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(54) Title: TUBULAR HANDLING APPARATUS

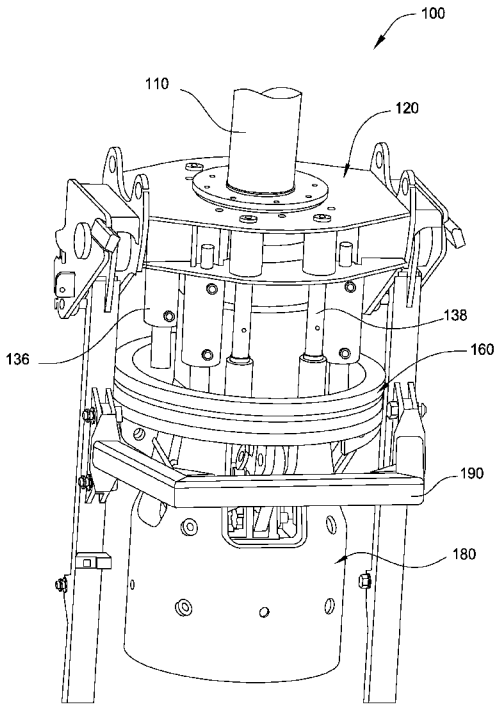

FIG. 1

(57) Abstract: In one embodiment, a tubular handling assembly for use with a top drive includes a mandrel coupled to the top drive; a gripping assembly for gripping and releasing a tubular, the gripping assembly coupled to and rotating with the mandrel; and an actuation assembly for actuating the gripping assembly, wherein the gripping assembly is rotatable relative to the actuation assembly.

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TUBULAR HANDLING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] Embodiments of the invention generally relate to an apparatus for handling tubulars using top drive systems. More particularly, the invention relates to a tubular handling apparatus for engaging a tubular and rotating at the same time.

Description of the Related Art

[0002] In the drilling and completion of wells, top drive systems are used to rotate a drill string to form a borehole. Top drive systems may also be used in a drilling with casing operation to rotate the casing. Top drives require a gripping element to facilitate the gripping of tubulars, whether the tubular is a drill string or a casing, and therefore, there is a need for an apparatus for adapting the top drive and engaging and rotating a tubular.

SUMMARY OF THE INVENTION

[0003] In one embodiment, a tubular handling assembly for use with a top drive includes a mandrel coupled to the top drive; a gripping assembly for gripping and releasing a tubular, the gripping assembly coupled to and rotating with the mandrel; and an actuation assembly for actuating the gripping assembly, wherein the gripping assembly is rotatable relative to the actuation assembly.

[0004] In another embodiment, a tubular handling assembly for use with a top drive includes a mandrel coupled to the top drive; a gripping assembly for gripping and releasing a tubular, the gripping assembly coupled to and rotating with the mandrel; a link assembly rotationally coupled to the mandrel; an actuator coupling rotationally coupled to the gripping assembly; and a plurality of actuators connected to the link assembly and the actuator coupling, wherein the plurality of actuators are configured to actuate the gripping assembly and the gripping assembly is rotatable relative to the plurality of actuators.

[0005] In another embodiment, a tubular handling assembly for use with a top drive includes a mandrel coupled to the top drive; a gripping assembly for gripping and releasing a tubular, the gripping assembly coupled to and rotating with the mandrel; a link assembly coupled to the mandrel using a first bearing assembly; and

an actuation cylinder coupled to the link assembly and to a ring assembly, wherein the actuation cylinder axially moves the ring assembly relative to the link assembly, and wherein the gripping assembly is coupled to the ring assembly using a second bearing assembly.

[0006] In another embodiment, a method of handling a tubular using a top drive includes coupling a mandrel to the top drive; rotationally coupling a gripping assembly to the mandrel, wherein the gripping assembly is configured to grip a tubular; coupling an actuation assembly to the gripping assembly, wherein the actuation assembly is configured to actuate the gripping assembly; gripping the tubular using the gripping assembly; and rotating the gripping assembly and the tubular relative to the actuation assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] So that the manner in which the above recited features of the 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.

[0008] Figure 1 is a perspective view of an embodiment of a tubular handling apparatus adapted to engage an external surface of a tubular;

[0009] Figure 2 is a cross-sectional view of the tubular handling apparatus shown in Figure 1;

[0010] Figure 3 is a perspective view of an embodiment of a tubular handling apparatus adapted to engage an internal surface of a tubular; and

[0011] Figure 4 is a partial cross-sectional view of the tubular handling apparatus shown in Figure 3.

