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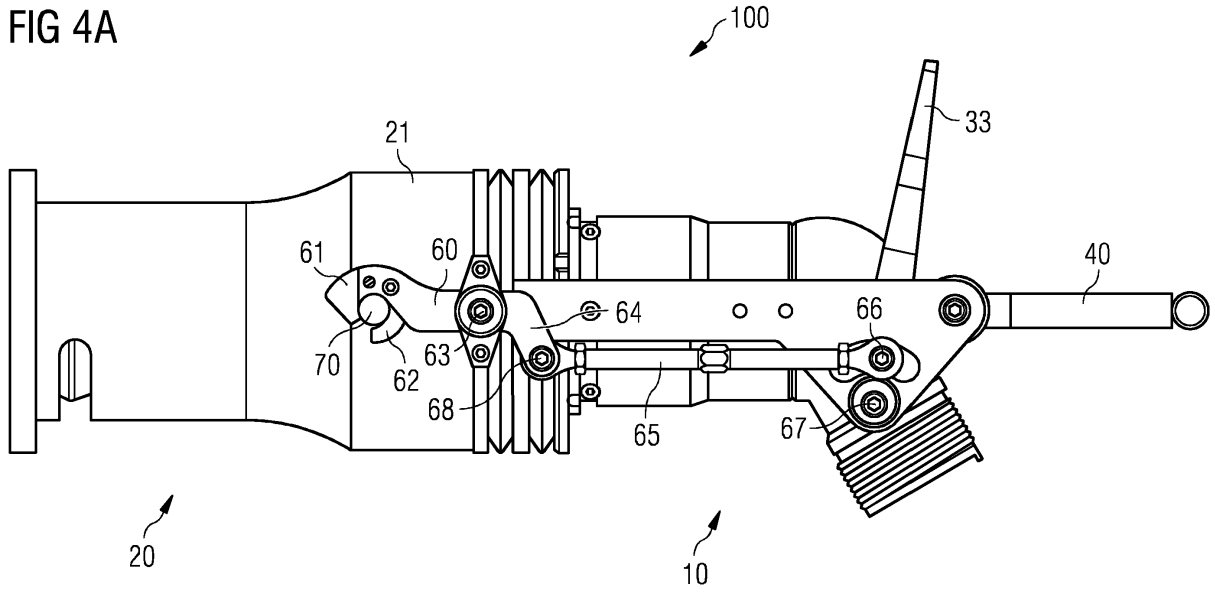
(71) Applicant: **Siemens Aktiengesellschaft**
80333 München (DE)

(72) Inventors:
- **Burrow, Christopher**
  Ulverston,Cumbria, LA12 9DD (GB)
- **Ronald, Julian**
  Ulverston, LA12 0SP (GB)
- **Simmonds, Mark**
  Ulverston, Cumbria, LA12 7QL (GB)
- **Simpson, Antonella**
  Ulverston, LA12 9AR (GB)

(54) Underwater connector

(57) A connector for use underwater or in a wet or severe environment is provided. A first connector part and a second connector part of the connector are adapted to have a mated position in which the first connector part and the second connector part are engaged with each other for establishing a connection. A locking mechanism of the connector is adapted to lock the first connector part to the second connector part in a mated position. The first connector part has a handle portion. The first connector part is configured such that by manipulating the handle portion of the first connector part, the first connector part can be disengaged from the second connector part when the locking mechanism is in a released state. The locking mechanism has a release element which is separate from the handle portion.

FIG 4A



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Description

Field of the invention

[0001] The invention relates to a connector for use underwater or in a wet or severe environment and to a method of operating such connector.

Background

[0002] Several applications are known in which electrical connections need to be provided underwater. Examples include a subsea installation for the production of hydrocarbons from a subsea well, in which different components of the subsea installation may need to be connected electrically or optically e.g. for providing a component with electric power or for communication purposes. Such connections may for example comprise a connection from a topside installation, such as a floating or a fixed platform, or from an onshore site to a subsea component, e.g. by an umbilical or a subsea cable. Other connections include electrical or optical connections between different type of subsea equipment, such as a connection between a subsea transformer and a subsea switchgear, between a subsea control unit and a component to be controlled, connections to a subsea pump or a subsea compressor or the like.

[0003] For providing an underwater connection, wet-mateable connectors are known which can be mated underwater. Since subsea installations may be located at great depths of water, e.g. in excess of 1,000, 2,000 or even 3,000 meters, mating of such connector can be performed by means of a remotely operated vehicle (ROV). For this purpose, a part of the connector which is for example terminates a cable is provided with a handle which can be gripped by the ROV. The ROV can then push the connector part into engagement with the other part of the connector, thereby completing the connection. In order to retain the connector in this mated position in which the connection is established, it is known to provide the connector with an internal latching mechanism. As an example, spring-loaded internal latching fingers which are mounted to one part of the connector can engage corresponding slots in the other part of the connector. Such latching mechanism can be engaged when the ROV pushes the connector part into engagement with the other connector part. The latching mechanism keeps the connector in the mated position when the mating force provided by the ROV is removed. For de-mating the connector, the ROV can apply a pull force to the handle of the connector. The latching mechanism inside the plug will retract the latch fingers, thus allowing the connector parts to be separated.

[0004] Such connectors have the advantage that they can be connected and disconnected with a single ROV operation. By means of such connectors, a connection, for example an electrical or optical connection, can be established in a fast and secure manner even at great water depths.

[0005] It is desirable to further increase the reliability of such connectors. Accidental disengagement of such connector can lead to a blackout of the respective subsea installation, e.g. if operating voltage is supplied via the connector. Such disengagement will also require the carrying out of a service operation. Also, it is desirable to ensure that when the connector parts are mated subsea by means of an ROV, the connector parts are fully mated. If they are not fully mated, they may accidentally disengage, or the connection may not be fully established. It is further desirable to prevent an unintentional de-mating of the connector parts, which can for example occur if the handle of the connector is knocked, e.g. by the ROV.

Summary

[0006] Accordingly, there is the need of obviating at least some of the drawbacks mentioned above and to provide an improved connector for underwater use. In particular, there is a need of improving the reliability when mating two parts of a connector underwater.

[0007] This need is met by the features of the independent claims. The dependent claims describe embodiments of the invention.

[0008] An embodiment of the invention provides a connector for use underwater or in a wet or severe environment. The connector comprises a first connector part and a second connector part adapted to have a mated position in which the first connector part and the second connector part are in engagement for establishing a connection. The connector further has a locking mechanism adapted to lock the first connector part to the second connector part in the mated position. The connector further comprises a handle portion provided on the first connector part, wherein the first connector part is configured such that by manipulating the handle portion of the first connector part, the first connector part can be disengaged from the second connector part when the locking mechanism is in a released state. The connector is further provided with a release element for the locking mechanism. The release element is separate from the handle portion. The release element is coupled to the locking mechanism such that upon actuation of the release element in the mated position, the locking between the first connector part and the second connector part is released. In other words, by actuation of the release element, the locking mechanism is unlocked.

[0009] By means of such connector, additional safety against an unintentional de-mating of the first connector part and the second connector part may be provided. In particular, due to the locking mechanism, the first connector part may not be separated from the second connector part by knocking or pulling on the handle portion of the first connector part, since the locking mechanism locks the first connector part to the second connector part in the mated position. Since the released element for the locking mechanism and the handle portion which

is used for disengaging the first connector part from the second connector part are separate and need to be operated separately, a more reliable mating of the connector can be achieved. Since two separate operations may be necessary to disconnect the first and second connector parts, an unintentional disconnection may be prevented.

[0010] By manipulating the handle portion of the first connector part, the first connector part may be brought from the mated position into an unmated position in which the first connector part is separated (or spaced apart) from the second connector part. Manipulating may for example comprise pulling, pushing, turning, twisting, bending or the like, depending on the particular configuration of the connector. In an embodiment, manipulating the handle portion of the first connector part comprises gripping the handle portion, e.g. by means of an ROV, and pulling the first connector part in axial direction away from the second connector part.

[0011] In an embodiment, the connector may further comprise a latching mechanism. The latching mechanism may be adapted so that in the mated position, the latching mechanism latches the first connector part to the second connector part. The latching mechanism may furthermore be configured such that by manipulating the handle portion of the first connector part when disengaging the first connector part from the second connector part, the latching between the first connector part and the second connector part is released. In such configuration, upon actuation of the release element and bringing the locking mechanism into the released state, the first and second connector parts are still engaged and latched by means of the latching mechanism, thus facilitating the unmating of the connector parts. As an example, the handle portion may comprise a handle, in particular a T-bar handle, and manipulating the handle portion may comprise pulling such handle. The latching mechanism may for example comprise latch fingers which are released upon pulling the handle.

[0012] In an embodiment, the locking mechanism comprises a first locking member provided on the first connector part and a second locking member provided on the second connector part.

[0013] One of the first and second locking members may be a fixed locking element and the other of the first and second locking members may be a movable locking element. The movable locking element may have a locked position in which the movable locking element is in engagement with the fixed locking element. It may further have a released position in which the movable locking element is disengaged from the fixed locking element. The locking mechanism may for example be configured such that by moving the first connector part into engagement with the second connector part, the movable locking element is brought into the locked position. In some embodiments, this may occur automatically. Furthermore, the release element may be coupled to the movable locking element such that by actuation of the release element, the movable locking element is brought into the released position. Such configuration has the advantage that for mating the first and second connector parts, only a single action (e.g. manipulation of the handle portion) may be required while for de-mating the first connector part from the second connector part, two actions, i.e. actuation of the release element and manipulation of the handle portion may be required. Accordingly, a fast and efficient mating and de-mating of the first and second connector parts can be achieved while reducing the risk of an unintentional de-mating.

[0014] Movable and fixed locking elements may be realized in different configurations, such as a locking hook and a locking pin, a latch, e.g. a spring latch, and a respective recess or slot, or the like.

[0015] In some embodiments, the movable locking element may comprise a biasing element configured and arranged to bias the movable locking element towards the locked position. As an example, by such biasing element, the movable locking element may snap into the locked position upon engagement of the first and second connector parts, and it may be moved into the released position by actuation of the release element for unmating the first and second connector parts. In other embodiments, the release element may comprise a biasing element which biases the release element towards a locked position, which corresponds to a locked position of the movable locking element. As an example, a leaf spring may be used as biasing element. The configuration may be such that during engagement, the movable locking element can snap into a locked position due to the applied biasing force, and that for actuating the release element and bringing the movable locking element into the released position, a force directed against the biasing force has to be applied to the release element.

[0016] In some embodiments, the movable locking element may be biased towards an equilibrium position (e.g. a position which it takes when the connector parts are in an unmated position). When the first and second connector parts are moved into engagement, the movable locking element may interact with the fixed locking element and may thereby be pushed out of the equilibrium position. When reaching the mated position, it may move back or snap back into the equilibrium position, thereby providing locking between the fixed locking element and the movable locking element.

