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(54) **A FLOATING INDEPENDENT POWER PLANT AND METHOD OF CONVERTING AN LNG CARRIER INTO ONE**

SCHWIMMENDES UNABHÄNGIGES KRAFTWERK UND VERFAHREN ZUR UMWANDLUNG EINES LNG-TRÄGERS IN EINES DAVON

CENTRALE ÉLECTRIQUE FLOTTANTE INDÉPENDANTE ET PROCÉDÉ DE CONVERSION D'UN TRANSPORTEUR DE GNL EN UNE

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Description

Field of the invention

[0001] The present invention relates to a floating independent power plant (FIPP) comprising a converted LNG carrier with a hull and a plurality of LNG storage tanks. The invention further relates to converting an LNG carrier into a floating independent power plant and to a power generator module for conversion of an LNG carrier into a floating independent power plant.

Background art

[0002] A method of converting a LNG carrier into a floating LNG plant is known from WO 2012/072292. Herein, the LNG carrier comprises as least a hull and a plurality of LNG storage tanks and the floating LNG plant comprises at least one sponson on the side of the hull, for creating additional hull volume, process equipment for LNG processing on the floating LNG plant, and a reservoir for storing fluids separated during the LNG processing, wherein said reservoir is formed by the ballast tank or in the space reserved for the ballast tank of the original LNG carrier. By using an existing tanker, project risk is reduced because the vessel is already available and not on the critical path for project schedules. The floating LNG plant, however, is limited to use with natural gas distribution systems for supplying natural gas to users onshore.

[0003] The present invention seeks to provide a floating LNG plant for supplying power. The present invention further seeks to provide a floating LNG plant which can be manufactured by converting an LNG carrier with reduced production in critical time. Further, the present invention seeks to provide a floating solution which allows to keep the initial full containment system of an LNG carrier.

Summary of the invention

[0004] Hereto, according to a first aspect, the present invention as claimed provides a floating independent power plant (FIPP) comprising a converted Moss type LNG carrier with a hull and a plurality of LNG storage tanks arranged within the hull, wherein the floating independent power plant comprises: a regasification unit, connected with an inlet to the plurality of LNG storage tanks, for regasification of stored LNG; a sponson on either side of the hull, each sponson being subdivided into a plurality of substantially equally sized compartments along the length of the sponson; a plurality of power generator modules comprising power generator sets, each forming one of the plurality of compartments and provided with an inlet connected to an outlet of the regasification unit for receiving fuel gas and adapted for generating electricity using the received fuel gas, wherein each of the compartments comprising a power generator set is provided with an exhaust stack and an air inlet in an upper side, with the exhaust stack and air inlet being located on longitudinally opposite sides of the compartment and with the exhaust stacks of adjoining compartments being combined; and cooling equipment, coupled to the plurality of power generation modules and arranged to cool the plurality of power generation modules.

[0005] The FIPP may be moored at any location where power needs be supplied. The lay-out of the FIPP allows the compartments of the sponsons holding the power generator sets being manufactured as modular units, which can be nearly finished prior to integration into the sponson. As a result, manufacturing logistics and efficiency are Improved. By placing the adjoining modular units in mirror position around adjoining walls, the exhaust stacks of adjoining compartments are combined, saving deck space.

[0006] Furthermore, with the power generation modules being located in the sponsons, which are added to the outside of the hull, the electricity producing elements are added onto and integrated with existing systems of the LNG carrier, thus refurbishment steps of the original LNG carrier parts is limited.

[0007] In the present text, the phrase "LNG carrier" or "original LNG carrier" is used. This means a vessel that has originally been constructed for transporting LNG.

[0008] In the present text the word "sponson" is used. The word sponson refers to any projecting hull structure in order to provide additional hull volume. The sponson normally extends along the length of a vessel. Optionally, the top side of the sponson can be made flat, thereby providing additional deck space. The top side could be adapted to be flush with the vessel's main deck. However, it should be noted that the top side of a sponson does not need to be flat and does not need to be flush with the vessel's main deck. It is very well possible to connect a sponson to the hull below the main deck.

[0009] According to an embodiment, the sponson Is divided in a lower part and an upper part. The lower part serves as a base onto which the power generator modules are placed to form the upper part and is integrated to the original LNG carrier in a dry-dock. This allows the generator modules being integrated with the vessel afloat, reducing the amount of time the vessel needs to be in the dry-dock. Furthermore, the power generator modules forming the upper part of the sponson may be assembled and pre-commissioned prior to integration on the lower sponson parts. Thus many construction phases of the FFIP may be carried out in parallel, reducing critical time of construction phases carried out on the vessel.

[0010] According to an embodiment. the FIPP comprises at least ten power generator modules and each sponson is subdivided into at least five compartments. Each power generator module may produce 18MW power, allowing the FIPP to produce at least 180MW in total.

[0011] In an embodiment, the floating independent power plant comprises a steam turbine generator and/or one or more diesel generators for supporting sailing such that the floating independent power plant is self-propelled during deployment. Having a propulsion unit on-board advantageously allows the vessel being repositioned and deployed to different locations without need of additional support vessels for towing.

[0012] In an embodiment, the cooling equipment comprises a closed fresh water circulation loop for each power generator set and a heat exchanger installed above each of the sponsons and/or on the main deck in direct contact with the outside environment, with each of the closed fresh water circulation loops running between one of the power generation sets and the heat exchanger, the heat exchanger being an air flow heat exchanger. As a result, no use is made of seawater for cooling the power generator sets. Thus no heated seawater is being returned to the sea, making the vessel compliant with the most severe environmental requirements on this subject.

[0013] In an embodiment, the air flow heat exchanger comprises a plurality of air cooled cells. This creates a large heat exchange area.

[0014] In an embodiment, the air flow heat exchanger further comprises at least one fan for providing forced airflow as local cooling medium, providing enhanced heat transfer.

[0015] In an embodiment, each power generator set is provided with at least one dedicated air cooled cell, such that each power generator set has dedicated cooling. This set-up avoids the need of a very large collector and a general pumping system for distributing cooling water evenly over each of the power generation modules when in use. The use of dedicated systems allows individual operation of each of the power generation modules according to match the electricity needs, i.e. when a relatively low amount of electricity is required from the FIPP some power generation modules may be switched off. Each unit operates as a separate entity.

[0016] In an embodiment, the cooling equipment comprises a closed fresh water circulation loop for each power generator set and a heat exchanger installed in the hull or one of the sponsons, with each of the closed fresh water loops running between one of the power generator sets and the heat exchanger for exchanging heat therewith and wherein the heat exchanger is connected with an inlet to at least one cold seawater storage tank for receiving seawater as cooling medium in the heat exchanger and with an outlet extending through the hull to overboard heated seawater to open sea, wherein the cold seawater storage tank is located in one or more compartments of the sponsons not holding a power generator set and the cold seawater storage tank is provided with a connection to a seawater lift system. The sea water lift system is already commonly available vessels for cooling on-board. This system does not require additional deck space, unlike the air cooling.

[0017] In an embodiment, each of the closed fresh water circulation loops comprises a pump for pumping the fresh water through the closed fresh water circulation loop, which pump is driven by the power generator set. This allows each unit being operated as a separate entity.

