



(51) International Patent Classification:

*B63B 35/44* (2006.01)      *B63B 22/04* (2006.01)  
*B63B 22/20* (2006.01)      *B63B 22/24* (2006.01)

(21) International Application Number:

PCT/AU2013/000971

(22) International Filing Date:

29 August 2013 (29.08.2013)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

2012903827 3 September 2012 (03.09.2012) AU

(71) Applicant: SEACAPTAUR IP LTD [AU/AU]; Suite 1, 185 Main Street, Osborne Park, Western Australia 6017 (AU).

(72) Inventor: ROBERTS, Alan; Suite 1, 185 Main Street, Osborne Park, Western Australia 6017 (AU).

(74) Agent: WRAYS; Ground Floor, 56 Ord Street, West Perth, Western Australia 6005 (AU).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: BUOY

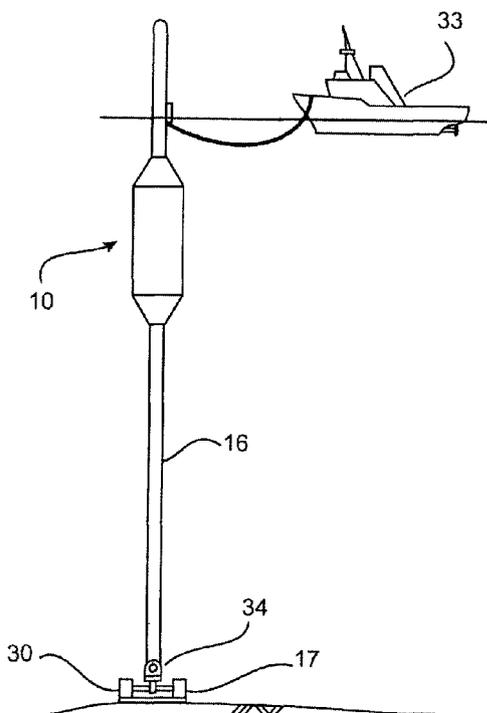


Figure 1c

(57) Abstract: A buoy comprising a body having an upper end and a lower end, the lower end having a lower column adapted to be attached to the seabed through a link. There is also provided a buoy comprising a body having at least one compartment adapted to receive and drive out ballast and a method for transporting and installing onto a seabed of a body of water a buoy, the method comprising towing the buoy in a horizontal position on the surface of the body of water by maintaining the at least one compartment unballasted and, at a location of deployment of the buoy ballasting the at least one compartment for locating the buoy in vertical position. In a preferred embodiment, the link comprises an articulated joint and the body of the buoy comprises a hydrocarbons processing system.

WO 2014/032106 A1

**Published:**

— *with international search report (Art. 21(3))*

**BUOY****TECHNICAL FIELD**

[0001] The present invention relates to hydrocarbon processing offshore.

[0002] The invention has been devised particularly, although not necessarily solely, in relation to subsea well access control, hydrocarbon processing and tanker loading.

**[0003] BACKGROUND ART**

[0004] The following discussion of the background art is intended to facilitate an understanding of the present invention only. The discussion is not an acknowledgement or admission that any of the material referred to is or was part of the common general knowledge as at the priority date of the application.

[0005] Typically, the hydrocarbon processing takes place either on a fixed offshore platform, a moored vessel, or a tethered floating structure.

[0006] When processing hydrocarbons on a fixed offshore platform, the supporting subsea structure, known as the "jacket", grows in size and weight exponentially with water depth, to the point where it is no longer physically practical or commercially viable to employ a fixed offshore platform for this purpose.

[0007] The alternate technical solution is typically a moored vessel, known as a FPSO (floating production storage offloading). In deeper water, the vessel often takes less conventional forms, tethered or with proprietary moorings and fixing systems, such as a TLP (tension leg platform).

[0008] When processing hydrocarbons on a vessel, the vessel is subject to the forces of the sea, which produce motions unfavorable to production operations. The motions can be modified by increasing the size of vessel, or imposing heavier moorings, or both.

[0009] The compound effects of increasing vessel size, and increasing mooring size, and complexity of the required interconnections between the seabed and the vessel, interconnections, leads to higher cost(s), which leads to a larger threshold resource size of the minimal commercially exploitable resource.

[0010] To break the cycle of a larger vessel being required, to withstand the forces of the sea, which in turn requires a larger mooring which in turn leads to cost and other

impacts, it is preferable beyond certain water depths to apply other solutions, particularly when the target resource is small.

[0011] The essence of the solution described herein is spar buoy designed such the sea supports the weight of the facilities by means of buoyancy, as is the case with a vessel, but is founded to the seabed, so as to limit vertical motions.

[0012] A spar buoy may have to be installed in hundreds of meters of water, and will hence be hundreds on meters long, and have to be constructed transported in the horizontal, and rotated to the vertical to deploy.

It is against this background that the present invention has been developed.

#### SUMMARY OF INVENTION

[0013] According to a first aspect of the invention there is provided a buoy comprising a body having an upper end and a lower end, the lower end having a lower column adapted to be attached to the seabed through a link.

[0014] Preferably, the link comprises a single link

[0015] Preferably, the link comprises an articulated joint.

[0016] Preferably, the articulated joint comprises an articulated limited rotation joint.

[0017] Preferably, the articulated joint is adapted to provide a ratio of restoring force and the drag resistance of the submerged parts during restoring movement such that the structure pivots through a limited motion range, resulting in the motions inside the spar buoy, under normal sea conditions, to be tolerable for persons to perform work inside the buoy.

[0018] Preferably, the base of the lower column of the spar buoy is adapted be fitted with a limited rotation articulated joint, and docking pin, for connecting into a subsea foundation.

[0019] Preferably, the articulated joint is included in a seabed foundation, the seabed foundation comprising a body having means for attaching the foundation to the seabed and means for attaching the lower column of the buoy to the foundation, the means for attaching the lower column comprises a cylinder having an upper end adapted to the receive the lower end of the lower column wherein the cylinder is adapted to receive a pull wire which during installation the lower column may be guided

to the seabed foundation, by means of a pull wire passing through the cylinder, the pull wire extends up to, for example, an attending vessel for pulling of the wire to guide the lower end into the cylinder.

[0020] According to a second aspect of the invention there is provided a buoy comprising a body having at least one compartment adapted to receive and drive out ballast.

