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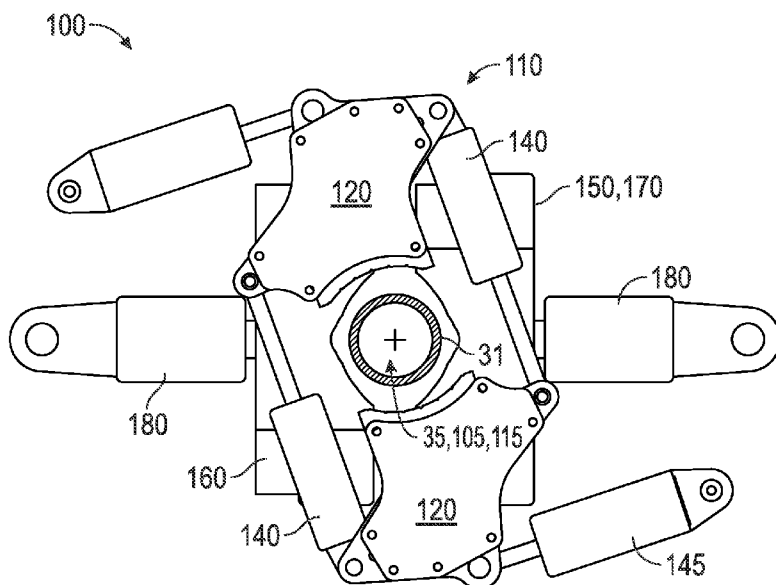
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THREADED CONNECTIONS

FIG. 7A

(57) Abstract: A clamping system (100) for making and breaking threaded connections between a first component and a second component includes a first clamp assembly (110) and a second clamp assembly (150). The first clamp assembly includes a first clamp member (120) and a second clamp member (120) disposed about an opening (111) in the first clamp assembly. The second clamp assembly includes a third clamp member (160) and a fourth clamp member (170) disposed about an opening (151) in the second clamp assembly. The opening (151) in the second clamp assembly is coaxially aligned with the opening (111) in the first clamp assembly. The first clamp member (120) and the second clamp member (120) are configured to engage the first component. The third clamp member (160) and the fourth clamp member (170) are configured to engage the second component. The first clamp member (120) and the second clamp member (120) are configured to rotate the first component relative to the second component.

CONCENTRIC LOW PROFILE CLAMPING SYSTEMS AND METHODS FOR MAKING AND BREAKING THREADED CONNECTIONS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims benefit of U.S. provisional patent application Serial No. 61/783,859, filed March 14, 2013, and entitled “Concentric Low Profile Clamping Systems and Methods for Making and Breaking Threaded Connections,” which is hereby incorporated by reference in its entirety.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

BACKGROUND

[0003] Embodiments described herein relate generally to systems and methods for gripping and manipulating threaded connections. More particularly, embodiments described herein relate to systems and methods for making and breaking threaded connections between downhole components such as pipe joints, sucker rods, completion and production tubulars, and completion and production assemblies, etc.

[0004] In drilling a borehole (or wellbore) into the earth for the recovery of hydrocarbons from a subsurface formation, it is conventional practice to connect a drill bit to the lower end of a drill string, then rotate the drill string with weight-on-bit (WOB) applied to the drill bit to enable the bit to progress downward into the earth to create the desired borehole. A kelly connected to the upper end of the drill string is suspended from a swivel supported by a derrick. The drill string is rotated with a rotary table in the drill floor that engages the kelly.

[0005] A typical drill string is made up from an assembly of drill pipe joints connected end-to-end and a bottom hole assembly (BHA) disposed between the lowermost pipe joint and the drill bit. The BHA includes sub-components such as drill collars, stabilizers, reamers and/or other drilling tools and accessories, selected to suit the particular requirements of the well being drilled. The individual pipe joints in the drill string are connected together with threaded connections. In particular, the lower end of each pipe joint comprises an externally threaded pin that is threaded into an internally threaded box at the upper end of the adjacent pipe joint.

[0006] During drilling operations, additional pipe joints are periodically added to the upper end of the drill string to lengthen the drill string and enable the drill bit to continue its advance through the formation. To add a new pipe joint to the drill string, the drill string is temporarily supported by slips placed in the drill floor and the kelly is removed from the drill string and connected to a new pipe joint, which is swung over and threaded into the upper end of the drill string. The new pipe joint is threaded into the upper end of the drill string and pre-loaded with a certain amount of torque in order to maintain a satisfactory connection during use. This is usually accomplished with power tongs and a spinning wrench suspended above the drilling floor, which operate by gripping above and below the connection between the drill string and the new pipe joint and applying torque to make up the threaded connection. This process is generally performed in reverse when tripping the drill string.

[0007] Conventional power tongs and spinning wrenches are usually large bulky pieces of equipment that take up space around the drill floor, and thus, are not particularly suited for use in confined drilling operations where space is at a premium. In addition, some conventional power tongs and spinning wrenches are operated with rig personnel on the drill floor, and hence, in some circumstances could raise safety concerns.

BRIEF SUMMARY OF THE DISCLOSURE

[0008] These and other needs in the art are addressed in one embodiment by a clamping system for making and breaking threaded connections between a first component and a second component. In an embodiment, the clamping system comprises a first clamp assembly including a first clamp member and a second clamp member disposed about an opening in the first clamp assembly. The opening in the first clamp assembly has a vertical central axis. In addition, the clamping system comprises a second clamp assembly disposed below the first clamp assembly and including a third clamp member and a fourth clamp member disposed about an opening in the second clamp assembly. The opening in the second clamp assembly is coaxially aligned with the opening in the first clamp assembly. The first clamp member and the second clamp member are configured to move radially inward and outward between an advanced position engaging the first component and a withdrawn position radially spaced apart from the first component. The third clamp member and the fourth clamp member are configured to move radially inward and outward between an advanced position engaging the second component and a withdrawn

position radially spaced apart from the second component. The third clamp member and the fourth clamp member are configured to prevent the rotation of the second component in the advanced position. The first clamp member and the second clamp member are configured to rotate the first component relative to the second component in the advanced position.

[0009] These and other needs in the art are addressed in another embodiment by a clamping system for making and breaking threaded connections between a first component and a second component. In an embodiment, the clamping system comprises an upper clamp assembly having an opening for receiving the first component. The opening of the upper clamp assembly has a central axis. The upper clamp assembly comprises a first clamp member disposed about the opening, a second clamp member disposed about the opening and circumferentially spaced from the first clamp member, a first linear actuator coupled to the first clamp member and the second clamp member, a second linear actuator coupled to the first clamp member and the second clamp member, a third linear actuator coupled to the first clamp member, and a fourth linear actuator coupled to the second clamp member. The first linear actuator and the second linear actuator are configured to move the first clamp member and the second clamp member radially inward and radially outward. The third linear actuator and the fourth linear actuator are configured to pivot the first clamp member and the second clamp member together about the central axis. In addition, the clamping system comprises a lower clamp assembly disposed below the upper clamp assembly and having an opening for receiving the second component aligned with the opening of the upper clamp assembly. The opening of the lower clamp assembly has a central axis. The lower clamp assembly comprises a first clamp member disposed about the opening of the lower clamp assembly, a second clamp member disposed about the opening of the lower clamp assembly and circumferentially spaced from the first clamp member of the lower clamp assembly, a first linear actuator coupled to the first clamp member of the lower clamp assembly, and a second linear actuator coupled to the second clamp member of the lower clamp assembly. The first linear actuator of the lower clamp assembly is configured to move the first clamp member of the lower clamp assembly radially inward and radially outward. The second linear actuator of the lower clamp assembly is configured to move the second clamp member of the lower clamp assembly radially inward and radially outward.

[0010] These and other needs in the art are addressed in another embodiment by a method for making or breaking a threaded connection between a first component and a second component.

In an embodiment, the method comprises (a) positioning an end of the first component within an opening in a first clamp assembly. In addition, the method comprises (b) positioning an end of the second component within an opening in a second clamp assembly disposed immediately below the first clamp assembly. Further, the method comprises (c) gripping the first component with a first clamp member and a second clamp member of the first clamp assembly. Still further, the method comprises (d) gripping the second component with a first clamp member and a second clamp member of the second clamp assembly. Moreover, the method comprises (e) simultaneously rotating the first clamp member and the second clamp member about a central axis of the first component to rotate the first component relative to the second component after (c) and (d).

[0011] Embodiments described herein comprise a combination of features and advantages intended to address various shortcomings associated with certain prior devices, systems, and methods. The foregoing has outlined rather broadly the features and technical advantages of the invention in order that the detailed description of the invention that follows may be better understood. The various characteristics described above, as well as other features, will be readily apparent to those skilled in the art upon reading the following detailed description, and by referring to the accompanying drawings. It should be appreciated by those skilled in the art that the conception and the specific embodiments disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] For a detailed description of the disclosed embodiments of the disclosure, reference will now be made to the accompanying drawings in which:

[0013] Figure 1 is a schematic view of a drilling system in accordance with principles described herein;

[0014] Figure 2 is a top view of the clamping system of Figure 1;

[0015] Figure 3 is a side view of the clamping system of Figure 1;

[0016] Figure 4 is a perspective view of the lower clamp assembly of Figure 2;

[0017] Figure 5 is a perspective view of the upper clamp assembly of Figure 2;

[0001] Figure 6 is a side view of the clamping system of Figure 1 and two pipe joints to be threaded together with the clamping system;

[0002] Figures 7A–7D are sequential top views of the clamping system of Figure 6 making up a threaded connection between the two pipe joints of Figure 6;

[0003] Figure 8 is a side view of the clamping system of Figure 1 and a threaded joint to be broken with the clamping system; and

[0004] Figures 9A–9D are sequential top views of the clamping system of Figure 8 breaking the threaded connection of Figure 8.

DETAILED DESCRIPTION OF THE DISCLOSED EMBODIMENTS

[0018] The following description is exemplary of embodiments of the disclosure. These embodiments are not to be interpreted or otherwise used as limiting the scope of the disclosure, including the claims. One skilled in the art will understand that the following description has broad application, and the discussion of any embodiment is meant only to be exemplary of that embodiment, and is not intended to suggest in any way that the scope of the disclosure, including the claims, is limited to that embodiment.

[0019] The drawing figures are not necessarily to scale. Certain features and components disclosed herein may be shown exaggerated in scale or in somewhat schematic form, and some details of conventional elements may not be shown in the interest of clarity and conciseness. In some of the figures, in order to improve clarity and conciseness, one or more components or aspects of a component may be omitted or may not have reference numerals identifying the features or components that are identified elsewhere. In addition, like or identical reference numerals may be used to identify common or similar elements.

[0020] The terms “including” and “comprising” are used herein, including in the claims, in an open-ended fashion, and thus should be interpreted to mean “including, but not limited to” Also, the term “couple” or “couples” is intended to mean either an indirect or direct connection. Thus, if a first component couples or is coupled to a second component, the connection between the components may be through a direct engagement of the two components, or through an indirect connection that is accomplished via other intermediate components, devices and/or connections. In addition, as used herein, the terms “axial” and “axially” generally mean along or parallel to a given axis (e.g., central axis of a body or a port), while the terms “radial” and

“radially” generally mean perpendicular to the axis. For instance, an axial distance refers to a distance measured along or parallel to the axis, and a radial distance means a distance measured perpendicular to the axis. Any reference to up or down in the description and the claims will be made for purpose of clarification, with “up,” “upper,” “upwardly,” or “upstream” meaning toward the surface of the borehole and with “down,” “lower,” “downwardly,” or “downstream” meaning toward the terminal end of the borehole, regardless of the bore orientation. In some applications of the technology, the orientations of the components with respect to the surroundings may be different.

