

INSERTION OF A PACKOFF INTO A WELLHEAD

Introduction

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This invention relates to wellheads, particularly subsea wellheads and more particularly the insertion of a packoff into a wellhead.

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Subsea wellheads commonly include hangers for the support of strings of casing which extend down into a well. It is necessary for at least some hangers, particularly a production casing hanger, to be provided with packoff seals. Such a packoff is usually inserted in a wellhead by means of a running tool inserted into the wellhead bore. In current practice, the aggregation of tolerances in the complex interface between the tool, a packoff, a casing hanger and the wellhead is liable to lead to uncertainty of the proper setting of the packoff.

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The present invention accordingly particularly relates to an assembly which provides a simple and reliable interface between a pack-off and a running tool and more particularly an interface which ensures the accurate location of the pack-off before it released from the tool. A further aim of the invention is to eliminate the need for a retrieval ring on the running tool for unset packoffs.

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Summary of the invention

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In one aspect the invention provides apparatus for the insertion of a pack-off into a recess in a bore of a wellhead body, comprising an activating sleeve which has a portion disposed for engagement with the pack-off for the movement of the pack-off into the recess and has body portions shaped for location on a datum member, the activating sleeve including a plurality of slots circumferentially spaced about the activating sleeve, a running tool which is adapted to move said activating sleeve into engagement with the packoff and carries a plurality of resiliently loaded dogs each disposed to be located in a respective one of the slots, and releasing means operative to release the dogs from the slots when the activating sleeve reaches a datum position.

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In a particular embodiment of the invention the said releasing means comprise a plurality of detent pins each positioned adjacent a respective one of said slots and disposed, when the activating sleeve has caused the packoff to be located in said recess, to engage a respective one of the dogs, whereby the dogs are
5 depressed out of the slots and allow the consequent release of the activating sleeve from the running tool.

The activating sleeve may comprise a slanted upper rim for engagement with the packoff and for location against the datum member. The activating sleeve may
10 comprise a part for location on a ridge of the datum member.

The apparatus preferably further comprises a resilient collet which fits within the said activating sleeve and urges the activating sleeve into location on the datum member. The collet preferably has slots in register with the slots in the activating
15 sleeve.

The datum member may comprise an outer sleeve which abuts and is located by the bore and a casing hanger. The datum member may have a surface for the guidance of the packoff into the recess.
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The invention also provides a method for the insertion of a pack-off into a recess in a bore of a wellhead body, comprising disposing an activating sleeve for engagement with the pack-off for the movement of the pack-off into the recess, the activating sleeve having body portions shaped for location on a
25 datum member within the bore and including a plurality of slots circumferentially spaced about the activating sleeve, running into the bore a tool which is adapted to move said activating sleeve into engagement with the packoff and carries a plurality of resiliently loaded dogs each disposed to be located in a respective one of the slots, and releasing the dogs from the slots when the activating sleeve
30 reaches a datum position that requires the correct insertion of the packoff in the recess.

The invention also provides an assembly for the insertion of a pack-off in a recess in a bore of a wellhead body, comprising an outer sleeve supporting the
35 packoff, an activating sleeve which has portions for engagement with the pack-

off (and the outer sleeve, the activating sleeve including a plurality of circumferentially spaced and axially extending slots, and a plurality of detent members located in the outer sleeve and each extending into a respective slot in the activating sleeve.

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Brief Description of the drawings

Figure 1 is a sectional view through a wellhead assembly which includes one embodiment of the invention.

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Figures 2 and 3 show to a larger scale one embodiment of the invention in different phases of its operation.

General Description

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Figure 1 illustrates in section part of a subsea wellhead. The particular wellhead illustrated is designed for use with a riser system of 13 $\frac{5}{8}$ " (346mm) inside diameter within a (standard) 36" (914.4 mm) outside diameter outer conductor. The comparatively slender bore through the wellhead allows a greater thickness for the wellhead than is usual. However, the invention is not necessarily limited to the stated dimensions of the riser system or other components.

