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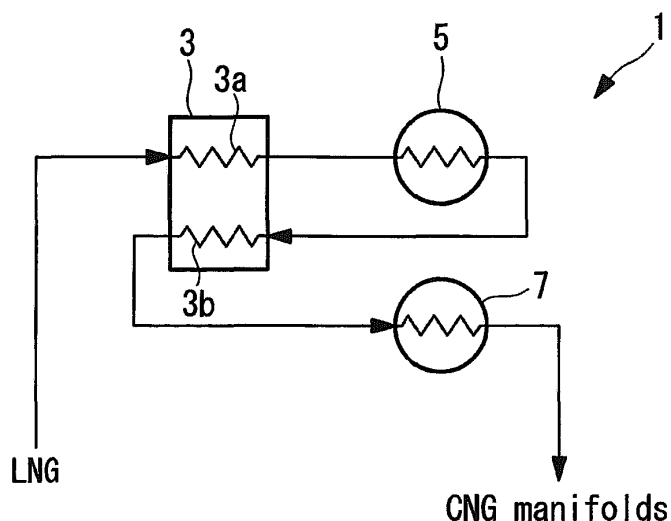
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(54) **LIQUEFIED GAS REGASIFICATION DEVICE AND METHOD FOR MANUFACTURING REGASIFIED GAS**

(57) A liquefied gas regasification plant which can regasify liquefied gas by a shell-and-tube-type heat exchanger with a simple configuration by preheating the liquefied gas with a simple configuration is provided. The liquefied gas regasification plant includes a preheating heat exchanger (3) that preheats LNG flowing through a preheated flow (3a) by gasification gas flowing through a preheating flow (3b), and a first shell-and-tube-type

heat exchanger (5) that regasifies the LNG preheated in the preheating heat exchanger (3) by seawater or fresh water, the gas regasified in the first shell-and-tube-type heat exchanger (5) being guided to the preheating flow (3b), the liquefied gas regasification plant further including a second shell-and-tube-type heat exchanger (7) that regasifies the LNG condensed through the preheating flow (3b) by seawater or fresh water.

FIG. 1



Description

{Technical Field}

[0001] The present invention relates to a regasification plant which regasifies liquefied gas such as LNG, and a regasification method.

{Background Art}

[0002] Regasification plants are used to regasify LNG (liquefied natural gas) stored in a storage tank so as to supply the LNG to a demand destination. A regasification plant with an open-rack-type vaporizer (ORV) system is often used as the regasification plants (e.g., see PTL 1 below). In the ORV system, seawater, which is used as a heat source, is sprayed on the outer surfaces of a plurality of heat transfer tubes arranged in a panel-like manner in the atmosphere, and LNG inside the heat transfer tubes is thereby gasified. However, the ORV system disadvantageously requires much seawater, and needs to ensure a heat transfer area where seawater flows, thereby making it difficult to reduce the size of the regasification plant. Thus, it is difficult to install the ORV system in an offshore floating body such as an FSRU (floating storage and regasification unit) and an FPSO (floating production, storage and offloading), or a marine vessel such as an LNG carrier.

{Citation List}

{Patent Literature}

{PTL 1}

[0003] Japanese Unexamined Patent Application, Publication No. Hei9-14586

{Summary of Invention}

{Technical Problem}

[0004] Meanwhile, in some cases, a regasification plant with an STV (shell-and-tube-type vaporizer) system in which a shell-and-tube-type heat exchanger 100 as shown in Fig. 3 is used is installed in a floating body or a marine vessel as a regasification plant having a smaller size than that with the ORV system.

[0005] As a typical structure, the shell-and-tube-type heat exchanger 100 includes an upstream header 103 into which LNG flows, a plurality of heat transfer tubes 107 connected to the upstream header 103 in parallel with each other, and a downstream header 105 into which the LNG passing through the heat transfer tubes 107 flows as shown in the drawing. Each of the heat transfer tubes 107 penetrates through a water chamber 109 defined by a cylindrical body (shell). As a main feature of the heat exchanger, the water chamber 109 is divided

into an upstream-side water chamber 109a and a downstream-side water chamber 109b at a substantially longitudinal center portion. Seawater (S.W.) is guided into the upstream-side water chamber 109a from the most upstream side (the left side in the drawing) of an LNG flow. The seawater is discharged from the downstream side of the upstream-side water chamber 109a (see a dashed line in the drawing). That is, in the upstream-side water chamber 109a, the seawater forms a parallel flow with respect to the LNG flow. Meanwhile, seawater is guided into the downstream-side water chamber 109b from the most downstream side (the right side in the drawing) of the LNG flow. The seawater is discharged from the upstream side of the downstream-side water chamber 109b (see a dashed line in the drawing). That is, in the downstream-side water chamber 109b, the seawater forms a counter flow with respect to the LNG flow. As described above, the seawater having a high temperature is used in a parallel flow on the most upstream side where the temperature of the LNG is lowest, thereby avoiding freezing on the outer surfaces of the heat transfer tubes. The seawater is used in a counter flow on the most downstream side of the LNG flow, thereby ensuring an LNG removal temperature.

