Abstract: The invention concerns a vessel (I) comprising a transfer system for transferring persons or goods from the vessel while subjected to waves and/or swell towards a substantially stationary destination, wherein the transfer system comprises a platform (2) having a first mass for supporting the persons or goods during transfer, and platform actuators (3) connecting the platform to the vessel and adapted for moving the platform relative to the vessel in such a manner that the platform or part of the platform is maintained spatially in a substantially stationary position.
VESSEL WITH SYSTEM FOR TRANSFERRING PERSONS OR GOODS

In a first aspect the present invention relates to a vessel comprising a transfer system for transferring persons or goods from the vessel while subjected to waves and/or swell towards a substantially stationary destination, wherein the system comprises a platform having a first mass for supporting the persons or goods during transfer, and platform actuators connecting the platform to the vessel and adapted for moving the platform relative to the vessel in such a manner that the platform or part of the platform is maintained spatially in a substantially stationary position.

Its main field of use is offshore industry where it is a known problem to transfer persons or goods from a vessel which moves in consequence to the influence of, among others, the swell, waves, currents and wind relative to a (substantially) stationary destination such as, for example an offshore drill rig, offshore wind turbine or another large vessel.

In response to this problem a vessel has been developed in accordance with the preamble of the main claim. Such a vessel is known from WO2007/120039.

The known system comprises a movable platform, a so called Stewart platform, which is actuated by six piston-cylinder assemblies in response to the motions of the vessel, in such a manner that the platform maintains a (substantially) stationary spatial position, thus a stationary position relative to the stationary destination. For the actual transfer of the persons or goods the platform may be provided with a gangway, crane or alike.

It has appeared that during use of such a vessel the platform actuators are constantly activated for achieving the desired stationary position of the platform and thus considerable forces are exerted onto the vessel. Especially in case of lightly damped vessel motions (such as
rolling for monohull vessels) this may prove disadvantageous. This situation may even be worse because vessels with respect to such barely damped motions move at or near to their natural frequencies and the excitation by the platform activators occurs exactly at those frequencies. As a result of the occurring resonance rather small excitations already may lead to large amplitudes of rolling motions of the resulting vessel movements.

It is an object of the present invention to provide an improved vessel of the above type and to prevent or at least diminish occurring resonance effects.

Thus, in accordance with the present invention a vessel is provided which is characterized in that the transfer system further comprises at least one compensation system for at least partially compensating motions of the vessel caused by the activation of the platform actuators, wherein the compensation system comprises a compensation actuator coupling the at least one compensation mass to the vessel for a movement relative thereto, and wherein the compensation mass is to the utmost two times the first mass and preferably to the utmost 1.5 times the first mass.

The compensation actuator compensates the forces caused by the first mass as a result of the position and accelerations of the platform and platform actuators, by positioning and/or moving the at least one compensation mass in such a manner that the mentioned forces are counteracted by opposite forces.

It is noted that with such a compensation mass it is only possible to neutralize the forces caused by the first mass, and that it is not possible to damp the rolling motions of the vessel caused by e.g. waves. The first mass is too small for damping rolling motions of the vessel, since a mass for roll damping needs to have a mass with a magnitude of at least 4 or 5% of the mass of the vessel.
In practice the compensation system may be used on vessels with a mass in a range of 500 - 1200 ton. The mass needed for roll damping of such a vessel is, therefore, in a range of 20 - 60 ton. Thus for roll damping of a vessel, an very large mass needs to be moved to and fro. In order to be able to move such a large mass, a large driver and control is necessary, due to which a large part of the space inside the vessel is needed for the roll damping.

The transfer system, in particular the first mass, as described above has a mass in a range of 5 - 10 ton. Due to the first mass, the compensation mass might be in a range of 5 - 15 ton. Due to the compensation system according to the invention, significant less mass is necessary for neutralizing the movement of the transfer system, which is economically advantageous with respect to, i.e., the costs of the driver and control for moving the compensation mass. Further, the compensation mass occupies less space within the vessel in comparison with a roll damping system, such that for example more goods may be transported with the vessel.

An additional advantage is that a relative small mass is easier controllable than a relative heavy weight, such as a roll damping system.

Moreover, a result of the compensation system is that the motions of the vessel are not or hardly influenced by the forces that the transfer system exerts on the hull of the vessel.

