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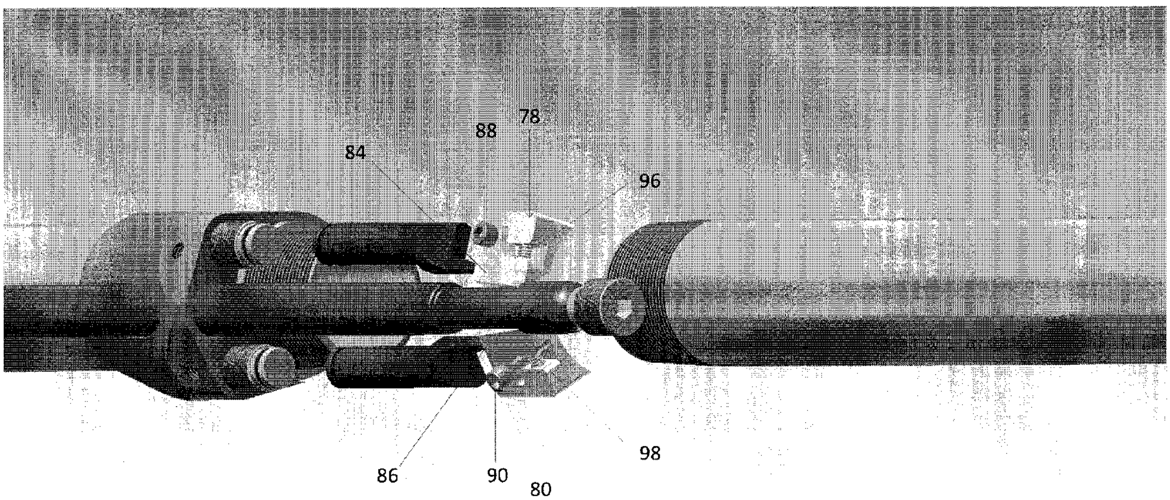
(54) Titre : METHODE ET APPAREIL POUR INSTALLATION DE FOND DE TROU DE TUBES DE PRODUCTION SPIRALES

(54) Title: METHOD AND APPARATUS FOR DOWNHOLE INSTALLATION OF COILED TUBING STRINGS



(57) Abrégé/Abstract:
A tool for releasably coupling a coiled tubing string to a primary tubing string includes: a tool body for coupling to a downstream end of the primary tubing string, the tool body comprising a locking mechanism for selectively coupling a coiled tubing end joint to the tool body, the locking mechanism being unlockable in response to fluid pressure inside the tool body exceeding a first threshold; a wellbore access mechanism openable in response to fluid pressure inside the tool exceeding a second threshold.

METHOD AND APPARATUS FOR DOWNHOLE INSTALLATION OF COILED TUBING STRINGS

Abstract

A tool for releasably coupling a coiled tubing string to a primary tubing string includes: a tool body for coupling to a downstream end of the primary tubing string, the tool body comprising a locking mechanism for selectively coupling a coiled tubing end joint to the tool body, the locking mechanism being unlockable in response to fluid pressure inside the tool body exceeding a first threshold;
a wellbore access mechanism openable in response to fluid pressure inside the tool exceeding a second threshold.

METHOD AND APPARATUS FOR DOWNHOLE INSTALLATION OF COILED TUBING STRINGS

Technical Field

[0001] The present disclosure relates to methods and apparatus for downhole installation of coiled tubing strings.

Background

[0002] Coiled tubing strings are installed adjacent to primary tubing strings in wellbores for many different applications. Sensor instrumentation, such as thermocouples or pressure sensors, for example, may be housed in coiled tubing strings. Coiled tubing strings may also be used in chemical injection or steam injection applications.

[0003] Coiled tubing strings have a relatively small diameter, which causes the coiled tubing strings to be flexible and, therefore, easily damaged during installation. Damage to the coiled tubing typically occurs when the tubing is pushed down from the surface into a vertical section of a horizontal well. Because coiled tubing installations may be up to 1500m in length, sinusoidal or helical buckling often occurs. In addition, excessive force applied when pushing the coiled tubing downhole often results in damage to the coiled tubing string particularly at excessive dog leg severity, upset or coupling locations.

[0004] When coiled tubing is damaged during installation, the tubing may be unusable for the immediate installation and/or for subsequent installations, particularly when the tubing breaks or fails. In some cases, damage caused during installation is not discovered immediately and the coiled tubing is operational for a time. For example, thermocouples or other downhole sensors may operate for a time and then fail. When the tubing is pulled to the surface, it may be discovered that the thermocouple failure is a result of damage that occurred during installation.

[0005] Improvement in methods and apparatus for downhole installation of coiled tubing is therefore desirable.

Summary

[0006] In an aspect of the present disclosure there is provided, a tool for releasably coupling a coiled tubing string to a primary tubing string, the tool including a locking mechanism for securing the coiled tubing string to the primary tubing string, the locking mechanism being releasable to de-couple the coiled tubing string from the primary tubing string in response to a first threshold pressure being reached; wherein a portion of the primary tubing string is openable to enable communication between a channel of the primary tubing string and the wellbore in response to a second, higher, threshold pressure being reached.

[0007] In another aspect of the present disclosure there is provided a tool for releasably coupling a coiled tubing string to a primary tubing string, the tool comprising: a tool body for coupling to a downstream end of the primary tubing string, the tool body comprising a locking mechanism for selectively coupling a coiled tubing end joint to the tool body, the locking mechanism being unlockable in response to fluid pressure inside the tool body exceeding a first threshold; a wellbore access mechanism openable in response to fluid pressure inside the tool exceeding a second threshold.

[0008] In still another aspect of the present disclosure there is provided a clamp assembly for coupling a coiled tubing string to a primary tubing string, the clamp assembly comprising; a coupler for coupling adjacent primary tubing members of the primary tubing string to one another; a clamp coupled to the coupler, the clamp comprising a hinge and a bracket located opposite the hinge, the bracket for receiving the coiled tubing string; wherein the bracket is sized for limiting non-axial movement of the coiled tubing string relative to the primary tubing string.

Drawings

[0009] The following figures set forth embodiments of the invention in which like reference numerals denote like parts. Embodiments of the invention are illustrated by way of example and not by way of limitation in the accompanying figures.

[0010] FIG. 1 is an isometric view of a tool according to an embodiment for coupling a coiled tubing string to a primary tubing string;

[0011] FIG. 2 is another isometric view of the tool of FIG. 1 with a tool body and downstream housing removed;

[0012] FIG. 3 is another isometric view of the tool of FIG. 1 with a cover and downstream housing removed;

[0013] FIG. 4 is another isometric view of the tool of FIG. 1 with the tool body and downstream housing shown as transparent;

[0014] FIG. 5 is an isometric view of a the tool body of the tool of FIG. 1;

[0015] FIG. 6 is another isometric view of the tool as shown in FIG. 3;

[0016] FIG. 7 is another isometric view of the tool as shown in FIG. 2;

[0017] FIG. 8 is an isometric view of the tool as shown in FIG. 2 with the coiled tubing string released;

[0018] FIG. 9 is yet another isometric view of the tool as shown in FIG. 2;

[0019] FIG. 10 is an isometric sectional view of a tool for coupling a coiled tubing string to a primary tubing string according to another embodiment;

[0020] FIG. 11 is an isometric sectional view of a portion of the tool of FIG. 10;

[0021] FIG. 12 is an isometric side view of the tool of FIG. 10 with a transition member of the tool shown as transparent;

[0022] FIG. 13 is an isometric top view of the tool of FIG. 10 with the transition member of the tool shown as transparent;

[0023] FIG. 14 is an isometric view of a rotating shear joint;

[0024] FIG. 15 is an exploded side view of the rotating shear joint of FIG. 14;

[0025] FIG. 16 is an isometric view of a portion of a primary tubing string and a coiled tubing string according to an embodiment;

[0026] FIG. 17A is an isometric view of a coupler of a primary tubing string;

[0027] FIG. 17B is a side view of the coupler of FIG. 17A;

[0028] FIG. 18A is an isometric view of a clamp according to an embodiment;

[0029] FIG 18B is an end view of the clamp of FIG. 18A; and

[0030] FIG. 19 is an isometric view of a portion of an end joint according to an embodiment.

Detailed Description of Embodiments

[0031] Numerous details are set forth to provide an understanding of the embodiments described herein. The embodiments may be practiced without these details. In other instances, well-known methods, procedures, and components have not been described in detail to avoid obscuring the embodiments described.

[0032] Referring to FIG. 1, a tool 10 for releasably coupling a coiled tubing string 12 to a primary tubing string 14 is generally shown. In the example described herein, the coiled tubing string 12 has a diameter of approximately 1.25 inches; however, the tool may be used with any commercially available coiled tubing.

[0033] As shown in FIG. 2, a coiled tubing end joint 16 is coupled to an end of the coiled tubing string 12. The coiled tubing end joint 16 includes an upstream portion 18, a reduced diameter portion 20 and an end portion 22, which has a diameter that is generally equal to the diameter of the upstream portion 18. The upstream portion 18 is coupled to an end of the coiled tubing string 12 by a welded connection, for example. A step including a radially extending wall 24 is provided between the cylindrical portion 20 and the end portion 22. It will be appreciated by a person skilled in the art that the coiled tubing end joint 16 is not limited to the configuration shown. The coiled tubing end joint 16 functions to close the end of the coiled tubing string 12 and provide a structure that is engageable by the tool 10 as will be described. Any arrangement that achieves both functions in a single part or multiple parts may be used. Further, in some applications, the end of the coiled tubing string 12 may be open. In such applications, the end thereof may include an outwardly extending flange, a collar or a groove that is engageable by the tool 10.

[0034] Referring back to FIG. 1, the tool 10 is assembled between the primary tubing string 14 and a primary tubing end joint 26. The primary tubing end joint 26 includes a rupture disc 28 that is rupturable to open the primary tubing end joint 26 when pressure inside the primary tubing end joint 26 exceeds a second threshold. It will be appreciated by a person skilled in the art that the rupture disc 28 may be replaced with any wellbore access mechanism that opens communication to the primary tubing string 14 in response to pressure inside the primary tubing end joint 26 exceeding a second threshold.

[0035] The tool 10 includes a tool body 30, a cover 32 and upstream and downstream housings 34 and 36, respectively. The upstream and downstream housings 34, 36 are coupled to the tool body 30 using set screws 45. The upstream and downstream housings 34, 36 are shaped to provide upstream and downstream tapers so that the tool 10 does not get caught on objects encountered downhole during deployment or retrieval of the tool 10.

[0036] Referring also to FIG. 3, the tool body 30 includes a support for receiving the coiled tubing end joint 16. In the present example, the support is a tube-shaped portion 38 of the tool body 30 that includes a coiled tubing-receiving channel 35 (shown in FIG. 5) sized to slidably receive the coiled tubing end joint 16 of the coiled tubing string 12. When received in the coiled tubing-receiving channel of the tube-shaped portion 38, a downstream surface 40 (shown in FIG. 2) of the end portion 22 of the coiled tubing end joint 16 abuts a plug 42. The plug 42 is coupled to the tube-shaped portion 38 of the tool body 30 by a threaded connection and functions as a stop to limit downstream movement of the coiled tubing string 12 relative to the tool 10.

[0037] Referring to FIGS. 4 and 5, the tool body 30 further includes a channel 44, which is defined by an inner surface 46 of the tool body 30 and extends through a length of the tool 10. The tool body 30 is coupled by threaded connections to an end 48 of the primary tubing string 14 and an end 50 of the primary tubing end joint 26. The tool body 30 further includes a first bore 52 and a second bore 54. The bores 52, 54 are located on either side of the tube-shaped portion 38 adjacent to the channel 44. Plugs 56 and 58 are received in upstream ends 60 and 62 of the first and second bores 52, 54, respectively, to seal the upstream ends 60, 62 of the bores 52, 54.

