



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.11.2023 Bulletin 2023/44

(51) International Patent Classification (IPC):
F17C 9/02 *(2006.01)*

(21) Application number: **22170760.7**

(52) Cooperative Patent Classification (CPC):
F17C 9/02; F17C 2205/0326; F17C 2205/0367;
F17C 2221/011; F17C 2221/014; F17C 2223/0161;
F17C 2223/033; F17C 2225/0123; F17C 2225/035;
F17C 2227/0311; F17C 2227/0393;
F17C 2250/032; F17C 2250/043; F17C 2250/0439;
F17C 2250/0473; (Cont.)

(22) Date of filing: **29.04.2022**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS LI LT LU LV MC MK MT NL NO PL
PT RO RS SE SI SK SM TR**

Remarks:

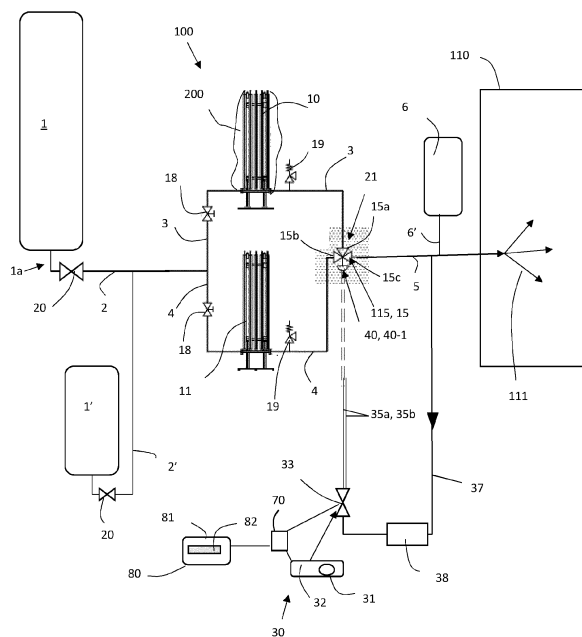
Amended claims in accordance with Rule 137(2)
EPC.

(54) **INSTALLATION AND PROCESS FOR PROVIDING A MEDICAL GAS TO A HOSPITAL**

(57) The invention concerns an installation (100) and a process for providing a gaseous compound, such as oxygen, to a building (110), such as a hospital. A first and a second atmospheric vaporizers (10, 11) are configured for alternatively vaporizing a liquid compound, i.e. a cryogenic liquid compound, such as liquid oxygen, provided by a cryogenic storage vessel (1) thereby obtaining a gaseous compound, such as gaseous oxygen. The vaporization of the liquid compound leads to a progressive icing of the vaporizer that works due to the cryogenic temperature of said liquid compound, namely deposit and solidification of water vapour present in ambient air sur-

rounding said atmospheric vaporizer. First valve means (115) alternatively provide to a main gas line (5), a flow of gaseous compound coming from one or the other of said first and second atmospheric vaporizers (10, 11), based on a prefixed duration (dt) that is sufficient for allowing ice formed around the vaporizer that is not fed with liquid compound, to melt down.

FIG. 1



(52) Cooperative Patent Classification (CPC): (Cont.)
F17C 2250/0636; F17C 2260/02; F17C 2260/032;
F17C 2270/02; F17C 2270/025

Description

[0001] The present invention concerns an installation and a process for providing a gaseous compound, typically a medical gas, such as oxygen, to a building, in particular to the gas network of a hospital or the like.

[0002] Various gaseous compounds, i.e. pure gases or gas mixtures, are used for treating patients in hospitals or the like, such as oxygen, air, N_2O , NO , N_2 , CO_2 , He ... or mixtures thereof. Among them, oxygen (O_2) is the most commonly used in respiratory therapy and life support. It is delivered to the patients in gaseous form, i.e. gaseous oxygen or GOX, using appropriate devices, such as respiratory masks, tubings, medical ventilators or respirators...

[0003] As large amounts of oxygen are required in hospitals, oxygen is usually provided in liquid form, i.e. LOX, by tank trucks or the like that deliver bulk LOX to the hospital facilities. Bulk LOX is then stored at cryogenic temperature, e.g. at less than $-190^\circ C$, in a cryogenic storage vessel(s) of several hundreds or thousands of liters that is arranged outside the hospital buildings, such as in a backyard or the like. Such a cryogenic storage vessel is thermally insulated for keeping oxygen in liquid state (i.e. LOX) at cryogenic temperature, i.e. at about $-196^\circ C$.

[0004] However, before use, LOX has to be vaporized, i.e. converted into gaseous oxygen or GOX. This is commonly done by means of a vaporization device, also called an atmospheric vaporizer, that receives the flow of LOX from the LOX storage vessel via a LOX line, i.e. a conduit, pipe or the like, and vaporizes it into GOX by thermal exchange with the ambient atmosphere. The ambient atmosphere that is at atmospheric temperature, i.e. generally of between $-5^\circ C$ to $+40^\circ C$, provides calories that heat the flow of LOX by thermal exchanges thereby obtaining a flow of gaseous oxygen or GOX.

[0005] GOX can be subsequently either stored in a buffer tank or directly provided to the gas network of the hospital, i.e. gas conduits or the like, by a gas line fluidly connecting the outlet of the atmospheric vaporizer to the gas network of the hospital that conveys gas or gases inside the hospital facilities to the various departments or services requiring oxygen, such as the emergency department, the operation rooms, the patient rooms....

[0006] However, the vaporization of LOX in an atmospheric vaporizer leads to a progressive icing of said vaporizer due to the cryogenic temperature of LOX. Said icing consists in a deposit and a solidification of water vapour present in ambient air surrounding the atmospheric vaporizer.

[0007] Icing is a real problem as it can negatively affect the mechanical structure of the vaporizer due to the weight of the accumulated ice that increases over the time. Further, icing can lead to malfunctionings of the device and/or to interruptions in the delivery of GOX to the hospital network and subsequently to the patients, which is obviously not acceptable, as a lack of oxygen may jeopardize their lives.

[0008] Another risk is that LOX is provided in lieu of GOX, which might lead to an accident if LOX enters into contact with non-stainless steel materials.

[0009] Similar problems may exist with other compounds, such as liquid nitrogen (LN_2) or other compounds, that may be used in hospitals or other facilities.

