

WEIGHT-SET MANDREL AND TUBING HANGER

CROSS REFERENCE TO RELATED APPLICATIONS

- [0001] The present application is a patent cooperation treaty (PCT) application that claims the benefit of and priority to Provisional U.S. Patent Application No. 62/214,754, filed September 4, 2015, titled “Weight-Set Mandrel and Tubing Hanger,” and U.S. Patent Application No. 15/257,700, also titled “Weight-Set Mandrel and Tubing Hanger,” filed September 6, 2016; both of the above applications are incorporated in their entirety herein by reference.

FIELD

- [0002] Embodiments usable within the scope of the present disclosure relate, generally, to a simplified weight-set hanger system requiring no manual intervention.

BACKGROUND

- [0003] It is common in the oil & gas industry for casing and tubing hangers to depend upon the installation of threaded connections, such as lockdown screws and/or threaded locking rings.
- [0004] However, these connections often require painstaking manual intervention, and the use of threaded connections limits the stability. For instance, threaded connections often require rotation of the packoff assembly, which introduces a chance for wellhead seals to be damaged. Additionally, these threaded parts must be replaced often due to wear and tear, which can raise the cost of wellhead operations.
- [0005] A need exists for a simplified system that can lock a casing or tubing hanger off a wellhead without the use of threaded lockdown screws, while minimizing rotation of lock rings, and still providing the needed stability and ease of maintenance.
- [0006] Embodiments of the apparatus described herein meet this and other needs.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0007] In the detailed description of the embodiments, presented below, reference is made to the accompanying drawings:
- [0008] FIG. 1 depicts an overall cross-section view of the actuator packoff assembly.
- [0009] FIG. 2A depicts a zoomed-in view of the packoff ring assembly and the actuator ring assembly in the unlocked position.
- [00010] FIG. 2B depicts a zoomed in view of the packoff ring assembly and the actuator ring assembly in the locked position.
- [00011] One or more embodiments are described below with reference to the listed Figures.

DETAILED DESCRIPTION OF THE EMBODIMENTS

- [00012] Before describing selected embodiments of the present disclosure in detail, it is to be understood that the present invention is not limited to the particular embodiments described herein. The disclosure and description herein is illustrative and explanatory of one or more presently preferred embodiments and variations thereof, and it will be appreciated by those skilled in the art that various changes in the design, organization, order of operation, means of operation, equipment structures and location, methodology, and use of mechanical equivalents may be made without departing from the spirit of the invention.
- [00013] As well, it should be understood the drawings are intended to illustrate and plainly disclose presently preferred embodiments to one of skill in the art, but are not intended to be manufacturing level drawings or renditions of final products and may include simplified conceptual views as desired for easier and quicker understanding or explanation. As well, the relative size and arrangement of the components may differ from that shown and still operate within the spirit of the invention.
- [00014] Moreover, it will be understood that various directions such as “upper,” “lower,”

“bottom,” “top,” “left,” “right,” and so forth are made only with respect to explanation in conjunction with the drawings, and that the components may be oriented differently, for instance, during transportation and manufacturing as well as operation. Because many varying and different embodiments may be made within the scope of the concept(s) herein taught, and because many modifications may be made in the embodiments described herein, it is to be understood that the details herein are to be interpreted as illustrative and non-limiting.

[00015] Referring to FIG. 1, the depicted embodiment of the invention comprises three separate locking devices built into a single actuator/packoff assembly 10. Actuator/packoff assembly 10 comprises an actuator ring 20 located above packoff body 30, as well as an upper lock ring 40, a lower lock ring 41, and a plurality of screw dog spring loaded lock pin assemblies 45. While the embodiment is depicted with two such lock pin assemblies 45 visible in cross-section, it should be noted that the depicted embodiment also comprises two additional lock pin assemblies 45 (not visible in cross-section), with a total of four arranged at 90 degree intervals. Screw dog spring loaded lock pin assemblies 45 can act as both spring loaded lock pin assemblies and screw dog pins for running and retrieval of the actuator packoff assembly 10. (For simplicity, FIG. 1 is numbered only on one side; numbers are duplicated as visible in FIG. 2A-2B.)