[0006] However, the shell-and-tube-type heat exchanger 100 in the above form has a more complicated structure than a shell-and-tube-type heat exchanger 100' in which only one water chamber is provided as shown in Fig. 4. Thus, the shell-and-tube-type heat exchanger 100 is disadvantageously high in cost and difficult to design.

[0007] As a configuration for employing the shell-and-tube-type heat exchanger 100' in which only one water chamber is provided as shown in Fig. 4, a method of preheating LNG in advance by another means may be used. For example, an IFV (intermediate-fluid-type vaporizer) system has been proposed. The method called IFV system includes a preheating step of indirectly preheating LNG using a primary heating source such as seawater via a non-freezing heat medium such as propane, in the upstream side of the shell-and-tube-type heat exchanger. In the preheating step, the temperature of the LNG at an inlet of the shell-and-tube-type heat exchanger can be increased to a temperature at which the LNG hardly freezes. The inexpensive shell-and-tube-type heat exchanger in which only one water chamber is provided can be thereby employed. However, there are disadvantages that the cost of the preheating step is high, handling and maintenance are troublesome because the non-freezing liquid such as propane is used, and an apparatus configuration also becomes complicated.

[0008] The present invention has been made in view of such circumstances, and an object thereof is to provide a liquefied gas regasification plant which can regasify liquefied gas by a heat exchanger with a simple configuration by preheating the liquefied gas with a simple configuration, and a regasification method.

{Solution to Problem}

[0009] To achieve the above object, a liquefied gas regasification plant, and a regasification method according to the present invention employ the following solutions.

[0010] That is, a liquefied gas regasification plant according to a first aspect of the present invention includes a preheating heat exchanger that preheats liquefied gas flowing through a preheated flow by a preheating fluid flowing through a preheating flow, and a first heat exchanger that regasifies the liquefied gas preheated in the preheating heat exchanger by seawater or fresh water, the gas regasified in the first heat exchanger being guided to the preheating flow, the liquefied gas regasification plant further including a second heat exchanger that regasifies the liquefied gas condensed through the preheating flow by seawater or fresh water.

[0011] In the preheating heat exchanger, the gas regasified in the first heat exchanger is guided to the preheating flow so as to preheat the liquefied gas. As described above, the liquefied gas is preheated by using the own heat of the regasified gas, and the preheating is performed using the single fluid flowing through the continuous path. Thus, it is not necessary to use another heat medium such as propane in a preheating step. The preheating step can be achieved with a simple configuration.

[0012] The liquefied gas preheated in the preheating heat exchanger is also guided to the first heat exchanger. The temperature of the liquefied gas flowing into the first heat exchanger is thereby increased. Thus, there is less possibility that a heat medium such as seawater or fresh water freezes around a heat transfer tube, or heat exchange performance is deteriorated due to ice generated on a heat exchange surface. Accordingly, when a shell-and-tube-type heat exchanger is used as the first heat exchanger, a shell-and-tube-type heat exchanger having a simple structure in which only one water chamber is provided can be employed.

[0013] The liquefied gas condensed through the preheating flow of the preheating heat exchanger is also guided to the second heat exchanger. The temperature of the liquefied gas passing through the preheating flow is reduced by giving heat to the liquefied gas flowing through the preheated flow while flowing through the preheating flow. However, since the gasification gas having a higher temperature than the liquefied gas flowing through the preheated flow is guided to the preheating flow, the liquefied gas cooled and condensed through the preheating flow can be prevented from being cooled to a temperature equal to that of the liquefied gas flowing into the preheating heat exchanger. The temperature of the liquefied gas flowing into the second heat exchanger can be thereby increased higher than the temperature of the liquefied gas. Thus, there is less possibility that a heat medium such as seawater or fresh water freezes around a heat transfer tube, or heat exchange perform-

ance is deteriorated due to ice generated on a heat exchange surface in a similar manner to the first heat exchanger described above. Accordingly, when a shell-and-tube-type heat exchanger is used as the first heat exchanger, a shell-and-tube-type heat exchanger, for example, having a simple structure in which only one water chamber is provided can be employed.

[0014] While the fluid flowing out of the preheated flow and the preheating flow of the preheating heat exchanger is referred to as "liquefied gas", the liquefied gas means not only a fluid in liquid phase, but also a fluid already gasified on an outlet side of the heat exchanger or a two-phase fluid having a predetermined wetness fraction.