[0017] In an embodiment, one of the first and second locking members comprises at least one locking pin and the other of the first and second locking members comprises at least one locking hook configured to engage the locking pin in the mated position. By means of a locking pin and a locking hook, a simple and robust locking mechanism may be realized.

[0018] The locking hook may have a locked position in which the locking hook is in engagement with the locking pin. The locking hook may be a movable element that is movable by actuation of the release element into a released position in which the locking hook is disengaged

from the locking pin. In other embodiments, the release element may for example retract a spring latch upon actuation.

[0019] In some embodiments, the locking hook may be a movable locking element and may have a tapered front portion. The locking pin and the locking hook may be configured and arranged such that when moving the first connector part into engagement with the second connector part, the locking hook is moved out of an equilibrium position by interaction between the locking pin and the (tapered) front portion of the locking hook. The locking hook or the release element or both may furthermore comprise a biasing element adapted to bring the locking hook back into the equilibrium position and into engagement with the locking pin in the mated position. With such configuration, a relatively simple but automatic engagement of the locking mechanism upon movement of the first connector part into the mated position can be achieved.

[0020] The locking hook may for example comprise an elongated body and may be mounted to the first or second connector part. It may be pivotable about an axis perpendicular to the mating direction (or longitudinal axis) of the first and second connector parts. The pivotable mount may be spring-loaded, so that the locking hook is rotated back into the equilibrium position by the spring force. Another possibility to provide biasing is the spring loading of the release element.

[0021] The locking hook may have a hook portion arranged forwardly (in the mating direction) and a rear portion (elongated body). To the rear portion (or lever portion) of the locking hook, an actuating rod may be coupled. The actuating rod may be movable by actuation of the release element. The locking hook may be movable by means of the actuating rod between a locked position and a released position.

[0022] The release element may be a release paddle or a release handle which is mounted to the first connector part and pivotable about an axis. The locking mechanism may comprise an actuating rod mounted to the release element such that pivoting of the release element results in a pushing or pulling motion of the actuating rod. The actuating rod may on its other end be coupled to the first locking member to actuate the first locking member, in particular to bring the first locking member from a locked position into a release position. Accordingly, an actuation of the release element can be transmitted via the actuating rod to the locking hook, so that the locking hook can be rotated about its pivotable mount, between the locked position and the released position.

[0023] The locking hook may comprise a latch adapted to at least partially close a throat opening of the locking hook. The looking mechanism may be configured such that an actuation of the release element moves the locking hook away from the locking pin such that the locking pin applies a force to the latch, thereby opening the latch and releasing the locking hook from the locking pin. The latch may furthermore be configured so as to prevent re-engagement of the locking mechanism after the release element was operated. In particular, it may be configured such that after releasing the locking hook from a locking pin, the locking hook cannot fall back into engagement with the locking pin. The latch may for example at least partially close the throat opening of the locking hook, thereby preventing the locking pin from entering the locking hook.

[0024] In such configuration, it may be effectively prevented that after actuation of the release element, the locking mechanism is again accidentally engaged before the first connector part is de-mated from the second connector part (i.e. brought into the unmated position).

[0025] In an embodiment, the locking hook may comprise a latch adapted to at least partially close a throat opening of the locking hook. The locking mechanism can be configured such that the latch is moved into an opened position during engagement of the first connector part with the second connector part, thereby allowing the locking hook to engage the locking pin. As an example, upon axially engaging the first connector part with the second connector part, the locking pin may apply a force against the latch of the locking hook. A front portion of the latched may be formed such that the locking pin pushes the latch into the open position, thereby pushing the locking hook into engagement with the locking pin.

[0026] In an embodiment, the first locking member and the second locking member are provided outside a housing of the first connector part and the second connector part, respectively. In such configuration, the locking mechanism can be kept relatively simple. Furthermore, the locking mechanism is accessible from the outside, and can be inspected without greater efforts. The locking mechanism is in particular external to a housing of the first and second connector parts. As an example, the first and second connector parts may be a plug part and a receptacle part of the connector, and the first locking member may be mounted to the housing of the plug part, and the second locking member may be mounted to the receptacle (or receptacle housing) of the receptacle part.

[0027] In an embodiment, at least one of the first and second locking members is adapted to provide a visual indication of whether the locking mechanism is in a locked state or in the released state. As an example, the visual indication may be provided by the locking hook being in engagement with the locking pin outside a housing of the first and second connector parts, the locked state thus being visible. The visual indication may additionally or alternatively be provided by or supported by providing a component of the locking mechanism in a specific color, e.g. a signal color or contrasting color. As an example, the locking pin may be provided in such color, in particular in a well visible color, such as a neon color or a yellow or orange color. When the locking hook is in engagement with the locking pin, a portion of the locking pin is covered, thus reducing the perception of the color. This way, the locked state can be indicated and recognized, e.g. by means of an ROV camera.

[0028] In an embodiment, the first locking member may comprise at least two locking hooks mounted to opposing sides of the first connector part. The second locking member may comprise at least two locking pins mounted to opposing sides of the second connector part. The locking hooks are arranged so as to engage the respective locking pins when the first and the second connector parts are in the mated position. A secure locking of the first connector part to the second connector part may thus be achieved.

[0029] In an embodiment, the locking mechanism is configured such that when the connector is brought into the mated position by moving the first connector part into engagement with the second connector part, the first connector part is automatically locked to the second connector part. This may for example be achieved by means of the above described locking hook and locking pin combination. Other embodiments are also conceivable, such as a spring loaded latch being brought automatically into engagement with a corresponding recess, or the like.

[0030] Accordingly, locking may be achieved without actuation of the release element. In particular, the first and second connector parts may be brought into engagement and may be locked to each other by manipulation of the handle portion only. The first connector part may be configured such that it can be brought into engagement with the second connector part by being gripped at the handle portion and moved into the mated position. Mating of the first and second connector parts is thus facilitated.

[0031] In some embodiments, the release element may be provided on the first connector part.

[0032] In an embodiment, the first connector part has a front portion which engages the second connector part, and the handle portion and the release element may be provided at a rear portion of the first connector part. This may facilitate access to the handle portion and to the release element.

[0033] In an embodiment, the release element and/or the handle portion are adapted to be operable by a remotely operated vehicle (ROV). This may allow the first and second connector parts to be mated at great depths of water, e.g. in excess of 1,000 m or even 2,000 m.

[0034] The first connector part may be a plug part of the connector and the second connector part may be a receptacle part of the connector having one or more receptacle pins adapted to enter a plug body of the plug part. Besides configurations in which the plug part is handled and operated by the ROV, configurations are also conceivable in which the receptacle part of the connector is handled and operated by the ROV.

[0035] According to a further embodiment of the invention, a method of operating a connector for use underwater or in a wet or severe environment is provided. The method comprises the steps of providing the connector in a mated position in which a first connector part of the connector at a second connector part of the connector are in engagement, and in which a locking mechanism of the connector locks the first connector part to the second connector part. It further comprises actuating a release element coupled to the locking mechanism to release the locking between the first connector part and the second connector part, thereby bringing the locking mechanism into a released state, and disengaging the first connector part from the second connector part by manipulating a handle portion of the first connector part. The handle portion is separate from the release element.

[0036] By means of such method, advantages similar to the ones outlined further above with respect to embodiments of the connector may be achieved. In particular, the method may be performed with a connector according to any of the above described embodiments and configurations.

[0037] In an embodiment, the method may further comprise the step of bringing the connector into the mated position by manipulating the first connector part by means of the handled portion so as to bring the first connector part into engagement with the second connector part, whereby the locking mechanism is automatically engaged. Engagement of the first and second connector parts may thus be facilitated. The step may for example be performed prior to the step of providing the connector in the mated position, or it may be performed for re-engaging the de-mated first and second connector parts.

[0038] In a further embodiment, the method may comprise the step of unlatching a latching mechanism which holds the first connector part in engagement with the second connector part by manipulating of the handle portion of the first connector part. This can in particular be performed during the disengagement step. The connector may thus be held in engagement by the latching mechanism after actuation of the release element, and a single operation may be used for releasing or unlatching the latching mechanism and disengaging the first and second connector parts. A secure and simple unmating operation may thus be achieved.

[0039] It is to be understood that the features mentioned above and those yet to be explained below can be used not only in the respective combinations indicated, but also in other combinations or in isolation, without leaving the scope of the present invention. In particular, the connector according to embodiments of the invention may comprise features as described with respect to embodiments of the method, and embodiments of the method may comprise steps for operating a connector in accordance with any of the described embodiments.

Brief description of the drawings

[0040] The foregoing and other features and advantages of the invention will become further apparent from the following detailed description read in conjunction with the accompanying drawings. In the drawings, like reference numerals refer to like elements.

Figure 1 is a schematic drawing showing a connector

according to an embodiment of the invention, with figure 1A showing the connector in a mated position and figure 1B showing the connector in an unmated position.

Figure 2 is a schematic drawing showing a partial side view and a partial top view of a connector according to a further embodiment of the invention.

Figure 3 is a schematic drawing showing a perspective view of a connector according to an embodiment of the invention prior to mating.

Figure 4 is a schematic drawing showing a side view and a top view of the connector of figure 3 in a mated state.

Figure 5 is a schematic drawing showing a side view of the connector of figures 3 and 4 after releasing the locking between a first and a second part of the connector.

Figure 6 is a schematic drawing showing a perspective view of selected components of a connector according to a further embodiment of the invention.

Figure 7 a flow diagram illustrating steps of a method according to an embodiment of the invention.

Detailed description

[0041] In the following, embodiments of the invention will be described in detail with reference to the accompanying drawings. It is to be understood that the following description of the embodiments is given only for the purpose of illustration and is not to be taken in a limiting sense. The drawings are to be regarded as being schematic representations only, and elements in the drawings are not necessarily to scale with each other. Rather, the representation of the various elements is chosen such that their function and general purpose become apparent to a person skilled in the art.

[0042] Figures 1A and 1B are schematic drawings showing a sectional side view of a connector according to an embodiment in a mated position (or mated state) and in an unmated position (or unmated state), respectively. Figure 1B shows the connector 100 in a state prior to mating or after de-mating. The connector 100 comprises a first connector part 10 and a second connector part 20, the first connector part 10 being a plug part and the second connector part 20 being a receptacle part in the example of figure 1. First and second connector parts 10 and 20 are adapted to engage each other and to be brought into the mated position illustrated in figure 1A for establishing a connection. In figure 1, a connector is shown which establishes a single electrical connection. In other embodiments, the connector 100 may establish plural electrical connections simultaneously, it may establish one or more optical connections, or it may establish electrical and optical connections simultaneously. Although embodiments of present invention are explained with respect to the connector 100 which establishes a single electrical connection, the explanations given below are similarly applicable to such other embodiments of the connector 100.

[0043] The plug part 10 has a plug body 11 and terminates (e.g. by means of a termination assembly) a subsea cable or hose 12. It further has a recess or opening 13 in which a shuttle pin may be provided, and in which a pin 23 of the receptacle 20 is allowed to enter when mating the plug and receptacle parts 10, 20. For establishing an electrical connection, the plug part 10 further comprises a socket contact 14, which is in electrical contact with the conductor 15 of the subsea cable 12.