[0010] A goal of the present invention is to provide improved installation and process for providing gaseous compounds to hospitals or the like that may solve those problems so that a gaseous compound, such as GOX or any other medical gas compound, can be continuously provided to a hospital network or the like, i.e. without any interruption or the like, despite the icing of the atmospheric vaporizer used for converting a liquid compound at cryogenic temperature into a gaseous compound.

[0011] A solution according to the present invention concerns an installation for providing a gaseous compound to a building, such as a hospital, especially to the gas network of a hospital or the like, comprising :

- at least one cryogenic storage vessel for storing a liquid compound at cryogenic temperature, i.e. a cryogenic liquid compound,
- at least one feeding line for conveying a flow of the cryogenic liquid compound from said at least one cryogenic storage vessel to at least a first and a second derivation line arranged in parallel and fluidly connected to said at least one feeding line,
- at least a first atmospheric vaporizer arranged on the first derivation line and at least a second atmospheric vaporizer arranged on the second derivation line, said first and second atmospheric vaporizers being configured for vaporizing said cryogenic liquid compound thereby obtaining a gaseous compound,
- at least one main gas line fluidly connected to the first and second derivation lines, downstream of the first and second atmospheric vaporizers, for recovering and conveying said gaseous compound vaporized in said atmospheric vaporizers,
- first valve means arranged on the main line and/or on the first and second derivation lines, downstream of the first and second atmospheric vaporizers, for controlling the flow of gaseous compound provided by said first and second atmospheric vaporizers,

and wherein said first valve means are piloted by pilot means for alternatively providing to the main line, a flow of gaseous compound coming from one or the other of said first and second atmospheric vaporizers, based on a prefixed duration (dt).

[0012] Depending on the embodiment, the installation of the present invention may comprise one or more of the following features:

- said first valve means are piloted (e.g. configured) for allowing, for the prefixed duration (dt), a flow of gaseous compound coming from the first atmospheric vaporizer to pass into the main line, and si-

multaneously interrupting, i.e. for said prefixed duration (dt), the flow of gaseous compound coming from the second atmospheric vaporizer, and vice versa.

- said first valve means comprise a 3-way valve. 5
- the 3-way valve comprises a first inlet fluidly connected to the first derivation line, a second inlet fluidly connected to second derivation line and an outlet fluidly connected to the main line.
- the prefixed duration is sufficient for allowing ice formed around the vaporizer that is not fed with liquid compound, to melt down. 10
- the prefixed duration is of between 6 and 30 hours, preferably of between 8 and 24 hours.
- the cryogenic liquid compound is liquid oxygen (LOX) and the gaseous compound is gaseous oxygen (GOX). 15
- alternatively, the cryogenic liquid compound is liquid nitrogen (LN₂) and the gaseous compound is gaseous nitrogen (GN₂). 20
- the at least one cryogenic storage vessel is located outside of the building, such as a hospital, for instance in a backyard or the like.
- the at least one cryogenic storage vessel has a capacity of about 3000 to 40000 liters of cryogenic liquid compound, such as LOX. 25
- the cryogenic liquid compound is converted into a gaseous compound inside the first and/or second atmospheric vaporizers by thermal exchange, i.e. exchange of calories, with the ambient atmosphere in contact with said first and second atmospheric vaporizers. 30
- the pilot means comprise timer means and/or duration setting means for setting the desired duration dt, preferably a rotative selector or similar.
- the pilot means comprise a timer device. 35
- the timer means and/or the duration setting means are arranged in the timer device, preferably embedded into a common timer device.
- the first valve means cooperate with actuator means controlled by the pilot means for alternatively providing to the main line, a flow of gaseous compound coming from one or the other of said first and second atmospheric vaporizers. 40
- the actuator means are pneumatically-controlled by the pilot means. 45
- said actuator means are pneumatically controlled by the pilot means for acting on the first valve means, especially on the the 3-way valve, for automatically switching the delivery of the flow of gaseous compound from the first inlet to the second inlet of the 3-way valve, or vice versa, to the main line, based on the prefixed duration dt. 50
- said actuator means comprise a pneumatic actuator pneumatically controlled by the pilot means by means of two pneumatic-control lines and a command electrovalve. 55
- the two pneumatic-control lines are parallelly-ar-

ranged.

- the two pneumatic-control lines are in fluid communication, through a pneumatic electrovalve, with a pressurized-gas line fluidly connected to the main line, downstream of the 3-way valve.
- the two pneumatic-control lines are in fluid communication with the pressurized-gas line via a pneumatic electrovalve.
- the main gas line is divided into two gas line portions, arranged in parallel.
- each gas line portion comprises, arranged in serial, a first manual valve, a pressure reducer, a second manual pressure sensor for measuring the reduced pressure, and a second valve.
- a first pressure sensor is arranged upstream of the first valve on one of the gas line portions for measuring the inlet pressure, namely the pressure provided by the 3-way valve.
- it further comprises electric power means for providing electric current to all the elements or parts of the installation that require electric power to work, especially the pilot means and the pneumatic electrovalve, esp. the coil of the pneumatic electrovalve.
- it further comprises monitoring device comprising a display screen for displaying various information, such as alarms, temperatures or any other information.
- the electric power means are also connected to the monitoring device.
- the monitoring device is further electrically connected to temperature sensor(s).
- the monitoring device can comprise a (micro)processor or the like for processing data, signals or measurements provided by the temperature sensors.
- the monitoring device is configured for triggering an alarm in case of problem, such as a malfunctioning, a wrong temperature measurement or a detection of an electrical power default.

[0013] The installation according to the present invention is configured for running a process for providing a gaseous compound, especially GOX, to a building, such as a hospital, as below explained.

[0014] In other words, the present invention also concerns a process for providing a gaseous compound to a building, such as a hospital, comprising the steps of :

- a) storing a liquid compound at cryogenic temperature, i.e. a cryogenic liquid compound, into at least one cryogenic storage vessel,
- b) conveying by means of at least one feeding line, a flow of cryogenic liquid compound from said at least one cryogenic storage vessel to at least a first and a second derivation line arranged in parallel and fluidly connected to said at least one feeding line,
- c) vaporizing said cryogenic liquid compound by means of at least a first atmospheric vaporizer arranged on the first derivation line and at least a sec-

ond atmospheric vaporizer arranged on the second derivation line, thereby obtaining a gaseous compound,

d) recovering and conveying the gaseous compound vaporized in said atmospheric vaporizers by means of at least one main gas line fluidly connected to the first and second derivation line, downstream of the first and second atmospheric vaporizers,

e) controlling the flow of gaseous compound provided by the first and second atmospheric vaporizers, by means of first valve means arranged on the main line and/or on the first and second derivation lines, downstream of the first and second atmospheric vaporizers, said first valve means being controlled by pilot means and

f) alternately providing to the main line, by means of the first valve means, a flow of gaseous compound coming from one or the other of said first and second atmospheric vaporizers, based on a prefixed duration (dt).

