RUNNING TOOL WITH RETRACTABLE COLLET FOR LINER STRING INSTALLATION IN A WELLBORE

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ABSTRACT

A running tool for installing a liner string having a profile in a wellbore. The running tool includes a mandrel, a prop assembly positioned about the mandrel and a collet assembly slidably positioned on the mandrel. The collet assembly has a generally cylindrical collet collar with a plurality of collet fingers extending therefrom each having a collet head on a distal end thereof. In a first position, the prop assembly radially outwardly flexes the collet fingers such that the collet heads engage the profile of the liner string and are operable to apply a force in the downhole direction to the liner string. In a second position, the collet assembly is remote from the prop assembly such that the collet fingers radially inwardly contract disengaging the collet heads from the profile of the liner string, thereby enabling removal of the running tool from the liner string.
Fig. 4A

Fig. 4B
RUNNING TOOL WITH RETRACTABLE COLLET FOR LINER STRING INSTALLATION IN A WELLBORE

CROSS-REFERENCE TO RELATED APPLICATIONS


TECHNICAL FIELD OF THE DISCLOSURE

[0002] This disclosure relates, in general, to equipment utilized in conjunction with operations performed in relation to subterranean wells and, in particular, to liner running tool having a retractable collet assembly for installing a liner string in a wellbore.

BACKGROUND

[0003] Without limiting the scope of the present invention, its background is described with reference to constructing a subterranean well, as an example.

[0004] In conventional practice, the drilling of an oil or gas well involves creating a wellbore that traverses numerous subterranean formations. For a variety reasons, each of the formations through which the well passes is preferably sealed. For example, it is important to avoid an undesirable passage of formation fluids, gases or materials out of a formation and into the wellbore or for wellbore fluids to enter a formation. In addition, it is commonly desired to isolate producing formations from one another and from nonproducing formations.

[0005] Accordingly, conventional well architecture typically includes the installation of casing within the wellbore. In addition to providing the sealing function, the casing also provides wellbore stability to counteract the geomechanics of the formation such as compaction forces, seismic forces and tectonic forces, thereby preventing the collapse of the wellbore wall. The casings are generally fixed within the wellbore by a cement layer between the outer wall of the casing and the wall of the wellbore. During the drilling of the wellbore, annuli are provided between the outer surfaces of the casings and the wellbore wall. When a casing string is located in its desired position in the well, a cement slurry is pumped via the interior of the casing, around the lower end of the casing and upwards into the annulus. As soon as the annulus around the casing is sufficiently filled with the cement slurry, the cement slurry is allowed to harden. The cement sets up in the annulus, supporting and positioning the casing and forming a substantially impermeable barrier.

[0006] In one approach, each casing string extends downhole from the surface such that only a lower section of each casing string is adjacent to the wellbore wall. Alternatively, the wellbore casings may include one or more liner strings, which do not extend to the surface of the wellbore, but instead typically extend from near the bottom end of a previously installed casing downward into the uncased portion of the wellbore. In such installations, the liner string may be set or suspended from a liner hanger. As yet another alternative, in some wellbore installations, a liner string may be installed in an uncased portion of the wellbore without being set or suspended from a liner hanger. Liner strings are typically lowered downhole on a work string that may include a running tool that attaches to the liner string. It has been found, that in certain wellbores such as deviated wellbores, horizontal wellbores, multilateral wellbores and the like, significant force may be required to work the liner string to the bottom of the wellbore. In addition, it has been found, that following liner string installation in such wellbores, it is sometimes difficult to retrieve the running tool out of the wellbore due to certain components of the running tool, such as collet assemblies, hanging up on profiles of the installed liner string.

