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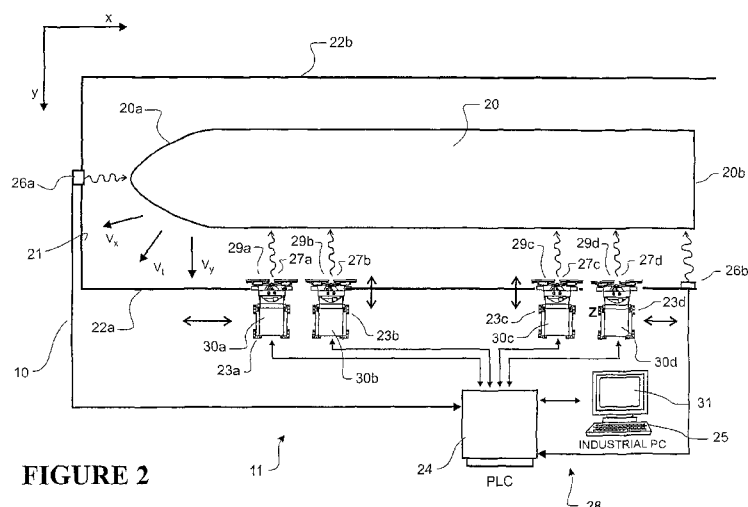
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(57) Abstract: This invention relates to a mooring system for securing a vessel to a mooring facility. It may comprise at least one mooring device for installation at a mooring facility in a position to allow the mooring device to assist in holding a vessel relative to the mooring facility. Each device comprises a rig and a hull coupler moveably supported relative the mooring facility by said rig. There is also at least one position and/or velocity sensor, for sensing position and/or velocity of a proximate vessel and/or part of the vessel that is or is to be held by the mooring device relative the mooring facility. A controller can at least control the at least one mooring device based on information received from or derived from the sensor.

"MOORING SYSTEM AND CONTROL"

FIELD OF INVENTION

The present invention relates to a mooring system for vessel mooring facilities, and in particular, although not solely, to a vacuum mooring device.

5 BACKGROUND

Mooring devices can be used to secure vessels when they arrive at mooring facilities such as docks, locks, wharfs and the like. The mooring device prevents the vessel from drifting away from the docking position.

10 Vacuum mooring systems (VMS) are commonly utilised, such as shown in Figure 1. These include a number of mooring devices Ia- Id each having a suction or vacuum pad supported by a rig that is attached to the dock 2 or other mooring facility. When a vessel 3 approaches the mooring facility 2, the rig is operated to manoeuvre the suction pads to the hull of the vessel 3 until they attach to the hull. The rig may use hydraulic rams to do so.

15 Mooring devices can withstand large forces due to the significant mass of vessels. Even so, a mooring device can be damaged if it is not operated correctly by the operator, or if the vessel is moving too quickly.

It is an object of the present invention to provide a mooring system and related method that can determine the position and/or velocity of an incoming vessel to allow for a mooring device to be controlled to reduce the likelihood of damage from incorrect operation and/or excessive vessel 20 velocities and/or to at least provide the public with a useful choice.

BRIEF DESCRIPTION OF THE INVENTION

In a first aspect the present invention consists in a mooring system for securing a vessel to a mooring facility, said mooring system comprising:

25 at least one mooring device for installation at a mooring facility in a position to allow the mooring device to assist in holding a vessel relative to the mooring facility, each device comprising a rig and a hull coupler moveably supported relative to the mooring facility by said rig,

30 at least one position and/or velocity sensor, for sensing position and/or velocity of a proximate vessel and/or part of the vessel that is or is to be held by the mooring device relative to the mooring facility, relative to the mooring facility and/or the hull coupler of said at least one mooring device, and

a controller to at least control the at least one mooring device based on information received from or derived from the sensor.

Preferably the system further comprising an output device for outputting, (based at least in part on information received from or derived from the sensor)

- a. visual information indicating the velocity and/or position of the proximate vessel and/or part(s) of the vessel relative to at least one of the mooring facility and the at least one mooring device,
- b. a graphical representation of the proximate vessel indicating the velocity and/or position of the vessel and/or part(s) of the vessel,
- c. an audible or visual warning if the velocity of the proximate vessel or part of the vessel exceeds a threshold.

Preferably the controller can control the rig of at least one mooring device to alter the position and/or velocity of the respective hull coupler of the mooring device relative to the mooring facility, when not coupled to the vessel in a manner to at least partially adjust for the position and/or velocity of an approaching vessel.

Preferably the controller can control the rig, in response to said information, automatically or under human control.

Preferably at least two mooring devices are provided to be located at spaced apart locations at the mooring facility, and wherein at least one sensor is provided to determine the location and/or velocity of a location of those parts of the proximate vessel proximate most each hull coupler of the at least two mooring devices.

Preferably the controller can control the rig of each mooring device to allow the position and/or velocity of the hull coupler of a respective mooring device to be changed relative to the mooring facility in response to location and/or velocity information sensed by the at least one sensor.

Preferably the hull coupler can be controlled so that during coupling thereof with the proximate vessel the velocity of the hull coupler relative the mooring facility is such as to reduce the impact of initial contact between the hull and the hull coupler when compared to if the hull couplers is held stationary relative the mooring facility.

Preferably the controller can control the velocity of the hull coupler in response to the information sensed by the at least one sensor. -

Preferably the controller can control the position of the hull coupler in response to the information sensed by the at least one sensor.

Preferably the controller can position the hull coupler in a position relative said mooring facility such that at the instance of initial contact with the hull of the proximate vessel during the coupling of the vessel with the mooring device, the rig is in a condition to allow it to move in a manner to facilitate the movement of the hull coupler, when coupled to the vessel, in a direction that that part of the vessel with which it is engaged, is moving upon the initial contact.

Preferably the position that the controller moves the hull coupler to, is one that provides for the maximum distance of travel to be provided for, for the hull coupler, by the rig.

Preferably the rig of each mooring device is operable to move, relative to the mooring facility, the respective hull coupler up and down and horizontally towards and away from an approaching vessel.

Preferably the hull coupler is a suction pad.

Preferably the sensors provide position information on an approaching vessel and/or part or parts of the vessel, from which the system can calculate the velocity of the vessel and/or part or parts of the vessel.

Preferably at least one sensor is disposed on one or more of the mooring devices.

Preferably at least one sensor is disposed on or adjacent a mooring facility.

Preferably the at least one sensor can detect or allow the derivation of one or more of:

the position and/or velocity of the bow of a vessel,

the position and/or velocity of the stern of a vessel,

the position and/or velocity of the hull of a vessel, and

the athwartship position or velocity of a vessel,

relative at least one of the mooring facility and the hull coupler of the or each mooring device.

