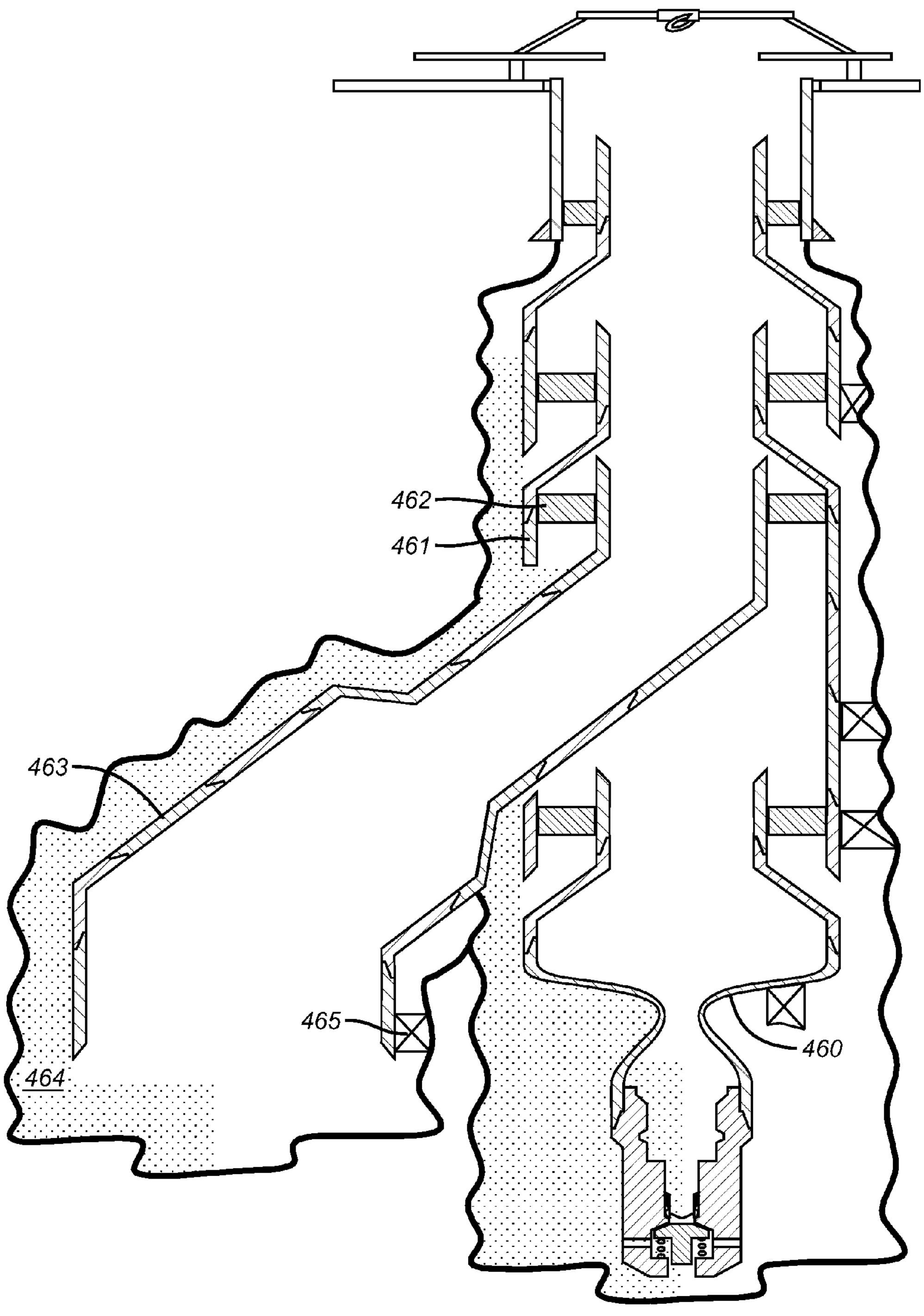


FIG. 46

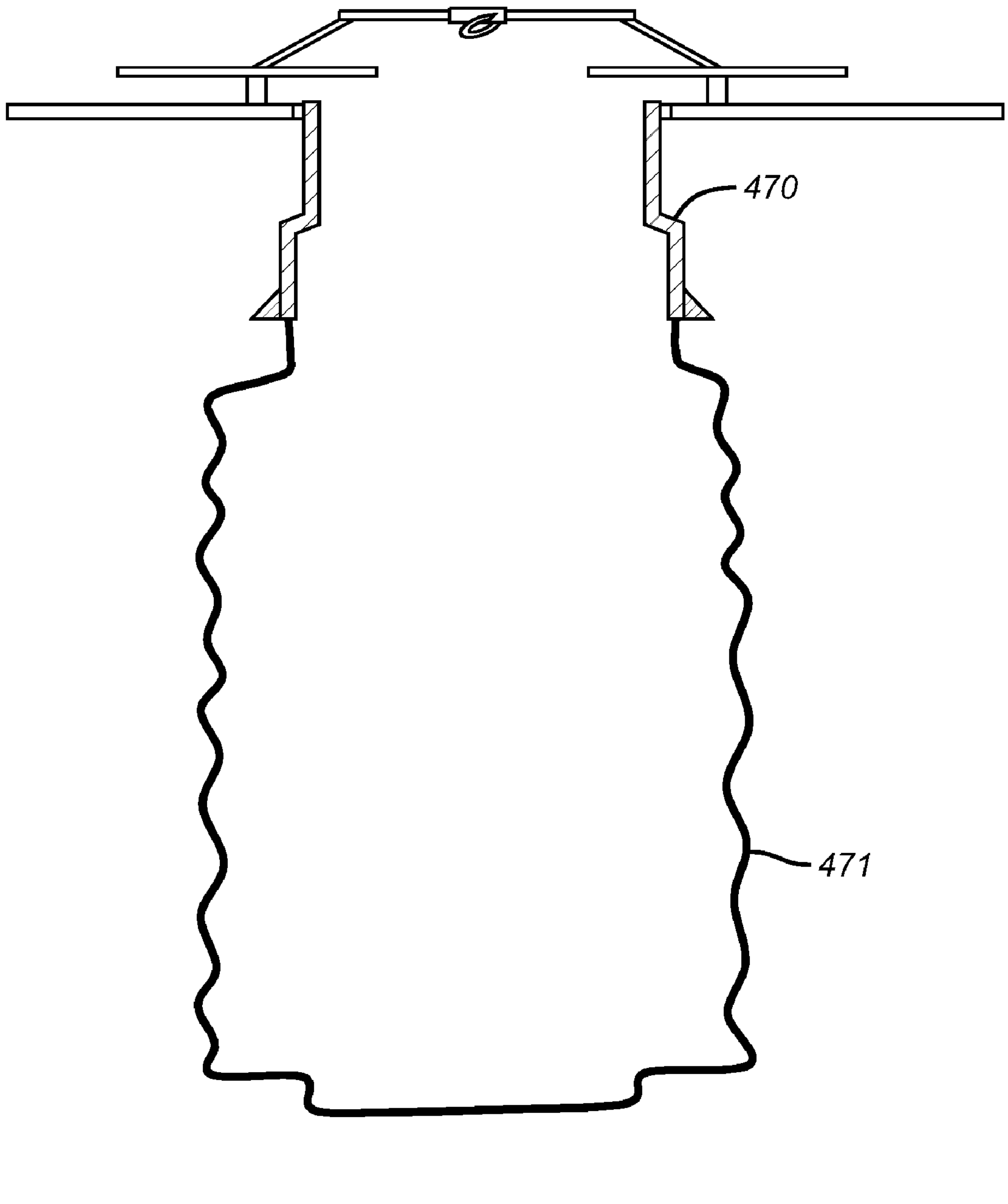


FIG. 47

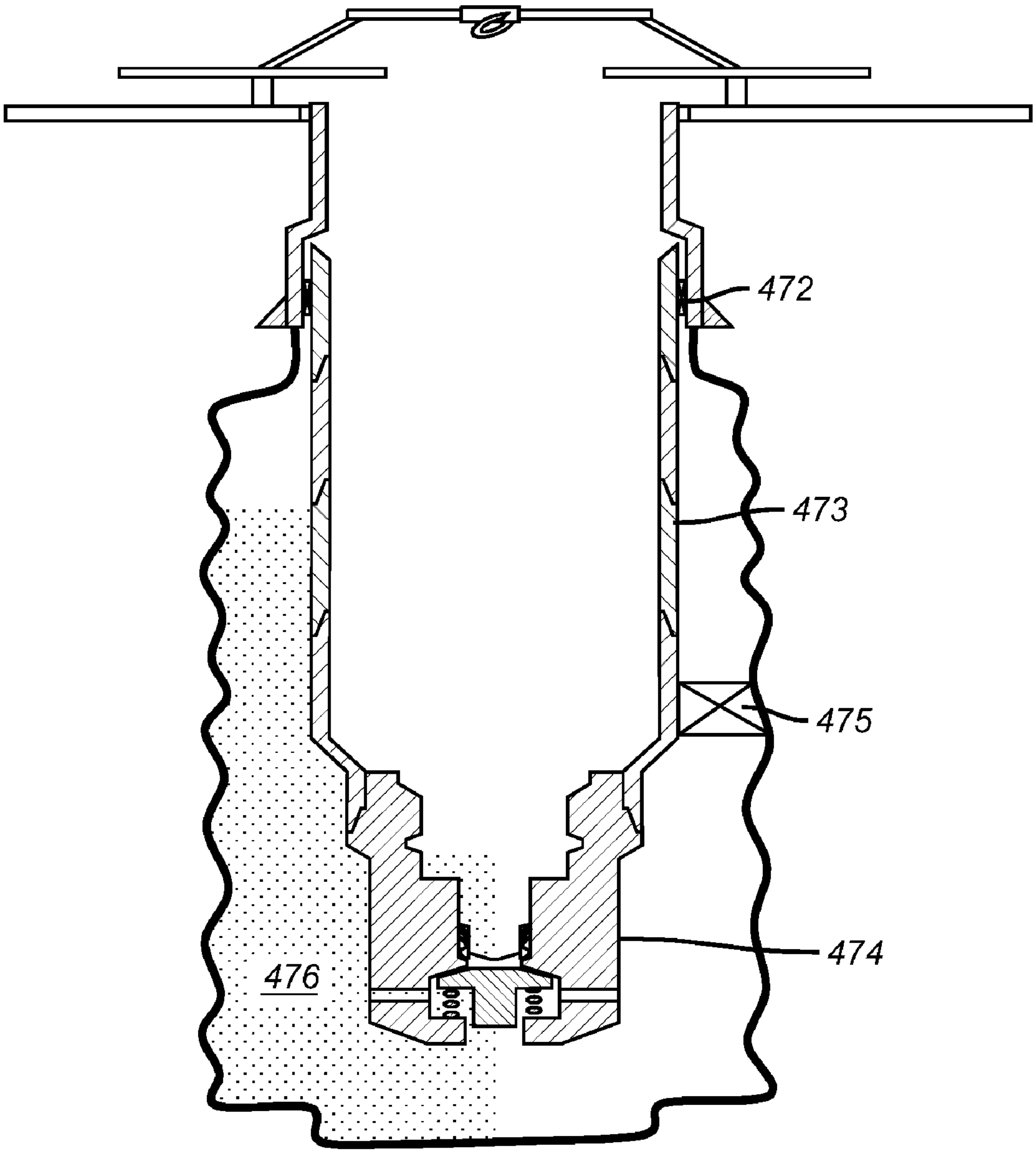


FIG. 48