[0018] In an embodiment, the regasification unit is provided with a closed fresh water circulation loop which runs between the regasification unit and the heat exchanger, for cooling the regasification unit.

[0019] In an embodiment, the floating independent power plant comprises an export gantry for connecting to an onshore grid for supply of the generated electricity thereto.

[0020] According to a second aspect, the invention provides a method of converting a Moss type LNG carrier to a floating independent power plant, comprising the steps of removing existing bilge keels from either side of the hull; providing a plurality of power generator modules each comprising a power generator set, an air inlet and an outlet, wherein the air inlet and the outlet are located on opposite sides of the module; assembling the plurality of power generator modules in an upper part of two sponsons, such that each of the two sponsons is subdivided into a plurality of substantially equally sized compartments along a longitudinal direction, and such that adjoining power generating modules are mirrored around their adjoining wall, and combining the outlets of adjoining power generator modules in a funnel of exhaust pipes; attaching the two sponsons to either side of the hull, integrating a lower part of each sponson at the location of the bilge keel; providing a regasification unit for creating fuel gas from LNG, connecting said regasification unit with an inlet to the LNG tanks and with an outlet for supplying created fuel gas to the plurality of power generator modules.

[0021] In an embodiment, the method further comprises providing each of the power generator modules with at least one air cooled cell on an upper side forming a deck of the sponson and a closed fresh water circulation loop running between the power generator set and said at least one air cooled cell. Preferably, this step is carried out for each sponson after the assembly of the plurality of power generator modules therein. However, optionally the air cooling system may be included in each modules prior to integration into the sponsons.

[0022] In an embodiment, the method further comprises providing at least one fan on an upper side of each of the power generator modules for creating a forced airflow that is directed over the at least one air cooled cell.

[0023] The invention provides a sponson for converting a Moss type LNG carrier to a floating independent power plant according to the method of claim 11, the sponson being subdivided into a plurality of substantially equally sized compartments along a longitudinal direction of the sponson and arranged to receive a plurality of power generator modules, each holding one power generator module, arranged such that adjoining power generating modules are mirrored around their adjoining wall, the sponson comprising at least one funnel of exhaust pipes for combining the outlets of adjoining power generator modules and said sponson being adapted for being fixedly mounted on a side of the hull of the Moss type LNG carrier.

Brief description of the drawings

[0024] Embodiments of a floating independent power plant according to the present invention will be described by way of example, with reference to the attached drawings, in which:

Fig. 1 shows a high-level schematic of the power generating system of a floating independent power plant;
Fig. 2A shows a schematic top view of an embodiment of a floating independent power plant according to the invention;
Fig. 2B shows a schematic cross-section of the floating independent power plant of Fig. 2A;
Fig. 2C shows a schematic of the cooling system of the floating independent power plant of Figs. 2A and B;
Fig. 3A shows a schematic top view of an embodiment of a floating independent power plant according to the invention;
Fig. 3B shows a schematic cross-section of the floating independent power plant of Fig. 3A; and
Fig. 3C shows a schematic of the cooling system of the floating independent power plant of Figs. 3A and B.

Description of embodiments

[0025] Fig. 1 shows a high-level schematic of the power generating system of a floating independent power plant (FIPP). The FIPP is shown to comprise manifolds 31, LNG tanks 30, a regasification unit 40, a boiler 41, a propulsion unit 42, a power generation module 50 with a power generator set 51 and a cooling system 52, and an export gantry 59. The manifolds 31 serve as an inlet to the LNG tanks 30 and are adapted for loading LNG via marine loading hoses from LNG carriers which more alongside the FIPP. The regasification unit 40 is with an inlet connected to an outlet of the LNG tanks 30 and is adapted to regasify LNG to provide gas as fuel gas via a first outlet to the plurality of power generation sets 51 and via a second outlet to the boiler 41. The boiler 41 is with a first outlet connected to the propulsion unit 42 and with a second outlet connected to the plurality of power generation sets 51. The power generation sets 51 are each connected with an electric output to the export gantry 59 for exporting generated electricity to a power grid. Each of the power generation sets 51 is individually connected to a cooling system 52. Two embodiments of FIPP cooling systems are described in more detail with reference to Figs. 2C and 3C.

[0026] The regasification unit comprises at least one centrifugal type fuel gas compressor (not shown) to compress boil-off gas from the LNG tanks 30 to a required fuel gas pressure for the gas engines. The at least one fuel gas compressor discharges pressurised gas to at least one fuel gas after-cooler/heater (not shown), which regulates the final temperature of the fuel gas prior to feeding the gas engines. The regasification unit further comprises at least one steam heated fuel gas vaporiser (not shown), adapted to produce from the LNG additional fuel gas which is required on top of the boil-off gas and suitable for direct supply to the gas engines. Pressurised LNG is introduced from the LNG tanks 30 and the boil-off gas is combined with the fuel gas downstream of the after-cooler/heater. The amount of boil-off gas and additional fuel gas in the mixture varies between 0% and 34%, depending on the operation and level of LNG in the LNG tanks. During loading and when the LNG tanks are full, a maximum of boil-off gas is generated such that the mixture contains 34%. As the level of LNG in the LNG tanks decreases, the amount of boil-off gas in the mixture decreases (linearly) to 0%. Each power generator set 51 comprises at least one gas engine and an electric power generator (both not shown), wherein the gas engine(s) will deliver mechanical power to the electric power generator(s) for the production of electricity.

[0027] When the FIPP is in power production mode, the gas at fuel gas power is lead from the regasification unit to at least one of the plurality of power generation modules 50 into the power generator set 51 thereof. According to an embodiment, the generated electricity from the at least one power generator set 51 is generated at 15 kV and raised up to 132 kV export voltage, metered and subsequently supplied to the onshore grid through the export gantry 59. The export voltage can be set to specific project needs. During this operation, the boiler 41 is running in order to supply steam for local power generation and LNG vaporisation. A boil-off gas system which is already present in the original LNG carrier is used for supplying gas to the boiler 41.

[0028] During deployment, the FIPP is self-propelled with a high pressure steam system as propulsion unit. The boiler 41 burns marine gas oil and/or gas depending on the LNG storage on board. All power generator units are shut-down during sailing. The required electricity for supporting the FIPP sailing is generated by a steam turbo generator and/or diesel generator, which is already present in the original LNG carrier from which the FIPP is converted and which is part of the aforementioned propulsion unit 42. Where a steam turbo generator is used, a secondary function of the boiler comprises continuous LNG gas burning, so that no diesel oil consumption is required.

[0029] Figs. 2A and 2B respectively show a schematic top view and cross-sectional view of an embodiment of a FIPP, with a detailed schematic of the cooling system thereof shown in Fig. 2C. The FIPP is a vessel, with four Moss type LNG tanks 30, having a sponson 10, 20 on both sides of the hull 1. The sponsons 10, 20 extend over the full length of a cargo section of the hull 1 and are constructed to house the power generation modules 50 with the gas engine driven power generator sets 51 and their supporting systems. The sponsons 10, 20 are both subdivided into six equal length sections forming twelve compartments in total. In each of the compartments of one of the sponsons 20 a single power generator set 51 is installed. The compartments with the power generator sets 51 can be manufactured and pre-commissioned separately as power generation modules 50 and installed into the sponsons in a near-complete state. Four of the compartments of the other of the sponsons are each formed by a single power generation module 50, while the two compartments in the middle of the ship under the LNG transfer station have a seawater cooling system 60 installed.