DETAILED DESCRIPTION

[0012] Embodiments of the invention provide a tubular handling apparatus for use with a top drive to engage and rotate a tubular such as a casing. Figure 1 is a

perspective view of an embodiment of a tubular handling apparatus adapted to engage an external surface of the tubular. The apparatus shown in Figure 1 will be referred to herein as an external gripping tool 100. The external gripping tool 100 generally includes a mandrel 110 for connecting to a top drive, a link assembly 120, an actuator coupling such as a leveling ring assembly 160, and a carrier 180 for gripping a tubular, which is also connected to the mandrel 110. The link assembly 120 and the leveling ring assembly 160 may assist with axial loads and support actuation members such as hydraulic or pneumatic cylinders while the carrier 180 includes gripping elements 182 for gripping a tubular. The mandrel 110 is used to rotate the tubular via the carrier 180.

[0013] Figure 2 is a cross-sectional view of the tubular handling apparatus shown in Figure 1. The link assembly 120 includes a link support housing 122 and links 124. The link support housing 122 includes a central opening 126 for receiving the mandrel 110, and the link support housing 122 is connected to the mandrel 110 via a coupling ring 128. The coupling ring 128 is attached to the mandrel 110 and rotates with the mandrel 110. In one embodiment, the coupling ring 128 could be a nut which threadedly attaches to an exterior surface of the mandrel 110.

[0014] A first bearing assembly 130 and a second bearing assembly 132 are coupled to the coupling ring 128 at an inner portion of the first and second bearing assemblies 130, 132, and the first and second bearing assemblies 130, 132 are coupled to the link support housing 122 at an exterior portion of the first and second bearing assemblies 130, 132. The bearing assemblies 130, 132, in one embodiment, include an inner ring and an outer ring with balls disposed between the two rings. In such configuration, the coupling ring 128 is connected to the inner portion of the inner ring of the bearing assemblies 130, 132, and the link support housing 122 is connected to the exterior portion of the outer ring of the bearing assemblies 130, 132.

[0015] As shown in Figure 2, the first bearing assembly 130 is positioned at an upper portion of the link support housing 122 and an upper portion of the coupling ring 128. In one embodiment, the coupling ring 128 includes an upper shoulder or groove for accepting the first bearing assembly 130. An optional retainer 134 may be used to retain the bearing assembly. The second bearing assembly 132 is positioned at a lower portion of the link support housing 122 and a lower portion of the coupling ring 128. In one embodiment, the coupling ring 128 includes a lower shoulder or groove

for accepting the second bearing assembly 132. Because the link support housing 122 is connected to the mandrel 110 via the coupling ring 128 and first and second bearing assemblies 130, 132, the link support assembly 120 does not rotate with the mandrel 110. However, axial loads experienced by the links 124 may be transferred to the mandrel 110 via the bearing assemblies 130, 132. Further, because the bearing assemblies 130, 132 are positioned at a top and bottom portion of the link support housing 122, the first and second bearing assemblies 130, 132 balance the loads acting on the assemblies 130, 132.

[0016] In one embodiment, a torque reaction bracket may be attached to the link support assembly 120 to prevent the link support housing 122 from rotating in relation to the mandrel 110 and the coupling ring 128. One end of the torque reaction bracket may be coupled to the link support assembly 120 and the other end of the torque reaction bracket may be coupled to a rotationally fixed location, such as a rail on a drilling derrick or part of the top drive. In another embodiment, the torque reaction bracket may be attached to the leveling ring member 162 of the leveling ring assembly 160 to prevent rotation of the leveling ring member 162. One end of the torque reaction bracket may be coupled to the leveling ring member 162 and the other end of the torque reaction bracket may be coupled to a rotationally fixed location, such as a rail on a drilling derrick or part of the top drive.

[0017] Actuation cylinders 136 are coupled to the link support assembly 120 and to the leveling ring assembly 160. In one embodiment, the actuation cylinders 136 are coupled to the link support housing 122 of the link support assembly 120 and a leveling ring member 162 of the leveling ring assembly 160. The actuation cylinders 136 allow the leveling ring assembly 160 to be axially moved relative to the link support assembly 120. In addition, torque support bars 138 (shown in Fig. 1), which in one embodiment are telescoping torque support bars, may optionally be connected to the link support assembly 120 and the leveling ring assembly 160 in order to provide structural support to the tubular handling apparatus 100. The torque support bars 138 may also keep the link support assembly 120 aligned with the leveling ring assembly 160.

[0018] The leveling ring assembly 160 includes a leveling ring member 162 that is connected to a slip link coupling 164. The leveling ring member 162 and slip link coupling 164 are connected by a first and second leveling ring bearing assembly 170,

172. As shown, the leveling ring 160 forms an outer ring and the slip link coupling 164 forms an inner ring. The slip link coupling 164 is coupled a slip link assembly 176, which is coupled to the carrier 180. Because the carrier 180 is connected to the mandrel 110, which rotates, the slip link assembly 176 and the slip link coupling 164 also rotate. However, the leveling ring member 162, which does not rotate, is connected to the slip link coupling 164 by the first and second leveling ring bearing assemblies 170, 172. Further, the leveling ring member 162 may be prevented from rotating by the actuation cylinders 136 and the optional torque support bars 138.