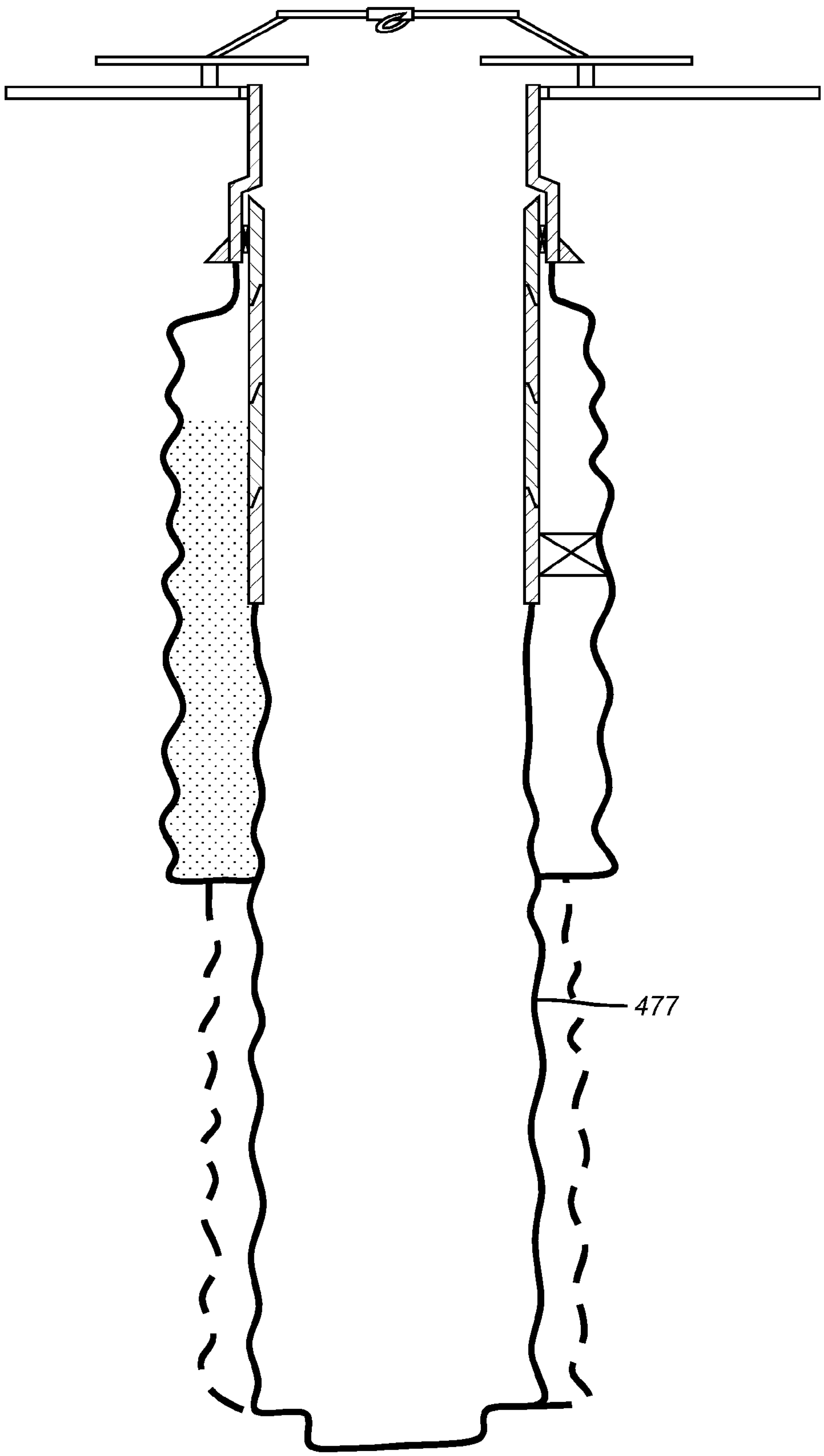


FIG. 49

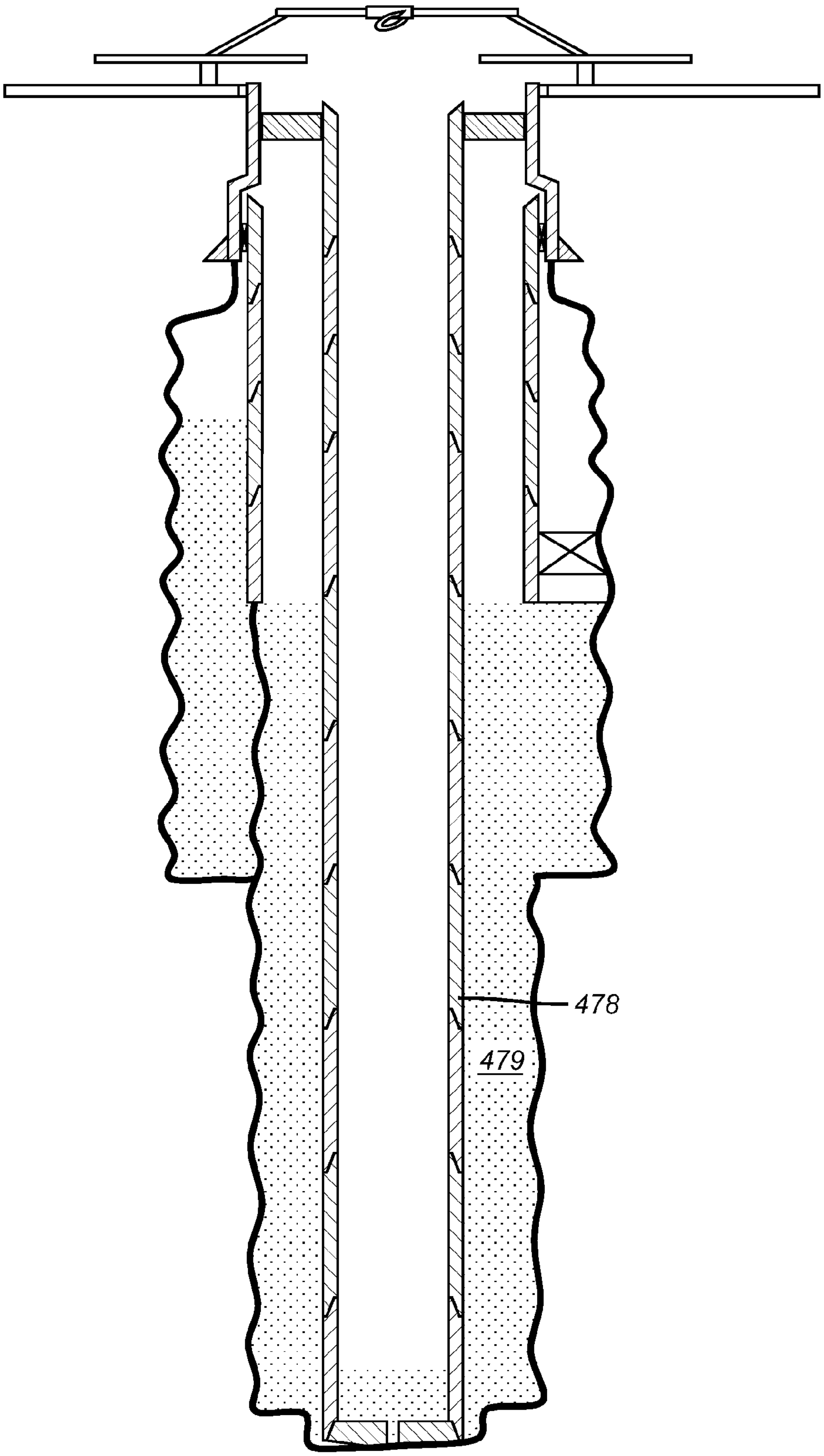


FIG. 50

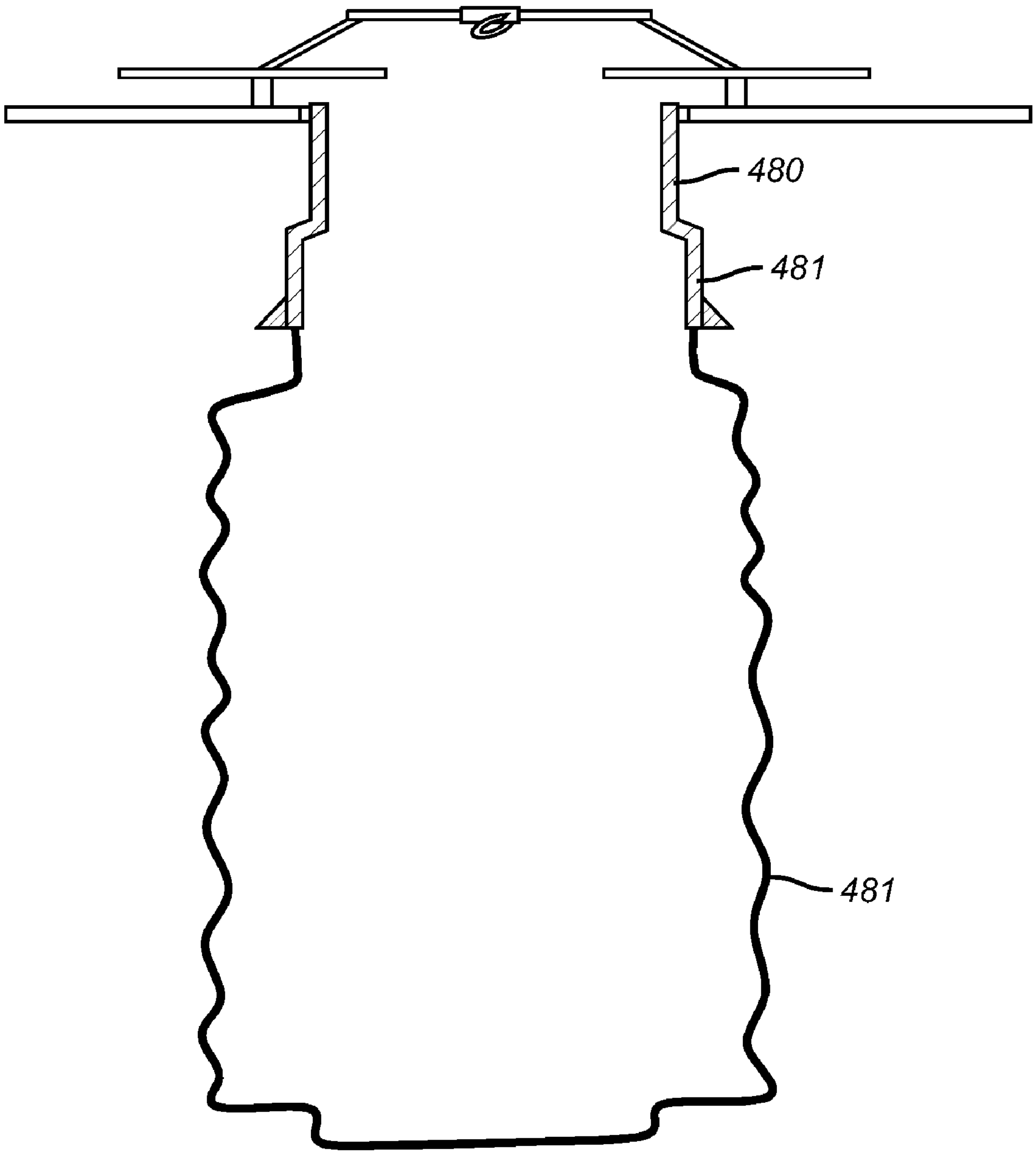


FIG. 51

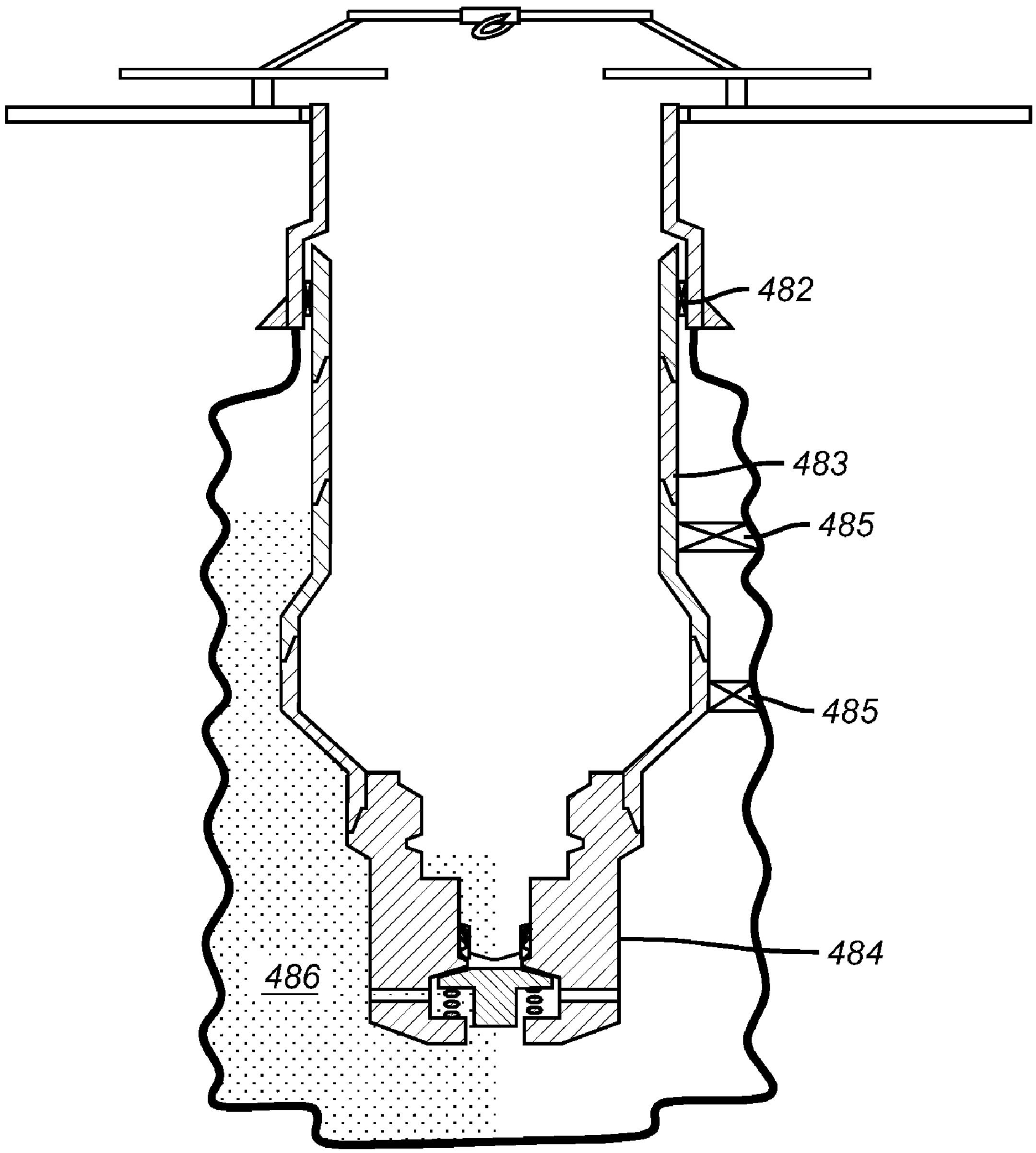


