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(54) **Stress relief joints for risers**

Zugentlastungsverbindung für Steigrohre

Joint de relaxation des contraintes pour colonnes montantes

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Description

[0001] This invention relates to stress relief joints for risers such as those used in the production of hydrocarbons offshore, and more particularly to such stress relief joints used for risers in conjunction with floating structures.

[0002] In the drilling and production of hydrocarbons offshore, the development of deep water operations from floating vessels has included the use of tendons and risers under tension extending from the vessel to the sea floor. Such floating vessels have included tension buoyant towers and spar structures in which the floating structures extend well below the surface of the water and are subjected to heave, pitch, and roll motions.

[0003] The lower ends of the tendons and risers are connected to the sea floor by means of additional pipes or risers embedded in and grouted to the sea floor. The upper ends of the tendons and risers pass through openings in the keel or bottom portion of the vessels and are supported vertically by tension means located near the water surface.

[0004] When the vessel moves laterally in response to environmental forces, appreciable bending stresses will be induced in the riser in the region just above the point where the riser is attached to the additional pipes at the sea floor. A current approach to the situation has been to use thicker than normal pipes. Disadvantages of this approach are higher manufacturing costs and lower quality consistency in manufacturing of the thicker pipe. This presents a need for a better arrangement for handling the bending stresses induced in the riser at the sea floor.

[0005] US-A-4 854 781 discloses a variable rigidity element for protecting a riser near the sea floor, the element comprising a number of shells surrounding the riser, two or more concentric rings of shells being proposed.

[0006] According to the invention there is provided a stress relief joint for use with a riser in floating systems wherein a vessel is subject to variable motion caused by wind, currents and/or wave action, the riser having one end connectable to the sea floor and an upper riser portion for passing through an opening at the bottom of the vessel, the stress relief joint comprising:

a plurality of layers received around the riser such that an annulus is formed between each layer and the riser, and between each of the layers, said layers being concentric with the riser and having first and second ends, with the first end of each layer extending beyond the first end of the layer immediately underneath;

characterised in that:

said plurality of layers comprises a plurality of pipes received around the riser; and

a flange is rigidly connected to the riser and the second end of said pipes.

[0007] A preferred embodiment of the invention provides a stress relief joint for use with riser pipe in floating systems wherein a vessel is subject to variable motion caused by wind, current, and/or wave action. The riser pipe has one end connectable to the sea floor and an upper portion arranged to pass through an opening at the bottom of the vessel. The lower end, which is connectable to other pipes at the sea floor, is provided with at least two concentric pipes or sleeves around the riser. The lower ends of the pipes and riser are welded to a flange. The upper end of each of the concentric pipes extends beyond the upper end of the pipe immediately surrounding it. The annulus between the concentric pipes and the riser is preferably filled with a durable and pliable material. Also, shims may be inserted in the annulus at the end of each pipe segment.

[0008] The invention will now be described by way of example with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

Fig. 1 is a schematic view of a floating vessel, sea floor, and riser interconnecting the vessel and sea floor;

Fig. 2 is an enlarged detail view of a portion of Fig. 1 showing an embodiment of the invention; and

Fig. 3 is an enlarged longitudinal sectional view of part of the arrangement shown in Fig. 2.

[0009] Fig. 1 generally and schematically shows a vessel 20 of spar or tension buoyant tower type with a pipe 22 exiting from its bottom or keel 24 and having a suitable connection 26 to the sea floor 28. Lateral horizontal excursion of the vessel 20 is indicated by its position at 20'. Bending stresses occur on the pipe 22 where it exits the vessel at the keel 24 and at the sea floor connection 26, the dotted lines 22' exaggerating such bending.

[0010] Fig. 2 illustrates the preferred embodiment of the invention. A stress relief joint 10 is generally comprised of sleeves or pipes 30, 32 and a flange 34.

[0011] As seen in Fig. 3, the pipes 30, 32 are received around the riser 22 such that they are concentric with the riser 22. The pipe 30 has an inner diameter larger than the outer diameter of the riser 22 such that an annulus is formed between the riser 22 and the first pipe 30. The pipe 32 has an inner diameter larger than the outer diameter of the pipe 30 such that an annulus is formed between the pipes 30, 32. The upper end of the pipe 30 extends beyond the upper end of the pipe 32 immediately surrounding it.

