(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 506 239 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.02.2025 Bulletin 2025/07

(21) Application number: **23190188.5**

(22) Date of filing: **08.08.2023**

(51) International Patent Classification (IPC):
B63B 39/00 *(2006.01)* ***B63B 39/03*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B63B 39/00; B63B 39/03; B63B 2207/02

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(71) Applicant: **Siemens Gamesa Renewable Energy A/S**
7330 Brande (DK)

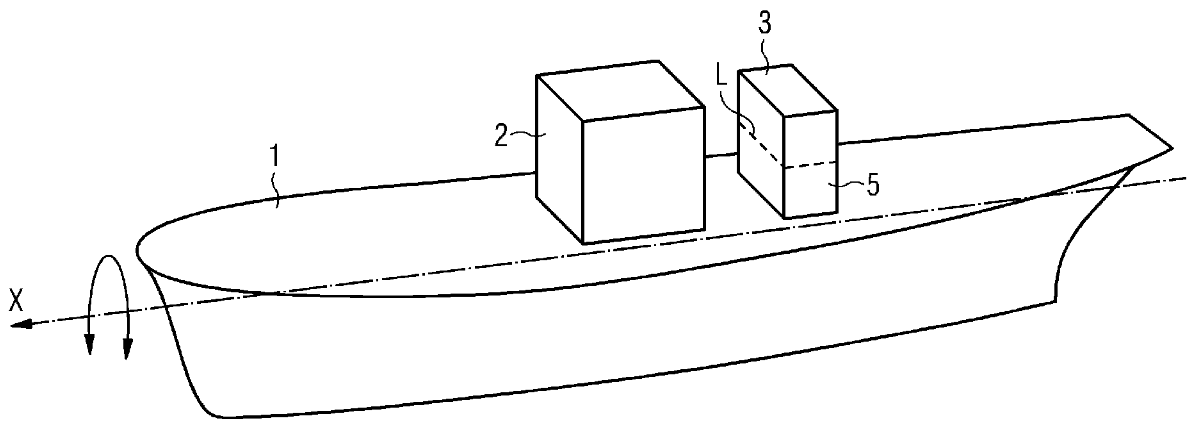
(72) Inventor: **Brice, Russell James**
7120 Vejle Øst (DK)

(74) Representative: **SGRE-Association**
Siemens Energy Global GmbH & Co. KG
SE I IM P Intellectual Property
Siemenspromenade 9
91058 Erlangen (DE)

(54) METHOD OF DAMPING A ROLLING MOVEMENT OF A SHIP

(57) It is described a method of damping a rolling movement of a ship (1). The method comprises loading a load (2) onto the ship (1); and mounting at least one tank (3) to the ship (1), the tank (3) is partly filled by a fluid (5) so that a natural frequency of a rolling motion of the loaded ship (1) including the mounted tank (3) is adjusted to a predetermined rolling frequency.

FIG 1



EP 4 506 239 A1

Description

Field of invention

[0001] The present invention relates to a method of damping a rolling movement of a loaded ship, and to a ship comprising a device configured to damp a rolling movement of the loaded ship. In the context of the present invention, the general expression "ship" also comprises barges and vessels amongst others.

[0002] Sea waves and strong wind conditions may lead to heavy rolling motions of a ship. The rolling motion is an oscillating movement of the ship around the longitudinal axis of the ship. This might lead to weather restricted operations for loading and discharging a cargo, when the ship is not docked in a sheltered environment. These weather restrictions can be very severe, making the operational durations of projects using a barge transport solution very long and costly. If the operational performance can be significantly improved, a lot of time and expense could be saved.

[0003] For example, the specific issue of operability of barges delivering wind turbine components to installation vessels offshore, is the limiting operation for a wind turbine installation. In particular for projects in USA, only a few vessels can sail back and forth directly for loading components in a harbour due to the Jones Act requirement. Wind turbines must be feed offshore to the installation vessel and lifted off the feeder barge by a jacked up wind turbine installation vessel (WTIV). The movement of the barge while lifting heavy components is highly challenging.

[0004] Complex lifting tools, dynamic motion compensation devices, and free surfaces in hull tanks are used to cope with the rolling motions so far. In general, tools are developed to remove or compensate for the individual motions of an object loaded on a barge, rather than reducing the movements of the entire barge.

<u>Summary of the Invention</u>

[0005] There may be a need for efficiently and readily damping the rolling motion of a ship. This need may be met by the subject matters according to the independent claims. The present invention is further developed as set forth in the dependent claims.