[0021] Referring now to Figure 1, an embodiment of a drilling system 10 for drilling a borehole 11 in an earthen formation 12 is shown. Drilling system 10 includes a derrick 20 supported by a drilling deck or floor 21. Derrick 20 includes a traveling block 22 for raising and lowering a top drive 23 configured to releasably connect to and support a drill string 30. Top drive 23 is supported by derrick 20 and employed to rotate drill string 30 when coupled thereto.

[0022] Drill string 30 has a central or longitudinal axis 35, a first or uphole end 30a (not visible in Figure 1), and a second or downhole end 30b. In addition, drill string 30 includes a plurality of components coupled together end-to-end. In particular, drill string 30 includes a plurality of tubulars or pipe joints 31 coupled together end-to-end, a bottom hole assembly (BHA) 32 coupled to the lower end of joints 31, and a drill bit 33 disposed at downhole end 30b and coupled to BHA 32. In this embodiment, each pipe joint 31 has a first or upper end 31a comprising an internally threaded box and a second or lower end 31b comprising an externally threaded pin. Joints 31 are connected end-to-end by threading pins into the mating boxes to form threaded connections or joints 34.

[0023] During drilling operations, drill bit 33 is rotated with top drive 23 and weight-on-bit (WOB) is applied to drill borehole 11 along a predetermined path through formation 12. Although the drill string 30 and the drill bit 33 are rotated from the surface with top drive 23 in this embodiment, in other embodiments, the drill string (e.g., drill string 30) and the drill bit (e.g., bit 33) may alternatively be rotated from the surface by a rotary table and/or the drill bit may be rotated with a downhole mud motor disposed in the drill string. During drilling operations a mud system 40 circulates pressurized drilling fluid or mud 41 down the drill string 30, through nozzles in the face of bit 33, and back up the annulus 42 between the drill string 30 and sidewall of borehole 11.

[0024] As drill bit 33 and drill string 30 penetrate deeper into formation 12, additional pipe joints 31 are periodically added to uphole end 30a of drill string 30. Similarly, when the drill string 30 is removed or tripped from borehole 11, pipe joints 31 are removed from uphole end 30a of drill string 30 and stored. In general, pipe joints 31 can be added to drill string 30 one or more than one at a time, and pipe joints 31 can be removed from drill string 30 one or more than one at a time. In this embodiment, three pipe joints 31 are added to and removed from drill string 30 at a time in the form of a pipe stand 36.

[0025] Referring still to Figure 1, a drill string support system 50 is positioned in drill floor 21 to support the weight of drill string 30 while adding or removing pipe joints 31 (i.e., when drill string 30 is not supported top drive 23). In this embodiment, string support system 50 comprises slips removably disposed in hole in drill floor 21 through which string 30 extends. A clamping system 100 is also disposed on the drill floor 21 immediately above string support systems 50. As will be described in more detail below, clamping system 100 is employed to make threaded connections between drill string 30 and pipe joint(s) 31 being added to thereto, and to break threaded connections between drill string 30 and pipe joint(s) 31 being removed therefrom.

[0026] Referring now to Figures 2 and 3, clamping system 100 is coupled to drill floor 21 and has a vertical central axis 105 coaxially aligned with axis 35 of drill string 30 and the hole in drill floor 21 through which string 30 extends. In this embodiment, clamping system 100 includes a first or upper clamp assembly 110 and a second or lower clamp assembly 150 positioned immediately below upper clamp assembly 110. As will be described in more detail below, during threaded joint makeup operations, lower clamp assembly 150 grips uphole end 30a of drill string 30 while a new pipe joint 31 (or pipe stand 36) is threadably coupled to uphole end 30a to increase the length of drill string 30. To sufficiently tighten and pre-load the threaded connection 34 therebetween, lower clamp assembly 150 continues to grip uphole end 30a and prevent its rotation while upper clamp assembly 150 moves into engagement with lower end of the new pipe joint 31 (or pipe stand 36), grips and applies rotational torque to the new pipe joint 31 (or pipe stand 36). During threaded joint breaking operations, lower clamp assembly 150 grips drill string 30 immediately below the threaded connection 34 to be broken and prevents rotation of drill string 30 below that connection 34 while upper clamp assembly 150 moves into engagement with drill string 30 immediately above the connection 34, grips and applies rotational torque to break the connection 34 between assemblies 110, 150.

[0027] Referring now to Figures 2–4, upper clamp assembly 110 has a vertical central axis 115 and includes a pair of radially opposed clamps or gripping members 120 disposed about axis 115, a first pair of linear actuators 140 extending between members 120, and a second pair of linear actuators 145 pivotally coupled to members 120. Upper clamp assembly 110 is concentrically disposed about axis 105 with axes 115, 105 coaxially aligned. In this embodiment, members 120 are angularly spaced 180° apart about axis 115. In addition, members 120 are radially spaced apart on opposite sides of axis 115, thereby defining a passage or opening 111 therebetween. As will be described in more detail below, linear actuators 140 move members 120 radially inward and outward relative to axis 115 to decrease and increase the size of opening 111, and linear actuators 145 rotate or pivot members 120 about axes 105, 115.

[0028] Each member 120 has a horizontal central axis 125, a radially inner side 121 facing opening 111, a radially outer side 122 radially opposite side 121 and distal opening 111, and lateral sides 123, 124 extending between inner side 121 and outer side 122. Axes 125 are coaxially aligned, oriented perpendicular to axes 105, 115, and intersect axes 105, 115. In addition, each axis 125 extends between lateral sides 123, 124 and intersects sides 121, 122 of the corresponding member 120. Thus, lateral sides 123, 124 are disposed on opposite sides of axis 125. Inner side 121 of each member 120 includes a concave gripping surface 126 for releasably engaging and gripping joints 31 during makeup and breaking operations.

[0029] Referring still to Figures 2–4, each linear actuator 140 has a central or longitudinal axis 141, a first end 140a, and a second end 140b opposite end 140a. In addition, each linear actuator 140 is configured to axially extend and retract, thereby moving ends 140a, b axially towards and away from each other. Axes 141 are oriented parallel to axes 125, are radially spaced from axes 105, 115, 125, and lie in a common horizontal reference plane oriented perpendicular to axes 105, 115. Thus, actuators 140 are disposed on opposite sides of axis 115.

[0030] Each end 140a, 140b of each actuator 140 is pivotally coupled to one member 120. In this embodiment, each actuator 140 has ends 140a, 140b pivotally coupled to lateral side 123 of one member 120 and lateral side 124 of the other member 120, respectively. Each actuator 140 can pivot at its ends 140a, 140b relative to members 120 about vertical axes extending through ends 140a, 140b. However, actuators 140 cannot move translationally relative to members 120.

[0031] Actuators 140 are operated together to move members 120 radially inward and radially outward relative to axes 105, 115 and each other. In particular, axial contraction of actuators 140

moves members 120 radially inward toward axes 105, 115 and each other, and axial extension of actuators 140 moves members 120 radially outward away from axes 105, 115 and each other. In this manner, actuators 140 can move members 120, and more specifically, gripping surfaces 126 into and out of engagement with a tubular (e.g., pipe joint 31) extending vertically through opening 111. Accordingly, each clamp member 120 may be described as having a radially advanced position with the corresponding actuator 140 extended and the clamp member 120 engaging a tubular (e.g., joints 31) extending through opening 111, and a radially withdrawn position with the corresponding actuator 140 contracted and the clamp member 120 withdrawn and radially spaced from a tubular extending through opening 111. Moreover, upper clamp assembly 110 may be described as having a closed position with clamp members 120 in the radially advanced positions and an open position with clamp members 120 in the radially withdrawn positions.

[0032] Referring still to Figures 2–4, each linear actuator 145 has a central or longitudinal axis 146, a first end 145a, and a second end 145b opposite end 145a. In addition, each linear actuator 145 is configured to axially extend and retract, thereby moving ends 145a, 145b axially towards and away from each other. Axes 146 are oriented generally perpendicular to axes 125, are radially spaced from axis 115, and lie in the same horizontal reference plane as axes 125, 141. Thus, actuators 145 are disposed on opposite sides of axes 105, 115.

[0033] Each end 145a of each actuator 145 is pivotally coupled to drill deck 21 (see Figure 1) and each end 145b of each actuator 145 is pivotally coupled to one member 120. In this embodiment, end 145b of one actuator 145 is pivotally coupled to outer side 122 of one member 120 and end 145b of the other actuator 145 is pivotally coupled to other side 122 of the other member 120. Ends 145b are intersected by axes 125 of members 120. Each actuator 145 can pivot at its end 145a relative to drill deck 21 about a vertical axis extending through the end 145a, and each actuator 145 can pivot at its end 145b relative to the corresponding member 120 about a vertical axis extending through the end 145b. However, actuators 145 cannot move translationally relative to deck 21 or members 120.

[0034] Actuators 145 are operated together to pivot or rotate members 120 in a first or threading direction 116 about axes 105, 115 to makeup a connection 34, and pivot or rotate members 120 in a second or unthreading direction 117 about axes 105, 115 to break a connection 34. In this embodiment, actuators 145 extend in opposite directions from aligned axes 125—one actuator

145 (top actuator in Figure 2) extends to the left of axes 125 and the other actuator 145 (lower actuator in Figure 2) extends to the right of axes 125. Thus, axial extension of actuators 145 rotates members 120 about axes 105, 115 in first direction 116, and axial contraction of actuators 145 rotates members 120 about axes 105, 115 in second direction 117. In this manner, actuators 145 can rotate members 120 about axes 105, 115.

[0035] Referring now to Figures 2, 3, and 5, lower clamp assembly 150 has a vertical central axis 155 and includes a pair of radially opposed clamps or gripping members 160, 170 disposed about axis 155 and a pair of linear actuators 180, one actuator 180 is coupled to member 160 and the other actuator 180 is coupled to member 170. Lower clamp assembly 150 is concentrically disposed about axis 105 with axes 155, 105 coaxially aligned. In this embodiment, members 160, 170 are angularly spaced 180° apart about axis 155. In addition, members 160, 170 are radially spaced apart on opposite sides of axis 155, thereby defining a passage or opening 151 therebetween. Axis 155 of lower clamp assembly 150 is coaxially aligned with axes 105, 115, and thus, openings 111, 151 are aligned with each other, thereby defining a vertical passage extending completely through clamping system 100. Drill string 30 and pipe joints 31 can be vertically lowered and raised through aligned openings 111, 151. As will be described in more detail below, linear actuators 180 move members 160, 170 radially inward and outward relative to axis 155 to decrease and increase the size of opening 151.

[0036] Member 160 has a horizontal central axis 165, a radially inner side 161 facing opening 151, a radially outer side 162 radially opposite side 161 and distal opening 151, and lateral sides 163, 164 extending between inner side 161 and outer side 162. Axis 165 is oriented perpendicular to axes 105, 115 and intersects axes 105, 115. In addition, axis 165 bisects member 160—axis 165 extends between lateral sides 163, 164 and intersects sides 161, 162. Thus, lateral sides 163, 164 are disposed on opposite sides of axis 165. Inner side 161 of member 160 includes a plurality of vertically spaced parallel gripping surfaces 166 defining a concave recess 167 disposed about axis 165. During makeup and breaking operations, joints 31 are positioned within recess 167 and are engaged and gripped by surfaces 166. In this embodiment, inner side 161 also includes a pair of elongate slots 168 disposed on either side of recess 167.