[0019] The slip link assembly 176 may include one or more links 178 that are connected to gripping elements 182, which are disposed in a window of the carrier 180. As the slip link assembly 176 axially moves with the leveling ring assembly 160, the links 178 move the gripping elements 182 within the carrier 180. The leveling ring assembly 160 helps ensure that the gripping elements 182 move in unison. The actuation cylinders 136 can be retracted to move the leveling ring assembly 160 upwards relative to the link assembly 120. In turn, the links 178 of the slip link assembly 176 move upwards with the leveling ring assembly 160, thereby lifting the gripping elements 182 upward to the non-gripping position. In one embodiment, the links keep the gripping elements 182 in the proper position relative to the window. When the actuation cylinders 136 are in an extended position, the leveling ring assembly 160 is furthest down axially, and the links 178 position the gripping elements 182 in a gripping position. Once the tubular is clamped, the top drive may rotate the mandrel 110 and the clamped tubular. To unclamp the tubular, the actuation cylinders 136 may be actuated to move back to their retracted position, which in turn will move the leveling ring assembly 160 and slip link assembly 176 up relative to the carrier 180, thereby causing the gripping elements 182 to release the tubular. Optionally, the internal gripping tool 200 may be equipped with a fill-up tool 290.

[0020] In one embodiment, a bracket 190 (shown in Figure 1) is connected to two of the links 124. The bracket 190 keeps the links 124 aligned during operation. For example, during pick up of a tubular, the bracket 190 prevents the links 124 from twisting relative to each other.

[0021] Figure 3 is a perspective view of an embodiment of a tubular handling apparatus adapted to engage an internal surface of the tubular, and will be referred to

herein as an internal gripping tool 200. The internal gripping tool 200 generally includes a mandrel 210 for connecting to a top drive and rotating the tubular, a link assembly 220 for supporting bails, a hydraulic actuator 218, which is in part supported by the link assembly 220, and gripping elements 280 for gripping a tubular from the internal surface of the tubular when actuated by the hydraulic actuator 218. Optionally, the internal gripping tool 200 may be equipped with a fill-up tool 290.

[0022] Figure 4 is a cross-sectional view of a top portion of the internal gripping tool 200 shown in Figure 3. The link assembly 220 includes a link support housing 222 that includes a central opening 226 for receiving the mandrel 210, and the link support housing 222 is connected to the mandrel 210 via a coupling ring 228. The coupling ring 228 is attached to the mandrel 210 and rotates with the mandrel 110. In one embodiment, the coupling ring 228 could be a nut which threadedly attaches to an exterior surface of the mandrel 210.

[0023] A first bearing assembly 230 and a second bearing assembly 232 are coupled to the coupling ring 228 at an inner portion of the first and second bearing assemblies 230, 232, and the first and second bearing assemblies 230, 232 are coupled to the link support housing 222 at an exterior portion of the first and second bearing assemblies 230, 232. The bearing assemblies 230, 232, in one embodiment, include an inner ring and an outer ring with balls disposed between the two rings. In such configuration, the coupling ring 228 is coupled to the inner portion of the inner ring of the bearing assemblies 230, 232, and the link support housing 222 is coupled to the exterior portion of the outer ring of the bearing assemblies 230, 232. As shown in Figure 4, the first bearing assembly 230 is positioned at an upper portion of the link assembly 220 and at an upper portion of the coupling ring 228. In one embodiment, the coupling ring 228 includes an upper shoulder or groove for accepting the first bearing assembly 230. The second bearing assembly 232 is positioned at a lower portion of the link assembly 220 and a lower portion of the coupling ring 228. In one embodiment, the coupling ring 228 includes a lower shoulder or groove for accepting the second bearing assembly 232. Because the link support housing 222 is connected to the mandrel 210 via the coupling ring 228 and first and second bearing assemblies 230, 232, the link support assembly 220 does not rotate with the mandrel 210. A torque reaction bracket may be provided to attach the non-rotating components to a fixture, such as a rail on a drilling derrick.

[0024] The hydraulic actuator 218 includes one or more actuation cylinders 236, which are coupled to the link support assembly 220 at an upper end, and coupled to an engagement plate 240 at a lower end. Bolts 224 or any other suitable fastening mechanism known to one skilled in the art, such as a pin connection, may be used to fasten the actuation cylinders 236 to the link support assembly 220 and the engagement plate 240. Optionally, torque support bars 238 shown in Figure 3, which in one embodiment are telescoping torque support bars, may optionally be connected to the link assembly 220 and the engagement plate 240 in order to provide structural support to the tubular handling apparatus 200.

[0025] An actuator coupling 242 is positioned between the actuation cylinders 236 and the engagement plate 240, and extends from the actuation cylinders 236 to an actuator pipe 250. The actuator pipe 250 is connected to the gripping elements 280. The actuator coupling 242 is connected to the actuator pipe 250 by a third bearing assembly 244. As shown, the actuator coupling 242 is disposed around the actuator pipe 250. Because the actuator pipe 250 is connected to the gripping elements 280, which in turn are coupled to the mandrel 210, the actuator pipe 250 rotates with the mandrel 210. However, because the actuator pipe 250 is connected to the actuator coupling 242 via the third bearing assembly 244, the actuator coupling 242 remains stationary along with the actuation cylinders 236 and the engagement plate 240.