Preferably the sensor(s) can be used to derive information on the change in velocity of the vessel or part of the vessel.

In a second aspect the present invention consists in a mooring facility comprising a mooring system according to what is described above.

In a further aspect the present invention consists in a method of mooring a vessel at a mooring facility that includes at least one mooring device positioned to allow the mooring device to assist in holding a vessel relative to the mooring facility, each device comprising a rig and a hull coupler moveably supported relative to the mooring facility by said rig, said method comprising:

sensing the position and/or velocity and/or change in velocity of one or more of the (a) bow, (b) stern, (c) hull, (d) part of the hull at where the hull coupler is to engage, of an approaching vessel, and the method further comprising, based on what is sensed, at least one of

- i. providing a warning for a mooring facility operator if the vessel's approach to the mooring facility exceeds a predetermined threshold,
- ii. providing visual and/or audible information indicating the velocity and/or change in velocity and/or position of a vessel or part or parts of the vessel relative at least one of the mooring facility and the hull coupler of the or each mooring device,

- iü. operating one or more mooring devices to alter the position of a respective hull coupler to at least partially adjust for the position and/or velocity of an approaching vessel.

In a further aspect die present invention consists in a method of operating a mooring system according to what is described above comprising one or more of:

providing die information-indicative of the velocity and/or position of an approaching vessel to an operator to allow them to decide to (i) operate the mooring device(s) to secure the vessel, or (ü) to operate (or not) the mooring device to prevent the vessel being secured.

Preferably the information is provided as graphical representation and will also include a warning (visual and/or audible) if the vessel's approach to the mooring facility exceed a predetermined threshold.

Preferably the method includes the control of mooring device(s) to manipulate the rig to alter the position and/or velocity of the hull coupler to at least partially adjust for the position and/or velocity of an approaching vessel.

In a further aspect the present invention consist in a mooring system or method according to what is described above wherein the mooring facility can be one or more of: a lock, a dock, a wharf, a barge.

In a further aspect the present invention consist in mooring facility that includes the mooring system as herein before described.

As used herein the term "and/or" means "and" or "or", or both.

As used herein "(s)" following a noun means the plural and/or singular forms of the noun.

The term "comprising" as used in this specification means "consisting at least in part of. When interpreting statements in this specification which include that term, the features, prefaced by that term in each statement, all need to be present but other features can also be present. Related terms such as "comprise" and "comprised" are to be interpreted in the same manner.

This invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more of said parts, elements or features, and where specific integers are mentioned herein which have known equivalents in the art to which this invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will be described with respect to the following drawings, of which:

Figure 1 shows a vessel secured to a mooring facility using a VMS,

5 Figure 2 shows a vessel approaching a mooring system in accordance with one embodiment of the invention,

Figure 3 shows an output device giving graphical information regarding the position and/or velocity of an approaching vessel,

10 Figure 4 shows a side elevation view of a mooring device arranged on a mooring facility in accordance with one embodiment of the invention,

Figure 5 shows a perspective view of two mooring devices arranged on a mooring facility according to one embodiment in perspective.

Figure 6 shows a method according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

15 Figure 2 shows, in schematic form, the present invention according to one embodiment. The present invention allows for sensing or detection of the position and/or velocity of a vessel 20 as it approaches a mooring facility 10, and operation of the mooring system 11 in accordance with the sensed/detected information. The mooring facility 10 could be a lock, dock, wharf, barge or the like. In the preferred embodiment shown in Figure 2, the mooring facility is a lock 10 comprising
20 two lateral sides 22a, 22b and a gate 21 or gates.

The mooring system (generally labelled 11) is installed at the mooring facility 10. The mooring system comprises one or more mooring devices e.g. 23a-23d, position sensors 26a, 26b, 27a-27d, and a controller system 28. The controller system can more generally be termed a "controller". The term "controller" can refer to the control system 28 as a whole, or some part
25 thereof. The controller system enables monitoring of the sensors, processing of information from the sensors, and general control of the mooring devices. The controller system 28 can comprise, for example, a computer 25 and programmable logic controller (PLC) 24.

Each mooring device 23a-23d comprises one or more hull couplers 29a-29d, such as suction or vacuum cups. A rig 30a-30d may hold the cups in a movable manner relative to the dock. Whilst
30 herein there is reference to vacuum cups, the cups may not draw a complete vacuum but instead create sufficient pressure differential to the ambient air pressure in order to remain attached to the vessel.

Each mooring device may include two vacuum cups.

Each rig 30a-30d is attached to a stationary portion of the mooring facility 10. The hull
35 couplers 29a-29d can be manoeuvred, by the rig 23a-23d attached to the mooring facility, to attach

to the hull of a vessel 20 to secure an approaching vessel 20. The mooring devices 23a-23d will be described in further detail later with respect of Figures 4 and 5. Preferably four mooring devices 23a-23d are stationed along the mooring facility 10; two 23a, 23b for securing the vessel towards the bow and two 23c, 23d for securing the vessel towards the stern. However, it will be appreciated that any suitable number of mooring devices could be utilised in the system.

Each mooring device 23a-23d comprises a distance sensor 27a-27d for sensing, at a plurality of instants, the distance of the vessel from the respective mooring device. In particular the distance to the vacuum cup is being measured.

Where the invention is executed at a lock, a distance sensor 26a may be positioned on the gate 21 of the lock 10 to measure the distance from the gate 21 to the bow 20a of the vessel or stern of the vessel, whichever is closest. A sensor 26b may also be placed at a location of the mooring facility to determine the distance from the lock 10 to the other end of the vessel such as stern 20b of the vessel or the bow of the vessel as the case may be.

The sensors can measure the distance at multiple points in time, and therefore obtain a measure as to the change in distance due to movement of the vessel over time. From this, the position and/or change of position of the vessel can be determined for both the x and the y axis displacements. This can provide a Cartesian coordinate determination of at least one of the position and the speed and the velocity (speed and direction) of parts of the vessel relative to the mooring facility.

This information is passed from the sensors 26a, 26b, 27a-27d to the controller system 28. By calculating the change in position of the vessel 20 over time from the sensor information, the controller system 28 can determine the velocity of the vessel in the x and y direction. It may do this by dividing the change in position along each axis by the change in time.

