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(54) FLOATING DRILLING PLATFORM WITH QUICK DISCONNECT LEGS

(71) We, MARATHON MANUFACTURING COMPANY, a corporation organised and existing under the laws of the State of Delaware, United States of America, of Marathon Building, 600 Jefferson, Houston, Texas 77002, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to self-elevating mobile offshore drilling platforms having sectioned legs with structural joints that can be quickly connected or disconnected.

The exploration for petroleum deposits in offshore land submerged by water has brought about the development of floating drilling platforms, either self-propelled or towed, so that expensive, massive equipment can be moved from one location or another in a minimum of time. Generally, these drilling platforms, or ships, include legs which can be lowered to the bottom of the submerged land to elevate and support the drilling platform during drilling and can be raised from the bottom while the platform is floated to another location. As exploration has moved to deeper and deeper water these legs, of course, have become longer and today often are 300 feet or more in length. The longer legs when in the raised position have raised the center of gravity of the structure to such an extent that there is a danger of capsizing or over-turning the whole platform, especially in rougher water when moving the drilling platform. Hence it has become necessary to remove an upper section or sections of each leg from the section of leg therebelow so that the length of the legs extending above the deck of the drilling platform is shortened sufficiently during the floating of the platform from location to location, to prevent capsizing or instability of the platform.

Such separation of the leg sections may obviously be accomplished in various ways, such as by releasable connecting joint for each leg, an example of which is shown in U.S. Patent No. 3,628,336.

It is an object of this invention to provide a new and improved quick disconnect structural joint for each leg of a floating drilling platform having legs with removable sections, wherein the joint which, when connected, distributes the vertical and lateral loads thereon to prevent damage to the connecting components of the joint and to facilitate separation and connection of the joints.

According to the present invention, there is provided an offshore drilling platform structure comprising a floating drilling platform and a plurality of legs for supporting said platform and mounted with respect to said platform for longitudinal movement relative thereto, each leg having a tubular member, power means for raising and lowering said leg relative to said platform, a removable upper section and a joint for connecting the removable section to the remaining portion of said leg; said joint comprising:

a female member having a plurality of longitudinally displaced raised annular surfaces,

a male member adapted to be received by said female member having a plurality of longitudinally displaced raised annular surfaces which mate with, and bear against, the corresponding raised annular surfaces of the female member, said raised annular surfaces being short in length with respect to the longitudinal length of the joint; and

locking means for releasably locking said male and female members together.

For a better understanding of the invention and to show how the same can be carried into effect, reference will now be made, by way of example only to the accompanying drawings, in which:

Fig. 1 is a schematic diagram showing a drilling platform according to this invention with its legs lowered in the operating or working position;

Fig. 2 is a schematic diagram of one corner of the said drilling platform showing one leg raised and the removable section shown in broken lines;

Fig. 3 is a vertical section of the pin and box joint of said drilling platform; and

Fig. 4 is a sectional view taken across one of the joints of the leg along line 4—4 in Fig. 3.

In the drawings, a floating drilling platform 10 carries a plurality of legs 12 which are adapted to be raised and lowered through the drilling platform by a suitable jacking means (not shown). The legs 12 generally have a base 13 which contacts the land underneath the water, or bottom B, and supports the platform 10 above the surface of the water W when the platform is in its working position.

With the exception of a derrick 14 the usual drilling apparatus carried on a drilling platform is not shown. Each of the legs 12 is generally an open truss structure having three or four substantially vertically disposed tubular members 16, each of which carries a conventional rack 18 shown in Figure 4 for moving each leg 12 up and down through openings in the drilling platform 10. While three legs 12 are preferred, the floating drilling platform 10 may have four or more legs 12 without departing from the scope of the invention. Each tubular member 16 is formed with at least one upper releasable detachable section 16a jointed to a lower section 16b by a quick disconnect joint J shown in detail in Figs. 3 and 4.

Where each open truss leg 12 has more than one tubular member 16, the tubular members are connected to form the open truss structure horizontal members 28, 29, diagonal supports 30 and, in the case where a four cornered leg is contemplated, horizontal diagonal members 32 (see Figure 4), to join tubular members 16 in opposite corners of the leg 12.

