# TREE PROTECTION SYSTEM

## Related Applications

This patent application is a non-provisional and claims priority to and the benefit of U.S. Provisional Patent Application No. 61/372,388 filed on August 10, 2010, incorporated by reference herein in its entirety.

## 2. Field of the Invention

This invention relates in general to production of oil and gas wells, and in particular to a protective net system deployed over a subsea wellhead assembly.

## 3. Description of Related Art

Typically mounted on any wellbore is a wellhead assembly having valves for controlling the flow of fluids from the wellbore as well as and ports for access to the wellbore. As such, wellhead assemblies normally include actuators associated with the valves and ports. When located subsea, the wellhead assemblies generally include control panels where remotely operated vehicles (ROV) may dock and interface with the wellhead actuators via hot stabs in the control panels. Because to be accessible by an ROV, the control panels are usually on an outer surface of the wellhead assembly. As the control panels are exposed to the surroundings of the wellhead assembly, they are unprotected from impacts that sometimes occur from objects dropped from the sea surface or those that may topple over. While some wellhead assemblies can include a metal pane covering an upper surface, the wellhead assembly may still be susceptible to damage from side or lateral impacts. In some instances subsea wellheads are protected by covers that envelope the wellhead assembly. The covers usually have openings in their sidewalls so an ROV can access the wellhead assembly. These covers though are often large making them unwieldy or heavy and because of the openings, the wellhead assembly within remains vulnerable to damaging impact from a falling and/or toppling object.

SUMMARY OF THE INVENTION:

Disclosed herein is an example of a wellhead assembly having a protective netting. In an example embodiment the wellhead assembly includes a wellhead housing, a production tree mounted on the wellhead housing, and a net disposed over the wellhead housing and production tree. The net has an access therethrough than can be selectively opened and closed so the wellhead assembly can be accessed. In an example embodiment, the wellhead assembly also includes a frame member for supporting the net thereon. Optionally, the net can include side panels disposed adjacent a lateral perimeter of the frame. The access can be made up of members that attach to and slide along vertical portions of the frame; thus by coupling lateral ends of the side panels to the sliding members, when the side panels are urged in a direction parallel to the vertical portions of the frame, the side panels move away from a protecting position and into a position so that the wellhead assembly may be accessed. In an example embodiment, the sliding members are collar like and circumscribe a vertical portion of the frame; ends of horizontal net members attached to the sliding members. In an alternate example embodiment, the access is a vertical slit in the net. In an example embodiment, the net is a series of horizontal and vertical net members that are attached to each other and cross over one another.

Also provided and described herein is a method of protecting a wellhead assembly. In an example embodiment the method includes providing a protective netting having net elements and an access through the net elements that can be opened and closed. The entire wellhead assembly is protected from falling objects by disposing the protective netting over the wellhead assembly. Accessing the wellhead assembly occurs through the access. In an example embodiment, the method further includes providing a frame over the wellhead assembly for supporting the netting. In an example embodiment, the access is a vertical slit in the protective netting. In an example embodiment, a frame is provided that has elongate support posts equipped with sliding attachments on the support posts. Thus by mounting the protective netting on the frame so that at least a portion of the protective netting attaches to the sliding attachments, when the sliding attachments are moved along the support posts, the portion of the protective netting

moves away from the wellhead assembly to define the access. In an example embodiment, the attachments are urged along the support posts with an arm attached to a remotely operated vehicle (ROV), this moves the portion of the protective netting to define an opening through the protective netting. With the access in an open configuration, the wellhead assembly can be manipulated with the ROV. In an example embodiment, the protective netting is deployed from a vessel to subsea and onto the wellhead assembly. In an example embodiment, the protective netting and the wellhead assembly are deployed together subsea.

BRIEF DESCRIPTION OF THE DRAWINGS:

Figure 1A is a side partial sectional view of a subsea wellhead assembly on the seafloor with a protective net.

Figure 1B is a perspective view of the subsea wellhead assembly of Figure 1A.

Figure 2 is an alternate example of a protective net used with a wellhead assembly on the seafloor.

Figure 3A is a perspective view of a subsea wellhead assembly with a protective net being lowered from a vessel to the seafloor.

Figure 3B is a perspective view of the subsea wellhead assembly and protective net of Figure 3A on the seafloor.

Figure 4 is a side perspective view of the subsea wellhead assembly of Figure 1 with a protective net assembly having an opening through a protective net.

Figure 5A is an alternate embodiment of a wellhead assembly having a protective netting in accordance with an embodiment of the present invention.

Figure 5B is an embodiment of the wellhead assembly of Figure 5A with a remotely operated vehicle creating an access in the protective netting in accordance with the present invention.

Figure 5C is a detail of an example of an attachment between the protective netting and a support post.

