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(54) Title: RISER SUPPORT

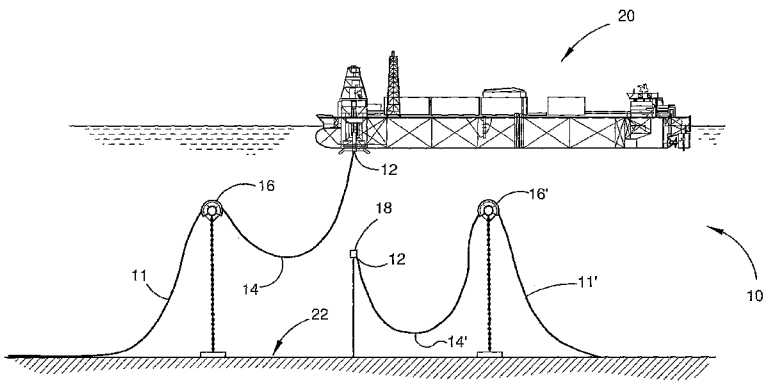


FIG. 1

(57) Abstract: A riser system including: at least one riser for extending from infrastructure on a sea bed and each riser having a riser termination; an end support restrained above and relative to the sea bed and having attachment means to couple each riser termination for storage and decouple each riser termination for coupling to a floating vessel; and an intermediate support supporting an intermediate portion of the riser to define a catenary bend between the intermediate support and the riser termination device.

Riser Support

Field of the invention

The invention relates to riser systems for communicating between infrastructure, such as a production well on a sea bed and a floating vessel.

Background of the invention

Risers are used in offshore oil and gas production for communicating between infrastructure on the sea bed and floating vessels on the surface.

It is sometimes desirable to disconnect the surface vessel from the riser. For this purpose risers are sometimes provided with a floating buoy that allows the riser termination to float when not in use. Australian patent no 677204 describes such a system. Australian patent no 677204 also describes the use of an intermediate support at an intermediate point along the riser for supporting and elevating the riser at the intermediate point and defining a catenary bend between the intermediate support and the riser termination/buoy. The riser termination and buoy float at the water surface and are allowed to drift about in a relatively large drift circle when disconnected from the floating vessel.

The upper strata of water in the sea is relatively turbulent. Floating riser termination and buoy combinations are from time to time damaged by this turbulence.

The addition of the floatation buoy to the riser termination requires specialised equipment which can add significant time and cost to the installation of the riser system. Additionally the use of a floatation buoy connected to the riser requires modification to the standard floating vessels which adds further cost.

Objects of the present invention include to provide an improved riser system, to provide an improved method of storing disconnected riser terminations, or at least provide alternatives in the market place.

Summary of the invention

There is provided a riser system including:

a riser for extending from infrastructure on a sea bed and having a riser termination;

an end support restrained above and relative to the sea bed and having attachment means to couple the riser termination for storage and decouple the riser termination for coupling to a floating vessel; and

an intermediate support supporting an intermediate portion of the riser to define a catenary bend between the intermediate support and the riser termination.

The riser system may be configured such that the catenary bend portion is supported above and clear of the sea bed when the riser termination is supported by the end support.

The riser termination is a device at the end of a riser which is used to connect the riser to a vessel floating installation or a platform. The riser termination is generally pulled into a connection conduit on the vessel installation or platform.

Preferably the end support has multiple attachment means to support multiple risers. A socket, hook or clamp are suitable forms of attachment means. The end support might be a rigid structure extending from the sea bed but is preferably a tethered buoy. The attachment means preferably include lead-in features, such as V-shaped extensions, for leading the riser, or riser connection means such as a line, into the attachment means.

Preferably the relative depth and spacing of the intermediate support and end support are selected so that contact between the end support and the riser is prevented when the riser termination is coupled to a floating vessel.

Advantageously the riser system includes a plurality of risers each having a respective intermediate support and riser termination. While more than one end support

may be used, it is preferable that the riser and terminations are able to cooperate with a single end support.

In another aspect of the invention there is provided a method of storing a riser termination for later coupling to a floating vessel, the method including the step of releasably coupling the riser termination to an end support, the end support being above and in a fixed position relative to the sea bed.

Preferably the end support has multiple attachment means to support multiple risers. A socket, hook or clamp is a suitable form of attachment means. The end support might be a rigid structure extending from the sea bed but is preferably a tethered buoy. The attachment means preferably include lead-in features, such as V-shaped extensions, for leading the riser, or riser connection means such as a line, into the attachment means.

The method may include supporting an intermediate portion of the riser using an intermediate support to define a catenary bend between the intermediate support and the riser termination. The intermediate support may be a float or floats attached to the riser. Preferably the intermediate support is a tethered buoy. The catenary bend portion may be supported above the sea bed.

In another aspect of the invention there is provided a method of installing a riser system including the steps of guiding a riser termination to couple with an end support restrained above and in a fixed position relative to a sea bed; extending the riser from the end support to an intermediate support for supporting the riser to define a catenary bend portion between the intermediate support and the end support; and extending the riser from the intermediate support to a low connection point, such as infrastructure on the sea bed.

Preferably the step of guiding the riser termination to couple with the end support includes extending a line between a top portion of the riser termination and a first vessel and suspending the riser termination in an inverted position, preferably from a second vessel; extending the riser such that the riser termination is lowered and is suspended

from the line in an upright position, and manoeuvring the riser via the line to couple the riser to the end support.

It is preferable to install the riser system without the catenary bend portion contacting the sea bed. For this purpose, the length of line may be sufficiently shorter than a sea bed depth so that the riser termination may be lowered and suspended from the line in the upright position without the riser contacting the sea bed.

Preferably the end support has multiple attachment means to support multiple risers. A socket, hook or clamp is a suitable form of attachment means. The end support might be a rigid structure extending from the sea bed but is preferably a tethered buoy. The sockets preferably include lead-in features, such as V-shaped extensions, for leading the riser into the socket, hook or clamp.

The intermediate support could be a float or floats attached to the riser. Preferably the intermediate support is a tethered buoy.