[0038] The first and second bores 52, 54 are sized to slidably receive first and second pistons 64 and 66, respectively, of a locking mechanism. Downstream ends 70, 72 of the pistons 64, 66 extend through openings in a wall 68 of the tool body 30 and seals are provided between the wall 68 and the pistons 64, 66. A first opening 74 extends between the channel 44 and the first bore 52 and a second opening 76 extends between the channel 44 and the second bore 54. The openings 74, 76 allow for fluid communication between the channel 44 and the bores 52, 54.

[0039] Referring also to FIGS. 6 and 7, a first cam support 78 and a second cam support 80 are coupled to an outer surface 82 of the tool body 30. In the present example, the cam supports 78, 80 are received in machined pockets that are provided in the outer surface 82 of the tool body 30. The cam supports 78, 80 may alternatively be coupled by welding or the tool body 30 may be machined to include cam support structures on the outer surface 82 thereof. The first and second cam supports 78, 80 are located on either side of the tube-shaped portion 38 of the tool body 30 and are oriented to allow first and second cams 84, 86, which are pivotally coupled thereto by first and second bolts 88, 90, to pivot into and out of contact with the radially extending wall 24 of the coiled tubing end joint 16 though openings 85 in the tool body 30. The cams 84, 86 are generally boot-shaped and each cam includes an upstream surface 92 at the heel, a downstream surface 94 at the toe and an axially extending surface 95 therebetween (shown in FIG. 9). First and second springs 96, 98 are coupled to the cam supports 78, 80 to bias the downstream surfaces 94 of the cams 84, 86 toward the coiled tubing end joint and into contact with the radially extending wall 24. The downstream ends 70, 72 of the pistons 64, 66 include arms 100, 102 (shown in FIG. 9), which abut the upstream surfaces 92 of the cams 84, 86. Downstream movement of the pistons 64, 66 causes the cams 84, 86 to pivot out of contact with the radially extending wall 24 into an unlocked position in which the coiled tubing end joint 16 is released. The unlocked position is shown in FIG. 8.

[0040] In order to assemble the tool 10, the tool body 30 is threaded onto the end 48 of the primary tubing string 14 and the primary tubing end joint 26 is threaded onto the opposite end of the tool body 30. The upstream housing portion 34, which is received on the primary tubing string 14, and the downstream housing portion 36, which is received on the primary tubing end joint 26, are then secured to the tool body 30 using set screws. The end portion 22 of the coiled tubing end joint 16 is then pushed into the coiled tubing-receiving channel until the end surface 40 of the coiled tubing end joint 16 abuts the plug 42. The end portion 22 forces the cams 84, 86 of the locking mechanism to pivot away from the coiled tubing string 12 as the coiled tubing end joint 16 advances and when the end portion 22 moves beyond the cams 84, 86, the cams 84, 86 are biased into abutment with the coiled tubing end joint 16. When the coiled tubing string 12 is secured to the primary tubing string 14 by the tool 10, the cams 84, 86 are in the locked position in which the downstream surfaces 94 of the cams 84, 86 abut the radially extending wall 24 of the coiled tubing end joint 16 and the axially extending surfaces 95 abut the cylindrical portion 20 of the coiled tubing end joint 16. In embodiments in which the radially extending wall is larger, the axially extending surfaces 95 may be spaced from the cylindrical portion when the cams 84, 86 are in the locked position.

[0041] In operation, after the coiled tubing string 12 has been secured to the primary tubing string 14 by the tool 10, the primary tubing string 14 is fed down a wellbore. When an installation location has been reached, fluid, such as water, for example, is pumped through the primary tubing 14. The fluid enters the channel 44 of the tool body 30 of the tool 10 and the tubing end joint 26. Because the tubing end joint 26 is sealed by the rupture disc 28, fluid is forced through the openings 74, 76 into the bores 52, 54 and pressure within the bores 52, 54 increases. When the pressure in the bores 52, 54 reaches a first threshold, the pistons 64, 66 are actuated to pivot the cams 84, 86 to an unlocked position in which the cams 84, 86 no longer engage the coiled tubing end joint 16. The coiled tubing string 12 may then be retracted from the tool 10. Fluid continues to be pumped into the primary tubing string 14 and when the pressure reaches a second threshold, the rupture disc 28 ruptures to open communication between the primary tubing string 14 and the wellbore. The primary tubing string 14 and the coiled tubing string 12 are then ready for use.

[0042] In the present example, the first threshold pressure is approximately 700 psi and the second threshold pressure is approximately 2000 psi. The thresholds are approximate and are determined based on the specifications of the rupture disc 28 and the specifications of the tool 10.

[0043] It will be appreciated by a person skilled in the art that the tool described herein is provided by way of example. Other tool configurations are possible. In general, any tool including a locking mechanism for securing the coiled tubing string to the primary tubing string that is actuable to release the coiled tubing string from the primary tubing string in response to a first threshold pressure within the tool and a channel that is openable to enable communication between a primary tubing string and the wellbore in response to a second, higher, threshold pressure may be used.

[0044] Referring to FIG. 10, another embodiment of a tool 110 is generally shown. Similar to the tool 10 of FIGS. 1-9, the tool 110 is for releasably coupling a coiled tubing string to a primary tubing string. The tool 110 includes a fitting 112, which is located at an upstream end, a tool body 116, which is located at a downstream end of the tool 110 and a transition member 114, which is located between the fitting 112 and the tool body 116.

[0045] Referring to FIG. 11, the fitting 112 includes a channel 118 that receives a piston 120. The piston 120 is slidable relative to an inner surface 122 of the channel 118 when shear pins 115, which couple the piston 120 to a wall 132 of the fitting 112, fail. Movement of the piston 120 through the channel 118 toward an upstream end 122 of the fitting 112 is limited by an inwardly extending flange 124, which functions as an upstream stop. Movement of the piston 120 toward a downstream end 126 of the fitting 112 is limited by an end surface 128 of the transition member 114, which functions as a downstream stop.

[0046] A plurality of slots 130 extend through the wall 132 of the fitting 112. The slots 130 are closed when the piston 120 is in an upstream position in which the piston 120 abuts the inwardly extending flange 124 to block communication between the channel 118 and the well. The slots 130 are open when the piston 120 is in a downstream position in which the piston 120 abuts the end surface 128 of the transition member 114. In the present example, six slots are provided in the wall 132 of the fitting 112. It will be appreciated by a person skilled in the art that any number of slots 130 may be used as long as the flow area of the slots generally equals the total open area of the primary tubing. Further, it will be appreciated by a person skilled in the art that the slot arrangement may be replaced with another wellbore access mechanism.

[0047] A pressure line 134 extends through a first line fitting 136, which is received in the piston 120 and coupled thereto, through the channel 118, through a second line fitting 138, which is received in the transition member 114 and coupled thereto, and through a bore 140 of the transition member 114 in order to communicate with the tool body 116. The first line fitting 136 includes a pair of seals 142 and is slidable relative to the pressure line 134.

[0048] Internal threads 144 are provided at the upstream end 122 of the fitting 112 for mating with a threaded end of the primary tubing string. Internal threads 146 are provided at the downstream end 126 of the fitting 112 for mating with a threaded upstream end 148 of the transition member 114.

[0049] Referring back to FIG. 10, the transition member 114 includes a bore 150 for receiving an end joint 176. The bore 150 extends from an opening 152 in a side of the transition member 114 through the transition member 114 to a downstream opening 154. The bore 150 is shaped to receive the end joint 176 of the coiled tubing string 12 from a position outside of the tool 110 and feed the end joint 176 into a coiled tubing-receiving channel 156 of the tool body 116. The coiled tubing-receiving channel 156 is sized to slidably receive the end joint 176 of the coiled tubing string 12, which includes a cylindrical portion and an end portion, as has been described with respect to the embodiment of FIGS. 1-9. The end joint 176 of the coiled tubing string 12 may be pre-bent in order to fit easily into the bore 150 during assembly of the tool 110.

[0050] As shown in FIG. 12, the tool body 116 is bullnose-shaped at a downstream end 158 thereof to facilitate movement of the tool 110 through the wellbore when the primary tubing string is deployed. The tool body 110 is coupled to the transition member 114 by bolts 160, which are received in mating bores 162 in an upstream end 164 of the tool body 116. The tool body 116 includes a first bore 166 and a second bore 168. The bores 166, 168 are located on either side of coiled tubing-receiving channel 150. Plugs (not shown) are received in upstream ends of the first and second bores 166, 168 to seal the upstream ends of the bores 166, 168. Referring also to FIG. 13, the first and second bores 166, 168 are sized to slidably receive first and second pistons 170 and 172, respectively. Downstream ends of the pistons 170, 172 extend through openings in a wall 174 of the tool body 116 and seals are provided between the wall 174 and the pistons 170, 172. The pressure line 134 communicates with the bores 166, 168.

[0051] The tool 110 includes a locking mechanism that is similar to the locking mechanism of the embodiment of FIGS. 1-9; therefore, like reference numerals have been used in FIGS. 12 and 13 to identify components of the locking mechanism. The detailed description of the components of the locking mechanism will not be repeated here. Similar to FIGS. 1-9, other locking mechanisms capable of selectively securing the coiled tubing end joint 176 to the tool 110 may alternatively be used.

[0052] Referring to FIGS. 14 and 15, the end joint 176, which is shown in FIG. 10, is coupled to the coiled tubing string 12 by a rotating shear joint 182. The rotating shear joint 182 includes an upstream body 184 that is received in an opening 190 of a downstream body 186 and coupled thereto by shear pins 188. The upstream body 184 includes a downstream end 194 including channels 196 formed therein and an upstream end 198 including channels 202 and grooves 200 formed therein. The downstream body 186 includes a threaded downstream opening 192 for coupling to the end joint 176. In order to couple the coiled tubing 12 and the end joint 176, the upstream body 184 is inserted into the outer diameter of the coiled tubing 12 and the coiled tubing 12 is deformed to conform to the shape of the upstream body 184 and form a solid connection therewith. The downstream body 186 is then threaded to threads of the end joint 176.

[0053] The rotating shear joint 182 allows for rotation of the coiled tubing string 12 relative to the end joint 176. Because the rotating shear joint 182 is assembled using shear pins 188, if for any reason, the coiled tubing cannot be retracted from the tool 110, the connection between the upstream body 184 and the downsteam body 186 of the rotating shear joint 182 may be sheared and the coiled tubing 12 retracted. In one example, six shear pins 188, which have a maximum combined rating of 10000 lbs, couple the upstream body 184 and the downsteam body 186 to one another. In this example, pulling the coiled tubing 12 with a force that exceeds 10000 lbs will cause the shear pins 188 to shear so that the coiled tubing 12 may be retracted. The rotating shear joint 182 may also be used in place of the welded joint of the embodiment of FIGS. 1-9.