[00016] As shown, actuator/packoff assembly 10 can be positioned between the outer diameter of a hanger 13 and an inner diameter of a spool body 11 (which may be a casing spool body or a tubing spool body). As further shown in the depicted embodiment, spool body 11 can comprise at least one locking groove 12, which can be positioned around the inner diameter of the spool body 11, while hanger 13 can comprise two locking grooves 14, 15, which can be positioned along the outer diameter thereof. Hanger 13 may be a tubing hanger, a fluted mandrel casing hanger, or any other suitable hanger, provided that two locking grooves 14, 15 are present on the hanger outer diameter.

[00017] As shown, upper lock ring 40 can be positioned on the first shoulder 31 (identified in FIG. 2A-2B) of the packoff body 30 next to an angled face 21 (identified in FIG. 2A-2B) of the actuator ring 20. Upper lock ring 40 is expandable upon the application of pressure, at which point upper lock ring 40

can be captured by locking groove 14 of hanger 13. Lower lock ring 41, as shown, can be expandable and positioned along a second shoulder 32 (identified in FIG. 2A-2B) of the packoff body 30 and a second angled face 22 (identified in FIG. 2A-2B) of actuator ring 20, and can be captured into position by locking groove 12 of spool body 11. In an embodiment, the first locking ring can provide a ninety percent (90%) circumferential lock, while the second locking ring can provide a ninety-five percent (95%) circumferential lock. However, other embodiments may provide more or less circumferential coverage, as necessitated by well conditions. Lock pin assemblies 45, as shown, can be captured by locking groove 15 of hanger 13. Packoff ring 30 is fitted with a plurality of s-seals 33 for sealing against both the spool body 11 and the hanger 13.

[00018] Prior to use, packoff body 30 and actuator ring 20 can be assembled together and held in the unlocked position by attachment shear pins (not shown). A plurality of alignment screws 25 can be screwed into actuator ring 20 through machined slots 34 within packoff body 30 to ensure alignment during running and retrieval. It should be appreciated that in this embodiment, these machined slots 34 are shown in this particular cross-section, but do not extend concentrically around the packoff assembly 30. Thus, packoff assembly 30 and first shoulder 31 appear to be separate components in this diagram but are actually parts of the same component.

[00019] Referring now to FIGS. 2A and 2B, the use of the actuator/packoff assembly 10 is illustrated in practice. Actuator/packoff assembly 10 can be run into position by industry standard running and retrieval tools that can, for example, utilize a J-slot type function that can be aligned with the screw dog spring loaded lock pin assemblies 45. As shown, actuator/packoff assembly 10 lands on the shoulder 16 (shown in FIG. 1) of hanger 13, which can rest on an inner diameter of the spool body 11. FIG. 2A depicts the actuator-pack off assembly 10 in an unlocked position for running/retrieval.

[00020] Once landed, the full weight of the tubing/casing string can be loaded onto the running and retrieval tool, which results in an downward stabbing force shearing the two attachment shear pins (not shown), and a downward force being applied onto the actuator/packoff assembly 10, which pushes the actuator ring 20 down towards

the packoff body 30, which is braced against a shoulder 16 of the hanger 13. It can be seen that the respective angled faces 21, 22 of the actuator ring 20 can act to force the respective locking rings 40, 41 away from the actuator ring, into respective grooves 14, 12 of respective hanger 13 and spool body 11. Lock pin assemblies 45, such as screw dog spring loaded lock pin assemblies 45, can then spring out from the J-slot and lock into groove 15 of hanger 13.

[00021] FIG. 2B depicts the actuator/packoff assembly 10 in its locked state with the attachment shear pins (not shown) sheared, and actuator ring 20 lowered by the stabbing force with respect to packoff body 30. The running/retrieval tool can then be rotated to release the actuator/packoff assembly 10 and withdrawn.

[00022] During retrieval, the running/retrieval tool can interface with the screw dog spring loaded lock pin assemblies 45, which can be aligned with a J-slot (or other suitable retrieval mechanism) and pulled upwards with an over-pull (e.g., in an embodiment, this over-pull force can be roughly equal to 20,000 lbs or 9,000 kg). This action can shear the screw dog spring loaded lock pin assemblies 45, separate the actuator ring 20 from the packoff body 30, and allow the locking rings 40, 41 to withdraw from their respective grooves 14, 12.