[0026] Actuation of the actuation cylinders 236 urges axial movement of the actuator coupling 242 and actuator pipe 250. When the actuation cylinders 236 are actuated to expand, a portion of the cylinders move downwards relative to the link support assembly 220. The gripping elements 280 are moved axially downwards relative to the mandrel 110 and result in the internal gripping tool 200 gripping the internal portion of the tubular. When the actuation cylinders 236 are actuated to contract, a portion of the cylinders move upwards relative to the link support assembly 220. The gripping elements 280 are moved axially upwards relative to the mandrel 110 and result in the internal gripping tool 200 releasing the internal portion of the tubular.

[0027] In use, the internal gripping tool 200 is positioned within an inner diameter of a tubular. The upper end of the tubular may engage or is proximate a bottom portion of the engagement plate 240. The gripping elements 280 may be actuated by the non-rotating actuation cylinders 236 to grip an internal surface of the tubular. As

discussed above, the actuation cylinders 236 are isolated from rotation by first, second, and third bearing assemblies 230, 232, 244 that provide a connection between the link support assembly 220 to the mandrel 210 and the connection between the actuator coupling 242 and engagement plate 240 to the mandrel 210. The engagement plate 240 may act to limit the vertical position of the tubular relative to the internal gripping tool 200. After the internal gripping tool 200 grips the internal surface of the tubular, the mandrel 210 may be rotated by the top drive to thread one joint of the gripped tubular to another tubular. As the mandrel 210 and the gripping elements 280 rotate, the actuation cylinders 236 that position the gripping elements 280 relative to the tubular do not rotate and are able to maintain the appropriate tension on the gripping elements 280. After the tubulars are made up or threaded together, the top drive may stop rotation of the mandrel 210, and the gripping elements 280 may be actuated by the actuation cylinders 236 to release the internal surface of the tubular.

[0028] In one embodiment, a tubular handling assembly for use with a top drive includes a mandrel coupled to the top drive; a gripping assembly for gripping and releasing a tubular, the gripping assembly coupled to and rotating with the mandrel; a link assembly rotationally coupled to the mandrel; an actuator coupling rotationally coupled to the gripping assembly; and a plurality of actuators connected to the link assembly and the actuator coupling, wherein the plurality of actuators are configured to actuate the gripping assembly and the gripping assembly is rotatable relative to the plurality of actuators.

[0029] In one or more of the embodiments described herein, a slip link coupling is disposed around the actuator coupling.

[0030] In one or more of the embodiments described herein, the plurality of actuators are connected to the actuator coupling and the gripping assembly is coupled to the slip link coupling.

[0031] In one or more of the embodiments described herein, the gripping assembly is configured to grip an exterior surface of a tubular.

[0032] In one or more of the embodiments described herein, the actuator coupling is disposed around an actuator pipe.

[0033] In one or more of the embodiments described herein, the gripping assembly is configured to grip an interior surface of a tubular.

[0034] In one or more of the embodiments described herein, the plurality of actuators are configured to axially move the actuator coupling.

[0035] In one or more of the embodiments described herein, the actuator coupling comprises a leveling ring.

[0036] In one or more of the embodiments described herein, one or more bearing assemblies couples the actuator coupling to the gripping assembly.

[0037] In one or more of the embodiments described herein, the plurality of actuators comprise a piston and cylinder assembly.

[0038] In one or more of the embodiments described herein, the actuator coupling is axially moved relative to the link assembly.

[0039] In one or more of the embodiments described herein, one or more bearing assemblies rotationally couples the link assembly to the mandrel.

[0040] In another embodiment, a tubular handling assembly for use with a top drive includes a mandrel coupled to the top drive; a gripping assembly for gripping and releasing a tubular, the gripping assembly coupled to and rotating with the mandrel; a link assembly coupled to the mandrel using a first bearing assembly; and a plurality of actuation cylinders coupled to the link assembly and to a ring assembly, wherein the plurality of actuation cylinders axially move the ring assembly relative to the link assembly, and wherein the gripping assembly is coupled to the ring assembly using a second bearing assembly.

[0041] In one or more of the embodiments described herein, a torque reaction bracket is coupled to the link assembly and to a rotationally fixed location to prevent the link assembly from rotating.

[0042] In one or more of the embodiments described herein, a torque support bar is coupled to the link assembly and the ring assembly to provide structural support.

[0043] In one or more of the embodiments described herein, the gripping assembly includes a plurality of gripping elements coupled to a housing.

[0044] In one or more of the embodiments described herein, the gripping elements engage an external surface of the tubular.

[0045] In one or more of the embodiments described herein, the gripping assembly includes a plurality of gripping elements coupled to an actuator pipe.

