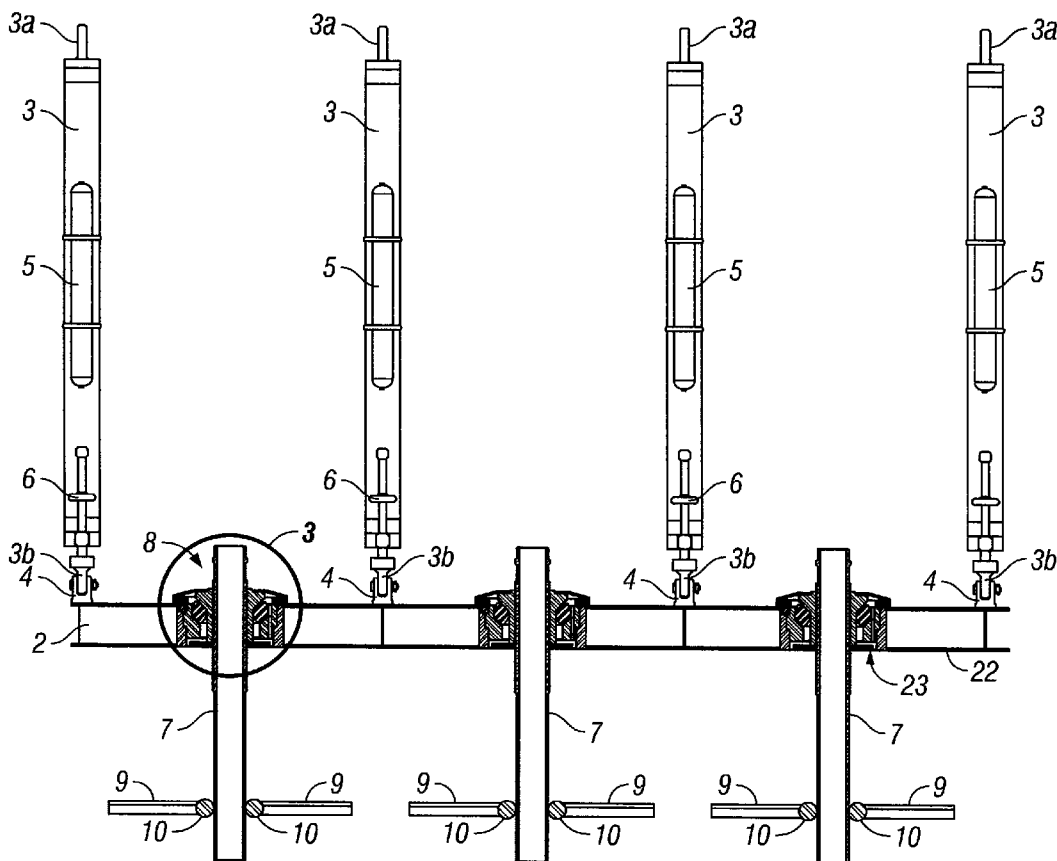


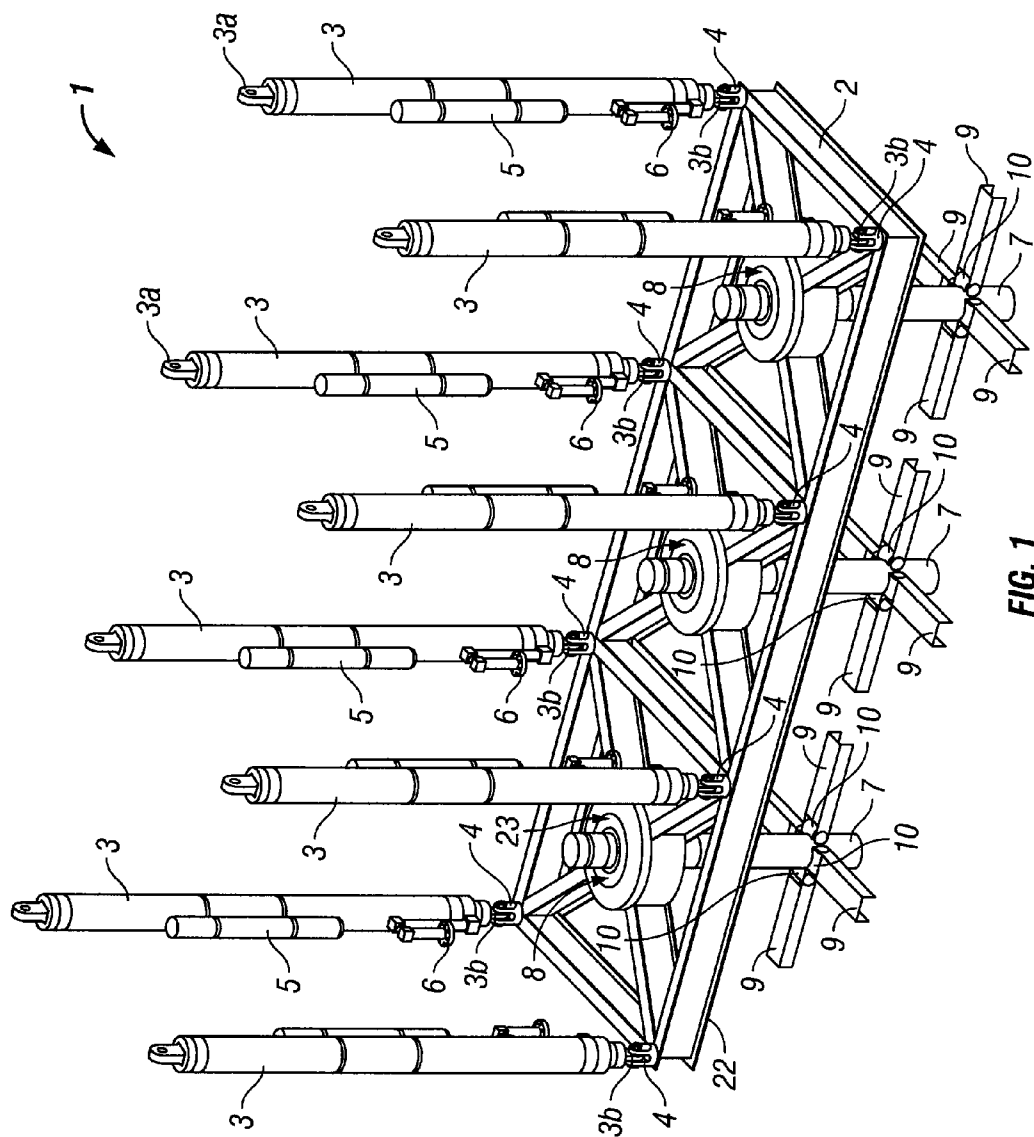


US 20120201611A1

(19) **United States**(12) **Patent Application Publication**
FLORES, SR. et al.(10) **Pub. No.: US 2012/0201611 A1**(43) **Pub. Date: Aug. 9, 2012**(54) **METHOD AND APPARATUS FOR
FACILITATING HANG OFF OF MULTIPLE
TOP TENSION RISER OR UMBILICALS
FROM A COMPENSATED TENSIONING
DECK**(52) **U.S. Cl. 405/224.4**(75) **Inventors:** **Ross William FLORES, SR.,**
Richmond, TX (US); **Terje Werner**
EILERTSEN, Houston, TX (US);
Gregory Kyle NORWOOD,
Houston, TX (US)(73) **Assignee:** **TECHNIP FRANCE, Courbevoie**
(FR)(21) **Appl. No.: 13/022,061**(22) **Filed: Feb. 7, 2011****Publication Classification**(51) **Int. Cl.**
E21B 17/01 (2006.01)(57) **ABSTRACT**

The disclosure provides a deck tensioning system, supporting multiple risers, that is coupled to an offshore platform and compensated for heave and horizontal movement. Such a tensioning system provides simplified access to the production trees on the risers. The tensioning system provides tensioning for a tensioning deck to which the multiple risers are coupled, while reducing the tensioning cylinders for individual risers. The deck tensioning system further provides a simplified tension flex connector ("TFC") with an intermediate movable member for each riser. The TFC assists in absorbing and/or adjusting for forces that may cause the tensioning deck to pitch and roll from the interactions between the multiple risers coupled to the tensioning deck as a unitary structure. If a fire or other event causes damage to the tension flex connector, the tension flex connector is designed to maintain a supporting connection with the riser without the intermediate movable member.





