



(51) International Patent Classification:

E21B 23/00 (2006.01) *E21B 17/00* (2006.01)
E21B 34/06 (2006.01)

(21) International Application Number:

PCT/US2015/039390

(22) International Filing Date:

7 July 2015 (07.07.2015)

(25) Filing Language:

English

(26) Publication Language:

English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,

BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

— with international search report (Art. 21(3))

(54) Title: HIGH-LOAD COLLET SHIFTING TOOL

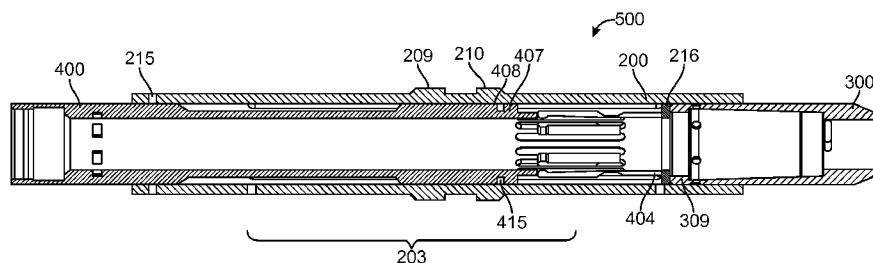


FIG. 6

(57) Abstract: A collet shifting tool for engaging an internal profile of a shifting sleeve and method relating to the collet shifting tool are disclosed. The tool may include a tubular collet sleeve, a collet mandrel, an optional collet tip, an optional primary shear mechanism, and a secondary shear mechanism. The secondary shear mechanism may be positioned to restrict movement of the collet mandrel through the internal sleeve cavity and thereby to align a raised wall portion of the tubular collet mandrel with a flexible portion of the tubular collet sleeve to prevent deformation of the flexible portion of the tubular collet sleeve. Preventing such deformation may allow for greater force to be exerted to the shifting sleeve via the collet shifting tool.

HIGH-LOAD COLLET SHIFTING TOOL

FIELD

[0001] The disclosure relates generally to collet shifting tool and more specifically to a collet shifting tool capable of delivering a one-time high load.

BACKGROUND

[0002] In some instances a valve or other tool needs to be installed at a location downhole that must be operated or shifted against a high differential pressure. For example, a ball valve may be used to isolate a down-hole formation. Particularly for small valve sizes, the load applied by conventional shifting tools may not be sufficient to overcome the forces due to differential pressure across the ball valve. For the foregoing reasons, there is a need for improved shifting tools and mechanisms.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] These and other features, aspects, and advantages of the present disclosure will become better understood with reference to the following description and appended claims, and accompanying drawings where:

[0004] 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;

[0005] FIG. 2 is a schematic illustration of a tubular collet sleeve according to an embodiment of the present disclosure;

[0006] FIG. 3 is a schematic illustration of a collet tip according to an embodiment of the present disclosure;

[0007] FIG. 4A is a schematic illustration of a tubular collet mandrel according to an embodiment of the present disclosure;

[0008] FIG. 4B is a schematic illustration of a portion of a tubular collet mandrel according to an embodiment of the present disclosure;

[0009] FIG. 5 is a schematic illustration of a collet shifting tool in a first configuration according to an embodiment of the present disclosure;

[0010] FIG. 6 is a schematic illustration of a collet shifting tool in a second configuration according to an embodiment of the present disclosure;

[0011] FIG. 7 is a schematic illustration of a collet shifting tool in a third configuration according to an embodiment of the present disclosure;

[0012] FIG. 8A is a schematic illustration of a collet shifting tool in the first configuration as shown in FIG. 5 in a first down-hole situation according to an embodiment of the present disclosure;

[0013] FIG. 8B is a schematic illustration of a collet shifting tool in the first configuration as shown in FIG. 6 in a second down-hole situation according to an embodiment of the present disclosure;

[0014] FIG. 8C is a schematic illustration of a collet shifting tool in the second configuration as shown in FIG. 7 in a third down-hole situation according to an embodiment of the present disclosure; and

[0015] FIG. 8D is a schematic illustration of a collet shifting tool in the second configuration as shown in FIG. 7 in a fourth down-hole situation according to an embodiment of the present disclosure.

[0016] It should be understood that the various embodiments are not limited to the arrangements and instrumentality shown in the drawings.

DETAILED DESCRIPTION

[0017] The present disclosure may be understood more readily by reference to the following detailed description of preferred embodiments of the disclosure as well as to the examples included therein. All numeric values are herein assumed to be modified by the term "about," whether or not explicitly indicated. The term "about" generally refers to a range of numbers that one of skill in the art would consider equivalent to the recited value (i.e., having the same function or result). In many instances, the term "about" may include numbers that are rounded to the nearest significant figure.

[0018] 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.

[0019] 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.

[0020] Casing string 40 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 engagable 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.

[0021] 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 of 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. The collet can pass through the valve, allowing it to travel both up and down hole, even beyond the valve.

[0022] 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.

[0023] Referring to FIG. 2, a schematic illustration of a tubular collet sleeve 200 according to an embodiment of the present disclosure is shown. The tubular collet sleeve 200 may have a tubular wall 201 defining an internal cavity 202. The tubular wall may include a flexible portion 203 that is elastically deformable in a radial direction perpendicular to a longitudinal axis 204. The flexible portion 203 may be defined by a plurality of longitudinal slots 205 separating a plurality of longitudinal arms 206. The flexible portion may include from 1 to

20, from 5 to 15, or from 8 to 24 longitudinal arms 206. The longitudinal axis 204, the longitudinal slots 205, and the longitudinal arms 206 may extend from near a down-hole end 207 of the tubular collet sleeve 200 to near an up-hole end 208 of the tubular collet sleeve 200. The flexible portion may occupy a substantially central portion of the tubular wall 201 and may cover from 10 to 90, from 20 to 80, from 30 to 70, from 40 to 60, or about 50 percent of the surface area of the tubular wall 201. One or more of the plurality of longitudinal arms 206 may include at least one engagement profile. The at least one engagement profile may have any suitable shape for engaging an internal profile of a shifting sleeve. For example, the at least one engagement profile may have a first protrusion 209 and/or a second protrusion 210. The first protrusion 209 and the second protrusion 210 may be separated by a distance, with the first protrusion being nearer to the up-hole end 208 and the second protrusion 210 being nearer the down-hole end 207. The first protrusion 209 may include a slanted face 211 and a flat face 213. The slanted face 211 may be nearer to the up-hole end 208 than the flat face 213. Similarly, the second protrusion 210 may include a slanted face 212 and a flat face 214. The slanted face 212 may be nearer to the down-hole end 207 than the flat face 214. The tubular wall, the plurality of longitudinal arms 206, the first protrusion 209, and the second protrusion 210 may be separate parts and integrally joined together or may be defined from a single part.

