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Kristensen

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(54) **SYSTEM FOR STABILIZING A VESSEL AGAINST A STATIONARY OBJECT**

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B63B 21/00 (2006.01)
B63B 27/30 (2006.01)
B63B 39/00 (2006.01)

(52) **U.S. Cl.**

CPC ***B63B 59/02*** (2013.01); ***B63B 21/00*** (2013.01); ***B63B 27/30*** (2013.01); *B63B 39/005* (2013.01)

(58) **Field of Classification Search**

CPC B63B 21/00; B63B 27/00; B63B 27/30; B63B 39/00; B63B 39/005; B63B 59/00; B63B 59/02

USPC 114/219

See application file for complete search history.

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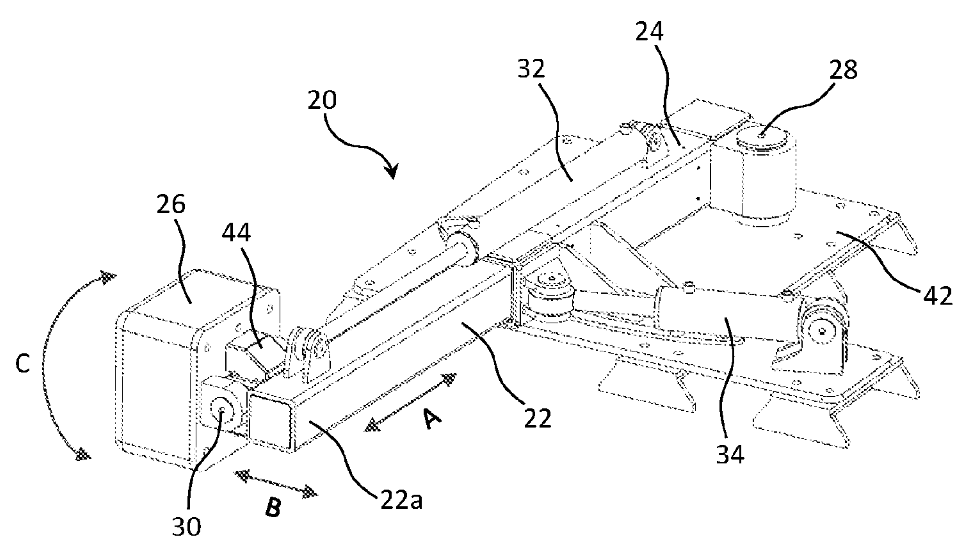
(57) **ABSTRACT**

Vessel (**60**), comprising a transverse bow (**62**) with an elongated bow fender (**10**) protruding with respect to the bow (**62**), which bow fender (**10**) is designed to be pushed against a stationary object (**50**), said vessel **60**) further comprises at least two engagement arms (**20**) with telescopic parts (**22**,**24**), said engagements arms (**20**) are mounted in a position above the bow fender (**10**) and facing each other, and each engagement arm (**20**) is pivotable against each other for engagement with the stationary object (**50**) from opposite directions. Each engagement arm (**20**) comprises a tiltable engagement pad (**26**) with a contacting surface (**26***a*) creating stabilizing contact between the contacting surfaces (**26***a*) of the engagement pads (**26**) and at least a part of the stationary object (**50**), said engagement pads (**26**) being tiltable about an axis running in same longitudinal direction as the engagement arms (**20**).