[0015] Depending on the embodiment, the process of the present invention may comprise one or more of the following features:

- the first valve means comprise a 3-way valve.
- the cryogenic liquid compound is liquid oxygen (LOX) and the gaseous compound is gaseous oxygen (GOX).
- alternatively, the cryogenic liquid compound is liquid nitrogen (LN₂) and the gaseous compound is gaseous nitrogen (GN₂).
- the at least one cryogenic storage vessel is located outside of the building, such as a hospital, for instance in a backyard or the like.
- the prefixed duration (dt) is chosen for being sufficient for allowing ice formed around the vaporizer that is not fed with cryogenic liquid compound, to melt down.
- the prefixed duration is of between 6 and 30 hours, preferably of between 8 and 24 hours.
- the at least one cryogenic storage vessel has a capacity of about 3000 to 40000 liters of cryogenic liquid compound.
- the flow of gaseous compound, such as GOX, provided by the first and/or second atmospheric vaporizers has a pressure of between 5 and 15 bar abs, typically of about 8 to 12 bar abs.

[0016] The present invention will be explained in more details in the following illustrative description of an embodiment of an installation according to the present invention, which is made in references to the accompanying drawings among them:

- Figure 1 is a scheme of an installation according to the present invention useable for providing GOX to the gas network of a hospital,

- Figures 2 and 3 show an embodiment of a pneumatically-controlled actuator associated to a 3-way valve useable in the installation of Figure 1,
- Figure 4 represents the gas regulation elements of the pressurized-gas line of the installation of Figure 1,
- Figure 5 shows a particular embodiment of the main gas line of the installation of Fig. 1, and
- Figure 6 shows the cooperation between the timer device and the pneumatic electrovalve of the installation of Figures 1-3.

[0017] Figure 1 shows an installation 100 for providing a gaseous compound, here gaseous oxygen or GOX, to the gas network 111 of a hospital 110, or similar facility, that delivers GOX to the different sites of use into the hospital, such as operation rooms, patient room or others.

[0018] The Installation 100 comprises a cryogenic storage vessel 1 for storing a cryogenic liquid compound, such as liquid oxygen or LOX in the present embodiment, at cryogenic temperature. The storage vessel 1 can contain a large volume of cryogenic liquid compound, e.g. LOX, preferably at least 3000 liters. The cryogenic storage vessel 1 is preferably insulated for keeping LOX at cryogenic temperature, i.e. at about -196°C in the case of LOX.

[0019] The passage of LOX from the cryogenic storage vessel 1 to a feeding line 2 is controlled by a delivery valve 20, or similar means, arranged on the feeding line 2, preferably arranged immediately at the exit 1a of the cryogenic storage vessel 1.

[0020] Optionally, the installation 100 can comprise several cryogenic storage vessels 1, 1' arranged in parallel and fluidly connected to the feeding line 2, that are used for providing LOX. For instance, as shown in [Fig. 1], the installation 100 can comprise a main storage vessel 1 and a secondary storage vessel 1' that is used in case of emergency, for instance when the main storage vessel 1 is empty, malfunctioning, in maintenance or the like. The secondary storage vessel 1' is fluidly connected to the feeding line 2 by an additional conduit 2' comprising an additional delivery valve 20' for controlling the delivery of LOX from the secondary storage vessel 1'.

[0021] The cryogenic storage vessel(s) 1 is further fluidly connected, via the feeding line 2, such as a gas pipe, conduit or the like, to a first 3 and a second 4 derivation line that are arranged in parallel and fluidly connected to the feeding line 2 so that LOX can be conveying in its liquid state from the cryogenic storage vessel 1 to said derivation lines 3, 4. In other words, the feeding line 2 is sub-divided in said (at least) two derivation lines 3, 4.

[0022] Each of said derivation lines 3, 4 comprises an atmospheric vaporizer 10, 11 for vaporizing LOX and thus obtaining GOX, namely a first atmospheric vaporizer 10 is arranged on the first derivation line 3 and a second atmospheric vaporizer 11 is arranged on the second derivation line 4.

[0023] In said atmospheric vaporizer 10, 11, LOX is heated by thermal exchange with the surrounding atmosphere so that it is converted into GOX, i.e. a gaseous product, by calory exchange.

[0024] Each of said derivation lines 3, 4 can further comprise a valve 18 arranged upstream of each atmospheric vaporizer 10, 11 that is used for maintenance.

[0025] Further, each of said derivation lines 3, 4 can also comprises safety means 19, i.e. safety valves, arranged downstream of each atmospheric vaporizer 10, 11 that are used for venting overpressures to the atmosphere. Said safety means 19 can comprise an overpressure valve or the like arranged on a safety conduit in fluid communication with each derivation line 3, 4.

[0026] Furthermore, a main gas line 5 is fluidly connected to the first and second derivation line 3, 4, downstream of the first and second atmospheric vaporizers 10, 11, for recovering GOX provided by the atmospheric vaporizers 10, 11. The main gas line 5 subsequently conveys the GOX to the gas network 111 of a hospital 110 or the like, namely to gas lines or conduits arranged in said hospital 110 for delivering the gas in the different sites in need thereof. In other words, the main gas line 5 is fluidly connected to the gas network 111 of the hospital, i.e. conduits, pipes or similar.

[0027] Optionally, at least a part of the GOX produced in the atmospheric vaporizers 10, 11 and recovered by the main gas line 5 can be stored, in gaseous form, in one or more buffer tank(s) 6 or the like, that is fluidly connected, by a buffer line 6', to said main gas line 5, downstream of the atmospheric vaporizers 10, 11. Valves or the like (not shown) arranged on the buffer line 6' and/or on the main gas line 5 are used for controlling the flow of GOX entering or exiting the buffer tank 6.