[0006] According to a first aspect of the invention, a method of damping a rolling movement of a ship is provided. The method comprises steps of loading a load onto the ship; and mounting at least one tank to the ship, the tank is partly filled by a fluid so that a natural frequency of a rolling motion of the loaded ship including the mounted tank is adjusted to a predetermined rolling frequency.

[0007] The filled tank has a natural sloshing frequency or period, which affects and thus adjusts the predetermined rolling frequency of the entire loaded ship. The sloshing period of the filled tank is different, preferably significantly away from a rolling frequency of the loaded ship without the tank or with an unfilled tank, and preferably significantly away from an estimated expected wave frequency of the sea.

[0008] For example, the ship can be a feeder barge. One or more large tanks of certain shapes can be arranged on a deck of a barge in a manner that they can be relatively easily removed. The tanks shall exhibit their sloshing period significantly away from the roll period of the loaded barge.

[0009] When the barge is loaded and in a sea state, it has reactions to the waves. Without using the tank, these reactions would be be very significant and create high difficulty in handling items on a barge in poor weather conditions. Every floating vessel has a natural frequency for its motions in 6 degrees of freedom. The most significant of these is the roll motion about the barge's longitudinal axis. When the natural frequency is nearby the frequency the waves encounter the barge, high motions are usually experienced which leads to large forces to sea fasten cargo and limitations to the wave height at which loading and discharge operations can occur. By enabling a very high amount of damping to the rolling motion of a barge according to the present invention, the influence of the sea state is dramatically less.

[0010] So far, tools have been developed to remove or compensate for the motions of an object loaded on a barge, rather than the reduce the movements of the barge. The purpose of using large tanks with a geometry specifically arranged to allow tuning the natural period of the barge to avoid coincidence with the prevailing sea state in accordance with the present invention means that the barges motions are wholistically reduced, whereas prior art compensation devices try to compensate for the local and relative movements of the loaded items loaded on the barge to keep the items approximately stationary. These prior art compensation devices also have limitations on their capabilities, if used in conjunction with roll damping of the barge, whereas the present invention is significantly more effective.

[0011] In an embodiment, the method further comprises steps of determining or measuring an initial natural rolling frequency of the rolling motion of the ship with the loaded load, estimating an expected wave frequency of the sea, and providing a predetermined fluid level in the tank to obtain the predetermined rolling frequency of the rolling motion of the ship with the loaded load so that a difference between the initial natural rolling frequency and the estimated expected wave frequency is smaller than a difference between the predetermined rolling frequency and the estimated expected wave frequency.

[0012] The step of determining or measuring the natural frequency can be made by calculations based on a well-known formula which for example take the load, a mass of the ship and a position of a center of gravity of the ship, etc. into account. Alternatively, the natural frequency of the rolling motion of the ship can be obtained by experiments which are carried out in advance. The step of estimating the expected wave frequency of the sea can be done by using an ocean report or statistical data, for instance.

[0013] In an embodiment, the method further comprises at least one of the following: filling and/or discharging the tank to obtain a predetermined fluid level, the predetermined fluid level is configured to adjust the natural frequency of the rolling motion of the loaded ship including the mounted tank to the predetermined rolling frequency; and adjusting a density of the fluid within the tank to a predetermined density, the predetermined density is configured to adjust the natural frequency of the rolling motion of the loaded ship including the mounted tank to the predetermined rolling frequency. In these embodiments, the tank can be an integral part of the ship which does not have to be detached or replaced.

[0014] In an embodiment, the method further comprises steps of selecting a tank having a predetermined shape or volume, the selected tank, when filled with the fluid with a predetermined fluid level, is configured to adjust the natural frequency of the rolling motion of the loaded ship including the selected tank to the predetermined rolling frequency, and providing the predetermined fluid level in the selected tank. Depending on the load of the loaded ship, an optimized tank out of the available tanks is selected to adjust the natural frequency of the rolling motion of the loaded ship to the predetermined rolling frequency. In this embodiment, the tank can either be an integral part of the ship which does not have to be detached or replaced, or the selected tank can be mounted to the ship and then filled with the fluid with the predetermined fluid level.

[0015] In an embodiment, the method further comprises steps of selecting a predetermined number of the tanks with predetermined fluid levels, the selected number of the tanks, when filled with the fluid, is configured to adjust the natural frequency of the rolling motion of the loaded ship including the selected number of the tanks to the predetermined rolling frequency, and providing the fluid levels in the selected number of the tanks. In this embodiment, the tanks can either be integral parts of the ship which do not have to be detached or replaced, or the tanks can be mounted to the ship and then filled with the fluid with the predetermined fluid levels.