[0030] Air inlets 54 and outlets are created in the upper side of each of the power generation module 50 compartments. These inlets 54 and outlets are located as far apart as possible on opposite sides of each compartment to maximise air flow there through. The outlets of two neighbouring compartments are combined into a single exhaust funnel 55 to minimise the number of structures on the upper deck of the sponsons 10, 20.

[0031] Preferably, the structures of the sponsons 10, 20 have the same frame distances as the original LNG carrier's hull 1 in order to guarantee continuation of the original LNG carrier's hull structure inside the sponsons for optimal load transfer in the structure. The lower part of each of the sponsons 10, 20 is integrated at the location of the former bilge keel at mid-ship. The height of the sponsons 10, 20 is continuous between the fore and aft ends, such that the upper sides of both sponsons 10, 20 is aligned with the upper deck of the hull 1. The shape of the hull 1 towards the ends thereof dictates a widening of the sponsons 10, 20 to maintain a proper connection between said sponsons 10, 20 and the hull 1. The sponsons 10, 20 are slightly tapered on both ends thereof to reduce the drag during sailing.

[0032] As visible in Fig. 2B, a pipe rack 58 is created on the upper deck to transport fuel gas, cooling water and cabling across the vessel. The pipe rack 58 is installed on the longitudinal sides of the deck of the original LNG carrier.

[0033] As shown in Fig. 2C, the cooling system 52' in this embodiment is based on a seawater cooling system 60. The cooling system 52' comprises a dedicated fresh water circulation loop 68 for each of the power generation modules 50 and the regasification unit 40, comprising at least one pump 51c for circulating the fresh water therein, and the seawater cooling system 60 located in the sponson 10, which comprises a sea chest 61, seawater lift pumps 62 and heat exchanger tanks 65. Each of the fresh water circulation loops 68 runs between the power generation module 50 or regasification unit 40, where the fresh water absorbs heat from the engines and auxiliaries, to the heat exchanger tanks, where the fresh water releases heat to the seawater therein, prior to being cycled back to the power generation module 50 or regasification unit 40. The sea chest 61 is located in the bottom of the sponson 10, below sea-level, and adapted to take in and store cold seawater. The seawater lift pumps 62 take 'cold' seawater as cooling medium from the sea chest 61 and pump it via inlets 63 into the heat exchanger tanks 65, where the cold seawater exchanges heat with the fresh water from the fresh water circulation loops 68 running there through. Heated seawater is expelled overboard the vessel via outlet channels 64, positioned at an upper side of the heat exchanger tanks 65.

[0034] Figs. 3A and 3B respectively show a schematic top view and cross-sectional view of an alternative embodiment of a FIPP, with a detailed schematic of the cooling system thereof shown in Fig. 3C. The embodiment of Fig. 3A-3C is similar to the one shown in Fig. 2A-2C, except that in the embodiment of Fig. 3A-3C both sponsons 10', 20' are subdivided into five equal length sections forming compartments, which have a single power generator set 51 installed therein. Furthermore, this embodiment's cooling system 52" is an air cooling system, as shown in Fig. 3C. The air cooling system 52" comprises a dedicated fresh water circulation loop 68' for each of the power generation modules 50', comprising a pump 5 1c for circulation of the fresh water therein, and a heat exchanger 69' in the form of air cooler cells 65' provided with fans 67 creating a forced ambient air flow. The fresh water in the fresh water circulation loop 68' is heated up by the gas engine and auxiliary equipment in the power generation module 50' and pumped to the air cooling cells, which are located outside the compartment on or above deck level, to exchange heat with the ambient air flow prior to being cycled back to the power generation module 50'. The air cooling cells are for example arranged at deck level, which may extend over the sponsons, or alternatively on a higher level, for example mounted on a rack above deck level. Each power generation module 50' is connected via the dedicated fresh water circulation loop 68' to a dedicated heat exchanger 69', which is installed above the sponson 10', 20'. The dedicated heat exchanger 69' may take almost full width of the sponson, in some embodiments. In a preferred configuration, each heat exchanger has five air cooler cells 65'. The fresh water is preferably lead over or through the air cooler cells in a thin flow layer, for example through the use of a finned tube bundle, in order to create a large heat exchange area and enhance heat transfer. The fans 67 provide additional (forced) airflow over the surface of the air cooler cells 65', further enhancing heat transfer and thus improving the cooling capacity of the cooling system.

[0035] The air cooling system 52" is shown to replace the seawater cooling system of Fig. 2, but alternatively it may be desirable to use the cooling system of Fig. 3C in addition to the seawater based cooling system of Fig. 2C.

[0036] The present invention has been described above with reference to a number of exemplary embodiments as shown in the drawings. Modifications and alternative implementations of some parts or elements are possible, and are included in the scope of protection as defined in the appended claims.

Claims

1. A floating independent power plant, FIPP, (100; 200) comprising a converted Moss type LNG carrier with a hull (1) and a plurality of LNG storage tanks (30) arranged within the hull, wherein the floating independent power plant comprises:

   - a regasification unit (40), connected with an inlet to the plurality of LNG storage tanks (30), for regasification of stored LNG;
   - a plurality of power generator modules (50; 50') comprising power generator sets (51), and being provided with an inlet connected to an outlet of the regasification unit (40) for receiving fuel gas and adapted for generating electricity using the received fuel gas;
   - cooling equipment (52; 52'; 52"), coupled to the plurality of power generation modules (50; 50') and arranged to cool the plurality of power generation modules; and
   - a sponson (10, 20; 10', 20') on either side of the hull (1), **characterized in that** each sponson (10, 20; 10'; 20') is subdivided into a plurality of substantially equally sized compartments (50, 60; 50') along a longitudinal direction of the sponson (10,20; 10', 20') fixedly mounted on either side of the hull (1) and arranged to receive the plurality of power generator modules (50; 50'), each compartment holding one power generator module (51), wherein, each of the plurality of power generation modules (50; 50') forms one of the plurality of compartments (50, 60; 50'), and wherein each of the compartments comprising a power generator set (51) is provided with an exhaust stack (55) and an air inlet (54) in an upper side, wherein the compartments are arranged such that adjoining power generating modules (50; 50') are mirrored around their adjoining wall with the exhaust stack (55) and air inlet (54) being located on longitudinally opposite sides of the compartment and with the exhaust stacks (55) of adjoining compartments being combined into one funnel of exhaust pipes.

2. The floating independent power plant (100; 200) according to claim 1, comprising at least ten power generator modules (50; 50') and wherein each sponson (10, 20; 10', 20') is subdivided into at least five compartments along the length of the sponson (10, 20; 10', 20').

3. The floating independent power plant (100; 200) according to any one of the preceding claims, wherein the floating independent power plant comprises a steam turbine generator and/or one or more diesel generators for supporting sailing such that the floating independent power plant is self-propelled during deployment.