[0007] Accordingly, a need has arisen for a running tool that is operable to deliver the required force to work the liner string to the bottom of the wellbore. In addition, a need has arisen for such a running tool that is operable to be retrieved out of the wellbore without hanging up on profiles of the installed liner string.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] For a more complete understanding of the features and advantages of the present disclosure, reference is now made to the detailed description along with the accompanying figures in which corresponding numerals in the different figures refer to corresponding parts and in which:

[0009] FIG. 1 is a schematic illustration of an offshore oil and gas platform installing a liner string in a subterranean wellbore according to an embodiment of the present disclosure;

[0010] FIG. 2A is a side view of a portion of a running tool in its running configuration for installing a liner string in a subterranean wellbore according to an embodiment of the present disclosure;

[0011] FIG. 2B is a quarter sectional view of a portion of a running tool in its running configuration positioned in a liner string according to an embodiment of the present disclosure;

[0012] FIG. 3A is a side view of a portion of a running tool in its retrieval configuration after installing a liner string in a subterranean wellbore according to an embodiment of the present disclosure;

[0013] FIG. 3B is a quarter sectional view of a portion of a running tool in its retrieval configuration after disengaging from a liner string according to an embodiment of the present disclosure; and

[0014] FIGS. 4A-4B are cross sectional views of a collet assembly for use in a running tool according to an embodiment of the present disclosure in its flexed and relaxed states, respectively.

DETAILED DESCRIPTION

[0015] While various system, method and other embodiments are discussed in detail below, it should be appreciated that the present disclosure provides many applicable inventive concepts, which can be embodied in a wide variety of specific contexts. The specific embodiments discussed herein are merely illustrative, and do not delimit the scope of the present disclosure.

[0016] The present disclosure is directed to a running tool that is operable to deliver the required force to work a liner string to the bottom of a wellbore. In addition, the running tool that of the present disclosure is operable to be retrieved out of the wellbore without hanging up on profiles of the installed liner string.

[0017] In a first aspect, the present disclosure is directed to a running tool for installing a liner string having a profile in a wellbore. The running tool includes a mandrel, a prop assembly positioned about the mandrel and a collet assembly slid-
ably positioned on the mandrel. The collet assembly has a generally cylindrical collet collar with a plurality of collet fingers extending therefrom each having a collet head on a distal end thereof. In a first position of the collet assembly relative to the mandrel, the prop assembly radially outwardly flexes the collet fingers such that the collet heads engage the profile of the liner string and are operable to apply a force in the downhole direction to the liner string. In a second position of the collet assembly relative to the mandrel, the collet assembly is remote from the prop assembly such that the collet fingers radially inwardly contract disengaging the collet heads from the profile of the liner string, thereby enabling removal of the running tool from the liner string.

[0018] In one embodiment of the running tool, in the second position of the collet assembly relative to the mandrel, an inner surface of the collet heads is proximate the mandrel forming clearance gaps therebetween. In another embodiment, in the second position of the collet assembly relative to the mandrel, an inner surface of the collet heads contacts the mandrel. In certain embodiments of the running tool, in the second position of the collet assembly relative to the mandrel, the collet fingers are angled toward the mandrel from the collet collar to the collet heads. In such embodiments, collet fingers may be angled between about 2 degrees and about 6 degrees or the collet fingers may be angled at least 3 degrees. In some embodiments of the running tool, in the first position of the collet assembly relative to the mandrel, the collet fingers are in a first radially outwardly flexed state and in the second position of the collet assembly relative to the mandrel, the collet fingers are in a second radially outwardly flexed state that is less than the first radially outwardly flexed state. In other embodiments of the running tool, in the first position of the collet assembly relative to the mandrel, the collet fingers are in the radially outwardly flexed state and in the second position of the collet assembly relative to the mandrel, the collet fingers are in a radially relaxed state. In these embodiments, in the second position of the collet assembly relative to the mandrel, the collet fingers may be operable to be radially inwardly flexed to contact an inner surface of the collet heads with the mandrel.

[0019] In a second aspect, the present disclosure is directed to a method for installing a liner string with a profile in a wellbore. The method includes lowering the liner string into the wellbore on a running tool, the running tool including a mandrel, a prop assembly positioned about the mandrel and a collet assembly slidably positioned on the mandrel, the collet assembly having a generally cylindrical collet collar with a plurality of collet fingers extending therefrom each having a collet head on a distal end thereof, engaging the collet heads in the profile of the liner string by radially outwardly flexing the collet fingers with the prop assembly; applying a force in the downhole direction to the liner string with the collet assembly; positioning the liner string at a desired location in the wellbore; disengaging the collet heads from the profile of the liner string by unpropping the collet assembly such that the collet fingers radially inwardly contract; and removing the running tool from the liner string.