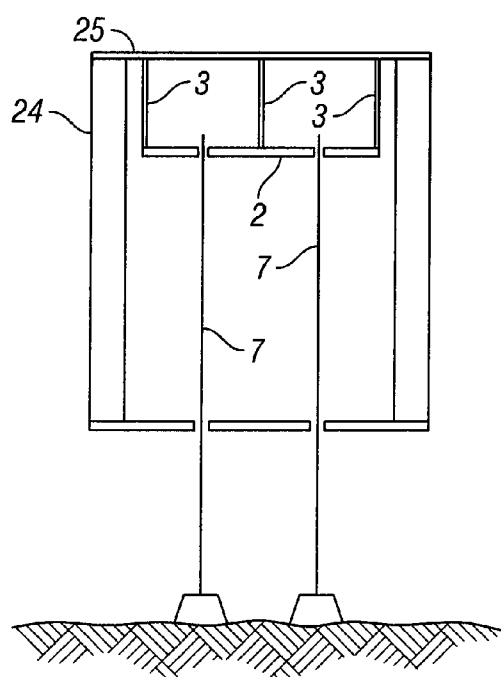


FIG. 1A

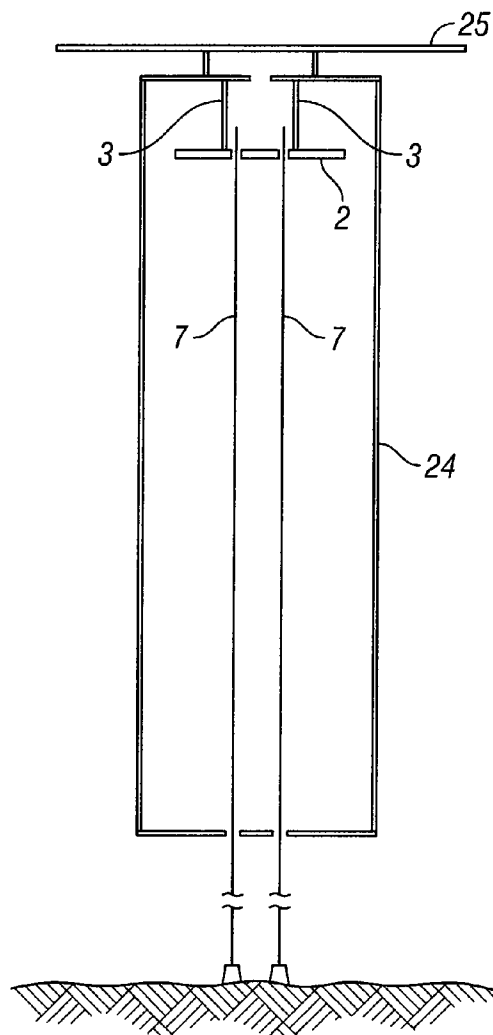


FIG. 1B

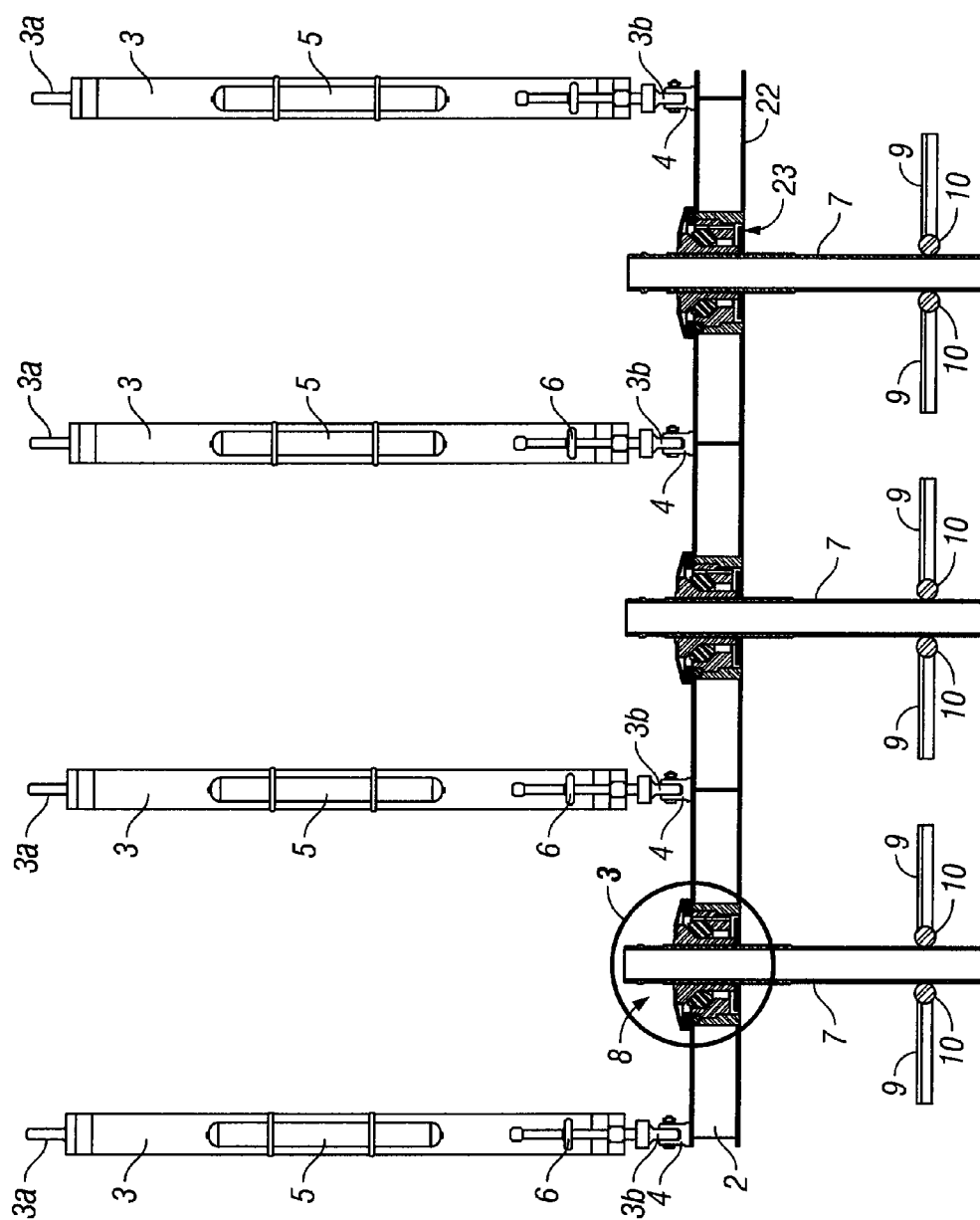


FIG. 2

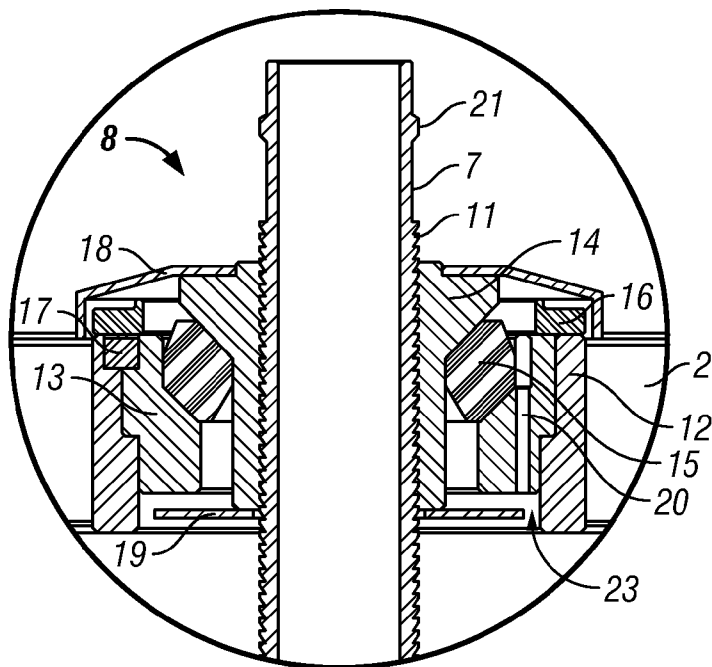


FIG. 3