The joint J for each leg 12 is preferably identical and therefore only one joint J will be described in detail. Thus, referred particularly to Figure 3, each joint J is comprised of a pin or male member 20 and a box or female member 22 having a bore 22c and so adapted that in its locked position on annular shoulder 24 of the pin or male member 20 rests with the upper leg section 16a on a circular end surface 26 of the female member 22 to carry the compression forces exerted when the leg 12 is resting on the bottom B supporting the drilling platform 10 in its working position as shown in Fig. 1. The female member 22 has on its interior surface two longitudinally displaced annular surfaces 22a and 22b of a smaller diameter than the bore 22c, and with the diameter at the surface 22b being less than at the surface 22a for a purpose to be hereinafter explained. These annular surfaces 22a and 22b are narrow or short in length with respect to the overall length of the joint J. For example, in a joint J having an overall length of about five feet, the length of each of the annular surfaces 22a and 22b is preferably only 2 to 3 inches and each is positioned such that they register with mating raised surfaces 20a and 20b on the external surface 20c of the male member 20 of the joint J. The upper annular surface 22a is preferably located near the open end of the female member. Below, and preferably adjacent, the lower annular raised surface 22b is a groove 22d, preferably annular, in the female member 22 which carries identical locking segments 34, 36 and 38 (Figure 4) and wedge guides 40 positioned to restrain any lateral movement of the locking segments 34, 36 and 38, as will be more fully explained.

The male member 20 of the joint has an annular groove 20d, which when the leg is connected, registers, or mates, with the groove 22d. The annular groove 20d of the male member receives the locking segments 34, 36 and 38 carried in the annular groove 22d of the female member when the joint is made and placed in its locked position, as will be more evident hereinafter.

It is an advantageous feature of this invention that when the joint J is connected, the annular surfaces 20a and 20b on the external surface of the male member 20 bear against the annular surfaces 22a and 22b, respectively, so that any lateral forces acting on each leg 12 caused by water and/or wind against the drilling platform 10 or legs 12 are distributed on these surfaces so as to span substantially the full length of the joint J to prevent a concentration of such forces on any one portion of the joint. When the joint J is in its connected position, it is sealed against the invasion of water into the joint by an O-ring 54 or other suitable seal, preferably located in an annular groove 26a on the upper surface 26 of the female member 22 of the joint.

Turning now to Fig. 4, for illustration purposes, locking segment 34 is shown in its locked position and locking segment 36 is shown completely withdrawn, or stated differently, in its unlocked position. Locking segment 38 is shown in an intermediate position being withdrawn from the annular groove 20d in the male member 20 by a shaft 56 operated by any suitable power means (not shown). Locking segment 34 is shown being held in its locked position by a locking pin 58 which is inserted through a hole 60 through the female member 22 communicating with the annular groove 22d. At least part of said hole 60 is threaded to secure the pin 58 to hold the locking segment 34 in position. When the joint J is connected for normal usage, each such locking segment 34, 36 and 38 is held in the locked position shown for the segment 34 by an identical or a similar pin 58. The hole 60 is made water tight when the joint is connected and locked by an O-ring 62 which may be conveniently carried on the pin 58 which has external threads 58a to mate with the internal threads of the hole 60.

Each locking segment 34, 36 and 38 has a threaded opening 52 in alignment with the hole 60 to receive the pin 58 when in the

locking position and the shaft 56 of the tool to remove the locking segment from the annular groove 20d. The internal threads of the hole 52 register with the external threads of the tool shaft 56 so that the shaft 56 is attached to each locking segment 34, 36 and 38 in the manner shown in Fig. 4 for the locking segment 38 to withdraw each segment from the groove 20d and into the groove 22d, or to insert each segment from the groove 20d to the locking position spanning both of the grooves 20d, 22d.

Locking segment 36 is shown being held in an unlocked position by a lock-out bolt 64 in one of the holes 60, which bolt 64 has inner threads registering with the threads of the hole 52 in the locking segment 36 and outer threads in threaded engagement with threads in the hole 60. Each segment may be similarly locked in the retracted position so as to be completely out of the groove 20d when the joint is to be separated and assembled. The lateral extent of each of the locking segments 34, 36 and 38 is such that, when in the locked position, each extends into both grooves 22d and 20d.

