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(54) OFFSHORE TRANSFER SYSTEM WITH A DOCKING POSITION ON A TRANSFER VESSEL THAT COMPRISES A MOTION COMPENSATED MOORING ELEMENT

(57) An offshore transfer system for transferring persons and/or cargo between a transfer vessel (TV) and an offshore object, wherein the transfer vessel (TV) comprises a docking position (DP) with a mooring element (ME), and wherein the offshore object comprises a docking arm, in particular a gangway (GW), that at a free end is provided with a coupling device (CD). The docking position (DP) on the transfer vessel (TV) has its mooring element (ME) at least partly compensated for transfer vessel motions, at least during a docking operation, and comprises one or more force actuators for moving the mooring element (ME) relative to the transfer vessel (TV), one or more sensors for detecting motions of the transfer vessel (TV), and a control unit for driving the one or more force actuators such that the motions of the transfer vessel (TV) get at least partly compensated for the mooring element (ME).

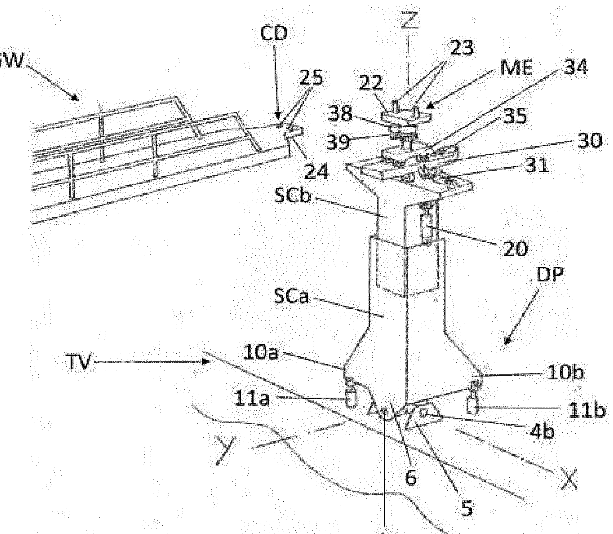

Fig. 1

EP 3 862 257 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an offshore transfer system for transferring persons and/or cargo between a transfer vessel and an offshore construction, floating platform or other vessel, wherein the transfer vessel is provided with a docking position, wherein the offshore construction, floating platform or other vessel comprises a docking arm, in particular a gangway, that at a free end is provided with a coupling device, and wherein the docking position comprises a mooring element that is configured to have the coupling device at the free end of the docking arm coupled thereto during a docking operation.

BACKGROUND TO THE INVENTION

[0002] From the state of the art all kinds of systems and constructions are known for making temporary connections at sea between transfer vessels and offshore constructions, floating platforms or other vessels. Those temporary connections particularly get formed by gangways. After such a gangway has been reliably coupled during a docking operation, the persons and/or cargo can then be quickly and safely transferred from the transfer vessel towards the offshore construction, floating platform or other vessel, and vice versa.

[0003] The gangway that mostly is provided on the transfer vessel, is provided at its free end with a suitable coupling device. This coupling device is configured to couple with a complementary mooring element of a docking position that forms part of or that is specifically provided on the offshore construction, floating platform or other vessel.

[0004] For example, from WO-02/20343 a system is known that is used for achieving a flexible walkway connection between a vessel and an offshore construction. For this purpose, the vessel is provided with a telescopically extendable walkway which at one end is movably mounted on the vessel around two shafts. At the free end of the walkway a coupling device is provided, which is made in such a way that it can be coupled to a substantially vertically pointing grip bar connected to the offshore construction. While mooring, the vessel is manoeuvred to a suitable starting position in relation to the grip bar. Next, the walkway is aimed towards the middle part of the grip bar by means of a suitable swivel movement and the walkway is extended until the coupling device encompasses the grip bar. Then, the coupling device's two hydraulically controlled coupling jaws - which can move towards each other from an open position - are closed. They are closed in such a way, that the coupling device still has the freedom to move upwards along the grip bar during the coupling phase. After reaching the required coupling position just below the landing, the coupling claws are moved closer towards each other in order to tightly clamp onto the grip bar and fix the position at that location. Finally, a number of degrees of freedom of the walkway are released, i.e. the movability around the two shafts and the telescopic extendibility. By using rotatable screws and satellite navigation, the vessel can be kept at its location without strong forces being submitted to the walkway and/or the grip bar.

[0005] A disadvantage here, is that the coupling procedure can sometimes be somewhat cumbersome, especially during stormy weather. The forces that are generated at the moment that the arm hits the grip rod, are very hard to control under these circumstances. This is due to the fact that at the moment of contact, large weights have to be slowed down and the drives concerned must be switched off immediately at the same time. Additionally, during the coupling phase, closing the coupling jaws has to be accurately attuned to the release of the walkway's remaining degrees of freedom, in order to avoid damages to the vessel. Another disadvantage is that the vertical grip rod has to extend over a large range, making it relatively expensive and difficult to assemble. Furthermore, the known system proved to be unsuitable for smaller vessels that are not 'dynamic positioned', i.e. they are not equipped in such a way that they can be kept in position by means of rotatable screws and satellite navigation.

[0006] Various other docking positions with mooring elements are known from the state of the art to be provided on all kinds of offshore constructions, floating platforms or vessels, and that are all specifically configured to cooperate with specifically designed coupling devices at the ends of gangways or other types of docking arms that are provided on all kinds of transfer vessels.

[0007] For example, Ampelmann nowadays is using a rubber D-buffer that is mounted at a tip of a gangway as coupling device, and a U- or H-profile that is mounted at a docking position of an offshore construction as mooring element. The rubber D-buffer is destined to be pushed into the U- or H-profile during a docking operation.

[0008] Here however the same disadvantage goes that the coupling phase leaves to be improved because it can be somewhat time consuming, less reliable and/or bring along a risk that vulnerable parts of the docking position or of the gangway may get damaged during the coupling phase, particularly during harsh weather or rough sea, or e.g. because one or more degrees of freedom of the gangway are difficult to control to stay stationary relative to the mooring element and/or are not released in time.

BRIEF DESCRIPTION OF THE INVENTION

[0009] The present invention aims to overcome those disadvantages at least partly or to provide a usable alternative. In particular the present invention aims to provide a user-friendly and safe offshore transfer system that is able to make the docking operation itself easier, quicker and less vulnerable, and that is also able to be properly performed during harsh weather conditions, rough sea or the like that cause the transfer vessel and possibly also the floating platform or other vessel to ride the waves and make large pitch, roll and/or heave motions .