In one embodiment of the vessel the compensation system is adapted for counteracting a rotational motion of the transfer system for transferring persons or goods around the rolling axis of the vessel, preferably for substantially neutralizing only the rolling movement of the vessel caused by the position and/or movement of the system for transferring persons or goods.
In another embodiment of the vessel it is possible that the at least one compensation mass is adapted to be moved linearly by its compensation actuator(s).

In another embodiment, the at least one compensation mass may have substantially the same weight as the first mass.

In an embodiment the compensation mass is adapted to be moved linearly by the compensation actuators substantially in a plane perpendicular to the longitudinal axis of the vessel. This mass may be used primarily to counteract motions of the vessel perpendicular to the longitudinal axis thereof caused by the transfer system for transferring persons or goods.

Constructively, it is advantageous when the compensation actuators comprise assemblies of linear guides and linear actuators. However, also other devices for achieving a linear motion of the compensation mass or masses may be used.

In yet another embodiment of the vessel according to the present invention the compensation actuators are adapted for offering the at least one compensation mass a rotational movement with three degrees of freedom and a linear movement with three degrees of freedom. This offers the compensation mass a range of movements sufficient for compensating/neutralizing nearly all excitations of the transfer system for transferring persons or goods.

In an embodiment the at least one compensation mass is adapted to be moved in counter phase to the first mass, preferably in a plane substantially perpendicular to the longitudinal axis of the vessel.

In such a case it is possible that the compensation actuators comprise six linear actuators, such as hydraulic or pneumatic piston cylinder assemblies which each at both ends by means of universal joints are connected to the vessel and the at least one compensation mass,
respectively. Basically, such an arrangement will correspond with a known arrangement of actuators used to move the platform.

In a special embodiment of the vessel according to the present invention, the at least one compensation mass is defined by an auxiliary platform moved by auxiliary platform actuators substantially similar to the platform and platform actuators and adapted to be moved substantially in counter phase to the motion of the platform in a plane substantially perpendicular to the longitudinal axis. The auxiliary platform and auxiliary platform actuators will counteract (and compensate) the excitation of the platform having the first mass and platform actuators.

To be most effective, a compensation mass theoretically should coincide with the platform and platform actuators; however, because of possible concurrent technical difficulties of such a theoretical arrangement, in practice there will be a small distance between those parts of the system either in longitudinal direction of the vessel.

In accordance with another embodiment, the at least one compensation mass may be located substantially at the same level as and close to the platform and platform actuators. The relative position between those parts then may be optimised with respect to the best compensation of the excitation in view of the most important movement of the vessel (for example rolling in monohull vessels).

In another embodiment the at least one compensation mass is located below the platform and platform actuators. Also in such a case the compensation mass may comprise an auxiliary platform moved by auxiliary platform actuators substantially similar to the platform and platform actuators; but also other types of a compensation mass are conceivable, for example using linear guides and linear actuators.
In yet another embodiment, the vessel further comprises control means for controlling the compensation actuators of the at least one compensation mass adapted to generate control signals for said compensation actuators based upon the movement of the platform. Such an embodiment directly uses the movement of the platform (for example based upon the control signals for its platform actuators) to generate the required control signals for the compensation actuators of the compensation mass.

However, it is possible too that the vessel further comprises control means for controlling the compensation actuators of the at least one compensation mass, which control means comprises sensors for sensing the position and acceleration of the first mass in a plane substantially perpendicular to the longitudinal axis of the vessel and means for generating control signals for said compensation actuators based upon an output of said sensors. As a result also the movements of the transfer system, in particular the first mass, are used as an input to generate control signals for the compensation actuators of the at least one compensation mass.

Then, in one embodiment of the vessel, the control means may be adapted to generate control signals for said compensation actuators for counteracting rolling of the vessel.

In an embodiment the control signals for the compensation actuators are substantially inverted control signals for controlling the platform actuators of the platform having the first mass. The compensation system may be controlled substantially on basis of the control signal for the transfer system, and therefore no additional measurements are necessary for controlling the compensation system. Therefore, a simple control of the compensation system is effectuated.
Hereinafter the invention will be elucidated by means of the drawing, in which:

Figure 1 schematically shows a first embodiment of a system for transferring persons or goods according to the present invention,

Figure 2 schematically shows a second embodiment of a system for transferring persons or goods according to the present invention.

Figure 3 schematically shows a third embodiment of a system for transferring persons or goods according to the present invention, and

Figure 4 schematically shows an embodiment of a compensation mass as it can be mounted on one or more locations of the vessel.

