

SUBSEA WELLHEAD STABILIZATION USING CYLINDRICAL SOCKETS

BACKGROUND OF INVENTION

[0001] The present disclosure relates in general to a wellhead assembly for use in producing subterranean hydrocarbons. More specifically, the present disclosure relates to a wellhead assembly having high and lower pressure wellhead housings with sockets whose respective outer surfaces are generally cylindrical.

DESCRIPTION OF PRIOR ART

[0002] Subsea wells typically include outer low pressure housing welded onto a conductor pipe, where the conductor pipe is installed to a first depth in the well, usually by driving or jetting the conductor pipe. A drill bit inserts through the installed conductor pipe for drilling the well deeper to a second depth so that high pressure housing can land within the low pressure housing. The high pressure housing usually has a length of pipe welded onto its lower end that extends into the wellbore past a lower end of the conductor pipe. The well is then drilled to its ultimate depth and completed, where completion includes landing a casing string in the high pressure housing that lines the wellbore, cementing between the casing string and wellbore wall, and landing production tubing within the casing. The aforementioned concentrically stacked tubulars exert a load onto the lower pressure housing that is transferred along an interface between the high and low pressure housings. Moreover, tilting the stacked tubulars generates a bending moment along the interface.

SUMMARY OF THE INVENTION

[0003] Disclosed herein a wellhead assembly, which in one embodiment includes an annular low pressure housing having a lower end set in a sea floor. In this example, an upper socket surface is formed along a portion of an inner surface of the low pressure housing; axially spaced apart from the upper socket surface is a lower socket surface formed along a portion of the inner surface of the low pressure housing. The wellhead assembly further includes an annular high pressure housing coaxially disposed within the low pressure housing, an upper socket surface formed along a portion of an outer surface of the high pressure housing that is in contact with the upper socket surface on the low pressure housing and that selectively exerts a load against the upper socket surface on the low pressure housing to define an upper loading interface. A lower socket surface is on the outer surface of the high pressure housing that is axially spaced apart from the upper socket surface on the high pressure housing and is in contact with the lower socket surface on the low pressure housing. The lower socket surface on the high pressure housing selectively exerts a load against the lower socket surface on the low pressure housing to define a lower loading interface. A latch assembly is coupled to the low pressure housing and the high pressure housing between the upper and lower loading interfaces. In an alternate example, the upper and lower loading interfaces project axially in a direction that is substantially parallel with an axis of the wellhead assembly. Optionally, the upper and lower loading interfaces are radially offset from one another. The wellhead assembly can alternatively further include a channel formed on an outer surface of the high pressure housing between the upper and lower loading interfaces and a passage axially formed through the high pressure housing having an end in communication with the channel and a lower end in communication with an annulus between the high and lower pressure housings on a side of the lower loading interface opposite

the channel. Included with this example is a passage radially extending through the lower pressure housing and in communication with the channel. In an example embodiment the latch is made up of a C-ring set in a groove provided on an outer surface of the high pressure housing. The latch may include a profile on an inner surface of the low pressure housing. A downward facing shoulder can optionally be included on an outer surface of the high pressure housing that contacts an upward facing shoulder on an inner surface of the low pressure housing when the high pressure housing lands in the low pressure housing.

[0004] Also described herein is a wellhead assembly that includes a low pressure housing mounted in a sea floor having a high pressure housing landed within. The high pressure housing has upper and lower radially thinner portions and a radially thicker portion disposed between and adjacent to the upper and lower radially thinner portions. An upper loading surface is provided on an outer surface of the radially thicker portion that terminates at a location where the radially thicker portion transitions into the upper radially thinner portion. A lower loading surface is formed on the outer surface of the radially thicker portion that terminates at a location where the radially thicker portion transitions into the lower radially thinner portion. Upper and lower loading surfaces are included on an inner surface of the low pressure housing that respectively engage the upper and lower loading surfaces on the radially thicker portion. A latch is provided for engaging the low and high pressure housings disposed axially between the upper loading surface and lower loading surface on the high pressure housing. An optional channel can be included on an outer surface of the high pressure housing disposed between the upper loading surface and lower loading surface on the high pressure housing and a passage providing communication between the channel and an annulus between the low and high pressure housings and adjacent the location where the radially thicker portion transitions to the lower radially

thinner portion. In an alternate example included is a production tree on an upper end of the high pressure housing. Optionally included is a casing hanger landed inside the high pressure housing and a tubing hanger landed inside the casing hanger..