The vertical height of each segment 34, 36, 38 is less than the vertical height of the groove 20d so that the upper surface of each segment, such as the upper surface 34a of the segment 34 as shown in Fig. 3 is spaced below the upper surface 20e of the groove 20d. By reason of such construction, vertical downward or compression loads on each leg cannot be transmitted to the segments 34, 36, 38 which are relatively weak structurally as compared to the tubular sections 16a, 16b, and instead, such loads are taken by the legs themselves by the supporting contact at the annular surfaces 24 and 26. Such segments 34, 36, 38 are thus subjected only to vertical upward or tension forces when the legs 12 are being raised relative to the platform 10, and such loads are far less than the compression loads so that they can be adequately handled by such segments without distortion or damage thereto. By preventing the compression loads from being applied to the segments 34, 36, 38, the risk of distorting or even shearing same is avoided, which thereby avoids the risk of such segments being difficult or impossible to retract when it is necessary to disconnect the joint J.

The locking segments 34, 36 and 38 are guided and restrained from lateral movement by wedge guides 40 carried in the groove 22d and affixed to the female member 22 by any suitable means such as pins 66, inserted in holes 72 drilled through the female member communicating with the annular groove 22d. The pins 66 may be suitably affixed to female member 22 by welding said pins into said holes 72.

It will be appreciated that the wedge guides 40 could be formed integrally with the member 22, so that the groove 22d is actually segmentally formed to provide a slot 22^1 for each of the segments 34, 36, 38. The wedge guides 40 have surfaces 40a and 40b facing locking segment 38 (for illustrative purposes) which face, and are substantially parallel to, each other and disposed in the direction of movement of the locking segment 38 to prevent lateral movement of locking segment 38 while said segment 38 moves into, and out of, groove 20d by contact with surfaces 38a and 38b on locking segment 38.

In the operation or use of the joint J of this invention prior to connection, the locking segments 34, 36 and 38 are locked in the withdrawn position in the groove 22d and are so held by the locking bolts 64 as shown in Fig. 4 for the segment 36. The male member 20 is inserted into the female member 22 until the shoulder 24 of said male member 20 bears upon the circular end 26 of the female member 22 and is carried and supported thereupon. In this position, the annular surfaces 20a and 20b of the male member 20 register with, and bear upon, the annular surfaces 22a and 22b, respectively, of the female member 22. The edges of these surfaces are preferably bevelled to allow unobstructed passage of the male member into the assembled position within the female member.

Once the male member 20 has been seated in the female member 22, the lock-out bolts 64 are removed and the locking segments 34, 36 and 38 are moved by suitable power means on the shafts 56 into the annular groove 22d of the male member 22. Then, the shafts 56 are removed from the segments 34, 36, 38 and the locking pins 58 are inserted through the holes 60 and into the holes 52 without threading therein, but with the threads 58a engaging the threads in the holes 60, thus locking the male member 20 within the female member 22.

The leg construction of the present invention is of particular value when the sections of the leg 12 are being removed after the drilling platform 10 has ceased operations at one location and is to be moved to another. The legs 12 are brought up through the drilling platform 10 by the jacking means until the joint is raised to a position where workmen have access thereto. The locking pins 58 are removed and the shafts 56 of a suitable power source are inserted into the holes 60 and screwed into the threads in holes 52 in the segments 34, 36, 38 such as shown for segment 38. The suitable power means then withdraws each segment 34, 36, 38 from its locked position in grooves 20d and 22d into its unlocked position in groove 22d of the female member 22. Each segment is then locked into the groove 22d with a lockout bolt 64 as shown for segment 36. Because the only surfaces where substantial contact be-

tween the male member 20 and the female member 22 are where annular surface 22a bears upon annular surface 20a and annular surface 22b bears upon annular surface 20b, the male member 20 need be moved only a short vertical distance relative to the female member 22 before the joint J is freed and easily disconnected. This advantage is particularly apparent when the diameter of the surfaces 20b, 22b is less than the diameter of the surfaces 20a, 22a, since after the disengagement of the surfaces 20a, 22a, the other surfaces of the male member 20 are of a smaller diameter and therefore do not provide any frictional resistance to the separation of the members 20, 22. This advantage is not present in pin and box joints where a substantial amount of the surface of the male member bears against the female member since often, after extended periods of time operating in a single location, a joint becomes bound by either corrosion or the adverse effect of forces applied on said joint. Such joints often require extended periods of time and effort for disconnection to be accomplished. Such disadvantage is not present in a platform whose legs embody the present invention.

