The sixth and eighth drive shafts 174, 178 are rotatably attached to the housing 102 along the axis 96 and rotate the respective jaws about the axis 96. The second and fourth drive shafts are also adjacent each other along the axis 96, and are laterally spaced apart along the axis 96. A portion of the jaw 140b adjacent the fourth drive shaft 178 does not overlap the jaw 130b when the jaws 130b and 140b are in the engaged position. However, an engagement portion of the jaw 140b overlaps and engages an engagement portion of the jaw 130b when the jaws 130b and 140b are in the engaged position.

When operating the latches 110, 120, 130, 140, the first latch 110 is rotated into an engaged position before the other latches 120, 130, 140. The second latch 120 can be rotated into an engaged position after the first latch 110 is actuated to the engaged position and before the other latches 130, 140 are actuated. The third latch 130 can be rotated into an engaged position after the first and second latches 110, 120 are actuated to the engaged position and before the other latch 140 is actuated. The fourth latch 140 can be rotated into an engaged position after the first, second, and third latches 110, 120, 130 are actuated to the engaged position. With all four latches in the engaged position, (as seen in Fig. 7) the elevator 100 is configured with a minimal diameter opening through the engaged latches 110, 120, 130, 140. With each successive closure of the latches 110, 120, 130, 140, the minimum diameter of the opening through the latches decreases. Conversely, as the latches are sequentially rotated from the engaged positions to disengaged positions in reverse order, the minimum diameter of the opening through the latches increases. This allows the elevator 100 to be reconfigured to handle tubulars 38 with a wide range of diameters. The elevator can be automatically reconfigured by the controller 50 and/or processors in the enclosure 150 based on sensor date, and/or manually configured by the controller 50 and/or the processors in the enclosure 150 based on user inputs.

Referring now to FIG. 7, in addition to the rotary actuators 212, 214, 216, 218 that operate the latches 110, 120, 130, 140, respectively, the elevator 100 can also include a rotary actuator 210 that operates to rotate the elevator housing 102 relative to the links 44. The rotary actuator 210 can be fixedly attached to the housing 102 and a drive shaft of the actuator 210 is coupled to the link interfaces 222, 224 by coupling 230. As the rotary actuator 210 rotates its drive shaft drives the coupling 230 and operates to rotate the link interfaces 222, 224, which rotate together relative to the housing 102. The link interface 222 can include a pair of angled flanges 226a, 226b disposed on opposite sides of a first link 44, and the link interface 224 can include a pair of angled flanges 228a, 228b disposed on opposite

protrusions 426 to allow the removable device 410 to receive the protrusions 426 into the openings 412 (see FIG. 22). When the protrusions 426 and the openings 412 are aligned, the first plate 404 can engage the mounting flange 425. However, since the biasing devices 408 urge the first and second plates 404, 406 away from each other, the removable device 410 cannot be rotated relative to the protrusions 426 (and retention feature 422) because the distance the mounting flange 425 to the opposite side of the second plate 406 is larger than the gap 428.

FIG. 23 shows the removable device 410 mounted onto the retainer mount 420 with a compression force applied to the second plate 406 via the compression handles 418, thereby compressing the springs 418 and reducing the distance from the mounting flange 425 to the opposite side of the second plate 406 to be less than the gap 428. In this configuration, the protrusions 426 are above the opposite side of the second plate 406 and the removable retainer 410 can be rotated as shown by arrows 430 to align the protrusions 426 with the recesses 414. With the protrusions 426 aligned with the recesses 414, the compression force applied to the compression handles 418 can be released and the biasing devices 408 will again urge the first and second plates 404, 406 away from each other forcing the protrusions 426 into the recesses 414. With the protrusions 426 seated in the recesses 414, the removable device 410 is prevented from rotating further and thereby secures the removable device 410 to the retainer mount 420.

FIG. 24 is a cross-sectional view of the link retainer 400 with the protrusions 426 seated in the recesses 414. It should be understood that the protrusions can be various shapes and sizes as long as the openings 412 match those shapes and sizes with appropriate clearances, and that the rotation into the secured position is possible.

FIG. 25 shows an elevator with a link interface system 220 that can include link interfaces 222, 224 which are similar to the link interface 222 shown in FIG. 14B that has adjustable angled flanges 226a, 226b. FIG. 25 also shows a link retainer 400 with extended handles 418 that can include an opening for improved operator grasping and manipulation of the handles 418.