[0020] The method may also include lowering the running tool downhole into the liner string, locating an inner surface of the collet heads proximate to the mandrel forming clearance gaps therebetween, contacting an inner surface of the collet heads with the mandrel; positioning the collet fingers at an angle toward the mandrel from the collet collar to the collet heads; placing the collet fingers in a reduced radially outwardly flexed state; placing the collet fingers in a radially relaxed state; and/or radially inwardly flexing the collet fingers to contact an inner surface of the collet heads with the mandrel.

[0021] In a third aspect, the present disclosure is directed to a collet assembly for reassemblingly engaging a profile of a downhole tubular. The collet assembly includes a generally cylindrical collet collar having a central axis and a plurality of collet fingers extending from the collet collar each having a collet head on a distal end thereof. In a first configuration, the collet fingers are in a radially outwardly flexed state such that the collet fingers extend substantially parallel with the central axis of the collet collar. In a second configuration, the collet fingers are in a radially relaxed state such that the collet fingers extend from the collet collar to the collet heads at an angle toward the central axis of the collet collar.

[0022] In certain embodiments of the second configuration, the collet fingers are angled between about 2 degrees and about 6 degrees toward the central axis of the collet collar when the collet fingers are in the radially relaxed state. In some embodiments of the second configuration, the collet fingers are angled at least 3 degrees toward the central axis of the collet collar when the collet fingers are in the radially relaxed state. In one embodiment of the second configuration, the collet fingers are operable to be radially inwardly flexed when the collet fingers are in the radially relaxed state.

[0023] Referring initially to FIG. 1, a running tool for installing a liner string in a subterranean wellbore is being deployed from an offshore oil or gas platform that is schematically illustrated and generally designated 10. A semi-submersible platform 12 is centered over submerged oil and gas formation 14 located below sea floor 16. A subsea conduit 18 extends from deck 20 of platform 12 to wellhead installation 22, including blowout preventers 24. Platform 12 has a hoisting apparatus 26, a derrick 28, a travel block 30, a hook 32 and a swivel 34 for raising and lowering pipe strings, such as a liner string 36.

[0024] A main wellbore 38 has been drilled through the various earth strata including formation 14. The terms “parent” and “main” wellbore are used herein to designate a wellbore from which another wellbore is drilled. It is to be noted, however, that a parent or main wellbore does not necessarily extend directly to the earth’s surface, but could instead be a branch of yet another wellbore. A casing string 40 is secured within main wellbore 38 by cement 42. The term “casing” is used herein to designate a tubular string used in a wellbore or to line a wellbore. The casing may be of the type known to those skilled in the art as a “liner” and may be made of any material, such as steel or a composite material and may be segmented or continuous, such as coiled tubing.

[0025] Casing string 38 includes a window joint 44 interconnected therein. In addition, casing string 38 includes a latch coupling 46. Latch coupling 46 has a latch profile that is operably engageable with latch keys of a latch assembly 48 such that latch assembly 48 may be axially anchored and rotationally oriented in latch coupling 46. In the illustrated embodiment, when the primary latch/key of latch assembly 48 has operably engaged the latch profile of latch coupling 46, a deflection assembly depicted as whipstock 50 is positioned in a desired circumferential orientation relative to window joint 44 such that a window can be milled, drilled or otherwise formed in window joint 44 in the desired circumferential direction. As illustrated, a branch or lateral wellbore 52 has been drilled from window joint 44 of main wellbore 38. The
terms “branch” and “lateral” wellbore are used herein to designate a wellbore that is drilled outwardly from its intersection with another wellbore, such as a parent or main wellbore. A branch or lateral wellbore may have another branch or lateral wellbore drilled outwardly therefrom.