[0021] Preferably, the body comprises an inner area and an outer area surrounding the inner area, the outer area comprising the at least one compartment.

[0022] Preferably, the body is adapted to be selectively located between a horizontal position and a vertical position with respect to a surface of a body of water.

[0023] Preferably, the buoy is selectively located between the horizontal position and the vertical position by selectively filling at least partially with ballast the compartment and emptying at least partially the compartment.

[0024] Preferably, the compartment is located within the body of the buoy at a location such that when the compartment is un-ballasted, the buoy is located in the horizontal position and when the compartment is ballasted, the buoy is located in the vertical position.

[0025] Preferably, there are a plurality of compartments.

[0026] Preferably, the plurality of compartments are placed and arranged in the body of the buoy, such that when un-ballasted, the buoy is located in the horizontal position and when the compartment are ballasted, the buoy is located in the vertical position.

[0027] In an alternative arrangement, the outer area comprises a double wall comprising the plurality of compartments.

[0028] Preferably, the compartments are adapted to be selectively either ballasted or un-ballasted for selectively locating the buoy between the horizontal position and the vertical position.

[0029] Preferably, a lower end of the buoy is adapted to be attached to the seabed of the body of water, the buoy, when the compartments are at least partially ballasted, relying upon the reserve buoyancy of the buoy to remain afloat.

[0030] Preferably, the outer space of the body of the buoy are sufficiently compartmented to adjust floating attitude for towing, and may be towed as a marine warranty compliant vessel, having appropriate intact and damaged stability characteristics.

[0031] According to a third aspect of the invention there is provided a buoy comprising a body having an external surface comprising attachment means adapted to receive a mooring system for moderating the movement of the buoy.

[0032] Preferably, the mooring system comprises links having first ends attached to the attachment means and second ends attached to a seabed of a body of water adapted to receive the buoy.

[0033] According to a fourth aspect of the invention there is provided a buoy comprising a body an inner area and an outer area surrounding the inner area, the inner area being adapted to receive a hydrocarbons processing system.

[0034] Preferably, the outer area comprises at least one compartment adapted to be selectively ballasted or un-ballasted.

[0035] Preferably, the body of the buoy comprises an external surface comprising attachment means adapted to receive a mooring system for moderating the movement of the buoy.

[0036] Preferably, the hydrocarbons processing system is adapted to be remotely controlled from a remote location.

[0037] Preferably, the hydrocarbons processing system comprises hydrocarbon processing equipment including power generation and utilities equipment, fire safety, services and life support required to process hydrocarbons.

[0038] Preferably, the hydrocarbons processing system further comprises a hydrocarbon delivery system having first means for importing and exporting hydrocarbons from wells and other seabed equipment and second means to provide power, control, communication to wells and seabed equipment.

[0039] Preferably, the body of the buoy comprises an upper end and a lower end, the upper end comprising an upper column and a main area, the main area comprising the hydrocarbon processing equipment and the lower end comprising a lower column comprising the hydrocarbons delivery system.

[0040] Preferably, the upper column is adapted to provide access, ventilation air supply, exhaust gas expulsion, communication and control antenna, and gas flaring facility and mooring of vessels and the transfer of produced hydrocarbons to vessels.

[0041] Preferably, the body of the buoy is fully water tight and positively buoyant.

[0042] According to a fifth aspect of the invention there is provided a method for transporting and installing onto a seabed of a body of water a buoy in accordance with any one of the first to third aspects of the invention, the method comprising towing the buoy in a horizontal position on the surface of the body of water by maintaining the at least one compartment un-ballasted and, at a location of deployment of the buoy ballasting the at least one compartment for locating the buoy in vertical position.

[0043] Preferably, the method further comprises attaching the lower end of the buoy to the seabed through the link.

[0044] In an arrangement, the buoy comprises a body built as a single structure, which can be built in the horizontal, towed from the build site or shipyard to the deployment site in the horizontal, and by manipulation of ballast placement in the main compartment and lower column, rotate to the vertical, immerse and connect to a seabed foundation, with limited assistance.

[0045] In a further arrangement, the seabed foundation to which the spar buoy is connected is able to withstand to considerable tensile loads applied, when the structure is de-ballasted after connection, thereby creating very high restoration forces, when the structure is displaced by the forces of the sea.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0046] Further features of the present invention are more fully described in the following description of several non-limiting embodiments thereof. This description is included solely for the purposes of exemplifying the present invention. It should not be understood as a restriction on the broad summary, disclosure or description of the invention as set out above. The description will be made with reference to the accompanying drawings in which:

Figures 1a, 1b and 1c show the steps to deploying and installing the buoy, in accordance with an embodiment of the invention;

Figure 2a shows a cross section of the main area of the body of the buoy in accordance with an embodiment of the invention depicting the inner area and the outer area comprising the compartments.

Figure 2b shows a cross section of the lower end of the body of the buoy in accordance with an embodiment of the invention showing the hydrocarbon delivery system.

Figure 3 shows the process for installing the lower end of the buoy to the .

Figure 4 shows an installed buoy comprising the motion moderating spread mooring.

#### DESCRIPTION OF EMBODIMENTS

[0047] Referring to Figure 4, the spar buoy 10 in accordance with an embodiment of the invention, is a continuous and singular structure, comprises a body having an upper column 12, which when installed penetrates the sea surface, a main area 14 which is submerged when installed and is adapted to contain an hydrocarbons processing equipment, and a lower column 16 which is adapted to connect to a seabed foundation 17 186, by means of an articulated joint 34. The lower column 16 is adapted to receive a hydrocarbon delivery system.

[0048] Referring to figure 2a, the buoy 10 comprises a body having at least one compartment 18 adapted to receive and drive out ballast. The body of buoy 10 comprises an inner area 20 and an outer area 22 surrounding the inner area 20, the outer area 22 comprising the at least one compartment 18. The body is adapted to be selectively located between a horizontal position and a vertical position with respect to the water surface. The buoy 10 is selectively located between the horizontal position and the vertical position by selectively filling at least partially with ballast the compartment 18 and emptying at least partially the compartment 18. The compartment 18 is located within the body of the buoy 10 at a location such that when the compartment 18 is un-ballasted, the buoy 10 is located in the horizontal position and when the compartment is ballasted, the buoy 10 is located in the vertical position.