The sensors 26a, 26b, 27a-27d could be any suitable optical or sonic sensors for determining distance. A velocity sensor could be used as well as, or instead of distance sensors. Laser, Doppler, radar or other sensors could be used, for example. At each instance where the controller determines the position and/or the velocity of the vessel, it passes this information directly or indirectly to an output device. For example, it may pass the information to a PC 25 that uses the information to provide output to a user on a screen 31. Alternatively, the information could be provided directly to an output device such as a screen (not shown) connected directly to the PLC 28.

Sensors could be used to not just measure the position and velocity of the vessel, but also of part or parts of the vessel. For example if the vessel is turning, the velocity of the bow and the stern can be different. The sensors could be used to let information about the velocity of the bow and stern of the vessel to be provided and used. Or of any other parts of the vessel such as those parts that are proximate most the mooring device or each mooring device.

Figure 3 shows, in schematic form, the information that may be provided on the visual output device 31. In the preferred embodiment, a graphical representation 32 of the vessel 20 and its positional relationship to the mooring facility 10 is displayed. This graphical representation is continually updated or animated, such that movement of the vessel 20 and its relative velocity will also be shown. Velocity of multiple parts of the vessel may also be displayed.

Information on change in velocity (eg acceleration or deceleration) of the vessel and/or part of parts of the vessel may be generated. This information may be displayed and/or otherwise used.

The information may indicate to an operator at the mooring facility 10 and/or onboard or viewable from onboard the vessel, the position and/or velocity of the vessel 20 and/or part or parts of the vessel without having to view the vessel directly. This can assist the operator to operate the mooring system 11 in an appropriate manner for the velocity and position of the vessel.

A visual output device 31 might provide an indication of the vessel position in plan view (as coordinates or a distance from a datum) and/or the vessel velocity (in knots or other suitable parameters). This indicates at least to the operator(s), information that enables them to make decisions in relation to the operation of the mooring system 11.

Further, the device might give an audible or visual warning if the approaching vessel's velocity exceeds a threshold. For example, if the velocity exceeds 5 knots, a warning will be issued to the operator indicating that the mooring system should not be operated to secure the vessel, as the vessel's velocity may damage the system.

Figures 4 and 5 show the mooring devices of one possible embodiment in further detail. Each mooring device 23a-23d comprises a rig that supports one or more hull couplers as described previously. A side elevation of a single mooring device, e.g. 23a, is shown in Figure 4. Two mooring devices are shown in Figure 5. In this case, they could be the bow mooring devices 23a, 23b. Each device is operable to enable the respective hull couplers to move:

- a) towards and away from the approaching vessel in the y direction (arrow A),
- b) up and down relative to the water in the z direction (arrow B), and also
- c) side-to-side longitudinally along the mooring facility in the x direction (arrow C).

Movement in these directions may occur simultaneously or not.

Each rig of a mooring device comprises a frame e.g. 40a, 40b with two sets of two struts respectively, e.g. 42a-42d and 43a-43d, one set positioned either side of the frame 40a, 40b. In each set, the first strut 42a-42d is hydraulically controlled and can pivotally adjust the second strut 43a-43d to adjust the position of the hull coupler in both the z and y directions. A hull coupler is pivotally attached to each second strut, meaning in the preferred embodiment there are two hull couplers for each mooring device. The term hull coupler can refer to each coupler alone, or each pair of couplers e.g. 27a.

Further, each frame 40a, 40b is slidingly coupled to a respective set of rails 41a, 41b, and 41c, 41d that enables the entire frame 40a, 40b, including the hull couplers, to slide up and down in a vertical (z) direction (arrow B). The combined actions of the struts 42a-42d, 43a-43d together the rails 41a-41d enables controlled movement of each hull coupler in the z and y direction by its
5 respective rig.

Further, for each mooring device, the respective frame 40a, 40b and the vertical rails 41a-41d are placed on horizontal rails 44a, 44b that run along the extent (or at least partially thereof) the mooring facility 10 in the x direction. This allows movement of the hull couplers in the x direction. As shown, several mooring devices 23a, 23b might share the same rail. Alternatively, they can have
10 separate rails. Therefore, the rig can be considered to comprise a separate or shared rail.

The action of the struts and the rails enable movement of the hull coupling in any of the x, y, z directions. This can be through passive movement under the influence of vessel movement, or by active control. That is, through hydraulics and control by the controller, the rigs can be operated to move the struts and/or frame on the rails to position the hull couplers in any required position.

As a result, the hull couplers can move in any of the xyz directions in response to movement of a vessel attached to the hull couplers. Similarly, through the controller system, 28, the position and/or velocity of the hull couplers can be controlled prior to attachment to the vessel hull in order to move them into an appropriate position (at an appropriate velocity) for coupling to the hull based on the position and/or velocity of the approaching vessel.

A possible method of operation of the system is described in relation to Figure 6. When a vessel approaches a mooring facility 10, the sensors 26a, 26b, 27a-27d will detect the vessel and take distance and/or velocity measurements via the sensors, step 60. This information is obtained continually or periodically throughout the mooring process. At each point, the position of the vessel is sensed then passed to the controller system 28, which determines the position and the
20 velocity of the vessel in the x and y directions, step 61. The controller then processes this information for direct display, step 62, or communication in another fashion to an operator, such as described in relation to Figure 3. Alternatively, the information can be passed to a computer or computer system 25 for presentation to a user.

One of a number of actions or operations can take place automatically, by the controller and/or by the operator, (eg at step 63) dependent on the position and/or velocity of the incoming
30 vessel. These may be carried out until mooring is complete, step 64. These operations are as follows.

If the vessel is approaching at a velocity that is not exceeding a threshold, the controller system 28 can control the rig of each mooring device to manipulate each hull coupler in a suitable
35 manner for attachment to the vessel.

For example, this might be by way of placing the hull coupler in a suitable position for coupling to a suitable position on the hull when the vessel reaches the desired mooring point.

Further, it might involve controlling the rig so that the hull coupler tracks or at least partially tracks the movement/velocity of the hull. This can be determined by the velocity of the hull. If the x, y and z directions of the hull couplers are moved to approximately track the velocity in the x, y and z directions of the hull as it approaches, this reduces the forces exerted by the hull onto the hull couplers and mooring devices as a whole when attachment actually takes place.

Even if the movement of a hull coupler is not controlled to match the full velocity of the hull, at least having some movement in the appropriate directions will reduce the force exerted by the hull on the hull couplers when connection takes place. Algorithms can operate the rigs to track the hull couplers in the desired manner based on the sensed velocity and position of the hull as it approaches.

Alternatively, the controller (or operator) may decide not to operate the facility to moor the vessel if the velocity of the vessel or the location of the vessel at here the mooring device is to attach is too high (above the threshold).

As the vessel approaches the mooring facility, an operator may manually operate a mooring devices to assist the coupling process.

