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(54) **GRIPPER ASSEMBLY AND LOCK/RELEASE METHOD FOR A COILED TUBING INJECTOR**

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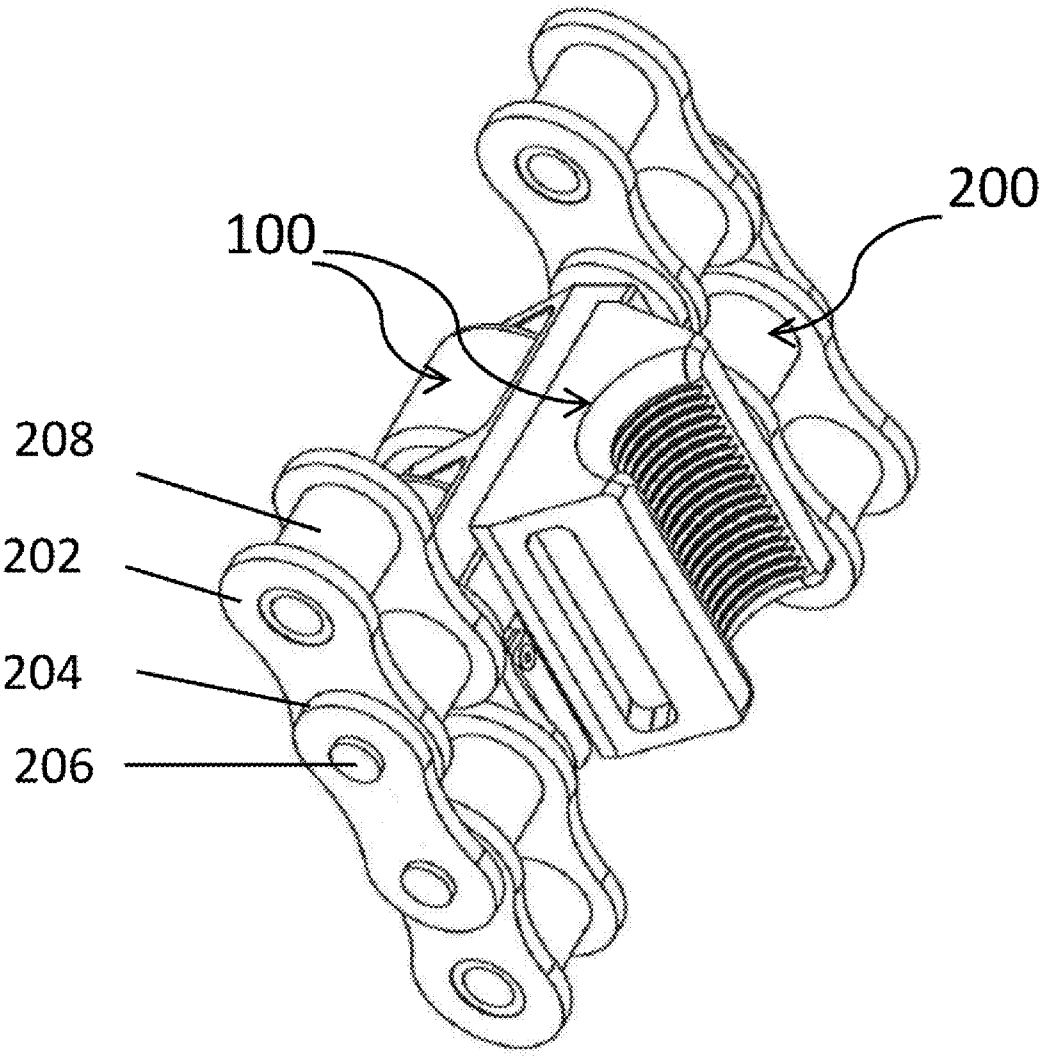
(57) **ABSTRACT**

A gripper assembly for a coiled tubing injector, each assembly of a plurality of assemblies having a carrier adapted for mounting to the injector drive and a gripper block releasably connected to the carrier using a locking mechanism. In an embodiment a locking tab extending from one of the gripper block and carrier engages a slot of the other of the carrier or block. A locking shaft extends through the assembly to engage the locking tab and releaseably lock the block to the carrier. The locking shaft is rotatable between a locking position to engage the locking tab to prevent release from the slot and a release position to release the locking tab from the slot. The shaft is biased to the locking position.



