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(71) Applicant: **Mange' S. s.r.l.**
15033 Casale Monferrato (AL) (IT)

(72) Inventor: **VARZI, Roberto**
15033 Casale Monferrato (AL) (IT)

(74) Representative: **Mola, Edoardo**
Praxi Intellectual Property S.p.A.
Corso Vittorio Emanuele II, 3
10125 Torino (IT)

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(54) **ACCUMULATOR COOLING METHOD FOR CONTROLLED ENVIRONMENT ARTICLE
TRANSPORTATION**

(57) A cooling method provides taking a liquefied gas, cooling by means of the liquefied gas a cooled chamber (3) containing cold accumulators (6), and taking the cooled accumulators (6) and store them in a transportable insulated chamber.

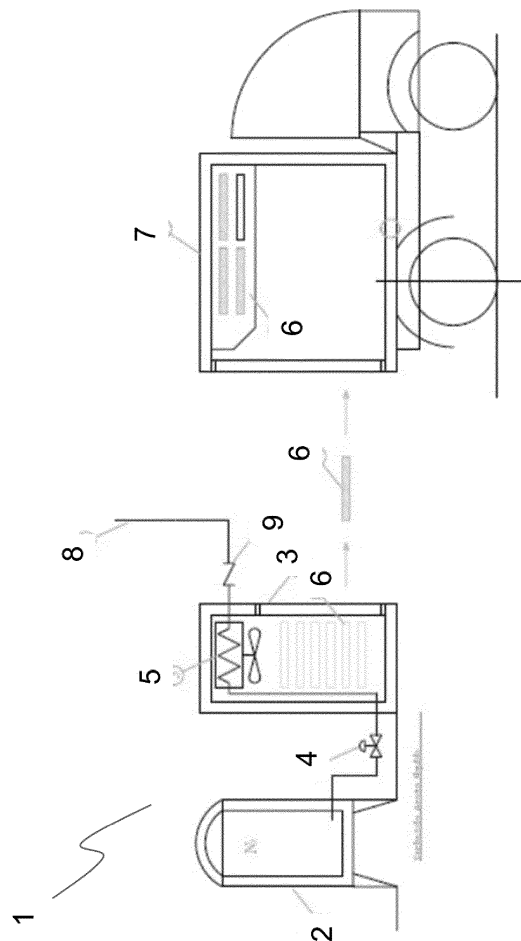


Fig. 1

Description

Technical Field

[0001] The present invention relates to the field of controlled-atmosphere transport, e.g. for foodstuff or drugs.

Background of the invention

[0002] A known controlled atmosphere transport road vehicle comprises an insulated chamber and a refrigeration apparatus with a compressor for a cooling liquid and a coil inside the insulated chamber for maintaining, thanks to the cooling liquid, a lower temperature than the outside.

Summary of the invention

[0003] The scope of the present invention is to increase efficiency of the transportation and maintenance of the controlled temperature in the insulated chamber. The scope of the present invention is achieved by a method according to claim 1 wherein a liquefied gas is used as an operational source of cooling energy to cool cold storage tanks, e.g. eutectic liquid plates, to be stored in insulated chambers for transportation of temperature-controlled goods below 24°C such as fresh or frozen food and medicines. The industrial process of gas liquefaction is known and efficient for large quantities, unlike the small compressor refrigeration apparatus arranged on board of transport road vehicles equipped with traction motor. In addition, a liquefied gas is an excellent cooling power source and therefore the transportation by container and storing within tanks allows a relatively high autonomy of the chambers for cooling the accumulators. In addition, the very low temperature available through a liquefied gas allow to reduce the time required for the cold storing into the accumulators as a result of an appropriate design due to the available high thermal gradient. Moreover, the use of a liquefied gas allows a 'cascade' use for different temperature requirements. For example, it is possible to cool two chambers connected in series with respect to the tank in which the second receives the cooling fluid from the first to have an internal temperature higher than that of the first chamber. For example, the first chamber is used to cool accumulators for transporting frozen foods and the second one for fresh foodstuffs. It is also possible that the cooling fluid used in the first chamber, which may be liquid or already gaseous, circulates in a heat exchanger for cooling fluids for various uses, such as industrial cooling circuits for industrial machinery, air conditioning circuits in the workplace or residential areas. Industrial methods are also known to liquefy inert and non-toxic gases, such as nitrogen, and this allows to limit the environmental impact to the maximum in case of plant malfunctions or gas leaks.