Referring to figure 1 only a small part of a vessel 1 is illustrated showing a transfer system for transferring persons or goods from the vessel towards a substantially stationary destination or construction mounted on an upper deck of the vessel 1. Such a transfer system generally comprises a platform 2, having a first mass, for supporting the persons or goods, platform actuators 3 connecting the platform 2 to the vessel 1 and a gangway 4 mounted on the platform 2.

The platform actuators 3 (which for example may comprise six fast acting pneumatic or hydraulic piston cylinder assemblies) are adapted for moving the platform 2 relative to the vessel 1 in such a manner that the platform is maintained spatially in a substantially stationary position, notwithstanding a movement of the vessel 1 due to external influences such as, among others, the swell, waves, and wind. As a result the platform 2 may be kept stationary relative to a (substantially) stationary destination or construction (such as, for example an offshore drill rig, offshore wind turbine or another vessel) and persons or
goods may be transferred in a safe manner to said stationary
destination (for example by means of the gangway 4).

The transfer system as described up to this point
1
5 corresponds with a well known system for transporting people
from a ship to a stationary construction located at sea as
used on vessels to date. In accordance with the present
invention, such a transfer system further comprises
compensation system with at least one compensation mass for
at least partially compensating motions of the vessel 1
10 caused by the activation of the platform actuators 3 and by
the resulting motion of the platform 2 relative to the
vessel.

In the embodiment according to figure 1 there is a
single compensation mass which by means of compensation
15 actuators is mounted to the vessel for a movement relative
thereto. The compensation mass is defined by an auxiliary
platform 5 (which may or may not be similar to the primary
platform 2; it is intended, for example, that the auxiliary
platform is defined by a mass with substantially the same
20 mass and inertia as the first mass, but without exactly the
same outer appearance; as such a gangway generally will not
be present).

It is noted that the compensation mass 5 is
25 substantially the same as the first mass, such that movement
of the compensation mass and first mass may be substantially
the same. When it is desired that the movement of the
compensation mass 5 is smaller than the movement of the
first mass for example due to available space in the vessel,
30 the compensation mass 5 has to become larger, for example to
the utmost two times the first mass or to the utmost 1.5
times the first mass.

The compensation actuators are defined by
auxiliary platform actuators 6. As is the case with the
35 platform 2, the compensation actuators 6 preferably comprise
six (linear) actuators, such as hydraulic or pneumatic
piston cylinder assemblies which each at both ends by means of universal joints 7 are connected to the vessel 1 and to the at least one compensation mass 5, respectively.

The auxiliary platform 5 and auxiliary platform actuators 6 are adapted to be moved substantially in counter phase to the motion of the platform 2 and platform actuators 3, in particular the first mass. As such, the compensation mass may be adapted for neutralizing a rotational motion of the vessel 1 around the rolling axis caused by excitation of the first mass of the transfer system.

Basically the compensation actuators 6 according to the embodiment of figure 1 are adapted for offering the compensation mass (auxiliary platform) 5 a rotational movement with three degrees of freedom and a linear movement with three degrees of freedom, preferably an one-directional movement. For compensating the movement of the vessel 1, i.e. neutralizing the excitation of the first mass, caused by the forces generated by the transfer system for transporting people from the ship to the stationary construction, in general only the rotation around the longitudinal axis of the vessel 1 needs to be compensated as due to the shape of the vessel 1 that are the only movements that might show increasing oscillations as a result of the forces earlier mentioned. In situations that the compensation mass 5 compensates only for rotation around the longitudinal axis it is sufficient to let this compensation mass 5 rotate around one axis or a linear movement of the compensation mass 5 in a plane perpendicular to the longitudinal axis or to the median plan of the vessel may be sufficient. The number of compensation actuators can then be reduced to one or two compensation actuators 6 that let the compensation mass 5 oscillate in counter phase with respect to the first mass.

In the illustrated embodiment the compensation mass 5 is located immediately below the platform 2 and
platform actuators 3 (specifically below the upper deck of the vessel 1), but it is conceivable too that it is located substantially at the same level as (and preferably close to) the platform 2 and platform actuators 3. In a further embodiment, a smaller compensation mass 5 might be located in front or behind the platform 2 or at both sides of platform 2.

