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(54) SYSTEM AND METHOD FOR OFFLOADING LCO2 FROM A SHIP TO AN INTERMEDIATE STORAGE AT AN LCO2 RECEIVING TERMINAL

(57) A system **150** for offloading LCO_2 from an LCO_2 carrier ship **30** to an intermediate LCO_2 storage tank **40** at an LCOz receiving terminal **200** connected to a long term LCO_2 storage facility **120** is disclosed, which system avoids cross-contamination from cargo of one ship to another, wherein a slip stream of LCO_2 withdrawn from a cargo import stream of LCO_2 being offloaded to the terminal **200** is vaporised and returned to the LCO_2 carrier ship **30,** and the vaporisation is used to provide sub-cooling of a remaining main stream of LCO_2, and wherein the resulting sub-cooled remaining main stream of LCOz is forwarded to the intermediate LCO_2 storage tank **40.** A corresponding method is also disclosed.

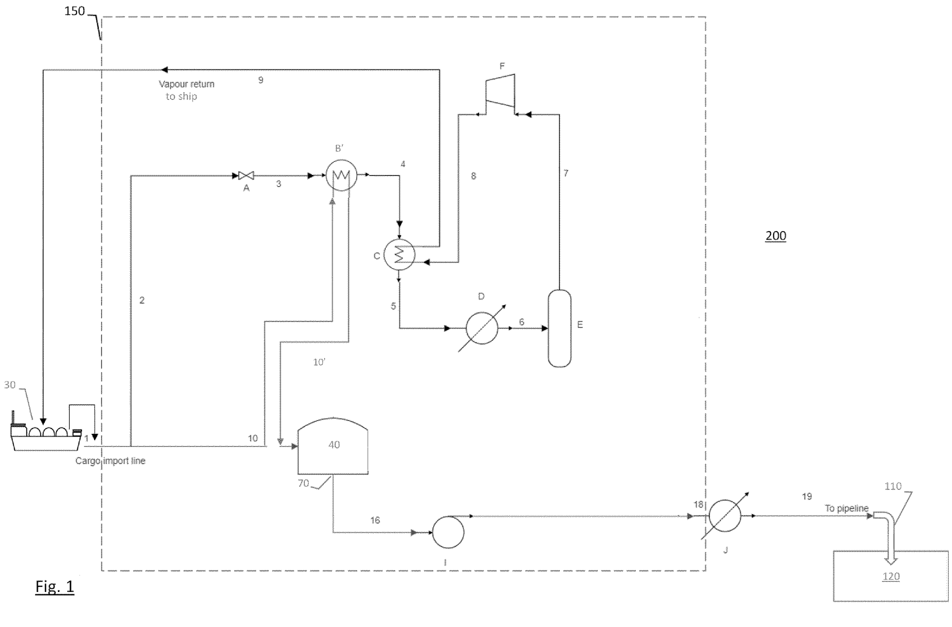

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention generally relates to carbon capture and storage (CCS) technology, and more particularly to a system for offloading liquid CO_2 (LCO_2) from an LCO_2 carrier ship to an intermediate LCO_2 storage tank at an LCO_2 receiving terminal connected to a long term LCO_2 storage facility, wherein cross-contamination from cargo of one ship to another, via common intermediate LCO_2 storage tanks, can be avoided. The invention also relates to a corresponding method. The invention uses a slip stream of LCO_2 withdrawn from a stream of LCO_2 being offloaded to the terminal which is vaporised and returned to the LCO_2 carrier ship, and the vaporisation is used to provide cooling for the remaining main stream of LCO_2, and the resulting subcooled remaining main stream is forwarded to the intermediate LCO_2 storage tank. The present invention also relates to a corresponding method.

BACKGROUND ART

[0002] Captured and liquefied carbon dioxide can be transported in the liquid phase (LCO_2) from various locations and customers to CO_2 receiving terminals at which the CO_2 will be temporarily stored in intermediate buffer storage tanks onshore, before being pumped in a dense phase via a pipeline and injected into an offshore long term storage reservoir. The purpose of the buffer storage is to allow for continuous injection to the long-term storage reservoir despite intermittent LCO_2 cargo transfer from ship.