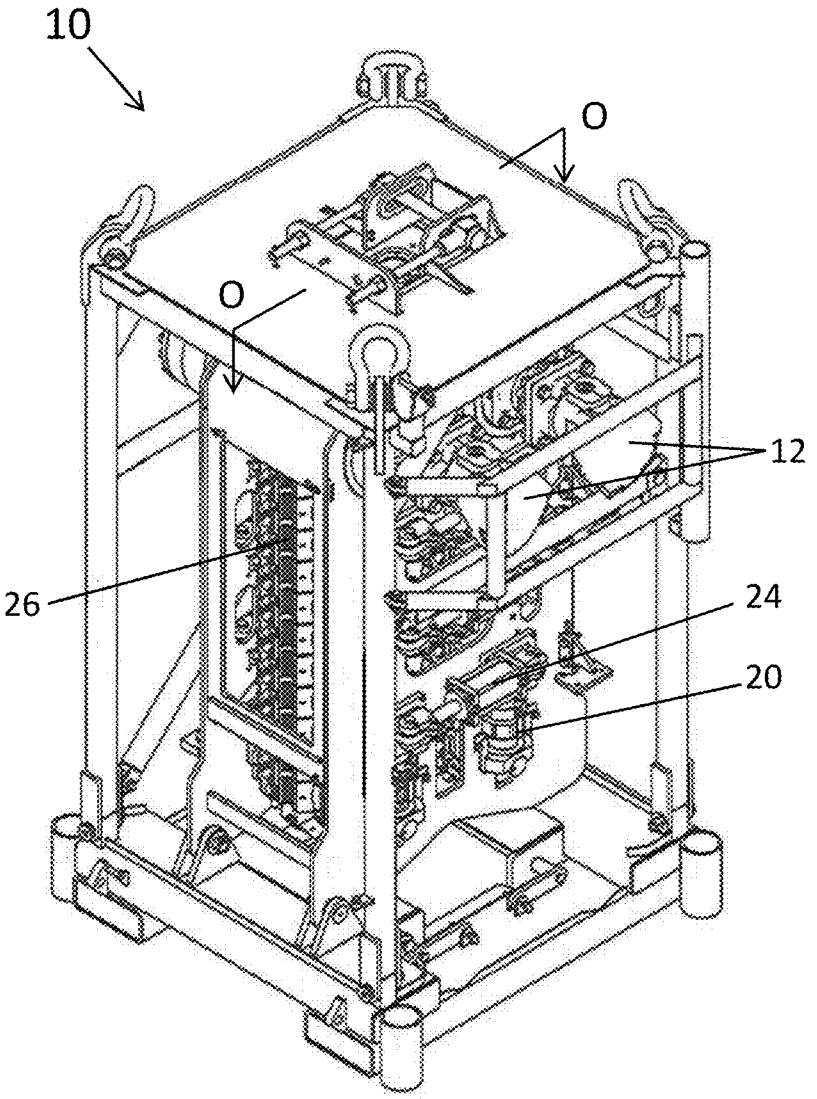


Fig. 1A - Prior Art

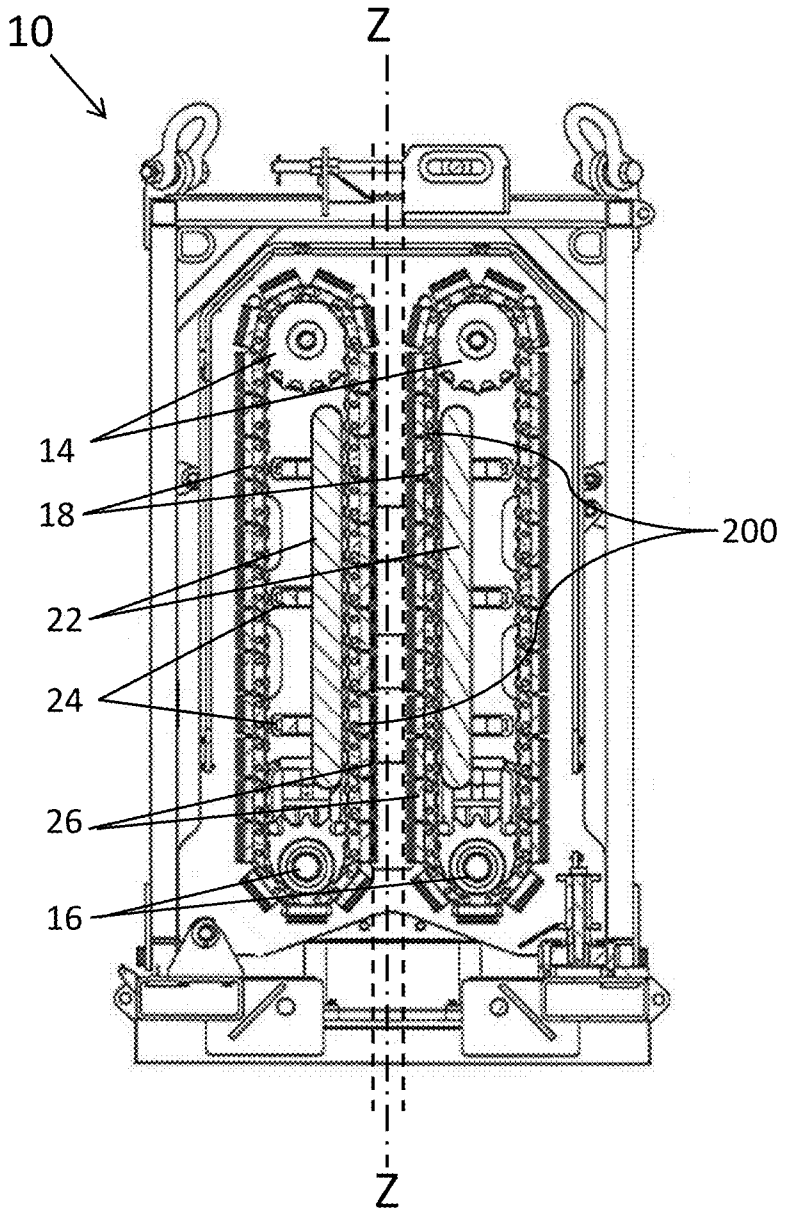


Fig. 1B - Prior Art

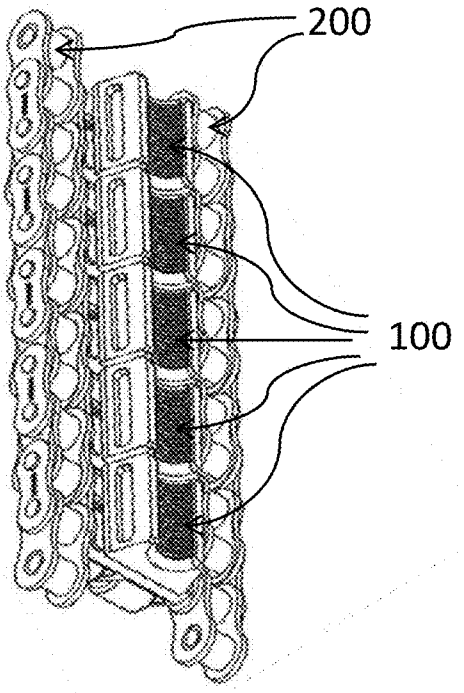


Fig. 2

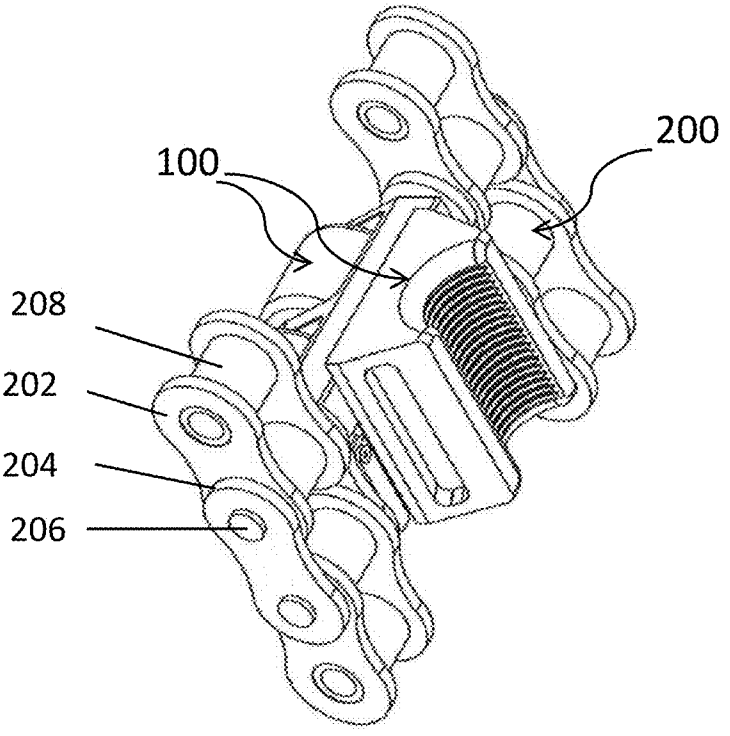


Fig. 3

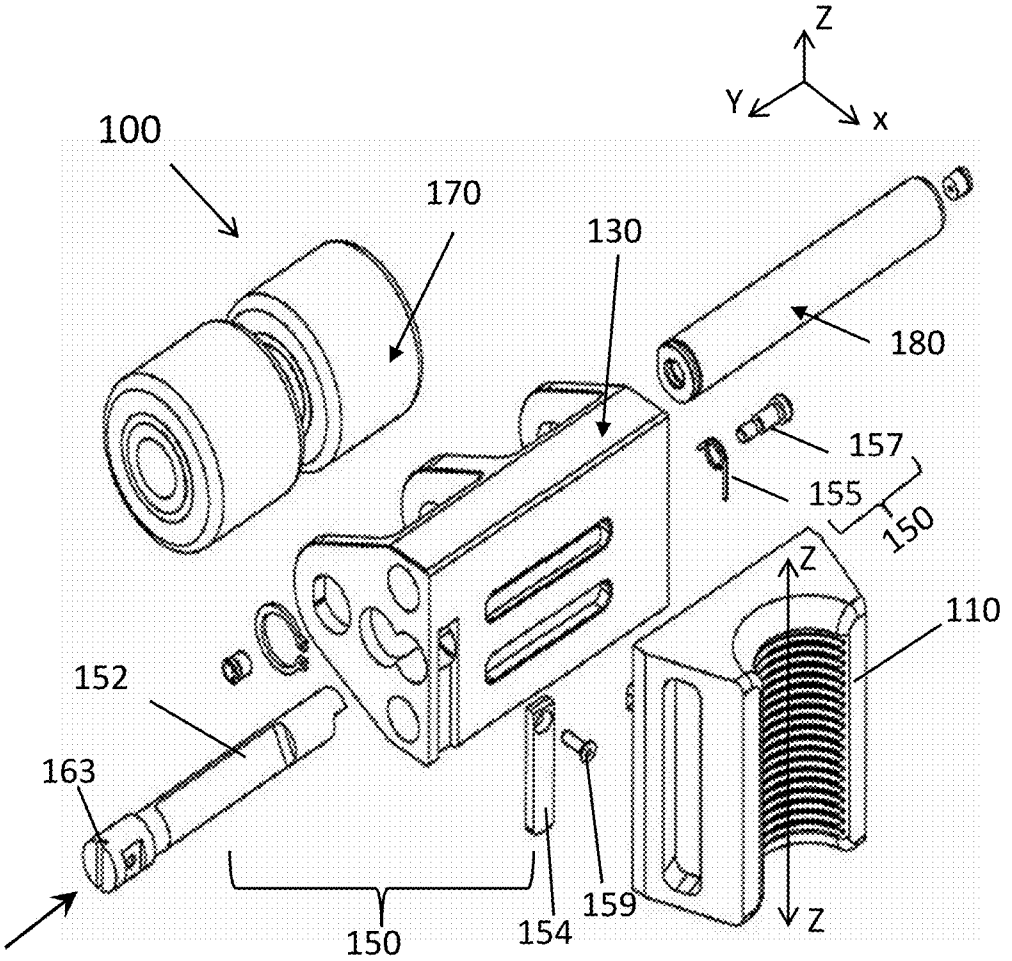
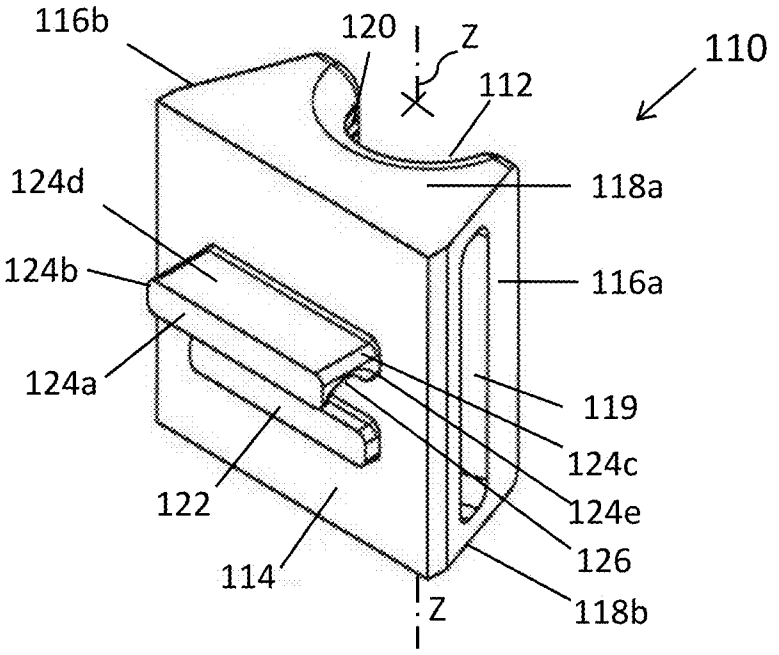


Fig. 4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118b
Z

Fig. 5

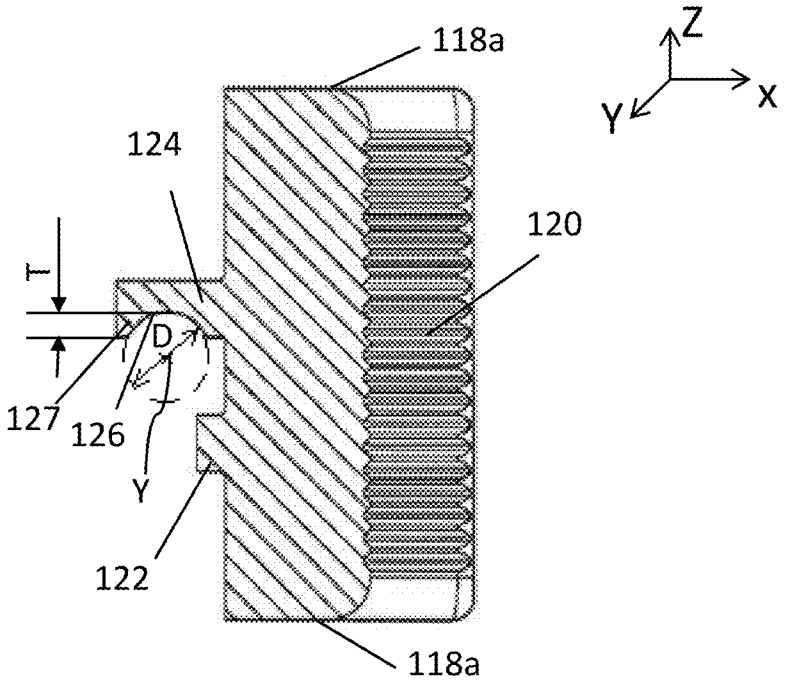
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Fig. 6

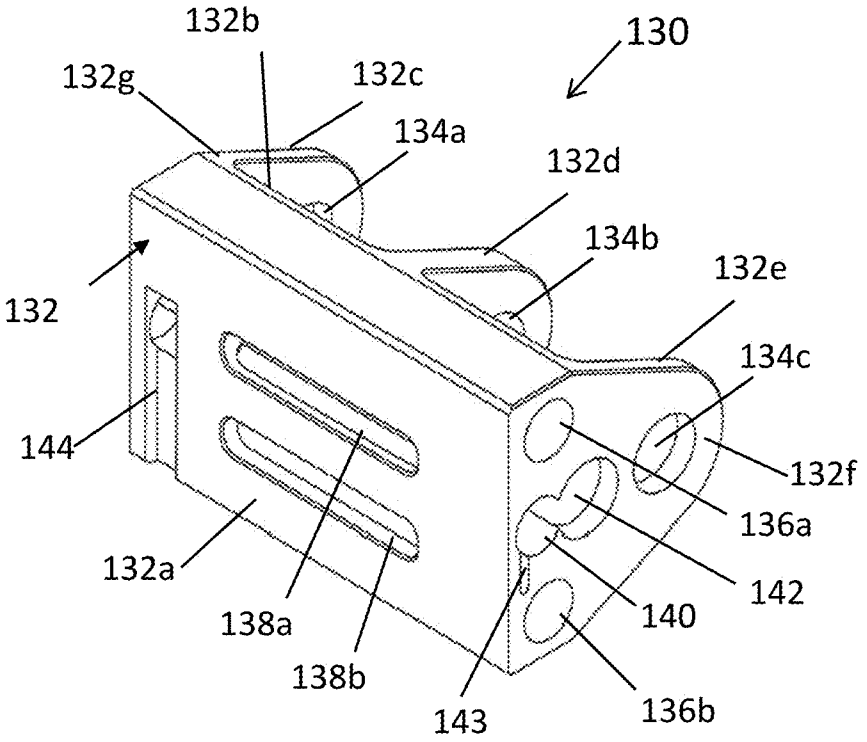
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Fig. 7

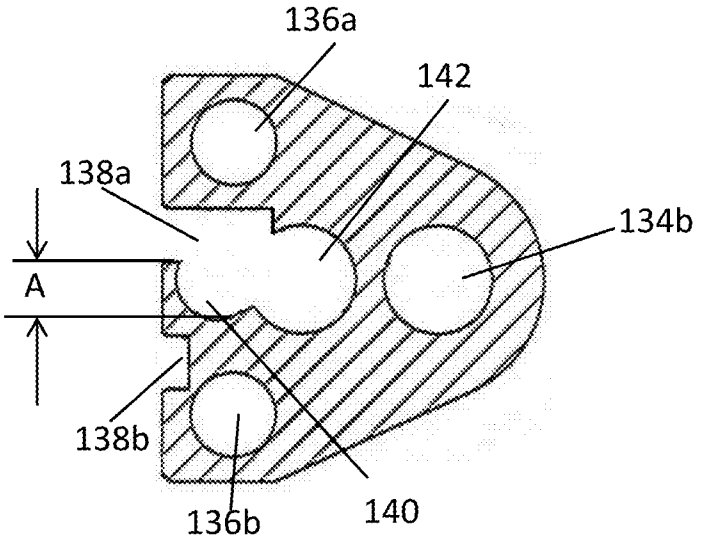
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Fig. 8

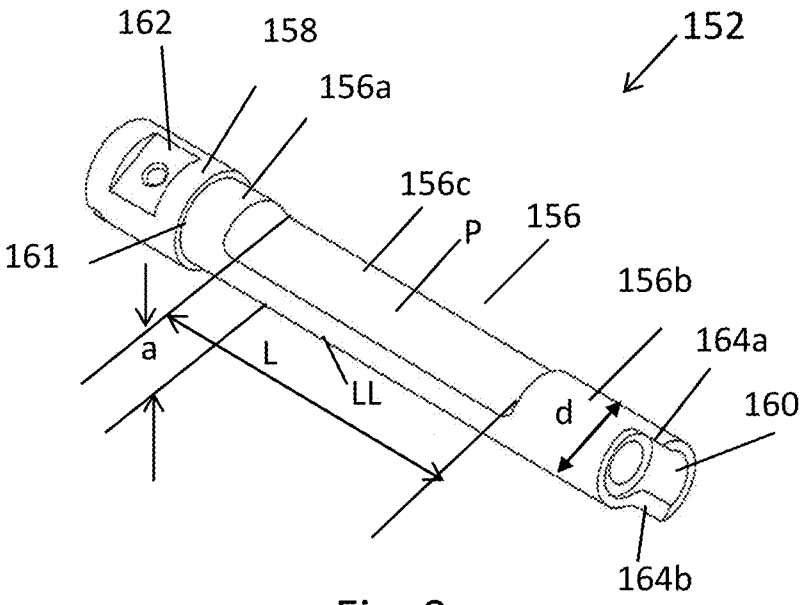
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Fig. 9

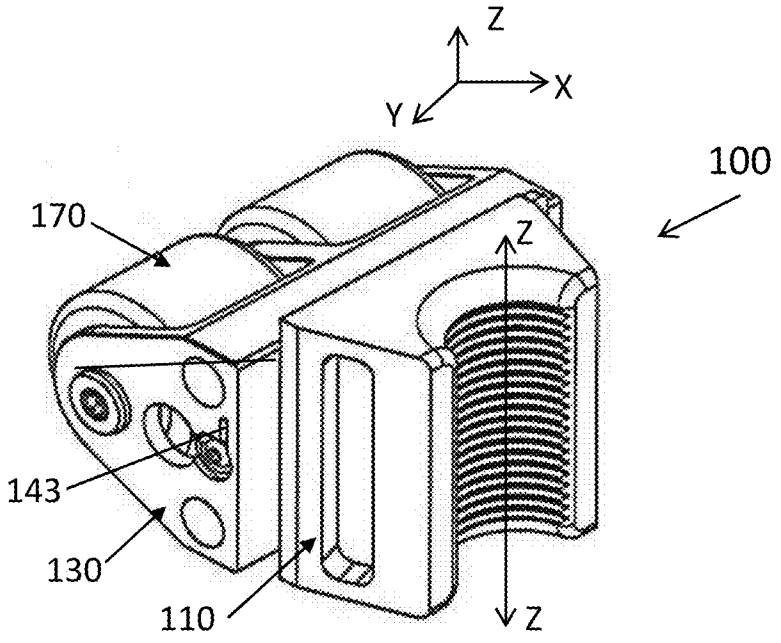
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Fig. 10