FIG. 52

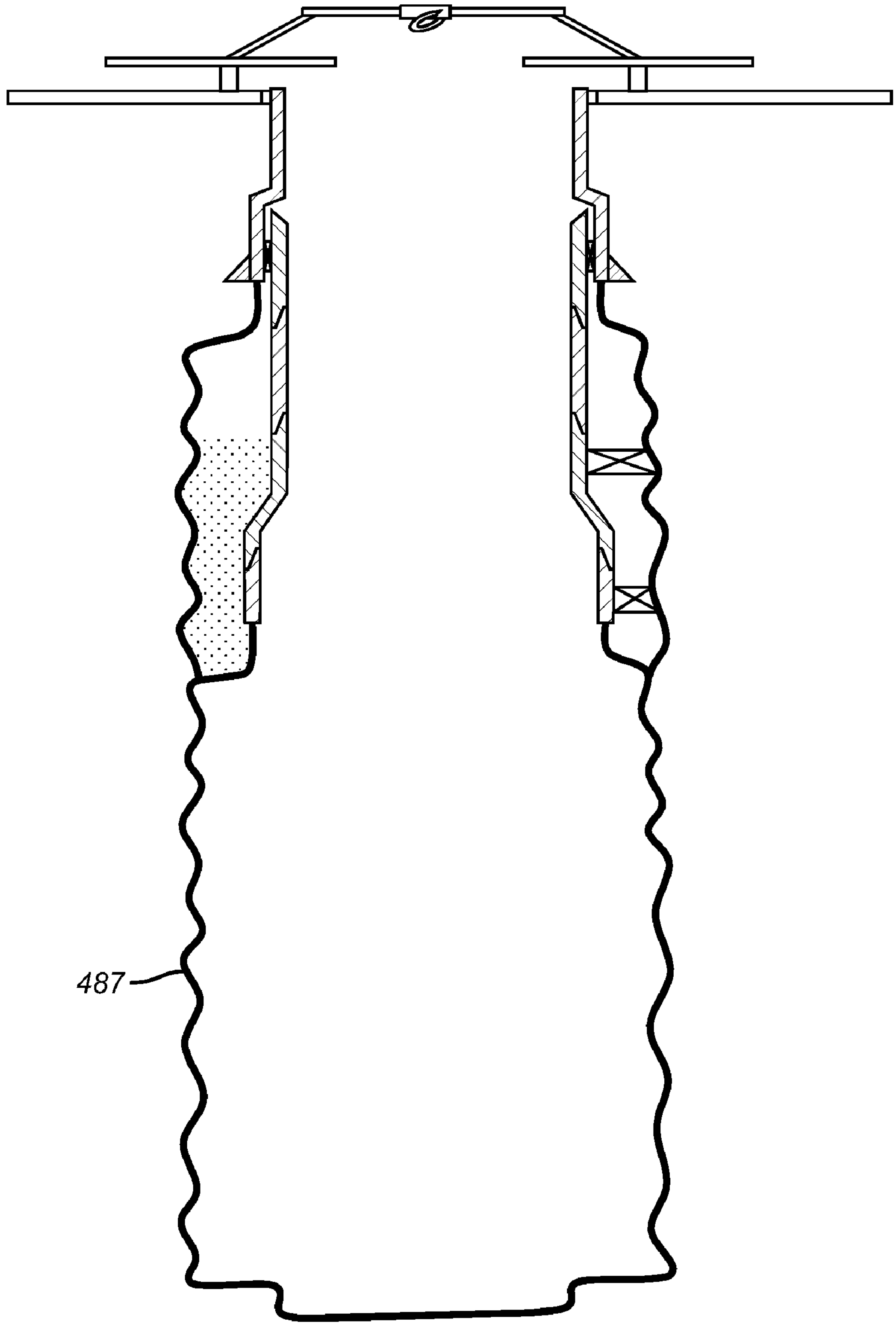


FIG. 53

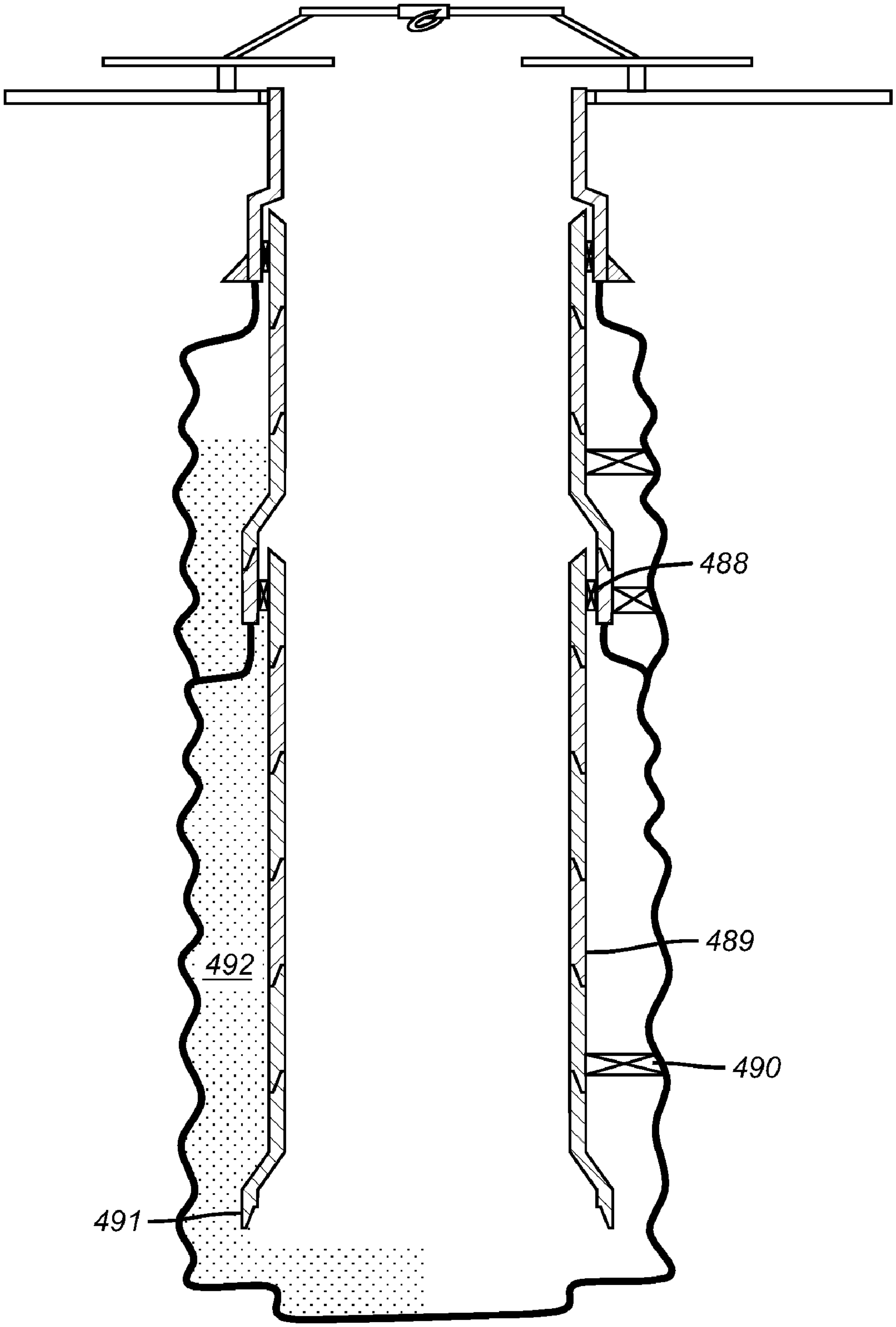


FIG. 54

METHOD FOR MAKING WELLBORE THAT MAINTAINS A MINIMUM DRIFT

PRIORITY INFORMATION

[0001] This application claims priority from U.S. Provisional Patent Application No. 61/087,269, filed on Aug. 8, 2008.