16 Claims, 4 Drawing Sheets



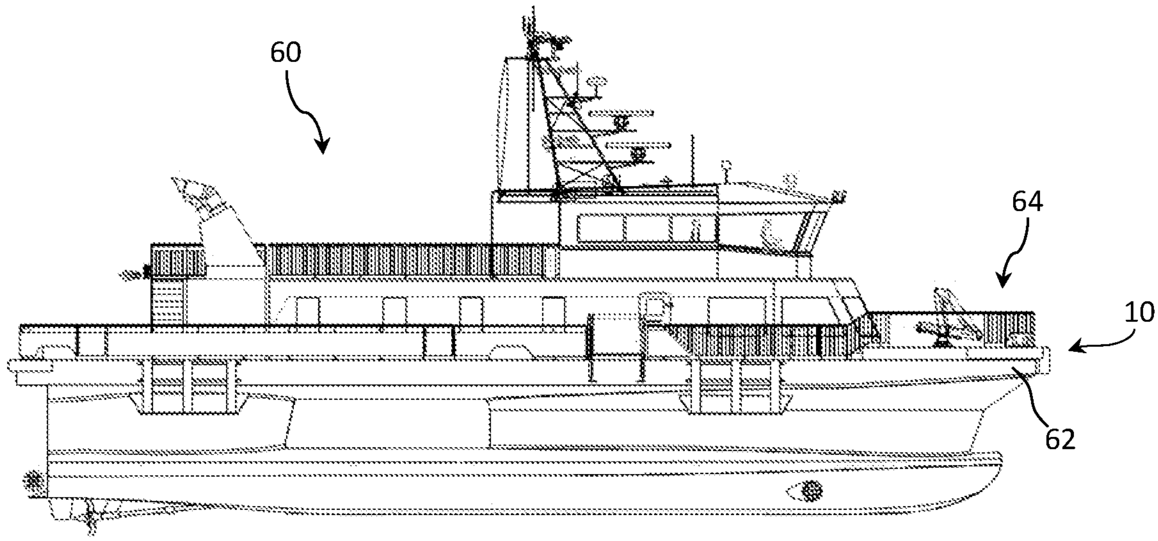


Fig. 1

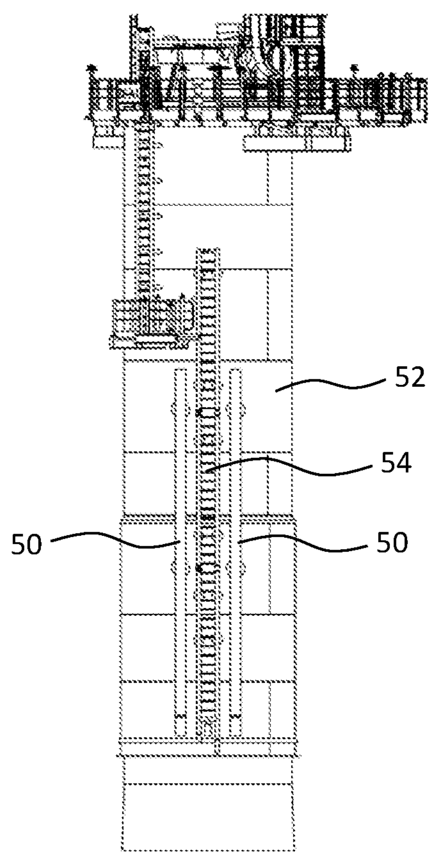


Fig. 2

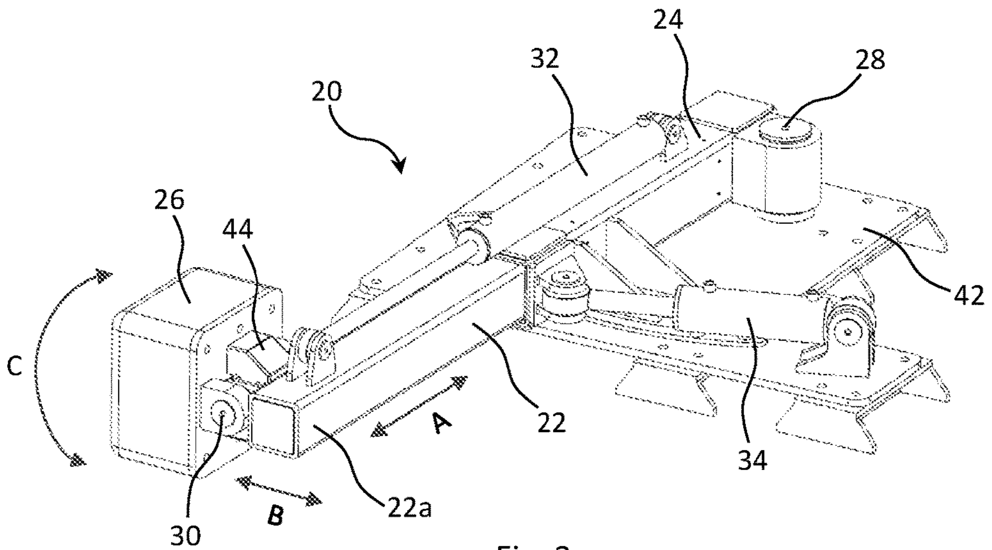


Fig. 3

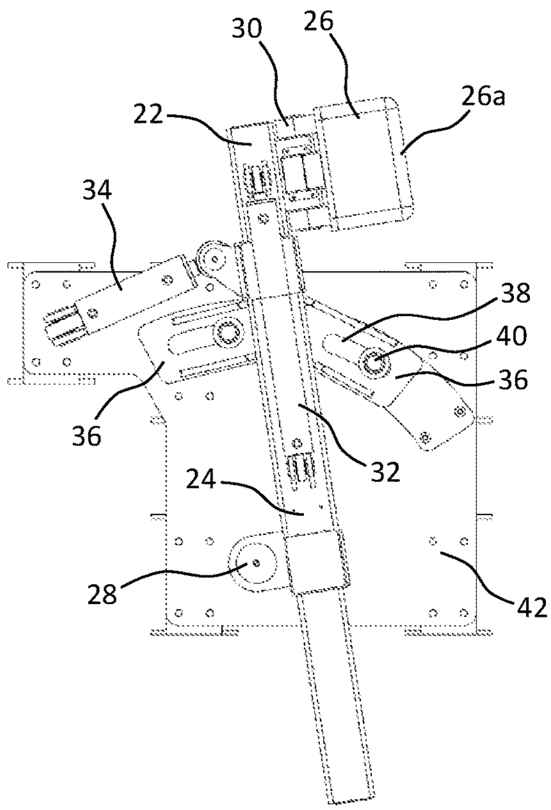


Fig. 4a

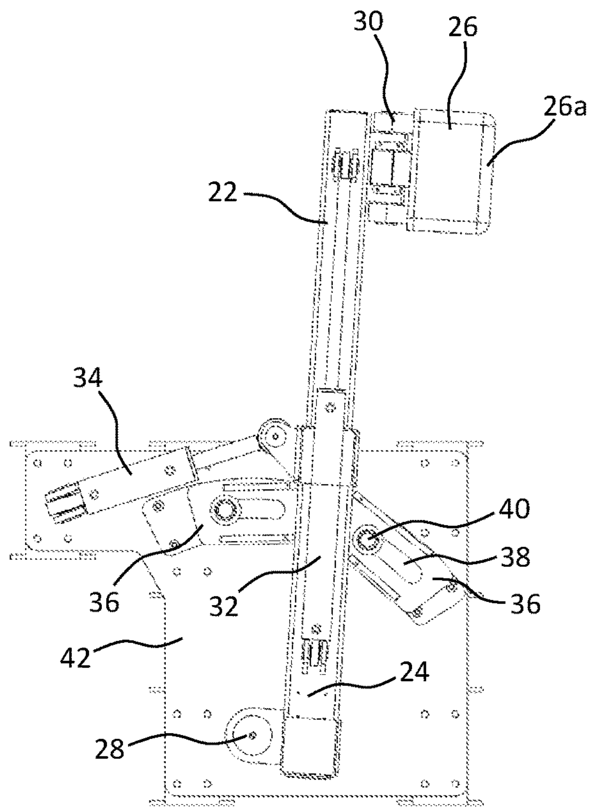