4. The floating independent power plant (200) according to any one of the preceding claims, wherein the cooling equipment (52") comprises a closed fresh water circulation loop (68') for each power generator set (51) and a heat exchanger (69') installed above each of the sponsons (10', 20') and/or on the main deck in direct contact with the outside environment, with each of the closed fresh water circulation loops running between one of the power generation sets and the heat exchanger, the heat exchanger being an air flow heat exchanger.

5. The floating independent power plant (200) according to claim 4, wherein the air flow heat exchanger (69') comprises a plurality of air cooled cells (65').

6. The floating independent power plant (200) according to claim 5, wherein the air flow heat exchanger (69') further comprises at least one fan (67) for providing forced airflow as local cooling medium.

7. The floating independent power plant (200) according to claim 5 or 6, wherein each power generator set (51) is provided with at least one dedicated air cooled cell (65').

8. The floating independent power plant (100) according to any one of claims 1 to 3, wherein the cooling equipment (52') comprises a closed fresh water circulation loop (68) for each power generator set 51) and a heat exchanger (65) installed in the hull (1) or one of the sponsons (10;20), with each of the closed fresh water loops (68) running between one of the power generator sets (51) and the heat exchanger for exchanging heat therewith and wherein the heat exchanger (65) is connected with an inlet (61) to at least one cold seawater storage tank (61) for receiving seawater as cooling medium in the heat exchanger and with an outlet (64) extending through the hull (1) to overboard heated seawater to open sea, wherein the cold seawater storage tank (61) is located in one or more compartments (60) of the sponsons (10, 20) not holding a power generator set and the cold seawater storage tank is provided with a connection to a seawater lift system (62).

9. The floating independent power plant (100; 200) according to any one of claims 4 - 8, wherein each of the closed fresh water circulation loops (68, 68') comprises a pump (51c) for pumping the fresh water through the closed fresh water circulation loop,

which pump is driven by the power generator set (51).

10. The floating independent power plant (100; 200) according to any one of claims 4 - 9, wherein the regasification unit (40) is provided with a closed fresh water circulation loop which runs between the regasification unit and the heat exchanger.

11. The floating independent power plant (100; 200) according to any one of the preceding claims, wherein the floating independent power plant comprises an export gantry (59) for connecting to an onshore grid for supply of the generated electricity thereto.

12. A method of converting a Moss type LNG carrier to a floating independent power plant (100; 200), comprising the steps of

removing existing bilge keels from either side of the hull (1);
providing a plurality of power generator modules (50; 50') each comprising a power generator set (51), an air inlet (54) and an outlet (55), wherein the air inlet and the outlet are located on opposite sides of the module (50; 50');
attaching two sponsons 10, 20; 10', 20') to either side of the hull (1), integrating a lower part of each sponson at the location of the bilge keel;
assembling the plurality of power generator modules (50; 50') in an upper part of the two sponsons (10, 20; 10', 20'), such that each of the two sponsons is subdivided into a plurality of substantially equally sized compartments (50, 60; 50') along a longitudinal direction, and such that adjoining power generating modules (50; 50') are mirrored around their adjoining wall, and combining the outlets (55) of adjoining power generator modules in a funnel of exhaust pipes;
providing a regasification unit (40) for creating fuel gas from LNG, connecting said regasification unit with an inlet to the LNG tanks and with an outlet for supplying created fuel gas to the plurality of power generator modules (50; 50').

13. The method according to claim 12, further comprising
providing each of the power generator modules (50') with at least one air cooled cell (65') on an upper side forming a deck of the sponson and a closed fresh water circulation loop (68') running between the power generator set and said at least one air cooled cell.

14. The method according to claim 13, further comprising providing at least one fan (67) on an upper side of each of the power generator modules (50; 50') for creating a forced airflow that is directed over the at least one air cooled cell (65').

Patentansprüche

1. Schwimmendes, unabhängiges Kraftwerk, FIPP, (100; 200), das aus einem umgebauten LNG-Tanker vom Typ Moss mit einem Rumpf (1) und einer Vielzahl von LNG-Lagertanks (30), die innerhalb des Rumpfs angeordnet sind, besteht, wobei das schwimmende, unabhängige Kraftwerk umfasst:

- eine Regasifizierungseinheit (40), die mit einem Einlass mit der Vielzahl von LNG-Lagertanks (30) verbunden ist, zur Regasifizierung von gespeichertem LNG;
- eine Vielzahl von Stromerzeugungsmodulen (50; 50'), die Stromerzeugungsaggregate (51) umfassen und
mit einem Einlass versehen sind, der mit einem Auslass der Regasifizierungseinheit (40) verbunden ist, um Brenngas aufzunehmen, und die zur Erzeugung von Elektrizität unter Verwendung des aufgenommenen Brenngases ausgelegt sind;
- eine Kühlanlage (52; 52'; 52"), die mit der Vielzahl von Stromerzeugungsmodulen (50; 50,) gekoppelt ist und so angeordnet ist, dass sie die Vielzahl von Stromerzeugungsmodulen kühlt; und
- einen Schwimmer (10, 20; 10', 20') auf jeder Seite des Rumpfs (1),

dadurch gekennzeichnet, dass
jeder Schwimmer (10, 20; 10'; 20') in eine Vielzahl von im Wesentlichen gleich großen Abteilen (50, 60; 50') entlang einer Längsrichtung des Schwimmers (10, 20; 10', 20') unterteilt ist, die fest an beiden Seiten des Rumpfs (1) angebracht und so angeordnet sind, dass sie die Vielzahl von Stromerzeugungsmodulen (50; 50') aufnehmen, wobei jedes Abteil ein Stromerzeugungsmodul (51) aufnimmt, wobei jedes der mehreren Stromerzeugungsmodule (50; 50') eines der mehreren Abteile (50, 60; 50') bildet und wobei jedes der Abteile, die einen Stromerzeugersatz (51) umfassen, mit einem Abgaskamin (55) und einem Lufteinlass (54) in einer oberen Seite versehen ist, wobei die Abteile so angeordnet sind, dass angrenzende Stromerzeugungsmodule (50; 50') an ihrer angrenzenden Wand gespiegelt sind, wobei der Abgaskamin (55) und der Lufteinlass (54) an in Längsrichtung gegenüberliegenden Seiten des Abteils angeordnet sind und wobei die Abgaskamine (55) angrenzender Abteile zu einem Trichter aus Abgasrohren kombiniert sind.

2. Schwimmendes, unabhängiges Kraftwerk (100; 200) gemäß Anspruch 1, das mindestens zehn

Stromerzeugungsmodule (50; 50’) umfasst und bei dem jeder Schwimmer (10, 20; 10’, 20’) in mindestens fünf Abteile entlang der Länge des Schwimmers (10, 20; 10’, 20’) unterteilt ist.

3. Schwimmendes, unabhängiges Kraftwerk (100; 200) gemäß einem der vorhergehenden Ansprüche, wobei das schwimmende, unabhängige Kraftwerk einen Dampfturbinengenerator und/oder einen oder mehrere Dieselgeneratoren zur Unterstützung der Fahrt umfasst, so dass das schwimmende, unabhängige Kraftwerk während des Einsatzes selbstfahrend ist.

