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(54) **Abandonment and recovery system for a subsea pipeline**

(57) The present invention relates to an abandonment and recovery system for a subsea pipeline. The system according to the invention comprises a pipeline attachment assembly configured to be attached to a pipeline end; and a cable attachment assembly configured to be attached to at least one abandonment and recovery cable; wherein the pipeline attachment assembly and the cable attachment assembly each comprise a respective one of two mating connector parts of a male/female-type connector.

Dit octrooi is verleend ongeacht het bijgevoegde resultaat van het onderzoek naar de stand van de techniek en schriftelijke opinie. Het octrooischrift komt overeen met de oorspronkelijk ingediende stukken.

Abandonment and recovery system for a subsea pipeline

The present invention relates to abandonment and recovery of a subsea pipeline.

Subsea pipelines are laid on the seabed by pipe laying vessels, onboard which vessels lengths of pipe are welded the one to the other to form a pipeline. During the process of welding lengths of pipe the one to the other, the lengths of pipe that have been welded the one to the other are lowered into the water and towards to seabed.

There are currently two main methods for laying a pipe-line: the J-lay method and the S-lay method.

The J-lay method is commonly used for deepwater pipe laying. With this method a length of pipe is erected to a vertical position, welded to the main pipeline and lowered directly into the water with a single bend, giving the pipeline which is being laid the form of a "J". On board the pipe laying vessel the pipeline is supported by a vertical orientated pipeline support structure that supports the pipeline and guides the pipeline into the water.

The S-lay method is commonly used for deepwater and ultra-deepwater pipe laying. With this method each length of pipe to be connected to the main pipeline is welded thereto and moved starting from a horizontal orientation over a pipeline support structure, the so-called stinger, on which pipeline support structure the pipeline is bend in the direction of the seabed. While being lowered towards the seabed, the pipeline is forced into a second bend in opposite direction and is laid on the seabed in an orientation substantially parallel to the seabed. The double bend gives the pipeline which is being laid the form of an "S".

Both in the J-lay method as in the S-lay method each length of pipe is after the welding thereof to the main pipeline first led through a number of tensioners that clamp around the pipe near the vessel side end of the pipeline and can exert a pulling force on the pipeline.

When a pipeline being laid must be abandoned from a pipe laying vessel, e.g. in case of an upcoming storm, a typical method of abandonment of the pipeline consists of first welding an pipeline attachment, known as an A&R head, to the vessel side end of the pipeline. Subsequently an A&R-cable that is with a first end thereof wound around the drum of a winch, is connected with the second end thereof to the A&R head by means of a releasable connector that is arranged on the second end of the A&R cable. After connection of the A&R-cable to the A&R-head, the vessel

side end of the pipeline is lowered to the seabed by paying out the A&R-cable by means of the winch. When the vessel side end of the pipeline is on the seabed the cable is disconnected from the A&R-head and pulled in such that the vessel can sail away.

The abandoned pipeline is thereafter recovered by lowering a C-hook that is arranged on the second end of the A&R cable towards the seabed. When the C-hook has almost reached the bottom, the vessel is positioned such that the hook is in the vicinity of a recovery sling that is connected to the A&R-head. Then a coupling operation is started, which operation has the goal to couple the C-hook to the recovery sling. This coupling operation is a so called "fishing"-operation, wherein the recovery sling is coupled to the hook by catching a loop of the recovery sling with the C-hook. To help catch the loop of the recovery sling, the loop of the recovery sling is generally held up by means of a buoy. . After catching the loop of the recovery sling with the C-hook, the actual recovery of the pipeline can start by pulling in the A&R-cable and thus pulling the end of the pipeline coupled to the A&R-cable towards the vessel.

Although the known A&R equipment, including the A&R head, the recovery sling, and the C-hook, are effective, a number of disadvantages are associated with the known A&R equipment. One disadvantage is that the transition of the known A&R equipment over and by pipe support and pipe handling equipment on board the vessel that is primarily designed for supporting and handling pipe is troublesome. Furthermore, the above described "fishing"-operation with the known A&R equipment, wherein a recovery sling is caught by a C-hook requires complex movements of the C-hook at the seabed.

The present invention has as one of its objectives to address at least one of the above disadvantages of the known A&R equipment.

Thereto the present invention provides an abandonment and recovery system for a subsea pipeline.

The abandonment and recovery system according to the invention comprises a pipeline attachment assembly configured to be attached to a pipeline end; a cable attachment assembly configured to be attached to at least one abandonment and recovery cable; wherein the pipeline attachment assembly and the cable attachment assembly each comprise a respective one of two mating connector parts of a male/female-type connector.

In the known A&R equipment including a recovery sling and a C-hook, the side way orientated opening of the C-hook requires complex movement of the C-hook relative to the recovery sling for hooking the recovery sling to the C-hook. During the fishing operation for recovering the pipeline after abandonment, the complex movements of the C-hook that are associated with hooking the recovery sling to the C-hook at the seabed are done by moving the pipe-laying vessel at the sea surface. Initiating such complex movements of the C-hook at the seabed by moving the pipe-laying vessel at the sea surface is very difficult and time consuming. Furthermore, the recovery sling provides an abrupt change in radial dimensions between the pipeline and the C-hook that both have larger radial dimensions. This abrupt change in radial dimensions extends over a significant distance because of the length of the loop of the recovery sling that is required to allow for hooking the loop of the recovery sling to the C-hook. This abrupt change in radial dimensions over a significant distance, makes supporting and handling of the A&R equipment comprising a recovery sling and a C- hook on pipe supporting and pipe handling equipment on board the pipe laying vessel troublesome.

Relative to the known use of a recovery sling and a C- hook, the use of a male/female-type connector according to the invention simplifies the movements of the connector parts the one relative to the other for subsea connecting and disconnecting the pipeline attachment assembly that is attached to the pipeline and the cable attachment assembly that is attached to the A&R cable(s). Connecting merely requires aligning the connector parts and inserting the male connector part into the female connector part. As will be further explained herein below under reference to figures showing embodiments of the system according to the invention, connecting the connector parts of the male/female-type connector according to the invention requires less complex movements of the connector parts the one relative to the other than hooking a recovery sling to a C-hook according to the prior art. Furthermore, the use of a male/female-type connector according to the invention instead of the recovery sling and the C-hook takes away the abrupt change in radial dimensions that is associated with the recovery sling and the C-hook.

Furthermore, since the male/female connector of the system according to the invention does not require a side way orientated opening, the side surface(s) of the connector that are contacted by the pipe supporting and pipe handling equipment can be adapted to be more compatible with the pipe supporting and pipe handling equipment.

In a preferred embodiment of the system according to the invention, the male/female-type connector has a cylindrical outer geometry. Such male/female-type connector, that also can be referred to as a cylindrical connector, is as a result of its cylindrical outer geometry more adapted

to pipe support and handling equipment on board a pipe laying vessel than a C-hook and recovery sling of the known A&R equipment. Preferably, the male-female-type connector comprises a cylindrical outer surface. More preferably the cylindrical outer surface extends along the mating connector parts in mated state of the connector parts.

In particular the provision of a male/female type connector with a cylindrical geometry allows for gradual diameter changes along the pipeline attachment assembly and the cable attachment assembly, making the transition of the pipeline attachment assembly and the cable attachment assembly over and by pipe supporting and pipe handling equipment on board the vessel that is primarily designed for supporting and handling pipe less troublesome.

In an advantageous embodiment of the system according to the invention, the pipeline attachment assembly and the cable connector assembly have a cylindrical geometry. In a preferred embodiment thereof, in the mated state of the connector parts of the male/female-type connector, the pipeline attachment assembly, the male/female-type connector, and the cable attachment assembly provide a series of contiguous cylindrical outer surfaces that provide a gradual diameter transition from the end of the pipeline attachment assembly that is configured to be attached to a subsea pipeline, along the pipeline attachment assembly, the male/female-type connector, and the cable attachment assembly.

According to a further advantageous embodiment of the system according to the invention, the pipe attachment assembly comprises one of the two connector parts; a pipeline attachment that is configured to be attached to a pipe section of a subsea pipeline; and a bendable connection that connects the pipeline attachment to the connector part, wherein the bendable connection has a cylindrical geometry. Preferably, the bendable, cylindrical connection is configured for allowing a bend of at least 90°. The bendable connection allows for the connector part of the pipeline attachment assembly to be held in a vertical orientation while the pipeline is laying on the seabed in a horizontal orientation. A vertical orientation of the connector part of the pipeline attachment assembly facilitates the mating of the connector part of the pipeline attachment assembly with the connector part of the cable attachment assembly that is suspended from the A&R-cable(s) in a vertical orientation.

According to an advantageous embodiment, the outer diameter of the bendable, cylindrical connection is substantially the same as the outer diameter of the cylindrical male/female-type connector.

In a preferred embodiment of the system according to the invention wherein the pipeline attachment assembly comprises a bendable connection, the bendable connection comprises a plurality of adjoining bodies having a cylindrical geometry. Preferably, the plurality of adjoining cylindrical bodies provide a series of contiguous cylindrical outer surfaces. Preferably, the diameter of the cylindrical bodies is substantially the same as the outer diameter of the cylindrical outer surface of the cylindrical male-female-type connector.

In an advantageous embodiment of the system wherein the pipeline attachment assembly comprises a bendable connection that comprises a plurality of adjoining cylindrical bodies, adjoining ends of adjoining cylindrical bodies have complementary shapes that cooperate to allow an articulation between adjoining cylindrical bodies. In a preferred embodiment thereof, the complementary shapes allow an articulation between adjoining cylindrical bodies comprised in the range of 5° to 15°, preferably 8° to 12°, most preferably an articulation of 10°.

In an advantageous embodiment of the system wherein the pipeline attachment assembly comprises a bendable, cylindrical connection that comprises a plurality of adjoining cylindrical bodies, adjoining cylindrical bodies are articulately connected the one to the other such that a series of U-joints, also known as universal joints, is provided.

In an alternative advantageous embodiment of the system wherein the pipeline attachment assembly comprises a bendable, cylindrical connection that comprises a plurality of adjoining cylindrical bodies, the cylindrical bodies have at least one of a spherical protrusion on one end and a spherical seat on the other end, such that the spherical protrusion of one of two adjoining cylindrical bodies fits in the spherical seat of the other one of the two adjoining cylindrical bodies thereby providing a spherical joint between the two adjoining cylindrical bodies.

In an advantageous embodiment of the system wherein the pipeline attachment assembly comprises a bendable connection that comprises a plurality of adjoining cylindrical bodies, at least one of the cylindrical bodies is weighted relative to other ones of the cylindrical bodies. Preferably, the weight of the weighted cylindrical body is substantially greater than the weight of other, unweighted cylindrical bodies. More preferably, the unweighted cylindrical bodies are approximately neutrally buoyant, whereas the weighted cylindrical body is negatively buoyant. In a preferred embodiment thereof, between the at least one weighted cylindrical body and the connector part of the pipeline attachment assembly there is a plurality of unweighted cylindrical bodies, wherein preferably the plurality of unweighted cylindrical bodies allow for a bend of at least 90°.

In an advantageous embodiment of the system wherein the pipeline attachment assembly comprises a bendable connection, the bendable connection comprises at least one force transmitting element that extends through the cylindrical elements from one end of the bendable connection to the other end and is connected to the pipeline attachment on one end and to the connector part on the other end. The at least one force transmitting element is for transmitting force from the pipeline attachment to the connector part and vice versa, in particular the tension associated with the pipeline being suspended from the A&R-cable(s). Preferably the at least one force transmitting element is a sling extending through the cylindrical elements from one end of the bendable connection to the other end, wherein the sling provides a loop on both ends of the bendable connection. In a preferred embodiment thereof, the sling is an endless loop sling.

In an advantageous embodiment of the system according to the invention wherein the pipeline attachment assembly comprises a bendable connection that comprises at least one sling, the pipeline attachment and the connector part are provided with hooks for connecting the at least one sling to the pipeline attachment and the connector part. Preferably, the hooks are arranged in an enclosure having a cylindrical outer surface wherein the diameter of the cylindrical outer surface is substantially the same as the diameter of the cylindrical bodies.

