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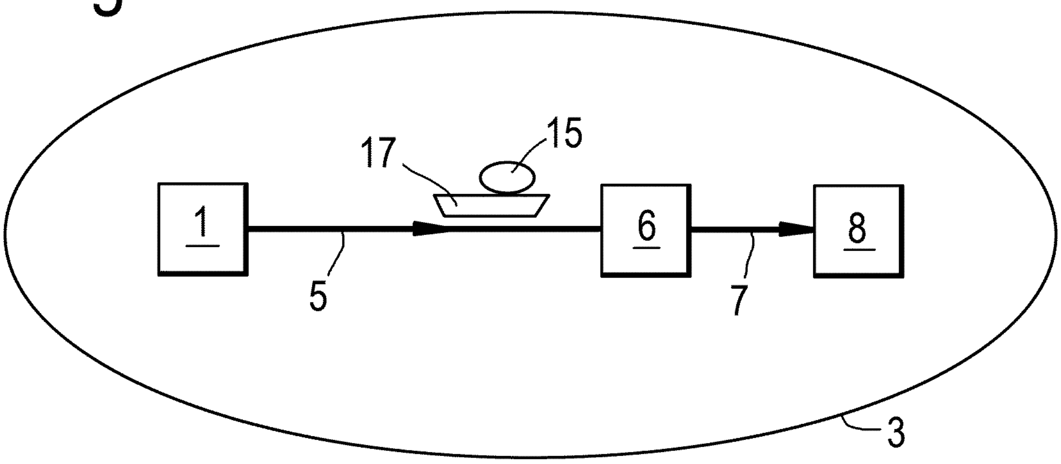
(54) Method of supplying a hydrocarbon load from a starting location to a destination

(57) A hydrocarbon load is supplied from a starting location (4) to a destination (8). The hydrocarbon load is provided at the starting location, and transported from the starting location (4) to an intermediate location (6). At the intermediate location (6) the hydrocarbon load is conditioned to provide a conditioned hydrocarbon load in the liquid state and at a pressure of about 1 to 2 bar. The conditioned hydrocarbon is present in a tank (15). This tank (15) comprising the conditioned hydrocarbon is transported from the intermediate location (6) to the destination (8), to provide a hydrocarbon load comprising the conditioned hydrocarbon in the liquid state and at a pressure from about 1 to 2 bar at the destination (8).

Fig.1



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Description

[0001] The present invention relates to a method of supplying a hydrocarbon load from a starting location to a destination. The destination may be an off-shore structure, such as a Floating Liquefaction Storage Off-shore (FLSO) facility.

[0002] Natural gas is a useful fuel source, as well as being a source of various hydrocarbon compounds. It is not unusual to liquefy natural gas in a liquefied natural gas (LNG) plant at or near the source of a natural gas stream to form a liquefied natural gas stream. Liquefied natural gas can be stored in cryogenic tanks, and/or transported in tankers, at atmospheric pressure and a temperature of about -162 °C.

[0003] Usually, natural gas, comprising predominantly methane, enters an LNG plant at elevated pressures and is often pre-treated to produce a purified feed stream suitable for liquefaction at cryogenic temperatures. The optionally purified gas is processed through a plurality of cooling stages where it is cooled against refrigerant in heat exchangers to progressively reduce its temperature until liquefaction is achieved. The liquid natural gas is then further cooled and expanded to final atmospheric pressure suitable for storage and transportation.

[0004] Typically, the liquefaction of natural gas, together with any necessary pre-treatment, is carried out in an on-shore facility. The natural gas must be transported from the natural hydrocarbon reservoir where it extracted to the liquefaction and optionally pre-treatment facility. Hydrocarbon reservoirs producing natural gas may be found off-shore. An off-shore structure, preferably a floating structure, for the processing of natural gas is advantageous because it provides an off-shore alternative to on-shore liquefaction plants. A floating structure for the liquefaction of natural gas can be moored off the coast, or close to or at a natural gas field, in waters deep enough to allow off-loading of the LNG product onto a hydrocarbon carrier vessel. It also represents a movable asset, which can be relocated to a new site when the gas field is nearing the end of its productive life, or when required by economic, environmental or political conditions.

[0005] Examples of such floating structures include a Floating Liquefaction Storage Off-shore (FLSO) facility, which combines the natural gas liquefaction process, storage tanks, loading systems and other infrastructure into a single floating structure. A Floating Liquefaction of Natural Gas (FLNG) facility or a Floating Production, Liquefaction, Storage and Off-loading (FPLSO) facility further contain other processing capabilities necessary to prepare the natural gas being produced from the natural hydrocarbon reservoir for the liquefaction process.

[0006] The natural gas liquefaction process, including processes operated on-shore or off-shore (e.g. aboard a floating structure) may utilise a refrigerant to reduce the temperature of the natural gas to cryogenic temperatures. The refrigerant is typically a multicomponent composition comprising a plurality of refrigerant components. The refrigerant components may comprise one or more hydrocarbon refrigerant components, such as ethane and propane. The natural gas itself may provide a source of such hydrocarbon refrigerant components, such that they can be produced as part of the liquefaction process. However, not all hydrocarbon reservoirs contain natural gas with sufficient concentrations of heavier hydrocarbons (compared to methane), such as ethane and propane, to provide them in sufficient quantities for use as refrigerant components. Furthermore, even if the natural gas does contain the necessary amounts of heavier hydrocarbons, it would require installation and operation of process equipment to extract the refrigerant components from the natural gas and to prepare them for use as refrigerant. In either case, the installation and operation of process equipment to extract and process the refrigerant components can be avoided by supplying the refrigerant components from a different location.

[0007] Consequently, a need exits to supply a hydrocarbon load, which can comprise one or more hydrocarbon components, either in relatively pure form or in a mixture, to a destination. The destination may be, for instance, an off-shore destination such as a FLSO or FLNG facility, where the hydrocarbon load can be used as refrigerant or refrigerant components in a refrigeration cycle.

[0008] Maritime Economics, by Martin Stopford (Taylor & Francis 2009, 3rd Edition), discloses gas tankers for carrying hydrocarbons such as ethylene. Such tankers are referred to as hydrocarbon carrier vessels herein. Such vessels can carry their hydrocarbon cargo in refrigerated and/or pressurised tanks. Both refrigerated and pressurised tanks are known to have disadvantages. Pressurised tanks are heavy in order to contain the pressurised cargo. They therefore have a low cargo to tank weight ratio and have risks associated with the handling of pressurised cargo. It will be appreciated that liquefied hydrocarbon gas and hydrocarbon vapours can be flammable.

[0009] The invention provides a method of supplying a hydrocarbon load from a starting location to a destination, said method comprising at least the steps of:

- providing a hydrocarbon load at a starting location;
- transporting the hydrocarbon load from the starting location to an intermediate location;
- conditioning the hydrocarbon load at the intermediate location to provide a conditioned hydrocarbon load in the liquid state and at a pressure of about 1 to 2 bar, said conditioned hydrocarbon load present in a tank;
- transporting the tank comprising the conditioned hydrocarbon load from the intermediate location to a destination to provide the conditioned hydrocarbon load in the liquid state and at a pressure from about 1 to 2 bar at the destination.

[0010] Embodiments of the present invention will now be described by way of example only and with reference to the accompanying non-limited drawing in which:

Figure 1 is a diagrammatic scheme of one embodiment of a method of supplying a hydrocarbon load described herein;
Figure 2 is a diagrammatic scheme of another embodiment of a method of supplying a hydrocarbon load described herein;
Figure 3 is a diagrammatic scheme of one embodiment of a method and apparatus for the manufacture of a conditioned ethane stream described herein;
Figure 4 is a diagrammatic scheme of another embodiment of a method and apparatus for the manufacture of a conditioned ethane stream described herein;
Figure 6 is a diagrammatic scheme of an overhead view of a horizontal cross-section of one embodiment of a fluid transfer assemblage described herein;
Figure 7 is a diagrammatic scheme of a method of transferring a fluid between a first moveable floating structure and a second floating structure.

[0011] It is proposed to divide the total journey from the starting location to the destination in at least two legs, one leg between the starting location and an intermediate location and a final leg between the intermediate location and the destination. The hydrocarbon load is conditioned in the intermediate location, whereby to providing the hydrocarbon load in tank and in a conditioned form being in the liquid state and at a pressure of about 1 to 2 bar.

[0012] Herewith it is achieved that the hydrocarbon load always starts the final leg from the intermediate location to the destination in the conditioned form regardless of the state in which the hydrocarbon load arrived in the intermediate location. This way it is possible to transport the hydrocarbon load from the starting location to the intermediate location in a state that is different from the conditioned form of being in the liquid state at a pressure of about 1 to 2 bar. This makes it easier to supply the hydrocarbon load to the destination in the conditioned form, while gaining freedom to accept hydrocarbon loads in unconditioned form at the intermediate location.

[0013] The conditioning of the hydrocarbon load at the intermediate location ensures that the hydrocarbon load can be provided at the starting location, and arrive at the intermediate location, in any state, for instance in any phase, at any temperature and at any pressure. The transportation step from the starting location to the intermediate location is now much less constrained than it would have been if no conditioning of the hydrocarbon load would take place in the intermediate location.

[0014] The method of the present invention is of particular utility for the supply of a conditioned hydrocarbon load for use as a refrigerant at the destination. Providing conditioned hydrocarbon refrigerant means that the equipment necessary to condition the hydrocarbon refrigerant at the destination is not needed, thereby freeing space which can be put to other uses. This is of significant benefit, particularly where the destination is an off-shore location such as a floating structure or any other destination where available space for equipment is limited.

[0015] Providing a conditioned hydrocarbon load to a destination for use as a refrigerant is also advantageous when the destination comprises a natural gas liquefaction facility, and the natural hydrocarbon reservoir from which the natural gas is extracted does not contain sufficient concentrations of the hydrocarbon refrigerant components such as ethane and propane to allow their separation from the natural gas and use as refrigerants. Even if the natural gas does contain the necessary amounts of heavier hydrocarbons, it would require installation and operation of process equipment to extract the refrigerant components from the natural gas and to prepare them for use as refrigerant. In either case, the installation and operation of process equipment to extract and process the refrigerant components can be avoided by supplying the refrigerant components from a different location, thereby freeing space which can be put to other uses.

[0016] Figure 1 shows a schematic representation of the starting location 4, the intermediate location 6, and the destination 8. A first transportation leg 5 extends between and connects the starting location 4, the intermediate location 6. A final transportation leg 7 extends between and connects the intermediate location 6 and the destination 8. The locations spread over a geographical area 3 in the method disclosed herein.

[0017] The intermediate location 6 may be on-shore or off-shore, but is typically on-shore. If on-shore, the intermediate location may be located on the coast, such as at a port, or may be located inland.

[0018] In the embodiment shown in Figure 2, the starting location 4 consists of a plurality of geographically dispersed starting locations 4a, 4b, 4c. The hydrocarbon load comprises a plurality of hydrocarbon loads, one or more provided from each of the plurality of starting locations 4a, 4b, 4c. Likewise, the first transportation leg 5 is also divided over a plurality of first transportation legs 5a, 5b, 5c, whereby each of the plurality uniquely extends between and connects one of the starting locations 4a, 4b, 4c and the intermediate location 6, respectively over a distance d1, d2, d3. The distances d1, d2, d3 between the intermediate location 6 and each of the plurality of starting locations 4a, 4b, 4c may be unequal to each other.

[0019] The starting locations 4a, 4b, 4c may be any distance from one-another and from intermediate location 6. One or more of the starting locations 4a, 4b, 4c may be on or off-shore, but they are typically on-shore, such as at a hydrocarbon storage depot or hydrocarbon manufacturing facility.

[0020] Each load of said plurality of hydrocarbon loads is transported to the same intermediate location 6. The destination 8 may be located less than or equal to 500 km, preferably less than or equal to 300 km, and/or more than or equal to 50 km, preferably more than or equal to 100 km, from the intermediate location 6.

[0021] The distance between the destination 8 and the intermediate location 6 may for instance be in the range of from 10 km to 500 km, and preferably in the range of from 50 to 300 km.

[0022] The distance between the intermediate location 6 and the destination 8, may be less than the distance between the intermediate location 6 and the starting location 4. In one embodiment, the intermediate location 6 is at least 500 km, preferably at least 1000 km from the starting location or at least one of the plurality of starting locations 4a, 4b, 4c.

[0023] A hydrocarbon load is provided at the starting location 4, and transported from the starting location 4 to an intermediate location 6. Transporting the hydrocarbon load between the starting location 4 and the intermediate location 6 can be achieved by any suitable transporter or combination of transporters. For instance, the transporter may be a hydrocarbon carrier vessel in which the hydrocarbon load is transported in a hydrocarbon cargo tank. The hydrocarbon may be transported at atmospheric pressure or above. Preferably, the hydrocarbon may be in liquid form, at atmospheric pressure or in a pressurised cargo tank. The cargo tank may be a cryogenic tank which is thermally insulated.