4. Schwimmendes, unabhängiges Kraftwerk (200) gemäß einem der vorhergehenden Ansprüche, wobei die Kühlanlage (52") einen geschlossenen Frischwasser-Zirkulationskreislauf (68’) für jeden Stromgeneratorsatz (51) und einen Wärmetauscher (69’) umfasst, der über jedem der Schwimmer (10’, 20’) und/oder auf dem Hauptdeck in direktem Kontakt mit der Außenumgebung installiert ist, wobei jeder der geschlossenen Frischwasser-Zirkulationskreisläufe zwischen einem der Stromgeneratorsätze und dem Wärmetauscher verläuft, wobei der Wärmetauscher ein Luftstrom-Wärmetauscher ist.

5. Schwimmendes, unabhängiges Kraftwerk (200) gemäß Anspruch 4, wobei der Luftstrom-Wärmetauscher (69’) eine Vielzahl von luftgekühlten Zellen (65’) umfasst.

6. Schwimmendes, unabhängiges Kraftwerk (200) gemäß Anspruch 5, wobei der Luftstrom-Wärmetauscher (69’) ferner mindestens einen Ventilator (67) zur Bereitstellung eines erzwungenen Luftstroms als lokales Kühlmedium umfasst.

7. Schwimmendes, unabhängiges Kraftwerk (200) gemäß Anspruch 5 oder 6, wobei jeder Stromgeneratorsatz (51) mit mindestens einer dedizierten luftgekühlten Zelle (65’) ausgestattet ist.

8. Schwimmendes, unabhängiges Kraftwerk (100) gemäß einem der Ansprüche 1 bis 3, wobei die Kühlanlage (52’) einen geschlossenen Frischwasser-Zirkulationskreislauf (68) für jeden Stromgeneratorsatz (51) und einen Wärmetauscher (65) umfasst, der im Rumpf (1) oder einem der Schwimmer (10; 20) installiert ist, wobei jeder der geschlossenen Frischwasser-Kreisläufe (68) zwischen einem der Stromgeneratorsätze (51) und dem Wärmetauscher verläuft, um mit diesem Wärme auszutauschen, und wobei der Wärmetauscher (65) mit einem Einlass (61) mit mindestens einem Kaltmeerwasserspeichertank (61), um Seewasser als Kühlmedium im Wärmetauscher aufzunehmen, und mit einem Auslass (64), der sich durch den Rumpf (1) erstreckt, um über Bord erwärmtes Meerwasser auf das offene Meer zu leiten, verbunden ist, wobei der Kaltmeerwasserspeichertank (61) in einem oder mehreren Abteilen (60) der Schwimmer (10, 20) angeordnet ist, die keinen Stromgeneratorsatz enthalten, und der Kaltmeerwasserspeichertank mit einer Verbindung zu einem Meerwasserhebesystem (62) versehen ist.

9. Schwimmendes, unabhängiges Kraftwerk (100; 200) gemäß einem der Ansprüche 4 - 8, wobei jeder der geschlossenen Frischwasser-Zirkulationskreisläufe (68, 68’) eine Pumpe (51c) zum Pumpen des Frischwassers durch den geschlossenen Frischwasser-Zirkulationskreislauf umfasst, wobei die Pumpe durch den Stromgeneratorsatz (51) angetrieben wird.

10. Schwimmendes, unabhängiges Kraftwerk (100; 200) gemäß einem der Ansprüche 4 - 9, wobei die Regasifizierungseinheit (40) mit einem geschlossenen Frischwasser-Zirkulationskreislauf versehen ist, der zwischen der Regasifizierungseinheit und dem Wärmetauscher verläuft.

11. Schwimmendes, unabhängiges Kraftwerk (100; 200) gemäß einem der vorhergehenden Ansprüche, wobei das schwimmende, unabhängige Kraftwerk ein Exportportal (59) zur Verbindung mit einem Onshore-Netz zur Einspeisung des erzeugten Stroms umfasst.

12. Verfahren zum Umwandeln eines LNG-Tankers vom Typ Moss in ein schwimmendes, unabhängiges Kraftwerk (100; 200), das die Schritte umfasst:

Entfernen vorhandener Bilgenkiele von beiden Seiten des Rumpfs (1);
Bereitstellen einer Vielzahl von Stromerzeugungsmodulen (50; 50’), die jeweils einen Stromerzeugersatz (51), einen Lufteinlass (54) und einen Auslass (55) umfassen, wobei der Lufteinlass und der Auslass an gegenüberliegenden Seiten des Moduls (50; 50’) angeordnet sind;
Anbringen von zwei Schwimmern (10, 20; 10’, 20’) an beiden Seiten des Rumpfs (1), wobei ein unterer Teil jedes Schwimmers an der Stelle des Bilgenkiels integriert wird;
Einbauen der Vielzahl von Stromerzeugungsmodulen (50; 50’) in einem oberen Teil der beiden Schwimmer (10, 20; 10’, 20’), so dass jeder der beiden Schwimmer in mehrere im Wesentlichen gleich große Abteile (50, 60; 50’) entlang einer Längsrichtung unterteilt ist und so dass angrenzende Stromerzeugungsmodule (50; 50’) an ihrer angrenzenden Wand gespiegelt sind, und die Auslässe (55) angrenzender

Stromerzeugungsmodule in einem Trichter aus Abgasrohren zusammengeführt werden;
Bereitstellen einer Regasifizierungseinheit (40) zum Erzeugen von Brenngas aus LNG, Verbinden der Regasifizierungseinheit mit einem Einlass zu den LNG-Tanks und mit einem Auslass zum Zuführen von erzeugtem Brenngas zu der Vielzahl von Stromerzeugungsmodulen (50; 50').

13. Verfahren nach Anspruch 12, ferner umfassend, Bereitstellen jedes der Stromerzeugungsmodule (50') mit mindestens einer luftgekühlten Zelle (65') auf einer Oberseite, die ein Deck des Schwimmers bildet, und einem geschlossenen Frischwasser-Zirkulationskreislauf (68'), der zwischen dem Stromerzeugersatz und der mindestens einen luftgekühlten Zelle verläuft,

14. Verfahren nach Anspruch 13, ferner umfassend das Bereitstellen mindestens eines Lüfters (67) auf einer Oberseite jedes der Stromerzeugungsmodule (50; 50'), um einen erzwungenen Luftstrom zu erzeugen, der über die mindestens eine luftgekühlte Zelle (65') geleitet wird.