[0037] Member 170 is substantially the same as member 160 previously described. Namely, member 170 has a horizontal central axis 175 coaxially aligned with axis 165 of member 160, a

radially inner side 171 facing opening 151 and radially opposed side 161, a radially outer side 172 radially opposite side 171 and distal opening 151, and lateral sides 173, 174 extending between inner side 171 and outer side 172. Axis 175 is oriented perpendicular to axes 105, 115 and intersects axes 105, 115. In addition, axis 175 bisects member 170—axis 175 extends between lateral sides 173, 174 and intersects sides 171, 172. Thus, lateral sides 173, 174 are disposed on opposite sides of axis 175. Inner side 171 of member 170 includes a plurality of vertically spaced parallel gripping surfaces 176 defining a concave recess 177 disposed about axis 115. During makeup and breaking operations, joints 31 are positioned within recess 177 and are engaged and gripped by surfaces 176. However, unlike member 160 previously described, inner side 171 of member 170 does not include slots disposed on either side of recess 177. Rather, in this embodiment, inner side 171 includes projections 178 disposed on either side of recess 177. Projections 178 are sized and configured to slidably engage mating slots 168 of member 160 when members 160, 170 are moved radially toward one another. Sliding engagement of mating slots 168 and projections 178 prevents members 160, 170 from moving vertically (i.e., axially relative to axis 115) relative to each other.

[0038] Referring still to Figures 2, 3, and 5, each linear actuator 180 has a central or longitudinal axis 181, a first end 180a, and a second end 180b opposite end 180a. In addition, each linear actuator 180 is configured to axially extend and retract, thereby moving ends 180a, 180b axially towards and away from each other. Axes 181 are coaxially aligned with axes 165, 175, and thus, perpendicularly intersect axes 115, 155.

[0039] End 180a of one actuator 180 is coupled to member 160, and end 180a of the other actuator 180 is coupled to member 170. Ends 180b are positioned distal the corresponding members 160, 170 and are pivotally coupled to drill deck 21 (see Figure 1). Thus, each end 180b can pivot at its end 180b relative to drill deck 21 about a vertical axis extending through end 180b, but cannot move translationally relative to deck 21.

[0040] Actuators 180 are operated together to move members 160, 170 radially inward and outward along axes 165, 175, 181. In particular, axial extension of actuators 180 move members 160, 170 toward axes 105, 165 and each other, and contraction of actuators 180 move members 160, 170 away from axes 105, 165 and each other. In this manner, actuators 180 can move members 160, 170, and more specifically, gripping surfaces 167, 177 into and out of engagement with a tubular (e.g., pipe joint 31) extending vertically through opening 151. Accordingly, each

clamp member 160, 170 may be described as having a radially advanced position with the corresponding actuator 180 extended and the clamp member 160, 170 engaging a tubular (e.g., joints 31) extending through opening 151, and a radially withdrawn position with the corresponding actuator 180 contracted and the clamp member 160, 170 withdrawn and radially spaced from a tubular extending through opening 151. Moreover, lower clamp assembly 150 may be described as having a closed position with clamp members 160, 170 in the radially advanced positions and an open position with clamp members 160, 170 in the radially withdrawn positions.

[0041] As previously described, each actuator 140, 145, 180 is a linear actuator configured to axially extend and contract. In general, actuators 140, 145, 180 can comprise any suitable linear actuator known in the art including, without limitation, hydraulic actuators, pneumatic actuators, electric actuators, or the like.

[0042] Figures 6 and 7A–7D illustrate the operation of clamping system 100 to makeup a threaded connection 34 between two pipe joints 31. In particular, a pipe stand 36 made of three pipe joints 31 is shown being threadably connected to uphole end 30a of drill string 30.

[0043] Referring first to Figures 6 and 7A, upper clamp assembly 110 and lower clamp assembly 150 are in their open positions with clamp members 120, 160, 170 radially withdrawn. In addition, actuators 145 of upper clamp assembly 110 are fully contracted such that members 120 are rotated in direction 117 to their greatest extent. Drill string 30 is suspended from top drive 23 through openings 111, 151 with axes 35, 115, 155 coaxially aligned (see Figure 1). Top drive 23 positions drill string 30 such that uphole end 30a is disposed between clamp members 160, 170 immediately below upper clamp assembly 110. Next, slips are positioned about string 30 in drill deck 21 below clamping system 100 and are used to support drill string 30 and maintain the vertical position of uphole end 30a as top drive 23 is disconnected from drill string 30. Top drive 23 is then coupled to pipe stand 36, which may be temporarily stored in a mousehole in drill deck 21. Pipe stand 36 is coaxially aligned with uphole end 30a and lowered with top drive 23 until the lower end of pipe stand 36 (i.e., the lower end 31b of the lowermost pipe joint 31 in pipe stand 36) is disposed in opening 111 immediately above uphole end 30a.

[0044] Moving now to Figures 7A and 7B, prior to, during or immediately after positioning the lower end of pipe stand 36 in opening 111 above drill string 30, lower clamp assembly 150 is transitioned from the open position to the closed position with uphole end 30a positioned

between radially opposed gripping surfaces 166, 176 by extending actuators 180 to bring clamp members 160, 170 into firm engagement with uphole end 30a, thereby preventing rotation of drill string 30 relative to clamp members 160, 170. Next, top drive 23 simultaneously rotates and lowers pipe stand 36 to thread the pin at the lower end of pipe stand 36 into the box at uphole end 30a to form a threaded connection 34 therebetween. With pipe stand 36 threaded into drill string 30 and lower clamp assembly 150 in the closed position, upper clamp assembly 110 is employed to sufficiently torque and preload connection 34. In particular, as shown in Figure 7B, upper clamp assembly 110 is transitioned to the closed position with the lower end of pipe stand 36 positioned between radially opposed gripping surfaces 126 by simultaneously contracting actuators 140 to bring clamp members 120 into firm engagement with the lower end of pipe stand 36, thereby preventing rotation of pipe stand 36 relative to clamp members 120.

[0045] Next, as shown in Figures 7B and 7C, with upper clamp assembly 110 in the closed position, members 120 are rotated about axis 115 in threading direction 116 to rotate and torque pipe stand 36 about axis 30 in threading direction 116 relative to uphole end 30a by simultaneously extending actuators 145. With threaded connection 34 sufficiently torqued and preloaded, upper clamp assembly 110 is transitioned to the open position by simultaneously extending actuators 140 to bring clamp members 120 out of engagement with the lower end of pipe stand 36 as shown in Figure 7D. With threaded connection 34 made up and sufficiently torqued, lower clamp assembly 150 is transitioned to the open position by simultaneously contracting actuators 180 to bring clamp members 160, 170 out of engagement with drill string 30. With the load of the lengthened drill string 30 supported by top drive 23, the slips in the drill deck 21 are removed and drilling operations can continue with drill string 30 extending through clamping system 100 with both clamp assemblies 110, 150 in the open positions.

[0046] In the manner described, clamping system 100 is employed to makeup a threaded connection 34. To break a threaded connection 34, the makeup operation previously described is performed in reverse. Figures 8 and 9A-9D illustrate the operation of clamping system 100 to break a threaded connection 34 between two pipe joints 31. For purposes of clarity and further explanation, the upper pipe joint 31 forming threaded connection 34 to be broken is designated with reference numeral 31' and the lower pipe joint 31 forming threaded connection 34 is designated with reference numeral 31'' in Figures 8 and 9A-9D. In this embodiment, pipe joint 31' is the lowermost pipe joint 31 of a pipe stand 36 made of three pipe joints 31.

[0047] Referring first to Figures 8 and 9A, upper clamp assembly 110 and lower clamp assembly 150 are in their open positions with clamp members 120, 160, 170 radially withdrawn. In addition, actuators 145 of upper clamp assembly 110 are fully extended such that members 120 are rotated about axis 115 in direction 116 to their greatest extent. Drill string 30 is suspended from top drive 23 through openings 111, 151 with axes 35, 115, 155 coaxially aligned. Top drive 23 positions drill string 30 such that connection 34 to be broken is disposed between clamp assemblies 110, 150. In particular, drill string 30 is positioned with upper end 31a of pipe joint 31'' in opening 151 and lower end 31b of pipe joint 31' in opening 111. Next, slips are positioned about string 30 in drill deck 21 below clamping system 100 and are used to support the portion of drill string 30 extending downhole as connection 34 is broken; the upper portion of drill string 30 above connection 34 and clamping system 100 is supported by top drive 23 as connection 34 is broken.

[0048] Moving now to Figures 9A and 9B, prior to, during or immediately after positioning connection 34 between assemblies 110, 150, lower clamp assembly 150 is transitioned from the open position to the closed position with upper end 31a of joint 31'' positioned between radially opposed gripping surfaces 166, 176 by extending actuators 180 to bring clamp members 160, 170 into firm gripping engagement with joint 31'', thereby preventing rotation of joint 31'' (and the portion of drill string 30 extending downhole therefrom) relative to clamp members 160, 170. Next, upper clamp assembly 110 is employed to break connection 34. In particular, as shown in Figure 9B, upper clamp assembly 110 is transitioned to the closed position with lower end 31b of joint 31' positioned between radially opposed gripping surfaces 126 by simultaneously contracting actuators 140 to bring clamp members 120 into firm gripping engagement with joint 31', thereby preventing rotation of joint 31' relative to clamp members 120.

[0049] As shown in Figures 9B and 9C, with upper clamp assembly 110 in the closed position, members 120 are rotated about axis 115 in unthreading direction 117 to rotate pipe joint 31' about axis 115 in direction 117 relative to pipe joint 31'' by simultaneously contracting actuators 145, thereby breaking threaded connection 34 between joints 31', 31''. With threaded connection 34 broken, upper clamp assembly 110 is transitioned to the open position as shown in Figure 9D by simultaneously extending actuators 140 to bring clamp members 120 out of engagement with pipe joint 31'. Next, top drive 23 simultaneously rotates and lifts pipe joint 31' to fully unthread the pin at lower end 31b of joint 31' from the box at upper end 31a of pipe joint

31''. Lower clamp assembly 150 is transitioned to the open position immediately after breaking connection 34, or after fully unthreading joints 31', 31'' with top drive 23.

[0050] Following disconnection of joints 31', 31'', upper joint 31' is suspended from top drive 23 and joint 31'' is suspended from the slips. Upper joint 31' is then moved to a storage location (e.g., pipe rack or mousehole) and disconnected from top drive 23, which is then connected to pipe joint 31'' and drill string 30 extending downhole therefrom. With the load of joint 31'' and drill string 30 supported by top drive 23, the slips in the drill deck 21 are removed and drill string 30 can be raised with top drive 23 to remove another pipe joint 31 (or stand 36).

[0051] In the manner described, clamping system 100 is employed to make and break threaded joints 34 between tubulars in a drill string (e.g., pipe joints 31 in drill string 30). As clamping system 100 is driven via actuators 140, 145, 180, it can be operated remotely, thereby reducing and/or eliminating intervention by rig personnel on the drill deck 21. Further, the design of clamping system 100 is relatively low profile, as the overall height of system 100 is generally defined by the heights of clamp members 120, 160, 170. For example, clamping system 100 has an axial height less than 20.0 in. (~50.8 cm), and more specifically an axial height between 12.0 in. (~30.48 cm) and 16.0 in. (~40.64 cm). Thus, the sum of the axial heights of upper clamp assembly 110 and lower clamp assembly 150 is less than 20.0 in. (~50.8 cm), and more specifically an axial height between 12.0 in. (~30.48 cm) and 16.0 in. (~40.64 cm). The relatively compact design and low profile of clamping system 100 may be particularly advantageous at locations where space is at a premium such as in drilling operations performed from an underground tunnel. Although clamping system 100 is described as being disposed on and coupled to drill deck 21, it should be appreciated that clamping system 100 could also be hidden within deck 21.

[0052] Although clamping system 100 has been shown and described in connection with making and breaking threaded connections between tubulars used in drilling operations (e.g., pipe joints 31 and pipe stands 36) in a drill string (e.g., drillstring 30), it should be appreciated that embodiments of clamping systems described herein (e.g., clamping system 100) can more generally be used to make and break threaded connections between any two downhole components including, without limitation, sucker rods, completion tubulars, production tubulars, completion assemblies and production assemblies. Such tubulars, rods, pipes, assemblies and the

like that are coupled together end-to-end with threaded connections or joints are more generically be referred to herein as “components.”