[0012] The annulus between the concentric pipes 30, 32 and the riser 22 is preferably filled with a durable and pliable material 36. The pliable material 36 helps to in-

sure that the riser 22 and the pipes 30, 32 all deflect laterally substantially the same amount. A suitable material for the operating environment, such as cement grout, is used as the pliable material 36. The lower ends of the pipes 30, 32 and riser 22 are welded to a flange 34.

[0013] Flange 34 is specially formed so as to effectively form short segments of the riser 22 and each pipe 30, 32, respectively indicated by numerals 22A, 30A, and 32A. Each segment extends upwardly from the base of the flange. This feature places the weld between the riser, pipes, and flange some distance away from the most severe fatigue location, where the riser and pipes meet the base of the flange. It can also be seen that the weld point of the riser 22 and each pipe 30, 32 to the flange 34 are spaced apart longitudinally. This allows the flange to be thicker at the base where needed for handling the loads occurring during normal conditions. The lower end of the annulus formed between each segment 22A, 30A, and 32A may be provided with rounded smooth surface profiles as illustrated to reduce the stress concentration associated with sharp corners in the surface profile.

[0014] Shims 38 may be inserted in the annulus at the upper end of each pipe 30, 32 and rigidly held in place by any suitable means such as welding. Shims 38 may be formed of metal, such as steel, to provide durability and serve as retainers for less rigid materials 36, such as polyurethane.

[0015] Although only two concentric pipes are shown, it should be understood that more may be used, depending upon the application and conditions. It should also be understood that although the preferred embodiment locates the stress relief joint at the lower end of the riser, the joint may be positioned at other locations on the riser where necessary to accommodate appreciable bending loads.

[0016] The invention provides the advantage of lower costs because it may be formed from standard pipe sections that are readily available or can be manufactured using readily available equipment. The design is more reliable than the very thick single pipe designs presently in use because it is easier to control the quality of the thinner pipe material. The concentric pipe design also is more reliable because there is redundancy in the pipe sections. The inner pipe normally has the highest hoop stresses since this pipe is required to contain internal and external pressures. However, with the invention, the bending stresses in the inner most pipe are significantly less than in the outer pipes. Thus, the inner most critical pipe is less likely to experience fatigue damage.

[0017] Because many varying and differing embodiments may be made within the scope of the inventive concept herein taught and because many modifications may be made in the embodiment herein detailed in accordance with the descriptive requirement of the law, it is to be understood that the details herein are to be interpreted as illustrative and not in a limiting sense.

Claims

1. A stress relief joint (10) for use with a riser (22) in floating systems wherein a vessel (20) is subject to variable motion caused by wind, currents and/or wave action, the riser (22) having one end connectable to the sea floor (28) and an upper riser portion for passing through an opening at the bottom (24) of the vessel (20), the stress relief joint comprising:

   a plurality of layers (30,32) received around the riser (22) such that an annulus is formed between each layer and the riser, and between each of the layers, said layers being concentric with the riser and having first and second ends, with the first end of each layer extending beyond the first end of the layer immediately underneath;

   characterised in that:

   said plurality of layers comprises a plurality of pipes (30,32) received around the riser (22); and
   a flange (34) is rigidly connected to the riser (22) and the second end of said pipes (30,32).

2. A stress relief joint according to claim 1, wherein:

   said plurality of pipes (30,32) is received around the lower end of the riser (22);
   said first end of said pipes (30,32) comprises the upper end, the upper end of each of said pipes (30,32) extending beyond the upper end of the pipe immediately underneath; and
   said flange (34) is rigidly connected to the lower end of the riser (22) and said pipes (30,32).

3. A stress relief joint according to claim 2, wherein:

   said plurality of pipes comprises first and second pipes (30,32) received around the lower end of the riser (22).

4. A stress relief joint according to claim 1, claim 2 or claim 3, including a pliable material (36) received in the annulus formed between said pipes (30,32) and between the innermost pipe (30) and the riser (22).

5. A stress relief joint according to any one of claims 1 to 4, including a shim (38) rigidly attached between said pipes (30,32), and between the innermost pipe (30) and the riser (22).

