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(54) **SUBSEA CONNECTOR**

(57) The invention relates to a subsea connector for coupling a movable subsea structure to a tubular fixed subsea structure, comprising:
a connector assembly comprising a throughbore and a clamping mechanism, the clamping mechanism being adapted to directly and removably couple the connector assembly to the tubular fixed subsea structure; the connector assembly further comprising at least one engagement member adapted to provide a, releasable connection to an end fitting adapter mountable on a string of tubulars.

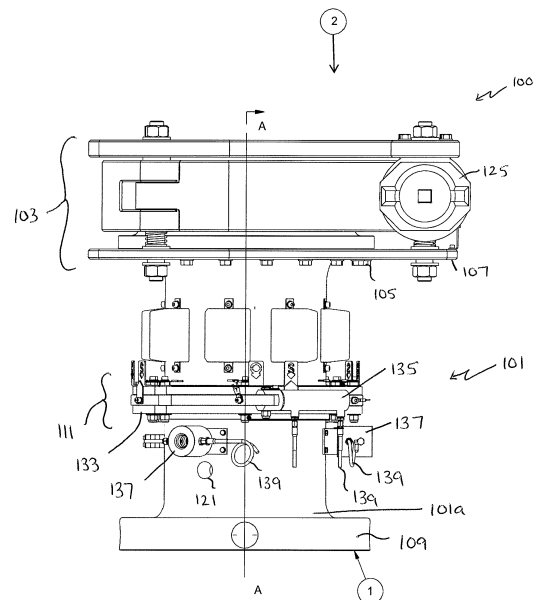


Figure 2

Description

[0001] The present invention relates generally to the field of subsea pipelines and manifolds, and in particular, to the field of subsea fluid connections of flexible pipes or umbilicals to a fixed structure including devices for limiting the bend of the flexible pipes or umbilicals. More particularly, the invention relates to a subsea connector allowing reliable installation and retrofit of marine equipment such as, for example, a bend-stiffener.

INTRODUCTION

[0002] In subsea operations, it is often required to connect a string of tubulars such as, for example, flexible pipes, flowlines or umbilicals to a fixed structure, such as an offshore floating platform or a vessel. A string of tubulars is hereinafter referred to as a "riser". The riser may include cabling or control lines for equipment on the seafloor, so that they can be controlled remotely from the surface structure (i.e. the platform or vessel). Thus, risers are conduits for transferring hydrocarbon production fluids, such as, crude oil or gases to and from the surface of a body of water such as an ocean or sea.

[0003] Figure 1 shows a typical setup for subsea operation, where production fluid is transferred from at least one subsea well 10 to a floating production, storage and offloading unit 20, also referred to as FPSO. A flexible riser 30 is used to transport the production fluid from the well 10, or a seabed production field in case of multiple wells, to the FPSO 20 via turret 40. Bend stiffeners 50 (only one connection is shown in Figure 1) are typically used where the flexible riser 30 joins the fixed structure (i.e. where the flexible riser 30 enters the turret 40 through an 'I'- or 'J' tube 60), in order to protect the flexible riser 30 from excessive cyclic bending due to movement that may be caused by waves, current or wind, or which may simply be caused by the movement of the FPSO 20. Often, the bend stiffener 50 is installed to the 'I'- or 'J'-tube 60 via a releasable connector assembly 70. The releasable connector assembly 70 may comprises a male connector portion 72, fitted to the bend stiffener 50, and a female connector portion 74, fitted to the 'I'- or 'J'-tube 60. During installation, the male connector portion 72 is attached to the bend stiffener 50 and an end-fitting 32 of the riser 30 is located and attached to the male connector portion 72. In particular, the end-fitting 32 of the riser 30 is located inside the throughbore of the male connector portion 72 and locked into place by, for example, a cam device, a clamp mechanism 78, a latch- or other interlocking mechanisms (not shown). The attachment of the male connector portion 72 and the end-fitting 32 is typically completed in a workshop.

[0004] Once the equipment (i.e. riser, end-fitting, bend stiffener and male connector portion) has been moved subsea, it is moved towards and into connection with the female connector portion 74 using a wire line 80 that is attached to the end-fitting 32 of the riser 30. When the

male connector portion 72 is located in the female connector portion 74, it is interlocked with the female connector portion 74 so as to form a secure connection. Typically, a latch cam is used to couple male and female connector portions 72 and 74. The riser 30 is then released from the engagement with the male connector portion 72 and drawn up and through the bend stiffener 50 and the 'I'-or 'J'-tube to be fixed into place at the FPSO 20.

[0005] The interlocking of the male and female connector portions, as well as, the release of the riser end-fitting 32 from the male connector portion 72 is conventionally done using, for example, subsea divers 90 and/or a Remotely Operated Vehicles (ROV) 92. In particular, the diver 90 or ROV 92 may operate the latch-cam 76 to secure the male connector portion 72 to the female connector portion 74, and then release the clamp mechanism 78 that is fixing the riser end-fitting 32 to the male connector portion 72.

[0006] Conventionally, connecting the female connector portion 74 to the turret 40 must be done in the shipyard whilst the fixed structure is in dry dock. In addition, the assembly comprising the interlocking male and female connector portions is subject to loading forces which, in time will fatigue the materials of the connected portions and, in extreme cases, lead to product failure.

[0007] Accordingly, it is an object of the present invention to provide a subsea connector that is suitable to operatively couple a moveable subsea structure with a fixed structure *in situ*. More particularly, it is an object of the present invention to provide a subsea connector suitable to retrofit a bend stiffener or bend limiter to a fixed structure (e.g. FPSO) whilst the fixed structure is *in situ* in a body of water.

SUMMARY OF THE INVENTION

[0008] A preferred embodiment of the invention seek to overcome one or more of the disadvantages of the prior art.