A further advantage over such prior art joints made possible by the above-described joint J which contributes to its quick-disconnect properties is that the joint while connected can be lubricated by filling the female member 22 with a suitable lubricant, such as a heavy oil or grease, which is contained by a solid diaphragm 70 welded to the internal surface 22f of the female member 22 below the joint J. When the male member 20 is seated in the female member 22 the lubricant fills the open spaces, such as, for example, the annular space between surfaces 20c and 22c and the grooves 22d and 20d, in the joint J. This serves to further protect the joint from corrosion and aids in the disconnection of the joint

WHAT WE CLAIM IS:—

1. An offshore drilling platform comprising a floating drilling platform and a plurality of legs for supporting said platform and mounted with respect to said platform for longitudinal movement relative thereto, each leg having a tubular member, power means for raising and lowering said leg relative to said platform, a removable upper section and a joint for connecting the removable section to the remaining portion of said leg; said joint comprising:

a female member having a plurality of longitudinally displaced raised annular surfaces,

a male member adapted to be received by sai dfemale member having a plurality of longitudinally displaced raised annular surfaces which mate with, and bear against, the corresponding raised annular surfaces of the female member, said raised annular surfaces being short in length with respect to the longitudinal length of the joint; and

locking means for releasably locking said male and female members together.

2. The structure of Claim 1, wherein said floating drilling platform includes:

a plurality of open truss legs having a plurality of tubular members at the corners of said legs.

3. The structure of Claim 1 or 2, wherein said raised annular surfaces of said female member of said joint are longitudinally displaced with one such annular surface being near the open end of said female member.

4. The structure of Claim 1, 2 or 3, wherein there are two longitudinally displaced raised annular surfaces.

5. The structure of any one of the preceding claims, wherein:

the female member has a plurality of internal slots formed therein;

the male member adapted to be received by said female member has an annular groove adapted to be laterally aligned with said slots; and

the locking means comprises a segmented locking element in each of said slots;

the structure additionally comprising means mounting said locking elements for lateral movement from a retracted joint-releasing position in said slots to a locking position spanning said slots and said annular groove.

6. The structure of Claim 3 or 4, or Claim 5 when appendant to Claim 3 or 4, wherein a said annular surface displaced away from the open end of said female member is near said annular groove in said female member.

7. The structure of Claim 5 or 6, wherein said male and female members have adjacent annular shoulders in abutting contact for transmitting compression loads from said upper removable section to said remaining leg portion therebelow; and the upper surface of each of said locking elements is longitudinally spaced below the upper surface of said annular groove when said shoulders are in abutting contact for thereby assuring that the compression loading on said leg is not taken by said locking segments.

8. The structure of any one of Claims 5 to 7, further comprising guide means between each of said segmental locking elements for guiding the same for movement laterally to and from the retracted and locking positions.

9. The structure of Claim 8, wherein each of said guide means has guide surfaces thereon in engagement with corresponding surfaces on each of said locking elements, the surfaces of each locking element being substantially parallel and disposed in the direction of movement of each element when

tween the male member 20 and the female member 22 are where annular surface 22a bears upon annular surface 20a and annular surface 22b bears upon annular surface 20b, the male member 20 need be moved only a short vertical distance relative to the female member 22 before the joint J is freed and easily disconnected. This advantage is particularly apparent when the diameter of the surfaces 20b, 22b is less than the diameter of the surfaces 20a, 22a, since after the disengagement of the surfaces 20a, 22a, the other surfaces of the male member 20 are of a smaller diameter and therefore do not provide any frictional resistance to the separation of the members 20, 22. This advantage is not present in pin and box joints where a substantial amount of the surface of the male member bears against the female member since often, after extended periods of time operating in a single location, a joint becomes bound by either corrosion or the adverse effect of forces applied on said joint. Such joints often require extended periods of time and effort for disconnection to be accomplished. Such disadvantage is not present in a platform whose legs embody the present invention.