[0054] In operation, after the coiled tubing string 12 has been secured to the primary tubing string 14 by the tool 110, the primary tubing string is fed down a wellbore. When an installation location has been reached, fluid, such as water, for example, is pumped through the primary tubing string. The fluid enters an upstream end of the channel 118 of the fitting 112 and the pressure line 134. Fluid from the pressure line 134 is forced through openings into the bores 166, 168 and pressure within the bores 166, 168 increases. When the pressure in the bores 166, 168 reaches a first threshold, the pistons 170, 172 are actuated to pivot the cams 84, 86 to an unlocked position in which the cams 84, 86 no longer engage the coiled tubing end joint. The coiled tubing string 12 and end joint 176 may then be retracted from the tool 110. Fluid continues to be pumped into the primary tubing string and when the pressure within the fitting 112 reaches a second threshold, the shear pins 115 fail and the piston 120 slides into a downstream position to open the slots 130, which opens communication between the primary tubing string and the wellbore. The primary tubing string and the coiled tubing string 12 are then ready for use.

[0055] The tool 110 is a low-profile tool that includes an overall outer diameter that is less than an outer diameter of couplings of the primary tubing string. In one example, the primary tubing string has a diameter of 2-7/8 inches with couplings having an outer diameter of 3-1/2 inches. In this example, the overall outer diameter of the tool 110 is less than 3-1/2 inches. As will be understood by a person skilled in the art, depending on the diameter of the primary tubing string, the fitting 112 of the tool 110 is interchanged with other fittings 112 in order to match the flow area of the slots with the total open area of the primary tubing.

[0056] The tool 10, 110 facilitates downhole installation of coiled tubing strings by coupling a coiled tubing string to a primary tubing string. The tool 10, 110 has a low profile so that modifications to the wellbore are not required to accommodate the tool 10, 110.

[0057] In an embodiment, the pistons are fitted with snap rings in order to restrict reverse movement of the pistons after they have been actuated. The snap rings provide a fail safe arrangement so that in the event that the fluid pressure is not able to maintain the pistons in the actuated position, the snap rings are able to perform this function.

[0058] In another embodiment, clamps are included to couple the coiled tubing 12 to the primary tubing string 10 along the length of the primary tubing string 10. Referring to FIG. 16. a first clamp 204 is coupled to an upstream end of a coupler 206 and a second clamp 208 is coupled to a downstream end of the coupler 206. The coupler 206 joins adjacent primary tubing string members in order to form the primary tubing string 10. As shown in FIGS 17A and 17B, the coupling 206 includes upstream and downstream threaded inside surfaces 210 and 212, respectively, for receiving adjacent primary tubing string members. Axial projections 214 extend from opposite ends of the coupling 206. In the embodiment shown, five axial projections 214 extend from each end. The axial projections 214 include openings 216 that extend circumferentially therethrough.

[0059] Referring also to FIGS. 18A and 18B, the first clamp 204 includes a first clamp member 218 and a second clamp member 220 including a hinge 222 and a bracket 224 that is opposite the hinge 222. The hinge 222 includes hinge fingers 226 and 228 of the second clamp member 220 that are coupled to hinge finger 230 by a pin 232. The first and second clamp members 218 and 220 include cutouts 234 for receiving the axial projections 214 of the coupler 206.

[0060] The bracket 224 includes a first side member 236 and a second side member 238. The side members 236, 238 include outwardly extending arms 240 for retaining the coiled tubing 12 and projections 242 that abut one another generally at a centreline of the first clamp 204. Openings 246 extend through the projection 242 of the first side member 236 and are aligned with openings 248 that extend partially through the projection 242 of the second side member 238. The openings 246, 248 receive fasteners 250, which secure the first clamp member 218 and the second clamp member 220 to one another. Openings 252 extend through the first side member 236 and the second side member 238 and are aligned with one another to receive a fastener 254 that passes through the opening 216 of the axial projection 214 of the coupler 206 that is sandwiched between the first side member 236 and the second side member 238.

[0061] Referring back to FIG. 16, the second clamp 208 is generally identical to the first clamp 204 but is installed in an opposite orientation relative thereto such that the cutouts 234 are directed toward the coupler 206 from both ends thereof. Together, the clamps 204, 208 limit non-axial movement of the coiled tubing string 12 relative to the primary tubing string 10. Some axial movement is possible, however.

[0062] Referring also to FIG. 19, an end joint 256 for use with the clamps 204, 208 is generally shown. The end joint 256 is similar to the end joint 176 but rather than being bent, the end joint 256 includes hinges 258, 260 at the transition locations. Unlike the fixed bends of end joint 176, the hinges 258, 260 allow the end joint 256 to straighten in order to be retracted through the clamps 204, 208.

[0063] Although the example of FIGS. 16-18B shows a pair of clamps for coupling the coiled tubing string 12 to the primary tubing string 10, a single clamp may instead be used. Further, clamps need not be provided at every coupler location on the primary tubing string 10. One or more clamps 204, 208 may be provided at all of the primary tubing member joints of the primary tubing string or at some of the joints thereof.

[0064] The clamps 204, 208 described herein couple the coiled tubing string 12 to the primary tubing string 10 along a length thereof rather than at a single location (ie. at the tool 10, 110). This arrangement avoids installations in which the coiled tubing string 12 becomes wrapped around the primary tubing string 10 in a helical manner, which leads to difficulties extracting the coiled tubing string 12 without damage occuring thereto.

[0065] Specific embodiments have been shown and described herein. Modifications and variations may occur to those skilled in the art. All such modifications and variations are believed to be within the scope and sphere of the present invention.

Claims

1. A tool for releasably coupling a coiled tubing string to a primary tubing string, the tool comprising:

a tool body for coupling to a downstream end of the primary tubing string, the tool body comprising a locking mechanism for selectively coupling a coiled tubing end joint to the tool body, the locking mechanism being unlockable in response to fluid pressure inside the tool body exceeding a first threshold;

a wellbore access mechanism openable in response to fluid pressure inside the tool exceeding a second threshold.

2. The tool of claim 1, wherein the wellbore access mechanism is located upstream of the tool body.

3. The tool of claim 1, comprising a rotating shear joint coupled to the coiled tubing end joint for receiving an end of the coiled tubing string.

4. The tool of claim 1, comprising a clamp coupled to a coupler of the primary tubing string, the clamp for receiving the coiled tubing string at a location along a length of the primary tubing string.

5. The tool of claim 1, wherein the tool body comprises:

a first end for coupling to a primary tubing string;

a second end for coupling to a primary tubing end joint;

an inner surface defining a channel and first and second bores, the channel for receiving fluid from an outlet of the primary tubing string, the first and second bores being in fluid communication with the channel through openings located adjacent an upstream end of the first and second bores; and a coiled tubing string support for receiving an end joint of the coiled tubing string;

first and second pistons slidably received in the first and second bores;

first and second cams coupled to the outer surface of a tool body housing at locations circumferentially spaced on either side of the coiled tubing string support, the first and second cams being movable between a locked position in which the cams abut an upstream side of a radially extending structure of the coiled tubing string end joint and an unlocked position in which the first and second cams are radially spaced from the radially extending structure, the first and second cams being biased toward the locked position and being movable in response to movement of the first and second pistons;

wherein when fluid pressure within the tool body exceeds the first threshold, the first piston and the second piston are actuated to move the first cam and the second cams to the unlocked position for releasing the coiled tubing string and when the fluid pressure within the tool body exceeds the second threshold, the channel of the tool body being opened.

6. The tool of claim 1, wherein the tool body comprises:

a coiled tubing receiving channel for receiving a downstream portion of the coiled tubing end joint;

a first end for coupling to a transition member, the transition member for receiving an upstream portion of the coiled tubing end joint to direct the coiled tubing end joint into the coiled tubing receiving channel;

first and second bores for receiving fluid from an outlet of the primary tubing string,

first and second pistons slidably received in the first and second bores;

first and second cams coupled to the outer surface of the housing at locations circumferentially spaced on either side of the coiled tubing string support, the first and second cams being movable between a locked position in which the cams abut an upstream side of a radially extending structure of the coiled tubing string end joint and an unlocked position in which the first and second cams are radially spaced from the radially extending structure, the first and second cams being biased toward the locked position and being movable in response to movement of the first and second pistons;

wherein when fluid pressure within the tool body exceeds the first threshold, the first piston and the second piston are actuated to move the first cam and the second cams to the unlocked position for releasing the coiled tubing string.

7. The tool of claim 6, wherein the first and second bores receive fluid through a pressure line for communicating with the outlet, the pressure line extending through the transition member.

8. The tool of claim 1, wherein the wellbore access mechanism comprises:

a fitting for coupling to a downstream end of the primary tubing string, the fitting comprising slots extending through a wall of the fitting;

a piston slidable though a channel of the fitting between a first position in which communication between the channel and the wellbore is blocked and a second position in which communication between the channel and the wellbore is open; and

shear pins coupling the piston to the fitting;

wherein the shear pins fail in response to the fluid pressure exceeding the second threshold to release the piston to the second position.

9. The tool of claim 1, comprising a transition member between the tool body and the wellbore access mechanism, the transition member for transitioning the coiled tubing end joint into a position within the tool body.