[0009] According to a first embodiment of the present invention, there is provided a subsea connector for coupling a movable subsea structure to a tubular fixed subsea structure, comprising:

a connector assembly comprising a throughbore and a clamping mechanism, the clamping mechanism being adapted to directly and removably couple the connector assembly to the tubular fixed subsea structure; the connector assembly further comprising at least one engagement member adapted to provide a releasable connection to an end-fitting adapter mountable on a string of tubulars.

[0010] The connector assembly preferably comprises a first actuator member operable to act upon the at least one engagement member so as to selectively release a locked engagement of the end fitting adapter with said

connector assembly, allowing said end fitting adapter to be moved through said throughbore of said connector assembly.

[0011] In embodiments of the invention, the connector assembly comprises an engagement assembly. Preferably the at least one engagement member forms part of an engagement assembly. More specifically, the at least one engagement member forms part of a hydraulically actuated engagement assembly. The at least one engagement member is preferably a latching arm.

[0012] The first actuator member may comprise a cam ring. In preferred arrangements, the cam ring is part of the engagement assembly. More specifically the cam ring is configured to act upon the at least one engagement member so as to selectively release a locked engagement of the end fitting adapter with said connector assembly, allowing said end fitting adapter to be moved through said throughbore of said connector assembly.

[0013] In preferred embodiments, the latching arm is coupled to the cam ring by a pin. The opening and closing of the diameter of the cam ring moves the pin and causes the latching arm to engage and disengage from the end fitting adapter.

[0014] Preferably the cam ring is coupled to a hydraulic cylinder. More specifically, the diameter of the cam ring is preferably increased and decreased by movement of the hydraulic cylinder to increase or decrease its length respectively.

[0015] The engagement assembly may further comprise a pressure inlet. Preferably, the pressure inlet is fluidly connected to the hydraulic cylinder.

[0016] The pressure inlet may be a hot stab receptacle.

[0017] The fluid connection may be by flexible hose or other conduit.

[0018] The subsea connector is most preferably a bend stiffener connector. Preferably the bend stiffener connector is adapted to be connected to a bend stiffener or a bend limiter. The connector assembly may further comprise fastener apertures in a downhole end thereof. The fastener apertures may receive fasteners, such as bolts, rivets or the like, the fasteners connecting a bend stiffener or bend limiter to the connector assembly. More specifically, the connector assembly may comprise a flange at a downhole end thereof, the flange comprising fastener apertures configured to receive fasteners such that a bend stiffener or bend limiter is connectable to the connector assembly.

[0019] The subsea connector is preferably a single piece connector assembly comprising a clamping mechanism, the single piece connector assembly being releasably connectable to a tubular fixed subsea structure and also to a moveable subsea structure. More specifically, the single piece connector assembly is configured to be directly connected to a turret, I-tube and/or J-tube on a fixed subsea structure. In this way, the requirement for a separate and additional female connector is mitigated. The resulting connector assembly comprises fewer interconnected elements and, therefore, the effects of

load fatigue which occurs in the joints between interconnected assembly components is reduced in the connector due to there being fewer component parts.

[0020] The clamping mechanism may be hydraulically actuated. Alternatively, the clamping mechanism may be screw thread actuated.

[0021] The clamping mechanism may comprise at least one moveable jaw or pair of jaws. Preferably, the clamping mechanism comprises a clamping ring. More specifically, the clamping ring defines an aperture, the aperture being of variable diameter and configured to receive a flange of a turret, I-tube or J-tube.

[0022] The clamping mechanism preferably comprises a flange receiving recess.

[0023] When the clamping mechanism is a clamping ring, the flange receiving recess is formed in the clamping ring.

[0024] The flange receiving recess is configured to receive the flange of a turret, I-tube and/or J-tube on a tubular fixed subsea structure. More specifically, the flange receiving recess is configured to encircle the flange of a turret, I-tube and/or J-tube on a tubular fixed subsea structure. In this way, the clamping mechanism surrounds the flange when the subsea connector is in position, mounted to the tubular fixed subsea structure.

[0025] The clamping mechanism is configured to provide a circumferential coupling such that the connector assembly can be directly coupled around the flange of the fixed subsea structure. More specifically, the clamping mechanism is adapted to encircle a turret flange on the tubular fixed subsea structure. By completely encircling the flange on the tubular fixed subsea structure, a releasable and secure coupling is formed.

[0026] In preferred arrangements, the clamping mechanism provides a substantially continuous contact surface between the connector assembly and the tubular fixed subsea structure. More specifically, the clamping mechanism provides a single contact surface between the connector assembly and the tubular fixed subsea structure.

[0027] The clamping mechanism provides a direct coupling between the connector and the tubular fixed subsea structure. In this way, the loading forces on the subsea connector act only on one interconnection between the fixed subsea structure and the connector rather than any two interconnection joints when both female and male connector portions are utilised.

[0028] In embodiments of the invention, the clamping mechanism comprises an actuating assembly operable to increase and decrease the diameter of the clamping ring.

[0029] The actuating assembly is preferably hydraulically activated.

[0030] The actuating assembly preferably comprises a torque bucket. More specifically, the torque bucket may be operably coupled to a stud bolt, which bolt is in turn operably coupled to pins.

[0031] During operation of the clamping mechanism,

torque applied to the stud bolt causes the pins to move away from one another in the direction of the longitudinal axis of stud bolt. Movement of the pins along the stud bolt in turn operates the clamping hinge mechanism, opening the clamping ring ready for coupling the connector assembly to the turret flange.

[0032] The subsea connector remains external of the fixed subsea structure following coupling of the connector to the fixed subsea structure. More specifically, the clamping mechanism is adapted to surround the attachment area of the tubular fixed subsea structure. The attachment area may be the flange of a turret, I-tube or a J-tube.

[0033] By providing the subsea connector of the invention, there is no longer a need for a female connector portion or assembly in the subsea connector assembly. The subsea connector is capable of being directly coupled to the tubular fixed subsea structure *in situ* as opposed to requiring the tubular fixed subsea structure to be in or to return to dry dock in order to attach the clamping mechanism.

