

(19) **DANMARK**

(10) **DK/EP 2333231 T3**



(12) **Oversættelse af
europæisk patentskrift**

Patent- og
Varemærkestyrelsen

-
- (51) Int.Cl.: **E 21 B 19/16 (2006.01)** **E 21 B 19/24 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2017-06-06**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2017-03-01**
- (86) Europæisk ansøgning nr.: **10191787.0**
- (86) Europæisk indleveringsdag: **2010-11-18**
- (87) Den europæiske ansøgnings publiceringsdag: **2011-06-15**
- (30) Prioritet: **2009-11-19 US 281590 P** **2010-11-16 US 947720**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
- (73) Patenthaver: **Weatherford Technology Holdings, LLC, 2000, St. James Place, Houston, TX 77056, USA**
- (72) Opfinder: **Clasen, Ditmar, Davenstedter Str. 193, 30455 Hannover, Tyskland**
Liess, Martin, Stoeckener Str. 12 B, 30926 Seelze, Tyskland
HELMS, Martin, Lerchenstrasse 2a, 31303 Burgdorf, Tyskland
- (74) Fuldmægtig i Danmark: **Marks & Clerk (Luxembourg) LLP, 44 rue de la Vallée, B.P. 1775, L-1017 Luxembourg, Luxembourg**
- (54) Benævnelse: **TANGPOSITIONERINGSARM**
- (56) Fremdragne publikationer:
WO-A1-2007/106999
GB-A- 807 892
GB-A- 2 191 989
US-A- 4 296 833
US-A1- 2005 061 548

DESCRIPTION

[0001] The present invention generally relates to handling of wellbore tools. In particular, although not exclusively, the invention relates to an apparatus for positioning a tool.

[0002] During a drilling operation, a drill string is used to form a wellbore. The drill string is made from multiple lengths of drill pipe. Typically, a tong is used to connect the drill pipe to the drill string. The tong rotates the drill pipe to screw the pin end of the drill pipe into the box end of the drill string. The tong provides the torque necessary to make-up (or break-out) the connection. At various times during the drilling operation, the tong is moved between several locations at the well site, such as at well centreline, mouse holes, or a storage position. Due to the size and the weight of the tong, the movement of the tong may be difficult. Therefore, there is a need for an apparatus and method for moving the tong at the well site.

[0003] WO2007/106999 A1 discloses an apparatus for positioning a tool at a well site, the apparatus comprising: a first arm rotationally connected to a guide on a column; a second arm connected to a tool attachment member at a pivot point which is offset from a centreline of the tool and the second arm is rotationally connected to the first arm; and a connecting member pivotally connected to the second arm and the guide.

[0004] UD 2005/0061548 describes a remotely controlled apparatus for positioning and stabbing pipe within a drilling rig derrick.

[0005] In accordance with one aspect of the present invention there is provided an apparatus for positioning a tool at a well site. The apparatus includes a first arm rotationally connected to a guide on a column. The apparatus further includes a second arm rotationally connected to the first arm. The second arm is also connected to a tool attachment member at a pivot point, wherein the pivot point is offset from the centreline of the tool. Additionally, the apparatus includes a flexible tension member having one end operatively connected to the guide and another end connected to the tool attachment member at a location closer to the centreline of the tool than the pivot point, wherein the flexible tension member is configured to maintain the tool in a specific orientation around the pivot point during the positioning operation. The apparatus further comprises a connecting member pivotally connected to the second arm and the guide, such that rotational movement of the first arm relative to the column causes the second arm to move the tool along a substantially horizontal plane.

[0006] The specific orientation may be a substantially vertical, or tilted, position. The apparatus may further include an adjustment member configured to adjust the length of the flexible member and therefore the orientation of the tool. Lengthening the flexible member may cause the tool to tilt in one direction around the pivot point and shortening the flexible member may cause the tool to tilt in another direction around the pivot point.

[0007] The rotational movement of the first arm relative to the column may cause the second arm to move the tool between an retracted position and an extended position. The adjustment member may be configured to adjust the orientation of the tool as the tool is moved between the retracted position and the extended position.

[0008] Additionally, the apparatus may include a cylinder and piston rod assembly pivotally connected to the guide and the first arm, wherein the cylinder and piston rod assembly is configured to rotate the first arm relative to the guide, which causes the second arm to move the tool between an extended position and a retracted position along a substantially horizontal plane.

[0009] The apparatus may further comprise a position assembly attached to the cylinder and piston rod assembly to limit the piston rod extension and thereby control the extended position of the tool.

[0010] The guide may be movable along a longitudinal axis of the column. The guide and the column may be rotatable around a longitudinal axis of the column.

[0011] A control panel may be operatively attached to the guide and configured to control the cylinder and rod assembly. A control panel may be configured to control all axis of motion of the apparatus.

[0012] The apparatus may include a first arm connected to a guide on a column at a first pivot point.

[0013] The apparatus further includes a second arm connected to the first arm at a second pivot point and connected to a tool attachment member at a third pivot point. Additionally, the apparatus includes a connecting member attached to the second arm at a fourth pivot point and attached to the guide at a fifth pivot point, wherein the second pivot point is between the third pivot point and the fourth pivot point. The rotational movement of the first arm around the first pivot point causes the second arm to

move the tool.

[0014] A cylinder and piston rod assembly may be pivotally connected to the guide and the first arm. The cylinder and piston rod assembly may be configured to rotate the first arm relative to the guide, which causes the second arm to move the tool between an extended position and a retracted position along a substantially horizontal plane.

[0015] In a further aspect, a method of positioning a tool at a wellsite is provided. The method includes the step of attaching the tool to a positioning apparatus. The positioning apparatus comprises a first arm pivotally connected to a guide on a column, a second arm pivotally connected to the first arm and a connecting member pivotally connected to the second arm and the guide. The method further includes the step of rotating the first arm relative to the column thereby causing the second arm to move the tool along a substantially horizontal plane. The positioning apparatus further comprises a connecting member pivotally connected to the second arm and the guide, such that rotational movement of the first arm relative to the column causes the second arm to move the tool along a substantially horizontal plane between the retracted position and the extended position

[0016] In yet a further aspect, the method includes the step of adjusting an orientation of the tool by manipulating the length of the flexible tension member. Additionally, the method includes the step of rotating the first arm relative to the column thereby causing the second arm to move the tool between a retracted position and an extended position.