[0044] The receptacle part 20 comprises the receptacle housing 21, in which the pin 23 (receptacle pin) is provided. In a front portion of the pin 23, a contact ring 24 is provided which is in electrical contact with a conductor 25 of the subsea cable or hose 22. Subsea cable 22 is terminated by the receptacle part 20 of connector 100 (e.g. by means of a termination assembly).

[0045] When mating the plug part 10 with the receptacle part 20, the plug body 11 enters the receptacle 21, and the pin 23 enters the recess 13 and pushes a shuttle pin back into the plug body 11, if such shuttle pin is provided. In the mated position as illustrated in figure 1A, the contact ring 24 is in electrical contact with the socket contact 14, thus providing an electrical connection between the conductors 15 and 25. As outlined above, it has to be emphasized that this is only an exemplary configuration for establishing an electrical connection, and that the connector 100 may comprise a different configuration for establishing such electrical connection, or may comprise a configuration for establishing an optical connection, or an electrical and optical connection, or plural such connections.

[0046] Furthermore, it should be clear that connector 100 may also be used in applications other than for establishing an electrical connection between two subsea cables 12, 22. As an example, the first or second connector part 10, 20 may be mounted to bulkhead, to a stab plate or the like.

[0047] In the example of figure 1, the first and second connector parts 10, 20 are wet-mateable by means of a remotely operated vehicle (ROV). For this purpose, the plug part 10 of the connector 100 is provided with a handle portion 40, which may for example be embodied by means of a T-shaped handle (T-bar). The handle portion 40 is adapted such that the ROV can grip the handle portion and move the connector part 10 from the unmated position illustrated in figure 1B into the mated position illustrated in figure 1A. In particular, the plug part 10 is inserted into the receptacle part 20 of connector 100 by an axial pushing action applied to the handle portion 40.

[0048] The connector 100 is furthermore equipped with a latching mechanism 50. Latching mechanism 50 com-

prises a latch on one connector part and a recess or slot on the other connector part. In the example of figure 1, it comprises the latch finger 51 on the plug part 10 and the recess 52 on the receptacle part 20. It should be clear that plural of such latch and recess pairs can be provided on connector 100, e.g. distributed circumferentially around the respective connector part, for example 2, 3, 4, 5 or 6 of such latch and recess pairs. Latch finger 51 is spring-loaded so that it takes the position illustrated in figure 1B without the application of an external force. During engagement of the first and second connector parts 10, 20, the latch finger 51 engages the recess 52. The latching mechanism 50 keeps the plug part 10 positioned in the receptacle part 20 when the mating force applied by the ROV is removed. Accordingly, the connector 100 is retained in the mated position as illustrated in figure 1A.

[0049] The latching mechanism 50 further comprises components inside the plug body 11, which mechanically connect the latched fingers 51 to the handle portion 40. The mechanism is such that if a pulling force of sufficient strength is applied to the handle portion 40, the latch finger 51 is retracted into the plug body 11. The latching between the plug part 10 and the receptacle part 20 is thus disengaged or released. Accordingly, without any further locking, the connector 100 can be brought from the mated position of figure 1A to the de-mated position of figure 1B by the application of a pulling force to the handle portion 40, e.g. by means of an ROV. The pulling force applied to handle portion 40 will retract the latch into the plug body 11 and will furthermore pull the plug part 10 apart from the receptacle part 20.

[0050] Connector 100 further comprises a locking mechanism 30 which is arranged external to the first and second connector parts 10, 20, i.e. it is mounted outside the plug body 11 and the receptacle housing 21. The locking mechanism 30 comprises a first locking member 31 mounted to the first connector part 10 and a second locking member 32 mounted to the second connector part 20. It further comprises a release element 33, which can for example be implemented in form of a handle, a paddle or the like. When the first and second connector parts 10, 20 are brought into the mated state as illustrated in figure 1A, the first and second locking members 31, 32 can be brought into engagement and can be locked to each other, so as to lock the first connector part 10 to the second connector part 20 (or vice versa). In the example of figure 1, locking may for example occur by means of latching between the locking members 31, 32, engagement of a locking bolt or the like. How locking is achieved between the locking members 31, 32 can be configured in correspondence to the particular application, and further examples include the use of a locking hook and a locking pin, as described herein with respect to the subsequent figures.

[0051] The locking mechanism 30 can be configured such that the locking is achieved by actuation of a respective actuator element, such as the release element 33. In a preferred configuration of the locking mechanism 30, locking occurs automatically upon engaging the first connector part 10 with the second connector part 20. This can for example be achieved by a latch snapping into a recess, or by the configuration described hereinafter which uses a locking hook and locking pin.

[0052] The locking mechanism 30 comprises the release element 33. The locking mechanism 30 is adapted such that an actuation of the release element 33 releases the locking between the first and second locking members 31, 32. As can be seen from figure 1, the release element 33 is separate from the handle portion 40 of the connector 100. This has the advantage that although a pulling or knocking of the handle portion 40 of connector 100 may release the latching mechanism 50, the first and second connector parts 10, 20 still remain in the mated position since they are locked together by means of the locking mechanism 30. An accidental knocking of the handle portion 40 will accordingly not lead to a de-mating of the first and second connector parts 10, 20. The connector 100 is adapted so that two operations, which may be performed by an ROV, are required in correct sequence to bring the connector 100 into an unmated position.

[0053] The ROV first has to actuate the release element 33 in order to unlock the locking mechanism 30, wherein the latching mechanism 50 still holds the connector parts 10, 20 together. The locking mechanism 30 is adapted so that upon actuation of the release element 33, the locking mechanism 30 retains the unlocked state (at least until the first and second locking members 31, 32 are (fully) disengaged). After the locking mechanism 30 is brought into the unlocked state, the handle portion 40 can be manipulated, in particular pulled, to unmate the first connector part 10 from the second connector part 20. As explained above, pulling the handle portion 40 may lead to the retrieving of the latch finger 51, thus releasing the internal latching mechanism 50. By pulling the handle portion 40, the first connector part 10 can then be disengaged, i.e. pulled out of the second connector part 20.

[0054] Accordingly, by means of locking mechanism 30, the first and second connector parts can be retained in their correct position when mated. Furthermore, the risk of an unintentional de-mating of the first and second connector parts 10, 20 can be reduced. By providing the handle portion 40 and the release element 33 separate from each other, two operations are required for unmating the connector 100, so that only the intentional disconnection of the two connector parts is enabled.

[0055] Furthermore, since the locking members 31, 32 of the locking mechanism are provided externally, the state of the locking mechanism 30 can be visible, e.g. to an ROV camera. The locking mechanism 30 can in particular be adapted to provide a visual indication of its state, in particular a visual indication that the mechanism 30 is in the locked state. As an example, one of the locking members 31, 32 may comprise a color mark, which is at least partially covered upon the locking mechanism

reaching the locked state. Accordingly, by an ROV camera, the color mark can be picked up. When the colored marking is covered as intended, it can be determined that the locking mechanism 30 is in the locked state, and that the first and second connector parts 10, 20 are correctly engaged. The locking mechanism may for example be configured such that when the first and second connector parts 10, 20 are not correctly engaged, e.g. not fully engaged, the locking mechanism 30 cannot enter the locked state. The locking mechanism 30 not entering the locked state is thus a visual indication of an incorrect engagement of the first and second connector parts 10, 20. Such visual indication allows the operator to complete the mating procedure or to initiate a new mating procedure in order to fully and correctly mate the first and second connector parts 10, 20. Locking mechanism 30 can thus further improve the underwater mating of connector 100.

[0056] The configuration described with respect to figure 1 is only one example, and that other configurations are conceivable. Handle portion 40 and release element 33 may for example be provided on the second connector part 20 (with the respective adaptations of the locking mechanism 30 and the latching mechanism 50). In other embodiments, they may be provided on different connector parts. It should also be clear that in some embodiments, no latching mechanism 50 may be provided, or the latching mechanism 50 may have an entirely different configuration. As an example a restriction within the receptacle housing 21 may engage a circumferential recess on a front portion of the plug body 11 for achieving that the first and second connector parts 10, 20 are held together in the mated position of figure 1A. In even other embodiments, latch fingers may for example be provided as a molded plastic component arranged circumferentially around the plug body 11. Such latch fingers may not be retractable into the plug body 11, but may be disengaged by means of a pulling force of sufficient strength applied to handle portion 40. Even other embodiments may comprise a rotary latching mechanism in which a rotating element provides latching upon engagement of the first and second connector parts 10, 20. Besides having latch elements 51 as illustrated in figure 1, different types of latch elements may be provided, such as spring-loaded balls arranged circumferentially around the inside of the receptacle housing. Latching may then for example occur to a groove provided within the plug body 11.

[0057] As can be seen from above, different implementations of the latching mechanism 50 are conceivable, and the embodiments are not limited with respect to the type of latching mechanism used and whether a latching mechanism is provided at all.

[0058] Furthermore, the handle portion 40 may be provided in shapes different to the T-bar handle schematically shown in figure 1. The handle may for example have a square or triangular shape with an opening therein or the shape may be a mixture of such geometric elements, e.g. a handle having a rectangular piece for being gripped and a triangular opening.

[0059] Figure 2 illustrates a first connector part 10 in an unmated state according to a further embodiment of the connector 100. The first locking member 31 of the locking mechanism 30 is mounted to the first connector part 10. In the embodiment of figure 2, the first connector part 10 is again a plug part of the connector 100 having a handle portion 40, a plug body 11 with a front portion 16, and latches 51 of a latching mechanism to which the handle portion 40 is coupled. The general explanations given above with respect to figure 1 are equally applicable to the embodiment of figure 2.

[0060] The first locking member 31 comprises a locking hook 60 having a hook portion 61 at a forward end thereof and a lever portion 64 at a rear end thereof. At joint 63, the locking hook is pivotably mounted to the first connector part 10.

[0061] The pivotable mount is such that the locking hook 60 is movable between an equilibrium position as illustrated in figure 2A and a released position as illustrated in figure 5. The equilibrium position is taken when the connector is unmated and no force is applied to the locking mechanism, in particular to the release element 33. As an example, the joint 63 may be spring-loaded so that the locking hook 60 is biased towards the equilibrium position. When being rotated around the joint 63, the spring applies a restoring force to the locking hook 60 which brings it back into the equilibrium position. In other embodiments, the release element 33 may be biased towards the locked position by a spring force (see for example figure 6), whereby the locking hook 60 is biased towards the equilibrium position of figure 2.