[0034] The connector assembly may comprise at least one first actuator member and at least one second actuator member.

[0035] The connector assembly may comprise at least one first engagement member and at least one second engagement member, each of said at least one first and second engagement member are operable to be acted upon by said first and/or second actuator member so as to selectively release a locked engagement between the end fitting adapter and said connector assembly, allowing said adapter assembly to be moved through said throughbore of said connector assembly.

[0036] Furthermore, the connector assembly may comprise a plurality of circumferentially arranged first and/or second actuator members, and wherein said adapter assembly may comprise a plurality of engagement members said plurality of engagement members may be circumferentially alignable with corresponding said plurality of actuator members.

[0037] This provides the advantage that each one of the plurality of engagement members can be aligned with and engaged by its corresponding actuator member. In particular, this provides the further advantage of improved functionality and safety, since the engagement members are only activated (e.g. released) when all of the actuator members are engaged simultaneously.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 [Prior Art] shows an example of a typical offshore setup for producing hydrocarbons from a subsea well and transferring the fluids to and from a FPSO via a flexible riser, wherein the riser is protect-

ed by a bend stiffener at the point of entering an 'I'-J-tube of the FPSO;

Figure 2 shows a bend stiffener connector of the present invention comprising a clamping mechanism for coupling directly to an I-tube flange on a turret;

Figure 3 shows a cross-sectional view of the bend stiffener connector of Figure 2 along section line A-A;

Figure 4 shows an alternative view of the reverse orientation of the bend stiffener connector of Figure 2 comprising a clamping mechanism for coupling directly to an I-tube flange on a turret;

Figure 5 shows a plan view taken from the downhole end in direction of arrow labelled "1" of the bend stiffener connector of Figure 2;

Figure 6 shows a plan view of the uphole end of the bend stiffener connector of Figure 2 in the direction of the arrow labelled 2; and

Figure 7 shows an exploded view of the encircled area "B" of Figure 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0039] In the context of this specification, terms such as "*top*" and "*bottom*", "*uphole*" and "*downhole*", and "*upper*" and "*lower*" refer to respective sides of the equipment when *in situ*, i.e. when the equipment is installed within the arrangement providing a connection between the FPSO and the subsea well / reservoir. In particular, the terms "*top*", "*upper*" and "*uphole*" refer to the side of the equipment directed towards the surface when *in situ*, the terms "*bottom*", "*lower*" and "*downhole*" refer to the side of the equipment directed towards the seabed or seafloor when *in situ*.

[0040] Also, in this specification the term "*bend stiffener*" may refer to any one of a bend - stiffener, -restrictor or -limiter. The terms "*fixed structure*", "*turret*", "*I-tube*" and "*J-tube*" may be used interchangeably. A "*riser*" is understood to mean any string of tubulars or umbilicals suitable to operatively connect the subsea well or any other seafloor equipment with the fixed structure, e.g. a FPSO vessel.

[0041] Referring now to Figure 2, a preferred embodiment of the present invention is shown. Bend stiffener connector assembly 101 comprises a hydraulically activated clamping mechanism 103 at an uphole end thereof, the clamping mechanism 103 being configured to surround a flange of an 'I'-tube (not shown).

[0042] Figure 2 shows the subsea connector generally depicted by the reference 100 is formed of a connector assembly 101 comprising a clamping mechanism 103. The clamping mechanism 103 in the depicted embodiment is fixed to the connector assembly body portion 101 a by bolts 105 through apertures (not shown) in connector assembly flange 107. The connector assembly 101, specifically the connector assembly body portion 101 a, is securely attached to the clamping mechanism 103 thereby forming a single piece bend stiffener connector as-

sembly 101. The bend stiffener connector 100 is then primed and ready for connection to an end-fitting adapter (not shown) mounted on a string of tubulars (not shown) and for subsequent coupling to a turret flange (not shown) on a turret buoy or the like.

[0043] As can be seen in Figure 2, the connector assembly body portion 101 comprises a flange 109 at the free end thereof opposing the end connected to the clamping mechanism 103. Flange 109 comprises bolt apertures (see 157 in Figure 5) which bolt apertures receive a fastener such as a bolt or rivet which in turn attaches a bend stiffener (not shown) to the lower side of flange 109 shown in Figure 5. The connector assembly 101 further comprises an engagement assembly generally depicted by the reference 111 which is adapted to provide a releaseable connection to an end fitting adaptor (not shown) which is itself mountable to a string of tubulars (not shown).

[0044] As best seen in Figures 2 and 3, the engagement assembly 111 comprises at least one engagement member in the form of a latching arm (123 in Figure 3). The engagement assembly 111 further comprises an actuator, comprising a cam ring 133 configured to act upon latching arm 123 (Figure 3). Operating the cam ring 133 moves the latching arm 123 (Figure 3) so as to release the locked engagement between the connector assembly 101 and the end fitting adaptor 117 (Figure 3) such that the end fitting adaptor is free to be moved through the throughbore 113 of the connector assembly 101.

[0045] The engagement assembly 111 further comprises hydraulic cylinder 135 which is fluidly connected by flexible hoses 139 to pressure inlets in the form of hot stab receptacles 137. In operation of the engagement assembly 111, pressure is input into hot stab receptacles 137. Hydraulic cylinder 135 is actuated by applied pressure through flexible hoses 139, the cylinder then acts upon the cam ring 133 to open same. The opening of the cam ring 133 causes the latching arms 123 to move out of engagement with the end fitting adaptor 117, thus unlocking the end fitting adaptor from the connector assembly 101. The cam ring 133 is coupled to the latching arm 123 by a moveable pin (not shown), the pin being moved by the opening and closing of the cam ring 133 so as to disengage and engage the latching arms 123 with the end fitting adaptor 117.