[0024] A repurposed ethylene carrier vessel or similar is not required to maintain the hydrocarbon in its original state, such as a liquid, when transporting the hydrocarbon load from the starting location 4 to the intermediate location 6. Such carrier vessels may be efficient for the transportation of large quantities of hydrocarbons, but are uneconomic for the transportation of smaller quantities of hydrocarbons such as ethane and propane. The monthly average supply requirement for hydrocarbon refrigerant component on for instance an FLSO facility may be considerably less than the cargo carrying capacity of such a hydrocarbon carrier vessel, for instance 10% to 15 % or possibly less by volume. Thus, the use of hydrocarbon carrier vessels as the transporter may thus not be practical if the hydrocarbon is to be supplied to a FLSO on a monthly basis.

[0025] Any transporter may be used, preferably one that can carry and transport a tank on a standard intermodal container, or a skid-mounted tank. An example is a conventional container vessel. No means to refrigerate the tank and/or the hydrocarbon load or to condition the hydrocarbon load during the transportation on the first transportation leg 5 is required. It will be apparent that other means of transport, such as railroad or road, or even pipeline, may thus also be used.

[0026] Figure 2 shows the transportation of a plurality of hydrocarbon loads from their respective starting location 4a, 4b, 4c to the intermediate location 6 over transportation legs 5a, 5b, 5c, respectively. Any suitable mode of transportation can be employed for any of these transportation legs, and they do not have to be the same mode of transportation.

[0027] At the intermediate location 6 the hydrocarbon load is conditioned whereby a conditioned hydrocarbon load is provided, being in the liquid state and at a pressure of about 1 to 2 bar. The conditioned hydrocarbon load is present in a tank 15.

[0028] The tank 15 comprising the conditioned hydrocarbon load from the intermediate location 6 is transported to the destination 8. At the destination, the conditioned hydrocarbon load is delivered in conditioned form in the liquid state at a pressure from about 1 to 2 bar.

[0029] The final transportation leg 7 of transporting the tank 15 comprising the conditioned hydrocarbon load from may be carried out without the refrigeration of one or both of the tank 15 and conditioned hydrocarbon load contained therein, preferably without the refrigeration of both the tank and the conditioned hydrocarbon load contained therein.

[0030] The hydrocarbon loads may comprise one or more hydrocarbon components, and may more preferably comprise one or more hydrocarbon refrigerant components. The hydrocarbon load may consist for at least 95 mol%, preferably for at least 98 mol%, of a main hydrocarbon component. Examples of a main hydrocarbon component are ethane, ethylene, propane, propylene, butane or isobutene, and may be suitable for use as a refrigerant component without further fractionation. As used herein, the main hydrocarbon component is the one which constitutes the highest proportion, by mol%, of the fluid. The presently proposed supply method may thus dispense with the requirement for fractionation equipment at the destination, providing a fluid comprising the desired composition for operation as a refrigerant.

[0031] In one embodiment, the hydrocarbon load for at least 95 mol%, preferably at least 98 mol%, consists of ethane, with the balance being one or more further components. In another embodiment, the hydrocarbon load may for at least 95 mol%, preferably at least 98 mol%, consist of propane, with the balance being one or more further components.

[0032] Further components, in addition to the main hydrocarbon components may be present in the fluid, such as further hydrocarbons, mercury and/or water. Preferably, the further components do not preclude the operation of the conditioned ethane as a refrigerant component at the temperature and pressure under which the refrigerant is intended to be used. In this respect, particularly when used in aluminium-based heat exchangers, it is preferred that the conditioned ethane comprises less than 50 ng/m^3, preferably less than 10 ng/m^3, and more preferably less than 5 ng/m^3 mercury.

[0033] The hydrocarbon load may be provided at the starting location 4 at any temperature or pressure and as a liquid, gas or multiphase mixture of liquid and gas. The hydrocarbon load may be present at the first location 4 in one or more hydrocarbon storage tanks (not shown). The hydrocarbon storage tanks may be pressurised or unpressurised, such that the hydrocarbon load is held at or above atmospheric pressure. The hydrocarbon load may be held at or below ambient temperature. If the hydrocarbon load is held below ambient temperature, the storage tanks may be thermally insulated and/or the storage tanks/hydrocarbon load may be refrigerated. Thermally insulated storage tanks, particularly cryogenic storage tanks are well known in the art. Similarly, refrigerant systems, such as dedicated hydrocarbon refrigerant systems are known to the skilled person.

[0034] The hydrocarbon load may have been transported from another site to the starting location for storage, or may have been manufactured at the starting location.

[0035] Preferably, there is a fixed relationship between the characteristics (i.e. phase and pressure) of the conditioned hydrocarbon load as it departs from the intermediate location 6 and as it arrives at the destination 8, such that the conditioned hydrocarbon load is still in its conditioned state upon arrival at the destination 8, even when no active conditioning is performed on the final transportation leg 7.

[0036] Thus, the final transportation leg 7 between the intermediate location 6 to the destination 8 is preferably more predictable and reproducible, e.g. in terms of the duration of the journey, compared to the one or more transportation legs between the starting location 4 to the intermediate location 6, such that the conditioned hydrocarbon load is still in conditioned state upon arrival at the destination 8. This may be facilitated, for instance, when the duration for the journey from the intermediate location 6 to the destination 8 is shorter than the duration of the journey from the starting location 4 to the intermediate location 6.

[0037] In one embodiment, the ratio, by mass, of conditioned hydrocarbon in the tank 15 upon arrival at the destination 8 (numerator) to the conditioned hydrocarbon in the tank 15 immediately after conditioning at the intermediate location 6 (denominator) is at least 0.95, preferably at least 0.99.

[0038] In one embodiment, the conditioned hydrocarbon load at the intermediate location 6 has the same composition as discussed above for the hydrocarbon load at the starting location 4. As used herein, the phrase "same composition" is intended to mean the same, or substantially the same, proportion of components. If the hydrocarbon load provided at the starting location is a multiphase mixture, the components of all phases present, such as liquid and gas, are included in the calculation of the proportion of components.

[0039] In one preferred embodiment, the conditioned hydrocarbon load leaving the intermediate location 6 consists for at least 95 mol%, more preferably at least 98 mol%, of ethane. In another embodiment, the conditioned hydrocarbon load leaving the intermediate location 6 consists for at least 95 mol%, more preferably at least 98 mol%, of propane. It is preferred that the conditioned hydrocarbon load comprises less than 50 ng/m^3 mercury as already discussed.

[0040] In one embodiment, when at least 95 mol%, preferably at least 98 mol%, of the conditioned hydrocarbon load consists of ethane, it may have a temperature of ≤ -88 °C, preferably in a range of from -100 °C to -88 °C. In another embodiment, when at least 95 mol%, preferably at least 98 mol%, of the conditioned hydrocarbon load consists of propane, it may have a temperature of ≤ -42 °C, preferably in a range of from -100 °C to -42 °C. In either embodiment, the pressure may be between 1 and 2 bar.

[0041] In one embodiment, the hydrocarbon load may be present at the starting location 4a, 4b, 4c as conditioned hydrocarbon i.e. in the liquid state and at a pressure of from about 1 to 2 bar. If the conditioned hydrocarbon is produced at the starting location, it can be held in thermally insulated storage tanks, which may be refrigerated, for instance by integration with the cooling system necessary to produce the conditioned hydrocarbon in the liquid state. The conditioned hydrocarbon may have an identical composition to that of the hydrocarbon load discussed above.

[0042] In one embodiment, the hydrocarbon load provided at at least one starting location 4a, 4b, 4c may be conditioned ethane i.e. a hydrocarbon load which consists for at least 95 mol% of ethane in the liquid state and at a pressure of from about 1 to 2 bar. The conditioned ethane may be provided at a temperature of less than or equal to -88 °C, preferably in the range of from -100 °C to -88 °C.

[0043] In one embodiment, the hydrocarbon load may be provided in the starting location 4 as part of a hydrocarbon cracking process being carried out at the starting location 4. The hydro cracking process may suitably be a thermal cracking process. The hydrocarbon cracking process, particularly a hydrocarbon cracking process for the manufacture of ethylene, can for instance provide a stream of ethane of sufficient purity, such as for at least 95 mol% consisting of ethane, for use as a hydrocarbon refrigerant component without further fractionation.

[0044] Figure 3 illustrates an apparatus 400 for providing a stream of conditioned ethane 820. Figure 4 illustrates another embodiment of such an apparatus wherein several not necessarily interrelated options for modification of the apparatus of Figure 3 are illustrated.

[0045] In both Figure 3 and Figure 4, a C2 fractionator 600 is in fluid communication with a C2 hydrocarbon stream 510. The C2 hydrocarbon stream 510, which contains substantial amounts of ethane and ethylene, may be obtained from a hydrocracker, as will be explained later. The C2 fractionator 600 is configured to separate the C2 hydrocarbon stream 510 into a C2 overhead stream 610 consisting mostly of ethylene, and a C2 bottoms stream 620 consisting mostly of ethane. Conditioning means is provided, comprising a conditioning pressure reducing device 700 and a conditioning gas/liquid separator 800.

[0046] The apparatus 400 can be used to produce ethylene and a conditioned ethane stream 820. The C2 hydrocarbon stream 510 is separated in the C2 fractionator

600 into the C2 overhead stream 610 and the C2 bottoms stream 620. A portion 630 of the C2 bottoms stream 620 is conditioned using the conditioning means. The conditioning includes at least the steps of expanding the portion 630 of the C2 bottoms stream 620, preferably in the conditioning pressure reducing device 700, whereby an expanded portion 710 of the C2 bottoms stream 620 is formed. The conditioning further includes removing a gaseous C2 stream 810 from the expanded portion 710, to provide the conditioned ethane stream 820.

[0047] The conditioned ethane stream 820 is in the liquid state, at a pressure in the range of from about 1 to 2 bar, and comprises at least 95 mol% ethane. The conditioned ethane stream 820 preferably comprises at least 95 mol% ethane, with the balance containing one or both of ethylene and propylene.

[0048] The C2 hydrocarbon stream 510 may be obtained from a hydrocarbon cracker used for the cracking of a C2+ hydrocarbon feed stream 410. The apparatus shown in Figure 3 is an apparatus 400 for the production of ethylene, which has been adapted to produce the conditioned ethane stream 820 as well.

[0049] The C2+ hydrocarbon feed stream 410 is provided at the inlet of a cracking zone 430. The C2+ hydrocarbon feed stream 410 being fed to the cracking zone 430 comprises at least one hydrocarbon having two or more carbon atoms. Preferably the C2+ hydrocarbon stream may comprise one or more of the group comprising ethane, propane, butane, naphtha such as C_5-C_{12} hydrocarbons, gas oil and hydrocracked vacuum gas oils. The C2+ hydrocarbon feed stream may be provided at a pressure of greater than 4 bar, more preferably at a pressure in the range of from 5 to 10 bar.

[0050] The cracking zone 430 is configured to crack the C2+ hydrocarbon feed stream 410 into a cracked hydrocarbon stream 440. The cracking zone 430 may comprise or form part of a cracking furnace, such as a pyrolysis furnace, in which the C2+ hydrocarbon feed stream 410 can be thermally cracked. It is preferred that the thermal cracking takes place in the presence of stream, which can be provided to the cracking zone 430 as steam stream 420.

[0051] The cracking zone 430 may be operated at a temperature of greater than 650 °C, preferably in a range of from 750 to 950 °C, to promote free radical reactions in which at least C2 hydrocarbons including ethylene are produced. Typically the thermal cracking is carried out without the presence of oxygen. The cracked hydrocarbons exit the cracking zone 430 as cracked hydrocarbon stream 440. The cracked hydrocarbon stream 440 typically comprises ethylene and ethane, and it may contain other components, such as typically methane, propane, propylene, butane and optionally acetylene. The ethane is provided in the cracked hydrocarbon stream 440 as one or both of uncracked ethane which may have been present as a component of the C2+ hydrocarbon feed stream 410 and ethane produced as part of the cracking reaction, for instance from the break-up of longer chain hydrocarbons (i.e. those having more than two carbon atoms).

[0052] A quenched hydrocarbon stream 460 is obtained by quenching the cracked hydrocarbon stream 440. To this end, the cracked hydrocarbon stream 440 may then be passed to a quench zone 450 in which the temperature of the cracked hydrocarbon stream 440 is reduced to stop the cracking reaction. In the embodiment shown in Figure 3, the cracked hydrocarbon stream 440 is quenched by direct contact with a quench stream 470, which may be one or more streams comprising water and/or quench oil to provide a quenched hydrocarbon stream 460. The quenched hydrocarbon stream 460 may further comprise water and/or quench oil used in the quench zone 450.

[0053] In an embodiment not shown in Figure 3 or 4, the cracked hydrocarbon stream 440 may be first cooled, preferably by indirect (i.e. non-contact) heat exchange, against a heat exchange fluid, such as a heat exchange fluid stream, in a quench heat exchanger prior to direct contact with the quench stream 470. The heat exchange fluid may be liquid water, such that after heat exchange, a steam stream is generated.

[0054] A compressed hydrocarbon stream 490 may next be obtained by compressing the quenched hydrocarbon stream 460. To this end, the quenched hydrocarbon stream 460 may be passed to a quenched stream compressor 480 which is arranged in fluid communication with the quench zone 450 and the quenched hydrocarbon stream 460. Prior to passage to the suction of the quenched stream compressor 480, the quenched hydrocarbon stream 460 may be passed through a quenched stream gas/liquid separation device (not shown), such as a knock-out drum, to remove liquid from the stream. The quenched stream compressor 480 may be a single compressor or a plurality of compressors in series. The quenched stream compressor 480 may be single or multistage. If a plurality of compressors are present, these may or may not share the same drive shaft. The quenched stream compressor 480 can be driven by a compressor driver 485, such as an electric motor or a turbine, such as a gas or steam turbine.