[0024] Still referring to FIG. 2, the tubular collet sleeve may include a primary shear mechanism 215 and a secondary shear mechanism 216. The primary shear mechanisms 215 may include one or more shear pins disposed in through-holes of the tubular wall 201. The shear pins may be adapted to break or to shear at a

predetermined shear force. The second shear mechanism 216 may include one or more shear pins disposed in through-holes of the tubular wall 204. The shear pins may be adapted to break or to shear at a predetermined shear force. Additionally or alternatively, the secondary shear mechanism 216 may be slidably disposed within the internal cavity 202 of the tubular collet sleeve. The secondary shear mechanism 216 may be adapted to break or to shear at a predetermined shear force. Further details of both the primary shear mechanism 215 and the secondary shear mechanism 216 will be discussed hereinafter.

[0025] Referring to FIG. 3, a schematic illustration of a collet tip 300 according to an embodiment of the present disclosure is shown. The collet tip 300 is generally tubular in shape, including a wall 301 defining boundaries of a generally hollow internal portion. Internal and external surfaces of the wall 301 may be multifaceted to define various aspects and profiles. The collet tip 300 may have a longitudinal axis 302, alignable with the longitudinal axis 204 of the tubular collet sleeve 200. The longitudinal axis 302 of the collet tip 300 may extend from an up-hole end 303 to a down-hole end 304. The hollow interior of the collet tip 300 may include a first cylindrical internal cavity 305, a frustoconical cavity 306, and a second cylindrical cavity 307. The first internal cavity 305 may extend from the up-hole end 303 to the frustoconical internal cavity 306. The frustoconical internal cavity 306 may extend from the first internal cavity 305 to the second internal cavity 307. The second internal cavity 307 may extend from the frustoconical internal cavity 306 to the down-hole end 304. The frustoconical internal cavity 306 may be defined by a slanted internal wall surface 308, extending generally from the first cylindrical internal cavity 305 to the second cylindrical internal cavity 307.

[0026] Still referring to FIG. 3, the collet tip 300 may include a first abutment profile 309, a second abutment profile 310, and a third abutment profile 311. The first abutment profile 309 may be at the up-hole end of the collet tip 300. The second abutment profile 310 may be at a junction of the first cylindrical cavity 305 and the frustoconical internal cavity 306. The third abutment profile 311 may be at a junction of the frustoconical internal cavity 306 and the second cylindrical internal cavity 307. The first abutment profile 309, the second abutment profile 310, and the third abutment profile 311 will be discussed in greater detail hereinafter.

[0027] Still referring to FIG. 3, the collet tip 300 may include one or more securing holes 312 in wall 301. The securing holes 312 may be used along with bolts, rivets, or the like to secure the collet tip 300 to another structure, such as the tubular collet sleeve 200. Additionally or alternatively collet tip 300 may be secured to another structure, such as tubular collet sleeve 200 by threading, welding, or gluing. The collet tip 300 may optionally have a frustoconical tip 313 formed by a slanting surface on wall 301.

[0028] Referring to FIG. 4A, a schematic illustration of a tubular collet mandrel 400 according to an embodiment of the present disclosure is shown. The tubular collet mandrel 400 may include a wall portion 401 defining an internal cavity 402 that extends from an up-hole end 403 to a down-hole end 404 along an axis 405. The wall 401 of the tubular collet mandrel 400 may include a recessed wall portion 406 and one or more raised wall portions 407. The recessed wall portion 406 may, for example, be disposed between two raised wall portions 407. The recessed wall portion 406 may be disposed substantially centrally along the length of the tubular collet mandrel 400. The raised wall portions 407 may have a substantially flat

cylindrical surface 408 tapering at first tapered wall portion 409 and at second tapered wall portion 410 to the recessed wall portion 406. At least one raised wall portion 407 may be present near the down-hole end 404 of the tubular collet mandrel 400 immediately adjacent to a section of the wall 401 that includes one or more fingers 411. The one or more fingers 411 may extend longitudinally along a surface of the wall 401 and may be separated by slots 413. The slots 413 may extend through the wall 401. The fingers 411 may include heads 412 extending radially away from the wall 401. The fingers 411 may be disposed at an end of each finger 411. The fingers 411 may be resiliently biased in a radial direction perpendicular to axis 405. The opposite end of each finger 411 being integral with wall 401. The wall 401 may transition abruptly from the raised wall portion 407 to the fingers 411 to form an abutment face 414. The abutment face may have a surface that is substantially perpendicular to axis 405. The abutment face need not be perpendicular. For example, the abutment face may be oriented at any suitable angle with respect to axis 405. The suitable angle may be any angle from about 90 to about 150 degrees. Finally, the wall 401, particularly the raised wall portion 407 may include one or more holes 415 for engaging the primary shear mechanism 215 of the tubular collet sleeve 200, as discussed in greater detail hereinafter.

[0029] The tubular collet sleeve 200, the collet tip 300, and the tubular collet mandrel 400 may be made from any suitable material, including but not limited to a metal, such as steel, stainless steel, or aluminum.

[0030] Referring to FIG. 4B, a cut-away schematic illustration of the down-hole end 404 the tubular collet mandrel 400 is shown. FIG. 4B shows an alternate configuration for the secondary shear

mechanism 216. As shown in FIG. 4B, the secondary shear mechanisms 216 is in the form of a shear ring 416. The shear ring 416 may include at least one protuberance 417. The protuberance 417 may be a shear screw. The protuberance 417 may be a raised ring portion extending along an internal wall portion of the shear ring 416. The raised ring portion may be continuous or discontinuous. The shear ring 416 may include a plurality of protuberances. Each of the one or more protuberances may correspond and engage with a notch or a hole in the tubular collet mandrel 400. The shear ring 416 may be surrounded by a protective sheath 419. Again, the shear ring 416 is an alternative configuration of the secondary shear mechanism 216 and may generally be used interchangeably. The secondary shear mechanism 216 may be adapted to break or to shear at a predetermined shear force. When the secondary shear mechanism 216 is configured as a shear ring 416, the one or more protuberances 417 may be adapted to break or to shear from the shear ring 416 at the predetermined shear force. After the one or more protuberances 417 break away, the tubular collet mandrel 400 may slide through the shear ring 416.

[0031] Further details of both the primary shear mechanism 215 and the secondary shear mechanism 216 will be discussed hereinafter.

[0032] Referring to FIG. 5, a schematic illustration of a collet shifting tool 500 in a first configuration according to an embodiment of the present disclosure is shown. The collet tip 300 may be disposed within the internal cavity 202 of the tubular collet sleeve 200 at the down-hole end 207 of the tubular collet sleeve 200. The collet tip 300 may be secured via any suitable method, including but not limited to bolting, riveting, welding, or threading. The tubular collet mandrel 400 may be disposed within the internal cavity 202 of the tubular

collet sleeve 200 at the up-hole end 208 of the tubular collet sleeve 200. The down-hole end 404 of the tubular collet mandrel 400 may abut the secondary shear mechanism 216. According to other embodiments the secondary shear mechanism 216 may have a starting position abutting the first abutment profile 309 at the up-hole end 303 of the collet tip 300, such that the secondary shear mechanism 216 need not slide through the internal cavity 202 of the tubular collet sleeve 200. The primary shear mechanisms 215 of the tubular collet sleeve may engage with corresponding holes 415 of the tubular collet mandrel. The engagement of the primary shear mechanisms 215 and the corresponding holes 415 allows the collet shifting tool 500 to be pushed down the main wellbore 38, for example, into the lateral wellbore 52 in proximity to formation 14, as illustrated in FIG. 1. Once the collet shifting tool 500 is in position, force may be applied until the primary shear mechanisms 215 break and allow the tubular collet mandrel 400 and the secondary shear mechanism 216 to slide further into the internal cavity 202 of the tubular collet sleeve 200 to the second configuration as illustrated in FIG. 6. The primary shear mechanisms 215 may be designed to break at a predetermined shear force. The predetermined shear force may be within a range of from about 100 to 2000 pounds.