[0017] The orientation of the tool may be adjusted prior to moving the tool and the orientation is maintained as the tool moves between the retracted position and the extended position. The orientation of the tool may be adjusted after the tool has moved between the retracted position and the extended position. The orientation of the tool may be adjusted as the tool moves between the retracted position and the extended position. The tool may be moved in a vertical direction by moving the guide member along a longitudinal axis of the column. The tool may be rotated around a longitudinal axis of the column.

[0018] In an additional aspect, the first arm is rotationally connected to a base. The positioning apparatus further includes a second arm rotationally connected to the first arm. The positioning apparatus also includes an extension arm connected between the second arm and a tool attachment member. In addition, the positioning apparatus includes a stabilizing member connected to the tool attachment member. The stabilizing member is configured to maintain the tool in a specific orientation during a positioning operation. The extension arm may be connected to the tool attachment member at a pivot point which is offset from a centreline of the tool.

[0019] In a further aspect, the method includes the step of attaching the tool to a positioning apparatus further comprising an extension arm and a stabilizing member pivotally connected, wherein the first arm is connected to a guide on a column. The method further includes rotating the first arm relative to the column thereby causing the second arm to move the tool from a retracted position to an extended position, moving the tool in a vertical direction by moving the guide member along a longitudinal axis of the column, and moving the tool past the extended position by rotating the extension arm relative to the second arm. An orientation of the tool may be adjusted by manipulating the length of the stabilizing member.

[0020] So that the manner in which the above recited features of the present invention can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

Figure 1 is a view illustrating a positioning apparatus in a retracted position.

Figure 2 is a view illustrating the positioning apparatus in an extended position.

Figure 3 is a view illustrating the positioning apparatus moving along a substantially horizontal path.

Figure 4 is another view of the positioning apparatus in the retracted position.

Figures 5A and 5B are views illustrating a cylinder member as the positioning apparatus moves between the retracted position and the extended position.

Figure 6 is a view illustrating a rotation drive for use with the positioning apparatus.

Figure 7 is a view illustrating a rotation drive for use with the positioning apparatus.

Figure 8 is a view illustrating the positioning apparatus with a control panel.

Figure 9 is a view illustrating a positioning apparatus with an extension arm in a first position.

Figure 10 is a view illustrating the positioning apparatus in Figure 9 with the extension arm in a second extended position.

[0021] Embodiments of the present invention generally relate to an apparatus for positioning a tool, such as a tong, a pipe-stabilizing tool, a gripping arm, welding equipment or any other wellbore equipment. To better understand the aspects of the present invention and the methods of use thereof, reference is hereafter made to the accompanying drawings.

[0022] Figure 1 is a view illustrating a positioning apparatus 100 in a retracted position. The positioning apparatus 100 is used to manipulate the position of a tool 50 at a well site. The positioning apparatus 100 is movable between the retracted position (Figure 1) and an extended position (Figure 2). Further, the positioning apparatus 100 may have any number of intermediate positions (Figure 3). The positioning apparatus 100 may include a base plate 175 for mounting the positioning apparatus 100 at the well site.

[0023] As illustrated in Figure 1, the positioning apparatus 100 includes a first arm 125 and a second arm 150. The first arm 125 is connected to a guide 120 via a connection member 165, and the first arm 125 is connected to the second arm 150 via a connection member 155. During the positioning operation, the first arm 125 pivots around the connection member 165 to extend and/or retract the second arm 150. The arms 125, 150 may comprise of two members mounted substantially parallel to each other and spaced apart (Figure 4). Preferably, the positioning apparatus 100 comprises a pair of first arms 125 mounted on either side of the guide 120 and a pair of second arms 150, each mounted to one of the first arms 125. The pair of first arms 125 may be synchronized such that the first arms 125 operate as a single unit. In one embodiment, the pair of first arms 125 are connected by a bar member 265 (Figure 6). In this embodiment, a single cylinder (not shown) may be connected between the bar member 265 and the guide 120 or any other suitable location on the positioning apparatus 100. This arrangement will allow the single cylinder to operate the first arms 125 rather than the cylinder 130 attached to each first arm 125. In another embodiment, a flow divider or another hydraulic device may be used to interconnect the cylinders 130 of the pair of first arms 125. In a further embodiment, a double-sided cylinder (not shown) may be used to control the movement of the pair of first arms 125.

[0024] The first arm 125 is also connected to the guide 120 via the cylinder 130. The cylinder 130 includes a piston rod 140 that is movable relative to the cylinder 130. As the piston rod 140 extends outward from the cylinder 130, the first arm 125 rotates around the connection member 165 in a direction away from the column member 105. As the piston rod 140 retracts into the cylinder 130, the first arm 125 rotates around the connection member 165 in a direction toward the column member 105. In other words, the piston rod 140 of the cylinder 130 controls the movement of the arms 125, 150 of the positioning apparatus 100. In another embodiment, the cylinder 130 may be positioned between the first arm 125 and the second arm 150. The cylinders of the positioning apparatus 100 may be connected to the hydraulic system of the tool 50 such that the tool 50 and the positioning apparatus 100 may be operated by a single control panel on the tool 50 or by a remote control device.

[0025] In one embodiment, the cylinders used in the positioning apparatus 100 are hydraulic counterbalance cylinders. The hydraulic counterbalance cylinders are configured as a pipe break safety valve, whereby if hydraulic pressure is lost in the system, then the hydraulic counterbalance cylinders will lock in position. Generally, the hydraulic counterbalance cylinders include a check valve arrangement on the rod side that can be opened by pilot pressure. The pressure on the incoming line on the piston side of the cylinder is used to open the check valve arrangement on the rod side. If the pressure on the incoming line is lost, then the check valve arrangement closes and the rod is locked in place. The locking of the rod causes the positioning apparatus 100 to become locked so that the tool 50 will not be dropped if hydraulic pressure in the system is lost.

[0026] The second arm 150 is connected to the first arm 125 via the connection member 155. The second arm 150 is also connected to the guide 120 by a connecting member 110. The connecting member 110 may be any type of member that is capable of operating in tension, such as a rod, a rope, or a chain. As illustrated, the connecting member 110 is attached to the guide 120 via a connection member 185, and the connecting rod is attached to the second arm 150 via a connection member 180. Preferably, the connecting member 110 is a fixed length rod, which controls the movement of the second arm 150 as the first arm 125 rotates around the connection member 165. As will be described herein, the first arm 125 and the second arm 150 are configured such that the positioning apparatus 100 can move the tool 50 along a substantially horizontal path during the positioning operation.