In preferred embodiment thereof, the bendable connection comprises three slings, wherein preferably for connecting the slings to the pipeline attachment and the connector part, the pipeline attachment and the connector part are provided with three hooks, wherein each hook has a hook body that protrudes from a respective surface of a base body, wherein the surfaces from which the hook bodies protrude correspond to surfaces of a tetrahedron. In a further preferred embodiment, the circumferential side surface of the protruding hook body is concave along at least a part of the circumferential length of the side surface, thereby providing a channel for the loop of one of the slings. Although three slings and associated hooks are preferred, alternatively the bendable connection has less or more than three slings and associated hooks.

In an advantageous embodiment of the system according to the invention wherein the pipeline attachment and the connector part are provided with three hooks, and each hook has a hook body that protrudes from a respective surface of a base body, wherein the surfaces from which the hook bodies protrude correspond to surfaces of a tetrahedron, the cross-section of each hook body in a plane parallel to the respective surface from which the hook body protrudes is drop shaped, wherein the drop point points away from the respective one of the pipeline attachment and the connector part.

According to a further advantageous embodiment of the system according to the invention, the pipeline attachment comprises a cylindrical body, wherein the outer diameter at the connector part end of the cylindrical body is substantially the same as the outer diameter of the cylindrical male/female connector. In a preferred embodiment thereof, the outer diameter at the pipeline end of the cylindrical and the outer diameter at the connector part end of the cylindrical body are different, and the cylindrical body tapers between the pipeline end and the connector part end.

According to a further advantageous embodiment of the system according to the invention, the male/female-type connector has a cylindrical geometry, and the cable attachment assembly comprises a shell having a cylindrical geometry that at one end has substantially the same outer diameter as the outer diameter of the male/female-type connector, and that least at the other end of the cylindrical shell tapers toward the central axis of the cylindrical shell.

According to a further advantageous embodiment of the system according to the invention, the system comprises a buoy and a connector cable configured for connecting the connector part of the pipeline attachment assembly to the buoy.

According to a further advantageous embodiment of the system according to the invention, the system comprises a guide wire that is at one end thereof connected to the connector part of the pipeline attachment assembly, preferably in or near the central longitudinal axis of the connector part; a guide conduit through the connector part of the cable attachment assembly that is configured to have the guide wire run there through, the guide conduit being arranged such that when the connector part of the cable attachment assembly is moved along the guide wire towards the end of the guide wire that is connected to the connector part of the pipeline attachment assembly, the connector part of the cable attachment assembly is guided to the connector part of the pipeline attachment for mating. In a preferred embodiment thereof, the guide wire is at the other end thereof connected to a buoy.

In an advantageous embodiment of the system according to the invention wherein the system is provided with a buoy, one of the pipeline attachment assembly and the cable attachment assembly is provided with a support frame for supporting the buoy. In a preferred embodiment thereof, the support frame is configured for releasable attaching the buoy thereon, and the support frame is rotatable mounted on the pipeline attachment or the cable attachment for rotation about the central longitudinal axis of the respective one of the pipeline attachment and the cable

attachment. In an advantageous embodiment, the support frame comprises guide walls for guiding the support frame over pipeline support roller of a pipe laying vessel.

In an advantageous embodiment of the male/female type connector one of the two mating connector parts comprises a mating cavity in which mating cavity the other one of the two mating connector parts is received in the mated state of the mating connector parts. In a preferred embodiment thereof the mating cavity and the connector part accommodated therein in the mated state of the mating connector parts are of complementary size and shape. Preferably, the mating cavity has a cylindrical inner surface and the connector part to be received in the mating cavity a cylindrical outer surface that mates with the cylindrical inner surface of the mating cavity when the connector part to be received in the mating cavity is inserted in the mating cavity. This is advantageous in that, for mating the mating connector parts, it suffices to align the central axis of the mating cavity and the central axis of connector part to be received by the mating cavity such that the central axes coincide. Once the central axes coincide it is not required to angularly align the connector parts about the coinciding central axes to insert the connector part to be received by the mating cavity in the mating cavity.

In an advantageous embodiment of the system according to the invention, at least one of the two mating connector parts comprises at least one protruding engaging member that engages the other one of the mating connector parts in the mated state of the mating connector parts. In a preferred embodiment thereof the engaging member is movable accommodated in an accommodation of the connector part that comprises the engaging member, which accommodation debouches at a surface of the connector part, wherein the engaging member is selectively movable between an engage state and a release state, wherein in the engage state the engaging member protrudes from the surface of the connector part. According to an advantageous embodiment only one of the mating connector parts comprises the selectively movable engaging members, wherein the cable attachment assembly comprises the connector part that comprises the selectively movable engaging members.

In a preferred embodiment of the system according to the invention wherein at least one of the connector parts comprises at least one movable engaging member, the engaging member is a ball. Alternatively, the at least one movable engaging member is a gripping tooth or a latching plate.

In an advantageous embodiment of the system according to the present invention wherein at least one of the connector parts comprises at least one protruding engaging member, the

protruding engaging member is one of two cooperating engaging members each arranged on a respective one of the two mating connector parts. In a preferred embodiment thereof, one of the two cooperating engaging members is a movable ball in accordance with an embodiment described herein above, whereas the other one of the two cooperating engaging members is a ball seat configured to be engaged by the ball in the mated state of the mating connector parts, wherein the ball seat is preferably one of a spherical indentation or a circumferential groove. Alternatively, the at least one movable engaging member is a gripping tooth or a latching plate, and the cooperating engaging member is a circumferential groove that can be engaged by the at least one gripping tooth or latching plate. According to a further alternative the protruding engaging member is one of two cooperating engaging members of a bayonet-type connector.

The accompanying drawings are used to illustrate non-limitative preferred exemplary embodiments of the present invention. The above stated and other advantages, features and objectives of the invention will become more apparent, and the invention better understood, from the following detailed description when read in combination with the accompanying drawings, wherein:

- figure 1 shows a side view of an embodiment of the system according to the invention;
- figure 2 shows a longitudinal section of the system of figure 1;
- figure 3 shows a perspective view with parts taken away of a male/female-type connector of the system of figure 1;
- figure 3A shows a longitudinal section of a detail of the male/female-type connector of the system of figure 1;
- figure 4 shows a longitudinal section of the male/female-type connector of figure 3;
- figure 5 shows a perspective view of a pipeline attachment of the system of claim 1;
- figure 6 shows a perspective view of a bendable connection of the system of claim 1;
- figures 6A and 6B detailed views of the system as shown in figure 2;
- figure 7 shows a side view of a part of a pipe laying vessel during use of the system of figure 1;
- figures 8 and 9 show in side view with parts taken away, the system of figure 1 at the seabed in two situations during an abandonment operation;
- figures 10 and 11 show in side view with parts taken away, the system of figure 1 at the seabed in two situations during a recovery operation.

Figures 1 and 2 show an embodiment of an abandonment and recovery system 1 according to the invention for a subsea pipeline 3. The system 1 is shown with a pipeline attachment

assembly 5, a cable attachment assembly 7, and a male/female-type connector 11 having a cylindrical geometry, hereinafter referred to as cylindrical connector 11.

The pipeline attachment assembly 5 is attached to end 13 of the subsea pipeline 3. The cable attachment assembly 7 is attached to respective cable ends of a set 15 of four abandonment and recovery (A&R) cables. The other ends of the set 15 of A&R-cables are each wound on a respective A&R-winch spool on board a pipe laying vessel 95(shown in figure 7).

In figures 1 and 2, the cylindrical connector 11 connects the cable attachment assembly 7 to the pipeline attachment assembly 5. The set 15 of A&R-cables 15 is thus connected to the subsea pipeline 3 via respectively the cable attachment assembly 7, the cylindrical connector 11, and the pipeline attachment assembly 5.

The cylindrical connector 11 comprises two mating connector parts: a female connector part 17 and a male connector part 19. The female connector part 17 is comprised by the pipeline attachment assembly 5. The male connector part 19 is comprised by the cable attachment assembly 7. In figures 1 and 2, the female connector part 17 and the male connector part 19 are in a mated state.

In figures 3 and 4, the cylindrical connector 11 is shown in more detail. In figures 3 the female connector part 17 and the male connector part 19 in unmated state. The male connector part 19 is being inserted in and being received by a mating cavity 21 inside the circumference of the cylindrical outer wall 23 of the female connector part 17. The mating cavity 21 of the female connector part 17 has a cylindrical inner mating surface 25, whereas the male connector part 19 has a cylindrical outer mating surface 27. The outer diameter do19 of the outer mating surface of the male connector part 19 closely fits the inner diameter di17 of the inner mating surface of the mating cavity 21 of female connector part 19.

The male connector part 19 comprises a plurality of balls 29 that are each movable arranged in a respective accommodation 31. In the shown mated state of the connector parts 17, 19, shown in figure 4, the balls 29 protrude from the cylindrical outer mating surface 27 of the male connector part 19 into circumferential grooves 33 that are provided in the inner mating surface 25 of the mating cavity 21 of the female connector part 17. The balls 29 and the circumferential grooves 33 are cooperating engaging members that provide that in the mating state of the connector parts 17 and 19 wherein the balls 29 extend into the circumferential grooves 33, the

female connector part 17 is engaged by the male connector part 19. The connecter parts 17 and 19 are thus connected.

For disconnecting the connector parts 17, 19, the balls 29 need to be moved out of the circumferential grooves 33 and into the accommodations 31. The cylindrical connector 11 shown in figures 3 and 4 is selectively operable for disconnecting the connector parts 17, 19. Thereto the male connector part 19 comprises a cylindrical mandrel 35 and a cylindrical sleeve 37 that is co-axially arranged on the cylindrical outer surface of the mandrel 35 for sliding over the cylindrical outer surface of the mandrel 35 in axial direction. The sleeve 37, that is also referred to as ball cage, is provided with through holes that each provide one of the accommodations 31. The mandrel 35 is provided with ball seats 39 in the cylindrical outer surface thereof that each are aligned with a respective accommodation 31. Each ball 29 accommodated in an accommodation 31 cooperates with the respective ball seat 39 that is aligned with the respective accommodation 31. The ball seat 39 is provided with a slanted control surface 41 that when the mandrel 35 is moved relative to the sleeve 37 in the axial direction indicated with arrow C, contacts the ball 29 cooperating therewith and forces the ball 29 in outward radial direction indicated with arrow D. When the mandrel 35 is moved relative to the sleeve 37 in the opposite axial direction indicated with arrow E, the slanted control surface 41 of the ball seat 39 is moved away from the ball 29 cooperating therewith, thereby allowing the ball 29 to move into the accommodation 31 in the radial direction indicated by arrow F. This allows the balls 29 to be moved out of the circumferential grooves 33 and the connector parts 17, 19 to be disconnected. The male connector part 19 is provided with a selectively operable lock, that is configured for locking axial movement of the sleeve 37 relative to the mandrel 35. The selectively operable lock can be operated by means of handle 38.

As shown in figures 3 and 4, the female connector part 17 comprises a cup shaped body 43 in which the mating cavity 21 is arranged. On the cylindrical outer surface of the cup shaped body 43 a spacer sleeve 45 is fixed that provides a cylindrical outer surface 47 of the cylindrical connector 11. In the mated state of the connector parts 17 and 19, as shown in figure 4, the cylindrical outer surface 47 extends along the connector parts 17, 19. The cylindrical outer surface 47 has an outer diameter d047.