[0046] In one or more of the embodiments described herein, the gripping elements engage an internal surface of the tubular.

[0047] In another embodiment, a method of handling a tubular using a top drive includes coupling a mandrel to the top drive; rotationally coupling a gripping assembly to the mandrel, wherein the gripping assembly is configured to grip a tubular; coupling a link assembly to the mandrel; disposing a plurality of actuation assemblies between the link assembly and a slip coupling, wherein the plurality of actuation assemblies are configured to actuate the gripping assembly; actuating the gripping assembly to grip the tubular by moving the slip coupling axially relative to the link assembly; and rotating the gripping assembly and the tubular relative to the plurality of actuation assemblies.

[0048] While the foregoing is directed to embodiments of the 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.

Claims:

1. A tubular handling assembly for use with a top drive, comprising:

a mandrel coupled to the top drive;

a gripping assembly for gripping and releasing a tubular, the gripping assembly coupled to and rotating with the mandrel;

a link assembly rotationally coupled to the mandrel;

an actuator coupling rotationally coupled to the gripping assembly; and

a plurality of actuators connected to the link assembly and the actuator coupling, wherein the plurality of actuators are configured to actuate the gripping assembly and the gripping assembly is rotatable relative to the plurality of actuators.

2. The assembly of claim 1, further comprising a slip link coupling disposed around the actuator coupling.

3. The assembly of claim 2, wherein the plurality of actuators are connected to the actuator coupling and the gripping assembly is coupled to the slip link coupling.

4. The assembly of claim 3, wherein the gripping assembly is configured to grip an exterior surface of a tubular.

5. The assembly of claim 1, wherein the actuator coupling is disposed around an actuator pipe.

6. The assembly of claim 5, wherein the gripping assembly is configured to grip an interior surface of a tubular.

7. The assembly of claim 1, wherein the plurality of actuators are configured to axially move the actuator coupling.

8. The assembly of claim 1, wherein the actuator coupling comprises a leveling ring.

9. The assembly of claim 1, further comprising one or more bearing assemblies for coupling the actuator coupling to the gripping assembly.

10. The assembly of claim 1, wherein the plurality of actuators comprise a piston and cylinder assembly.

11. The assembly of claim 1, wherein the actuator coupling is axially moved relative to the link assembly.

12. The assembly of claim 1, further comprising one or more bearing assemblies for rotationally coupling the link assembly to the mandrel.

13. A tubular handling assembly for use with a top drive, comprising:

a mandrel coupled to the top drive;

a gripping assembly for gripping and releasing a tubular, the gripping assembly coupled to and rotating with the mandrel;

a link assembly coupled to the mandrel using a first bearing assembly; and

a plurality of actuation cylinders coupled to the link assembly and to a ring assembly, wherein the plurality of actuation cylinders axially move the ring assembly relative to the link assembly, and

wherein the gripping assembly is coupled to the ring assembly using a second bearing assembly.

14. The assembly of claim 13, further comprising a torque reaction bracket that is coupled to the link assembly and to a rotationally fixed location to prevent the link assembly from rotating.

15. The assembly of claim 13, further comprising a torque support bar that is coupled to the link assembly and the ring assembly to provide structural support.

16. The assembly of claim 13, wherein the gripping assembly includes a plurality of gripping elements coupled to a housing.

17. The assembly of claim 16, the gripping elements engage an external surface of the tubular.

18. The assembly of claim 13, wherein the gripping assembly includes a plurality of gripping elements coupled to an actuator pipe.

19. The assembly of claim 18, wherein the gripping elements engage an internal surface of the tubular.

20. A method of handling a tubular using a top drive, comprising:

coupling a mandrel to the top drive;

rotationally coupling a gripping assembly to the mandrel, wherein the gripping assembly is configured to grip a tubular;

coupling a link assembly to the mandrel;

disposing a plurality of actuation assemblies between the link assembly and a slip coupling, wherein the plurality of actuation assemblies are configured to actuate the gripping assembly;

actuating the gripping assembly to grip the tubular by moving the slip coupling axially relative to the link assembly; and

rotating the gripping assembly and the tubular relative to the plurality of actuation assemblies.