FIELD OF THE INVENTION

[0002] The field of the invention relates to techniques for tubular expansion and sealing in open hole with attachment techniques to an existing tubular.

BACKGROUND OF THE INVENTION

[0003] Various techniques have been developed to expand liners and attach them to existing casing already in the wellbore. Some of these techniques involve running a liner with a wide bell at the bottom where the expansion equipment is located and then driving the swage up the liner and out the top and along the way setting external seals to the surrounding casing as the swage makes an exit. One such process is shown in U.S. Pat. No. 6,470,966. The extensive list of prior art included in that patent is representative of the state of the art in downhole tubular expansion techniques that include attachment to an existing tubular. Other patents show the use of swages that include a series of retractable rollers that can be radially extended downhole to initiate a tubular expansion such as of a casing patch as for example is illustrated in U.S. Pat. No. 6,668,930. Some devices swage in a top to bottom direction as illustrated in U.S. Pat. No. 6,705,395.

[0004] What is needed and addressed by the present invention are refinements to the previous techniques that improve performance, mitigate risk and save time to reduce the cost to the operator. Techniques involving expansion in stages coupled with cementing in between are envisioned. An adjustable swage to expand on location removes the need for oversized bells to house the expansion equipment as done in some techniques. Techniques using cement or just sealing externally in open hole are envisioned. Composite materials facilitate subsequent drill out while improved shoe configuration improves circulation when tripping into the hole. The shoe and/or liner can be rotationally locked to work the string for delivery downhole. These and other advantages will become more apparent to one skilled in the art from a review of the description of the preferred embodiments and the associated drawings, while recognizing that the full scope of the invention is given by the claims.

SUMMARY OF THE INVENTION

[0005] An expansion and cementing assembly is run into the well as the expandable liner is made up. A work string is tagged into the expansion assembly and run to depth. Pressure drives the swage to initially expand and move uphole with the attached work string until the liner is expanded above the location of the subsequent cement placement. The assembly is then lowered to engage the guide/float shoe to perform the cementing step. The swage assembly is then released from the guide/float shoe and the balance of the expansion is performed without further expansion against the recently placed cement. The expansion assembly can start at the guide/float shoe or higher, in which case expansion can occur initially in a downhole direction and later be completed in an uphole direction. Variations without cementing are also contemplated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. **1** is a view of a wellbore that has been cased with an open hole segment below;

[0007] FIG. **2** is the view of FIG. **1** showing a liner with a float shoe inserted into the open hole segment through the casing;

[0008] FIG. **3** is the view of FIG. **2** with the swage assembly being run in;

[0009] FIG. **4** is the view of FIG. **3** with the circulation established through the swage assembly and the float shoe as the liner is run in;

[0010] FIG. **5** is the view of FIG. **4** with the swage assembly expanded but not yet driven;

[0011] FIG. **6** is the view of FIG. **5** with the swage assembly released from the supporting string and being driven down to the float shoe;

[0012] FIG. **7** is the view of FIG. **6** with the circulation re-established after the swage assembly engages the float shoe;

[0013] FIG. **8** is the view of FIG. **7** with the support string releasing the liner and being advanced further into the liner using additional stands added above;

[0014] FIG. **9** is the view of FIG. **8** with the swage assembly again latched to the supporting string and cement pumped through the float shoe to fill the annulus around the already expanded liner;

[0015] FIG. **10** is the view of FIG. **9** with the swage assembly now driven up to complete the expansion of the liner top into the casing;

[0016] FIG. **11** is the view of FIG. **10** with the swage assembly out of the fully expanded liner and the liner hanger to the surrounding casing engaged;

[0017] FIG. **12** is a view similar to FIG. **1** to illustrate an alternative method;

[0018] FIG. **13** is the view of FIG. **12** with the liner in the well showing a swage assembly connected to the float shoe;

[0019] FIG. **14** is the view of FIG. **13** with the work string run in to engage the swage assembly;

[0020] FIG. **15** is the view of FIG. **14** with the circulation established as the liner is run into the open hole;

[0021] FIG. **16** is the view of FIG. **15** with the swage assembly extended in the liner;

[0022] FIG. **17** is the view of FIG. **16** with the swage assembly pressure released from the float shoe and ready to move uphole;

[0023] FIG. **18** is the view of FIG. **17** with the swage assembly driven uphole;

[0024] FIG. **19** is the view of FIG. **18** with the swage assembly again engaged to the float show after initial expansion;

[0025] FIG. **20** is the view of FIG. **19** with the annulus around the expanded portion of the liner being cemented;

[0026] FIG. **21** is the view of FIG. **20** with the swage assembly driven up to complete the expansion above the cemented zone and engage the hanger on the liner to the casing;

[0027] FIG. **22** is the view of FIG. **21** with the swage assembly removed from the liner;

[0028] FIG. **23** is another view of FIG. **1** for an alternative embodiment without cementing the liner;

[0029] FIG. **24** is the view of FIG. **23** with the liner in the hole and suspended from the surface with an open hole packer outside the liner;

[0030] FIG. **25** is the view of FIG. **24** with the string latched into the swage assembly that is supported at the float shoe;

[0031] FIG. **26** is the view of FIG. **25** with the circulation established for running in the liner;

[0032] FIG. **27** is the view of FIG. **26** with the swage assembly expanded;

[0033] FIG. **28** is the view of FIG. **27** with the swage assembly released to move uphole from the float shoe;

[0034] FIG. **29** is the view of FIG. **28** with the liner expanded and the open hole packer set;

[0035] FIG. **30** is the view of FIG. **29** with the swage expanding the hanger on the liner into contact with the casing; and

[0036] FIG. **31** is the view of FIG. **30** with the swage assembly out of the liner and the float shoe ready to be drilled out or retrieved to the surface.

[0037] FIG. **32** shows an open hole that can be under reamed with respect to the cased hole above;

[0038] FIG. **33** shows a liner inserted and expanded to hang off the casing above with options to seal it with cement or external packers or both or neither;

[0039] FIG. **34** shows an under reamed open hole below the already expanded and hung off liner;

[0040] FIG. **35** shows a production string through the expanded liner and hung off the casing where the production string can be cemented or not as needed;

[0041] FIG. **36** shows a casing patch application using expansion;

[0042] FIG. **37** shows an open hole patch using expansion;

[0043] FIG. **38** shows an open hole patch in an under reamed hole;

[0044] FIG. **39** shows an under reamed open hole below a cased hole;

[0045] FIG. **40** is the view of FIG. **39** with a liner inserted and expanded to create a lower bell in the under reamed portion of the well;

[0046] FIG. **41** is the view of FIG. **40** with the shoe drilled out of the bottom of the expanded liner and further showing a variety of sizes of new hole to be drilled deeper;

[0047] FIG. **42** is the view of FIG. **41** with a production string run in and hung off the casing and optionally cemented;

[0048] FIG. **43** is the view of FIG. **41** with a second liner hung off from the bell of the liner above and optionally externally sealed with cement or/and one or more packers pr neither;

[0049] FIG. **44** is the view of FIG. **43** with the lower liner expanded in two dimensions to create a lower bell;

[0050] FIG. **45** is the view of FIG. **44** with the length of the liner below the liner lap expanded to allow for high setting a subsequent liner in the event of a hole collapse;

[0051] FIG. **46** shows a sequence of liners allowing the sidetrack exit while maintaining bore size;

[0052] FIG. **47** shows a cased hole with a bell on the lower end of the casing that can be there for run in or created with expansion of a subsequent liner and an under reamed open hole below;

[0053] FIG. **48** is the view of FIG. **45** with a liner run in and hung off in the casing bell and optionally sealed with cement or/and one or more external packers or neither;

[0054] FIG. **49** shows a casing with a lower bell and an upper liner hung from the bell with an open hole below the size of the expanded liner or under reamed; and

[0055] FIG. **50** is the view of FIG. **47** with a production liner inserted through the expanded liner above it and the production liner hung from above the bell in the casing;

[0056] FIG. **51** shows a cased hole with a bell on the lower end of the casing that can be there for run in or created with expansion of a subsequent liner and an under reamed open hole below.

