The devices may be complex or use friction to resist the upward movement. These devices also include thrust columns that have adjustment notches.

Summary:

According to a first aspect, there is provided an offshore riser joint assembly, comprising: a central riser pipe: an upper support flange on an upper end portion of the central riser pipe and a lower support flange on a lower end portion of the central riser pipe, each of the support flanges having a plurality of openings; a plurality of auxiliary lines spaced around the central riser pipe, each auxiliary line having an upper end extending through one of the openings in the upper support flange and a lower end extending through one of the openings in the lower support flange; a buoyancy module assembly mounted around the central riser pipe and the plurality of the auxiliary lines; upper and lower thrust flanges carried by at least one of the auxiliary lines, the upper thrust flange being at an upper end of the buoyancy module assembly and the lower thrust flange being at a lower end of the buoyancy module assembly; an upper thrust link extending between the upper thrust flange and the upper support flange for transferring an upward force imposed by the buoyancy module assembly while submersed to the upper support flange; a lower thrust link extending between the lower thrust flange and the lower support flange for transferring a downward force imposed by the weight of the buoyancy module assembly while out of water to the lower support flange; and wherein: the upper thrust flange is axially movable relative to the auxiliary line on which it is carried so that upward thrust forces applied to the upper thrust flange pass through the upper thrust link directly to the upper support flange, bypassing the auxiliary line on which the upper thrust flange is carried.

According to a second aspect, there is provided an offshore riser joint assembly, comprising: a central riser pipe; an upper support flange on an upper end portion of the central riser pipe and a lower support flange on a lower end portion of the central riser pipe, each of the support flanges having a plurality of openings; a plurality of auxiliary lines spaced around the central riser pipe, each auxiliary line having an upper end extending through one of the openings in the upper support flange and a lower end extending through one of the openings in the lower support flange; a buoyancy module assembly mounted around the central riser pipe and the plurality of the auxiliary lines: upper and lower thrust flanges carried by at least one of the auxiliary lines, the upper thrust flange being at an upper end of the buoyancy module assembly and the lower thrust flange being at a lower end of the buoyancy module assembly; an upper thrust link extending between the upper thrust flange and the upper support flange for transferring an upward force imposed by the buoyancy module assembly While submersed to the upper support flange; a lower thrust link extending between the lower thrust flange and the lower support flange for transferring a downward force imposed by the weight of the buoyancy module assembly while out of water to the lower support flange; and wherein the upper

thrust link comprises an upper thrust sleeve through which the one of the auxiliary lines pass, the upper thrust flange being secured to the upper thrust sleeve, the upper thrust sleeve having an upper end that abuts a lower side of the upper support flange.

According to a third aspect, there is provided an offshore riser joint assembly, comprising: a central riser pipe; an upper support flange on an upper end portion of the central riser pipe and a lower support flange on a lower end portion of the central riser pipe, each of the flanges having a plurality of openings; a plurality of auxiliary lines spaced around the central riser pipe, each auxiliary line having an upper end extending through one of the openings in the upper support flange and a lower end extending through one of the openings in the lower support flange; a buoyancy module assembly of a buoyant material mounted around the central riser pipe and the auxiliary lines; a pair of upper thrust sleeves, each of the upper thrust sleeves sliding over one of the auxiliary lines, each of the upper thrust sleeves having an upper thrust flange that is engaged by an upper end of the buoyancy module assembly, each of the upper thrust sleeves being mounted so as to transfer upward thrust imposed by the buoyancy module assembly to the upper support flange; and a pair of lower thrust sleeves, each of the lower thrust sleeves sliding over one of the auxiliary lines, each of the lower thrust sleeves having a lower thrust flange that is engaged by a lower end of the buoyancy module assembly, each of the lower thrust sleeves being mounted so as to transfer weight of buoyancy module assembly while out of water to the lower support flange.