FIG. 25 is a representative perspective view a housing 102 of an elevator 100 with latch assemblies of the elevator 100 removed to observe a circular weight sensor 480 positioned around a center of the elevator 100. A spacer ring 108 (not shown) can be mounted above it and transfer weight of a tubular 34 captured in the elevator 100 to the circular weight sensor 480. In operation of the elevator 100, the latches, when in a closed

CLAIMS

1. A system for conducting subterranean operations comprising:

an elevator configured to move a tubular, the elevator comprising:

a housing defining a central bore configured to receive the tubular therein, the central bore having a central axis;

a rotary actuator contained within the housing; and

a link interface system configured to rotate the housing +/- 102 degrees about a housing axis, wherein the rotary actuator comprises a rotatable drive shaft that is rotatably coupled to the link interface system and is configured to rotate a link interface of the link interface system about the housing axis.

2. The system of claim 1, wherein the link interface system is configured to engage a pair of links and rotate the housing relative to the links within a range of +/- 4 degrees, +/- 8 degrees, +/- 12 degrees, +/- 16 degrees, +/- 20 degrees, +/- 24 degrees, +/- 28 degrees, +/- 32 degrees, +/- 36 degrees, +/- 40 degrees, +/- 44 degrees, +/- 48 degrees, +/- 52 degrees, +/- 56 degrees, +/- 60 degrees, +/- 64 degrees, +/- 68 degrees, +/- 72 degrees, +/- 76 degrees, +/- 80 degrees, +/- 84 degrees, +/- 88 degrees, +/- 92 degrees, +/- 95 degrees, +/- 96 degrees, +/- 100 degrees, and +/- 102 degrees relative to an axis of at least one of the links.

3. The system of claim 1, further comprising a hydraulic generator and an energy storage device, wherein the hydraulic generator generates electrical energy for operation of the elevator and stores a portion of the electrical energy in the energy storage device, and wherein the elevator is configured to be operated in an explosive environment.

4. The system of claim 1, wherein the elevator, with the housing in a substantially horizontal orientation, is configured to support a tubular that weighs up to 1180 metric tons (~ 1300 short tons), or up to 1134 metric tons (~ 1250 short tons), or up to 1189 metric tons (~ 1200 short tons), or up to 907 metric tons (~ 1000 short tons), or up to 680 metric tons (~ 750 short tons), or up to 454 metric tons (~ 500 short tons), or up to 318 metric tons (~ 350 short tons), or up to 227 metric tons (~ 250 short tons).

5. The system of claim 1, wherein the elevator is configured to manipulate the tubular between horizontal and vertical orientations, and wherein the tubular weighs up to 3000 kg (~ 3 short tons).

6. The system of claim 1, wherein the elevator further comprises one or more sensors disposed between a spacer ring and the housing, and a controller, wherein the sensors detect a force applied between the spacer ring and the housing, and the controller is configured to determine a weight of the tubular supported by the elevator.

7. The system of claim 1, further comprising a top drive coupled to the elevator housing via a pair of links, with each of the links rotationally attached to the top drive at one end and rotationally attached to the housing at an opposite end.

8. The system of claim 1, wherein the housing axis is perpendicular to the central axis, wherein the link interface system comprises a rotary actuator having a body and a drive shaft, with the body fixedly attached to the housing and the drive shaft coupled to a link interface that is rotationally attached to the housing, and wherein when the drive shaft is rotated by the rotary actuator, the link interface is rotated about the housing axis.

9. The system of claim 1, further comprising a rotary actuator coupled to a pair of jaws of the elevator and a sensor coupled to the rotary actuator, wherein the sensor detects an angular position of the rotary actuator, and a controller is configured to determine whether the pair of jaws are in an engaged or disengaged position.

10. The system of claim 1, further comprising:

a rig;

a top drive supported by the rig;

a pair of links rotatably attached to the top drive; and

the elevator rotatably attached to the pair of links.

11. The system of claim 1, wherein the link interface system is configured to interface with any one of a plurality of links with at least one of the plurality of links having a first diameter, another one of the plurality of links having a second diameter, and the first diameter is different than the second diameter.

12. The system of claim 11, wherein the link interface system comprises at least one pair of angled flanges that are configured to vary a clearance between angled flanges of the at least one pair of angle flanges from a first clearance to a second clearance, wherein the first clearance allows the angled flanges of the at least one pair of angled flanges to straddle a link with the first diameter and prevents the angled flanges of the at least one pair of angled flanges from straddling a link with the second diameter.

13. The system of claim 1, further comprising:

a first latch comprising first and second jaws, with each of the first and second jaws being coupled to the housing and configured to be moveable between an engaged position and a disengaged position; and

an electronics controller disposed in an electronics enclosure within the housing and configured to control the elevator to handle the tubular.

14. The system of claim 13, further comprising an electronics controller disposed in the enclosure and configured to control the elevator to handle the tubular, wherein the electronics enclosure is configured to be ATEX certified or IECEx certified according to EX Zone 1 requirements.

15. The system of claim 14, further comprising a hydraulic generator and an energy storage device, wherein the hydraulic generator generates electrical energy for operation of the elevator and stores a portion of the electrical energy in the energy storage device, and wherein the storage device is disposed within the electronics enclosure.