DETAILED DESCRIPTION OF THE INVENTION:

Figure 1A illustrates an example embodiment of a subsea wellhead assembly 10 in a partial side sectional view. The subsea wellhead assembly 10 includes a wellhead housing 12 shown mounted over casing 14 that is inserted into a subsea formation 16. A coupling mounts a production tree 18 on the wellhead housing 12. The production tree 18 typically includes laterally projecting fluid flow lines 20 having wing valves 22 disposed within the lines 20. In one of many possible configurations, a main bore 24 projects vertically along the production tree 18 and in line with the wellhead housing 12. A swab valve 26 is set in the main bore 24 for controlling the flow through the main bore 24. Projecting upward from the end of the main bore 24 is a reentry mandrel 28.

A protective net 30 is illustrated spanning between and connected to vertically mounted guideposts 32 that are oriented substantially parallel with the main bore 24. The lower ends of the guidepost 32 are mounted on a support frame 34 shown mounted on the wellhead housing 12 and radially extending outward. The support frame 34 can be made up of individual structural elements or a plate-like planar structure. The subsea well head assembly 10 also includes a service control module (SCM) 36 for local control of the valves 22, 26 and other mechanisms provided on the wellhead assembly 10. A control line (not shown), such as a flying lead, can be attached to the SCM 36 for delivering control commands to and from the SCM 36. Figure 1B provides a perspective view of the wellhead assembly 10 of Figure 1A. In the embodiment of Figure 1B, the net 30 includes a series of interconnecting net members 37 that are strategically spaced apart so the net 30 has sufficient strength to protect components of the wellhead assembly 10 from falling debris or other impacts.

Figure 2 depicts an alternative embodiment of a net 40 that can be used for protecting a wellhead assembly 10 subsea. In this example the net 40 envelopes the sides and the overhead of the wellhead assembly 10. The net 40 of Figure 2 is made of interconnected net members 42 strategically spaced to provide an adequate barrier for falling and/or

toppling objects to prevent impact with the wellhead assembly 10. The net members 37 and/or 42 can be made from lines, ropes, straps, monofilament, or any other type of elongated member. In one example, the net members 37 and 42 are formed from Kevlar®; optionally, other aramid or carbon fibers can be used for forming the net members 37 and 42. The dimensions, spacing, and arrangement of the net members 37, 42 may vary on the particular application of the net 30, 40; these details however are within the capabilities of those skilled in the art and may be determined without undue experimentation.

Figure 3A illustrates in a perspective view an example of using a workboat 44 for deploying a net 40A shown set on a frame 46. The net 40A and frame 46 are lowered to the seafloor for protecting the subsea wellhead assembly 10 (Figure 3B). Referring now to Figure 3B, the frame 46 includes upper horizontal girders 48 arranged in a rectangle that circumscribes the reentry mandrel 28. In an example embodiment, the reentry mandrel 28 inserts through the portion of the net 40A set within the upper horizontal girders 48. Lower girders 50 are shown horizontally mounted on the seafloor and form a rectangular-like shape having an outer perimeter greater than the upper girders 48. Vertically mounted posts 52 attach between the upper and lower girders 48, 50. Since the lower girders 50 have a perimeter larger than the upper girders 48, the vertical posts 52 angle radially outward with distance away from the upper girders 48.

Referring back to Figure 3A, although the net 40A and frame 46 are shown being lowered subsea from the workboat 44, the net 40A and frame 46 may also be lowered from other types of vessels, including any type of an offshore platform. A remote operated vehicle (ROV) 54, optionally deployed from the workboat 44, is adjacent the net 40A and may be used to aid in laying the net 40A and frame 46 over the wellhead assembly.

Referring now to Figure 4, a perspective view is shown of an alternate frame 46A with a protective net 40B. In this example, the frame 46A is largely rectangular with upper and lower rectangularly shaped girders 48A, 50A that circumscribe the frame 46A at vertically spaced apart locations. As such, the girders 48A, 50A of Figure 4 have largely

the same dimensions. Vertical posts 52A are shown mounted between the respective corners of the upper and lower girders 48A, 50A and extending largely parallel to the main bore 24 of the subsea assembly 10. Included with the upper girder 48A are horizontal joists 55 shown set between parallel members of the upper girders 48A. The combination of the upper girders 48A and the horizontally mounted joists 55 provide an upper surface for supporting the net 40B. The vertical posts 52A define a vertical perimeter for the sides of the net 40B. A vertically extending slit 56 on one side of the net 40B of Figure 4 defines an access by forming an opening by which the wellhead assembly 10 may be accessed. In an example embodiment, the ROV 54 may access the wellhead assembly 10 through the slit 56. Optionally, the slit 56 may be on another side of the net 40B, or further optionally, the net 40B may include more than one slit 56 In the embodiment of Figure 4 the ROV 54 includes a mechanical arm 58 and may be controlled via an attached tether line 60. The arm 58 can be used to slide apart the portions of the net 40B adjacent the slit 56 to form an opening through the net 40B for accessing the subsea wellhead assembly 10.