[0027] The second arm 150 is connected to a tool attachment member 225 via a connection member 160. The tool attachment member 225 is able to rotate around the connection member 160 as the positioning apparatus 100 moves between the retracted position and the extended position. The tool attachment member 225 may be configured to grip and support the tool 50 during

and after the positioning operation. In one embodiment, the tool attachment member 225 comprises a plurality of plates that are connected on a base portion of the tool 50. In another embodiment, the tool 50 may be welded to the attachment member 225. In a further embodiment, the attachment member 225 may comprise releasable jaws configured to hold the tool 50.

[0028] The positioning apparatus 100 may include a column member 105 mounted to the base plate 175. A guide 120 is disposed on the column member 105, and the guide 120 is rotationally fixed with respect to the column member 105. The column member 105 may be rotated about its longitudinal axis to place the tool 50 at any desired location about the column member 105. A rotational drive may be used to rotate the column member 105, such as a hydraulic motor (Figure 6). In another embodiment, the guide 120 may be rotatable relative to the column member 105. A motor (not shown) may be used to rotate the guide 120 relative to the column member 105. The guide 120 is movable along the longitudinal axis of the column member 105, which allows the positioning apparatus 100 to raise and lower the tool 50 during the positioning operation. In other words, the tool 50 moves in a vertical direction as the guide 120 moves along the longitudinal axis of the column member 105. A hydraulic or pneumatic cylinder (not shown) may be used to move the guide 120 along the longitudinal axis of the column member 105.

[0029] As shown in Figure 1, the tool attachment member 225 is connected to a tension member 115, such as a chain, a belt or a cable. Preferably, the tension member 115 is flexible to allow the tension member 115 to bend around the rollers 190 (Figure 4). The tension member 115 is attached to the tool attachment member 225 via a connection member 170. The tension member 115 is also connected to the bracket through which the connection member 165 runs. The bracket is attached to the guide 120. The tension member 115 may alternatively be connected to the arm 125 or to the guide 120. As such, the tool attachment member 225 is operatively connected to the guide 120 via a tension member 115. The tension member 115 loops around the roller 190 (Figure 4) or sprocket disposed between the portions of the second arm 150.

[0030] The tension member 115 is configured to stabilize the tool 50 such that the tool 50 is maintained in a specific orientation (e.g., a substantially vertical position or a tilted position) during the positioning operation. The tool 50 is free to pivot about the connection member 160; however, the tension member 115 prevents the tool 50 from pivoting beyond a set limit in one direction. The second arm 150 and the tension member 115 are attached to the tool attachment member 225 at a location that is offset from the centre of gravity of the tool 50. As shown, the tension member 115 is connected to the attachment member 225 at a location closer to the centre of gravity of the tool 50 than the second arm 150. The arrangement of the connection points to the tool 50 allows the tension member 115 to stabilize the tool 50 as the positioning apparatus 100 moves the tool 50 along a substantially horizontal plane during the positioning operation.

[0031] The tension member 115 may be fixed in length or the length may be adjustable. In one embodiment, the positioning apparatus 100 may include an adjustment mechanism (not shown) configured to adjust the length of the tension member 115 and thus the orientation of the tool 50. For example, if the adjustment mechanism increases the length of the tension member 115, then the tool 50 will pivot about the connection member 160 in a first direction. Alternatively, if the adjustment mechanism decreases the length of the tension member 115, then the tool 50 will pivot about the connection member 160 in a second opposite direction. As such, the adjustment mechanism can adjust the orientation of the tool 50 such that the tool 50 may be in a downward tilted orientation, a substantially vertical orientation, or upward tilted orientation. Further, the adjustment mechanism may adjust the orientation of the tool 50 prior to moving the tool 50 in the positioning operation or after moving the tool 50 to the desired position. Additionally, the adjustment mechanism may be configured to adjust the orientation of the tool 50 while the positioning apparatus 100 moves the tool 50 during the positioning operation. The adjustment mechanism may be any mechanism known in the art that is configured to adjust the length of the tension member 115, such as a lever mechanism, a turnbuckle, a hydraulic cylinder and roller (or pulley) arrangement or a sprocket arrangement. Additionally, the adjustment mechanism may be operated by manual manipulation or the adjustment mechanism may be controlled by a control system, such as the operating control system of the positioning apparatus 100.

[0032] Figure 2 is a view illustrating the positioning apparatus 100 in an extended position. As illustrated, the piston rod 140 of the cylinder 130 has been extended. The movement of the piston rod 140 of the cylinder 130 causes the first arm 125 to pivot around the connection member 165. The second arm 150 is free to rotate around the connection member 155. The rotation of the second arm 150 is controlled by the connecting member 110 such that the upper end of the second arm 150 is maintained closer to the column 105 than the connection member 155. Hence, the lower end of the second arm 150 is pivoted away from the column 105. As the second arm 150 moves away from the column 105, the tool 50 is moved along the substantially horizontal plane as shown in Figure 3.

[0033] Figure 4 is another view of the positioning apparatus 100 in the retracted position. As illustrated, the arms 125, 150 may include two members mounted substantially parallel to each other and spaced apart. Each of the arms 125, 150 are configured to move together as a unit during the positioning operation. Also illustrated in Figure 4 is the rollers 190 (alternatively axes, pulleys or sprockets) for use with the tension member 115. The rollers 190 may be stationary or the rollers 190 may be rotatable. As

previously set forth, the tension member 115 is used to stabilize the tool 50 such that the tool 50 is maintained in the specific orientation during the positioning operation.

[0034] Figures 5A and 5B are views illustrating the cylinder 130 as the positioning apparatus 100 moves between the retracted position and the extended position. In one embodiment, the position of the positioning apparatus 100 may be set by using a position assembly 210 attached to the cylinder 130. As set forth herein, the movement of the piston rod 140 of the cylinder 130 controls the movement of the arms 125, 150 and therefore controls the movement of the tool 50. If the tool 50 is to be placed at a location multiple times, then the position assembly 210 may be used to limit the extension of the piston rod 140 such that tool 50 is placed at the same location each time the positioning apparatus 100 is in the extended position. In the embodiment illustrated in Figures 5a and 5b, the position assembly 210 includes a plurality of rods and plates. Nuts on the rods may be adjusted such that the extension of the piston rod 140 may be limited. In other embodiments, sensors may be used to monitor the extension of the piston rod 140 of the cylinder 130. The sensors may be limit switches. The sensors may form part of a control circuit, which limits movement of the piston rod 140 when a pre-set extension has been reached. The sensors may also be configured to measure the movement of the piston rod 140 along a travel path inside the cylinder 130. The sensors are linked to the control circuit attached to the cylinder 130. When the piston rod 140 becomes close to a predetermined location along the travel path, the sensors will send a signal to the control circuit to reduce the fluid flow to the cylinder 130, which in turn slows the movement of the piston rod 140 and the movement of the positioning apparatus 100. Upon reaching the predetermined location along the travel path, the sensor will send a signal to the control circuit to stop the fluid flow to the cylinder 130, which in turn stops the movement of the piston rod 140 and the movement of the positioning apparatus 100.