[0028] Depending on the embodiment, the main gas line 5 can be a unique conduit or the like or can be divided, i.e. ramified, in several sub-lines arranged in parallel.

[0029] First valve means 115 is arranged on the main gas line 5 and/or on the first and second derivation lines 3, 4, downstream of the first and second atmospheric vaporizers 10, 11, for controlling the flow of liquid compound, i.e. LOX, passing through, i.e. traversing, the first and second atmospheric vaporizers 10, 11 and hence also the flow of GOX delivered by the first and second derivation lines 3, 4 to the main gas line 5.

[0030] During the conversion of LOX into GOX in one or the other of the atmospheric vaporizers 10, 11, for instance in the first atmospheric vaporizer 10 as shown in [Fig. 1], an ice layer 200 progressively appears around said atmospheric vaporizer 10, 11.

[0031] As already mentioned, this progressive icing of the vaporizer 10 (or 11) is caused by a deposit/solidification of water vapour present in the ambient air surrounding the atmospheric vaporizer that contains LOX at cryogenic temperature (i.e. at about -196°C).

[0032] This is a serious problem as said ice layer 200 may deteriorate the structure of the vaporizers 10, 11 and/or lead to gas supply disruptions or the like.

[0033] According to the present invention, for trying to solve said icing issues, the first valve means 115 are configured for alternately allowing a flow of gaseous compound, e.g. here GOX, to be delivered by only one or the other of said first and second atmospheric vaporizers 10, 11, based on a prefixed duration dt.

[0034] The duration dt is chosen so as to be sufficient for melting some to all the layer of ice 200 formed around the atmospheric vaporizer 10, 11 that has to be thawed. It can be selected by the operator as below explained.

[0035] GOX thus produced is at a pressure of between 5 and 15 bar abs, typically of about 8 to 12 bar abs.

[0036] Preferably, the first valve means 115 comprises a 3-way valve 15 arranged at the point of junction 21 of the first and second derivation lines 3, 4 with the main line 5, namely downstream of the atmospheric vaporizers 10, 11.

[0037] Said 3-way valve 15 comprises a first inlet 15a fluidly connected to the first derivation line 3, a second inlet 15b fluidly connected to the second derivation line 4 and an outlet 15c fluidly connected to the main line 5, as shown in Fig. 1 & 2.

[0038] The first valve means 115 are configured for alternately providing GOX coming from one or the other of said atmospheric vaprizers 10, 11, to the main line 5 for a prefixed duration dt, while no GOX is produced by the other vaporizer 10, 11, and vice versa.

[0039] In this way, the ice layer 200 accumulated around the atmospheric vaporizer 10, 11, while it was running for producing GOX from LOX, has sufficient time to melt down, during the time, i.e. the prefixed duration dt, it does not deliver GOX. This allows guaranteeing a continuous delivery of GOX to the gas network 111 of the hospital 110 as only the atmospheric vaporizer 10, 11 that is not fully covered by an ice layer 200 works and produces GOX.

[0040] In contrast, the other atmospheric vaporizer 10, 11, that is largely surrounded by an ice layer 200 formed while it was running for producing GOX from LOX, does not work anymore during the prefixed duration dt so that said layer of ice 200 can naturally and slowly melt down by heat exchange with the surrounding atmosphere, and hence progressively disappears.

[0041] In other words, one of the atmospheric vaporizers 10, 11 works and produces GOX from LOX, while the other atmospheric vaporizer 10, 11 is in a 'stand-by' or "stop" mode, i.e. does not work, so that the ice layer 200 surrounding said other atmospheric vaporizer 10, 11 can melt down, and vice versa.

[0042] The prefixed duration dt is chosen for allowing the ice layer 200 to at least partially or completely melt down thereby freeing the atmospheric vaporizer 10, 11 from said ice. Said duration dt can be set by an operator as below explained. Preferably, the duration dt is of several hours, preferably of between 6 h and 30 h, typically between 8h and 24h.

[0043] The alternating running of the atmospheric vaporizers 10, 11 is obtained by means of the 3-way valve

15 that is controlled for allowing LOX to circulate only in one of the two first and second derivation lines 3, 4 and be vaporized therein.

[0044] The 3-way valve 15 is controlled by actuator means 40 cooperating with said pneumatic 3-way valve 15.

[0045] The installation 100 of the present invention further comprises pilot means 130 comprising duration setting means 31 and timer means 32 that can be embedded into a timer device 30, as shown in Figure 6.

[0046] Duration setting means 31 can comprise one or several rotatable button(s) or selector(s), selection touch(es), cursor(s) or the like, that are configured for allowing the user choosing or selecting a desired duration dt, typically a duration dt of between 6 h and 30 h, preferably of between 8h to 24h.

[0047] The duration setting means 31 and the timer means 32, such as a temporisation, a timer or the like, cooperate together for piloting a pneumatic electrovalve 33, such as a solenoid valve or the like, based on the duration dt that has been set by the operator.

[0048] In short, the timer means 32 act on the coil of the pneumatic electrovalve 33 for 'activating' or 'deactivating' said coil thereby allowing automatically-switching from one atmospheric vaporizer to the other 10, 11, and vice versa, based on the duration dt.

[0049] The pneumatic electrovalve 33 is arranged, as shown in Fig. 6, between a pressurized-gas line 37 fluidly connected to the main line 5, and two pneumatic command lines 35a, 35b arranged in parallel and further fluidly connected to actuator means 40 cooperating with the pneumatic 3-way valve 15, as illustrated in Fig. 1, 4 & 5.

[0050] The pneumatic electrovalve 33 controls the delivery of gas pressure, i.e. underpressure gas, provided by the pressurized-gas line 37 to one or the other of the two pneumatic command lines 35a, 35b that are fluidly connected to the pneumatic electrovalve 33 and to the 3-way valve 15, i.e. to the actuator means 40.

[0051] Said cooperation between timer means 32 and the pneumatic electrovalve 33 that pneumatically-controls the 3-way valve 15 useable in the installation 100 of the invention is illustrated in Figures 1 & 4-6.

[0052] The two pneumatic command lines 34 provide gas under pressure, such as GOX in the present embodiment, that can act on the actuator means 40 of the 3-way valve 21 for controlling them, especially a pneumatic actuator 40-1.