[0016] In an embodiment, the tank is filled between 30% and 70%, preferably between 40% and 50%, with the fluid. Because the tank is not fully filled, a sloshing motion of the fluid is possible. In an embodiment, the fluid is or comprises water, preferably sea water.

[0017] According to a second aspect of the invention, a ship is provided. The ship is loaded with a load so that the loaded ship has a predetermined natural frequency of a rolling motion. The ship comprises a device configured to damp a rolling movement of the loaded ship, wherein the device comprises at least one tank which is partly filled by a fluid so that the natural frequency of the rolling motion of the loaded ship including the tank is adjusted to the predetermined rolling frequency.

[0018] The second aspect of the present invention achieves the same advantages as the first aspect of the present invention.

[0019] In an embodiment, in a cross section of the tank along a transverse axis of the ship, the tank comprises a central portion and two lateral portions, wherein a surface area of the central portion is smaller than surface areas of each lateral portion. A high sloshing amplitude can be obtained in the lateral portions, while the entire tank is configured to save space due to the smaller central portion. In an embodiment, the cross section of the tank along the transverse axis of the ship can substantially be U-shaped, H-shaped, X-shaped or V-shaped.

[0020] In an embodiment, the ship is configured to mount a group of tanks, wherein the ship comprises a subgroup of the tanks, which is configured to provide the predetermined rolling frequency.

[0021] In an embodiment, the ship comprises a mounting device being configured to mount any tank of a group comprising different tanks having different sizes or shapes, wherein the different tanks being partly filled with the fluid are configured to provide different natural frequencies of the rolling motion of the loaded ship. In an embodiment, the mounting device is configured to interchangeably mount each tank of the group.

[0022] In an embodiment, the load is a component of a wind turbine, for example a tower or tower segment, a nacelle or a blade.

[0023] It has to be noted that embodiments of the invention have been described with reference to different subject matters. In particular, some embodiments have been described with reference to apparatus type claims whereas other embodiments have been described with reference to method type claims. However, a person skilled in the art will gather from the above and the following description that, unless other notified, in addition to any combination of features belonging to one type of subject matter also any combination between features relating to different subject matters, in particular between features of the apparatus type claims and features of the method type claims is considered as to be disclosed with this application.

Brief Description of the Drawings

[0024] The aspects defined above and further aspects of the present invention are apparent from the examples of embodiment to be described hereinafter and are explained with reference to the examples of embodiment. The invention will be described in more detail hereinafter with reference to examples of embodiment but to which the invention is not limited.

Fig. 1 shows a perspective view of a ship according to an embodiment;

Fig. 2 shows a cross section of a ship and a tank according to an embodiment;

Fig. 3 shows a cross section of a ship and tanks according to an embodiment;

Fig. 4 shows a plan view of a ship and a group of different tanks according to an embodiment.

Detailed Description

[0025] The illustrations in the drawings are schematically. It is noted that in different figures, similar or identical elements are provided with the same reference signs.

[0026] **Fig. 1** shows a ship 1 according to an embodiment. The ship 1 is loaded with a load 2 so that the loaded ship 1 has a predetermined natural frequency of a rolling motion. The ship 1 comprises a device configured to damp or reduce a rolling movement of the loaded ship 1. The device comprises at least one tank 3 which is partly filled by a fluid 5 with a fluid level L so that the natural frequency of the rolling motion of the loaded ship 1 including the tank 3 is adjusted to the predetermined rolling frequency.

[0027] The rolling motion of the ship 1 is its motion along a longitudinal axis X of the ship, which can be caused by the sea waves. The filled tank 3 has a natural sloshing frequency or period, which affects and thus adjusts the predetermined rolling frequency of the entire loaded ship 1. The sloshing period of the filled tank 3 is different, preferably significantly away from a rolling frequency of the loaded ship 1 without the tank 3 or with the unfilled tank 3, or significantly away from an estimated expected wave frequency of the sea.

[0028] **Fig. 2** shows a cross section of a ship 1 and a tank 3 along a transverse axis of the ship 1 according to an embodiment. In the cross section of the tank 3, the tank 3 comprises a central portion 32 and two lateral portions 31, 33, wherein a surface area of the central portion 32 is smaller than surface areas of each lateral portion 31, 33. The cross section of the tank 3 along the transverse axis of the ship 1 can also be substantially U-shaped, H-shaped, V-shaped or X-shaped.