Figure 5A illustrates an alternate example embodiment of the net 30A used for protecting the wellhead assembly 10 where the net 30A further includes side panels 62 that drape along the lateral sides of the wellhead assembly 10. The panels 62 are supported by optional posts 64. The panels include horizontal net members 66 that mount to the posts on sliding attachments 68. Vertical net members 70 may attach across the horizontal members 66 for enhancing the integrity of the panels 62. Figure 5B depicts an example feature of the net 30A wherein an arm(s) 58 of the ROV 54 temporarily moves a portion of one of the panels 62 away from a control panel 72 by downwardly sliding the horizontal members 66 to urge the sliding attachments 68 along the posts 64 thereby defining an access by forming an opening. Hot stabs 74 and other attachments on the control panel 72 can be accessed by the ROV 54, then the panels 62 returned to their configuration of Figure 5A and in a protecting position. An example embodiment of the sliding attachment 68 is shown in expanded detail in Figure 5C where the sliding attachments 68 mount on rods 69 attached to the posts 64 and are slidable over the rods 69. In an example embodiment, a coefficient of friction between the sliding attachment

68 and rods 69 is maintained at a level to resist sliding movement from gravity thereby maintaining a structural form when left unattended.

While the invention has been shown or described in only some of its forms, it should be apparent to those skilled in the art that it is not so limited, but is susceptible to various changes without departing from the scope of the invention.

**PARTS LIST**

| | |
|---|---|
| 10 | wellhead assembly |
| 12 | wellhead housing |
| 14 | casing |
| 16 | formation |
| 18 | producton tree |
| 20 | flow lines |
| 22 | wing valves |
| 24 | main bore |
| 26 | swab valve |
| 28 | reentry mandrel |
| 30 | net |
| 32 | guideposts |
| 34 | support frame |
| 36 | service control module |
| 37 | net members |
| 40 | net |
| 42 | net members |
| 44 | workboat |
| 46 | frame |
| 48 | girders |
| 50 | girders |
| 52 | posts |
| 54 | ROV |
| 55 | joists |
| 56 | slit |
| 58 | mechanical arm |
| 60 | tether line |
| 62 | net panels |
| 64 | posts |
| 66 | members |
| 68 | sliding attachment |
| 69 | rods |
| 70 | vertical member |
| 72 | control panel |
| 74 | hot stab |

WHAT IS CLAIMED IS:

1. A wellhead assembly 10 comprising:

a wellhead housing 12;

a production tree 18 mounted on the wellhead housing 12;

characterized by,

a net 30 disposed over the wellhead housing 12 and production tree 18; and

a selectively openable and closable access 56 in the net 30.

2. The wellhead assembly 10 of claim 1, further characterized by a frame 46 for supporting the net 30 thereon.

3. The wellhead assembly 10 of claim 2, characterized in that the net 30 includes side panels 62 disposed adjacent a lateral perimeter of the frame 46, and wherein the access 56 comprises slidable members 66 attached to vertical portions 64 of the frame 46 and where lateral ends of the side panels 62 couple to the slidable members 62, so selectively urging the side panels 62 in a direction parallel with the vertical portions 64 of the frame 46 moves the side panels 62 away from a protecting position and into a position so that the wellhead assembly 10 may be accessed.

4. The wellhead assembly 10 of claim 3, characterized in that the slidable member 62 comprises a collar like assembly that circumscribes a vertical portion of the frame 46 and has ends of horizontal net members 66 attached thereto.

5. The wellhead assembly 10 of any of claims 1-4, characterized in that the selectively openable and closable access 56 in the net 30 comprises a vertical slit in the net 30.

6. The wellhead assembly 10 of any of claims 1-5, characterized in that the net 30 comprises a series of horizontal and vertical net members 66, 70 that are attached to and cross one another.

7. The wellhead assembly 10 of any of claims 1-6, further characterized by a frame assembly 46 comprising interconnected elongate frame members 48, 50 on which the net 30 is supported.

8. A method of protecting a wellhead assembly 10 comprising:

providing a protective netting 30 having net elements 42 and a selectively openable and closeable access 56 through the net elements 42;

characterized by,

protecting the entire wellhead assembly 10 from falling objects by disposing the protective netting 30 over the wellhead assembly 10; and

accessing the wellhead assembly 10 through the access 56.

9. The method of claim 8, further characterized by providing a frame 46 over the wellhead assembly 10 for supporting the netting 30.

10. The method of claims 8 or 9, characterized in that the openable and closeable access 56 comprises a vertical slit 56 in the protective netting 30.

11. The method of any of claims 8-10, further characterized by providing a frame 46 having elongate support posts 64 and sliding attachments 68 on the support posts 64, mounting the protective netting 30 on the frame 46 so that at least a portion of the protective netting 30 attaches to the sliding attachments 68, wherein the portion of the protective netting 30 defines the access 56 by selectively urging the sliding attachments 68 along the support posts 64.

12. The method of any of claims 8-11, further characterized by accessing the wellhead assembly 10 by sliding attachments 68 along the support posts 64 with an arm attached to a remotely operated vehicle (ROV) 54 thereby moving the portion of the protective netting 30 to define an opening through the protective netting 30 and manipulating the wellhead assembly 10 with the ROV.

13. The method of any of claims 8-12, further characterized by deploying the protective netting 30 from a vessel to subsea and onto the wellhead assembly 10.

14. The method of any of claims 8-13, further characterized by deploying the protective netting 30 and the wellhead assembly 10 together subsea.