[00023] The design described herein yields several advantages over existing hanger assemblies. As there is no rotation of the actuator/packoff assembly itself, only the running and retrieval tool, the chances of seal damage are minimized while ensuring that the hanger remains safely locked during tubing and casing running operations. Installation and retrieval requires little or no maintenance or manual intervention, and the cost of replacement parts amounts to, in a preferred embodiment, a total of six shear pins (i.e., two on running being sheared by push force and four on retrieval being sheared by over-pull).

[00024] Although several preferred embodiments of the invention have been illustrated in the accompanying drawings and described in the foregoing specification, it will be understood by those of skill in the art that additional embodiments, modifications and alterations may be constructed from the invention principles disclosed herein, while still falling within the scope of the disclosed invention.

CLAIMS

1. A weight set hanger system comprising:

a hanger comprising a hanger shoulder;

a spool body;

a rotationally fixed packoff body resting on the hanger shoulder, the rotationally fixed packoff body comprising a first load shoulder, a second load shoulder, and a plurality of seals;

a first locking ring positioned on the first load shoulder and projecting inward;

a second locking ring positioned on the second load shoulder and projecting outward;
and

an actuating ring located above the packoff body and first and second locking rings and comprising a first angled face, and a second angled face;

wherein the actuating ring further comprises a plurality of spring-loaded locking pin assemblies, and in that, in use, the actuating ring is configured to transmit a pressure to the rotationally fixed packoff body, wherein, in use, the first load shoulder and the first angled face are configured to force the first locking ring away from the actuating ring in a respective groove of the hanger, wherein, in use, the second load shoulder and the second angled face are configured to force the second locking ring away from the actuating ring in a respective groove of the spool body, wherein, in use the plurality of spring-loaded locking pin assemblies are configured to spring towards the hanger, and wherein the plurality of seals seal against the hanger.

2. The weight set hanger system of claim 1, wherein the rotationally fixed packoff body further comprises a plurality of slots.

3. The weight set hanger system of claim 2, wherein the actuating ring further comprises a plurality of alignment screws corresponding with the plurality of slots.

4. The weight set hanger system of claim 1, wherein the spool body concentrically surrounds the hanger and rotationally fixed packoff body.

5. The weight set hanger system of claim 4, wherein the spool body comprises a first groove along the inner diameter thereof.
6. The weight set hanger system of claim 5, wherein the second locking ring is forced into the first groove.
7. The weight set hanger system of claim 5, wherein the hanger further comprises a second groove and a third groove along the outer diameter thereof.
8. The weight set hanger system of claim 7, wherein the first locking ring is forced into the second groove, and wherein the plurality of spring-loaded locking pin assemblies lock into the third groove.
9. The weight set hanger system of claim 4, wherein the plurality of seals additionally seal against the spool body.
10. A method of securing a weight set hanger comprising the steps of:
 - assembling a pack-off assembly comprising an actuating ring, a packoff body, a first locking ring, a second locking ring, a plurality of seals, a plurality of shear pins, and a plurality of spring-loaded locking pin assemblies;
 - installing a weight set hanger having an outer diameter within the bore of a spool body having an inner diameter, wherein a first groove is located on the inner diameter of the spool body, and wherein a second and a third groove are located on the outer diameter of the weight set hanger;
 - using a running tool aligned with the spring-loaded locking pin assemblies to install the pack-off assembly into a gap between the outer diameter of the hanger and the inner diameter of the spool body;
 - stabbing down with the running tool to apply downward pressure to the pack-off assembly and compress the actuating ring against the packoff body, thereby severing the plurality of shear pins, and locking the first locking ring into the first groove, the second locking ring into the second groove, and locking the spring-loaded locking pin assemblies into the third groove; and

rotating the running tool independent of the pack-off assembly to release the plurality of spring-loaded locking pin assemblies and leave the pack-off assembly in place.

11. The method of claim 10, wherein the step of stabbing down with the running tool further comprises forcing the plurality of locking rings away from the pack-off assembly by compressing them between a plurality of shoulders of the packoff body and a plurality of angled faces of the actuating ring.

12. The method of claim 10, wherein the step of stabbing down with the running tool further comprises depressing the plurality of spring-loaded locking pin assemblies into alignment with the third groove of the weight set hanger.

13. The method of claim 10, further comprising the steps of:

re-aligning the running tool with the plurality of spring-loaded locking pin assemblies; and

applying an overpull force sufficient to shear the plurality of spring-loaded locking pin assemblies, thereby releasing the actuating ring from the packoff body.