10. The tool of claim 1, wherein the tool body is bullnose-shaped.

11. The tool of claim 5, wherein the first and second pistons are fitted with snap rings.

12. The tool of claim 6, wherein the first and second pistons are fitted with snap rings.

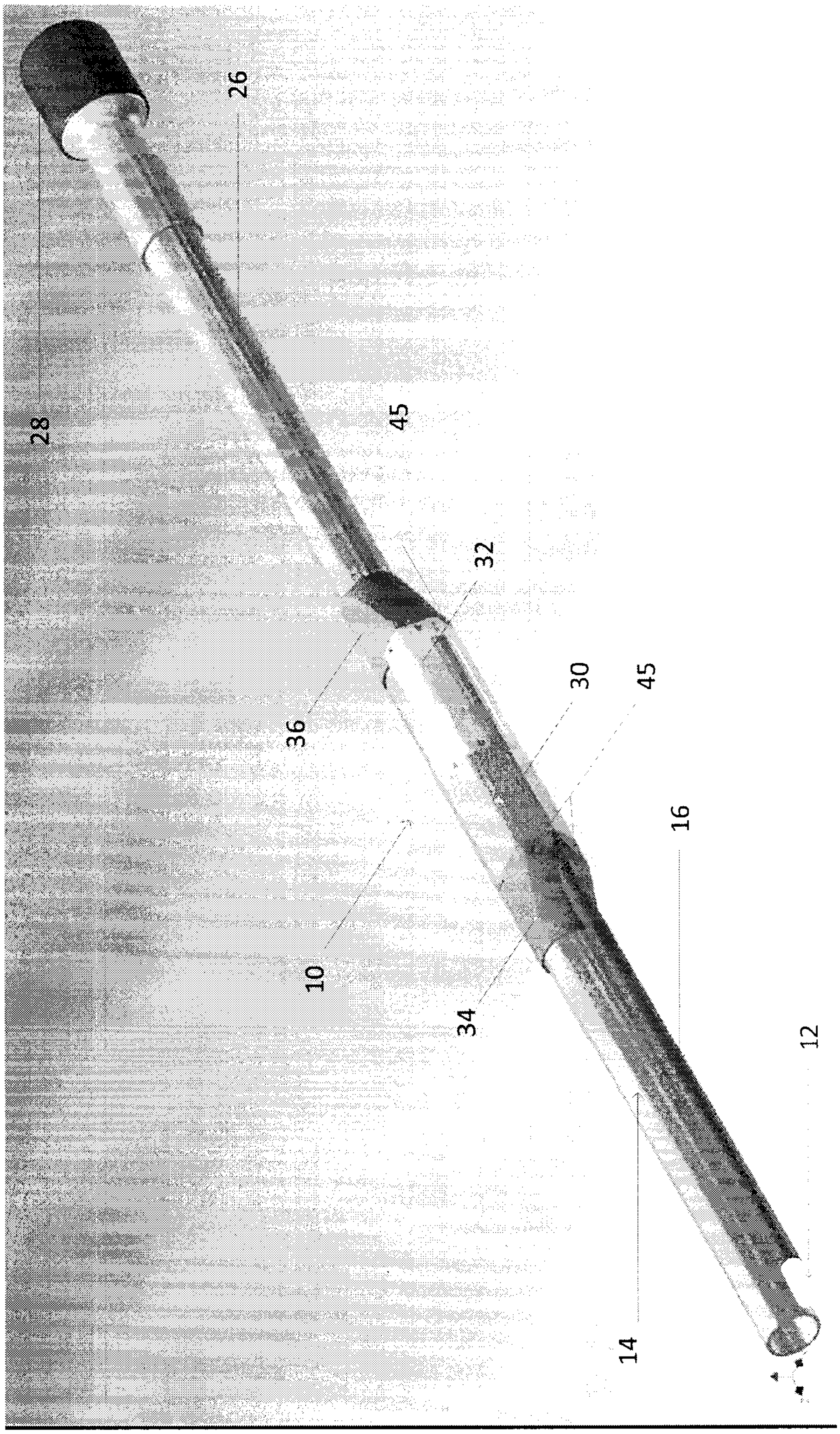