[0053] While preferred embodiments have been shown and described, modifications thereof can be made by one skilled in the art without departing from the scope or teachings herein. The embodiments described herein are exemplary only and are not limiting. Many variations and modifications of the systems, apparatus, and processes described herein are possible and are within the scope of the invention. For example, the relative dimensions of various parts, the materials from which the various parts are made, and other parameters can be varied. Accordingly, the scope of protection is not limited to the embodiments described herein, but is only limited by the claims that follow, the scope of which shall include all equivalents of the subject matter of the claims. Unless expressly stated otherwise, the steps in a method claim may be performed in any order. The recitation of identifiers such as (a), (b), (c) or (1), (2), (3) before steps in a method claim are not intended to and do not specify a particular order to the steps, but rather are used to simplify subsequent reference to such steps.

CLAIMS

What is claimed is:

1. A clamping system for making and breaking threaded connections between a first component and a second component, the system comprising:

a first clamp assembly including a first clamp member and a second clamp member disposed about an opening in the first clamp assembly, the opening in the first clamp assembly having a central axis; and

a second clamp assembly axially adjacent the first clamp assembly and including a third clamp member and a fourth clamp member disposed about an opening in the second clamp assembly, the opening in the second clamp assembly being coaxially aligned with the opening in the first clamp assembly;

wherein the first clamp member and the second clamp member are configured to move radially inward and outward relative to the central axis of the opening in the first clamp assembly between an advanced position engaging the first component and a withdrawn position radially spaced apart from the first component;

wherein the third clamp member and the fourth clamp member are configured to move radially inward and outward relative to the central axis of the opening in the second clamp assembly between an advanced position engaging the second component and a withdrawn position radially spaced apart from the second component;

wherein the third clamp member and the fourth clamp member are configured to prevent the rotation of the second component when in the advanced position;

wherein the first clamp member and the second clamp member are configured to rotate the first component relative to the second component when in the advanced position.

2. The clamping system of claim 1, wherein the first clamp member and the second clamp member are configured to rotate the first component relative to the second component in a first direction about the central axis of the opening in the first clamp assembly to make a threaded connection between the first component and the second component, and configured to rotate the first component relative to the second component in a second direction about the central axis of

the opening in the first clamp assembly opposite the first direction to break a threaded connection between the first component and the second component.

3. The clamping system of claim 2, wherein the third clamp member has a radially inner side including a concave recess for receiving the second component and a pair of slots disposed on opposite sides of the concave recess;

wherein the fourth clamp member has a radially inner side opposed the radially inner side of the third clamp member, wherein the radially inner side of the fourth clamp member includes a concave recess for receiving the second component and a pair of projections disposed on opposite sides of the concave recess;

wherein the projections are configured to slidingly engage the slots when the third clamp member and the fourth clamp member are in the advanced positions.

4. The clamping system of claim 2, wherein the first clamp assembly further comprises:

a first linear actuator coupled to the first clamp member and the second clamp member;

a second linear actuator coupled to the first clamp member and the second clamp member;

wherein the central axis is disposed between the first linear actuator and the second linear actuator;

wherein the first linear actuator and the second linear actuator are configured to transition the first clamp member and the second clamp member between the advanced and the withdrawn positions.

5. The clamping system of claim 4, wherein the first clamp assembly further comprises:

a third linear actuator coupled to the first clamp member; and

a fourth linear actuator coupled to the second clamp member;

wherein the central axis is disposed between the third linear actuator and the fourth linear actuator;

wherein the third linear actuator and the fourth linear actuator are configured to rotate the first clamp member and the second clamp member in a first direction about the central axis to make the threaded connection and rotate the first clamp member and the second clamp member

in a second direction about the central axis that is opposite the first direction to break the threaded connection.

6. The clamping system of claim 5, wherein each linear actuator has a central axis, a first end, a second end, and is configured to move the first end relative to the second end.

7. The clamping system of claim 6, wherein the central axis of the first linear actuator, the second linear actuator, the third linear actuator and the fourth linear actuator lie in a common horizontal plane oriented perpendicular to the central axis of the opening in the first clamp assembly.

8. The clamping system of claim 5, wherein the second clamp assembly further comprises:
a fifth linear actuator coupled to the third clamp member; and
a sixth linear actuator coupled to the fourth clamp member;
wherein the fifth linear actuator and the sixth linear actuator are configured to transition the third clamp member and the fourth clamp member between the advanced and the withdrawn positions.

9. The clamping system of claim 8, wherein each linear actuator has a central axis, a first end, a second end, and is configured to move the first end relative to the second end;
wherein the central axis of the fifth linear actuator and the central axis of the sixth linear actuator are coaxially aligned and intersect the central axis of the opening in the second clamp assembly.

10. A clamping system for making and breaking threaded connections between a first component and a second component, the system comprising:
an upper clamp assembly having an opening for receiving the first component, the opening of the upper clamp assembly having a central axis;
wherein the upper clamp assembly comprises:
a first clamp member disposed about the opening;

a second clamp member disposed about the opening and circumferentially spaced from the first clamp member;

a first linear actuator coupled to the first clamp member and the second clamp member;

a second linear actuator coupled to the first clamp member and the second clamp member, wherein the first linear actuator and the second linear actuator are configured to move the first clamp member and the second clamp member radially inward and radially outward relative to the central axis of the opening of the upper clamp assembly;

a third linear actuator coupled to the first clamp member; and

a fourth linear actuator coupled to the second clamp member, wherein the third linear actuator and the fourth linear actuator are configured to pivot the first clamp member and the second clamp member together about the central axis of the opening of the upper clamp assembly;

a lower clamp assembly disposed below the upper clamp assembly and having an opening for receiving the second component aligned with the opening of the upper clamp assembly, the opening of the lower clamp assembly having a central axis;

wherein the lower clamp assembly comprises:

a first clamp member disposed about the opening of the lower clamp assembly;

a second clamp member disposed about the opening of the lower clamp assembly and circumferentially spaced from the first clamp member of the lower clamp assembly;

a first linear actuator coupled to the first clamp member of the lower clamp assembly, wherein the first linear actuator of the lower clamp assembly is configured to move the first clamp member of the lower clamp assembly radially inward and radially outward relative to the central axis of the opening of the lower clamp assembly; and

a second linear actuator coupled to the second clamp member of the lower clamp assembly, wherein the second linear actuator of the lower clamp assembly is configured to move the second clamp member of the lower clamp assembly radially inward and radially outward relative to the central axis of the opening of the lower clamp assembly.

11. The clamping system of claim 10, wherein each linear actuator has a central axis, a first end, and a second end, wherein each linear actuator is configured to move the first and second ends relative to each other.

12. The clamping system of claim 10, wherein the central axis of each linear actuator of the upper clamp assembly lies in a first plane oriented perpendicular to the central axis of the upper clamp assembly; and

wherein the central axis of each linear actuator of the lower clamp assembly lies in a second plane oriented perpendicular to the central axis of the lower clamp assembly.

13. The clamping system of claim 10, wherein the first clamp member and the second clamp member of the upper clamp assembly are radially opposed one another;

wherein the first clamp member and the second clamp member of the lower clamp assembly are radially opposed one another.

14. The clamping system of claim 10, wherein the first linear actuator and the second linear actuator of the upper clamp assembly are disposed on opposite sides of the central axis of the upper clamp assembly.

15. A method for making or breaking a threaded connection between a first component and a second component, the method comprising:

(a) positioning an end of the first component within an opening in a first clamp assembly;

(b) positioning an end of the second component within an opening in a second clamp assembly disposed immediately adjacent the first clamp assembly;

(c) gripping the first component with a first clamp member and a second clamp member of the first clamp assembly;

(d) gripping the second component with a first clamp member and a second clamp member of the second clamp assembly; and

(e) simultaneously rotating the first clamp member and the second clamp member about a central axis of the first component to rotate the first component relative to the second component after (c) and (d).

16. The method of claim 15, wherein (c) comprises moving the first clamp member and the second clamp member of the first clamp assembly radially inward toward the central axis of the first component; and

wherein (d) comprises moving the first clamp member and the second clamp member of the second clamp assembly radially inward toward a central axis of the second component.

17. The method of claim 16, wherein (c) further comprises:

contracting a first linear actuator having a first end coupled to the first clamp member of the first clamp assembly and a second end coupled to the second clamp member of the first clamp assembly; and

contracting a second linear actuator having a first end coupled to the first clamp member of the first clamp assembly and a second end coupled to the second clamp member of the first clamp assembly.

18. The method of claim 17, wherein (e) comprises:

extending or contracting a third linear actuator having an end coupled to the first clamp member of the first clamp assembly; and

extending or contracting a fourth linear actuator having an end coupled to the second clamp member of the first clamp assembly.

19. The method of claim 18, wherein (d) comprises:

extending a fifth linear actuator having an end coupled to the first clamp member of the second clamp assembly; and

extending a sixth linear actuator having an end coupled to the second clamp member of the second clamp assembly.

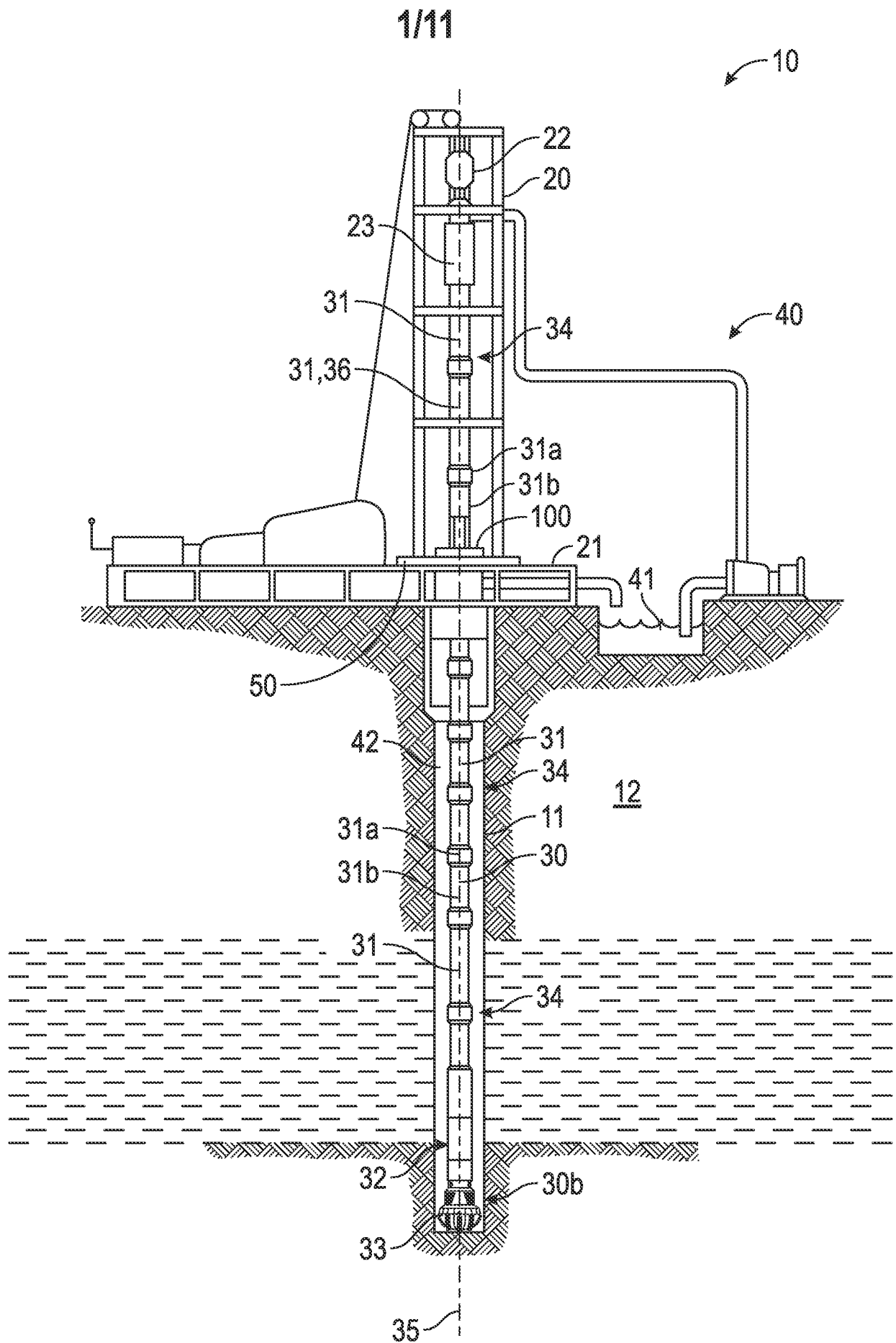
20. The method of claim 15, wherein (d) occurs before (c).