[0055] The quenched stream compressor 480 provides a compressed hydrocarbon stream 490 at its discharge. The compressed hydrocarbon stream 490 may have a pressure in the range of from 10 to 50 bar. An optional step comprising removal of acid gasses may be applied to the compressed hydrocarbon stream 490 and/or the quenched hydrocarbon stream 460. This is option if the compressed hydrocarbon stream 490 and/or the quenched hydrocarbon stream 460 comprises acid gas such as carbon dioxide and/or gaseous oxides of sulphur and it is desired to lower their concentration. An example is shown in Figure 4, where an acid gas removal system 495 is provided in the compressed hydrocarbon stream 490, wherein the compressed hydrocarbon stream 490 can be contacted with an acid gas absorbent liquid 496. Examples of acid gas absorbent liquid 496 include monoethanolamine or an aqueous alkali solution such as an alkali metal hydroxide, for instance sodium hydroxide solution.

[0056] The compressed hydrocarbon stream 490, optionally after treatment to lower the concentration of acid gas, may then be passed to a hydrocarbon separation zone 500 in which the compressed hydrocarbon stream 490 is cooled and fractionated to provide the C2 hydrocarbon stream 510 as one of the fractionated streams. The hydrocarbon separation zone 500 is arranged to receive the discharge outlet of the quenched stream compressor 480. The C2 hydrocarbon stream 510 is enriched in ethane and ethylene relative to the cracked hydrocarbon stream 440, such that it comprises a higher mol% concentration of these components. The C2 hydrocarbon stream 510 may be in vapour phase.

[0057] Typically, the step of cooling and separating the compressed hydrocarbon stream 490 in the hydrocarbon separation zone 500 further provides a C1 hydrocarbon stream 520 comprising methane. The step of cooling and separating the compressed hydrocarbon stream 490 generally provides cooling and single or multiple fractionation steps.

[0058] The C2 hydrocarbon stream 510 may be provided at a temperature of less than -10 °C, more preferably in the range of from -40 to -20 °C, still more preferably at about -30 °C. The C2 hydrocarbon stream 510 may be a pressurised stream with respect to atmospheric pressure, and preferably has a pressure of greater than 10 barg, more preferably in the range of from 10 to 25 barg, still more preferably about 17 barg.

[0059] The pressures of the C2 overhead stream 610 and C2 bottoms stream 620 will be similar to that of the C2 hydrocarbon stream 510 with only a small pressure drop in C2 fractionator 600. Preferably, the pressures of the C2 overhead stream 610 and C2 bottoms stream 620 will be in the range of from 10 to 25 barg, more preferably about 17 barg.

[0060] The C2 overhead stream 610 may be provided at a temperature of less than -25, more preferably in a range of from -40 to -30 °C, still more preferably at about - 35 °C. The C2 overhead stream 610 may comprise ethylene vapour. The C2 bottoms stream 620 may be provided at a temperature of less than 0 °C, more preferably in a range of from -15 to -5 °C, still more preferably about -10 °C. The C2 bottoms stream may comprise ethane liquid. The C2 bottoms stream may comprise at least 95 mol% ethane.

[0061] The portion 630 of the C2 bottoms stream 620 that is subject to the conditioning in the conditioning means, as described above, may be a C2 bottoms slip stream. A remainder of the C2 bottoms stream 620, which is not included in the portion 630 of the C2 bottoms stream 620, may be employed as a C2 recycle stream 640. In such cases, the remainder of the C2 bottom stream 620 is recycled to form part of the C2+ hydrocarbon feed stream 410. The C2 recycle stream 640 may be passed to a first recycle stream pressure reduction device 910, such as a Joule-Thomson valve, to provide a first expanded C2 recycle stream 650 having a pressure of about or above that of the C2+ hydrocarbon feed stream 410.

[0062] Cold from the C2 recycle stream 640 and/or from the first expanded C2 recycle stream 650 after the optional pressure reduction step in the pressure reduction device 910 may be recovered by heat exchanging with a cold recovery stream. The resulting C2 recycle stream from which the cold has been recovered is a first warmed C2 recycle stream 930. The first warmed C2 recycle stream 930 may be allowed to form part of the C2+ hydrocarbon feed stream 410, which completes the recycling.

[0063] Figure 3 illustrates an embodiment wherein, prior to passing the first expanded C2 recycle stream 650 to the C2+ hydrocarbon feed stream 410, a portion of the cold is recovered from this stream. In this example, the first expanded C2 recycle stream 650 may be passed to a first recycle heat exchanger 920 in which it is heat exchanged against a heat exchange fluid, such as a refrigerant, thereby heating the first expanded C2 recycle stream 650 to provide a first warmed C2 recycle stream and a cooled heat exchange fluid. The first recycle heat exchanger 920 may be a shell and tube or a plate and fin heat exchanger. The heat exchange fluid such as a refrigerant may be used in the hydrocarbon separation zone 500. The first warmed C2 recycle stream 930 comprising ethane vapour may be injected into the C2+ hydrocarbon feed stream 410.

[0064] After having passed through the conditioning pressure reduction device 700 it has become an expanded C2 slip stream 710. The conditioning pressure reduction device 700 may suitably be a Joule-Thomson valve. The expanded portion 710, such as the expanded C2 slip stream, may be a multi-phase stream that comprises gaseous and liquid phases. The gaseous C2 stream 810 that is removed from the expanded portion 710 comprises the gaseous phase from the multi-phase stream. Said removing of the gaseous C2 stream 810 from the expanded C2 slip stream comprises separating the expanded C2 slip stream into the gaseous C2 stream 810 and a liquid C2 stream. To this end, the expanded portion 710 may be passed to the conditioning gas/liquid separator 800.

[0065] The conditioned ethane stream 820 is obtained from the liquid C2 stream. In one group of embodiments, illustrated in Figure 3, the liquid C2 stream may be in the form of the conditioned ethane stream 820, without further steps. In such cases, the liquid C2 stream is already conditioned to meet the predetermined target for the conditioned ethane stream 820 wherein the conditioned ethane stream is in the liquid phase and at a pressure of about 1 to 2 bar. Thus, the liquid C2 stream may have a temperature in the range of from less than or equal to -88 °C, preferably in the range of from -100 °C to -88 °C.

[0066] An alternative embodiment is shown in Figure 4 wherein the liquid C2 stream is subject to further cooling, before it is discharged as the conditioned ethane stream 820. This will be further explained below.

[0067] In any case, including each of the embodiments of Figures 3 and 4, the conditioned ethane stream 820 may be conveyed directly to a conditioned ethane storage tank 900. The conditioned ethane storage tank 900 is preferably a thermally insulated storage tank. The conditioned ethane storage tank 900 may be provided on an intermodal container, preferably in the form of tank 15 described herein.

[0068] As a result of the C2 separation in C2 fractionator 600, the liquid C2 stream preferably comprises at least 95 mol% ethane, more preferably at least 98 mol% ethane. The balance of the liquid C2 stream may be one or both of ethylene and propylene, together with other further components.

[0069] The gaseous C2 stream 810 comprising ethane from the conditioning gas/liquid separating device may be recycled to the C2+ hydrocarbon feed stream 410 to form part of the C2+ hydrocarbon feed stream. Optionally the pressure of the stream is adjusted in a pressure adjustment step, to a pressure about that of, or just above that of, the C2+ hydrocarbon feed stream 410. This pressure adjustment may require the compression of the gaseous C2 stream 810, for instance in a second recycle stream compressor (not shown).

[0070] Cold from the gaseous C2 stream 810, either before or after the optional pressure adjustment step if such step is employed, may be recovered by heat exchanging with a cold recovery stream. Figures 3 and 4 show embodiments wherein, prior to passing the gaseous C2 stream 810 to the C2+ hydrocarbon feed stream 410 or a second recycle stream compressor, at least a portion of the cold is recovered from this stream. For example, the gaseous C2 stream 810 may be passed to a second recycle heat exchanger 1000, such as a shell and tube or a plate and fin heat exchanger, in which it is heat exchanged against a heat exchange fluid, such as a refrigerant, thereby heating the gaseous C2 stream 810 and cooling the heat exchange fluid.

[0071] The resulting gaseous C2 stream 810 from which the cold has been recovered may be a second warmed C2 recycle stream 1010. The second warmed C2 recycle stream 1010 may be allowed to form part of the C2+ hydrocarbon feed stream 410, which completes the recycling. Figure 4 shows an example wherein the optional pressure adjustment step 1005 is applied to the second warmed C2 recycle stream 1010 after the optional cold recovery.

[0072] The cooled heat exchange fluid 1001 may be used in the hydrocarbon separation zone 500. The second warmed C2 recycle stream 1010 comprising ethane vapour may be injected into the C2+ hydrocarbon feed stream 410 after optional compression as discussed above.

[0073] The recovered cold from the C2 recycle stream 640 and/or from the first expanded C2 recycle stream 650 and/or from the gaseous C2 stream 810, either before or after the optional pressure adjustment step if such step is employed, may be used in the hydrocarbon cracker to assist in the cracking process, such as in the cooling of the compressed hydrocarbon stream 490 in the hydrocarbon separation zone 500, or in the part cooling of a refrigerant stream which may be used in one or both first and second conditioning heat exchangers that will be discussed below.

[0074] As illustrated in Figure 4, the C2 bottoms slip stream 630 may be heat exchanged and cooled against (i) a portion of the C2 recycle stream 640 after a pressure reduction step and/or (ii) a portion of the gaseous C2 stream 810, optionally after an pressure reduction step. In a still further embodiment, the liquid C2 stream 815 may be heat exchanged and cooled against (i) a portion of the C2 recycle stream 640 after a pressure reduction step and/or (ii) a portion of the gaseous C2 stream 810, optionally after a pressure reduction step. Thus, within the meaning of the present disclosure, one or both of the C2 recycle stream 640, or a portion thereof, and the gaseous C2 stream 810, or a portion thereof may be used as refrigerant stream.

[0075] In an embodiment shown in Figure 4, the liquid C2 stream 815 from the conditioning gas/liquid separator 800 can be heat exchanged against a refrigerant stream 831 in a first conditioning heat exchanger 830, whereby transferring heat from the liquid C2 stream 815 to the refrigerant stream 831. In such embodiments the conditioned ethane stream 820 is formed by the liquid C2 stream 815 from which heat has been extracted in the first conditioning heat exchanger 830. The liquid C2 stream 815 can thus be cooled against the refrigerant stream 831 to provide the conditioned ethane stream 820 in a sub-cooled condition, for instance as a sub-cooled conditioned ethane stream, and a warmed refrigerant stream 832. The sub-cooled conditioned ethane stream may have a temperature of less than -90 °C. The refrigerant stream 831 may be a refrigerant in an external cooling circuit dedicated for this purpose, or part of an integrated cooling circuit with at least one further heat-exchange elsewhere in the ethylene production facility, for instance in hydrocarbon separation zone 500. The refrigerant in the refrigerant stream 831 may be methane or mainly consist of methane.

[0076] Alternatively, the refrigerant stream 831 may be a portion of the gaseous C2 stream 810 which has been expanded in a second recycle pressure reduction device, such as a Joule-Thomson valve, to provide an expanded gaseous C2 stream. The heat exchange of the liquid C2 stream 815 against the expanded gaseous C2 stream provides the conditioned ethane stream 820, for instance as a sub-cooled stream and a warmed gaseous C2 stream. The warmed gaseous C2 stream may be subsequently compressed in a pressure adjustment step, for instance in a second recycle stream compressor, to provide a second warmed C2 recycle stream which can be passed to the C2+ hydrocarbon feed stream 410.

[0077] In another alternative embodiment, the refrigerant stream 831 may be a portion of the C2 recycle stream 640, which may have been expanded in a first recycle stream pressure reduction device 910, such as a Joule-Thomson valve, to provide a first expanded C2 recycle stream 650. The liquid C2 stream 815 can be heat exchanged against the first expanded C2 recycle stream 650 to provide the conditioned ethane stream 820, for instance as a sub-cooled stream and a warmed further first expanded C2 recycle stream. The warmed first expanded C2 recycle stream 650 can be passed to the C2+ hydrocarbon feed stream 410, for instance after compression in a first recycle stream compressor to provide a first compressed C2 recycle stream.

[0078] In such alternative embodiments, the first conditioning heat exchanger 830 may therefore be provided by first or second recycle heat exchangers 920, 1000.

[0079] In a further alternative embodiment, the C2 bottoms slip stream 630 may be heat exchanged against a refrigerant stream 731 in a second conditioning heat exchanger 730. The C2 bottoms slip stream 630 can be cooled against the refrigerant stream 731 to provide a cooled C2 bottoms slip stream 635, and a warmed refrigerant stream 732. In a similar manner to the previous embodiments, the refrigerant stream 731 may be a refrigerant in an external cooling circuit dedicated for this purpose, or part of an integrated cooling circuit with at least one further heat-exchange elsewhere in the ethylene production facility, for instance in hydrocarbon separation zone 500. Alternatively, the refrigerant stream may be a portion of the first expanded C2 recycle stream 650 and/or a portion of the gaseous C2 stream 810. In these cases, the second conditioning heat exchanger 730 may therefore provided by said first or second recycle heat exchangers 920, 1000.

