

ACTUATOR ROTATOR ADAPTER**Technical Field:**

The invention concerns the transfer of fluids between two loading/off-loading units. The invention is particularly useful in a system for marine transfer of gas, liquefied gas and hydrocarbons such as oil, for example between a production vessel/installation and a shuttle tanker.

Background and prior art:

When transferring fluids from loading/off-loading units, such as from one vessel to another or from a vessel to an installation, it is known in the art to connect a fluid conduit from one vessel to a fluid conduit on the other vessel. The connection is commonly facilitated by two coupling housings on the respective fluid conduits. The coupling housings typically comprise valves.

It is known in the art from WO2010137990A1 to perform so-called tandem loading of fluids from one vessel to the other. Two vessels will line up with bows substantially facing each other directly while a hose is transferred from one vessel to the other. WO2010137990A1 describes a first coupling housing comprising guiding element and a second coupling housing comprising a receptacle. This system allows for aligning of the first and second coupling housings when the bows of the respective vessels are also aligned.

However, it has recently been raised a need to transfer fluids between loading/off-loading units such as vessels positioned such that the loading/off-loading points, e.g the bows, are at an angle larger than about $\pm 30^\circ$.

The coupling system of WO2010137990A1 is not designed for such extreme angles between the loading/off-loading points, since there is a risk that the guiding element will not enter the receptacle at a proper angle which may cause the coupling housings to twist and misalign. This may make a secure coupling of the housings impossible.

WO2018015311A1 discloses a transfer system suitable for transfer of fluids between the bow area of a vessel and a hydrocarbon delivery installation at open sea. The system allows for larger angles between the loading/offloading points by implementation of a drive system of at least three separately controlled drive units configured to generate pendulum movements and rotational movement of a coupling housing to align with another coupling housing being pulled in by a bridle attached to bridle ears. Although this system provides means for coupling fluid conduits arranged at a large angle between them the system is limited to adjustment of one coupling housing while the other coupling housing is allowed at least some freedom of movement while attached to the bridle system.

The present invention seeks to solve the above-mentioned need for secure coupling when loading/off-loading points are positioned at a large angle with respect to each other while precisely aligning the axis of two coupling housing as well as rotational alignment of two coupling housings.

5 **Summary of the invention:**

The present invention is set forth and characterized in the main claims, while the dependent claims describe other characteristics of the invention.

10 In a first aspect the invention concerns a coupling system for coupling a first fluid conduit to a second fluid conduit suitable for transferring fluids between a first and second loading/offloading unit the coupling system comprising
a first coupling housing for fluid connection to the first fluid conduit at a first end, the first coupling housing comprising
- a second end opposite the first end, and
- a central longitudinal axis A_x running from the first end to the second
15 end,
a second coupling housing for fluid connection to the second fluid conduit at a first end, the second coupling housing comprising
- a second end opposite the first end, and
- a central longitudinal axis B_x running from the first end to the second
20 end,
- a guiding element attached at a side of the second coupling housing and extending substantially in the direction of the central longitudinal axis B_x and away from the first end, the guiding element comprising a guiding element head at the end distal from the second coupling
25 housing,
a suspension configured for suspending the first coupling housing, wherein the suspension comprises
- a receptacle attached to the suspension, wherein the receptacle is configured for accepting the guiding element therein, and wherein the
30 receptacle comprises a central longitudinal axis C_x running from the receptacle end proximal to the suspension to the receptacle end distal from the suspension, and
wherein the coupling system comprises pull-in means for attachment to the guiding element head,
35 wherein in the pull-in means is configured for pulling the guiding element into the receptacle,
characterized in that the receptacle is rotatably attached to the suspension and thereby configured for rotating around the central longitudinal axis (C_x) for aligning central longitudinal axis (B_x) with central longitudinal axis (A_x).

The pull-in means may for example be a rope, wire or chain made from a suitable material such as fibers, synthetic fibers or a metal such as steel.

The pull-in means may be threaded through the receptacle.

5 As used herein the term “fluid” is understood to cover a gas or a liquid or a material able to flow.

In one example configuration of the coupling system the suspension comprises
- a rotation drive unit attached to a side of the suspension
wherein the rotation drive unit is connected to the receptacle and configured for
exerting a rotational force to the receptacle. The rotation drive unit may for example
10 be a motor, a worm gear or a hydraulic actuator or cylinder.