[0003] A general description of an outline of a CCS chain can be found in Conceptualization of CO_2 Terminal for Offshore CCS Using System Engineering Process by Hyonjeong et al. *Energies*, 2019, 12, 4350. Said CCS chain description includes the return of CO_2 carriers to consider the vaporised CO_2 (VCO_2) in returning carriers. According to Hyonjeong et al., the same volume of VCO_2 must be loaded into the carrier's cargo tank when unloading LCO_2 from the carrier to the CO_2 terminal. The carrier's cargo tank is displaced by the VCO_2 of the storage tanks at the terminal, while LCO_2 fills the storage tanks. There are two reasons for loading VCO_2 into the carrier's cargo tank. The first is to allow the pressure and temperature of the cargo tank to be controlled during the unloading process. Constant pressure and temperature facilitate the process. The second reason is to prevent the rapid decrease in temperature due to Joule-Thomson cooling.

[0004] Thus, for example, during LCO_2 cargo transfer between ship and onshore intermediate storage, the displaced vapour in the onshore intermediate storage tank could be returned to the CO_2 carrier ship via a vapour return connection for pressure maintenance in both sets of tanks, i.e. of the carrier ship and of the intermediate storage of the CO_2 receiving terminal, respectively.

[0005] However, depending on origin and purity of the LCO_2 being received at the terminal, the vapour in the onshore storage tank or tanks may contain impurities. In the event that restrictions are imposed on the vapour quality of vapour being returned to the ship that are not met by the vapour composition in the onshore storage, such impurities could pose a substantial impediment to the functioning of the CCS chain. In particular, LCO_2 receiving terminals served by multiple customers, with CO_2 originating from various sources, could face challenges from a technical and commercial point with undesired cross-contamination caused by impurities contained in the vapour space of the onshore storage tanks when returned to the ships.

[0006] It would be desirable to enable pressure maintenance in both sets of tanks, i.e. of the carrier ship and of the intermediate storage of the CO_2 receiving terminal, while reducing, and preferably avoiding, the risk of contaminating an LCOz carrier tank at a ship in connection with offloading LCO_2 from the ship to an LCO_2 receiving terminal. Moreover, this should preferably be achieved in an energy efficient manner.

[0007] It is an object of the present invention to provide a system and a method enabling the above.

SUMMARY OF THE INVENTION

[0008] The present invention is based on using a slip stream of LCO_2, which is being withdrawn from a stream LCO_2 being offloaded from a ship and imported to the terminal, for sub-cooling a remaining LCO_2 main stream being imported to the terminal, wherein the two streams are kept separate, and wherein the sub-cooled remaining LCO_2 main stream is forwarded to the storage tank. The required heat for partial or complete vaporisation of the LCO_2 slip stream is provided by the remaining LCO_2 main stream. The resulting LCO_2 main stream having a sub-cooled temperature is forwarded to the storage tank. After complete vaporisation of the LCO_2 slip stream, the resulting CO_2 vapour is compressed and led back to the ship in a vapour return conduit.

[0009] The present invention allows for loading of an LCO_2 main stream with a saturation pressure below that of the storage tank. With sufficient subcooling from the LCO_2 main stream being introduced into the storage tank, this allows for reducing the pressure rise during loading (due to the colder incoming liquid "collapsing" the vapour by condensing part of it). An advantage of the inventive idea is that it suppresses the formation of vapour in the storage tank, and may also eliminate or substantially reduce the need for refrigeration, or reliquefaction of vapour or boil-off gas to stay within pressure capabilities of intermediate storage at the terminal.