[0057] FIG. **52** is the view of FIG. **51** with a liner run in and hung off in the casing bell with a second casing bell positioned at the bottom that can be created upon expansion of the liner or created with expansion of a subsequent liner and is optionally sealed with cement and/or one or more external packers or neither.

[0058] FIG. **53** is the view of FIG. **52** with the shoe drilled out and the open hole below under reamed to accommodate a subsequent liner.

[0059] FIG. **54** is the view of FIG. **53** with an additional liner shown run in and hung off as the one above it and as subsequent liners can also be installed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0060] FIG. **1** shows casing **10** in a wellbore **12** that extends from the surface **14**. The open hole portion **16** has a pilot hole **18** at the lower end. A rig **19** is illustrated schematically at the surface **14**. In FIG. **2** a liner **20** is supported from the rig **19** and extends into the open hole **16**. Liner **20** has a hanger/packer **22** on the outside that will eventually support the liner **20** and seal it to the casing **10**. A sealed latch assembly **24** is located inside the float shoe **26**. Float shoe **26** has a spring loaded one way valve **28** as well as a bottom exit **30** as well as side exits **32**. The side exits promote well conditioning during circulation when running in the liner **20**. The float shoe **26** allows flow in the liner **20** to exit but prevents reverse flow such as cement later pumped through the liner **20** and into the surrounding annulus **34**. The float shoe **26** can also be made of a soft composite material or other similar materials that promote rapid drill out after the cementing is completed.

[0061] FIG. **3** shows the insertion of an assembly **36** that comprises from the bottom up a latch component **38** designed to seal and latch to component **24** when brought into contact with it. Further uphole is a piston assembly **40** designed to selectively change the size of the adjustable swage **42** such as is illustrated in U.S. Pat. No. 7,128,146, for example. Further up is an uphole oriented swab cup **44** and a disconnect **46**. A section of pipe **50** spaces the lower swab cup **44** from an oppositely oriented upper swab cup **48**. Further up is a running tool **52** shown gripping the interior of the liner **20** and finally an annular debris barrier **54** is designed to keep debris from getting into the liner **20** as it is circulated when being run into the well **12**.

[0062] FIG. **4** shows a run in string **56** starting to be assembled above the debris barrier **54** and the liner **20** now supported through the string **56** off of rig **19** as it is delivered deeper into the wellbore with circulation through the assembly **36** represented by arrow **58** and return flow represented by arrow **60**. In this view it is easy to see the function of the debris barrier **54**. The valve **28** responds to delivered pressure from the surface **14** to open and let the flow out through the lateral shoe passages **32** to allow for a secondary flow path in case the bottom is plugged when resting on bottom.

[0063] In FIG. **5** a plug or dart or some other obstructing device **62** is dropped or pumped until landed to seal off passage **64**. Then with passage **64** closed at its lower end and pressurized the pressure **66** acts on piston assembly **40** as indicated by arrows **66**. The swage assembly **42** grows in radial dimension to create an initial bump out **68** in the liner **20**.

[0064] In FIG. **6** the pressure in passage **64** has been further increased to cause a separation between components **46** so that the applied pressure in passage **64** now can enter space **70** as indicated by arrows **72**. That pressure acts on lower swab cup **44** that looks uphole while the liner **20** which is gripped by running tool **52** and is supported off of string **56** from rig **19** remains immobile despite uphole pressure on upper swab cup **48** which is downhole oriented. Arrows **66** indicate that pressure on the piston assembly **40** continues to keep the swage assembly **42** at an enlarged dimension as it travels toward the float shoe **26** until components **38** and **24** re-latch and seal as shown in FIG. **7**.

[0065] In FIG. **7** components **38** and **24** have latched and a pressure buildup has popped a disc internal to dart **62** so that circulation can be established with the bulk of the liner **20** below the casing **10** already expanded. Arrows **72** and **74** represent circulation flow through passages **32** and **36** in the float shoe **26**.

[0066] FIG. **8** shows that circulation has stopped and the float shoe **28** is resting on bottom in the pilot hole **18**. The string **56** is being added to at the surface **14** to again bring together the connection **46** so that cementing around the already expanded portion of the liner **20** can take place.

[0067] In FIG. **9** the connection **46** is brought together in a sealing relationship and cement **76** is delivered into annulus **34** to the top **77** of the expanded portion of liner **20**. The cement **76** goes down passage **64** and through the one way valve **28** in the float shoe **26** to the annulus **34**. A wiper plug or dart **78** wipes passage **64** clear of the cement **76**. Optionally some cement **76** can be pumped above plug **78** to ease subsequent drill out as shown in FIG. **10**.

[0068] In FIG. **10** with wiper plug **78** remaining landed a buildup of pressure in passage **64** builds an uphole pressure on sealed latch **24** which has a downhole oriented swab cup **80** whose presence results in an uphole force represented by arrow **82** to drive the assembly **36** uphole to finish the expansion of the liner **20** into a sealed relationship with the casing **10**. The swage assembly **42** remains at maximum dimension because the piston assembly **40** is pressurized at this time as the movement uphole of the **36** continues.

[0069] FIG, **11** shows the expansion of the liner **20** to be complete and the hanger/packer **24** set to the casing **10** as a result of the conclusion of the expansion. It should be noted that the uphole oriented expansion of FIG. **10** does not occur against cement **76** already in annulus **34**. Rather, expansion continues once the extended swage assembly **42** reaches the location **77** which marked the end of expansion. The assembly **36** can now come all the way out of the liner **20**. The shoe **26** can now be drilled out and more hole can be drilled.

[0070] FIG. **12** begins another embodiment for a well with casing **100** and an open hole portion **102** terminating in a pilot hole **104**. In FIG. **13** a liner string **106** is supported from a rig **108**. At the bottom of the liner **106** is a float shoe **110** with a one way valve **112** and lateral exits **114**. The float shoe **110** has a seat **116** for landing a plug as will be later described. A latch assembly **118** releasably holds the swage assembly **120** and the piston assembly **122** that controls the dimension of the swage assembly **120** to the float shoe **110**. Above the piston assembly **122** is one portion **124** of a latch assembly. Outside the liner **106** is a hanger/packer **126**.

[0071] FIG. **14** shows a string **128** with another portion **130** of a connection that will seal and connect to portion **124**. Alternatively, the running string **128** could deliver the piston assembly **122** and the swage assembly **120** with a latch below that engages the float shoe **110**. This engagement can be with a type HRD running tool sold by Baker Oil Tools or an equivalent.

[0072] FIG. **15** shows the liner **106** lowered to the pilot hole **104** and circulation through string **128** out ports **112** and **114** and up through the annulus **133** as represented by arrows **132** and **134** as such lowering is taking place. A debris barrier **136** is at the top of liner **106** for the reason explained before. String **128** supports the liner **106** near its lower end using latch assembly **118**.

[0073] FIG. **16** shows that circulation has stopped and a plug **138** has been landed on seat **116** to allow pressure built up in string **128** to reach the piston assembly **122** so that its movement causes the swage assembly **120** move out to a larger dimension putting a bump out **142** in liner **106**. Further pressure buildup as shown in FIG. **17** releases the latch connection **118** to the float shoe **110**.

[0074] FIG. **18** shows pressure buildup against the plug **138** increasing the volume of chamber **144** as the swage assembly **120** continues to hold its enlarged dimension by virtue of continuous pressure on the piston assembly **122** schematically represented by arrow **140**. The uphole expansion is allowed to continue to a point below the bottom of the casing **100** but leaves the liner **106** expanded over substantially its entire length.

[0075] FIG. **19** shows the string **128** lowered so that latch **118** is back inside float shoe **110** and secured and a follow on pressure buildup blows a passage through the plug **138** so that the assembly is ready for cementing as shown in FIG. **20**. In FIG. **20** cement **145** is delivered through passages **112** and **114** at a pressure that keeps the piston assembly **122** ports closed. After cement **145** is delivered to annulus **133** up to location **146** on the liner **106** representing where expansion stopped, a wiper plug **148** is landed on the now opened plug **138**. Optionally some cement **145** can be pumped above plug **148** to ease subsequent drill out as shown in FIG. **20**.

