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(54) **GRAVEL PACK INNER STRING ADJUSTMENT DEVICE**

INNENSTRANGEINSTELLUNGSVORRICHTUNG FÜR EIN KIESPAKET

DISPOSITIF DE RÉGLAGE DE TRAIN DE TIGES INTERNE POUR ENSEMBLE DE GRAVILLONNAGE

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(56) References cited:
US-A- 4 433 725
US-A1- 2003 141 075
US-B1- 6 349 770

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This is a continuation-in-part of U.S. Appl. No. 12/913,981, filed 28-OCT-2010.

[0002] This application is filed concurrently with U.S. Pat. Appl. No. 13/345,418 and entitled "One Trip Toe-to-Heel Gravel Pack and Liner Cementing Assembly" (205-0260US).

BACKGROUND

[0003] Some oil and gas wells are completed in unconsolidated formations that contain loose fines and sand. When fluids are produced from these wells, the loose fines and sand can migrate with the produced fluids and can damage equipment, such as electric submersible pumps (ESP) and other systems. For this reason, completions can require screens for sand control.

[0004] Horizontal wells that require sand control are typically open hole completions. In the past, stand-alone sand screens have been used predominately in these horizontal open holes. However, operators have also been using gravel packing in these horizontal open holes to deal with sand control issues. The gravel is a specially sized particulate material, such as graded sand or proppant, which is packed around the sand screen in the annulus of the borehole. When applied, the gravel acts as a filter to keep any fines and sand of the formation from migrating with produced fluids.

[0005] In a gravel pack assembly for a horizontal open hole, proper linear spacing of an inner service tool relative to outer components of the assembly can be particularly important. Operators typically run fixed pipe lengths down the assembly and rely on pipe tallies and available pipe lengths to determine the correct space out for the service tool in the assembly. Unfortunately, the lengths of any screens and the service tool in the horizontal open hole can be considerable, and relying on pipe tallies to achieve correct spacing may prove difficult.

[0006] Additionally, the service tool for a gravel pack assembly is typically moved to perform various functions during gravel pack operations. Due to well depth, deviation, tubing stretch, friction, and the type of gravel pack completion to be run, determining the position of the service tool downhole in the assembly can be very difficult. This is especially true in long horizontal gravel pack completions. In the end, pumping of sand slurry when the tool is in an incorrect position in the assembly can cause the service tool to stick and can have catastrophic consequences.

[0007] Typically, mechanical indicating collets have been used in the prior art to locate the service tool in the assembly. Additionally, "smart" collets have been used, which reciprocate between a relaxed position and a propped position for positive identification of the service tool's location. Unfortunately, mechanical indication may not always work due to high drag forces and other issues involved in moving the service tool in the downhole assembly.

[0008] US 6 349 770 B1 discloses a space-out compensating apparatus and method for sequentially and simultaneously landing an anchor seal assembly into a previously run downhole packer, and landing a tubing hanger into a wellhead, so that the integrity of the seals in the anchor seal assembly of the tool is not compromised, and the completion can be concluded in a single run.

[0009] US 2003/141075 A1 discloses an apparatus and method for achieving proper space-out of well components. One aspect of the disclosure utilizes a dummy production string with a sliding measurement device to measure the proper space-out distance.

[0010] The subject matter of the present disclosure is directed to overcoming, or at least reducing the effects of, one or more of the problems set forth above.

SUMMARY

[0011] As noted above, proper linear spacing of an inner service tool relative to outer components of a downhole assembly can be particularly important. To deal with this issue, an adjustment device is used to adjust a length of an inner string deployed in a downhole assembly, such as a toe-to-heel gravel pack assembly. The device has first and second (tubular) members telescopically coupled together. The first member is coupled to one portion of the inner string, while the second member is coupled to another portion of the inner string. A ratchet disposed on the first member can engage a catch on the second member to fix the length of the adjustment device. The ratchet can include a dog having a plurality of chamfered teeth. The catch, which is movable relative to the ratchet, can include a plurality of grooves defined around the outside of the second member to engage the teeth of the ratchet dog.

[0012] The inner string and device are deployed in the downhole assembly to determine proper space out of the inner string for subsequent operation, such as gravel packing. When deployed, the first and second members of the device are in an extended condition. When the inner string eventually bottoms out in the assembly, the ratchet allows the second member to move in one direction relative to the first member so the device can collapse and shorten the length of the inner string. A key between the two members can ride in a slot, which allows the two members to slide relative to one another but not rotate.

[0013] When the inner string is then pulled up from the downhole assembly, the ratchet engages the catch (*i.e.*, the teeth on the dog engages in the grooves) to prevent the second member from moving in an opposite direction relative to the first member. In this way, the device does not extend again as the inner string is pulled uphole so the device is maintained in one fixed length.

[0014] When the device is brought to the surface, operators can permanently maintain the adjustment device

in its fixed length determined downhole by installing a locking element between first and second telescoping members. For example, operators can replace the ratchet dogs with chamfered teeth with locking dogs having unchamfered teeth. Engaged in the grooves of the catch, the locking dog will prevent movement of the second member in either direction inside the first member.

[0015] As noted previously, knowing the location of a downhole inner string in a downhole assembly can facilitate operations. To deal with this issue, a downhole assembly, such as a gravel pack assembly, has a body defining a body passage therethrough. First sealing surfaces or seats disposed in the body passage separate a sealable space in the body passage. For example, these seats can be polished surfaces in the body passage having a smaller diameter than the rest of the passage.

[0016] An inner string, such as an inner string of a gravel pack assembly, is movably disposed in the body passage and defines a bore for communicating fluid from a surface pump to an outlet port on the inner string. A valve in the bore can divert the pumped fluid out the outlet port.

[0017] First seals disposed on the inner string selectively seal with the first seats when the inner string is moved in the body. When this occurs, the outlet port communicates the pumped fluid into the sealable space of the body, which produces a measureable pressure buildup. Using the pressure buildup as an indication, a first position of the inner string can then be correlated to the known location of the sealable space in the downhole assembly. A second position for the inner string in the body can then be calculated based on a known distance in the downhole assembly from the first location to a second location of another feature, such as a port in the assembly. Being able to determine positions for the inner string allows operators to more properly position the inner string to desired locations in the downhole assembly during gravel pack or other operations.

[0018] The foregoing summary is not intended to summarize each potential embodiment or every aspect of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 shows a gravel pack assembly having an adjustment device and a hydraulic locating device for an inner string.

Fig. 2 shows a cross-section of an adjustment device according to the present disclosure.

Fig. 3 shows a detail of a ratchet dog and grooves for the disclosed adjustment device.

Figs. 4A-4B shows the adjustment device in a fully collapsed state along different cross-sectional planes.

Fig. 5A shows portion of the assembly and locating device in an initial stage of engagement.

Fig. 5B shows portion of the assembly and locating device in a sealed stage of engagement.

Fig. 5C shows portion of the assembly and locating device in a subsequent stage of engagement.

Fig. 6 shows portion of the assembly having another locating device with an integral housing.

DETAILED DESCRIPTION

A. Downhole Assembly

[0020] Figure 1 shows a downhole assembly 100 having an adjustment device 30 and a locating device 160 according to the present disclosure. As shown, the downhole assembly 100 is a gravel pack assembly, although other type of assemblies used downhole can benefit from the disclosed devices 30 and 160. As one example, a cementing assembly for cementing a liner in an open borehole may benefit from the disclosed devices 30 and 160. With the benefit of the present disclosure, other suitable downhole assemblies for one or both of the devices 30 and 160 will be apparent to one of ordinary skill in the art.

[0021] The gravel pack assembly 100 has multiple gravel pack sections 102A-B, but the assembly 100 can generally have one or more sections. With multiple sections 102A-B, however, the assembly 100 segments compartmentalized reservoir zones so that multiple gravel pack and frac pack operations can be performed in the borehole 10. Isolating elements 104, such as packers, can dispose between these gravel pack sections 102A-B to isolate them from one another.

[0022] In any event, the gravel pack assembly 100 can be similar to the gravel pack assemblies disclosed in U.S. Appl. Ser. No. 12/913,981. As such, the gravel pack assembly 100 is a toe-to-heel gravel pack system that allows operators to pack the borehole 10 from the toe to heel in each section 102A-B. In the depicted configuration, each gravel pack section 102A-B has two screens 140A-B, alternate path devices or shunts 150, and ported housings 130A-B with ports 132A-B, although any of the other disclosed variations can be used.