In one example configuration of the coupling system the receptacle comprises
- at least two receptacle guides attached to the receptacle end distal to the
suspension and spaced apart for accepting the guiding element in between
them and configured to support the guiding element. In one example
15 configuration of the coupling system the receptacle comprises a transversal
receptacle guide attached to the receptacle end distal to the suspension and
extending in the transversal direction to the at least two receptacle guides at
least a part of the length of the space therebetween.

20 In another example configuration of the coupling system the receptacle comprises
two upper transversal receptacle guides.

The receptacle guides may be rollers, bars or even plates and may be suitable for
lowering friction between the guiding element and the receptacle.

In one example configuration of the coupling system one or more of the receptacle
guides, transversal receptacle guide and/or upper transversal guides are configured
25 as rollers, bars or even plates.

In one example configuration of the coupling system at least a portion of the cross
section of the guiding element is non-circular for non-rotational interaction with the
receptacle. The cross section of the guiding element may for example be square, an
elongated rectangle, oval, oblong or other shapes that are non-circular and suitable
30 for non-rotational interaction with another object such as the receptacle.

In one example configuration of the coupling system the second coupling housing
comprises a second coupling fluid conduit connection for connection to a fluid
conduit wherein the second fluid conduit connection is a swivel connection for
allowing free rotation of the coupling housing relative to the second fluid conduit.

In one example configuration of the coupling system the suspension is attached to a cardan suspension for allowing pivoting movement around at least one axis or at least two axes. This helps the alignment of central longitudinal axis A_x and central longitudinal axis B_x .

- 5 In one example configuration of the coupling system the first coupling housing comprises
- a coupling flange arranged at the second end
 - a guide pin extending from the first coupling flange for interacting with and guiding a second coupling flange arranged at the second end towards the first
- 10 coupling flange.

In one example configuration of the coupling system the first coupling housing comprises at least one coupling means and a coupling means actuator configured for interacting with a coupling means interface on the second coupling housing for coupling the first coupling housing and the second coupling housing.

- 15 The coupling means may for example be gripper claws, a threaded screw connection, a pin connection or the like. The coupling means interface may be adapted to the type of coupling means used, for example by comprising threads or by being a defined notch for gripper claws to interact with.

- 20 In one example configuration the coupling system comprises a controller unit for controlling the coupling system. The controller unit may be connected through wires or wirelessly to at least the pulling means and the suspension. The controller unit may be connected to any of the drive unit, the coupling means, the valve on the first and/or the second coupling housing, the cardan suspension.

- 25 Any of the pulling means, suspension, drive unit, the coupling means, the valve on the first and/or the second coupling housing, the cardan suspension may be configured with one or more sensors to provide feedback to the controller unit. The sensors may include such units as cameras, tension sensors, ultrasound sensors etc.

The controller unit may be stationary or portable.

- 30 In a second aspect the invention relates to a method for transferring fluid between first loading/off-loading unit to a second loading/off-loading unit, the method comprising the following steps:

- A. providing the coupling system according to any of the example configurations as stated above,

- B. positioning the first loading/off-loading unit and the second loading/off-loading unit within operating range of the fluid conduit and with a suitable angle between loading/off-loading points on the loading/off-loading units,
- 5 C. connecting the pull-in means to the guiding element head at one end and connecting the pull-in means to the pulling means at the other end
- D. operating the pulling means to pull in the second coupling housing towards the first coupling housing,
- E. optionally operating the rotation drive unit to align the receptacle with the guiding element when the second coupling housing is within a distance of
10 from about 0.1 m to about 3 m, about 1 m to 2 m, for example 1.5 m of the first coupling housing,
- F. operating the pulling means to pull in the second coupling housing such that the guiding element enters the receptacle
- G. optionally operating the pulling means to pause the pulling in before the
15 second coupling flange is at a vertical level of the guide pin
- H. operating the rotation drive unit to align axis B_x with axis A_x

During step E the guiding element head could even contact the receptacle, as long as the coupling housing and the receptacle may rotate relative to each other.

The method may further comprise the following step

- 20 I. optionally operating the pulling means to pull in the second coupling housing and using the guide pin to ensure that the second coupling flange is aligned and in proximity of the first coupling flange.

The method may further comprise the following step

- 25 J. optionally operate the coupling means actuator to facilitate an interaction of the coupling means with the coupling means interface and thereby coupling the first coupling housing and the second coupling housing.