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The major component of the wellhead is a generally cylindrical wellhead body 1 which is received within a generally cylindrical conductor housing 2. The conductor housing 2 has a lower annular rim 3 which abuts and, by means of a weld 4, supports an outer cylindrical conductor casing 5 that extends downwardly from the conductor housing 2 into a (pre-drilled) hole in the seabed (not shown).

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The lower part 6 of the body 1 tapers inwardly to a narrower rim 7 which abuts and, by means of a weld 8, supports a casing extension 9. In this example the casing extension 9 has an outside diameter of 14" (355.6mm) and an inside diameter of 13 $\frac{5}{8}$ " (346mm).

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Typically the casing extension 9 extends down at least as far as the level of the seabed and preferably somewhat further. The conductor housing 2 has lateral

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vent ports 10 in communication with the annular space 11 between the outer conductor 5 and the casing extension 9.

5 A column of cement is formed in the space 11 between the outer conductor 5 and the casing extension 9 (and any casing components suspended from it). Cement is pumped down the well and rises up the annular space 11 up to at least the lower part 6 of the body 1.

10 Wellhead systems are exposed to cyclic forces which will, if great enough, lead to potential fatigue damage and integrity failure of all or part of the wellhead system. Cement on the outside of the wellhead extension will reduce the freedom for the extension to flex is liable to introduce repetitive stresses high enough for potential fatigue failure.

15 In this example the casing extension 9 is provided with a resilient sleeve 12 made of rubber or other suitable polymeric material. The sleeve preferably extends all the way round the extension and extends from the bottom 6 of the wellhead body 1 for a suitable distance part of, or all, the way down the casing extension 9. The thickness of the sleeve 12 needs to be selected such that it allows some flexure
20 of the casing extension but does not prejudice the structural support that the extension requires. The sleeve 12 is composed of a multiplicity of inter-fitting rings 13a, 13b. The rings except for the uppermost ring 13a each have an upper outer flange 14 and an inner lower flange 15 so that each upper flange 14 fits over a shoulder formed by the lower flange 15 on the adjacent upper ring. The
25 rings thereby fit singly together to form a substantially continuous resilient sleeve on the outside of the casing extension 9. The sleeve 12 may therefore be provided to any desired depth on the casing extension. Each of the upper flanges 14 has a radial through-bore 16 which facilitates the close fitting of the rings 13.

30 The body 1 and the conductor housing 2 are relatively pre-tensioned by means of a tensioning device 17. This will not be described in detail because it preferably has a construction and manner of operation as described in GB-2393990-B and US-7025145-A. Very briefly, movement of an operating member 18 causes outward oblique movement of a driving ring 19 and thereby tensioning
35 of the body 1.

Within the casing extension 9 is disposed a production casing 20 extending downwardly from and supported by a production casing hanger 21. Various components associated with this casing hanger 21 are described in detail below.

5 In this example the production casing has a 10.75" (273.05mm) outside diameter.

The annular space 22 between the production casing and the casing extension 9 is usually called the 'B' annulus. It is desirable to monitor the pressure in the B annulus. Normally the B annulus is sealed by cement at its lower end and sealed
10 by means of a 'pack-off' at the production casing hanger. Monitoring of the pressure within the B annulus enables the detection of for example a leak in a casing string. Such a leak is liable to cause collapse or other damage to the production casing.

15 Extending obliquely upwardly from the inner surface of the lower part 6 of the wellhead body 1 are passageways 23 in communication with an annular gallery 24. Although this gallery opens to the interior of the wellhead bore, it does so between upper and lower pack-offs associated with the casing hanger 21.

20 Extending upwardly within the body 1 from the gallery 24 is a vertical passageway 25 (mostly shown by a chain line in Figure 1) which extends to a shoulder 38 at the top of the bore 29 but is blocked at its top 39. The passageway 25 is in communication with an annular gallery 26 on the outside of a slide valve 27 disposed about a sleeve 28 that fits into the upper part of the
25 bore 29 which extends axially through the wellhead. . The valve 27 is biased to a closer (lower) position by means of springs 30 between the top shoulder of the valve and a radial flange 31 of the sleeve 28.