[0053] The gas under pressure can be GOX provided by a pressurized-gas line 37 fluidly connected to the main line 5, namely downstream of the 3-way valve 15, as represented in Fig. 1.

[0054] The pressurized-gas line 37 preferably comprises gas regulation elements 38 as detailed in Fig. 4, comprising an on/off valve 38-1, a pressure reducer 38-2 for controlling the pressure level, and an over-pressure safety valve 38-3 in fluid communication with the atmosphere for venting any over-pressure to the atmosphere.

[0055] Actuator means 40 preferably comprise a pneumatic actuator 40-1 as shown in Fig. 2 and 3, associated to the valve means 115, especially the 3-way valve 15 for pneumatically controlling said 3-way valve 15 in order to open or close the first and/or second inlets 15a, 15b, so that a flow of gaseous compound, e.g. GOX, coming from one or the other of said first and second atmospheric vaporizers 10, 11, is alternately provided to the main line 5, via the outlet 15c.

[0056] Thus, one of the two pneumatic command lines 35a, 35b pneumatically cooperates with the pneumatic actuator 40-1 for opening the passage of GOX through the first way 15a of the 3-way valve 15 for the duration dt, whereas the other of the two pneumatic command lines 35a, 35b simultaneously cooperates with the pneumatic actuator 40-1 for closing the passage of GOX through the second way 15a of the 3-way valve 15, and vice versa.

[0057] In other words, pilot means 130 are configured for pneumatically-controlling the 3-way valve 15 via the pneumatic electrovalve 33, the two pneumatic command lines 35a, 35b and the actuator means 40, i.e. a pneumatic actuator 40-1, on the basis of the duration dt set by the operator by means of the duration settings means 31 that cooperate with the timer means 32, i.e. thanks to a timer device 30, as shown in Figure 6.

[0058] As shown in Fig. 2 & , the two pneumatic command lines 35a, 35b, such as copper or copper alloy conduits, are fluidly connected to two pressure inlets 41 of the pneumatic actuator 40-1, i.e. the actuator means 40, preferably by threaded connectors 42 or the like.

[0059] As shown in Fig. 6, electric power means 70, such as an AC/DC power supply, are provided for delivering electric current to all the elements or parts of the installation 100 that require electric power to work, in particular to the timer device 30, to the coil of the pneumatic electrovalve 33, to a monitoring device 80 or any other elements in need thereof.

[0060] The electric power means 70, especially the AC/DC power supply, can be electrically-connected to the mains (110/220V) as the power source and, if need be, to a power converter for converting a high voltage, e.g. 110/220V, into a lower voltage, e.g. 24V or any other suitable voltage.

[0061] As illustrated in Fig. 6, the electric power means 70 provide power, via electric lines, cables 71 or the like, to the coil of the pneumatic electrovalve 33 and to the timer device 30, and further to the monitoring device 80.

[0062] In the present embodiment, the installation 100 further comprises a monitoring device 80 comprising a housing 81 and a display screen 82 for displaying various information, such as alarms, temperatures or any other information.

[0063] The monitoring device 80 can comprise a (micro)processor or the like, for instance an electronic card, for processing data, signals or measurements provided by temperature sensors 55 as said monitoring device 80 is connected to temperature sensors 55 arranged up-

stream of the gas line portions 5-1, 5-2. Thanks to the monitoring device 80, it is possible to control the temperature of GOX provided by the two atmospheric vaporizers 10, 11 and to trigger alarms in case of malfunctioning, wrong temperature measurement or detection of an electrical power default.

[0064] Figure 5 shows a particular embodiment of the main gas line 5 of the installation 100 of Fig. 1, wherein said main gas line 5 is divided into two gas line portions 5-1, 5-2, arranged in parallel.

[0065] Each gas line portion 5-1, 5-2 comprises, arranged in serial, a first manual valve 50, a pressure reducer 51, a second manual pressure sensor 52 for measuring the reduced pressure, and a second valve 53. Further, a first pressure sensor 54 can be arranged upstream of the first valve 50 on one of the gas line portions 5-1, 5-2 for measuring the inlet pressure, namely the pressure provided by the 3-way valve 15.

[0066] Such gas line portions 5-1, 5-2 can be helpful for controlling the gas pressure of GOX provided by the two atmospheric vaporizers 10, 11 before it is sent to the network 11 of the hospital 110 or the like.

[0067] Further, as already mentioned, the main gas line 5 can also comprise temperature sensors 55 arranged upstream of the gas line portions 5-1, 5-2, so that it is possible to control the temperature of GOX provided by the two atmospheric vaporizers 10, 11 and remotely figure out whether the vaporization of LOX is correctly done in the atmospheric vaporizer 10, 11.

[0068] Optionally, the main gas line 5 can also be provided with oxygen coming from the secondary storage vessel 1' that is used in case of emergency, via an emergency gas line 60 equipped with a valve 61 as shown in Fig. 5. If the secondary storage vessel 1' contains LOX, it will have to be vaporized before being conveyed by emergency gas line 60, for instance by means of an additional atmospheric vaporizer (not shown) arranged between the secondary storage vessel 1' and the emergency gas line 60.

[0069] Generally speaking, the installation 100 and the process of the present invention can work automatically, once the duration dt is set by the operator, for instance a duration of about 6h to 24h. The switching between the first and the second derivation lines 3, 4, and vice versa, is automatically operated by the pilot means 30 including the timer means 32, namely each time when the duration dt is over, for instance every 24h or less. This allows the ice layer 200 of the not-used atmospheric vaporizer 10, 11 to progressively melt by thermal exchange, i.e. heating, with the ambient atmosphere, while the other atmospheric vaporizer 10, 11 produces GOX by vaporization of LOX.

[0070] In other words, the installation 100 and process of the present invention allow an automatic switch from one atmospheric vaporizer (that is stopped, i.e. does not work anymore) to other atmospheric vaporizer 10, 11, located downstream of a LN₂ or LOX storage, thereby allowing a melting of the ice formed on the atmospheric

vaporizer that is stopped during a given duration dt and hence guaranteeing a continuous delivery of GN₂ or GOX to a hospital facilities or the like.