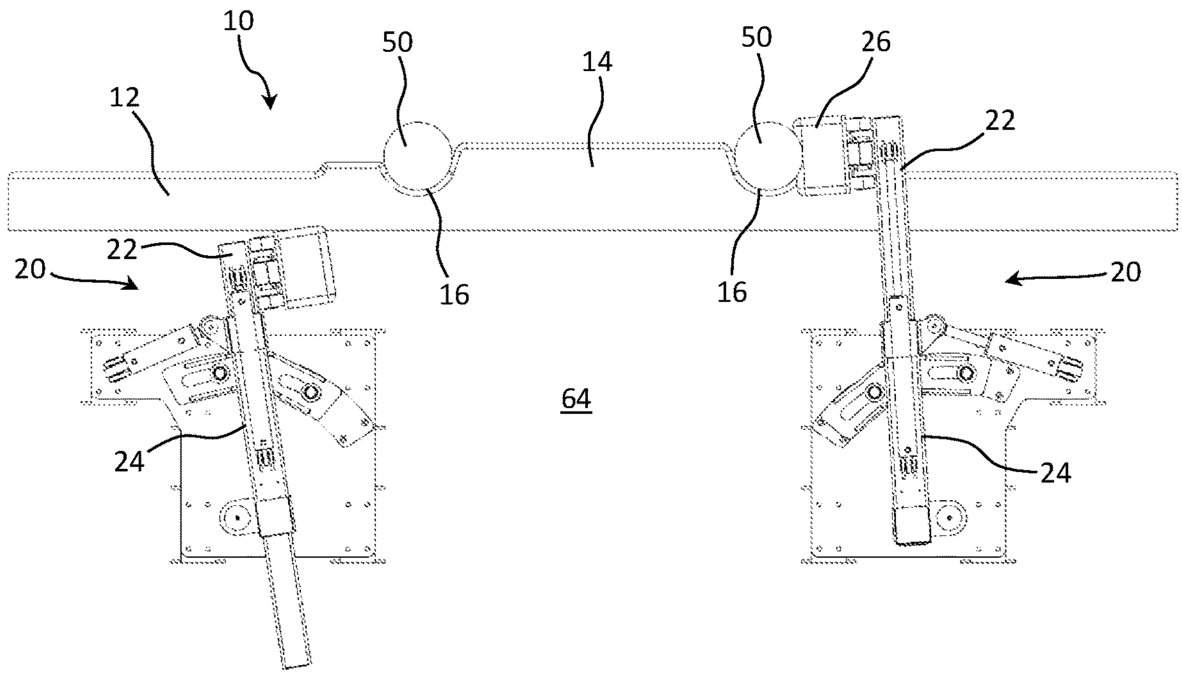


Fig. 4b


10
12
50
14
50
26
22
22
20
16
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64
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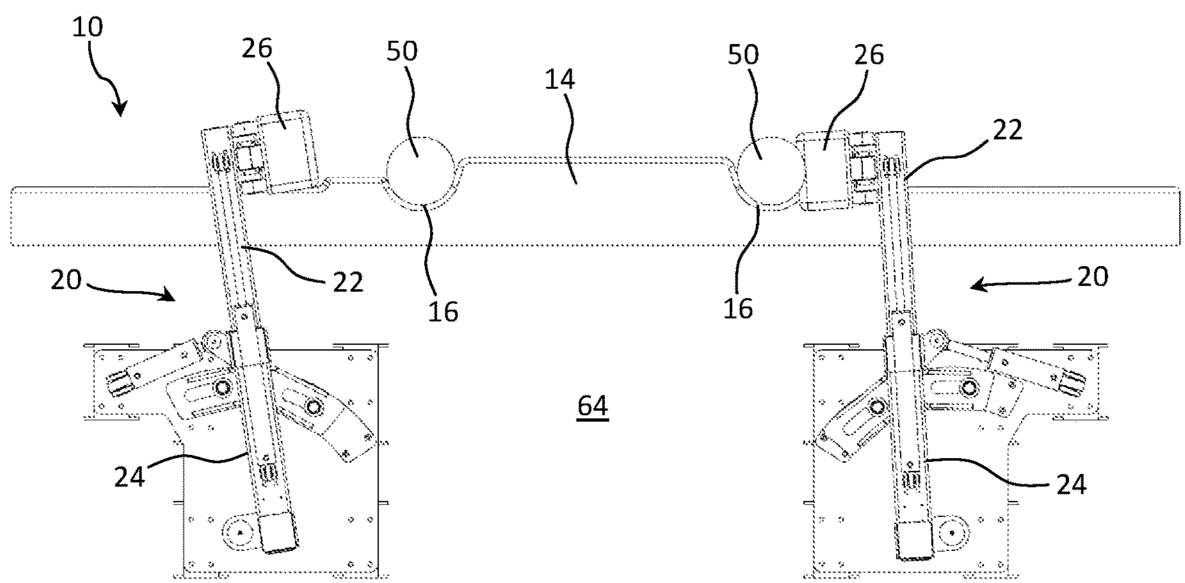
24