[0029] In a neutral state, the fluid 5 within the tank has a neutral fluid level L. On the sea, when the ship 1 is subjected to the waves, the fluid 5 in the tank 3 is sloshing and exhibits an oscillating sloshing level L1. Due to the specific shape of the tank 3, where the surface area of the central portion 32 is smaller than surface areas of each lateral portion 31, 33, a high sloshing amplitude can be obtained in the lateral portions 31, 33, while the entire tank 3 is configured to save space due to the smaller central portion 32. For example, the free space above the recessed central portion 32 can be used for storage purposes, for example the load 2 could be placed there. The same effect can be achieved, when the tank 3 along the transverse axis of the ship 1 is substantially U-shaped, H-shaped, V-shaped or X-shaped.

[0030] **Fig. 3** shows a cross section of a ship 1 and tanks 3 according to an embodiment. The ship 1 is configured to mount a group of tanks 3, wherein the ship comprises a subgroup of the tanks 3, which is configured to provide the predetermined rolling frequency. In the embodiment of Fig. 3, the ship 1 is configured to mount four tanks 3 as a maximum. For example, depending on the mass of the loaded load 2, which affects the rolling frequency of the ship 1, some of the four tanks 3 can be removed or remain unfilled to obtain the predetermined rolling frequency of the loaded ship 1.

[0031] **Fig. 4** shows a plan view of a ship 1 and a group of different tanks 3.1, 3.2, 3.3 having different shapes or volumes according to an embodiment. The ship 1 comprises a mounting device 4 being configured to mount any tank 3.1, 3.2, 3.3 of the group, wherein each tank 3.1, 3.2, 3.3 being partly filled with the fluid 5 is configured to provide different natural frequencies of the rolling motion of the loaded ship 1. For example, depending on the load 2, one out of the group of different tanks 3.1, 3.2, 3.3 is selected and partly filled with the fluid 5 so that the natural frequency of the rolling motion of the loaded ship 1 including the selected tank 3.1, 3.2 or 3.3 is adjusted to the predetermined rolling frequency. Each tank 3.1, 3.2, 3.3 can be provided with an adaptor 6 which is configured to be mounted to the mounting device 4.

[0032] Preferably, the mounting device 4 is configured to interchangeably mount each tank 3.1, 3.2, 3.3 of the group so that a modular system is achieved.

[0033] The present invention is particularly useful in cases, where the load 2 is a heavy component of a wind turbine, such as a tower, a nacelle or a blade.

[0034] In the following, a method of damping a rolling movement of a ship 1 is described. The method comprises steps of loading a load 2 onto the ship 1, and mounting at least one tank 3 to the ship 1. The tank 3 is partly filled by a fluid 5 with the fluid level L so that a natural frequency of a rolling motion of the loaded ship 1 including the mounted tank 3 is adjusted to a predetermined rolling frequency. The rolling motion of the ship 1 is its motion along a longitudinal axis X of the ship, which can be caused by the sea waves. The filled tank 3 has a natural sloshing frequency or period, which affects and thus adjusts the predetermined rolling frequency of the entire loaded ship 1. The sloshing period of the filled tank 3 is different, preferably significantly away from a rolling frequency of the loaded ship 1 without the tank 3 or with the unfilled tank 3.

[0035] In an embodiment, the method can further comprise a step of determining or measuring an initial natural rolling frequency f_1 of the rolling motion of the ship 1 with the loaded load 2, for example without the tank 3 or with the unfilled tank 3. This initial natural rolling frequency f_1 can be calculated by a well-known formula for example by taking the load 2, a mass of the ship 1 and a position of a center of gravity of the ship 1 into account. Alternatively, the initial natural rolling frequency f_1 of the rolling motion of the ship 1 can be obtained by experiments which are carried out in advance.

[0036] The method further comprises a step of estimating an expected wave frequency f_{exp} of the sea. This can be done by using an ocean report or statistical data, for instance.