[0033] Referring to FIG. 6, a schematic illustration of a collet shifting tool 500 in a second configuration according to an embodiment of the present disclosure is shown. As described with respect to FIG. 5, in the second configuration, the secondary shear mechanism 216 and optionally the primary shear mechanism 215 have slid through the internal cavity 202 of the tubular collet sleeve. As discussed above, the secondary shear mechanism 216 may have an initial position abutting the first abutment profile 309 at the up-hole end 303 of the

collet tip 300. In either case, the down-hole end 404 of the tubular collet mandrel abuts and presses against the secondary shear mechanism 216, which in turn abuts and presses against the first abutment profile 309 of the collet tip 300. In the second configuration, the substantially flat cylindrical surface 408 of a raised wall portion 407 of the wall of the tubular collet mandrel substantially aligns with the flexible portion 203 of the tubular collet sleeve to prevent the flexible portion 203 from deforming in a radial direction perpendicular to axis 204 of the tubular collet sleeve. As will be discussed in greater detail hereinafter, preventing such deflection allows the first protrusion and/or the second protrusion 210 to engage an internal radial profile 803 of a shifting sleeve 802 to apply force to down-hole equipment, such as, a ball valve 801, as illustrated in Figures 8A – 8D.

[0034] Still referring to Figure 6, the secondary shear mechanism 216 may be designed to break at a predetermined shear force. The predetermined shear force may be within a range of about 5,000 to about 40,000 pounds. Force applied to the tubular collet mandrel 400 may eventually break the secondary shear mechanism and allow the tubular collet mandrel to slide into a third configuration in which the internal cavity 309 of the collet tip 300, as illustrated in FIG. 7.

[0035] Referring to FIG. 7, a schematic illustration of a collet shifting tool 500 in a third configuration according to an embodiment of the present disclosure is shown. In the third configuration, the secondary shear mechanism 216 has broken, allowing the tubular collet mandrel to slide into the internal cavity 307 of the collet tip 300. Upon entering the internal cavity 307 of the collet tip 300, the fingers 411 of the tubular collet mandrel 400 flex in a radial direction perpendicular to axis 405 of the tubular collet mandrel to abut the

second abutment profile 310 of the collet tip, which holds the tubular collet mandrel 400 in place. In the third configuration, the abutment face 414 of the tubular collet mandrel 400 may also abut the first abutment profile 309 of the collet tip 300. The recessed wall portion 406 of the tubular collet mandrel 400 is substantially aligned with the flexible portion 203 of the tubular collet sleeve 200 to allow the flexible portion 203 to deform in a radial direction perpendicular to the longitudinal axis 204 of the tubular collet sleeve 200. This radial deformation of the flexible portion 203 of the tubular collet sleeve 200 may allow the first protrusion 209 and the second protrusion 210 to slide past an internal radial profile 803 of a shifting sleeve 802, as illustrated in Figures 8A – 8D. In the third configuration, the collet shifting tool 500 may still be used to apply force to down-hole equipment, such as, a ball valve 801, as illustrated in Figures 8A – 8D, but the amount of force that may be applied is less than the force that may be applied when the collet shifting tool 500 is in the second configuration, because of the ability of the flexible portion 203 of the tubular collet sleeve 200 to flex or to deform in the radial direction perpendicular to the longitudinal axis 204. In the third configuration, therefore, the collet shifting tool 500 may function as a conventional shifting tool allowing for opening and closing of a ball valve 801, for example.

[0036] An advantage of various embodiments is that in the second configuration, as illustrated in FIG. 6, a larger amount of force can be applied to down-hole equipment, such as, a ball valve 801, as illustrated in Figures 8A – 8D. In other words, the collet shifting tool 500 may allow for a one-time high-load to be generated, which allows the collet shifting tool 500 to be used when the ball valve 801 must open against a high differential. This is particularly useful for small

valve sizes, where the load applied by conventional shifting tools is not sufficient to overcome the forces due to differential pressure across the ball valve. The collet shifting tool 500, according to various embodiments, provides a single use high-load capability, and after the first use functions as a conventional shifting tool, allowing the ball valve to be opened and closed as required, i.e. with a bi-directional profile.

[0037] Another advantage of various embodiments is that the collet shifting tool 500 may have an inverted or a standard profile. Inverted collets may pass under a diameter smaller than their outer diameter with a small force, provided there is no sharp profiles to get trapped between the two upsets, but when they pass a profile that will fit between the two upset profiles they need a high force to deflect. An inverted profile may allow the tool to pass through a seal bore without causing damage to the seal bore or to the collet shifting tool 500. More specifically, the inverted profile may allow the collet shifting tool 500 to pass through a specified minimum restriction with minimal force and without causing galling or scoring. The collet shifting tool 500 may run on coiled tubing, wash pipe, or drill pipe. The collet shifting tool 500 may latch into the shifting sleeve, as illustrated in Figures 8A – 8D, to apply force to down-hole equipment, such as, ball valve 801.

[0038] Referring to FIG. 8A, a schematic illustration of a collet shifting tool 500 in the first configuration as shown in FIG. 5 is shown. More specifically, the collet shifting tool 500 is shown in a first down-hole situation 804, where the collet shifting tool 500 is about to engage a shifting sleeve 802. The shifting sleeve 802 may engage down-hole equipment, such as a ball valve 801. The shifting sleeve 802 may be used to open and close the ball valve 801, according to

known mechanisms. The shifting sleeve 802 may include an internal radial profile 803, also referred to as a "nubbin." The first protrusion 209 and the second protrusion 210 of the tubular collet sleeve 200 may be sized and positioned to engage the internal radial profile 803.

[0039] In the first down-hole situation 804, illustrated in FIG. 8A, the primary shear mechanism 215 is intact and the collet shifting tool 500 may be forced down-hole. When the internal radial profile 803 of the shifting sleeve 802 contacts the second protrusion 210, the flexible portion 203 of the tubular collet sleeve 200 may deform inwardly in a radial direction perpendicular to axis 204. The deformation of the flexible portion 203 may allow the internal radial profile 803 to slide over the second protrusion 210 and come to rest between the first protrusion 209 and the second protrusion 210. Once the internal radial profile 803 has come to rest between the first protrusion 209 and the second protrusion 210, force may be applied to attempt to actuate a down-hole apparatus, such as ball valve 801, via the shifting sleeve 802. The force may be sufficient to actuate the down-hole apparatus, such as the ball valve 801. If the force is not sufficient to actuate the down-hole apparatus, then additional force may be applied. Since the flexible portion 203 of the tubular collet sleeve 200 is able to deform in a radial direction perpendicular to axis 204, however, application of additional force could result in the internal radial profile 803 of the shifting sleeve 802 to deflect the flexible portion 203 and pass over the first protrusion 209. To avoid this potentiality, the primary shear mechanism 215 may be adapted to break at a shear force that is less than the force required for the internal radial profile 803 of the shifting sleeve 802 to deflect the flexible portion 203 and pass over the first protrusion 209. Therefore, upon continued application of sufficient force, the primary shear

mechanism 215 may break. When the primary shear mechanism 215 breaks, tubular collet mandrel 400 may slide through internal cavity 202 of the tubular collet sleeve 200 until the secondary shear mechanism 216 abuts the first abutment profile 309 of the collet tip 300, as shown in FIG. 8B.