[0023] Briefly, gravel pack operations with the assembly 100 involve initially deploying an inner string 110 into the first gravel pack section 102A. A conveyance 20 manipulates the inner string 110 and can use any of the conveyance methods known in the art. During operations, a pumping system 22 can pump fluid and/or slurry for a gravel or frac pack operation down the inner string 110 as needed, and a pressure sensor 24 can detect a buildup of pressure caused by the pumped fluid. Many of these features are conventional components and are not described in detail here.

[0024] Once the inner string 110 is deployed in the assembly 100, the uphole packer 14 on a liner hanger and other packers 104 along the assembly 100 remain unset. Operators pump washdown fluid through the inner string 110, and the circulated fluid leaves the string's outlet ports 112 and passes through a float shoe 122 of a shoe

track 120 at the end of the first section 102A. In washing down the borehole 10, the circulated fluid passes through the annulus and uphole so the fluid can enter the casing 12 and return to the surface.

[0025] After washdown and setting of the packers 14 and 104, the assembly 100 can commence with gravel pack operations. The string's outlet ports 112 with its seals 114 isolate in fluid communication with the lower flow ports 132A in the first housing 130A of the first section 102A. Positioning the string's ports 112 with the flow ports 132A requires operators to calculate distances and determine the string's position in the assembly 100 relative to the ports' locations. To help with these procedures, the assembly 100 uses a hydraulic locating device 160 as discussed in detail below. As shown, the device 160 is preferably located between the shoe track 120 and the ported housing 130A.

[0026] With the string's ports 112 communicating with the first ports 132A, slurry can then be pumped down the inner string 110 to gravel and frac pack the surrounding zone of the borehole 10. As the slurry enters the surrounding borehole annulus, gravel packing of the first section 102A occurs in a toe-to-heel arrangement as discussed in detail in U.S. Appl. Ser. No. 12/913,981.

[0027] Once sandout occurs at this port 132A, the inner string 110 can again be moved so that the outlet ports 112 isolate to upper flow ports 132B connected to the shunts 150 in this first section 102A. Slurry pumped down the inner string 110 can then fill the borehole annulus around the lower end of the shoe track 120, which can be done to further pack the borehole 10 or to dispose of excess slurry from the string 110.

[0028] Operations can then proceed with similar steps being repeated up the borehole 10 for each of the subsequent gravel pack sections (e.g., 102B) separated by the intervening packers 104. Again, additional details and steps in the operation of the toe-to-heel gravel pack system 100 of Figure 1 are provided in U.S. Appl. Ser. No. 12/913,981 so they are not repeated here in detail.

B. Adjustment Device

[0029] As noted previously, proper linear spacing of a service tool relative to outer assembly components can be important, especially in a horizontal open hole. Rather than running fixed pipe lengths and relying on a pipe tally and available pipe lengths to achieve correct space out for the inner string 110, operators make up the adjustment device 30 on the inner string 110 above the outlet ports 112 and seals 114. The device 30 allows operators to achieve proper spacing, which is even more critical in the toe-to-heel assembly 100 of the present disclosure.

[0030] Notably, the inner string 110 in this toe-to-heel assembly 100 first locates at the bottom of the shoe track 120 to communicate washdown fluid out the float shoe 122 as described above. The gravel pack operation then proceeds with the inner string 110 being moved to a number of flow ports 132 along the assembly 100. If the inner string 110 is not run or spaced out properly, then operations will not proceed effecting, and the assembly 100 may become damaged.

[0031] To help space out the inner string 110, the adjustment device 30 has an upper member 40 with a distal member 60 telescopically disposed therein. Thus, the distal member 60 is linearly expandable and collapsible relative to the upper member 40. Before actually commencing gravel pack operations, operators make up the device 30 in its extended condition on the inner string 110 and then run the inner string 110 and the expanded adjustment device 30 downhole. Eventually, the inner string 110 tags against the bottom of the gravel pack assembly 100, and the adjustment device 30 collapses until the upper member 40 of the adjustment device 30 (or some other portion of the inner string 110) shoulders out. At this point, the inner string 110 has obtained its proper space out length in the assembly 100.

[0032] At the surface, operators mark the exposed pipe to indicate the extent of pipe used during run-in, and operators then raise the adjustment device 30 and inner string 110 back out of the well. As the adjustment device 30 is pulled uphole, the device 30 at least temporarily locks in position so the adjustment device 30 maintains a fixed length. At the surface, operators then fix the current length of the adjustment device 30 to prevent further adjustment. Finally, operators run the inner string 110 and fixed device 30 back downhole into the assembly 100, and the determined space out will put the bottom of the inner string 110 in the desired location in the first gravel pack section 102A, as needed.

[0033] Figure 2 shows the adjustment device 30 in more detail. As noted previously, the device 30 includes an upper (tubular) member 40 and a distal (tubular) member 60 telescopically disposed therein. Although the device 30 is shown with two telescoping members 40 and 60, more members could be used.

[0034] At its uphole end, the upper member 40 has a coupling 42 that couples to uphole components (not shown), such as an uphole portion of the inner string (110). The distal member 60 extends from the upper member's downhole end, and the two members 40 and 60 may be initially held in an extended condition by shear pins 46 or the like. Ratchet dogs 50 are disposed in slots 45 around the outside of the upper member 40, and a retaining sleeve 44 disposed on the upper member 40 helps hold the ratchet dogs 50 in place. Seals 62 on the distal member 60 engage inside the upper member 40 to inhibit fluid flow between the members 40 and 60.

[0035] The outside of the distal member 60 has catches or grooves 65 spaced apart from one another along most of the member's length. The actual length of the members 40 and 60 can be much greater than depicted in Figure 2 so that the distal member 60 can expand and collapse a considerable distance as need for an implementation.

[0036] In Figure 2, the device 30 is shown extended as when it is initially run downhole. When fully extended,

the ratchet dogs 50 engage in the topmost catch grooves 65 on the distal member 60. After the device 30 locates on bottom in the assembly 100, the members 40 and 60 collapses, and the ratchet dogs 50 ratchet up the catch grooves 65 on the distal member 60.

[0037] Figure 3 shows a detail of the ratchet dogs 50 engaging in catch grooves 65 on the distal member 60. The ratchet dogs 50 have a number of teeth 55 with chamfered leading edges. As the distal member 60 moves into the upper member 40, the chamfered teeth 55 let the catch grooves 65 pass thereby.

[0038] Springs 52 disposed behind the ratchet dogs 50 bias them toward the surface of the distal member 60 so the teeth 55 can engage in the catch grooves 65. The springs 52 can be leaf springs or other types of biasing elements. Preferably, the catch grooves 65 are arranged in sets to engage the multiple teeth 55 on the ratchet dogs 50, but it will be appreciated that a number of ratcheting mechanisms can be used, including those conventionally used in downhole tools for packers or sliding sleeves.

[0039] As the inner string 110 is disposed in the assembly 100 and engages bottom, the members 40 and 60 collapse together until the upper member 40 (or some other part of the inner string 110) shoulders out in the assembly 100. Shouldering can be achieved in a number of ways. For example, the assembly 100 can have a restricted passage that allows the distal member 60 to pass therethrough when bottoming out in the assembly 100, but the restricted passage engages the upper member 40 when moved against it.

[0040] Once the device 30 is collapsed and shoulders out, operators pull up the inner string 110 to the surface. Operators remove the retaining sleeve 44 and replace the ratchet dogs 50 with locking dogs (not shown) in the slots 45. These locking dogs (not shown) can be similar to the ratchet dogs 50, but they lack ratcheting chamfers so the locking dogs will not ratchet in the distal member's catch grooves 65. Operators then make up the sleeve 44 so the locking dogs are held and distal member 40 is permanently locked in position. At this point, operators can redeploy the inner string 110 with the device 30 in its fixed length downhole to proceed with gravel pack operations.

[0041] Figures 4A-4B show different cross-sections of the adjustment device 30 in a fully collapsed position. Figure 4A shows the ratchet dogs 50 disposed in the upper member 40 for engaging the outer catch grooves 65 in the distal member 60. In general, one or more such dogs 50 can be used, but the dogs 50 are preferably arranged consistently about the circumference of the members 40 and 60, although they need not be at the same longitudinal location.