Claims

1. Installation (100) for providing a gaseous compound to a building (110), such as a hospital, comprising :

- at least one cryogenic storage vessel (1) for storing a liquid compound at cryogenic temperature,
- at least one feeding line (2) for conveying a flow of liquid compound from said at least one cryogenic storage vessel (1) to at least a first (3) and a second (4) derivation lines arranged in parallel and fluidly connected to said at least one feeding line (2),
- at least a first atmospheric vaporizer (10) arranged on the first derivation line (3) and at least a second atmospheric vaporizer (11) arranged on the second derivation line (4), said first and second atmospheric vaporizers (10, 11) being configured for vaporizing said liquid compound thereby obtaining a gaseous compound,
- at least one main gas line (5) fluidly connected to the first and second derivation line (3, 4), downstream of the first and second atmospheric vaporizers (10, 11), for recovering and conveying the gaseous compound vaporized in said atmospheric vaporizers (10, 11),
- first valve means (115) arranged on the main line (5) and/or on the first and second derivation lines (3, 4), downstream of the first and second atmospheric vaporizers (10, 11), for controlling the flow of gaseous compound provided by said first and second atmospheric vaporizers (10, 11),

and wherein said first valve means (115) are piloted by pilot means (130) for alternatively providing to the main line (5), a flow of gaseous compound coming from one or the other of said first and second atmospheric vaporizers (10, 11), based on a prefixed duration (dt).

2. Installation according to claim 1, **characterized in that** said first valve means (115) are piloted for allowing, for the prefixed duration (dt), a flow of gaseous compound coming from the first atmospheric vaporizer (10) to pass into the main line (5), and simultaneously interrupting the flow of gaseous compound coming from the second atmospheric vaporizer (11), and vice versa.
3. Installation according to any one of claims 1 or 2, **characterized in that** the prefixed duration is of be-

tween 8 hours and 24 hours.

4. Installation according to any one of claims 1 to 3, **characterized in that** said first valve means (115) comprise a 3-way valve (15) comprising :
 - a first inlet (15a) fluidly connected to the first derivation line (3),
 - a second inlet (15b) fluidly connected to second derivation line (4) and
 - an outlet (15c) fluidly connected to the main line (5).
5. Installation according to claim 1, **characterized in that** said pilot means (130) comprise timer means (32) and duration setting means (31) for setting the desired duration (dt), preferably a rotative selector.
6. Installation according to claim 5, **characterized in that** the first valve means (115) cooperate with actuator means (40) controlled by the pilot means (130) for alternatively providing to the main line (5), a flow of gaseous compound coming from one or the other of said first and second atmospheric vaporizers (10, 11).
7. Installation according to claims 4 and 6, **characterized in that** the actuator means (40) are pneumatically-controlled by the pilot means (130).
8. Installation according to claims 4 and 6 or 7, **characterized in that** said actuator means (40) are pneumatically controlled by the pilot means (130) for acting on the first valve means (115) for automatically switching the delivery of the flow of gaseous compound from the first inlet (15a) to the second inlet (15b) of the 3-way valve (15), or vice versa, to the main line (5), based on the prefixed duration (dt).
9. Installation according to any one of the preceding claims, **characterized in that** said actuator means (40) comprise a pneumatic actuator (40-1) pneumatically controlled by the pilot means (130) via two pneumatic-control lines (35a, 35b) and a pneumatic electrovalve (33).
10. Installation according to claim 9, **characterized in that** the two pneumatic-control lines (35a, 35b) are in fluid communication, through the pneumatic electrovalve (33), with a pressurized-gas line (37) fluidly connected to the main line (5), downstream of the 3-way valve (15).
11. Installation according to any one of the preceding claims, **characterized in that** the pilot means (130) further comprise a timer device (30) comprising the timer means (32) and duration setting means (31).

12. Installation according to any one of the preceding claims, **characterized in that** :

- the liquid compound is liquid oxygen (LOX) and the gaseous compound is gaseous oxygen (GOX) or
- the liquid compound is liquid nitrogen (LN₂) and the gaseous compound is gaseous nitrogen (GN₂).

13. Process for providing a gaseous compound to a building (110), such as a hospital, comprising the steps of :

- a) storing a liquid compound at cryogenic temperature into at least one cryogenic storage vessel (1),
- b) conveying by means of at least one feeding line (2), a flow of liquid compound from said at least one cryogenic storage vessel (1) to at least a first (3) and a second (4) derivation lines arranged in parallel and fluidly connected to said at least one feeding line (2),
- c) vaporizing said liquid compound by means of at least a first atmospheric vaporizer (10) arranged on the first derivation line (3) and at least a second atmospheric vaporizer (11) arranged on the second derivation line (4), thereby obtaining a gaseous compound,
- d) recovering and conveying the gaseous compound vaporized in said atmospheric vaporizers (10, 11) by means of at least one main gas line (5) fluidly connected to the first and second derivation line (3, 4), downstream of the first and second atmospheric vaporizers (10, 11),
- e) controlling the flow of gaseous compound provided by the first and second atmospheric vaporizers (10, 11), by means of first valve means (115) arranged on the main line (5) and/or on the first and second derivation lines (3, 4), downstream of the first and second atmospheric vaporizers (10, 11), said first valve means (115) being controlled by pilot means (130) and
- f) alternatively providing to the main line (5), through the first valve means (115), a flow of gaseous compound coming from one or the other of said first and second atmospheric vaporizers (10, 11), based on a prefixed duration (dt).

14. Process according to Claim 13, **characterized in that** the first valve means (115) comprise a 3-way valve (15).

15. Process according to Claim 13, **characterized in that**:

- the liquid compound is liquid oxygen (LOX) and the gaseous compound is gaseous oxygen

(GOX), or the liquid compound is liquid nitrogen (LN₂) and the gaseous compound is gaseous nitrogen (GN₂), and
 - the prefixed duration is of between 6 and 30 hours, preferably of between 8 and 24 hours.

Amended claims in accordance with Rule 137(2) EPC.