The operator can view the position and velocity of the approaching vessel on the display, and from that information operate the velocity and position of the rigs (and therefore the hull couplers) in the required x, y and z direction to effect coupling to secure the vessel in an effective and safe manner.

Based on this information, the operator may opt not to operate the mooring system and not secure the vessel, if it appears dangerous to do so. For example, the position of the vessel might not be correct or the velocity of the vessel might be too high.

If an audible or visual warning signal is displayed to indicate that the vessel or part of the vessel is approaching a mooring device too quickly, then the operator may opt not to couple the vessel to the mooring facility. Alternatively, the controller may override manual operation to prevent this.

A number of alternatives to the embodiment described above are possible. For example, it is not essential to have distance sensors on all the mooring devices and the berths or gates. There could simply just be one or two sensors positioned appropriately either on the mooring facility and/or one or more of the mooring devices in order to obtain the appropriate distance information, from which position and ultimately velocity of the vessel can be determined. Having sensors on the mooring facility and on all the mooring devices is preferable, as this provides distance information relative to the mooring facility and also the moving mooring devices.

Instead of distance or position sensors, sensors could be velocity sensors that directly measure the velocity of the vessel relative to the mooring facility and/or the mooring devices. Or measure or allow the derivation of a change in velocity.

5 The system may also facilitate the prepositioning of a hull coupler prior to engagement to the vessel. This can allow for the rig to be moved into a position to allow for hull coupler to move after it is attached. As the rig has limits to its range of movement in the x, y and z directions, it is desirable to have the rig in a position to that once attached, the hull coupler can continue to move with the vessel in the direction the vessel is traveling in upon engagement. So if there vessel has a component of velocity in a forwards direction when alongside the mooring facility, the rig may be
10 positioned at its limit of movement in the X direction towards the stern of the vessel. The rig can then travel to let the hull coupler move in the x direction away from that limit towards the other x-direction limit more proximate to the bow of the vessel.

While one type of output and representations of information on the output are shown in Figures 2 and 3, any suitable output and arrangement of information on the output could be
15 provided.

One possible mooring device is shown in Figures 4 and 5. Any other suitable mooring device that enables movement of the hull couplers in x, y and/or z directions could be used. That movement could be provided by moving mechanisms such as struts, or rails placed in the x, y or z direction or some combination of both. The provision of rails to allow movement in the x, y and z
20 direction allows for greater movement than that from the struts.

The present invention may utilise a mooring device that may be of a kind described in PCT International Application No. PCT/NZ02/00062. The description of the mooring device(s) in PCT/NZ02/00062 is hereby incorporated by reference

CLAIMS

1. A mooring system for securing a vessel to a mooring facility, said mooring system comprising:

at least one mooring device for installation at a mooring facility in a position to allow the mooring device to assist in holding a vessel relative to the mooring facility, each device comprising a rig and a hull coupler moveably supported relative the mooring facility by said rig,

at least one position and/or velocity sensor, for sensing position and/or velocity of a proximate vessel and/or part of the vessel that is or is to be held by the mooring device relative the mooring facility, relative to the mooring facility and/or the hull coupler of said at least one mooring device, and

a controller to at least control the at least one mooring device based on information received from or derived from the sensor.

2. A mooring system according to claim 1 further comprising an output device for outputting, (based at least in part on information received from or derived from the sensor) :

- a. visual information indicating the velocity and/or position of the proximate vessel and/or part(s) of the vessel relative to at least one of the mooring facility and the at least one mooring device,
- b. a graphical representation of the proximate vessel indicating the velocity and/or - position of the vessel and/or part(s) of the vessel,
- c. an audible or visual warning if the velocity of the proximate vessel or part of the vessel exceeds a threshold.

3. A mooring system according to claim 1 or 2 wherein the controller can control the rig of at least one mooring device to alter the position and/or velocity of the respective hull coupler of the mooring device relative to the mooring facility, when not coupled to the vessel in a manner to at least partially adjust for the position and/or velocity of an approaching vessel.

4. A mooring system according to claim 3 wherein the controller can control the rig, in response to said information, automatically or under human control.

5. A mooring system according to anyone of claims 1 to 4 wherein at least two mooring devices are provided to be located at spaced apart locations at the mooring facility, and wherein at least one sensor is provided to determine the location and/or velocity of a location of those parts of the proximate vessel proximate most each hull coupler of the at least two mooring devices.

6. A mooring system as claimed in anyone of claims 1 to 5 wherein the controller can control the rig of each mooring device to allow the position and/or velocity of the hull coupler of a respective mooring device to be changed relative to the mooring facility in response to location and/or velocity information sensed by the at least one sensor.

7. A mooring system as claimed in claim 6 wherein the hull coupler can be controlled so that during coupling thereof with the proximate vessel the velocity of the hull coupler relative the mooring facility is such as to reduce the impact of initial contact between the hull and the hull coupler when compared to if the hull couplers is held stationary relative the mooring facility.

8. A mooring system as claimed in anyone of claims 1 to 7 wherein the controller can control the velocity of the hull coupler in response to the information sensed by the at least one sensor.

9. A mooring system as claimed in anyone of claims 1 to 8 wherein the controller can control the position of the hull coupler in response to the information sensed by the at least one sensor.

9. A mooring system as claimed in anyone of claims 1 to 9 wherein the controller can position the hull coupler in a position relative said mooring facility such that at the instance of initial contact with the hull of the proximate vessel during the coupling of the vessel with the mooring device, the rig is in a condition to allow it to move in a manner to facilitate the movement of the hull coupler, when coupled to the vessel, in a direction that that part of the vessel with which it is engaged, is moving upon the initial contact.

10. A mooring system as claimed in claim 9 wherein the position that the controller moves the hull coupler to, is one that provides for the maximum distance of travel to be provided for, for the hull coupler, by the rig.

11. A mooring system according to any preceding claim wherein the rig of each mooring device is operable to move, relative to the mooring facility, the respective hull coupler up and down and horizontally towards and way from an approaching vessel.

12.. A mooring system according to any proceeding claim wherein the hull coupler is a suction pad.

13. A mooring system according to any preceding claim wherein the sensors provide position information on an approaching vessel and/or part or parts of the vessel, from which the system can calculate the velocity of the vessel and/or part or parts of the vessel.

14.. A mooring system according to any preceding claim wherein at least one sensor is disposed on one or more of the mooring devices.

15. A mooring system according to any preceding claim wherein at least one sensor is disposed on or adjacent a mooring facility.