The valve 27 can be moved between its open (upper) position and closed (lower)
30 position by the application of fluid pressure either above or below the valve by way of passageways not shown in Figure 1. When the valve is in its open position the vertical passageway 25 from the B annulus is in communication by way of the gallery 26 in the valve 27 with an isolation sleeve disposed above the sleeve 28.

The production casing hanger 21 carries a split ring 32 which is forced laterally into a recess in the bore when the production casing hanger is landed. Below the lower pack-off 32 is a sleeve 33 which lands on a shoulder in the bore 29.

5 The casing hanger 21 has an upper packoff 34 which is associated with a resilient annular collet 35 and an activating sleeve 36. The purposes of the activating sleeve 36, which will be described in more detail with reference to Figures 2 and 3, are to facilitate the insertion of the pack-off and to ensure that the pack-off is released from a running tool (not shown) only when the pack-off is set in
10 place. The collet 35 is the preferred means for retaining the activating sleeve and in position when the tool has been withdrawn.

Also shown in Figure 1 is a slot 37 which allows by-pass of the tubing hanger (not shown) into the body 1 of the wellhead. This feature is not relevant to the claimed
15 invention and will not be described further herein.

Particular Description of the Invention

The activating sleeve 36 has a plurality of circumferentially spaced, axially
20 extending slots and the collet 35 has a corresponding plurality of similar slots that are each in register with a respective slot in the activating sleeve 36. Located within an outer sleeve are detent members constituted by pins. Each of these is located in a position adjacent a respective slot in the sleeve 36 and the corresponding slot in the collet 35. The slots and pins are shown to a small scale
25 in Figure 1 but will be described in detail with reference to the larger scale Figures 2 and 3.

The collet 35 has a multiplicity of vertical ribs spaced between each of the slots so that it can urge the sleeve 36 outwardly, whereby to retain the sleeve 36 and
30 thereby the packoff 34 in their intended final positions.

Figure 2 and 3 illustrate the wellhead in the region of the packoff 34 in greater detail. These Figures also illustrate the action of a running tool 50 which is inserted into the bore 29 of the wellhead and initially carries an assembly of the
35 activating sleeve 36, the packoff 34 and an outer sleeve 41, as well as preferably

the collet 35. Figure 2 illustrates the wellhead and the tool just before the final phase of location of the packoff 34 and Figure 3 illustrates the wellhead and the tool at the completion of the final phase of location.

- 5 Figures 2 and 3 are schematic only and represent a vertical half-section through the relevant part of the wellhead and the tool.

10 The packoff 34 is to be located in an annular grooved recess 51 in the bore of body 1. The packoff 34 has an outer periphery which conforms in shape to that of the grooved recess 51.

15 The outer sleeve 41, which constitutes a reaction or datum member for the location of the packoff 34, makes sealing engagement with the body 1 and the casing hanger 21 at locations 53 and 54 respectively and has an inner shoulder 55 which abuts and is located by a top shoulder 56 of the casing hanger 21. The top surface 57 of the outer sleeve 41 is flat, radially directed and aligned with the bottom edge of the recess 51.

20 The activating sleeve 36 has an outwardly slanted upper rim 58 of which the upper surface 59 is engaged by the head 60 of the tool 50. The lower and outer surface 61 of the rim 58 engages the correspondingly slanted top surface of the packoff 34. The lower surface of the packoff 34 abuts the top surface 57 of the outer sleeve 41. Accordingly, downward movement of the activating sleeve 36 under the action of the tool 50 will force the packoff 34 outwardly into the recess 51.

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The top rim 58 of the activating sleeve 36 has on its inner side an annular groove 62 into which an upper rim 63 of the collet 35 fits.

30 The activating sleeve 36 extends downwardly from the rim 58. Its intermediate, generally cylindrical, part 68 has the axially extending slots 40, of which only one is shown in Figures 2 and 3. The slots 40 are spaced circumferentially around the sleeve 36.

The activating sleeve 36 is shaped to locate on the outer sleeve 41. In particular it has at its lower part a foot 64 which, as shown in Figure 3, eventually locates around an annular ridge 65 on the inside of the outer sleeve 41. The lower part of the sleeve 36 has also an inner heel 66 around which the lower margin 67 of the
5 collet 35 fits. The collet 35 has, as previously mentioned, slots each of which corresponds to, and is in radial and axial register with, a respective slot 40 in the activating sleeve 36.