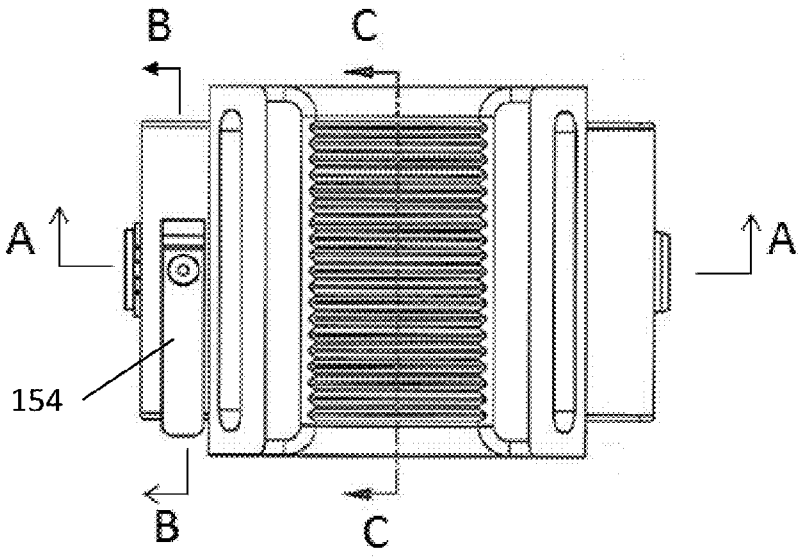

Fig. 11

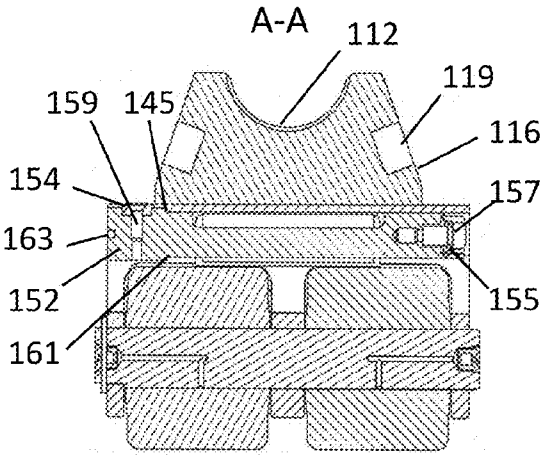

Fig. 12

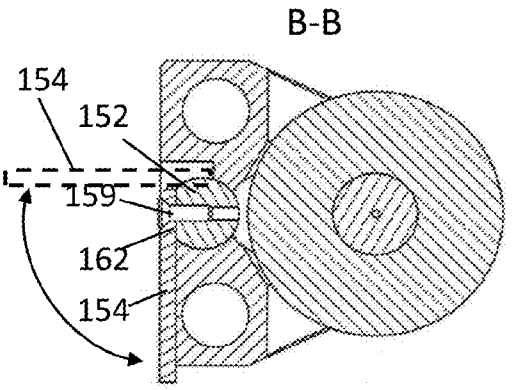

Fig. 13

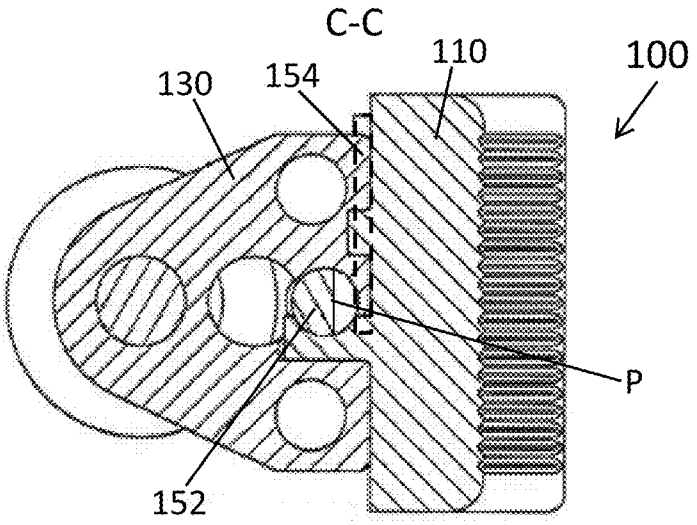

Fig. 14A

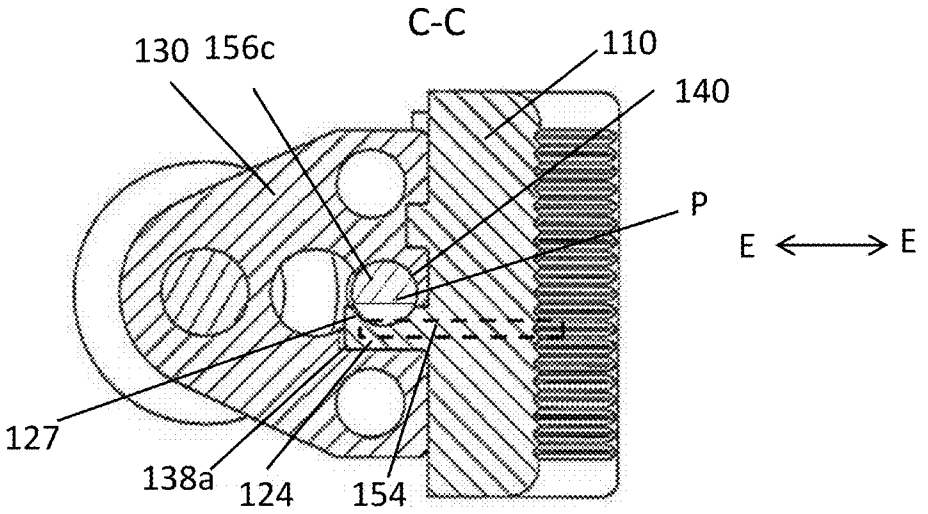

Fig. 14B

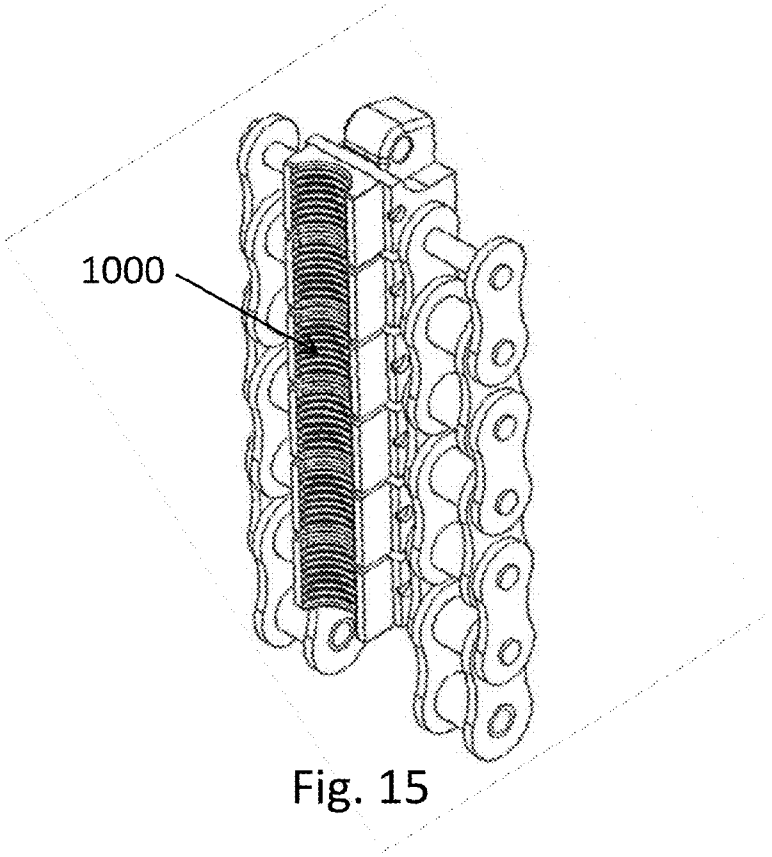
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Fig. 15

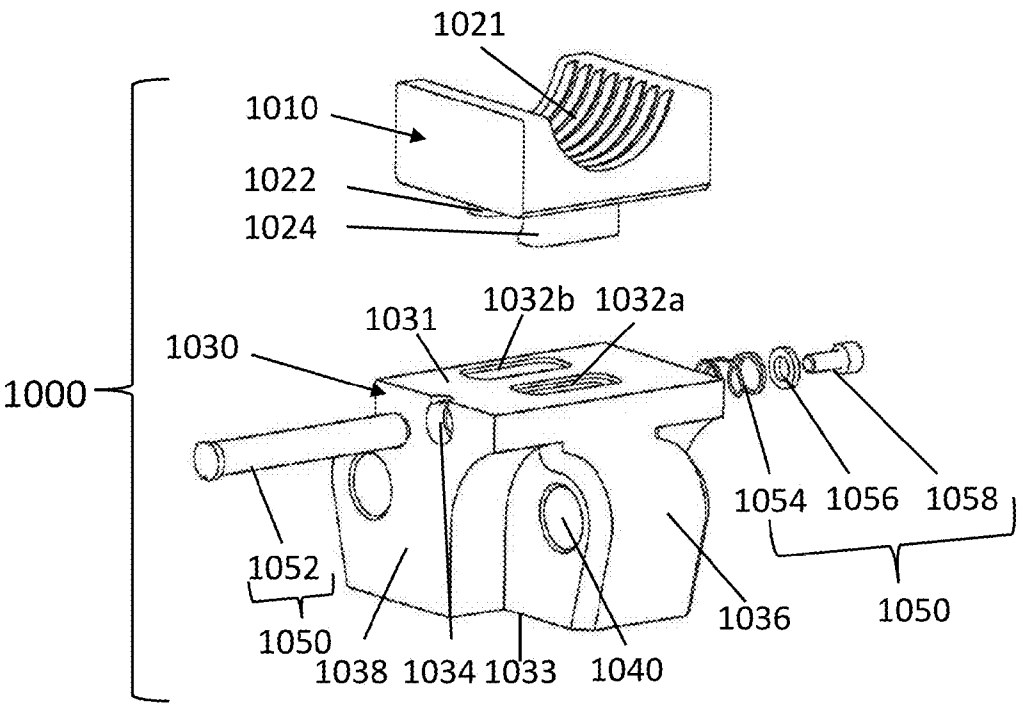
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Fig. 16

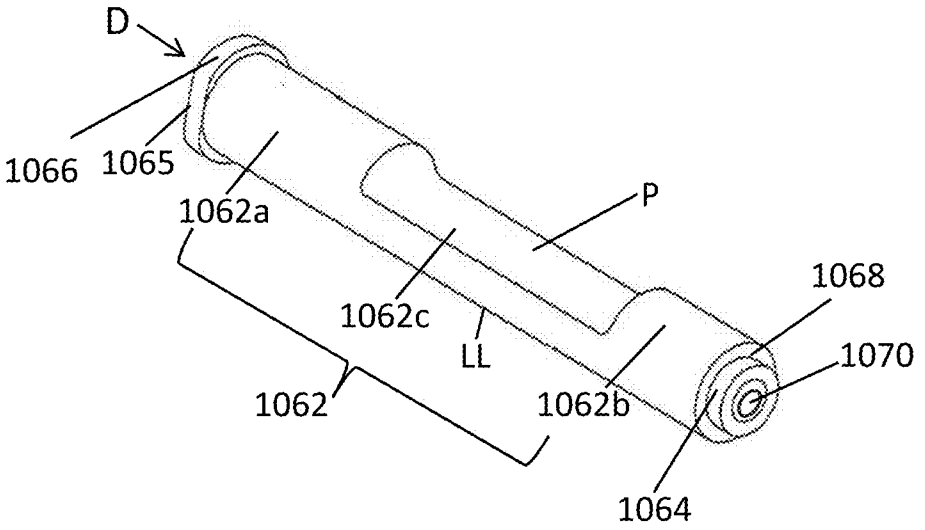
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Fig. 17

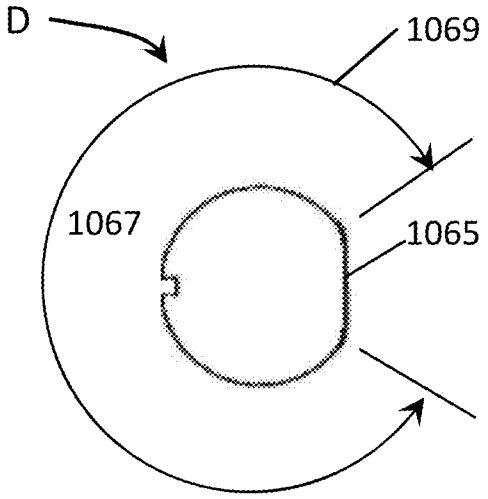
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Fig. 18