[0010] Accordingly, in one aspect the invention relates to a system **150** for offloading LCO_2 cargo from an LCO_2 carrier ship **30** to an intermediate LCO_2 storage tank **40** at an LCO_2 receiving terminal **200,** which system avoids cross-contamination of cargo from one LCO_2 carrier ship **30** to another, said system comprising: an intermediate LCO_2 storage tank **40;** an LCO_2 cargo import conduit **1, 10, 10'** connected to the intermediate LCO_2 storage tank **40** configured to receive an LCO_2 cargo import stream from the LCO_2 carrier ship **30;** a CO_2 vapour return conduit **4, 5, 6, 7, 8, 9** configured to be connected to the LCO_2 carrier ship **30** and to return from the system **150** CO_2 vapour to the LCO_2 carrier ship **30;** an LCO_2 outlet **70** from the intermediate LCO_2 storage tank **40** configured to discharging LCO_2 from the intermediate LCO_2 storage tank **40;** which system additionally comprises an LCO_2 slip stream conduit **2** connected to the LCO_2 cargo import conduit **1** configured to withdrawing a slip stream of LCO_2 from the LCO_2 cargo import conduit **1;** a pressure let-down valve **A** connected to the LCO_2 slip stream conduit **2** configured to receiving the slip stream of LCO_2 having a first temperature **11,** and to exiting an at least partly vaporised stream of LCO_2 having a second lower temperature **T2;** a partly vaporised stream conduit **3** connected to the pressure let-down valve **A** configured to receiving the at least partly vaporised stream of LCO_2 having a second lower temperature **T2;** a first heat exchanger **B'** connected to the partly vaporised stream conduit **3** and to an LCO_2 main stream conduit **10,** respectively, said heat exchanger being configured to receiving the at least partly vaporised stream of LCO_2 having the second lower temperature **T2,** to receiving the LCO_2 remainder import main stream from the LCO_2 remainder import conduit **10,** to transferring heat from the LCO_2 remainder import main stream to the at least partly vaporised stream of LCO_2 having the second lower temperature **T2,** to exiting a sub-cooled LCO_2 remainder import main stream and to exiting an at least partly vaporised stream of LCO_2, respectively; wherein the CO_2 vapour return conduit **4, 5, 6, 7, 8, 9** is further configured to receiving CO_2 vapour resulting from the at least partly vaporised stream of LCO_2 having the second lower temperature **T2,** and wherein a vapour return compressor **F** is arranged along vapour return conduit **4, 5, 6, 7, 8, 9** configured to compressing the CO_2 vapour to be returned to the LCO_2 carrier ship **30.**

[0011] In a preferred embodiment of the system, the system additionally comprises means configured to vaporising a remaining non-vaporised fraction of the at least partly vaporised stream of LCO_2 exiting the first heat exchanger **B'.**

[0012] In another aspect, the invention relates to a method for offloading LCO_2 cargo from an LCO_2 carrier ship **30** to an intermediate LCO_2 storage tank **40** at an LCO_2 receiving terminal **200,** avoiding cross-contamination of cargo from one LCO_2 carrier ship **30** to another, said method comprising the following steps: **i.** receiving an import stream of LCO_2 from an LCO_2 carrier ship **30** and directing a main stream of LCO_2 to an intermediate LCO_2 storage tank **40;** ii. withdrawing LCO_2 from an LCO_2 outlet **70** from the intermediate LCO_2 storage tank **40; iv.** returning CO_2 vapour from the terminal **200** back to the LCO_2 carrier ship **30,** which method additionally comprises the following steps: v. withdrawing from the stream of LCO_2 a slip stream of LCO_2; **vi.** subjecting the withdrawn slip stream of LCO_2 having a first temperature **T1** to a reduced pressure, thereby partly vaporising the withdrawn LCO_2 slip stream having a first temperature **T1** so as to produce an at least partly vaporised LCO_2 slip stream having a second lower temperature **T2; vii'.** subjecting the remaining LCO_2 import main stream after step **v.** to heat exchange with the at least partly vaporised LCO_2 slip stream having the second lower temperature **T2,** thereby sub-cooling the remaining LCO_2 import main stream to a lower temperature; **viii'.** forwarding the resulting sub-cooled remaining LCO_2 import main stream from step **vii'** to the intermediate LCO_2 storage tank **40;** wherein, in step **iv.,** the CO_2 vapour from the terminal **200** being returned to the LCO_2 carrier ship **30** comprises a stream of CO_2 vapour obtained from the slip stream of LCO_2 and is subjected to compression before being returned to the ship **30.**

[0013] In a preferred embodiment of the method, the method additionally comprises a step **ix.** wherein a remaining non-vaporised fraction of the at least partly vaporised LCO_2 slip stream after heat exchange in step **vii'.** is vaporised.