10 The tool 50 carries a set of circumferentially spaced dogs 69 of which only one is shown in Figures 2 and 3. Each dog is mounted in a respective radial bore 70 in the tool and resiliently biased outwards by a respective compression spring 71. Each dog 69 extends through a respective slot in the collet 35 into the respective slot 40 in the activating sleeve.

15 The assembly of the packoff and its associated parts is preferably inserted into the wellhead as follows. The outer sleeve 41 is disposed with the packoff ring 34 above it. The activating sleeve 36 and the collet 35 within it are fitted to, and high on, the outer sleeve 41, the foot 64 being above the ridge 65 on the outer sleeve. The detent pins 42 are inserted through slots 77 in the outer sleeve and
20 are fixed in position in each slot 77 by a respective obliquely disposed screw plug 78.

25 The assembly of the packoff 34, the outer sleeve 41, the activating sleeve 35 and preferably the collet 35 is engaged by the running tool 50. This phase is shown in Figure 2. The dog 69 is at the top of the respective slot 40 whereas the detent pin 42 is spaced from the dog. The dog 69 has a bevelled facet 72 which can be engaged by a bevelled facet 73 of the respective detent pin 42.

30 Load is applied to the top of the activating sleeve. When the outer sleeve 41 reaches a datum position abutting the hanger 21, it can provide reaction which enables the activating sleeve to push the packoff ring 34 into the profile 51 in the wellhead bore. The spring foot at the lower end of the activating sleeve 36 snaps over the ridge 65. The activating sleeve 36 thereby urges the outer sleeve 41 into sealing engagement (preferably metal-to-metal) with the wellhead bore.

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The pack-off 34 is gradually forced outwards into the recess 51 by the rim 58 of the sleeve 36. The rim slides over the top of the pack-off 34 and, when the pack-off 34 is fully in the recess 51, the sleeve 36 can move downwardly to locate against a bevelled shoulder 74 of the outer sleeve 41 as shown in Figure 3. In
5 this state the foot 64 of the sleeve 36 is located under the ridge 65, so that the activating sleeve 36 is locked in position under the action of the collet 35, which urges the activating sleeve into its location on the outer sleeve 41.

As the rim 58 of the activating sleeve reaches the datum surface 74, the detent
10 pin 42 can abut the spring-loaded dog 69 in the tool 50. The pin 42 can move the dog inwardly against the force of spring 71 to release that dog from the retainer 35 and the sleeve 36. The correct location of the sleeve 36 occurs when the packoff 34 is fully in the recess 51 and the head 58 of the sleeve 36 contacts the datum surface 74. The position of the detent pin 42 is selected such that if the
15 surface 61 of the head 58 does not reach the surface 74 the dog is not released from the collet 35 and the activating sleeve 36 by the detent pin 42. Thus the pin 42 constitutes a means which is operative to release the dog from the slot 40 only when the sleeve 36 reaches a datum position that requires the correct insertion of the packoff 34 in the recess 51.

20 If the packoff is not correctly set, the dogs 69 will remain in the slots in the activating sleeve 36 and the collet 35; the assembly can therefore be retrieved simply by withdrawal of the tool 50.

25 The assembly may be retrieved after being set by pulling up the activating sleeve 36 by means of the tool 50 or otherwise with sufficient force to move the part 64 of the sleeve 36 upwards over the ridge 65. The activating sleeve 36 will move upwards until the detent pins 42 engage the bottom of the slots 40 in the activating sleeve 36. At this point the activating sleeve 36 is raised sufficiently, to
30 a position corresponding to that shown in Figure 2, for the packoff ring 34 to collapse inwardly and release itself from the profile 51. The pins 42 will now transfer the retrieval force from the activating sleeve 36 to the outer sleeve 41, releasing the seal that the outer sleeve 41 made with the wellhead.

The assembly avoids the use of shearing pins on the tool. It avoids unnecessary debris and is reusable in the event of failure to set the packoff correctly..