[0042] Figure 4B shows a key 70 disposed in the upper member 40 and held by the sleeve 44. The key 70 rides within a longitudinal groove 67 along a length of the distal member 60. Thus, the two members 40 and 60 can slide relative to one another, but the key 70 prevents rotation of the members 40 and 60 relative to one another. Although one key 70 is shown, more than one key 70 may be used.

C. Locating Device

[0043] As can be seen in the toe-to-heel gravel pack assembly 100 of Figure 1, the inner string 110 runs to the very bottom of the assembly 100 to the shoe track 120 for washdown during gravel pack operations. Then, the inner string 110 is manipulated in the assembly 100 to a number of ports 132A-132B and other positions to perform the gravel pack operations in the various sections 102A-B. As will be appreciated, knowing the location (distance) of various features (ports, etc.) relative to the position of the inner string 110 in the assembly 100 can help operators move and position the inner string 110 properly and effectively in the assembly 100 during operations.

[0044] To that end, the gravel pack assembly 100 includes one or more locating device 160 disposed thereon for locating the inner string 110 at different positions in the assembly 100. As shown in Figure 1, one of the locating devices 160 can be disposed near the shoe track 120 between the float shoe 122 and the first ports 132A on the ported housing 130A of the first section 102A. Having the device 160 in this location allows operators to correlate the inner string's position to at least one location in the assembly 100, and preferably the furthest location. As will be appreciated, the length of the assembly 100, the length of the inner string 110 to reach the assembly's end, drag forces, friction, possible deflection, and other factors may make conventional techniques for locating the inner string 110 in the assembly 100 difficult. Therefore, having the locating device 160 in this distal location of the assembly 100 can be beneficial for determining other positions for the inner string 110 in the assembly 100.

[0045] Knowing this one location of the device 160 at the distal extent and knowing the details and dimensions of the assembly 100 disposed downhole, operators can then calculate distances to other locations (i.e., ports 132A-B) on the assembly 100 so other positions for the placement of the inner string 110 can be determined. If desired, the locating device 160 could be located elsewhere on the assembly 100.

[0046] Moreover, more than one locating device 160 can be used on the assembly 100 so several locations can be determined along the assembly 100 during operations. For example, each section 102A-B of the assembly 100 can have a comparable locating device 160 so positions for the inner string 110 can be determined at multiple locations when performing operations. In the end, this can help operators find the various ports 132A-B individually in the sections 102A-B.

[0047] Rather than using mechanical techniques for location, which can be unreliable, the locating device 160 uses hydraulic techniques for locating the position of the

inner string 110 in the assembly 100. Turning to Figures 5A-5C, portion of the assembly 100 is shown with the inner string 110 disposed in a locating device 160. Here, the locating device 160 includes a tubular 161 connected by a downhole coupling 162 to the shoe track 120 and connected by an uphole coupling 163 to a ported housing 130. Again, the device 160 could be located elsewhere on the assembly 100, in which case the couplings 162, 163 would couple to other components, such as between uphole and downhole sections 102A-B of the assembly 100.

[0048] Rather than using separate couplings 162, 163 as shown, the device 160 can be an integral component as shown in Figure 6 having its tubular housing 161 with coupling members formed thereon. Either way, the device 160 of Figures 5A-5C and 6 has an inner passage 165 that is in fluid communication with passages 135 and 125 of the housing 130 and shoe track 120. The inner passage 165 forms a sealable space with internal sealing surfaces or seats 164 disposed at both ends. These seats 164 can be internal polished surfaces with a reduced diameter from the other passages 125/135/165.

[0049] The inner string 110 has external seals 114 disposed one each side of outlet ports 112. The seals 114 are adapted to engage the inner polished seats 164 of the couplings 161, 163 as discussed below. (A reverse arrangement may also be used in which the couplings 161, 163 have internal seals for engaging polished surfaces or seats on the inner string 110.) As shown here, the inner string 110 also includes a valve (i.e., seat 116 and dropped ball 118) that can close off fluid flow down the string 110 and divert the flow out the outlet ports 112. Other valve arrangements could also be used, or the distal end of the inner string 110 can be permanently closed off.

[0050] As shown in Figure 5A, as the inner string 110 passes uphole in the assembly 100 from the shoe track 120 (or a lower section 102) to the locating device 160, circulated fluid is pumped slowly down the string 110 and is diverted out the outlet ports 112. (In general, the circulated fluid can be any suitable fluid used during gravel/frac pack operations. Preferably, the circulated fluid is water, brine, or some other type of carrying or washdown fluid. Although less desirable, the circulated fluid could include gravel packing slurry or frac treatment.)

[0051] As it is pumped, the circulated fluid can flow downhole in the annulus between the string 110 and assembly 100 (i.e., shoe track 120 and other downhole component). Eventually as shown in Figure 5A, the upper seal 114 of the string 110 engages the lower seat 164 of the locating device 160.

[0052] With further uphole movement of the string 110 as shown in Figure 5B, the outlet ports 112 reach the inner passage 165 of the device 160, and the seals 114 engage the seats 164. This creates a sealed space of the passage 165 in the device 160 that is isolated from uphole and downhole portions of the assembly's inner passages 135 and 125. The sealing between the seals 114 and the seats 164 may be intended to inhibit flow and may not necessarily create a fluid tight seal.

[0053] As the string 110 reaches this sealable space of the passage 165, fluid pumped slowly down the inner string 110 to the string's outlet ports 112 creates a measureable buildup in pressure, which can be detected by the pressure sensor (24) at the surface or elsewhere on the assembly 100. Further movement of the string 110 uphole eventually moves the seals 114 out of the device 160 as shown in Figure 5C. At this point, the circulated fluid can exit the outlet ports 112 and can pass up the annulus so there is no more measurable pressure buildup.

[0054] When the pressure buildup occurs with the string's ports 112 sealed at the locating device 160, operators can identify this buildup and can associate the string's current position with the location of the device 160 on the assembly 100. From this known location and the known dimensions and configuration of the assembly 100 deployed downhole, other position for positioning the inner string 110 can be calculated for other desired locations on the assembly 100. Movement to these other positions can be easily achieved by further moving the inner string 110 the calculated distances to the other locations of the assembly 100.

[0055] The locating device 160 works regardless of the amount of pipe and drag in the inner string 110 when manipulated in the assembly 100. Therefore, at any time during operations, this known location of the device 160 can be found by movement of the string 110 and slow pumping until indication is observed so calculations to other locations can be determined.

[0056] Movement of the inner string 110 in the assembly 100 of Figures 5A-5C has been uphole. The locating device 160, however, can operate equally as well with downhole movement of the string 110 in the device 160. Furthermore, although the locating device 160 has been used on a particular gravel pack assembly 100 in which gravel packing occurs from toe-to-heel, the features of the locating device 160 and inner string 110 can be used on any suitable downhole assembly in which circulated fluid from a port on the string 110 can help locate the string's position in the locating device 160 and further help determine other positions for the string 110 in the downhole assembly. For example, the locating device 160 could be used with a conventional gravel pack assembly and a crossover tool, or the locating device 160 could be used with a cementing assembly and a service tool. Additionally, the locating device 160 can be helpful in locating an inner string in a number of downhole components, such as locating in an extend reach frac pack assembly, a multi-zone frac system, an inflatable packer, and others. Accordingly, the above-description directed to the particular gravel pack assembly 100 is meant to be illustrative of a particular application of the disclosed subject matter.

[0057] The foregoing description of preferred and other embodiments is not intended to limit or restrict the scope

or applicability of the inventive concepts conceived of by the Applicants. It will be appreciated with the benefit of the present disclosure that features described above in accordance with any embodiment or aspect of the disclosed subject matter can be utilized, either alone or in combination, with any other described feature, in any other embodiment or aspect of the disclosed subject matter.

[0058] In exchange for disclosing the inventive concepts contained herein, the Applicants desire all patent rights afforded by the appended claims. Therefore, it is intended that the appended claims include all modifications and alterations to the full extent that they come within the scope of the following claims.