21. The method of claim 20, further comprising rotating the first component relative to the second component after (d) and before (c).

22. The method of claim 20, further comprising:

(f) disengaging the first component with the first clamp member and the second clamp member of the first clamp assembly; and

(g) rotating the first component relative to the second component after (c), (d) and (f).



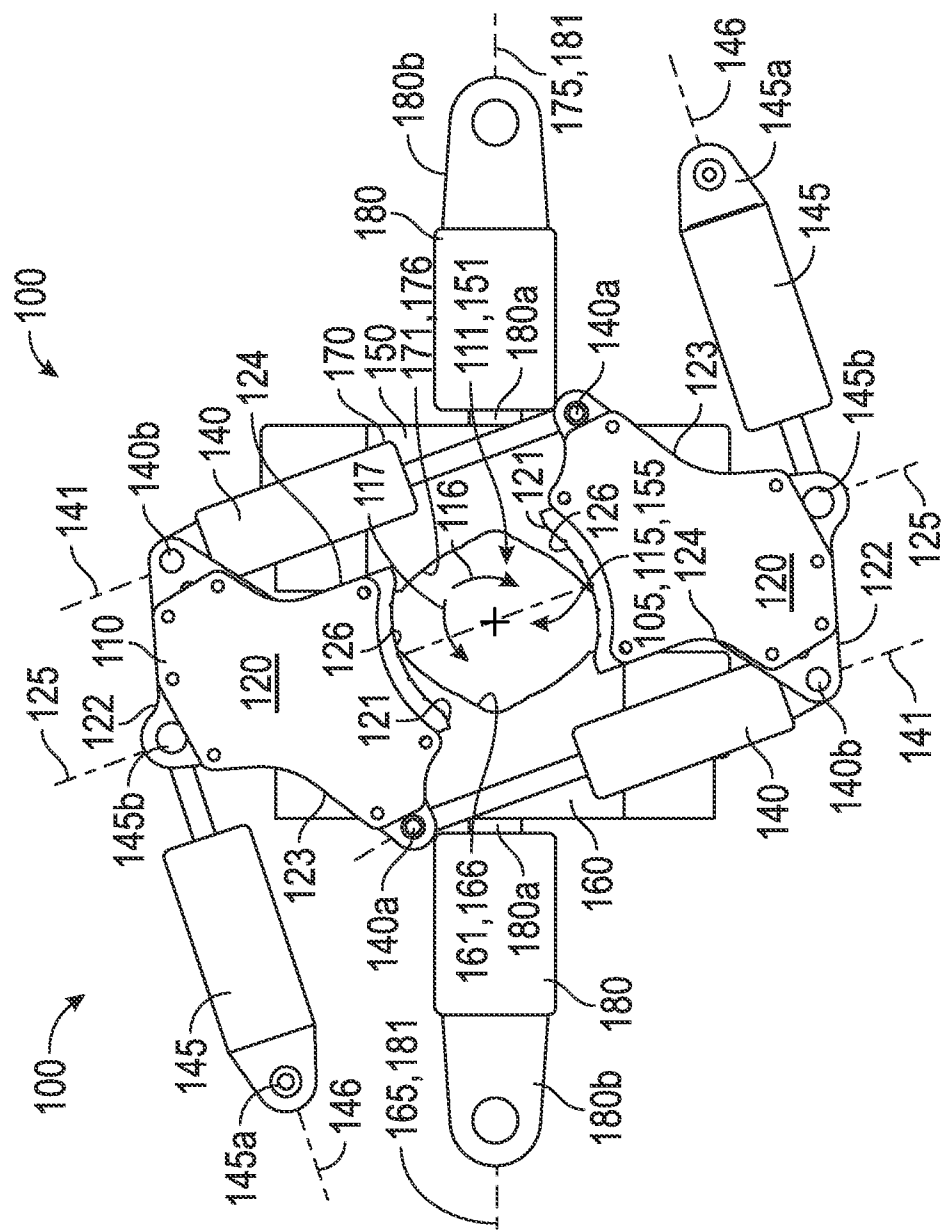
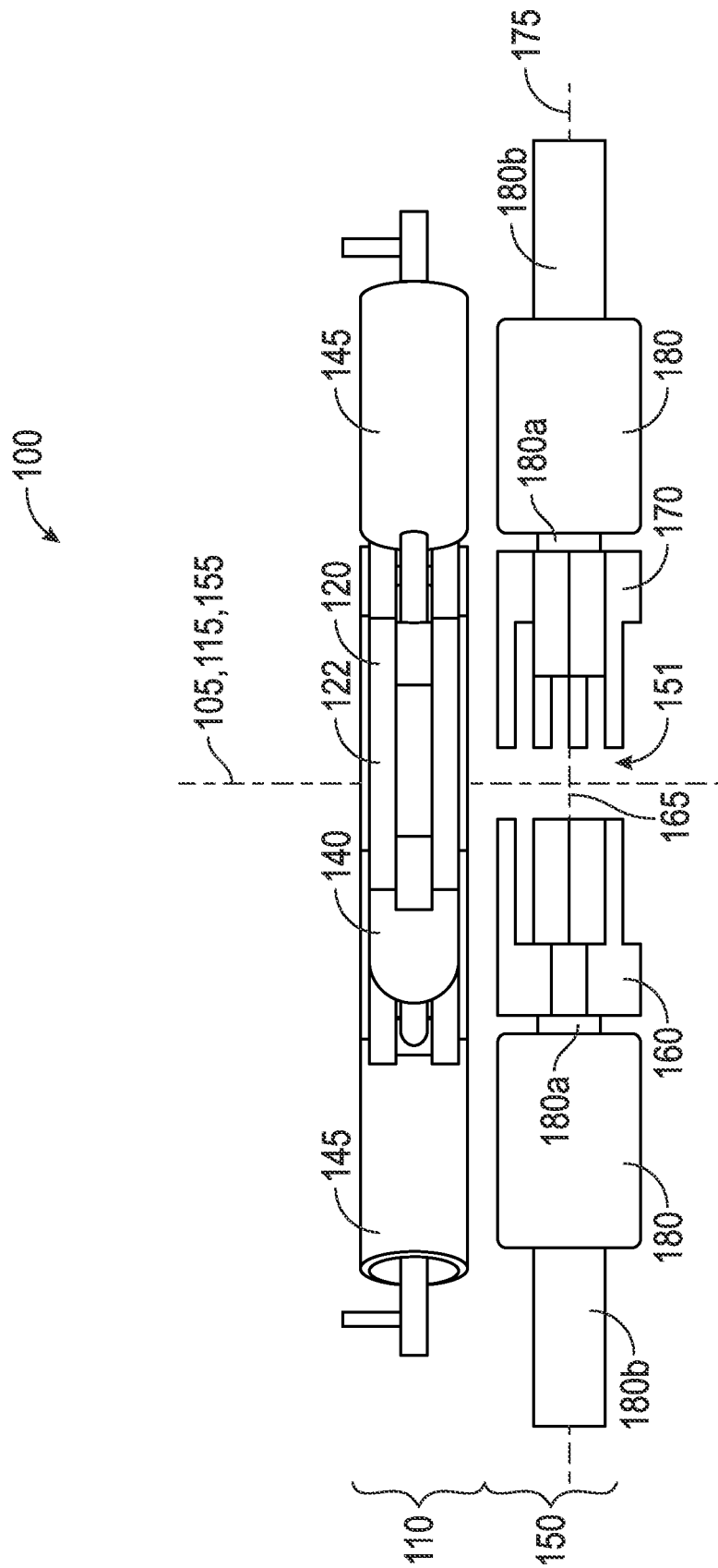


FIG. 2



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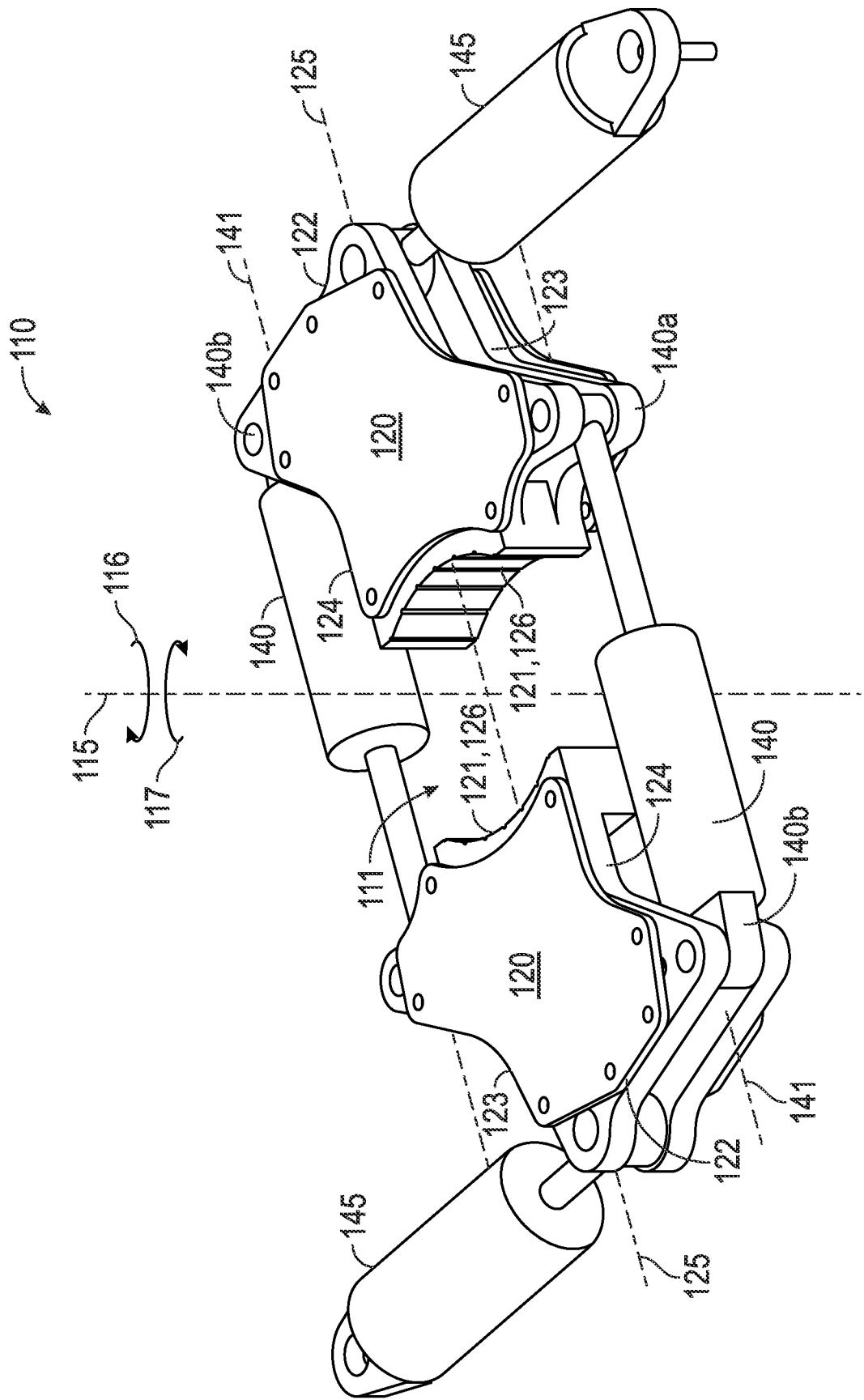