[0040] Referring to FIG. 8B, a schematic illustration of a collet shifting tool 500 in the second configuration as shown in FIG. 6 is shown. More specifically, the collet shifting tool 500 is shown in a second down-hole situation 805, where the collet shifting tool 500 has engaged a shifting sleeve 802 and sufficient force has been applied to break the primary shear mechanism 215. The tubular collet mandrel 400 has moved deeper into internal cavity 202 of the tubular collet sleeve 200 to force the secondary shear mechanism 216 against the first abutment face 309 of the collet tip 300. In the second down-hole situation 805, the substantially flat cylindrical surface 408 of a raised wall portion 407 of the wall of the tubular collet mandrel substantially aligns with the flexible portion 203 of the tubular collet sleeve to prevent the flexible portion 203 from deforming in a radial direction perpendicular to axis 204 of the tubular collet sleeve. Preventing such deformation of the flexible portion 203 allows the first protrusion 209 and/or the second protrusion 210 to continue to engage an internal radial profile 803 of a shifting sleeve 802 and to apply force to down-hole equipment, such as, a ball valve 801, as illustrated in Figures 8A – 8D. After a predetermined amount of force has been applied, however, the secondary shear mechanism 216 may break and the tubular collet mandrel 400 may slide further through internal cavity 202 of the tubular collet sleeve 200 and into the internal cavity 307 of the collet tip 300 as illustrated in FIG. 8C.

[0041] Referring to FIG. 8C, a schematic illustration of a collet shifting tool 500 in the third configuration as shown in FIG. 7 is shown. More specifically, the collet shifting tool 500 is shown in a third down-hole situation 806, where the collet shifting tool 500 continues to engage a shifting sleeve 802 after the secondary shear mechanism 216 has broken. The tubular collet mandrel 400 has passed into the internal cavity 307 of the collet tip 300. Upon entering the internal cavity 307 of the collet tip 300, the fingers 411 of the tubular collet mandrel 400 may flex in a radial direction perpendicular to axis 405 of the tubular collet mandrel to abut the second abutment profile 310 of the collet tip, which holds the tubular collet mandrel 400 in place. The abutment face 414 of the tubular collet mandrel 400 may also abut the first abutment profile 309 of the collet tip 300. The recessed wall portion 406 of the tubular collet mandrel 400 is substantially aligned with the flexible portion 203 of the tubular collet sleeve 200 to allow the flexible portion 203 to deform in a radial direction perpendicular to the longitudinal axis 204 of the tubular collet sleeve 200. This radial deformation of the flexible portion 203 of the tubular collet sleeve 200 may allow the first protrusion 209 and the second protrusion 210 to slide past the internal radial profile 803 of the shifting sleeve 802. The collet shifting tool 500 may still be used to apply force to down-hole equipment, such as, a ball valve 801, but the amount of force that may be applied may be less than the force that may be applied when the collet shifting tool 500 is in the second configuration, because of the ability of the flexible portion 203 of the tubular collet sleeve 200 to flex or to deform in the radial direction perpendicular to the longitudinal axis 204. Therefore, the collet shifting tool 500 may function as a conventional shifting tool allowing for opening and closing of a ball valve 801, for example. Since the flexible portion 203

of the tubular collet sleeve 200 can deform in a radial direction perpendicular to the longitudinal axis 204 of the tubular collet sleeve 200, the collet shifting tool 500 may be retracted from the shifting sleeve 802 as shown in FIG. 8D.

[0042] Referring to FIG. 8D, a schematic illustration of a collet shifting tool 500 in the third configuration as shown in FIG. 7 is shown. More specifically, the collet shifting tool 500 is shown in a fourth down-hole situation 807, where the collet shifting tool 500 has disengaged the shifting sleeve 802. To disengage, reverse force was applied to the shifting collet tool 500 to pull it in a direction leading out of the lateral wellbore 52 or out of the main wellbore 38 and the flexible portion 203 of the tubular collet sleeve 200 deformed radially inwardly when the internal radial profile 803 pressed against the second protrusion 210 of the tubular collet sleeve 200. The collet shifting tool 500 can be made to reengage the shifting sleeve by applying force in the opposite direction.

[0043] For the sake of brevity, only certain ranges are explicitly disclosed herein. However, ranges from any lower limit may be combined with any upper limit to recite a range not explicitly recited, as well as, ranges from any lower limit may be combined with any other lower limit to recite a range not explicitly recited, in the same way, ranges from any upper limit may be combined with any other upper limit to recite a range not explicitly recited. Additionally, whenever a numerical range with a lower limit and an upper limit is disclosed, any number and any included range falling within the range is specifically disclosed. In particular, every range of values (of the form, "from about a to about b," or, equivalently, "from approximately a to b," or, equivalently, "from approximately a-b") disclosed herein is to be understood to set forth every number and range encompassed

within the broader range of values even if not explicitly recited. Thus, every point or individual value may serve as its own lower or upper limit combined with any other point or individual value or any other lower or upper limit, to recite a range not explicitly recited.

[0044] It should be understood that the compositions and methods are described in terms of "comprising," "containing," or "including" various components or steps, the compositions and methods can also "consist essentially of" or "consist of" the various components and steps.

[0045] Therefore, the present invention is well adapted to attain the ends and advantages mentioned as well as those that are inherent therein. The particular embodiments disclosed above are illustrative only, as the present invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Although individual embodiments are discussed, the invention covers all combinations of all those embodiments. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. Also, the terms in the claims have their plain, ordinary meaning unless otherwise explicitly and clearly defined by the patentee. It is therefore evident that the particular illustrative embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the present invention.

CLAIMS

What is claimed is:

1. A collet shifting tool for engaging an internal profile of a shifting sleeve, the collet shifting tool comprising:
 - a tubular collet sleeve,
 - the tubular collet sleeve having an outer sleeve wall,
 - the outer sleeve wall defining an internal sleeve cavity,
 - the outer sleeve wall comprising a flexible portion,
 - the flexible portion being deformable in a radial direction into the internal sleeve cavity,
 - the flexible portion having at least one engagement profile adapted to engage the internal profile of the shifting sleeve;
 - a collet mandrel,
 - the collet mandrel being sized to fit within the internal sleeve cavity,
 - the collet mandrel having an outer mandrel wall,
 - the outer mandrel wall comprising a raised wall portion;
 - optionally a primary shear mechanism positioned to restrict movement of the collet mandrel through the internal sleeve cavity, the primary shear mechanism being adapted to break at a first shear force; and
 - a secondary shear mechanism positioned to restrict movement of the collet mandrel through the internal sleeve cavity and thereby to align the raised wall portion of the tubular collet mandrel with the flexible portion of the tubular collet sleeve to

prevent deformation of the flexible portion of the tubular collet sleeve in the radial direction into the internal sleeve cavity, the secondary shear mechanism being adapted to break at a second shear force.