Fig. 5


10
26
50
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50
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22
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64
24
24

Fig. 6

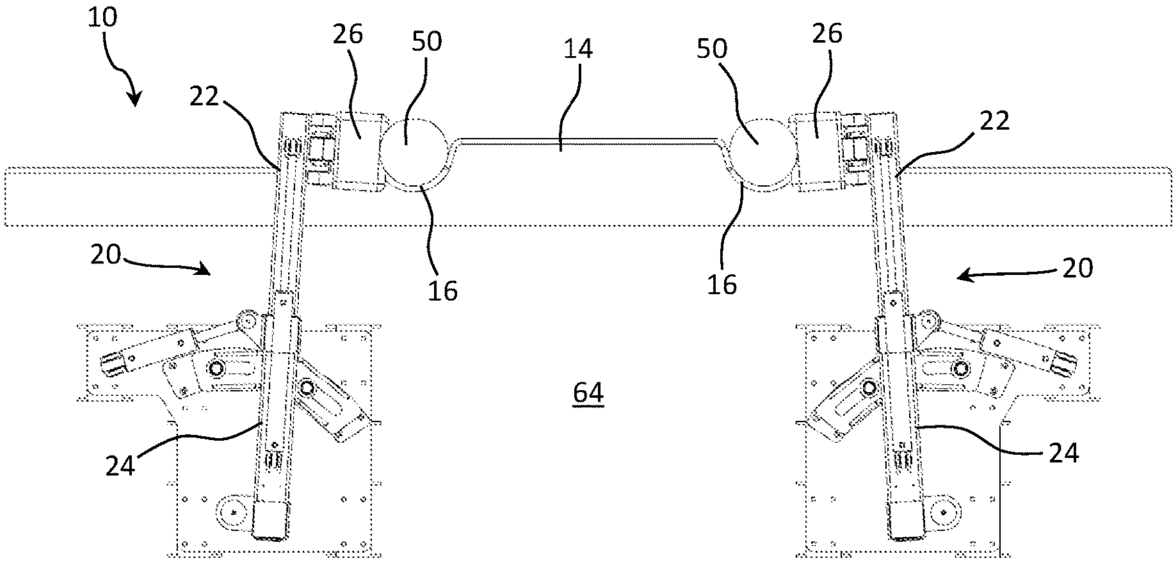

Fig. 7

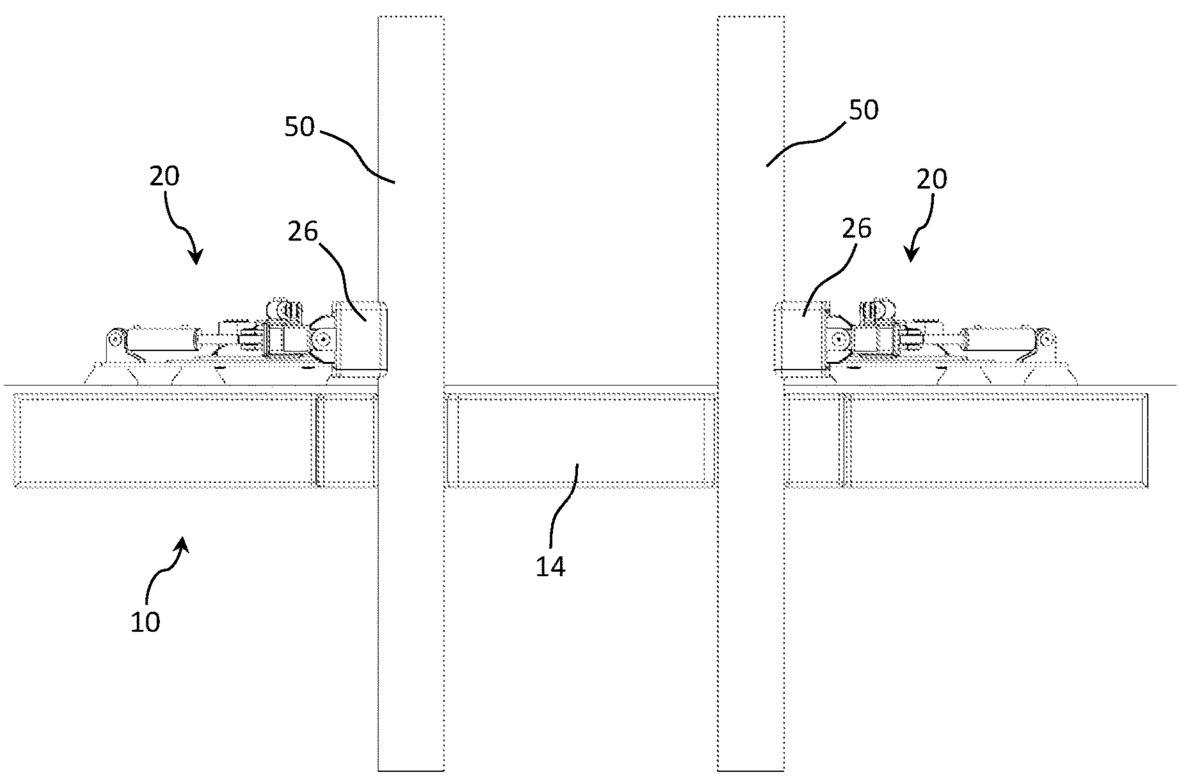

Fig. 8

SYSTEM FOR STABILIZING A VESSEL AGAINST A STATIONARY OBJECT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of priority to European Patent Application No. 20176699.5 filed on May 27, 2020 and incorporated in its entirety by reference herein.