[0010] According to the present invention this aim is achieved by an offshore transfer system for transferring persons and/or cargo between a transfer vessel and an offshore construction, floating platform or other vessel according to claim 1. The transfer vessel according to this system comprises a docking position, whereas the offshore construction, floating platform or other vessel according to this system comprises a docking arm, in particular a gangway, that at a free end is provided with a coupling device. The docking position on the transfer vessel comprises a mooring element that is configured to have the coupling device at the free distal end of the docking arm coupled thereto during a docking operation. According to the inventive thought the docking position on the transfer vessel has its mooring element at least partly compensated for motions of the transfer vessel, at least during the docking operation. For this, the docking position comprises one or more force actuators for moving the mooring element relative to the transfer vessel, one or more sensors for detecting one or more of pitch, roll and/or heave motions of the transfer vessel, and a control unit for driving the one or more force actuators such that the one or more detected motions of the vessel get at least partly compensated for the mooring element of the docking position.

[0011] Advantageously, the invention is able to create a stable mooring element of the docking position on the transfer vessel, even when this transfer vessel is thrown in all kinds of directions by wind and waves. Owing to the provision of the feedback-loop between the sensors, the control unit and the force actuators, it is possible to keep the mooring element substantially still/motionless in one or more orientations, or when desired even in its entirety.

[0012] During compensation, the one or more force actuators of the docking position on the transfer vessel are accurately driven by the control unit in dependency of the one or more of pitch, roll and/or heave motions of the transfer vessel that are detected by the one or more sensors, in such a way that those one or more detected motions get at least partly compensated for the mooring element. In this manner one or more of x-, y- and z-orientations of the mooring element can be maintained independent of the one or more motions of the transfer vessel. Thus the mooring element can be kept quite stable for those respective one or more x-, y- and z-orientations, while the transfer vessel has all freedom to make all kinds of small or large pitch, roll and/or heave motions that are caused by waves, wind, etc.

[0013] This may truly facilitate the coupling of the coupling device at the end of the docking arm, like the gangway, thereto during a docking operation of the transfer vessel with the offshore construction, floating platform or other vessel. Either the docking arm can be quickly, easily and reliably be manoeuvred with its end part towards the stably held at least partly motion compensated mooring element, either the transfer vessel with its stably held at least partly motion compensated mooring element can be quickly, easily and reliably be manoeuvred towards the end part of the docking arm. A large risk for dangerous or possibly damaging situations to occur is no longer present.

[0014] Another important advantage is that the invention also makes it possible to maintain having the mooring element at least partly motion compensated after the coupling with the docking arm has taken place. This may facilitate a stepping from the transfer vessel onto the gangway and from the gangway onto the transfer vessel.

[0015] In an embodiment the compensation of the mooring element is controlled such by the control unit that the position resp. orientation of the mooring element is referred to the "fixed world", that is to say kept substantially stable relative to the horizon. It is however also possible that the compensation of the mooring element is controlled such by the control unit that the position resp. orientation of the mooring element is referred to the coupling device at the end of the docking arm, including when this docking arm is of a type that can be actively manoeuvred such that the coupling device at its free end gets to make movements to and from the mooring element during a docking operation. The at least partly motion compensated mooring element is well able to also take care of compensating any such movements of the free end of the docking arm as well. For that, one or more additional sensors can be provided for detecting movements of the free end of the docking arm as well, and the control unit for driving the one or more force actuators then can be configured such that the movements of the free end of the docking arm also can get at least partly compensated for the mooring element of the docking position on the transfer vessel.

[0016] In addition thereto or in the alternative, when the docking arm is provided on a somewhat moving floating platform or other vessel, the docking arm advantageously may be supported thereupon via a basis that does not necessarily have to be motion compensated relative to this floating platform or other vessel at all, not even partly. The at least partly motion compensated mooring element is well able to also take care of compensating any such movements of the floating platform or other vessel as well. For that, one or more additional sensors can be provided for detecting one or more of pitch, roll and/or heave motions of the floating platform or other vessel as well, and the control unit for driving the one or more force actuators then can be configured such that the one or more detected motions of the floating platform or other vessel also can get at least partly compensated for the mooring element of the docking position on the transfer vessel.

[0017] Owing to the invention, the docking arm, during a docking operation, may be kept rigid in its entirety relative to the offshore construction, floating platform or other vessel upon which it is supported. The transfer vessel with its stably held at least partly motion compensated mooring element then can be sailed towards the offshore construction, floating platform or other vessel, where it can be carefully manoeuvred with its stably held at least partly motion compensated mooring element towards the coupling device at the free end of the docking arm and have it coupled thereto.

[0018] It is however preferred that the docking arm is of a type that, during a docking operation, can be actively manoeuvred along one or more degrees of freedom, like being swivelled around a horizontal axis and/or turned around a vertical axis at the location of its supported proximal end relative to the offshore construction, floating platform or other vessel, and/or like being extended or retracted by movable telescoping parts thereof. The stability in space of the mooring element on the transfer vessel then makes it way easier for an operator to manoeuvre the docking arm with its coupling device towards the mooring element and couple it therewith. It even makes it possible to have such a coupling operation performed in a fully automated manner without an operator being needed at all. Another important advantage of an at least partly motion compensated mooring element that is provided on a transfer vessel in combination with a manoeuvrable docking arm that is provided on an offshore construction, floating platform or other vessel, is that it is no longer critical during a docking operation, when the docking arm's degrees of freedom get released. This release no longer has to be accurately attuned with the exact moment that the coupling device has gotten coupled with the mooring element. As long as the mooring element gets at least partly compensated for the one or more motions of the transfer vessel underneath it, no large pushing or pulling "break-free" forces shall all of a sudden be able to start occurring. This adds to the safety of the offshore transfer system. The same goes for a decoupling phase, then also it is no longer critical at what exact moment in time the docking arm needs to get actively manoeuvred again in relation to the exact moment in time its coupling device gets actively released again from the mooring element on the transfer vessel.

[0019] The transfer vessel with its stably held at least partly motion compensated mooring element then can be sailed towards the offshore construction, floating platform or other vessel where it can be kept 'dynamic positioned'. Subsequently the docking arm can be carefully manoeuvred with the coupling device at its free end towards the stably held at least partly motion compensated mooring element and have it coupled thereto.