[0014] The present invention provides a method and system providing vapour return for pressure support of LCO_2 carrier ship **30** tanks during liquid off-loading by generating vapours directly from the off-loading cargo at the terminal **200,** eliminating the risk for potential off-spec vapour return from the onshore storage tank facility **40.**

[0015] Also, the invention provides an energy efficient measure to reduce the amount of displaced vapour in the onshore storage tanks **40,** by sub-cooling the main feed stream to the intermediate storage tanks via heat integration with the ship vapour return **4, 5, 6, 7, 8, 9.**

[0016] The present invention provides a method for a force-vaporising a slip stream of $LC0_2$ withdrawn from the off-loaded LCO_2 cargo, providing vapour for pressure support to the ship tanks without ingress of any potential contaminants from the main onshore storage facility. The system also provides sub-cooling duty for the incoming LCO_2 feed stream to the onshore storage tanks, reducing or eliminating the energy requirements and need for a BOG system.

[0017] The present invention achieves the advantage of providing CO_2 vapour return to an off-loading LCO_2 carrier ship **30,** independent of the content in the onshore storage tanks, i.e. avoiding exposure of potential contaminants contained in the vapour space from previous off-loaded cargos, such as from other LCO_2 carrier ships **30.**

[0018] Further embodiments and advantages of the invention will be apparent from the following detailed description and appended claims.

[0019] In the present disclosure, same reference numeral is used both to denote the conduit and the stream flowing therein. For example, reference numeral **2** is used to both denote the slip stream conduit, and also to denote the slip stream itself flowing in said conduit.

[0020] The term "long-term" as used herein denotes a storage intended to be permanent.

[0021] The present system and method may be combined with either one or both of the embodiments disclosed in applicant's co-pending applications filed on even date herewith, especially, as a compliment, with a method and system handling BOG, such as the system and method of applicant's co-pending application.

BRIEF DESCRIPTION OF THE ATTACHED DRAWING

[0022] Figure 1 shows an embodiment of the inventive system **150** as indicated by the dashed line implemented into an LCO_2 receiving terminal **200.** The inventive system **150** in its most generic embodiment does not include **C, D, E,** which in a preferred embodiment can be arranged along the vapour return conduit **4, 5, 6, 7, 8, 9,** and does also not include **I**, and **J,** which are units conventionally included in a conventional LCO_2 receiving terminal **200,** in which the inventive system **150** has not been implemented.

DETAILED DESCRIPTION OF THE INVENTION

[0023] The core of the invention is a process scheme that enables efficient heat integration between the cold closed-circuit vapour return stream to LCO_2 carrier ship **30** and the warmer remaining main stream of LCO_2 being forwarded to the storage tanks **40.** This is achieved by using a slip stream of the off-loaded LCO_2 cargo, which serves a dual purpose:

- as the CO_2 pressure is let down to e.g. 7 barg, the temperature will drop to approximately -45°C, providing refrigeration for remaining main stream of LCO_2 during filling of onshore storage tanks **40.** This enables sub-cooling of the incoming feed, i.e. the remaining main stream of LCO_2, resulting in a reduced saturation pressure in the storage tanks, reducing the pressure rise in the tanks during filling of the storage tank **40;**
- the cold low pressure LCO_2 is vaporised by indirect heat exchange in the first heat exchanger **B'** which enables a closed-circuit vapour return system, eliminating the risk for potential off-spec vapour return from the onshore storage tank facility.

[0024] In the above connection, a lower pressure will increase the cooling duty in the first heat exchanger **B',** but will also increase the compressor duty of vapour return compressor **F.**

[0025] Without CO_2 vapour return from the LCO_2 receiving terminal **200** to the LCO_2 carrier ship **30,** e.g. in order to avoid cross-contamination of the tanks of the LCO_2 carrier ship **30,** vapour for pressure maintenance on the ship could possibly alternatively be generated by force-vaporising liquid CO_2 cargo on the ship. Such solution is however considered inferior to the solution offered by the invention, since, i.a., with such solution, the displaced vapour in the intermediate LCO_2 storage tank or tanks **40** during filling will increase the sizing and energy requirements for a BOG-handling system of the LCO_2 receiving terminal **200.**

[0026] In the embodiment of the invention illustrated in **FIG. 1,** LCO_2 is offloaded from a ship **30** at pressures from e.g. 15-18 barg (denoted as medium pressure (MP), with a typical saturation temperature between -30°C and -20°C).