The various aspects of the invention are complementary and each may incorporate the features of the other aspects.

Brief description of the drawings

The figures illustrate preferred embodiments of the invention.

Figure 1 is a schematic view of a riser system;

Figure 2 illustrates the inverted lowering of the riser termination;

Figure 3 illustrates an upright riser suspended from a line;

Figure 4 illustrates the manoeuvring and coupling operation;

Figure 5 illustrates the riser being extended to an intermediate support;

Figure 6 illustrates the riser supported by the intermediate support;

Figure 7 is a perspective view of the buoy portion of an end support;

Figure 8 is a close up perspective view of the mounting sockets on the buoy;

Figure 9 is a top view of the sockets on the buoy;

Figure 10 is a perspective view of the buoy supporting multiple risers;

Figure 11 is an end view of the buoy supporting multiple risers;

Figure 12 is a side view of the buoy supporting multiple risers;

Figure 13 is a perspective view of the buoy supporting multiple risers; and

Figure 14 is a top view of the buoy supporting multiple risers.

Detailed description of the embodiments

Figure 1 illustrates a riser system according to an embodiment of the present invention coupled to a Floating Production Storage and Offloading vessel (FPSO) 20.

The illustrated embodiment includes two risers 11 and 11'. Each riser extends from the sea bed 22 to a riser termination 12, 12'. The risers 11, 11' are supported by intermediate supports 16 and 16'. Catenary bend portions 14 and 14' are respectively defined between intermediate supports 16 and 16' and the riser termination 12 and 12'.

"Catenary" is used herein per its usual use in this art i.e. the shape of a chain supported at both ends. It refers to the curved shape assumed by the suspended riser. The term is not limited to the curve assumed by a uniform heavy cord (as in the strict dictionary definition). For example, the net buoyancy of various points along the catenary bend portion 14 could be varied, e.g. by the addition of weights or floats, which would alter the shape. This altered shape is intended to fall within the scope of the term catenary bend as used herein.

The use of intermediate supports 16, 16' and a catenary bend portions 14, 14' allows the location of the riser to be more accurately controlled and minimises the maximum tension experienced by the riser.

The riser 11 is illustrated in the in use position. Riser termination 12 is engaged with the FPSO 20 for communicating with infrastructure (not shown) on the sea floor 22. Riser 11' is illustrated in the "storage position". The riser termination 12' is coupled to the end support 18.

In this embodiment, the end support 18 and the intermediate supports 16 and 16' are tethered buoys as illustrated. Alternative arrangements are possible. For example, the end support 18 might be a rigid structure extending from the sea floor. Similarly, the intermediate supports might simply be a float or a series of floats positioned along a portion of the risers.

The tethered supports preferably include a buoy, a tether and ballast. Alternatively, the buoys could be tethered to a structure fixed to the sea bed. In an embodiment, the ballast may be buoyant for manoeuvring into position and then flooded such that it sinks to the sea floor 22. Alternatively a tethered buoy may be configured such that it may be flooded and sunk to the seabed for later refloating when required. The tether is preferably heavy chain but may be wire or synthetic fibre. It is desirable to provide a redundant tether, which might be a synthetic cord, in case of damage to the chain.

As illustrated, the intermediate supports are spaced from the end support and are relatively higher than the end support 18. The relative height and spacing of the intermediate supports 16, 16' and the end support 18, and the length of the riser within the catenary bend portions 14, 14' are selected such that the catenary bend portion 14 when in the coupled position (as illustrated) cannot interfere with the end support 18 thereby avoiding damage to the riser 11. Similarly, the relative height and spacing of the intermediate supports 16, 16' and the end support 18 and the length of riser material within the catenary bend portions 14, 14' is selected so that when the riser 11, 11' is in

the storage position, the catenary bend portions 14, 14' cannot interfere with the sea bed 22 thereby avoiding damage to the catenary bend portion 14'.

Figure 2 illustrates the initial stages of installing a riser system in accordance with an embodiment of the invention. As shown, the riser termination 12" is lowered into the water from an installation vessel 26 in an inverted position. Riser termination 12" is suspended by riser 11" such that it can be lowered by extending riser 11" from the installation vessel 26. A line 24 is attached to an upper portion of the riser termination 12". In this embodiment the line 24 is attachment to the upper portion of the riser termination 12" via a short line 48 and a coupling device 50. As will be described in more detail below short line 48 extends from the upper portion of the riser termination 12" to the coupling device 50. The coupling device 50 is in turn connected to the line 24. Of course, the upper portion of the riser termination 12" is downwardly disposed whilst the riser termination 12" is in the illustrated inverted position. The line 24 is secured to a vessel 28 (but in other embodiments may be secured to a crane or winch aboard the installation vessel).

As illustrated, the vessels 26 and 28 are positioned proximal to an end support 18" and an intermediate support 16". Both the intermediate support 16" and the end support 18" take the form of tethered buoys in this embodiment. As illustrated, the end support 18" in this embodiment includes a buoy portion 30 and a pair of tethers 32. The use of a pair of tethers serves to stabilise and orient the buoy portion 30.

As riser 11" is extended from the vessel 26, the riser termination 12" is lowered until it is suspended from the line 24 and thereby turned from the inverted position (illustrated in Figure 2) to the upright position illustrated in figure 3. The buoy portion 30 includes sockets 36 for receiving the coupling device 50 and thereby coupling with the end portion 12" of the riser 11". Details of the sockets 36 are discussed in more detail below.

After uprighting the riser termination 12", the vessel 28 is manoeuvred such that the short line 48 with coupling device 50 connected is captured within socket 36 as illustrated in figure 4. Line 24 is then reeled out until the coupling device 50 (connected

to the short line 48 and in turn connected to the upper portion of the riser termination 12") is engaged with socket 36. The line 24 is then released from the coupling device 50 connected to the short line 48. The riser termination 12" is thereby coupled to the end support 18".