FIELD OF THE INVENTION

The present invention relates to a vessel comprising a transverse bow with an elongated bow fender protruding with respect to the bow, which bow fender is designed to be pushed against a stationary object. The vessel further comprises at least two engagement arms with telescopic parts, said engagements arms are mounted in a position above the bow fender and facing each other, and each engagement arm is pivotable against each other for engagement with the stationary object from opposite directions.

The vessel can for instance be a service vessel for the offshore wind industry and oil and gas market.

BACKGROUND OF THE INVENTION

Offshore wind turbines are normally gathered in wind farms placed on the continental shelf with reduced water dept. Higher wind speeds are available offshore compared to land, which supplies more energy.

Oil and gas platforms, special in Far East, Mexico, Brazil etc. where service personnel need to embark and disembark the platforms from service vessels, the inventive bow fender with sideways forces, will improve the vessels stability, and safety and ability for the service personnel.

Offshore wind power refers to the construction of wind farms in bodies of water to generate electricity from wind. Offshore wind power utilizes traditional fixed-bottom wind turbine technologies, as well as deep-water areas utilizing floating wind turbines.

The service crews are normally brought from ports or accommodation vessels with service vessels, and the service personnel embark and disembark between the service vessel and the turbines or platforms.

Each wind turbine has normally two vertical support poles/fender bars to protect the turbine while the service vessel approaches the turbine and allows the service personnel to use the turbine ladder between the two support poles for embarking and disembarking. With the vessel's engines/propellers the vessel's transverse bow-fender is pushed against the support poles.

The challenge is to keep the bow of the vessel steady when the service personnel embark and disembark in rougher sea conditions.

Different solutions have been used. For instance, stabilized walkways have been tried, cranes with claws, etc. One solution is use of a hydraulic clamping system that is mounted on the deck of the crew transfer vessel. Its main elements are two hydraulic arms, which can rotate around a vertical axis. At their front-end a hydraulic clamp is mounted which can be swung around the vertical fender bars of the wind turbine, and by activating two hydraulic rams they pull the vessel's fender against the fender bars with a preset force. The resulting friction stabilizes the position of the vessel.

GB 2476858 A discloses an apparatus for stabilizing a floating craft against a stationary structure. The apparatus comprises means of attaching the apparatus to a floating craft, an elongate fender comprising a structure contacting face, and at least two jaws, each comprising a front face and a structure-contacting surface. At least one jaw is movable from a first position to a second position and vice versa, in order that said jaws may be positioned in a first open position where the structure contacting surfaces of the jaws are relatively far apart and a second closed position wherein the structure contacting surfaces of the jaws are relatively close together. During use, the apparatus is positioned such that a suitably sized part of the stationary structure is placed between the jaws, the said jaws can then be brought into the closed position, thereby creating craft stabilizing contact between the structure contacting surfaces of the jaws and the structure.

EP 2520485 A1 discloses a system for mooring a vessel against a stationary object, for example the mast of a wind turbine erected in water. The stationary object comprises at least one substantially vertical bumper bar, which is attached to the stationary object by means of an extension. The vessel comprises a hull, an engine for propelling the vessel, and a buffer body, which protrudes in relation to the hull. The bumper bar comprises a substantially vertical, inside guide track, which substantially faces the stationary object, and a substantially vertical, outside guide track, which substantially faces away from the stationary object. The vessel comprises at least one engagement arm, which at one end is provided with an engagement member. The engagement arm can be moved in relation to the hull between a mooring state, in which the engagement member engages on the inside guide track of the bumper bar and is vertically displaceable along this, and a release state, in which the engagement member is out of engagement with the inside guide track. The buffer body in the mooring state engages on the outside guide track of the bumper bar and is vertically displaceable along this. The inside guide track protrudes sideways in relation to an adjacent part of the extension of the bumper bar such that the engagement member of the engagement arm in the mooring state can be moved past the extension on vertical displacement along the inside guide track of the bumper bar.

EP2316721 A1 disclose a floating vessel that is stabilized against a stationary object, for example a mast of an offshore wind turbine. The vessel comprises a hull, a motor for the propulsion of the vessel, a buffer body, which protrudes with respect to the hull, as well as at least one engagement arm. The engagement arm is at one end provided with an engagement member for engaging on the stationary object. First, the buffer body of the vessel is pushed against the stationary object by means of the motor. The buffer body is hereby substantially stabilized against the stationary object. Next, the engagement body engages on the stationary object while the buffer body and the stationary object remain mutually stabilized by the pushing. After this, the engagement arm is subjected to tensile load while the stationary object is engaged by the engagement member.

OBJECTS OF THE PRESENT INVENTION

An object of the present invention is to provide an improved, alternative and simplified solution, wherein the vessel's bow fender and engagement equipment is adjustable to improve docking and to stabilize the bow while the service crew embark and disembark in rough sea conditions.

The bow fender of the invention will also improve adjustment of forces acting on the bow fender/bow of the vessel and the wind turbine foundation.