According to a fourth aspect, there is provided a method of providing buoyancy to an offshore riser assembly having a central riser pipe, an upper support flange on an upper end portion of the central riser pipe, a lower support flange on a lower end on a lower end portion of the central riser pipe, and a plurality of auxiliary lines spaced around the central riser pipe, each auxiliary line having ends extending through openings in the upper and lower support flanges, the method comprising: placing upper and lower thrust flanges at upper and lower ends of a buoyancy module assembly, and mounting the buoyancy module assembly around the central riser pipe and the auxiliary lines; mounting an upper thrust link between the upper thrust flange and the upper support flange, the upper thrust link being axially movable relative to the central riser pipe and the auxiliary lines; transferring an upward force imposed by the buoyancy module assembly while submersed from the upper thrust flange directly from the upper thrust link to the upper support flange, bypassing the central riser pipe and the auxiliary lines; and transferring a downward force imposed by the weight of the buoyancy module assembly while out of water from the lower thrust flange to the lower support flange.

In this invention, upper and lower thrust flanges are carried by at least one of the auxiliary lines. The upper thrust flange is at an upper end of a buoyancy module assembly, and the lower thrust flange is at a lower end of the buoyancy module assembly. An upper thrust link extends between the upper thrust flange and an upper support flange secured to the central riser pipe. The upper thrust link transfers an upward force imposed by the buoyancy module assembly while submersed to the upper support flange. A lower thrust link extends between the lower thrust flange and a lower support flange of the central riser pipe. The lower thrust link transfers a downward force imposed by the weight of the buoyancy module while out of water to the lower support flange.

The upper thrust flange is axially movable relative to the auxiliary line on which it is carried so that upward thrust forces applied to the upper thrust flange pass through the upper thrust link directly to the upper support flange, bypassing the auxiliary line on which the upper thrust flange is carried.

An adjustment mechanism adjusts a distance from one of the thrust flanges to the other. In the preferred embodiment, a set of external threads is located on at least one of the auxiliary lines. A threaded nut is in engagement with the external threads. One of the thrust links is engaged by the threaded nut so as to selectively position one of the thrust flanges at a selected point along a length of the assembly.

Preferably, there are two of the upper flanges and two lower flanges, each spaced 180 degrees apart from the other relative to an axis of the central riser pipe. In the

Claims

1. An offshore riser joint assembly, comprising:

a central riser pipe;

an upper support flange on an upper end portion of the central riser pipe and a lower support flange on a lower end portion of the central riser pipe, each of the support flanges having a plurality of openings;

a plurality of auxiliary lines spaced around the central riser pipe, each auxiliary line having an upper end extending through one of the openings in the upper support flange and a lower end extending through one of the openings in the lower support flange;

a buoyancy module assembly mounted around the central riser pipe and the auxiliary lines;

upper and lower thrust flanges carried by at least one of the auxiliary lines, the upper thrust flange being at an upper end of the buoyancy module assembly and the lower thrust flange being at a lower end of the buoyancy module assembly;

an upper thrust link extending between the upper thrust flange and the upper support flange for transferring an upward force imposed by the buoyancy module assembly while submersed to the upper support flange; and

a lower thrust link extending between the lower thrust flange and the lower support flange for transferring a downward force imposed by the weight of the buoyancy module assembly while out of water to the lower support flange.

2. The riser joint assembly according to claim 1, wherein:

the upper thrust flange is axially movable relative to the auxiliary line on which it is carried so that upward thrust forces applied to the upper thrust flange pass through the upper thrust link directly to the upper support flange, bypassing the auxiliary line on which the upper thrust flange is carried.

3. The riser joint assembly according to claim 1, further comprising an adjustment mechanism that selectively adjusts a distance from one of the thrust flanges to the other.

4. The riser joint assembly according to claim 1, wherein:

the upper thrust flange comprises two of the upper flanges, each spaced 180 degrees apart from the other relative to an axis of the central riser pipe; and

the lower thrust flange comprises two of the lower flanges, each spaced 180 degrees apart from the other relative to the axis of the central riser pipe.

5. The riser joint assembly according to claim 1, wherein the upper and lower thrust links comprise thrust sleeves, each receiving one of the auxiliary lines.

6. The riser joint assembly according to claim 1, wherein the upper thrust link comprises an upper thrust sleeve through which the one of the auxiliary lines pass, the upper thrust flange being secured to the upper thrust sleeve, the upper thrust sleeve having an upper end that abuts a lower side of the upper support flange.

7. The riser joint assembly according to claim 1, further comprising:

a set of external threads on at least one of the auxiliary lines;

a threaded nut in engagement with the external threads; and

one of the thrust links is engaged by the threaded nut so as to selectively position one of the thrust flanges at a selected point along a length of the riser joint assembly.