BRIEF DESCRIPTION OF DRAWINGS

[0005] Some of the features and benefits of the present invention having been stated, others will become apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

[0006] FIG. 1 is a side sectional view of engaging together example embodiments of high and low pressure wellhead housings in accordance with the present invention.

[0007] FIG. 2 is a side perspective view of the high and low pressure wellhead housings of FIG. 1 in engagement to form a portion of an embodiment of a wellhead assembly and in accordance with the present invention.

[0008] FIG. 3 is a side sectional view of the portion of the wellhead assembly of FIG. 2 further including a production tree and in accordance with the present invention.

[0009] While the invention will be described in connection with the preferred embodiments, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents, as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF INVENTION

[0010] The method and system of the present disclosure will now be described more fully hereinafter with reference to the accompanying drawings in which embodiments are shown. The method and system of the present disclosure may be in many different forms and should not be construed as limited to the illustrated embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey its scope to those skilled in the art. Like numbers refer to like elements throughout.

[0011] It is to be further understood that the scope of the present disclosure is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. In the drawings and specification, there have been disclosed illustrative embodiments and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation.

[0012] Figure 1 is a side sectional view of an example of a wellhead assembly 10 being formed by inserting a high pressure housing 12 into a low pressure housing 14. A weld 16 on the high pressure housing 12 of Figure 1 attaches an upper portion 18 to a lower portion 20, where the lower portion 20 extends downward and into a wellbore 21. Similarly, the low pressure housing 14 includes a weld 22 attaching an upper portion 24 to lower portion 26. In the example of Figure 1, the lower portion 26 is anchored within a sea floor 27. A transition 28 on the upper portion 18 indicates where its thickness changes. Below the transition 28 the thickness of the upper portion 18 is substantially the same as a thickness of the lower portion 20, whereas above the transition its thickness increases to a maximum width to define a middle section of the high

pressure housing 12. An upper terminal end of the middle section is defined by an upper transition 29, which indicates a location where the radial thickness of the high pressure housing 12 decreases. The radial thickness of the high pressure housing 12 above the transition 29 is less than along the middle section, but greater than below transition 28. The changes in radial thickness define a thicker middle section with two radially thinner portions projecting axially away from the middle section. Further illustrated in the example of Figure 1 is a passage 30 in the upper portion 18 that extends axially downward from a channel 31 shown circumscribing the middle portion along its outer surface. The passage 30 communicates between the channel 31 and an annulus between the high and low pressure housings 12, 14.

[0013] A lower socket surface 32 is shown formed on an outer periphery of the upper portion 18 and facing generally radially outward from an axis A_X of the wellhead assembly 10; a lower end of the lower socket surface 32 terminates adjacent the transition 28. The low pressure housing 14 also includes a lower socket surface 34 that is formed on an inner circumferential surface of the low pressure housing 14. In the example of Figure 1, a lower end of the lower socket surface 34 terminates adjacent where the radial thickness of the low pressure housing 14 decreases to a thickness substantially the same as a thickness of the lower portion 26. In one embodiment, a radial passage 36 is further illustrated that extends through the upper and thicker portion 24 of the low pressure housing 14. In an example embodiment, the radial passage 36 is above an upper terminal end of the lower socket surface 34.