FIG. 4

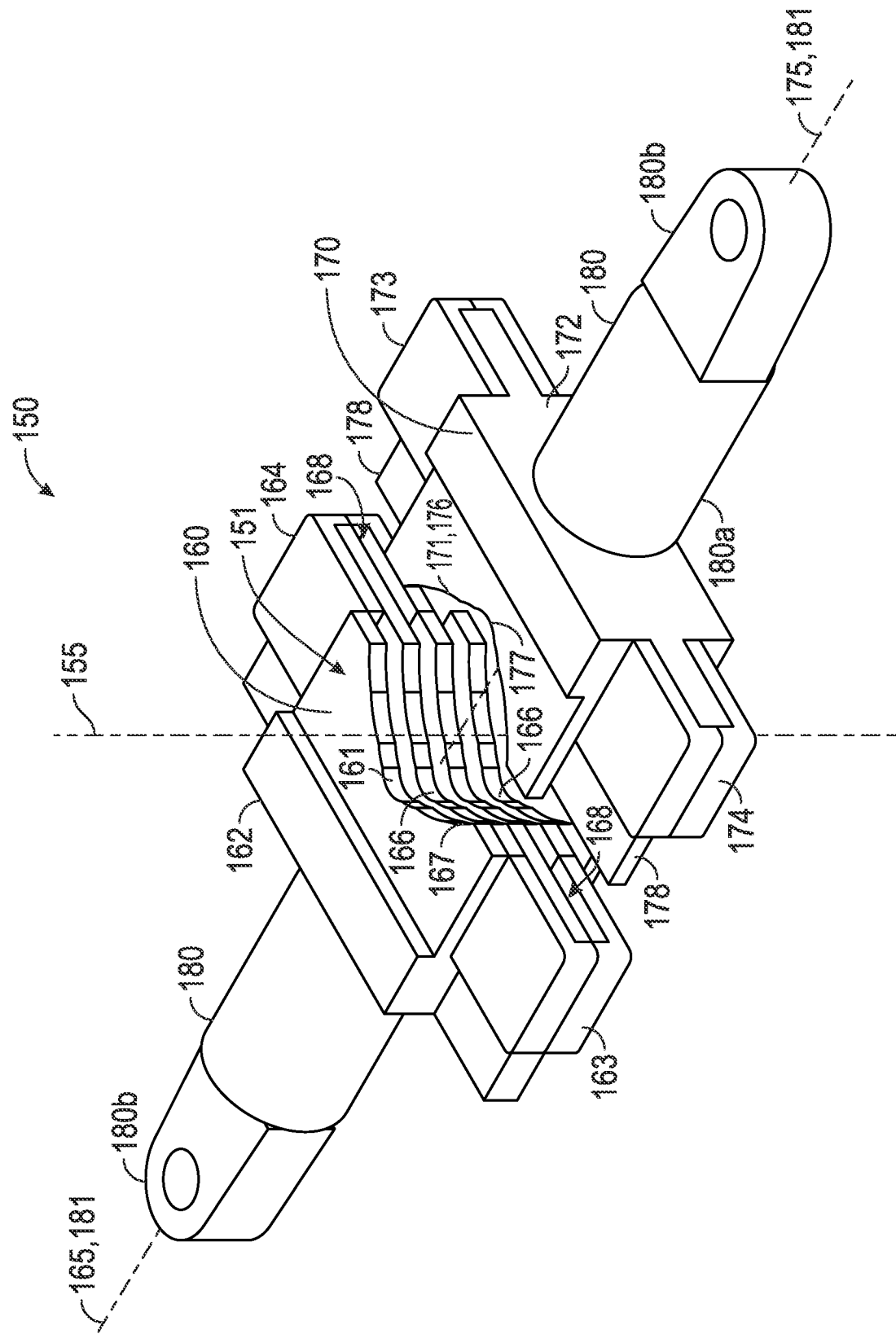


FIG. 5

6/11

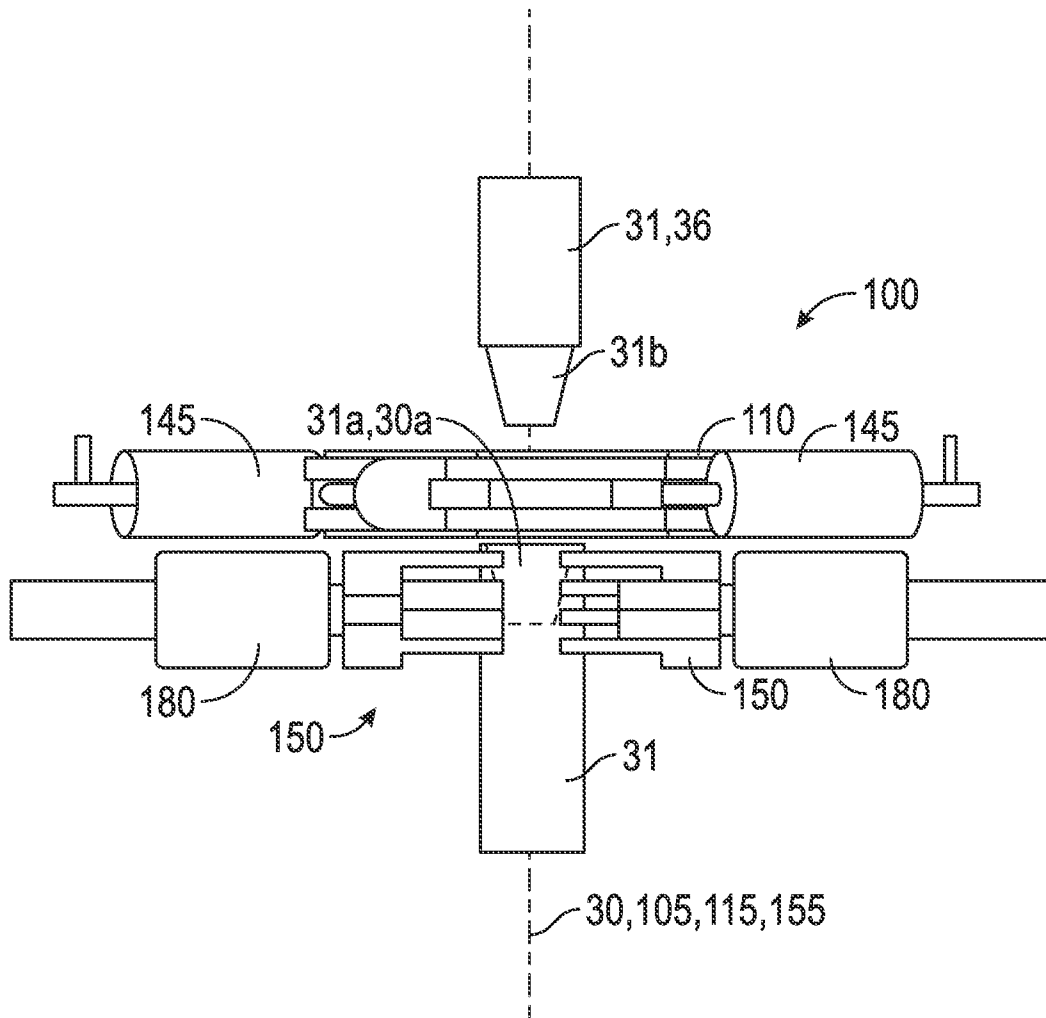


FIG. 6

7/11

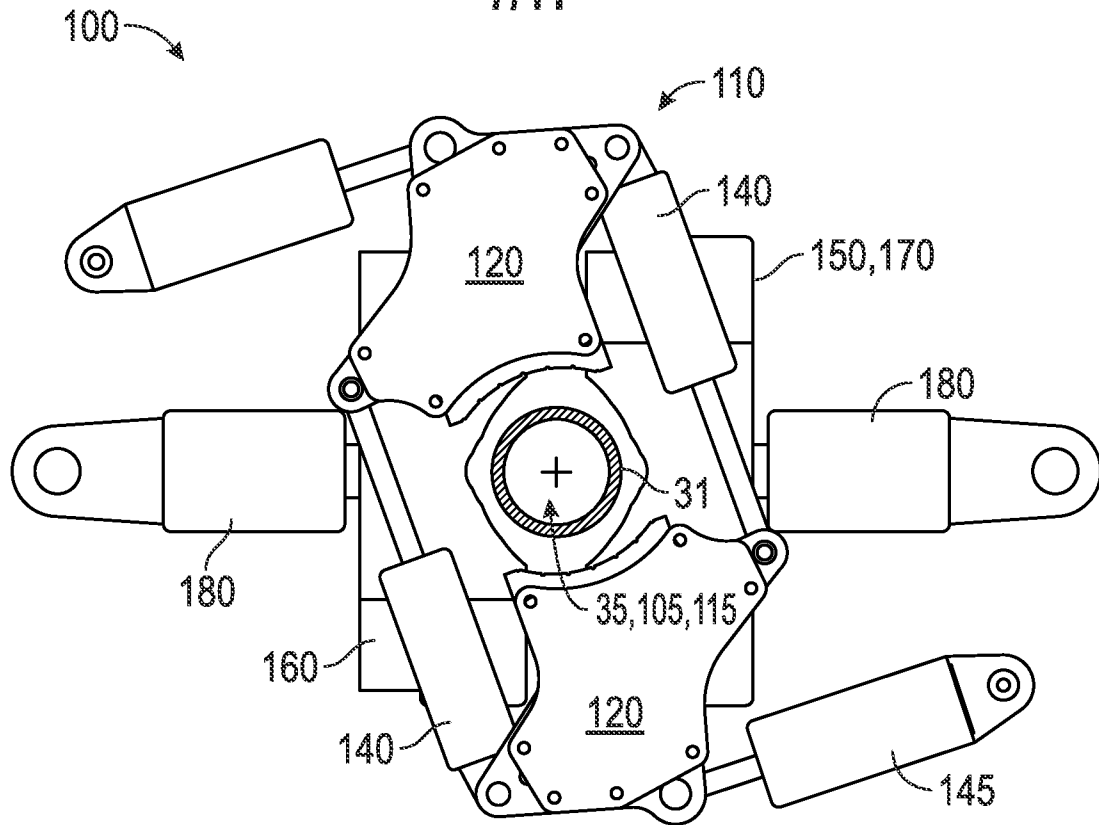


FIG. 7A

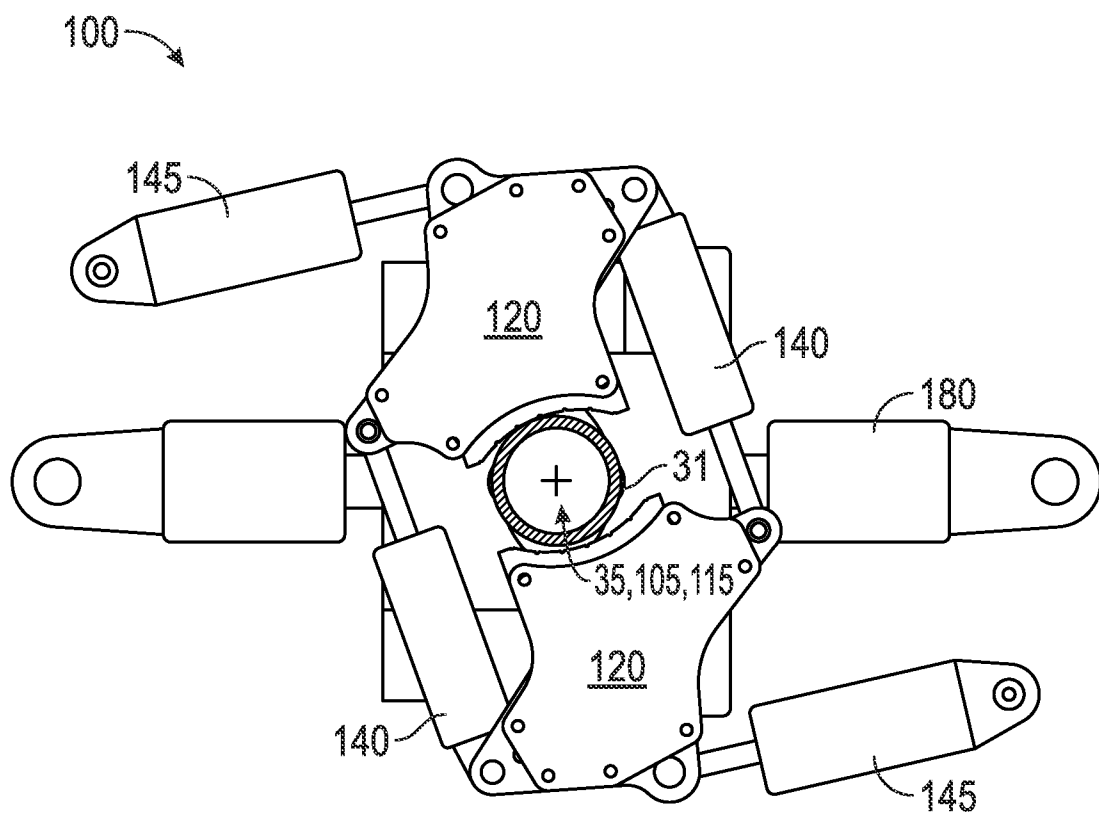


FIG. 7B

8/11

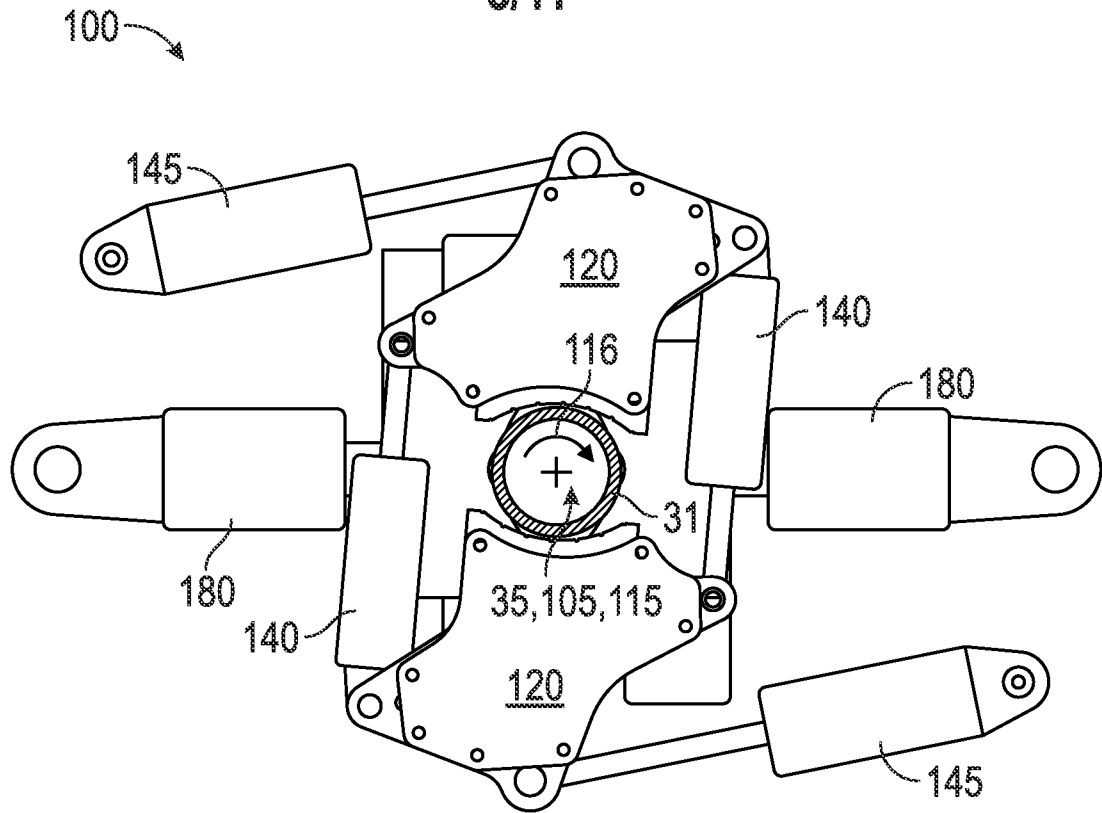


FIG. 7C

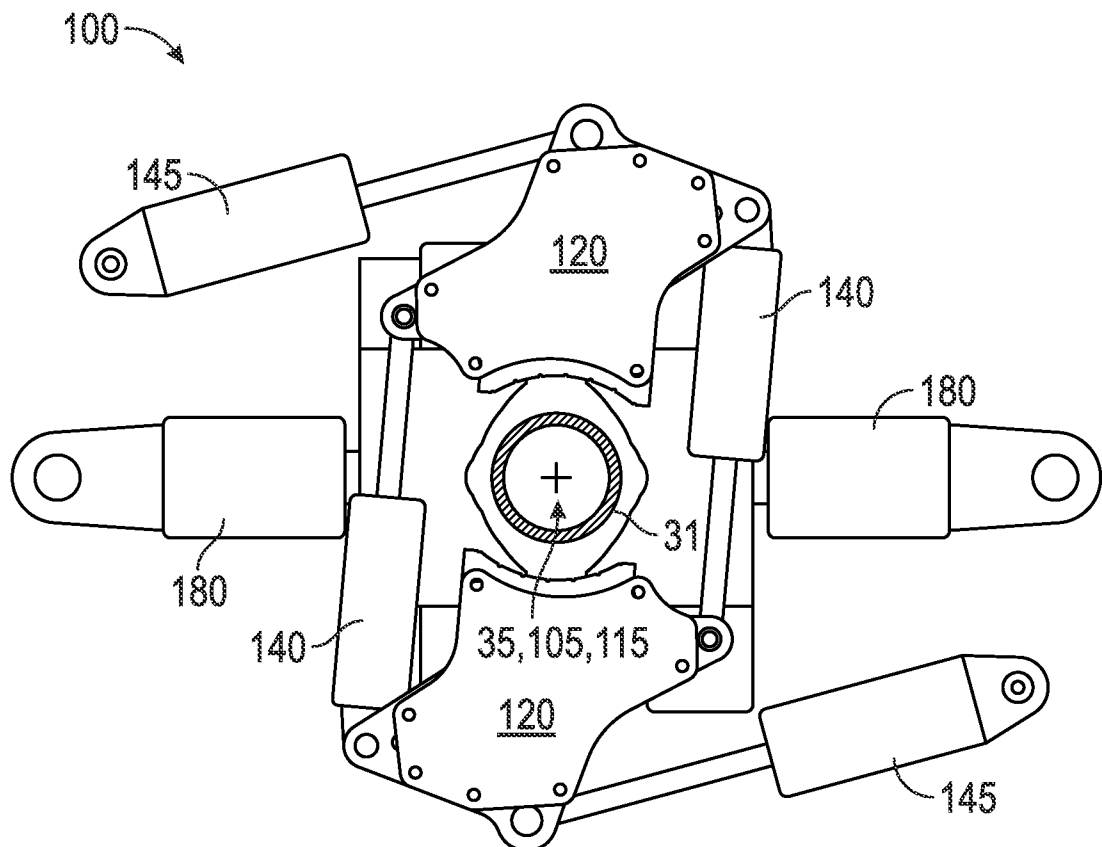


FIG. 7D

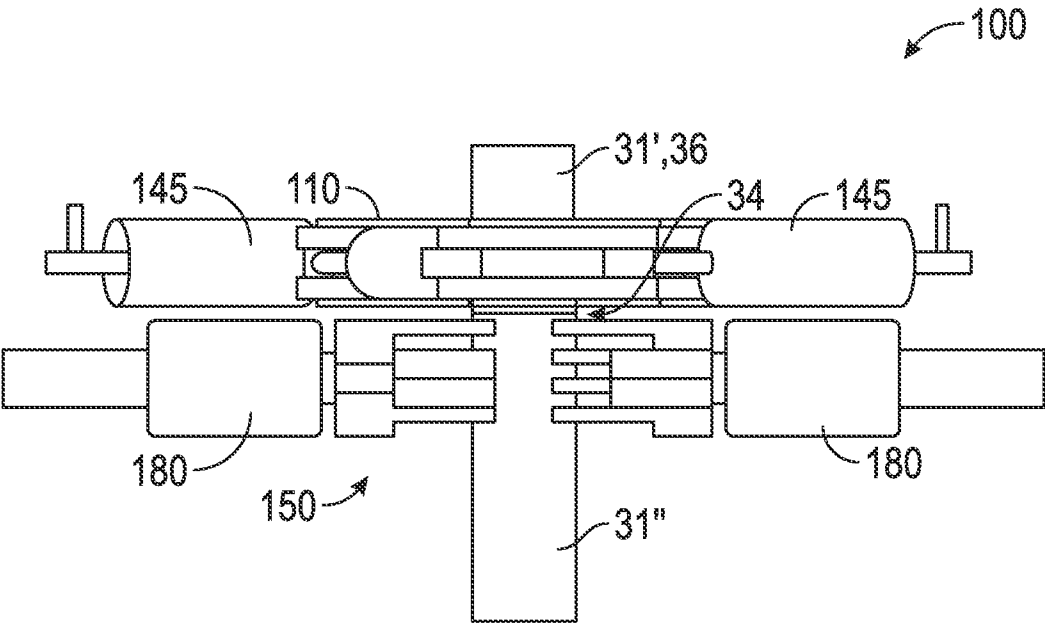


FIG. 8

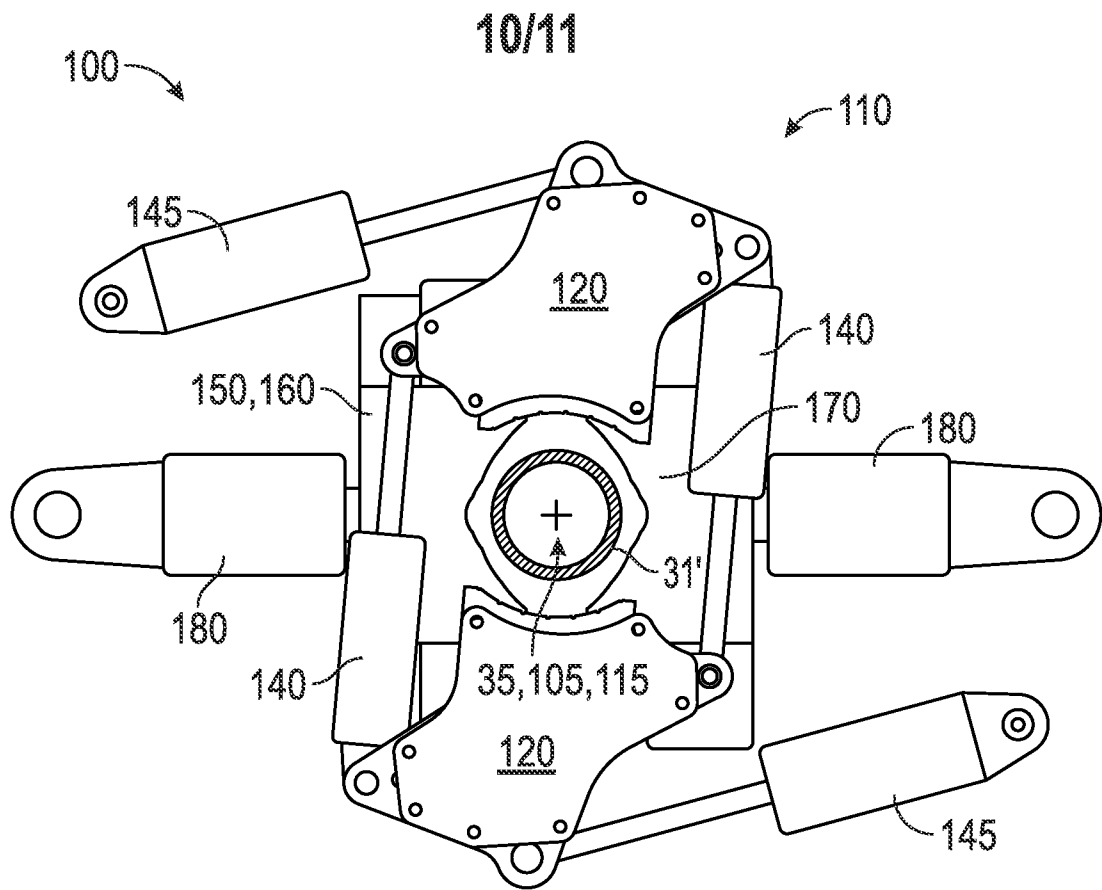


FIG. 9A

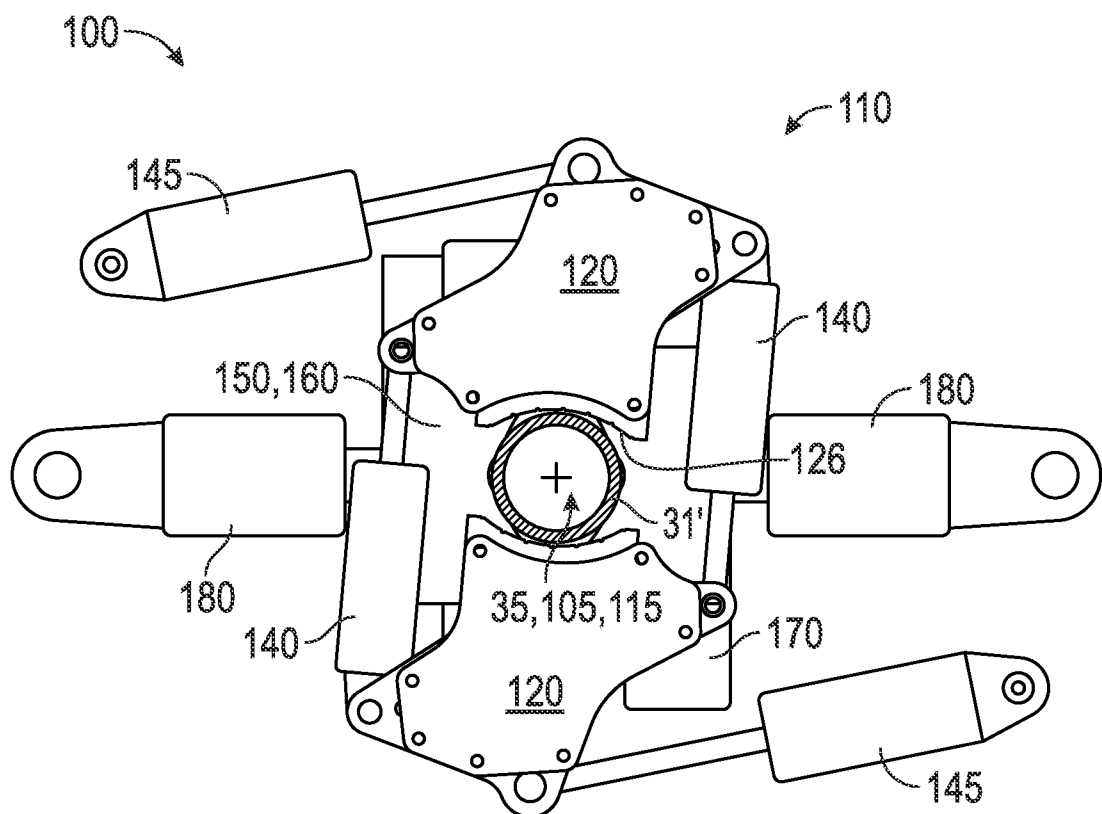


FIG. 9B

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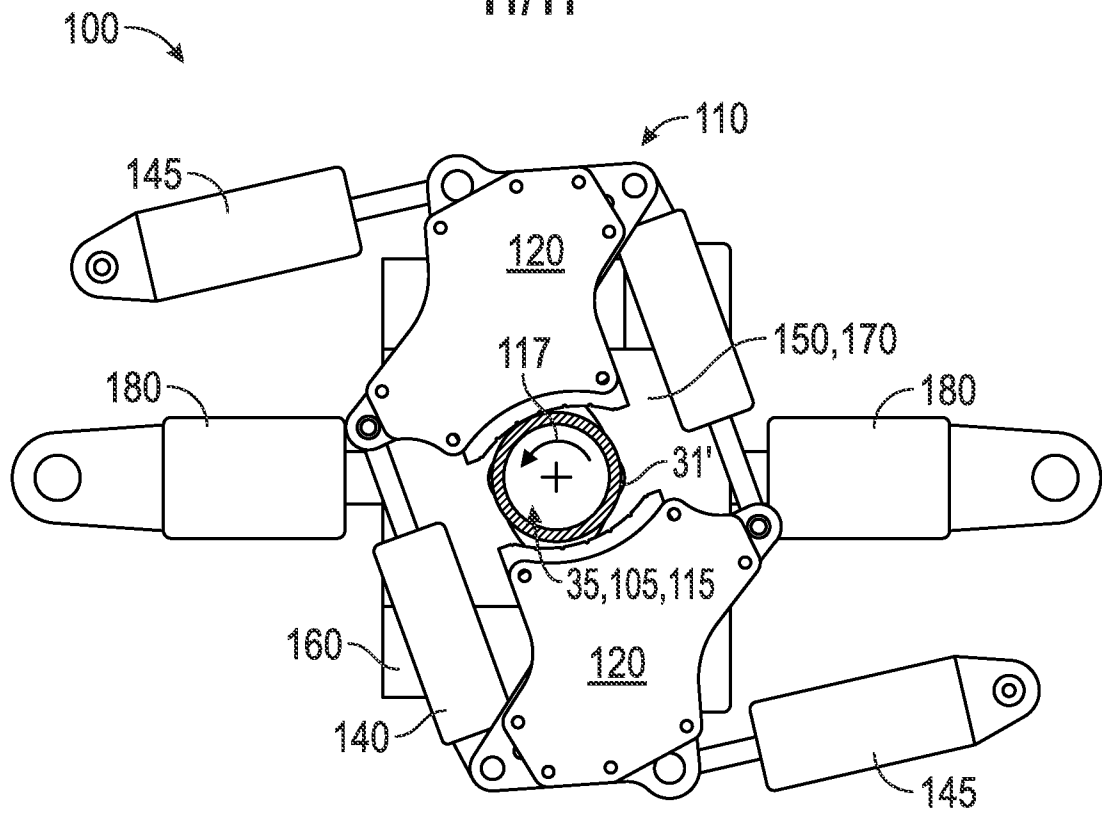


FIG. 9C