[0020] In a preferred embodiment, the mooring element can be supported by and connected to the transfer vessel by means of a hinge connection that is designed to allow the transfer vessel to rotate relative to the mooring element in a rotation direction around an y-axis, wherein the y-axis extends substantially horizontal, in particular in a direction transverse to a longitudinal direction of the transfer vessel, and wherein a first one of the one or more force actuators acts between the transfer vessel and the mooring element for swivelling the mooring element around the hinge connection relative to the transfer vessel at least in the rotation direction around said y-axis. Thus the most important one of the transfer vessel motions, that is to say the pitch rotations around its transverse y-axis can get compensated for.

[0021] In addition thereto or in the alternative, the hinge connection can be designed to allow the transfer vessel to also rotate relative to the mooring element in a rotation direction around an x-axis, wherein the x-axis extends substantially horizontal, in particular in a direction parallel to a longitudinal direction of the transfer vessel, wherein the x- and y-axis extend orthogonal relative to each other, wherein a second one of the one or more force actuators acts between the transfer vessel and the mooring element for swivelling the mooring element around the hinge connection relative to the transfer vessel at least in the rotation direction around said x-axis. Thus the second most important one of the transfer vessel motions, that is to say the roll rotations around its longitudinal x-axis can get compensated for.

[0022] In combination a specific type of 2-DOF hinge support of the mooring element on the transfer vessel can be obtained that together with the provision of the force actuators acting in those same 2-DOF's advantageously make it possible to provide a well-supported mooring element, of which a desired orientation, can be maintained under all circumstances whatever pitching or rolling movements the transfer vessel makes on the waves. Each time the mooring element leaves its desired orientation, the force actuators can be actuated in such a way that the mooring element is quickly and smoothly brought back into its desired orientation. The force actuators do not have to bear the weight of the mooring element, this weight can be carried by the hinge connection. The force actuators merely serve the purpose of keeping the mooring element in its desired orientation.

[0023] The hinge connection is of the type having at least two rotational degrees-of-freedom (DOF) whereas shifting displacements between the transfer vessel and the mooring element at the location of the hinge connection are counteracted, and whereas forces, like weight forces, can be transmitted from the mooring element towards the vessel and vice versa. The hinge connection can take up forces not only in a downward direction but also in the sideways directions without allowing relative displacements of the hinge connection itself in those directions. The hinge connection thus forms a true 2-D pivotal connection between the mooring element and the transfer vessel.

[0024] Persons and cargo can now be transferred over the docking arm towards the offshore construction, floating platform or other vessel. When coupled to the transfer vessel, the docking arm is supported at both ends between the transfer vessel and the offshore construction, floating platform or other vessel, and forms a reliable bridge between them, for example in the form of a gangway. The permanent stable positioning of the mooring element herewith helps to prevent or minimize uncontrollable acceleration forces in horizontal directions caused by sudden pitching or rolling transfer vessel movements. Such forces could otherwise lead to uncontrollable situations in which the docking arm might get damaged.

[0025] In a particular embodiment the hinge connection may comprise two substantially horizontal orthogonal pivot pins. Those two pivot pins may form part of a so-called Universal or Cardan joint or an assembly of two Gimbals also referred to as a two-axis Gimbal. The Universal joint, Cardan joint or Gimbal assembly allows the mooring element and transfer vessel to swivel around both the x- and y-axes relative to each other. The pivot pins are located close together and preferably lie in a same common substantially horizontal plane. They form a double-pivoted support that allows the rotation of the mooring element and vessel relative to each other about two respective axes. With the Universal joint, the Cardan joint and the Gimbal assembly, the mooring element can be mounted on one of the pivot pins, whereas the transfer vessel can be mounted to the other remaining pivot pin. Together the pivot pins of the hinge connection are well able to keep the mooring element substantially immobile with respect to its orientation relative to the horizon regardless of the pitching and rolling motions of the transfer vessel.

[0026] In a preferred further or alternative embodiment, the mooring element may be supported by and connected to the transfer vessel by means of a z-guidance designed to allow the transfer vessel to move relative to the mooring element in a translation direction along a z-axis, wherein the z-axis extends substantially vertical, and wherein a third one of the one or more force actuators acts between the transfer vessel and the mooring element for translating the mooring element along the guidance relative to the transfer vessel at least in the translation direction along said z-axis.

[0027] In addition thereto or in the alternative, the mooring element may be supported by and connected to the transfer vessel by means of an x-guidance designed to allow the transfer vessel to move relative to the mooring element in a translation direction along the x-axis, wherein a fourth one of the one or more force actuators acts between the transfer vessel and the mooring element for translating the mooring element along the guidance relative to the transfer vessel at least in the translation direction along said x-axis.

[0028] In addition thereto or in the alternative, the guidance can be designed to allow the transfer vessel to also move relative to the mooring element in a translation direction along the y-axis, wherein a fifth one of the one or more force actuators acts between the transfer vessel and the mooring element for translating the mooring element along the guidance relative to the transfer vessel at least in the translation direction along said y-axis.

[0029] Thus any substantial vertical up and down movements and/or any substantial horizontal back and forth movements and/or any substantial left and right movements of the transfer vessel no longer have to be absorbed by the docking arm changing its angle of inclination around a horizontal hinge connection and/or around a turntable connection with the offshore construction, floating platform or other vessel. Instead the mooring element itself then can get actively compensated for those up and down, back and forth, and left and right movements as well by the control unit and the respective force actuators.

[0030] In a preferred further or alternative embodiment, the docking position further may comprise an upright column extending upwards from the transfer vessel, wherein the mooring element is provided on an upper portion of the column. This adds to the safety of the transfer system particularly during storm and high waves.

[0031] In addition thereto, lever arms can then be provided which are fixedly connected to the column and extend in a substantially sideways direction from it, the force actuators being provided in between the transfer vessel and the lever arms. The lever arms make it possible to use less strong force actuators.

[0032] The force actuators can be of various types, like spindles, stays which can be tensioned or loosened, etc. Preferably, hydraulic cylinders are used since they are able to respond very quickly and thus are able to prevent the mooring element, or the column on top of which the mooring element can be provided, from swinging around too much.

[0033] Preferably the control unit operates fully automated. For this a position sensor for sensing the orientation of the mooring element relative to the horizon, in particular for sensing deteriorations of the column, on top of which the mooring element preferably gets mounted, from a substantially vertical orientation. Furthermore the control unit then is provided for automatically steering the force actuators in dependence of sensed orientations by the position sensor in such a way that the force actuators bring the mooring element back to its aimed orientation, in particular bring the column on top of which it is mounted, back to its substantially vertical orientation. Depending on the rolling and pitching speed of the transfer vessel, the column in this way can for example be kept within +/-2 degrees from the vertical until wind-force 8.