16. A mooring system according to any preceding claim wherein the at least one sensor can detect or allow the derivation of one or more of:

- the position and/or velocity of the bow of a vessel,
- the position and/or velocity of the stern of a vessel,
- the position and/or velocity of the hull of a vessel, and
- the athwartship position or velocity of a vessel,

relative at least one of the mooring facility and the hull coupler of the or each mooring device.

17. A mooring system as claimed in claim 1 wherein the sensor(s) can be used to derive information on the change in velocity of the vessel or part of the vessel.

18. A mooring facility comprising a mooring system according to any preceding claim.

5 19. A method of mooring a vessel at a mooring facility that includes at least one mooring device positioned to allow the mooring device to assist in holding a vessel relative to the mooring facility, each device comprising a rig and a hull coupler moveably supported relative the mooring facility by said rig, said method comprising:

sensing the position and/or velocity and/or change in velocity of one or more of the (a)
10 bow, (b) stern, (c) hull, (d) part of the hull at where the hull coupler is to engage, of an approaching vessel, and the method further comprising, based on what is sensed, at least one of

iv. providing a warning for a mooring facility operator if the vessel's approach to the mooring facility exceed a predetermined threshold,

v. providing visual and/or audible information indicating the velocity and/or
15 change in velocity and/or position of a vessel or part or parts of the vessel relative at least one of the mooring facility and the hull coupler of the or each mooring device,

vi. operating one or more mooring devices to alter the position of a respective hull coupler to at least partially adjust for the position and/or velocity of an
20 approaching vessel.

20. A method of operating a mooring system according to any one of claims 1 to 11 comprising one or more of:

providing the information indicative of the velocity and/or position of an approaching vessel to an operator to allow them to decide to (i) operate the mooring device(s) to secure the
25 vessel, or (ii) to operate (or not) the mooring device to prevent the vessel being secured.

21. A method as claimed in claim 20 wherein the information is provided as graphical representation and will also include a warning (visual and/or audible) if the vessel's approach to the mooring facility exceed a predetermined threshold.

22. A method as claimed in claim 20 or 21 wherein the method includes the control of mooring
30 device(s) to manipulate the rig to alter the position and/or velocity of the hull coupler to at least partially adjust for the position and/or velocity of an approaching vessel.

23. A mooring system or method according to any preceding claim wherein the mooring facility can be one or more of: a lock, a dock, a wharf, a barge.

24. A mooring facility that includes the mooring system as claimed in claim 1.

AMENDED CLAIMS

received by the International Bureau on 10 February 2009 (10.02.2009)

CLAIMS

1. A mooring system for securing a vessel to a mooring facility, said mooring system comprising:
 - a) at least one mooring device for installation at a mooring facility in a position to allow the mooring device to assist in holding a vessel relative to the mooring facility, each device comprising a rig and a hull coupler moveably supported relative the mooring facility by said rig,
 - b) at least one position and/or velocity sensor, for sensing position and/or velocity of a proximate vessel and/or part of the vessel that is to be held by the mooring device relative the mooring facility, relative to the mooring facility and/or the hull coupler of said at least one mooring device, and
 - c) a controller to at least control the at least one mooring device based on information received from or derived from the sensor.
2. A mooring system according to claim 1 further comprising an output device for outputting, (based at least in part on information received from or derived from the sensor) :
 - a) visual information indicating the velocity and/ or position of the proximate vessel and/or part(s) of the vessel relative to at least one of the mooring facility and the at least one mooring device,
 - b) a graphical representation of the proximate vessel indicating the velocity and/or position of the vessel and/or part(s) of the vessel,
 - c) an audible or visual warning if the velocity of the proximate vessel or part of the vessel exceeds a threshold.
3. A mooring system according to claim 1 or 2 wherein the controller can control the rig of at least one mooring device to alter the position and/or velocity of the respective hull coupler of the mooring device relative to the mooring facility, when not coupled to the vessel in a manner to at least partially adjust further the position and/ or velocity of an approaching vessel.
4. A mooring system according to claim 3 wherein the controller can control the rig, in response to said information, automatically or under human control.
5. A mooring system according to anyone of claims 1 to 4 wherein at least two mooring devices are provided to be located at spaced apart locations at the mooring facility, and wherein at least one sensor is provided to determine the location and/or velocity of those parts of the proximate vessel that is most proximate each hull coupler of the at least two mooring devices.
6. A mooring system as claimed in anyone of claims 1 to 5 wherein the controller can control the rig of each mooring device to allow the position and/or velocity of the hull coupler of a respective mooring device to be changed relative to the mooring facility in response to location and/or velocity information sensed by the at least one sensor.

7. A mooring system as claimed in claim 6 wherein the hull coupler can be controlled so that during coupling thereof with the proximate vessel the velocity of the hull coupler relative the mooring facility is such as to reduce the impact of initial contact between the hull and the hull coupler when compared to if the hull coupler is held stationary relative the mooring facility.

8. A mooring system as claimed in anyone of claims 1 to 7 wherein the controller can control the velocity of the hull coupler in response to the information sensed by the at least one sensor.

9. A mooring system as claimed in anyone of claims 1 to 8 wherein the controller can control the position of the hull coupler in response to the information sensed by the at least one sensor.

10. A mooring system as claimed in anyone of claims 1 to 9 wherein the controller can position the hull coupler in a position relative said mooring facility such that at the instance of initial contact with the hull of the proximate vessel during the coupling of the vessel with the mooring device, the rig is in a condition to allow it to move in a manner to facilitate the movement of the hull coupler, when coupled to the vessel, in a direction that that part of the vessel with which it is engaged, is moving upon the initial contact.

11. A mooring system as claimed in any one of claims 9 or 10, wherein the position that the controller moves the hull coupler to, is one that provides for the maximum distance of travel to be provided for, for the hull coupler, by the rig.

12. A mooring system according to any preceding claim wherein the rig of each mooring device is operable to move, relative to the mooring facility, the respective hull coupler up and down and horizontally towards and away from an approaching vessel.

13. A mooring system according to any preceding claim wherein the hull coupler is a suction pad.

14. A mooring system according to any preceding claim wherein the sensors provide position information on an approaching vessel and/or part or parts of the vessel, from which the system can calculate the velocity of the vessel and/or part or parts of the vessel.

15. A mooring system according to any preceding claim wherein at least one sensor is disposed on one or more of the mooring devices.

16. A mooring system according to any preceding claim wherein at least one sensor is disposed on or adjacent a mooring facility.

17. A mooring system according to any preceding claim wherein the at least one sensor can detect or allow the derivation of one or more of:

- the position and/or velocity of the bow of a vessel,
- the position and/or velocity of the stern of a vessel,
- the position and/or velocity of the hull of a vessel, and
- the athwartship position or velocity of a vessel,

relative at least one of the mooring facility and the hull coupler of the or each mooring device.