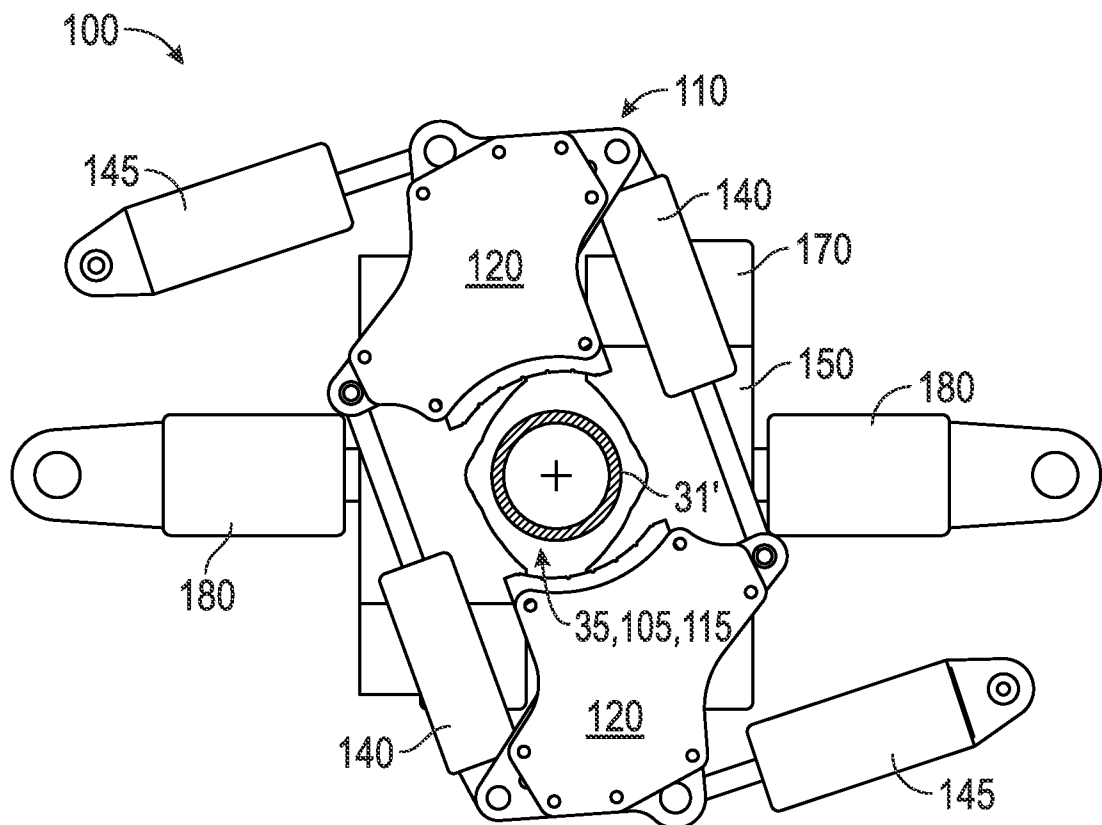


FIG. 9D

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2014/025424

A. CLASSIFICATION OF SUBJECT MATTER
 INV. E21B19/16
 ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1 519 086 A (ECKEL MFG CO) 26 July 1978 (1978-07-26)	1-7, 10-18, 20-22
Y	page 2, line 46 - page 5, line 45; figures -----	8,9,19
X	WO 2009/031166 A1 (SGOLASTRA & GIAMPAOLI S R L [IT]; SGOLASTRA MAURIZIO [IT]) 12 March 2009 (2009-03-12)	1,2
Y	page 3, line 19 - page 5, line 25; figures -----	8,9,19
A	US 7 062 991 B1 (WEST NEIL EDWARD [US] ET AL) 20 June 2006 (2006-06-20) column 4, line 45 - column 9, line 40; figures 1-10 -----	1-22



Further documents are listed in the continuation of Box C.



See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search

21 August 2014

Date of mailing of the international search report

01/09/2014

Name and mailing address of the ISA/

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Authorized officer

Dekker, Derk

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2014/025424

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 1519086	A	26-07-1978	NONE

WO 2009031166	A1	12-03-2009	NONE

US 7062991	B1	20-06-2006	CN 101346529 A 14-01-2009
		US 7062991 B1	20-06-2006