[0015] Also, the shell-and-tube-type heat exchanger is preferably used as the first heat exchanger and/or the second heat exchanger. However, the present invention is not particularly limited thereto, and, for example, a heat exchanger with an ORV system described above may be employed.

[0016] Also, when the liquefied gas is heated using a secondary closed loop of fresh water or the like as the heating medium in the first heat exchanger and the second heat exchanger, a non-freezing liquid may be added so as to further prevent the heat medium water from freezing.

[0017] Moreover, in the liquefied gas regasification plant according to the first aspect, a cooling flow that precools or condenses boil-off gas may be provided in the preheating heat exchanger.

[0018] A facility for reliquefying boil-off gas generated from a tank that stores liquefied gas or the like may be provided in some cases. In this case, the cooling flow that precools or condenses the boil-off gas is provided in the preheating heat exchanger, so that the liquefied gas can be more effectively preheated in conjunction with the cooling of the boil-off gas.

[0019] Particularly, a plate-type heat exchanger easily provided with a multi-flow configuration in which a plurality of independent flows is formed is preferably used as the preheating heat exchanger as described below.

[0020] Moreover, in the liquefied gas regasification plant according to the first aspect, a plate-type heat exchanger may be used as the preheating heat exchanger.

[0021] When the plate-type heat exchanger is used as the preheating heat exchanger, the preheating heat exchanger can be made compact.

[0022] To be more specific, the plate-type heat exchanger may be a plate-fin-type or plate-coil-type heat exchanger. The plate-type heat exchanger is preferably made of stainless steel or aluminum alloy.

[0023] Also, a regasification method according to a second aspect of the present invention includes a preheating step of preheating liquefied gas flowing through a preheated flow by a preheating fluid flowing through a preheating flow by using a preheating heat exchanger, and a first regasification step of regasifying the liquefied gas preheated in the preheating step by seawater or fresh water by using a first heat exchanger, the gas regasified

in the first heat exchanger being guided to the preheating flow, the method further including a second regasification step of regasifying the liquefied gas condensed through the preheating flow by a heat medium such as seawater or fresh water by using a second heat exchanger.

[0024] In the preheating step by the preheating heat exchanger, the gas regasified in the first heat exchanger is guided to the preheating flow so as to preheat the liquefied gas. As described above, the liquefied gas is preheated by using the own heat of the regasified gas, and the preheating is performed using the single fluid flowing through the continuous path. Thus, it is not necessary to use another heat medium such as propane in the preheating step. The preheating step can be achieved with a simple configuration.

[0025] Also, in the first regasification step by the first heat exchanger, the liquefied gas preheated in the preheating heat exchanger is guided. The temperature of the liquefied gas flowing into the first heat exchanger is thereby increased. Thus, there is less possibility that seawater or fresh water freezes around a heat transfer tube. Accordingly, when a shell-and-tube-type heat exchanger is used as the first heat exchanger, a shell-and-tube-type heat exchanger having a simple structure in which only one water chamber is provided can be employed.

[0026] Also, in the second regasification step by the second heat exchanger, the liquefied gas condensed through the preheating flow of the preheating heat exchanger is guided. The temperature of the liquefied gas passing through the preheating flow is reduced by giving heat to the liquefied gas flowing through the preheated flow while flowing through the preheating flow. However, since the gasification gas having a higher temperature than the liquefied gas flowing through the preheated flow is guided to the preheating flow, the liquefied gas cooled and condensed through the preheating flow is not cooled to a temperature equal to that of the liquefied gas flowing into the preheating heat exchanger. The temperature of the liquefied gas flowing into the second heat exchanger can be thereby increased higher than the temperature of the liquefied gas. Thus, there is less possibility that seawater or fresh water freezes around a heat transfer tube. Accordingly, when a shell-and-tube-type heat exchanger is used as the second heat exchanger, a shell-and-tube-type heat exchanger having a simple structure in which only one water chamber is provided can be employed.

[0027] While the fluid flowing out of the preheated flow and the preheating flow of the preheating heat exchanger is referred to as "liquefied gas", the liquefied gas means not only a fluid in liquid phase, but also, in particular, a fluid gasified at an outlet of the heat exchanger or a two-phase fluid having a predetermined wetness fraction.

[0028] Also, the shell-and-tube-type heat exchanger is preferably used as the first heat exchanger and/or the second heat exchanger. However, the present invention is not particularly limited thereto, and, for example, a heat exchanger with an ORV system described above may be employed.

[0029] Also, when a secondary closed loop of fresh water or the like is used as the heating medium in the first heat exchanger and the second heat exchanger, a non-freezing liquid may be added.

{Advantageous Effects of Invention}

[0030] In the preheating heat exchanger, the liquefied gas is preheated by using the own heat of the regasified gas in the first heat exchanger, and the preheating is performed using the single fluid flowing through the continuous path. Thus, it is not necessary to use another heat medium such as propane in the preheating step. The preheating can be performed with a simple configuration.