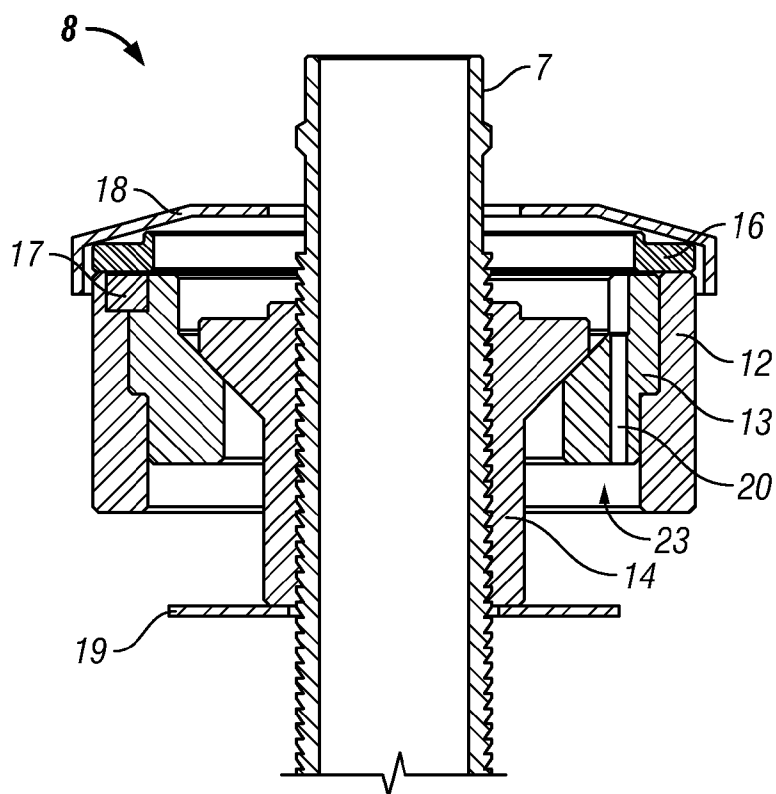


FIG. 4

**METHOD AND APPARATUS FOR
FACILITATING HANG OFF OF MULTIPLE
TOP TENSION RISER OR UMBILICALS
FROM A COMPENSATED TENSIONING
DECK**

CROSS REFERENCE TO RELATED
APPLICATIONS

[0001] Not applicable.