[0027] A slip stream **2** of the off-loaded cargo stream **1** is fed to a pressure let-down control valve **A,** where the pressure is let down to e.g. 6-10 barg (denoted as low pressure (LP), with a saturation temperature between -50°C and -40°C).

[0028] The flow rate of the slip stream **2** will be determined by the off-loading rate, and typically around 5% of the total flow will be required.

[0029] On the downstream side **3** of the pressure let-down valve **A** a two-phase LP LCO_2 stream is fed to the first heat exchanger **B'.** In the embodiment in **FIG. 1** the first heat exchanger **B'** is depicted as a shell and tube heat exchanger but could alternatively be of another type, such as a plate or plate-fin heat exchanger. In the first heat exchanger **B',** the cold two-phase LP stream provides cooling of the remaining main stream of LCO_2 being forwarded to the storage tank **40** during filling thereof.

[0030] Ideally, in a case of operation wherein the two-phase LP LCO_2 stream has been fully vaporised after heat exchange in the first heat exchanger **B',** the resulting CO_2 vapour could be returned to the shipafter compression of the CO_2 vapour stream **7** in a vapour return compressor **F.** It is presently believed that an additional heat exchanger **C** in the vapour return conduit will in most cases not be needed, as the LCO_2 slip stream will in most cases be completely vaporized (due to the large heat duty of the LCO_2 main stream, i.e. the slip stream is likely to be approximately 5% of the total LCO_2 import flow).

[0031] Following heat exchange in the first heat exchanger **B'** in a case of operation wherein the partly vaporised LP LCO_2 stream **4** has not been fully vaporised, the stream is further vaporised in a second heat exchanger **C,** using the warm discharge stream **8** of CO_2 vapour from the vapour return compressor **F.** In the inventive system, first and second heat exchangers **B'** and **C,** respectively, could be referred to as cross heat exchangers.

[0032] In case the heat content of the compressor discharge stream **8** is not sufficient to completely vaporise the LP LCO_2, so that a partly vaporised LCO_2 stream **5** remains after the second heat exchanger **C,** a dedicated vaporiser **D** is provided. The vaporiser **D** could be heated electrically, by ambient sea water or other suitable heat sources available at the terminal **200.**

[0033] From the vaporiser **D** the LP CO_2 **6** is preferably fed to a knock-out drum **E** to ensure that any remaining liquid droplets are not found in the suction flow **7** to the vapour return compressor **F.**

[0034] The vapour return compressor **F** will increase the pressure to be compatible with the ship cargo tank pressure. The compressor discharge **8** is cooled by cross-heat exchange in heat exchanger **C,** providing heat for vaporisation of a remaining liquid phase in the LP stream **4** as described above.

[0035] Vapour **9** is returned to ship **30** at pressure and temperature compatible with the MP cargo at a rate that approximately equals the volumetric flow of off-loaded liquid 1.

[0036] As shown in the embodiment of the invention illustrated in **FIG. 1,** the offloaded LCOz is split into two process sections. As described above, the LP **2** is providing vapour for the displaced liquid in the ship cargo tanks **30** in a closed circuit **2, 3, 4, 5, 6, 7, 8, 9.** The major part of the imported LCO_2, i.e. the main stream of LCO_2 **10** resulting after withdrawal of the slip stream **2,** is transferred **10'** after cooling in **B'** to a lower temperature to the intermediate storage tank(s) **40.**

[0037] The storage tank or tanks **40** are operated at MP condition, and liquid CO_2 is transferred **16** to injection pump or pumps **I.** In the embodiment of **FIG. 1,** the injection pump **I** is shown as a single pump but could also be configured in series with booster pumps. The pump(s) provide sufficient head for dense phase CO_2 to be exported to a pipeline **110** and subsequently injected into a reservoir **120** for permanent storage. Downstream of the injection pump **I**, an injection heater **J** may be provided to avoid sub-zero temperatures entering the pipeline **110.** The injection heater **J** could e.g. be heated electrically, by ambient sea water or other suitable heat sources available at the terminal.