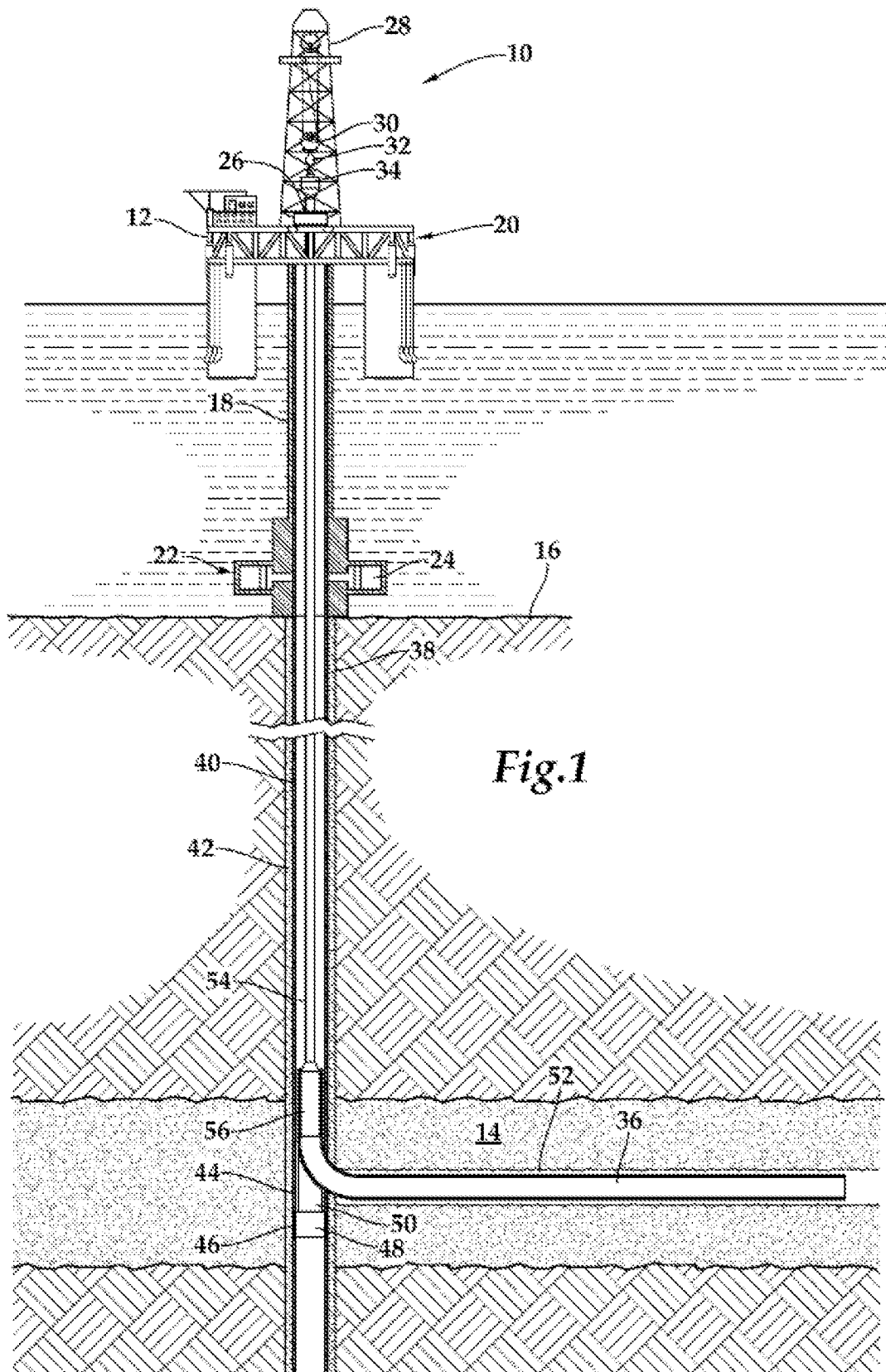
2. The collet shifting tool according to Claim 1, wherein the outer mandrel wall further comprises at least one finger, the at least one finger being resiliently biased in a radial direction out of the internal mandrel cavity.
3. The collet shifting tool according to Claim 2, further comprising a collet tip, disposed within the internal sleeve cavity and having at least one abutment profile adapted to engage the at least one finger of the tubular collet mandrel.
4. The collet shifting tool according to Claim 3, wherein the outer mandrel wall further comprises a recessed wall portion, and wherein the recessed wall portion of the tubular collet mandrel is positioned and sized to permit deformation of the flexible portion of the tubular collet sleeve in the radial direction into the internal sleeve cavity when the at least one finger engages the at least one abutment profile of the collet tip.
5. The collet shifting tool according to Claim 1, wherein the first shear force is less than the second shear force.
6. The collet shifting tool according to Claim 1, wherein the first shear force is in a range of from about 100 to about 2,000 pounds.
7. The collet shifting tool according to Claim 1, wherein the second shear force is in a range of from about 5,000 to about 40,000 pounds.

8. The collet shifting tool according to Claim 1, wherein the engagement profile comprises a first protrusion and a second protrusion.
9. The collet shifting tool according to Claim 1, wherein the flexible portion of the tubular collet sleeve comprises a plurality of longitudinal arms, defined by a plurality of longitudinal slots in the outer wall of the collet sleeve.
10. The collet shifting tool according to Claim 1, wherein the outer wall of the tubular collet sleeve comprises at least one through hole adapted to engage the primary shear mechanism.
11. The collet shifting tool according to Claim 1, wherein the outer wall of the tubular collet sleeve comprises at least one through hole adapted to engage the secondary shear mechanism.
12. The collet shifting tool according to Claim 1, wherein the secondary shear mechanism is slidably disposed within the internal cavity of the collet sleeve.
13. A method for engaging an internal profile of a shifting sleeve via a collet shifting tool comprising a tubular collet sleeve and a collet mandrel, the method comprising:
inserting the collet shifting tool into a wellbore;
engaging the internal profile of the shifting sleeve with at least one engagement profile of the collet shifting tool;
holding a raised wall portion of the collet mandrel relative to the at least one engagement profile to prevent disengagement of the at least one engagement profile with the internal profile of the shifting sleeve until a predetermined force is applied.
14. The method according to Claim 13, wherein holding the raised

wall portion of the collet mandrel relative to the at least one engagement profile comprises pressing the collet mandrel against a secondary shear mechanism.