18- A mooring system as claimed in claim 1 wherein the sensor(s) can be used to derive information on the change in velocity of the vessel or part of the vessel.

19. A mooring facility comprising a mooring system according to any of the preceding claims.

20. A method of mooring a vessel at a mooring facility that includes at least one mooring device positioned to allow the mooring device to assist in holding a vessel relative to the mooring facility, each device comprising a rig and a hull coupler moveably supported relative the mooring facility by said rig, said method comprising:

a) sensing the position and/or velocity and/or change in velocity of one or more of the (a) bow, (b) stern, (c) hull, (d) part of the hull at where the hull coupler is to engage, of an approaching vessel, and the method further comprising, based on what is sensed, at least one of

i) providing a warning for a mooring facility operator if the vessel's approach to the mooring facility exceed a predetermined threshold,

ii) providing visual and/ or audible information indicating the velocity and/or change in velocity and/or position of a vessel or part or parts of the vessel relative at least one of the mooring facility and the hull coupler of the or each mooring device,

iii) operating one or more mooring devices to alter the position of a respective hull coupler to at least partially adjust for the position and/or velocity of an approaching vessel.

21. A method of operating a mooring system according to any one of claims 1 to 11 comprising one or more of:

providing the information indicative of the velocity and/or position of an approaching vessel to an operator to allow them to decide to (i) operate the mooring device(s) to secure the vessel, or (ii) to operate (or not) the mooring device to prevent the vessel being secured.

22. A method as claimed in claim 20 wherein the information is provided as graphical representation and will also include a warning (visual and/or audible) if the vessel's approach to the mooring facility exceed a predetermined threshold.

23. A method as claimed in claim 20 or 21 wherein the method includes the control of mooring device(s) to manipulate the rig to alter the position and/ or velocity of the hull coupler to at least partially adjust for the position and/or velocity of an approaching vessel.

24. A mooring system or method according to any preceding claim wherein the mooring facility can be one or more of: a lock, a dock, a wharf, a barge.