[0034] Further preferred embodiments of the invention are stated in the dependent subclaims.

[0035] The invention also relates to a transfer vessel according to claim 14 and to method according to claim 15.

DETAILED DESCRIPTION OF THE DRAWINGS

[0036] An example of the transfer system according to the invention shall be explained in more detail below with reference to the accompanying drawing in which:

- Fig. 1 schematically shows a perspective view of a motion compensated mooring element on a transfer vessel together with part of a gangway to be coupled thereto;

- Fig. 2 shows a first variant hereof; and
- Fig. 3a and b show a second variant hereof preceding and after coupling.

[0037] In fig. 1 a transfer vessel, of which merely a small portion is shown, is given the reference TV. The transfer vessel TV has a longitudinal direction along an x-axis and a transverse direction along an y-axis. The transfer vessel TV is provided with an upper deck on top of which a docking position DP is provided that comprises a supporting column SC and a mooring element ME on top thereof. The column SC extends upwardly in a vertical direction along a z-axis.

[0038] Between the column SC and the transfer vessel TV a Cardan joint 4 is provided. The Cardan joint 4 forms a hinge connection which has two pivot pins 4a, 4b extending in the horizontal directions x and y and allowing the transfer vessel TV and the column SC to rotate relative to each other around those x- and y-axes. An angle of 90 degrees is enclosed between the two pivot pins 4a, 4b.

[0039] The pivot pin 4b is supported by brackets 5 which are fixedly connected to the transfer vessel TV. The pivot pin 4a is supported by brackets 6 which are fixedly connected to a lower end of the column SC. The column SC projects upwardly in the vertical direction along a z-axis and encloses angles of 90 degrees with both pivot pins 4a, 4b.

[0040] The lower end of the column SC includes two lever arms 10, a first one 10a extending in the x-direction, and a second one 10b extending in the y-direction. Between outer ends of the lever arms 10 and the transfer vessel TV, first and second hydraulic cylinders 11a, 11b are placed. Those cylinders 11 may be pivotally mounted with one side to the lever arms 10 and at their other side to the transfer vessel TV. When operated, the hydraulic cylinders 11 are lengthened or shortened and force the column SC, together with the mooring element ME on top thereof, to rotate/swivel around the x- and/or y-axis relative to the transfer vessel TV.

[0041] The column SC has a lower column part SCa and an upper column part SCb. The upper column part SCb is guided telescopingly relative to the lower column part SCa such that it is movable up and down along the z-axis. Between the lower and upper column parts SCa and SCb, a third hydraulic cylinder 20 is placed. When operated, the hydraulic cylinder 20 is lengthened or shortened and forces the upper column part SCb, together with the mooring element ME on top thereof, to translate along the z-axis relative to the transfer vessel TV.

[0042] The mooring element ME is configured to have a complementary coupling device CD that is provided at a free end of a gangway GW coupled thereto during a docking operation of the transfer vessel TV with an offshore object (not shown in fig. 1) on which the gangway GW is provided. In the embodiment shown in fig. 1 the mooring element ME comprises a coupling surface 22 and two upwardly projecting pins 23, whereas the coupling device CD comprises a coupling surface 24 with two through going openings 25 that are dimensioned slightly larger than the pins 23.

[0043] Between the mooring element ME and the top of the column SC, a first guidance member 30 is provided that is movably guided relative to the upper column part SCb such that it is movable back and forth along the x-axis. Between the first guidance member 30 and the upper column part SCb, a fourth hydraulic cylinder 31 is placed. When operated, the hydraulic cylinder 31 is lengthened or shortened and forces the mooring element ME to translate along the x-axis relative to the transfer vessel TV.

[0044] Between the mooring element ME and the top of the column SC, furthermore a second guidance member 34 is provided that is movably guided relative to the first guidance member 30 such that it is movable between starboard and port side along the y-axis. Between the first guidance member 30 and the second guidance member 34, a fifth hydraulic cylinder 35 is placed. When operated, the hydraulic cylinder 35 is lengthened or shortened and forces the mooring element ME to translate along the y-axis relative to the transfer vessel TV.

[0045] Between the mooring element ME and the top of the column SC, furthermore a turntable 38 is provided that is rotatable relative to the second guidance member 34 such that it is rotatable clockwise and counter-clockwise around the z-axis. Between the second guidance member 34 and the turntable 38, a toothed gear 39 is placed. When operated, the toothed gear 39 is rotated in either direction and forces the mooring element ME to rotate around the z-axis relative to the transfer vessel TV.

[0046] A possible method for docking the transfer vessel TV to the offshore object shall now be explained with reference to fig. 1. In fig. 1 it is shown that the vessel TV has already been sailed to a position alongside the offshore object such that the mooring element ME is positioned in the neighbourhood of the gangway GW that projects sideways of the offshore object. The transfer vessel TV than be kept at that position, for example by being dynamically positioned.

[0047] The gangway GW is of a type that is telescopingly extendable and that can be turned around a vertical axis and that can swivel around a horizontal axis. Thus if necessary the gangway GW can be manoeuvred to point with its outer end towards the mooring element ME. If necessary, for example depending on the water level of the sea, it is also possible to raise or lower the gangway GW in such a way that the gangway GW gets to point towards the mooring element ME. Subsequently the gangway GW can be extended until the coupling device CD comes to lie straight above the mooring element ME. By subsequently lowering the gangway GW, the coupling device CD automatically gets to grip with its openings 25 over the pins 23.

[0048] During the entire docking operation cq coupling process the mooring element ME can be kept in a stable orientation and position relative to the offshore object.

[0049] As soon as the coupling is made, the gangway GW can be given the full freedom to extend or retract such that the distance between the transfer vessel TV and the offshore object can change somewhat. At the same time the swivelling of the gangway GW can also be set free such that the gangway GW is free to alter its angle of inclination, which gives the transfer vessel TV the freedom to rise up and downwards somewhat together with the waves. Furthermore, the turning of the gangway GW can also be set free such that the gangway GW is given the full freedom to turn such that the transfer vessel TV is given the freedom to turn left or right.