8. The riser joint assembly according to claim 1, further comprising:

at least one clamp bolted around the central riser pipe between the support flanges, the clamp having a hub portion and a plurality of legs extending outward from the hub portion; and

a retainer securing each of the auxiliary lines to an outer end of one of the legs.

9. The riser joint assembly according to claim 1, wherein the buoyancy module assembly comprises a plurality of foam block sections, each foam block section having at least two block segments fitted around the central riser pipe and the auxiliary lines and strapped in position, the foam block sections being stacked end on end between the thrust flanges.

10. An offshore riser joint assembly, comprising:

a central riser pipe;

an upper support flange on an upper end portion of the central riser pipe and a lower support flange on a lower end portion of the central riser pipe, each of the flanges having a plurality of openings;

a plurality of auxiliary lines spaced around the central riser pipe, each auxiliary line having an upper end extending through one of the openings in the upper support flange and ea lower end extending through one of the openings in the lower support flange;

a buoyancy module assembly of a buoyant material mounted around the central riser pipe and the auxiliary lines;

a pair of upper thrust sleeves, each of the upper thrust sleeves sliding over one of the auxiliary lines, each of the upper thrust sleeves having an upper thrust flange that is engaged by an upper end of the buoyancy module assembly, each of the upper thrust sleeves being mounted so as to transfer upward thrust imposed by the buoyancy module assembly to the upper support flange; and

a pair of lower thrust sleeves, each of the lower thrust sleeves sliding over one of the auxiliary lines, each of the lower thrust sleeves having a lower thrust flange that is engaged by a lower end of the buoyancy module assembly, each of the lower thrust sleeves being mounted so as to transfer weight of buoyancy module assembly while out of water to the lower support flange.

11. The riser joint assembly according to claim 10, wherein:

each of the upper thrust sleeves is axially movable relative to the auxiliary line on which it is carried so that upward thrust forces applied to the upper thrust flanges pass through the upper thrust sleeves directly to the upper support flange, bypassing the auxiliary lines on which the upper thrust sleeves are carried.

12. The riser joint assembly according to claim 10, further comprising:

an adjustment mechanism in cooperative engagement with one of the pairs of thrust sleeves to selectively adjust a distance from the pair of lower thrust sleeves to the pair of upper thrust sleeves.

13. The riser joint assembly according to claim 10, further comprising:

a set of external threads on each of the auxiliary lines carrying the pair of lower thrust sleeves;

a threaded nut in engagement with each set of external threads and each lower thrust sleeve for varying a position of each of the lower thrust sleeves relative to the upper thrust sleeves.

14. The riser joint assembly according to claim 10, wherein:

the upper thrust flanges are located on lower ends of the upper thrust sleeves; and

the lower thrust flanges are located on upper ends of the lower thrust sleeves.

15. The riser joint assembly according to claim 10, further comprising:

at least one clamp bolted around the central riser pipe between the support flanges, the clamp having a hub portion and a plurality of legs extending outward from the hub portion; and

a retainer securing each of the auxiliary lines to an outer end of one of the legs.

16. The riser joint assembly according to claim 10, wherein the buoyancy module assembly comprises a plurality of foam block sections, each foam block section having at least two block segments fitted around the central riser pipe and the auxiliary lines and strapped in position, the foam block sections being stacked end on end between the thrust flanges.

17. A method of providing buoyancy to an offshore riser assembly having a central riser pipe, an upper support flange on an upper end portion of the central riser pipe, a lower support flange on a lower end on a lower end portion of the central riser pipe, and a plurality of auxiliary lines spaced around the central riser pipe, each auxiliary line having ends extending through openings in the upper and lower support flanges, the method comprising:

placing upper and lower thrust flanges on at least one of the auxiliary lines;

mounting a buoyancy module assembly around the central riser pipe and the auxiliary lines, with an upper end of the buoyancy module assembly in engagement with the upper thrust flange and a lower end of the buoyancy module assembly in engagement with the lower thrust flange;

transferring an upward force imposed by the buoyancy module assembly while submersed from the upper thrust flange to the upper support flange; and

transferring a downward force imposed by the weight of the buoyancy module assembly while out of water from the lower thrust flange to the lower support flange.