[0076] Once again pressure is built up from the FIG. **20** position to cause latch **118** to release and to allow the swage assembly **120** held extended by piston assembly **122** that is now under pressure to be driven up through the already expanded portion to location **146** and then further up to the top of the liner **106**. The swage assembly **120** can optionally have a backup seal like a swab cup **150** shown in FIG. **20** so that it can keep a seal while driven up to the location **146** where expansion will continue until the hanger/packer **126** is against the casing **100**, as shown in FIG. **21**, and for continued movement until the entire liner **106** is expanded and all the expansion equipment is removed as shown in FIG. **22**. At that point the float shoe **110** can be milled out.

[0077] FIG. **23** starts an embodiment that tracks the previous embodiment only without cementing and instead using an open hole packer to seal the annulus around the expanded liner. As before a casing **200** is above an open hole **202** that is drilled or **204** if it is under-reamed. A rig **206** is at the surface **208**. As shown in FIG. **24**, the liner string **210** has a hanger/packer **212** for eventual support and sealing contact with the casing **200** and one or more external open hole packers **214**

such as for example FORMpac® or REPacker® sold by Baker Oil Tools. At the lower end of the liner **210** is a float shoe **216** with a one way valve **218** and side outlets **220** and a lower port **220**A. A latch assembly **222** is latched into the float shoe **216** for ultimate support of the liner **210** as will be explained below. Going uphole there is an adjustable swage assembly **224** with a piston operating assembly **226** and a connector profile **228**. FIG. **25** illustrates a running string **230** with a connector **232** at its lower end adapted to contact connector profile **228** for a supporting and sealed connection to allow running in the liner **210** to the pilot hole **234** as shown in FIG. **26**. As stated before for an alternative, the assembly that is above the float shoe **216** can be run into the liner **210** after the liner is assembled in the wellbore **202** or **204**. In FIG. **26**, string **230** is used to lower liner **210** while circulation represented by arrows **236** and **238** flowing through lateral outlets **220** and lower port **220**A facilitate the advancement of the liner **210**. A debris barrier **240** prevents debris from entering the liner **210** during circulation as it is advanced into the wellbore.

[0078] In FIG. **27** a plug **242** is landed to allow pressure buildup in the string that is represented by arrow **244**, This pressure actuates the piston assembly **226** to increase the size of the swage assembly **224** and to create a bump out **246** in the liner **210**. As shown in FIG. **28** further pressure increase and set down weight releases the latch assembly **222** so that the swage assembly **224** start being powered uphole with pressure and/or overpull. An optional seal such as a swab cup **248** could be used with the swage assembly **224** in the event that the swage assembly itself will not sufficiently seal against the liner it is trying to expand as better illustrated in FIG. **29**. Also in FIG. **29** the swage assembly is moved up the substantial length of the liner **210** with the result being that the open hole packer **214** is sealed against the open hole **202**. Multiple open hole packers can be run. Because there is no cementing in this embodiment, the swage assembly can be driven continuously until the hanger/packer is set against the casing **200** as shown in FIG. **30**. The expansion equipment is removed as shown in FIG. **31** out the top of the liner **210** and the float shoe **216** can be milled out.

[0079] The remaining FIGS. focus on some applications of the techniques described above. FIG. **32** shows a parent casing **300** and more hole drilled that can include under reaming as represented by **301** or simply an extension of the hole that is the size of the parent casing **300** as represented by the dashed line in FIG. **32**. This view was previously illustrated in other FIGS. discussed earlier.

[0080] FIG. **33** is a split view indication that liner **302** is hung off the casing **300** using a hanger/packer **320**. At the lower end is a shoe **303**. The view is split showing that liner **302** is sealed with cement **304** on the left or with an external packer or seal **305** on the right as an alternative. As another alternative the cement **304** and seal **305** can be used together. There can be one or more seals **305** employed. The packer **305** can seal either to the smaller or larger bore such as **301** depending on how the hole is drilled and which sealing device is used.

[0081] FIG. **34** shows the liner **302** expanded and hung off the parent casing **300** and the shoe **303** drilled out with the annulus around the liner **302** isolated. More hole **310** is drilled which could be a straight bore or an under reamed bore as actually shown.

[0082] FIG. **35** shows a second liner **311** through the expanded liner **302** and hung off the parent casing **300**. Although the liner **311** is shown cemented, it could also be in open hole without cement and it could be slotted. Alternatively it could be hung off liner **302** but hanging off the casing **300** allows a larger inside diameter for liner **311**. Additionally, the hanging of liner **311** from casing **300** allows for subsequent flow to be isolated from the expanded liner **302** which might have not have the required pressure capacity or corrosion resistance. The extension bore if under reamed allows lower circulation pressure when cementing the production liner **311**. The staging of the liners **302** and **311** allows different mud weights to be used to account for differing formation properties so as to avoid mud loss or formation damage during drilling and subsequent running of the string **311**.

[0083] FIG. **36** shows a casing patch application where the casing **400** has a break or a crack or is otherwise damaged **401** and a section of tubular **402** can be inserted into position and expanded by the techniques described above so that pair of straddling seals **403** are disposed on opposed sides of the break **401**. Alternatively, longer continuous seals can be expanded to cover the damaged sections in place of straddling. Alternatively, the tubular **402** can be expanded into the inside wall of the casing **400** without seals such as **403** and simple expansion results in a tight seal that can be metal to metal.

[0084] FIG. **37** illustrates an open hole patch application where additional hole **411** has been drilled past the casing **410** and in the open hole region there is a fluid loss zone, water or other undesirable fluid is being produced into the wellbore, and/or sloughing formation. The tubular patch **412** can be run in and expanded in the manner shown before with the use of external packers **413** to straddle the zone where the losses or unwanted inflow or sloughing is occurring. Alternatively, longer continuous seals can be expanded to cover the damaged sections in place of straddling. It should be noted that there may be a reduction in the drift diameter in the patch **412** as compared to the drift diameter of the casing **420** which will restrict the passage of bit and drill string assemblies, possibly leading to a smaller open hold being drilled below the open hole patch. However, FIG. **38** is the same view as FIG. **37** with the drilled hole **411** having been under reamed in the troublesome zone so that after expansion of the patch **412** to engage the seals **413** the drift diameter of the patch is at least as large as the drift diameter in the casing **420** and maintains the bit passage diameter for continuous drilling of the hole further.

[0085] FIG. **39** starts another sequence of views with a cased hole **430** and an under reamed open hole **431** below it. In FIG. **40** a liner **432** has been inserted and expanded to two diameters or possibly more diameters depending on the cone capabilities. The smaller diameter is in casing **433** and the larger diameter is in the under reamed open hole **431** below. As covered before, a shoe **434** can be run if cement **435** is the option selected or if the alternative of external packers **436** is used. In either even the shoe provides a seat as a part of the expansion process previously discussed. The inside dimension of the liner **437** in the open hole is at least as large as its inside diameter inside the casing **433**. In FIG. **41** the shoe **434** is drilled out and additional hole **438** is drilled with a possible variation of the degree of under reaming which accounts for the dashed and solid line in the FIG. The innermost dashed line **439** represents the hole that would be made with the largest bit to fit through the top of the liner **432** while the next series of dashed lines represent under reaming to get the inside dimension of the lower end **437** of the same liner that had previously been expanded into an under reamed portion of the well above. The solid line represents a continuation of the bore size above. FIG. **42** shows another tubular **440** which can be the production string inserted and optionally cemented with cement **441** although it could be left in open hole without cement. Essentially what will pass through the top **432** of the liner above can be used. Again the lower bore size depends on formation conditions and whether cementing is to be done. In FIG. **42** the hole is under reamed to be about the size of the expanded portion **437** of the liner above. The string **440** is hung and/or sealed off inside the casing **442** but could optionally be hung off the bell portion **437** of the upper liner. The latter is illustrated in FIG. **43** where the second liner **446** is expanded and hung and/or sealed off at **445** to the already expanded liner above and in the enlarged bell portion. The string **446** can be cemented **448** or sealed with external packers **447**. At the top, it can be hung from the bell of the previously expanded liner above using a hanger/packer **445**. Note that there is no reduction in drift size as between the smallest dimension of the liner above **432** and the expanded dimension of the string **446**. This is due to the lower string **446** being hung off in the bell of the liner above at hanger/packer **445**.