[0062] At the rearward portion (or lever portion) 64 of the locking hook 60, it is pivotably coupled to an actuating rod 65 by a joint 68. Release element 33 is provided in form of a handle or paddle and is pivotably mounted at joint 67 to the first connector part 10. The actuating rod 65 is at its other end pivotably coupled to the release element 33 by a joint 66. In such configuration, if the release element 33 is pushed towards the front portion 16 of the connector part 10, the actuating rod 65 will also be pushed in a forward direction. Accordingly, a force will be applied to the lever portion 64 of locking hook 60, which will lead to a rotation of the locking hook 60 around the joint 63. Hook portion 61 will thus be moved from its equilibrium position to a released position, which will be explained in a further detail with respect to figure 5. Locking hook 60 furthermore comprises a latch 62 (safety latch) which is pivotable into an open position in which the throat of hook portion 61 is open. The latch 62 is spring-loaded, e.g. by means of a leaf spring, so that without application of force, it will return into the equilibrium position illustrated in figure 2A.

[0063] As illustrated in the top view of figure 2B, the locking mechanism can be provided symmetrically on both sides of the first connector part 10. Two locking hooks 60 and two actuating rods 65 may thus be arranged at opposing sides of the first connector part 10.

[0064] Figure 3 is a perspective view of an embodiment of connector 100, which includes the first connector part 10 according to the embodiment of figure 2. Figure 3 illustrates a position of the connector 100 prior to mating or after de-mating, i.e. it illustrates an unmated position. In the embodiment of figure 3, the second connecting member 32 is provided in form of locking pins 70. Locking pins 70 are mounted to the receptacle housing 21 at opposing sides thereof. The locking pins 70 and the locking hooks 60 are arranged so as to allow an engagement of the locking pins 70 by the locking hooks 60.

[0065] Preferably the locking mechanism 30 is configured so as to automatically engage the locking between the first and second locking members 31, 32 upon mating of the first and second connector parts 10, 20. When mating the first and second connector parts 10, 20, the first connector part 10 is held by the handle portion 40 and is moved axially (i.e. in the direction of the longitudinal axis of the plug body 11) into engagement with the receptacle housing 21. As illustrated in figure 2A, the forward facing part of the hook portion 61 has a tapered shape, so that when the plug part 10 is pushed into the receptacle part 20, the tapered front portion interacts with the locking pin 70. The locking hook will thus be pushed out of its equilibrium position (hook portion 61 will be pushed upwards in figure 2A). Upon further engagement, the locking pin 70 abuts the latch 62 of locking hook 60. The force applied to the latch 62 will cause the latch to move backwards, thus opening the throat of hook portion 61. Due to the biasing force applied to the locking hook 60 (e.g. by the leaf spring shown in figure 6), which pushes the locking hook 60 back into its equilibrium position, the locking hook 60 will snap into engagement with the locking pin 70 upon further engagement of the first and second connector parts.

[0066] This is illustrated in figure 4A. As can be seen, the locking hook 60 has returned to its equilibrium position and is now in a locked position in which locking is provided between the locking hook 60 and the locking pin 70. Since latch 62 is spring-loaded, it has also returned to its equilibrium position, thereby closing the throat of hook portion 61 and preventing accidental unlocking. The latch 62 may also be biased so as to apply a force to the locking pin 70 in the locked position illustrated in figure 4A.

[0067] As mentioned above, the internal latching mechanism 50, if provided, may at the same time provide an internal latching between the first and second connector parts 10, 20. By manipulating the first connector part 10 by means of handle portion 40, the connector 10 can be brought into the mated position, and the latching mechanism 50 and the locking mechanism 30 can both be engaged automatically and in some embodiments also simultaneously. By providing such locking mechanism 30, it is thus possible to provide locking between the first and second connector parts 10, 20 by a single ROV action.

[0068] Figure 4B shows a top view of the connector 100 in the mated state which illustrates that the locking mechanism 30 can have corresponding locking members on both sides of the connector 100.

[0069] As can be seen from figures 4A and 4B, the connector 100 cannot be unmated by a manipulation of the handle portion 40 only. Rather, it is necessary to first unlock the locking mechanism 30 before the first and second connector parts 10, 20 can be separated.

[0070] The unlocking is illustrated in figure 5. The release element 33 is actuated by pushing the release element 33 in a forward direction (as seen with respect to the first connector part 10 and indicated by the arrow). This causes the actuating rod 65 to move forward, thus pushing the lever portion 64 of the locking hook 60 forwardly. The locking hook 60 accordingly pivots around the joint 63. This causes an upward motion of the hook portion 61. Since the latch 62 is movable and spring loaded, the force applied by locking pin 70 to the latch 62 upon an upward motion of hook portion 61 will open the latch 62, thus releasing the hook portion 61 from the locking pin 70. Once the latch 62 is free of the locking pin 70, the spring loading will cause the latch 62 to return to its equilibrium position, which is illustrated in figure 5. The throat of the hook portion 61 is thus closed again. Latch 62 is configured such that it will not move further towards the throat of hook portion 61, so that hook portion 61 cannot again move into engagement with locking pin 70. The released position of the locking mechanism as illustrated in figure 5 will thus be retained by the locking hook 60, even after the actuation force applied to the release element 33 is removed.

[0071] After actuation of the release element 33, the locking mechanism 30 thus retains its unlocked state. Nevertheless, the first and second connector parts 10, 20 are still hold in engagement by the internal latching mechanism 50. Accordingly, the ROV can release the release element 33 and can grab the handle portion 40 without an uncontrolled disengagement of the connector parts. Upon grabbing the handle portion 40, the ROV can apply a pulling force. This will release the latching mechanism 50, as explained above, and will furthermore pull the first connector part 10 out of the second connector part 20. The connector 100 is thus de-mated in a safe and secure manner.

[0072] The locking mechanism 30 is furthermore adapted to provide a visual indication of whether it is in the locked state or not. This is achieved by providing a coloring or color mark on the locking pin 70. This color mark, which can be in a signal color, is visible when the locking mechanism is not engaged. Upon the hook portion 61 engaging the locking pin 70, the color mark is covered by the hook portion 61. This can be recognized by an ROV camera, thus giving a positive confirmation of the connector 100 being correctly engaged and locked. Furthermore, since the first and second locking members 31, 32 are mounted outside respective housings of the first and second connector parts, the correct locking of the locking mechanism 30 can also be monitored without

any additional color marks, e.g. by a visual inspection of the hook portion 61 engaging the locking pin 70.

[0073] It should be clear that the embodiment of the connector 100 illustrated and explained with respect to the figures 2 to 5 is only an exemplary implementation of the locking mechanism 30. In other embodiments, the release element 33 and the movable locking element (e. g. the locking hook 60) may be provided on the second connector part, e.g. on the receptacle part of connector 100. In even other embodiments, the locking hook 60 may be a fixed locking element, and the locking pin 70 may be a movable locking element which can be moved from a locked position to a released position. In further embodiments, the locking mechanism may only comprise a single pair of first and second locking members, or may comprise more than two pairs of first and second locking members.

[0074] Figure 6 is a perspective view showing the first connector part 10 of the connector 100 of figures 2-5. Only selected components of the connector are shown for the purpose of a comprehensive presentation. The locking mechanism 30 comprises two leaf springs 34 adapted to bias the release element 33 towards a locked position. This means that for moving the release element 33 into the released position, the biasing force applied by the springs 34 has to be overcome. Since the biasing force is transmitted via the actuating rods 65 to the locking hook 60, this also implies that the locking hook 60 is biased towards the locked position, thus enabling the automatic engagement of the locking mechanism as described above.

[0075] Figure 7 is a flow diagram illustrating a method according to an embodiment of the invention. In step S1, a first connector part and a second connector part of the connector 100 are provided for subsea use. The handle portion 40 of the first connector part 10 is then gripped by means of an ROV in step S2. By manipulating, in particular by pushing the handle portion of the first connector part, the first connector part is moved into engagement with the second connector part in step S3, thereby bringing the connector 100 into a mated position. By means of the latching mechanism 50, the first connector part is latched to the second connector part in step S4. As explained above, this can occur automatically while bringing the connector into the mated position. In step S5, the locking mechanism 30 of the connector 100 is engaged automatically. This means that when bringing the connector into the mated position, the first connector part is automatically locked to the second connector part, e.g. by means of the hook and pin configuration explained further above.

[0076] In step S6, the connector is operated in the mated position. For de-mating the connector (i.e. bringing it into the unmated position), the release element 33 is actuated in step S7, e.g. by means of an ROV. The actuation of the release element 33 brings the locking mechanism 30 into the released state (step S8), whereby the first connector part is unlocked from the second connector part. In step S9, the handle portion 40 of the first connector part 10 is manipulated, for example by pulling and possibly rotating the handle portion 40. This can again occur by means of an ROV, which releases the release element 33 and grips the handle portion 40. By manipulating the handle portion 40, the first connector part is disengaged from the second connector part. The manipulation may furthermore be such that the latching mechanism is unlatched, i.e. the first connector part is unlatched from the second connector part. After disengagement, the connector is in an unmated state (step S10).

[0077] The method may be performed with the connector 100 in any of the above outlined configurations.

[0078] It should be clear that not all steps need to be performed, and that steps may be performed in a different order. As an example, a servicing operation may only require the de-mating of the connector, and thus the performance of steps S6 to S8. In other embodiments, such as the installation of a subsea cable, only the providing of a connection may be required, and the method may thus comprise only the steps S1 to S5.

[0079] Embodiments of the invention may thus provide several advantages. The locking mechanism allows the connector parts to be retained in their correct position, i. e. additional mechanical strength against disengagement is provided. The locking mechanism furthermore provides a visual indication of a correct or incorrect engagement of the first and second connector parts. By providing the release element separate from the handle portion, only an intentional disconnection of the first and second connector part is possible. The risk of an unintentional disengagement of the connector parts can be reduced significantly.

[0080] While specific embodiments are disclosed herein, various changes and modifications can be made without departing from the scope of the invention. The present embodiments are to be considered in all respects as illustrative and non-restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

Claims

1. A connector for use underwater or in a wet or severe environment, comprising

   - a first connector part (10) and a second connector part (20) adapted to have a mated position in which the first connector part and the second connector part are engaged with each other for establishing a connection,
   - a locking mechanism (30) adapted to lock the first connector part (10) to the second connector part (20) in the mated position,
   - a handle portion (40) provided on the first connector part (10), the first connector part (10) being configured such that by manipulating the

handle portion (40) of the first connector part, the first connector part (10) can be disengaged from the second connector part (20) when the locking mechanism (30) is in a released state,
- a release element (33) for the locking mechanism (30), wherein the release element (33) is separate from the handle portion (40), the release element (33) being coupled to the locking mechanism (30) such that upon actuation of the release element in the mated position, the locking between the first connector part (10) and the second connector part (20) is released.

2. The connector according to claim 1, further comprising a latching mechanism (50), wherein in the mated position, the latching mechanism (50) is adapted to latch the first connector part (10) to the second connector part (20), wherein the latching mechanism (50) is configured such that by manipulating the handle portion (40) of the first connector part when disengaging the first connector part from the second connector part, the latching between the first connector part and the second connector part is released.