The present invention also provides a solution that makes it easy to center the bow of the vessel to the correct position, which save time and increase the safety.

Is an object to provide as solution that provides even pressure against a wind turbine foundation, when the vessel is rolling transverse to the wind turbine foundation, which improves safety.

It is also an object to provide solution in where the pressure against the wind turbine foundation is adjustable, in both transverse and longitudinally direction.

SUMMARY OF THE INVENTION

The present invention discloses a stabilizing apparatus for a vessel, comprising at least two engagement arms with several telescopic parts, said engagements arms are facing each other, and each engagement arm is pivotable against each other for engagement with a stationary object from opposite directions, each engagement arm comprises a tiltable engagement pad with a contacting surface creating stabilizing contact between the contacting surfaces of the engagement pads and at least a part of the stationary object, said engagement pads being tiltable about an axis running in same longitudinal direction as the engagement arms, wherein the telescopic parts of each engagement arm comprise a first telescopic part and a second housing part, and the engagement pad is tiltable supported in a hinged connection on an outer free end of the first telescopic part.

The present invention further discloses a vessel comprising a transverse bow with an elongated bow fender protruding in a forward direction with respect to the bow, which bow fender is designed to be pushed against a stationary object, said vessel further comprises at least two engagement arms with several telescopic parts, said engagements arms are mounted in a position above the bow fender and facing each other, and each engagement arm is pivotable against each other for engagement with the stationary object from opposite directions, each engagement arm comprises a tiltable engagement pad with a contacting surface creating stabilizing contact between the contacting surfaces of the engagement pads and at least a part of the stationary object, said engagement pads being tiltable about an axis running in same longitudinal direction as the engagement arms, wherein the telescopic parts of each engagement arm comprise a first telescopic part and a second housing part, and the engagement pad is tiltable supported in a hinged connection on an outer free end of the first telescopic part.

The telescopic parts of each engagement arm can comprise a first telescopic part and a second housing part.

The first telescopic part can be extractable and slidably accommodated in the second housing part, and said second housing part can be pivotably supported in a pivot connection.

A first pressure cylinder can be connected between the first telescopic part and the second housing part, providing extraction and retraction of the first telescopic part with respect to the second housing part.

A second pressure cylinder can be connected to the second housing part in an area distal to the pivot connection, providing said pivot movement of the second housing part.

The second housing part may comprise one or more slide guides guiding the pivot movement.

Further, the hinged connection can comprise one or more rubber blocks preventing unwanted tilting movement of the engagement pad with respect to the first telescopic part.

The bow fender preferably comprises an elongated fender made of rubber or polyurethane.

The bow fender can on a front face comprise one or more impressions accommodating at least a part of the stationary object, such as the support poles, and wherein the stabilizing contact between the contacting surfaces of the engagement pads when the engagement arms are activated prevent any substantial movement of said part of the stationary object with respect to the bow fender.

The contacting surface of the tiltable engagement pad can be made of rubber or polyurethane.

DESCRIPTION OF THE FIGURES

Embodiments of the present invention will now be described, by way of example only, with reference to the following figures, wherein:

FIG. **1** shows an example of a crew transfer vessel equipped with a bow fender.

FIG. **2** shows an example of a stationary object, such as an offshore wind turbine foundation.

FIG. **3** shows a perspective view of an engagement arm with telescopic parts according to the invention.

FIG. **4*a*** shows a plan view of the engagement arm in a parked and retracted position.

FIG. **4*b*** shows a plan view of the engagement arm in an activated and extracted position.

FIG. **5** shows a plan view of a bow fender and two engagement arms in parked and active positions, respective, in where the left engagement arm is in parked and retracted position and the right engagement arm is in active engagement position against a stationary object.

FIG. **6** shows a plan view of the bow fender and two engagement arms in active positions, in where the left engagement arm is being telescopically extracted and the right engagement arm is in active engagement position against the stationary object.

FIG. **7** shows a plan view of the bow fender and two engagement arms in active positions, in where the left engagement arm and the right engagement arm are in active engagement positions against the stationary object.

FIG. **8** shows a front view of the bow fender and two engagement arms in active positions, in where in the left engagement arm and the right engagement arm are in active engagement positions against the stationary object.

DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

The present invention is related to a vessel **60** as shown in FIG. **1**, such as a crew transfer vessel discussed previously, equipped with a bow fender **10**. At least an upper part of the bow **62** is on a front face flat and is equipped with an elongated bow fender **10** placed transverse on the bow **62**. The invention also relates to a stabilizing or engagement apparatus mounted on said vessel **60**.

A wind turbine foundation **52** is shown in FIG. **2** having two vertical support poles/fender bars **50** to protect the wind turbine while the service vessel **60** approach the turbine and allows the service personnel to use a wind turbine ladder **54** between the two support poles for embarking and disembarking. With the vessel's engines/propellers, the vessel's transverse bow fender **10** is pushed against the support poles **50**. A vessel **60** with a bow fender **10** according to the invention can be used to adjust or reduce the impact on the support poles, or other foundation, when the vessel **60** approaches and docs at the wind turbine.