The method may further comprise the following steps between step E and F;

- optionally operating the cardan suspension to align the receptacle with the guiding element when the second coupling housing is within about 0.1 m to
30 about 3 m, about 1 m to 2 m, for example 1.5 m of the first coupling housing, 1 meter of the first coupling housing.

The method may further comprise the following step after step J

- 35 operating the cardan suspension to an angle to relieve any angular forces acting upon the connected first coupling housing and second coupling housing.

Brief description of the drawings:

Fig. 1 shows a view of two vessels positioned with about 90° between the bows

Fig. 2 shows a view of the coupling system with the pull-in means attached to the guide element head at one end and a winch at the other end. Also shown is the angle α and angle β which the cardan suspension can rotate.

5 Fig. 3 shows a head on view of the cardan suspension with the first coupling housing, the receptacle. Also shown is the angle γ which the cardan suspension can rotate.

Fig. 4 shows a view of the first and second coupling housing and the receptacle where the guide element has not entered and is not aligned with the receptacle.

10 Fig. 5 shows a view of the first and second coupling housing and the receptacle where the guide element has not entered but is aligned with the receptacle.

Fig. 6 shows a view of the first and second coupling housing and the receptacle where the guide element has entered the receptacle.

Fig. 7 shows a view of the first and second coupling housing and the receptacle where side walls in the receptacle is removed.

15 Fig. 8 shows a view where the central longitudinal axis of the first and second coupling housings are aligned.

Figs. 9A-9D shows the steps of aligning and coupling the first and second coupling housings after the guiding element has entered the receptacle.

Detailed description of the invention:

20 In the following, specific embodiments of the invention will be described in more detail with reference to the figures. However, the invention is not limited to the embodiments and illustrations contained herein. It is specifically intended that the invention includes modified forms of the embodiments, including portions of the
25 embodiments and combinations of elements of different embodiments. It should be appreciated that in the development of any actual implementation, as in any engineering or design project, specific decisions must be made to achieve the developer's specific goals, such as compliance with system and/or business-related constraints. Moreover, it should be appreciated that such a development effort might
30 be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication and manufacture for the skilled person having the benefit of this disclosure.

Figs. 1-9D illustrates various parts and various states of operation of a coupling system 1.

35 Fig. 1 shows a view of a first loading/offloading unit 400 and a second loading/off-loading unit 500. The loading/offloading units 400, 500 may for example be vessels

such as production vessels, shuttle tankers, floating production storage and offloading installations (FPSO). The loading/offloading units 400,500 may also be installations such as offshore platforms or installations on a quay. The loading/offloading units 400, 500 are capable of receiving fluid or offloading fluid.

5 The first loading/offloading unit 400 comprises a suspension 300 which is mounted to the first loading/offloading unit 400. The suspension 300 is configured for suspending a first coupling housing 100. The first coupling housing 100 may be attached to the suspension 300 via a coupling housing engagement 301. The first coupling housing 100 may be fluidly connected to a first fluid conduit 101 as shown
10 in for example Fig 2. The first fluid conduit 101 may, at the end distal from the first coupling housing 100, be fluidly connected to a storage compartment located on the first loading/offloading unit 400 or alternatively a storage compartment located elsewhere.

The suspension 300 may be mounted at a side of the loading/offloading unit 400. If
15 the first loading/offloading unit 400 is a vessel the suspension 300 may be mounted at the stern, port, starboard or at the bow of the vessel. The suspension 300 may be mounted at the top deck or alternatively at any of the lower decks with a suitable opening in the side of the vessel for access to the first coupling housing 100. In case the first loading/offloading unit 400 is an offshore platform or an installation at a
20 quay the suspension 300 may be mounted on any suitable structure known to the skilled person, for example a crane.

The second loading/offloading unit 500 may comprise a second fluid conduit arrangement 210 which may hold a second fluid conduit 201. The second fluid conduit 201 may for example be rolled up on the fluid conduit arrangement 210
25 such that a suitable length of the fluid conduit 201 may be deployed when in use. The second fluid conduit 201 may comprise a second coupling housing 200 fluidly connected at a free end. The second fluid conduit 201 may, at the end distal from the second coupling housing 200, be fluidly connected to a storage compartment located on the second loading/offloading unit 500 or alternatively a storage
30 compartment located elsewhere.