3. The connector according to claim 1 or 2, wherein the locking mechanism (30) comprises a first locking member (31) provided on the first connector part (10) and a second locking member (32) provided on the second connector part (10).

4. The connector according to claim 3, wherein at least one of the first and second locking members (31, 32) is a fixed locking element (32) and the other of the first and second locking members is a movable locking element (31), the movable locking element (31) having a locked position in which the movable locking element (31) is in engagement with the fixed locking element (32) and a released position in which the movable locking element (31) is disengaged from the fixed locking element (32), wherein the locking mechanism (30) is configured such that by moving the first connector part into engagement with the second connector part, the movable locking element (31) is brought into the locked position, and wherein the release element (33) is coupled to the movable locking element (31) such that by actuation of the release element (33), the movable locking element can be brought into the released position.

5. The connector according to claim 3 or 4, wherein one of the first and second locking members (31, 32) comprises at least one locking pin (70) and the other of the first and second locking members comprises at least one locking hook (60) configured to engage the locking pin (70) in the mated position.

6. The connector according to claim 5, wherein the locking hook (60) has a locked position in which the locking hook (60) is in engagement with the locking pin (70), wherein the locking hook (60) is a movable locking element that is movable by actuation of the release element (33) into a released position in which the locking hook (60) is disengaged from the locking pin (70).

7. The connector according to claim 5 or 6, wherein the locking hook (60) is a movable locking element, the locking hook having a tapered front portion, wherein the locking pin (70) and the locking hook (60) are configured and arranged such that when moving the first connector part (10) into engagement with the second connector part (20), the locking hook (60) is moved out of an equilibrium position by interaction between the locking pin (70) and the front portion of the locking hook (60), the locking mechanism further comprising a biasing element adapted to bring the locking hook back into the equilibrium position and into engagement with the locking pin in the mated position.

8. The connector according to any of claims 5-7, wherein the locking hook comprises a latch (62) adapted to at least partially close a throat opening of the locking hook (60), wherein the locking mechanism (30) is configured such that an actuation of the release element (33) moves the locking hook away from the locking pin such that the locking pin (70) applies a force to the latch (62), thereby opening the latch and releasing the locking hook from the locking pin.

9. The connector according to any of claims 3 to 8, wherein the first locking member (31) and the second locking member (32) are provided outside a housing (11, 21) of the first connector part and the second connector part, respectively.

10. The connector according to any of claims 3-9, wherein at least one of the first and second locking members (31, 32) is adapted to provide a visual indication of whether the locking mechanism (30) is in a locked state or in the released state.

11. The connector according to any of claims 3-10, wherein the first locking member (31) comprises at least two locking hooks (60) mounted to opposing sides of the first connector part (10) and wherein the second locking member (32) comprises at least two locking pins (70) mounted to opposing sides of the second connector part, each locking hook (60) being arranged so as to engage a respective locking pin (70) when the first and second connector parts (10, 20) are in the mated position.

12. The connector according to any of the preceding claims, wherein the locking mechanism (30) is con-

figured such when the connector is brought into the mated position by moving the first connector part into engagement with the second connector part, the first connector part (10) is automatically locked to the second connector part (20).

13. The connector according to any of the preceding claims, wherein the first connector part (10) has a front portion (16) which engages the second connector part (20), and wherein the handle portion (40) and the release element (33) are provided at a rear portion of the first connector part (10).

14. The connector according to any of the preceding claims, wherein the release element (33) and/or the handle portion (40) are adapted to be operable by an ROV.

15. A method of operating a connector for use underwater or in a wet or severe environment, the method comprising the steps of

- providing the connector (100) in a mated position in which a first connector part (10) of the connector and a second connector part (20) of the connector are in engagement, wherein a locking mechanism (30) of the connector (100) locks the first connector part (10) to the second connector part (20),
- actuating a release element (33) coupled to the locking mechanism (30) to release the locking between the first connector part (10) and the second connector part (20), thereby bringing the locking mechanism (30) into a released state, and
- disengaging the first connector part (10) from the second connector part (20) by manipulating a handle portion (40) of the first connector part (10), the handle portion (40) being separate from the release element (33).