[0049] In the arrangement shown in the figures there are a plurality of compartments 18. The plurality of compartments 18 may be placed and arranged in the body of the buoy 10, such that when un-ballasted, the buoy 10 is located in the

horizontal position and when the compartment are ballasted, the buoy 10 is located in the vertical position.

[0050] Alternatively, the outer area 22 of the buoy 10 is divided into compartments. For this the outer area 22 of the buoy 10 comprises a double wall comprising the plurality of compartments 18. The plurality of compartments 18 are adapted to be selectively either ballasted or un-ballasted for selectively locating the buoy 10 between the horizontal position and the vertical position. The outer area 22 of the body of the buoy 10 is sufficiently compartmented, to be able to adjust floating attitude for towing, and may be towed as a marine warranty compliant vessel, having appropriate intact and damaged stability characteristics.

[0051] Referring to Figure 1a, the spar buoy 10 is adapted to be built in the horizontal position and towed on the water surface to the deployment location in the horizontal position. Referring to Figure 1b, on arrival at the deployment location the spar buoy 10 is able to be rotated to the vertical, by addition of ballast to compartments located within buoy 10 and the lower column 16, managed and monitored by umbilical cable 24 to an attending vessel 26. Referring to Figure 1c, ballast is added to the compartments 18 until the spar buoy 10 is able to almost make contact with the seabed.

[0052] Figure 2a cross section of the main area of the body of the buoy 10 in accordance with an embodiment of the invention depicting the inner area 20 and the outer area 22 comprising the compartments 18. Referring to Figures 2a, in an arrangement the buoy 10 comprises an inner area 20 and an outer area 22. The outer area 22 comprises the compartments. The inner area 20 provides an open space for placement of hydrocarbon processing equipment and machinery.

[0053] Figures 2b is a cross-section of the lower column, depicting the compartments 18. In an arrangement the lower end comprises an inner area 20 and an outer area 22. The outer area 22 comprises the compartments 18. The inner area 20 provides the space necessary for all of the piping 9 and cables 10 required to pass down the buoy 10 to connect to pipelines and subsea wells located on the seabed, at near or distant from the installed buoy 10, for which processing and control will be undertaken on the buoy 10.

[0054] The buoy 10 in accordance with the present embodiment of the invention is adapted to be attached to the seabed through a seabed foundation 17 (see figure 3). For this the lower column 16 of the buoy 10 is adapted to be attached to the seabed

through a link 32 comprising an articulated joint 34. In an arrangement, the articulated joint 34 comprises an articulated limited rotation joint 34. The articulated joint 34 is adapted to provide a ratio of restoring force and the drag resistance of the submerged parts of the buoy 10 during restoring movement such that the structure pivots through a limited motion range, resulting in the motions inside the spar buoy 10, under normal sea conditions, to be tolerable for persons to perform work inside the buoy 10. This is particularly useful in view that as will be described in greater detail the buoy 10 is adapted to process hydrocarbons.

[0055] Referring to figure 3, the articulated joint 34 is included in a seabed foundation 17. The seabed foundation 17 comprises a body having means for attaching the foundation 17 to the seabed and means for attaching the lower column 16 of the buoy 10 to the foundation 17. The means for attaching the lower column 16 comprises a cylinder 36 having an upper end 38 adapted to the articulated joint 34. The cylinder 36 is adapted to receive a pull wire 38. During installation, the lower column 3 may be guided to the seabed foundation 17, by means of a pull wire 38 passing through the cylinder. The pull wire 38 extends up to, for example, an attending vessel (not shown) on the water surface for pulling of the wire 38 to guide the lower end of the lower column 16 into the cylinder 30.

[0056] Figure 4 shows an installed buoy 10 comprising a motion moderating spread mooring 40. The motion moderating spread mooring system 40 comprises comprising a plurality of links 42 such as chains or other mooring appliances connected to the seabed and the buoy 10. The mooring system 40 may be optional and can be installed if it is determined that movement of the buoy 10 need to be controlled.

[0057] As mentioned before, figures 3 show the method for transporting the buoy 10 to the location of installation of the buoy 10. The method for installing the buoy 10 comprises towing via vessel 33 the buoy 10 in a horizontal position on the surface of the body of water by maintaining the at least one compartment 18 un-ballasted. At the location of deployment of the buoy 10 ballasting the at least one compartment 18 occurs. This allows to locating the buoy 10 in a vertical position. The method further comprises attaching the lower end of the buoy 10 to the seabed through the articulated joint 34.

[0058] Further, the buoy 10 is adapted to process hydrocarbons. For this the inner area 20 of buoy 10 is adapted to receive a hydrocarbons processing system. In a

particular arrangement, the hydrocarbons processing system is adapted to be remotely controlled from a remote location. The hydrocarbons processing system comprises hydrocarbon processing equipment including power generation and utilities equipment, fire safety, services and life support required to process hydrocarbons. The hydrocarbons processing system further comprises a hydrocarbon delivery system having first means for importing and exporting hydrocarbons from wells and other seabed equipment and second means to provide power, control, communication to wells and seabed equipment.

[0059] The hydrocarbons processing system comprises hydrocarbon processing equipment and a hydrocarbon delivery system 31. The main area 14 of the buoy 10 is adapted to receive the hydrocarbon processing equipment. The lower column 16 is adapted to receive the hydrocarbons delivery system. The upper column 12 is adapted to provide access, ventilation air supply, exhaust gas expulsion, communication and control antenna, and gas flaring facility and mooring of vessels and the transfer of produced hydrocarbons to vessels.

[0060] It is evident that the present system is particularly advantageous for producing hydrocarbons from remote offshore fields, in particular marginal production wells. The reason being that in water depths beyond those for fixed offshore platform, and modest production facility may be installed to produce hydrocarbons, where otherwise a large floating facility has to be deployed on surface. Such a floating facility having many complex mooring and interconnection components, which in the case of a buoy 10 in this form can be replaced by one articulated mechanical connection, and one junction -adaptor plate

Modifications and variations as would be apparent to a skilled addressee are deemed to be within the scope of the present invention.

Further, it should be appreciated that the scope of the invention is not limited to the scope of the embodiments disclosed. For example, such may be fixed to a subsea tank and act as a production storage offloading site, or might act as a remote location production facility producing into a pipeline gathering system.