Patentansprüche

1. Zugentlastungsverbindung (10) für die Verwen-

dung mit eine Rohrverbindung (22) in Schwimmsystemen, bei denen ein Wasserfahrzeug (20) verschiedenen durch Wind, Strömung und/oder Wellengang verursachten Bewegungen unterworfen ist, wobei die Rohrverbindung (22) ein Ende, das mit dem Meeresgrund (28) verbindbar ist, und einen oberen Rohrverbindungsabschnitt für das Hindurchführen durch eine Öffnung (24) im Boden des Wasserfahrzeugs (20) hat, wobei die Zugentlastungsverbindung aufweist:

eine Mehrzahl von Lagen (30, 32), die um die Rohrverbindung herum angeordnet sind, so daß zwischen jeder Lage und der Rohrverbindung und zwischen jeder der Lagen eine Ringkammer gebildet wird, wobei die Lagen zu der Rohrverbindung konzentrisch angeordnet sind und erste und zweite Enden haben, wobei sich das erste Ende jeder Lage über das erste Ende der direkt darunterliegenden Lage hinaus erstreckt,

dadurch gekennzeichnet, daß:

die Mehrzahl von Lagen eine Mehrzahl von Rohren (30, 32) aufweisen, die um die Rohrverbindung (22) herum angeordnet sind, und
ein Flansch (34) starr mit der Rohrverbindung (22) und dem zweiten Ende der Rohre (30, 32) verbunden ist.

2. Zugentlastungsverbindung nach Anspruch 1, wobei:

die Mehrzahl von Rohren (30, 32) um das untere Ende der Rohrverbindung (22) herum angeordnet sind,
das erste Ende der Rohre (30, 32) das obere Ende umgreift, wobei sich das obere Ende von jedem Rohr (30, 32) über das obere Ende des unmittelbar darunterliegenden Rohres hinaus erstreckt, und
der Flansch (34) starr mit dem unteren Ende der Rohrverbindung (22) und den Rohren (30, 32) verbunden ist.

3. Zugentlastungsverbindung nach Anspruch 2, wobei:

die Mehrzahl von Rohren ein erstes und ein zweites Rohr (30, 32) aufweist, die um das untere Ende des Steigrohrs (22) herum angeordnet sind.

4. Zugentlastungsverbindung nach Anspruch 1, Anspruch 2 oder Anspruch 3, die ein biegsames Material (36) beinhaltet, das in der Ringkammer aufgenommen ist, die zwischen den Rohren (30, 32) und zwischen dem am weitesten innen liegenden Rohr (30) und der Rohrverbindung (22) gebildet wird.

5. Zugentlastungsverbindung nach einem der Ansprüche 1 bis 4, die ein Abstandsstück (38) beinhaltet, das fest zwischen den Rohren (30, 32) und zwischen dem am weitesten innen liegenden Rohr (30) und der Rohrverbindung (22) angebracht ist.

Revendications

1. Joint de relaxation des contraintes (10) destiné à être utilisé avec une colonne montante (22) dans des systèmes flottants dans lesquels un vaisseau (20) est soumis à un mouvement variable causé par le vent, les courants et/ou l'action des vagues, la colonne montante (22) ayant une extrémité pouvant être reliée au fond de la mer (28) et une partie de colonne montante supérieure pour traverser une ouverture dans le fond (24) du vaisseau (20), le joint de relaxation des contraintes comprenant :

une pluralité de couches (30, 32) accrochées autour de la colonne montante (22) de sorte qu'une couronne soit formée entre chaque couche et la colonne montante, et entre chacune des couches, lesdites couches étant concentriques avec la colonne montante et ayant des première et seconde extrémités, la première extrémité de chaque couche s'étendant au-delà de la première extrémité de la couche située immédiatement en dessous ;

caractérisé en ce que :

ladite pluralité de couches comprend une pluralité de tuyaux (30, 32) accrochés autour de la colonne montante (22) ; et
une bride (34) est rigidement rattachée à la colonne montante (22) et à la seconde extrémité desdits tuyaux (30, 32).

2. Joint de relaxation des contraintes selon la revendication 1, dans lequel :

ladite pluralité de tuyaux (30, 32) est accrochée de l'extrémité inférieure de la colonne montante (22) ;
ladite première extrémité desdits tuyaux (30, 32) comprend l'extrémité supérieure, l'extrémité supérieure de chacun desdits tuyaux (30, 32) s'étendant au-delà de l'extrémité supérieure du tuyau situé immédiatement en dessous ; et
ladite bride (34) est rigidement rattachée à l'extrémité inférieure de la colonne montante (22) et auxdits tuyaux (30, 32).