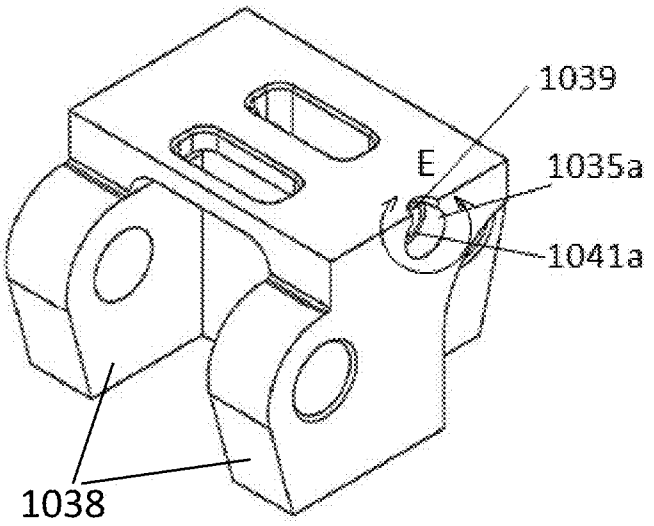


Fig. 19

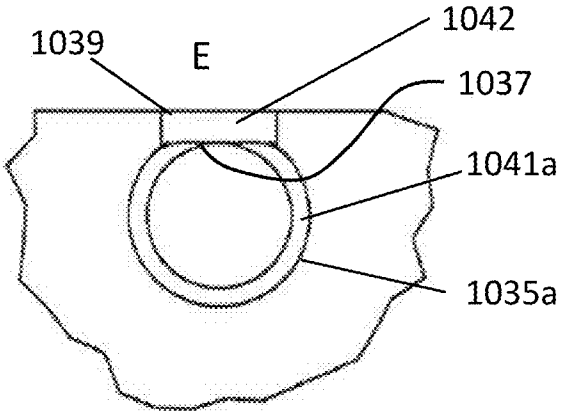


Fig. 20

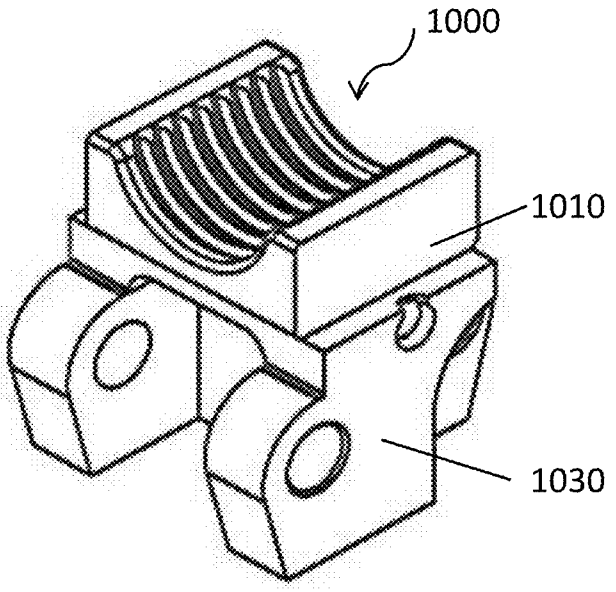


Fig. 21

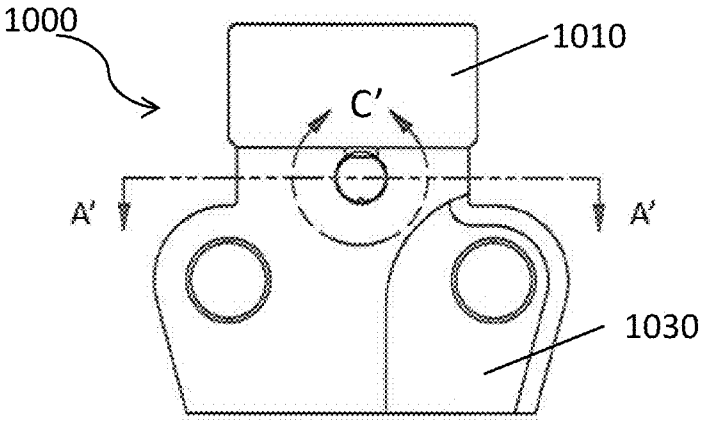


Fig. 22

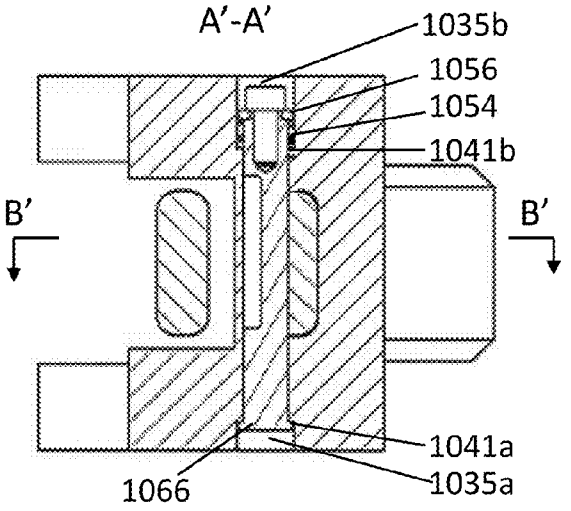


Fig. 23A

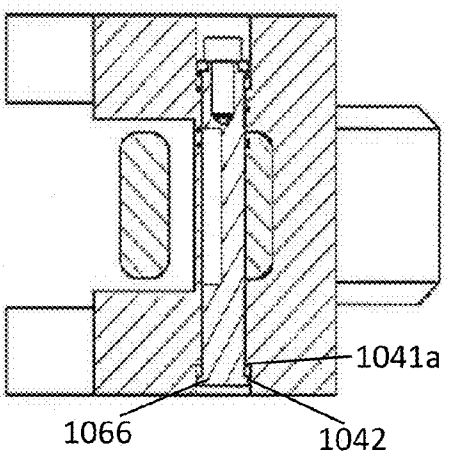


Fig. 23B

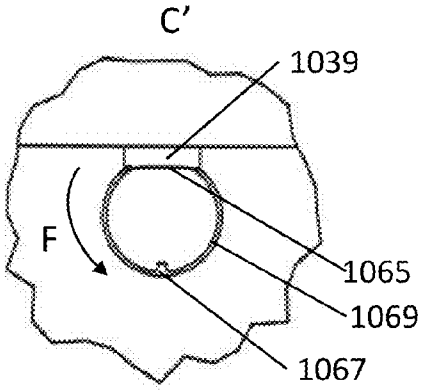
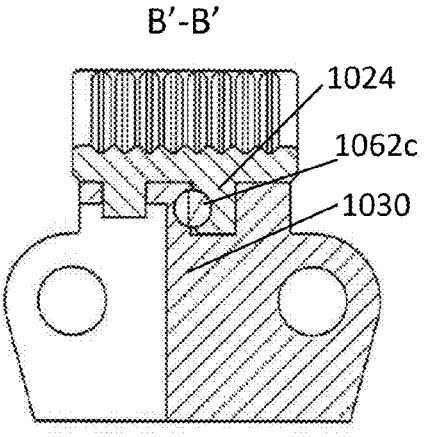


Fig. 24



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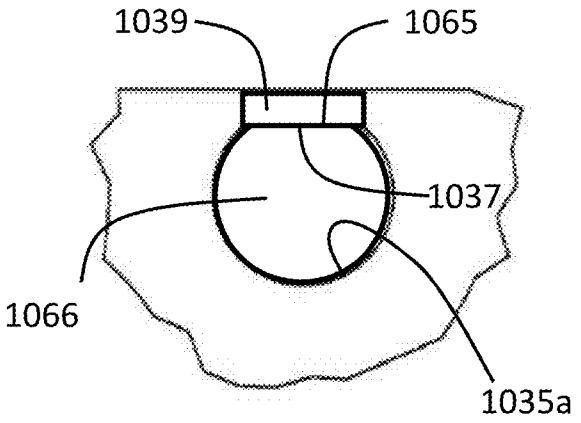

Fig. 23C

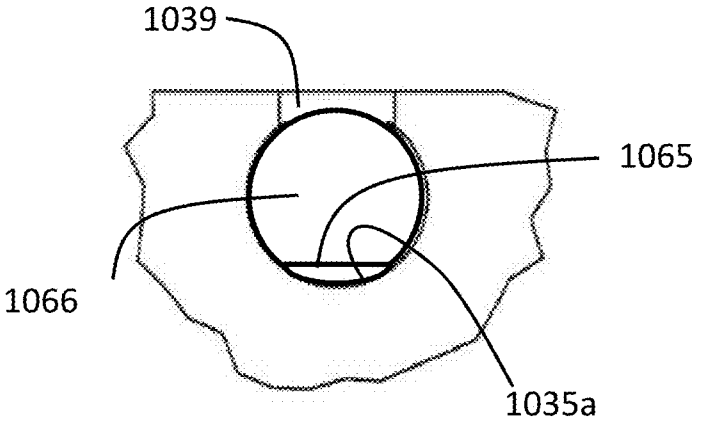

Fig. 23D

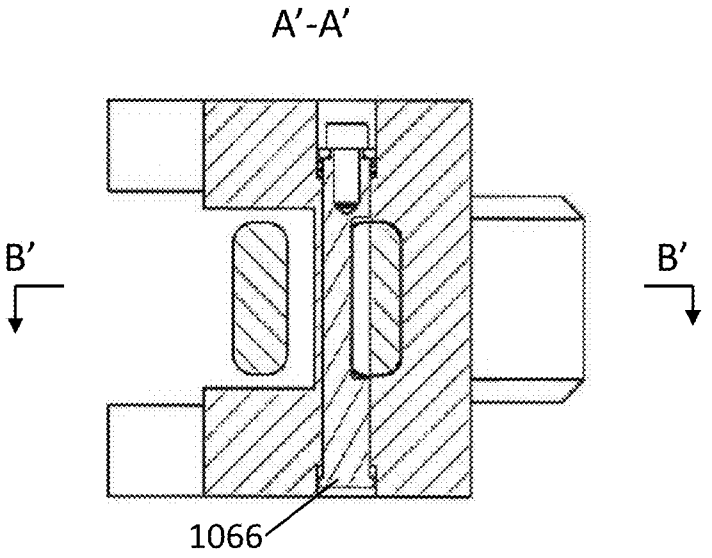

Fig. 26

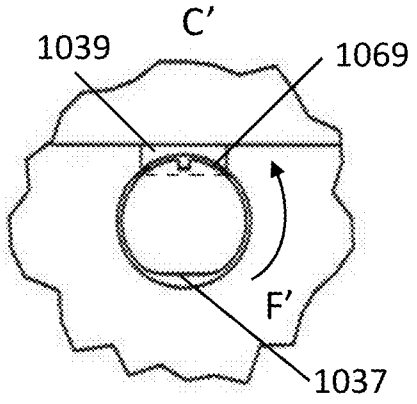

Fig. 27

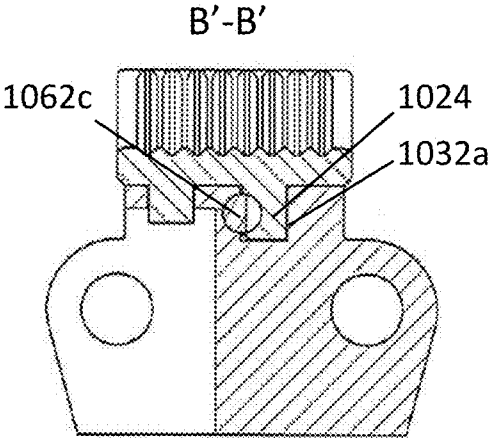

Fig. 28

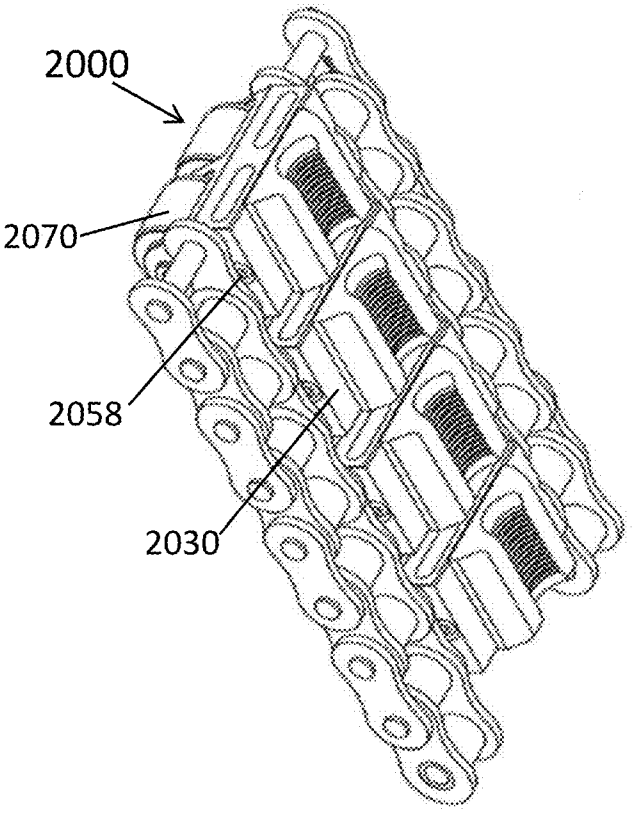

Fig. 29

GRIPPER ASSEMBLY AND LOCK/RELEASE METHOD FOR A COILED TUBING INJECTOR

FIELD

[0001] The present disclosure relates generally to gripper assemblies for coiled tubing injectors, more particularly to a lock/release method therefore.

BACKGROUND

[0002] It is well known that injectors are widely used in the oil and gas industry to run coiled tubing into or out of wellbores for performing different downhole operations, such as workover services, drilling, completions, and production. As one of the important parts of a coiled tubing injector, a gripper assembly is used to engage and grip the coiled tubing for forcibly inserting and withdrawing a continuous length of coiled tubing into or out of oil and gas wellbores.

[0003] Generally, the injector is supported in a mast over a wellbore. A continuous length of coiled tubing is spooled and supported on a reel, and is fed to via an arced guide or gooseneck. The injector utilizes series of gripper blocks mounted on a pair of opposing endless chains to grip the coiled tubing.