Throughout the specification and claims, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0061] Throughout this specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

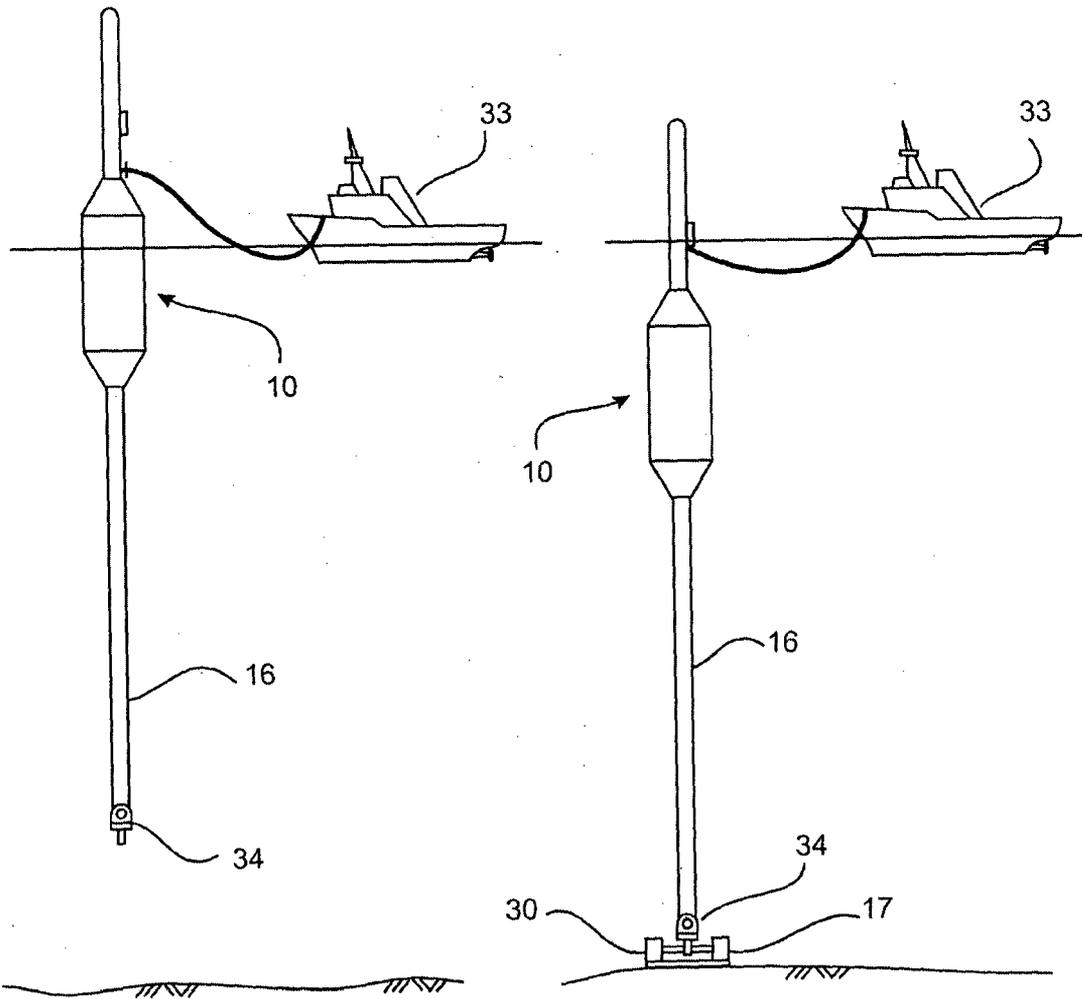
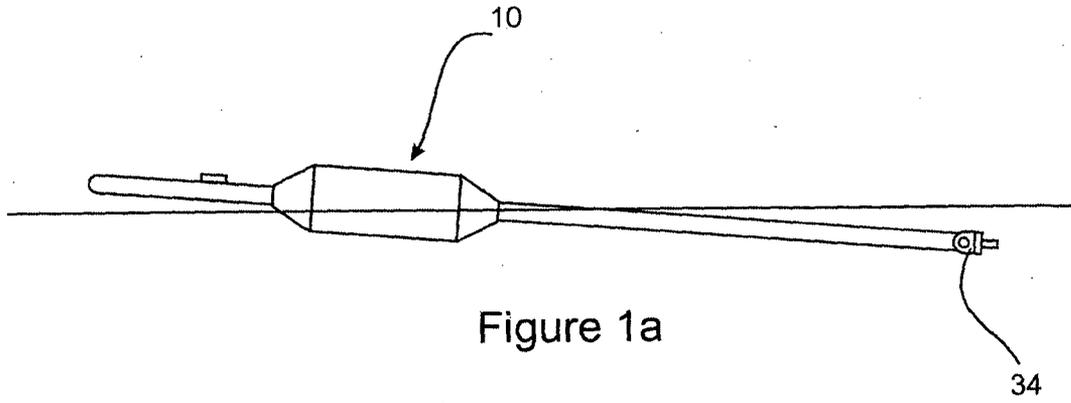
## Claims

1. A buoy comprising a body having an upper end and a lower end, the lower end having a lower column adapted to be attached to the seabed through an articulated joint .
2. A buoy in accordance with claim 1 the link comprises a single articulated joint, the resistance to the forces the sea on the body or the buoy, and restoration forces being due to the buoyancy of the body of the buoy, applied to the articulated joint.
3. The body of the buoy in accordance with claim 2 adapted to such that the drag resistance, the resorting forces, the speed of response to both drag and restoration forces, causes the buoy to pivot through a limited motion range, resulting in the motions inside the spar buoy, under normal sea conditions, to be tolerable for persons to perform work inside the buoy.
4. A buoy in accordance with claims 4 or 5 wherein a base of the lower column of the spar buoy is adapted be fitted with a limited rotation articulated joint, and a docking pin, for connecting into a subsea foundation.
5. A buoy in accordance with any one of claims 4 to 6 wherein the articulated joint is may be connected to a seabed foundation, by means of a pin device with pull wire, the pull wires passes through the pin adaptor located in the seabed foundation, providing a means of guiding the pin into the subsea foundation and installing by means of a vessel on surface applying appropriate force to the pull wire.
6. A buoy comprising a body having at least one compartment adapted to receive and drive out ballast.
7. A buoy in accordance with claim 8 wherein the body comprises an inner area and an outer area surrounding the inner area, the outer area comprising the at least one compartment.
8. A buoy in accordance with claims 8 or 9 the body of the buoy is adapted to be selectively located between a horizontal position and a vertical position with respect to a surface of a body of water.