The system further may comprise control means (not illustrated) for controlling the compensation actuators 6 of the compensation mass 5, adapted to generate control signals for said compensation actuators 6 based upon the movement of the platform 2 (and the movement of the platform actuators 3). Further additional control means (not shown) may be provided, also for controlling the compensation actuators 6 of the compensation mass 5. Such additional control means may comprises sensors (not illustrated) for sensing the position and acceleration of the first mass in a plane substantially perpendicular to the longitudinal axis of the vessel or in a direction perpendicular to a central plane through the longitudinal axis of the vessel and means for generating control signals for said compensation actuators based upon an output of said sensors. As a result control signals for the compensation actuators 6 may be calculated in such a manner that the compensation mass (auxiliary platform) 5 carries out a movement for in an optimal manner compensating (counteracting) an excitation of the platform 2.

With respect to the sensors, it is noted that different kinds of sensors may be used, such as optical sensors, acceleration sensors, position sensors, encoders, velocity sensors, angular velocity sensors, etc.

Of course it is also possible that the control signals for the compensation actuators 6 of the compensation mass 5 are directly derived from the original control signals for the platform actuators 3 (for example having
substantially the same magnitude but an opposite sign, depending on the characteristics of the system in general and of the compensation mass in specific).

Referring to figure 2, a second embodiment of a vessel with system according to the present invention is illustrated. The upper part of the system (which, basically represents a state of the art system) is similar to the transfer system for transporting people from a ship to a stationary construction located at sea as described before and therefore the description thereof is not repeated.

The lower part of the system according to this second embodiment comprises two compensation masses 8, 9 which are adapted to be moved linearly by respective compensation actuators 10, 11 (for example in parallel to the longitudinal axis of the vessel 1 and in parallel to transverse axis of the vessel which is perpendicular to the central plane of the vessel, respectively). The compensation actuators 8, 9 (which may comprise any type of linear actuators, such as for example cylinder piston assemblies, cable drives, gear racks) are devised for moving the compensation masses 10, 11 to and fro, for example along linear guides 12, 13 attached stationary to the vessel 1 and located immediately under the upper part of the system, for instance immediately under the upper deck.

It is noted that in an simple embodiment, the two compensation masses 8, 9 may be formed as a single mass or there is only one compensation mass 8 or 9 that moves in one direction for instance in the direction of the transverse axis. Further, the total mass of the two compensation masses 8, 9 may be to the utmost two times the first mass, or 1.5 times the first mass. The total mass of the two compensation masses 8, 9 may also be the same as the first mass.

Although this second embodiment shows two separate compensation masses each adapted for a to and fro movement in a specific direction, it is also conceivable that both
compensation masses 8,9 are combined into a single mass which is adapted to carry out linear movements in different directions (for example in parallel to the longitudinal axis of the vessel and in parallel to transverse axis of the vessel, respectively) and, thus, in combination may carry out movements in any other direction (in a plane extending through said two original directions) or even along a curved trajectory, if needed (in said plane). As mentioned earlier the combined single mass may also move in a single direction.

The operation of this second embodiment generally is similar to that of the first embodiment (although, because this embodiment only allows the compensation mass or masses to be moved in a more restricted manner, its capability for compensating or counteracting excitations may be less). Control means and sensors may be provided in accordance with the first embodiment.

Referring to figure 3 a third embodiment of a vessel with system according to the present invention is illustrated schematically. The figure 3 shows the vessel 1 with a platform 14 mounted on the rear of the vessel. Platform actuators 15 move the platform 14 and maintain the platform 14 in a stationary position while the ship moves in waves and/or swell. It will be clear that the platform 14 can rotate on a turret 18 that is mounted on the deck, that the platform 14 can move in height by changing its inclination and that the length can be adapted as required. In the shown embodiment transverse compensators 16 are mounted on deck in front and at the rear of the turret 18 and the longitudinal compensators 17 are mounted under the deck. In other embodiments these positions can be different and are dependent on the available space and the required compensation.

Referring to figure 4 an embodiment of a compensation mass as it can be mounted on one or more
locations of the vessel is illustrated schematically. In the embodiment, an actuator 20 can move a mass 19 over a rail. As shown the actuator 20 comprises a motor, for instance a hydraulic motor, that drives a gear that engages a rack mounted in the direction of the rail. The actuator 20 and the mass 19 are mounted under a cover 21 to protect them against the environment.