[0038] Ideally, in a case of operation wherein BOG and/or displaced vapour can be completely re-liquefied in the storage tank by virtue of the cooler LCO_2 entering the tank, a BOG system is not required.

[0039] A BOG system may be included in the inventive system in order to handle any excessive pressure rise in the storage tank not being balanced by the colder LCO_2 being fed to the storage tank, such as using applicant's system for reliquefaction of a fraction of the BOG as disclosed in applicant's co-pending application filed on even date herewith.

LIST OF REFERENCE SIGNS USED

[0040]

1, 10, 10'	LCO_2 cargo import conduit, wherein 1 is a cargo import conduit, 10 is a remainder LCO_2 cargo import conduit, and 10' is a sub-cooled remainder LCO_2 cargo import conduit
2	LCO_2 slip stream conduit
3	partly vaporised LCO_2 stream conduit
4, 5, 6, 7, 8, 9	CO_2 vapour return conduit
16	conduit connecting bottom outlet 70 with injection pump I
17	conduit connecting outlet from injection pump with injection heater J
18	injection pump conduit
19	injection heater conduit connecting injection heater with pipeline
30	LCO_2 carrier ship
40	intermediate LCO_2 storage tank
150	system for offloading LCO_2 cargo (from an LCO_2 carrier ship)
70	LCO_2 outlet (from intermediate LCO_2 storage tank)
200	LCO_2 receiving terminal
110	pipeline
120	underground long term storage facility
T1	first temperature (of slip stream)
T2	second lower temperature (of partly vaporised LCO_2 stream)
A	pressure let-down valve
B'	first heat exchanger
C	second heat exchanger
D	vaporiser
E	knock-out drum
F	vapour return compressor
I	injection pump
J	injection heater

Claims

1. A system (150) for offloading LCO_2 cargo from an LCO_2 carrier ship (30) to an intermediate LCO_2 storage tank (40) at an LCO_2 receiving terminal (200), which system avoids cross-contamination of cargo from one LCO_2 carrier ship (30) to another, said system comprising:

- an intermediate LCO_2 storage tank (40);
- an LCO_2 cargo import conduit (1, 10, 10') connected to the intermediate LCO_2 storage tank (40) configured to receive an LCO_2 cargo import stream from the LCO_2 carrier ship (30);
- a CO_2 vapour return conduit (4, 5, 6, 7, 8, 9) configured to be connected to the LCO_2 carrier ship (30) and to return from the system (50) CO_2 vapour to the LCO_2 carrier ship (30);
- an LCO_2 outlet (70) from the intermediate LCO_2 storage tank (40) configured to discharging LCO_2 from the intermediate LCO_2 storage tank (40);

characterized in additionally comprising,

- an LCO_2 slip stream conduit (2) connected to the LCO_2 cargo import conduit (1) configured to withdrawing a slip stream of LCO_2 from the LCO_2 cargo import conduit (1);

- a pressure let-down valve (A) connected to the LCO_2 slip stream conduit (2) configured to receiving the slip stream of LCO_2 having a first temperature (T1), and to exiting an at least partly vaporised stream of LCO_2 having a second lower temperature (T2);
- a partly vaporised stream conduit (3) connected to the pressure let-down valve (A) configured to receiving the at least partly vaporised stream of LCO_2 having a second lower temperature (T2);
- a first heat exchanger (B') connected to the partly vaporised stream conduit (3) and to the LCO_2 remainder import conduit (10), respectively, said heat exchanger being configured to receiving the at least partly vaporised stream of LCO_2 having the second lower temperature (T2), to receiving the LCO_2 remainder import main stream from the LCO_2 remainder import conduit (10), to transferring heat from the LCO_2 remainder import main stream to the at least partly vaporised stream of LCO_2 having the second lower temperature (T2), to exiting a a sub-cooled LCO_2 remainder import main stream and to exiting an at least partly vaporised stream of LCO_2, respectively;
- wherein the CO_2 vapour return conduit (4, 5, 6, 7, 8, 9) is further configured to receiving CO_2 vapour resulting from the at least partly vaporised stream of LCO_2 having the second lower temperature (T2), and wherein a vapour return compreesor (F) is arranged along vapour return conduit (4, 5, 6, 7, 8, 9) configured to compressing the CO_2 vapour to be returned to the LCO_2 carrier ship (30).