[0031] Also, since the liquefied gas is preheated, there is less possibility that freezing occurs around the heat transfer tube of the first heat exchanger. Accordingly, the heat exchanger with a simple configuration can be employed.

[0032] Also, since the temperature of the liquefied gas flowing into the second heat exchanger can be increased higher than the temperature of the liquefied gas, there is less possibility that seawater or fresh water freezes around the heat transfer tube. Accordingly, the heat exchanger with a simple configuration can be employed.

{Brief Description of Drawings}

[0033]

{Fig. 1}

Fig. 1 is a view illustrating a liquefied gas regasification plant according to a first embodiment of the present invention.

{Fig. 2}

Fig. 2 is a view illustrating a modification of Fig. 1.

{Fig. 3}

Fig. 3 is a longitudinal sectional view illustrating a shell-and-tube-type heat exchanger in which two water chambers are provided.

{Fig. 4}

Fig. 4 is a longitudinal sectional view illustrating a shell-and-tube-type heat exchanger in which only one water chamber is provided.

{Description of Embodiments}

[0034] In the following, an embodiment according to the present invention will be described by reference to the drawings.

{First Embodiment}

[0035] In the following, a first embodiment of the present invention will be described.

[0036] An LNG storage facility (liquefied gas storage facility) is provided in an offshore floating body such as

an FSRU (floating storage and regasification unit) and an FPSO (floating production, storage and offloading), or a marine vessel such as an LNG carrier. Fig. 1 shows a regasification plant 1 that regasifies LNG (liquefied gas) guided from an LNG storage tank (liquefied gas storage tank) of the LNG storage facility so as to supply the LNG to a demand destination.

[0037] As shown in Fig. 1, the regasification plant 1 includes a preheating heat exchanger 3 that preheats the LNG, a first shell-and-tube-type heat exchanger (first heat exchanger) 5 that regasifies the liquefied gas preheated in the preheating heat exchanger 3 using seawater or fresh water, and a second shell-and-tube-type heat exchanger (second heat exchanger) 7 that regasifies the liquefied gas guided from the preheating heat exchanger 3 using seawater or fresh water.

[0038] A preheated flow 3a to which the LNG fed from the LNG storage tank by a transfer pump is guided, and a preheating flow 3b to which gasification gas regasified in the first shell-and-tube-type heat exchanger 5 is guided are provided in the preheating heat exchanger 3.

[0039] The preheating heat exchanger 3 is a plate-type heat exchanger. To be more specific, the plate-type heat exchanger may be a plate-fin-type or plate-coil-type heat exchanger. The plate-type heat exchanger is preferably made of stainless steel or aluminum alloy.

[0040] In the preheating heat exchanger 3, the LNG passing through the preheated flow 3a is preheated, for example, from between -160°C and -155°C to between -100°C and -40°C . While the preheated fluid is simply referred to as LNG (which means liquefied gas), the LNG means not only a fluid in liquid phase, but also a two-phase fluid having a predetermined wetness fraction.

[0041] The gasification gas passing through the preheating flow 3b is heated by cooling the LNG passing through the preheated flow 3a. The gasification gas is cooled, for example, from about 10°C to between -100°C and -40°C . The temperature of the gasification gas flowing out of the preheating flow 3b can be set based on the design of the preheating heat exchanger 3. The temperature is preferably set equal to that of the LNG flowing out of the preheated flow 3a. Accordingly, the first shell-and-tube-type heat exchanger 5 and the second shell-and-tube-type heat exchanger 7 can be set to the same capacity.

[0042] The first shell-and-tube-type heat exchanger 5 is a shell-and-tube-type heat exchanger having a simple structure in which only one water chamber is provided as shown in Fig. 4. Seawater or fresh water is guided into the water chamber so as to form a counter flow with respect to an LNG flow. The preheated LNG is heated, for example, to about 10°C and regasified in the first shell-and-tube-type heat exchanger 5.

[0043] The gasification gas regasified in the first shell-and-tube-type heat exchanger 5 is guided to the preheating flow 3b of the preheating heat exchanger 3 as described above.

[0044] The second shell-and-tube-type heat exchang-

er 7 is a shell-and-tube-type heat exchanger having a simple structure in which only one water chamber is provided as shown in Fig. 4 in a similar manner to the first shell-and-tube-type heat exchanger 5. Seawater or fresh water is guided into the water chamber so as to form a counter flow with respect to an LNG flow. The LNG cooled and condensed in the preheating heat exchanger 3 is heated, for example, to about 10°C and regasified in the second shell-and-tube-type heat exchanger 7. While the fluid cooled in the preheating heat exchanger 3 is simply referred to as LNG (which means liquefied gas), the LNG means not only a fluid in liquid phase, but also a fluid in gas phase, or a two-phase fluid having a predetermined wetness fraction.

[0045] The gasification gas regasified in the second shell-and-tube-type heat exchanger 7 is guided to a CNG (compressed natural gas) manifold, and thereafter supplied to a demand destination.

[0046] The aforementioned regasification plant 1 is used as described below so as to produce the regasified gas.

[0047] The LNG fed from the LNG storage tank by the transfer pump is guided to the preheated flow 3a of the preheating heat exchanger 3, where the LNG is preheated, for example, to between -100°C and -40°C (a preheating step).

[0048] The preheated LNG is guided to the first shell-and-tube-type heat exchanger 5, where the preheated LNG is heated, for example, to about 10°C and regasified using seawater or fresh water (a first regasification step).

[0049] The regasified gasification gas is guided to the preheating flow 3b of the preheating heat exchanger 3, where the regasified gasification gas is cooled, for example, to between -100°C and -40°C by cooling the LNG flowing through the preheated flow 3a.

[0050] The LNG flowing out of the preheating flow 3b is guided to the second shell-and-tube-type heat exchanger 7, where the LNG is heated, for example, to about 10°C and regasified using seawater or fresh water (a second regasification step).

[0051] The regasified gasification gas is guided to the CNG manifold, and supplied to the demand destination.

[0052] Following effects are obtained by the regasification plant 1 in the present embodiment.

[0053] In the preheating heat exchanger 3, the gas regasified in the first shell-and-tube-type heat exchanger 5 is guided to the preheating flow 3b so as to preheat the LNG flowing through the preheated flow 3a. As described above, the LNG is preheated by using the own heat of the regasified gas, and the preheating is performed using the single fluid flowing through the continuous path. Thus, it is not necessary to use another heat medium such as propane in the preheating step. The preheating step can be achieved with a simple configuration.

[0054] The LNG preheated in the preheating heat exchanger 3 is also guided to the first shell-and-tube-type heat exchanger 5. The temperature of the LNG flowing into the first shell-and-tube-type heat exchanger 5 is

thereby increased. Thus, seawater or fresh water does not possibly freeze around a heat transfer tube. Accordingly, the shell-and-tube-type heat exchanger having a simple structure in which only one water chamber is provided can be employed.

[0055] The LNG condensed through the preheating flow 3b of the preheating heat exchanger 3 is also guided to the second shell-and-tube-type heat exchanger 7. It is designed such that the temperature of the LNG passing through the preheating flow 3b is reduced by giving heat to the LNG flowing through the preheated flow 3a while flowing through the preheating flow 3b, but the LNG is not cooled to a temperature equal to that of the LNG flowing into the preheated flow 3a of the preheating heat exchanger 3. The temperature of the LNG flowing into the second shell-and-tube-type heat exchanger 7 can be thereby increased. Thus, seawater or fresh water does not possibly freeze around a heat transfer tube. Accordingly, the shell-and-tube-type heat exchanger having a simple structure in which only one water chamber is provided can be employed. Particularly, in the present embodiment, the temperature of the LNG flowing out of the preheated flow 3a and flowing into the first shell-and-tube-type heat exchanger 5, and the temperature of the LNG flowing out of the preheating flow 3b and flowing into the second shell-and-tube-type heat exchanger 7 are set equal to each other. Thus, the first shell-and-tube-type heat exchanger 5 and the second shell-and-tube-type heat exchanger 7 can be set to the same capacity. Consequently, the shell-and-tube-type heat exchangers can be prepared at low cost.

{Modification}

[0056] Fig. 2 shows a modification of the regasification plant according to the present embodiment.

[0057] In a regasification plant 1', the preheating heat exchanger 3 is provided with a cooling flow 3c that pre-cools or condenses boil-off gas (referred to as "BOG" below). The other components in the configuration are similar to those in Fig. 1, and thus assigned the same reference numerals to omit the description thereof.

[0058] The BOG is inevitably generated from the LNG storage tank or the like by heat input. The BOG is cooled and reliquefied in some cases. When the BOG is reliquefied, a reliquefaction facility is installed adjacent to the regasification plant 1'. In this case, the cooling flow 3c that pre-cools or condenses the BOG is provided in the preheating heat exchanger 3. The BOG pre-cooled or condensed through the cooling flow 3c is guided to a condenser or a condensate tank.

[0059] The LNG flowing through the preheated flow 3a can be more effectively preheated by the BOG in conjunction with the cooling of the BOG in the cooling flow 3c as described above.

[0060] Particularly, in the present embodiment, the plate-type heat exchanger is used as the preheating heat exchanger 3. The plate-type heat exchanger is easily pro-

vided with a multi-flow configuration in which a plurality of independent flows is formed, and is thus preferably used.

[0061] Although the LNG is described as an example of the liquefied gas in the aforementioned embodiment, the present invention is not limited thereto. For example, another liquefied gas such as LPG (liquefied petroleum gas) and LEG (liquefied ethylene) may be also employed.

[0062] Also, although the aforementioned embodiment is described using the first shell-and-tube-type heat exchanger and the second shell-and-tube-type heat exchanger, the present invention is not limited thereto. The effects by preheating may be also obtained with respect to another heat exchanger. For example, a heat exchanger with an ORV system may be employed.

{Reference Signs List}

[0063]

- 1, 1' Regasification plant
- 3 Preheating heat exchanger
- 3a Preheated flow
- 3b Preheating flow
- 3c Cooling flow
- 5 First shell-and-tube-type heat exchanger (first heat exchanger)
- 7 Second shell-and-tube-type heat exchanger (second heat exchanger)

Claims

1. A liquefied gas regasification plant comprising a preheating heat exchanger that preheats liquefied gas flowing through a preheated flow by a preheating fluid flowing through a preheating flow, and a first heat exchanger that regasifies the liquefied gas preheated in the preheating heat exchanger by seawater or fresh water, the gas regasified in the first heat exchanger being guided to the preheating flow, the liquefied gas regasification plant further comprising a second heat exchanger that regasifies the liquefied gas condensed through the preheating flow by seawater or fresh water.
2. The liquefied gas regasification plant according to claim 1, wherein a shell-and-tube-type heat exchanger is used as the first heat exchanger and/or the second heat exchanger.
3. The liquefied gas regasification plant according to claim 1 or 2, wherein a cooling flow that pre-cools or condenses boil-off gas is provided in the preheating heat exchanger.
4. The liquefied gas regasification plant according to

any one of claims 1 to 3, wherein a plate-type heat exchanger is used as the preheating heat exchanger.

5. A regasification method comprising
- a preheating step of preheating liquefied gas flowing through a preheated flow by a preheating fluid flowing through a preheating flow by using a preheating heat exchanger, and
- a first regasification step of regasifying the liquefied gas preheated in the preheating step by seawater or fresh water by using a first heat exchanger, the gas regasified in the first heat exchanger being guided to the preheating flow,
- the method further comprising a second regasification step of regasifying the liquefied gas condensed through the preheating flow by seawater or fresh water by using a second heat exchanger.

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FIG. 1

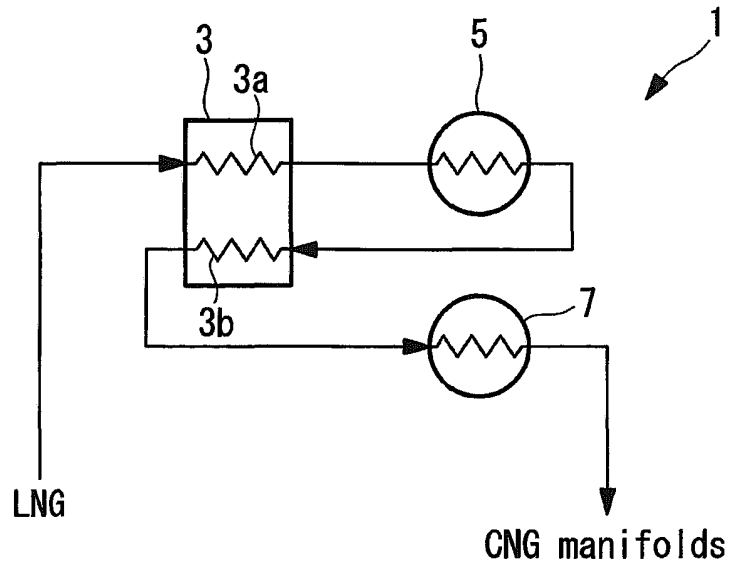


FIG. 2

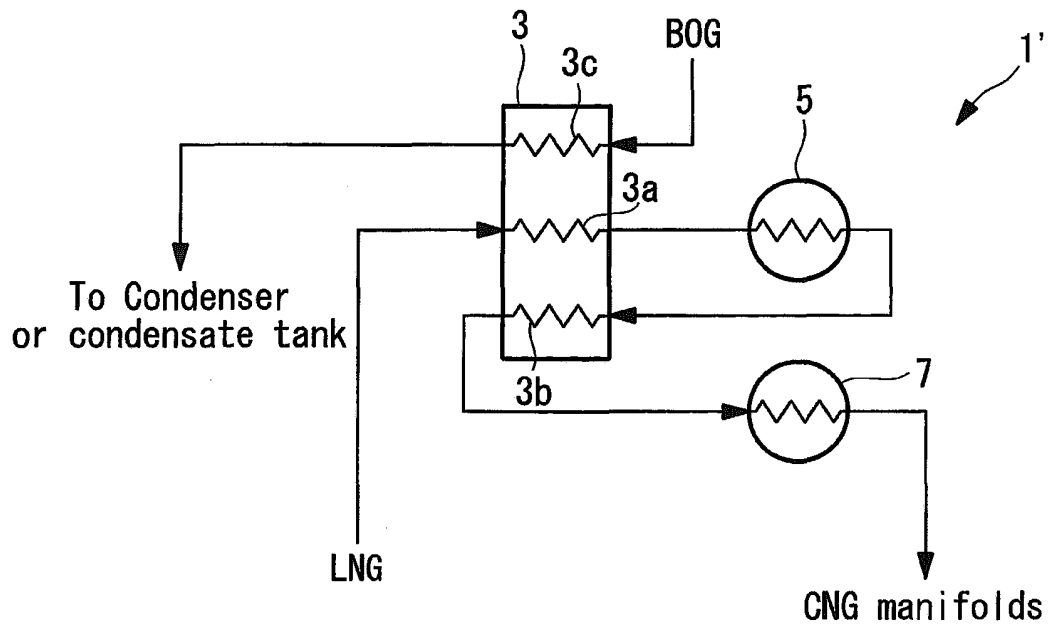


FIG. 3

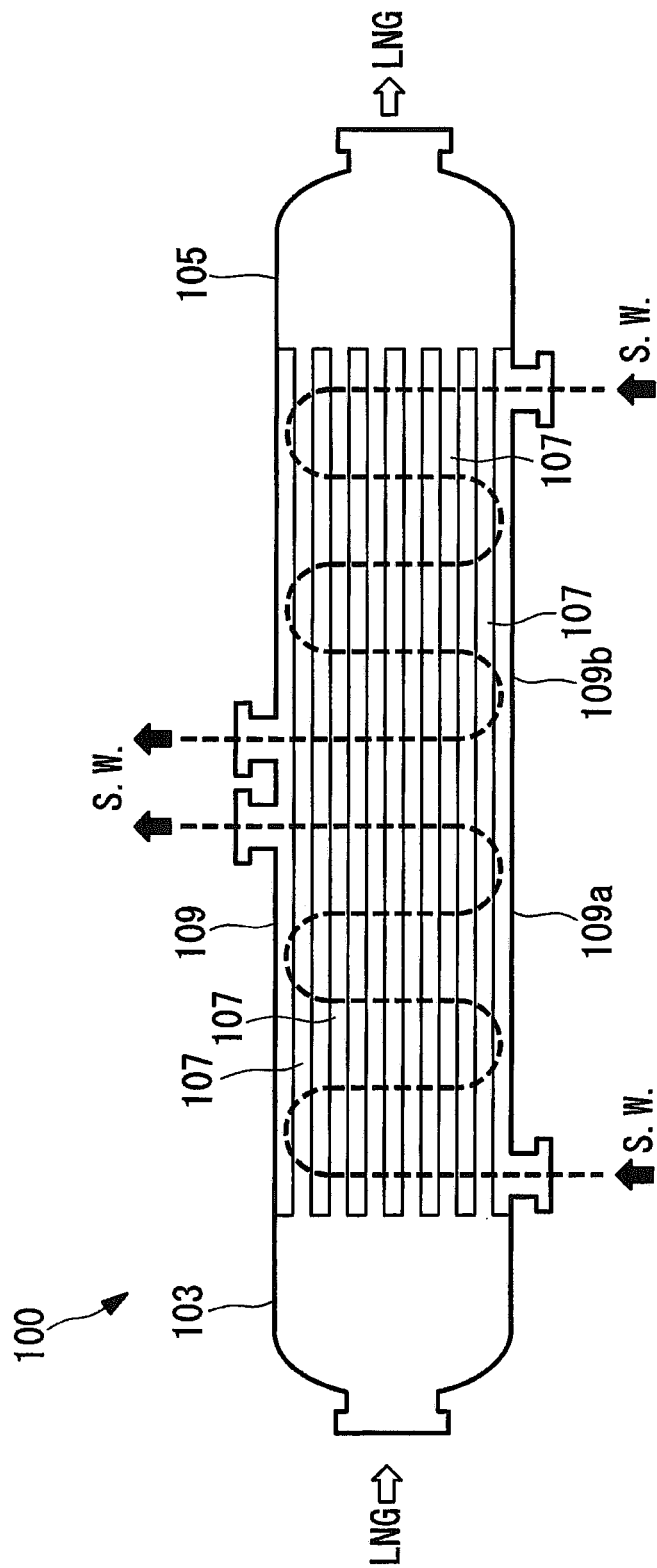
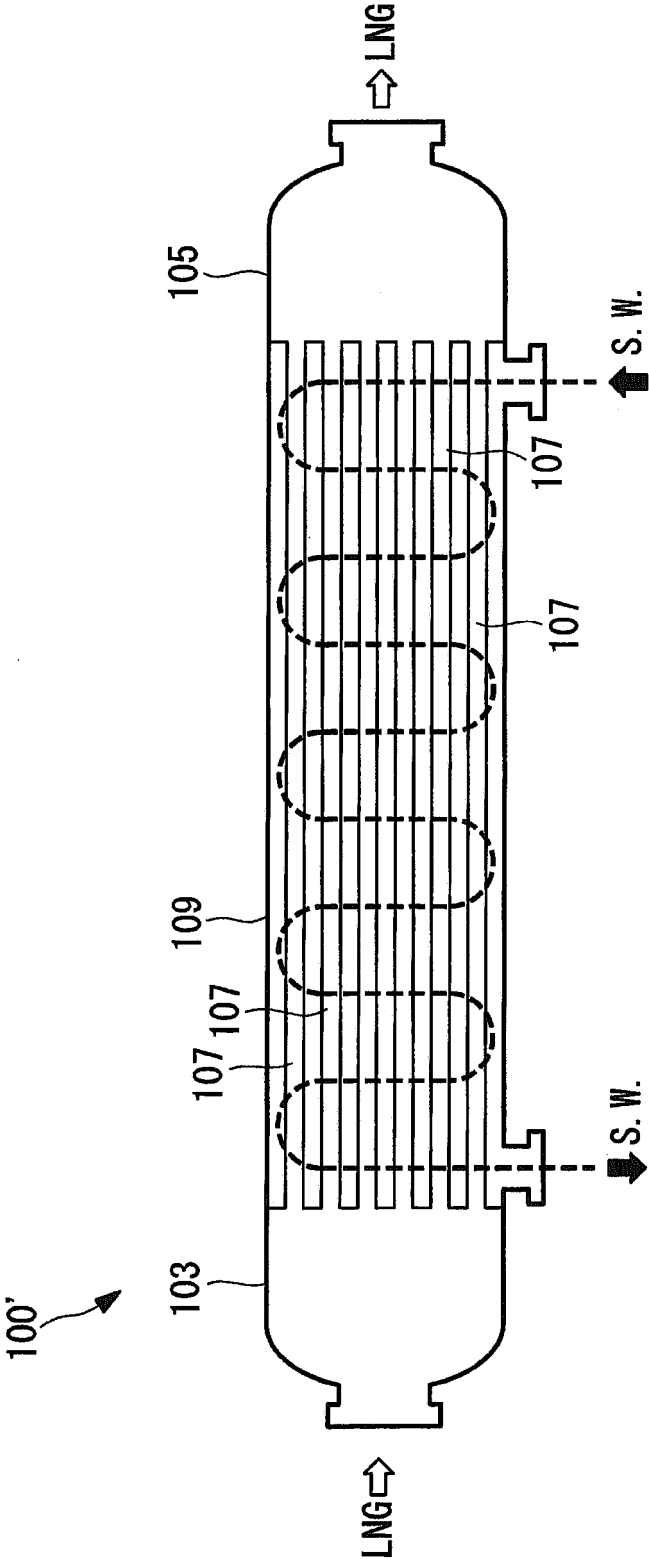


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/052518

A. CLASSIFICATION OF SUBJECT MATTER

F17C9/04 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F17C9/04

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 102008013084 A1 (MESSER GROUP GMBH), 24 September 2009 (24.09.2009), paragraphs [0016] to [0022]; fig. 1 & EP 2255137 A & WO 2009/109505 A1	1-5
Y	JP 2006-194440 A (Snecma), 27 July 2006 (27.07.2006), paragraph [0087]; fig. 1 & US 2006/0222523 A1 & EP 1672270 A2 & FR 2879720 A & KR 10-2006-0069346 A & ES 2314599 T	1-5
Y	JP 9-060799 A (Kobe Steel, Ltd.), 04 March 1997 (04.03.1997), paragraphs [0029] to [0032]; fig. 1 (Family: none)	3



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

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Japanese Patent Office

Authorized officer

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INTERNATIONAL SEARCH REPORT

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PCT/JP2012/052518

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 9-183989 A (Nippon Sanso Corp.), 15 July 1997 (15.07.1997), paragraphs [0024] to [0027]; fig. 1 (Family: none)	3
A	US 5373701 A (THE BOC GROUP, INC.), 20 December 1994 (20.12.1994), entire text; all drawings & JP 7-27297 A	1-5
A	FR 2582785 A1 (Philippe AGLIANY), 05 December 1986 (05.12.1986), entire text; all drawings (Family: none)	1-5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP HEI914586 B [0003]