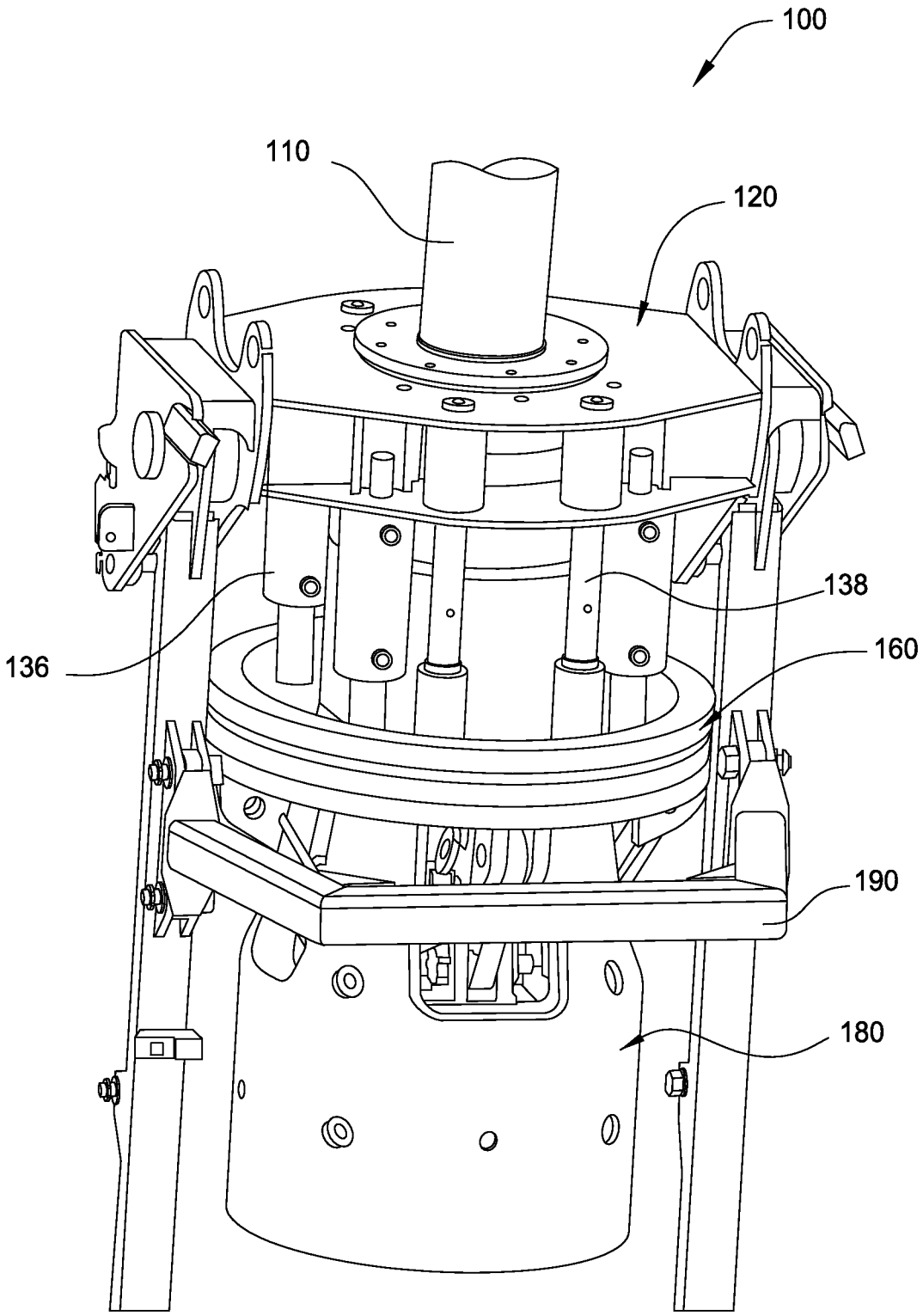

FIG. 1

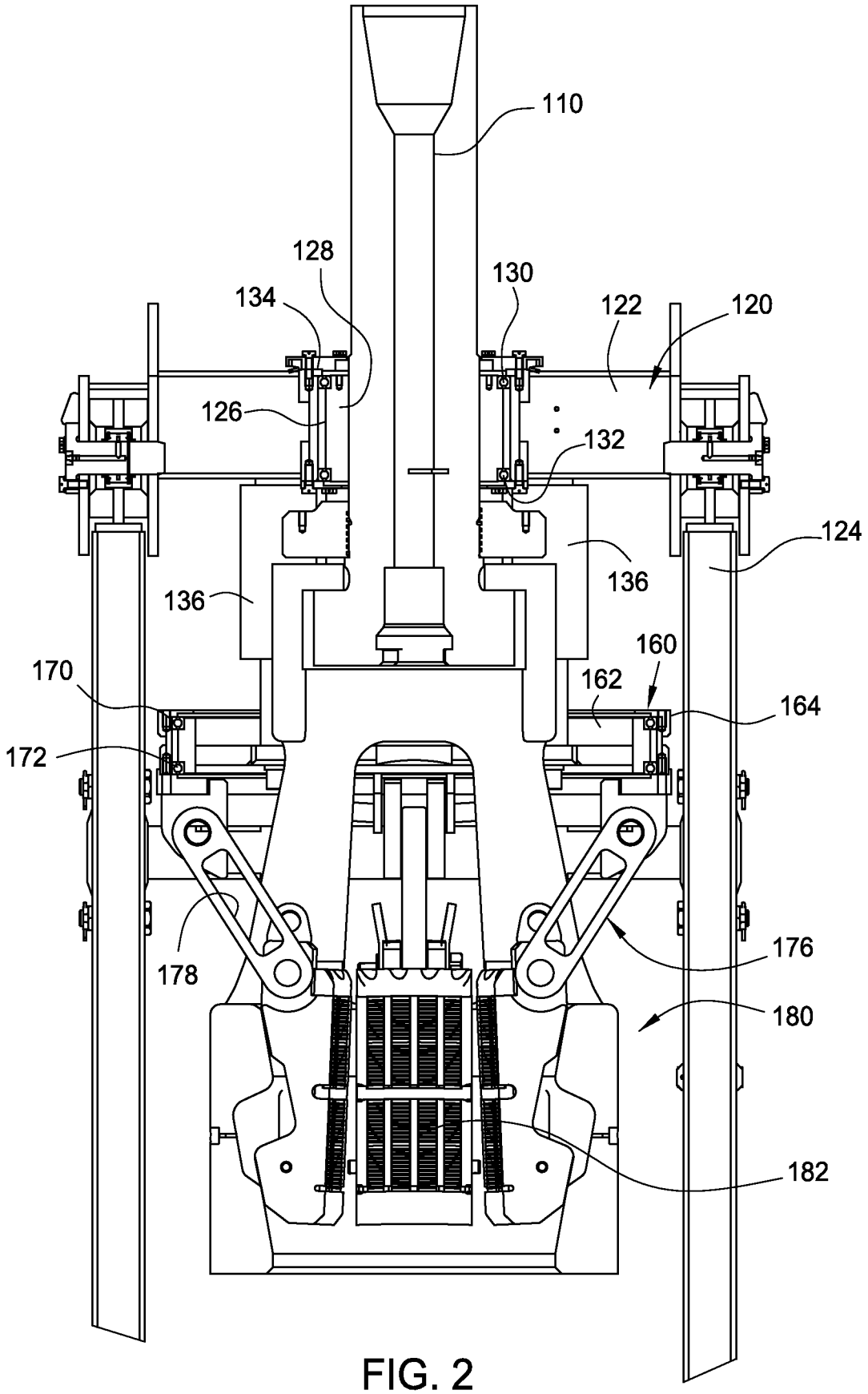
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FIG. 2