[0014] Still referring to Figure 1, upper socket surface 38 is similarly provided on the outer surface of the high pressure housing 12 shown facing generally radially outward from the axis A_X , and having an upper end that terminates adjacent transition 29. An upper socket surface 40 on the low pressure housing 14 faces radially inward towards axis A_X and has an upper terminal

end proximate an upper terminal end of the low pressure housing 14. As further discussed below, a latching system is included for coupling together the high and low pressure housings 12, 14 that includes a C-ring 42 disposed within a groove 44 formed on the outer surface of the radially thicker section of the upper portion 18. The C-ring 42 and groove 44 illustrate one example of embodiment of a latching mechanism for engaging the high and low pressure housings 12, 14.

[0015] Referring now to Figure 2, an example is illustrated of the high pressure housing 12 landed within low pressure housing 14. In this example, the upper socket surfaces 38, 40 are aligned and in contact with one another so that any bending moment forces exerted onto the high pressure housing 12 can be transferred onto the low pressure housing 14. Axially distal from the upper socket surfaces 38, 40 are the lower socket surfaces 32, 34, also in engagement and in contact with one another for effectively transferring bending moment loads from the high pressure housing 12 to low pressure housing 14. In the embodiment illustrated, the lower socket surfaces 32, 34 are a maximal distance from the upper socket surfaces 38, 40, thereby increasing bending moment transfer between the inner and outer wellhead housings 12, 14 and consequently reducing respective angular movement of the high pressure housing 12 within low pressure housing 14. When in the landed configuration of Figure 2, the passage 36 registers with channel 31, so that passage 36 is in fluid communication with passage 30 and with the annulus between the high and low pressure housings 12, 14. As shown, passage 36 and channel 31 are between the lower socket surfaces 32, 34 and the upper socket surfaces 38, 40. Further shown in the example of Figure 2 are load shoulders 45, 46 respectively formed on the high and low pressure housings 12, 14, which are in axial contact with one another, thereby transferring an axial load from the high pressure housing 12 onto the low pressure housing 14 for supporting the

high pressure housing 12 within low pressure housing 14. Additionally, a profile 47 is shown formed on an inner surface of the low pressure housing 14 and strategically located so to engage an outer surface of the C-ring 42 for latching together the high and low pressure housings 12, 14. Moreover, by locating the latching mechanism of the C-ring 42, along with the channel 31, axially between the upper socket surfaces 38, 40 and lower socket surfaces 32, 34, the maximal distance between the socket surfaces can be achieved. As such, forgings of the upper portions 18, 24 need not be altered in order to achieve sufficient bending moment transfer between the housings 12, 14.

[0016] Another advantage of the wellhead housing 10 disclosed herein is that in one embodiment, the socket surfaces 32, 34, 38, 40 each are generally vertical so that minimal forces are required to insert the high pressure housing 12 within low pressure housing 14. In one example of use, axial forces required to urge the high pressure housing 12 inside low pressure housing 14 were less than about 200,000 pounds force.

[0017] Figure 3 is a side sectional view of an example of the wellhead assembly 10 shown with a production tree 48 mounted on an upper end of the high pressure housing 12. Further illustrated is a casing hanger 50 landed on an inner surface of the high pressure housing 12 and supporting a string of casing 52 shown depending downward into the wellbore 21. Coaxially inserted within the casing 52 is a tubing hanger 54 having a corresponding string of tubing 56 that projects coaxially within the casing 52. Thus, in this example, the low pressure housing 14 axially supports the load of the high pressure housing 12 tubing and casing hangers 50, 54, casing 52, and tubing 56. Further in the example of Figure 3, the tubing communicates with a main bore 58 that projects axially through the production tree 48.

[0018] In one optional example, one of the socket surfaces can have a convex shape while an opposing or mating socket surface can still have a cylindrical or substantially vertical profile. Similarly, both the inner and outer socket surfaces may have convex shapes that deform when the high pressure housing 12 inserts and lands within the low pressure housing 14. In another optional embodiment, one of the socket team members can be in a separate housing where the housing is welded to the member holding the other socket surface.