Revendications

1. Centrale électrique indépendante flottante, FIPP, (100 ; 200) comprenant un transporteur de gaz naturel liquéfié, GNL, de type Moss converti avec une coque (1) et une pluralité de réservoirs de stockage de GNL (30) agencés à l'intérieur de la coque, dans laquelle la centrale électrique indépendante flottante comprend :

- une unité de regazéification (40), reliée à l'aide d'une entrée à la pluralité de réservoirs de stockage de GNL (30), pour une regazéification de GNL stocké ;
- une pluralité de modules de production d'énergie (50 ; 50') comprenant des ensembles de générateurs d'énergie (51), et
étant pourvue d'une entrée reliée à une sortie de l'unité de regazéification (40) pour recevoir du gaz combustible et adaptée pour générer de l'électricité en utilisant le gaz combustible reçu ;
- un équipement de refroidissement (52 ; 52'; 52"), couplé à la pluralité de modules de production d'énergie (50 ; 50') et agencé pour refroidir la pluralité de modules de production d'énergie ; et
- un flotteur (10, 20 ; 10', 20') de part et d'autre de la coque (1),

caractérisée en ce que
chaque flotteur (10, 20 ; 10'; 20') est subdivisé en une pluralité de compartiments (50, 60 ; 50') de taille sensiblement égale le long d'une direction longitudinale du flotteur (10, 20 ; 10', 20') montés de manière fixe de part et d'autre de la coque (1) et agencées pour recevoir la pluralité de modules de générateur d'énergie (50 ; 50'), chaque compartiment contenant un module de générateur d'énergie (51), dans laquelle chacun de la pluralité de modules de générateur d'énergie (50 ; 50') forme l'un de la pluralité de compartiments (50, 60 ; 50'), et dans laquelle chacun des compartiments comprenant un ensemble de générateurs de d'énergie (51) est pourvu d'un tuyau d'échappement (55) et d'une entrée d'air (54) dans un côté supérieur, dans laquelle les compartiments sont agencés de telle sorte que des modules de production d'énergie voisins (50 ; 50') sont en image miroir autour de leur paroi voisine, le tuyau d'échappement (55) et l'entrée d'air (54) étant situées sur des côtés longitudinalement opposés du compartiment et les tuyaux d'échappement (55) de compartiments voisins étant combinés en un entonnoir de tuyaux d'échappement.

2. Centrale électrique indépendante flottante (100 ; 200) selon la revendication 1, comprenant au moins dix modules de générateur d'énergie (50 ; 50') et dans laquelle chaque flotteur (10, 20 ; 10', 20') est subdivisée en au moins cinq compartiments le long de la longueur du flotteur (10, 20 ; 10', 20').

3. Centrale électrique indépendante flottant (100 ; 200) selon l'une quelconque des revendications précédentes, dans laquelle la centrale électrique flottante indépendante comprend un générateur de turbine à vapeur et/ou un ou plusieurs générateurs diesel pour supporter la navigation de telle sorte que la centrale électrique indépendante flottante est automotrice pendant un déploiement.

4. Centrale électrique indépendante flottante (200) selon l'une quelconque des revendications précédentes, dans laquelle l'équipement de refroidissement (52") comprend une boucle de circulation d'eau douce fermée (68') pour chaque ensemble de générateurs d'énergie (51) et un échangeur de chaleur (69') installé au-dessus de chacun des flotteurs (10', 20') et/ou sur le pont principal en contact direct avec l'environnement extérieur, avec chacune des boucles de circulation d'eau douce fermée s'étendant entre l'un des ensembles de production d'énergie et l'échangeur de chaleur, l'échangeur de chaleur étant un échangeur de chaleur à écoulement d'air.

5. Centrale électrique indépendante flottante (200) selon la revendication 4, dans laquelle l'échangeur de chaleur à écoulement d'air (69') comprend une pluralité de cellules refroidies par air (65').

6. Centrale électrique indépendante flottante (200) selon la revendication 5, dans laquelle l'échangeur de chaleur à écoulement d'air (69') comprend en outre au moins un ventilateur (67) pour fournir un écoulement d'air forcé en tant que milieu de refroidissement local.

7. Centrale électrique indépendante flottante (200) selon la revendication 5 ou 6, dans laquelle chaque ensemble de générateurs d'énergie (51) est pourvu d'au moins une cellule refroidie par air dédiée (65').

8. Centrale électrique flottante indépendante (100) selon l'une quelconque des revendications 1 à 3, dans laquelle l'équipement de refroidissement (52') comprend une boucle de circulation d'eau douce fermée (68) pour chaque ensemble de générateurs d'énergie (51) et un échangeur de chaleur (65) installé dans la coque (1) ou l'un des flotteurs (10 ;20), chacune des boucles d'eau douce fermée (68) s'étendant entre un certain des ensembles de générateurs d'énergie (51) et l'échangeur de chaleur pour échanger de la chaleur avec celui-ci et dans laquelle l'échangeur de chaleur (65) est relié à une entrée (61) à au moins un réservoir de stockage d'eau de mer froide (61) pour recevoir de l'eau de mer en tant que milieu de refroidissement dans l'échangeur de chaleur, et à une sortie (64) s'étendant à travers la coque (1) pour évacuer l'eau de mer chauffée en pleine mer, dans laquelle le réservoir de stockage d'eau de mer froide (61) est situé dans un ou plusieurs compartiments (60) des flotteurs (10, 20) ne contenant pas d'ensemble de générateurs d'énergie et le réservoir de stockage d'eau de mer froide est pourvu d'une liaison à un système de levage d'eau de mer (62).

9. Centrale électrique flottante indépendante (100 ; 200) selon l'une quelconque des revendications 4 à 8, dans laquelle chacune des boucles de circulation d'eau douce fermées (68, 68') comprend une pompe (51c) pour pomper l'eau douce à travers la boucle de circulation d'eau douce fermée, laquelle pompe est entraînée par l'ensemble de générateurs d'énergie (51).

10. Centrale électrique indépendante flottante (100 ; 200) selon l'une quelconque des revendications 4 à 9, dans laquelle l'unité de regazéification (40) est pourvue d'une boucle de circulation d'eau douce fermée qui s'étend entre l'unité de regazéification et l'échangeur de chaleur.

11. Centrale électrique indépendante flottante (100 ; 200) selon l'une quelconque des revendications précédentes, dans laquelle la centrale électrique indépendante flottante comprend un portique d'exportation (59) destiné à être relié à un réseau terrestre pour lui fournir l'électricité générée.

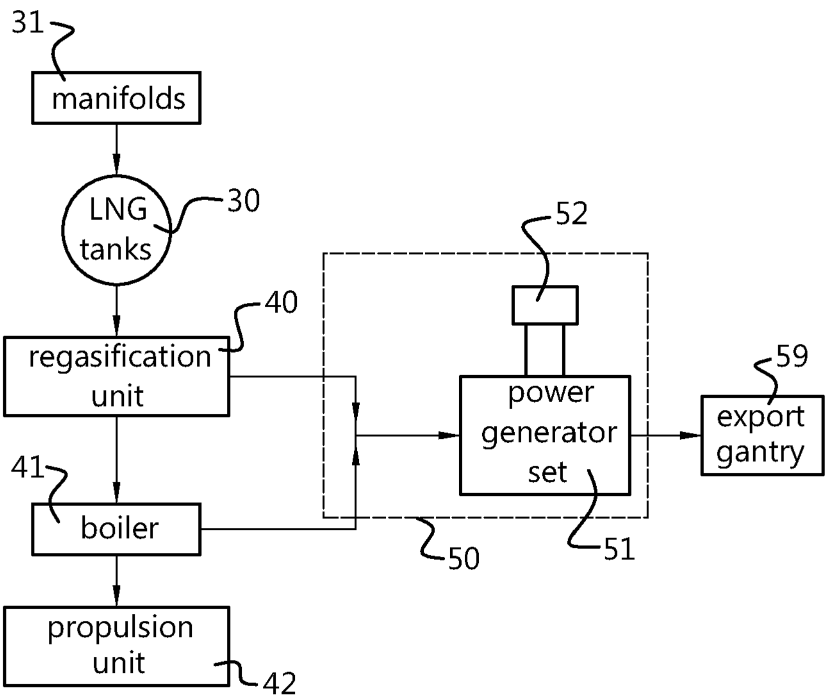
12. Procédé de transformation d'un transporteur de GNL de type Moss en une centrale électrique flottante indépendante (100 ; 200), comprenant les étapes consistant à