18. The method according to claim 17, further comprising selectively adjusting the position of one of the upper and lower flanges relative to the other.

19. The method according to claim 17, further comprising:

mounting an upper thrust link between the upper thrust flange and the upper support flange; and wherein

transferring an upward force comprises passing the upward force through the upper thrust link to the upper support flange, bypassing the auxiliary line on which the upper thrust flange is placed.

20. The method according to claim 17, wherein placing upper and lower thrust flanges comprises positioning the thrust flanges on opposite sides of an axis of the central riser pipe.

The invention claimed is:

1. An offshore riser joint assembly, comprising:

a central riser pipe:

an upper support flange on an upper end portion of the central riser pipe and a lower support flange on a lower end portion of the central riser pipe, each of the support flanges having a plurality of openings;

a plurality of auxiliary lines spaced around the central riser pipe, each auxiliary line having an upper end extending through one of the openings in the upper support flange and a lower end extending through one of the openings in the lower support flange;

a buoyancy module assembly mounted around the central riser pipe and the plurality of the auxiliary lines;

upper and lower thrust flanges carried by at least one of the auxiliary lines, the upper thrust flange being at an upper end of the buoyancy module assembly and the lower thrust flange being at a lower end of the buoyancy module assembly;

an upper thrust link extending between the upper thrust flange and the upper support flange for transferring an upward force imposed by the buoyancy module assembly while submersed to the upper support flange;

a lower thrust link extending between the lower thrust flange and the lower support flange for transferring a downward force imposed by the weight of the buoyancy module assembly while out of water to the lower support flange; and wherein:

the upper thrust flange is axially movable relative to the auxiliary line on which it is carried so that upward thrust forces applied to the upper thrust flange pass through the upper thrust link directly to the upper support flange, bypassing the auxiliary line on which the upper thrust flange is carried.

2. The riser joint assembly according to claim 1, further comprising an adjustment mechanism that selectively adjusts a distance from one of the thrust flanges to the other.

3. The riser joint assembly according to claim 1, wherein:

the upper thrust flange comprises two of the upper flanges, each spaced 180 degrees apart from the other relative to an axis of the central riser pipe; and

the lower thrust flange comprises two of the lower flanges, each spaced 180 degrees apart from the other relative to the axis of the central riser pipe.

4. The riser joint assembly according to claim 1, wherein the upper and lower thrust links comprise thrust sleeves, each receiving one of the auxiliary lines.

5. An offshore riser joint assembly, comprising:

a central riser pipe;

an upper support flange on an upper end portion of the central riser pipe and a lower support flange on a lower end portion of the central riser pipe, each of the support flanges having a plurality of openings;

a plurality of auxiliary lines spaced around the central riser pipe, each auxiliary line haying an upper end extending through one of the openings in the upper support flange and a lower end extending through one of the openings in the lower support flange;

a buoyancy module assembly mounted around the central riser pipe and the plurality of the auxiliary lines:

upper and lower thrust flanges carried by at least one of the auxiliary lines, the upper thrust flange being at an upper end of the buoyancy module assembly and the lower thrust flange being at a lower end of the buoyancy module assembly;

an upper thrust link extending between the upper thrust flange and the upper support flange for transferring an upward force imposed by the buoyancy module assembly while submersed to the upper support flange;

a lower thrust link extending between the lower thrust flange and the lower support flange for transferring a downward force imposed by the weight of the buoyancy module assembly while out of water to the lower support flange; and wherein

the upper thrust link comprises an upper thrust sleeve through which the one of the auxiliary lines pass, the upper thrust flange being secured to the upper thrust sleeve, the upper thrust sleeve having an upper end that abuts a lower side of the upper support flange.

6. The riser joint assembly according to claim 5, further comprising:

a set of external threads on at least one of the auxiliary lines;

a threaded nut in engagement with the external threads; and

one of the thrust links is engaged by the threaded nut so as to selectively position one of the thrust flanges at a selected point along a length of the riser joint assembly.

7. The riser joint assembly according to claim 5, further comprising:

at least one clamp bolted around the central riser pipe between the support flanges, the clamp having a hub portion and a plurality of legs extending outward from the hub portion; and

a retainer securing each of the auxiliary lines to an outer end of one of the legs.