2. The system (150) of claim 1, additionally comprising:

- means (C, D, E) arranged along the CO_2 vapour return conduit (4, 5, 6, 7, 8, 9) configured to vaporising a remaining non-vaporised fraction of the at least partly vaporised stream of LCO_2 exiting the first heat exchanger (B).

3. A method for offloading LCO_2 cargo from an LCO_2 carrier ship (30) to an intermediate LCO_2 storage tank (40) at an LCO_2 receiving terminal (200), avoiding cross-contamination of cargo from one LCO_2 carrier ship (30) to another, said method comprising the following steps:

i.) receiving a stream of LCO_2 from an LCO_2 carrier ship (30) and directing a main stream thereof to an intermediate LCO_2 storage tank (40);
ii.) withdrawing LCO_2 from an LCO_2 outlet (70) from the intermediate LCO_2 storage tank (40);
iv.) returning CO_2 vapour from the terminal (200) back to the LCO_2 carrier ship (30),

characterized in additionally comprising the following steps:

v.) withdrawing from the stream of LCOz a slip stream of LCO_2;
vi.) subjecting the withdrawn slip stream of LCO_2 having a first temperature (T1) to a reduced pressure, thereby partly vaporising the withdrawn LCO_2 slip stream having a first temperature (T1) so as to produce an at least partly vaporised LCO_2 slip stream having a second lower temperature (T2);
vii'.) subjecting a remaining LCO_2 import main stream resulting after step (v). to heat exchange with the at least partly vaporised LCO_2 slip stream having the second lower temperature (T2), thereby cooling the remaining LCO_2 import main stream to a lower temperature;
viii'.) forwarding the resulting sub-cooled remaining LCO_2 import main stream from step vii' to the intermediate LCO_2 storage tank (40);

wherein, in step (iv.), the CO_2 vapour from the terminal (200) being returned to the LCO_2 carrier ship (30) comprises a stream of CO_2 vapour obtained from the slip stream of LCO_2 and is subjected to compression before being returned to the ship (30).

4. The method for offloading LCO_2 cargo from an LCO_2 carrier ship (30) to an intermediate LCO_2 storage tank (40) at an LCO_2 receiving terminal (200) of claim 1, additionally comprising the following steps:

ix.) vaporising a remaining non-vaporised fraction of the at least partly vaporised LCO_2 slip stream after heat exchange in step (vii),
wherein, in step (iv.), the CO_2 vapour from the terminal being returned to the LCO_2 carrier ship (30) comprises the resulting CO_2 vapour from step (ix.).