[0037] Thereafter, a predetermined fluid level L is provided in the tank 3 to obtain a predetermined rolling frequency f_2 of the rolling motion of the ship 1 with the loaded load 2 so that a difference $|f_1 - f_{exp}|$ between the initial natural rolling frequency f_1 of the rolling motion of the ship 1 including the loaded load 2 and the estimated expected wave frequency f_{exp} is smaller than a difference $|f_2 - f_{exp}|$ between the predetermined rolling frequency f_2 of the rolling motion of the ship 1 including the loaded load 2 and the tank 3 having the predetermined fluid level L, and the estimated expected wave frequency f_{exp}. Preferably, the sloshing frequency of the filled tank 3 and the predetermined rolling frequency f_2 of the ship 1 including the loaded load 2 and the tank 3 having the predetermined fluid level L is significantly away from the estimated expected wave frequency f_{exp} of the sea so that the rolling movement of a ship 1 is well damped.

[0038] In an embodiment, the method further comprises steps of filling and/or discharging the tank 3 to obtain a pre-determined fluid level L, wherein the predetermined fluid level L is configured to adjust the natural frequency of the rolling motion of the loaded ship 1 including the tank 3 with the predetermined fluid level L to the predetermined rolling frequency.

[0039] In another embodiment, the method further comprises steps of adjusting a density of the fluid 5 within the tank 3 to a predetermined density, wherein the predetermined density is configured to adjust the natural frequency of the rolling motion of the loaded ship 1 including the filled tank 3 to the predetermined rolling frequency.

[0040] In an embodiment as shown in Fig. 4, the method further comprises steps of selecting a tank 3.1, 3.2 or 3.3 having a predetermined shape or volume, the selected tank 3.1, 3.2 or 3.3, when filled with the fluid 5 with a predetermined fluid level L, is configured to adjust the natural frequency of the rolling motion of the loaded ship 1 including the selected tank 3.1, 3.2 or 3.3 to the predetermined rolling frequency, and providing the predetermined fluid level L in the selected tank 3.1, 3.2 or 3.3. Depending on the load of the loaded ship 1, one of the tanks 3.1, 3.2 or 3.3 can be selected to adjust the natural frequency of the rolling motion of the loaded ship 1 to the predetermined rolling frequency.

[0041] In an embodiment as shown in Fig. 3, the method further comprises steps of selecting a predetermined number of the tanks 3, wherein the selected number of the tanks 3, when filled with the fluid 5 with predetermined fluid levels L, is configured to adjust the natural frequency of the rolling motion of the loaded ship 1 including the selected number of the tanks 3 to the predetermined rolling frequency, and providing the fluid levels L in the selected number of the tanks 3. For example, the selected number of prefilled tanks 3 can be mounted. Alternatively, the tanks 3 can be mounted in an empty state to the ship 1, and only the selected number of the tanks 3 is filled with the fluid 5.

[0042] The tank 3 is preferably filled between 30% and 70%, more preferred between 40% and 50%, with the fluid 5. Because the tank 3 is not fully filled, a sloshing motion of the fluid 5 is possible. The fluid 5 is or comprises water, preferably sea water.

[0043] It should be noted that the term "comprising" does not exclude other elements or steps and "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.

[0044] Independent of the grammatical term usage, individuals with male, female or other gender identities are included within the term.

Claims

1. A method of damping a rolling movement of a ship (1), the method comprising:
   loading a load (2) onto the ship (1); and
   mounting at least one tank (3) to the ship (1), the tank (3) is partly filled by a fluid (5) so that a natural frequency of a rolling motion of the loaded ship (1) including the mounted tank (3) is adjusted to a predetermined rolling frequency.

2. The method according to the preceding claim, further comprising steps of:
   determining or measuring an initial natural rolling frequency (f_1) of the rolling motion of the ship (1) with the loaded load (2);
   estimating an expected wave frequency (f_{exp}) of the sea; and providing a predetermined fluid level (L) in the tank (3) to obtain the predetermined rolling frequency (f_2) of the rolling motion of the ship (1) with the loaded load (2) so that a difference ($|f_1 - f_{exp}|$) between the initial natural rolling frequency (f_1) and the estimated expected wave frequency (f_{exp}) is smaller than a difference ($|f_2 - f_{exp}|$) between the predetermined rolling frequency (f_2) and the estimated expected wave frequency (f_{exp}).

3. The method according to any one of the preceding claims, further comprising at least one of the following:

   filling and/or discharging the tank (3) to obtain a predetermined fluid level (L), the predetermined fluid level (L) is configured to adjust the natural frequency of the rolling motion of the loaded ship (1) including the mounted tank (3) to the predetermined rolling frequency; and
   adjusting a density of the fluid (5) within the tank (3) to a predetermined density, the predetermined density is configured to adjust the natural

frequency of the rolling motion of the loaded ship (1) including the mounted tank (3) to the predetermined rolling frequency.