As shown in figures 3 and 4, the male connector part 19 is attached to a cable attachment 49 comprised by the cable attachment assembly 7. The cable attachment 49 is provided with lugs 51, in particular four lugs, which are each configured for coupling a respective A&R cable 15a, 15b, 15c, 15d thereto. As shown in figures 1 and 2, the cable assembly 7 further comprises a cylindrical shell 53 that at one end 55, adjacent the cylindrical connector 11, has an outer diameter

do55 that is the same as, or substantially the same as, the outer diameter do47 of the cylindrical outer surface 47 of the cylindrical connector 11. The cylindrical shell 53 tapers towards the opposite end 57 of the cylindrical shell 53 away from the cylindrical connector 11, such that the outer diameter do57 at the opposite end 57 is smaller than the outer diameter do55 at the end 55 adjacent the cylindrical connector 11. In particular, the outer diameter do57 at the end 57 approaches the outer diameter of the bundle provided by the set 15 of A&R-cables. The cylindrical shell 53 thus provides a smooth transition to the outer diameter do47 of the cylindrical outer surface 47. Thus the A&R cables 15 are coupled to the cable attachment 49 to which attachment 49 the male connector part 19 is attached. The A&R cables 15 pass through the cylindrical shell 53 that extends along the cable attachment 49 and away from the male connector part 19.

As shown in figures 3 and 4, the cup shaped body 43 of the female connector part 17 is attached to a base body 59. The base body 59 has arranged thereon three hook bodies 61, 63, 65. Each hook body 61, 63, 65 protrudes from a respective surface 67, 71, 73 of the base body 59, wherein each surface corresponds to a surface of a tetrahedron. Each hook body 61, 63, 65 has a cross-section in a plane parallel to the respective surface 67, 71, 73 from which the hook body 61, 63, 65 protrudes that is drop shaped, wherein the drop point points away from the female connector part 17. The circumferential side surface 61a, 63a, 65a of the protruding hook bodies 61, 63, 65 is concave. Each of the concave side surfaces 61a, 63a, 65a, provide a channel for one of the three slings 75, 77, 79 of a bendable connection 81 that, as shown in figures 1 and 2, is comprised by the pipeline attachment assembly 5. As shown in figures 3 and 4 a sling binding ring 82 is provided for binding the slings 75, 77, 79 together and preventing the slings 75, 77, 79 from unhooking. As shown in figures 3 and 4 the spacer sleeve 45 that provides the cylindrical outer surface 47 of the cylindrical connector 11 extends over the hook bodies 61, 63, 65.

The bendable connection 81 connects the female connector 17 to a pipeline attachment 83. The pipeline attachment 83 comprises a cylindrical body 85 that at one end 87 is fixed to the end 13 of the subsea pipeline 3. In particular the tapered cylindrical body 85 is welded to the end 13 of the subsea pipeline 3. As shown in figure 5, the opposite end 89 the cylindrical body 85 is attached to a base body 159. The base body 159 has arranged thereon three hook bodies 161, 163, 165. Each hook body 161, 163, 165 protrudes from a respective surface 167, 171, 173 of the base body 159, wherein each surface corresponds to a surface of a tetrahedron. Each hook body 161, 163, 165 has a cross-section in a plane parallel to the respective surface 167, 171, 173 from which the hook body 161, 163, 165 protrudes that is drop shaped, wherein the drop point points away from the pipeline attachment 83. The circumferential side surface 161a, 163a, 165a of the protruding hook bodies 161, 163, 165 is concave. Each of the concave side surfaces 161a, 163a, 165a, provide a

channel for one of the three slings 75, 77, 79 of the bendable connection 81 that, as shown in figures 1 and 2, is comprised by the pipeline attachment assembly 5.

As shown in figures 1 and 2 and in figure 6, the bendable connection 81 comprises a plurality of adjoining cylindrical bodies 91. The adjoining cylindrical bodies 91 provide a row 93 of cylindrical bodies 91. Each of the cylindrical bodies 91 has a central through hole through which the three slings 75, 77, 79 extend. The slings 75, 77, 79 are endless loop slings that each provide a respective loop adjacent each of the ends 93a, 93b of the row 93 of cylindrical bodies 91.

The outer diameter do91 of each of the cylindrical bodies 91 is the same as, or substantially the same, thereby providing a series of contiguous cylindrical outer surfaces . Referring to figure 6A, the outer diameter do91 of the cylindrical bodies 91 is the same as, or substantially the same as, the outer diameter do47 of the cylindrical outer surface 47 of the cylindrical connector 11. As shown in figures 6 and 6A, a transition sleeve 92 is provided on the end 93b of the row 93 of cylindrical bodies 91 that provides a smooth transition between the cylindrical outer surface of the cylindrical body 91 at the end 93b of the row 93 and the outer surface of the spacer sleeve 45 that provides the cylindrical outer surface 47 of the cylindrical connector 11.

Furthermore, referring to figure 6B, the outer diameter do89 of the cylindrical body 85 of the pipeline attachment 83, at the end 89 adjacent the bendable connection 81 is the same as, or substantially the same as, the outer diameter do91 of the cylindrical bodies 91. As shown in figures 6 and 6B, a transition sleeve 92 is provided on the end 93a of the row 93 of cylindrical bodies 91. Together with the outer surface of the spacer sleeve 46 that is provided at the end 89 of the pipe attachment 83 and extends along the hook bodies 161, 163, 165, the transition sleeve 92 provides a smooth transition between the cylindrical outer surface of the cylindrical body 91 at the end 93a of the row 93 and the cylindrical outer surface of the cylindrical body 85 of the pipeline attachment 83.

This provides a smooth transition between the outer surface of the cylindrical bodies 91 and the pipeline attachment 83. As shown in figure 5, the outer diameter do87 at the opposite end 87 of the cylindrical body 85 of the pipeline attachment 83 is the same as, or substantially the same as, the outer diameter do3 of the subsea pipeline 3. Since the outer diameter do89 at one end 89 of the cylindrical body 85 of the pipeline attachment 83 is greater than the outer diameter do87 at the other end 87, the cylindrical body 85 is tapered to provide a smooth transition between the outer

surface of the subsea pipeline 3 and the outer surface of the cylindrical bodies 91 of the bendable connection 81.

Thus, referring to figure 1, in the mated state of the connector parts 17, 19, the pipeline attachment 83, the bendable connection 81, the cylindrical connector 11, and the cylindrical shell 53, provide a series of cylindrical outer surfaces that provides a smooth transition from the outer surface of the subsea pipeline 3, along the pipeline attachment assembly 5, the cylindrical connector 11, and the cable attachment assembly 7 to the set of A&R-cables 15. Referring to figure 7, this advantageously facilitates a smooth transition of the pipeline attachment assembly 5, the cylindrical connector 11, and the cable attachment assembly 7 over a stinger 93 of a pipe laying vessel 95 during abandonment and recovery of the subsea pipeline 3.

Referring to figures 1, 2 and 6, adjoining ends of adjoining cylindrical bodies 91 of the bendable connection 81 have complementary shapes that cooperate to allow an articulation between adjoining cylindrical bodies 91. As shown adjoining cylindrical bodies 91 are articulately connected the one to the other such that a series of U-joints, also known as universal joints, is provided. In particular, for each series of three adjoining cylindrical bodies 91a, 91b, 91c, the middle cylindrical body 91b is hingedly connected to one 91a of the other cylindrical bodies for hinging about a first hinge axis a, whereas the middle cylindrical body 91b is hingedly connected to the other one 91c of the other cylindrical bodies for hinging about a second hinge axis b, wherein the first hinge axis a and second hinge axis b extend perpendicular the one relative to the other. In an alternative embodiment (not shown) the cylindrical bodies 91 have a spherical protrusion on one end and a spherical seat on the other end, such that the spherical protrusion of one of two adjoining cylindrical bodies fits in the spherical seat of the other one of the two adjoining cylindrical bodies thereby providing a spherical joint between the two adjoining cylindrical bodies instead of a U-joint.

Referring to figure 10, in the embodiment shown in figure 6, each spherical joint allows for an articulation α between adjoining cylindrical bodies 91 of 10°. As shown in figure 11, the bendable connection 81 allows for a bend β of at least 90°.

As shown in figures 1 and 2, the system 1 comprises a buoy 103. As will be further explained herein below under reference to figures 8 to 11, the buoy 103 is used during disconnecting and connecting operations. When the buoy 103 is not used, the buoy 103 is releasable arranged on a support frame 115 that is arranged on the cylindrical shell 53 of the cable attachment assembly 7. The support frame 115 is rotatable mounted on the cylindrical shell 53 for

rotation about the central longitudinal axis of the cable attachment assembly 7. The support frame 115 comprises guide walls 117 for guiding the support frame 115 over pipeline support rollers 119 arranged on the stinger 93 of a pipe laying vessel 95 shown in figure 7.

By means of figures 8 and 9 disconnecting the set 15 of A&R cables from the pipeline 3 is illustrated during abandonment operation after the pipeline 3 has been laid down on the seabed 101. In figure 8 is shown that after lying down the pipeline 3 on the seabed 101, the buoy 103 has been released from its support frame 115. The buoy 103 is connected to the female connector part 17 by means of a connector cable 105. In figure 8 is illustrated that once the buoy 103 is released, the buoy 103 pulls the female connector part 17 upwards, thereby axially moving the sleeve 37 of the male connector part 19 (shown in figures 3 and 4) in the direction of arrow C relative to the mandrill 35 of the male connector part 19. The sleeve 37 of the male connector part 19 is subsequently engaged by the lock provided in the male connector part 19 in a position relative to the mandrill 35 in which position the balls 29 can be moved out of the circumferential grooves 33 of the female connector part 17 into the accommodation 31. This allows to subsequently pull the male connector part 19 out of the mating cavity 21 of the female connector part 17 by pulling the set 15 of A&R cables in. As shown in figure 9, once the male connector part 19 has been pulled out of the mating cavity 21 of the female connector part 17, the buoy 103 holds the female connector part 17 in an upward orientation with the mating cavity 21 directed upwards, ready to receive therein the male connector part 19 during the recovery operation.

In figures 10 and 11 connecting the set 15 of A&R cables to the pipeline 3 during recovery operation of the pipeline 3 that lays abandoned on the seabed 101. In figure 10, the end 13 of the subsea pipeline 3 is lying abandoned on the seabed 101. The connector parts 17, 19 are disconnected. The female connector part 17 is held in an upward orientation by means of a buoy 103 that is connected to the female connector part 17 by means of a connector cable 105. The connector cable 105 comprises two connector cable parts 105a, 105b that are coupled by means of a selectively releasable coupling 107.

Referring to figure 10 and figure 6, one of the cylindrical bodies 91 of the bendable connection 81, referred to as weighted cylindrical body 109, is provided with weight that causes the weighted cylindrical body 109 and the cylindrical bodies 91 between the weighted cylindrical body 109 and the pipeline attachment 83 to remain lying on the seabed while the buoy 103 bends the part of the bendable connection 81 between the weighted cylindrical body 109 and the female connector part 17 such that the female connector part 17 is in an upward orientation with the mating cavity 21 directed upwards, ready to receive therein the male connector part 19. As shown

in figure 10 for guiding the male connector part 19 into the mating cavity 21, first a guide wire 111 that is at one end thereof connected to the female connector part 17, in or near the central longitudinal axis l of the female connector part 17, is run through a guide conduit 113 that extends through the male connector part 19. In the shown embodiment, the guide wire 111 is run through the guide conduit 113 by an ROV 116. Subsequently, the ROV 116 operates the selectively releasable coupling 107 of the connector cable 105, thereby disconnecting the cable connection between the buoy 103 via connector cable 105. The buoy 103 will then rise in the direction of arrow G and pull the guide wire 111 tight as shown in figure 11, such that the male connector part 19 and the mating cavity 21 of the female connector part 17 are aligned for mating. Subsequently, by paying out the set 15 of A&R-cables, the male connector part 19 is lowered and guided along the guide wire 111 into the mating cavity 21 of the female connector part 17. While the male connector part 19 is inserted in the mating cavity 21, the sleeve 37 the balls 29 of the male connector part 19 are caused to protrude out of the cylindrical surface 27 of the mate connector part 19 and into the circumferential grooves 33 of the female connector part 17, such that the male connector part 19 and the female connector part 17 are connected once the male connector part 19 is fully inserted in the mating cavity 21 of the female connector part 17. Thus a connection between the abandoned subsea pipeline 3 and the set 15 of A&R-cables is established.