[0004] FIGS. **1**A and **1**B illustrate a typical coiled tubing injector, generally indicated by reference number **10**. Injector **10** includes two hydraulic motors **12**, a pair of drive sprockets **14**, a pair of idler sprockets **16**, a pair of endless chains **18**, tension cylinders **20** and pressure beam **22** driven by a group of traction cylinders **24**. Each endless chain **18** is mounted between one drive sprocket **14** and one idle sprocket **16**, and is tensioned by a respective tension cylinder **20** connected to the idle sprocket **16**. Each endless chain **18** also carries a series of gripper assemblies **26**. A pair of pressure beams **22** forcibly urges pairs of opposing gripper assemblies **26** together, applying gripping forces, to grip the coiled tubing in therebetween. Meanwhile, the gripper assembly is driven by the endless chain. As a result, the coiled tubing, represented by the broken line in FIG. **1**B is forced to move downward or upward over the wellhead, inserting or withdrawing the coiled tubing respectively, into or out of the wellbore.

[0005] A conventional gripper assembly is usually a unitary block, a plurality of the blocks being mounted to the opposing endless chains. The chains rotate in opposing directions and are arranged to meet along a linear portion arranged inline over the wellhead. Each block has a concave injection surface having an axis aligned with the direction of travel, the concave profile being transverse to the direction of movement. Each block has a semi-circular, V-shape or combined curved and planar cross-sectional profile for engaging the coil tubing between its profile and its opposing block's profile. In opposing arrangement, opposing blocks form an obround, diamond or hybrid gripping profile. Each or inline adjacent blocks are connected to another block by connecting links of a conventional chain. Such prior art gripper blocks are disclosed in U.S. Pat. No. 3,258,110 to Pilcher, U.S. Pat. No. 5,094,340 to Avakov, U.S. Pat. No. 5,853,118 to Avakov and U.S. Pat. No. 6,230,955 to Parks. During operation, the gripping surface of the gripper blocks wear and can get damaged due to repetitive engagement with coiled tubing. Frequent replacement of old gripper blocks for new is often required. In addition, various diameters of coiled tubing require different sizes of profiles and gripper blocks. In the case of wear, a whole new set of different sizes of gripper blocks may be needed to replace all the old gripper assemblies. However, the above mentioned gripper blocks are connected directly through the linkage of the chain. In order to replace the worn or damaged gripper block with a new one, a few adjacent linkages of the chain have to be disassembled first. Then the worn or old gripper block can be released from the chain and further released from adjacent gripper blocks. The installation procedure is opposite to the above disassembling procedure. The whole operation is complex and time-consuming.

[0006] Various improvements have been made to gripper block designs for ease of replacement in field operation. One such design is a gripper assembly including a carrier mounted on the chain and a releasable gripper shoe carried in the carrier has been used to replace the conventional one piece of gripper block. One simple means for fastening the gripper shoe to the carrier is to use pins or screws. An example of this type of gripper assembly is disclosed in U.S. Pat. No. 6,892,810 to Austbo et al. The gripper assembly comprises a block body, a gripper plate connected with the block body by pins, and a flex layer disposed between the gripper plate and the block body to allow the gripping surface of the gripper plate to move relative to the block body. This relative movement allows the gripping surface of the gripper block to rapidly conform to changes in the outer diameter of coiled tubing.

[0007] Other designs have also been developed to improve the performance of the gripper assembly. U.S. Pat. No. 6,173,769 to Goode discloses a gripper assembly having a carrier and a removable gripping shoe mounted to the carrier. The removable shoe includes a plurality of tongues for sliding into slots formed on the carrier, and is floated on the carrier by inserting an elastomeric pad sandwiched between the carrier and shoe. A manually depressible spring along one side of the carrier prevents the shoe from sliding out of the slots during operation of the injector.

[0008] U.S. Pat. No. 8,191,620 to Maschek, Jr. et al. discloses a gripper assembly comprising a carrier for securing the gripper to the chain drive mechanism of the coiled tubing injector unit and a gripping shoe carried by the carrier. The gripper shoe has at least one downwardly extending leg carrying an inwardly projecting tab. The inwardly projecting tab and downwardly extending leg cooperates with the carrier to preclude lateral movement of the gripper shoe while permitting rotational movement of the gripper shown on the carrier. The configuration of the gripper assembly permits quick and easy removal and replacement of the gripping shoe.

[0009] Although various improvements have been made to various gripper assemblies for facilitating installation and removal in operation, there is still significant time and expense required.

[0010] There is still room for alternatives or improved gripper assemblies that are easy to maintain and replace with additional savings in time and cost.

SUMMARY

[0011] Accordingly, a gripper assembly of a plurality of gripper assemblies is provided. The gripper assembly is adapted for drivable connection to the a coiled tubing injector. Each gripper assembly comprises a carrier mountable to the coiled tubing injector and a reliable gripper block. The carrier has a first locking part, and the gripper block a second locking part. A locking shaft interfaces with the first and second locking parts for releasable connection of the second locking part of the gripper block to the first locking part of the carrier.

The locking shaft is operable, such as through rotation, between a release position and a locking position. In the locking position, the locking shaft engages both the first locking part and the second locking part for connecting the gripper block and carrier. The gripper block is released from the carrier upon actuation of the locking shaft to the release position.

[0012] In embodiments, the carrier has a front mounting surface and the gripping block has a back surface. The first locking part of the carrier comprises a locking slot in the front mounting surface and the carrier further supports the locking shaft aligned with the locking slot. The second locking part comprises a locking tab projecting rearwardly from the back surface. After the locking tab is inserted into the locking slot, the locking shaft is actuated to engage the locking tab, trapping the locking tab within the locking slot, retaining the locking tab to the carrier.

[0013] In one embodiment, the locking shaft is cylindrical, having a diameter and a chorded portion removed therealong and a non-chorded locking portion. The length of the chorded portion is at least as long as the locking tab. The locking shaft resides within a locking profile. The locking tab has a locking lip formed along the locking tab. The locking shaft is rotatable between the locking and release position wherein, upon rotating actuation of the locking shaft to the locking position, the non-chorded locking portion is engaged with the locking tab. When the locking shaft rotates to the release position, the chorded section is aligned with the locking tab for passing the locking lip thereby for releasing the locking tab from the slot and carrier.

[0014] Corresponding positioning slot and tab can be provided in the respective in the front mounting surface of the carrier and projecting from the back surface of the gripper block. The positioning slot and tab are spaced from the locking slot and tab. The positioning tab is inserted into the positioning slot to aid in transfer of inline forces therebetween. The locking slot and tab and the positioning slot and tab can have n aspect ratio of length to width that is predominately in a transverse direction to the force vector.

[0015] In an embodiment, actuation of the locking shaft is through a handle connected to the locking shaft through a handle groove in the front mounting surface of the carrier. The locking shaft is actuated from the locking to the release position by rotation of the handle along an angle between about 45 to about 90 degrees. A restoring spring located between the carrier and the locking shaft biases the locking shaft to normally rotate to the locking position.

[0016] As a result of one of more of the embodiments described herein, a simple to implement and overall improved design is provided. The gripper assembly is readily maintained or replaced with significant savings in cost and time. The design of locking mechanism assures an automatic safety lock for retaining the gripper block to the carrier. The gripper block is retained against accidental release from the carrier through minimization of the opportunity for improper operation, and therefore avoids gripper assembly failure and harm to the injector and personnel.

[0017] In an alternative embodiment, rotating actuation of the locking shaft is secured between the two positions using a shaped retaining end of the locking shaft and a corresponding shaped counterbore. The shaft is actuable through an axial displacement to alternately disengage the shaped retaining end for rotation to the release position and engage the shaped retaining end in the locking position. The shaft is axially biased in the locked position.

[0018] The locking shaft has a control end and a retaining end extends through a locking hole extending through the carrier. The shaft's retaining end has an upset and a flat chorded edge formed thereon. The locking hole has a counterbore for receiving the retaining end. The counterbore has a flat edge encroaching on the counterbore and corresponding to the flat chorded edge of the retaining end. When the retaining end's flat chorded edge is angularly aligned with the counterbore's flat edge the flat chorded edge engages the flat edge and the locking shaft can shift axially to the locking position. The control end of the locking shaft is biased to retain the retaining end engaged with the counterbore's flat edge in the locking position. The locking shaft is actuable to the released position by overcoming the biasing to temporarily disengage the retainer end flat edge from the counterbore's flat edge so as to enable rotation of the locking shaft.

[0019] This alternative locking shaft embodiment avoids the need for space for accommodating a locking handle, therefore permitting one to minimize the size of the carrier or reduce the weight of the whole assembly or maximizing the size of the gripper block.

[0020] According to another aspect of the invention, there is provided a coiled tubing injector comprising a pair of opposing endless chains and a plurality of gripper assemblies driven by the pair of endless chain for running coiled tubing in or out of a well. Each gripper assembly can be as described in the embodiments above.

[0021] According to another aspect of the invention, there is provided a lock/release method for a gripper assembly driven by a coiled tubing injector. The gripper assembly comprises a carrier having a first locking part and a gripper block having a second locking part releaseably connected by a locking shaft. A locking tab projecting from one of the block or carrier is inserted into a slot of the other of the carrier or block, a back mounting surface of the block engaging a front mounting surface of the carrier. The locking shaft is engageable between the first and second locking parts wherein, in an embodiment, the shaft is rotatable between locking position to engage both the first locking part and the second locking part for connecting the gripper block and the carrier; and a release position to release the gripper block from the carrier.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Embodiments will now be described more fully with reference to the accompanying drawings in which:

[0023] FIG. **1**A is a perspective view of a traditional coiled tubing injector having prior art coiled tubing grippers;

[0024] FIG. **1**B is a cross-section view along O-O of FIG. **1**A;

[0025] FIG. **2** is a perspective view of a series of gripper assemblies mounted on a portion of an endless chain according to a first embodiment of the present invention;

[0026] FIG. **3** is a perspective view of a close look of one gripper assembly of FIG. **2**;

[0027] FIG. **4** is an exploded view of the gripper assembly of FIG. **3**;

[0028] FIG. **5** is a perspective view of the mounting side of the gripper block of the gripper assembly of FIG. **4**;

[0029] FIG. **6** is a cross-section view of the gripper block of FIG. **5**;

[0030] FIG. **7** is a perspective view of a carrier for the gripper assembly FIG. **4**;

[0031] FIG. **8** is a cross-section view of the flanges of the carrier of FIG. **7**;

[0032] FIG. **9** is a perspective view of a locking shaft of the gripper assembly in FIG. **4**;

[0033] FIG. **10** is a perspective view of the gripper assembly of FIG. **4**;

[0034] FIG. **11** is a front view of the gripper assembly of FIG. **10**;

[0035] FIG. **12** is a cross-section view of the gripper assembly along A-A of FIG. **11**;

[0036] FIG. **13** is a cross-section view of the gripper assembly along B-B of FIG. **11**;

[0037] FIG. **14**A is a cross-section view of the gripper assembly along C-C of FIG. **11** at lock position;

[0038] FIG. **14**B is a cross-section view of the gripper assembly along C-C of FIG. **11** at open/release position;

[0039] FIG. **15**, in a second embodiment, illustrates a perspective view of a series of gripper assemblies mounted on a portion of an endless chain;

[0040] FIG. **16** is an exploded view of the gripper assembly in FIG. **15**;

[0041] FIG. **17** is a perspective view of a locking shaft of the gripper assembly in FIG. **16**;

[0042] FIG. **18** is a side view of the locking shaft of FIG. **17** from direction D;

[0043] FIG. **19** is a perspective view of the carrier in FIG. **16**;

[0044] FIG. **20** is an enlarged partial view of region E in FIG. **19**;

[0045] FIG. **21** is a perspective view of the gripper assembly in FIG. **16**;

[0046] FIG. **22** is a front view of the gripper assembly of FIG. **21**;

[0047] FIG. **23**A is a cross-section view of the gripper assembly along A'-A' of FIG. **22** at original locking position;

[0048] FIG. **23**B is a cross-section view of the gripper assembly along A'-A' of FIG. **22** after the locking shaft has been pushed to start the release operation;

[0049] FIG. **23**C is an end view of the retaining end of the driving shaft in the counterbore according to FIG. **23**A in the locking position;

[0050] FIG. **23**D is an end view of the retaining end of the driving shaft in the counterbore according to FIG. **23**B in the open/release position;

[0051] FIG. **24** is an enlarged partial view of region C' of FIG. **22** at locking position;

[0052] FIG. **25** is a cross-section view of the gripper assembly along B'-B' of FIG. **23** at locking position;

[0053] FIG. **26** is a cross-section view of the gripper assembly along A'-A' of FIG. **22** at open/release position;

[0054] FIG. **27** is an enlarged partial view of region C' of FIG. **22** at open/release position;

[0055] FIG. **28** is a cross-section view of the gripper assembly along B'-B' of FIG. **26** at open/release position; and

[0056] FIG. **29** in a third embodiment, illustrates a perspective view of a series of gripper assemblies mounted on a portion of an endless chain.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0057] Referring now to FIGS. **2** to **14**, a first embodiment is shown of a gripper assembly used in a general coiled tubing injector to engage and grip coiled tubing for inserting and withdrawing continuous length of coiled tubing into or out of wellbores. As shown in FIGS. **1**B and **2**, a plurality of gripper assemblies **100**,**100** . . . are arranged in a series about each of a pair of opposing endless chains **200**,**200** of a coiled tubing injector **10**. Each gripper assembly **100** is driven by respective chain **200** in opposing relation to another opposing gripper **100** driven by its respective opposing chain **200**, gripping and sandwiching the coiled tubing therebetween. Other driving arrangements may be known to which the gripper assemblies **100** can be driveable supported.