FIG. 1

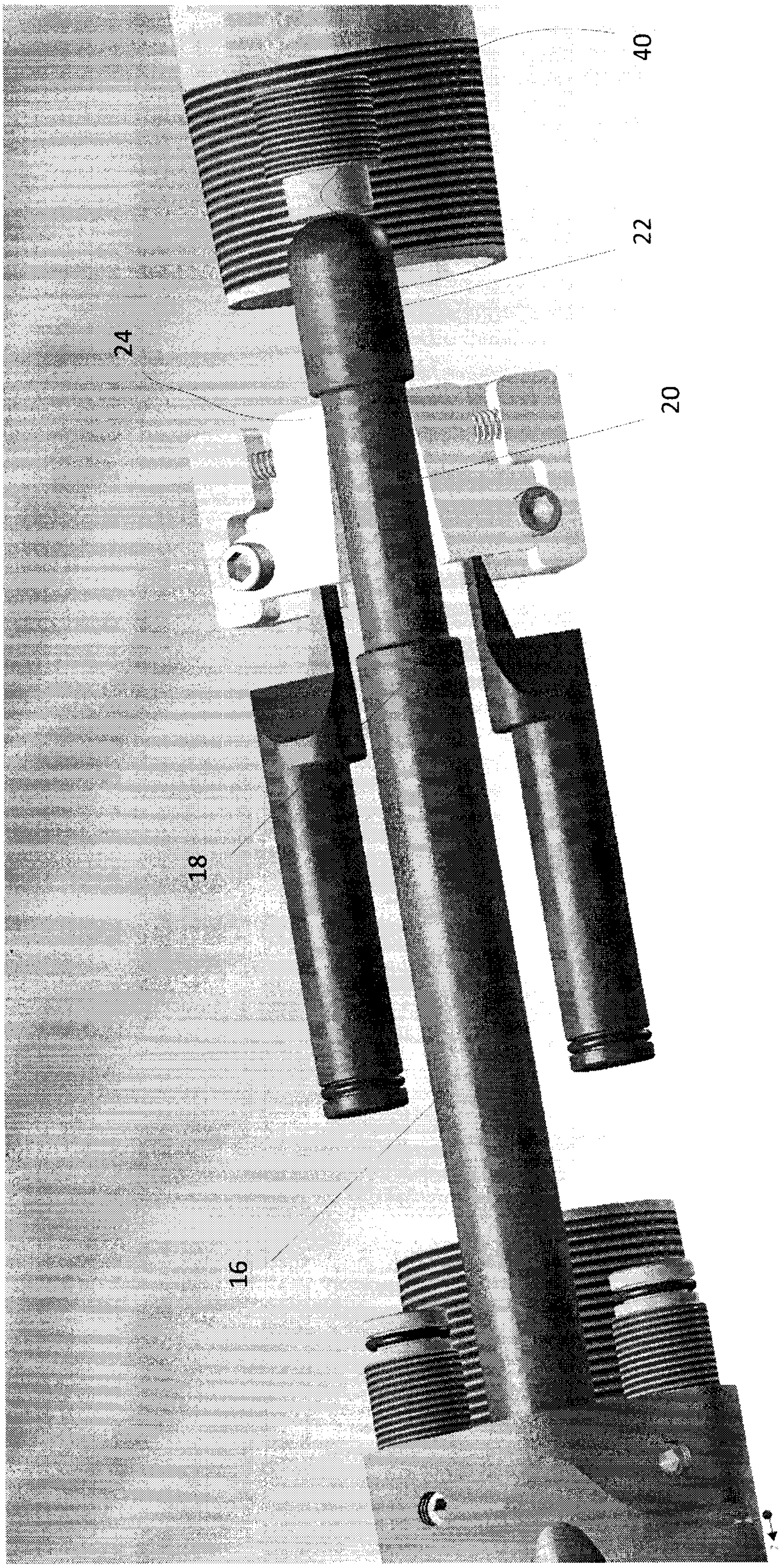


FIG. 2

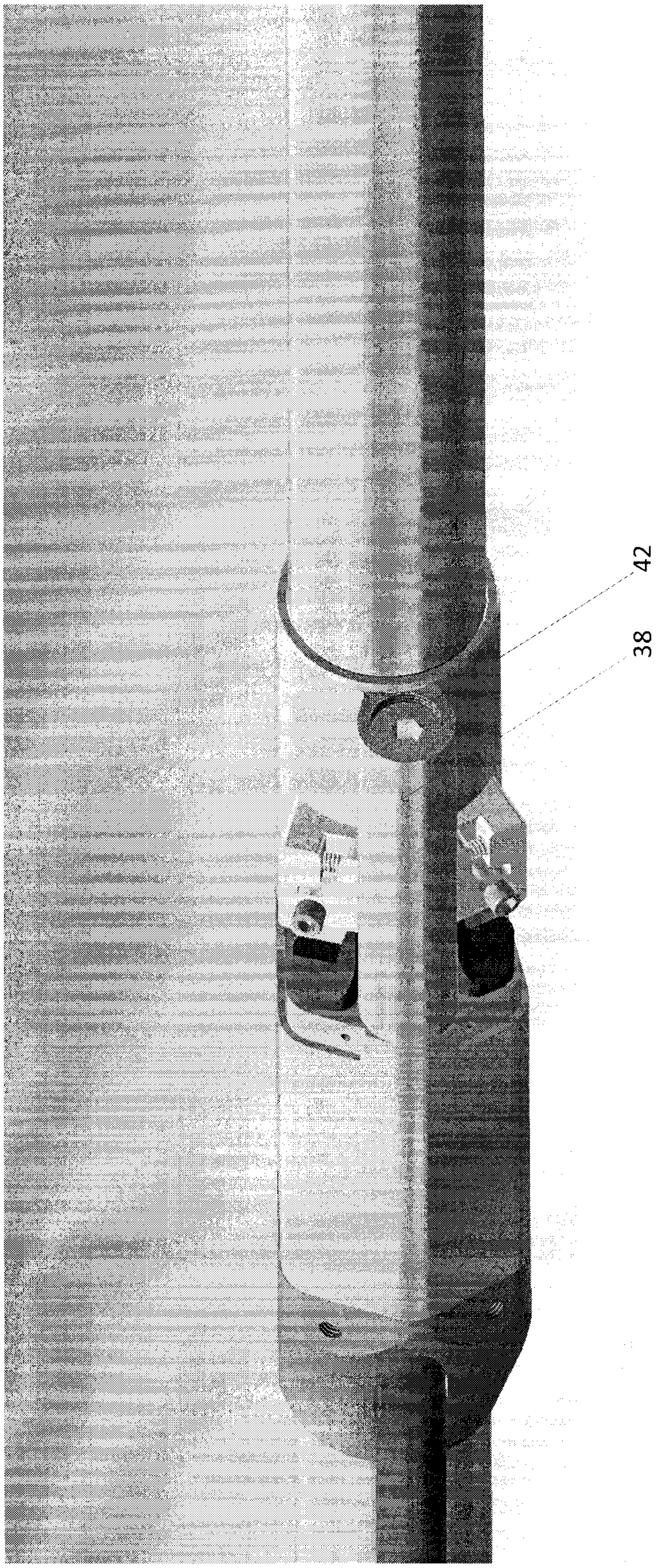


FIG. 3

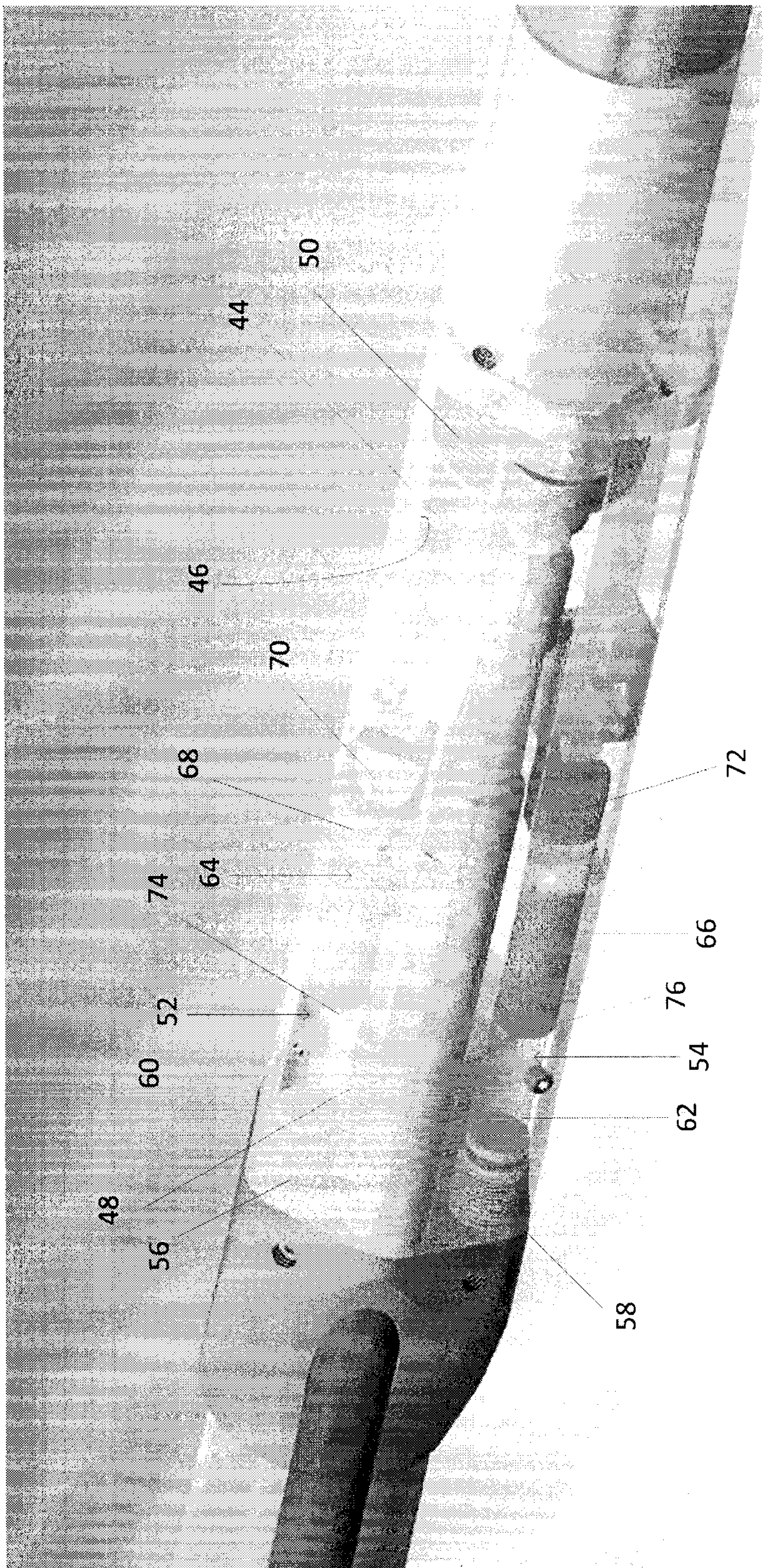


FIG. 4

FIG. 5

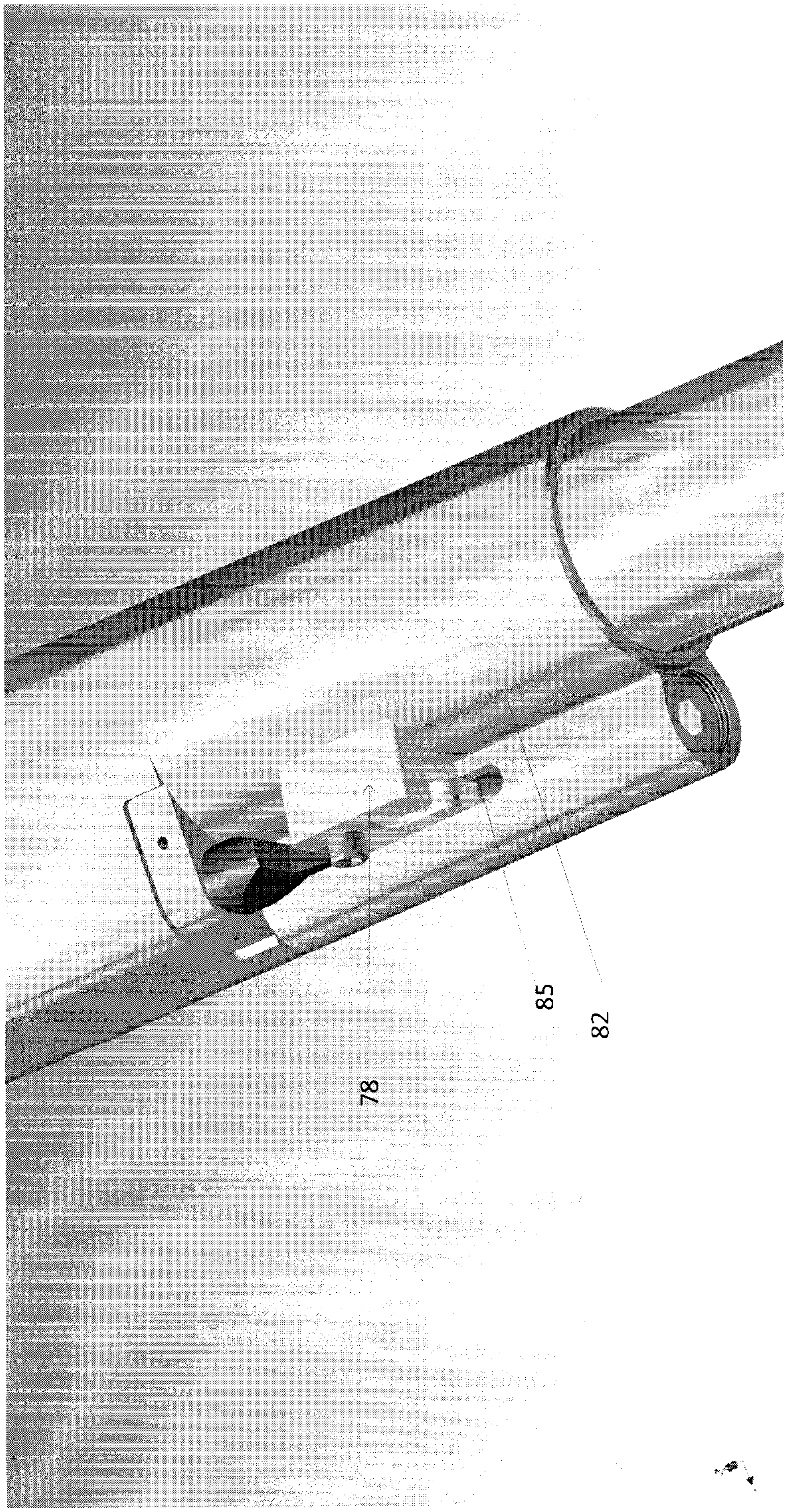


FIG. 6

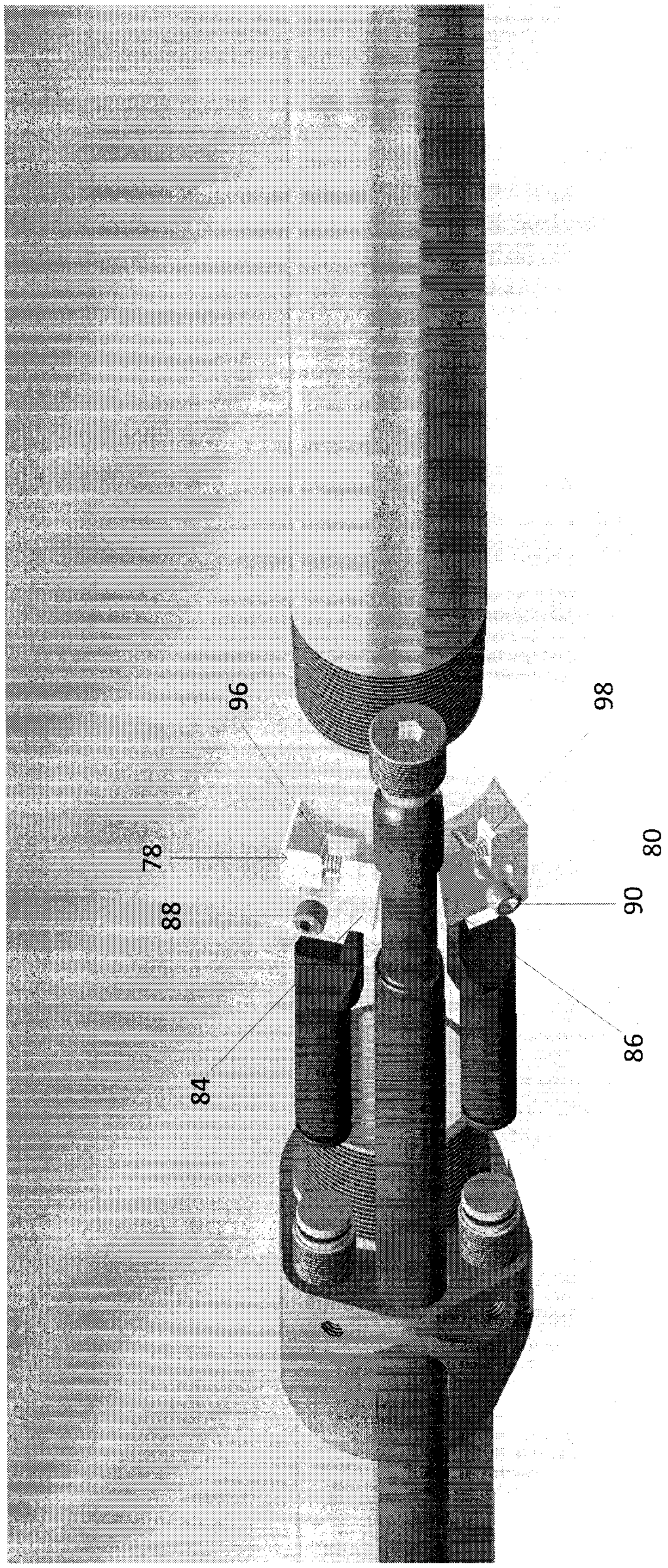


FIG. 7