Brief description of the drawings

[0004] Further purposes and advantages of the present invention will be clear from the following detailed description of an example of an embodiment thereof (and variants thereof) and by the accompanying drawings given by way of example only and not limiting, wherein:

- Figure 1 shows a schematic view of a cooling station for cold accumulators according to the method of the present invention;
- Figure 2 shows images of a first apparatus test of the method of the present invention;
- Figure 3 shows a detailed functional diagram of the components of the cooling apparatus according to a preferred and non-limiting embodiment of the present invention.

Detailed description of preferred embodiments of the invention

[0005] Figure 1 shows, as a whole, a cooling station 1 comprising a tank 2 of a liquefied gas, for example nitrogen at a temperature of approximately 160 ° C and a pressure of about 200 bar, and a cooling chamber 3 cooled by the liquefied gas of tank 2. Specifically, the temperature of the cooling fluid to the cooling chamber 3 comes adjusted by a valve 4 to regulate the pressure, e.g. a lamination valve. Inside the chamber 3, the heat exchange can be performed through several 5 devices, e.g. coils or evaporators, which they receive the refrigerant at a lower temperature to that of the tank, for example - 80 ° C. Preferably, chamber 3 is ventilated to make the temperature homogeneous internal. According to the method of the present invention, they are also supplied 6 cold accumulators containing a substance which preferably solidifies at the temperature of chamber 3, as hollow plates containing an eutectic liquid and/or azeotropic with freezing temperature of - 35 °C. Thanks to the high temperature gradient available through the use of a liquefied gas, it is possible to obtain relatively limited freezing times of the batteries. For example, with reference to the test apparatus in figure 2, and the temperatures indicated above, plates 6 were cooled in about 30 minutes, consuming 140 litres of nitrogen. In particular, the cooling time to obtain the complete cooling of an eutectic plate depends on the size of the eutectic plates and it is possible to check the freezing process by controlling or estimating an amount of thermal energy, i.e. heat, to be removed from the plate liquid in order to complete the full phase transition from liquid to solid by the eutectic liquid. Therefore, for the same size of eutectic plate, the time to complete the process is related to the rate of heat removal and the temperature gradient (AT) in which the eutectic plate is located, compared to the eutectic plate is, compared to the external ambient temperature.

[0006] Accumulators 6, after cooling or phase transition are extracted from the chamber 3 and placed in a

transportable insulated transportable chamber 7. The figure illustrates an embodiment in which chamber 7 is on board a motorised road vehicle but it is also possible to provide insulated chambers 7 that can be unloaded by hand, for example for medicines, which can be transported in the trunk compartment of vehicles or on bicycles, scooters, etc.

[0007] In particular, Figure 3 shows in more detail, according to an embodiment, a sketch 10 of a cooling apparatus covered by the present patent application.

[0008] The cooling apparatus comprises a cooling apparatus comprises a cold generation unit 20 where the cooling fluid is stored, a cold storage unit 30, preferably an insulated chamber 31 also known as a "cell" or chamber as mentioned in the preceding paragraphs and realising a closed volume thermally insulated in such a way as to maintain a controllable temperature on its internal surface which is controllable and lower than the temperature present in the external environment surrounding cell 31 and mobile or fixed; and, finally, a cold utilisation unit 40 configured to connect to the storage unit 30 and designed to be housed in dedicated seats (not illustrated) in transport vehicles.

[0009] In particular, cold generation unit 20 comprises a refrigerant storage element, preferably a pressurised tank 21 containing liquid nitrogen; a control and operating unit for the parameters supply of the cooling fluid, preferably a control unit 22, which by means of temperature and pressure sensors receive values of thermo-physical parameters of cold accumulator 6, e.g. an eutectic plate, and sets the optimal values of nitrogen quantity and/or nitrogen supply time to achieve the best combination of performance of the apparatus; a connection group 23, arranged in series and at the end of the generation unit 20, and finally at least a refrigerant transportation line, preferably a hose or conduit 24, connecting tank 21 to the connection unit 23 and through control unit 22.