The second fluid conduit arrangement 210 may be mounted at a side of the loading/offloading unit 500. If the loading/offloading unit 500 is a vessel the second fluid conduit arrangement 210 may be mounted at the stern, port, starboard or at the bow of the vessel. The second fluid conduit arrangement 210 may be mounted at the
35 top deck or alternatively at any of the lower decks with a suitable opening in the side of the vessel for deploying the second coupling housing 200. In case the loading/offloading unit is an offshore platform or an installation at a quay the second fluid conduit arrangement 210 may be mounted on any suitable structure known to the skilled person.

The first coupling housing 100 and the second coupling housing 200 may be used to establish a fluid connection between the first and second fluid conduit 101, 201 such that any fluid can be transferred therethrough. It is to be understood that in this context a “fluid” is any substance that can flow such as gases and liquids including liquified gases.

Now turning to Fig. 2 which shows the suspension 300 mounted to a cardan suspension 420 which may also be called a gimbal mount. The cardan suspension 420 is able to pivot back and forth an angle of a , b from vertical. As shown in Fig. 3 the suspension 300 may also be capable of pivoting and an angle c in a plane transversal of the plane shown in Fig. 2. The angles a , b , and c may for example be maximally 90° or more.

Shifting focus briefly to Fig. 6 where it is shown that the second coupling housing 200 may comprise a first end 211 configured for connection to the fluid conduit 201 and second end 212 that is opposite of the first end. The second coupling housing may also display a central longitudinal axis B_x running from the first end 211 to the second end 212.

Turning to Fig. 4 which illustrates the second fluid conduit 201 with the second coupling housing 200 connected at one end. The second coupling housing 200 comprises a guiding element 203 attached to a side of the coupling housing 200 at one end. The guiding element 203 extends substantially in the axial direction B_x at a radial distance d from the central longitudinal axis B_x of the second coupling housing 200. The guiding element 203 comprises a guiding element head 204 at the end distal from the second coupling housing 200.

Turning back to Fig. 2, a pull-in means 50, such as a rope, wire or chain may be attached to the guiding element head 204. The pull-in means 50 may be attached to a pulling means 410, such as a winch, at the end distal from the element head 204. The pulling means 410 is for applying a pulling force to the pull-in means 50. For smaller systems the pulling force may be applied manually for example by human power.

The pull-in means 50 may be threaded through a receptacle 310 and run via pulleys 120, 121 to the pulling means 410. The receptacle 310 is adapted to accept the guiding element 203 when the guiding element 203 is pulled into the receptacle 310 due to a pulling force applied through the pull-in means 50 via the pulling means 410. The receptacle 310 is rotationally attached to the suspension 300 and may rotate both clockwise and counter-clockwise.

The guiding element 203 may have a flat elongated shape in the direction perpendicular to the central longitudinal axis B_x of the second coupling housing 200. The receptacle 310 may have a corresponding flat internal shape extending at

least a part of the internal part of the receptacle. When the flat part of the guiding element 203 and the flat part of the receptacle interact rotation of the coupling housing 200 around the central longitudinal axis B_x is coupled to rotation of the receptacle 310 and thus prevented as long as the receptacle 310 does not rotate.

- 5 The cardan suspension 420 allows for adjusting tilt of the first coupling housing 100 and the receptacle 310 such that the angle is favorable for entry of the guiding element 203 into the receptacle 310.

10 The coupling system 1 may also comprise a controller unit 150 which may be connected through wires or wirelessly to at least the pulling means 410 and the suspension 300. The controller unit 150 may be a stationary unit for example located in a control room on the loading/offloading unit 400, for example on the bridge of a vessel. It can also be envisaged that the control unit 150 is portable where a wireless connection would be most practical. The function of the controller unit 150 will be disclosed in more detail below.

- 15 Fig. 4 and Fig 5 shows the first and second coupling housings 100, 200 in proximity of each other. The guiding element head 204 is at a distance of for example between 0.1m and 1m from the receptacle 310. The distance could be longer, such as 2m-3m or more, and the distance could be shorter than 0.1m, the guiding element head 204 could even contact the receptacle 310, as long as the coupling housing 200 and the
20 receptacle 310 may rotate relative to each other.

Shifting focus briefly to Fig. 6, the first coupling housing 100 connected to the first fluid conduit 101 at a first end 111 and may comprise a second end 112 opposite the first end 111. The first coupling housing 100 may display a central longitudinal axis A_x running from the first end to the second end. The receptacle 310 is attached to
25 the suspension 300 at one end and displays a central longitudinal axis C_x running from the receptacle 310 end proximal to the suspension 300 to the receptacle 310 end distal from the suspension 300. Central longitudinal axis A_x and central longitudinal axis C_x are parallel to each other and spaced apart for example a distance D.