15. The method according to Claim 14, wherein the secondary shear mechanism is adapted to break at the predetermined force.
16. The method according to Claim 13, further comprising engaging at least one finger of the collet mandrel with an abutment profile of the collet shifting tool to lock the collet mandrel in place relative to the collet sleeve.
17. The method according to Claim 16, further comprising aligning a recessed wall portion of the collet mandrel with the at least one engagement profile.
18. The method according to Claim 17, further comprising applying force in a direction suitable to withdraw the collet shifting tool from the wellbore.
19. The method according to Claim 18, further comprising allowing the at least one engagement profile to disengage from the internal profile of the shifting sleeve by deforming into the recessed wall portion of the collet mandrel.
20. The method according to Claim 19, further comprising reengaging the internal profile of the shifting sleeve with the at least one engagement profile of the collet shifting tool.

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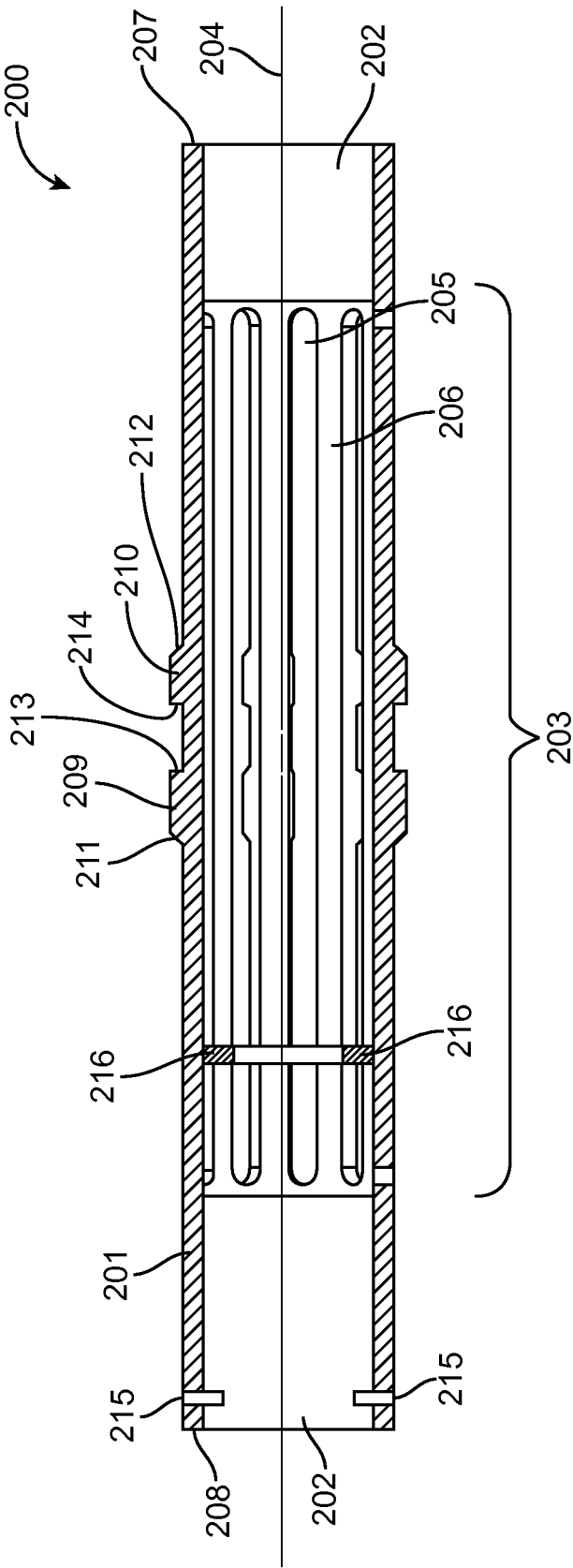