- 5 Apart from the dogs such as dog 69 the tool 50 may be of customary design. In practice it may be a multi-purpose tool which comprises concentric inner and outer cylindrical parts 75 and 76. However, the design and purposes of the tool except as are discussed above are not directly relevant to the invention.

Claims

1. Apparatus for the insertion of a pack-off (34) into a recess (51) in a bore (29) of a wellhead body, comprising an activating sleeve (36) which has a portion (58) disposed for engagement with the pack-off (34) for the movement of the pack-off into the recess and has body portions shaped for location on a datum member (41), the activating sleeve (36) including a plurality of slots (40) circumferentially spaced about the activating sleeve, a running tool (50) which is adapted to move said activating sleeve into engagement with the packoff and carries a plurality of resiliently loaded dogs (69) each disposed to be located in a respective one of the slots (40), and means (42) operative to release the dogs from the slots (65) when the activating sleeve (36) reaches a datum position.
2. Apparatus according to claim 1, in which the said means (42) comprises a plurality of detent pins each positioned adjacent a respective one of said slots (40) and disposed, when the activating sleeve (36) has caused the packoff (34) to be located in said recess (51), to engage a respective one of the dogs (69), whereby the dogs (69) are depressed out of the slots and allow the consequent release of the activating sleeve (36) from the running tool (50).
3. Apparatus according to claim 2, in which the detent pins (42) are located in the datum member (41).
4. Apparatus according to any of claims 1 to 3, in which the activating sleeve comprises a slanted upper rim (58) for engagement with the packoff (34) and for location against the datum member (41).
5. Apparatus according to any of claims 1 to 4, in which the activating sleeve (36) comprises a part (64) for location on a ridge (65) of the datum member (41).
6. Apparatus according to any of claims 1 to 5, and further comprising an annular resilient collet (35) which fits within the said activating sleeve (36) and urges the activating member into location on the datum member (41).

7. Apparatus according to claim 6, in which the collet (35) has slots (68) in register with the slots (40) in the activating sleeve (36).

5 8. Apparatus according to any of claims 1 to 7, in which the datum member (41) comprises an outer sleeve which abuts and is located by the bore (29) and a casing hanger (21).

9. Apparatus according to claim 8, in which the outer sleeve (41) has a top surface (57) for the guidance of the packoff (34) into the recess (51).

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10. Apparatus according to claim 8 or 9, in which the outer sleeve (41) makes sealing engagement with the bore (29).

11. A method for the insertion of a pack-off (34) into a recess (51) in a bore (29) of a wellhead body, comprising:

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disposing an activating sleeve (36) for engagement with the pack-off for the movement of the pack-off into the recess, the activating sleeve having body portions shaped for location on a datum member (41) within the bore and including a plurality of slots (40) circumferentially spaced about the activating sleeve;

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running into the bore a tool (50) which is adapted to move said activating sleeve into engagement with the packoff and carries a plurality of resiliently loaded dogs (69) each disposed to be located in a respective one of the slots; and

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releasing the dogs from the slots when the activating sleeve (36) reaches a datum position that requires the correct insertion of the packoff in the recess.

30 12. An assembly for the insertion of a pack-off (34) in a recess (51) in a bore (29) of a wellhead body (1), comprising an outer sleeve (41) supporting the packoff, an activating sleeve (36) which has portions for engagement with the pack-off (34) and the outer sleeve (41), the activating sleeve including a plurality of circumferentially spaced and axially extending slots (40), and a plurality of

detent members (42) located in the outer sleeve (41) and each extending into a respective slot in the activating sleeve.

13. An assembly according to claim 12, in which the activating sleeve (36)
5 comprises a slanted upper rim (58) for engagement with the packoff (34) and for location against the outer sleeve (41).

14. An assembly according to claim 12 or 13, in which the activating sleeve
(36) comprises a lower part (64) for location on a ridge (65) of the outer sleeve
10 (41).

15. An assembly according to any of claims 12 to 14, in which the outer
sleeve (41) is disposed to abut and to be located by the bore (29) and a casing
hanger (21).
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