- 30 The distance d and the distance D are adapted such that central longitudinal axis A_x and central longitudinal axis B_x may be aligned by rotation of the receptacle 310 about the central longitudinal axis C_x when the guiding element 203 has been inserted into the receptacle 310.

35 Fig. 4 shows that the suspension 300 comprises a rotation drive unit 313 attached at a side of the suspension 300. The rotation drive unit 313 may for example be a motor which comprises a drive unit engagement device 312 which may be a sprocket. The drive unit engagement device 312 may be connected to a receptacle engagement device 311, which may be a sprocket, that is fixed to the receptacle

310. It can also be envisaged that the rotation drive unit 313 is another type of drive unit, for example a worm gear, a hydraulic actuator or a cylinder and that drive unit engagement device 312 is a rod connected to the receptacle engagement device 311 which may for example be a connection point on the receptacle 310. Activation of
5 the rotation drive unit 313 may rotate the receptacle both clockwise and counter-clockwise about the axis C_x relative to the suspension 300. The rotation drive unit 313 is configured to apply a rotational force to the rotation drive unit engagement device 312, thereby rotating the receptacle 310.

10 Fig. 4 shows a situation where the flat shape of the guiding element 203 is rotationally misaligned with the internal flat shape of receptacle 310. Entrance of the guiding element 203 into the receptacle is thus not possible to perform in a smooth way or not at all. In order to align the flat shape of the receptacle 310 with the flat shape of the guiding element 203 the receptacle may be rotated about the central longitudinal axis C_x by operating the rotation drive unit 313.

15 Fig. 5 shows a situation where the flat shape of the guiding element 203 is rotationally aligned with the receptacle 310 entrance. The alignment may be achieved by operating the rotational drive unit 313 and thereby rotating the receptacle about the central longitudinal axis C_x . It is in this position possible for the guiding element 203 to enter the receptacle 310 smoothly if a pulling force is
20 applied to the pull-in means 50.

Fig. 6 shows that the first coupling housing 100 may comprise a coupling means 103 arranged at a side of the first coupling housing 100 and a coupling means actuator 106 for activating the coupling means 103 for engaging the second coupling housing 200. The second coupling housing 200 may comprise a coupling
25 means interface 207 adapted for the coupling means 103 to engage with. It could be envisaged that the coupling housing comprises a plurality of coupling means 103, either connected individually to a plurality coupling means actuators 106 or the plurality of coupling means 103 may all be connected to a single coupling actuator 106. The coupling means 103 may for example be gripper claws, a threaded screw
30 connection, a pin connection or the like. The coupling means 207 interface may be adapted to the type of coupling means 103 used, for example by comprising threads or by being a defined notch for gripper claws to interact with.

The first coupling housing 100 may be connected to the first fluid conduit 101 at a first fluid conduit connection 107 which may for example be a swivel connection.

35 The second coupling housing 200 may be connected to the second fluid conduit 201 at a second fluid conduit connection 202 which may for example be a swivel connection. A swivel connection may rotate freely and thus mitigate any torsional loads exerted on the fluid conduits 101, 201 from the coupling housing 100, 200..

The first coupling housing 100 further comprises a first coupling flange 105 arranged at the second end 112. The first coupling flange 105 extends in a radial direction relative to the central longitudinal axis A_x and comprises an opening for allowing fluids to flow therethrough. The coupling housing 100 may comprise a
5 guide pin 104 attached at the periphery of the coupling flange 105 and extending in a direction substantially parallel to the central longitudinal axis A_x away from the first coupling housing 100.

The second coupling housing 200 may comprise a second coupling flange 205 arranged at the second end 212. The second coupling flange 205 extends in a radial
10 direction relative to the central longitudinal axis B_x and comprises an opening for allowing fluids to flow therethrough.