In case after establishing the connection between the abandoned subsea pipeline 3 and the set 15 of A&R-cables, the pipe laying vessel from which the set 15 of A&R cables are suspended makes a substantial heave motion causing the mated connector parts 17, 19 to be pulled upwards, the part of the bendable connection 81 between the weighted cylindrical body 109 and the pipeline attachment 83 that remained on the seabed, serves as a heave compensator. A sudden substantial upward motion of the female connector part 17 causes the weighted cylindrical body 109 to leave the seabed to move upwards, thereby preventing the end 3 of the pipeline 3 from being picked up laterally. It is noted that also during the abandonment operation after the pipeline has been laid down on the seabed and before the male connector part 19 and female connector part 17 are unmated, such as in the situation shown in figure 8, the weighted cylindrical body 109 provides the same heave compensation.

Although the principles of the invention have been set forth above with reference to specific embodiments, it must be understood that this description is given solely by way of example and not as limitation to the scope of protection, which is defined by the appended claims.

Conclusies

1. Systeem voor het achterlaten en ophalen van een onderzeese pijpleiding, omvattende:

- een pijpleidingbevestigingssamenstel dat is geconfigureerd om te worden bevestigd aan een pijpleidingeinde; en
- een kabelbevestigingssamenstel dat is geconfigureerd om te worden bevestigd aan ten minste een achterlaat- en ophaalkabel;

waarbij het pijpleidingbevestigingssamenstel en het kabelbevestigingssamenstel elk een van twee parende verbinderdelen van een man/vrouw-type verbinder omvat.

2. Systeem voor achterlaten en ophalen volgens conclusie 1, waarbij

- de man/vrouw-type verbinder een cilindrische geometrie heeft.

3. Systeem voor achterlaten en ophalen volgens conclusie 2, waarbij

- het pijpleidingbevestigingssamenstel en het kabelbevestigingssamenstel een cilindrische geometrie hebben.

4. Systeem voor achterlaten en ophalen volgens een van de conclusies 1 tot en met 3, waarbij

- in de gepaarde toestand van de verbinderdelen van de man/vrouw-type verbinder, het pijpleidingbevestigingssamenstel, de man/vrouw-type verbinder, en het kabelbevestigingssamenstel een serie van contigue cilindrische buitenoppervlakken verschaffen die een geleidelijke diametertransitie vanaf het einde van het pijpleidingbevestigingssamenstel dat geconfigureerd is om te worden verbonden met een onderzeese pijpleiding, langs het pijpleidingbevestigingssamenstel, de man/vrouw-type verbinder, en het kabelbevestigingssamenstel.

5. Systeem voor achterlaten en ophalen volgens een van de conclusies 1 tot en met 4, waarbij het pijpleidingverbindingssamenstel omvat:

- een van de twee verbinderdelen;
- een pijpleidingbevestiging die is geconfigureerd om te worden bevestigd aan een pijpsectie van een onderzeese pijpleiding; en

- een buigbare verbinding die de pijpleidingbevestiging verbindt met het verbinderdeel, waarbij de buigbare verbinding een veelvoud aan elkaar liggende lichamen omvat met een cilindrische geometrie.

6. Systeem voor achterlaten en ophalen volgens conclusie 5, waarbij

- de buigbare verbinding is geconfigureerd om een bocht van ten minste 90° toe te laten.

7. Systeem voor achterlaten en ophalen volgens conclusie 5 of 6, waarbij

- de man/vrouw-type verbinder een cilindrische geometrie heeft; en
- de buitendiameter van de cilindrische lichamen in hoofdzaak hetzelfde is als de buitendiameter van de man/vrouw-type verbinder.

8. Systeem voor achterlaten en ophalen volgens een van de conclusies 5 tot en met 7, waarbij

- aanliggende einden van aan elkaar liggende cilindrische lichamen complementaire vormen hebben die samenwerken teneinde een articulatie tussen aanliggende cilindrische lichamen toe te laten.

9. Systeem voor achterlaten en ophalen volgens conclusie 8, waarbij

- de complementaire vormen een articulatie toelaten tussen aan elkaar liggende cilindrische lichamen die is omvat in het bereik van 5° tot en met 15°, bij voorkeur 8° tot 12°, meest bij voorkeur een articulatie van 10°.

10. Systeem voor achterlaten en ophalen volgens conclusie 8 of 9, waarbij

- aan elkaar liggende cilindrische lichamen articulerend zijn verbonden met elkaar zodanig dat een serie van kruiskoppelingen is verschaft.

11. Systeem voor achterlaten en ophalen volgens conclusie 8 of 9, waarbij

- de cilindrische lichamen ten minste één hebben van een sferisch uitsteeksel aan een einde en een sferische zitting aan het andere einde, zodanig dat het sferische uitsteeksel van twee

aan elkaar liggende cilindrische lichamen past in de sferische zitting van de andere van twee aan elkaar liggende cilindrische lichamen zodat een kogelgewricht is verschaft tussen de twee aan elkaar liggende cilindrische lichamen.

12. Systeem voor achterlaten en ophalen volgens een van de conclusies 5 tot en met 11, waarbij

- ten minste een van de cilindrische lichamen verzwaard is ten opzichte van de andere van de cilindrische lichamen.

13. Systeem voor achterlaten en ophalen volgens conclusie 12, waarbij tussen het ten minste ene verzwaarde cilindrische lichaam en het verbinderdeel van het pijpleidingbevestigingssamenstel zich een veelvoud niet-verzwaarde cilindrische lichamen bevinden, waarbij bij voorkeur het veelvoud niet-verzwaarde cilindrische lichamen een bocht toelaten van ten minste 90°.

14. Systeem voor achterlaten en ophalen volgens een van de conclusies 5 tot en met 13, waarbij

- de buigbare verbinding ten minste een krachtdoorleidend element omvat dat zich uitstrekt door de cilindrische elementen heen vanaf een einde van de buigbare verbinding naar het andere einde en is verbonden met de pijpleidingbevestiging aan een einde en met het verbinderdeel aan het andere einde.

15. Systeem voor achterlaten en ophalen volgens conclusie 14, waarbij

- het ten minste ene krachtdoorleidende element een hijsstrop is, die zich door de cilindrische elementen heen uitstrekt van een einde van de buigzame verbinding naar het andere einde, waarbij de hijsstrop een lus verschaft aan beide einden van de buigbare verbinding, waarbij bij voorkeur de hijsstrop een eindloze hijsstrop is.

16. Systeem voor achterlaten en ophalen volgens conclusie 15, waarbij

- voor het verbinden van de hijsstrop met de pijpleidingbevestiging en het verbinderdeel, de pijpleidingbevestiging en het verbinderdeel zijn voorzien van een haak.

17. Systeem voor achterlaten en ophalen volgens conclusie 16, waarbij

- de buigbare verbinding drie hijsstroppen omvat; en
- voor het verbinden van de hijsstroppen met de pijplijnbevestiging en het verbinderdeel, de pijpleidingbevestiging en het verbinderdeel zijn voorzien van drie haken, waarbij elke haak een haaklichaam heeft dat vooruit steekt vanuit een betreffend oppervlak van een basislichaam, waarbij de oppervlakken van waaruit de haaklichamen uitsteken corresponderen met oppervlakken van een tetrahedron.

18. Systeem voor achterlaten en ophalen volgens conclusie 17, waarbij

- het rondomvoerend zijoppervlak van het uitstekende haaklichaam concaaf is langs ten minste een gedeelte van de omtreklengte van het zijoppervlak, waardoor een kanaal is verschaft voor de lus van een van de hijsstroppen.

19. Systeem voor achterlaten en ophalen volgens conclusie 17 of 18, waarbij

- de dwarsdoorsnede van elk haaklichaam in een vlak parallel aan het betreffende oppervlak van waaruit het haaklichaam uitsteekt, druppelvormig is, waarbij de druppelpunt weg wijst van de betreffende van de pijpleidingbevestiging en het verbinderdeel.

20. Systeem voor achterlaten en ophalen volgens een van de conclusies 1 tot en met 19, waarbij

- de man/vrouw-type verbinder een cilindrisch buitenoppervlak omvat dat zich uitstrekt langs de parende verbinderdelen in de gepaarde toestand van de verbinderdelen.

21. Systeem voor achterlaten en ophalen volgens een van de conclusies 1 tot en met 20, waarbij

- een van de twee samenwerkende verbinderdelen een paringsholte omvat, in welke paringsholte de andere van de twee parende verbinderdelen wordt ontvangen in de gepaarde toestand van de parende verbinderdelen.

22. Systeem voor achterlaten en ophalen volgens conclusie 21, waarbij

- de paringsholte en het daarin in de gepaarde toestand van de verbinderdelen ontvangen verbinderdeel van complementair afmeting en vorm zijn, waarbij bij voorkeur de paringsholte een cilindrisch binnenoppervlak heeft en het verbinderdeel dat in de paringsholte

wordt ontvangen een cilindrisch buitenoppervlak heeft dat paart met het cilindrische binnenoppervlak van de paringsholte wanneer het verbinderdeel dat in paringsholte te ontvangen is in de paringsholte is gebracht.

23. Systeem voor achterlaten en ophalen volgens een van de conclusies 1 tot en met 22, waarbij

- ten minste een van de twee parende verbinderdelen ten minste een uitstekend aangrijporgaan omvat dat de andere van de parende verbinderdelen aangrijpt in de gepaarde toestand van de parende verbinderdelen.

24. Systeem voor achterlaten en ophalen volgens conclusie 23, waarbij

- het aangrijporgaan beweegbaar is geaccommodeerd in een accommodatie van het verbinderdeel dat het aangrijporgaan omvat, welke accommodatie uitmondt aan een oppervlak van het verbinderdeel, waarbij het aangrijporgaan selectief beweegbaar is tussen een aangrijptoestand en een vrijgavetoestand, waarbij in de aangrijptoestand het aangrijporgaan uitsteekt vanuit het oppervlak van het verbinderdeel.

25. Systeem voor achterlaten en ophalen volgens conclusie 24, waarbij

- slechts een van de samenwerkende verbinderdelen het selectief beweegbare aangrijporgaan omvat, waarbij het kabelbevestigingssamenstel het verbinderdeel omvat dat de selectief beweegbare aangrijporganen omvat.

26. Systeem voor achterlaten en ophalen volgens conclusie 24 of 25, waarbij

- het aangrijporgaan een kogel is.

27. Systeem voor achterlaten en ophalen volgens een van de conclusies 23 tot en met 26, waarbij

- het uitstekende aangrijporgaan een van twee parende aangrijporganen is die elk zijn gearrangeerd op een betreffende van twee parende verbinderdelen.

28. Systeem voor achterlaten en ophalen volgens conclusie 26 en 27, waarbij

- de andere van de twee parende aangrijporganen een kogelzitting is die is geconfigureerd om te worden aangegrepen door de kogel in de gepaarde toestand van de parende verbinderdelen, waarbij de kogelzitting bij voorkeur een is van een sferische indentatie of een rondomvoerende groef.

29. Systeem voor achterlaten en ophalen volgens een van de conclusies 1 tot en met 28, waarbij

- de man/vrouw-type verbinder een cilindrische geometrie heeft; en
- het kabelbevestigingssamenstel een schaal omvat met een cilindrische geometrie, welke schaal aan een einde daarvan in hoofdzaak dezelfde buitendiameter heeft als de buitendiameter van de man/vrouw-type verbinder, en dat het andere einde van de cilindrische schaal taps toeloopt richting de centrale aslijn van de cilindrische schaal.

30. Systeem voor achterlaten en ophalen volgens een van de conclusies 1 tot en met 29, waarbij

- de man/vrouw-type verbinder een cilindrische geometrie heeft; en
- de pijpleidingbevestiging een lichaam omvat met een cilindrische geometrie, waarbij de buitendiameter aan het verbinderdeeleinde van het cilindrische lichaam in hoofdzaak hetzelfde is als de buitendiameter van de man/vrouw-type verbinder.