4. The method according to any one of the preceding claims, further comprising steps of:
selecting a tank (3) having a predetermined shape or volume, the selected tank (3), when filled with the fluid (5) with a predetermined fluid level (L), is configured to adjust the natural frequency of the rolling motion of the loaded ship (1) including the selected tank (3) to the predetermined rolling frequency, and providing the predetermined fluid level (L) in the selected tank (3).

5. The method according to any one of the preceding claims, further comprising steps of:
selecting a predetermined number of the tanks (3), the selected number of the tanks (3), when filled with the fluid (5) with predetermined fluid levels (L), is configured to adjust the natural frequency of the rolling motion of the loaded ship (1) including the selected number of the tanks (3) to the predetermined rolling frequency, and providing the fluid levels (L) in the selected number of the tanks (3).

6. The method according to any one of the preceding claims, wherein
the tank (3) is filled between 30% and 70%, preferably between 40% and 50%, with the fluid (5).

7. The method according to any one of the preceding claims, wherein
the fluid (5) is or comprises water, preferably sea water.

8. A ship (1) loaded with a load (2) so that the loaded ship (1) has a predetermined natural frequency of a rolling motion, the ship (1) comprising a device configured to damp a rolling movement of the loaded ship (1), the device comprising:
at least one tank (3) which is partly filled by a fluid (5) so that the natural frequency of the rolling motion of the loaded ship (1) including the tank (3) is adjusted to the predetermined rolling frequency.

9. The ship (1) according to the preceding claim, wherein in a cross section of the tank (3) along a transverse axis of the ship (1), the tank (3) comprises a central portion (32) and two lateral portions (31, 33), wherein a surface area of the central portion (32) is smaller than surface areas of each lateral portion (31, 33).

10. The ship (1) according to any one of claims 8 and 9, wherein
the cross section of the tank (3) along the transverse axis of the ship (1) is substantially U-shaped, H-shaped, X-shaped or V-shaped.

11. The ship (1) according to any one of claims 8 to 10, wherein
the ship (1) is configured to mount a group of tanks (3), wherein the ship comprises a subgroup of the tanks (3), which is configured to provide the predetermined rolling frequency.

12. The ship (1) according to any one of claims 8 to 11, wherein
the ship (1) comprises a mounting device (4) being configured to mount any tank (3.1, 3.2, 3.3) of a group comprising different tanks (3.1, 3.2, 3.3) having different sizes or shapes, wherein the different tanks (3.1, 3.2, 3.3) being partly filled with the fluid (5) are configured to provide different natural frequencies of the rolling motion of the loaded ship (1).

13. The ship (1) according to the preceding claim, wherein the mounting device (4) is configured to interchangeably mount each tank (3.1, 3.2, 3.3) of the group.