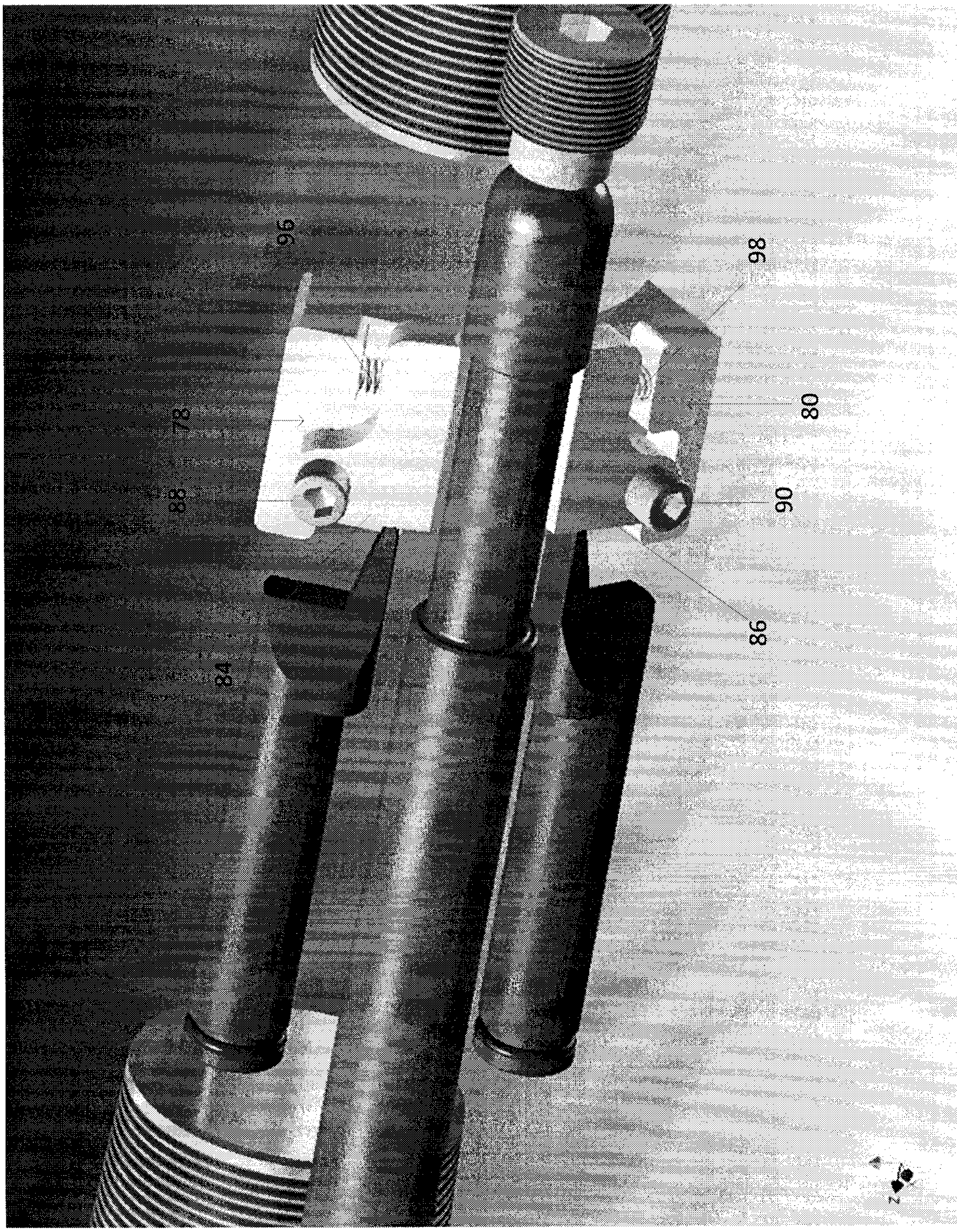


FIG. 8

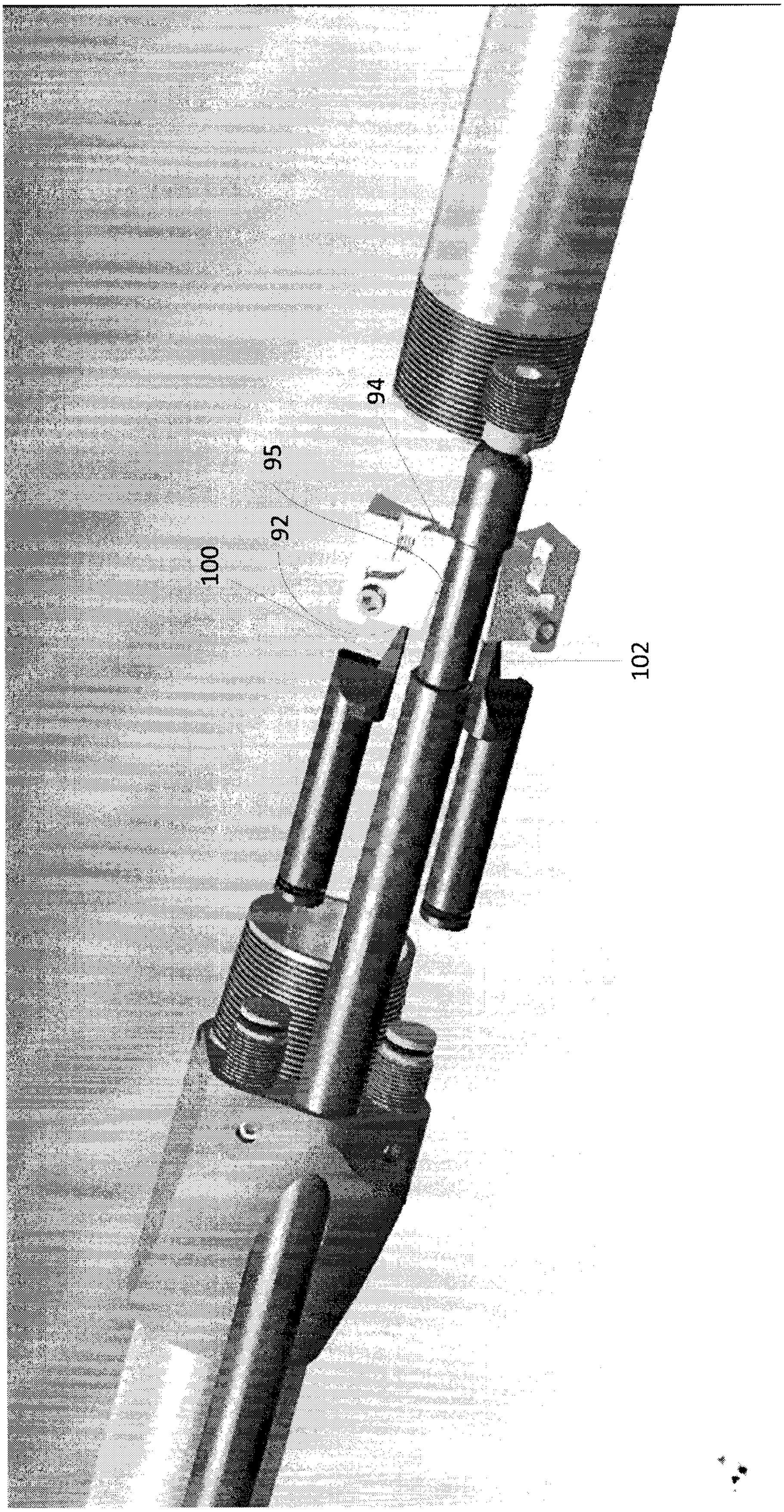


FIG. 9

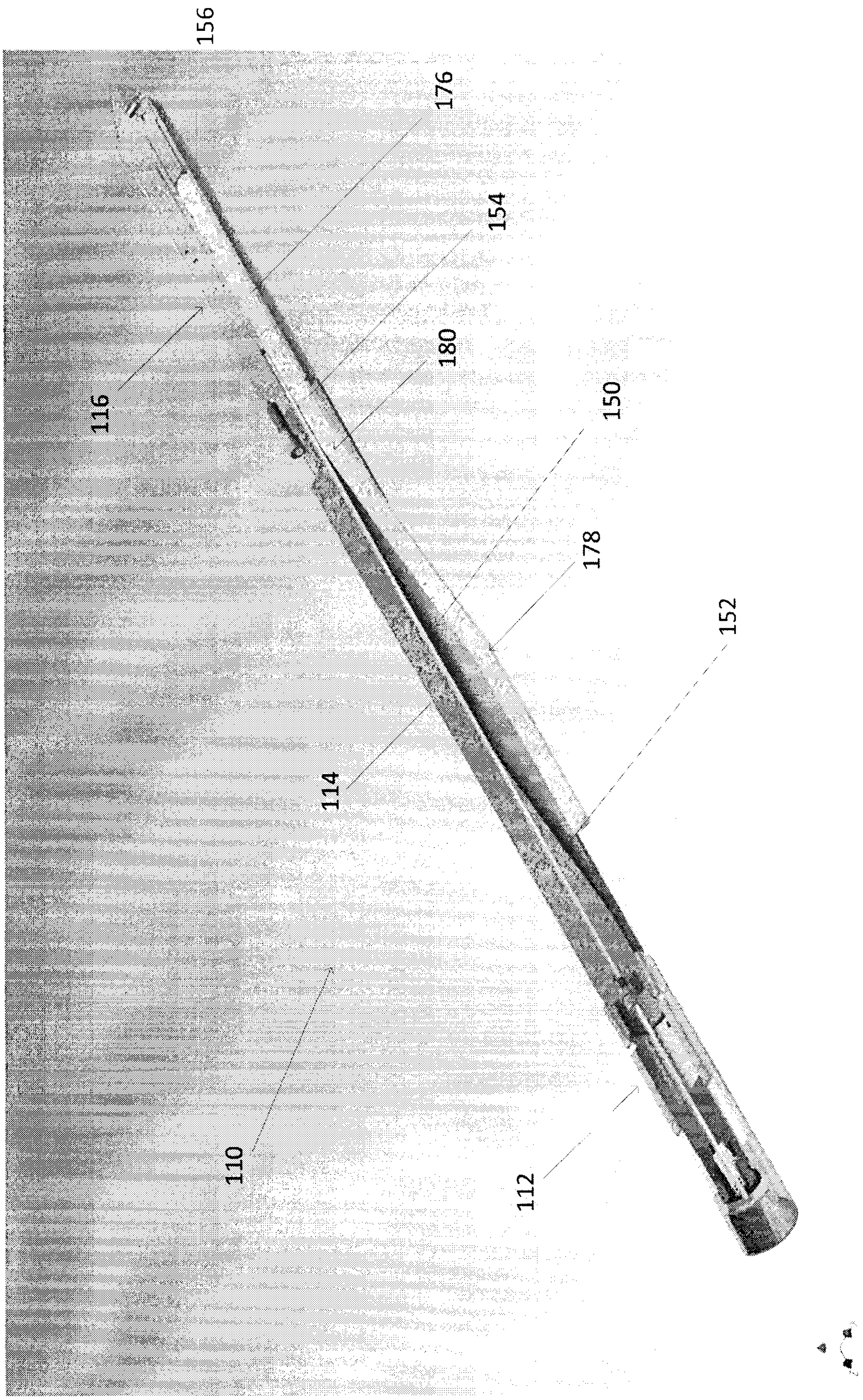


FIG. 10

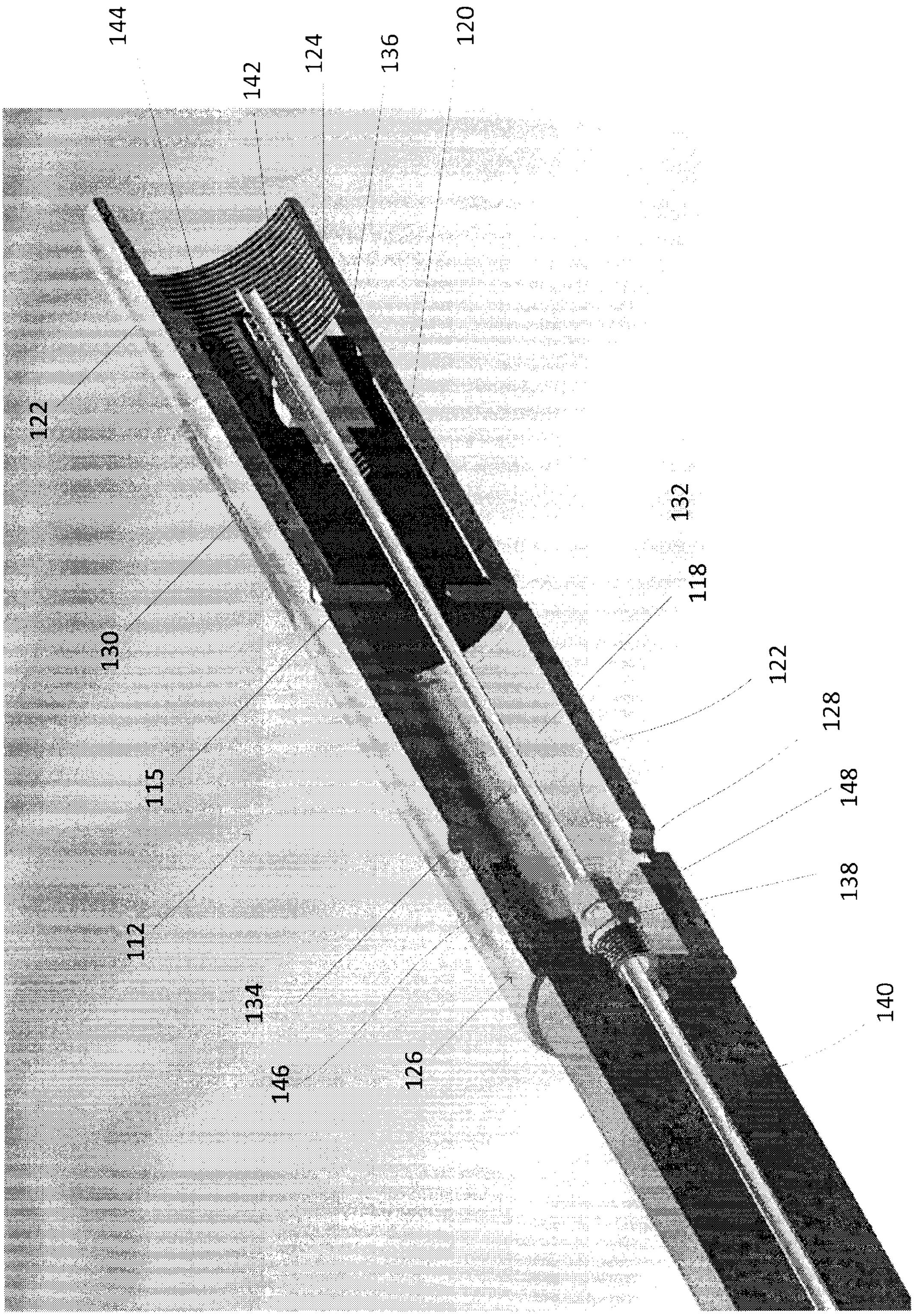

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FIG. 11

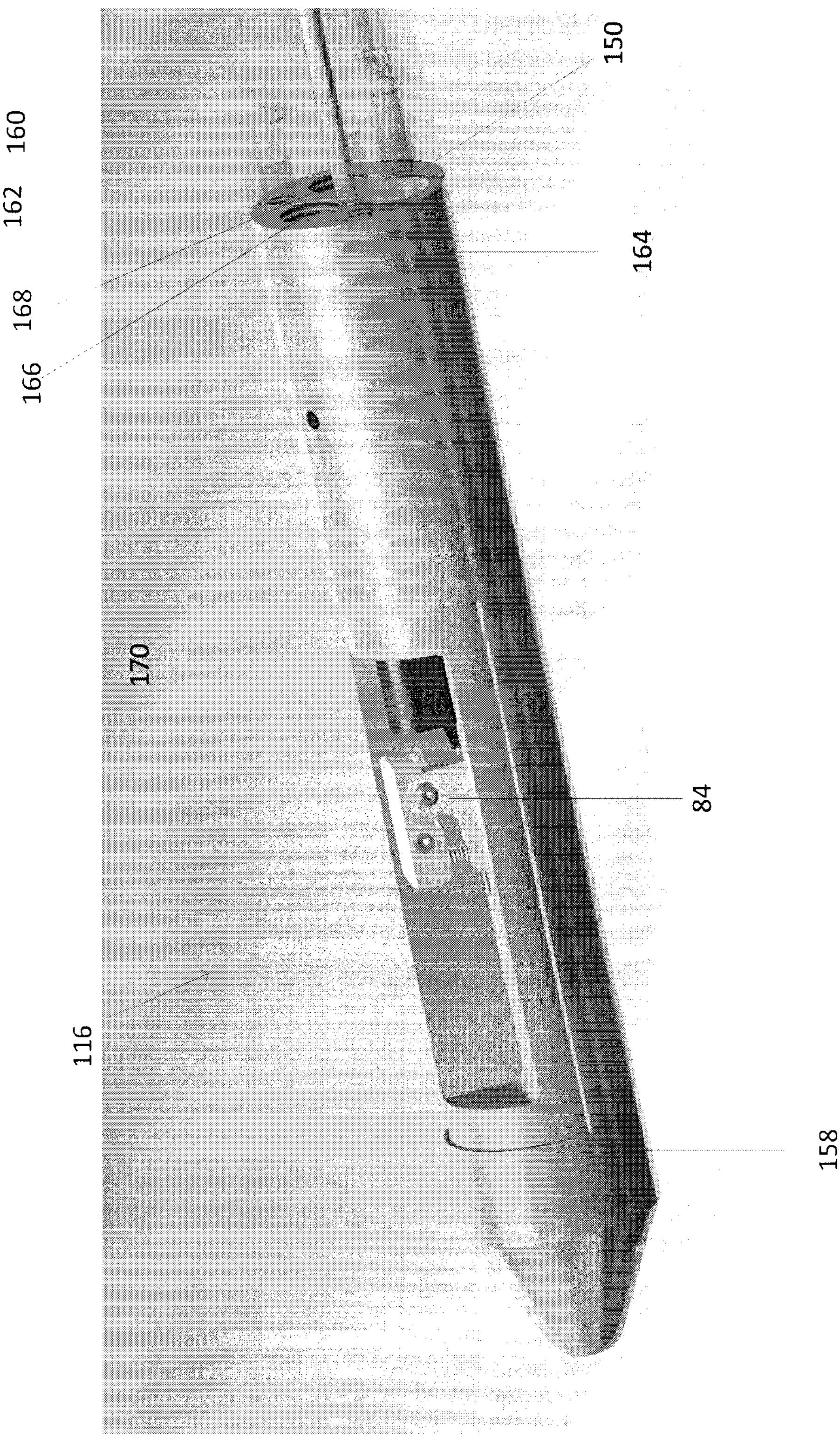