[0046] Figure 3 shows the cross sectional view of the bend stiffener connector 100 of Figure 2 along the line A-A. Connector 100 has a connector assembly body portion 101a having a throughbore 113 for receiving an end fitting adaptor 117 which itself is mounted to an end of a string of tubulars. The end fitting adaptor 117 comprises a coloured band 119 which aligns with each of three viewing holes 121 in the connector assembly body 101a when the end fitting adaptor 117 is mounted in throughbore 113. The appearance of the coloured band 119 in viewing holes 121 when the end fitting adaptor 117 is in position in the throughbore 113 indicates that the end fitting is correctly aligned with the bend stiffener connector en-

gagement members, in the form of latching arms 123.

[0047] As best seen in Figure 3, connector assembly 101 has a turret flange receiving aperture 141 having a diameter "T" when the clamping mechanism 103 is in the closed position. Clamping mechanism 103 comprises a clamping ring 145 having a flange receiving recess 143. The clamping ring 145 defines the aperture 141.

[0048] Referring to Figures 3 and 4, the clamping mechanism 103 comprises a torque bucket 125 coupled to stud bolt 127. Stud bolt 127 is operably connected through pins 129a and 129b. Torque bucket 125, stud bolt 127 and pins 129a and 129b together form an actuator mechanism for clamping ring 145, clamping ring 145 itself being attached to top plate 147 by bolts 105.

[0049] During the attachment of connector assembly 101 to a turret flange the diameter of turret flange receiving aperture 141 is temporarily increased by hingedly opening clamping ring 145. The diameter of the aperture 141 defined by clamping ring 145 is increased by hydraulic actuation of clamping mechanism 103 and the movement of pins 129a and 129b along stud bolt 127. Torque bucket 125 operates the rotation of stud bolt 127 which in turn moves pins 129a and 129b in elongate slots 131a and 131b respectively (see Figures 5 and 6). During the opening of clamping ring 145, pins 129a and 129b will be moved apart from one another such that the distance between them is greater than when the clamping ring 145 is in the closed position. Additional hinging pins 151a and 151b are shown clearly in Figures 5 and 6. The additional hinging pins allow a double hinging of the clamping mechanism 103 during operation.

[0050] In Figure 3, a turret flange (not shown) is receivable into turret flange recess 143 of clamping ring 145. In order to couple the connector 100 to the turret flange (not shown) clamping mechanism 103 is hydraulically actuated via torque bucket 125 to reduce the diameter of the turret flange receiving aperture 141 therefore locking the clamping mechanism 103 around the turret flange. Once in position around the turret flange, the engagement assembly 111 can be activated to release latching arms 123 from the end fitting adaptor 117 with the end fitting adaptor 117 and the string of tubulars mounted thereto can then be moved through bore 113 in the connector assembly 101 and into the turret.

[0051] As best seen in Figure 4, in the clamping mechanism 103 is bolted to flange 107 at the uphole end of connector assembly body portion 101a. The clamping mechanism 103 comprises torque bucket 125 coupled to stud bolt 127 which bolt is in turn operably coupled to pins 129a and 129b. As torque is applied to stud bolt 127 via torque bucket 125, stud bolt 127 acts to move pins 129a and 129b away from one another in the direction of the longitudinal axis of stud bolt 127. Pins 129a and 129b move in elongate slots 131a and 131b (see Figures 5 and 6). Movement of pins 129a and 129b within elongate slots 131a and 131b operates the clamping hinge mechanism opening the clamping mechanism ready for coupling the connector assembly 101 to the turret flange

(not shown).

[0052] Referring to Figure 5 the connector assembly 101 is viewed from beneath with flange 109 clearly visible. Fastener apertures 157 in the form of bolt holes in the depicted embodiment, facilitate connection of a bend stiffener (not shown) to the connector assembly 101. Figure 6 depicts the opposite end of the connector assembly 101 in plan view. In the depicted arrangement pins 129a and 129b are in their closest possible orientation in slots 131 a and 131 b and therefore clamping ring 145 is in the closed configuration.

[0053] In the embodiment depicted in Figures 2 to 7, the connector assembly 101 comprises of body portion 101 a to which the engagement assembly 111, including the latching arms 123 and first actuator member 133 are coupled. The engagement member 123 and actuator member 133 together form part of an engagement assembly 111. The engagement assembly 111 comprising cam ring 133 coupled to latching arms 123 (shown in Figure 3).

[0054] The engagement assembly 111 is operable to provide a locked engagement with the end fitting adaptor 117 but to be releasable therefrom upon activation. Cam ring 133 is activated hydraulically by fluid connection to hydraulic cylinder 135 which in turn is fluidly connected through flexible hoses 139 to pressure inlet valves in the form of hot stab receptacles 137. Cam ring 133 is activated by pressure flow in through hot stab receptacles 137 activating hydraulic cylinder 135 which in turn operates cam ring 133 to release the engagement of the latching arm 123 from the end fitting adaptor 117. The mechanism disengaging the latching arm 123 from the end fitting adaptor 117 comprises a pin (not shown) and a latching cam mechanism.

[0055] The operation of the latching arms 123 is clearly shown in Figure 7 where end fitting adaptor 117 comprises of recess 115 into which the end of latching arm 123 is engaged in the locked position. The grease nipple 153 and its associated conduit 155 allow the operation of the latching arm 123 to be maintained. In operation, latching arm 123 is moved out of recess 115 upon the hydraulic actuation of cam ring 133. Once the latching arm 123 is disengaged from end fitting adaptor recess 115, the end fitting adaptor 117 is free to move through the through-bore 113 of the connector assembly 101 into the turret (not shown).

[0056] The connector assembly 101 maybe disengaged from the turret flange with further hydraulic actuation of the clamping mechanism 103 as set out hereinabove. It is thus envisaged that the connector assembly of the present invention may be coupled and decoupled from a tubular fixed subsea structure and may also be retrofit to such a structure.