14. The ship (1) according to any one of claims 8 to 13, wherein
the load (2) is a component of a wind turbine.

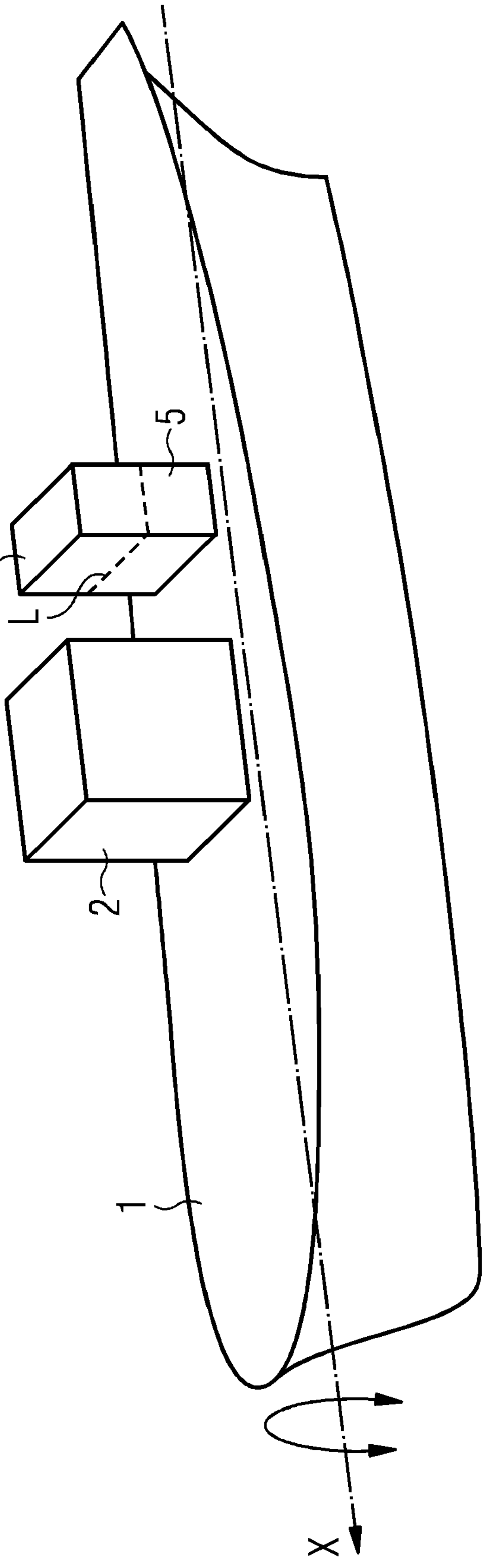


FIG 1

FIG 2

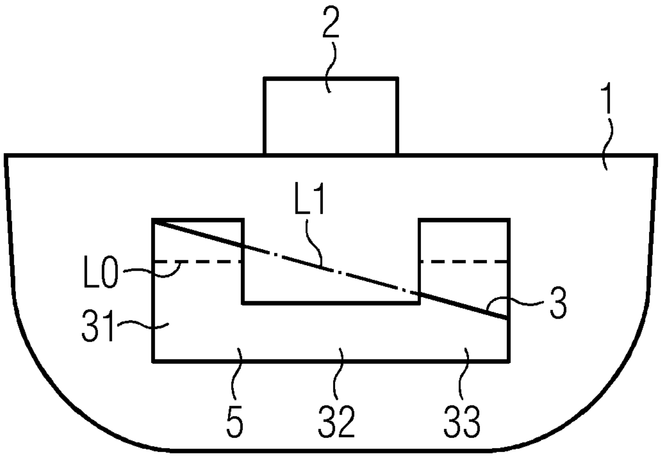


FIG 3

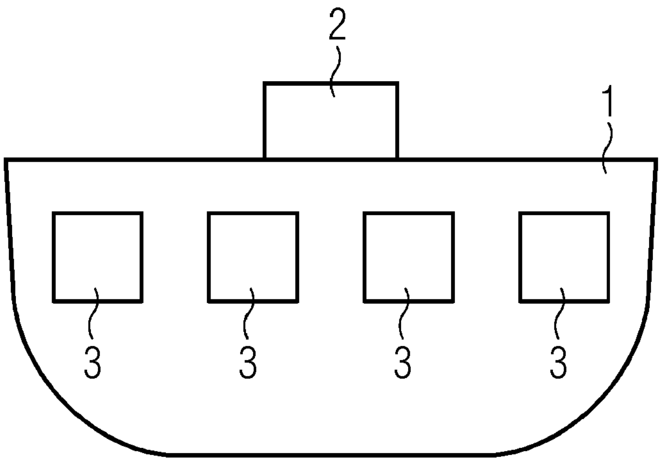
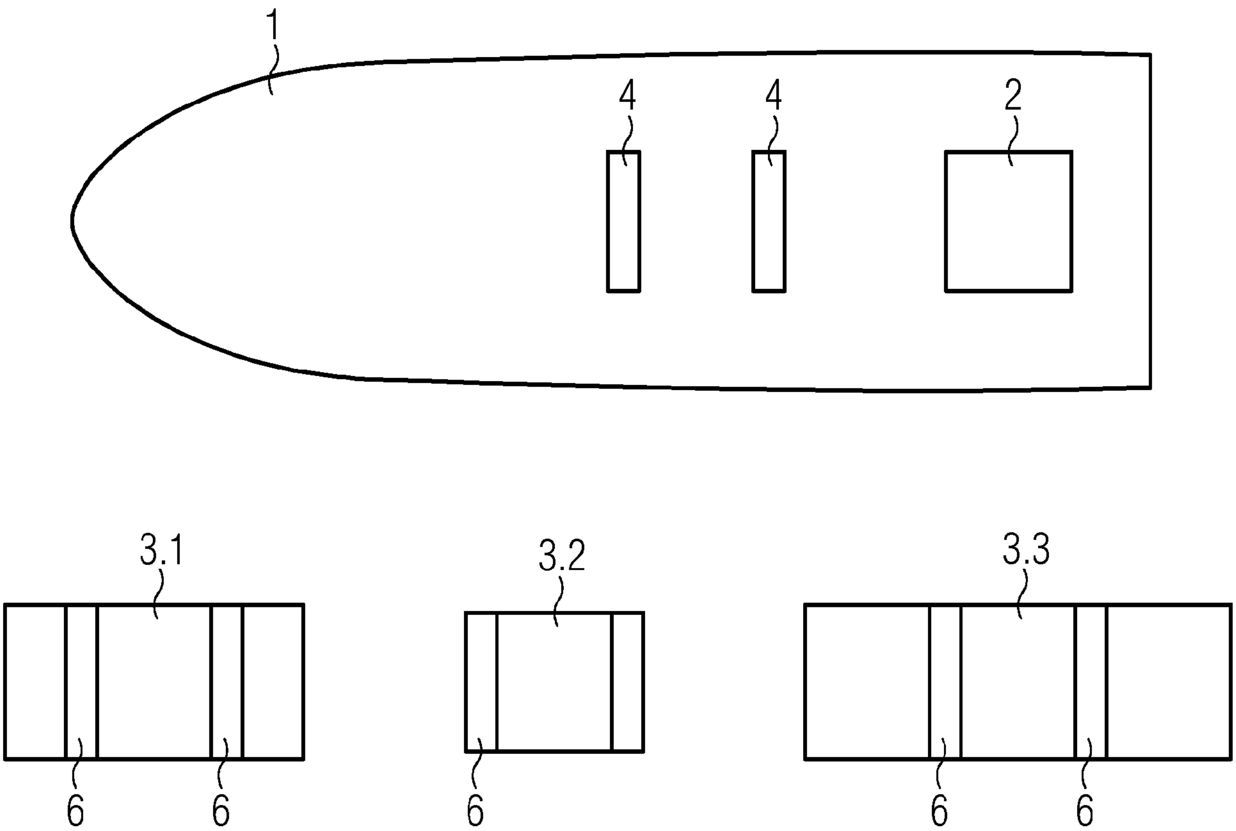