As shown in Fig. 7 the receptacle 310 may comprise at least two receptacle guides 314 spaced apart and arranged proximal to the end distal from the suspension 300. The receptacle guides 314 may be bars, plates or rollers for minimizing friction and
15 aiding smooth entry of the guiding element 203 therebetween. The receptacle guides 314 may be parallel, extend transverse to the central longitudinal axis C_x and be arranged at a suitable distance apart for interacting with the guiding element 203. The receptacle 310 may further comprise a transversal receptacle guide 315 arranged further distal from the suspension than the receptacle guides 314. The
20 transversal receptacle guide 315 may support the guiding element 203 when it is entered in the receptacle 310. A set of two upper transversal receptacle guides 316, 317 may be arranged at the end of the receptacle proximal to the suspension 300. The upper transversal receptacle guides 316, 317 may be arranged such that the guiding element head 204 abuts against them when the guiding element 203 is
25 inserted into in the receptacle 310 for stabilizing the guiding element 203 therein. When the guiding element head 204 abuts against the upper transversal receptacle guides 316, 317 the second coupling flange 205 is still at a sufficient distance from the first coupling flange 105 for allowing rotation of the receptacle 310 and the second coupling housing 200 about the central longitudinal axis C_x without any
30 parts of the coupling system 1 colliding see also Figs. 9A-9C.

With reference to Fig. 8, the first coupling housing 100 may comprise a valve 108 for sealingly covering the opening in the first coupling flange 105. The valve 108 may be removed from the opening in the first coupling flange 105 thereby allowing
35 flow of fluid therethrough. The second coupling housing 200 may comprise a valve 208 for sealingly covering the opening in the second coupling flange 205. The valve 208 may be removed from the opening in the second coupling flange 205 thereby allowing flow of fluid therethrough.

Now referring to Fig. 9A and 9B which show two situations where the guiding element 203 is entered into the receptacle 310 such that it abuts the upper

transversal receptacle guides 316, 317, but the central longitudinal axis A_x and the central longitudinal axis B_x of the first and second coupling housing 100, 200 respectively are not aligned. Said two situations may for example occur if the receptacle have been rotated about the central longitudinal axis C_x for aligning the guiding element 203 with the receptacle 310 as discussed above with reference to Figs. 4 and 5. A final coupling of the first and second coupling housings 100, 200 may not occur until their central longitudinal axes A_x , B_x have been aligned.

Fig. 9C shows a situation where the central longitudinal axis A_x and the central longitudinal axis B_x of the first and second coupling housing 100, 200 respectively are have been aligned by rotating the receptacle 310 about the central longitudinal axis C_x by operating the rotation drive unit 313. Note that the receptacle 310 may rotate both ways from the position illustrated in Fig. 9A and the position illustrated in Fig. 9B.

Fig. 9D shows a situation where the guiding element 203 has been pulled fully into the receptacle, for example by operating the pulling means 410 for applying a pulling force to the guide element head 204. The first and second coupling flanges 105, 205 are in contact with each other and the valves 108, 208 may be opened to establish a fluid connection between the first and second fluid conduits 101, 201.

Optionally, the coupling means actuator 106 may be operated when the second coupling housing 200 and the coupling means interface 207 is within reach of the coupling means 103, but before the first and second coupling flanges 105, 205 has made contact. By operating the coupling means actuator 106 the coupling means 103 engages the coupling means interface 207 in order to move the first and second coupling housing 100, 200 together with sufficient force to create a sealing coupling between the first and second coupling flange 105, 205 where the central longitudinal axis A_x and the central longitudinal axis B_x are perfectly aligned.

The control unit 150 shown in Fig. 2 may be connected to and be used to control for example speed and tension that the pulling means 410 applies to the pull-in means 50, activation of the coupling means actuator 106, tilt of the cardan suspension 420, activation of the rotation drive 313 unit for rotation of the receptacle 310. Said parts may be equipped with sensors suitable for communicating a state or position of various parts of the system to the control unit 150, which may be used to control said units, either through manual input or automatically by running appropriate software on the control unit 150 or a connected computer. The control unit 150 may be equipped with a suitable software interface to communicate with external computer-based systems such as external control units located on other loading/offloading units.

It is also understood that some or all of the above-mentioned adjustments and coupling operations as well as the steps mentioned below may be operated and performed manually.