[0050] According to the invention the column SC with the mooring element ME on top thereof maintains to be vertically orientated both during coupling and after the coupling has been made. For this, operation of the hydraulic cylinders 11 may be necessary. Depending on the amount and direction of rolling or pitching movements the transfer vessel TV makes, the hydraulic cylinders 11 need to be adjusted in length in order to have the column SC maintain its vertical orientation. This is obtained by means of a control unit which receives sensor signals of a position sensor which is built into the mooring element ME. Whenever the control unit receives a signal of the sensor that the column SC has left its vertical orientation, it immediately sends out corresponding signals to the hydraulic cylinders 11 to change their length(s) and with this exert suitable forces to the column SC in order to have it move back towards its aimed vertical orientation.

[0051] The hydraulic cylinders 11 can be operated over and over again each time that it is necessary to make a correction in order to have the column SC maintain its vertical orientation.

[0052] In a similar manner to the abovementioned automated compensation of the orientation of the mooring element ME for rolling and pitching movements of the transfer vessel TV, also an automated compensation of the position of the mooring element ME for x-y-z-translational motions, movements or displacements of the transfer vessel TV can take place, both during coupling and after the coupling has been made. For this, operation of the hydraulic cylinders 20, 31, 35 may be necessary. Depending on the amount and direction of the translational movements the transfer vessel TV makes, the hydraulic cylinders 20, 31, 35 need to be adjusted in length in order to have the mooring element ME maintain not only its orientation but also its position. This is also obtained by means of the control unit receiving the sensor signals of the position sensor. Whenever the control unit receives a signal of the sensor that the mooring element has left its position, it immediately sends out corresponding signals to the hydraulic cylinders 20, 31, 35 to change their length(s) and with this exert suitable forces to the mooring element ME in order to have it move back towards its aimed position.

[0053] In addition thereto or in the alternative, the operation of the hydraulic cylinders 20, 31, 35 also can be used for docking the transfer vessel's mooring element ME onto a gangway with less DOF's, for example a gangway that is not telescopingly extendable and/or not turnable and/or not swivable. After the transfer vessel TV has been sailed to the proximity of such a more rigid gangway GW, the mooring element ME subsequently can be accurately manoeuvred towards the coupling device CD by means of operation of the hydraulic cylinders 20, 31, 35. During this accurate manoeuvring, the mooring element ME is advantageously controlled by the control unit to substantially maintains its orientation by means of the automated pitch and roll compensations. The accurate manoeuvring can be done manually but also can be automated by equipping the mooring element ME and the coupling device CD with suitable sensors that are configured to send signals to the control unit. If it is then detected that the pins on the mooring element ME are not properly aligned with the openings in the coupling device CD on the gangway GW, then the mooring element ME can even be rotated around the z-axis by operation of the toothed gear 39. Thus a coordination of the mooring element ME with the stationary or moving tip of the gangway GW is possible.

[0054] In fig. 2 a variant is shown in which the mooring element ME is only compensated for pitch and roll motions as well as for up and down motions. For that the docking position (DP) still comprises a telescopingly extendable support column SC that is rotatable around a hinge connection with two horizontal orthogonal pivot pins 4a, 4b.

[0055] The mooring element ME here comprises an upwardly projecting bar 50 above a dish-shaped coupling surface 51.

[0056] It can be seen here that the gangway GW is mounted with a base 52 to an offshore object that here is formed by a Floating Production, Storage and Offloading (FPSO) platform. Between the base 52 and the gangway GW a hinge connection is provided which has a single pivot pin 54 which extends in a horizontal direction and which allows the gangway GW to swivel around this horizontal axis. The gangway GW comprises a fixed gangway section GWa and a telescoping gangway section GWb. The telescoping gangway section GWb can slide in and out of the fixed gangway section GWa in a direction A. Between the two sections (hydraulic) drive means can be provided for actively lengthening or shortening the gangway GW whenever desired, in particular during a coupling action to the mooring element ME on the transfer vessel TV. The gangway GW is hung to the base by means of cables 55 which are run over a hoisting device. Thus the angle of inclination of the gangway GW can actively be altered whenever desired, in particular during a coupling action to the mooring element ME on the transfer vessel TV. Between the base 52 and the offshore object a turnable connection is provided which allows the base 52 together with the gangway GW to turn around a vertical axis.

[0057] At its outer free end the gangway GW is provided with the coupling device CD that here is formed by a hook 52 which is complementary to the bar 50 and that is operable between an open and closed position.

[0058] In fig. 3 a variant is shown in which the mooring element ME is only compensated for pitch motions. For that the docking position comprises a support column SC that now is merely rotatable around a hinge connection with one horizontal pivot pins 4a.

[0059] The mooring element ME here comprises a sideways projecting connection surface. The gangway GW here is of a similar type as the one shown in fig. 2, that is to say that it is telescopingly extendable, turnable and swivable relative to the offshore object it is mounted to. At its outer free end the gangway GW is provided with a coupling device CD that is complementary to the mooring element ME, for example by means of electromagnetic attraction forces.

[0060] Thus an economic simple version of the transfer system is provided that still makes use of the inventive pitch compensation for its mooring element on the transfer vessel. The other transfer vessel motions can be dealt with by the slewing/luffing/telescoping provisions that are already provided in the gangway GW on the other offshore object.

[0061] Besides the embodiments shown numerous variants are possible. For example the dimensions and shapes of the various parts can be varied, and instead of hydraulic cylinders other types of force actuators can be used. Also all kinds of other types of coupling means can be provided at or near the free end of the gangway and on the mooring element. Instead of gangway it is also possible to use other types of docking arms along or via which the transfer of persons and/or cargo can take place after docking.

[0062] Thus the invention provides for an effective, user-friendly and save transfer system with which persons and all kinds of cargo can be quickly transferred from a transfer vessel towards a stationary or floating offshore object even at heavy sea or otherwise difficult conditions.

[0063] It should be understood that various changes and modifications to the presently preferred embodiments can be made without departing from the scope of the invention, and therefore will be apparent to those skilled in the art. It is therefore intended that such changes and modifications be covered by the appended claims.