retirer les quilles antiroulis existantes de part et d'autre de la coque (1) ;
fournir une pluralité de modules de générateur d'énergie (50 ; 50') comprenant chacun un ensemble de générateurs d'énergie (51), une entrée d'air (54) et une sortie (55), dans laquelle l'entrée d'air et la sortie sont situées sur des côtés opposés du module (50 ; 50') ;
fixer deux flotteurs (10, 20 ; 10', 20') de part et d'autre de la coque (1), en intégrant une partie inférieure de chaque flotteur au niveau de l'emplacement de la quille antiroulis ;
assembler la pluralité de modules de générateur d'énergie (50 ; 50') dans une partie supérieure des deux flotteurs (10, 20 ; 10', 20'), de telle sorte que chacun des deux flotteurs soit subdivisé en une pluralité de compartiments de taille sensiblement égale (50, 60 ; 50') le long d'une direction longitudinale, et de telle sorte que des modules de générateur d'énergie voisins (50 ; 50') soient en image miroir autour de leur paroi voisine, et combiner les sorties (55) de modules de générateur d'énergie voisins dans un entonnoir de tuyaux d'échappement ;
fournir une unité de regazéification (40) pour créer du gaz combustible à partir de GNL, relier ladite unité de regazéification avec une entrée vers les réservoirs de GNL et avec une sortie pour fournir le gaz combustible créé à la pluralité de modules de générateur d'énergie (50 ; 50').

13. Procédé selon la revendication 12, comprenant en outre la fourniture à chacun des modules de générateur d'énergie (50') d'au moins une cellule refroidie par air (65') sur un côté supérieur formant un pont du flotteur et d'une boucle de circulation d'eau douce fermée (68') s'étendant entre l'ensemble de générateurs d'énergie et ladite au moins une cellule refroidie par air.

14. Procédé selon la revendication 13, comprenant en outre la fourniture d'au moins un ventilateur (67) sur un côté supérieur de chacun des modules de générateur d'énergie (50 ; 50') pour créer un écoulement d'air forcé qui est dirigé au-dessus de la au moins une cellule refroidie par air (65').

Fig. 1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manifolds
LNG tanks
30
52
40
regasification unit
41
boiler
power generator set
59
export gantry
50
51
propulsion unit
42