25. A mooring facility that includes the mooring system as claimed in claim 1.

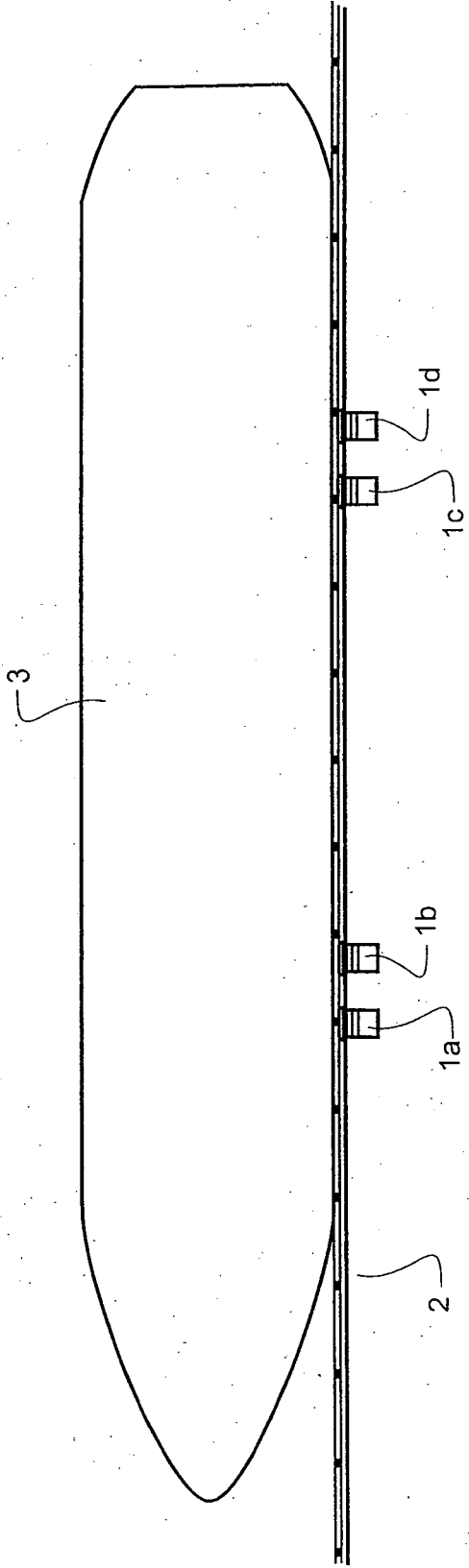


FIGURE 1

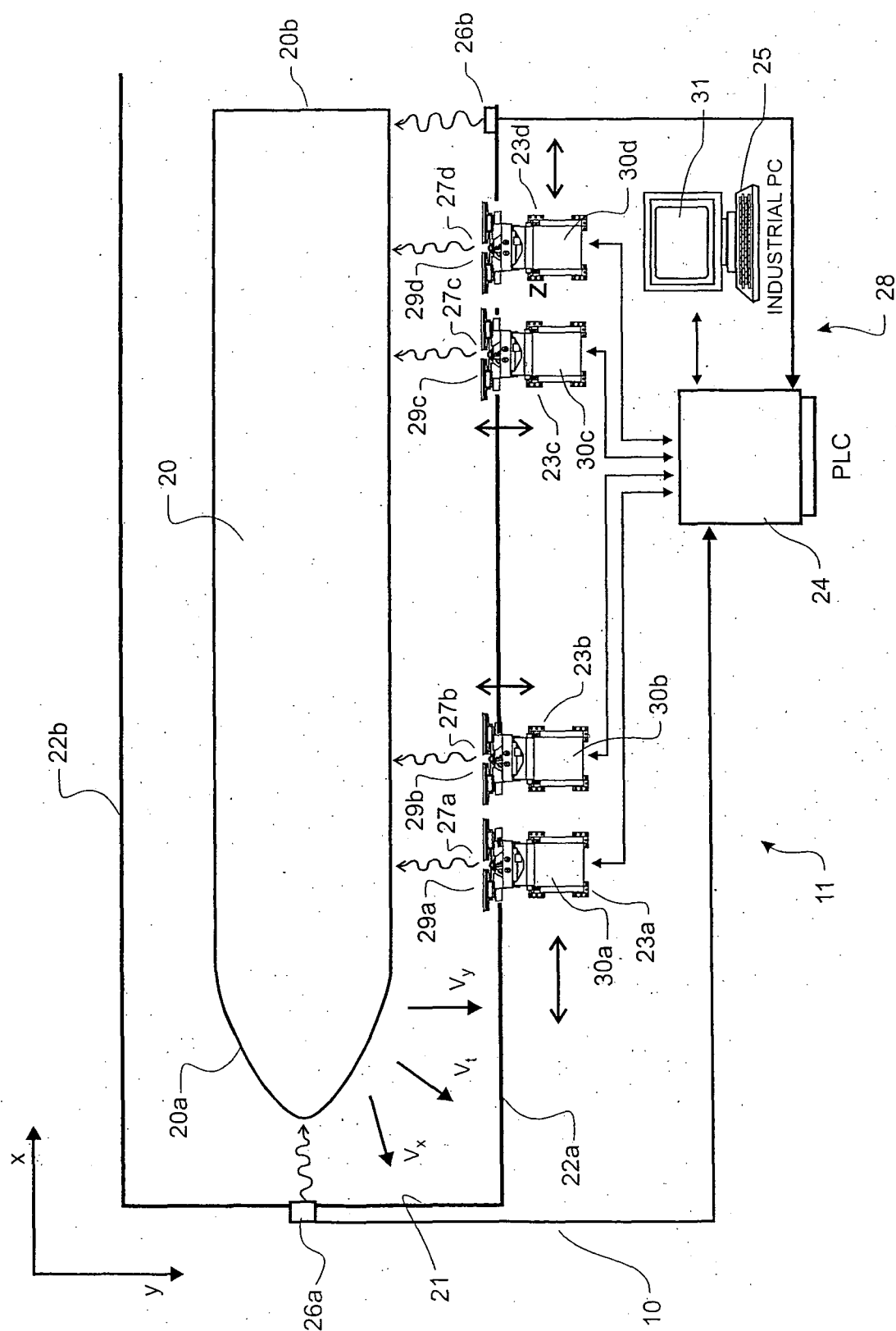
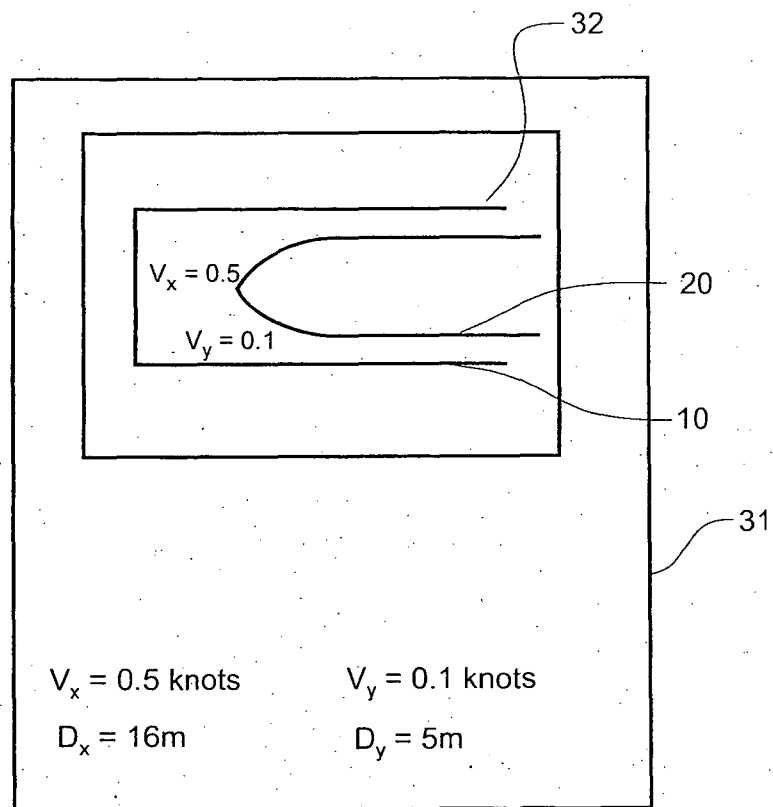