[0058] In FIG. **2**, a portion of a linear section of conventional endless chain **200** is shown with gripper assemblies **100** installed thereto. Turning to FIG. **3** one gripper assembly **100** in isolation is installed to the chain **200**, with its associated components. The chain **200** normally includes inner chain plates **202**, outer chain plates **204**, pins **206** and chain rollers **208**.

[0059] With reference to FIG. **4**, in a first embodiment, the gripper assembly **100** comprises a gripper block **110**, a carrier **130**, a locking mechanism **150** for releasably securing gripper block **110** to carrier **130** for ease of block replacement, and a pair of coaxial rollers **170** installed on a transverse roller shaft **180** that is supported by carrier **130**. The carrier **130** has a first locking part and the block has a second locking part. The first and second locking parts are secured together using the locking mechanism **150**.

[0060] Locking mechanism **150** further includes locking shaft **152**, locking handle **154**, restoring spring **155**, retaining member **157** and a handle fastener **159** for fastening locking handle **154** to locking shaft **152**.

[0061] With further reference to FIGS. **5** and **6**, each gripper block **110** comprises a concave gripping surface **112**, a back surface **114**, a pair of side surfaces **116***a* and **116***b*, and a pair of leading and trailing facets **118***a* and **118***b*. Gripping surface **112** extends between the two facets **118***a* and **118***b*, for forming a substantially continuous gripping surface with adjacent and opposing blocks **110**, **110**. The gripping surface **112** has a concave semi-circular, V-shape or compound profile along a cross-section or transverse plane X-Y perpendicular to a moving direction of the coiled tubing, as indicated by inline axis Z-Z, in order to accommodate the coiled tubing. Gripping surface **112** can have a plurality or transverse wickers or parallel grooves **120** spaced along the surface **112** to aid in gripping, each extending along plane X-Y as disclosed in the prior art, such as in U.S. Pat. No. 5,853,118, U.S. Pat. No. 6,230,955 and U.S. Pat. No. 8,191,620.

[0062] Back surface **114** located on the opposite side of the gripping surface **112** is a generally flat surface, and is used to engage with similarly and generally flat surface **132***a* of carrier **130**. Side surfaces **116***a* and **116***b* are located between back surface **114** and gripping surface **112**. Material of the block that is not actively required for strength or function can be removed for reducing overall weight of the gripper block. For example, recesses **119** can be formed on each side surface **116***a*,**116***b*. Similarly, in this embodiment and also shown in FIG. **12**, each side surface **116***a*,**116***b* can slope inwardly from back surface **114** towards gripping surface **112**, reducing weight still further, as the gripping surface **112** can be smaller than the back surface **114**. However, it is appreciated by those skilled in the art that the configuration of side surfaces **116***a*, **116***b* can depend on the size and strength requirement of the gripping surface. If the size of gripping surface **112** is greater than that of the back surface **114**, side surfaces

116*a*,116*b* may slope or diverge outwardly from back surface **114** towards gripping surface **112**.

[0063] The gripper block **110** and carrier **130** transfer inline forces therebetween, the carrier **130** transferring inline injection forces from the chain **200** to the blocks **110**, and the blocks **110** transferring reactive forces back into the carrier **130**. To enable the transfer of forces therebetween a tab and slot arrangement is provided, the tab of one component extending removeably into the slot of the other component. As illustrated, the gripper block is fit with one or more tabs **124**,**122** to engage one or more slots **138***a*,**138***b* of the carrier **130**.

[0064] At least one tab also operates as a locking mechanism. As shown, in one embodiment, tab **122** performs a force coupling function and tab **124** performs at least a locking function. The locking tab **124** can also bear some of the transfer of forces between block and carrier.

[0065] As shown in the embodiment of FIGS. **5** to **8**, to avoid compromising the locking mechanism **150** for releasable connection, the block **110** further comprises elongated positioning tab **122** for fitting in a corresponding recess or slot **138***b* in carrier **130**. The slot **138***b* need not extend through the entirely of the carrier **130**. The slot **138***a* has a recess or depth sufficient to receive the tab **124**.

[0066] Tab **122** is directed to force transfer and has an inline thickness that corresponds to and is substantially that of the inline width of the slot **138***b*. Hence, the tab **122** fits with the slot **138***b* for a drivable connection therebetween, the tab **122** and slot **138***b* transferring forces between the block **110** and carrier **130**.

[0067] The tab **122** projects outward and rearward from back surface **114**. As appreciated by those skilled in the art, the positioning tab can employ a variety of shapes as long as they are able to effectively engage in a corresponding-shaped slot of carrier **130**, such as, but not limited to, rectangle or cylinder shape and the like. The various shapes, of both tab and slot having driving inline interfaces that are generally transverse to the applied forces.

[0068] To retain the tab **122** in a drivable connection to the carrier **130**, locking tab **124** is releaseably retained thereto. The second locking part or locking tab **124** projects outwardly and rearwardly from the back surface **114** of gripper block **110** to engages or fit to the first locking part being the corresponding locking recess or locking slot **138***a* in carrier **130**.

[0069] The locking tab **124** is an elongated body extended along the transverse direction, generally transverse to the inline axis Z-Z. It has a rear surface **124***a*, two opposite ends **124***b* and **124***c*, and two leading and trailing inline surfaces **124***d* and **124***e*. A locking surface **126** for engaging with locking shaft **152** of locking mechanism **150** is formed on one of the inline surfaces and has a transversely extending concave surface.

[0070] The locking surface **126** cooperates with a releasable locking shaft **152**, supported from the carrier **130**, for retaining the locking tab **124** to the carrier. The locking shaft **152** has an outer surface, at least a portion of which has a profile that matches with the locking mechanism of inline surfaces **124***d* and **124***e*. In the embodiment having a driving or positioning tab **122** and corresponding slot, the locking mechanism retains the gripper block to the carrier and need not be involved in the inline driving forces. However, the locking tab can also aid in transferring driving forces. Once the locking shaft **152** has engaged the locking surface **126**, the locking tab **124** cannot be accidentally or forcibly disengaged from the carrier **130**.

[0071] In this embodiment, the inline surface **124***e* is formed with the concave locking surface **126**. Locking surface **126** extends between end **124***b* and end **124***c* along transverse axis Y-Y, which is perpendicular to the coil tubing's inline moving direction Z-Z.

[0072] Referring to FIG. **6**, the locking surface **126** along plane X-Z is an concave recess corresponding to a compatible surface on the locking shaft. In this embodiment, the arc is a circular arc having diameter D. The arc of the locking surface **126** does not extend to the maximum rearward extent of the tab **124**, therefore forming a retaining lip or overhang **127** having depth T. This diameter matches with the outer diameter of corresponding circular profile portion of the locking shaft **152**. The depth T of the arc, also referred to depth of the locking surface, is any size smaller than diameter D. It is preferred that depth T is smaller than the radius or D/2. Depth T is related to the radial dimension of locking shaft **152**. A smaller or shallower depth T allows more choices for choosing a larger radial dimension for the locking shaft **152**. A locking shaft having a larger radial dimension is strong as is the tab **124** having a less abrupt locking surface **126**. Choosing a shallower depth T for the locking surface **126** makes it possible to choose a larger locking shaft **152**, and therefore makes the connection between gripper block **110** and carrier **130** stronger. The length of the locking tab **124** between two ends **124***b* and **124***c* and the width between two side surfaces **124***d* and **124***e* can be up to about the length and the width, respectively, of the corresponding locking slot **138***a* of carrier **130**, details of which will be discussed later.

[0073] Now referring to FIGS. **7** and **8** in more detail, carrier **130** comprises a base body **132** having a flat front face or mounting surface **132***a*, a back surface **132***b* and two or more transversely-spaced flanges **132***c*, **132***d* projecting from back surface **132***b* of body **132**. Three flanges **132***c*, **132***d* and **132***e* are shown. Front face **132***a* forms a supporting surface for back surface **114** of block **110**. Two outermost surfaces of the outermost flanges **132***c* and **132***e* flanges form a pair of end surfaces **132***f* and **132***g* of carrier **130**. Three holes **134***a*, **134***b* and **134***c* are formed in the three flanges **132***c*, **132***d*, **132***e*, respectively. Axes of the three holes are aligned, being co-axial, in order to receive the roller shaft **180**. Two rollers **170** can be installed between each pair of the flanges and supported by roller shaft **180** extending coaxially therethrough.

[0074] For connecting the carrier to the chain **200**, two additional through holes **136***a* and **136***b* extend transversely through base body **132** from one end surface **132***f* to the other end surface **132***g*. As appreciated by those skilled in the art, pins **206** are inserted into through holes **136***a* and **136***b* to secure carrier **130** to chain **200** by known traditional methods.

[0075] On the front surface **132***a*, there are two parallel slots, locking slot **138***a* and positioning slot **138***b*, formed in the base body **132** for receiving locking tab **124** and positioning tab **122**, respectively. A locking hole **140** also extends from one side surface **132***f* to the other side surface **132***g* and parallel with concave locking surface **126**. As can be seen in FIG. **8**, locking hole **140** partially encroaches on or overlaps with the locking slot **138***a*, being in communication with each other forming an integrated cavity. When the locking tab **124** is inserted into locking slot **138***a*, and locking shaft **152** of

FIGS. **4** and **9** is installed into hole **140**, the shaft **152** engages locking tab **124** so that that gripper block **110** is fixedly secured to carrier **130**.

[0076] With reference to FIG. **9**, only a locking portion LL of the circumference and length of the locking shaft **152** has a profile for engaging the locking surface **126**. The locking shaft **152** is rotatable between two positions, an open position to enable insertion and extraction of the locking tab **124**, and a locked position to engage the locking tab **124** within the carrier **130**. When rotated to the locking position, the locking portion LL of shaft **152** engages the locking surface **126** or interferes with the release of locking tab **124** from the carrier **130**. When rotated to the open/release position, the shaft's locking portion LL is rotated to a disabled position, aligning a recessed surface P with lip **127** and releasing the locking tab **124**.

[0077] As seen in FIGS. **4** and **7**, the rotation of the shaft **152** can be biased to the locked position or aided using a locking handle **152**. The carrier **130** further comprises a handle recess or groove **144** for accommodating the locking handle **154** of locking mechanism **150**. Handle groove **144** partially overlaps with locking hole **140** so that one end of locking handle **154** can be mounted tangentially to access locking shaft **152** through the overlapped area.

[0078] As determined during the design process, the carrier **130** has also been fit with additional lightening holes **142** for reducing overall weight of the carrier. Although in this embodiment, holes **142** are located in flanges, it is understood by those skilled in the art that non-structural materials can be removed such as forms of holes, recesses or slots located in other areas of carrier for reducing weight.

[0079] In more detail in FIG. **9**, locking shaft **152** is an elongated solid cylinder comprising a middle portion **156**, a handle end **158** and a retaining end **160**. The middle portion has two end bushing sections **156***a* and **156***b*, and a locking section **156***c* in between. The two end bushing sections **156***a* and **156***b* have diameter d that matches with the diameter and spaced to correspond with the spaced ends of locking hole **140** of carrier **130**, as well as the diameter D of the locking surface **126** of gripping block **110**. The locking section **156***c* has the same effective diameter D as that of the two end sections **156***a*,**156***b* but having the flat surface P portion formed therealong by removing a chord of the shaft for a portion along the longitudinal direction at least as long as the lip **127**. The removed chord portion P forms the release profile of the shaft and the remaining portion, having depth a, forms the locking portion LL. Simply, the locking depth a of the locking portion LL interferes with removal of locking tab **124** and removed chord portion P does not.

[0080] The locking depth a of the shaft is preferably equal to or less than a depth A of the corresponding locking hole **140** corresponding to depth T of lip **127**. The length L of the flat release surface P and locking portion LL are about the length or greater than the length of locking tab **124** of gripper block **110** and preferably greater than the length of the locking slot **138***a*. That is to say, lip **127** is sized to slot **138***a* and when the locking shaft **152** is inserted in locking hole **140** and at open/release position, flat surface P does not exceed the edge of locking hole **140**, as shown in FIG. **14**B, therefore releasing lip **127**. The locking tab **124** of gripper block **110** is able to directly insert into or release from the locking slot **138***a* of carrier **130** along the direction indicated by arrow E-E.