31. Systeem voor achterlaten en ophalen volgens conclusie 30, waarbij

- de buitendiameter aan het pijpleidingeinde van het cilindrische lichaam en de buitendiameter aan het verbinderdeeleinde van het cilindrische lichaam verschillend zijn en het cilindrische lichaam taps toeloopt tussen het pijpleidingeinde en het verbinderdeeleinde.

32. Systeem voor achterlaten en ophalen volgens een van de conclusies 1 tot en met 31, omvattende:

- een boei en een verbinderkabel die is geconfigureerd voor het verbinden van het verbinderdeel van het pijpleidingbevestigingssamenstel met de boei.

33. Systeem voor achterlaten en ophalen volgens een van de conclusies 1 tot en met 32, omvattende

- een geleidingsdraad die aan een einde daarvan is verbonden met het verbinderdeel van het pijpleidingbevestigingssamenstel, bij voorkeur in of nabij de centrale longitudinale aslijn van het verbinderdeel;

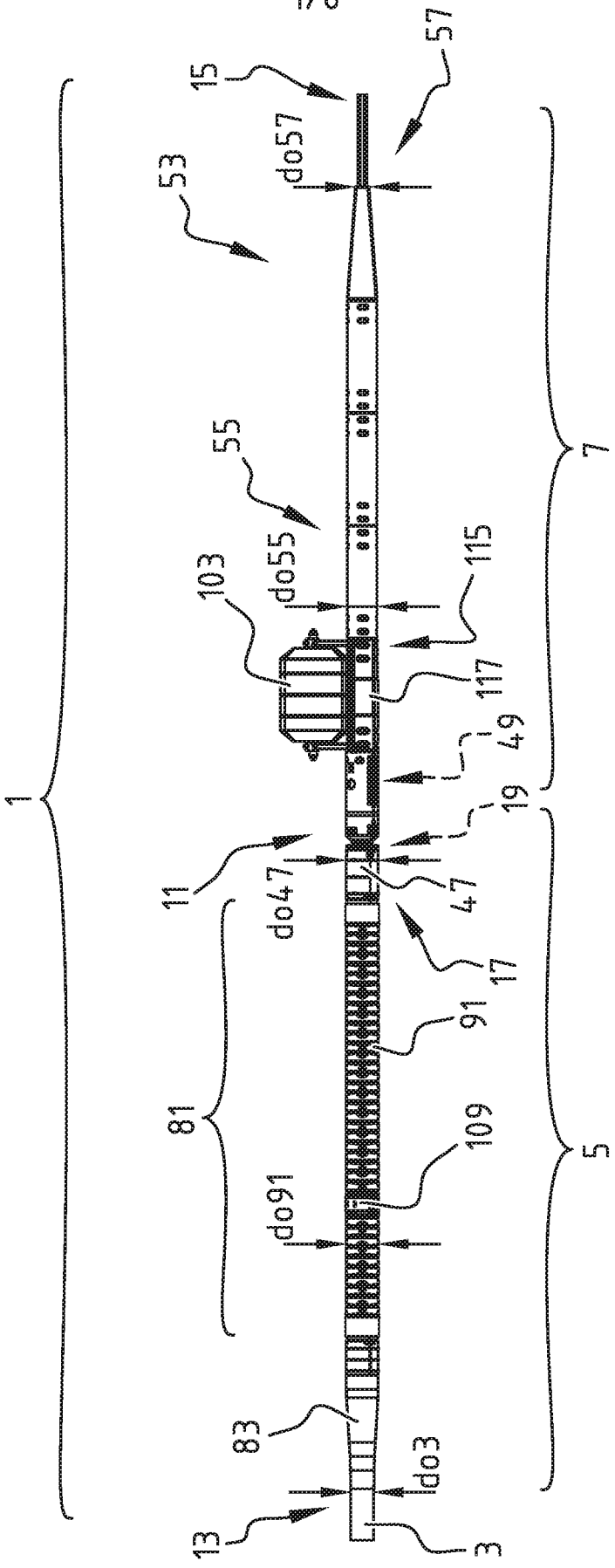
- een geleidingskanaal door het verbinderdeel van het kabelbevestigingssamenstel heen, dat is geconfigureerd om de geleidingsdraad daar doorheen te laten lopen, waarbij het geleidingskanaal zodanig is gearrangeerd dat wanneer het verbinderdeel van het kabelbevestigingssamenstel langs de geleidingsdraad wordt bewogen richting het einde van de geleidingsdraad dat is verbonden met het verbinderdeel van het pijpleidingbevestigingssamenstel, het verbinderdeel van het kabelbevestigingssamenstel wordt geleid naar het verbinderdeel van de pijpleidingbevestiging ten einde daarmee te paren.

34. Systeem voor achterlaten en ophalen volgens conclusie 33,
waarbij
- de geleidingsdraad aan het andere einde daarvan is verbonden met een boei, bij voorkeur de boei van conclusie 32.

35. Systeem voor achterlaten en ophalen volgens conclusie 30 of 34,
waarbij
- de pijpleidingbevestiging van het pijpleidingbevestigingssamenstel is voorzien van een draaggestel voor het dragen van de boei.

36. Systeem voor achterlaten en ophalen volgens conclusie 35,
waarbij
- het pijpleidingbevestigingssamenstel of het kabelbevestigingssamenstel is op een buitenoppervlak daarvan is voorzien van een draaggestel voor de boei, waarbij het draaggestel is geconfigureerd om de boei losneembaar daarop te bevestigen, en waarbij het draaggestel roteerbaar is gemonteerd op het buitenoppervlak voor rotatie rond de centrale longitudinale aslijn van de betreffende van het pijpleidingbevestigingssamenstel en het kabelbevestigingssamenstel.

37. Systeem voor achterlaten en ophalen volgens conclusie 36,
waarbij
- het draaggestel geleidingswanden omvat voor het geleiden van het draaggestel over pijpleidingdraagrollen van een pijplegvaartuig.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do57
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FIG. 1