Claims

1. A method for communicating fluid to a borehole (10) having a downhole assembly (100) disposed therein, the downhole assembly (100) having at least one first port (122, 132) for fluid communication outside the downhole assembly (100), the method comprising:

   installing an adjustment device (30) on an inner string (110) for running downhole, the adjustment device (30) being collapsible to a plurality of fixed lengths, the inner string (110) having at least one second port (112) for fluid communication outside the inner string (110);
   deploying the adjustment device (30) and the inner string (110) downhole in the downhole assembly (100);
   adjusting a length of the inner string (110) while downhole by collapsing the adjustment device (30) to one of the fixed lengths when bottoming out the inner string (110) in the downhole assembly (100);
   pulling up the adjustment device (30) and the inner string (110) in the downhole assembly (100);
   maintaining the adjustment device (30) in the one fixed length; and
   redeploying the fixed adjustment device (30) and the inner string (110) downhole in the assembly (100) with the at least one second port (112) of the inner string (110) spaced out a known distance relative to the at least one first port (122, 132) of the downhole assembly (100).

2. The method of claim 1, wherein deploying the adjustment device (30) and the inner string (110) downhole in the downhole assembly (100) comprises deploying the adjustment device (30) in an extended condition.

3. The method of claim 1 or 2, wherein maintaining the adjustment device (30) in the one fixed length and redeploying the fixed adjustment device (30) comprises locking the adjustment device (30) in the one fixed length and redeploying the inner string (110) with the adjustment device (30) in the locked length.

4. The method of claim 1, 2, or 3, wherein collapsing the adjustment device (30) to one of the fixed lengths comprises telescoping a first member (60) of the adjustment device (30) into a second member (40) of the adjustment device (30), and optionally wherein maintaining the adjustment device (30) in the one fixed length comprises:

   catching the first member (60) in the one fixed length in the second member (40), and optionally
   installing a locking element between first and second telescoping members (40, 60) of the adjustment device (30).

5. The method of claim 4, further comprising preventing rotation of the first and second members (40, 60) relative to one another.

6. The method of any one of claims 1 to 5, further comprising:

   positioning the at least one second port (112) on the inner string (110) relative to the at least one first port (122, 132); and
   conducting fluid down the inner string (110) to the at least one second port (112) positioned relative to the at least one first port (122, 132).

7. A device for communicating fluid to a borehole (10) having a downhole assembly (100) disposed therein, the downhole assembly (100) having at least one first port (122, 132) for fluid communication outside the downhole assembly (100), the device comprising:

   an inner string (110) deploying in the downhole assembly (100) and having at least one second port (112) for fluid communication outside the inner string (110), the inner string (110) comprising a first member (40) coupled to one portion of the inner string (110) deploying in the downhole assembly (100); and a second member (60) telescopically coupled to the first member (40), the second member (60) coupled to another portion of the inner string (110) deploying in the downhole assembly (100); and
   means for adjusting a length of the inner string (110) while downhole comprising:

      means for collapsing the second member (60) relative to the first member (40) to one of a plurality of fixed lengths when bottoming

out the inner string (110) in the downhole assembly (100),
means (50, 65) for ratcheting movement of the first member (40) in one direction relative to the second member (60), and
means (50, 65) for preventing movement of the second member (60) in an opposite direction relative to the first member (40),

wherein the first and second members (40, 60) adjusting the length of the inner string (110) space out the at least one second port (112) of the inner string (110) a known distance relative to the at least one first port (122, 132) of the downhole assembly (100).

8. The device of claim 7,
wherein for the means (50, 65) for adjusting, at least one ratchet (50) is disposed on the first member (40); and at least one catch (65) is disposed on the second member (60) and movable relative to the at least one ratchet (50),
wherein the at least one ratchet (50) allows the second member (60) to move in one direction relative to the first member (40), and
wherein the at least one ratchet (50) engages in the at least one catch (65) and prevents the second member (60) from moving in an opposite direction relative to the first member (40).

9. The device of claim 7 or 8, wherein the means (50, 65) for adjusting or the at least one ratchet (50) comprises a dog having at least one tooth with a chamfer in the one direction.

10. The device of claim 9, wherein the means (50, 65) for adjusting or the at least one catch (65) comprises a groove defined on the second member (60) and engaging the at least one tooth of the dog (50) in an opposite direction.

11. The device of claim 10, wherein the dog (50) has a plurality of the at least one tooth, and wherein the at least one catch (65) has a set of the at least one groove engaging the teeth of the dog (50).

12. The device of any one of claims 7 to 11, wherein the means for adjusting (50, 65) or the at least one catch (65) comprises a plurality of grooves defined along a length of the second member and engageable with the at least one ratchet (50) in a number of fixed lengths of the second member (60) relative to the first member (40).

13. The device of any one of claims 7 to 12, further comprising means (67, 70) for preventing rotation of the first and second members (40, 60) relative to one another.

14. The device of claim 13, wherein the means (67, 70) for preventing rotation comprises:

a slot (67) defined on one of the first and second members (40, 60); and
a key (70) disposed on the other of the first and second members (40, 60) and movable in the slot (67), the key (70) in the slot (67) preventing rotation of the first and second members (40, 60) relative to one another.

15. The device of any one of claims 7 to 14, further comprising means for locking the first and second members in the one fixed length.

Patentansprüche

1. Verfahren zum Weiterleiten von Fluid zu einem Bohrloch (10), das eine Bohrlochbaugruppe (100) hat, die in demselben angeordnet ist, wobei die Bohrlochbaugruppe (100) wenigstens eine erste Öffnung (122, 132) zur Fluidweiterleitung außerhalb der Bohrlochbaugruppe (100) hat, wobei das Verfahren Folgendes umfasst:

das Installieren einer Einstellungsvorrichtung (30) an einem inneren Strang (110) zum Betrieb unter Tage, wobei die Einstellungsvorrichtung (30) auf mehrere festgelegte Längen zusammenschiebbar ist, wobei der innere Strang (110) wenigstens eine zweite Öffnung (112) zur Fluidweiterleitung außerhalb des inneren Strangs (110) hat,
das Einsetzen der Einstellungsvorrichtung (30) und des inneren Strangs (110) unter Tage in der Bohrlochbaugruppe (100),
das Einstellen einer Länge des inneren Strangs (110), während er sich unter Tage befindet, durch das Zusammenschieben der Einstellungsvorrichtung (30) auf eine der festgelegten Längen, wenn der innere Strang (110) in der Bohrlochbaugruppe (100) unten aufgesetzt wird,
das Hochziehen der Einstellungsvorrichtung (30) und des inneren Strangs (110) in der Bohrlochbaugruppe (100),
das Halten der Einstellungsvorrichtung (30) in der einen festgelegten Länge und
das Umsetzen der festgelegten Einstellungsvorrichtung (30) und des inneren Strangs (110) unter Tage in der Baugruppe (100) wobei die wenigstens eine zweite Öffnung (112) des inneren Strangs (110) eine bekannte Strecke im Verhältnis zu der wenigstens einen ersten Öffnung (122, 132) der Bohrlochbaugruppe (100) nach außen beabstandet ist.

2. Verfahren nach Anspruch 1, wobei das Einsetzen der Einstellungsvorrichtung (30) und des inneren Strangs (110) unter Tage in der Bohrlochbaugruppe (100) das Einsetzen der Einstellungsvorrichtung (30) in einem ausgefahrenen Zustand umfasst.

3. Verfahren nach Anspruch 1 oder 2, wobei das Halten der Einstellungsvorrichtung (30) in der einen festgelegten Länge und das Umsetzen der festgelegten Einstellungsvorrichtung (30) das Arretieren der Einstellungsvorrichtung (30) in der einen festgelegten Länge und das Umsetzen des inneren Strangs (110) mit der Einstellungsvorrichtung (30) in der arretierten Länge umfasst.

4. Verfahren nach Anspruch 1, 2 oder 3 wobei das Zusammenschieben der Einstellungsvorrichtung (30) auf eine der festgelegten Längen das Einschieben eines ersten Elements (60) der Einstellungsvorrichtung (30) in ein zweites Element (40) der Einstellungsvorrichtung (30) umfasst und wobei wahlweise das Halten der Einstellungsvorrichtung (30) in der einen festgelegten Länge Folgendes umfasst:

das Erfassen des ersten Elements (60) in der einen festgelegten Länge in dem zweiten Element (40) und wahlweise
das Installieren eines Arretierungselements zwischen dem ersten und dem zweiten teleskopischen Element (40, 60) der Einstellungsvorrichtung (30).