As illustrated in figure 5, the installation vessel 26 is then manoeuvred toward and over the intermediate support 16" such that the riser 11" is engaged with the intermediate support 16". An engagement feature 38 is fitted to the riser 11" for this purpose. The riser 11" is thereby engaged with the intermediate support 16" such that a catenary bend portion 14" is formed as illustrated in figure 6. The installation vessel can then continue on to lay the riser to the infrastructure (not shown).

As illustrated in figure 6, the catenary bend portion is supported above the sea bed 22" such that damage to the riser 11" is avoided. The riser termination 12" is securely coupled to the end support 18" by the engagement device 50 and short line 48 connected to the riser termination 12" and thereby kept safely away from the turbulent zone in the upper strata of the water.

The stored riser termination 12', (or 12") is then readily retrieved for attachment to an FPSO 20.

Using this method allows the riser system to be installed without the FPSO 20. This has the significant commercial advantage. Both the FPSO 20 and the installation vessel 26 are expensive long lead time items. Requiring the FPSO to be present during installation of the riser system, as in prior art systems, leads to significant risk of expense which is saved by the preferred embodiments of the present invention.

Figures 7 to 14 illustrate an embodiment of the buoy portion 30' of an end support. The buoy portion 30' includes two buoyant substantially cylindrical tanks having hemispherical end portions. The tanks 44 are in adjacent parallel horizontal juxtaposition and connected by a pair of bracket portions 46.

The buoy 30' includes a bank of four (in this particular embodiment) sockets 36' on each outwardly disposed side face. The sockets 36' are arranged to catch the line 24 and couple to the riser 12" as illustrated in figures 4 and 5.

Each socket 36' includes lead-in features 42. The lead in features include a pair of extending members which, in plan view as in figure 9, outwardly diverge. As best illustrated in figure 8, each outwardly extending portion of the lead in features 42 is formed by a loop of bar material lying in a vertical plane. The lead in features 42 each lead into a respective vertical open-ended slot which provides an entrance into a keyhole feature having an upwardly open cavity with an upper lead in feature for receiving a coupling device 50 attached to a line 48, which in turn supports the riser termination 12, such that the coupling member is retained within the upwardly open cavity by the weight of the riser 11 and the riser termination 12. The coupling device 50 is preferably a master link. Another preferred detail (not shown) is a locking device, such as a pin, to further retain the coupling device 50 within the upwardly open cavity.

The preferred embodiments of the present invention allow the riser termination 12 and its connected riser 11 to be recovered from the end support 18. This gives considerable commercial advantage in allowing the connection of the riser termination 12 and its connected riser 11 to an FPSO or other surface vessel without the need for a construction vessel.

The riser termination 12 is decoupled from the end support 18 by connecting a line from a winch or crane at the surface to the coupling device 50. This winch or crane could be aboard an FPSO or second vessel. By lifting the coupling device 50 upwardly from the upwardly extending cavity the coupling device 50, connecting line, riser termination 12 and its connected riser 11 can be recovered for connection to an FPSO or other surface vessel.

The preferred embodiments of the present invention also permit the riser termination 12 and its connected riser 11 to be recoupled with the end support 18 should the FPSO or surface vessel need to be disconnected from the riser. The preferred embodiments of the present invention permit this to be performed, at

commercial advantage, without the need for an expensive construction vessel to assist. This would be conducted in a reverse manner to that described previously. A coupling device 50 and short line 48 would be reconnected to the riser termination 12. A line from a winch or crane aboard an FPSO or second vessel would be connected to the coupling device 50. The riser termination 12 and its connected riser 11 would be lowered back down to the end support 18. The short line 48 would be guided into the socket 36 by the lead in features 42 and the coupling device 50 lowered into the upwardly open cavity in the socket 36. The line from the surface winch or crane would be disconnected from the coupling device 50 leaving the riser termination 12 and its connected riser 11 again supported by the coupling device 50 and short line 48 from the end support 18.

It will be understood that the invention disclosed and defined in this specification extends to all alternative combinations of two or more of the individual features mentioned or evident from the text or drawings. All of these different combinations constitute various alternative aspects of the invention.

It will also be understood that the term "comprises" (or its grammatical variants) as used in this specification is equivalent to the term "includes" and should not be taken as excluding the presence of other elements or features.

Claims

1. A riser system including:

at least one riser for extending from infrastructure on a sea bed and each riser having a riser termination;

an end support restrained above and relative to the sea bed and having attachment means to couple each riser termination for storage and decouple each riser termination for coupling to a floating vessel; and

an intermediate support supporting an intermediate portion of the riser to define a catenary bend between the intermediate support and the riser termination device.

2. The riser system of claim 1 wherein the intermediate support and end support are configured to support the catenary bend portion above and clear of the sea bed when the riser termination is supported by the end support.

3. The riser system of claim 1 or 2 wherein the intermediate support is formed by one or more floats.

4. The riser system of claim 1 or 2 wherein the relative depth and spacing of the intermediate support and end support are selected so that contact between the end support and the riser is prevented when the riser termination is coupled to a floating vessel.

5. The riser system of claim 1 or 2 including a plurality of risers and a respective intermediate support for each riser, each riser having a respective riser termination.

6. The riser system of 5 wherein the riser terminations are cooperable with the end support; the end support having respective attachment means for each riser.

7. The riser system of claim 5 wherein the end support has multiple attachment means to support multiple risers.

8. The riser system of claim 5 wherein each attachment means includes lead-in features for leading the respective riser or a respective riser connection means into coupling alignment.

9. A method of storing a riser termination for later coupling to a floating vessel, the method including the step of releasably coupling the riser termination to an end support to the end support being above and in a fixed position relative to the sea bed.

10. The method of claim 9 including supporting an intermediate portion of the riser using an intermediate support to define a catenary bend between the intermediate support and the riser termination.

11. The riser system of claim 10 wherein the relative depth and spacing of the intermediate support and end support are selected so that contact between the end support and the riser is prevented when the riser termination is coupled to a floating vessel.