[0026] Liner string 36 is being lowered downhole on a work string 54 that includes a running tool 56 that attaches work string 54 to liner string 36. As shown, liner string 36 is being positioned in lateral wellbore 52 that is generally horizontal. Due to friction between liner string 36 and the surface of lateral wellbore 52, significant force may be required to push liner string 36 to the bottom or toe of lateral wellbore 52. This is achieved by applying a force in the downhole direction to liner string 36 with a collet assembly running tool 56 that engages a profile within liner string 36. After liner string 36 is positioned at a desired location in wellbore 52, the collet assembly disengages from the profile, which enables running tool 56 to be retrieved to the surface with work string 54.

[0027] Even though Fig. 1 depicts a liner string being installed in a horizontal wellbore, it should be understood by those skilled in the art that the present running tool is equally well suited for use in wellbores having other orientations including vertical wellbores, slanted wellbores, deviated wellbores or the like. Accordingly, it should be understood by those skilled in the art that the use of directional terms such as above, below, upper, lower, upward, downward, uphole, downhole and the like are used in relation to the illustrative embodiments as they are depicted in the figures, the upward direction being toward the top of the corresponding figure and the downward direction being toward the bottom of the corresponding figure, the uphole direction being toward the surface of the well, the downhole direction being toward the toe of the well. Also, even though Fig. 1 depicts an offshore operation, it should be understood by those skilled in the art that the present running tool is equally well suited for use in onshore operations.

[0028] Referring next to Figs. 2A–2B, therein is depicted a section of a running tool 100 for installing a liner string in a subterranean wellbore. As best seen in Fig. 2B, a liner string 102 may include any number of substantially tubular sections that are preferably formed from jointed tubulars that are threadably coupled together at the surface. In the illustrated section, liner string 102 includes an upper liner tubular 104 and an intermediate liner tubular 106 that are threadably coupled together at threaded connection 108. In the illustrated embodiment, liner string 102 defines a profile 110 between an upper shoulder 112 of intermediate liner tubular 106 and a lower shoulder 114 of upper liner tubular 104. Running tool 100 is positioned at least partially within liner string 102 and is operable to transport, apply downward force on and set liner string 102 in the wellbore. Running tool 100 includes a plurality of substantially tubular members that may be referred to as a generally tubular mandrel 116 that cooperate together to form a central bore 118 extending throughout. In the illustrated section, tubular mandrel 116 includes an upper mandrel tubular 120 that may be threadably and seatingly coupled to or operably associated with other components of the work string at its upper end. Upper mandrel tubular 120 is threadably coupled on it lower end to an intermediate mandrel tubular 122. Upper mandrel tubular 120 has a radially expanded lower section 124 that defines an upper shoulder 126. Upper mandrel tubular 120 also has a radially reduced channel 128.

[0029] A prop assembly 130 including a prop extension 132 is disposed around upper mandrel tubular 120. A snap ring 134 prevents axial movement of prop assembly 130 beyond predetermined limits along upper mandrel tubular 120. A collet assembly 136 is slidably positioned around upper mandrel tubular 120. Collet assembly 136 includes a generally cylindrical collet collar 138 having a plurality of collet fingers 140 extending therewith from each having a collet head 142 on a distal end thereof. Collet heads 142 include lower shoulders 144 that form a mating surface with upper shoulder 112 of intermediate liner tubular 106. In addition, collet heads 142 include upper shoulders 146 that form a mating surface with lower shoulder 114 of upper liner tubular 104. Collet collar 138 has a lower shoulder 148.

[0030] In operation and additionally referencing FIGS. 3A–3B, running tool 100 is used to install liner string 102 in a wellbore. In the illustrated embodiment, as liner string 102 is being run downhole via work string 54, significant force may be required to push lower string 102 to its desired location, particularly in deviated, horizontal or multilateral wellbores. The force from the surface is applied through work string 54 to upper mandrel tubular 120. In the running configuration of running tool 100, upper mandrel tubular 120 applies the downforce to intermediate liner tubular 106 via collet assembly 136. Specifically, as best seen in Fig. 2B, prop assembly 130 radially outwardly flexes collet fingers 140 such that collet heads 142 engage profile 110 of liner string 102. In this configuration, the downward force from upper mandrel tubular 120 is applied to upper shoulder 112 of intermediate liner tubular 106 by lower shoulders 144 of collet heads 142.