With reference to Figs. 1-9 the steps to ensure a successful alignment and coupling the coupling housing 100, 200 may proceed as follows:

- providing the coupling system 1 as disclosed above,
- positioning the first loading/off-loading unit 400 and the second loading/off-loading unit 500 within operating range of the fluid conduit 201 and with a suitable angle between loading/off-loading points on the loading/off-loading units 400, 500,
- connecting the pull-in means 50 to the guiding element head 204 at one end and connecting the pull-in means 50 to the pulling means 410 at the other end
- operating the pulling means 410 to pull in the second coupling housing 200 towards the first coupling housing 100,
- optionally operating the rotation drive unit 313 to align the receptacle 310 with the guiding element 203 when the second coupling housing 200 is within a distance of about 1 meter of the first coupling housing 100,
- operating the pulling means 410 to pull in the second coupling housing 200 such that the guiding element 203 enters the receptacle 310
- optionally operating the pulling means 410 to pause the pulling in before the second coupling flange 205 is at a vertical level of the guide pin 104
- operating the rotation drive unit 313 to align axis B_x with axis A_x
- operating the pulling means 410 to pull in the second coupling housing 200 and using the guide pin 104 to ensure that the second coupling flange 205 is aligned and in proximity of the first coupling flange 105
- operate the coupling means actuator 106 to facilitate an interaction of the coupling means 103 with the coupling means interface 207 and thereby coupling the first coupling housing 100 and the second coupling housing 200.
- optionally operating the cardan suspension 420 to align the receptacle 310 with the guiding element 203 when the second coupling housing 200 is within about 1 meter of the first coupling housing 100,
- optionally operating the cardan suspension 420 to an angle to relieve any angular forces acting upon the connected first coupling housing 100 and second coupling housing 200.

List of references:

1	Coupling system
50	Pull-in means
100	First coupling housing
101	First fluid conduit
103	Coupling means
104	Guide pin
105	First coupling flange
106	Coupling means actuator
107	First fluid conduit connection
108	Valve
111	First end
112	Second end
120	Pulley
121	Pulley
150	Controller unit.
A _x	Axis A
200	Second coupling housing
201	Second fluid conduit
202	Second fluid conduit connection (Swivel connection)
203	Guiding element
204	Guiding element head
205	Second coupling flange
207	Coupling means interface
208	Valve
210	Second fluid conduit arrangement
211	First end
212	Second end
B _x	Axis B
300	Suspension
301	Coupling housing engagement
310	Receptacle
311	Receptacle engagement device
312	Rotation drive unit engagement device
313	Rotation drive unit
314	Receptacle guide
315	Transversal receptacle guide
316	Upper transversal receptacle guide
317	Upper transversal receptacle guide
C _x	Axis C

400	First loading/off-loading unit
410	Pulling means
420	Cardan suspension
500	Second loading/off-loading unit

CLAIMS

1.

A coupling system (1) for coupling a first fluid conduit (101) to a second fluid conduit (201) suitable for transferring fluids between a first and second

- 5 loading/offloading unit (400, 500) the coupling system (1) comprising
- a first coupling housing (100) for fluid connection to the first fluid conduit (101) at a first end (111), the first coupling housing (100) comprising
 - a second end (112) opposite the first end (111), and
 - a central longitudinal axis (A_x) running from the first end to the
 - 10 second end,
 - a second coupling housing (200) for fluid connection to the second fluid conduit (201) at a first end (211), the second coupling housing 200 comprising
 - a second end (212) opposite the first end (211), and
 - 15 - a central longitudinal axis (B_x) running from the first end (211) to the second end (212),
 - a guiding element (203) attached at a side of the second coupling housing (200) and extending substantially in the direction of the central longitudinal axis B_x and away from the first end (211), the
 - 20 guiding element (203) comprising a guiding element head (204) at the end distal from the second coupling housing (200),
 - a suspension (300) configured for suspending the first coupling housing (100), wherein the suspension (300) comprises
 - a receptacle (310) attached to the suspension (300), wherein the
 - 25 receptacle (310) is configured for accepting the guiding element (203) therein, and wherein the receptacle (310) comprises a central longitudinal axis (C_x) running from the receptacle (310) end proximal to the suspension (300) to the receptacle (310) end distal from the suspension (300), and
 - 30 wherein the coupling system (1) comprises
 - pull-in means (50) for attachment to the guiding element head (204), wherein in the pull-in means (50) is configured for pulling the guiding element (203) into the receptacle (310),
 - 35 **characterized in that** the receptacle (310) is rotatably attached to the suspension (300) and thereby configured for rotating around the central longitudinal axis (C_x) for aligning central longitudinal axis (B_x) with central longitudinal axis (A_x).

2.

The coupling system (1) according to claim (1), wherein the suspension (300) comprises

- a rotation drive unit (313) attached to a side of the suspension (300) wherein the rotation drive unit (313) is connected to the receptacle (310) and configured for exerting a rotational force to the receptacle (310).