1. Installation (100) for providing a gaseous compound to a building (110), such as a hospital, comprising :

- at least one cryogenic storage vessel (1) for storing a liquid compound at cryogenic temperature,
- at least one feeding line (2) for conveying a flow of liquid compound from said at least one cryogenic storage vessel (1) to at least a first (3) and a second (4) derivation lines arranged in parallel and fluidly connected to said at least one feeding line (2),
- at least a first atmospheric vaporizer (10) arranged on the first derivation line (3) and at least a second atmospheric vaporizer (11) arranged on the second derivation line (4), said first and second atmospheric vaporizers (10, 11) being configured for vaporizing said liquid compound thereby obtaining a gaseous compound,
- at least one main gas line (5) fluidly connected to the first and second derivation line (3, 4), downstream of the first and second atmospheric vaporizers (10, 11), for recovering and conveying the gaseous compound vaporized in said atmospheric vaporizers (10, 11),
- first valve means (115) arranged on the main line (5) and/or on the first and second derivation lines (3, 4), downstream of the first and second atmospheric vaporizers (10, 11), for controlling the flow of gaseous compound provided by said first and second atmospheric vaporizers (10, 11), said first valve means (115) comprising a 3-way valve (15),

and wherein said first valve means (115) are piloted by pilot means (130) for alternatively providing to the main line (5), a flow of gaseous compound coming from one or the other of said first and second atmospheric vaporizers (10, 11), based on a prefixed duration (dt),
characterized in that :

- the pilot means (130) comprise timer means (32) and duration setting means (31) for setting the desired duration (dt),
- the first valve means (115) cooperate with actuator means (40) controlled by the pilot means (130) for alternatively providing to the main line (5), a flow of gaseous com-

pound coming from one or the other of said first and second atmospheric vaporizers (10, 11), said actuator means (40) comprising a pneumatic actuator (40-1) pneumatically controlled by the pilot means (130) via two pneumatic-control lines (35a, 35b) and a pneumatic electrovalve (33), and
 - the two pneumatic-control lines (35a, 35b) are in fluid communication, through the pneumatic electrovalve (33), with a pressurized-gas line (37) fluidly connected to the main line (5), downstream of the 3-way valve (15).

2. Installation according to claim 1, **characterized in that** said first valve means (115) are piloted for allowing, for the prefixed duration (dt), a flow of gaseous compound coming from the first atmospheric vaporizer (10) to pass into the main line (5), and simultaneously interrupting the flow of gaseous compound coming from the second atmospheric vaporizer (11), and vice versa.

3. Installation according to any one of claims 1 or 2, **characterized in that** the prefixed duration is of between 8 hours and 24 hours.

4. Installation according to any one of claims 1 to 3, **characterized in that** the 3-way valve (15) comprises :

- a first inlet (15a) fluidly connected to the first derivation line (3),
- a second inlet (15b) fluidly connected to second derivation line (4) and
- an outlet (15c) fluidly connected to the main line (5).

5. Installation according to claim 1, **characterized in that** the duration setting means (31) for setting the desired duration (dt) comprises a rotative selector.

6. Installation according to claim 1, **characterized in that** the actuator means (40) are pneumatically-controlled by the pilot means (130).

7. Installation according to claims 1 or 6, **characterized in that** said actuator means (40) are pneumatically controlled by the pilot means (130) for acting on the first valve means (115) for automatically switching the delivery of the flow of gaseous compound from the first inlet (15a) to the second inlet (15b) of the 3-way valve (15), or vice versa, to the main line (5), based on the prefixed duration (dt).

8. Installation according to any one of the preceding claims, **characterized in that** the pilot means (130) further comprise a timer device (30) comprising the

timer means (32) and duration setting means (31).

9. Installation according to any one of the preceding claims, **characterized in that** it further comprises monitoring device (80) comprising a display screen (82). 5
10. Installation according to Claim 9, **characterized in that** the monitoring device (80) is configured for triggering an alarm in case of problem, such as a malfunctioning, a wrong temperature measurement or a detection of an electrical power default. 10
11. Installation according to any one of the preceding claims, **characterized in that** the main gas line (5) is divided into two gas line portions (5-1, 5-2), arranged in parallel, each gas line portion (5-1, 5-2) comprises, arranged in serial, a first manual valve (50), a pressure reducer (51), a second manual pressure sensor (52) for measuring the reduced pressure, and a second valve (53). 15 20
12. Installation according to any one of the preceding claims, **characterized in that** : 25
 - the liquid compound is liquid oxygen (LOX) and the gaseous compound is gaseous oxygen (GOX) or
 - the liquid compound is liquid nitrogen (LN₂) and the gaseous compound is gaseous nitrogen (GN₂). 30
13. Process for providing a gaseous compound to a building (110), such as a hospital, comprising the steps of : 35
 - a) storing a liquid compound at cryogenic temperature into at least one cryogenic storage vessel (1),
 - b) conveying by means of at least one feeding line (2), a flow of liquid compound from said at least one cryogenic storage vessel (1) to at least a first (3) and a second (4) derivation lines arranged in parallel and fluidly connected to said at least one feeding line (2), 40 45
 - c) vaporizing said liquid compound by means of at least a first atmospheric vaporizer (10) arranged on the first derivation line (3) and at least a second atmospheric vaporizer (11) arranged on the second derivation line (4), thereby obtaining a gaseous compound, 50
 - d) recovering and conveying the gaseous compound vaporized in said atmospheric vaporizers (10, 11) by means of at least one main gas line (5) fluidly connected to the first and second derivation line (3, 4), downstream of the first and second atmospheric vaporizers (10, 11), 55
 - e) controlling the flow of gaseous compound pro-

vided by the first and second atmospheric vaporizers (10, 11), by means of first valve means (115) arranged on the main line (5) and/or on the first and second derivation lines (3, 4), downstream of the first and second atmospheric vaporizers (10, 11), said first valve means (115) comprising a 3-way valve (15) and being controlled by pilot means (130) and
f) alternatively providing to the main line (5), by means of actuator means (40) cooperating with the first valve means (115), and through said first valve means (115), a flow of gaseous compound coming from one or the other of said first and second atmospheric vaporizers (10, 11), based on a prefixed duration (dt),

characterized in that the pilot means (130) are pneumatically-controlling, via two pneumatic-control lines (35a, 35b) and a pneumatic electrovalve (33), a pneumatic actuator (40-1) of the actuator means (40), said two pneumatic-control lines (35a, 35b) being in fluid communication, through the pneumatic electrovalve (33), with a pressurized-gas line (37) fluidly connected to the main line (5), downstream of the 3-way valve (15).

14. Process according to Claim 13, **characterized in that** the liquid compound is liquid oxygen (LOX) and the gaseous compound is gaseous oxygen (GOX), or the liquid compound is liquid nitrogen (LN₂) and the gaseous compound is gaseous nitrogen (GN₂).
15. Process according to Claim 13, **characterized in that** the prefixed duration is of between 6 and 30 hours, preferably of between 8 and 24 hours.