[0035] Figure 6 is a view illustrating a rotation drive for use with the positioning apparatus 100. In one embodiment, the rotational drive may be a hydraulic motor 250 attached to a slewing ring 255. For clarity, the tool 50 is not shown in Figure 6. The hydraulic motor 250 includes a gear member that interacts with an internal gear of the slewing ring 255. Upon activation of the rotational drive, the hydraulic motor 250 rotates the internal gear of the slewing ring 255, thereby causing the column member 105 to rotate along its longitudinal axis. In another embodiment, the rotational drive may be a cylinder 275 that is connected to a bracket 280 fixed to a post 270 as illustrated in Figure 7. For clarity, the tool 50 is not shown in Figure 7. The cylinder 275 is mounted in a bracket 285 that is attached to the column 105. Upon activation of rotational drive, the cylinder 275 applies a force on the bracket 280 fixed to the post 270, thereby causing the column member 105 to rotate along its longitudinal axis.

[0036] Figure 8 is a view illustrating the positioning apparatus 100 with a control panel 305. As shown in Figure 8, the control panel 305 is connected to the guide 120 to allow the control panel 305 to move along with the guide 120 during the positioning operation. It should be understood, however, that the control panel 305 may be located at any suitable location on the positioning apparatus 100 without departing from principles of the present invention. The control panel 305 is connected to a control circuit on the positioning apparatus 100, which controls the operation of the cylinders of the positioning apparatus 100. The control panel 305 may be configured to control all axis of motion (vertical, horizontal, rotation) of the tool 100. The control panel 305 may also be connected to the tool 50 via one or more hydraulic or pneumatic hoses 310. In this manner, the control panel 305 may be configured to control the positioning apparatus 100 and the tool 50. Additionally, this arrangement allows the positioning apparatus 100 to control different tools using the same control panel 305. In other words, the positioning apparatus 100 and the control panel 305 may be used with different wellbore tools (e.g., tongs) to allow the interchangeability of tools.

[0037] Figure 9 is a view illustrating a positioning apparatus 300 with an extension arm 375. For convenience, the components in the positioning apparatus 300 that are similar to the components in the positioning apparatus 100 will be labelled with the same number indicator. The positioning apparatus 300 is used to manipulate the position of the tool 50 at a well site. The positioning apparatus 300 is movable between a retracted position, multiple intermediate positions and an extended position in a similar manner as the positioning apparatus 100. The positioning apparatus 300 may be moved to a position that beyond the extended position by using the extension arm 375.

[0038] As illustrated in Figure 9, the positioning apparatus 300 includes a first arm 325 and a second arm 350. The first arm 325 is connected to the guide 120 via the connection member 165, and the first arm 325 is connected to the second arm 350 via the connection member 155. During the positioning operation, the first arm 325 pivots around the connection member 165 to extend and/or retract the second arm 350. The arms 325, 350 may comprise of two members mounted substantially parallel to each other and spaced apart. Preferably, the positioning apparatus 300 comprises a pair of first arms 325 mounted on either side of the guide 120 and a pair of second arms 350, each mounted to one of the first arms 325. The pair of first arms 325 may be synchronized such that the first arms 325 operate as a single unit. The connecting member 110 connects the second arm 350 to the guide 120. The connecting member 110 may be any type of member that is capable of operating in tension, such as a rod, a rope, or a chain. Preferably, the connecting member 110 is a fixed length rod, which controls the movement of the second arm 350 as the first arm 325 rotates around the connection member 165. The first arm 325 and the second arm 350 are configured

such that the positioning apparatus 300 can move the tool 50 along a substantially horizontal path during the positioning operation.

[0039] The positioning apparatus 300 further includes the extension arm 375. Generally, the extension arm 375 is used to extend the reach of the positioning apparatus 300 past the extended position. The extension arm 375 is an optional component that may be used to allow the tool 50 to be placed at the centreline of the wellbore, mouse holes, or another position offset from the centreline of the wellbore.

[0040] As shown in Figure 9, connection members 355, 360, 385 and 390 are used to connect an optional stabilizing member 380, an arm attachment member 340, a tool attachment member 330 and the extension arm 375. Connection member 355 is also used to connect the extension arm 375 to the second arm 350. The extension arm 375 is configured to rotate around the connection member 355 between a first position (Figure 9) and a second extended position (Figure 10). The extension arm 375 may be rotated relative to the second arm 350 by a hydraulic piston, mechanical linkage or any other rotation device known in the art.

[0041] The tension member 115 is connected to the arm attachment member 340 by a connection arrangement 370. The tension member 115 works in conjunction with the optional stabilizing member 380 to stabilize the tool 50 such that the tool 50 is maintained in a specific orientation (e.g., a substantially vertical position or a tilted position) during the positioning operation. The tool 50 is free to pivot about the connection member 360; however, the stabilizing member 380 and the tension member 115 prevent the tool 50 from pivoting beyond a set limit in one direction. The extension arm 375 and the stabilizing member 380 are attached to the tool attachment member 330 at a location that is offset from the centre of gravity of the tool 50. The arrangement of the connection points to the tool 50 allows the stabilizing member 380 and the tension member 115 to stabilize the tool 50 as the positioning apparatus 300 moves the tool 50 along a substantially horizontal plane during the positioning operation. In another embodiment, the tension member 115 may be connected directly to the tool 50 or the tool attachment member 330.