Claims

1. An offshore transfer system for transferring persons and/or cargo between a transfer vessel (TV) and an offshore construction, floating platform (FPSO) or other vessel,
wherein the transfer vessel (TV) comprises:

   - a docking position (DP) with a mooring element (ME),
   wherein the offshore construction, floating platform (FPSO) or other vessel comprises:
   - a docking arm, in particular a gangway (GW), that at a free end is provided with a coupling device (CD),

   wherein the mooring element (ME) is configured to have the coupling device (CD) at the free end of the docking arm coupled thereto during a docking operation,
   characterized in that,
   the docking position (DP) on the transfer vessel (TV) has its mooring element (ME) at least partly compensated for transfer vessel motions, at least during the docking operation, and comprises:

   - one or more force actuators for moving the mooring element (ME) relative to the transfer vessel (TV);
   - one or more sensors for detecting one or more of pitch, roll and/or heave motions of the transfer vessel (TV); and
   - a control unit for driving the one or more force actuators such that the one or more detected motions of the transfer vessel (TV) get at least partly compensated for the mooring element (ME) of the docking position (DP).

2. Offshore transfer system according to claim 1, wherein the mooring element (ME) is supported by and connected to the transfer vessel (TV) by means of a hinge connection (4) designed to allow the transfer vessel (TV) to rotate relative to the mooring element (ME) in a rotation direction around an y-axis, wherein the y-axis extends substantially horizontal, and
wherein a first one (11a) of the one or more force actuators acts between the transfer vessel (TV) and the mooring element (ME) for swivelling the mooring element (ME) around the hinge connection (4) relative to the transfer vessel (TV) at least in the rotation direction around said y-axis.

3. Offshore transfer system according to claim 2, wherein the hinge connection (4) is designed to allow the transfer vessel (TV) to also rotate relative to the mooring element (ME) in a rotation direction around an x-axis,
wherein the x- and y-axis extend substantially horizontal and orthogonal relative to each other, and
wherein a second one (11b) of the one or more force actuators acts between the transfer vessel (TV) and the mooring element (ME) for swivelling the mooring element (ME) around the hinge connection (4) relative to the transfer vessel (TV) at least in the rotation direction around said x-axis.

4. Offshore transfer system according to claim 3, wherein the hinge connection (4) comprises two sub-

stantially horizontal orthogonal pivot pins (4a, 4b).

5. Offshore transfer system according to claim 4, wherein the two pivot pins (4a, 4b) form part of a Universal joint, Cardan joint or a Gimbal assembly.

6. Offshore transfer system according to one of the preceding claims, wherein the mooring element (ME) is supported by and connected to the transfer vessel (TV) by means of a z-guidance designed to allow the transfer vessel (TV) to move relative to the mooring element (ME) in a translation direction along a z-axis, wherein the z-axis extends substantially vertical, and wherein a third one (20) of the one or more force actuators acts between the transfer vessel (TV) and the mooring element (ME) for translating the mooring element (ME) along the z-guidance relative to the transfer vessel (TV) at least in the translation direction along said z-axis.

7. Offshore transfer system according to one of the preceding claims, wherein the mooring element (ME) is supported by and connected to the transfer vessel (TV) by means of a x- and/or y-guidance designed to allow the transfer vessel (TV) to move relative to the mooring element (ME) in a translation direction along an x- and/or y-axis,
wherein the x- and/or y-axis extend substantially horizontal and orthogonal relative to each other, and
wherein a fourth and/or fifth one (31, 35) of the one or more force actuators acts between the transfer vessel (TV) and the mooring element (ME) for translating the mooring element (ME) along the x- and/or y-guidance relative to the transfer vessel (TV) at least in the translation direction along said x- and/or y-axis.

8. Offshore transfer system according to one of the preceding claims, wherein the docking position further comprises:

- an upright column (SC) extending upwards from the transfer vessel (TV),

wherein the mooring element (ME) is provided on an upper portion of the column (SC).

9. Offshore transfer system according to claim 8, wherein lever arms (10a, 10b) are provided which are fixedly connected to the column (SC) and extend in a substantially sideways direction from it, the force actuators being provided in between the transfer vessel (TV) and the lever arms (10a, 10b).

10. Offshore transfer system according to one of the preceding claims, wherein the one or more sensors comprise:

- a position sensor for sensing deteriorations from an aimed orientation of the mooring element (ME),

wherein the control unit is configured for driving the force actuators in dependence of sensed deteriorations by the position sensor such that the force actuators bring the mooring element (ME) back to its aimed orientation.

11. Offshore transfer system according to one of the preceding claims, wherein the force actuators are hydraulic cylinders.

12. Offshore transfer system according to one of the preceding claims, wherein the docking arm is telescopingly extendable, wherein drive means are provided for retracting or extending the docking arm during mooring
and/or
wherein the docking arm is mounted on the offshore construction, floating platform or other vessel movable around a horizontal and/or vertical shaft, wherein drive means are provided for retracting or extending the docking arm during a docking operation.

13. A transfer vessel (TV) for an offshore transfer system according to one of the preceding claims, comprising a mooring element (ME) that is at least partly compensated for transfer vessel motions.

14. Method for coupling the transfer vessel (TV) with the docking arm on the offshore construction, floating platform or other vessel, according to one of the preceding claims, comprising the steps:

- sailing the transfer vessel (TV) to a position close to the offshore construction, floating platform or other vessel; and
- coupling the coupling device (CD) at the free end of the docking arm to the mooring element (ME) on the transfer vessel (TV),

characterized in that,
during and/or after the coupling has been made, the force actuators are operated for getting or keeping the mooring element (ME) positioned in an aimed orientation independent of motions of the transfer vessel (TV).