[0010] In particular, control unit 22, receives a temperature signal from a sensor in contact with the accumulator 6 and verifies the condition that the temperature of the accumulator reaches the freezing threshold of the liquid contained in the accumulator freezing threshold of the liquid contained in accumulator 6, preferably between -30 and -35 °C. and monitors the pressure value reached by the apparatus, e.g. in duct 24, during the freezing process in order to ensure its safety, i.e. the pressure does not exceed a predetermined maximum value. Alternatively or in combination, control unit 22 verifies a flow rate or quantity of nitrogen directed towards accumulator 6 and calculates the time required for freezing on the basis of the temperature measured on board accumulator 6 when the latter is loaded into the cell. Or, are a flow rate or quantity of nitrogen delivered from the tank 21 and a tank size, are stored or set 21 and an accumulator size, and the time of nitrogen delivery is calculated based on the difference in temperature of the nitrogen with accumulator 6 loaded in the cell.

[0011] The connection unit 23 provides communica-

tion between the cold generation unit 20 and storage unit 30, and comprises a control element, preferably a solenoid valve 25 for controlling, through the opening and closing of the passage section of circuit line 24, the flow of line 24 of the circuit, the flow of the refrigerant fluid and to exchange return information with the aid to exchange feedback information with control unit 22 such as a temperature of the accumulator 6 charged in the cell and/or a pressure inside the cell; and a connecting member communicating with solenoid valve 25, preferably a quick multi-connection 26. In particular, the rapid multi-connection 26 performs the function of a mechanical and fluidic connection between generating unit 20 and generation unit 20 and storage unit 30, fluidic connection, and electrical/electronic connection, with the control unit 22.

[0012] In particular, the mechanical connection guarantees the connection and interfacing between multi-connection 26 and cell 31 providing structural continuity between the members of the apparatus of Fig.3; the fluidic connection ensures the supply from the reservoir 21 to cell 31, e.g. to accumulator 6 of the thermal flow of refrigerant; and finally the function of electrical connection with control unit 22 allows the programming therefore the control of the thermophysical parameters of the apparatus.

[0013] Storage unit 30, located in a fixed or mobile position, comprises a cell 31 capable of creating a closed and thermally insulated volume to guarantee on its internal surface a temperature lower than the temperature acting on the external surface and corresponding to the ambient temperature; and at least one housing 32 for allowing the engagement and disengagement of rapid multi-connection 27 belonging to the generating unit 20 and the passage of the refrigerant through the wall of said cell 31.

[0014] In particular, the housing 32 comprises at least one inlet port 33, preferably cylindrical, preferably passing through a wall of cell 31 which achieves a releasable communication with cold generation unit 20 and comprising an external stop 34 and an internal stop surface 35. Outer stop surface 34, preferably cylindrical, is suitable for housing a coupling element, preferably a bushing 36 and the inner stop surface 35 is suitable for housing a sensor, preferably a temperature sensor 38 mechanically positioned in contact with utilization unit 40, and an adapter element, preferably a plug-in terminal block 37, positioned between the eutectic plate 41 (described below) and quick multiconnection 26, making the mechanical connection. In addition, storage unit 30, has a door allowing communication with the external environment and housing a fluid control element, preferably a mechanical air valve 48 for better pressure balancing during the cooling process, between the internal volume of cell 31 and the external environment.

[0015] Furthermore, valve 48 defines a localised pressure drop, e.g. by means of a narrowing of the passage area with respect to a cross-section of coil 46, so as to retain the nitrogen in the coil for a longer period of time

and to favour the thermal heat exchange with the same nitrogen consumption.

[0016] Storage unit 30 is designed to engage and disengage with utilisation unit 40; the latter comprises a fluid refrigerant containment element, preferably a eutectic plate 41 having a preferably prismatic and flattened shape, comprising at least one lower connection element 42, preferably cylindrical, which allows the refrigerant fluid to flow inside eutectic plate 41 through the connection with plug terminal 37, and at least one upper connection element 43, preferably cylindrical, which allows the refrigerant fluid to flow inside the eutectic plate 41 one upper connection element 43, preferably cylindrical and comprising a cylindrical and comprising a line portion, preferably a conveyor section 45 which allows the discharge or discharge or escape of the refrigerant from eutectic plate 41 through an eutectic 41 through a closing element, preferably a mechanical valve 44, preferably integral with eutectic plate 41 and mechanically coupled to manifold section 45 and maintaining the fluid inside the eutectic plate 41 until the parameters of pressure and temperature are set by means of the solenoid valve 25.