[0042] The stabilizing member 380 may be fixed in length or the length may be adjustable at either connection point. In one embodiment, the positioning apparatus 300 may include an adjustment mechanism (not shown) configured to adjust the length of the stabilizing member 380 and thus the orientation of the tool 50. For example, if the adjustment mechanism increases the length of the stabilizing member 380, then the tool 50 will pivot about the connection member 360 in a first direction. Alternatively, if the adjustment mechanism decreases the length of the stabilizing member 380, then the tool 50 will pivot about the connection member 360 in a second opposite direction. As such, the adjustment mechanism can adjust the orientation of the tool 50 such that the tool 50 may be in a downward tilted orientation, a substantially vertical orientation, or upward tilted orientation. Further, the adjustment mechanism may adjust the orientation of the tool 50 prior to moving the tool 50 in the positioning operation or after moving the tool 50 to the desired position. Additionally, the adjustment mechanism may be configured to adjust the orientation of the tool 50 while the positioning apparatus 300 moves the tool 50 during the positioning operation. The adjustment mechanism may be any mechanism known in the art that is configured to adjust the length of the stabilizing member 380, such as a lever mechanism, a turnbuckle, a hydraulic cylinder and roller (or pulley) arrangement or a sprocket arrangement. Additionally, the adjustment mechanism may be operated by manual manipulation or the adjustment mechanism may be controlled by a control system, such as the operating control system of the positioning apparatus 300. In one embodiment, the stabilizing member 380 is a fixed length rod; however, the stabilizing member 380 may be any type of member that is capable of operating in tension, such as a rope, or a chain.

[0043] Figure 10 is a view illustrating the extension arm 375 in the second extended position. As illustrated, the guide 120 has moved along the longitudinal axis of the column member 105. As also shown, the extension arm 375 has rotated relative to the second arm 350 around the connection member 355 to position the tool 50. In the embodiment shown, the extension arm 375 is rotated independent of the second arm 350 by a rotation drive device attached to the extension arm 375. The rotation drive device may be connected to the control panel 305 attached to the guide 120 (Figure 8). In any case, the extension arm 375 is rotated relative to the second arm 350 after the second arm 350 is in the extended position (Figure 9).

[0044] In another embodiment, the extension arm 375 may be rotated as the second arm 350 is rotated. The synchronization of the extension arm 375 and the second arm 350 may be accomplished by mechanical linkage and/or with connection with the control circuit on the positioning apparatus 300. In the case of mechanical linkage, the piston rod 140 causes the movement of the first arm 325, the second arm 350 and the extension arm 375. The movement of the piston rod 140 of the cylinder 130 causes the first arm 325 to pivot around the connection member 165. The connecting member 110 controls the rotation of the second arm 350 such that the upper end of the second arm 350 is maintained closer to the column 305 than the connection member 155. Hence, the lower end of the second arm 350 is pivoted away from the column 105. As the second arm 350 moves away from the column 105, the extension arm 375 is rotated around connection member 355.

[0045] While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO2007106898A1 [0003]
- WO2005000154A [0004]

TANGPOSITIONERINGSARM

PATENTKRAV

1. Anordning (100) til positionering af et redskab (50) ved en borebrønd, hvilken anordning omfatter:
en første arm (125), der er drejbart forbundet med et styr (120) på en søjle (105);
- 5 en anden arm (150), der er forbundet med et redskabsfastgørelseselement (225) ved et omdrejningspunkt, der er forskudt for en centerlinje for redskabet, og den anden arm er drejbart forbundet med den første arm; og
et fleksibelt element (115), der har én ende, der er operativt forbundet med styret, og en anden ende, der er forbundet med redskabsfastgørelseselementet ved en lokalitet, der ligger tættere på centerlinjen
- 10 for redskabet end omdrejningspunktet, hvor det fleksible element er konfigureret til at bevare redskabet i en specifik orientering omkring omdrejningspunktet under positioneringshandlingen;
hvor anordningen endvidere omfatter et forbindelseselement (110), der er drejbart forbundet med den anden arm og styret, således at den roterende bevægelse af den første arm i forhold til søjlen bevirker, at den anden arm bevæger redskabet langs et i det væsentlige horisontalt plan.
- 15 2. Anordning ifølge krav 1, hvor den specifikke orientering er en i det væsentlige vertikal position.
3. Anordning ifølge krav 1, hvor den specifikke orientering er en vipet position.
4. Anordning ifølge krav 1, 2 eller 3, der endvidere indbefatter et justeringselement, der er konfigureret til at justere længden af det fleksible element (115) og dermed redskabets orientering.
5. Anordning ifølge krav 4, hvor forlængelse af det fleksible element (115) bevirker, at redskabet (50)
- 20 vipper i en retning omkring omdrejningspunktet, og afkortning af det fleksible element bevirker, at redskabet vipper i en anden retning omkring omdrejningspunktet.
6. Anordning ifølge et hvilket som helst af de foregående krav, hvor den roterende bevægelse af den første arm (125) i forhold til søjlen (105) bevirker, at den anden arm (150) bevæger redskabet (50) mellem en tilbagetrukken position og en forlænget position.
- 25 7. Anordning ifølge krav 6, når det afhænger af krav 4 eller 5, hvor justeringselementet er konfigureret til at justere orienteringen af redskabet (50), når redskabet bevæges mellem den tilbagetrukne position og den forlængede position.
8. Anordning ifølge et hvilket som helst af de foregående krav, der endvidere omfatter en cylinder- og stempelstangsenhed (130, 140), der er drejbart forbundet med styret (120) og den første arm (125), hvor
- 30 cylinder- og stempelstangsenheden er konfigureret til at rotere den første arm i forhold til styret, hvilket bevirker, at den anden arm (150) bevæger redskabet (50) mellem den forlængede position og den tilbagetrukne position langs et i det væsentlige horisontalt plan.
9. Anordning ifølge krav 8, der endvidere omfatter en positionsenhed (210), der er forbundet med cylinder- og stempelstangsenheden (130, 140) for at begrænse stempelstangsforlængelsen og derved styre
- 35 den forlængede position af redskabet (50).
10. Anordning ifølge et hvilket som helst af de foregående krav, hvor:
den første arm (125) er forbundet med styret (120) på søjlen ved et første omdrejningspunkt (165);

- 2 -

den anden arm (150) er forbundet med den første arm (125) ved et andet omdrejningspunkt (155) og forbundet med redskabsfastgørelseselementet ved et tredje omdrejningspunkt (160); og

forbindelseselementet (110) er forbundet med den anden arm ved et fjerde omdrejningspunkt (180) og forbundet med styret ved et femte omdrejningspunkt (185), hvor det andet omdrejningspunkt er mellem
5 det tredje omdrejningspunkt og det fjerde omdrejningspunkt, og hvor den roterende bevægelse af den første arm omkring det første omdrejningspunkt bevirker, at den anden arm bevæger redskabet.