9. A buoy in accordance with claim 10 wherein the buoy is selectively located between the horizontal position and the vertical position by selectively filling at least partially with ballast the compartment and emptying at least partially the compartment.
10. A buoy in accordance with any one of claims 8 to 11 wherein the compartment is located within the body of the buoy at a location such that when the compartment is un-ballasted, the buoy is located in the horizontal position and when the compartment is ballasted, the buoy is located in the vertical position.
11. A buoy in accordance with any one of claims 8 to 12 wherein there are a plurality of compartments.
12. A buoy in accordance with claim 13 wherein the plurality of compartments are placed and arranged in the body of the buoy, such that when un-ballasted, the buoy is located in the horizontal position and when the compartment are ballasted, the buoy is located in the vertical position.
13. A buoy in accordance with claims 13 or 14 wherein the outer area comprises a double wall comprising the plurality of compartments.
14. A buoy in accordance with any one of claims 13 to 15 wherein the compartments are adapted to be selectively either ballasted or un-ballasted for selectively locating the buoy between the horizontal position and the vertical position.
15. A buoy in accordance with any one claims 8 to 16 a lower end of the buoy is adapted to be attached to the seabed of the body of water, the buoy, when the compartments are at least partially ballasted, relying upon the reserve buoyancy of the buoy to remain afloat.
16. A buoy in accordance with any one of claims 15 to 17 wherein the outer area of the body of the buoy are sufficiently compartmented to adjust floating attitude for towing, and may be towed as a marine warranty compliant vessel, having appropriate intact and damaged stability characteristics.
17. A buoy comprising a body having an external surface comprising attachment means adapted to receive a mooring system for moderating the movement of the buoy.

18. A buoy in accordance with claim 19 wherein the mooring system comprises links having first ends attached to the attachment means and second ends attached to a seabed of a body of water adapted to receive the buoy.
19. A buoy comprising a body an inner area and an outer area surrounding the inner area, the inner area being adapted to receive a hydrocarbons processing system.
20. A buoy in accordance with claim 21 wherein the outer area comprises at least one compartment adapted to be selectively ballasted or un-ballasted.
21. A buoy in accordance with claim 22 wherein the body of the buoy comprises an external surface comprising attachment means adapted to receive a mooring system for moderating the movement of the buoy.
22. A buoy in accordance with any one of claims 21 to 23 wherein the hydrocarbons processing system is adapted to be remotely controlled from a remote location or vessel .
23. A buoy in accordance with any one of claims 21 to 24 wherein the hydrocarbons processing system comprises hydrocarbon processing equipment including power generation and utilities equipment, fire safety, services and life support required to process hydrocarbons.
24. A buoy in accordance with any one of claims 21 to 25 wherein the hydrocarbons processing system further comprises a hydrocarbon delivery system having first means for importing and exporting hydrocarbons from wells and other seabed equipment and second means to provide power, control, communication to wells and seabed equipment.
25. A buoy in accordance with any one of claims 21 to 26 wherein the body of the buoy comprises an upper end and a lower end, the upper end comprising an upper column and a main area, the main area comprising the hydrocarbon processing equipment and the lower end comprising a lower column comprising the hydrocarbons delivery system.
26. A buoy in accordance with claim 27 wherein the upper column is adapted to provide access, ventilation air supply, exhaust gas expulsion, communication and control antenna, and gas flaring facility and mooring of vessels and the transfer of produced hydrocarbons to vessels.

27. A buoy in accordance with any one of the preceding claims wherein the body of the buoy is fully water tight and positively buoyant.
28. A method for transporting and installing onto a seabed of a body of water a buoy in accordance with any one of the first to third aspects of the invention, the method comprising towing the buoy in a horizontal position on the surface of the body of water by maintaining the at least one compartment un-ballasted and, at a location of deployment of the buoy ballasting the at least one compartment for locating the buoy in vertical position.
29. A method in accordance with claim 30 wherein the method further comprises attaching the lower end of the buoy to the seabed through the link.
30. A method in accordance with claims 30 or 31 wherein the buoy comprises a body built as a single structure, which can be built in the horizontal, towed from the build site or shipyard to the deployment site in the horizontal, and by manipulation of ballast placement in the main compartment and lower column, rotate to the vertical, immerse and connect to a seabed foundation, with limited assistance.
31. A method in accordance with claims 30 or 31 wherein the seabed foundation to which the spar buoy is connected is able to withstand to considerable tensile loads applied, when the structure is de-ballasted after connection, thereby creating very high restoration forces, when the structure is displaced by the forces of the sea.
32. A buoy as herein described with reference to the figures of the accompanying drawings.
33. A method as herein described with reference to the figures of the accompanying drawings.