[0017] In particular, eutectic plate 41, has a structure preferably prismatic and realizing an internal volume housing a heat exchange element ((not illustrated in Fig. 3) shaped to form a grid, preferably an "S" shaped metal coil 46 (not illustrated in Fig. 3) and traversed on the inside by the fluid entering the lower part through the lower connection element 42 and exiting from the eutectic plate 41 in the upper part through the upper connection element 43. The internal volume is filled with a eutectic liquid 47 in contact with coil 46. The average insertion pressure of the refrigerant inside metallic coil 46 is preferably 4 bar, while it subsequently expands due to the temperature increase until it reaches a value of 20 bar.

[0018] The refrigerant flows along metal coil 46 and exchanges energy with surrounding eutectic liquid 47. Once the thermophysical characteristics of pressure and temperature inside eutectic plate 41 are reached, e.g. the freezing of the eutectic liquid, plate 41 is disconnected from storage unit 30 through plug terminal 37, and housed in sites obtained inside a mobile vehicle for maintaining an internal temperature below than the external temperature of environment during transportation. For example, plug 37 is provided with a bayonet connection or similar so that unloaded plate 41, after having been placed in the cell, is fluid-tightly connected to plug 37. At the end of the cooling process, the excess of refrigerant fluid is basked in the cell 31 and subsequently removed manually or by means of suitable valves for disposal in special plants or dispersed. into the atmosphere without any particular effects, in the case of nitrogen.

[0019] According to the method of the invention, the exhausted liquefied gas exiting device 5 can be can be either recovered through a closed circuit or, in particular if inert and non-toxic, be released into the environment by means of an outlet port 8 appropriately connected to a non-return valve 9 to prevent air from entering device 5.

[0020] According to an embodiment not illustrated, due to the high thermal gradient available with a liquefied gas, it is possible to connect by cascade different users of cooling capacity, i.e. in series with respect to the tank 2 and the chamber 3.

[0021] For example, the exhausted fluid from device 5 can be used to cool an additional chamber in which the temperature is higher than the temperature of the chamber 3. Or, it is possible that the exhausted fluid exiting device 5 enters a heat exchanger. for cooling additional fluids for various other uses, for example for cooling industrial machinery or for air conditioning circuits for environments intended for animals, plants, or people.

Claims

1. Cooling or refrigeration method comprising the steps of:

- Taking, e.g. from a tank (2), a liquefied gas and sending it in at least one cooled chamber (3);
- Checking an internal chamber temperature (3) by reducing the gas pressure leaving the tank in order to the internal temperature of the chamber (3) is higher than the internal temperature of the tank (2);
- Loading into the cooled chamber (3) at least one cold accumulator (6) comprising a casing and a substance in a fluid state at 24 °C, to obtain a transition to the solid state of the substance;
- After an interval of time to achieve cooling of the substance, removing the accumulator (6) and storing it in an insulated chamber (7) which can be transported to maintain a temperature lower than 24 °C inside the insulated chamber.

2. Method according to claim 1, wherein the transportable insulated chamber is configured to be unloaded and loaded either by hand onto a vehicle.

3. Method according to any one of claims 1 or 2, comprising the further step of providing at least a further cooled chamber fluidically connected in series to the at least one cooled chamber for receiving from the latter a flow of fluid at a temperature lower than 24 °C and originally coming from the tank, so that the temperature inside of the at least further cooled chamber is higher than that in the at least one cooled chamber.

4. Method according to any one of the preceding claims, comprising the step of arranging a heat exchanger fluidically in series with the at least one cooled chamber to receive from the latter a fluid flow rate at a temperature lower than 24 °C and initially coming from the tank.

5. Method according to any one of the preceding

claims, wherein the liquefied gas is inert and comprising the step of releasing the gas into the atmosphere after use in the at least one cooled chamber.