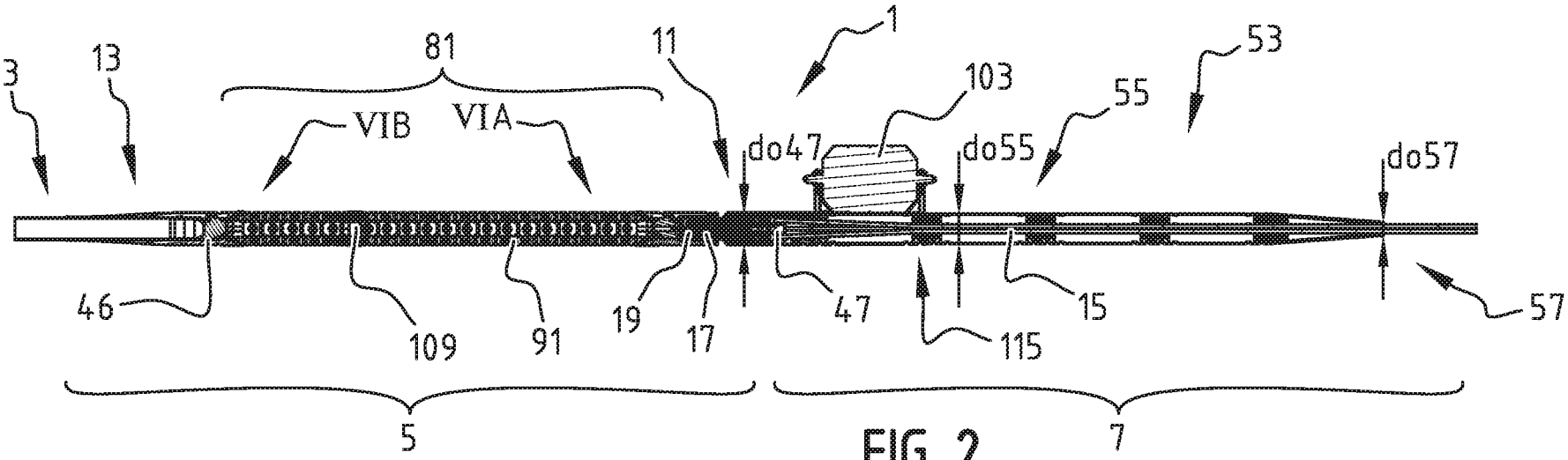


FIG. 2

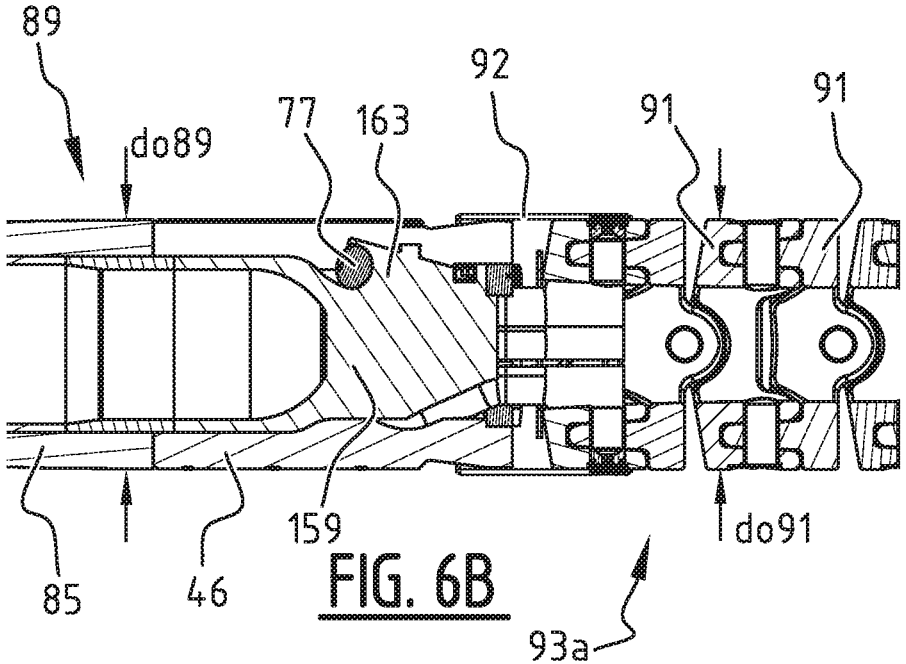


FIG. 6B

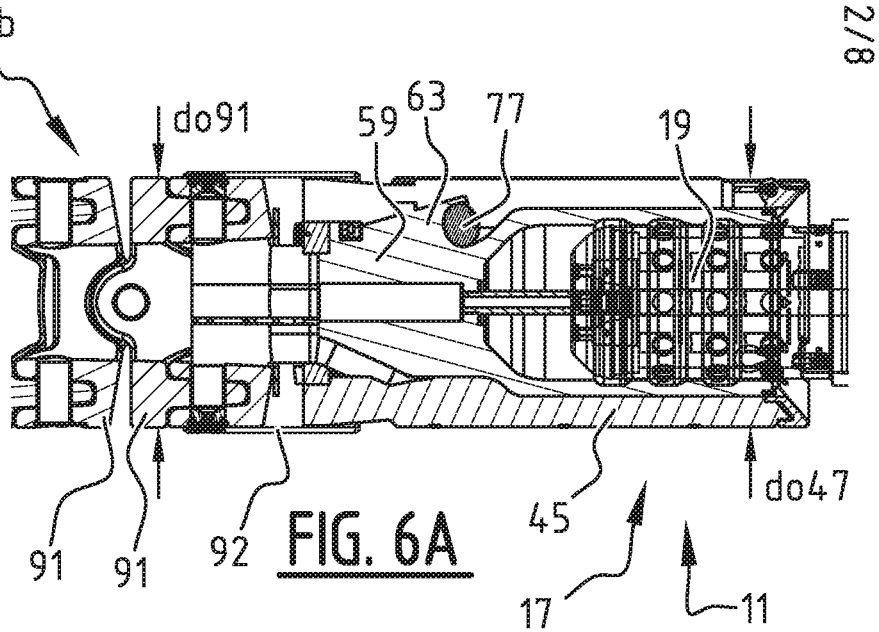


FIG. 6A

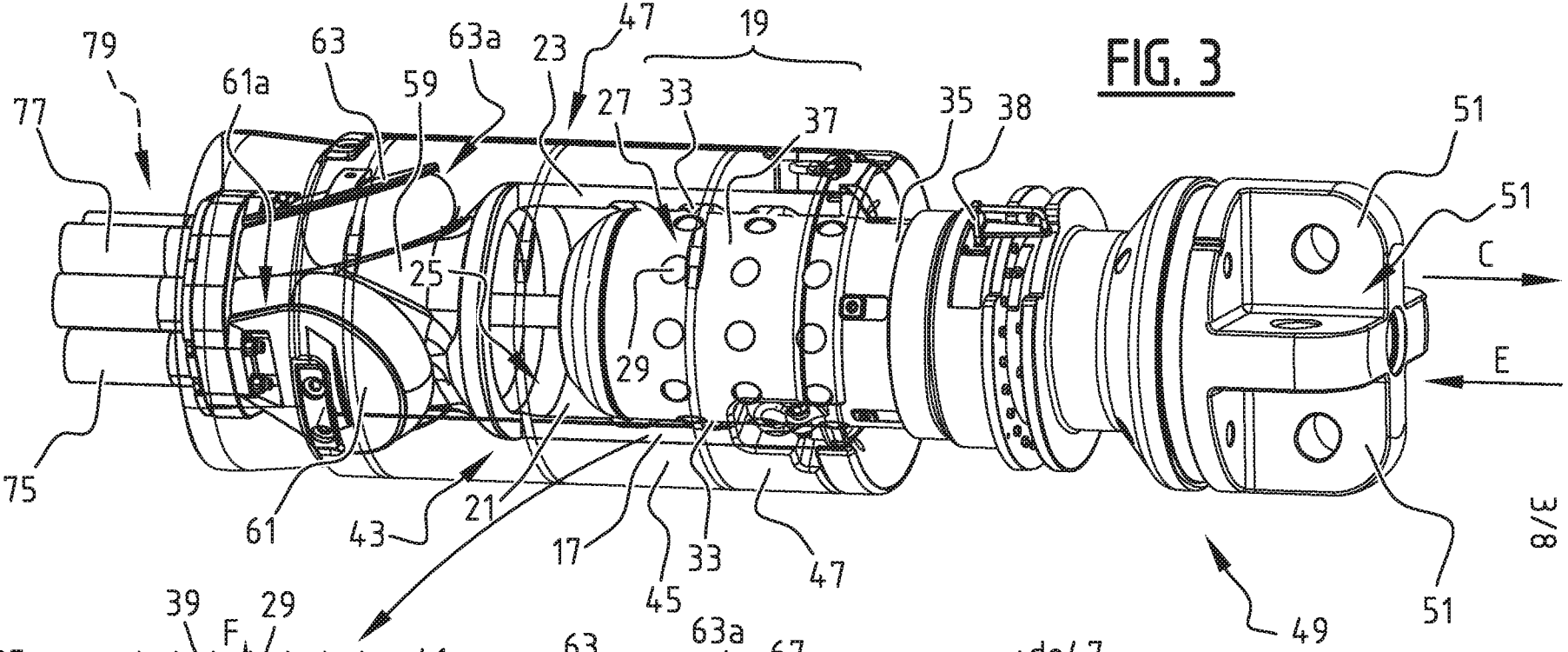


FIG. 3

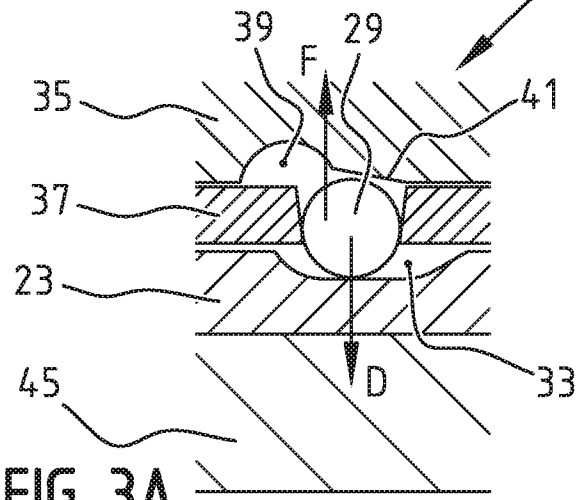


FIG. 3A

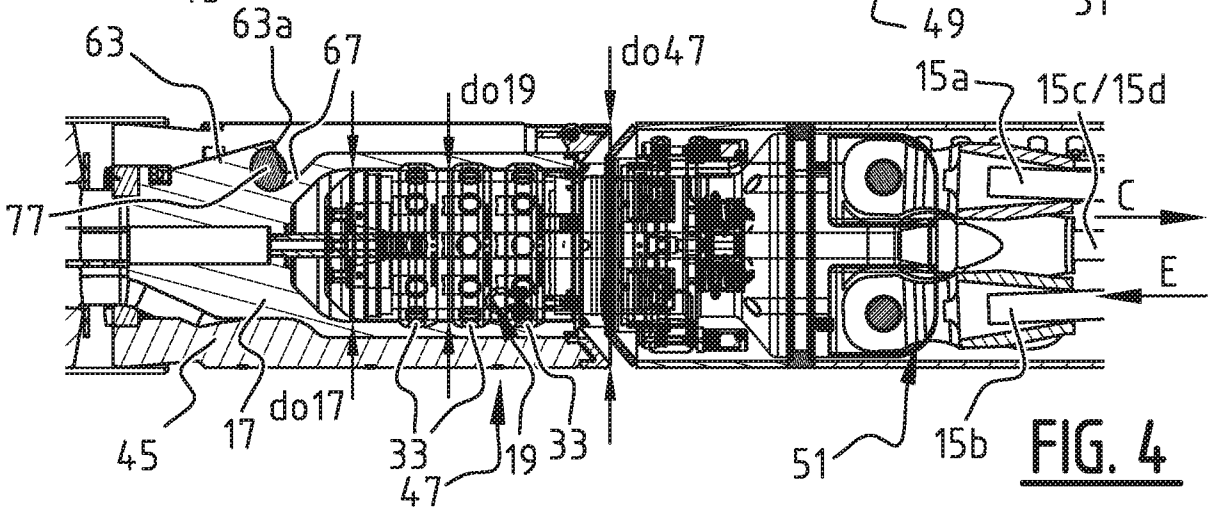
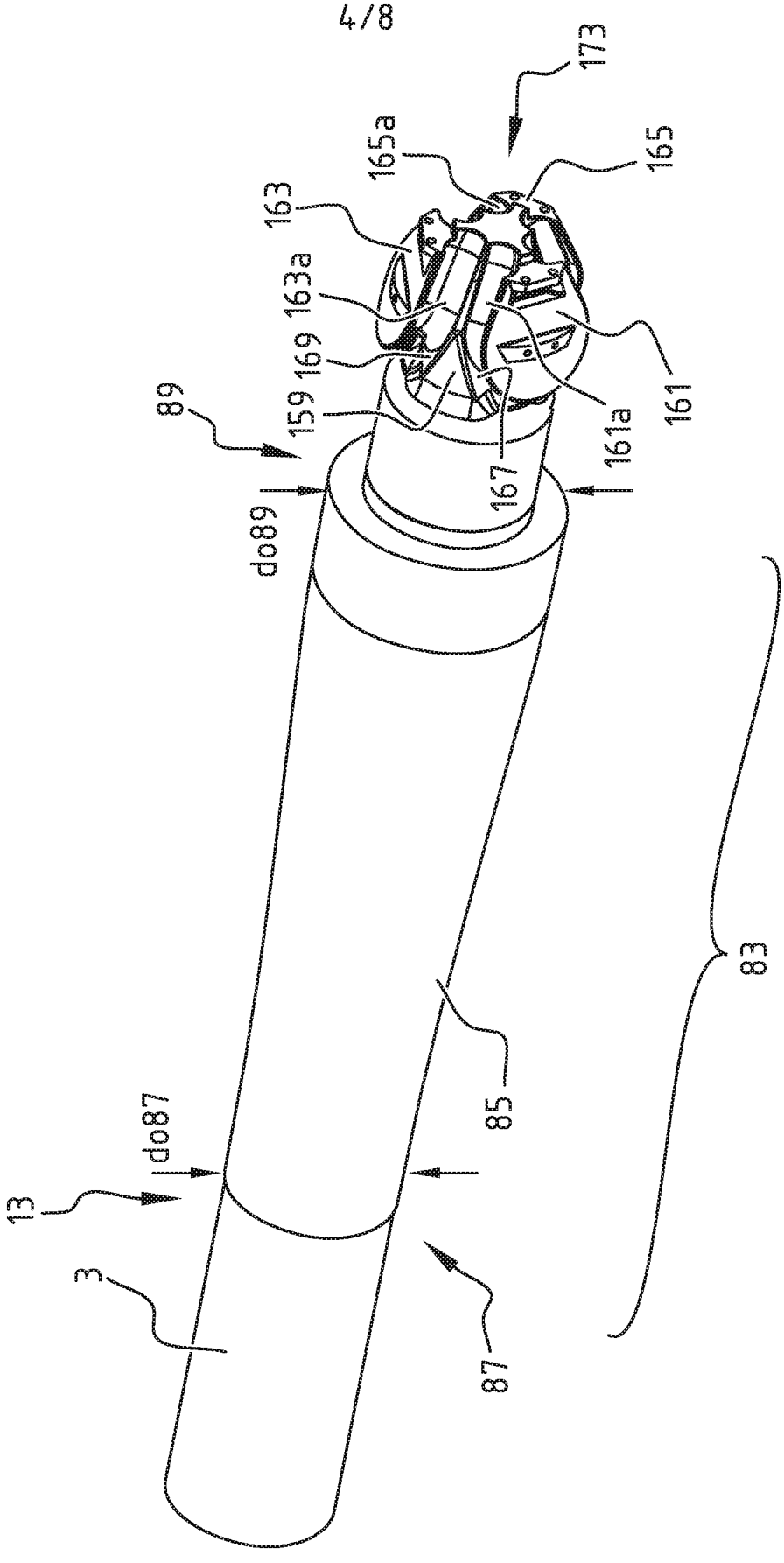