[0081] The handle end **158** of locking shaft **152** has an outer diameter that matches with locking hole **140**, which makes the locking shaft **152** rotatable in locking hole **140**. Preferably, in this embodiment, the outer diameter of handle end **158** is greater than the outer diameter of middle portion **156**. Accordingly, locking hole **140** has a greater diameter near end surface **132***g* of flange **132***c* than the rest of the locking hole **140**, as shown in FIGS. **9** and **12**, such that the lateral movement of the locking shaft **152** in the locking hole **140** is limited in one direction by shoulder **161** of the locking shaft **152** and shoulder **145** of the locking hole **140**. A portion of the handle end **158** has been milled to form a recess **162** with a flat surface. Also as shown in FIGS. **4**, **12** and **13**, locking handle **154** also has a flat back surface for engaging with the flat surface of recess **162** of locking shaft **152**. The locking handle **154** is received in recess **162** and fastened to locking shaft **152** by fastener **159**. Lifting or lowering a free end of locking handle **154** results in a rotation of locking shaft **152** so that locking shaft **152** is able to switch between the locking position and the open/release position to lock or release gripper block **110** from carrier **130**. Although in this embodiment, a screw is used as fastener **159** to thread into a threaded hole in locking shaft **152**, those skilled in the art understand that other types of fasteners can be utilized. It is preferred that an indicator notch **163** is made on handle end **158** of locking shaft **152** to indicate a rotation angle of the locking shaft **152** with respect to its original position.

[0082] The retaining end **160** extends from end section **156***b* of middle portion **156** and has a tubular shape with part being cut off to form edges or stops **164***a* and **164***b*, one of which is used to retain one end of a biasing member or restoring spring **155**. The outer diameter of the retaining end **160** is the same as that of middle portion **156** for inserting into locking hole **140**. The inner diameter of retaining end **160** is big enough to accommodate retaining member **157**, such as a screw that is fastened to the driving draft **152** and retains spring **155**. The restoring spring **155**, such as a torsion spring, is located between locking shaft **152** and retaining member **157**, with one end held by edge **164***a* and the other end held in a groove **143** at the end surface of carrier **130**, free from being covered by the gripper block, shown in FIGS. **7** and **10**.

[0083] When locking handle **154** is manually lifted up for releasing the gripper block **110**, the restoring spring **155** is engaged by stop **164***a* of locking shaft **152**, twisted and hence energized. Forces generated by restoring spring **155** bias and urge the locking shaft **152** to normally rotate to the locking position, which is in opposite direction to the release position. The locking shaft **152** is rotationally driven by the handle **154** to rotate the shaft a first angle in a first direction against the biasing torque of the torsion spring to the open/release position, and able to automatically rotate back a same angle as the first angle in an opposite direction to the first direction to the locking position upon restoring force of the torsion spring.

[0084] This mechanism assures an automatic safety lock for gripper block **110** and carrier **130**. Unless overridden by manual actuation of the handle **154**, the spring retains the locked position to prevent gripper block **110** from accidental release from carrier **130** due to improper operation or carelessness, and therefore avoids gripper assembly failure or harm to the injector and user.

[0085] Now the installation and lock/release operation of the gripper assembly **100** are described in detail with reference to FIGS. **4** through **14**. First of all, rollers **170** are arranged coaxially between each pair of the flanges of carrier **130**. Roller shaft **180** is inserted into holes **134** in flanges **132** and holes of rollers **170**. Roller shaft **180** is retained to carrier

130 by a traditional retaining ring clipped to the circular groove at the end of locking shaft 152. Then the locking shaft 152 is inserted into locking hole 140 of carrier 130. Restoring spring 155 is placed between locking shaft 152 and carrier 130, with one end held by edge 164 of locking shaft 152 and the other end held by groove 143 of carrier 130. Retaining member 157 is threaded into locking shaft 152 to sustain locking shaft 152 in carrier 130 and in also retains restoring spring 155 thereto. Meanwhile, recess 162 of locking shaft 152 is exposed through the handle groove 144 in carrier 130. Handle 154 is placed in handle groove 144 and aligned the flat surface of recess 162 of locking shaft 152. The handle 154 is fastened to locking shaft 152 by fastener 159. Now, the carrier 130 is ready to install on the endless chain via traditional method, such as through holes 136 and pins 206, as discussed above.

[0086] As shown in FIGS. 11 to 14B, the original position of locking shaft 152 is set as a locking position according to the first embodiment, corresponding to which the locking handle 154 is set at a lower position. There is no force or torque, or very small amount of pre-load force or torque applied to restoring spring 155 at this position.

[0087] During operation, in order to insert/release gripper block 110 from carrier 130, a user first manually lifts locking handle 154 a certain first angle, coordinated with the extent of removed chord portion P, between about 45 and about 90 degrees in this embodiment. The handle is assessable in an exposed portion of the carrier 130 adjacent side walls 116*a* or 116*b* of the gripper block 110. The handle rotationally drives locking shaft 152, rotating the shaft 152 the same angle, orienting the chord portion P with the locking tab 124. Now, the locking shaft 152 is located at open/release position shown in FIG. 14B. At this moment, the locking section 156*c* or portion P of locking shaft 152 is fully aligned with locking hole 140, which makes locking slot 138*a* a clear opening. The locking tab 124 of gripper block 110 can readily move in or out of locking slot 138*a* of carrier 130. Then the positioning tab 122 and locking tab 124 of gripper block 110 are aligned with positioning slot 138*b* and locking slot 138*a* of carrier 130, respectively, and are able to insert into positioning slot 138*b* and locking slot 138*a* of carrier 130 directly. After that, locking handle 154 is lowered down. Locking shaft 152, urged by restoring spring 155, or as assisted by manual manipulation of the locking handle 154, rotates backward a same angle as the first angle to return its original position, which is the locking position. At this position shown in FIG. 14A, at least part of the locking section 156*c* or LL of locking shaft 152 has engaged locking surface 126 of locking tab 124 of gripper block 110. In this way, the gripper block 110 and carrier 130 are locked together tightly.

[0088] Locking shaft 152 and locking handle 154 can be rotated any angle to switch between a locking position and an open position, shown in this embodiment between and angle from about 45 to about 90 degrees. Those skilled persons in the art understand that various degrees or other types of design or connection between locking shaft 152 and locking handle 154 can be employed.

[0089] In this embodiment, positioning tab 122 and position slot 138*b* have been shown as assisting with defining relative position of gripper block 110 and carrier 130 for drivable coupling. However, it is appreciated by those skilled in art that only locking tab 124 and locking slot 138*a* with a certain profile are enough to define the relative position of gripper block 110 and carrier 130 for drivable coupling and force transfer, even without positioning tab 122 and positioning slot 138*b*.

[0090] Now turning to FIGS. 15 to 28, a second embodiment of a gripper assembly 1000 similarly comprises a gripper block 1010, a carrier 1030 and a locking mechanism 1050. The gripper block 1010, similar to gripper block 110 of the first embodiment, includes a gripping surface 1021, a positioning tab 1022 and a locking tab 1024.

[0091] One difference between this second embodiment and the first embodiment is the actuation of the locking mechanism 1050. Instead of using a locking handle for manual actuation, the locking shaft of the locking mechanism 1050 is configured for axial movement to shift between the locking and open positions. Rotational actuation is secured between the two positions using a shaped retaining end for the locking shaft and a shoulder at one end, and an actuating or driven component at another end. The driven components enable movement along the longitudinal direction of the shaft and then rotate to switch between the locking position and the open/release position. This design saves space over that previously allocated for accommodating a locking handle, therefore permitting one to minimize the size of the carrier or reduce the weight of the whole assembly or maximizing the size of the gripper block. Details of the locking mechanism 1050 will be discussed later.

[0092] Carrier 1030, also similar to the first embodiment, comprises a base body having a flat front face or mounting surface 1031 and a back surface 1033. Instead of three flanges projecting from the back surface for supporting two rollers in the first embodiment, carrier 1030 has a tongue 1036 and a pair of spaced apart ears 1038 formed between mounting surface 1031 and back surface 1033. A space between the pair of ears 1038 is adapted to receive a tongue of an adjacent carrier. Tongue 1036 and ears 1038 are provided with pin holes 1040. Pin holes 1040 in ears 1038 of one carrier are aligned with a pin hole in the tongue of an adjacent carrier after they are assembled together. Therefore, pins of a conventional endless chain (not shown) can be inserted in the pin holes for connecting and securing a series of carriers together to the endless chain. Such design has been discussed in prior art U.S. Pat. No. 5,094,340.

[0093] Back surface 1033 is used to engage a skate chain (not shown) interposed between the pressure beam and the carriers. Gripping forces are transferred from the pressure beam to the skate chain, then to the carrier and further to the gripper block for gripping coiled tubing. Friction between the carrier and the pressure beam are reduced through the skate chain during force transferring. This design is very effective to reduce the wear on the back surface 1033 of carrier as disclosed in U.S. Pat. No. 5,094,340, and is not discussed in further detail herein.

[0094] Similar to the first embodiment, on the front mounting surface 1031, there are two parallel slots, the locking slot 1032*a* and the positioning slot 1032*b* for receiving the locking tab 1024 and the positioning tab 1022 of gripper block 1010, respectively. Locking hole 1034 extending through the base body and parallel to the two slots is for receiving a locking shaft 1052 of locking mechanism 1050. The location of the locking hole 1034 with respect to the locking slot 1032*a* and the positioning slot 1032*b* is similar to the first embodiment, and will not be repeated here.

[0095] In this embodiment, locking mechanism 1050 comprises a locking shaft 1052, a compression spring 1054, a

washer **1056** and a socket head cap screw **1058**. The locking handle of the first embodiment is eliminated for reducing the size of the carrier or for use of a larger gripper block.

[0096] In more detail in FIG. **17**, the locking shaft **1052** of the second embodiment comprises a middle portion **1062**, a control end **1064** and a retaining end **1066**. The middle portion **1062** has two end bushing sections **1062***a* and **1062***b*, and a locking section **1062***c* in between. The two end bushing sections **1062***a* and **1062***b* have a diameter that matches with the diameter of locking hole **1034** of carrier **1030**, as well as the diameter of the locking surface of gripping block **1010**. The locking section **1062***c* is the same shaft body as the two end sections **1062***a* and **1062***b* but having a flat surface P formed by removing a chord of the shaft along the longitudinal direction. Similar to the first embodiment, the removed chord portion P forms the release profile of the shaft and the remaining portion forms the locking portion LL.

[0097] Control end **1064** extends from end section **1062***b* of middle portion **1062** and has a diameter smaller than that of end section **1062***b*, forming a shoulder **1068** therebetween. After the locking shaft **1052** is inserted in carrier **1030**, washer **1056** is placed on control end **1064** and abuts shoulder **1068** to hold compression spring **1054** mounted between the washer **1056** and a shoulder **1041***b* of the carrier **1030**, shown in FIGS. **23**A and **23**B. Furthermore, control end **1064** includes a threaded blind hole **1070** for receiving socket head cap screw **1058**. Socket head cap **1058** is threaded into the threaded blind hole **1070** to fixedly secure the washer **1056** to the locking shaft **1052**. After that, forces applied by a conventional tool, such as an allen key, to socket head cap **1058** push the locking shaft **1052** to move forward against the force of compression spring **1054**. Release of the pressure on the locking shaft **1052** allows it to return to its original position upon the restoring force of compression spring **1054**, which corresponds to an approximately relaxed status of compression spring **1054**.

[0098] Retaining end **1066** has a shaped upset having a larger effective diameter than that of the shaft's end section **1062***a*. A shown in FIG. **18**, a portion or chord of the retaining end **1066** is machined to a flat edge **1065** while the rest of the retaining end maintains a circular edge **1069** at full diameter.

[0099] Accordingly, as shown in FIGS. **19**, **20**, **23**A and **23**B, the locking hole **1034** has a first counterbore **1035***a* for receiving the retaining end **1066**, the counterbore having a flat edge **1037** encroaching on the counterbore **1035***a* and corresponding to the flat chorded portion or edge **1065** of the retaining end **1066**. The first counterbore **1035***a* has a diameter corresponding to that of the retaining end **1066** and sized for axially receiving same. The counterbore **1035***a* is in axial communication with locking hole **1034** in carrier **1030**. The flat edge **1037** can extend partially and axially along the counterbore **1035***a*, a remaining outboard portion of the counterbore remaining at full diameter. Thus, during axial manipulation between locked and open/released positions, the retaining end **1066** need not fully exit the counterbore **1035***a*.

[0100] Thus, the size and shape of retaining end **1066** corresponds with the first counterbore **1035***a* of carrier **1030**. Meanwhile, as shown in FIG. **23**A, the retaining end **1066** is biased to abut a first shoulder **1041***a* of the first counterbore **1035***a*, limiting the longitudinal movement of the locking shaft **152** in one direction and aligning the locking section **1062***c* for use. When retaining end's flat chorded edge **1065** is angularly aligned with the counterbore's flat edge **1037**, the locking shaft can shift axially, deeper into the counterbore **1035***a*, engaging the flat chorded portion with the flat edge to prevent rotation and maintaining the locking shaft in the locking position.

[0101] In addition, as shown in FIG. **24**, an indicator notch **1067** can be machined into retaining end **1066**, on the opposite side of flat edge **1065**, for visual indication of a relative position of the driving shaft **1052** with respect to carrier **1030**.

[0102] Carrier **1030** also comprises an opening **1039** in communication with first counterbore **1035***a*. Opening **1039** intersects with first counterbore **1035***a* at flat edge **1037**. The opening **1039** has a bottom surface **1042** that is higher than the first shoulder **1041***a*. When the locking shaft **1052** is pushed from control end **1064**, the retaining end **1066** on the other side moves forward as if to axially leave or extend from counterbore **1035***a*. As a result as shown in FIG. **23**B, the retaining end **1066** extends axially off of first shoulder **1041***a* and free from flat edge **1037** so that the locking shaft **1052** is free to rotate. As the locking shaft **1052** further rotates, the circular edge **1069** of retaining end **1066** is axially spaced outboard from flat edge **1037** and free to rotate through opening **1039** such that the locking shaft **1052** is able to switch from a locking position an open/release position, details of which will be discussed later.