3. Joint de relaxation des contraintes selon la revendication 2, dans lequel :

ladite pluralité de tuyaux comprend des premier et second tuyaux (30, 32) accrochés autour de l'extrémité inférieure de la colonne montante (22).

4. Joint de relaxation des contraintes selon la revendication 1, la revendication 2 ou la revendication 3, comprenant un matériau pliable (36) reçu dans la couronne formée entre lesdits tuyaux (30, 32) et entre le tuyau le plus intérieur (30) et la colonne montante (22).

5. Joint de relaxation des contraintes selon l'une quelconque des revendications 1 à 4, comprenant une cale (38) rigidement attachée entre lesdits tuyaux (30, 32), et entre le tuyau le plus intérieur (30) et la colonne montante (22).

FIG. 1

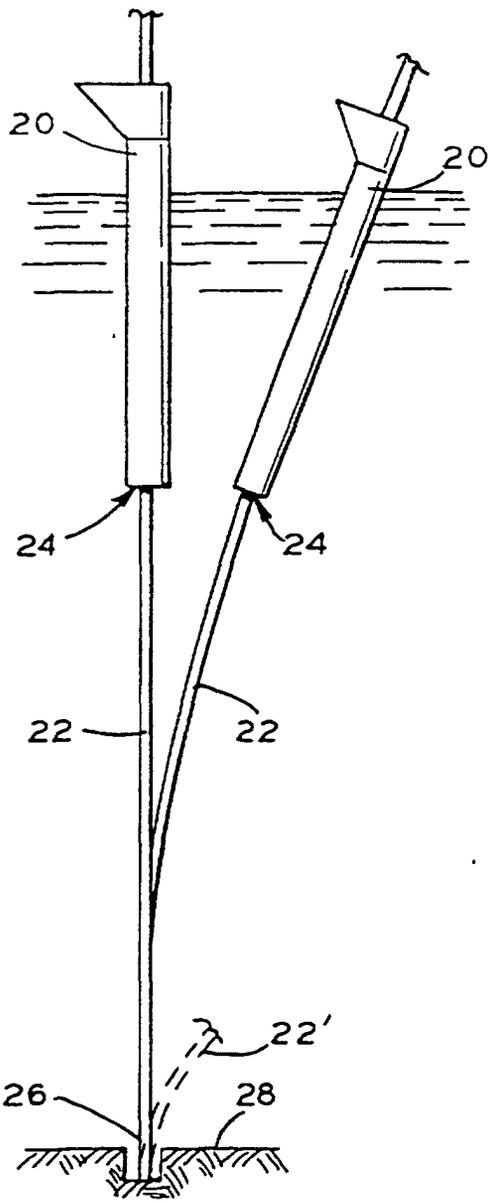


FIG. 2

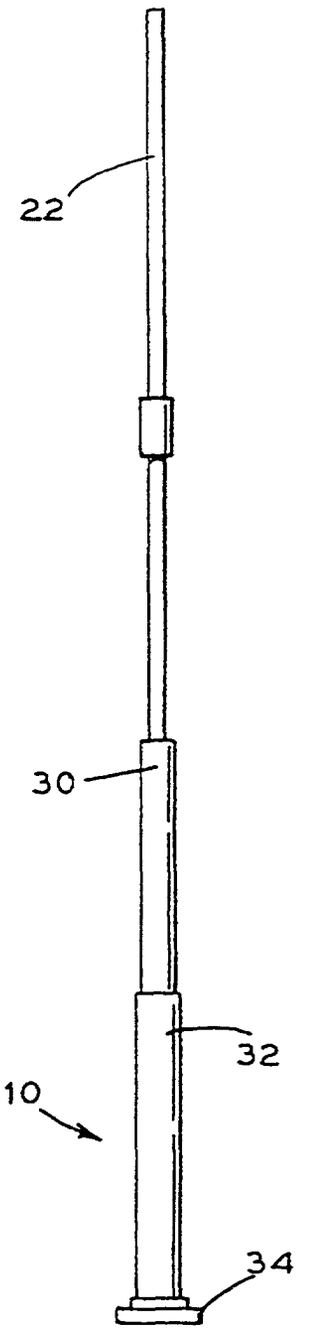


FIG. 3