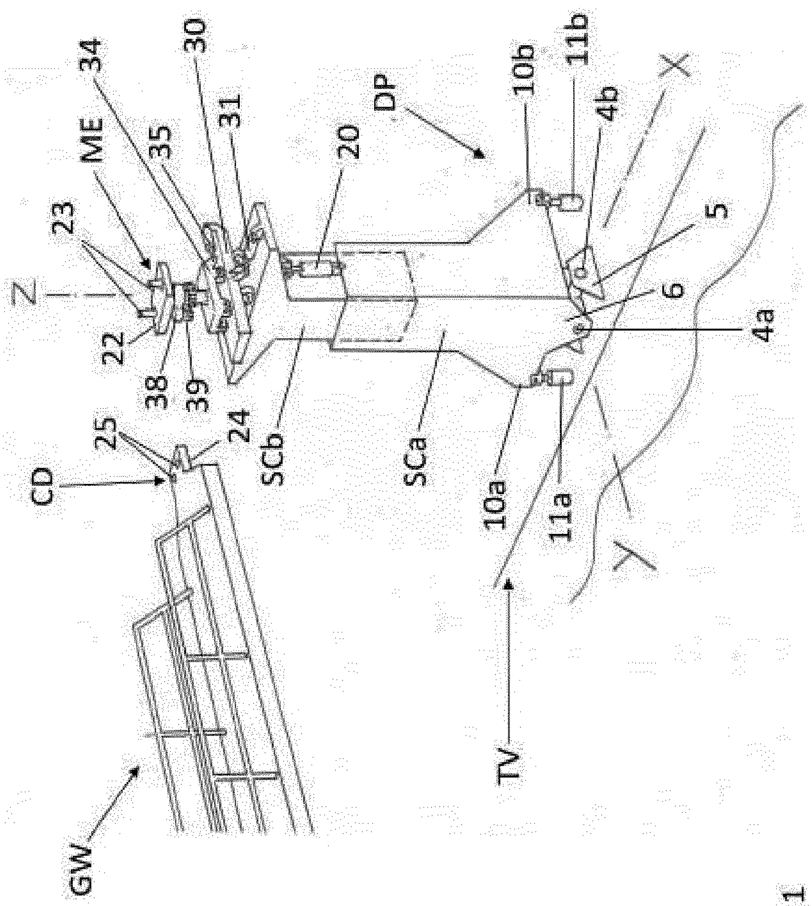
GW
CD
25
24
SCb
SCa
10a
11a
TV
Y
22
38
39
Z
23
ME
34
35
30
31
20
DP
10b
11b
4b
X
5
6
4a

Fig. 1

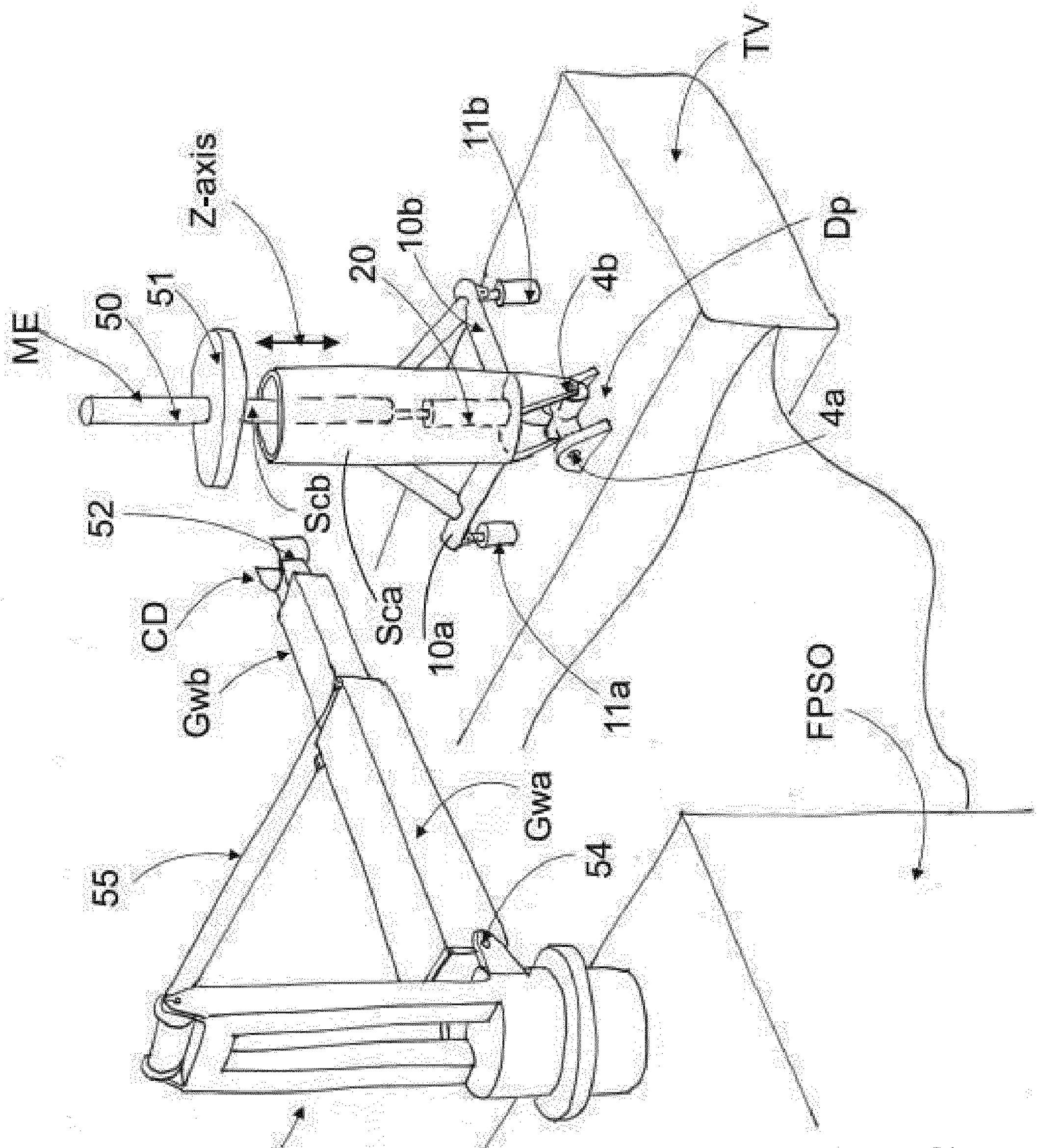
ME
50
51
Z-axis
20
10b
11b
TV
Dp
4b
4a
Scb
52
CD
Sca
10a
11a
Gwb
FPSO
Gwa
55
54
52