12. A method of installing a riser system including the steps of guiding a riser termination to couple with an end support restrained above and in a fixed position relative to a sea bed; extending the riser from the end support to an intermediate support for supporting the riser to define a catenary bend portion intermediate the intermediate support and the end support; and extending the riser from the intermediate support to a low connection point.

13. The method of claim 12 wherein the step of guiding the riser termination to couple with the end support includes extending a line between a top portion of the riser termination and a first vessel and suspending the riser termination in an inverted position, extending the riser such that the riser termination is lowered and is suspended from the line in an upright position, and manoeuvring the riser via the line to couple the riser termination to the end support.

14. The method claim 13 wherein the suspending of the riser termination is from a second vessel.

15. The method of claim 14 wherein the length of line is shorter than a sea bed depth so that the riser termination is able to be lowered and suspended from the line in the upright position without the riser contacting the sea bed.

16. The method of claim 12 to 15 wherein the catenary bend is supported above and clear of the sea bed.

17. The method of claim 13 or 14 including coupling multiple risers to the end support, the end support having multiple attachment means to support multiple risers.

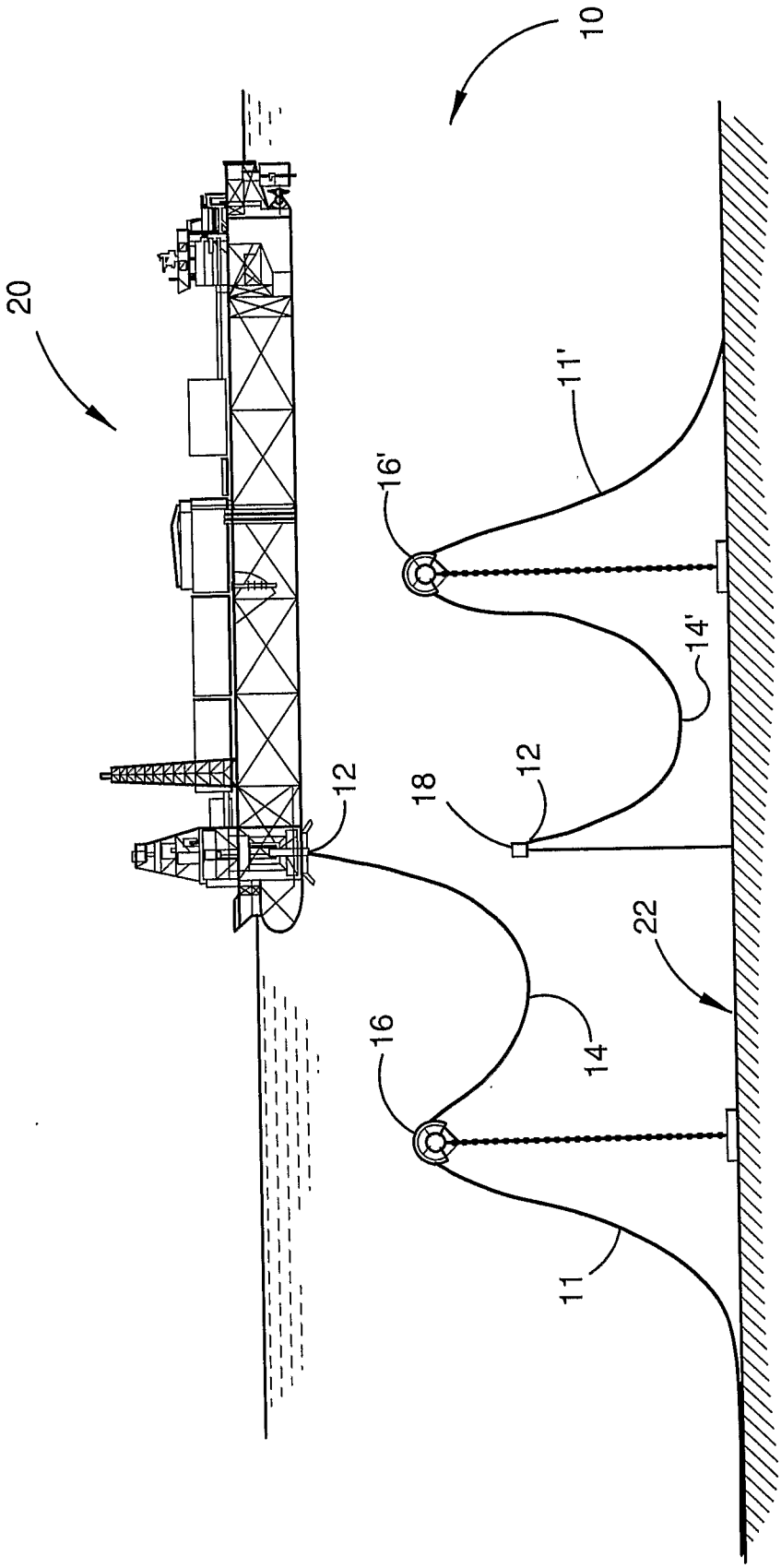


FIG. 1

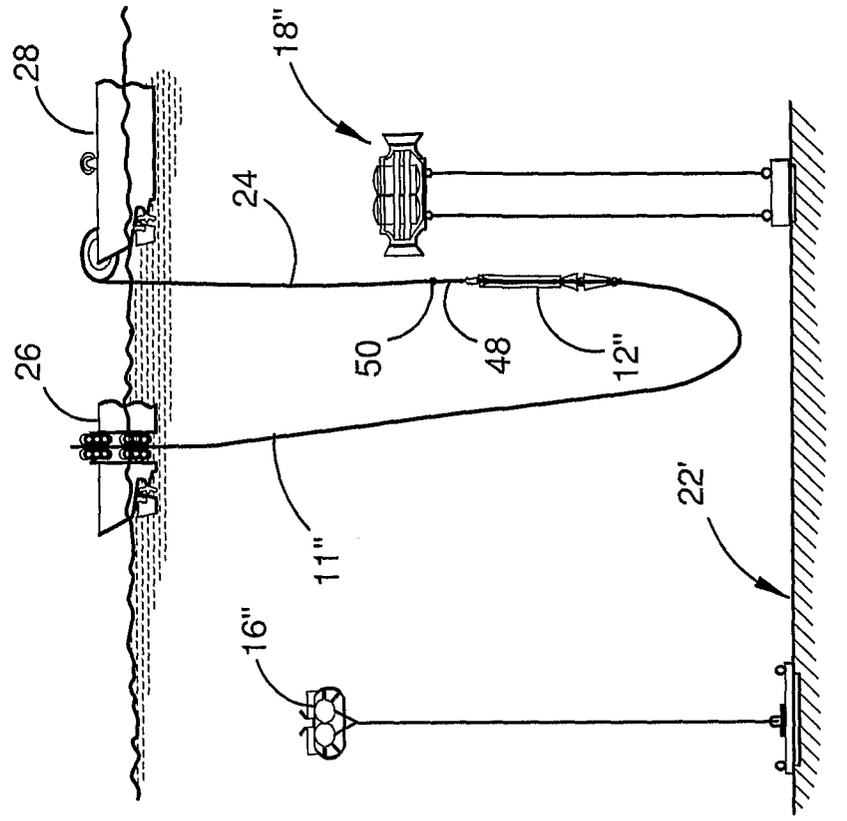


FIG. 3

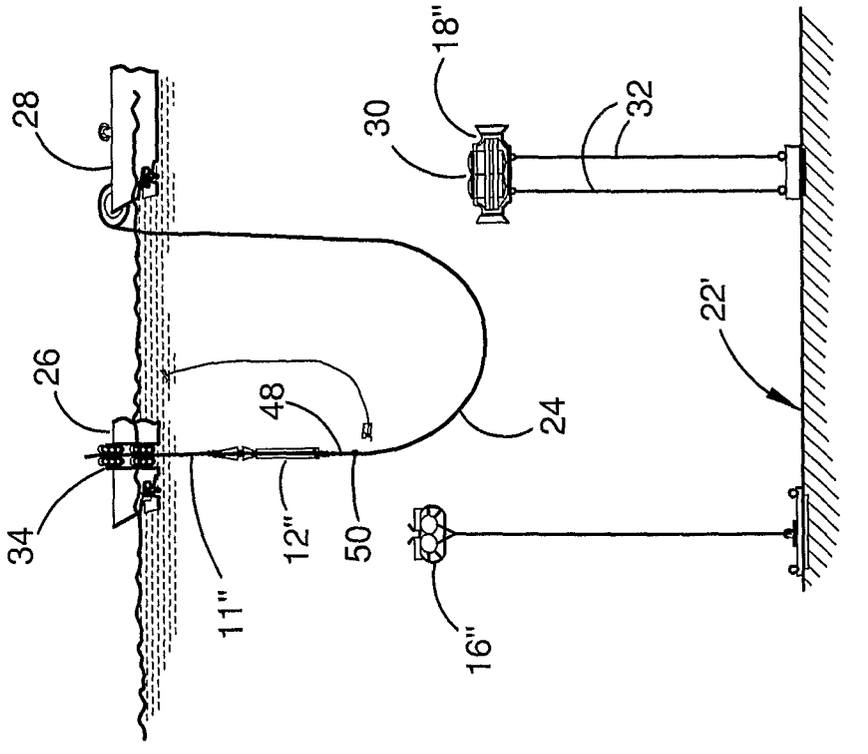


FIG. 2

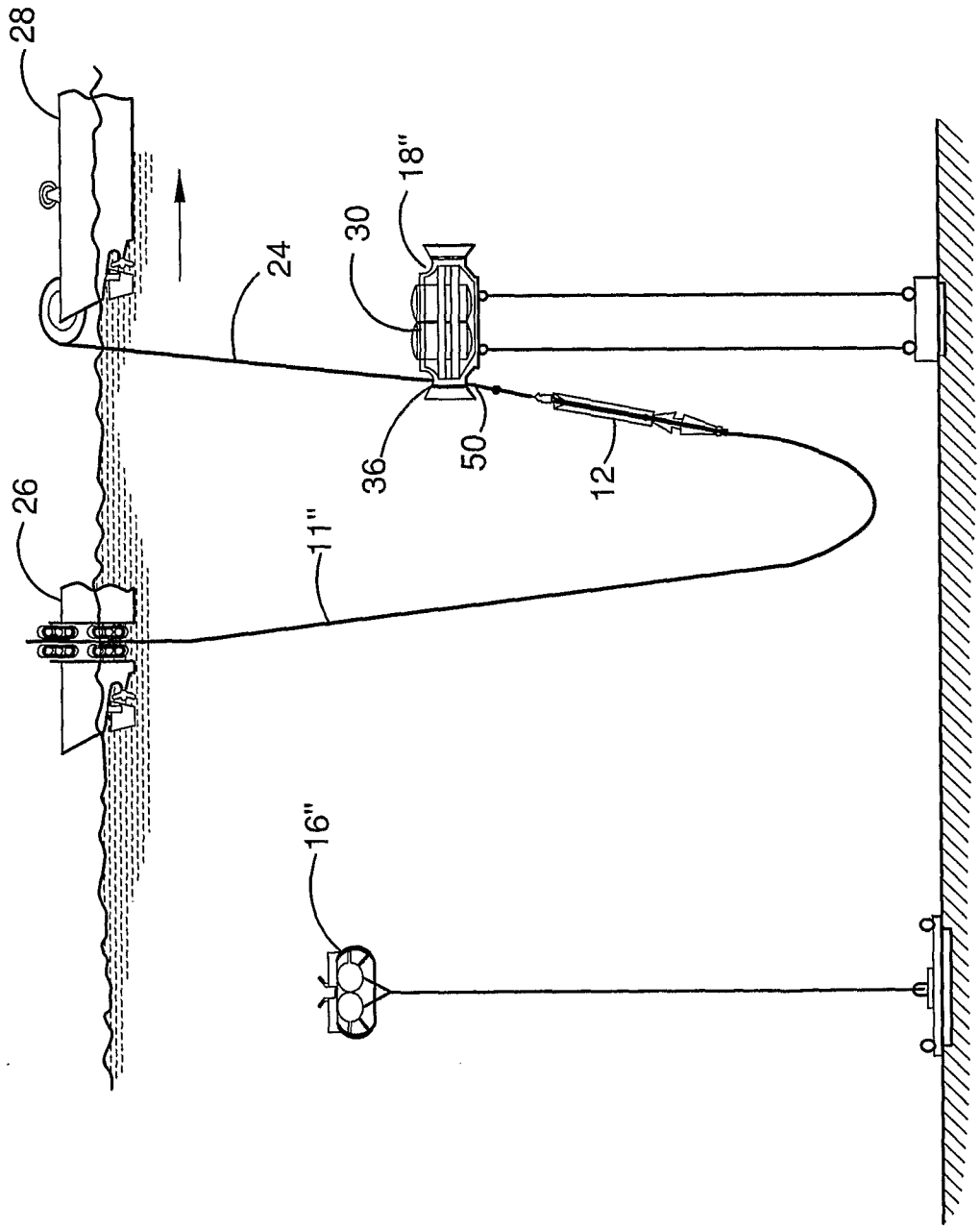


FIG. 4

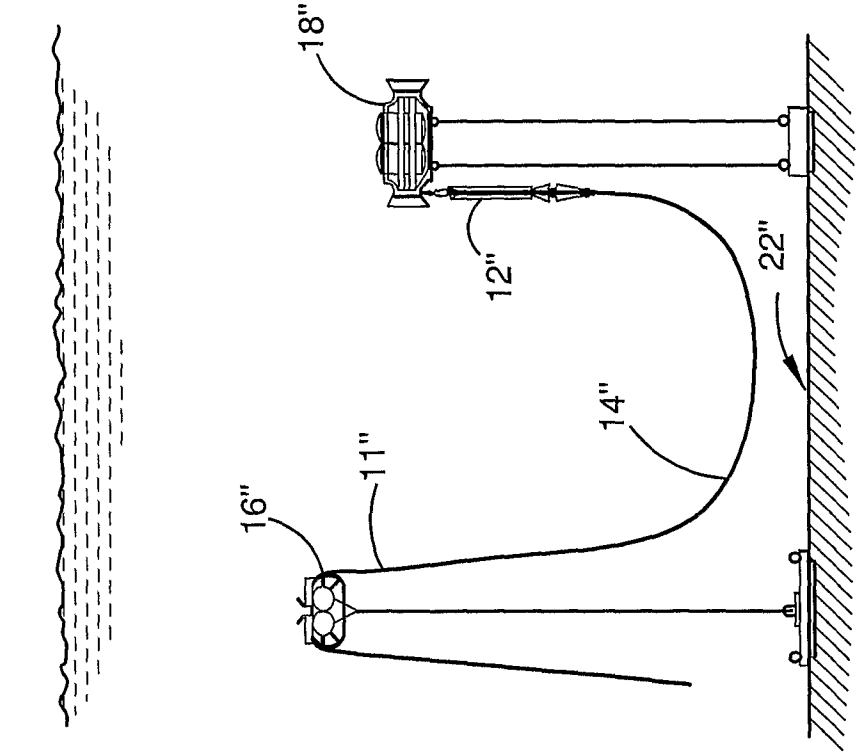


FIG. 6

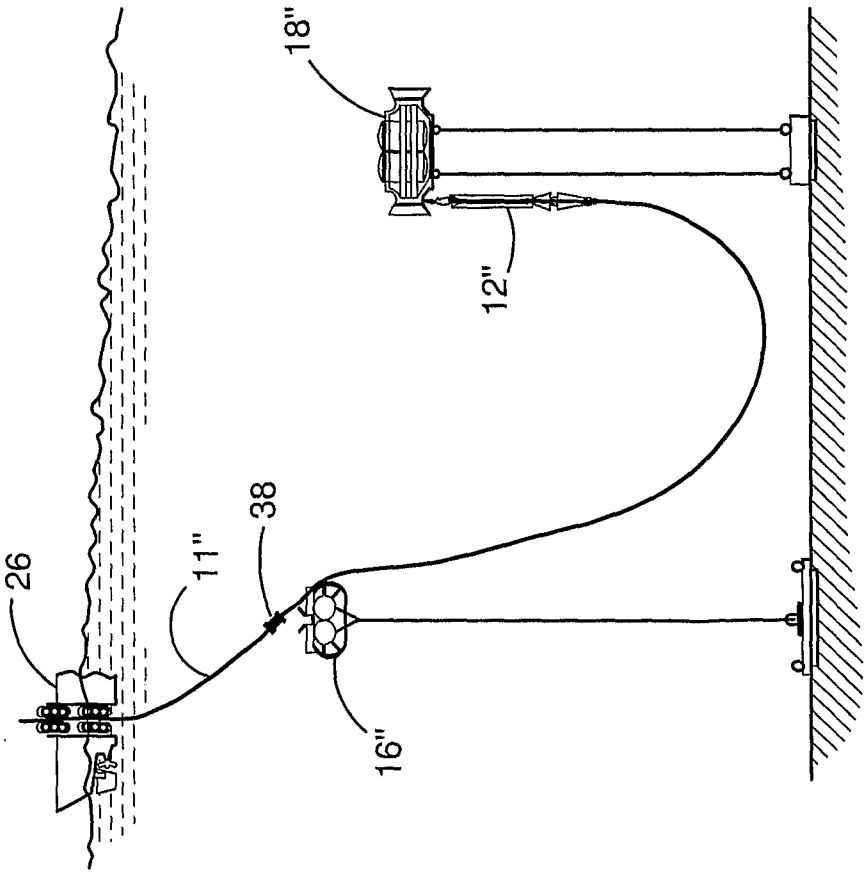


FIG. 5