The bow fender **10** can in its simplest form be a rubber fender mounted to a base plate. One example of the bow fender **10**, as shown in the drawings, can comprise an elongated rubber fender **12**. In the middle of the rubber fender **12** there is a thicker part **14** protruding on a central front side, which is pressed against the support poles **50** and possibly the ladder **54** of the wind turbine foundation **52**. The bow fender **10** further comprises, either in the thicker part **14** or adjacent the thicker part **14**, an impression **16** for each pole **50** of the wind turbine foundation **52**. As seen in FIG. **5**, particularly on the left side, the rubber fender **12** can have several protruding steps with different thickness, which from left to center can be a first step with a first thickness, a second thicker step with the impression **16** and a third central and thickest step, in where the impression is located in the transition between the second and third step. The bow fender **10** is as mentioned mounted on the bow of a vessel **60**, such as a crew transfer vessel, with the thicker part **14** facing forward.

The elongated fender **12** is disclosed as made of rubber, but the elongated fender **12** can be made of plastic or other suitable material such as polyurethane. The bow fender **10** is disclosed in relation to a wind turbine foundation but may of course be used with any similar offshore construction.

Such a bow fender **10** can for instance be approximately 10 m long, and with a thickness of 45 cm and a height of 65-100 cm. Support poles **50**, or fender bars, on a typical wind turbine foundation **52** have a diameter of 33 cm, and a center distance of for instance 1.8 m. The thicker part **14** of the bow fender can be accommodated between the support poles **50** when the vessel **60** is pushing forward. The impressions **16** on the bow fender preferably have the same diameter as the support poles **50** of the wind turbine foundation **52**.

FIG. **3** shows an engagement arm according to the invention, and which comprises at least two telescopic parts **22**,**24**, wherein a first telescopic part **22** is movable from a retracted position to an extracted position slidably in a second housing part **24**. The first telescopic part **22** is extracted and retraced by using a first pressure cylinder **32** connected between the first telescopic part **22** and the housing part **24**, as indicated by the direction of the arrow A. The second housing part **24** is pivotably supported in a pivot connection **28**, and the pivot movement is provided by a second pressure cylinder **34** connected to a distal end of the second housing part **24**. Hence, the first telescopic part **22** and the second housing part **24** can thus swing or pivot in the direction indicated by the arrow B.

The pressure cylinders **32**,**34** can be hydraulic cylinders or pneumatic cylinders, or for that matter electric driven actuators, which can be connected to a control panel on a deck **64** of the vessel **60** or from a bridge of the vessel **60**.

To guide the sideways pivot movement of the two telescopic parts **22**,**24**, the second housing part **24** can be connected to one or more slide guides **36**, for instance having a slot **38**, straight or curved, in where a stationary pin **40** is moving. The second housing part **24** will thus be forced to move in the same directions as the slots **36**.

An engagement pad **26** is tiltable mounted to an outer end of the first telescopic part **22**, wherein the engagement pad **26** is tiltable supported in a hinged connection **30**. The engagement pad **26** is tiltable about an axis running longitudinally and parallel to at least the first telescopic part **22** of the engagement arm **20**, i.e. running in the same direction as the arrow A. Tilting movement is indicated by the arrow C.

The back of the engagement pad **26** can comprise one or more small rubber blocks **44** preventing the engagement pad **26** from "falling down" and tilt to much in a downward direction with respect to the first telescopic part **22**. The small rubber blocks **44** can be screwed to a back plate of the hinged connection **30** and cover the hinged connection **30**, and possibly abutting the outer end **22***a* of the first telescopic part **22** if the engagement pad **26** tilt too much. The pad of the engagement pad **26** can be made of rubber or polyurethane, and using small rubber blocks **44** on the backside may also counterbalance the engagement pad **26**. Optionally, the tilting movement of the engagement pad **26** can be controlled by an actuator (not shown).

The rubber pad of the engagement pad **26** can be screwed to the back plate of the hinged connection **30**, which makes it easy to exchange the pads in they get worn-out.

The tiltable engagement pad **26** has a contacting surface **26***a* creating stabilizing contact between the contacting surfaces **26***a* of the engagement pads **26** and at least a part of the stationary object **50**, said engagement pads **26** being tiltable about an axis running in same longitudinal direction as the engagement arms **20**.

In an embodiment (not shown) the engagement pad **26** can be tiltable in two directions, the first direction being about the first axis running in same longitudinal direction as the engagement arm **20** and the second direction being about a second axis running transverse to the first longitudinal axis.

The telescopic parts **22**,**24**, pressure cylinders **32**,**34**, slide guides **36**, etc., can be mounted on a foundation **42**, which is mounted on the deck **64** of the vessel **60**. The foundation is mounted higher than the bow fender **10** to allow at least the first telescopic part **22** to be able to pivot above and at least partly in front of the bow fender **10**.

During initial docking of the vessel **10** to the wind turbine foundation **52**, the bow fender **10** will hit the support poles **50** of the wind turbine foundation **52**. If the vessel is 150-175 dwt and the vessel is moving at 1-2 knots, the force will be quite large. As an example, the forces acting on one of the support poles on the wind turbine foundation **52** may vary from 440 kN for a vessel of 150 dwt and speed of 1 knots up to 2330 kN for a vessel of 175 dwt and speed of 2 knots. Dependent of the angle of the bow fender and the speed of the vessel, the combined impact forces on the support points may thus vary from approximately 40 kN to 260 kN. Hence, at least the support poles **50** of the wind turbine foundation **52** can be subjected to large forces.

FIG. **5** shows the bow fender **10** and two engagement arms **20** in parked and active positions, respective, in where the left engagement arm **20** is in parked and retracted position and the right engagement arm **20** is in active engagement position against a stationary object, such as the support poles **50** of the wind turbine foundation **52**. The two engagement arms **20** can be activated simultaneously or separately.