6. Method according to any one of the preceding claims, comprising the step of measuring a first temperature of the cold accumulator (6, 41) to be regenerated by means of a sensor (38) to be and, by means of a control unit (22) receiving a signal from the sensor (38) and an electro-valve (25) controlled by the control unit (22), dosing a quantity of nitrogen to be sent towards the insulated chamber (7, 31) in order to freeze the cold accumulator (6). 5
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7. Method according to claim 6, wherein the control unit (22) is programmed to receive as input dimensional and thermodynamic data of the accumulator (6, 41) and at least one second temperature of the liquefied gas and to calculate, on the basis of said input data and the first temperature, a delivery time of the liquefied gas in order to obtain the freezing of the cold accumulator (6). 15
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8. Method according to any one of claims 6 or 7, wherein the tank (2, 21) is portable by hand or with a cart and is fluidically connected to the chamber (7, 31) by a multifunction connector (26) configured to define an electrical connection releasable data exchange with the sensor (38) and a releasable fluidic connection for gas delivery from the tank (2, 21). 25
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9. Method according to any one of the preceding claims, wherein said accumulator (6) comprises an internal coil (46) having an inlet port (33) for receiving gas from tank (2, 21) and an outlet port (48) for releasing gas inside the chamber (7) the hotter gas after having given off cooling power to the accumulator (6) during the passage through the coil (46). 35
10. Method according to claim 9, wherein the outlet port (48) comprises an air valve configured to define a localized pressure drop and retain the gas longer into the coil (46). 40

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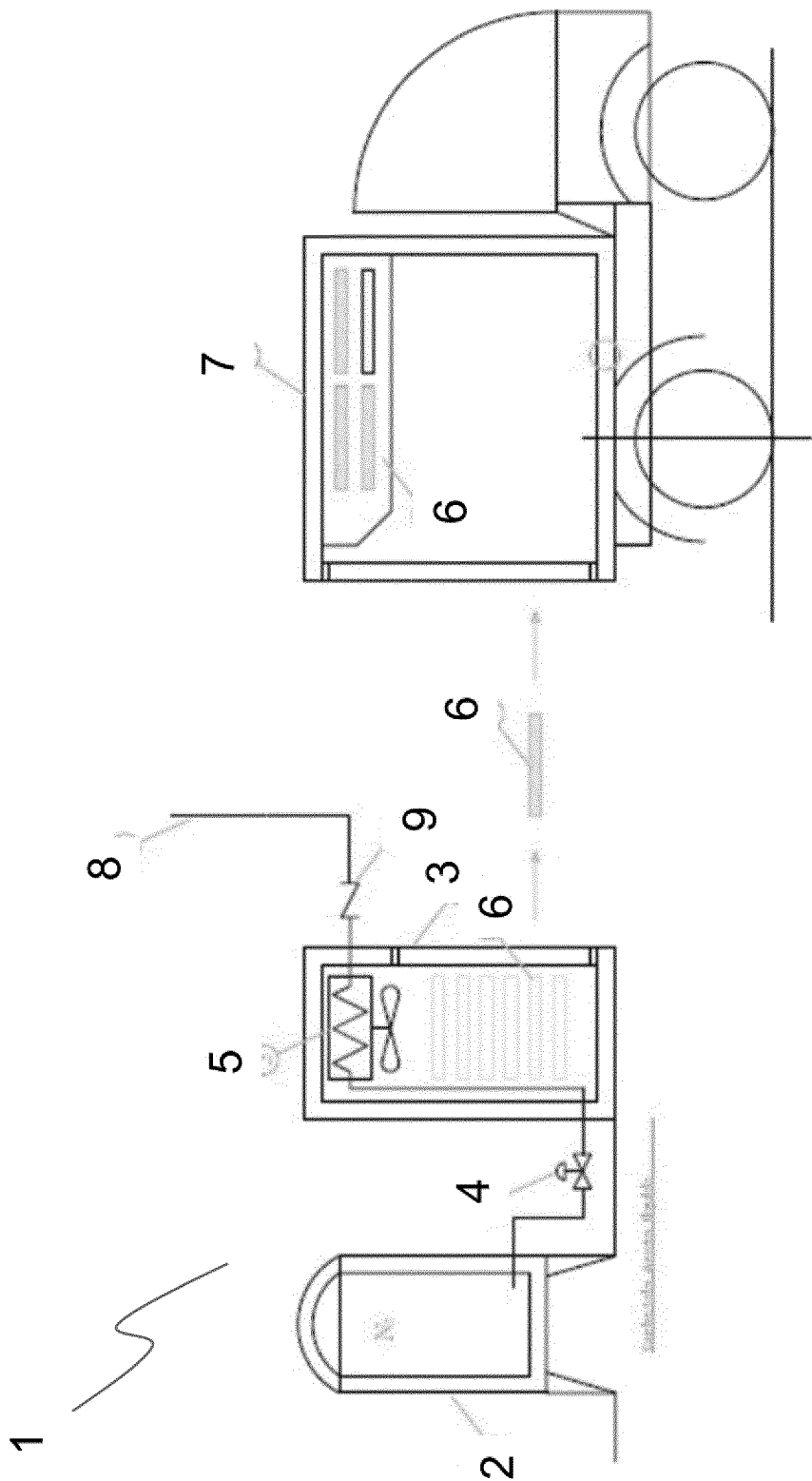