STATEMENT REGARDING FEDERALLY
SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

REFERENCE TO APPENDIX

[0003] Not applicable.

BACKGROUND OF THE INVENTION

[0004] 1. Field of the Invention

[0005] The invention relates to generally to the field of floating offshore platforms or vessels for the exploitation of undersea deposits of petroleum and natural gas. More specifically, it relates to a system and apparatus for tensioning risers that extend from a subsea wellhead or subsurface structure to a floating platform or vessel.

[0006] 2. Description of the Related Art

[0007] Offshore platforms for the exploitation of undersea petroleum and natural gas deposits typically support production risers that extend to the platform from one or more wellheads or structures on the seabed. In deep water applications, floating platforms (such as spars, tension leg platforms, extended draft platforms, and semi-submersible platforms) are typically used. These platforms are subject to motion due to wind, waves, and currents. Consequently, the risers employed with such platforms must be tensioned to permit the platform to move relative to the risers. Also, riser tension must be maintained, so that the riser does not buckle under its own weight. Accordingly, the tensioning mechanism must exert a substantially continuous tension force to the riser within a well-defined range. One broad class of risers is the category called "Top Tensioned Risers" or TTRs. Such risers extend from the subsea wellheads below the hull of the platform substantially vertically to the deck area of the platform, where they are supported by a tensioning mechanism. Such risers are termed "Top Tensioned Riser." Each TTR typically extends from a riser tension point up into the production deck levels of the platform with the use of a heavy wall conduit or stem joint. At the top of the conduit or stem joint is an upper riser termination, where a surface wellhead and a production tree or flow control device are mounted. (Platforms with such an arrangement are called "dry tree" platforms.) A flexible jumper attached to the production tree enables the produced well fluids to be transferred to the topside processing facilities.

[0008] Passive buoyancy cans are a well-known type of riser tensioning mechanism that is used primarily on spars. The buoyancy cans independently support each TTR, which allows the platform to move up and down relative to the riser. This ability to move isolates the risers from the heave motion of the platform and eliminates any increased riser tension caused by the horizontal offset of the platform in response to the marine environment.

[0009] Hydro-pneumatic tensioner systems are another form of a riser tensioning mechanism used to support TTRs on various dry tree platforms. Hydro-pneumatic riser tensioning has its origins in the support of drilling risers of MODUs (mobile offshore drilling units).

[0010] A plurality of active hydraulic cylinders with pneumatic accumulators can be connected between the platform and the riser to provide and maintain the necessary riser tension. Platform responses to environmental conditions, mainly heave and horizontal motions causing hull set-down, necessitate changes in riser length relative to the platform, which causes the tensioning cylinders to stroke in and out. The spring effect caused by the gas compression or expansion during riser stroke partially isolates the riser from the low heave platform motions, while maintaining a nearly constant riser tension. However, when the platform takes a significant horizontal offset, the compression of the gas in the cylinders causes increased cylinder pressure and thus increased riser tension. The magnitude of this increased riser tension is a function of the stiffness of the riser and the tensioning system. Such tensioning systems are designed, so that each system operates independently on a single riser. Further, several risers can be individually supported by a movable deck, which in turn is supported by winches or hydraulic cylinders to the floating platform. The movable deck is constrained from horizontal movement by guides, rails, and other structures but allowed to move in the vertical direction. The winches or hydraulic cylinders appear to allow macro adjustments to an overall elevation of the deck relative to the platform, while the individual tensioning systems operate as heave and horizontal motion compensators upon the individual risers. Examples of such solutions are disclosed in U.S. Pat. Nos. 4,934,870, 6,431,284 and 6,669,784.

[0011] While the benefits of a vertically movable deck with multiple risers are disclosed in systems of such patents, such systems retain the complexities of individual tensioning systems for each riser. There remains a need for a different system and method for an offshore platform suspending multiple risers therefrom.

BRIEF SUMMARY OF THE INVENTION

[0012] The disclosure provides a deck tensioning system, supporting multiple risers, that is coupled to an offshore floating platform and compensated for heave and horizontal movement. Such a tensioning system provides simplified access to the production trees on the risers. The tensioning system provides tensioning for a tensioning deck to which the multiple risers are coupled, while reducing the tensioning cylinders for individual risers. The deck tensioning system further provides a simplified tension flex connector ("TFC") with an intermediate movable member for each riser. The TFC assists in absorbing and/or adjusting for forces that may cause the tensioning deck to pitch and roll from the interactions between the multiple risers coupled to the tensioning deck as a unitary structure. If a fire or other event causes damage to the tension flex connector, the tension flex connector is designed to maintain a supporting connection with the riser without the intermediate movable member.