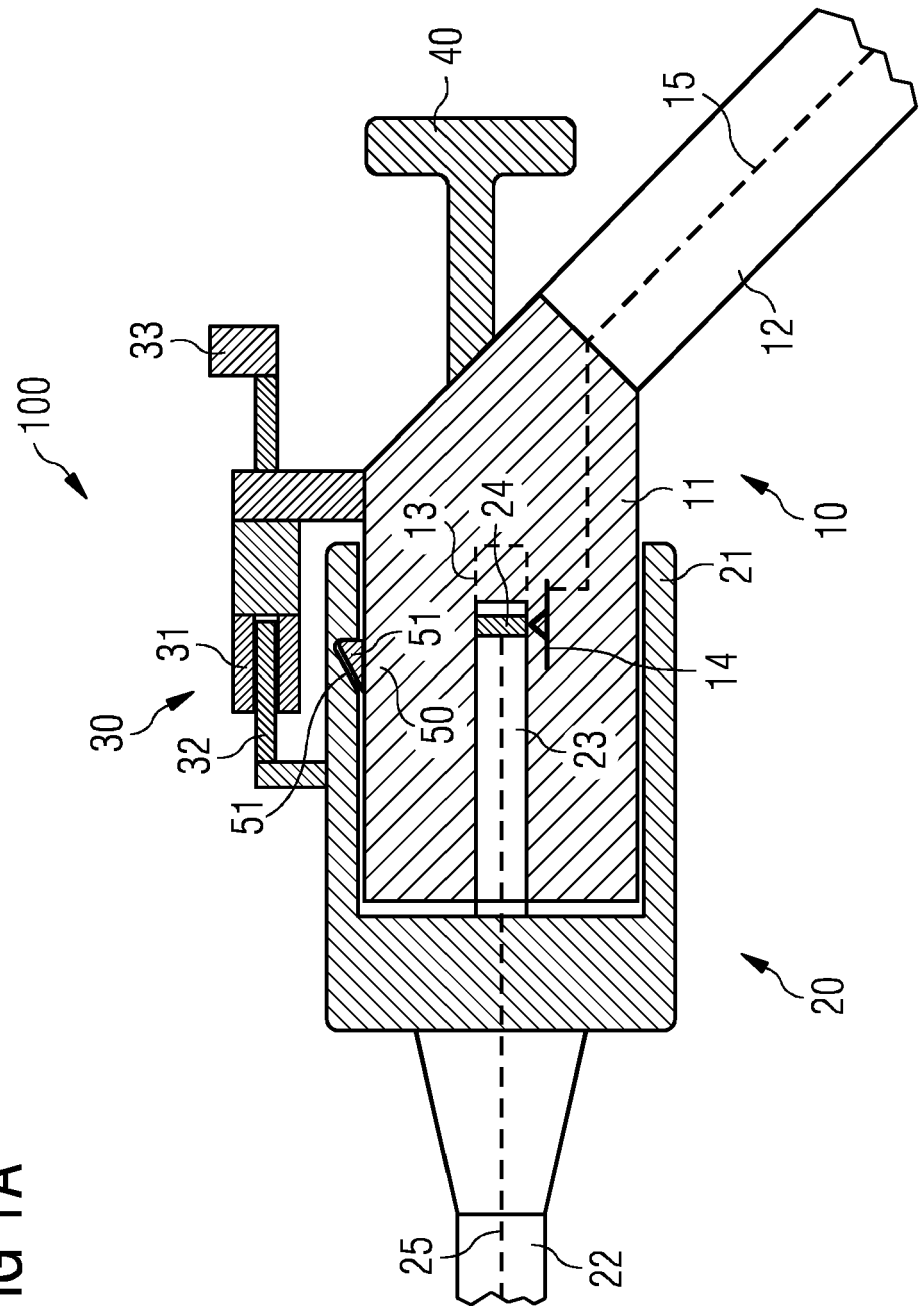


FIG 1A

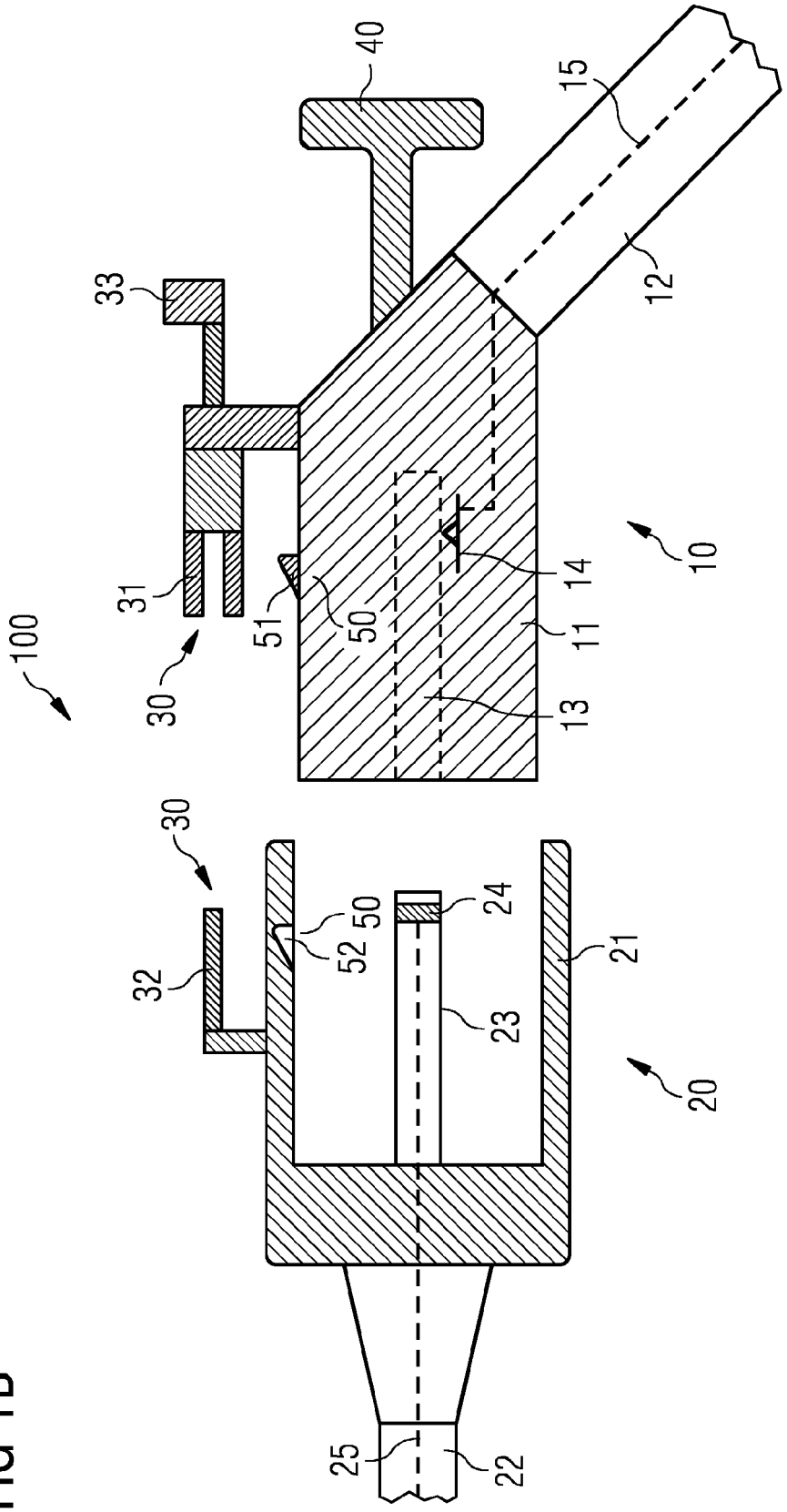


FIG 1B

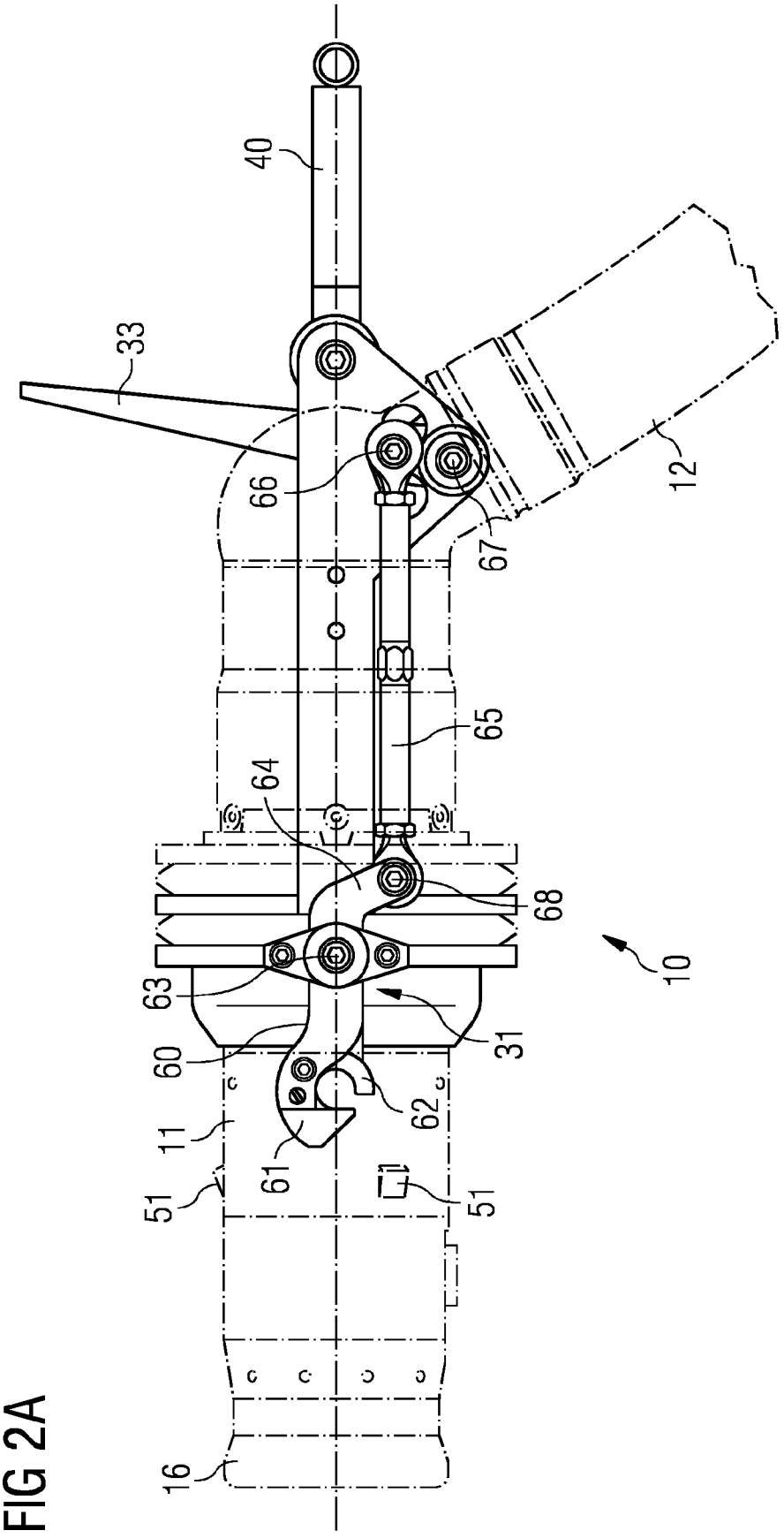


FIG 2A