[0019] The present invention described herein, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned, as well as others inherent therein. While a presently preferred embodiment of the invention has been given for purposes of disclosure, numerous changes exist in the details of procedures for accomplishing the desired results. These and other similar modifications will readily suggest themselves to those skilled in the art, and are intended to be encompassed within the spirit of the present invention disclosed herein and the scope of the appended claims.

CLAIMS

What is claimed is.

1. A wellhead assembly comprising:

an annular low pressure housing having a lower end set in a sea floor;

an upper socket surface formed along a portion of an inner surface of the low pressure housing and a lower socket surface formed along a portion of the inner surface of the low pressure housing that is axially spaced apart from the upper socket surface;

an annular high pressure housing coaxially disposed within the low pressure housing;

an upper socket surface formed along a portion of an outer surface of the high pressure housing that is in contact with the upper socket surface on the low pressure housing and that selectively exerts a load against the upper socket surface on the low pressure housing to define an upper loading interface;

a lower socket surface on the outer surface of the high pressure housing axially spaced apart from the upper socket surface on the high pressure housing and in contact with the lower socket surface on the low pressure housing, and that selectively exerts a load against the lower socket surface on the low pressure housing to define a lower loading interface; and

a latch assembly coupled to the low pressure housing and the high pressure housing between the upper and lower loading interfaces.

2. The wellhead assembly of claim 1, wherein the upper and lower loading interfaces project axially in a direction that is substantially parallel with an axis of the wellhead assembly.
3. The wellhead assembly of claim 1, the upper and lower loading interfaces are radially offset from one another.
4. The wellhead assembly of claim 1, further comprising a channel formed on an outer surface of the high pressure housing between the upper and lower loading interfaces and a passage axially formed through the high pressure housing having an end in communication with the channel and a lower end in communication with an annulus between the high and lower pressure housings on a side of the lower loading interface opposite the channel.
5. The wellhead assembly of claim 4, further comprising a passage radially extending through the lower pressure housing and in communication with the channel.
6. The wellhead assembly of claim 1, wherein the latch comprises a C-ring set in a groove provided on an outer surface of the high pressure housing.
7. The wellhead assembly of claim 6, wherein the latch further comprises a profile on an inner surface of the low pressure housing.
8. The wellhead assembly of claim 1, further comprising a downward facing shoulder on an outer surface of the high pressure housing that contacts an upward facing shoulder on an inner surface of the low pressure housing when the high pressure housing lands in the low pressure housing.
9. A wellhead assembly comprising:

a low pressure housing mounted in a sea floor;

a high pressure housing landed in the low pressure housing and having upper and lower radially thinner portions and a radially thicker portion disposed between and adjacent to the upper and lower radially thinner portions;

an upper loading surface on an outer surface of the radially thicker portion that terminates at a location where the radially thicker portion transitions into the upper radially thinner portion;

a lower loading surface on the outer surface of the radially thicker portion that terminates at a location where the radially thicker portion transitions into the lower radially thinner portion;

upper and lower loading surfaces on an inner surface of the low pressure housing that respectively engage the upper and lower loading surfaces on the radially thicker portion; and

a latch engaging the low and high pressure housings disposed axially between the upper loading surface and lower loading surface on the high pressure housing.

10. The wellhead assembly of claim 9, further comprising a channel on an outer surface of the high pressure housing disposed between the upper loading surface and lower loading surface on the high pressure housing and a passage providing communication between the channel and an annulus between the low and high pressure housings and adjacent the location where the radially thicker portion transitions to the lower radially thinner portion.

11. The wellhead assembly of claim 9, further comprising a production tree on an upper end of the high pressure housing.

12. The wellhead assembly of claim 9, further comprising a casing hanger landed inside the high pressure housing and a tubing hanger landed inside the casing hanger.