[0080] Still referring to Figure 4, the so optionally cooled C2 bottoms slip stream 635 can be passed through the conditioning pressure reduction device 700, which has already been described herein above, to provide the expanded C2 slip stream 710 as a multi-phase stream comprising gaseous and liquid phases.

[0081] In all embodiments represented by Figures 3 and 4, the expanded C2 slip stream 710 can be passed to the conditioning gas/liquid separator 800, in which the multi-phase stream is separated to provide the gaseous C2 stream 810 comprising ethane vapour, and the liquid C2 stream 820 comprising ethane liquid. The cooling of the C2 bottoms slip stream 630 by heat exchange against said refrigerant 731 is advantageous because this produces a higher proportion of the liquid C2 stream 815 compared to the gaseous C2 stream 810 after expansion and gas/liquid separation, thereby allowing for producing a higher proportion of the conditioned ethane stream 820.

[0082] Returning to Figure 1, once provided, the hydrocarbon load, which may be formed from the conditioned ethane stream 820, is transported from the starting location 4 to the intermediate location 6. In the embodiment illustrated in Figure 1, for example, the tank 15 has been filled with the hydrocarbon load already at the starting location 4. The transporting of the tank 15 to the intermediate location 6 may involve loading the tank 15 onto a container vessel 17 (or another suitable transporter), and transporting the tank 15 by the container vessel 17 or other suitable transporter. The tank 15 may subsequently be off-loaded from the container vessel 17 or other suitable transporter. The off-loading may be done at the intermediate location 6 and/or at any auxiliary location 2 as will be explained.

[0083] The transportation to the intermediate location 6 may occur via multiple transportation legs via one or more auxiliary locations 2 that are geographically separated from both the starting location 4 and the intermediate location 6, preferably by at least 50 km. An example is shown in Figure 5. In such a configuration, the tank 15 may be off-loaded from the transporter (such as container vessel 17) on which is carried in the auxiliary location 2. After off-loading the tank 15 from the container vessel 17 or other transporter in the auxiliary location 2, the tank may be further transported from the auxiliary location 2 to the intermediate location 6 over a second transportation leg 9. This may be done using the same mode of transportation, but typically will be done using a different mode of transportation.

[0084] For instance, the auxiliary location 2 may be a seaport where the tanks 15 are off-loaded and re-loaded onto a rail car for further transportation over transportation leg 2. In another example, the auxiliary location 2 may be a sea port where the tanks are filled with the hydrocarbon load which arrived in a tanker.

[0085] In the example of Figure 5 all of the hydrocarbon loads from the plurality of starting locations pass through the auxiliary location 2, but this is not a requirement of the invention. One of more of the plurality of the hydrocarbon loads may bypass the auxiliary location 2 or pass through another auxiliary location (not shown).

[0086] Any suitable transportation means, or combination of transportation means, may be used to transport the hydrocarbon load from the starting location 4 to the intermediate location 6, such as one or more of truck, rail car, carrier vessel etc.

[0087] For instance, the hydrocarbon load may be transferred from a hydrocarbon storage tank 900 at the starting location 4, such comprised in the ethylene cracker of Figures 3 or 4 or another hydrocarbon manufacturing facility, to an auxiliary location 2, over water, road or rail. The hydrocarbon load may alternatively be pumped from the starting location 4 to the auxiliary location 2.

[0088] The hydrocarbon load may then be transported from the auxiliary location 2 to the intermediate location 6, optionally via second, third or additional auxiliary locations, using the same or a different mode of transportation. For instance, the hydrocarbon load may be transported over water from the auxiliary location 2 in the form of a sea port to a second auxiliary location (not shown) which may also be in the form of a sea port. The hydrocarbon load may then be transported from the second auxiliary location to the intermediate location 6, over water or land.

[0089] The hydrocarbon load may be transported in a tank. As used herein, the term "tank" is a storage container for the hydrocarbon load. The tank may be present in the cargo hold of a hydrocarbon carrier vessel, a trailer for a truck or a rail carriage. In some embodiments, the tank is present as part of an intermodal container, which can be transported from one location to another, and from one transporter to another, without off-loading and reloading of the contents of the container (in this case the hydrocarbon load).

[0090] An intermodal container comprising at least the tank is ideally suited to this purpose because it can be used in a global containerised intermodal freight transport system in which it can be used with and transferred between many modes of transport including ship, rail or truck.

[0091] Preferably the tank, such as the cargo tank of a carrier vessel or in an intermodal container is thermally insulated and vapour-tight, particularly if it is intended to transport the hydrocarbon load in a conditioned form, which is in the liquid state.

[0092] The tank carrying the hydrocarbon load, particularly in a hydrocarbon carrier vessel, may be refrigerated. Refrigeration is typically carried out when the hydrocarbon load is or comprises conditioned hydrocarbon, in order to maintain it in the liquid state. A tank refrigeration system comprising tank refrigerant, tank heat exchanger, tank refrigerant compressor, tank refrigerant cooler and optionally a tank refrigerant pressure reduction device may be provided. The tank heat exchanger heat exchanges and cools the hydrocarbon load, which may be present as boil off gas from the hydrocarbon load, against the tank refrigerant to cool the hydrocarbon load and warm the refrigerant. The tank refrigerant compressor compresses the warmed tank refrigerant to provide compressed tank refrigerant. The compressed tank refrigerant can then be cooled in the tank refrigerant cooler to provide cooled tank refrigerant, which can then be optionally expanded by the tank refrigerant pressure reduction device to provide cooled, optionally expanded, tank refrigerant which can be used in the heat exchange against the hydrocarbon load. Such systems are known in the art.

[0093] The tank may also take the form of a high pressure tube, one or more of which may be mounted on a skid for transportation. The high pressure tube is suited for the transportation of the hydrocarbon load if it has a pressure above ambient pressure and/or for if it is provided in the form of a multiphase mixture. In a high pressure tube the hydrocarbon load may have a pressure of > 30 bar, preferably in the range of from 35 to 165 bar. Such hydrocarbon loads are typically multi-phase mixtures comprising vapour and liquid phases. It will be apparent that such pressurised tubes are unsuited for the transportation of conditioned hydrocarbons in the liquid state and at a pressure of from about 1 to 2 bar.

[0094] In more detail, the step of transporting the hydrocarbon load from the starting location 4 to the intermediate location 6 may comprise:

- loading the tank 15 comprising the hydrocarbon load, such as an intermodal container 10 comprising the tank 15, or one or more pressurised tubes on a skid, onto a container vessel 17, for instance by crane;
- transporting the tank 15 on the container vessel by sea; and
- off-loading the tank 15 or the one or more pressurised tubes from the container vessel 17, for instance by another crane.

[0095] The step of loading the tank 15 or the pressurised tubes onto the container vessel 17 may place at a first port, which may be in the starting location 4, or any auxiliary location 2 geographically separated from the starting location 4 and intermediate location 6. The step of off-loading the tank 15 from the container vessel 17 may take place at a second port, which may be in the intermediate location 6 or the in auxiliary location 2.

[0096] The step of transporting the hydrocarbon load from the starting location 4 to the intermediate location 6 may further comprise, after off-loading the tank 15 from the container vessel 17 at the auxiliary location 2, further transporting the tank 15 from the auxiliary location 2 to the intermediate location 6, for instance by truck or rail.

[0097] The hydrocarbon load can arrive at the intermediate location 6 after transport from the starting location 4 in any state, temperature and pressure, and not just the state in which it was provided at the starting location 4. This is because conditioning of the hydrocarbon load is carried out at the intermediate location 6. It is the conditioning which sets the state and pressure range at which the conditioned hydrocarbon load is supplied to the destination 8.

[0098] Thus, a hydrocarbon load provided at the starting location 4 as conditioned hydrocarbon may arrive at the intermediate location 6, in non-conditioned state. In non-conditioned state the hydrocarbon load is not in the liquid state and/or is not at a pressure in the range of from about 1 to 2 bar. For instance, the hydrocarbon load may comprise hydrocarbon vapour at a pressure greater than 2 bar upon arrival at the intermediate location 6. For this reason, the transportation step from starting to intermediate locations can be carried out without refrigeration of the hydrocarbon load, even when it is provided as conditioned hydrocarbon. For similar reasons, the duration of the transportation step between the starting and intermediate locations is not limited, because there is no need to preserve any particular property of the hydrocarbon load.

[0099] The conditioning step at the intermediate location 6 may comprise discharging the hydrocarbon load from the tank or tube in which it is transported to the intermediate location 6. For instance, if the hydrocarbon load is transported in the cargo tank of a hydrocarbon tanker, it can be off-loaded at the port, for instance via flexible piping or fluid loading arms. Similarly, if the hydrocarbon load is transported in a high pressure tube, it can be transferred from the tube to be conditioned. The hydrocarbon load may then be conditioned exterior to the tank or tube and reloaded into a suitable tank 15 for transportation along the final transportation leg 7 to the destination 8.

[0100] Alternatively, the hydrocarbon load may be loaded into the suitable tank 15 and then conditioned inside the tank 15. If the hydrocarbon load is already transported to the intermediate location 6 in a suitable tank 15, the conditioning step may be carried out in the same tank 15 in which the hydrocarbon load arrived at the intermediate location 6. The hydrocarbon load may have been this tank 15 since it was provided at the starting location 4, or may have been transferred to that tank 15 at an auxiliary location 2.

[0101] The conditioning step comprises at least the step of heat exchanging the hydrocarbon load against a conditioning refrigerant whereby extracting heat from the hydrocarbon load to provide the conditioned hydrocarbon load. The heat exchange cools the hydrocarbon load and warms the conditioning refrigerant to provide warmed conditioning refrigerant. If the hydrocarbon load comprises vapour, the conditioning step may liquefy at least a part of the vapour.

[0102] The conditioning step utilises conditioning means comprising at least a conditioning heat exchanger in which the hydrocarbon load is heat exchanged against the conditioning refrigerant to provide the conditioned hydrocarbon load.

[0103] The conditioning refrigerant preferably has an atmospheric bubble point lower than the atmospheric bubble point of the hydrocarbon load to be conditioned. Preferably the conditioning refrigerant has an atmospheric bubble point lower than the main hydrocarbon component of the hydrocarbon load. The conditioning refrigerant may be selected from one or more of the group comprising nitrogen, methane, ethane, propane and butane. When the hydrocarbon load comprises ethane as the main hydrocarbon component, the conditioning refrigerant may be nitrogen or methane. When the hydrocarbon load comprises propane as the main hydrocarbon component, the conditioning refrigerant may be nitrogen, methane or ethane. In a preferred embodiment, the conditioning refrigerant is nitrogen, more preferably liquid nitrogen.

[0104] If the conditioning step is carried out in the tank 15 holding the hydrocarbon load, then the tank may further comprise tank conditioning means comprising a tank conditioning heat exchanger. For instance, the tank 15 may comprise one or more conditioning refrigerant coils through which the conditioning refrigerant is passed during conditioning and whereby heat is exchanged between the conditioning refrigerant and the hydrocarbon load contained in the tank 15 whereby the hydrocarbon load is cooled. The tank 15 may therefore function as a shell and tube heat exchanger with the hydrocarbon load on the shell side and the refrigerant in the tube side.

[0105] The conditioning means comprising the conditioning heat exchanger may be a closed or open refrigerant system. A closed refrigerant system is one in which after heat exchange, all the conditioning refrigerant is treated and recirculated so that it may carry out further conditioning.

[0106] In an open refrigerant system, only a part, or none of the refrigerant may be treated and recirculated so that it may carry out further conditioning. For example, an open refrigerant system may comprise a conditioning refrigerant storage tank, which is preferably vapour tight and thermally insulated, and the tank conditioning heat exchanger. A conditioning refrigerant stream, such as a liquid nitrogen stream, can be passed from a conditioning refrigerant storage tank to the tank conditioning heat exchanger, where it is heat exchanged against the hydrocarbon load to provide conditioned hydrocarbon load.

[0107] After heat exchange, the warmed conditioning refrigerant stream may be a single phase stream comprising gaseous conditioning refrigerant or a multi-phase stream comprising liquid and gaseous conditioning refrigerant. In an open refrigerant system, when the conditioning refrigerant is nitrogen, any gaseous nitrogen produced by the heat exchange can be vented to the atmosphere. Thus, when the warmed conditioning refrigerant stream is a single phase stream comprising gaseous nitrogen, it can be vented. In an alternative embodiment, when the warmed conditioning refrigerant stream is a multi-phase stream comprising liquid and gaseous conditioning refrigerant, it can be passed to a conditioning refrigerant gas/liquid separation device in which the phases are separated to provide a conditioning refrigerant return stream comprising liquid conditioning refrigerant and a conditioning refrigerant continuing stream comprising gaseous conditioning refrigerant. The conditioning refrigerant return stream can be passed to the conditioning refrigerant storage tank. When the conditioning refrigerant is nitrogen, the conditioning refrigerant continuing stream, which comprises gaseous nitrogen, can be vented to the atmosphere.