The invention is not limited to the embodiments described before, which may be varied widely within the scope of the invention as defined by the appending claims. For example, the compensation mass may have a mass which differs from the mass of the platform (with or without its actuators) and may be moved in any other appropriate manner, for example as a pendulum with a pendulum arm with specific length by means of three linear actuators positioned around said pendulum arm.
CLAIMS

1. Vessel comprising a transfer system for transferring persons or goods from the vessel while subjected to waves and/or swell towards a substantially stationary destination, wherein the transfer system comprises:

   a platform having a first mass for supporting the persons or goods during transfer, and
   platform actuators connecting the platform to the vessel and adapted for moving the platform relative to the vessel in such a manner that the platform or part of the platform is maintained spatially in a substantially stationary position,

   characterized in that the transfer system further comprises at least one compensation system for at least partially compensating motions of the vessel caused by the activation of the platform actuators,
   wherein the compensation system comprises a compensation actuator coupling at least one compensation mass to the vessel for a movement relative thereto, and

   wherein the compensation mass is to the utmost two times the first mass and preferably to the utmost 1.5 times the first mass.

2. Vessel according to claim 1, wherein the compensation system is adapted for counteracting a rotational motion of the transfer system for transferring persons or goods around the rolling axis of the vessel, preferably for substantially neutralizing only the rolling movement of the vessel caused by the position and/or movement of the system for transferring persons or goods.

3. Vessel according to any of the preceding claims, wherein the at least one compensation mass is adapted to be moved linearly by its compensation actuator(s).
4. Vessel according to any one of the preceding claims, wherein the at least one compensation mass has substantially a same weight as the first mass.

5. Vessel according to claim 4, wherein the compensation mass is adapted to be moved linearly by the compensation actuators substantially in a plane perpendicular to the longitudinal axis of the vessel.

6. Vessel according to any one of the preceding claims, wherein the compensation actuators comprise assemblies of linear guides and linear actuators.

7. Vessel according to any one of the preceding claims, wherein the compensation actuators are adapted for offering the at least one compensation mass a rotational movement with three degrees of freedom and a linear movement with three degrees of freedom.

8. Vessel according the any one of the preceding claims, wherein the at least one compensation mass is adapted to be moved in counter phase to the first mass, preferably in a plane substantially perpendicular to the longitudinal axis of the vessel.

9. Vessel according to claim 8, wherein the compensation actuators comprise six linear actuators, such as hydraulic or pneumatic piston cylinder assemblies which each at both ends by means of universal joints are connected to the vessel and to the at least one compensation mass, respectively.

10. Vessel according to any one of the preceding claims, wherein the at least one compensation mass is defined by an auxiliary platform moved by auxiliary platform actuators substantially similar to the platform and platform actuators and adapted to be moved substantially in counter phase to the motion of the platform in a plane substantially perpendicular to the longitudinal axis.

11. Vessel according to any one of the previous claims, wherein the at least one compensation mass is
located substantially at the same level as and close to the platform and platform actuators.

12. Vessel according to any of the claims 1-11, wherein the at least one compensation mass is located below the platform and platform actuators.

13. Vessel according to any one of the preceding claims, further comprising control means for controlling the compensation actuators of the at least one compensation mass adapted to generate control signals for said compensation actuators based upon the movement of the platform.

14. Vessel according to any one of the preceding claims, further comprising control means for controlling the compensation actuators of the at least one compensation mass.

15. Vessel according to claim 14, wherein the control means comprises sensors for sensing the position and acceleration of the first mass in a plane substantially perpendicular to the longitudinal axis of the vessel and means for generating control signals for said compensation actuators based upon an output of said sensors.

16. Vessel according to claim 14 or 15, wherein the control means are adapted to generate control signals for said compensation actuators for counteracting rolling of the vessel caused by motions of the transfer system for transferring persons or goods.

17. Vessel according to any one of the claims 14 - 16, wherein the control signals for the compensation actuators are substantially inverted control signals for controlling the platform actuators of the platform having the first mass.
### INTERNATIONAL SEARCH REPORT

**International application No**

PCT/EP2013/070515

**A. CLASSIFICATION OF SUBJECT MATTER**

- INV. B63B27/14  B63B27/30  B63B39/02
- ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

- B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

- EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<td>WO 2012/021062 A1 (AMELPGMANN OPERATIONS B V [NL]; VAN DER TEMPEL JAN [NL]; GERNER FREDRI) 16 February 2012 (2012-02-16) page 3, line 26 - page 4, line 9; figures 1-3</td>
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* Further documents are listed in the continuation of Box C. See patent family annex.

**D. DOCUMENTS CONSIDERED TO BE RELEVANT**

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**Date of the actual completion of the international search**

20 January 2014

**Date of mailing of the international search report**

29/01/2014

**Name and mailing address of the ISA/**

European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk
Tel: (+31-70) 340-2040, Fax: (+31-70) 340-3016

**Authorized officer**

Vermeulen, Tom
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