In FIG. **6** the left engagement arm **20** is being telescopically extracted and the engagement pad **26** is placed near the left pole **50**, while the right engagement arm **20** is in active engagement position against the right pole **50**. FIG. **7** shows the bow fender **10** and the two engagement arms **20** in active positions, in where the engagement pad **26** of the left engagement arm and the engagement pad **26** of the right engagement arm **20** are in active engagement positions against the two support poles **50** of the wind turbine foundation. FIG. **8** shows a front view of the bow fender **10** and the two engagement arms **20** in active positions.

When both engagement arms **20** are activated and pushed against the support poles **50** of the wind turbine foundation **52**, as particularly seen in FIGS. **7** and **8**, the support poles **50** will be accommodated and trapped in the impressions **16** on the bow fender **10**, and the stabilizing contact between the contacting surfaces of the engagement pads **26** prevent any substantial movement of the support poles **50** with respect to the bow fender **10** in any direction. However, as the engagement arms are not locked at the backside of the support poles, the support poles will not be subjected to large tensile forces

When the vessel is rolling transverse to the wind turbine foundation **52**, the tiltable engagement pads **26** on the engagement arms **20** provides that even pressure is maintained in the contacting surfaces against the support poles **50**, which improves safety.

It is possible with the present engagement arms **20** to adjust the pressure against the support poles **50**, in both transverse and longitudinally direction.

I claim:

1. A vessel, comprising a transverse bow with an elongated bow fender protruding in a forward direction with respect to the bow, which bow fender is designed to be pushed against a stationary object, said vessel further comprises

at least two engagement arms with several telescopic parts,

said engagements arms are mounted in a position above the bow fender and facing each other, and each engagement arm is pivotable against each other for engagement with the stationary object from opposite directions,

each engagement arm comprises a tiltable engagement pad with a contacting surface creating stabilizing contact between the contacting surfaces of the engagement pads and at least a part of the stationary object,

said engagement pads being tiltable about an axis running in same longitudinal direction as the engagement arms, wherein

the telescopic parts of each engagement arm comprise a first telescopic part and a second housing part, and the engagement pad is tiltable supported in a hinged connection on an outer free end of the first telescopic part,

wherein the first telescopic part is extractable and slidably accommodated in the second housing part, and said second housing part is pivotably supported in a pivot connection, and

wherein a first pressure cylinder is connected between the first telescopic part and the second housing part, providing extraction and retraction of the first telescopic part with respect to the second housing part.

2. The vessel according to claim **1**, wherein a second pressure cylinder is connected to the second housing part in an area distal to said pivot connection, providing the pivot movement of the second housing part.

3. The vessel according to claim **2**, wherein the second housing part comprises one or more slide guides guiding the pivot movement.

4. The vessel according to claim **1**, wherein said hinged connection on the outer free end of the first telescopic part comprises one or more rubber blocks preventing unwanted tilting movement of the engagement pad with respect to the first telescopic part.

5. The vessel according to claim **1**, wherein the bow fender comprises an elongated fender made of rubber.

6. The vessel according to claim **1**, wherein the bow fender comprises an elongated fender made of polyurethane.

7. The vessel according to claim **1**, wherein the bow fender on a front face comprises one or more impressions accommodating at least a part of the stationary object, and wherein the stabilizing contact between the contacting surfaces of the engagement pads when the engagement arms are activated prevent any substantial movement of said part of the stationary object with respect to the bow fender.

8. The vessel according to claim **1**, wherein the contacting surface of the tiltable engagement pad is made of rubber.

9. The vessel according to claim **1**, wherein the contacting surface of the tiltable engagement pad is made of polyurethane.

10. A stabilizing apparatus for a vessel, comprising

at least two engagement arms with several telescopic parts,

said engagements arms are facing each other, and each engagement arm is pivotable against each other for engagement with a stationary object from opposite directions,

each engagement arm comprises a tiltable engagement pad with a contacting surface creating stabilizing contact between the contacting surfaces of the engagement pads and at least a part of the stationary object,

said engagement pads being tiltable about an axis running in same longitudinal direction as the engagement arms, wherein

the telescopic parts of each engagement arm comprise a first telescopic part and a second housing part, and the engagement pad is tiltable supported in a hinged connection on an outer free end of the first telescopic part, and

wherein a first pressure cylinder is connected between the first telescopic part and the second housing part, providing extraction and retraction of the first telescopic part with respect to the second housing part.

11. The stabilizing apparatus according to claim **10**, wherein the first telescopic part is extractable and slidably accommodated in the second housing part, and said second housing part is pivotably supported in a pivot connection.

12. The stabilizing apparatus according to claim **10**, wherein a second pressure cylinder is connected to the second housing part in an area distal to said pivot connection, providing the pivot movement of the second housing part.

13. The stabilizing apparatus according to claim **12**, wherein the second housing part comprises one or more slide guides guiding the pivot movement.

14. The stabilizing apparatus according to claim **10**, wherein said hinged connection on the outer free end of the first telescopic part comprises one or more rubber blocks preventing unwanted tilting movement of the engagement pad with respect to the first telescopic part.

15. The stabilizing apparatus according to claim **10**, wherein the contacting surface of the tiltable engagement pad is made of rubber.

16. The stabilizing apparatus according to claim **10**, wherein the contacting surface of the tiltable engagement pad is made of polyurethane.

* * * * *