[0057] It would be appreciated for persons skilled in the art that the above embodiment has been described by way of example only and not in any limiting sense and that various alterations and modifications are possible without the departing from the scope of the invention as

defined by the appended claims.

Claims

1. A subsea connector for coupling a movable subsea structure to a tubular fixed subsea structure, comprising:
 - a connector assembly comprising a throughbore and a clamping mechanism, the clamping mechanism being adapted to directly and removably couple the connector assembly to the tubular fixed subsea structure; the connector assembly further comprising at least one engagement member adapted to provide a releasable connection to an end fitting adapter mountable on a string of tubulars.
2. A subsea connector according to claim 1, comprising a first actuator member operable to act upon the at least one first engagement member so as to selectively release a locked engagement of the end fitting adaptor with said connector assembly, allowing said end fitting adaptor to be moved through said through-bore of said connector assembly.
3. A subsea connector according to claim 1 or claim 2, being a bend stiffener connector.
4. A subsea connector according to any one of claims 1 to 3, further comprising fastener apertures in a downhole end thereof.
5. A subsea connector according to any one of claims 1 to 4, wherein the connector assembly is a single piece connector assembly comprising a clamping mechanism, the single piece connector assembly being releasably connectable to a tubular fixed subsea structure and to a moveable subsea structure.
6. A subsea connector according to any one of claims 1 to 5, wherein the connector assembly is configured to be directly connected to a turret, I-tube and/or J-tube on a fixed subsea structure.
7. A subsea connector according to any one of claims 1 to 6, wherein the clamping mechanism is hydraulically actuated.
8. A subsea connector according to any one of claims 1 to 6, wherein the clamping mechanism is screw thread actuated.
9. A subsea connector according to any one of claims 1 to 8, wherein the clamping mechanism comprises a flange receiving recess.

10. A subsea connector according to claim 9, wherein the flange receiving recess is configured to receive the flange of a turret, I-tube or J-tube on a tubular fixed subsea structure. 5
11. A subsea connector according to claim 9 or claim 10, wherein the flange receiving recess is configured to encircle the flange of a turret, I-tube or J-tube on a tubular fixed subsea structure. 10
12. A subsea connector according to any one of claims 1 to 11, wherein the clamping mechanism is configured to provide a circumferential coupling such that the connector assembly can be directly coupled around the flange of the fixed subsea structure. 15
13. A subsea connector according to any one of claims 1 to 12, wherein the clamping mechanism provides a substantially continuous contact surface between the connector assembly and the tubular fixed subsea structure. 20
14. A subsea connector according to claim 13, wherein the clamping mechanism provides a single contact surface between the connector assembly and the tubular fixed subsea structure. 25
15. A subsea connector according to any one of claims 1 to 14, wherein the clamping mechanism provides a direct coupling between the connector assembly and the tubular fixed subsea structure. 30
16. A subsea connector according to any one of claims 1 to 15, wherein the clamping mechanism is adapted to surround an attachment area of the tubular fixed subsea structure. 35
17. A subsea connector for coupling a movable subsea structure to a tubular fixed subsea structure substantially as hereinbefore described with reference to Figures 2 to 7 of the accompanying drawings. 40

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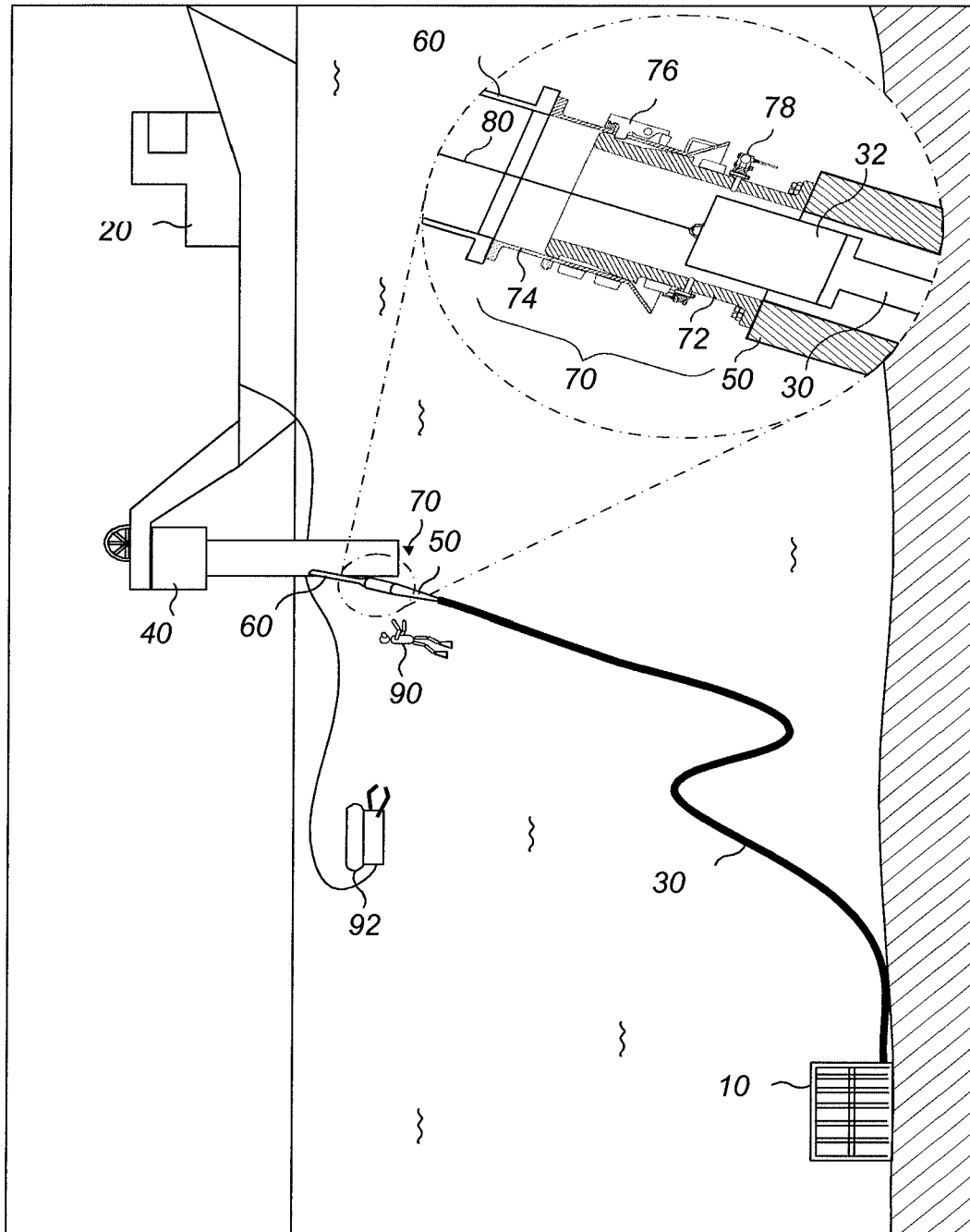