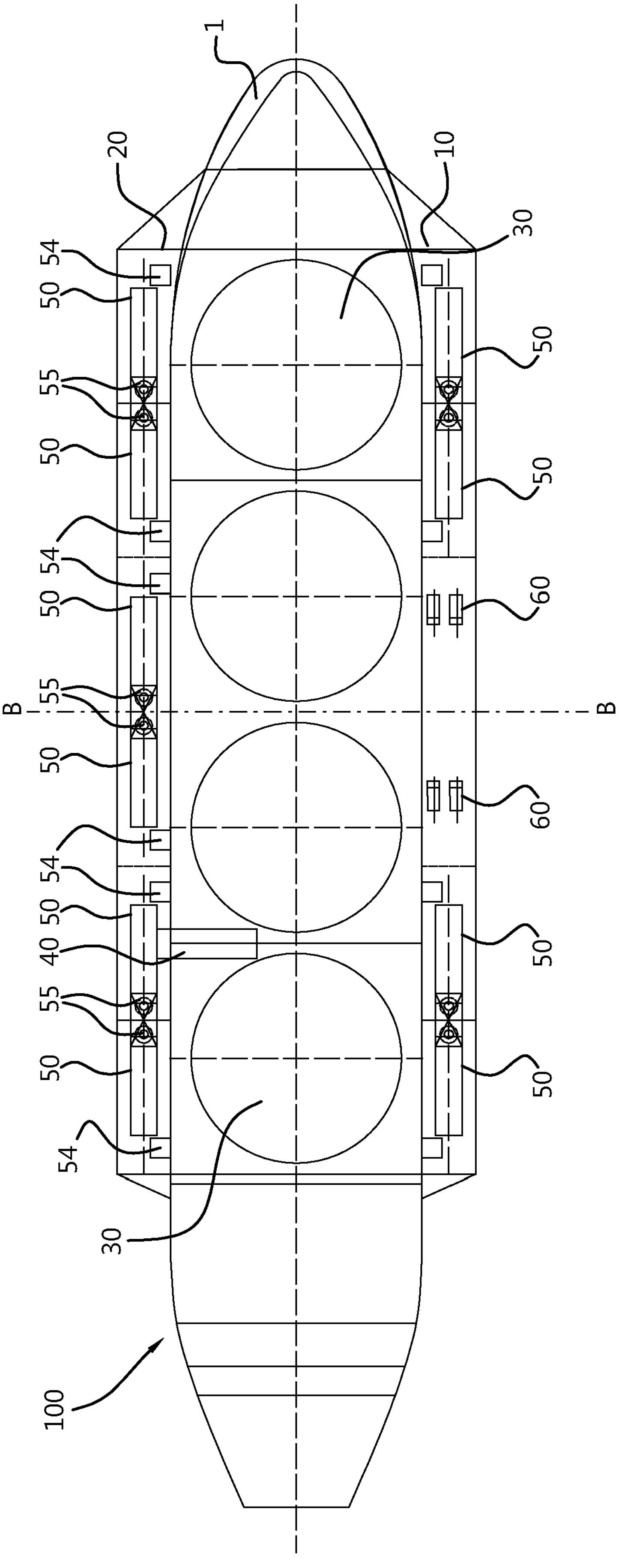


Fig. 2A

Fig. 2B

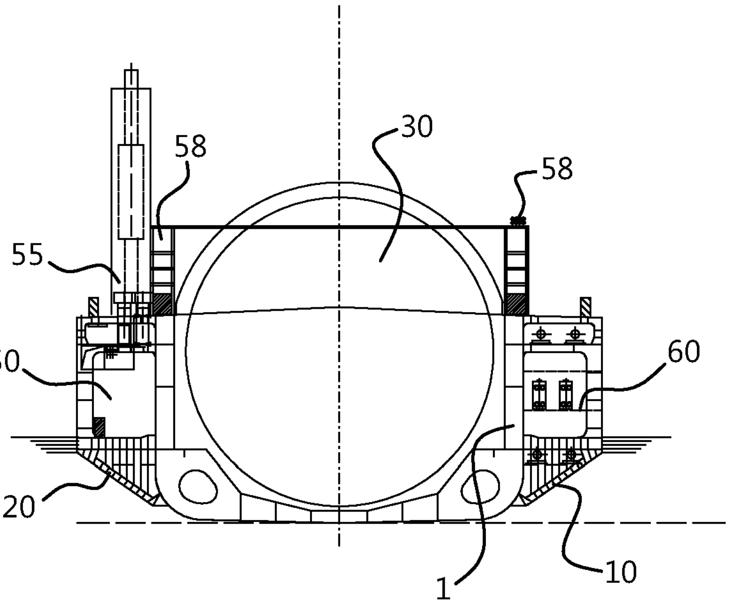
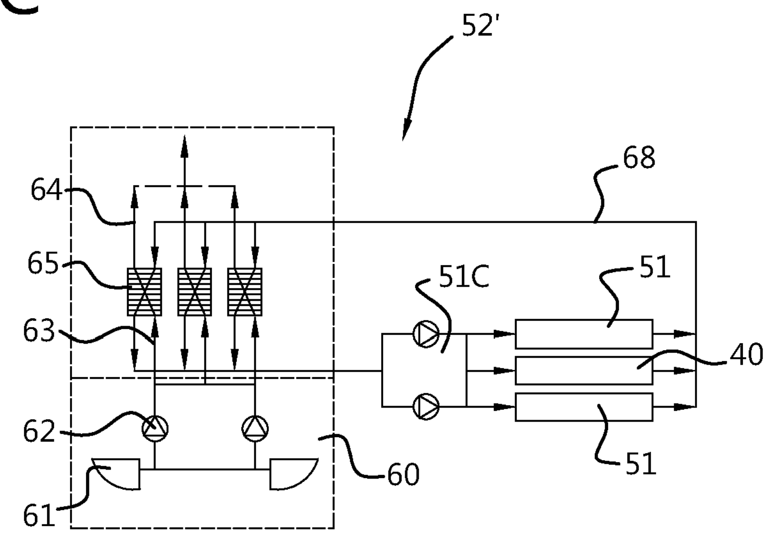


Fig. 2C



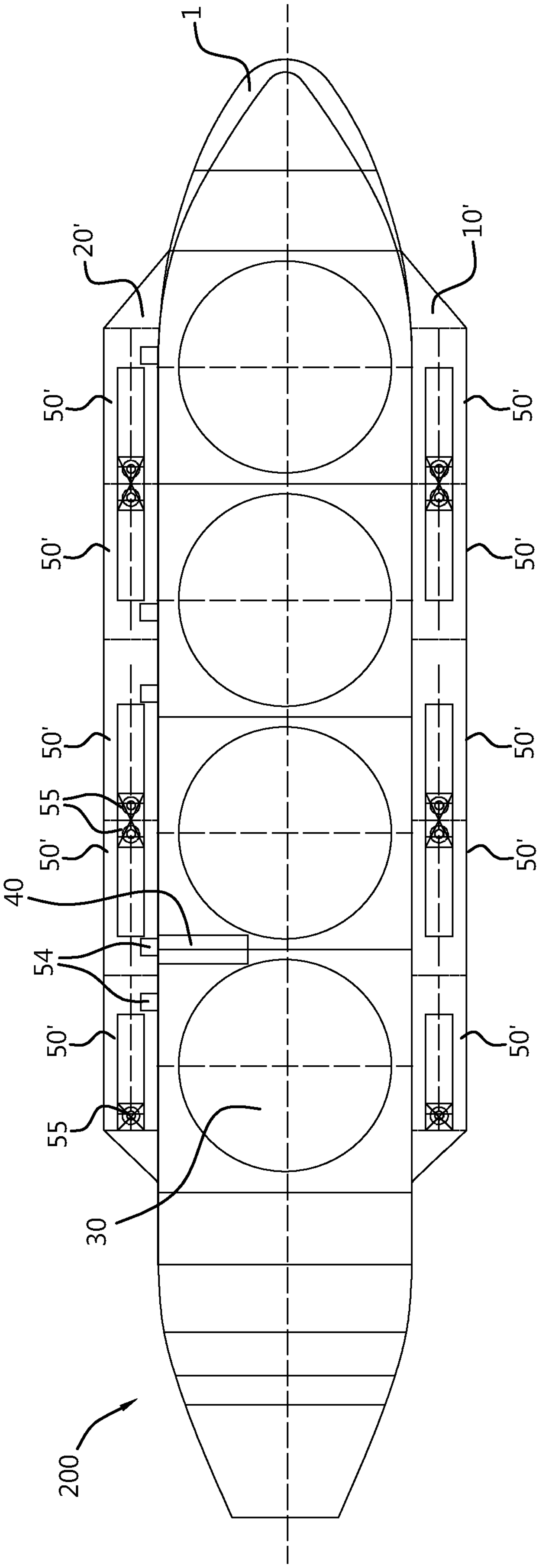


Fig. 3A

Fig. 3B

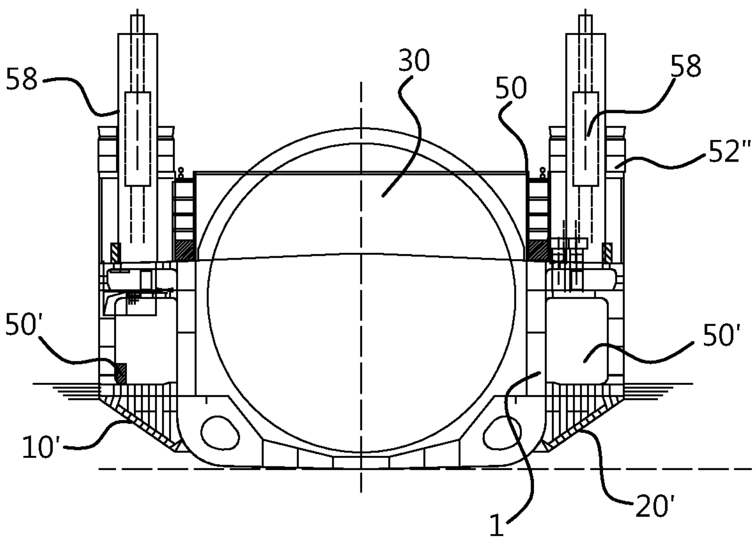
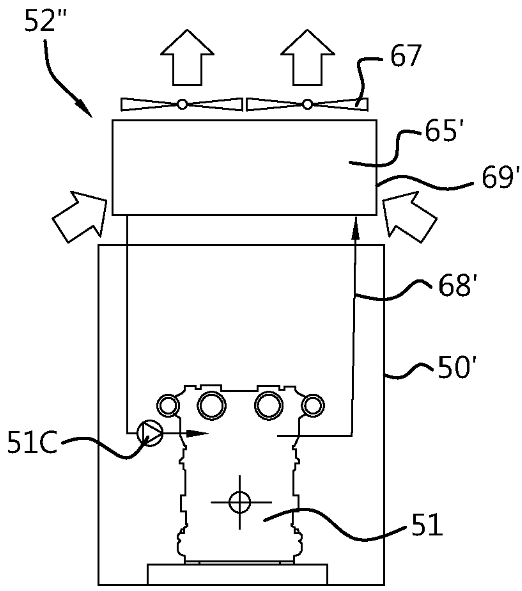


Fig. 3C



REFERENCES CITED IN THE DESCRIPTION

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