[0103] Turning to FIGS. **23**A and **23**B again, carrier **1030** has a second counterbore **1035***b* on the opposite side of the first counterbore **1035***a* for receiving compression spring **1054**, washer **1056** and socket head cap screw **1058**. It has a larger diameter than locking hole **1034** and therefore a second shoulder **1041***b* is formed therebetween. The second shoulder **1041***b* along with the compression spring **1054** and washer **1056** limits a longitudinal movement of the locking shaft in the pushing direction.

[0104] With reference to FIGS. **16** through **28**, the installation and the locking/release operation of the gripper assembly according to the second embodiment of the invention are described in greater detail.

[0105] As shown in FIGS. **16** and **23**A, the control end **1064** of the locking shaft **1052** is inserted into locking hole **1034** from the first counterbore **1035***a* until the control end **1064** enters into second counterbore **1035***b*. Compression spring **1054** and washer **1056** are then placed on control end **1064** in sequence through second counterbore **1035***b*. Compression spring **1054** is located between the second shoulder **1041***b* of second counterbore **1035***b* and the washer **1056**. Socket head cap screw **1058** is threaded into threaded hole **1070** of the control end **1064** to secure washer **1056** to locking shaft **1052**, sandwiching the spring **1054** between the control end and the carrier **1030**. On the other end of the locking shaft **1052**, retaining end **1066** is biased by spring **1054** to abut the first shoulder **1041***a*. Locking and releasing action, actuated through longitudinal movement of the locking shaft **1052**, is conducted in two directions: a pushing direction applied at the control end **1064**, resisted by spring **1054** against the second shoulder **1041***b*; and a biased retracting direction, limited or stopped by engagement of the retaining end **1066** and the first shoulder **1041***a*. The locking shaft **1052** is able to move forward against the compressed force of compression spring **1054** along the longitudinal direction upon a pressure applied to socket head cap screw **1058** by a tool, such as an Allen key. The locking shaft **1052** is also able to retract upon the restoring force of compression spring **1054**.

[0106] As shown in FIGS. **23**A and **23**B, the control end **1064** of the locking shaft is biased for retaining the retaining

end axially in the carrier with the retaining end's flat chorded portion engaged with the counterbore's flat edge in the locking position. The locking shaft is actuable to the released position by overcoming the biasing to temporarily disengage the retainer end flat edge from the counterbore's flat edge so as to enable rotation of the locking shaft.

[0107] Normally, the locking shaft **1052** is set at the locking position with its retaining end **1066** residing in first counterbore **1035***a* as shown in FIG. **23**A. At this position, and shown in FIG. **23**C, rotation of the locking shaft **1052** is delimited by the flat edge **1065** of retaining end **1066** engaging flat edge **1037** of first counterbore **1035***a*. The axial position of the locking shaft **1052** along longitudinal direction is limited by first shoulder **1041***a* of first counterbore **1035***a*. The non-chorded, locking portion LL of locking shaft **1052** engages carrier **1030** and the other part of the locking portion LL engages locking tab **1024** of gripper block **1010**, locking gripper block **1010** and carrier **1030** together. As shown in FIG. **24**, indicator **1067** is visualized by a user and indicates the position of the locking shaft **1052** with respect to carrier **1030**, which is the locking position at this moment. Meanwhile, compression spring **1054** is at its extended or most relaxed state.

[0108] As shown in FIG. **23**B, In order to switch to the open/release position for installing or removing gripper block **1010** from carrier **1030**, the control end **1064** of locking shaft **1052** is first pushed by a tool at socket head cap screw **1058** to move axially forward. Retaining end **1066** is pushed out to extend beyond bottom surface **1042** of flat edge **1037** to access opening **1039**. Flat edge **1065** of retaining end **1066** is no longer restricted by flat edge **1037** of first counterbore **1035***a*. Locking shaft **1052** is then free to rotate. As shown in FIG. **23**D, locking shaft **1052** is driven by the tool to further rotate a first angle, for example 180 degrees in this embodiment, to an open/release position. The locking shaft **1052** is rotated 180 degrees, counterclockwise in this instance as indicated by direction F illustrated in FIG. **24** as viewed from the retaining end **1066**.

[0109] With reference to FIGS. **26** to **28**, the open/release position is shown. After this rotation, part of circular edge **1069** of retaining end **1066** sits in opening **1039** as shown in FIG. **27**. The locking portion LL is fully held only in carrier **1030** and the chorded portion P, **1062***c* aligns with locking slot **1032***a* shown in FIG. **28**. This opens locking slot **1032***a* releasing locking tab **1024**. Locking tab **1024** of gripper block **1010** can be directly inserted and removed from carrier **1030**.

[0110] After gripper block **1010** is inserted or removed from carrier **1030**, the locking shaft **1052** is again driven by the tool at socket head cap screw **1058** to rotate a second angle, for example, also 180 degrees counterclockwise indicated by direction F' in FIG. **27** as viewed from the retaining end **1066**. Circular edge **1069** rotates through opening **1039** to again align flat edge **1065** of locking shaft **1052** with flat edge **1037** of first counterbore **1035***a*. Retaining end **1066** of driving shaft **1052** urged by restoring force of compression spring **1054** is biased axially again into first counterbore **1035***a* to engage first shoulder **1041***a*. Locking shaft **1052** returns to the locking/original position shown in FIGS. **23** to **25**.

[0111] Although in this embodiment, locking shaft **1052** has been rotated 180 degrees counter-clockwise to switch from locking position to open/release position, and 180 degrees counter-clockwise from open/release position to locking position; it is understood by those skilled in the art that the rotation angle and direction are not limited to this embodiment. Rotating locking shaft clockwise can achieve the same result.

[0112] Although the first embodiment describes a locking mechanism including a locking handle installed in the carrier with rollers, and the second embodiment describe a locking mechanism including socket head cap screw installed in the carrier with a flat back surface, certain type of locking mechanism is not limited to the applications with a certain type of carrier. That is to say, any type of locking mechanism can apply to any type of carrier. For example, FIG. **29** shows a gripper assembly **2000** according to a third embodiment of the present invention that the locking mechanism having socket head cap screw **2058** applies to carrier **2030** installed with rollers **2070**.

[0113] Although in the embodiments, the locking tab and the locking slot are configured in the gripper block and in the carrier, respectively, those skilled in the art understand that they are not restricted to those embodiments. The locking tab can be configured to extend from the carrier and the locking slot can be formed in the gripper block. Accordingly, the locking hole is not limited to be in the carrier. On the contrary, it can be configured to extend through the gripper block.

[0114] Although embodiments have been described above with reference to the accompanying drawings, those skilled in the art will appreciate that variations and modifications may be made without departing from the scope thereof as defined by the appended claims.

The embodiments of the invention for which an exclusive property or privilege is claimed are defined as follows:

1. A gripper assembly of a plurality of gripper assemblies driven by a coiled tubing injector, each gripper assembly comprising:

a carrier driven by the coiled tubing injector, the carrier having a first locking part;

a gripper block having a second locking part; and

a locking shaft for releasable connection of the second locking part of the gripper block to the first locking part of the carrier, the locking shaft operable between a release position and a locking position,

wherein, upon actuation of the locking shaft to the locking position the locking shaft engages both the first locking part and the second locking part for connecting the gripper block and carrier and upon actuation of the locking shaft to the release position, the gripper block is released from carrier.

2. The gripper assembly of claim **1**, wherein the carrier has a front mounting surface and the gripping block has a back surface,

the first locking part comprising locking slot in the front mounting surface and the carrier further supports the locking shaft aligned with the locking slot; and

the second locking part comprising a locking tab projecting rearwardly from the back surface,

wherein actuation of the locking shaft further comprises insertion of the locking tab into the locking slot and whereby the locking shaft engages the locking tab, retaining the locking tab to the carrier.

3. The gripper assembly of claim **2**, wherein the locking tab is inserted into the locking slot when the back surface of the gripping block seats against the front mounting surface of the carrier.

4. The gripper assembly of claim **2**, wherein the locking shaft extends parallel to and adjacent the locking slot and the

locking tab has a locking profile formed therealong, in the locking position with the locking tab inserted into the locking slot, the locking shaft engages the locking profile for interfering with removal of the locking tab from the locking slot.

5. The gripper assembly of claim **2**, wherein the injector and gripping block have a coiled tubing inline axis, the locking slot and locking tab extending generally transverse to the inline axis.

6. The gripper assembly of claim **5**, wherein the locking tab and locking slot transfer inline forces therebetween.

7. The gripper assembly of claim **6**, further comprising:

a positioning slot in the front mounting surface; and

a positioning tab projecting rearwardly from the back surface, the positioning slot and tab spaced from the locking slot and tab,

wherein the positioning tab is inserted into the positioning slot for transfer of inline forces therebetween.

8. The gripper assembly of claim **2**, wherein

the locking shaft engages a locking profile of the locking tab;

the locking profile forms locking lip in along the locking tab; and

the locking shaft is positioned between the locking lip and the carrier's front mounting surface for retaining the gripper block to the carrier.

9. The gripper assembly of claim **8**, wherein the locking tab is an elongated body having a concave locking surface in the locking profile corresponding to a cylindrical locking shaft.

10. The gripper assembly of claim **8**, wherein

the locking shaft is cylindrical, having a diameter and a chorded portion and a non-chorded locking portion formed therealong, a length of the chorded portion being at least as long as the locking tab;

the locking shaft resides within the locking profile and is rotatable between the locking and release position wherein upon rotating actuation of the locking shaft

to the locking position the non-chorded locking portion is engaged with the locking tab; and

to the release position, the chorded portion is aligned with the locking tab for passing the locking lip thereby for releasing the locking tab from the carrier.

11. The gripper assembly of claim **10** wherein the chorded portion is located intermediate along the locking shaft.

12. The gripper assembly of claim **8**, further comprising a transverse shaft bore through the carrier for rotatably supporting the locking shaft therein and for positioning a locking shaft axis parallel thereto wherein the locking shaft partially overlaps the locking profile.

13. The gripper assembly of claim **1**, wherein the locking shaft is rotationally biased to the locking position.

14. The gripper assembly of claim **13**, further comprising a rotational actuating handle extending laterally from the locking shaft.

15. The gripper assembly of claim **14**, further comprising a handle groove in the front mounting surface of the carrier, the handle groove being in communication with the shaft for connection of the handle to the shaft therethrough.

16. The gripper assembly of claim **14** wherein the locking shaft is actuated from the locking to the release position by rotation along an angle between about 45 to about 90 degrees.

17. The gripper assembly of claim **9** wherein:

the locking shaft is supported in a locking hole extending through the carrier, further comprising:

the locking shaft has a control end and retaining end,

the shaft's retaining end having an upset and a flat chorded edge formed thereon;

the locking hole has a counterbore for receiving the retaining end, the counterbore having a flat edge encroaching on the counterbore and corresponding to the flat chorded edge of the retaining end;

when retaining end's flat chorded edge is angularly aligned with the counterbore's flat edge, the locking shaft can shift axially to the locking position, engaging the flat chorded edge with the flat edge.

18. The gripper assembly of claim **17** wherein

the control end of the locking shaft is biased to retain the retaining end axially in the carrier with the retaining end's flat chorded portion engaged with the counterbore's flat edge in the locking position.

19. The gripper assembly of claim **18** wherein

the locking shaft is actuable to the released position by overcoming the biasing to temporarily disengage the retainer end flat edge from the counterbore's flat edge so as to enable rotation of the locking shaft.

20. The gripper assembly of claim **1**, wherein each carrier is supported upon an endless chain of the coiled tubing injector.

21. A coiled tubing injector comprises:

a pair of opposing endless chains;

a plurality of gripper assemblies driven by the pair of endless chain for running coiled tubing in or out of a well; wherein

each gripper assembly comprises:

a carrier having a first locking part;

a gripper block having a second locking part; and

a locking shaft for releasable connection of the second locking part of the gripper block to the first locking part of the carrier, the locking shaft operable between a release position and a locking position,

wherein, upon actuation of the locking shaft to the locking position the locking shaft engages both the first locking part and the second locking part for connecting the gripper block and carrier and upon actuation of the locking shaft to the release position, the gripper block is released from carrier.

22. A method for releaseably locking a gripper block to a carrier of a gripper assembly driven by a coiled tubing injector comprising:

coupling a first locking part of one of the carrier and block and a second locking part of the other of the block and carrier;

locating a locking shaft between the first and second locking parts; and

actuating the locking shaft between a locking position and a release position, by

rotating the locking shaft to the locking position to engage both of the first and second locking parts for connecting the gripper block and the carrier;

rotating the locking shaft to the release position to disengage the first locking part from the second locking parts for releasing the gripper block from the carrier.

23. The method of claim **22** wherein:

the coupling of the first locking part and the second locking part of the other further comprises inserting a locking tab into a locking slot;

the locating of the locking shaft further comprises locating the locking shaft between the locking tab and locking slot; and

the actuating the locking shaft further comprises rotating the locking shaft to engage a non-chorded portion of the locking shaft with the locking tab in the locking position and rotating the locking shaft to align a chorded portion of the shaft with the with the locking tab in the release position.

24. The method of claim **22** wherein

the rotating of the locking shaft to the release position further comprises overcoming a biasing of the locking shaft to the locking position.

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