[0031] Once liner string 102 is positioned in the desired location in the wellbore, running tool 100 can be decoupled from liner string 102 and retrieved to the surface. This may be accomplished using hydraulic pressure, shear force, string rotation or a combination thereof to decouple a lower collet (not pictured) or other component to allow relative movement between mandrel 116 and liner string 102. Thereafter, shifting mandrel 116 uphole relative to liner string 102 unprops collet assembly 136 through the interaction of lower shoulder 114 of upper liner tubular 104 with upper shoulders 146 of collet heads 142. Once collets heads 142 are off of or remote from prop extension 132 of prop assembly 130, as best seen in Fig. 3B, collet fingers 140 radially inwardly contract such that an inner surface of collet heads 142 is proximate to the outer surface of upper mandrel tubular 120 forming clearance gaps therebetween or in contact with the outer surface of upper mandrel tubular 120. In the case of contact between the inner surface of collet heads 142 and the outer surface of upper mandrel tubular 120, collet fingers 140 go from a first radially outwardly flexed state supported by prop extension 132 to a second radially outwardly flexed state supported by upper mandrel tubular 120, wherein the first radially outwardly flexed state is greater than the second radially outwardly flexed state. In the case of a proximate relationship between the inner surface of collet heads 142 and the outer surface of upper mandrel tubular 120, collet fingers 140 go from a radially outwardly flexed state supported by prop extension 132 to radially relaxed state, wherein a radially inwardly directed force could cause collet fingers 140 to be radially inwardly flexed until the inner surface of collet heads 142 contacts upper mandrel tubular 120. Depending upon the desired relationship between the inner surface of collet heads 142 and the outer surface of upper mandrel tubular 120, collet
fingers 140 may be angled toward upper mandrel tubular 120 from collet collar 138 to collet heads 142 between about 2 degrees and about 6 degrees and preferably at least 3 degrees. [0032] In this radially refracted configuration of collet assembly 136, collet heads 142 have disengaged from mating profile 110, thereby releasing running tool 100 from liner string 102. Thereafter, running tool 100 may be withdrawn uphole from liner string 102 and out of the wellbore. Importantly, due to the radially contracted configuration of collet assembly 136, running tool 100 can be retrieved out of the wellbore without collet heads 140 hanging up on profiles or other radially reduced regions of liner string 102. In addition, running tool 100 may be lowered further into downhole into liner string 102, if desired, without collet heads 140 hanging up on profiles or other radially reduced regions of liner string 102.

[0033] Referring next to FIGS. 4A-4B, therein are depicted cross sectional views of a collet assembly in its radially outwardly flexed state and its relaxed state, respectively. Collet assembly 136 includes a generally cylindrical collet collar 138 having a central axis 150. Collet assembly 136 also includes a plurality of collet fingers 140 that extend from collet collar 138. Each collet finger 140 has a collet head 142 on a distal end thereof. Collet heads 142 include lower shoulders 144 for mating with upper shoulder 112 of intermediate liner tubular 106, as described above. In addition, collet heads 142 include upper shoulders 146 for mating with upper shoulder 114 of upper liner tubular 104, as described above. Collet collar 138 has a lower shoulder 148. Collet assembly 136 has a first configuration, in which collet fingers 140 are in a radially outwardly flexed state such that collet fingers 140 extend substantially parallel with central axis 150 of collet collar 138, as best seen in FIG. 4A. This configuration corresponds to the configuration in FIG. 2B wherein collet assembly 136 is engaged in profile 110 of liner string 102. Collet assembly 136 has a second configuration, in which collet fingers 140 are in a radially relaxed state such that collet fingers 140 extend from collet collar 138 to collet heads 142 at an angle toward central axis 150, as best seen in FIG. 4B. This configuration corresponds to the configuration in FIG. 3B wherein collet assembly 136 is disengaged from profile 110 of liner string 102. In this illustrated embodiment, collet fingers 140 are angled toward central axis 150 at about 3 degrees, however, other angles both greater than and less than 3 degrees are also possible and are considered within the scope of the present disclosure including, but not limited to angles between about 2 degrees and about 6 degrees. [0034] It should be understood by those skilled in the art that the illustrative embodiments described herein are not intended to be construed in a limiting sense. Various modifications and combinations of the illustrative embodiments as well as other embodiments will be apparent to persons skilled in the art upon reference to this disclosure. It is, therefore, intended that the appended claims encompass any such modifications or embodiments.