FIG 4



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 19 0188

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	FR 3 127 465 A1 (GAZTRANSPORT ET TECHNIGAZ [FR]) 31 March 2023 (2023-03-31) * paragraphs [0056] - [0103]; claims; figures *	1-14	INV. B63B39/00 B63B39/03
X	NAZIRI HARITH ASLAM AHMAD ET AL: "Multi-Stabilizer Devices for Marine Vessel, Design and Control - A Review", 2022 IEEE 9TH INTERNATIONAL CONFERENCE ON UNDERWATER SYSTEM TECHNOLOGY: THEORY AND APPLICATIONS (USYS), IEEE, 5 December 2022 (2022-12-05), pages 1-13, XP034313402, DOI: 10.1109/USYS56283.2022.10072471 [retrieved on 2023-03-21] * pages 8-13; figures 14-17 *	1-14	
X	OSAMA A. MARZOUK ET AL: "Control of ship roll using passive and active anti-roll tanks", OCEAN ENGINEERING, vol. 36, no. 9-10, 1 July 2009 (2009-07-01), pages 661-671, XP055375560, AMSTERDAM, NL ISSN: 0029-8018, DOI: 10.1016/j.oceaneng.2009.03.005 * pages 663-370 *	1-14	TECHNICAL FIELDS SEARCHED (IPC) B63B
A	WO 2009/048322 A1 (ITREC BV [NL]; BEREZNITSKI ALEXEL [NL] ET AL.) 16 April 2009 (2009-04-16) * page 11, lines 14,15; figure 6 * * page 10, line 24 *	1,8	
A	JP H04 312686 A (MITSUBISHI HEAVY IND LTD; PARU KOUZOU KK) 4 November 1992 (1992-11-04) * claims 1-3; figures *	1-14	

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	23 January 2024	Knoflacher, Nikolaus

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 23 19 0188

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

23-01-2024

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
FR 3127465	A1	31-03-2023	FR 3127465	A1	31-03-2023
			WO 2023052626	A1	06-04-2023
WO 2009048322	A1	16-04-2009	CN 101918271	A	15-12-2010
			DK 2207713	T3	17-06-2013
			EP 2207713	A1	21-07-2010
			KR 20100071070	A	28-06-2010
			US 2010307401	A1	09-12-2010
			WO 2009048322	A1	16-04-2009
JP H04312686	A	04-11-1992	JP H04312686	A	04-11-1992
			JP H07103716	B2	08-11-1995

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82