8. The riser joint assembly according to claim 5, wherein the buoyancy module assembly comprises a plurality of foam block sections, each foam block section having at least two block segments fitted around the central riser pipe and the auxiliary lines and strapped in position, the foam block sections being stacked end on end between the thrust flanges.

9. An offshore riser joint assembly, comprising:

a central riser pipe;

an upper support flange on an upper end portion of the central riser pipe and a lower support flange on a lower end portion of the central riser pipe, each of the flanges having a plurality of openings;

a plurality of auxiliary lines spaced around the central riser pipe, each auxiliary line having an upper end extending through one of the openings in the upper support flange and a lower end extending through one of the openings in the lower support flange;

a buoyancy module assembly of a buoyant material mounted around the central riser pipe and the auxiliary lines;

a pair of upper thrust sleeves, each of the upper thrust sleeves sliding over one of the auxiliary lines, each of the upper thrust sleeves having an upper thrust flange that is engaged by an upper end of the buoyancy module assembly, each of the upper thrust sleeves being mounted so as to transfer upward thrust imposed by the buoyancy module assembly to the upper support flange; and

a pair of lower thrust sleeves, each of the lower thrust sleeves sliding over one of the auxiliary lines, each of the lower thrust sleeves having a lower thrust flange that is engaged by a lower end of the buoyancy module assembly, each of the lower thrust sleeves being mounted so as to transfer weight of buoyancy module assembly while out of water to the lower support flange.

10. The riser joint assembly according to claim 9, wherein:

each of the upper thrust sleeves is axially movable relative to the auxiliary line on which it is carried so that upward thrust forces applied to the upper thrust flanges pass through the upper thrust sleeves directly to the upper support flange, bypassing the auxiliary lines on which the upper thrust sleeves are carried.

11. The riser joint assembly according to claim 9, further comprising:

an adjustment mechanism in cooperative engagement with one of the pairs of thrust sleeves to selectively adjust a distance from the pair of lower thrust sleeves to the pair of upper thrust sleeves.

12. The riser joint assembly according to claim 9, further comprising:

a set of external threads on each of the auxiliary lines carrying the pair of lower thrust sleeves; and

a threaded nut in engagement with each set of external threads and each lower thrust sleeve for varying a position of each of the lower thrust sleeves relative to the upper thrust sleeves.

13. The riser joint assembly according to claim 9, wherein:

the upper thrust flanges are located on lower ends of the upper thrust sleeves; and

the lower thrust flanges are located on upper ends of the lower thrust sleeves.

14. The riser joint assembly according to claim 9, further comprising:

at least one clamp bolted around the central riser pipe between the support flanges, the clamp having a hub portion and a plurality of legs extending outward from the hub portion; and

a retainer securing each of the auxiliary lines to an outer end of one of the legs.

15. The riser joint assembly according to claim 9, wherein the buoyancy module assembly comprises a plurality of foam block sections, each foam block section having at least two block segments fitted around the central riser pipe and the auxiliary lines and strapped in position, the foam block sections being stacked end on end between the thrust flanges.

16. A method of providing buoyancy to an offshore riser assembly having a central riser pipe, an upper support flange on an upper end portion of the central riser pipe, a lower support flange on a lower end on a lower end portion of the central riser pipe, and a plurality of auxiliary lines spaced around the central riser pipe, each auxiliary line having ends extending through openings in the upper and lower support flanges, the method comprising:

placing upper and lower thrust flanges at upper and lower ends of a buoyancy module assembly, and mounting the buoyancy module assembly around the central riser pipe and the auxiliary lines;

mounting an upper thrust link between the upper thrust flange and the upper support flange, the upper thrust link being axially movable relative to the central riser pipe and the auxiliary lines;

transferring an upward force imposed by the buoyancy module assembly while submersed from the upper thrust flange directly from the upper thrust link to the upper support flange, bypassing the central riser pipe and the auxiliary lines; and

transferring a downward force imposed by the weight of the buoyancy module assembly while out of water from the lower thrust flange to the lower support flange.

17. The method according to claim 16, further comprising selectively adjusting the position of one of the upper and lower flanges relative to the other.

18. The method according to claim 16, wherein placing upper and lower thrust flanges comprises positioning the thrust flanges on opposite sides of an axis of the central riser pipe.