Figure 1 (Prior Art)

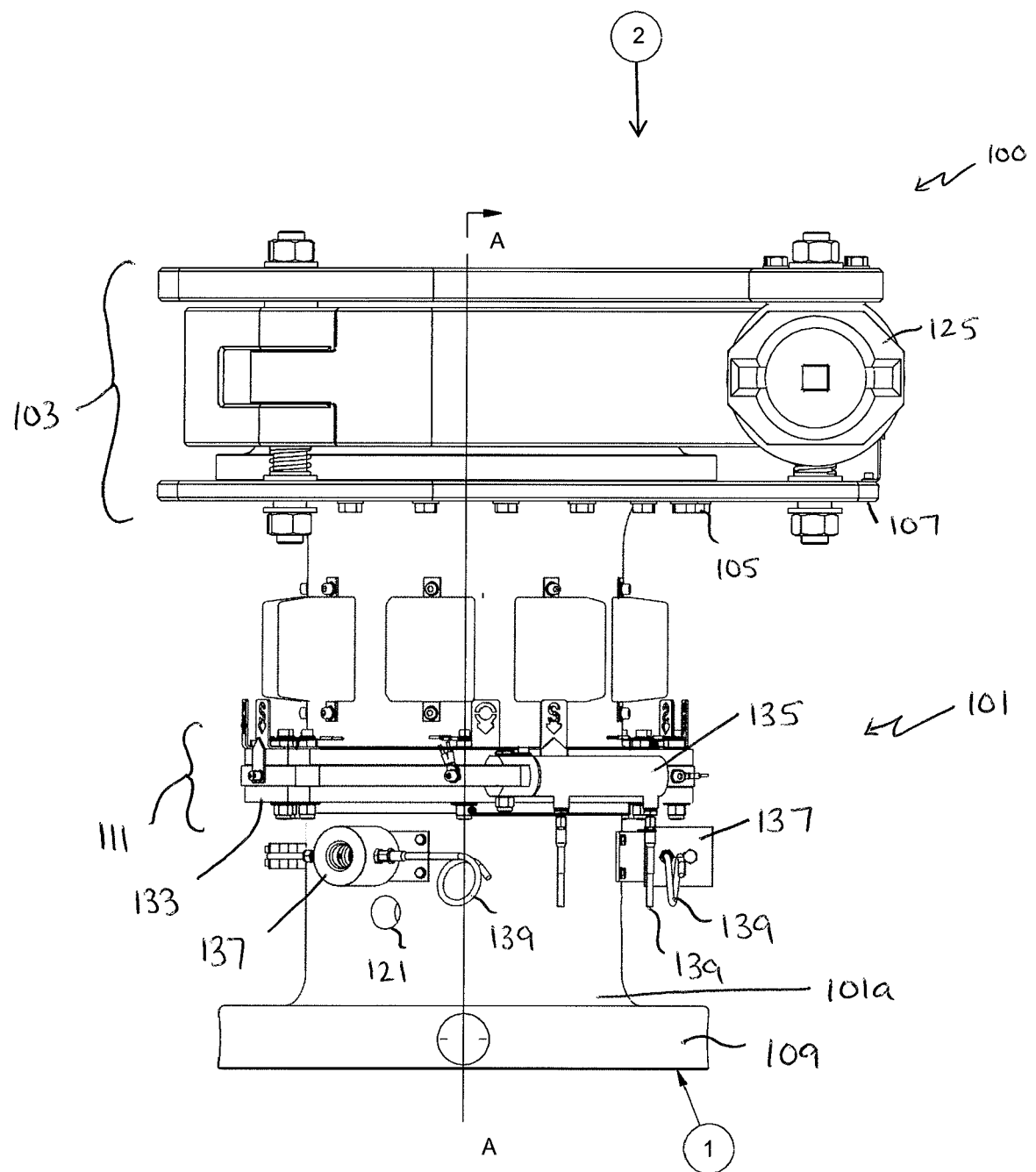


Figure 2

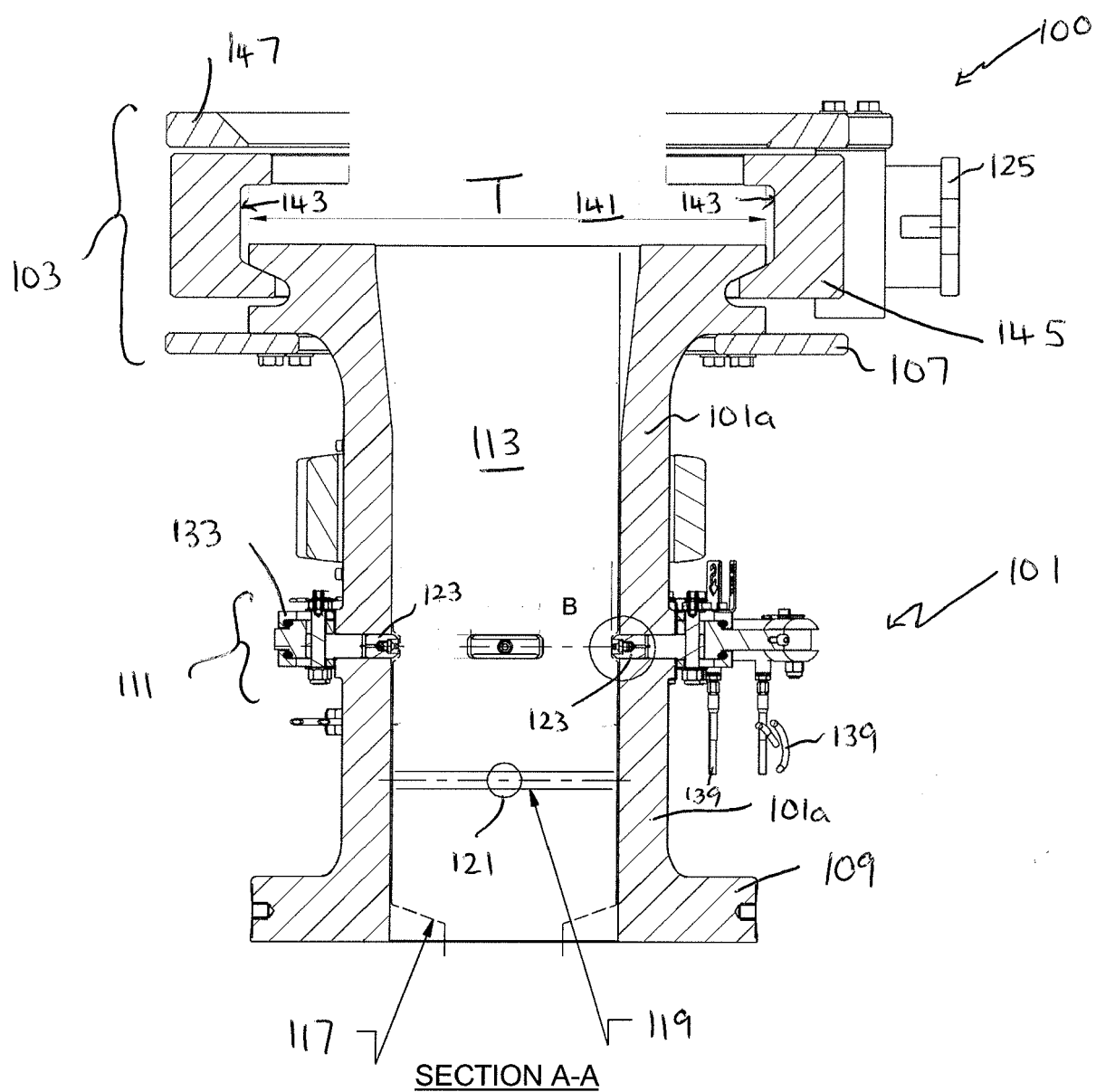


Figure 3

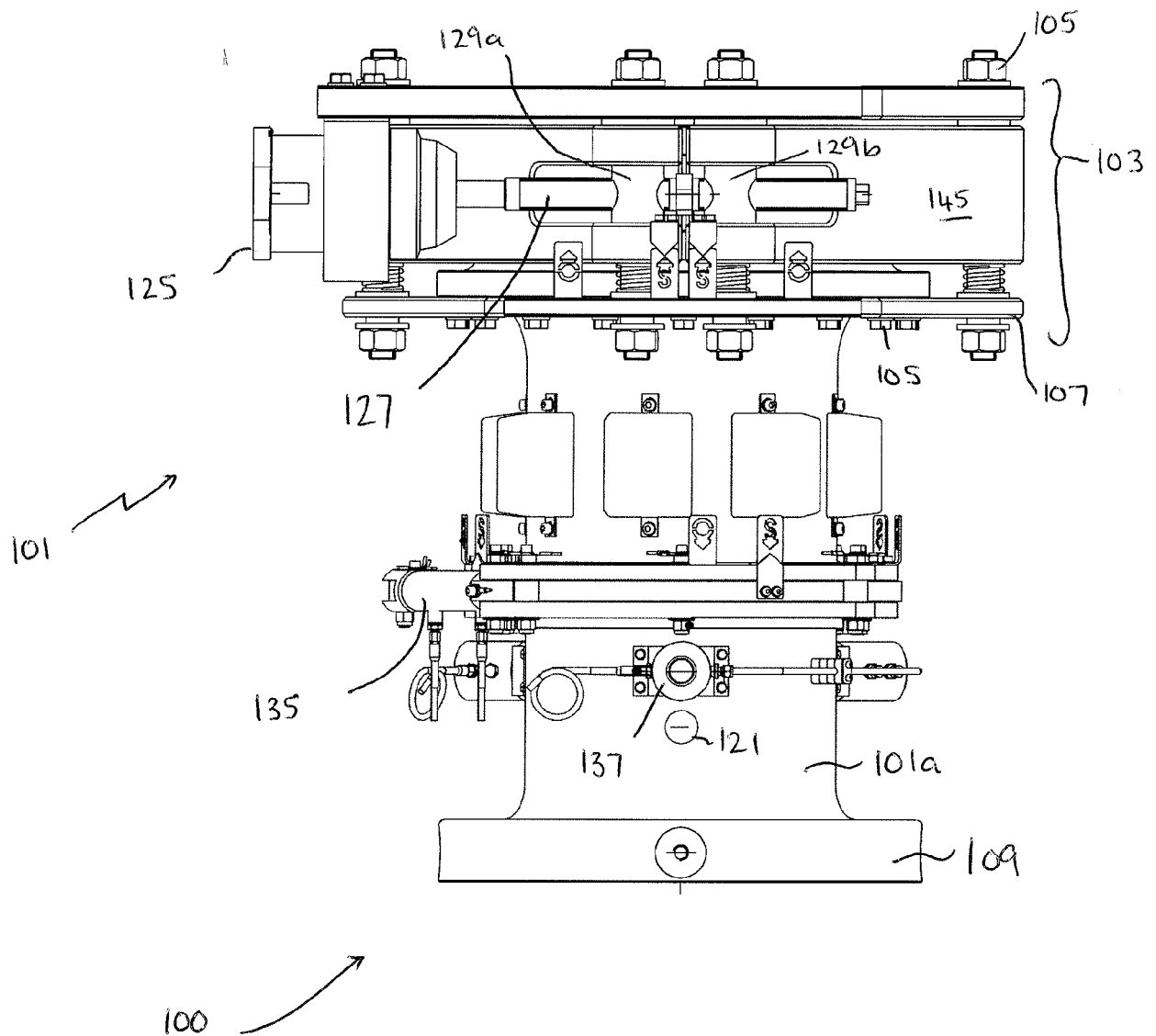


Figure 4

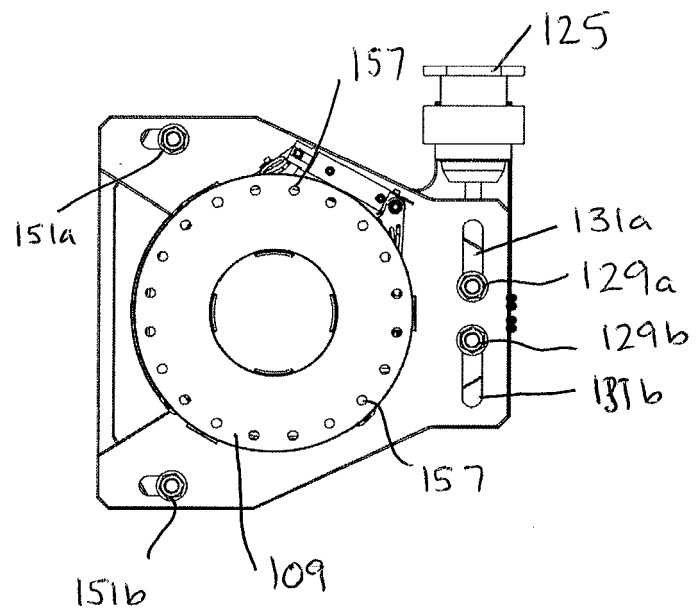