5. Verfahren nach Anspruch 4, das ferner das Verhindern einer Drehung des ersten und des zweiten Elements (40, 60) im Verhältnis zueinander umfasst.

6. Verfahren nach einem der Ansprüche 1 bis 5, das ferner Folgendes umfasst:

das Anordnen der wenigstens einen zweiten Öffnung (112) an dem inneren Strang (110) im Verhältnis zu der wenigstens einen ersten Öffnung (112, 132) und
das Leiten von Fluid den inneren Strang (110) hinab zu der wenigstens einen zweiten Öffnung (112), die im Verhältnis zu der wenigstens einen ersten Öffnung (112, 132) angeordnet ist.

7. Vorrichtung zum Weiterleiten von Fluid zu einem Bohrloch (10), das eine Bohrlochbaugruppe (100) hat, die in demselben angeordnet ist, wobei die Bohrlochbaugruppe (100) wenigstens eine erste Öffnung (122, 132) zur Fluidweiterleitung außerhalb der Bohrlochbaugruppe (100) hat, wobei die Vorrichtung Folgendes umfasst:

einen inneren Strang (110), der in der Bohrlochbaugruppe (100) ausgefahren wird und wenigstens eine zweite Öffnung (112) zur Fluidweiterleitung außerhalb des inneren Strangs (110) hat, wobei der innere Strang (110) ein erstes Element (40), das an einen Abschnitt des inneren Strangs (110) gekoppelt ist, der in der Bohrlochbaugruppe (100) ausfährt, und ein zweites Element (60), das teleskopisch an das erste Element (40) gekoppelt ist, wobei das zweite Element (60) an einen anderen Abschnitt des inneren Strangs (110) gekoppelt ist, der in der Bohrlochbaugruppe (100) ausfährt, umfasst, und
Mittel zum Einstellen einer Länge des inneren Strangs (110), während er sich unter Tage befindet, die Folgendes umfassen:

Mittel zum Zusammenschieben des zweiten Elements (60) im Verhältnis zu dem ersten Element (40) auf eine der festgelegten Längen, wenn der innere Strang (110) in der Bohrlochbaugruppe (100) unten aufgesetzt wird,
Mittel (50, 65) zum Rasten einer Bewegung des ersten Elements (40) in einer Richtung im Verhältnis zu dem zweiten Element (60) und
Mittel (50, 65) zum Verhindern einer Bewegung des zweiten Elements (60) in einer entgegengesetzten Richtung im Verhältnis zu dem ersten Element (40),
wobei das erste und das zweite Element (40, 60), welche die Länge des inneren Strangs (110) einstellen, die wenigstens eine zweite Öffnung (112) des inneren Strangs (110) um eine bekannte Strecke im Verhältnis zu der wenigstens einen ersten Öffnung (122, 132) der Bohrlochbaugruppe (100) beabstanden.

8. Vorrichtung nach Anspruch 7,
wobei für die Mittel (50, 65) zum Einstellen wenigstens eine Sperrklinke (50) an dem ersten Element (40) angeordnet ist und wenigstens eine Falle (65) an dem zweiten Element (60) angeordnet und im Verhältnis zu der wenigstens einen Sperrklinke (50) beweglich ist,
wobei die wenigstens eine Sperrklinke (50) ermöglicht, dass sich das zweite Element (60) in einer Richtung im Verhältnis zu dem ersten Element (40) bewegt, und
wobei die wenigstens eine Sperrklinke (50) in der wenigstens einen Falle (65) in Eingriff kommt und verhindert, dass sich das zweite Element (60) in einer entgegengesetzten Richtung im Verhältnis zu dem ersten Element (40) bewegt.

9. Vorrichtung nach Anspruch 7 oder 8, wobei die Mittel (50, 65) zum Einstellen oder die wenigstens eine Sperrklinke (50) einen Mitnehmer umfassen, der we-

nigstens einen Zahn mit einer Abschrägung in der einen Richtung hat.

10. Vorrichtung nach Anspruch 9, wobei die Mittel (50, 65) zum Einstellen oder die wenigstens eine Falle (65) eine Rille umfassen, die an dem zweiten Element (60) definiert ist und den wenigstens einen Zahn des Mitnehmers (50) in einer entgegengesetzten Richtung in Eingriff nimmt.

11. Vorrichtung nach Anspruch 10, wobei der Mitnehmer (50) mehrere von dem wenigstens einen Zahn hat und wobei die wenigstens eine Falle (65) einen Satz der wenigstens einen Rille hat, der die Zähne des Mitnehmers (50) in Eingriff nimmt.

12. Vorrichtung nach einem der Ansprüche 7 bis 11, wobei die Mittel (50, 65) zum Einstellen oder die wenigstens eine Falle (65) mehrere Rillen umfassen, die entlang einer Länge des zweiten Elements geformt sind und mit der wenigstens einen Sperrklinke (50) in einer Anzahl von festgelegten Längen des zweiten Elements (60) im Verhältnis zu dem ersten Element (40) in Eingriff gebracht werden können.

13. Vorrichtung nach einem der Ansprüche 7 bis 12, die ferner Mittel (67, 70) zum Verhindern einer Drehung des ersten und des zweiten Elements (40, 60) im Verhältnis zueinander umfasst.

14. Vorrichtung nach Anspruch 13, wobei die Mittel (67, 70) zum Verhindern einer Drehung Folgendes umfassen:

einen Schlitz (67), der an dem einen von dem ersten und dem zweiten Element (40, 60) definiert ist, und
einen Keil (70), der an dem anderen von dem ersten und dem zweiten Element (40, 60) angeordnet und in dem Schlitz (67) beweglich ist, wobei der Keil (70) in dem Schlitz (67) eine Drehung des ersten und des zweiten Elements (40, 60) im Verhältnis zueinander verhindert.

15. Vorrichtung nach einem der Ansprüche 7 bis 14, die ferner Mittel zum Arretieren des ersten und des zweiten Elements in der einen festgelegten Länge umfasst.

Revendications

1. Procédé pour acheminer un fluide jusqu'à un trou de forage (10) qui comporte un assemblage de fond de puits (100) disposé en son sein, l'assemblage de fond de puits (100) comportant au moins un premier orifice (122, 132) pour une communication de fluide à l'extérieur de l'assemblage de fond de puits (100), le procédé comprenant :

l'installation d'un dispositif de réglage (30) sur une colonne interne (110) pour une utilisation en fond de puits, le dispositif de réglage (30) pouvant être replié selon une pluralité de longueurs fixes, la colonne interne (110) comportant au moins un second orifice (112) pour une communication de fluide à l'extérieur de la colonne interne (110) ;
le déploiement du dispositif de réglage (30) et de la colonne interne (110) en fond de puits dans l'assemblage de fond de puits (100) ;
le réglage d'une longueur de la colonne interne (110) tandis qu'elle est en fond de puits en repliant le dispositif de réglage (30) selon l'une des longueurs fixes lorsque la colonne interne (110) touche le fond dans l'assemblage de fond de puits (100) ;
la remontée du dispositif de réglage (30) et de la colonne interne (110) dans l'assemblage de fond de puits (100) ;
le maintien du dispositif de réglage (30) selon la longueur fixe définie ; et
le redéploiement du dispositif de réglage fixe (30) et de la colonne interne (110) en fond de puits dans l'assemblage de fond de puits (100), l'au moins un second orifice (112) de la colonne interne (110) étant espacé d'une distance connue par rapport à l'au moins un premier orifice (112, 132) de l'assemblage de fond de puits (100).

2. Procédé selon la revendication 1, dans lequel le déploiement du dispositif de réglage (30) et de la colonne interne (110) en fond de puits dans l'assemblage de fond de puits (100) comprend le déploiement du dispositif de réglage (30) dans une condition étendue.

3. Procédé selon la revendication 1 ou 2, dans lequel le maintien du dispositif de réglage (30) selon la longueur fixe définie et le redéploiement du dispositif de réglage fixe (30) comprennent le blocage du dispositif de réglage (30) selon la longueur fixe définie et le redéploiement de la colonne interne (110) tandis que le dispositif de réglage (30) est selon la longueur bloquée.