FIG. 12

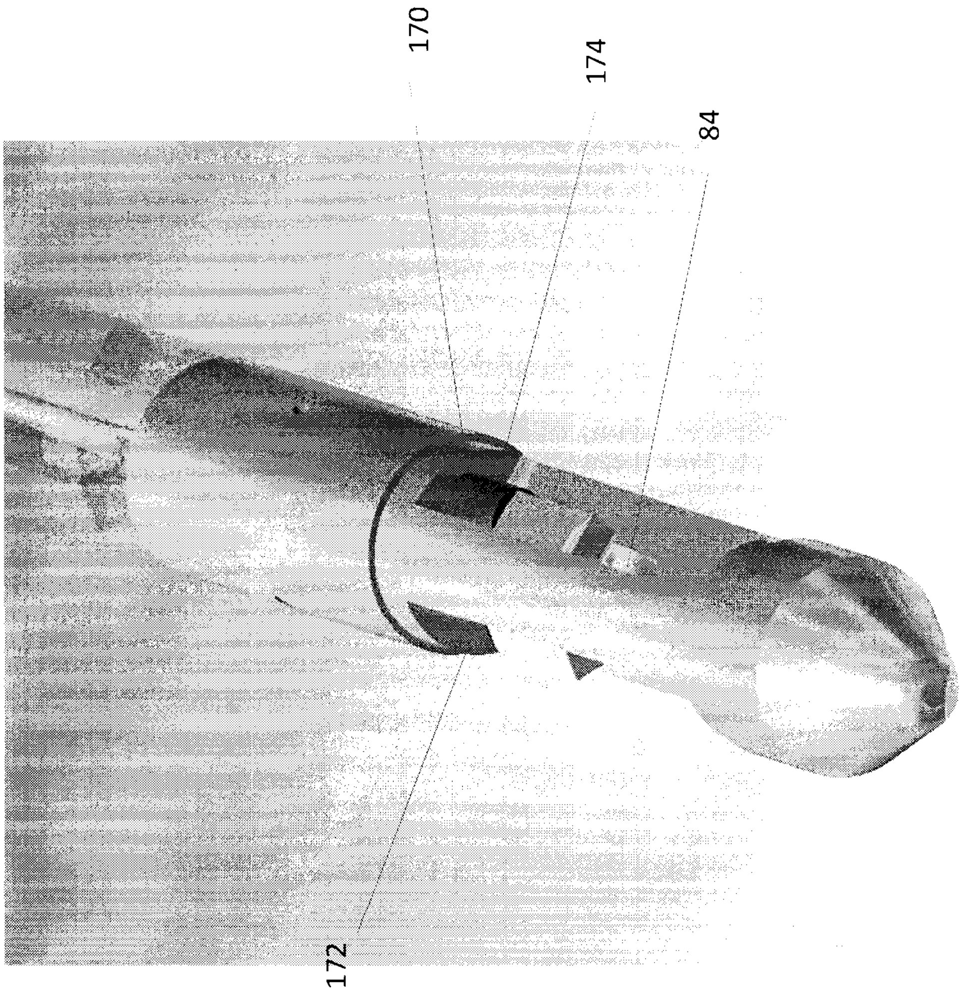


FIG. 13

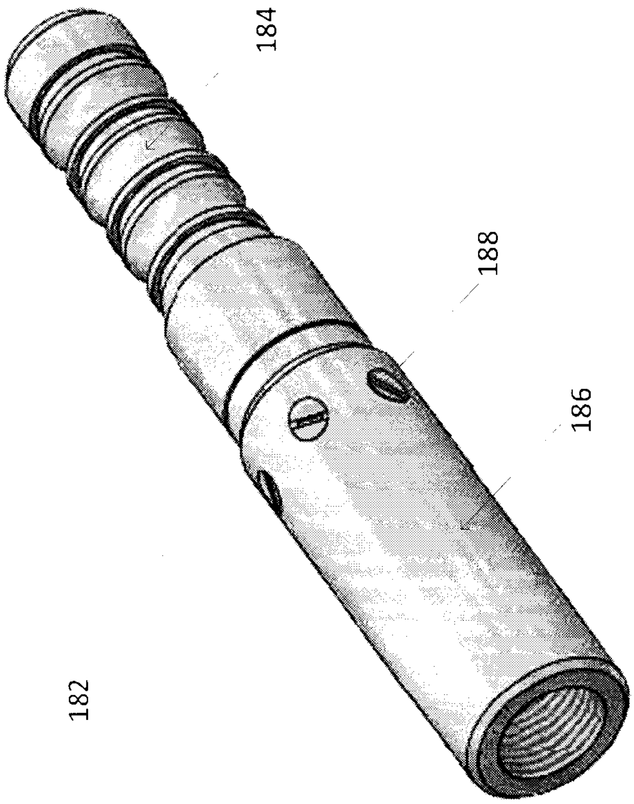


FIG. 14

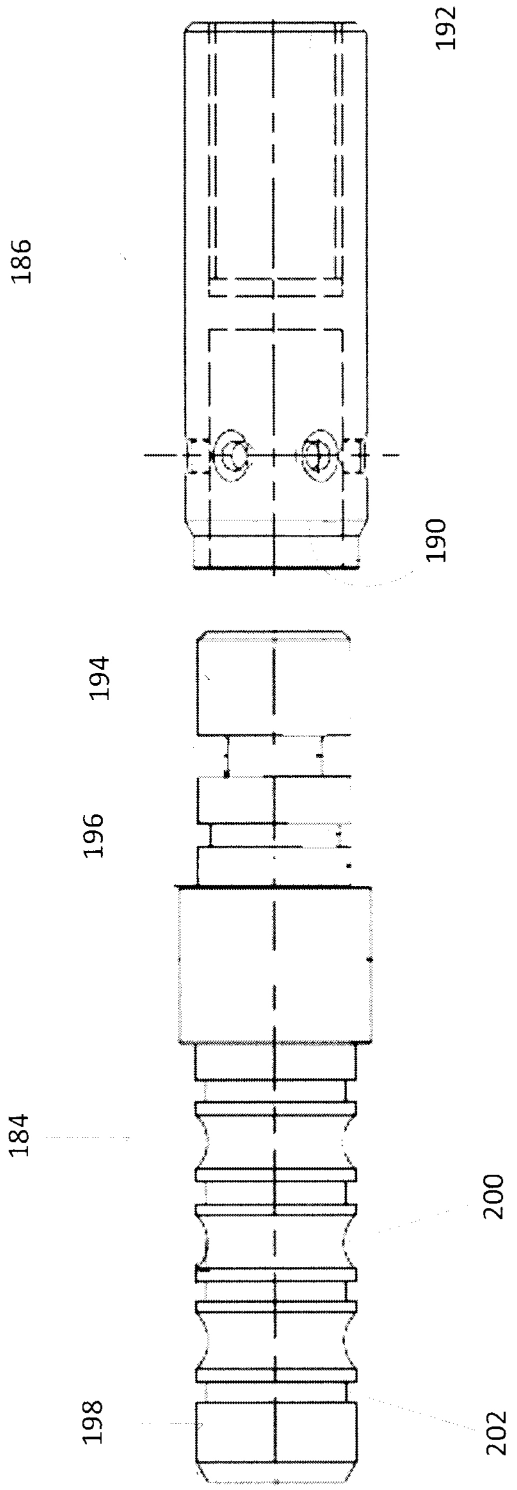


FIG. 15

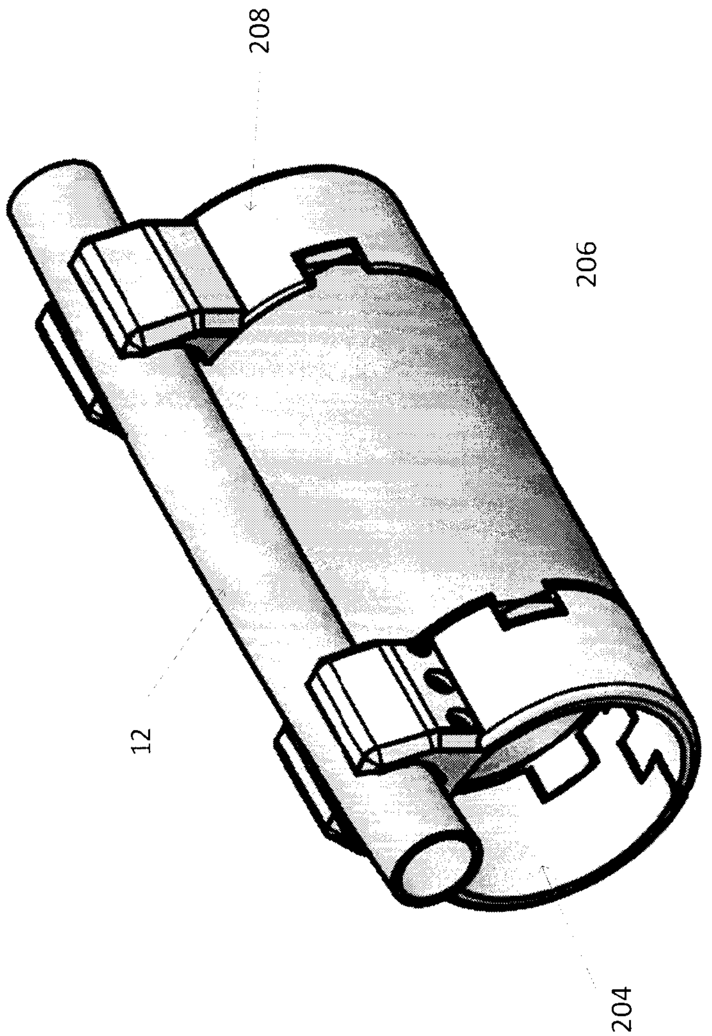


FIG. 16

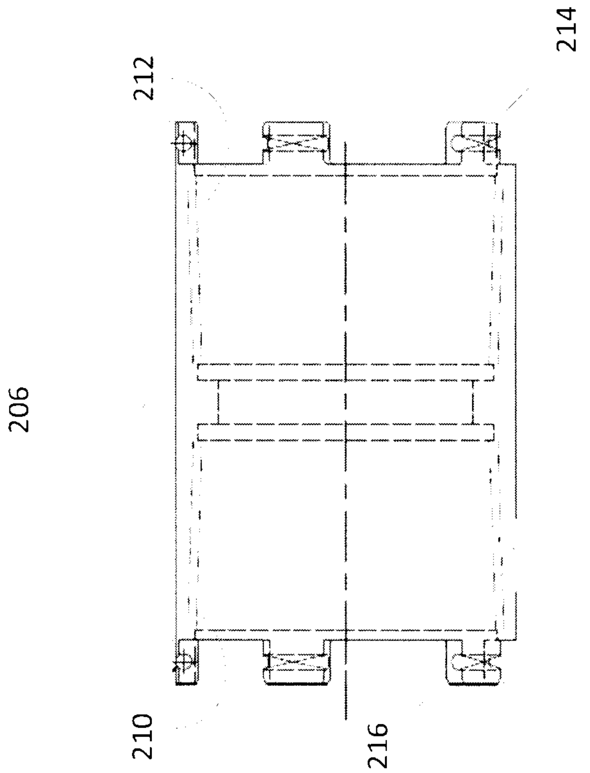


FIG. 17B