[0108] In an alternative embodiment, in a closed refrigerant system, either the warmed conditioning refrigerant stream, particularly if it is a single phase gaseous stream, or the conditioning refrigerant continuing stream, can be passed to a conditioning refrigerant compressor in which either stream is compressed to provide a compressed conditioning refrigerant stream. The compressed conditioning refrigerant stream can then be cooled in a conditioning refrigerant cooler, for instance against ambient air, or a further refrigerant in a further refrigerant system, to provide a cooled conditioning refrigerant stream. The cooled conditioning refrigerant stream may then be optionally expanded in a conditioning refrigerant pressure reducing device, such as a Joule-Thomson valve, to provide a cooled, optionally expanded conditioning refrigerant stream, which can be passed back to the conditioning refrigerant storage tank for reuse.

[0109] It will be apparent that when the tank conditioning heat exchanger is present in a tank comprising the hydrocarbon load, such as the tank 15 of an intermodal container 10, the conditioning step may comprise connecting the tank conditioning heat exchanger to conditioning refrigerant storage tank such that they are in fluid communication, passing the conditioning refrigerant through the tank conditioning heat exchanger thereby heat exchanging and cooling the hydrocarbon load to provide a conditioned hydrocarbon load in the tank, and disconnecting the conditioning refrigerant storage tank from the tank conditioning heat exchanger.

[0110] If the conditioning heat exchanger is not provided in the tank 15 holding the hydrocarbon load, the hydrocarbon load can be passed, for instance from a hydrocarbon load storage tank, to a conditioning means in which it is conditioned. The conditioning means can comprise a conditioning heat exchanger and optionally a conditioning refrigerant gas/liquid separator, a conditioning refrigerant compressor, a conditioning refrigerant cooler and a conditioning refrigerant pressure reduction device as discussed above. The conditioning means may be an open or closed refrigerant system as already discussed.

[0111] If a conditioned hydrocarbon was provided at the starting location 4, the hydrocarbon load may no longer comprise conditioned hydrocarbon upon arrival at the intermediate location, or the proportion of conditioned hydrocarbon in the hydrocarbon load may have decreased. In such a case, the conditioning step re-conditions the hydrocarbon load at the intermediate location to restore its properties, and in particular to return the hydrocarbon to liquid form and a pressure of about 1 to 2 bar.

[0112] The properties of the conditioned hydrocarbon may have changed during transportation between the starting location 4 and intermediate location 6, for instance due to unavoidable thermal transfer from the environment, leading to evaporation of the hydrocarbon and an increase in vapour content, for instance within the tank.

[0113] The conditioning of the hydrocarbon load may also comprise the further treatment of the hydrocarbon load at the intermediate location 6. For instance, the hydrocarbon load may be treated to remove inerts such as water during the conditioning step. The hydrocarbon load may also be fractionated during the conditioning step, to increase the proportion of the main hydrocarbon component. However, it is preferred that the composition of the conditioned hydrocarbon load provided at the intermediate location is substantially the same as that of the hydrocarbon load provided at the starting location, such that no fractionation of the hydrocarbon load is required at the intermediate location. Thus, in one embodiment, the composition of the hydrocarbon load provided at the starting location 4, in terms of the proportion of hydrocarbon components, is substantially the same as that of the conditioned hydrocarbon load provided by conditioning at the intermediate location 6.

[0114] If the conditioning step is not carried out in a tank, the conditioned hydrocarbon load can be passed from the conditioning means to the tank 15. The tank 15 is preferably thermally insulated and vapour tight. In a preferred embodiment, the tank is present in an intermodal container 10.

[0115] In the embodiment of Figure 2 and 5, a plurality of hydrocarbon loads are provided to the intermediate location 6. The conditioning step may thus further comprise the step of combining the plurality of hydrocarbon loads to provide the conditioned hydrocarbon. This combining step can be carried out before the step of heat exchanging the hydrocarbon loads against a conditioning refrigerant, such that the plurality of hydrocarbon loads are combined into a single (combined) hydrocarbon load which is then conditioned to provide the conditioned hydrocarbon load. Alternatively, each hydrocarbon load may be conditioned separately, and the conditioning step may further comprise the step of combining a plurality of conditioned hydrocarbon loads. The conditioned hydrocarbon load may be passed to a tank or a plurality of tanks.

[0116] If the plurality of hydrocarbon loads are of the same composition, the conditioned hydrocarbon load or plurality of conditioned hydrocarbon loads will have a similar composition to that of the plurality of hydrocarbon loads but be in the liquid state and at a pressure of from 1 to 2 bar.

[0117] If the plurality of hydrocarbon loads have two or more different compositions e.g. a first hydrocarbon load comprises ethane as a main hydrocarbon component and a second hydrocarbon load comprises propane as a main hydrocarbon component, then these can be combined at the intermediate location in a predetermined proportion to provide a conditioned hydrocarbon load which comprises the components of the hydrocarbon loads. Thus, the conditioning step may further comprise the step of combining the plurality of hydrocarbon loads of different compositions in a predetermined proportion to provide a combined hydrocarbon load comprising the components of the plurality of hydrocarbon loads.

[0118] The step of combining the hydrocarbon loads can be carried out before the heat exchange against the conditioning refrigerant such that a combined hydrocarbon load is provided which is subsequently heat exchanged against a conditioning refrigerant to provide the conditioned hydrocarbon load. Alternatively, the conditioning step may comprise the step of heat exchanging the plurality of hydrocarbon loads against conditioning refrigerant to provide a plurality of conditioned hydrocarbon loads. The plurality of conditioned hydrocarbon loads may then be combined in predetermined proportion to provide a (combined) conditioned hydrocarbon load in a tank, the (combined) conditioned hydrocarbon load comprising the components of the plurality of hydrocarbon loads, in the liquid state and at a pressure of from about 1 to 2 bar. The (combined) conditioned hydrocarbon load in the tank can then be transported from the intermediate location 6 to the destination 8.

[0119] When the destination 8 is an off-shore location, such as a FLSO, and the intermediate location is a port, the tank can be transported in a single transportation step, for example by the supply vessel. For instance, the tank 15, preferably as part of the intermodal container 10, can be loaded aboard the supply vessel, for instance by crane, and then transported to the off-shore destination 8.

[0120] When the destination 8 is an off-shore location, and the intermediate location 6 is not a port, the final transportation leg 7 may comprise two or more transportation stages. The tank comprising the conditioned hydrocarbon load can be first transported from the intermediate location 6 to an auxiliary location (not shown) which is a port, for instance by road or rail. At the port, the tank can be loaded onto the supply vessel. In a second transporting stage, the tank comprising the conditioned hydrocarbon load can be transported from the port at the auxiliary location to the off-shore destination 8 by the supply vessel. A fluid supply assemblage suited to this purpose is discussed in relation to Figures 6 and 7 below.

[0121] Figure 6 shows a horizontal cross-section of one example of such as fluid supply assemblage 1, as viewed from above a base 140. The fluid supply assemblage 1 comprises a plurality of intermodal containers 10a, 10b, 10c. The cross-section is taken mid-way through the intermodal containers 10. Although three intermodal containers 10a, 10b, 10c are shown in the embodiment of Figure 6, the assemblage may comprise more or less containers, such as 2, 4, 5, 6, 7, 8, 9, 10 or more than 10. The intermodal containers may be of any size, but are typically 20 feet (6.10 m) or 40 feet (12.19 m) in length for use in a global containerised intermodal freight transport system

[0122] Each intermodal container 10a, 10b, 10c comprises a tank 15a, 15b, 15c for a fluid. Preferably the tank 15 is thermally insulated, more preferably multi-layer thermally insulated, when it is to hold cryogenic fluid. The thermal insulation may include a vacuum jacket (not shown). Preferably the tank 15 is vapour tight.

[0123] The use of intermodal containers comprising a tanks that are thermally insulated and/or vapour-tight, provides the advantage that the fluid may be transported and supplied in the form in which it can be most readily transferred, stored and used at its destination such as a floating structure. The fluid may be a cryogenic liquid.

[0124] The tank 15 may comprise one or more pressure relief valves, comprising at least a lowest pressure relief valve (not shown). Such a tank will have an associated hold time for a particular fluid. The hold time is the time elapsed from loading until the pressure under equilibrium conditions in the tank reaches the level of the lowest pressure relief valve setting. After the lowest pressure relief valve is opened, the loss of fluid to evaporation can be quantified by a net evaporation rate. In order to prevent escape of fluid vapour from the tank, the residence time of fluid in the tank 15 should not exceed the hold time.

[0125] The tank 15 may have any shape of horizontal cross-section, such as quadrilateral, circular or elliptical. Figure 6 shows three tanks, a first tank 15a, a second tank 15b, and a third tank 15c, each with elliptical horizontal cross-sections. Each tank 15a, 15b, 15c comprises a tank inlet (not shown) and a tank outlet 25, particularly a first tank outlet 25a on the first tank 15a, a second tank outlet 25b on the second tank 15b, and a third tank outlet 25c on the third tank 15c. The tank inlet and tank outlet 25 provide fluid communication between the inside and outside of the tank 15. The tank inlet and tank outlet 25 may have associated tank inlet and tank outlet valves (not shown) in order to isolate the inside of the tank 15 from the external environment.

[0126] Preferably the tank inlet is located gravitationally higher than the tank outlet. More preferably, the tank inlet is located at or near the top of the tank while the tank outlet is located at or near the bottom of the tank (with respect to gravity). The tank outlet 25 in Figure 6 is shown located at the gravitationally lowest part of the tank 15.

[0127] The fluid supply assemblage 1 further comprises a transfer manifold 50. The transfer manifold 50 comprises a plurality of manifold inlets 55. The transfer manifold 50 of the embodiment of Figure 6 comprises three manifold inlets in the form of a first manifold inlet 55a, a second manifold inlet 55b, and a third manifold inlet 55c. Each of the manifold inlets 55a, 55b, 55c are in fluid communication with a manifold outlet 60, in this case the same manifold outlet. Inlet fluid flow control valves 57a, 57b, 57c are provided downstream of each manifold inlet 55 so that each inlet can be independently isolated. Similarly, outlet fluid control valve 59 is provided upstream of the manifold outlet 60 so that it can be isolated.

[0128] The transfer manifold 50 allows the interlinking of the tanks 15a, 15b, 15c. In the embodiment shown in Figure 6, all of the intermodal containers 10 present in the fluid supply assemblage are interlinked via the transfer manifold 50. This is achieved by connecting the tank outlet 25 with a manifold inlet 55. Each tank outlet 25 is connected to a different manifold inlet 55. Figure 6 shows three pairs of such connections, namely tank outlets 25a, 25b, 25c connected to manifold inlets 55a, 55b, 55c respectively. In this way, the fluid held in tanks 15a, 15b, 15c can be passed via the transfer manifold 50 to a single manifold outlet 60..

[0129] The use of intermodal containers in the fluid supply assemblage allows for a modular construction of the fluid supply assemblage 1, thereby providing flexibility in the number of containers to be attached to the transfer manifold 50. For the purposes of the supply of hydrocarbon refrigerant components at the destination 8, the fluid supply assemblage 1 may comprise from 2 to 20, more preferably from 5 to 10 intermodal containers, typically of 20 or 40 kliter (20 m^3) capacity each.

[0130] In an embodiment not shown in Figure 6, the three intermodal containers 10a, 10b, 10c may be releasably and mechanically interlinked. For instance, the intermodal container 10 may further comprise a frame to support the tank 15. When the intermodal containers 10 are positioned adjacent to one another, the frames may be mechanically interlinked, for instance by bolting them together.

[0131] The fluid supply assemblage 1 further comprises a fluid transfer connector 80 in fluid communication with the manifold outlet 60. The fluid transfer connector is adapted to be attached to a fluid transfer line, such as a that of flexible hose, typically an aerial, floating or crane boom hose. It is preferred that the fluid transfer connector 80 further comprises a restriction collar 90. The restriction collar 90 operates to prevent any flexible hose which is connected to the fluid transfer connector 80 from adopting a configuration with a bending radius less than that of the minimum bending radius of the flexible hose. In this way, damage, particularly rupture of any flexible hose is mitigated by ensuring that the minimum bending radius is not passed. The restriction collar 90 may be configured as an open cone as shown in Figure 6.

[0132] The fluid supply assemblage 1 may be used for the supply and transfer of hazardous fluids, such as cryogenic and/or flammable fluids. It is therefore preferred that the fluid transfer connector 80 further comprises an emergency release coupling 85. The emergency release coupling 85 may be situated upstream of the manifold outlet 60 and downstream of any flexible hose to which the fluid transfer connector 80 is connected. The emergency release coupling 85 is configured to quickly separate the manifold outlet 60 from any flexible hose to which it is connected via the fluid transfer connector 80. It can do this by separating the end of the fluid transfer connector 80 having the restriction collar 90 from the manifold outlet 60. The emergency release coupling may comprise an emergency fluid control valve 86, operable to stop fluid flow between the manifold outlet 60 and any flexible hose to which the fluid transfer connector is attached. The emergency release coupling 85 is configured to activate when the safe operating envelope of a flexible hose connected to fluid transfer connector 80 is exceeded during the transfer of fluid from tanks 15a, 15b, 15c. The safe operating envelope can be monitored by a variety of means known in the art, for instance by a satellite positioning or a guide wire and gimbal attached to the end of the flexible hose, which may be housed on a crane boom, which is connected to the fluid connector.

[0133] The fluid supply assemblage 1 may further comprise a base 140, having a surface 140a. The transfer manifold 50 may be attached to the base 140, preferably the surface 140a thereof. The transfer manifold may be permanently attached to such a base, for instance by welds, rivets or the like. The intermodal containers may be releasably secured to the base 140, for instance by releasable bolts or other suitable releasable attachment means.