11. Anordning ifølge et hvilket som helst af de foregående krav, der endvidere omfatter:

en forlængerarm (375), der er forbundet mellem den anden arm (150) og redskabsfastgørelseselementet; og

10 et stabiliseringsselement (380), der er forbundet med redskabsfastgørelseselementet, hvilket stabiliseringsselement er konfigureret til at bevare redskabet (50) i den specifikke orientering under en positioneringshandling;

hvor forlængerarmen eventuelt er forbundet med redskabsfastgørelseselementet ved et omdrejningspunkt, der er forskudt for en centerlinje for redskabet.

15 12. Fremgangsmåde til positionering af et redskab (50) ved en borebrønd, hvilken fremgangsmåde omfatter:

fastgørelse af redskabet til en positioneringsanordning (100), hvilken positioneringsanordning omfatter en første arm (125), der er drejbart forbundet med et styr (120) på en søjle (105), en anden arm (150), der er drejbart forbundet med den første arm, og et fleksibelt spændingselement (115), der er
20 operativt forbundet med den anden arm og styret;

justering af en orientering af redskabet ved regulering af længden af det fleksible spændingselement; og

rotation af den første arm i forhold til søjlen, hvilket dermed bevirker, at den anden arm bevæger redskabet mellem en tilbagetrukken position og en forlænget position;

25 hvor positioneringsanordningen endvidere omfatter et forbindelseselement (110), der er drejbart forbundet med den anden arm og styret, således at den roterende bevægelse af den første arm i forhold til søjlen bevirker, at den anden arm bevæger redskabet langs et i det væsentlige horisontalt plan mellem den tilbagetrukne position og den forlængede position.

13. Fremgangsmåde ifølge krav 12, hvor orienteringen af redskabet (50) justeres før bevægelse af
30 redskabet og orienteringen bevares, når redskabet bevæger sig mellem den tilbagetrukne position og den forlængede position, eller orienteringen af redskabet justeres, efter at redskabet har bevæget sig mellem den tilbagetrukne position og den forlængede position, eller orienteringen af redskabet justeres, når redskabet bevæges mellem den tilbagetrukne position og den forlængede position.

14. Fremgangsmåde ifølge krav 13, der endvidere omfatter ét eller flere af følgende trin:

35 bevægelse af redskabet (50) i en vertikal retning ved bevægelse af styreelementet (120) langs en længdeakse for søjlen (105) og

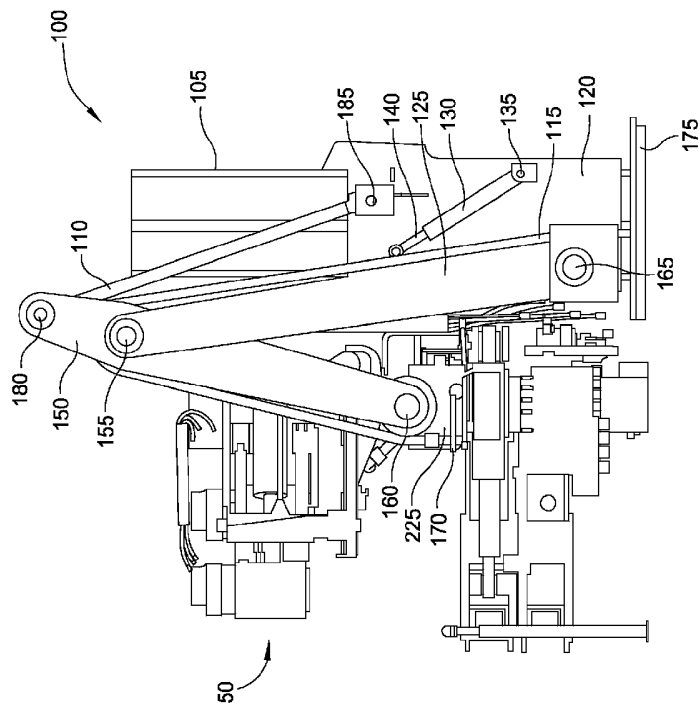
rotation af redskabet omkring en længdeakse for søjlen.

15. Fremgangsmåde ifølge et hvilket som helst af kravene 12 til 14, hvor positioneringsanordningen (100) endvidere omfatter en forlængerarm (375) og et stabiliseringsselement (380), der er drejbart forbundet

- 3 -

med den anden arm (150), hvilken fremgangsmåde endvidere omfatter bevægelse af redskabet (50) forbi den forlængede position ved rotation af forlængerarmen i forhold til den anden arm, og eventuelt ved justering af en orientering af redskabet ved regulering af længden af stabiliseringselementet.