[0013] The disclosure provides a deck tensioning system for an offshore floating platform having a plurality of risers extending downward from the platform and suspended from the platform, comprising: a tensioning deck having a frame, the frame defining a plurality of openings adapted to receive the plurality of risers; a plurality of flexibly mounted control

cylinders adapted to suspend the tensioning deck to the offshore platform, the control cylinders coupled with flexible connections to the tensioning deck, the platform, or a combination thereof, the flexible connections adapted to allow the tensioning deck to move in at least one horizontal direction relative to the offshore floating platform; and a plurality of tension flex connectors coupled between the tensioning deck and the risers, the tension flex connectors disposed in the openings of the frame, the tension flex connectors adapted to allow the risers to move at angles to the tensioning deck while the tension flex connectors support the risers to the tensioning deck.

[0014] The disclosure also provides a method of supporting a riser from an offshore floating platform, comprising: supporting a tensioning deck from the offshore platform, the tensioning deck having a frame; allowing the frame to move in at least one horizontal direction and a vertical direction relative to the platform; supporting a plurality of risers from the tensioning deck; and allowing the risers to move angularly relative to the tensioning deck.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0015] FIG. 1 is schematic perspective view illustrating a deck tensioning system for an offshore floating platform.

[0016] FIG. 1A is a schematic overall view of the deck tensioning system coupled with an exemplary associated offshore floating platform.

[0017] FIG. 1B is a schematic overall view of the deck tensioning system coupled with another exemplary associated offshore floating platform.

[0018] FIG. 2 is a schematic side view of the deck tensioning system with a partial cross-sectional view through a tension flex connector that couples the risers with a tensioning deck on the tensioning system.

[0019] FIG. 3 is a detailed schematic cross sectional view of the tension flex connector with the riser and the tensioning deck.

[0020] FIG. 4 is a detailed schematic cross sectional view for the tension flex connector without the movable member.

DETAILED DESCRIPTION

[0021] The Figures described above and the written description of specific structures and functions below are not presented to limit the scope of what Applicant has invented or the scope of the appended claims. Rather, the Figures and written description are provided to teach any person skilled in the art how to make and use the inventions for which patent protection is sought. Those skilled in the art will appreciate that not all features of a commercial embodiment of the inventions are described or shown for the sake of clarity and understanding. Persons of skill in this art will also appreciate that the development of an actual commercial embodiment incorporating aspects of the present inventions will require numerous implementation-specific decisions to achieve the developer's ultimate goal for the commercial embodiment. Such implementation-specific decisions may include, and likely are not limited to, compliance with system-related, business-related, government-related and other constraints, which may vary by specific implementation, location, and from time to time. While a developer's efforts might be complex and time-consuming in an absolute sense, such efforts would be, nevertheless, a routine undertaking for those of

ordinary skill in this art having benefit of this disclosure. It must be understood that the inventions disclosed and taught herein are susceptible to numerous and various modifications and alternative forms. The use of a singular term, such as, but not limited to, "a," is not intended as limiting of the number of items. Also, the use of relational terms, such as, but not limited to, "top," "bottom," "left," "right," "upper," "lower," "down," "up," "side," and the like are used in the written description for clarity in specific reference to the Figures and are not intended to limit the scope of the invention or the appended claims. Where appropriate, some elements have been labeled with an alphabetic character after a number to reference a specific member of the numbered element to aid in describing the structures in relation to the Figures, but is not limiting in the claims unless specifically stated. When referring generally to such members, the number without the letter is used. Further, such designations do not limit the number of members that can be used for that function.

[0022] The disclosure provides a deck tensioning system, supporting multiple risers, that is coupled to an offshore platform and compensated for heave and horizontal movement. Such a tensioning system provides simplified access to the production trees on the risers. The tensioning system provides tensioning for a tensioning deck to which the multiple risers are coupled, while reducing the tensioning cylinders for individual risers. The deck tensioning system further provides a simplified tension flex connector ("TFC") with an intermediate movable member for each riser. The TFC assists in absorbing and/or adjusting for forces that may cause the tensioning deck to pitch and roll from the interactions between the multiple risers coupled to the tensioning deck as a unitary structure. If a fire or other event causes damage to the tension flex connector, the tension flex connector is designed to maintain a supporting connection with the riser without the intermediate movable member.

[0023] FIG. 1 is schematic perspective view illustrating a deck tensioning system for an offshore floating platform. FIG. 1A is a schematic overall view of the deck tensioning system coupled with an exemplary associated offshore floating platform. FIG. 1B is a schematic overall view of the deck tensioning system coupled with another exemplary associated offshore floating platform. FIG. 2 is a schematic side view of the deck tensioning system with a partial cross-sectional view through a tension flex connector that couples the risers with a tensioning deck on the tensioning system. FIG. 3 is a detailed schematic cross sectional view of the tension flex connector with the riser and the tensioning deck. FIG. 4 is a detailed schematic cross sectional view for the tension flex connector without the movable member. The figures will be described in conjunction with each other.