Figure 5

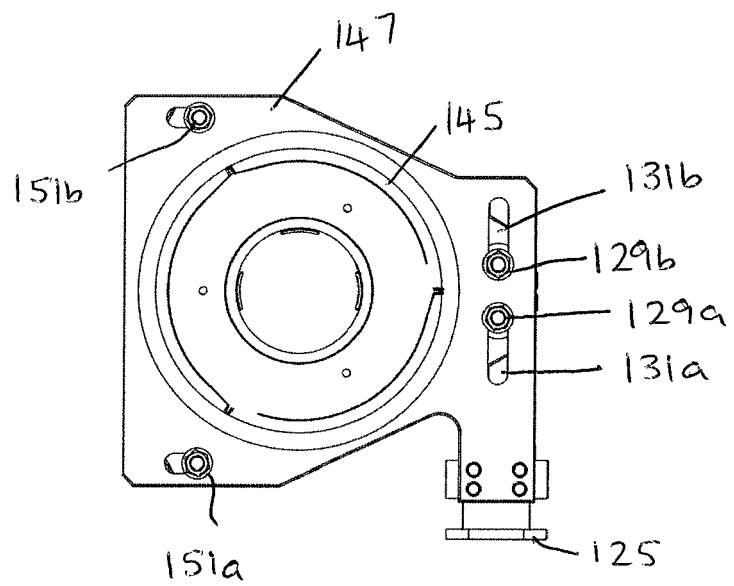


Figure 6

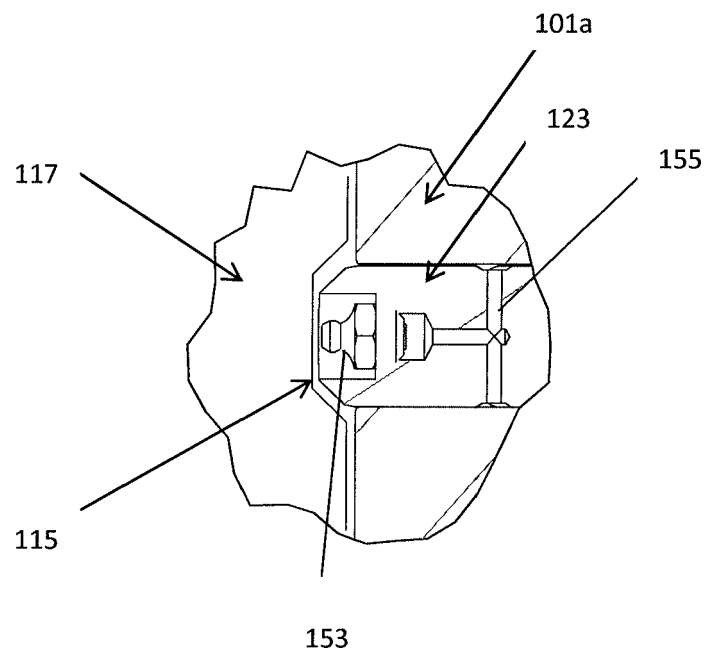


Figure 7



EUROPEAN SEARCH REPORT

Application Number
EP 17 16 9318

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EPO FORM 1503 03.82 (P04C01)

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 July 2017	Examiner Ing, James
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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