3.

The coupling system (1) according to any of the preceding claims, wherein the receptacle (310) comprises

- at least two receptacle guides (314) attached to the receptacle end distal to the suspension (300) and spaced apart for accepting the guiding element (203) in between them and configured to support the guiding element (203).

4.

The coupling system (1) according to claim 3, wherein the receptacle (310) comprises a transversal receptacle guide (315) attached to the receptacle end distal to the suspension (300) and extending in the transversal direction to the at least two receptacle guides (314) at least a part of the length of the space therebetween.

5.

The coupling system (1) according to any of the preceding claims, wherein the receptacle (310) comprises two upper transversal receptacle guides (316, 317).

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The coupling system (1) according to claim 4 and 5, wherein one or more of the receptacle guides (314), transversal receptacle guide (315) and/or upper transversal guides (316, 317) are configured as rollers.

7.

The coupling system (1) according to any of the preceding claims, wherein at least a portion of the cross section of the guiding element (203) is non-circular for non-rotational interaction with the receptacle (310).

8.

The coupling system (1) according to any of the preceding claims, wherein the second coupling housing (200) comprises

- a second coupling fluid conduit connection (202) for connection to a fluid conduit

wherein the second fluid conduit connection (22) is a swivel connection.

9.

The coupling system (1) according to any of the preceding claims, wherein the suspension (300) is attached to a cardan suspension (420) for allowing pivoting movement around at least one axis.

5 10.

The coupling system (1) according to any of the preceding claims, wherein the first coupling (100) housing comprises

- a coupling flange (105) arranged at the second end (112)
- a guide pin (104) extending from the first coupling flange (105) for
10 interacting with and guiding a second coupling flange (205) arranged at the second end (212) towards the first coupling flange (105).

11.

The coupling system (1) according to any of the preceding claims, wherein the first coupling housing (100) comprises at least one coupling means (103) and a coupling
15 means actuator (106) configured for interacting with a coupling means interface (207) on the second coupling housing (200) for coupling the first coupling housing (100) and the second coupling housing (200).

12.

The coupling system (1) according to any of the preceding claims further
20 comprising a controller unit (150) for controlling the coupling system (1).

13.

A method for transferring fluid between first loading/off-loading unit (400) to a second loading/off-loading unit (500), the method comprising the following steps;

- A. providing the coupling system 1 according to any of the claims 1-12,
- 25 B. positioning the first loading/off-loading unit (400) and the second loading/off-loading unit (500) within operating range of the fluid conduit (201) and with a suitable angle between loading/off-loading points on the loading/off-loading units (400, 500),
- C. connecting the pull-in means (50) to the guiding element head (204) at one
30 end and connecting the pull-in means (50) to the pulling means (410) at the other end
- D. operating the pulling means (410) to pull in the second coupling housing (200) towards the first coupling housing (100),

- E. optionally operating the rotation drive unit (313) to align the receptacle (310) with the guiding element (203) when the second coupling housing (200) is within a distance of 1 meter of the first coupling housing (100),
- 5 F. operating the pulling means (410) to pull in the second coupling housing (200) such that the guiding element (203) enters the receptacle (310)
- G. optionally operating the pulling means (410) to pause the pulling in before the second coupling flange (205) is at a vertical level of the guide pin (104)
- H. operating the rotation drive unit (313) to align axis (B_x) with axis (A_x)
- 10 14.
The method according to claim 13 further comprising the following step
- I. optionally operating the pulling means (410) to pull in the second coupling housing (200) and using the guide pin (104) to ensure that the second coupling flange (205) is aligned and in proximity of the first coupling flange (105)
- 15 15.
The method according to claim 13 or 14 further comprising the following step
- J. optionally operating the coupling means actuator (106) to facilitate an interaction of the coupling means (103) with the coupling means interface (207) and thereby coupling the first coupling housing (100) and the second coupling housing (200).
- 20 16.
The method according to any of the claims 13-15 further comprising the following steps between step E and F;
- optionally operating the cardan suspension (420) to align the receptacle (310) with the guiding element (203) when the second coupling housing (200) is within about 1 meter of the first coupling housing (100),
- 30 17.
The method according to claim 15 further comprising the following step after step J;
- operating the cardan suspension (420) to an angle to relieve any angular forces acting upon the connected first coupling housing (100) and second coupling housing (200).
- 35