[0024] The deck tensioning system 1 tensions multiple risers with compensated tensioning. The deck tensioning system 1 is coupled to an offshore floating platform 24, generally having a hull deck 25, such as shown in FIGS. 1A and 1B. The term "floating platform" is used broadly herein and for purposes of the present description includes both platforms (such as spars, tension leg platforms, extended draft platforms, and semi-submersible platforms, and the like) and vessels (such as drilling vessels, production vessels, FPSOs, and the like). This deck tensioning system 1 may support any number of risers and/or umbilicals (collectively, referenced herein as risers). A tensioning deck 2 is formed from a frame 22 having a plurality of openings 23. The openings 23 provide a location for a plurality of risers 7 to be coupled with the tensioning

deck 2 and thence to the platform 24. The openings 23 can be supplemented and/or reinforced by a deck landing ring 12. The deck landing ring 12 is advantageously used to support a tension flex connector 8 described below.

[0025] The tensioning deck 2 is coupled below one or more control cylinders 3 (such as hydraulic or pneumatic cylinders or combinations thereof) on an attachment 4 via a connection 3b on the lower end of the cylinder to allow for horizontal movement of the tensioning deck from the relative heave, pitch, yaw, and roll of the floating platform 24, in contrast to other suspended decks such as disclosed in the above background section. The upper end 3a of each cylinder 3 is coupled to the floating platform 24, such as to the hull deck 25. One or both of the connections 3a, 3b may be a flexible connection that allows movement in at least one horizontal direction and advantageously in multiple horizontal directions (that is, in orthogonal “x” and “y” directions, including combinations thereof). Such a flexible connection can include a moment-free connection that allows movement at multiple angles in at least two horizontal directions. Example of such a moment-free connection could be a spherical bearing, a flex joint, or simply two shackles coupled together.

[0026] A plurality of risers 7 are coupled to the tensioning deck 2, which may pitch, roll and/or stroke up or down. In some embodiments, an optional lower structure 9 coupled to the platform 24 below the tensioning deck 2 may further support movement of the risers 7 and would depend on a riser analysis and hull analysis based on a riser loading to the hull. In such embodiments, an optional roller 10 can be used to assist the risers to move vertically relative to the platform as the platform moves. These motions occur due to the floating platform’s offset from a pattern center, heave, pitch, or roll, causing a change in a geometric distance between the riser’s null elevation at a rest state on the vessel and the subsea wellhead. The change in distance results in a tightening or relaxing of the supported risers. The change may be different between the risers 7 attached to the same tensioning deck 2 and result in unequal loading of the tensioning deck. The unequal loading may cause the tensioning deck 2 to pitch, roll, and stroke as the hydraulic cylinders passively equalize the moment and forces imparted to the tensioning deck by both the cylinders 3 and risers 7 when the floating platform heaves, pitches, yaws, and rolls relative to the tensioning deck. Due to the pitch/roll of the tensioning deck 2, a new connection between the riser (tension joint) and the tensioning deck is desirable.

[0027] A flexible connection is provided between the risers 7 and the tensioning deck 2. As more particularly seen in FIGS. 2 and 3, this flexible connection is termed herein a tension flex connector (TFC) 8. The TFC 8 is coupled and supported to the tensioning deck 2 by a load shoulder in the deck landing ring 12 of the tensioning deck. The TFC 8 is restrained to the deck landing ring 12 by a split retaining ring 16. Rotation between the TFC and the tensioning deck is prevented by an alignment key 17 interfacing with the deck landing ring. The riser 7 is connected to a TFC inner body 14 via a thread profile 11. The threaded connection from the thread profile 11 allows the riser elevation to be adjusted relative to the TFC 8 and the tensioning deck 2 to accommodate riser space out. Once adjusted, the TFC supports the riser loads. A movable element 15 is disposed between the TFC inner body 14 and a TFC outer body 13, and allows for some flexibility between the riser 7 and the tensioning deck 2, while maintaining tension force on the riser. The movable element

15 can include a flexible member. Alternatively, the movable element 15 can include a spherical bearing. Other than some flexibility within the movable element 15, the vertical movement of the riser 7 is fixed relative to the tensioning deck 2, while the overall vertical movement of the riser and tensioning deck is controlled by the control cylinders 3 linking the tensioning deck to the hull of the offshore platform 24. A typical dry tree system or telescopic joint is connected to the riser using a standard attachment point 21. The TFC internal components are protected from contaminants such as drilling/completion fluids by an upper cover 18 and lower cover 19. A port 20 allows draining of fluid from the TFC. These covers and other components may be insulated to prolong internal component life.