Fig 2

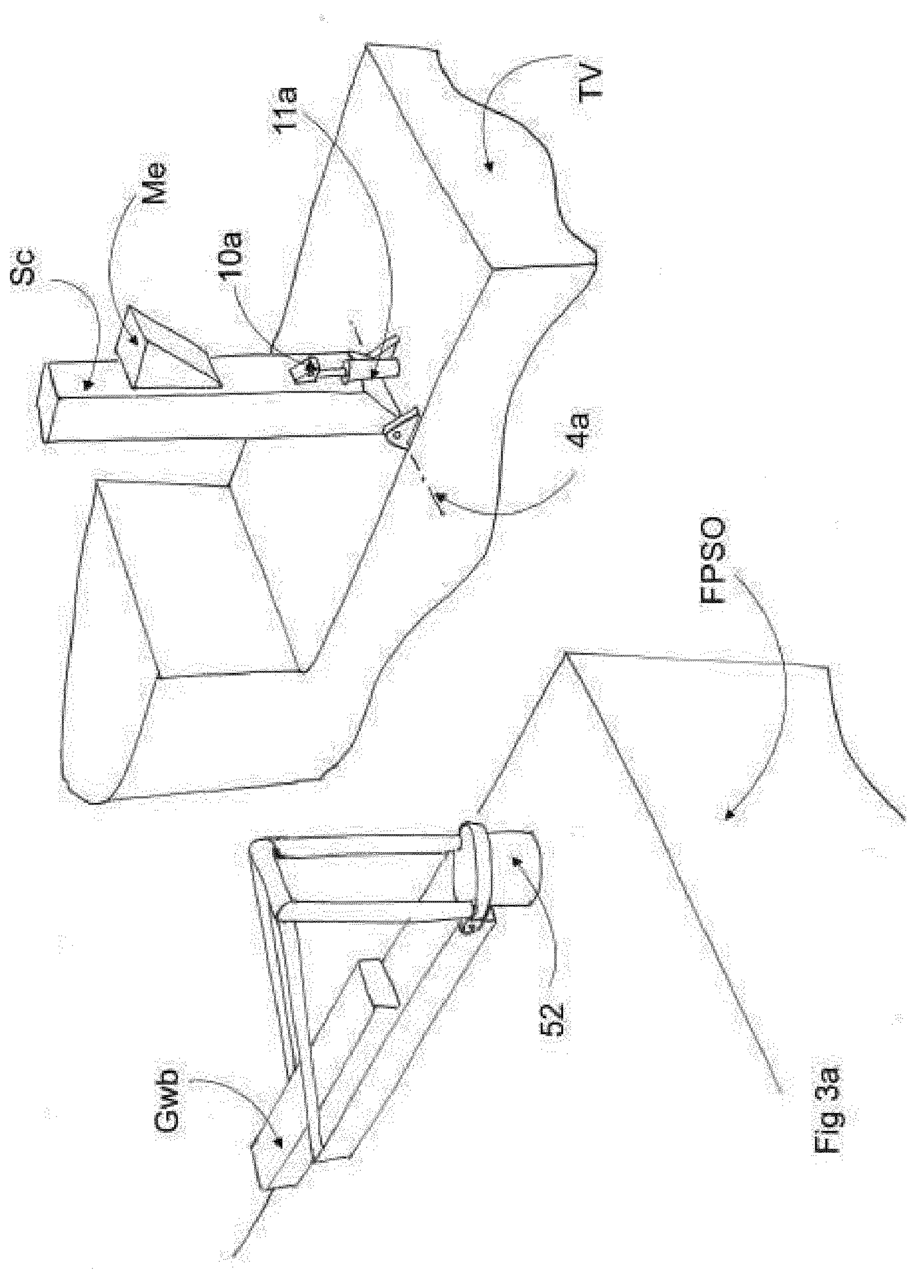

Fig 3a

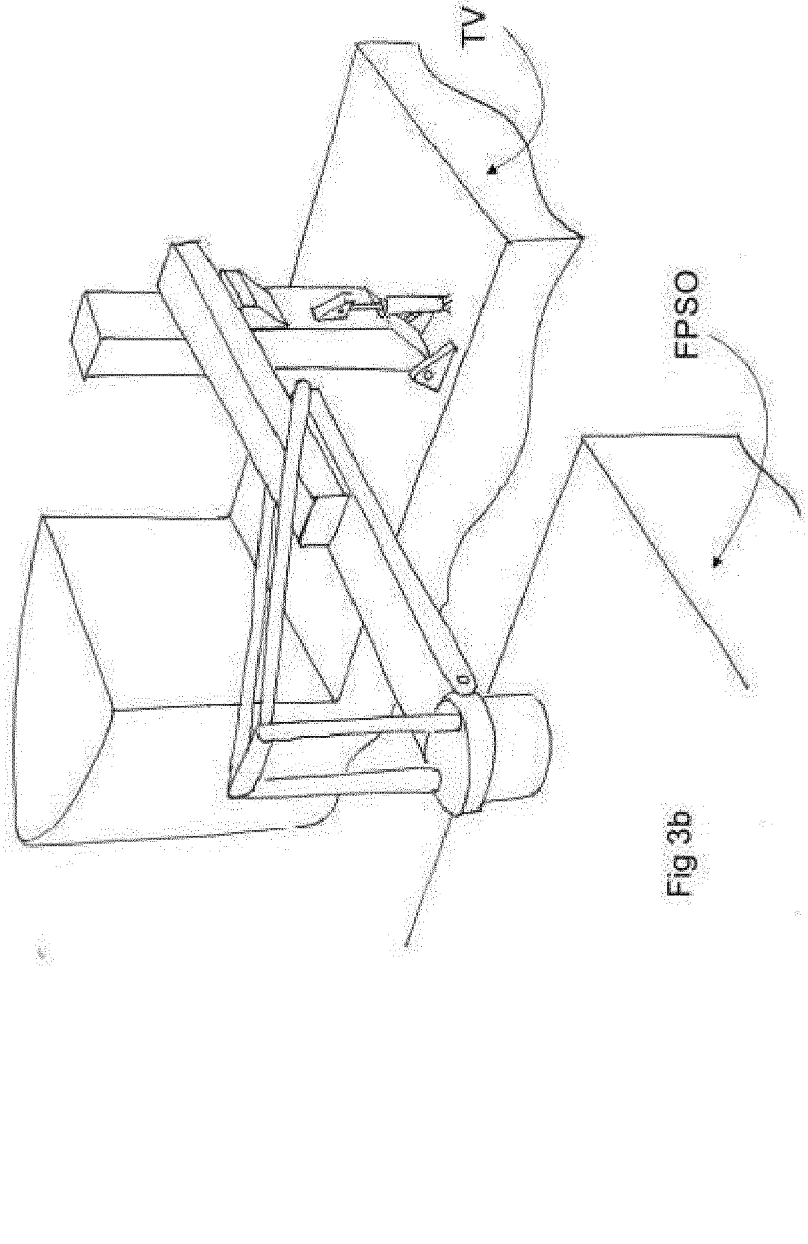

Fig 3b

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EUROPEAN SEARCH REPORT

Application Number
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Y	* paragraph [0027] - paragraph [0028] *	5	
A	* paragraph [0041] * * paragraph [0043]; figure 3 * -----	8,9	ADD. B63B17/00
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B63B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	24 June 2021	Schmitter, Thierry

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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