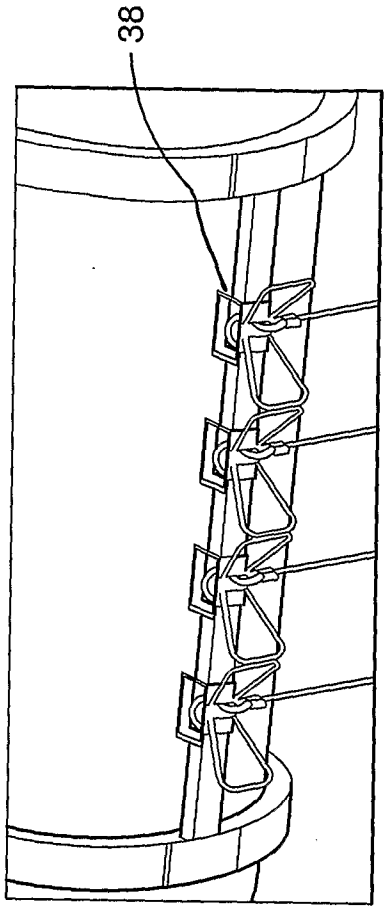


FIG. 8

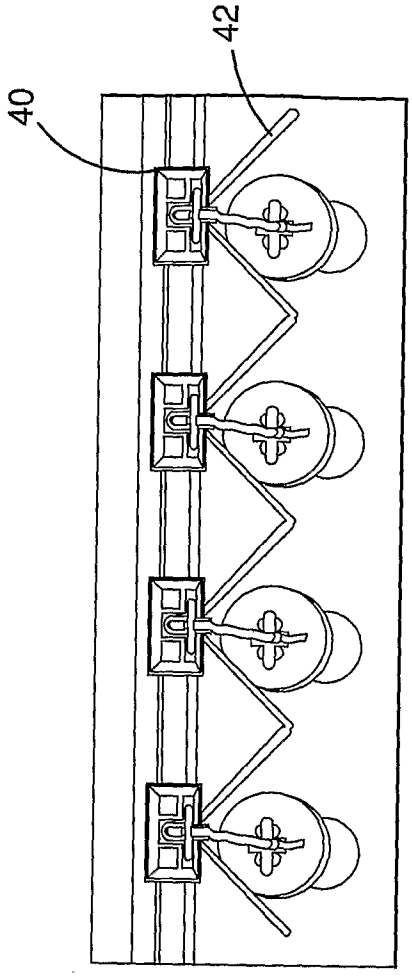


FIG. 9

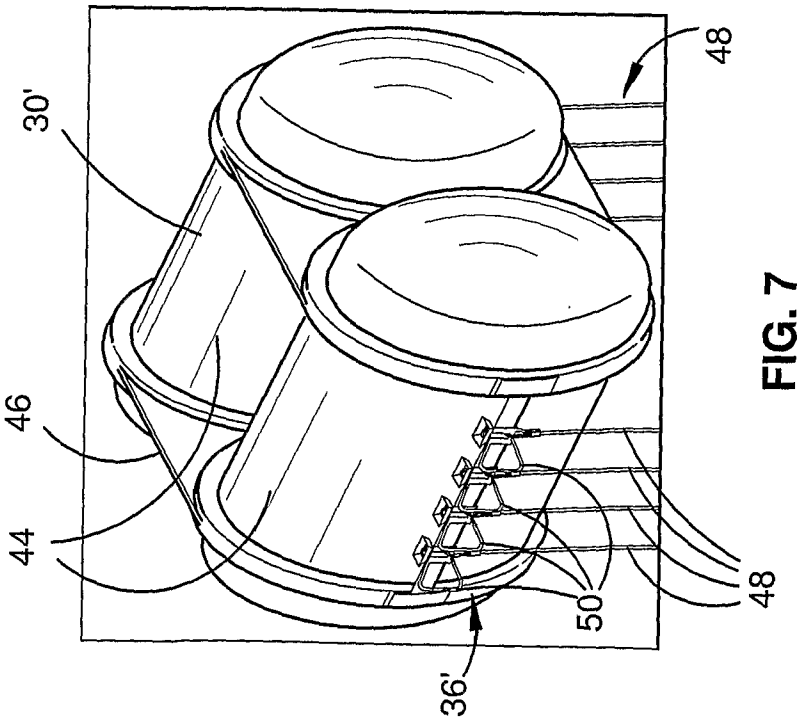


FIG. 7

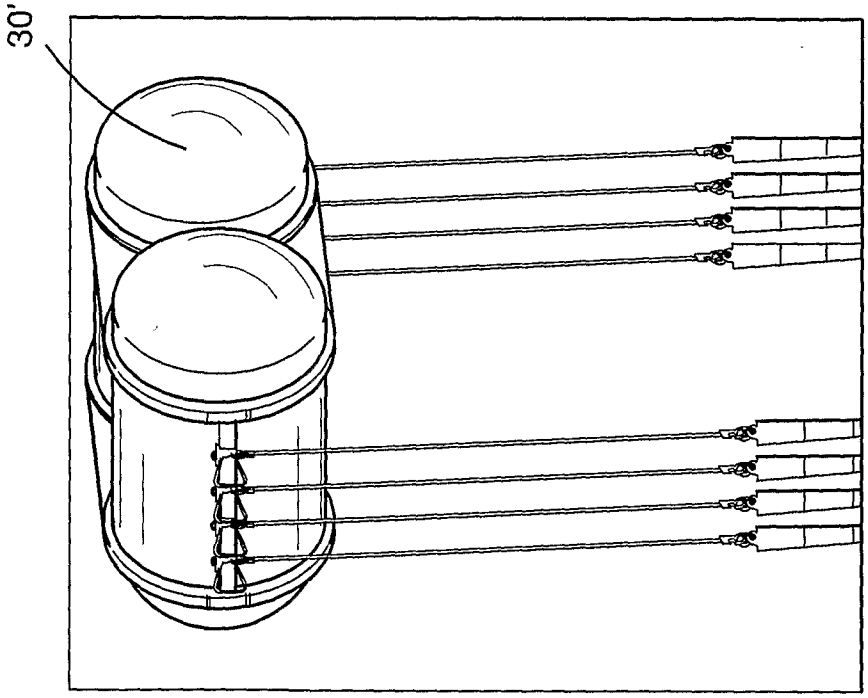


FIG. 10

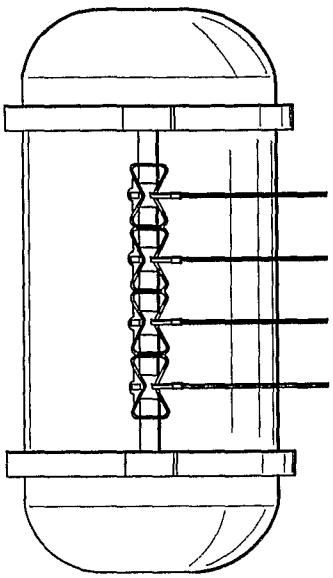


FIG. 12

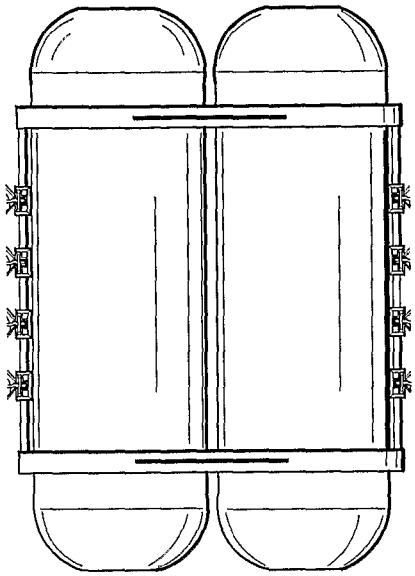


FIG. 14

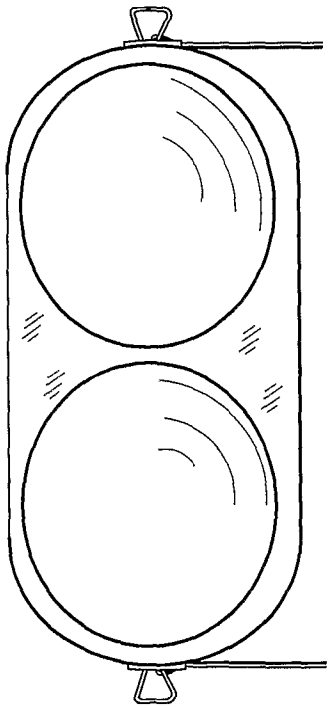


FIG. 11

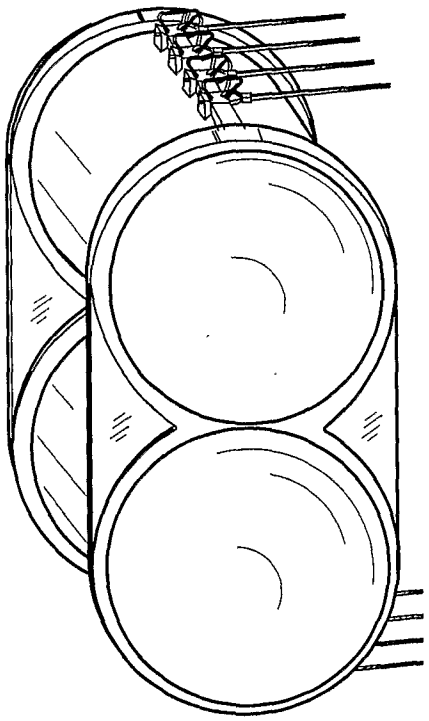


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2009/000332

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

E21B 43/01 (2006.01) *E21B 43/013* (2006.01) *E21B 17/01* (2006.01) *F16L 1/12* (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPI and EPODOC: IPC Marks: F16L 1/12, E21B 43/01, E21B 43/013, E21B 17/01 and keywords: SEA, OCEAN, UNDER WATER, RISER, UMBLICAL, LINE, TUBE, PIPE, SAG, CATENARY, CURVE, ARC.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5957074 A (de BAAN et al.) 28 September 1999 Col. 5 lines 53-67, Col. 6 lines 15-24, Col. 8 lines 39-64, Figures 4A and 5	5-8, 10- 11, 14-17