[0028] Referring particularly to FIG. 4, the inner body 14 of the TFC is sized and designed to land on and be supported by the outer body 13 to prevent loss of the riser when the movable element 15 is not present. Stated differently, the outer body is sized and designed to resist a downward movement of the inner body through the outer body. Such an occurrence could be caused by events causing damage to the TFC, particularly the flexible element 15, such as a fire or internal component deterioration.

[0029] The TFC 8 minimizes the forces transmitted to the risers due to pitch/roll of the tensioning deck 2. Using a tensioning deck 2 with TFCs 8 for a deck tensioning system 1 provides the advantages of simplified access of the production trees, reduction in the number of tensioning cylinders required, and ultimately a reduction in weight and cost of the tensioning system.

[0030] Other and further embodiments utilizing one or more aspects of the inventions described above can be devised without departing from the spirit of the invention. For example, different connections and equipment can be used for heave and horizontal movement of the tensioning deck and for the riser tension flex connector. Other variations in the system are possible.

[0031] Further, the various methods and embodiments described herein can be included in combination with each other to produce variations of the disclosed methods and embodiments. Discussion of singular elements can include plural elements and vice-versa. References to at least one item followed by a reference to the item may include one or more items. Also, various aspects of the embodiments could be used in conjunction with each other to accomplish the understood goals of the disclosure. Unless the context requires otherwise, the word “comprise” or variations such as “comprises” or “comprising,” should be understood to imply the inclusion of at least the stated element or step or group of elements or steps or equivalents thereof, and not the exclusion of a greater numerical quantity or any other element or step or group of elements or steps or equivalents thereof. The device or system may be used in a number of directions and orientations. The term “coupled,” “coupling,” “coupler,” and like terms are used broadly herein and may include any method or device for securing, binding, bonding, fastening, attaching, joining, inserting therein, forming thereon or therein, communicating, or otherwise associating, for example, mechanically, magnetically, electrically, chemically, operably, directly or indirectly with intermediate elements, one or more pieces of members together and may further include without limitation integrally forming one functional member with another in a unitary fashion. The coupling may occur in any direction, including rotationally.

[0032] The order of steps can occur in a variety of sequences unless otherwise specifically limited. The various steps described herein can be combined with other steps, interlineated with the stated steps, and/or split into multiple steps. Similarly, elements have been described functionally and can be embodied as separate components or can be combined into components having multiple functions.

[0033] The invention has been described in the context of preferred and other embodiments and not every embodiment of the invention has been described. Apparent modifications and alterations to the described embodiments are available to those of ordinary skill in the art given the disclosure contained herein. The disclosed and undisclosed embodiments are not intended to limit or restrict the scope or applicability of the invention conceived of by the Applicant, but rather, in conformity with the patent laws, Applicant intends to protect fully all such modifications and improvements that come within the scope or range of equivalent of the following claims.

What is claimed is:

1. A deck tensioning system for an offshore floating platform having a plurality of risers extending downward from the platform and suspended from the platform, comprising:

a tensioning deck having a frame, the frame defining a plurality of openings adapted to receive the plurality of risers;

a plurality of flexibly mounted control cylinders adapted to suspend the tensioning deck from the platform, the control cylinders coupled with flexible connections to the tensioning deck, the platform, or a combination thereof, the flexible connections adapted to allow the tensioning deck to move in at least one horizontal direction relative to the platform; and

a plurality of tension flex connectors coupled between the tensioning deck and the risers, the tension flex connectors disposed in the openings of the frame, the tension flex connectors adapted to allow the risers to move at

angles to the tensioning deck while the tension flex connectors support the risers to the tensioning deck.

2. The system of claim 1, wherein the flexible connections of the control cylinders are adapted to allow the tensioning deck to move in multiple horizontal directions relative to the offshore floating platform.

3. The system of claim 1, wherein the control cylinders are adapted to control vertical movement of the tensioning deck and the risers coupled to the tensioning deck relative to the offshore floating platform.

4. The system of claim 1, wherein relative vertical movement of the risers to the tensioning deck are fixed by the tension flex connectors.

5. The system of claim 1, wherein the tension flex connectors comprise an inner body and an outer body and the outer body is adapted to resist a downward movement of the inner body through the outer body.

6. A method of supporting a riser from an offshore floating platform, comprising:

supporting a tensioning deck from the offshore floating platform, the tensioning deck having a frame;

allowing the frame to move in at least one horizontal direction and a vertical direction relative to the platform;

supporting a plurality of risers from the tensioning deck; and

allowing the risers to move angularly relative to the tensioning deck.

7. The method of claim 6, wherein allowing the frame to move in the at least one horizontal direction comprises allowing the frame to move in multiple horizontal directions relative to the offshore floating platform.

8. The method of claim 6, wherein allowing the frame to move in the at least one horizontal direction and the vertical direction relative to the platform comprises allowing the frame to move relative to pitch, roll, and yaw of the platform.

* * * * *