A further advantage over such prior art joints made possible by the above-described joint J which contributes to its quick-disconnect properties is that the joint while connected can be lubricated by filling the female member 22 with a suitable lubricant, such as a heavy oil or grease, which is contained by a solid diaphragm 70 welded to the internal surface 22f of the female member 22 below the joint J. When the male member 20 is seated in the female member 22 the lubricant fills the open spaces, such as, for example, the annular space between surfaces 20c and 22c and the grooves 22d and 20d, in the joint J. This serves to further protect the joint from corrosion and aids in the disconnection of the joint

WHAT WE CLAIM IS:—

1. An offshore drilling platform comprising a floating drilling platform and a plurality of legs for supporting said platform and mounted with respect to said platform for longitudinal movement relative thereto, each leg having a tubular member, power means for raising and lowering said leg relative to said platform, a removable upper section and a joint for connecting the removable section to the remaining portion of said leg; said joint comprising:

a female member having a plurality of longitudinally displaced raised annular surfaces,

a male member adapted to be received by sai dfemale member having a plurality of longitudinally displaced raised annular surfaces which mate with, and bear against, the corresponding raised annular surfaces of the female member, said raised annular surfaces being short in length with respect to the longitudinal length of the joint; and

locking means for releasably locking said male and female members together.

2. The structure of Claim 1, wherein said floating drilling platform includes:

a plurality of open truss legs having a plurality of tubular members at the corners of said legs.

3. The structure of Claim 1 or 2, wherein said raised annular surfaces of said female member of said joint are longitudinally displaced with one such annular surface being near the open end of said female member.

4. The structure of Claim 1, 2 or 3, wherein there are two longitudinally displaced raised annular surfaces.

5. The structure of any one of the preceding claims, wherein:

the female member has a plurality of internal slots formed therein;

the male member adapted to be received by said female member has an annular groove adapted to be laterally aligned with said slots; and

the locking means comprises a segmented locking element in each of said slots;

the structure additionally comprising means mounting said locking elements for lateral movement from a retracted joint-releasing position in said slots to a locking position spanning said slots and said annular groove.

6. The structure of Claim 3 or 4, or Claim 5 when appendant to Claim 3 or 4, wherein a said annular surface displaced away from the open end of said female member is near said annular groove in said female member.

7. The structure of Claim 5 or 6, wherein said male and female members have adjacent annular shoulders in abutting contact for transmitting compression loads from said upper removable section to said remaining leg portion therebelow; and the upper surface of each of said locking elements is longitudinally spaced below the upper surface of said annular groove when said shoulders are in abutting contact for thereby assuring that the compression loading on said leg is not taken by said locking segments.

8. The structure of any one of Claims 5 to 7, further comprising guide means between each of said segmental locking elements for guiding the same for movement laterally to and from the retracted and locking positions.

9. The structure of Claim 8, wherein each of said guide means has guide surfaces thereon in engagement with corresponding surfaces on each of said locking elements, the surfaces of each locking element being substantially parallel and disposed in the direction of movement of each element when

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moving to and from the retracted and locking positions.

10. The structure of any one of Claims 5 to 9, wherein said female member has a lateral opening for each of said locking elements and a lock-in pin adapted to extend through each said opening for engagement with each said element and having means for securing the same to said female member for holding each said locking element in the locking position.

11. The structure of Claim 10, further comprising seal means between each lock-in pin and said tubular member for preventing fluid from leaking into said joint through said openings.

12. The structure of any one of Claims 5 to 11, wherein said female member has a lateral opening for each of said locking elements; and

a lock-out bolt adapted to extend through each said opening and having means for securing the same to each said locking element aligned therewith and said female member for holding each said locking element in the retracted position.

13. The structure of Claim 7, or any one of Claims 8 to 12, when appendant to Claim 7, further comprising seal means between said abutting shoulders to prevent fluid from leaking into said joint therebetween.

14. The structure of any one of the preceding claims, wherein said female member and said male member have inner and outer longitudinally spaced annular surfaces, each of a relatively short length as compared to the length of said joint.

15. The structure of Claim 14, wherein the inner contacting surfaces have a smaller diameter than the outer contacting surfaces to facilitate quick disconnecting of the joint.

16. The structure of any one of the preceding claims, further comprising a solid diaphragm attached to the inner surface of the female member below said joint to contain a lubricant in said joint.

17. An offshore drilling platform substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

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