DRAWINGS



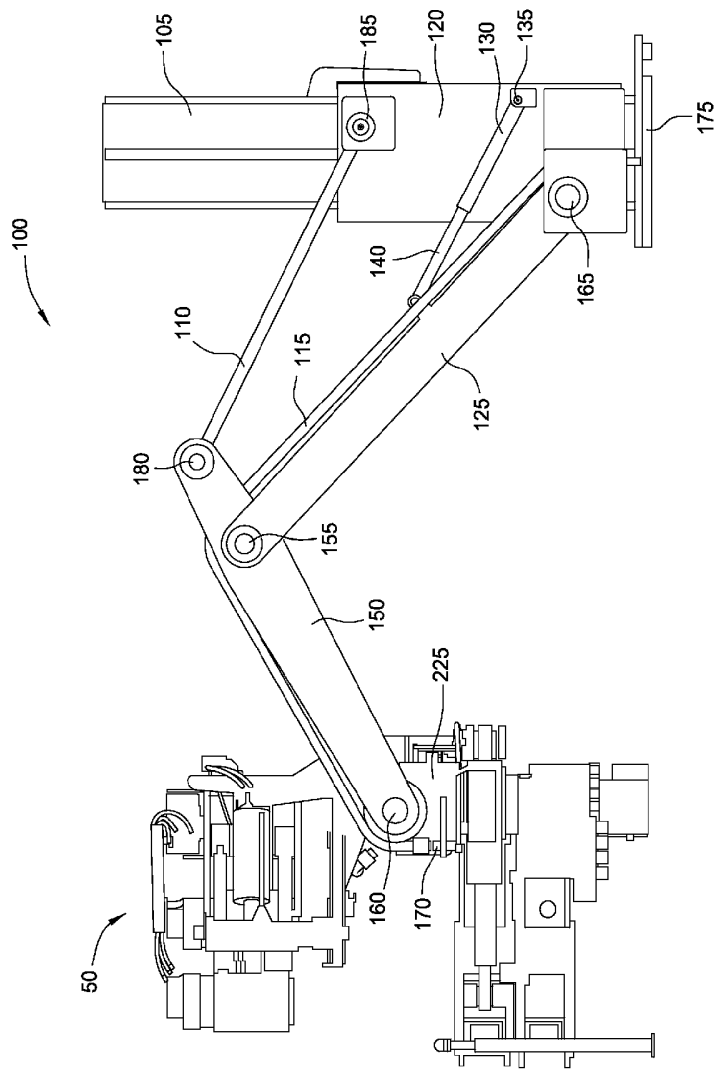
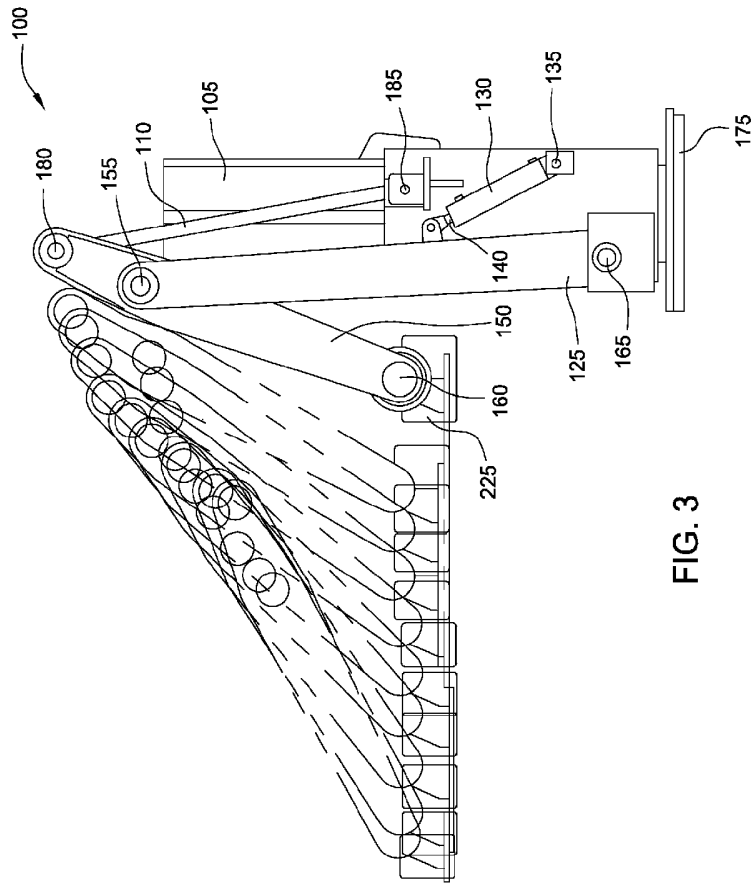
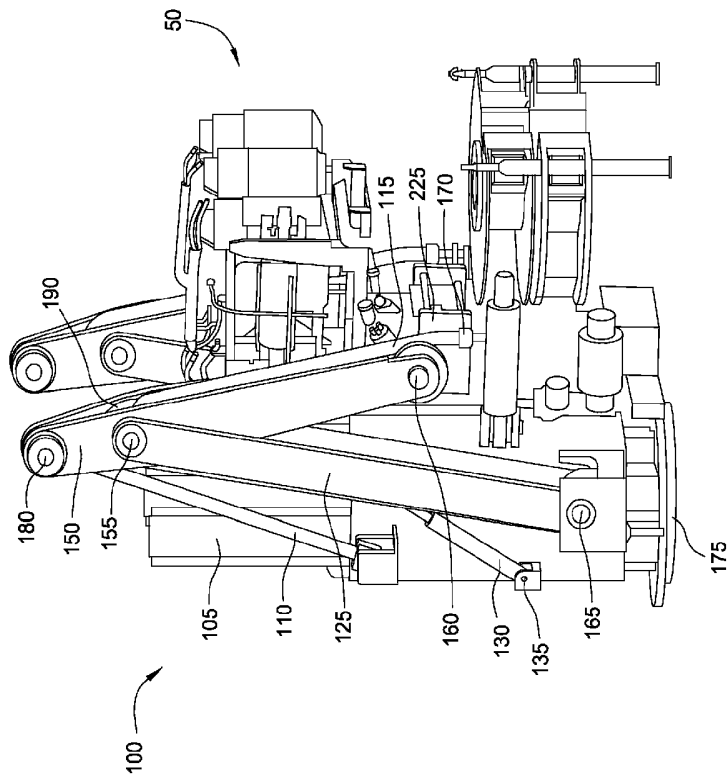