What is claimed is:

1. A running tool for installing a liner string having a profile in a wellbore, the running tool comprising:
   a mandrel;
   a collet assembly slidably positioned on the mandrel, the collet assembly having a generally cylindrical collet collar with a plurality of collet fingers extending therefrom each having a collet head on a distal end thereof; and
   a prop assembly positioned about the mandrel, wherein, in a first position of the collet assembly relative to the mandrel, the prop assembly radially outwardly flexes the collet fingers such that the collet heads engage the profile of the liner string and are operable to apply a force in the downhole direction to the liner string; and wherein, in a second position of the collet assembly relative to the mandrel, the collet assembly is remote from the prop assembly such that the collet fingers radially inwardly contract disengaging the collet heads from the profile of the liner string, thereby enabling removal of the running tool from the liner string.

2. The running tool as recited in claim 1 wherein, in the second position of the collet assembly relative to the mandrel, an inner surface of the collet heads is proximate the mandrel forming clearance gaps therebetween.

3. The running tool as recited in claim 1 wherein, in the second position of the collet assembly relative to the mandrel, an inner surface of the collet heads contacts the mandrel.

4. The running tool as recited in claim 1 wherein, in the second position of the collet assembly relative to the mandrel, the collet fingers are angulated toward the mandrel from the collet collar to the collet heads.

5. The running tool as recited in claim 4 wherein the collet fingers are angled between about 2 degrees and about 6 degrees.

6. The running tool as recited in claim 1 wherein, in the first position of the collet assembly relative to the mandrel, the collet fingers are in a radially outwardly flexed state and wherein, in the second position of the collet assembly relative to the mandrel, the collet fingers are in a radially relaxed state.

7. The running tool as recited in claim 1 wherein, in the first position of the collet assembly relative to the mandrel, the collet fingers are in a radially outwardly flexed state and wherein, in the second position of the collet assembly relative to the mandrel, the collet fingers are operable to be radially inwardly flexed to contact an inner surface of the collet heads with the mandrel.

9. A method for installing a liner string with a profile in a wellbore, the method comprising:
   lowering the liner string into the wellbore on a running tool,
   the running tool including a mandrel, a prop assembly positioned about the mandrel and a collet assembly slidably positioned on the mandrel, the collet assembly having a generally cylindrical collet collar with a plurality of collet fingers extending therefrom each having a collet head on a distal end thereof;
   engaging the collet heads in the profile of the liner string by radially outwardly flexing the collet fingers with the prop assembly;
   applying a force in the downhole direction to the liner string with the collet assembly;
   positioning the liner string at a desired location in the wellbore;
   disengaging the collet heads from the profile of the liner string by unpropping the collet assembly such that the collet fingers radially inwardly contract; and
   removing the running tool from the liner string.
10. The method as recited in claim 9 further comprising lowering the running tool downhole into the liner string after disengaging the collet heads from the profile of the liner string.

11. The method as recited in claim 9 wherein disengaging the collet heads from the profile of the liner string further comprises locating an inner surface of the collet heads proximate to the mandrel forming clearance gaps therebetween.

12. The method as recited in claim 9 wherein disengaging the collet heads from the profile of the liner string further comprises contacting an inner surface of the collet heads with the mandrel.

13. The method as recited in claim 9 wherein disengaging the collet heads from the profile of the liner string further comprises positioning the collet fingers at an angle toward the mandrel from the collet collar to the collet heads.

14. The method as recited in claim 9 wherein disengaging the collet heads from the profile of the liner string further comprises placing the collet fingers in a reduced radially outwardly flexed state.

15. The method as recited in claim 9 wherein disengaging the collet heads from the profile of the liner string further comprises placing the collet fingers in a radially relaxed state.

16. The method as recited in claim 15 further comprising radially inwardly flexing the collet fingers to contact an inner surface of the collet heads with the mandrel.

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