FIG. 2

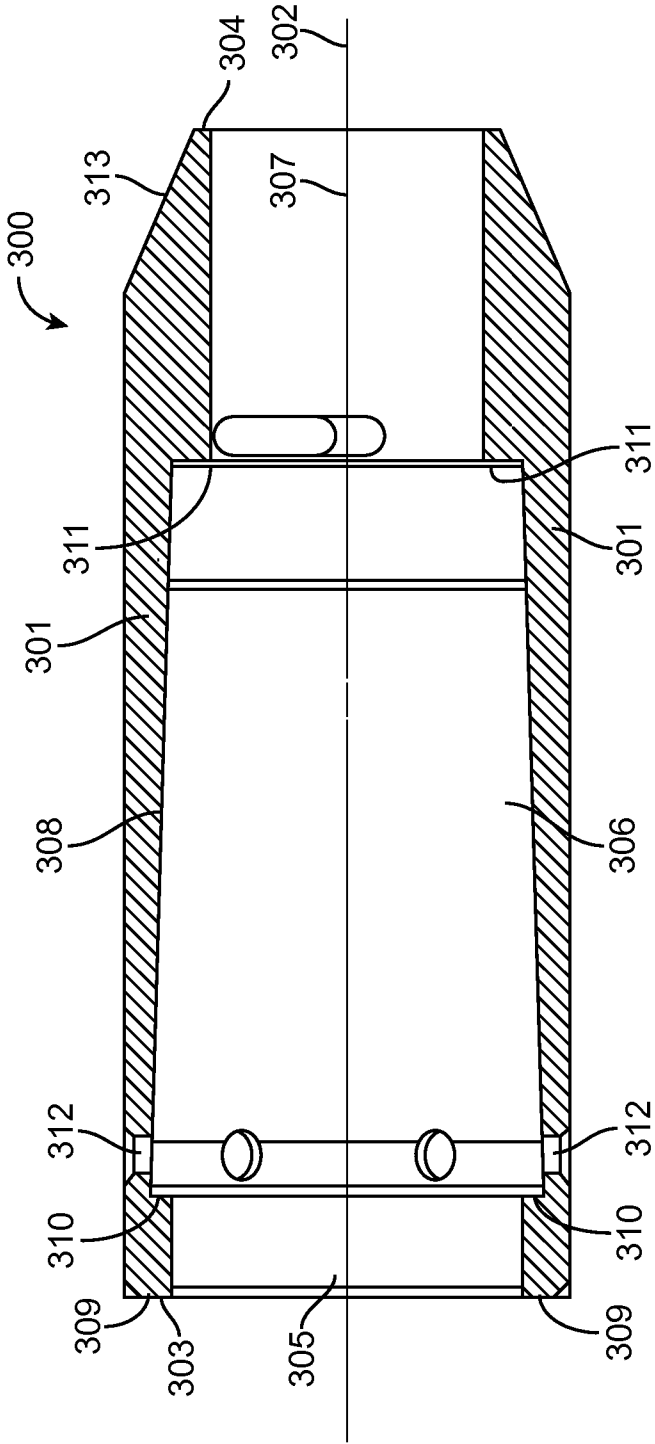


FIG. 3

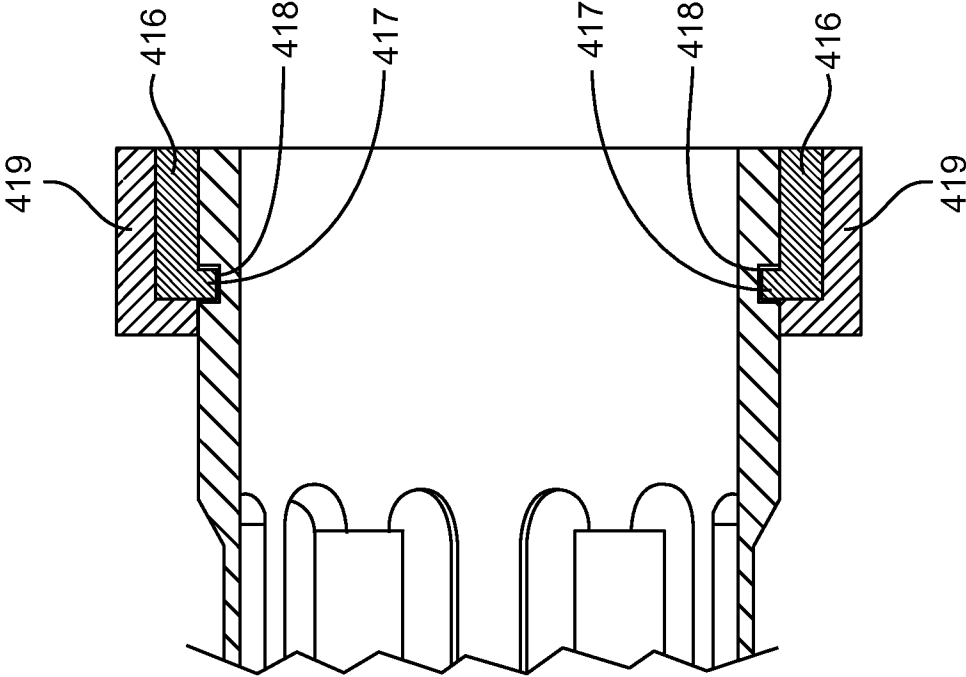


FIG. 4B

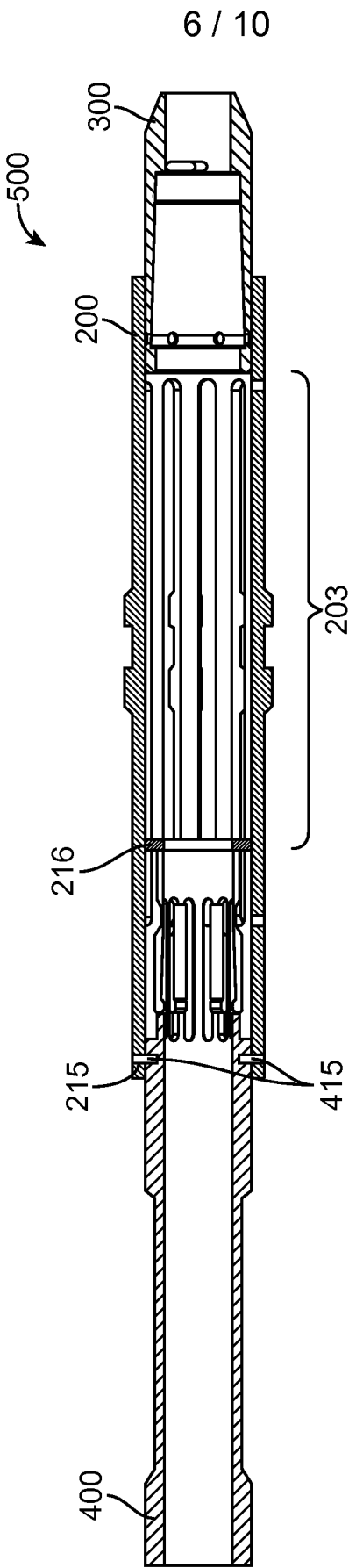


FIG. 5

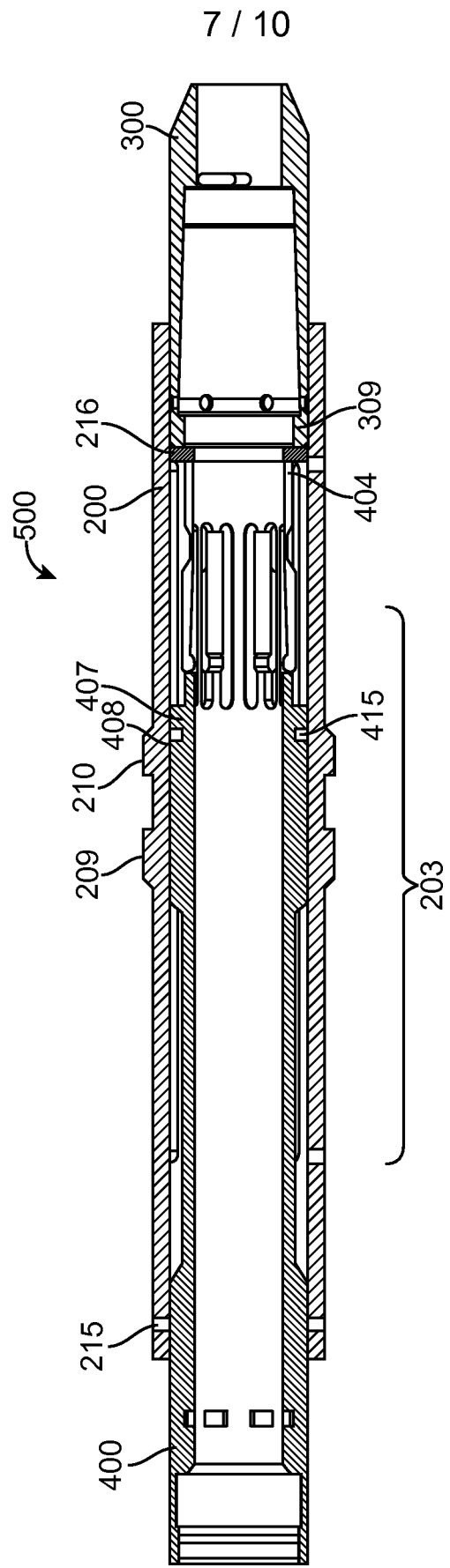


FIG. 6

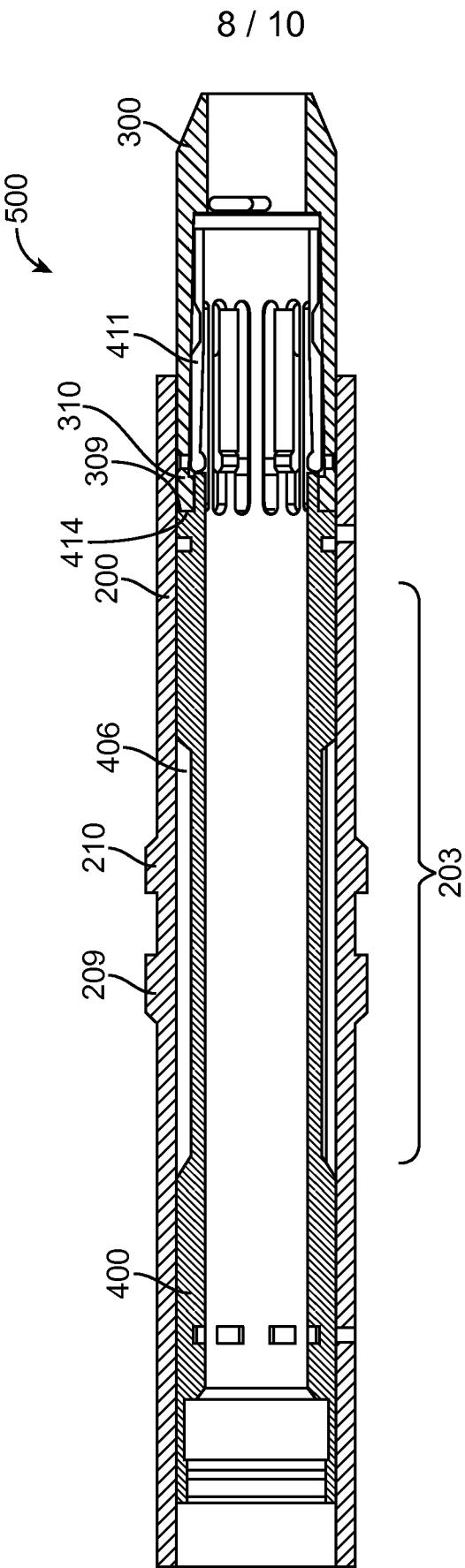


FIG. 7

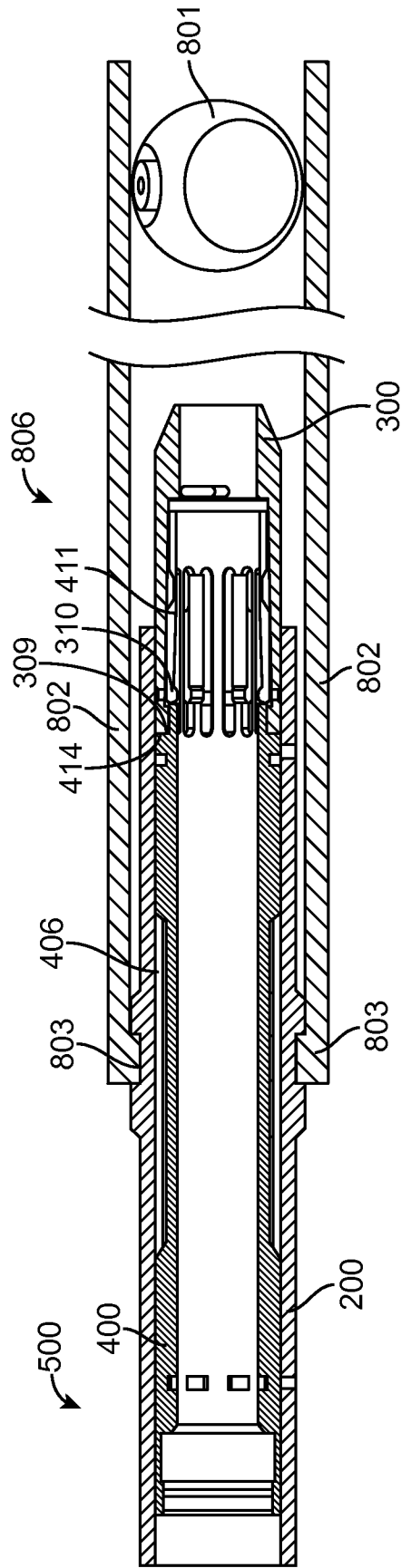


FIG. 8C

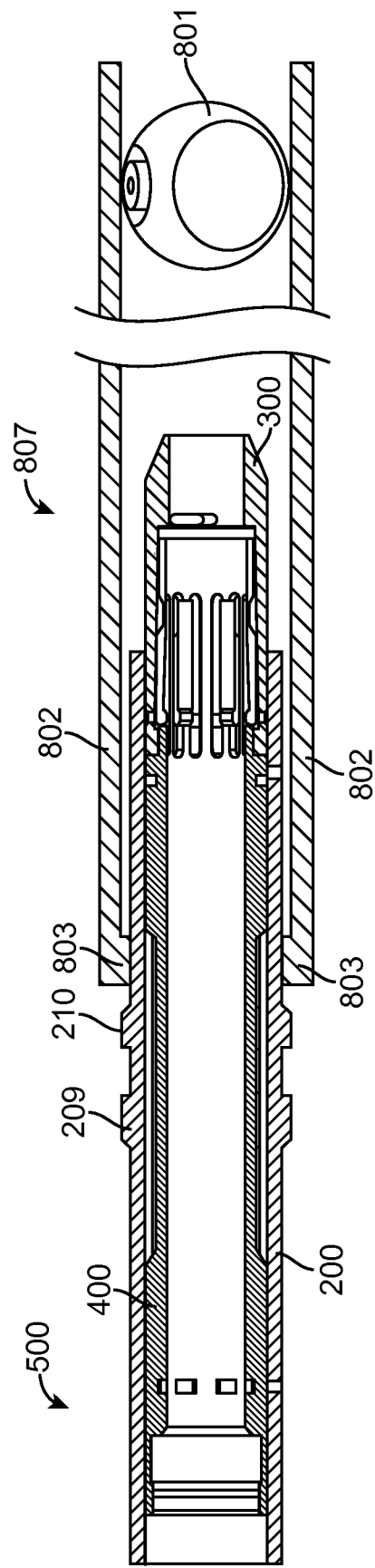


FIG. 8D

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/039390**A. CLASSIFICATION OF SUBJECT MATTER****E21B 23/00(2006.01)i, E21B 34/06(2006.01)i, E21B 17/00(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
E21B 23/00; E21B 43/00; E21B 19/22; E21B 31/12; E21B 34/14; E21B 34/06; E21B 17/00Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: shifting tool, collet sleeve, collet mandrel, primary shear mechanism, and secondary shear mechanism**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5029642 A (CRAWFORD, JAMES B.) 09 July 1991 See column 12, line 52 - column 13, line 5 and figures 12-13.	1,5-11,13-15
A		2-4,12,16-20
Y	US 2011-0290505 A1 (RENSHAW et al.) 01 December 2011 See paragraphs [0026], [0028]-[0031], [0034], [0038], [0048] and figures 1A-1 B.	1,5-11,13-15
Y	US 2010-0108323 A1 (WILKIN, JAMES F.) 06 May 2010 See paragraph [0040] and figure 8B.	8
A	US 2013-0264071 A1 (NOFFKE et al.) 10 October 2013 See paragraphs [0022]-[0025], [0027] and figure 2.	1-20
A	US 2012-0312555 A1 (CAMINARI et al.) 13 December 2012 See paragraphs [0021]-[0022], [0030]-[0031], [0033], claim 12, and figures 1, 4A-5B.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

18 December 2015 (18.12.2015)

Date of mailing of the international search report

21 December 2015 (21.12.2015)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/039390

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US 2013-0264071 A1	10/10/2013	AU 2012-376850 A1 CA 2870057 A1 CN 104204398 A EP 2836665 A1 MX 2014012139 A WO 2013-154527 A1	25/09/2014 17/10/2013 10/12/2014 18/02/2015 12/02/2015 17/10/2013
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