[0134] In an embodiment not shown in Figure 6, the fluid supply assemblage 1 may further comprise additional intermodal containers which are not connected to the transfer manifold 50 i.e. containers whose tanks are not in fluid communication with the transfer manifold 50 via connection of their tank outlet to a manifold inlet. This may occur, for instance when different fluids are held in the tanks of different intermodal containers. For example, first tanks of first intermodal containers containing a first fluid may be connected to the transfer manifold for fluid transfer, while second tanks of second intermodal containers containing a second fluid different from the first fluid are not connected to the transfer manifold, but are still present as part of the fluid supply assemblage 1. After transfer of the first fluid from the first tanks of the first intermodal containers, the tank outlets of the first tanks can be disconnected from the transfer manifold. The tank outlets of the second tanks containing the second fluid can then be connected to the manifold inlets of the transfer manifold in order to facilitate the transfer of the second fluid.

[0135] In a further embodiment not shown in Figure 6, the tank 15 of the intermodal container 10 may further comprise a tank conditioning means. Herewith the fluid contained inside of tank 15 may be cooled. Preferably the tank conditioning means can cool the fluid contained inside the tank, to maintain it in the liquid state and at a pressure in the range of from about 1 to 2 bar and/or to condense vapour in the tank into fluid in a liquid state and at a pressure in the range of from about 1 to 2 bar.

[0136] The fluid supply assemblage 1 is preferably present on the supply vessel, more preferably a dynamically positionable supply vessel, such as that suitable to supply an off-shore facility such as a FLSO. The fluid supply assemblage 1 can be located on the deck of such a vessel. For instance the base 140 may be a prepared location on the deck.

[0137] The fluid supply assemblage 1 can be assembled by providing the intermodal containers 10a, 10b, 10c each comprising a tank 15a, 15b, 15c, each tank 15 having at least a tank inlet (not shown) and a tank outlet 25a, 25b, 25c as discussed above. The intermodal containers 10 can be provided with their tanks 15 containing fluid, such as a hydrocarbon load, particularly a hydrocarbon refrigerant component.

[0138] The fluid supply assemblage may be assembled in the intermediate location using intermodal containers 10with tanks 15 that already contain the conditioned hydrocarbon load or the hydrocarbon load to be conditioned. A plurality of such intermodal containers 10a, 10b 10c, with tanks 15a, 15b, 15c, may be provided. The assemblage is finished by connecting each tank outlet 25a, 25b, 25c of at least two tanks of the plurality of intermodal containers to a different manifold inlet 55a, 55b, 55c such that at least the two tanks of the plurality of intermodal containers are in fluid communication with the manifold outlet 60 via the transfer manifold 50.

[0139] When the fluid supply assemblage 1 is provided aboard the supply vessel, the assembling may be done in a port, preferably in the intermediate location 6. For instance, the intermodal containers 10 may be transported to the port, for instance over sea or land as described above with reference to Figures 1, 2, and 5, and then lifted aboard the supply vessel, for instance by crane. Each intermodal container may be loaded onto the surface 140a of the base 140, whereby preferably each tank outlet 25 of the plurality of intermodal containers is aligned with a manifold inlet 55 of the transfer manifold 50.

[0140] The intermodal containers 10 can for instance be positioned on the surface 140a of the base 140 of the fluid supply assemblage 1 facing outside the hull of the floating vessel, for instance in a position such that the tank outlets 25 are aligned with the manifold inlets 55 of the transfer manifold 50. The intermodal containers 10 may then be releasably attached to the base 140 and/or one another for instance by releasably attaching one of said intermodal containers to one or more other adjacent intermodal containers of said plurality of intermodal containers. The tank outlets 25 of some, but not necessary all, of the intermodal containers can then be attached to the manifold inlets 55 of the transfer manifold 50.

[0141] As illustrated in Figure 7, the assemblage disclosed herein may be provided a floating supply vessel, such as an off-shore supply vessel. Figure 7 shows a schematic diagram of a cross-section of the side view of a method of transferring the conditioned hydrocarbon load between a first moveable floating structure 200, such as the floating supply vessel, comprising a fluid supply assemblage 1, and a second floating structure 300 comprising a liquefaction facility 350, such as a FLSO, FLNG or FPLSO or other similar structure requiring external supply of a refrigerant fluid.

[0142] The base 140 of the fluid supply assemblage may be an area of the deck of the supply vessel, with intermodal containers 10 each comprising tanks 15 attached to a surface 140a facing outside the hull 205. Only a single tank 15 is visible in the cross-section of Figure 7, but the fluid supply assemblage 1 comprises at least one further intermodal container and tank. The tanks 15 comprise the conditioned hydrocarbon load, which may be in the form of a cryogenic fluid.

[0143] The transfer manifold may also be attached to the base 140, preferably to the surface 140a thereof. As the intermodal containers 10 with the tanks 15 are outside of the confined area in the hull 205 underneath the deck, the safety measures may be less stringent compared with when the fluid in the tanks of the intermodal containers would have to be stored in a fluid cargo tank inside the hull.

[0144] A flexible hose 320 is shown attached at a first end to the fluid transfer connector 80 of the transfer manifold and at a second end to a second structure manifold 310. The second structure manifold 310 is on the second floating structure 300 and is in fluid connection with a second structure fluid storage tank 330. The second structure fluid storage tank 330 may be in the form of a cryogenic storage tank. Flexible hoses for the transfer of fluids, such as hydrocarbons and/or cryogenic fluids between floating structures are known in the art. When the conditioned hydrocarbon load consists of a cryogenic fluid, the flexible hose may be thermally insulated.

[0145] After the conditioned hydrocarbon load has passed between the fluid supply assemblage 1 and the second floating structure 300, it can then be stored in one or more of the second structure fluid storage tanks 330, in which the conditioned hydrocarbon load is held the liquid state at or near atmospheric pressure. No further processing of the conditioned hydrocarbon load, particularly a hydrocarbon refrigerant component, such as one or more of fractionation, temperature adjustment and pressure adjustment may be required as it may already be provided in the required state from the fluid supply assemblage 1.

[0146] Figure 7 shows second structure fluid storage tank 330 located underneath a deck 340 within a hull 305 of the second floating structure 300. In an alternative embodiment, the second structure fluid storage tank 330 may be located on deck 340, preferably facing outside the hull 305 of the second floating structure 300. The second structure fluid storage tank 330 is preferably one or both of thermally insulated and refrigerated, for instance so that it can store a cryogenic fluid, such as a hydrocarbon refrigerant component in the liquid state and at a pressure of from about 1 to 2 bar.

[0147] The conditioned hydrocarbon load held in the tank 15 of the intermodal container 10 may be transferred from the first moveable floating structure 200 to the second floating structure 300 as follows. The fluid supply assemblage 1 can be assembled as discussed above on the deck 140 of the first moveable floating structure 200 at port. The first moveable floating structure 200 can then be transported to the location of the second floating structure 300, preferably under its own power, for instance when the first moveable floating structure 200 is the supply vessel, in contrast to, for instance, a moveably floating structure like a barge which does not comprise an engine and could be towed to the location by a supply vessel. The first moveable floating structure 200 can be dynamically positioned next to the second floating structure 300, for instance using a positioning system, such as satellite, radar or other electromagnetic positioning systems. It is preferred that the two floating structures are positioned side-by-side i.e. with their shortest horizontal axis next to one another such as starboard to port or port to port or port to starboard of the two floating structures.

[0148] The fluid transfer connector 80 of the fluid supply assemblage 1 can then be aligned with the second structure manifold 310, for instance by manoeuvring the first moveable floating structure 200, typically using thrusters if it is the supply vessel.

[0149] Once alignment is achieved, a flexible hose 320 can be connected between the fluid transfer connector 80 and the second structure manifold 310. In a preferred embodiment the flexible hose 320 is first attached to the second structure manifold 310 or may be already attached to the second structure manifold 310 and resides on the second floating structure 300. The flexible hose 320 may be a floating hose or attached to a crane boom. If the flexible hose 320 is present as part of a crane boom, the boom can be moved from its storage position into its operating position. The configuration of the operating position will depend on the height of the second structure manifold 310 versus that of the fluid transfer connector 80 of the fluid supply assemblage 1. Once the flexible hose 320 is connected between the fluid transfer connector 80 and the second structure manifold 310, the relative positions of the first and second floating structures 200, 300 should be maintained until disconnection of the flexible hose 320.

[0150] The flexible hose 320 can then be purged. For instance, when the fluid to be transferred is a hydrocarbon refrigerant component, the purge fluid may be nitrogen gas.

[0151] The fluid, such as a hydrocarbon refrigerant component, can then be transferred from the tanks 15 of the fluid supply assemblage 1 of the first floating structure 200, through the flexible hose 320 to the second structure manifold 310 of second floating structure 300 and into the second structure fluid storage tank 330. It is preferred that the fluid is transferred without pressuring the system by more than a few bar, for instance by more than 4 bar.

[0152] The conditioned hydrocarbon load may be transferred via a fluid transfer means. An example of such fluid transfer means is pump 100, arranged to displace the liquid fluid from a pump inlet 105 to a pump outlet 110 by directly interacting with the liquid fluid. An inert gas such as nitrogen may be passed into the tank 15 of the intermodal container 10, for instance via a tank inlet, to replace the fluid being supplied to the second floating structure 300.

[0153] Alternatively, the fluid transfer device may be a compressor (not shown), or other suitable device which indirectly acts upon the liquid fluid. If the fluid transfer device is a compressor, a drive gas, such as an inert gas like nitrogen or a portion of any fluid vapour present in the tank or provided by the vaporisation of a portion of the liquid fluid in the tank, may be compressed in the compressor and injected into the tank, for instance via the tank inlet, thereby pressuring the tank and causing the fluid liquid to be transferred from the tank via the tank outlet to the manifold inlet.

[0154] The fluid transfer device may be connected between the tank outlet 25 and manifold inlet 55, for instance if it is a pump. In this case a plurality of pumps is required, one for each manifold inlet (55a, 55b, 55c). Alternatively, the fluid transfer device may be connected between the manifold outlet 60 and the fluid transfer connector 80, for instance such that one single pump 100 may be used to off-load fluid from a plurality of tanks, by drawing from all the tanks which are in fluid communication with the manifold outlet 60. As a further alternative, a gas injector system comprising a compressor as the fluid transfer means and optionally a source of transfer gas may be provided. The gas injector system can be connected to the tank inlets of the tanks to be off-loaded.

[0155] Once the transfer of the conditioned hydrocarbon load has been completed, the flexible hose 320 can then be purged with purge fluid, such as nitrogen. The flexible hose 320 may then be disconnected from the fluid transfer connector 80. The flexible hose 320 may then be returned to the second floating structure, for instance by returning any crane boom supporting the flexible hose 320 to its storage position. The first moveable floating structure 200 may then be moved away from the second floating structure 300 and return to port.

[0156] Once aboard the second floating structure 300, the conditioned hydrocarbon load, such as a hydrocarbon refrigerant component, may be used in a liquefaction facility 350, such as in the cooling and liquefaction of natural gas.

[0157] The first moveable floating structure 200 may then return to port. Those intermodal containers 10 comprising tanks 15 empty of or depleted the hydrocarbon load, which are connected to the transfer manifold 50, can have their tank outlets disconnected from the manifold inlets. The intermodal containers 10 comprising tanks 15 empty of or depleted may be released from the base 140 of the fluid supply assemblage 1. The intermodal containers 10 comprising tanks 15 empty of or depleted may then be off-loaded from the first moveable floating structure 200, for instance by crane. Once off-loaded, the intermodal containers comprising empty tanks may be purged with inert gas such as nitrogen, and then transported to another location to be refilled. Once refilled, the intermodal containers can be returned to the port to be re-assembled into assemblage 1.

[0158] As used herein, the term "C2" relates to the number of carbon atoms in the hydrocarbon molecule being equal to two. A C2 hydrocarbon stream comprises hydrocarbons having 2 carbon atoms per molecule, such as one or both of ethane and ethylene. A C2+ hydrocarbon stream comprises hydrocarbons having 2 or more carbon atoms per molecule, such as one or more of ethane, ethylene, propane, propylene, butane etc. A C2 separator, e.g. a deethaniser, is a device to separate hydrocarbons having 2 carbon atoms per molecule, such as one or both of ethane and ethylene, from a composition of hydrocarbons, which may further comprise hydrocarbons having more than two and/or less than two carbon atoms. A C2 fractionator is a device that can separate ethane and ethylene.

[0159] As used herein, the term "vapour-tight" means that, when the associated valves, such as the tank inlet and tank outlet valves are closed, the container comprising the fluid does not leak vapour from the evaporation of fluid in the liquid state e.g. it does not leak hydrocarbon vapour such as ethane vapour or propane vapour. In one embodiment, the term "vapour-tight" is intended to mean that the tank has a pressure loss of less than 0.0075 bar over 5 minutes after having pressurised to the maximum allowable working pressure of the tank of the intermodal container.