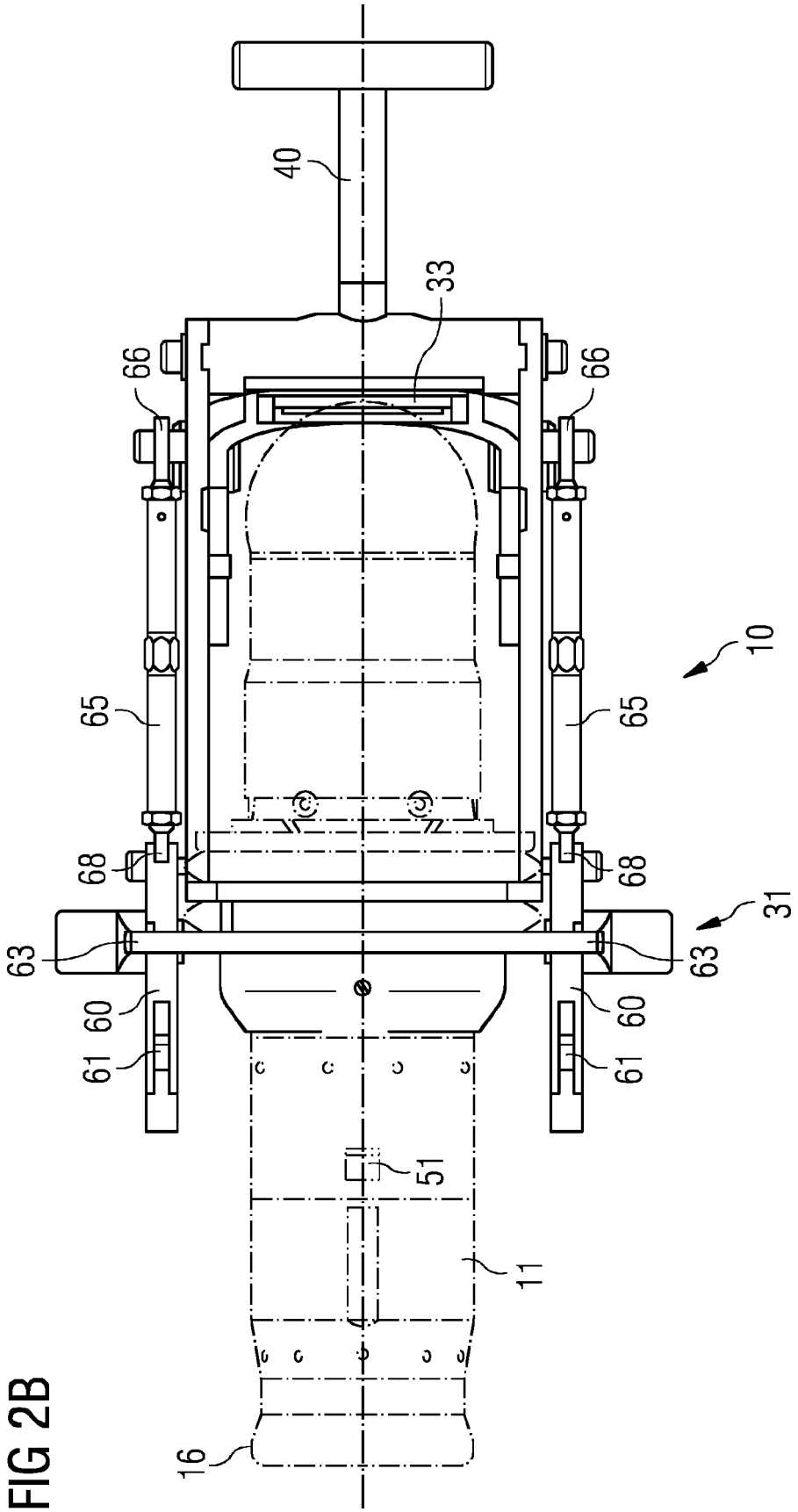


FIG 2B

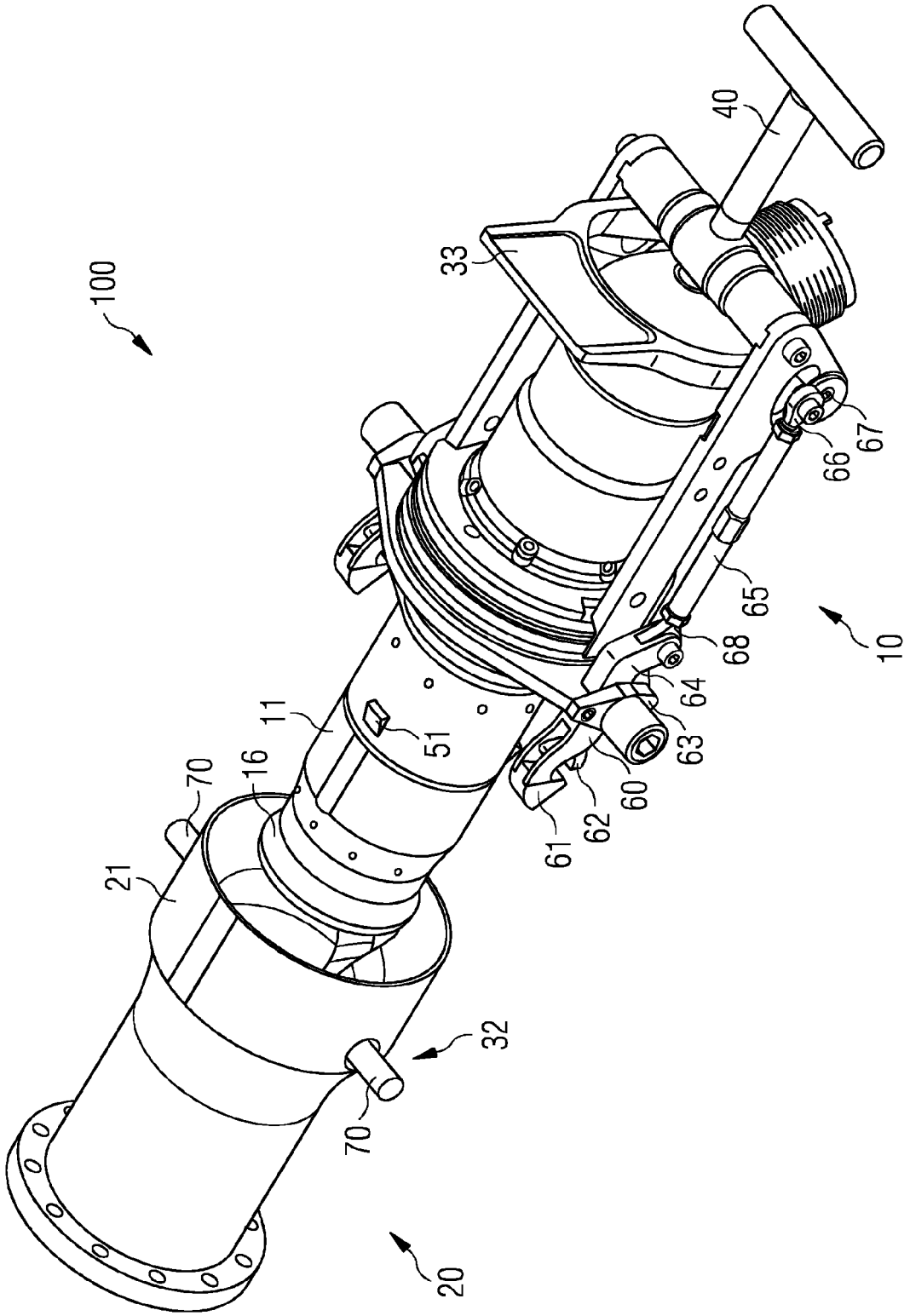


FIG 3

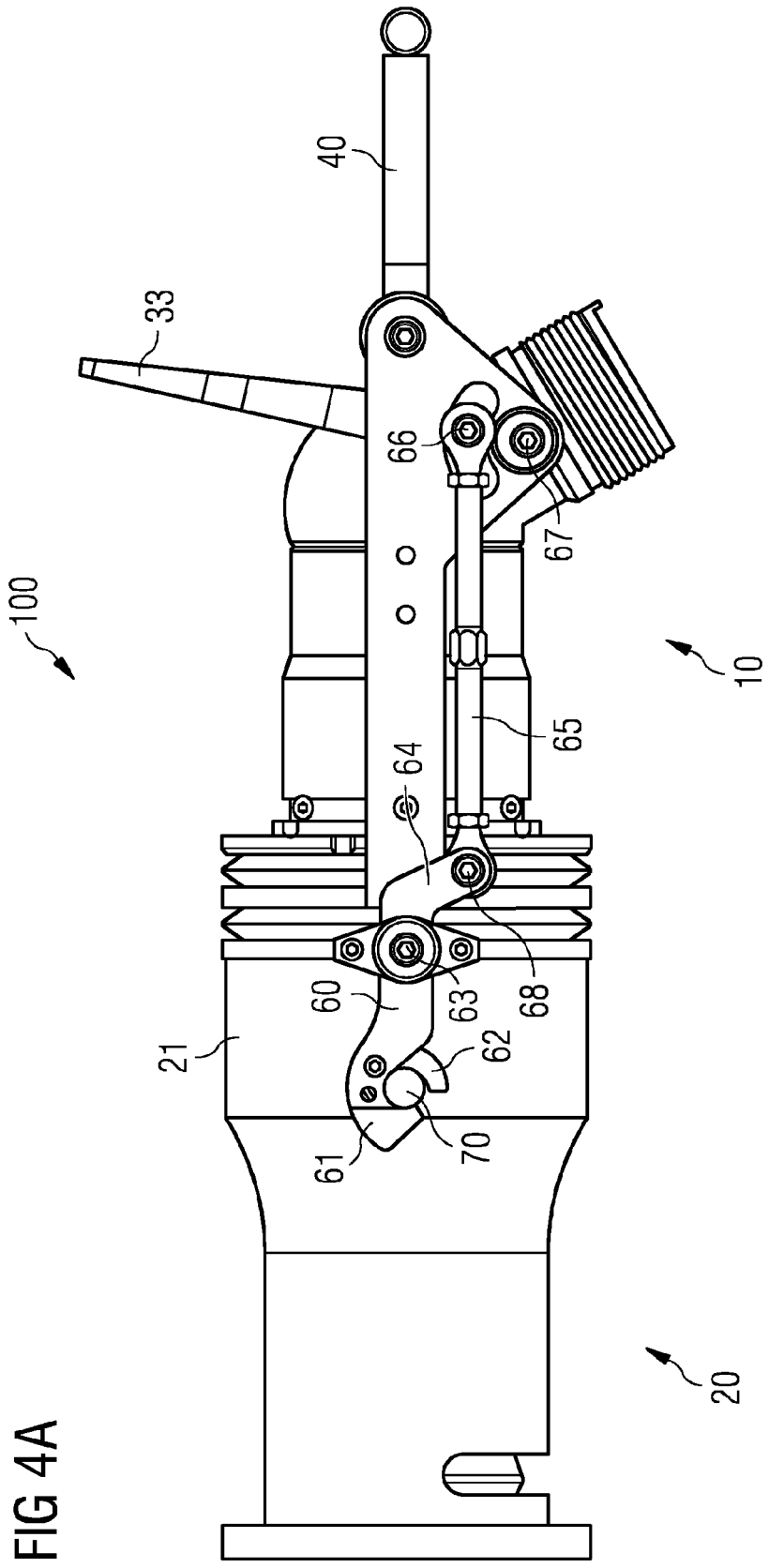
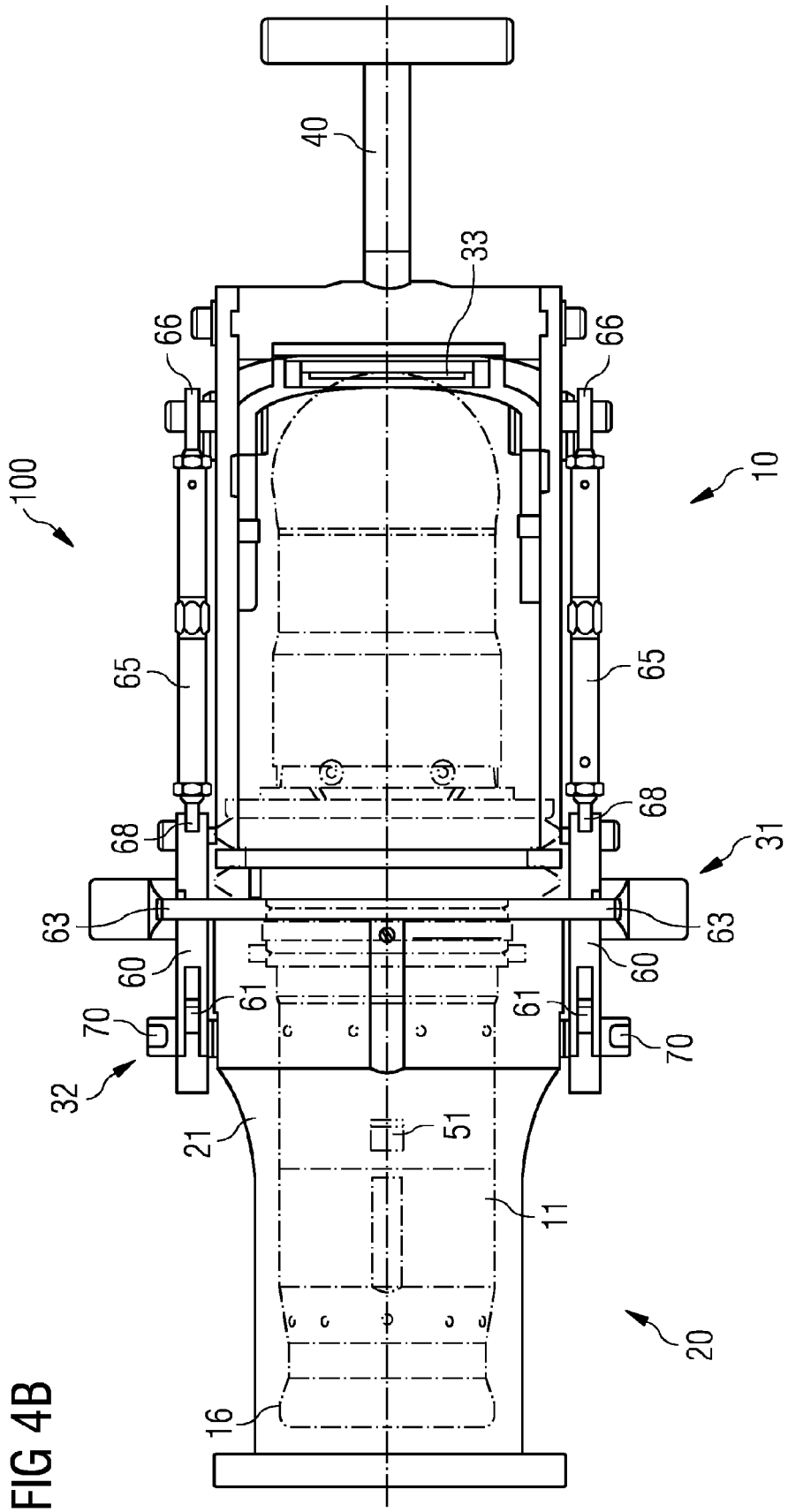