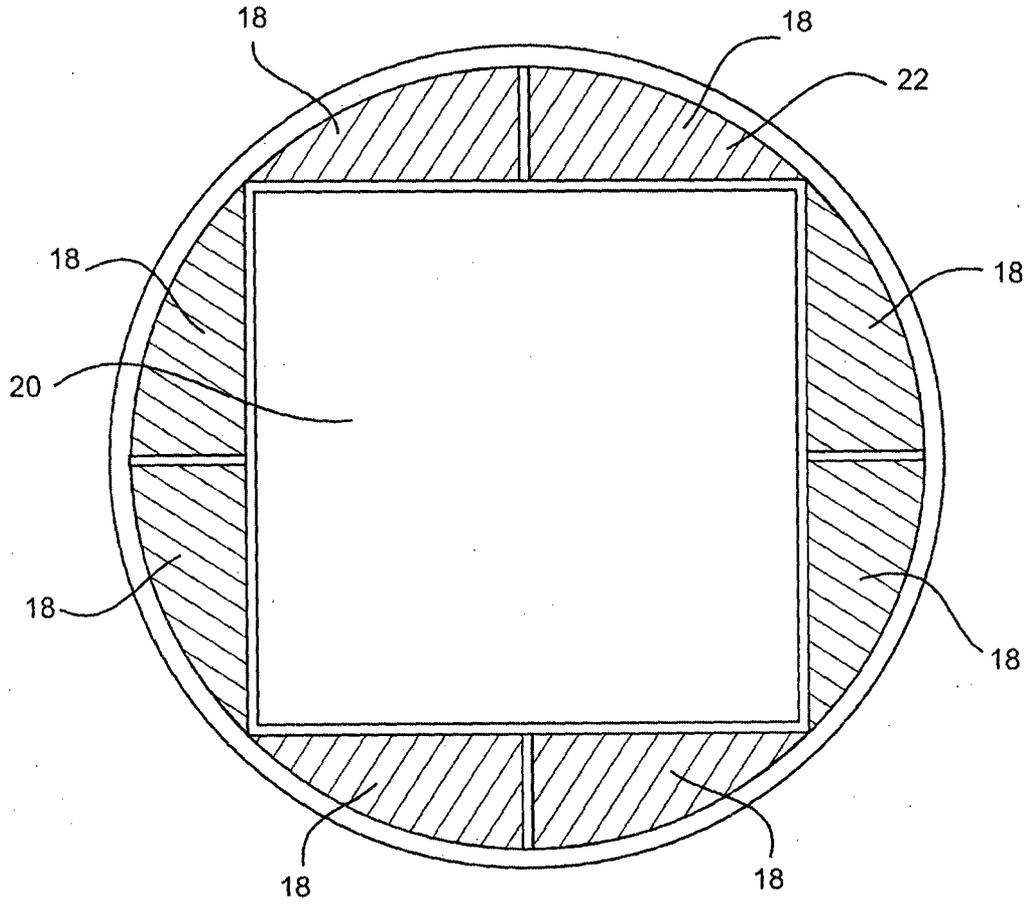


Figure 2a

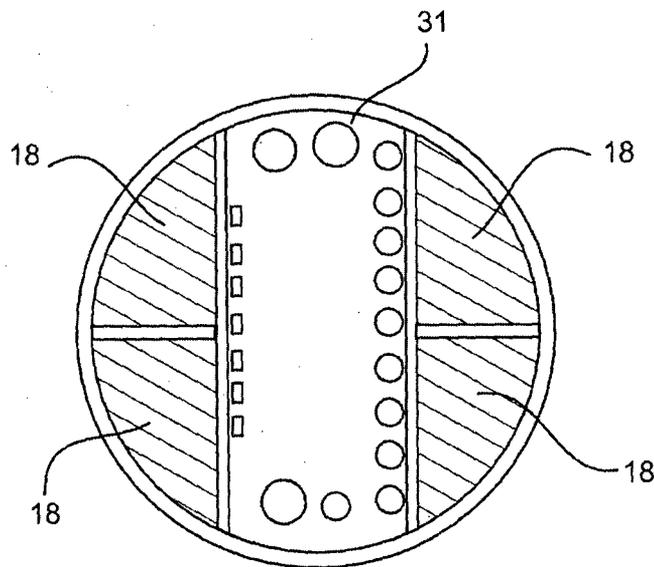


Figure 2b

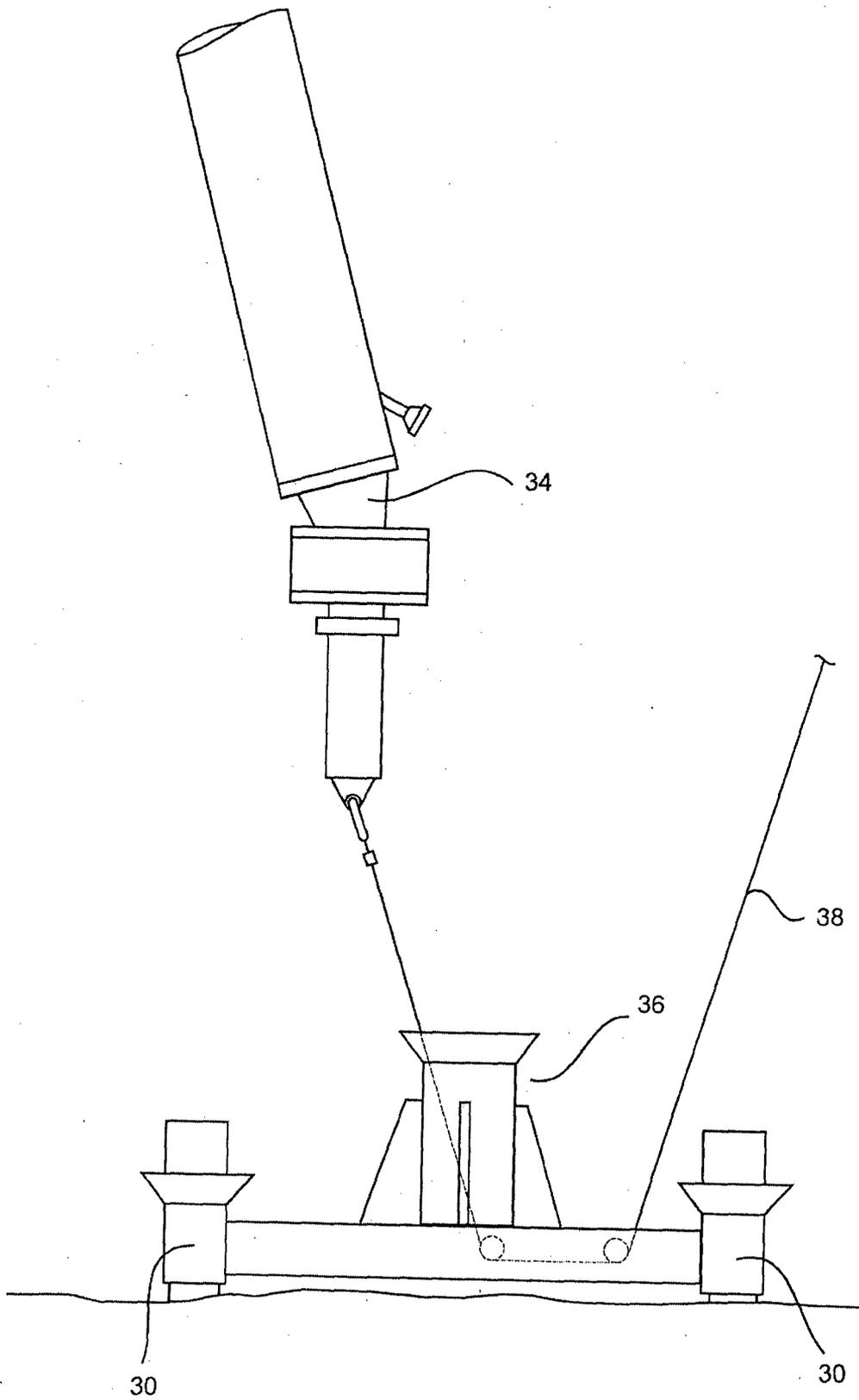


Figure 3

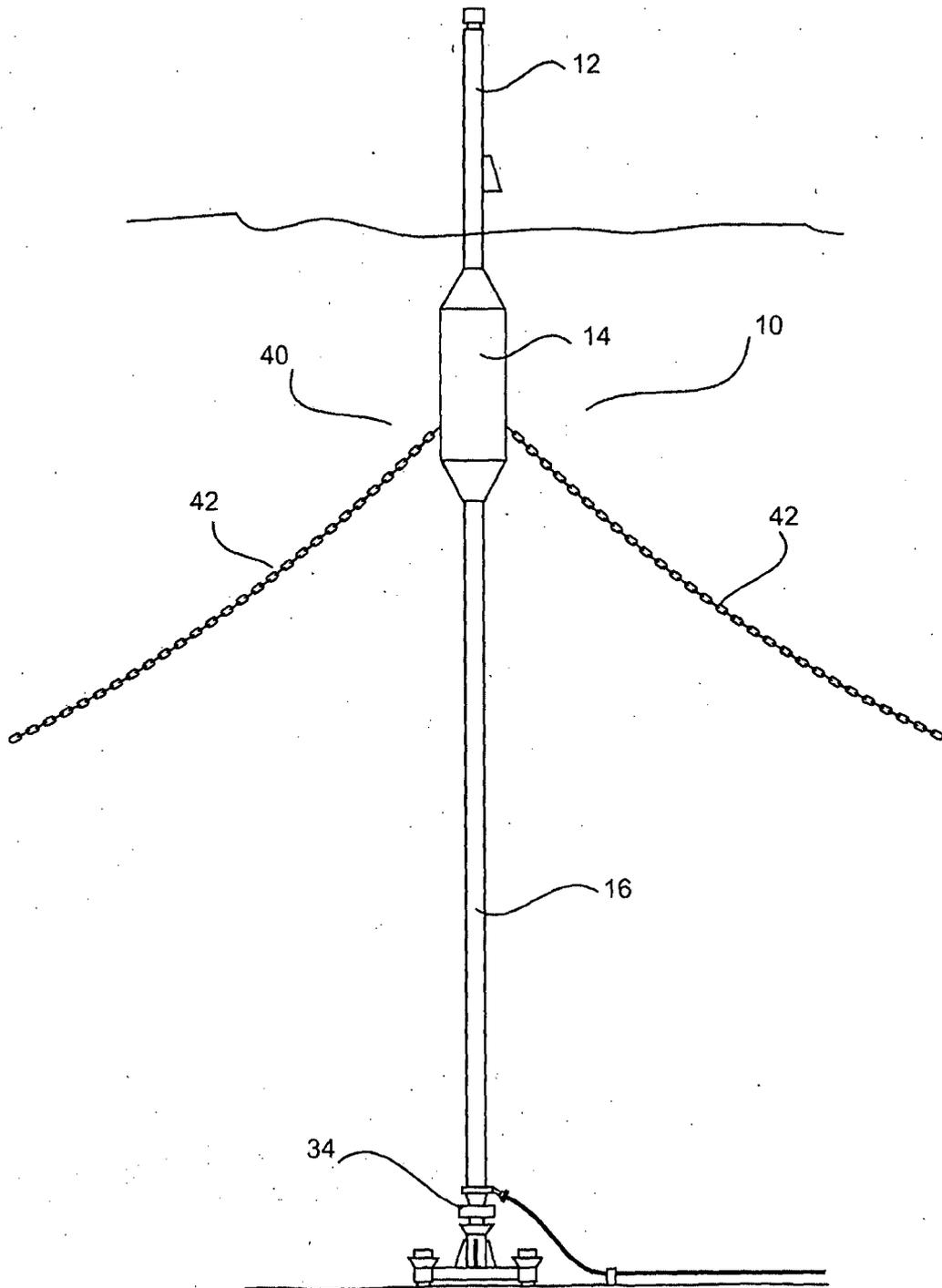


Figure 4

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/AU2013/000971

## A. CLASSIFICATION OF SUBJECT MATTER

**B63B 35/44 (2006.01) B63B 22/20 (2006.01) B63B 22/04 (2006.01) B63B 22/24 (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)

EPODOC, WPI, IPC/CPC Marks B63B35/44, B63B22/20, B63B22/18, B63B22/04, B63B22/24, E21B43/01 and Keywords: spar buoy, vertical column, articulated joint, anchor, rotate, swivel, pivot, seabed, seafloor and similar terms

Espacenet, CPC Marks B63B35/4406 and Keywords: spar buoy

Google Patents and Keywords: articulated loading column oil; buoy pin device pull wire articulate

Google and Keywords: articulated single mooring joint pin

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* Special categories of cited documents:		
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	
"P" document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search  
6 November 2013Date of mailing of the international search report  
06 November 2013

## Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE  
PO BOX 200, WODEN ACT 2606, AUSTRALIA  
Email address: pct@ipaaustralia.gov.au  
Facsimile No.: +61 2 6283 7999

## Authorised officer

Yew-Seng How  
AUSTRALIAN PATENT OFFICE  
(ISO 9001 Quality Certified Service)  
Telephone No. 0262832945