4. Procédé selon la revendication 1, 2 ou 3, dans lequel le repliement du dispositif de réglage (30) selon l'une des longueurs fixes comprend l'emboîtage par effet télescopique d'un premier élément (60) du dispositif de réglage (30) à l'intérieur d'un second élément (40) du dispositif de réglage (30), et en option, dans lequel le maintien du dispositif de réglage (30) selon la longueur fixe définie comprend :

la capture du premier élément (60) selon la longueur fixe définie dans le second élément (40) ; et en option
l'installation d'un élément de blocage entre les premier et second éléments à effet télescopique (40, 60) du dispositif de réglage (30).

5. Procédé selon la revendication 4, comprenant en outre l'empêchement de la rotation des premier et second éléments (40, 60) l'un par rapport à l'autre.

6. Procédé selon l'une quelconque des revendications 1 à 5, comprenant en outre :

le positionnement de l'au moins un second orifice (112) sur la colonne interne (110) par rapport à l'au moins un premier orifice (122, 132) ; et le fait de faire dévaler un fluide le long de la colonne interne (110) jusqu'à l'au moins un second orifice (112) qui est positionné par rapport à l'au moins un premier orifice (122, 132).

7. Dispositif pour acheminer un fluide jusqu'à un trou de forage (10) qui comporte un assemblage de fond de puits (100) disposé en son sein, l'assemblage de fond de puits (100) comportant au moins un premier orifice (122, 132) pour une communication de fluide à l'extérieur de l'assemblage de fond de puits (100), le dispositif comprenant :

une colonne interne (110) qui est déployée dans l'assemblage de fond de puits (100) et qui comporte au moins un second orifice (112) pour une communication de fluide à l'extérieur de la colonne interne (110), la colonne interne (110) comprenant un premier élément (40) qui est couplé à une section de la colonne interne (110) qui est déployée dans l'assemblage de fond de puits (100) ; et un second élément (60) qui est couplé de façon télescopique au premier élément (40), le second élément (60) étant couplé à une autre section de la colonne interne (110) qui est déployée dans l'assemblage de fond de puits (100) ; et
des moyens pour régler une longueur de la colonne interne (110) tandis qu'elle est en fond de puits comprenant :

des moyens pour replier le second élément (60) par rapport au premier élément (40) selon l'une d'une pluralité de longueurs fixes lorsque la colonne interne (110) touche le fond dans l'assemblage de fond de puits (100) ;
des moyens (50, 65) pour permettre le déplacement par effet de cliquet du premier élément (40) dans une direction par rapport au second élément (60) ; et
des moyens (50, 65) pour empêcher le déplacement du second élément (60) dans une direction opposée par rapport au premier élément (40) ;
dans lequel les premier et second éléments (40, 60) qui règlent la longueur de la colonne interne (110) ont pour effet que l'au moins un second orifice (112) de la colonne interne (110) est espacé d'une distance connue par rapport à l'au moins un premier orifice (122, 132) de l'assemblage de fond de puits (100).

8. Dispositif selon la revendication 7,
dans lequel, pour les moyens (50, 65) pour régler, au moins un cliquet (50) est disposé sur le premier élément (40) ; et au moins un moyen de capture (65) est disposé sur le second élément (60) et peut être déplacé par rapport à l'au moins un cliquet (50) ;
dans lequel l'au moins un cliquet (50) permet que le second élément (60) soit déplacé dans une direction par rapport au premier élément (40) ; et
dans lequel l'au moins un cliquet (50) est engagé dans l'au moins un moyen de capture (65) et il empêche que le second élément (60) ne soit déplacé dans une direction opposée par rapport au premier élément (40).

9. Dispositif selon les revendications 7 ou 8, dans lequel les moyens (50, 65) pour régler ou l'au moins un cliquet (50) comprennent un chien qui comporte au moins une dent présentant un chanfrein dans la direction définie.

10. Dispositif selon la revendication 9, dans lequel les moyens (50, 65) pour régler ou l'au moins un moyen de capture (65) comprennent une gorge qui est définie sur le second élément (60) et qui engage l'au moins une dent du chien (50) dans une direction opposée.

11. Dispositif selon la revendication 10, dans lequel le chien (50) comporte une pluralité de l'au moins une dent, et dans lequel l'au moins un moyen de capture (65) comporte un jeu de l'au moins une gorge engageant les dents du chien (50).

12. Dispositif selon l'une quelconque des revendications 7 à 11, dans lequel les moyens pour régler (50, 65) ou l'au moins un moyen de capture (65) comprennent une pluralité de gorges qui sont définies suivant une longueur du second élément et qui peuvent être engagées par l'au moins un cliquet (50) sur un certain nombre de longueurs fixes du second élément (60) par rapport au premier élément (40).

13. Dispositif selon l'une quelconque des revendications 7 à 12, comprenant en outre un moyen (67, 70) pour

empêcher la rotation des premier et second éléments (40, 60) l'un par rapport à l'autre.

14. Dispositif selon la revendication 13, dans lequel le moyen (67, 70) pour empêcher la rotation comprend :

une fente (67) qui est définie sur l'un des premier et second éléments (40, 60) ; et
une clavette (70) qui est disposée sur l'autre des premier et second éléments (40, 60) et qui peut être déplacée dans la fente (67), la clavette (70) dans la fente (67) empêchant la rotation des premier et second éléments (40, 60) l'un par rapport à l'autre.

15. Dispositif selon l'une quelconque des revendications 7 à 14, comprenant en outre des moyens pour bloquer les premier et second éléments selon la longueur fixe définie.