FIGURE 2

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**FIGURE 3**

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FIGURE 4

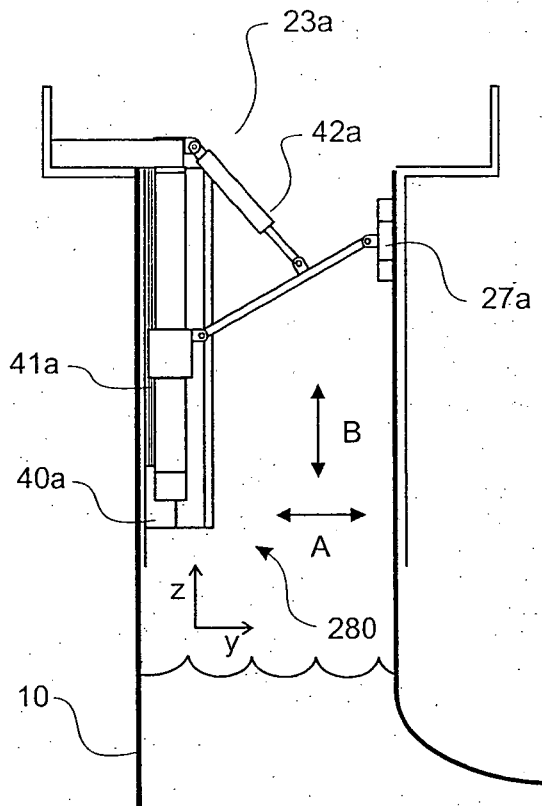
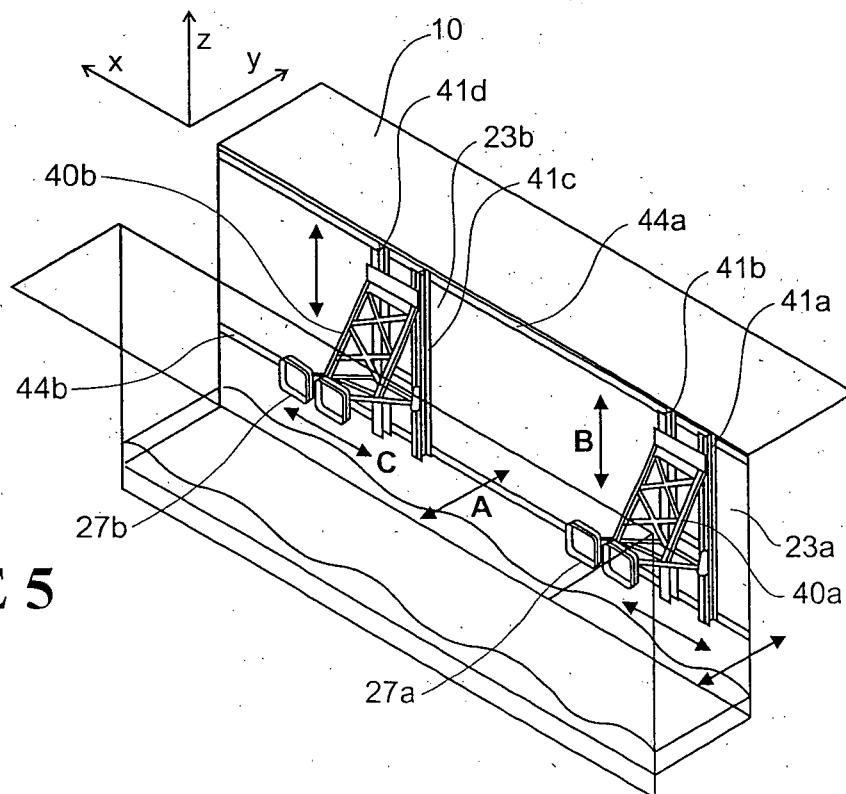
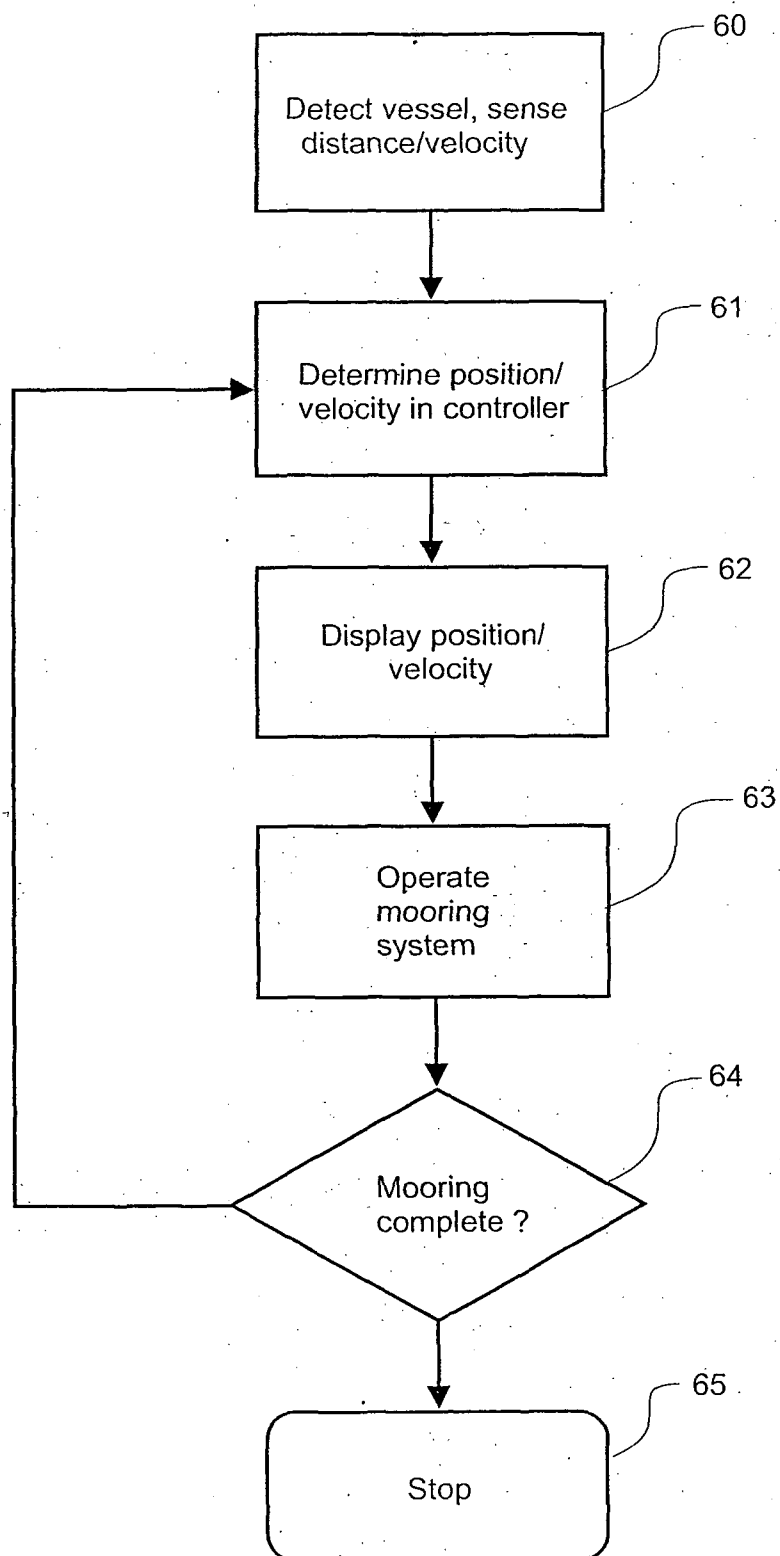


FIGURE 5



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**FIGURE 6**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2008/00025 1

A. CLASSIFICATION OF SUBJECT MATTER Int. Cl. <i>B63B 21/00</i> (2006.01) 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) Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU:PAIS IPC B63B21/00 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) WPI, EPODOC: IPC B63B 21/00 and Keywords (berth, dock, mooring, sensor, distance, speed) and like terms USPTO & ESP@CE: keywords (mooring, sensor, distance, location, speed, velocity, controller, suction, vacuum) and like terms		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2006/0081 166 A1 (MONTGOMERY et al) 20 April 2006 Whole document	
A	US 6439147 B2 (COTTRELL et al.) 27 August 2002 Whole document	
A	GB 2388356 B (SMART) 28 January 2004 Whole document	
A	US 3707717 A (FRIELING HAUS) 26 December 1972 Whole document	
☐ Further documents are listed in the continuation of Box C ☒ See patent family annex		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 28 November 2008		Date of mailing of the international search report 10 DEC 2008
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. +61 2 6283 7999		Authorized officer DrARUN SHARMA AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 2 6222 3642

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PC17NZ2008/000251

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
US	2006081 166	AU	2003281692	CA	2494529	CN	1671592
		EP	1534583	KR	20060009809	NO	20050938
		NZ	520450	US	7293519	US	2008/156244
		WO	2004/011326				
US	6439147	AU	27618/01	us	2001029879	WO	2001/051345
GB	2388356	AU	22101/02	GB	2369607	GB	2388355
		US	7021231	US	2005005833	WO	2002/044013
US	3707717	JP	48029199				
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.							
END OF ANNEX							