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/AU2013/000971
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/0082514 A1 (HORTON, III et al) 05 April 2012 Figs 1-2, 4-5, 10a, 10b; Paras 0007, 0033, 0039, 0043-0044, 0051-0053, 0061, 0078-0084, 0087, 0099-0101	1-5, 6, 8-12, 14-15, 17-18, 27-31
X	GB 2133446 A (TREASURE OFFSHORE PRODUCTION SYSTEMS LIMITED) 25 July 1984 Figs 3, 7-11; Pg 1 Lines 22-30, 83-88; Pg 2 Line 101; Pg 3 Lines 27-51; Pg 4 Line 124-130; Pg 5 Lines 1-10, 34-37, 49-60	1-3, 6, 11, 13, 15, 17, 19, 23-24, 27
X	US 3768268 A (LAFFONT et al) 30 October 1973 Abstract; Fig 1; Col 1 Lines 27-28, 61-65; Col 2 Lines 11-17, 46-68; Col 3 Lines 1-3	1-2, 4-6, 8-12, 14-15, 17, 27-31
X	US 3413946 A (VON SCHULTZ) 03 December 1968 Figs 1, 6; Col 3 Lines 1-4, 36, 61-66; Col 7 Lines 11-17, 43-44	1-2, 6-18, 27-31
X	US 5044450 A (ASO et al) 03 September 1991 Abstract; Figs 1, 4a-4b; Col 3 Lines 15-20	1-2, 17-18
X	US 4685833 A (IWAMOTO) 11 August 1987 Figs 1-3; Col 1 Lines 9-10; Col 2 Lines 36, 52-53; Col 3 Lines 12-13, 24-30, 56-57, 60-63; Col 4 Lines 21-24	1, 6-7, 11, 13, 15, 17-27
X	EP 0256177 A1 (FLUOR CORPORATION) 24 February 1988 Figs 1-3; Pg 4 Lines 10-19; Pg 5 Lines 5-42	6-7, 11, 13, 15, 17-18, 27
A	US 8251005 B2 (CARACOSTIS et al) 28 August 2012 Whole document	
A	US 6854933 B2 (HORTON, III) 15 February 2005 Whole document	
A	US 2012/0031320 A1 (BAUDUIN et al) 09 February 2012 Whole document	
A	US 6109830 A (DE BAAN) 29 August 2000 Whole document	

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.: **32-33**  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:  
**See Supplemental Box**
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

**See Supplemental Box for Details**

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

**Supplemental Box****Continuation of Box II**

The claims do not comply with Rule 6.2(a) because they rely on references to the description and drawings.

**Continuation of: Box III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- Claims 1-5 are directed to a buoy comprising a body having an upper end and a lower end, the lower end having a lower column adapted to be attached to the seabed through an articulated joint. The feature of an attachment to the seabed through an articulated joint is specific to this group of claims.
- Claims 6-16 and 28-31 are directed to a buoy or a method for transporting and installing thereof comprising a body having at least one compartment adapted to receive and drive out ballast. The feature of at least one compartment adapted to receive and drive out ballast is specific to this group of claims.
- Claims 17-18 are directed to a buoy comprising a body having an external surface comprising attachment means adapted to receive a mooring system. The feature of attachment means adapted to receive a mooring system is specific to this group of claims.
- Claims 19-27 are directed to a buoy comprising a body having an inner area and an outer area surrounding the inner area, the inner area being adapted to receive a hydrocarbons processing system. The feature of an inner area being adapted to receive a hydrocarbons processing system is specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a priori*.

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/AU2013/000971**

This Annex lists known 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.

<b>Patent Document/s Cited in Search Report</b>		<b>Patent Family Member/s</b>	
<b>Publication Number</b>	<b>Publication Date</b>	<b>Publication Number</b>	<b>Publication Date</b>
US 2012/0082514 A1	05 Apr 2012	US 2012082514 A1	05 Apr 2012
		WO 2012047910 A2	12 Apr 2012
GB 2133446 A	25 Jul 1984	GB 2133446 B	15 Oct 1986
US 3768268 A	30 Oct 1973	CA 938116 A1	11 Dec 1973
		GB 1310475 A	21 Mar 1973
		NL 7112887 A	23 Mar 1972
		NL 163846 B	16 May 1980
		US 3768268 A	30 Oct 1973
US 3413946 A	03 Dec 1968	None	
US 5044450 A	03 Sep 1991	AU 5053690 A	06 Sep 1990
		GB 2230290 A	17 Oct 1990
		GB 2230290 B	10 Feb 1993
		JP H02227389 A	10 Sep 1990
		JP 2543405 B2	16 Oct 1996
		US 5044450 A	03 Sep 1991
US 4685833 A	11 Aug 1987	CA 1238198 A1	21 Jun 1988
		GB 2156283 A	09 Oct 1985
		GB 2156283 B	25 Nov 1987
		JP S60212512 A	24 Oct 1985
		NO 851244 A	30 Sep 1985
		US 4685833 A	11 Aug 1987
EP 0256177 A1	24 Feb 1988	US 4606673 A	19 Aug 1986
US 8251005 B2	28 Aug 2012	AU 2008239913 B2	22 Sep 2011
		CN 101657351 A	24 Feb 2010
		GB 2459423 A	28 Oct 2009
		GB 2459423 B	15 Feb 2012
		NO 20093325 A	11 Nov 2009
		US 2011005443 A1	13 Jan 2011
		US 8251005 B2	28 Aug 2012
		WO 2008127958 A1	23 Oct 2008
US 6854933 B2	15 Feb 2005	BR 0313324 A	21 Jun 2005
		BR 0313324 B1	10 Sep 2013

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

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/AU2013/000971**

This Annex lists known 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.

<b>Patent Document/s Cited in Search Report</b>		<b>Patent Family Member/s</b>	
<b>Publication Number</b>	<b>Publication Date</b>	<b>Publication Number</b>	<b>Publication Date</b>
		EP 1540127 A2	15 Jun 2005
		EP 1540127 B1	22 Nov 2006
		OA 12898 A	13 Oct 2006
		US 2004028479 A1	12 Feb 2004
		US 6854933 B2	15 Feb 2005
		US 2004052586 A1	18 Mar 2004
		WO 2004015239 A2	19 Feb 2004
US 2012/0031320 A1	09 Feb 2012	EP 2414217 A1	08 Feb 2012
		EP 2414217 B1	17 Apr 2013
		US 2012031320 A1	09 Feb 2012
		WO 2010112603 A1	07 Oct 2010
US 6109830 A	29 Aug 2000	GB 2330157 A	14 Apr 1999
		GB 2330157 B	07 Nov 2001
		NO 982559 A	08 Apr 1999
		NO 318688 B1	25 Apr 2005
		OA 10869 A	18 Feb 2003
		US 6109830 A	29 Aug 2000

**End of Annex**

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

Form PCT/ISA/210 (Family Annex)(July 2009)