A	US 5823131 A (BOATMAN et al.) 20 October 1998 Abstract, Col. 1 line 55-Col. 2 line 24, Col. 4 lines9-18, Col. 4 lines 42-53, Figures 2 and 4-7	1-3, 5-11, 14-17
A	US 5480264 A (HUNTER) 2 January 1996 Col 2. line 33-Col.4 line 10, Col. 5 lines 20-40, Figures 1-2	1-4
A	WO 2004/033848 A1 (ROCK-WATER LIMITED) 22 April 2004 Pages 24-28, Figures 19a-20e	12-14

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

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Date of the actual completion of the international search	Date of mailing of the international search report
29 May 2009	03 JUN 2009
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer **ALISON GREEN** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 2 6283 2174

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2009/000332

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5275510 A (de BAAN et al.) 4 January 1994 Col. 4 line 5- line 42, Col. 5 lines 37-62, Figures 1, 7, 7A and 8A-8C	1-4
A	US 5941746 A (ISNARD et al.) 24 August 1999 Col. 1 lines 9-11, Col. 3 lines 1-3, Col. 3, lines 11-15, Col. 3 lines 39-45, Figure 1 and 2	1-3, 5-17
P, A	WO 2008/152505 A1 (SINGLE BUOY MOORINGS, INC) 18 December 2008 Abstract, Page 4 line 5-Page 5line 4, Page 7 line20-Page 8 line 6 and Figures 1a-8	1, 10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2009/000332

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5957074	NONE					
US	5941746	AU	38374/97	CA	2216047	EP	0831023
		NO	974325				
US	5480264	NONE					
WO	2004033848	AU	2003270284				
US	5275510	NONE					
US	5823131	AU	54444/98	BR	9713731	CA	2282696
		EP	0941200	NO	992911	OA	11127
		WO	9824686				
WO	2008152505	US	2008311804				

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX