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Published:
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(54) Title: SMALL SCALE LNG TERMINAL

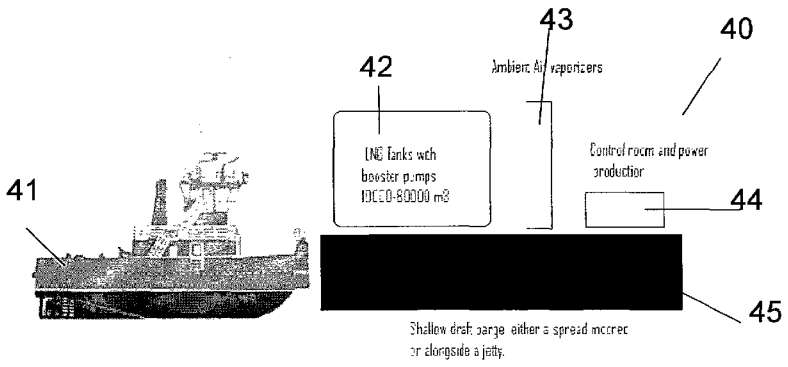


Fig. 4

(57) Abstract: A small scale LNG terminal comprising at least one LNG storage tank for storing LNG a hull structure comprised of a section of a former LNG carrier comprising a ship hull and providing support for the LNG storage tank, and a base structure providing structural integrity. The LNG terminal is manufactured by converting an LNG carrier by sub-dividing the hull and tank system to separate units and combine at least one unit with a base structure to form an integrated structure that will provide support of equipment, structural integrity and floatability.

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Small scale LNG terminal

The invention regards a small scale LNG terminal and a method for manufacturing an LNG terminal. More specific the invention regards re-use of an LNG carrier.

Natural gas is a widely used hydrocarbon gas in private homes as well as in the industry, and is also used for electric power generation, as well as being used as fuel for transportation purposes. Natural gas is often piped from the gas production source to the consumers, but over longer distances transporting the natural gas at sea in liquid form (LNG) proves economically favorable. The ability to transport the gas in liquid form also enables provision of gas to distant markets, and LNG ship transportation is an established industry, representing a growing portion of the total natural gas transport worldwide.

Natural gas is a clean fuel compared to e.g. coal, oil and diesel, meaning emissions to air can be greatly reduced when replacing the consumption of coal or oil/diesel with natural gas, where such replacement can be made. Natural gas is also in many markets favorably priced compared to oil and diesel. There are hence strong drivers for increasing the consumption of natural gas, where natural gas can be made available, as long as there also are economic benefits associated with the natural gas consumption compared to the consumption of coal and oil/diesel. It is hence important to make technical solutions available that can provide natural gas to markets at competitive prices.

Land based LNG import terminals have been constructed worldwide for regasification of LNG and provision of natural gas to consumers. Such land based LNG terminals are associated with significant capital investments. Hence, in the recent years, floating LNG import terminals have been built on basis of modified LNG carrier designs, which greatly reduces the capital investment related to the LNG import.

The object of the invention is to provide a small scale LNG terminal and a method for manufacturing such an LNG terminal which is cost effective.

The object of the invention is achieved by means of the patent claims.

A small scale LNG terminal comprises:
- at least one LNG storage tank for storing LNG
- a hull structure comprised of a section of a (former) LNG carrier comprising a ship hull and providing support for the LNG storage tank,
- a base structure providing structural integrity.

The LNG carrier is a traditional ship for transporting LNG in LNG storage tanks. The LNG storage tanks may be spherical tanks or membrane tanks or other suitable design. The hull of the LNG carrier supports the LNG storage tanks and comprises

all necessary LNG handling equipment and machinery systems enabling the LNG transport.

A method for manufacturing an LNG terminal comprises converting an LNG carrier by sub-dividing the hull and tank system to obtain at least one unit which comprises:

- at least one LNG storage tank for storing LNG and
- a hull structure providing support for the LNG storage tank.

There is further provided a base structure combined with the LNG carrier unit to form an integrated structure that will provide support of equipment, structural integrity and floatability.

The LNG carrier can during the conversion be sub-divided into physically separate sections, where a section comprises one or more LNG storage tanks and associated hull supporting structure. The number of storage tanks can be adapted to the intended use and thus the need for storage capacity. Additional structures (the base structures) may be constructed and connected to the hull structure in order to provide the necessary floatability and structural integrity, as well as providing the required space for equipment installation. The base structure is shaped to give the LNG terminal the desired properties such as buoyancy and stability/centre of gravity.

In one embodiment the base structure and the hull structure form an integrated floating structure, having buoyancy for keeping the LNG terminal afloat. Desired properties may in this embodiment for example be flat bottom and shallow draft for floating in shallow waters, as well as sufficient base area to ensure appropriate stability.

In another embodiment, the base structure is arranged to support the hull structure on the seabed.

In one aspect of the invention the LNG terminal further comprises equipment for loading LNG, regasification of LNG and discharge of natural gas, for distribution of such natural gas to consumers onshore. LNG regasification equipment may in one embodiment comprise ambient air vaporizers, or vaporizers using sea water as heating medium for regasifiaction, and other necessary or desired equipment for regasification. Equipment for distribution/provision of natural gas to consumers may in one embodiment be means or connections for connecting to piping or transporting vehicles.

In another aspect of the invention the LNG terminal may alternatively or additionally comprise equipment for electrical power production for distribution of

such electric power to consumers onshore. Electric power production equipment may in one embodiment comprise piston engines or gas turbines as generator drives, as well as other necessary or desired equipment for power production. As the LNG terminal is small scale, it is possible to locate it near the user, thus minimizing transport distances and hence reducing costs associated with delivery of natural gas and/or electric power to the user.

In another embodiment of the invention the LNG terminal may also comprise means for LNG storage and delivery of LNG as fuel to vessels or vehicles at sea or land.

The equipment and processes onboard the LNG terminal may be monitored and controlled by a control system.

The invention will now be described in more detail by means of examples and with reference to the accompanying figures.

Figure 1and 2 shows schematically an LNG carrier with four spherical tanks for transport of LNG.

Figure 3 shows an example of an LNG terminal according to the invention being moved by a pusher tug.

Figure 4 shows another example of LNG terminal being moved by a pusher tug.

Figure 1 shows schematically an LNG carrier 10 with spherical tanks 12 for transport of LNG. The LNG carrier 10 is used for storage and transportation of LNG. The LNG carrier 1 comprises essentially a ship hull 11, in which spherical LNG storage tanks 12 are provided, and a propulsion system 13 with engines, equipment for provision of fuel, propeller(s) etc. The LNG carrier 10 is considered well known for a skilled person and will not be described in detail herein.

According to the invention, an LNG carrier, for example of the type shown in figure 1, is divided into separate sections or units comprising at least one spherical LNG storage tank for storing LNG. In figure 2 an example is provided for sub-dividing the LNG carrier of figure 1 into several sections or units 21a-21d.

Each section or unit thus comprises one LNG storage tank and a hull structure providing support for the LNG storage tank.

Figure 3 shows an example of an LNG terminal 30 according to the invention being moved by a pusher tug 31. In this example the LNG terminal 30 is being used as a barge for transportation and storage of LNG at sea. The LNG terminal 30 comprises at least one LNG storage tank 32 for storing LNG and a barge hull 33. The barge hull 33 is constructed on basis of a section or unit of a hull structure of a (former) LNG carrier, and comprising such a unit with additional supporting structures which provides support, structural integrity and floatability of the LNG terminal.

Figure 4 shows another example of LNG terminal 40 being moved by a pusher tug 41. In this example the LNG terminal is a floating storage and regasification unit (FSRU) which can store LNG and deliver natural gas by regasifying the liquid gas. The terminal 40 comprises at least one LNG storage tank 42, equipment for LNG regasification (which may comprise ambient air vaporizers) 43, as well as facilities for control and power production 44. The barge hull 45 is constructed on basis of a unit of a hull structure of a (former) LNG carrier, as in figure 3.

CLAIMS

1. A small scale LNG terminal comprising:
- at least one LNG storage tank for storing LNG
- a hull structure comprised of a section of a (former) LNG carrier comprising a ship hull and providing support for the LNG storage tank,
- a base structure providing structural integrity.

2. LNG terminal according to claim 1, where the base structure and the hull structure jointly form a floating structure having buoyancy and hydrostatic stability for keeping the LNG terminal afloat.

3. LNG terminal according to claim 1, where the base structure is arranged to support the hull structure at land.

4. LNG terminal according to claim 1, where the base structure is arranged to support the hull structure at the seabed.

5. LNG terminal according to claim 1, further comprising LNG regasification means and means for provision of natural gas to consumers.

6. LNG terminal according to claim 6, where the LNG regasification means comprises vaporizers using ambient air as heating medium for regasification of LNG.

7. LNG terminal according to claim 6, where the LNG regasification means comprises vaporizers using sea water as heating medium for regasification of LNG.

8. LNG terminal according to claim 1, comprising means for electric power production and means for provision of electric power to consumers.

9. LNG terminal according to claim 1, comprising means for fuelling vessels or vehicles.

10. LNG terminal according to claim 1, comprising means for loading and discharging LNG.

11. LNG terminal according to claim 1, where the LNG storage tank(s) is a spherical tank.

12. LNG terminal according to claim 1, where the LNG storage tank(s) is a membrane tank.

13. Method for manufacturing an LNG terminal, by converting an LNG carrier comprises sub-dividing the hull and tank system to obtain at least one unit comprising

- at least one LNG storage tank for storing LNG and
- a hull structure providing support for the LNG storage tank,

and providing a base structure combined with the LNG carrier unit to form an integrated structure that will provide support of equipment, structural integrity and floatability.

14. LNG terminal according to claim 1, where equipment and processes onboard the LNG terminal are monitored and controlled by a control system.

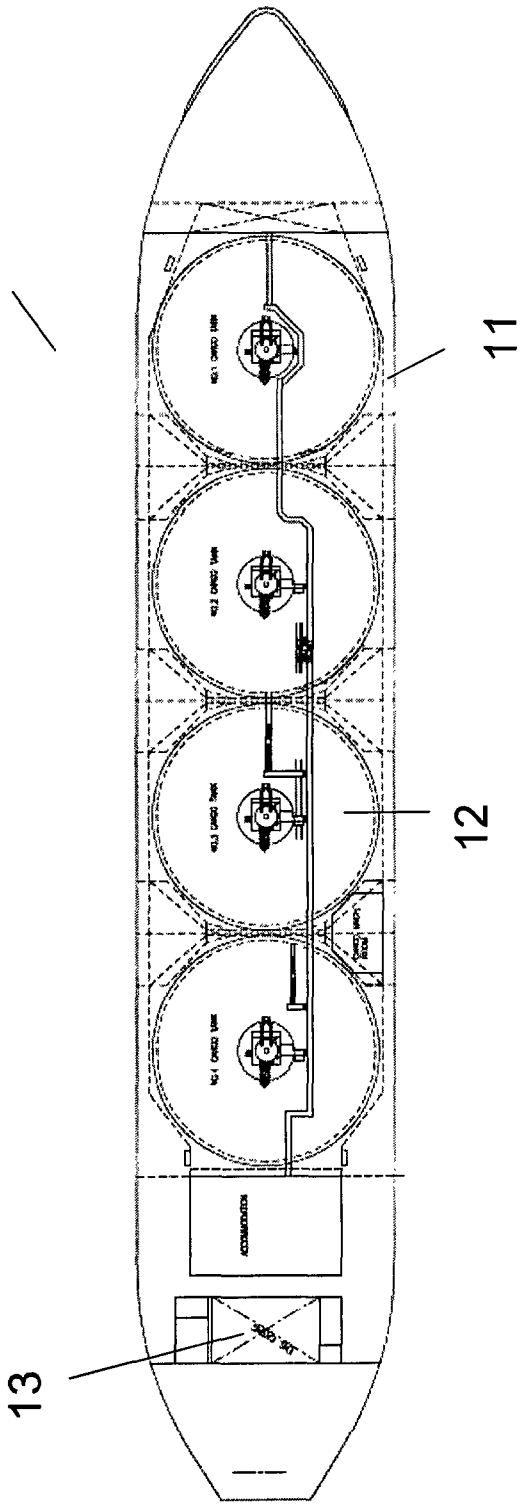


Fig. 1

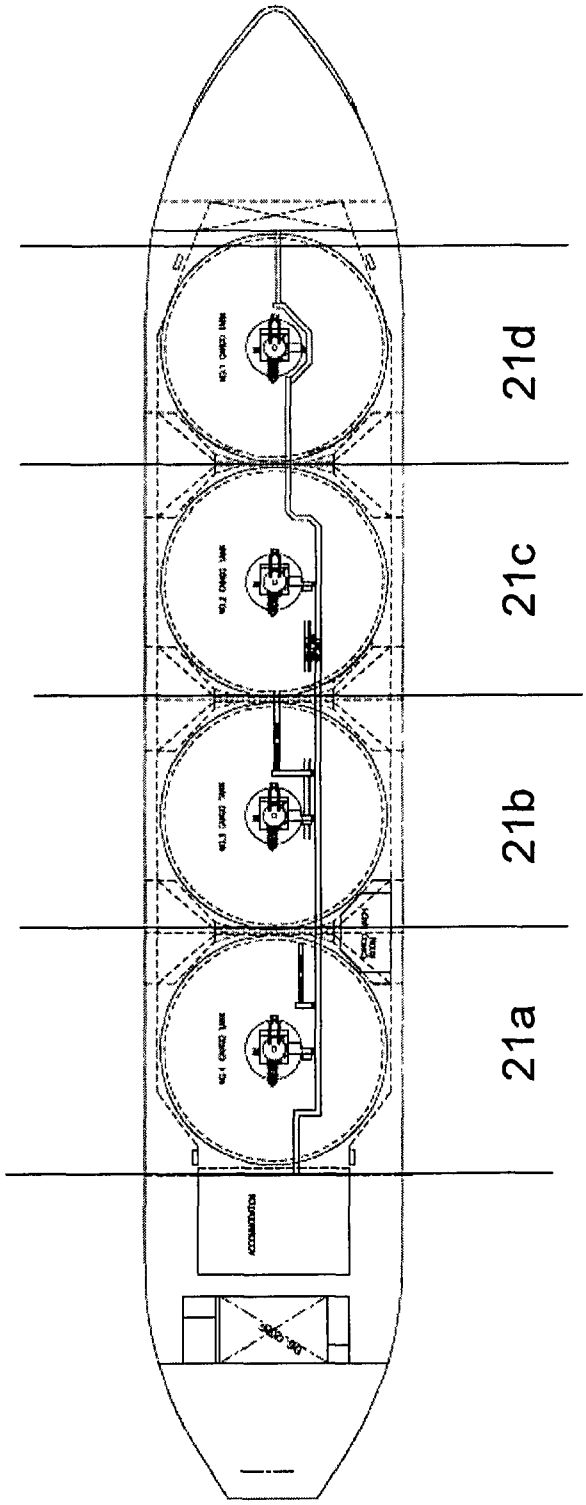


Fig 2

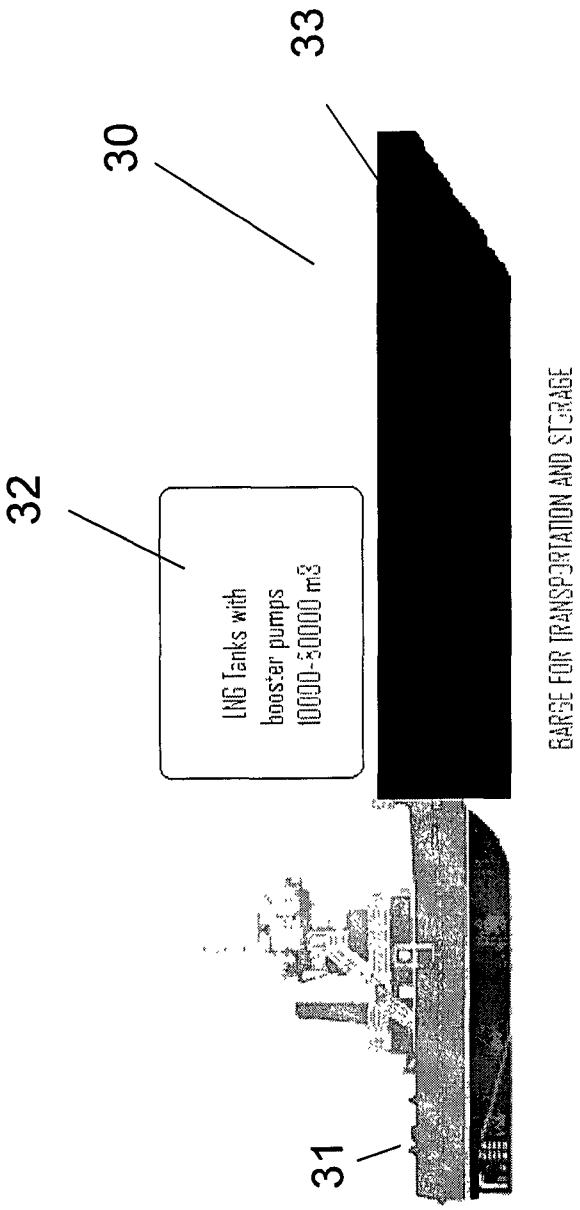

33
30
32
LNG Tanks with
booster pumps
10000-50000 m3
BARGE FOR TRANSPORTATION AND STORAGE
31

Fig 3

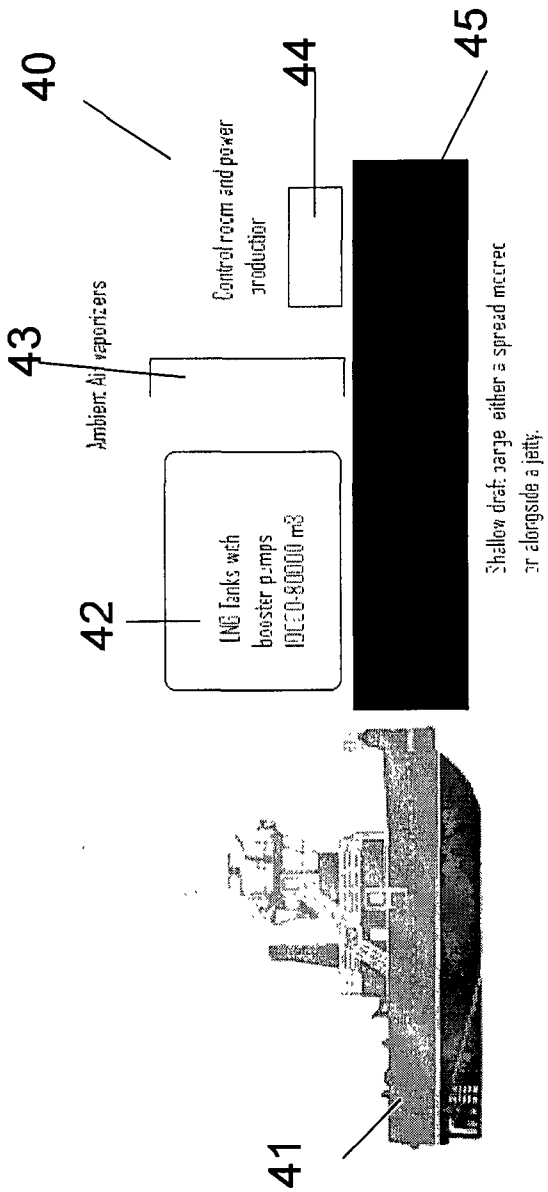

40
44
45
43
Control room and power production
Ambient Air vaporizers
42
LNG Tanks with booster pumps
Shallow draft barge either a spread moored or alongside a jetty.
41

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/NO2012/000005

A. CLASSIFICATION OF SUBJECT MATTER
INV. F17C9/02 F17C6/00 F17C5/06
ADD.

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)
F17C

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/104077 A1 (WOODSIDE ENERGY LTD [AU]; FAKA SOLOMON ALADJA [US]; MACMILLAN ADRIAN A) 20 September 2007 (2007-09-20) the whole document	1-4,13
X	EP 2 045 506 A1 (SHELL INT RESEARCH [NL]) 8 April 2009 (2009-04-08) the whole document	1-4,13
X	WO 2008/033183 A2 (EXXONMOBIL UPSTREAM RES CO [US]; MATHEWS WILLIAM S [US]; EHRHARDT MARK) 20 March 2008 (2008-03-20) the whole document	1-4,13

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 September 2012	19/03/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Nicol, Boris

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO2012/000005

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-4, 13

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-4, 13

   A small scale LNG terminal according to claim 1, wherein the base structure and the hull structure jointly form a floating structure having buoyancy and hydrostatic stability.

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2. claims: 5-7

   A small scale LNG terminal according to claim 1, further comprising LNG regasification means.

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3. claim: 8

   A small scale LNG terminal according to claim 1, further comprising means for electric power production.

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4. claims: 9, 10

   A small scale LNG terminal according to claim 1, further comprising means for loading and discharging LNG.

   ---

5. claims: 11, 12

   A small scale LNG terminal according to claim 1, further comprising a spherical tank or membrane tank.

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6. claim: 14

   A small scale LNG terminal according to claim 1, further comprising equipment and processes onboard the LNG terminal which are monitored and controlled by a control system.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/NO2012/000005

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