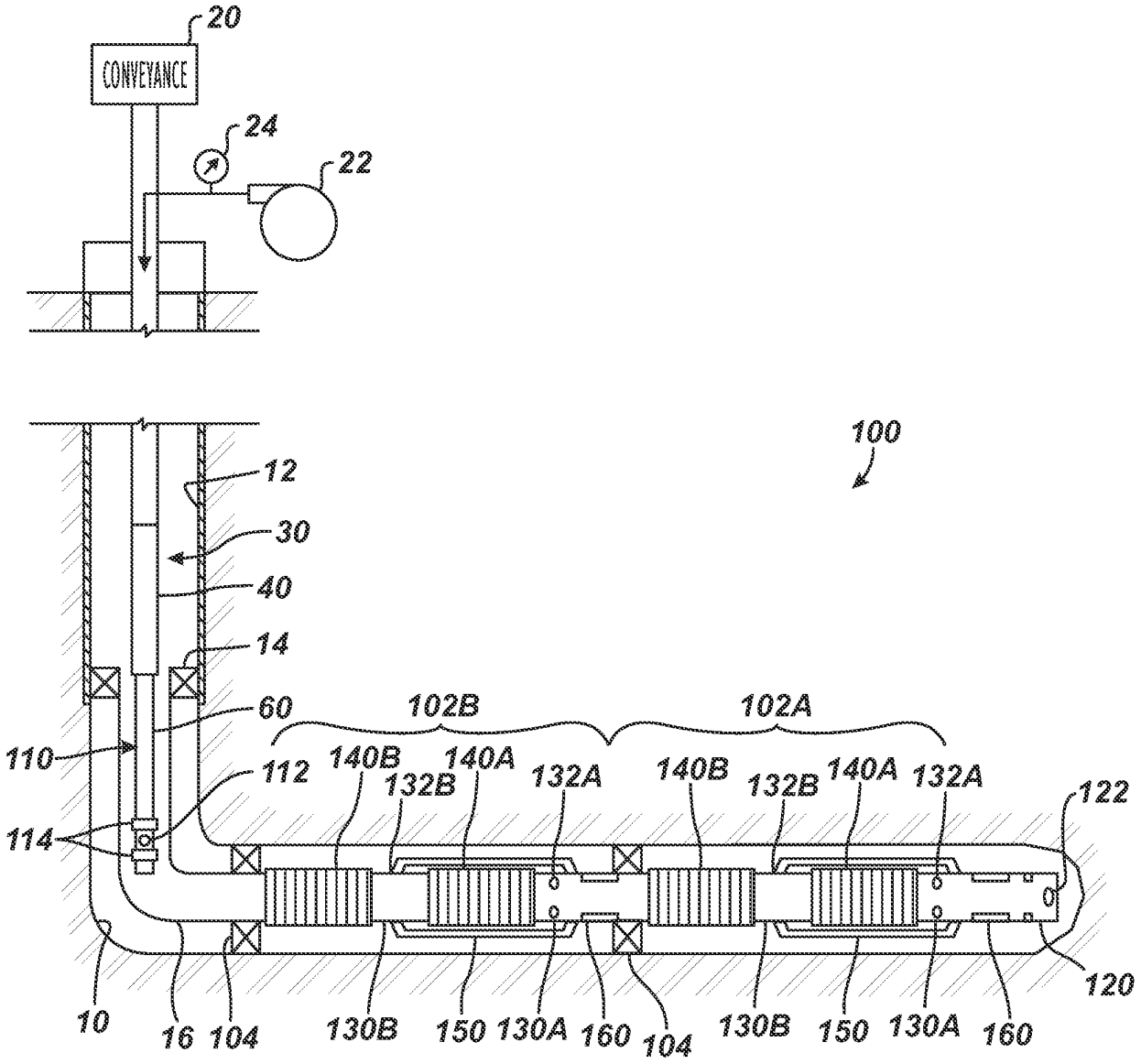

20
CONVEYANCE
24
22
100
12
30
40
14
60
102B
102A
110
112
140B
140A
132B
132A
140B
132B
140A
132A
122
114
120
10
16
104
130B
150
130A
160
104
130B
150
130A
160