FIG. 4


173
165a
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169
159
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161
161a
167
do89
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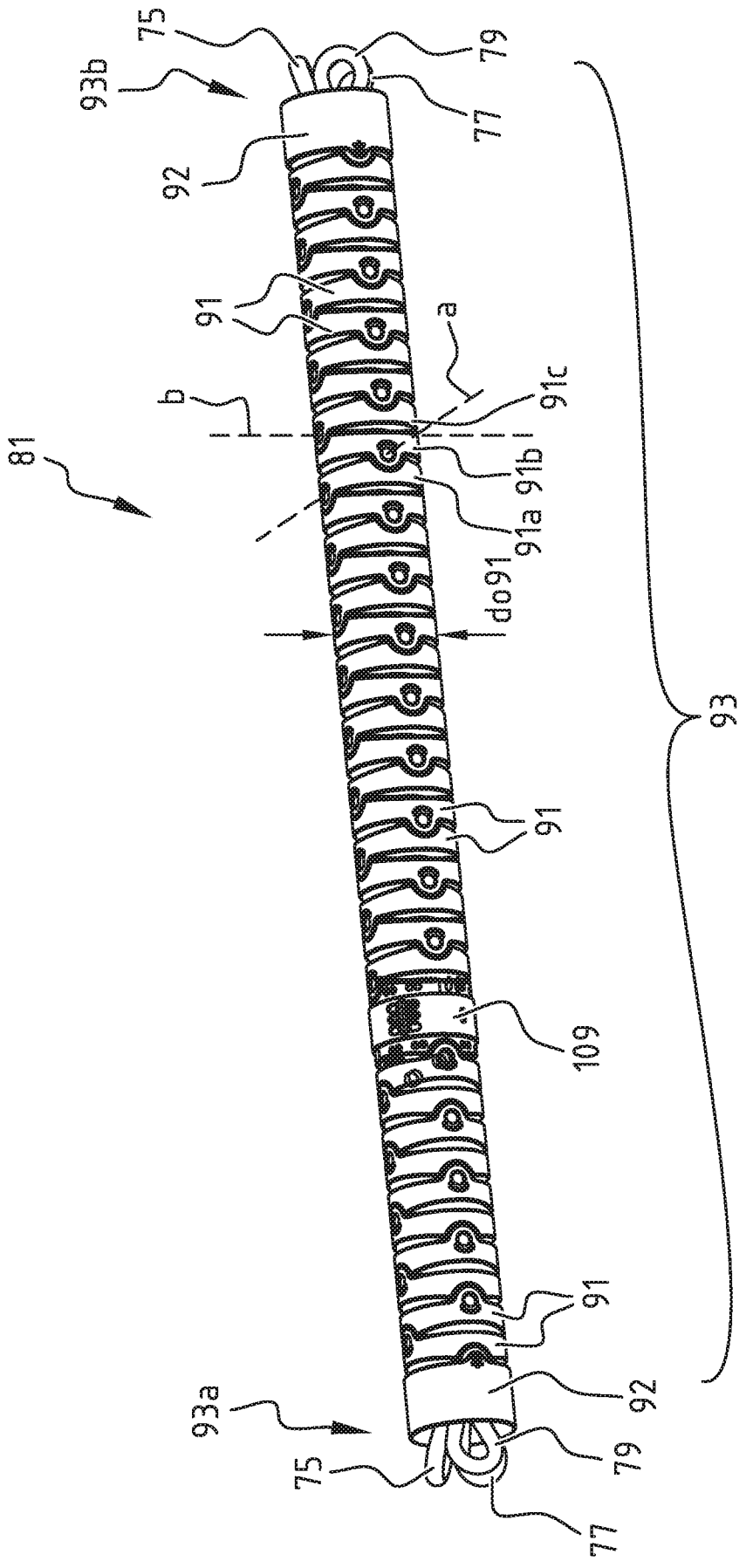
do87
13
3
87

FIG. 5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93b
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FIG. 6

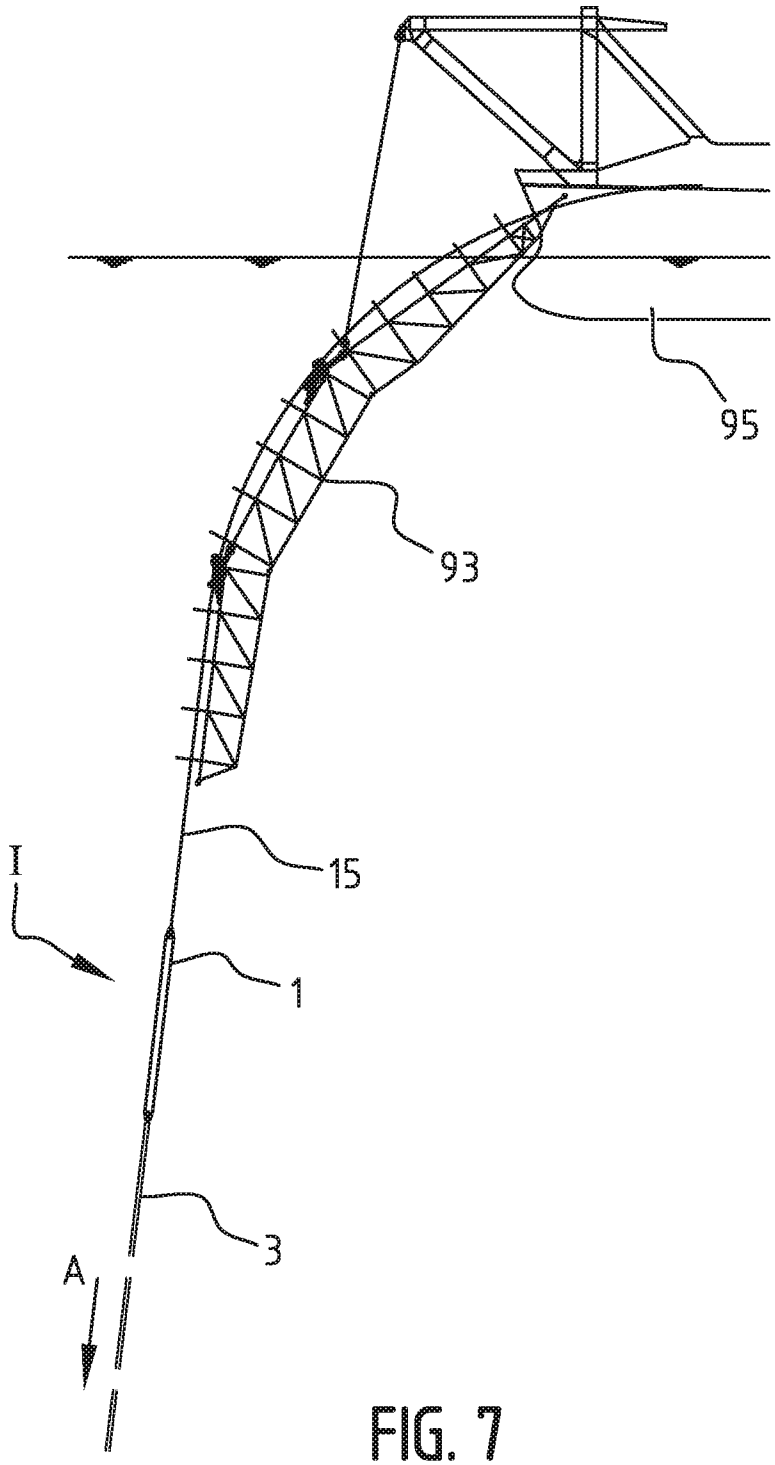


FIG. 7

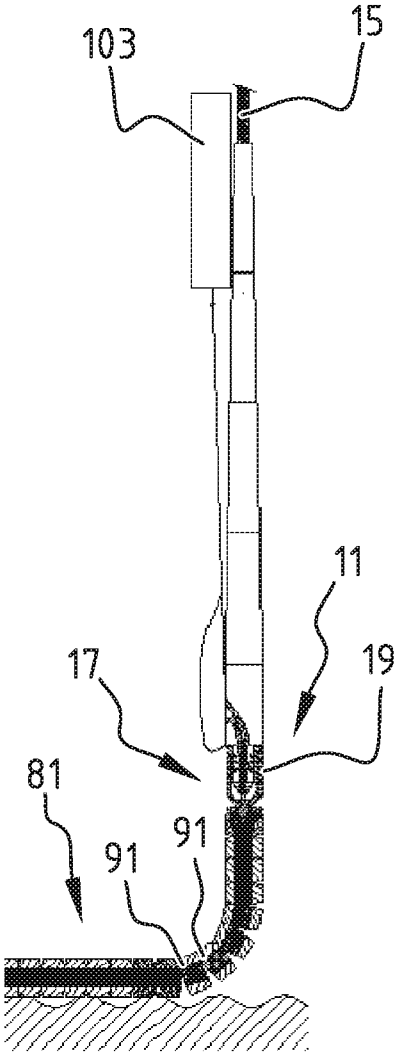


FIG. 8

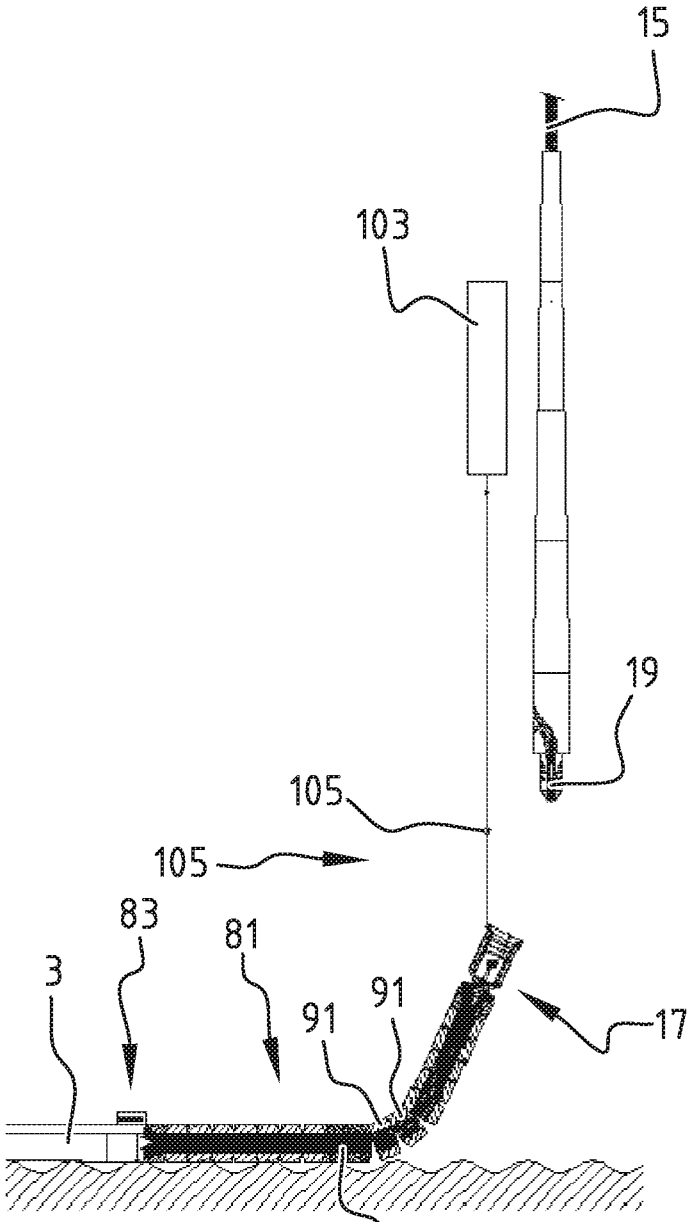
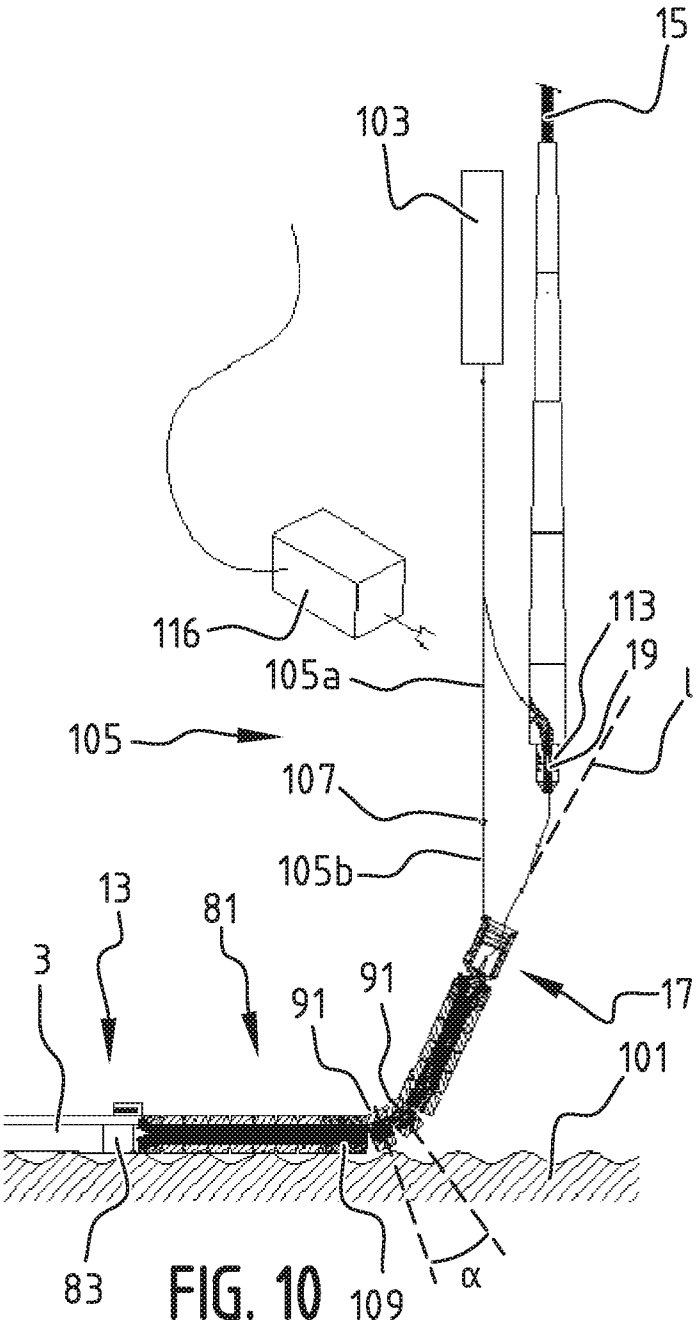