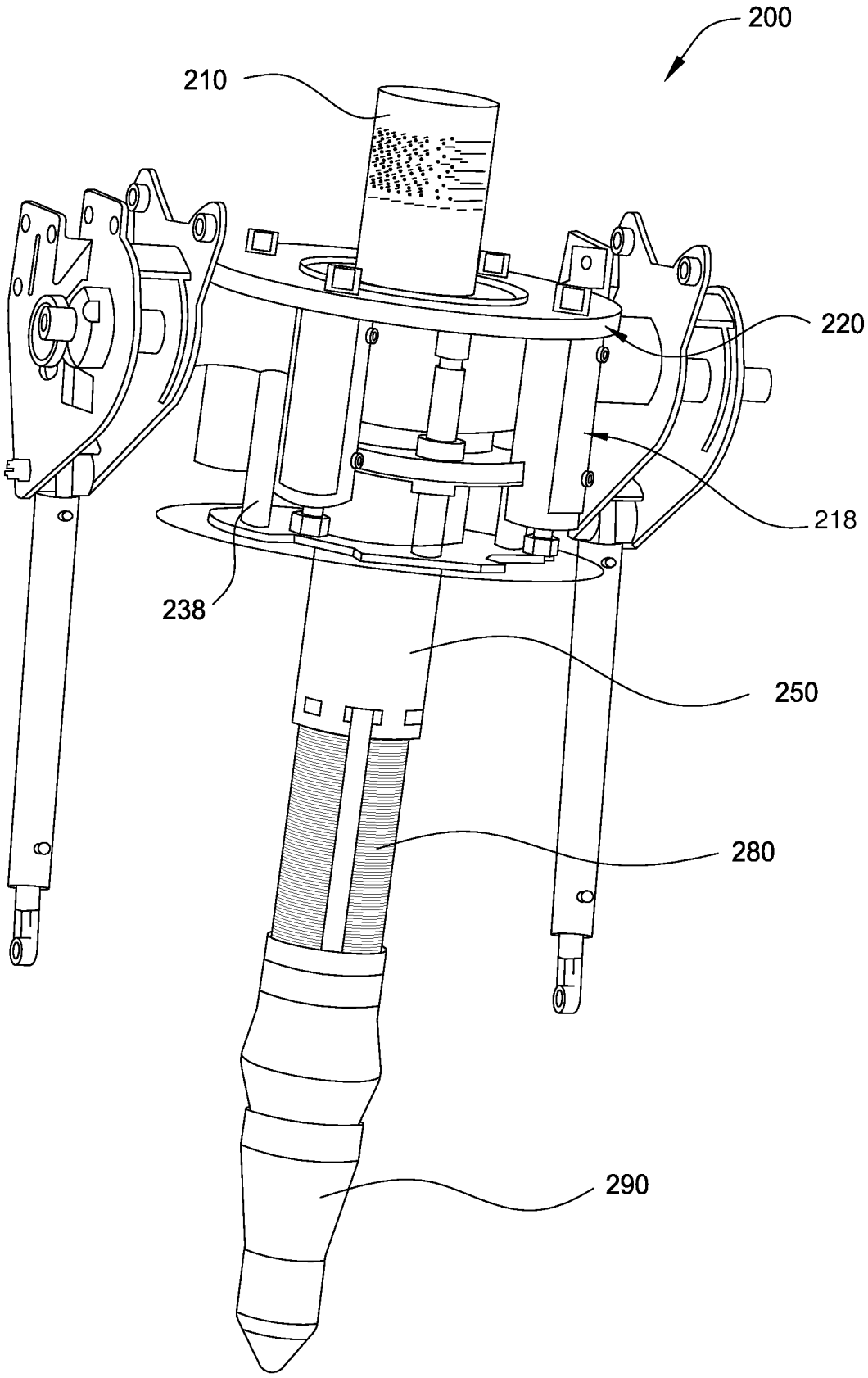

FIG. 3

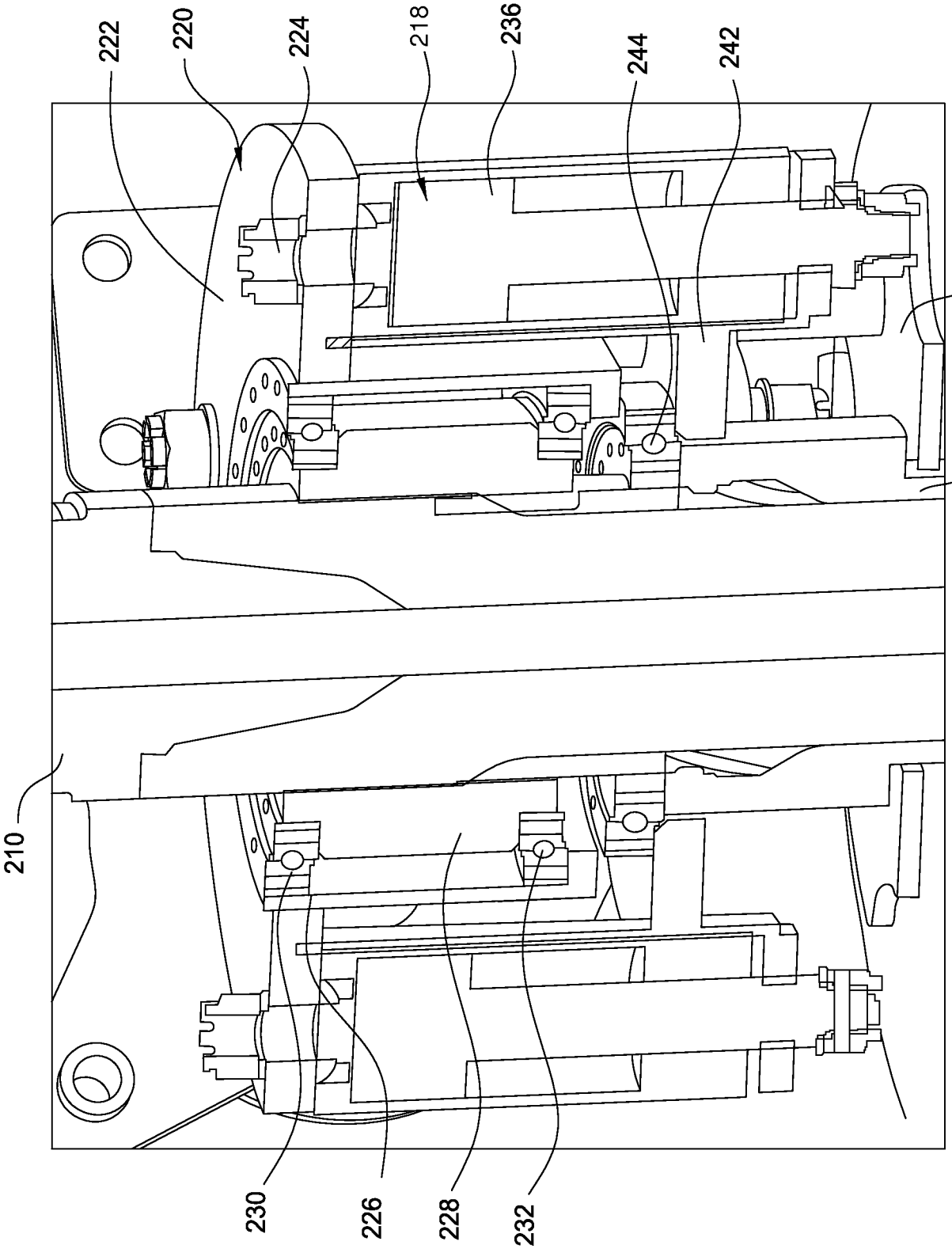

FIG. 4