[0160] As used herein, the term "thermally insulated" means that steps are taken to minimise heat exchange between the fluid in the tank of the intermodal container and the external environment. In one embodiment, the tank has a heat influx of less than 75 W/m^2 at the bubble point temperature of the contents of the tank over at least 90% of the outer surface area of the tank at a 50% filling ratio and +15 °C ambient temperature such as defined in engineering standard EN 12213. The tank may be multi-layer thermally insulated. In one embodiment, the tank may be provided with a vacuum jacket in the intermodal container.

[0161] As used herein, the term "assemblage" is an apparatus of assembled components such as an arrangement of interlinked components. Typically the fluid supply assemblage comprises a plurality of intermodal containers and a transfer manifold, in which at least one of the one or more, preferably all, of the plurality of intermodal containers are removable from the fluid supply assemblage and are replaceable.

[0162] Suitable intermodal containers, for instance 20 feet (6.1 m) in length with a tank capacity of 20000 liters, or 40 feet (12.2 m) in length with a tank capacity of 43500 liters, are available from Chart Industries Group D&S (Chart Ferox as, Děč in, the Czech Republic).

[0163] An example of a flexible hose capable of transferring cryogenic hydrocarbon liquids, including LPG (propane, butane), ethane, and LNG (predominantly methane), is available from Trelleborg Oil & Marine Hoses of Trelleborg Industrie SAS, under the name of Cryoline (TM).

[0164] The pressure unit "bar" as used herein is identical to "bar absolute" or "bara". The term "liquid state" is intended to represent a fluid at or below its bubble point at the governing pressure.

[0165] The person skilled in the art will understand that the present invention can be carried out in many various ways without departing from the scope of the appended claims.

Claims

1. A method of supplying a hydrocarbon load from a starting location (4) to a destination (8), said method comprising at least the steps of:

   - providing a hydrocarbon load at a starting location (4);
   - transporting the hydrocarbon load from the starting location (4) to an intermediate location (6);
   - conditioning the hydrocarbon load at the intermediate location (6) to provide a conditioned hydrocarbon load in the liquid state and at a pressure of about 1 to 2 bar, said conditioned hydrocarbon present in a tank (15);
   - transporting the tank (15) comprising the conditioned hydrocarbon from the intermediate location (6) to a destination (8) to provide a hydrocarbon load comprising the conditioned hydrocarbon in the liquid state and at a pressure from about 1 to 2 bar at the destination (8).

2. The method of claim 1, wherein the intermediate location (6) is in an on-shore location such as a port and/or the destination (8) is in an off-shore location such as a Floating Liquefaction Storage-offshore facility.

3. The method of claim 1 or claim 2, wherein the hydrocarbon load and the conditioned hydrocarbon load both consist of one of: (1) at least 95 mol% consisting of ethane with the balance being one or both of ethylene and propylene, and optionally other further components; (2) at least 95 mol% consisting of propane with the balance being one or both of ethylene and propylene, and optionally other further components; and (3) at least 98 mol% consisting of a mixuture of two or more of the group comprising ethane, ethylene, propane, butane, and isobutene, the balance consisting of further components excluding ethane, ethylene, propane, butane, and isobutene.

4. The method of any of the preceding claims, wherein the step of providing a hydrocarbon load at the starting location (4) comprises providing the hydrocarbon load in the tank (15), and wherein the step of transporting the hydrocarbon load from the starting location (4) to the intermediate location (6) comprises loading the tank (15) onto a container vessel (17), transporting the tank (15) by the container vessel (17) and subsequently off-loading the tank (15) from the container vessel (17).

5. The method of claim 4, wherein the step of off-loading the tank (15) from the container vessel (17) is carried out at an auxiliary location (2) that is geographically separated from both the starting location (4) and the intermediate location (6), and wherein the step of transporting the hydrocarbon load from the starting location (4) to the intermediate location (6) further comprises, after off-loading the tank (15) from the container vessel (17) in the auxiliary location (2), further transporting the tank from the auxiliary location (2) to the intermediate location (6).

6. The method of any of the preceding claims, wherein the tank (15) is provided in an intermodal container (10) comprising said tank (15).

7. The method of any of the preceding claims, wherein the step of transporting the hydrocarbon load from

the starting location (4) to the intermediate location (6) is carried out without applying external refrigeration power to the hydrocarbon load.

8. The method of any of the preceding claims, wherein in the step of providing the hydrocarbon load at the starting location (4), the hydrocarbon load is provided as a conditioned hydrocarbon load, in the liquid state and at a pressure of about 1 to 2 bar.

9. The method of any of the preceding claims wherein, the distance between the intermediate location (6) and the starting location (4) is larger than the distance between the intermediate location (6) and the destination (8).

10. The method of any of the preceding claims, wherein the starting location (4) comprises a plurality of geographically dispersed starting locations (4a, 4b, 4c) and wherein the hydrocarbon load comprises a plurality of hydrocarbon loads, wherein said plurality of hydrocarbon loads are provided in each of the geographically dispersed starting locations (4a, 4b, 4c), wherein each load of said plurality of hydrocarbon loads is transported to the same intermediate location (6).

11. The method of claim 10, wherein the distances (d1, d2, d3) between the intermediate location (6) and each of the plurality of starting locations (4a, 4b, 4c) are different.

12. The method of any of the preceding claims, wherein the step of transporting the tank (15) comprising the conditioned hydrocarbon from the intermediate location (6) to the destination (8) is carried out without the refrigeration of one or both of the tank and the conditioned hydrocarbon.

13. The method of claim 12, wherein the duration of the step of transporting the tank (15) from the intermediate location (6) to the destination (8) is sufficiently short that upon arrival the hydrocarbon load is still in conditioned form, being in the liquid state and at a pressure of from about 1 to 2 bar.

14. The method of any of the preceding claims, wherein the ratio, by mass, of the conditioned hydrocarbon in the tank (15) at the destination (numerator) to the conditioned hydrocarbon provided in the tank (15) by the conditioning step at the intermediate location (6) (denominator) is at least 0.95, preferably at least 0.99.

15. The method of any of the preceding claims, wherein said tank (15) is a thermally insulated and vapour-tight tank.

Fig.1

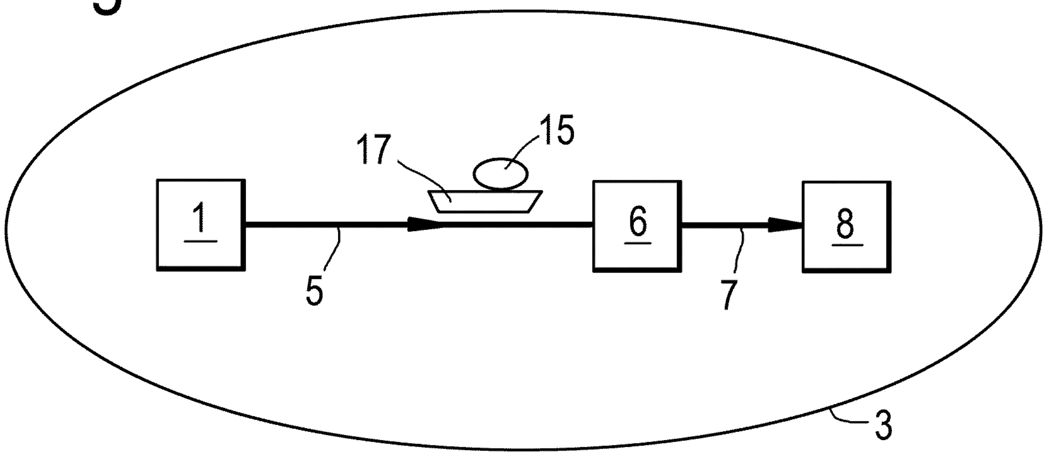
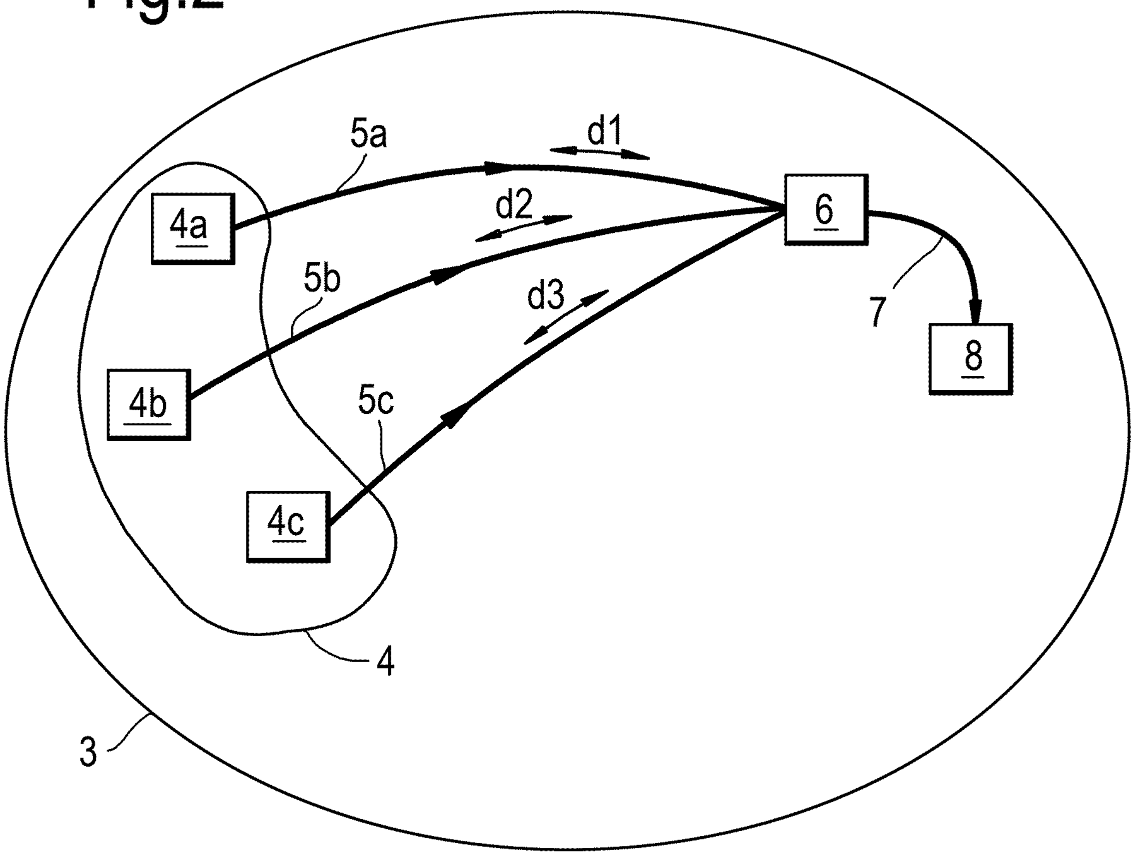