[0086] In FIG. **44** the upper and lower liners are expanded to two or more different dimensions. The lower liner is hung with hanger packer **452** in the bell of the liner above it. The lower portion **453** of the lower liner is flared out so that the choke points for flow are at the hanging areas of both liners and in each case there is no reduction of drift regardless how many strings are run and sequentially hung from the string above. Here again the option of cementing **455** or using an external packer or packers **454** is also illustrated. The process can be repeated to add additional expandable liners until depth is reached. Open hole production can be another option.

[0087] FIG. **45** shows a progression of FIG. **44** where the second liner **456** has been drilled out and the open hole **457** has been under reamed to accommodate another expandable liner. The third liner **458** is shown off bottom due to a collapse of the open hole **459**. Alternatively, the liner could become stuck in the open hole for a variety of reasons including differential sticking and fill. Although the third liner **458** did not reach its targeted depth, it is still able to be expanded in two or more dimensions, maintaining flexibility for further wellbore construction. The extended recess section length of the previous liner **456** accommodates the length that the third liner **458** is set high by means of a longer liner lap. It can therefore be seen that the extended recess diameter section of the previous liner increases the flexibility of operations and mitigates risk beyond that of a shorter recess length. If a shorter recess length were present in the second liner **456**, then the third liner **458** would not have been able to be expanded without restricting the pass through diameter.

[0088] FIG. **46** is a further embodiment of the operational flexibility and risk mitigation provided by the extended recess diameter length. A third liner **460** has been installed into the wellbore below a second expandable liner **461**. The third liner **460** is shown in a no longer useable form as collapsed. Alternatively, the third liner could be leaking, not fully expanded, or otherwise damaged. Alternatively, the open hole below an undamaged third liner **460** could render the third liner unusable if for example the open hole stopped producing hydrocarbons, started producing water, or opened up for fluid losses. The sidetrack technique is then employed above the third liner **460** milling a window out of the side of the second liner **461** in a section that has been expanded to the recess diameter. After the window is milled the open hole section is further drilled and under reamed as required to accommodate running in a fourth liner **463** out of the window. The fourth liner is expanded in two or more dimensions and a hanger packer **462** is hung and/or sealed off in the recess diameter section of the second liner **461**. The section of the fourth liner **463** outside of the milled window in the second liner **461** is able to be expanded to the recess diameter. Open hole isolation for the fourth liner **463** is accomplished with cement **464** and/or the use of open hole packer or packers **465**. The bottom of the fourth liner **463** has been drilled out for further wellbore construction. All of the operational flexibility and risk mitigation provided by the two or more dimension expansion of the fourth liner and the recess resulting can be utilized in further wellbore construction such as: several additional Monobore liners are able to be run, ability to perform additional sidetracks, ability to set subsequent liners off of bottom, and running production strings of pipe to produce reservoirs without reducing the size of these production strings due to restricted pass through.

[0089] FIG. **47** shows and upper casing **470** that has a bell at the lower end either in the condition installed or due to expansion into it of the first liner to be hung. In FIG. **45** there is no liner in the hole but the FIG. is intended to be schematic of both ways a bell can be formed. FIG. **48** shows a liner **473** hung with hanger/packer **472** in the bell of casing **470**. Again the shoe is used to expand the string **473** and to facilitate cementing **476** or use of an external packer or packers **475** or both or neither if production will occur from open hole. FIG. **49** shows the shoe **474** drilled out and the hole **477** extended to the diameter of the expanded liner above. It can be under reamed to make it even larger should the formation characteristics and the cement delivery pressure be an issue. Running clearance could also be an issue that would warrant under reaming for running in of the liner **478** shown in FIG. **50**. The production liner **478** can be cemented **479** or it can be in open hole without cement or sealed with external packers. The string **478** is hung off the smaller dimension of the casing above the bell where the upper liner is supported. As a result of two dimension expansion of the upper liner with the upper end in the bell of the casing and the upper wellbore under reamed, the resulting internal dimension to depth is not reduced and the use of the upper liner for staged completion of the well does not narrow the size of the production liner **478** which is dictated by the casing size where the production liner **478** is shown to be supported in FIG. **50**.

[0090] FIGS. **51-54** show a progression of the wellbore construction concepts shown in FIGS. **47-50** in which the subsequent liner also contains a bell for the sake of being able to repeat the process multiple times without restriction of pass through. FIG. **51** shows and upper casing **480** that has a bell **481** at the lower end either in the condition installed or due to expansion into it of the first liner to be hung. In FIG. **51** there is no liner in the hole but the FIG. is intended to be schematic of both ways a bell can be formed. FIG. **52** shows a liner **483** hung with hanger/packer **482** in the bell **481** of casing **480**. Again the shoe **484** is used to expand the string **483** and to facilitate cementing **486** or use of an external packer or packers **485** or both or neither. FIG. **52** shows a bell section at the bottom of the liner **483** that is created either as a part of the process of expansion of this string or upon the installation of subsequent liner. FIG. **53** shows the shoe **484** drilled out and the hole **487** drilled out and under reamed as above. FIG. **54**

shows the installation of a second liner **489** hung with a hanger/packer **488** in the bell of the previous liner. Zonal isolation is shown to be performed either with cement **492**, one or more open hole packers **490**, or both or neither. The second liner **489** contains a bell section **491** as the previous liner that can be used to hang off subsequent liners without restricting the wellbore.

[0091] Those skilled in the art will appreciate that the various embodiments offer many advantages that include improved circulation from the lateral ports in the float shoe and a fast drill out from using soft materials for the float shoe. There is an ability to transmit torque through the liner string as it is being advanced right down to the float shoe. Using an adjustable swage removes the need for a bell portion in the liner assembly reducing surge/swab effects. The liner is substantially expanded prior to cementing making for a smaller volume to cement with shorter pump times and earlier compressive strength. The balance of the expansion to tie the liner to the casing is not done against cement. The adjustable swage also allows removal through the liner at any time should the full expansion of the liner become impossible for some reason.

[0092] The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below.

We claim:

1. A method of creating a well while maintaining a minimum drift between or among when connected successive tubular strings, comprising:

providing at least one upper tubular string for support in a wellbore;

configuring said upper tubular string to have a hanging segment adjacent an upper end thereof whose internal dimension defines the drift dimension and an adjacent recess segment having a larger dimension than said internal dimension that defines said drift dimension;

positioning at least one lower tubular string through said internal dimension and overlapping said recess segment of said upper tubular string;

providing at least one of a sealing and a hanging device extending on said lower string down a predetermined distance from a top of said lower tubular string;

configuring the height of said recess dimension of said upper string to be substantially longer than said predetermined distance;

expanding said one of a sealing and hanging device of said lower tubular string into said recess segment so that the internal diameter of said predetermined distance is at least as large as said drift dimension.

2. The method of claim **1**, comprising:

configuring the height of said recess dimension of said upper string to be long enough to accommodate at least one window that allows said lower tubular string to exit through said recess segment of said upper tubular string.

3. The method of claim **2**, comprising:

creating a lateral by extending a portion of said lower tubular string through said window where the internal dimension of said window is at least as large as said drift dimension.

4. The method of claim **1**, comprising:

making the recess segment of said upper tubular string extend the balance of the overall length of said upper tubular string beyond said hanging segment.

5. The method of claim **1**, comprising:

extending the wellbore beyond said upper tubular string a sufficient depth to allow the top of said lower tubular string to reach a lower end within the recess segment of said upper tubular string;

being unable to fully advance said top of said lower tubular string to said lower end of said recess segment of said upper tubular string;

securing said at least one of a hanging and a sealing device on said lower tubular string to said recessed segment of said upper tubular string at whatever location said lower tubular string ceases to advance.

6. The method of claim **3**, comprising:

creating at least one lateral drift dimension by adding at least one liner string to said lateral beyond said window.

7. The method of claim **1**, comprising:

expanding another portion of said second tubular string to a larger dimension than said internal dimension that defines said drift to create a second tubular string recess segment.

8. The method of claim **7**, comprising:

configuring said recess segment on said lower tubular string at least as long as said recess segment on said upper tubular string.

9. The method of claim **7**, comprising:

creating a main bore with at least said upper and lower tubular strings that retains said drift dimension.

10. The method of claim **9**, comprising:

providing at least one lateral from said main bore through at least one of said recess segments using another string.

11. The method of claim **1**, comprising:

sealing an annular space around at least one of said upper and lower tubular strings with a sealing material.

12. The method of claim **1**, comprising:

sealing an annular space around at least one of said upper and lower tubular strings with an open hole packer.

13. The method of claim **12**, comprising:

using a swelling sealing element in said open hole packer.

14. The method of claim **11**, comprising:

sealing an annular space around at least one of said upper and lower tubular strings with an open hole packer.

* * * * *