FIG. 9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113
19
105a
105
107
105b
13
81
3
91
91
17
101
83
109
α

FIG. 10

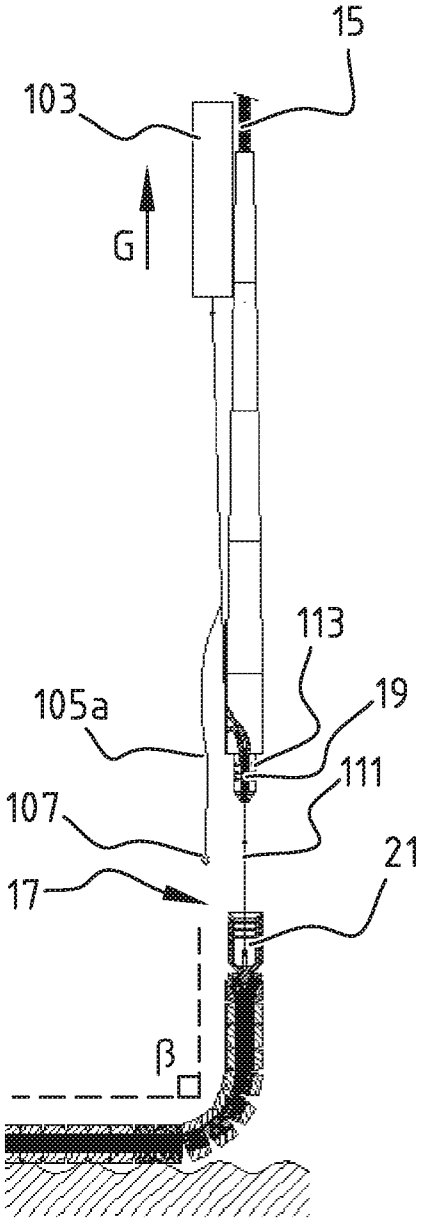
15
103
G
113
19
105a
111
107
21
17
β

FIG. 11

Abstract

The present invention relates to an abandonment and recovery system for a subsea pipeline. The system according to the invention comprises a pipeline attachment assembly configured to be attached to a pipeline end; and a cable attachment assembly configured to be attached to at least one abandonment and recovery cable; wherein the pipeline attachment assembly and the cable attachment assembly each comprise a respective one of two mating connector parts of a male/female-type connector.

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	2X/2UR29/61
Nederlands aanvraag nr. **2018569**	Indieningsdatum **23-03-2017**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Bluemarine Offshore Yard Service B.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **05-08-2017**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN69420**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

F16L1/16;F16L1/20

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**F16L**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	☐ **GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	☐ **GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2018569

A. CLASSIFICATIE VAN HET ONDERWERP
INV. F16L1/16 F16L1/20
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen)
F16L

Onderzochte andere documentatie dan de minimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	WO 01/48410 A1 (SAIPEM SPA [IT]; GIOVANNINI UMBERTO [IT]; PENZO VINCENZO [IT]) 5 juli 2001 (2001-07-05)	1-4, 20-22, 30-32
Y	* samenvatting; figuren *	23-29
A	* bladzijden 19-22; figuren 10, 11a, 11b *	7-19

X	US 5 318 384 A (MALOBERTI RENE [FR] ET AL) 7 juni 1994 (1994-06-07)	1-3,5,6, 33-37
Y	* samenvatting; figuren * * kolommen 3-5 *	23-29

X	US 4 153 381 A (HAWLEY ROYAL T) 8 mei 1979 (1979-05-08)	1-4, 20-22, 30-32
Y	* samenvatting; figuren * * kolom 2 *	23,28

	-/--	

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

* Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
16 november 2017	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Untermann, Nils

1

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2018569

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
Y	EP 1 850 043 A2 (ALLSEAS GROUP SA [CH]) 31 oktober 2007 (2007-10-31) * samenvatting; figuren * * alinea [0027] * -----	29
Y	GB 2 027 157 A (SAIPEM SPA) 13 februari 1980 (1980-02-13) * samenvatting; figuren * * bladzijden 3,4 * -----	23-28

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2018569

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 0148410	A1 05-07-2001	AT 341731 T	15-10-2006
		AU 2170801 A	09-07-2001
		BR 0016701 A	24-09-2002
		CA 2394868 A1	05-07-2001
		EP 1240451 A1	18-09-2002
		ES 2273741 T3	16-05-2007
		NO 20023019 A	21-08-2002
		US 2003099515 A1	29-05-2003
		WO 0148410 A1	05-07-2001
US 5318384	A 07-06-1994	AU 649667 B2	02-06-1994
		BR 9105667 A	04-08-1992
		CA 2056394 A1	01-10-1991
		DE 69104454 D1	10-11-1994
		DK 0477349 T3	10-04-1995
		EP 0477349 A1	01-04-1992
		ES 2029976 T1	16-10-1992
		FR 2660390 A1	04-10-1991
		NO 914707 A	28-01-1992
		US 5318384 A	07-06-1994
		WO 9115397 A1	17-10-1991
US 4153381	A 08-05-1979	GEEN	
EP 1850043	A2 31-10-2007	AU 2007201636 A1	08-11-2007
		BR PI0701629 A	11-12-2007
		EP 1850043 A2	31-10-2007
		EP 1962005 A1	27-08-2008
		ES 2347301 T3	27-10-2010
		ES 2401159 T3	17-04-2013
		US 2007248418 A1	25-10-2007
GB 2027157	A 13-02-1980	AR 219404 A1	15-08-1980
		AU 523174 B2	15-07-1982
		BE 875795 A	23-10-1979
		BR 7903358 A	18-03-1980
		CA 1092375 A	30-12-1980
		DE 2913335 A1	07-02-1980
		DK 116779 A	29-01-1980
		ES 483647 A1	01-03-1980
		FR 2431951 A1	22-02-1980
		GB 2027157 A	13-02-1980
		IE 47872 B1	11-07-1984
		IT 1097770 B	31-08-1985
		JP S5522587 A	18-02-1980
		JP S6222037 B2	15-05-1987
		NL 7902702 A	30-01-1980
		NL 8501730 A	01-11-1985
		NO 790916 A	29-01-1980
		NZ 189988 A	17-06-1983
		PT 69408 A	01-04-1979
		US 4234268 A	18-11-1980

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN69420	23.03.2017		NL2018569

International Patent Classification (IPC)
INV. F16L1/16 F16L1/20

Applicant
Bluemarine Offshore Yard Service B.V.

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the application
- ☒ Box No. VIII Certain observations on the application

	Examiner
	Untermann, Nils

Application number

WRITTEN OPINION

NL2018569

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	7-19, 23-29
	No:	Claims	1-6, 20-22, 30-37
Inventive step	Yes:	Claims	7-19
	No:	Claims	1-6, 20-37
Industrial applicability	Yes:	Claims	1-37
	No:	Claims	

2. Citations and explanations

see separate sheet

WRITTEN OPINION

Box No. VII Certain defects in the application

see separate sheet

Box No. VIII Certain observations on the application

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1	WO 01/48410 A1 (SAIPEM SPA [IT]; GIOVANNINI UMBERTO [IT]; PENZO VINCENZO [IT]) 5 juli 2001 (2001-07-05)
D2	US 5 318 384 A (MALOBERTI RENE [FR] ET AL) 7 juni 1994 (1994-06-07)
D3	US 4 153 381 A (HAWLEY ROYAL T) 8 mei 1979 (1979-05-08)
D4	EP 1 850 043 A2 (ALLSEAS GROUP SA [CH]) 31 oktober 2007 (2007-10-31)
D5	GB 2 027 157 A (SAIPEM SPA) 13 februari 1980 (1980-02-13)

1 **Claim 1**

1.1 The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

1.2 Document D1 discloses (the references in brackets applying to this document):

systeem voor het achterlaten en ophalen van een onderzeese pijpleiding (figures, abstract), omvattende:

een pijpleidingbevestigingssamenstel ("A/R connector 14", figures 10, 11a, 11b, page 19, line 25 - page 22, line 32) dat is geconfigureerd om te worden bevestigd aan een pijpleidingeinde ("abandonment string 13"); en

een kabelbevestigingssamenstel ("connector part 15", figures 11a, 11b, pages 21, 22) dat is geconfigureerd om te worden bevestigd aan ten minste een achterlaat- en ophaalkabel ("steel rope 16", page 21, lines 15-18 figures 3-5);

waarbij het pijpleidingbevestigingssamenstel (14) en het kabelbevestigingssamenstel (15) elk een van twee parende verbinderdelen van een man/vrouw-type verbinder (figures 10, 11a, 11, "female part 141 of connector 14", page 19, line 27; "male part 171 of connector 15", figures 11a, 11b") omvat.

Hence, the subject matter of claim 1 is clearly not new with regard to D1.

1.3 Furthermore, the subject matter of claim 1 is not new with regard to D2, see figures 4-9, cols, 4, 5; cable 21 with male part 20, part 1 with female part 8.

1.4 Furthermore, the subject matter of claim 1 is not new with regard to D3, see figure 1, col. 2; cable 21 with male part 40, adapter flange 26 as female part attached to pipeline 22.

2 **Claims 2-37**

2.1 Dependent claims 2-6 and 20-37 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step.

- Claims 2, 3, 20-22, 30-32: D1, figures 10, 11a, 11b; D2, figures 4-9; D3, figure 1,
- Claim 4: D3, figure 1,
- Claims 5, 6: D2, figures 4-9, "chain 2",
- Claims 23-28: D5, figure 4, two sets of shoes 98 as gripping members,
- Claim 29, D4, figures 3, 4, [0027], "shells 36",
- Claim 33-37: D2, figures 4, 5, "sling 28", "buoyancy element 6",

2.2 The combination of the features of the following claims is neither known from, nor rendered obvious by, the available prior art:

- Claim 7-11,
- Claims 12, 13,
- Claims 14-19.

Re Item VII

Certain defects in the application

3 The features of the claims are not provided with reference signs placed in parentheses.

4 The relevant background art disclosed in documents D1-D5 is not mentioned in the description, nor is this document identified therein.

Re Item VIII

Certain observations on the application

5 On page 11, lines 4-23, mechanism for locking the female connector 17 to the male connector 19 by means of balls 29 is described.

In particular, the passage on page 11, lines 13-20 reads:

> "The ball seat 39 is provided with a slanted control surface 41 that when the mandrel 35 is moved relative to the sleeve 37 in the axial direction indicated with arrow C, contacts the ball 29 cooperating therewith and forces the ball 29 in outward radial direction indicated with arrow D. When the mandrel 35 is moved relative to the sleeve 37 in the opposite axial direction indicated with arrow E, the slanted control surface 41 of the ball seat 39 is moved away from the ball 29 cooperating therewith, thereby allowing the ball 29 to move into the accommodation 31 in the radial direction indicated by arrow F."

However, from a technical point of view and in light of figures 3, 3A and 4 of the present application, the underlined letter C and E should be inverted in the above-mentioned passage.