Fig.2



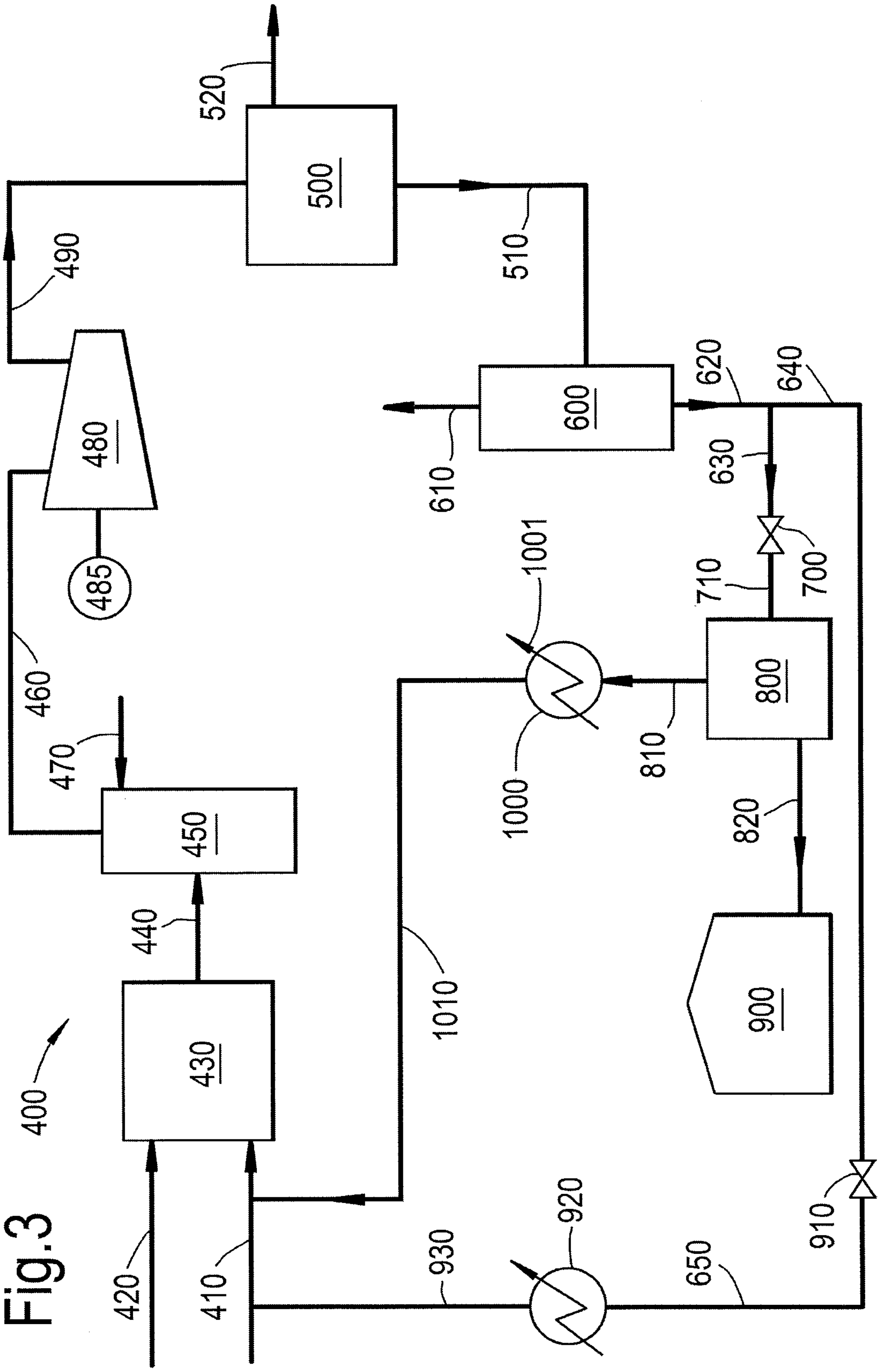

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Fig.3

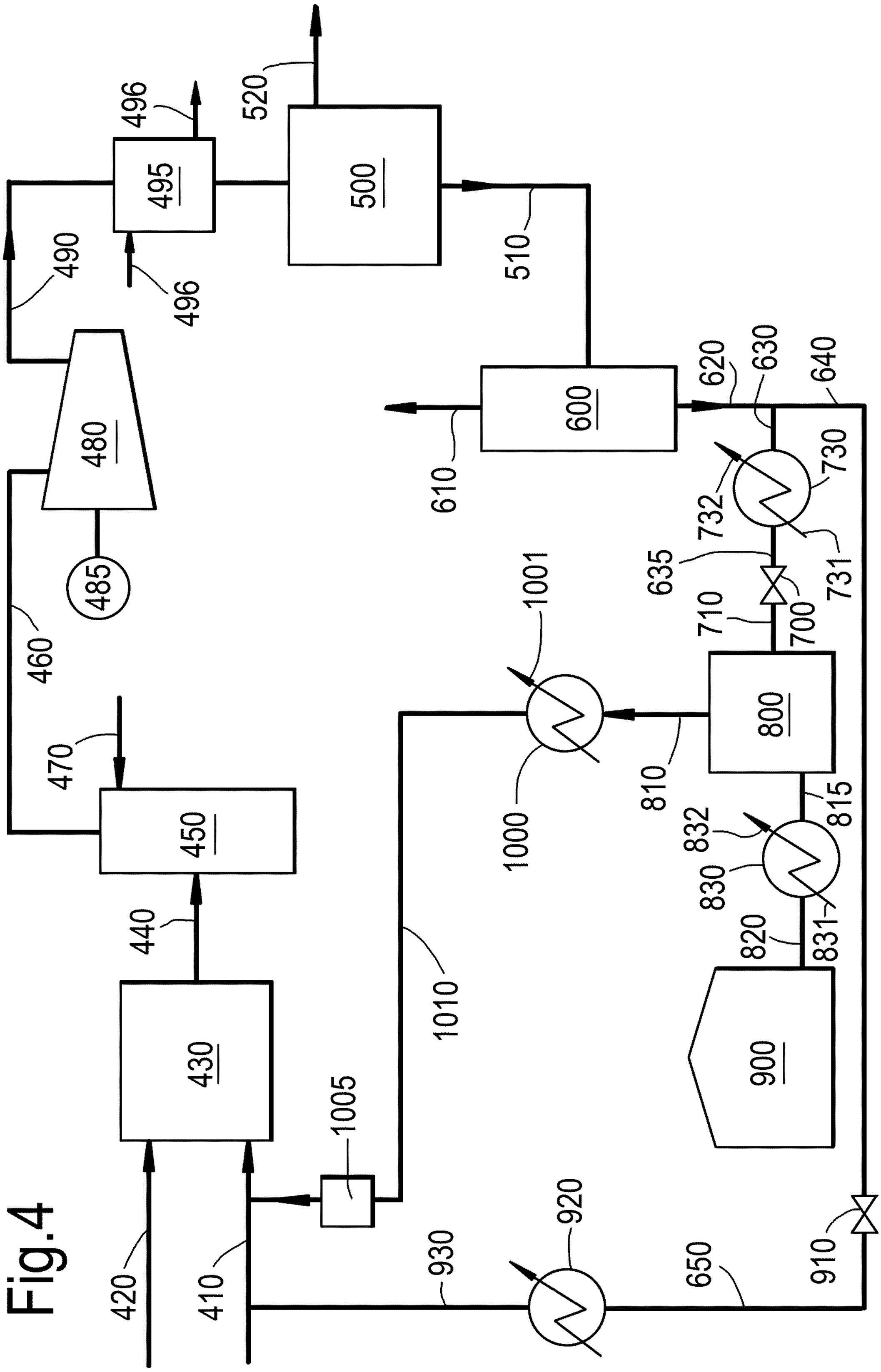
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Fig.4

Fig.5

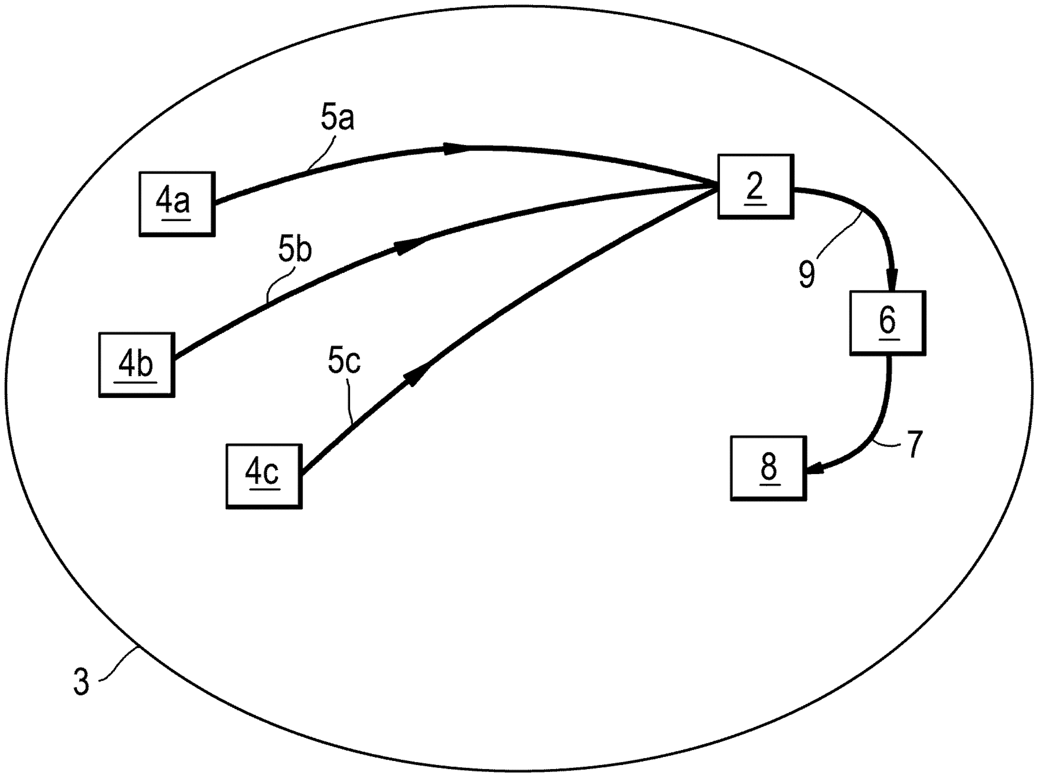

Fig.6

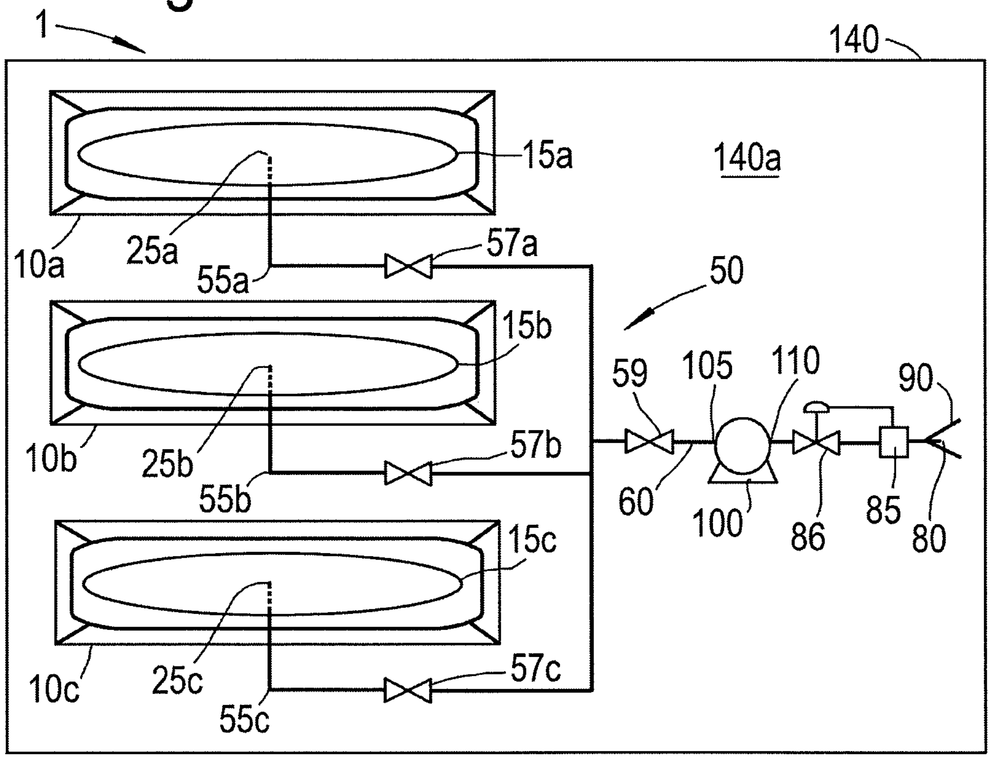
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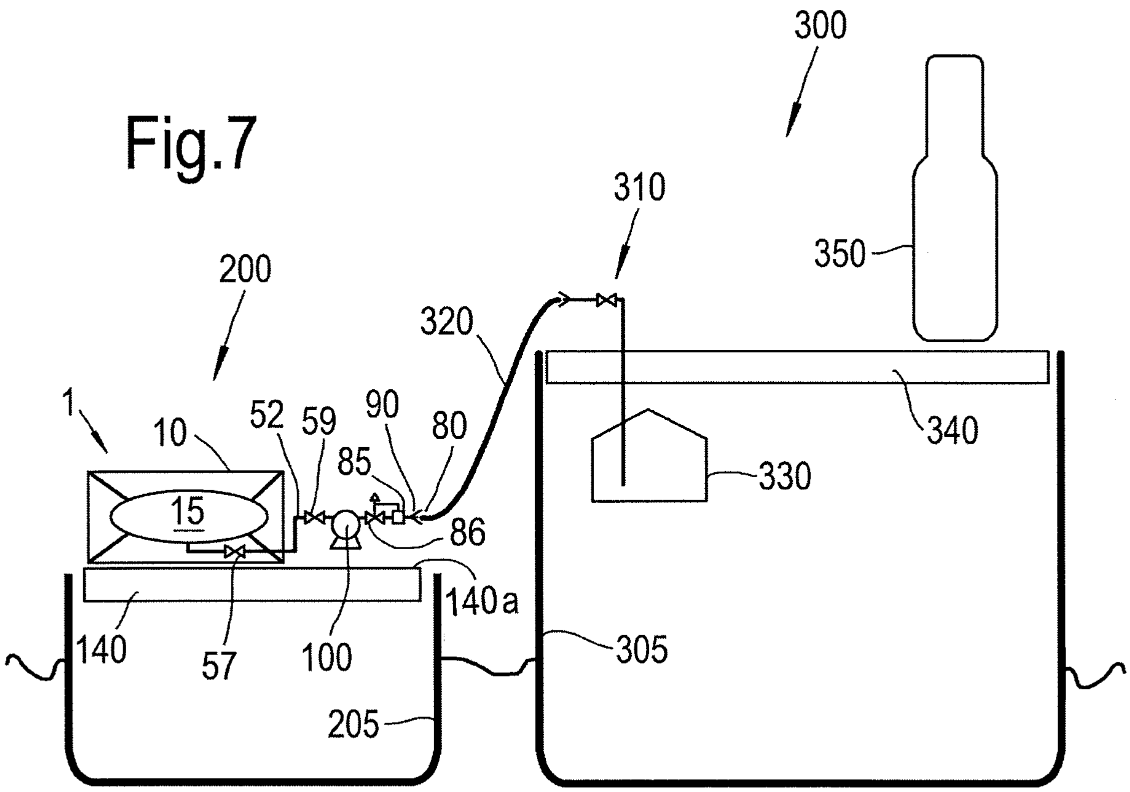
Fig.7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EUROPEAN SEARCH REPORT

Application Number
EP 12 19 9545

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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
Munich	17 October 2013	Stängl, Gerhard

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EUROPEAN SEARCH REPORT

Application Number
EP 12 19 9545

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1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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