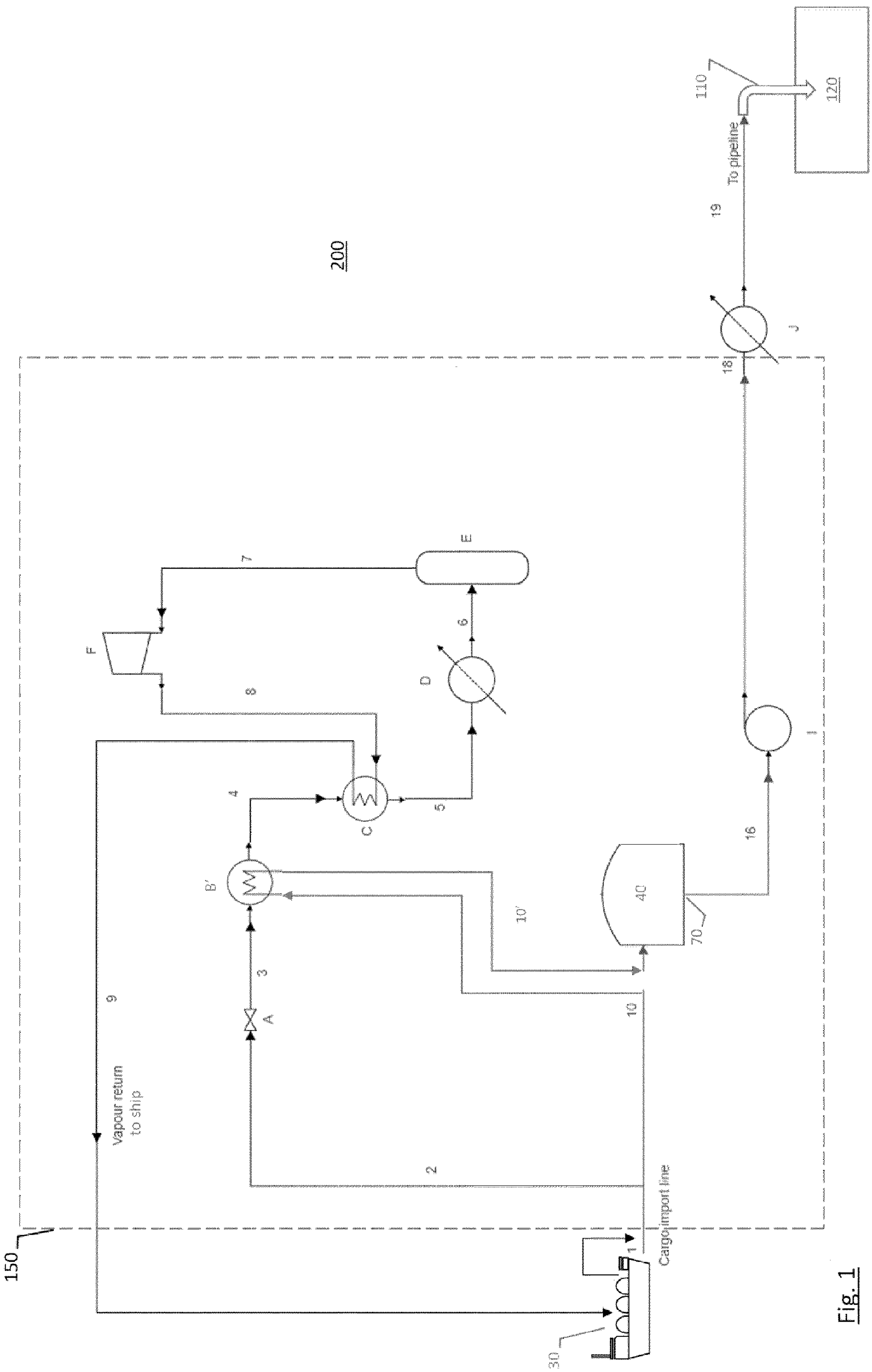
200
150
To pipeline
110
120
19
18
J
I
16
40
70
10'
10
E
7
6
D
F
8
C
5
4
B'
3
A
2
9
Vapour return
to ship
Cargo import line
1
30

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 23 15 4918

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	NOH HYONJEONG ET AL: "Conceptualization of CO2 Terminal for Offshore CCS Using System Engineering Process", ENERGIES, vol. 12, no. 22, 15 November 2019 (2019-11-15), page 4350, XP093055447, DOI: 10.3390/en12224350 * paragraph [4.1.3] * * paragraph [05.1]; figures 8,9 * -----	1-4	INV. F17C3/00 F17C6/00 F17C7/02
Y	JP H06 33873 B2 (TOKYO GAS CO LTD) 2 May 1994 (1994-05-02) * the whole document * -----	1-4	
A	JP S58 46298 A (NIPPON KOKAN KK) 17 March 1983 (1983-03-17) * figure 2 * -----	1,3	

TECHNICAL FIELDS SEARCHED (IPC)

F17C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 June 2023	Fritzen, Claas

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CATEGORY OF CITED DOCUMENTS

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EP 23 15 4918

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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23-06-2023

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