FIG 4A


40
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16

FIG 4B

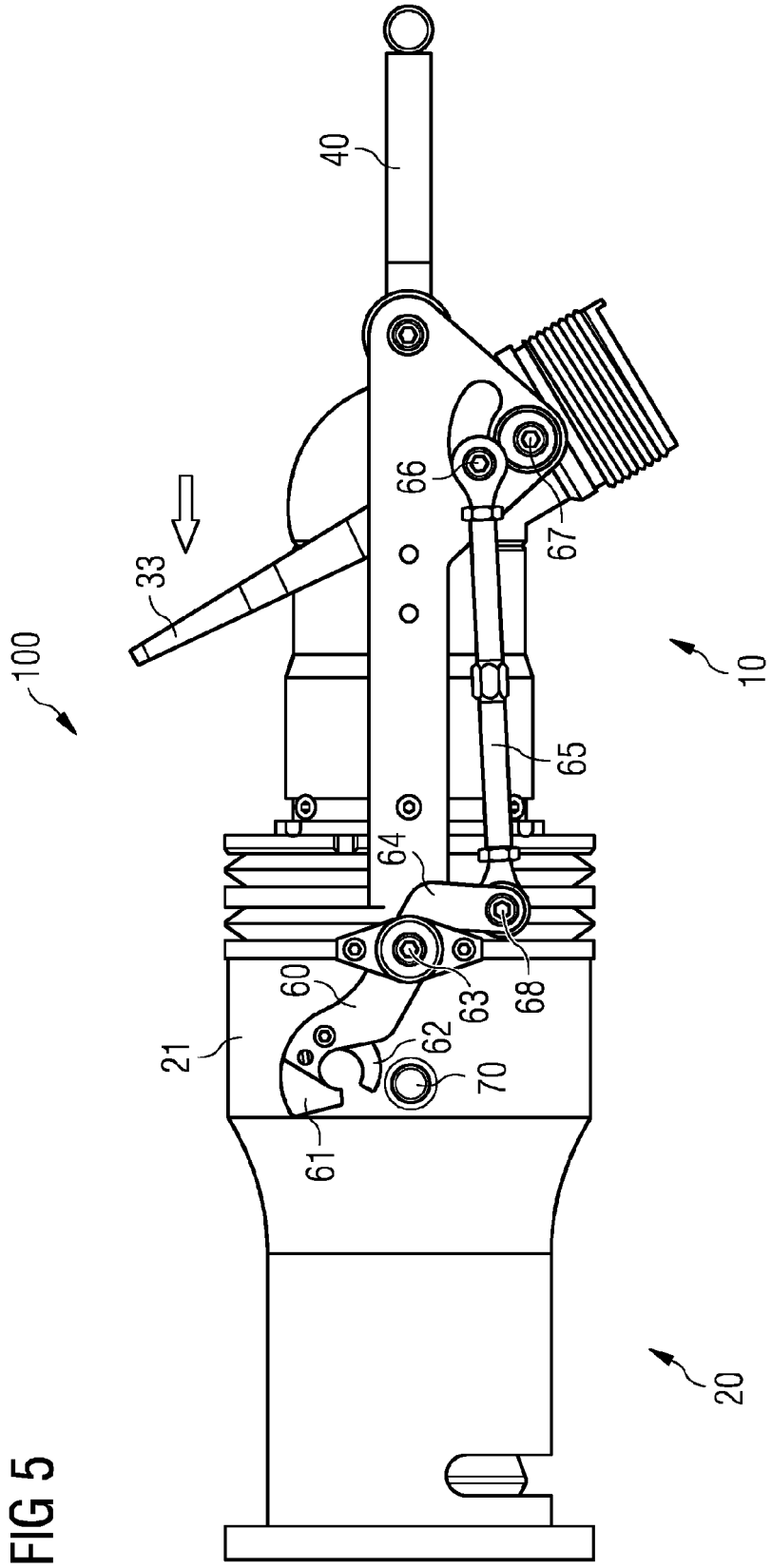


FIG 5

FIG 6

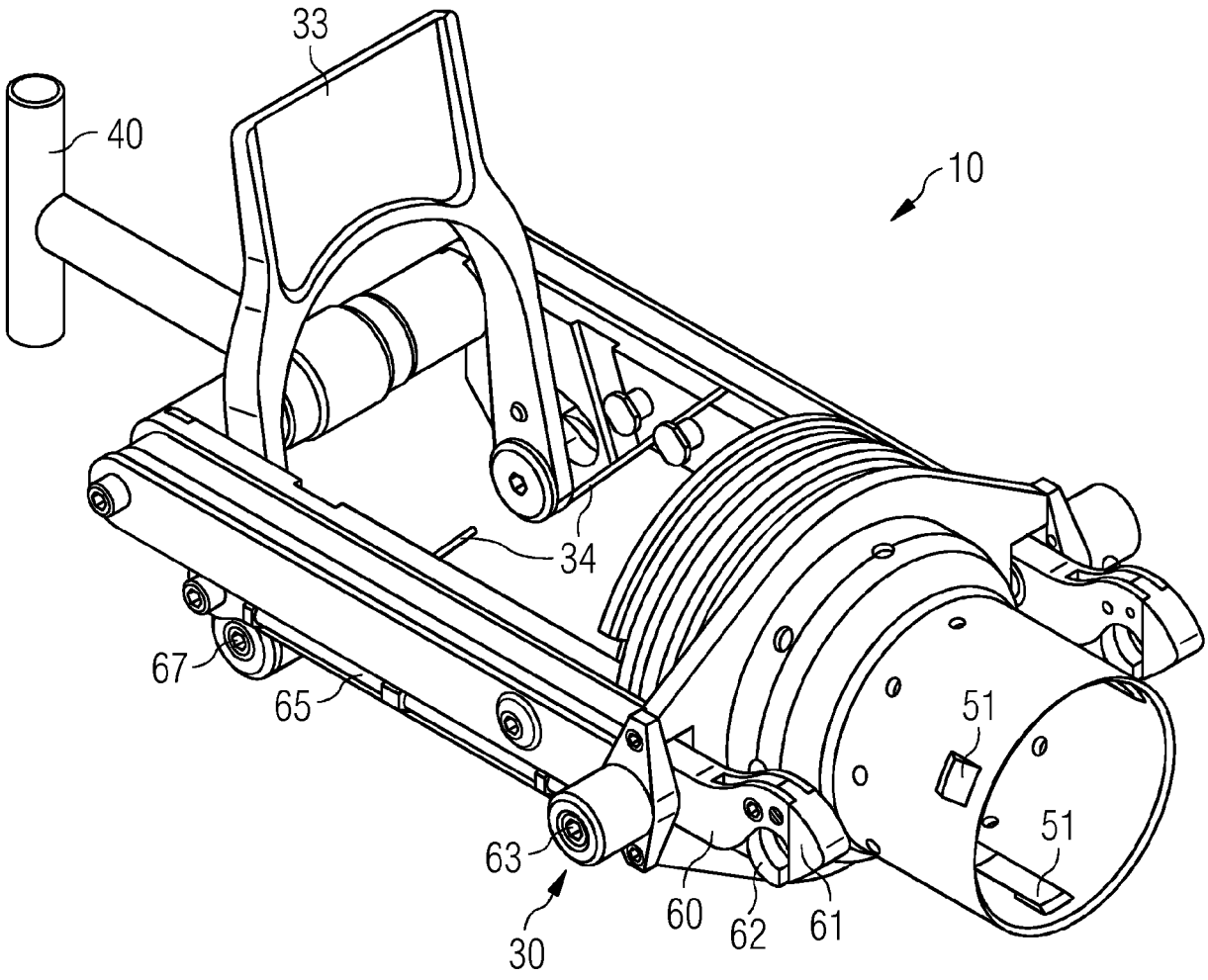
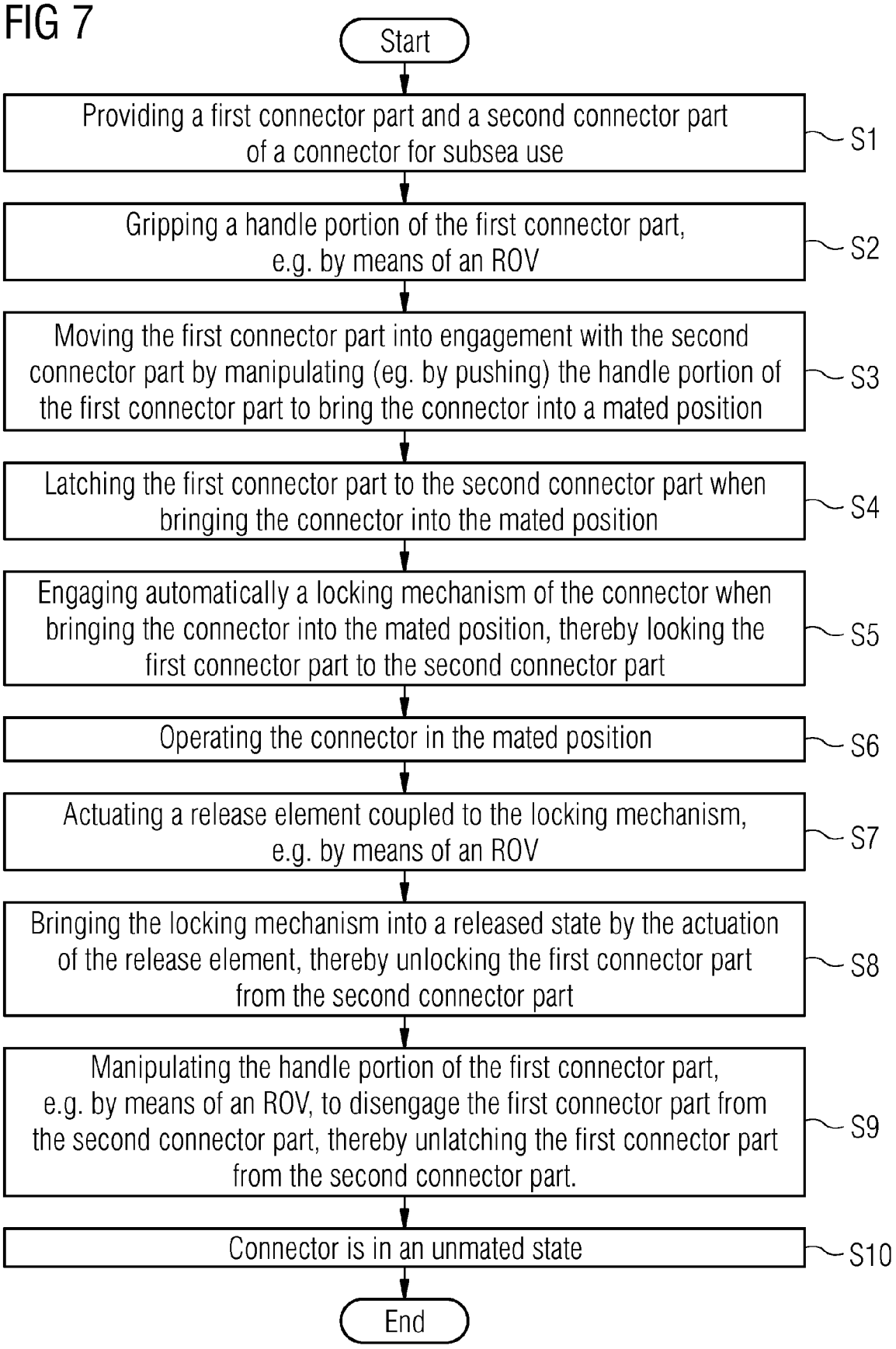


FIG 7


Start
Providing a first connector part and a second connector part of a connector for subsea use
S1
Gripping a handle portion of the first connector part, e.g. by means of an ROV
S2
Moving the first connector part into engagement with the second connector part by manipulating (eg. by pushing) the handle portion of the first connector part to bring the connector into a mated position
S3
Latching the first connector part to the second connector part when bringing the connector into the mated position
S4
Engaging automatically a locking mechanism of the connector when bringing the connector into the mated position, thereby looking the first connector part to the second connector part
S5
Operating the connector in the mated position
S6
Actuating a release element coupled to the locking mechanism, e.g. by means of an ROV
S7
Bringing the locking mechanism into a released state by the actuation of the release element, thereby unlocking the first connector part from the second connector part
S8
Manipulating the handle portion of the first connector part, e.g. by means of an ROV, to disengage the first connector part from the second connector part, thereby unlatching the first connector part from the second connector part.
S9
Connector is in an unmated state
S10
End

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EUROPEAN SEARCH REPORT

Application Number
EP 13 19 1093

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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H01R
E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	23 January 2014	Knack, Steffen

CATEGORY OF CITED DOCUMENTS

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23-01-2014

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