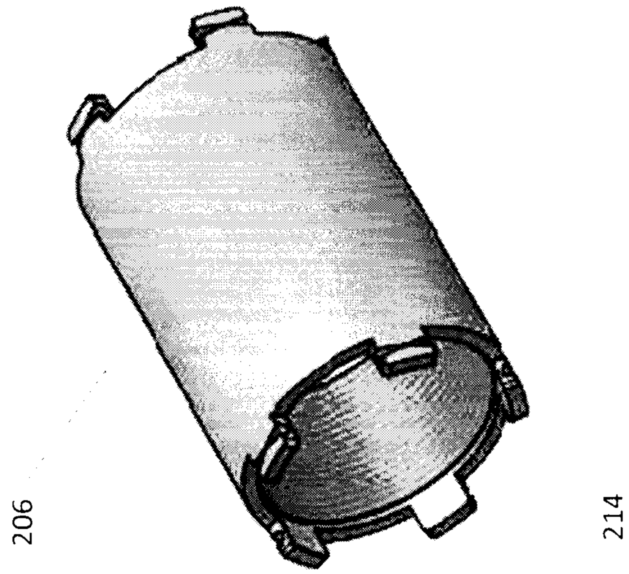


FIG. 17A

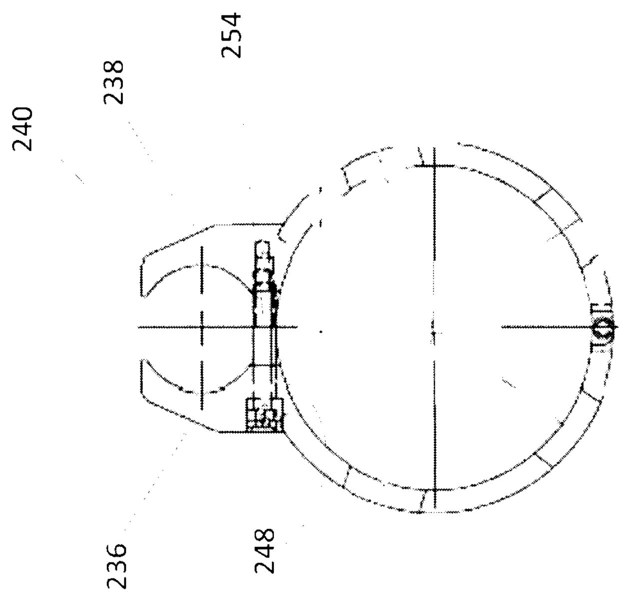


FIG. 18B

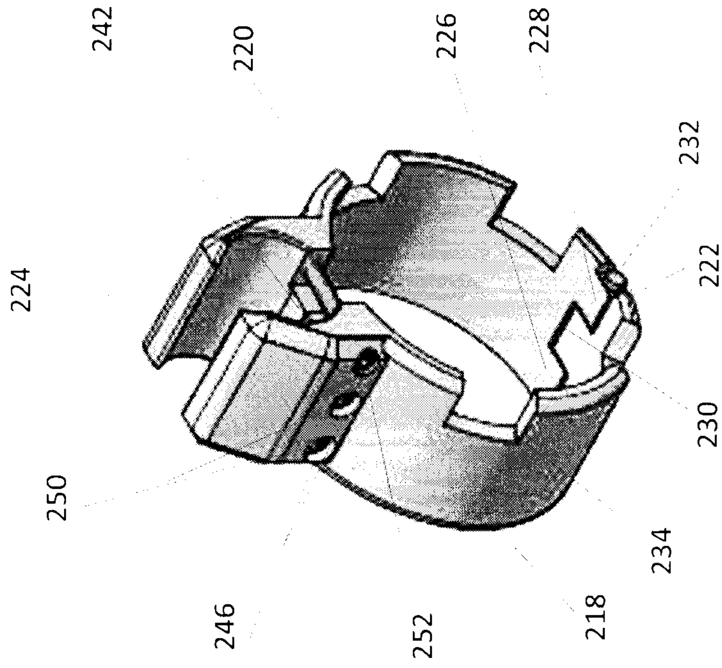


FIG. 18A

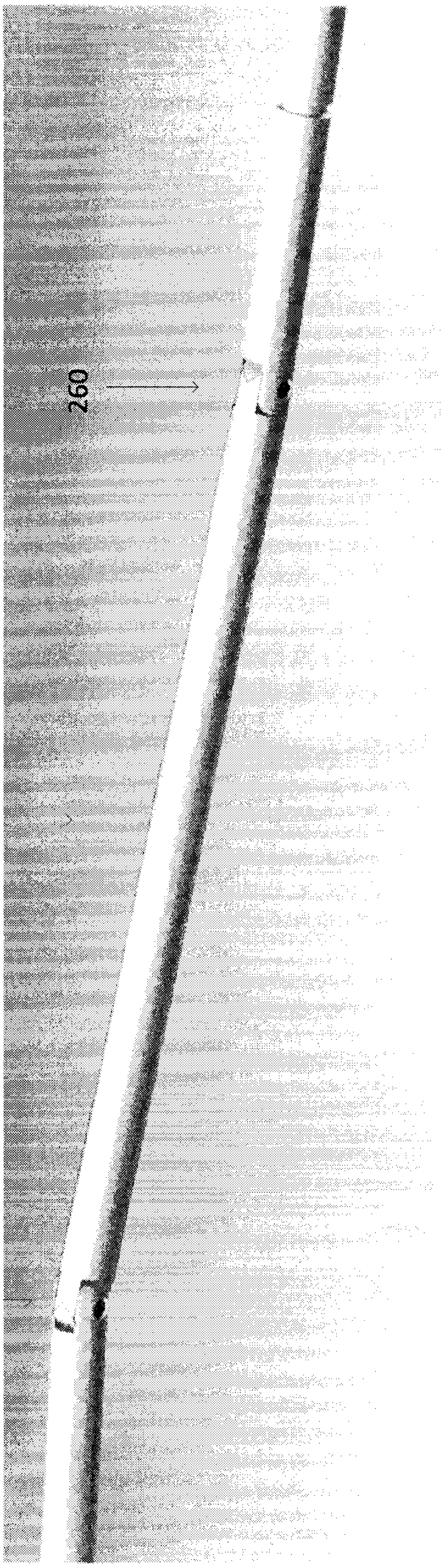
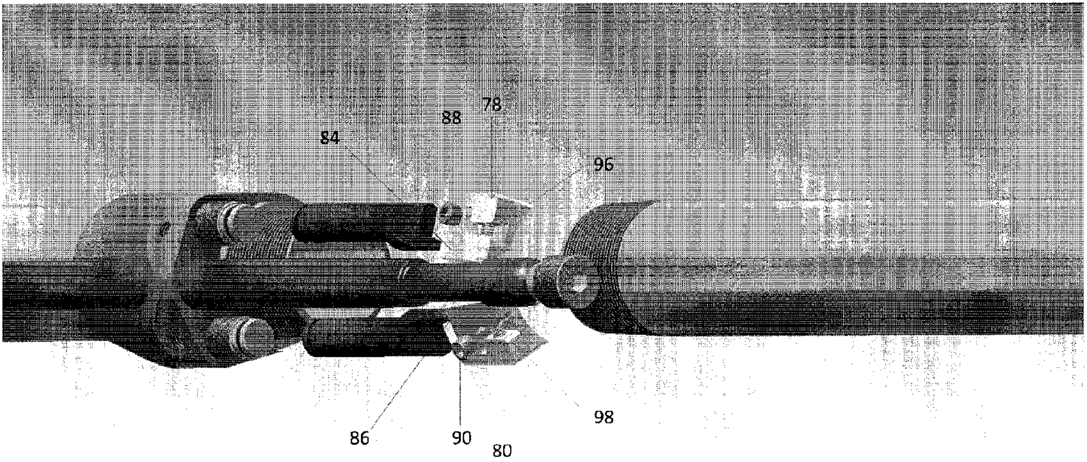


FIG. 19



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