FIG. 1

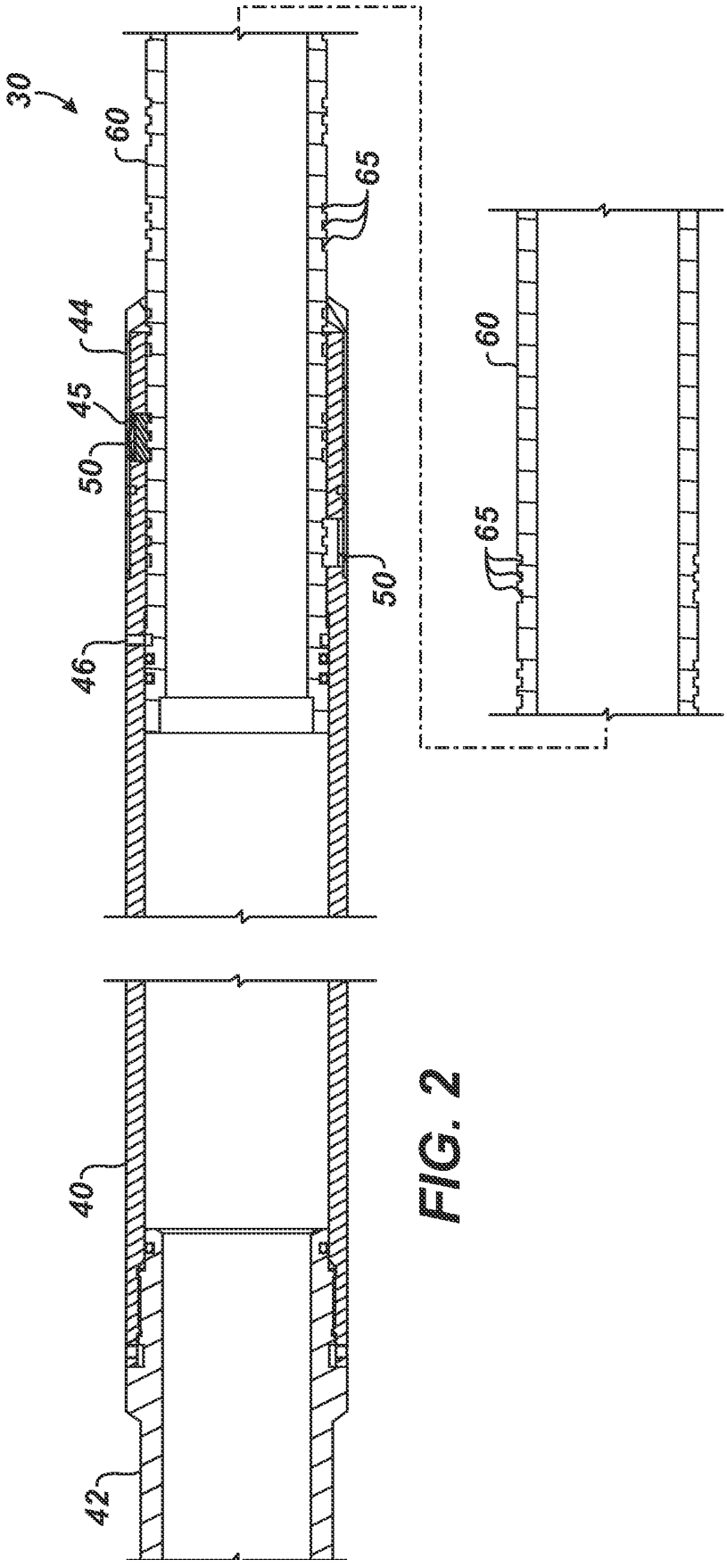


FIG. 2

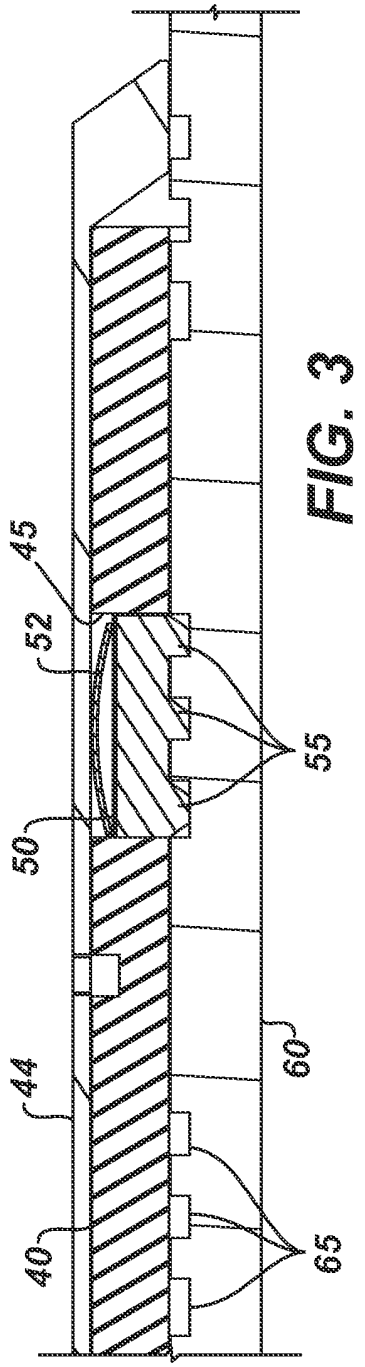


FIG. 3

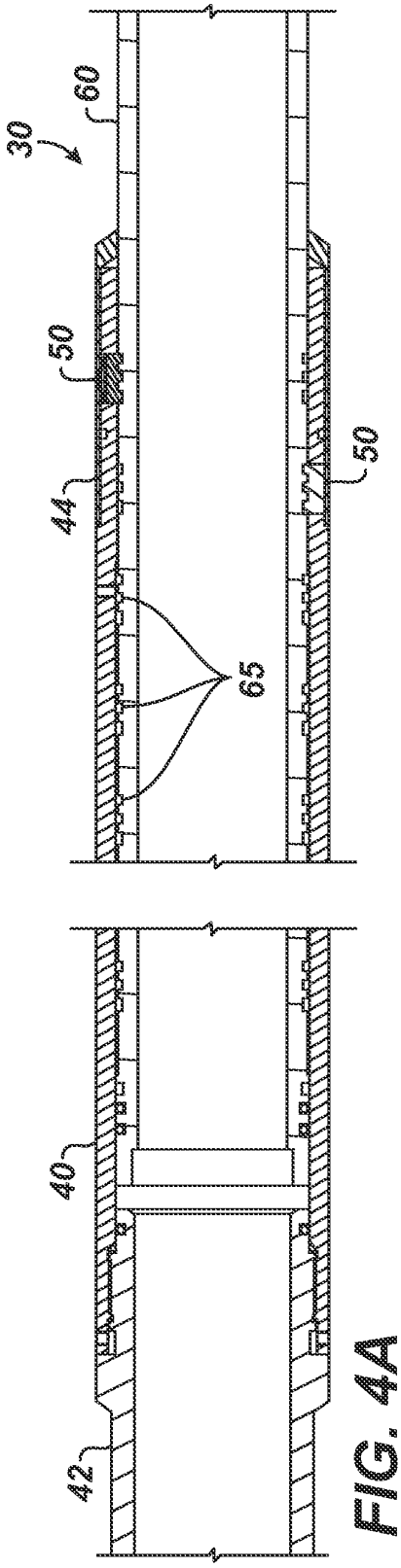


FIG. 4A

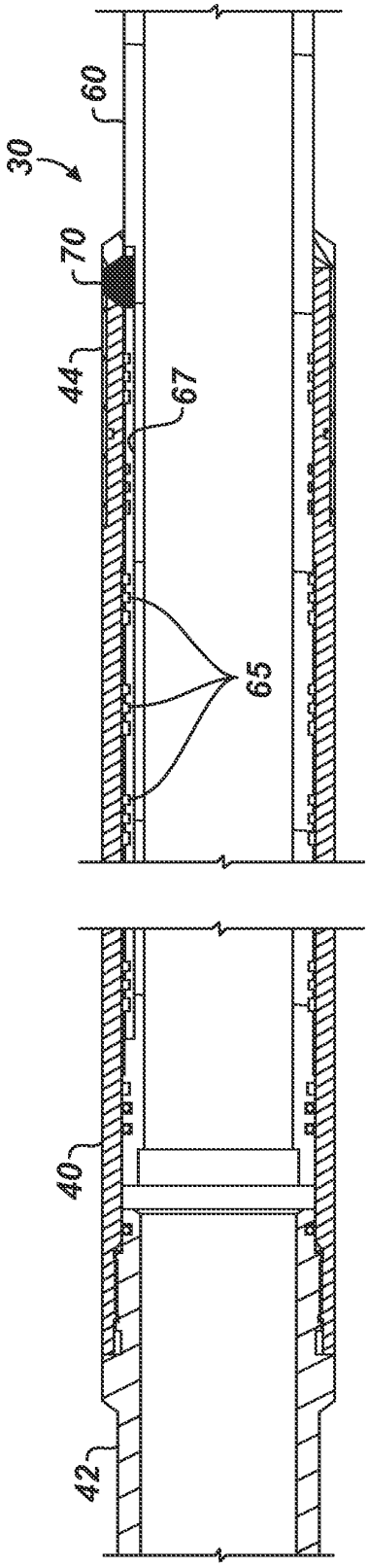


FIG. 4B

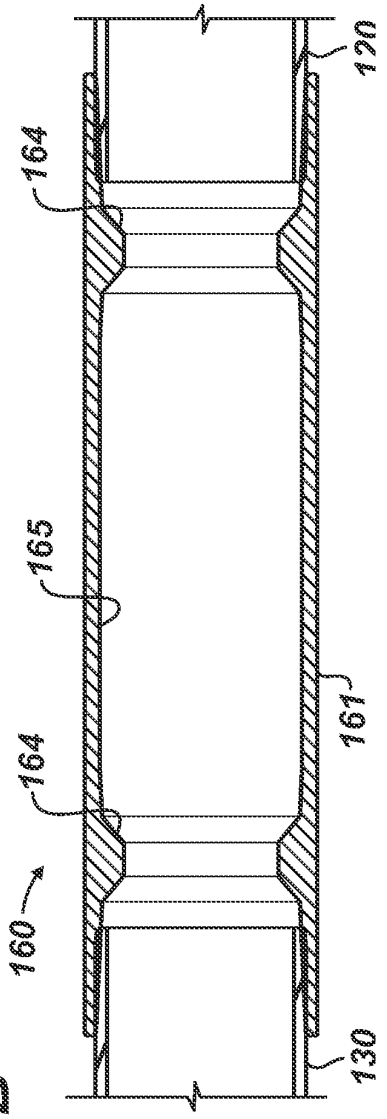


FIG. 6

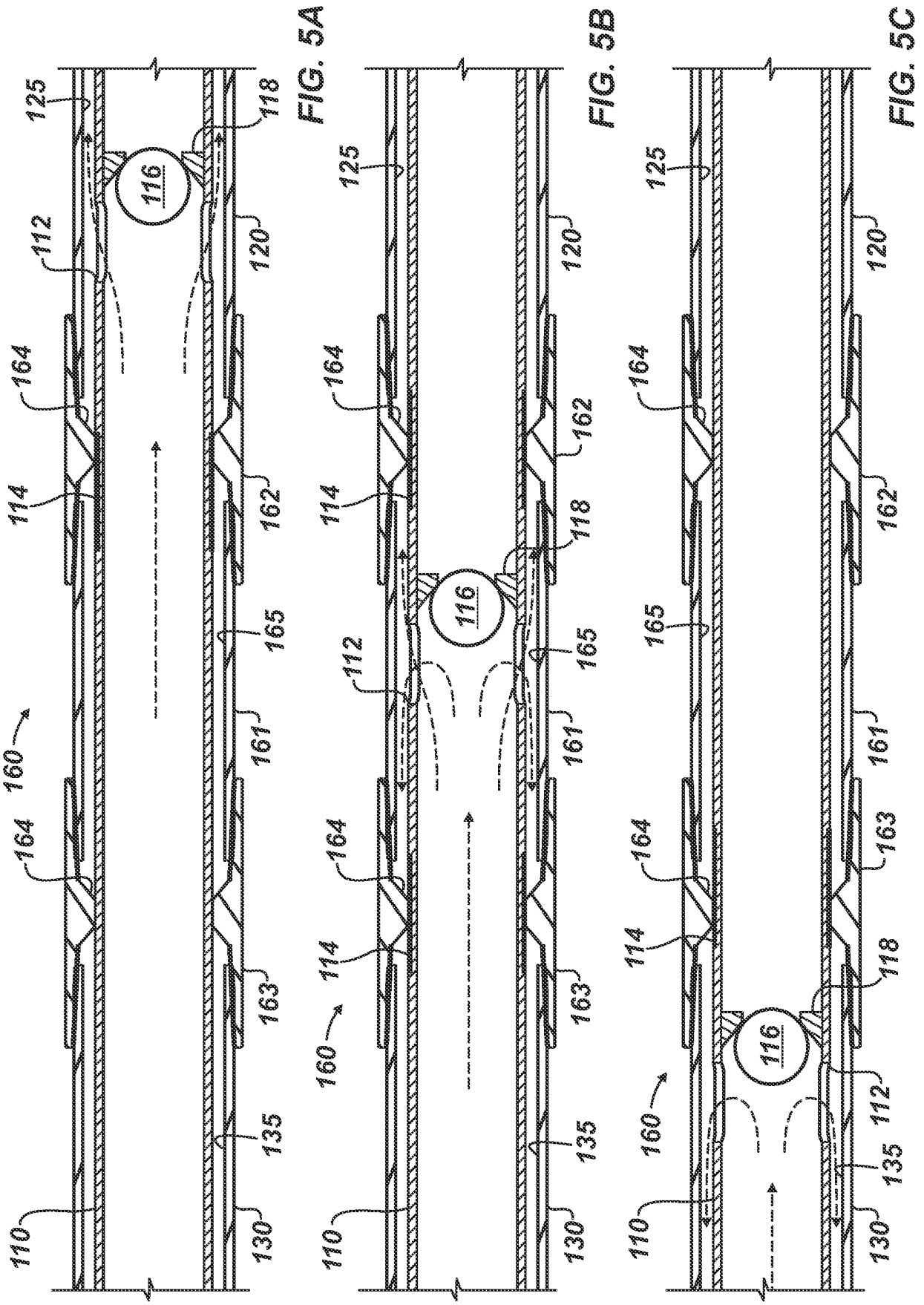


FIG. 5A

FIG. 5B

FIG. 5C

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 91398110 A **[0001]**
- US 345418 A **[0002]**
- US 6349770 B1 **[0008]**
- US 2003141075 A1 **[0009]**
- US 913981 A **[0022]**
- US 12913981 B **[0026] [0028]**