Fig. 1

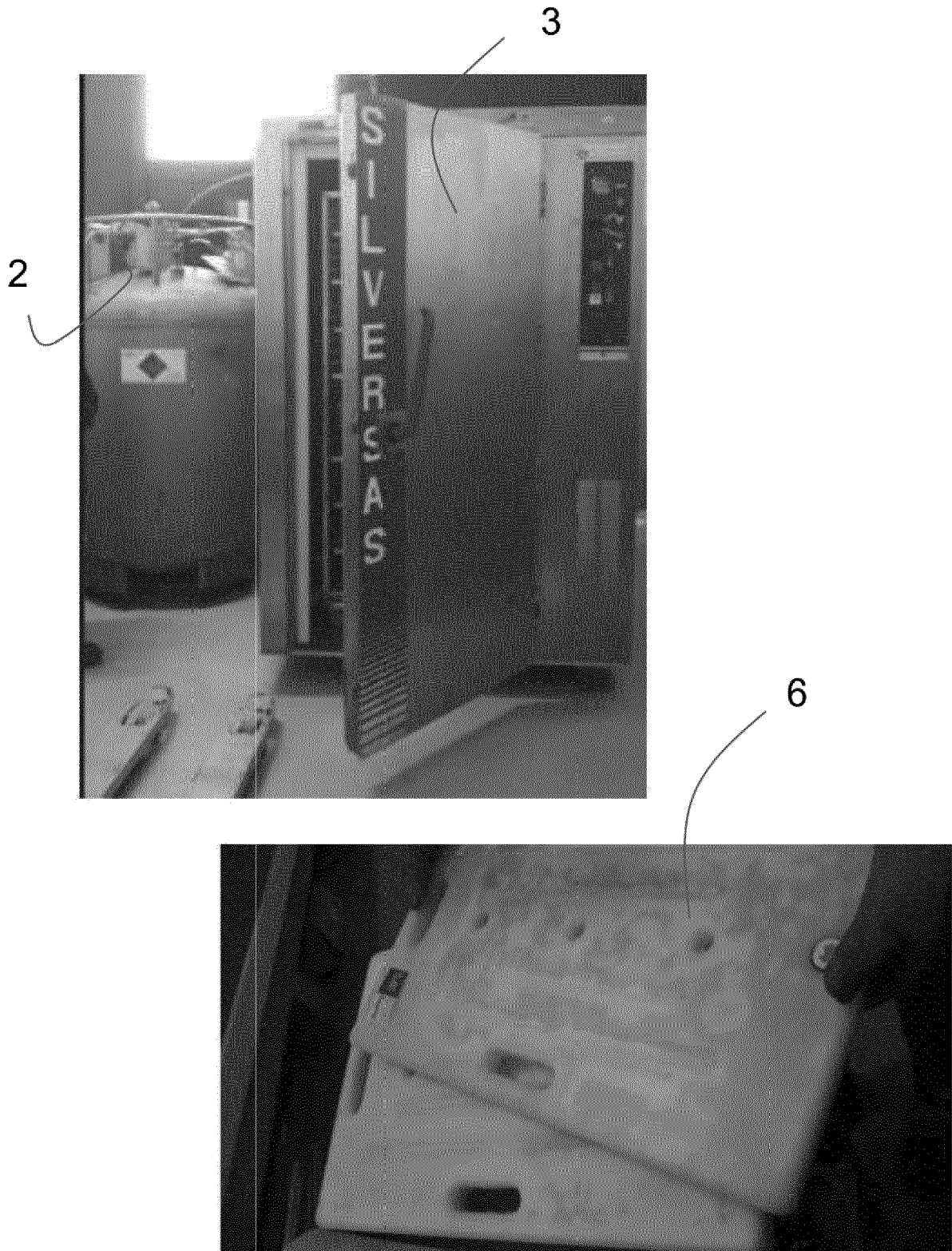


Fig. 2

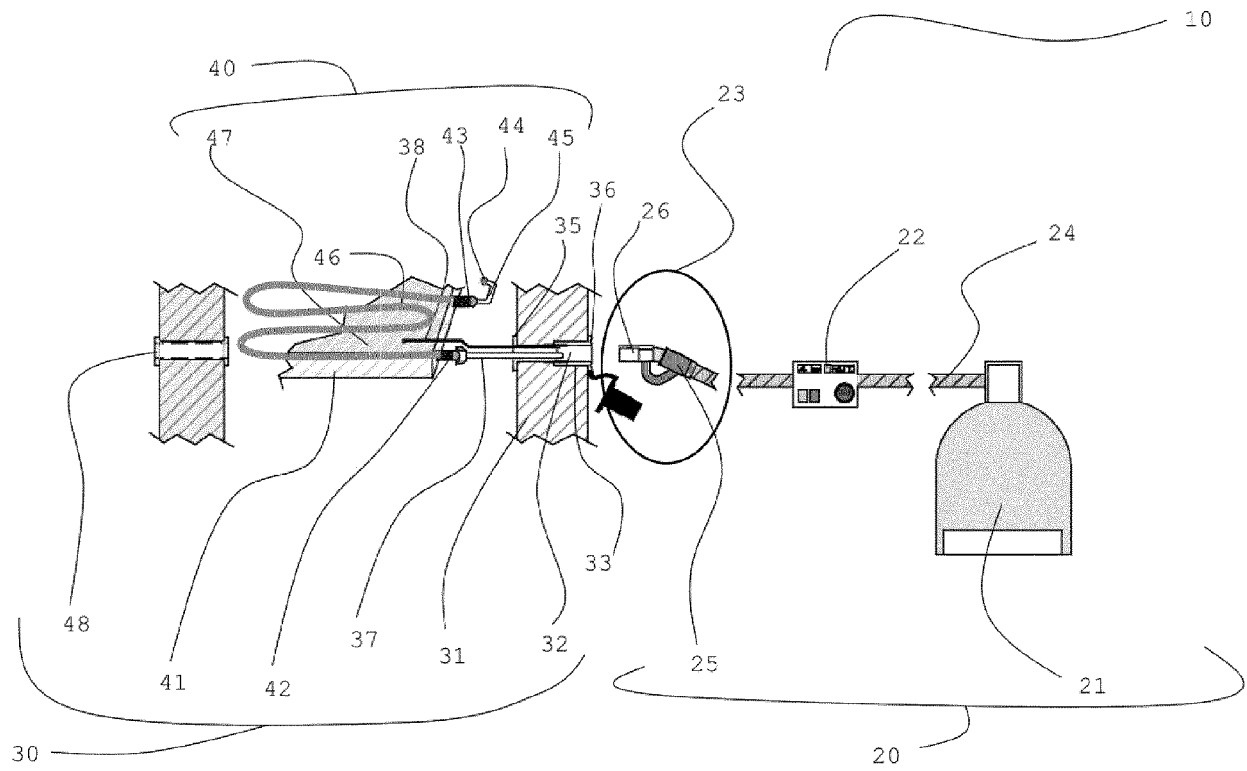


Fig. 3



EUROPEAN SEARCH REPORT

Application Number

EP 21 20 2270

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EPO FORM 1503 03.82 (P04C01)

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 2 March 2022	Examiner Dezso, Gabor
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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