FIG. 2





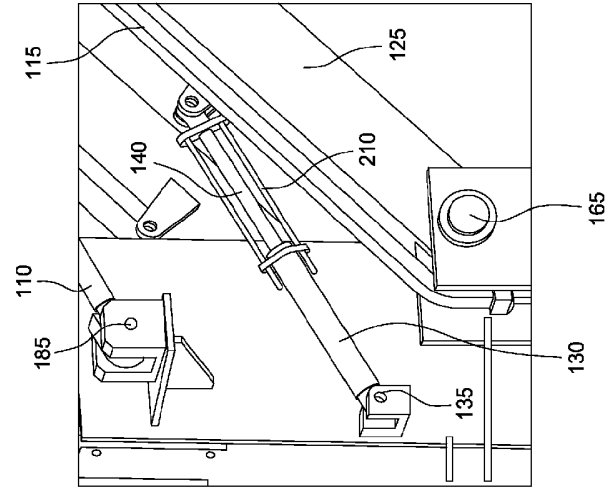


FIG. 5A

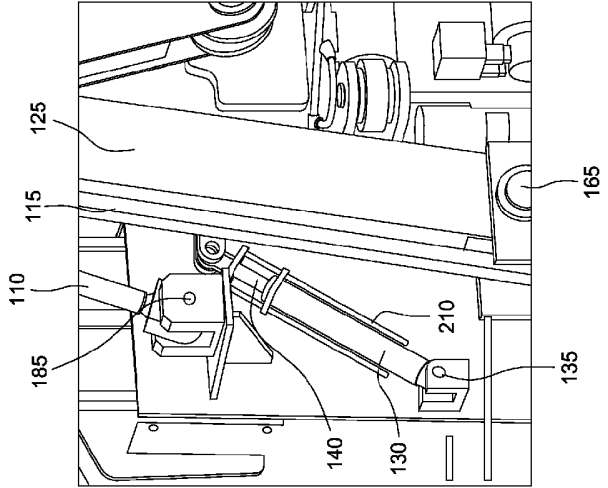
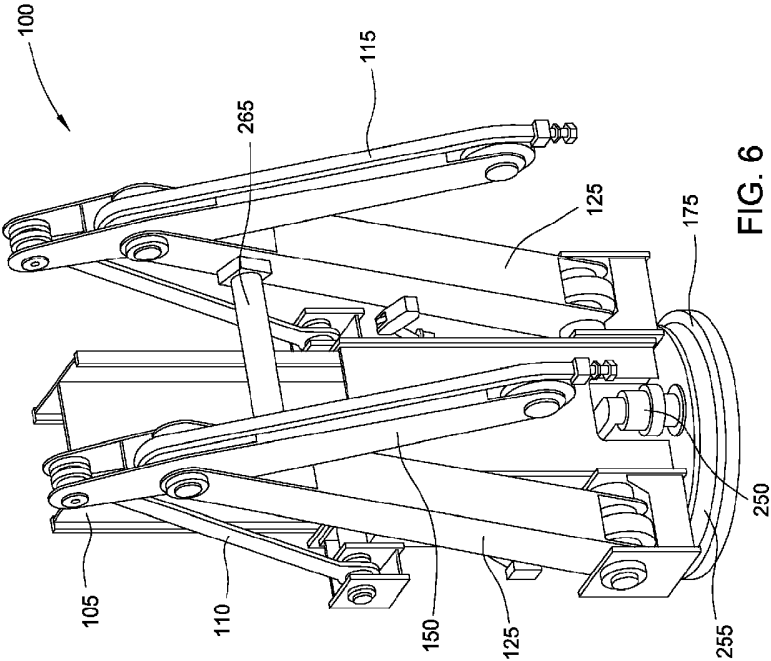
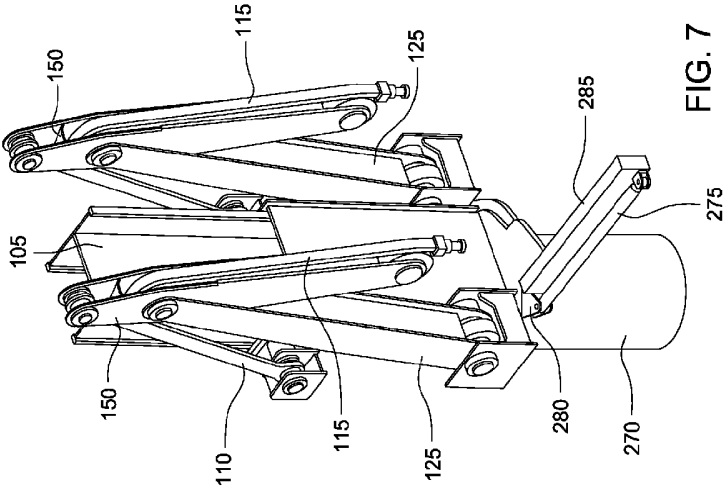


FIG. 5B





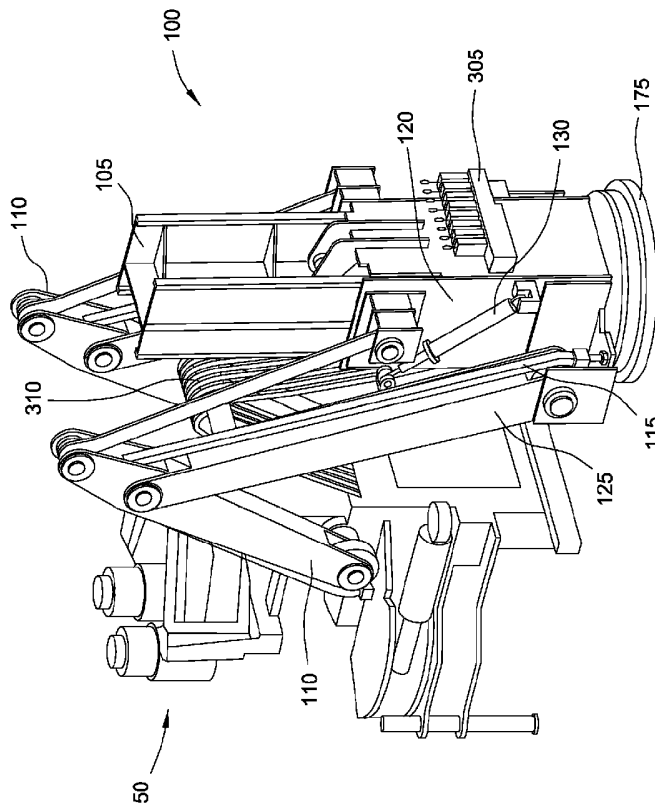


FIG. 8

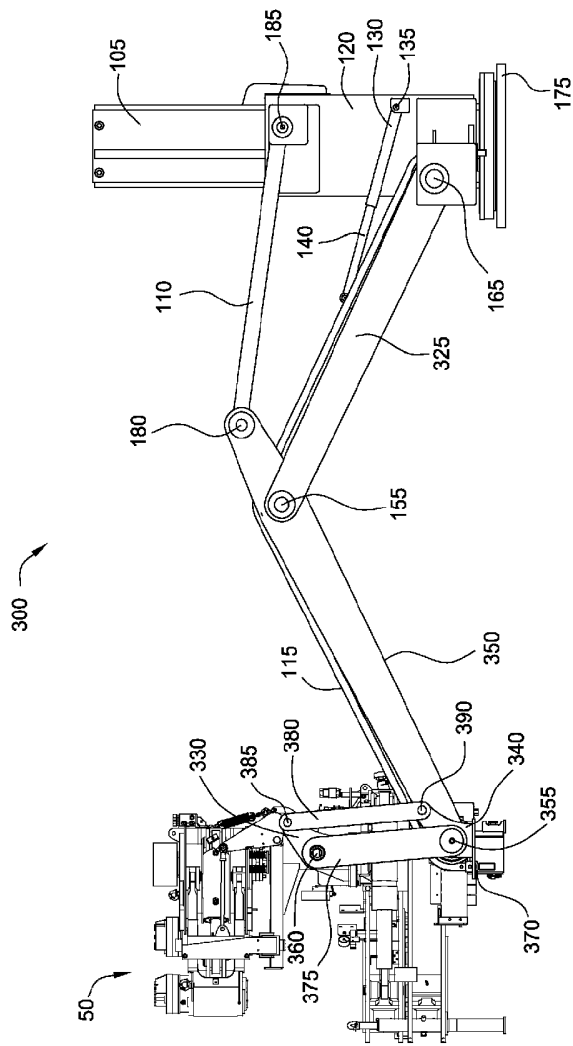


FIG. 9