FIG. 1

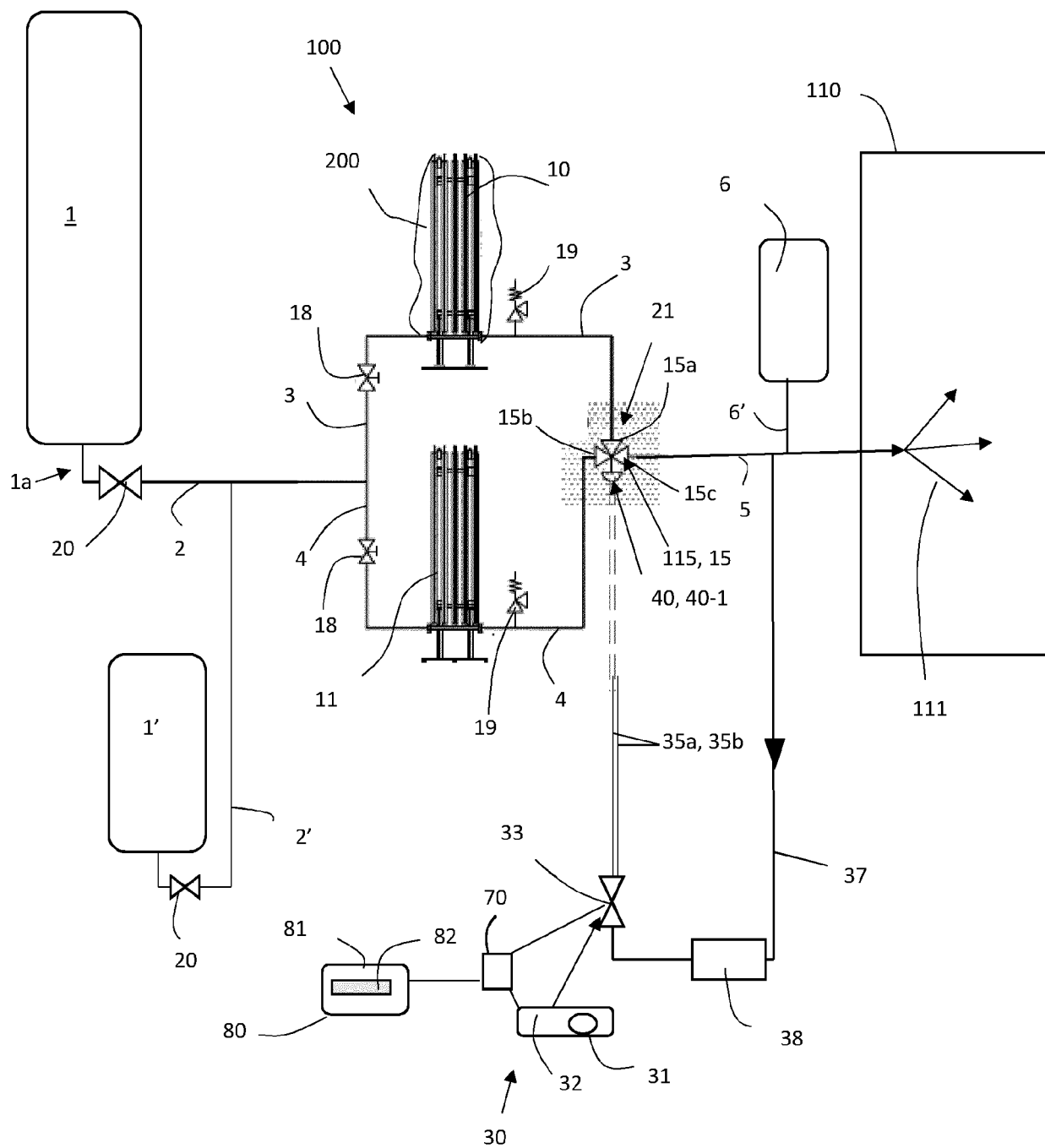


FIG. 2

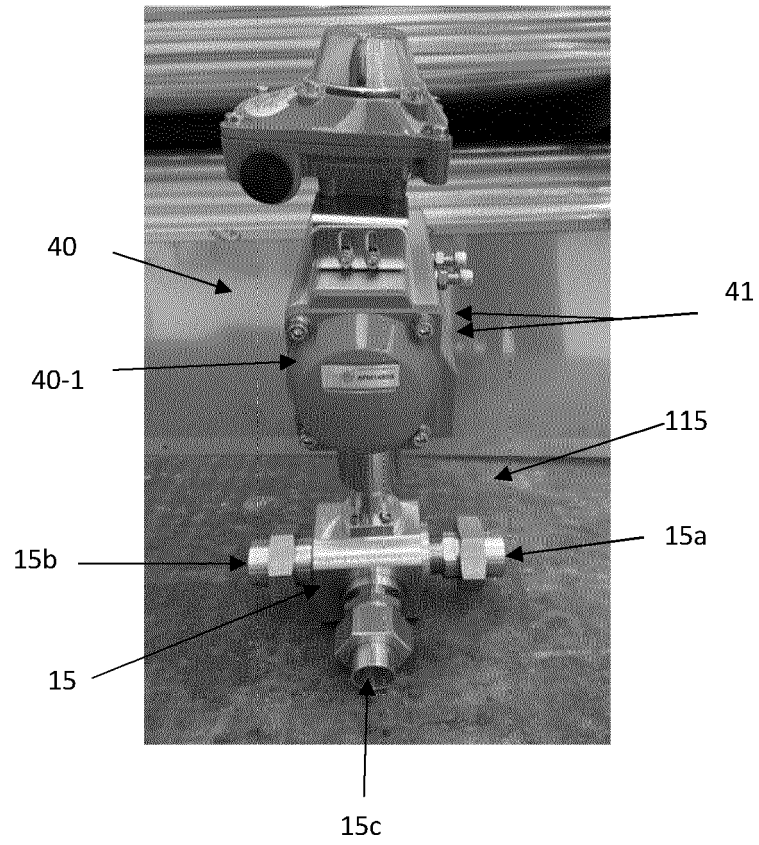


FIG. 3

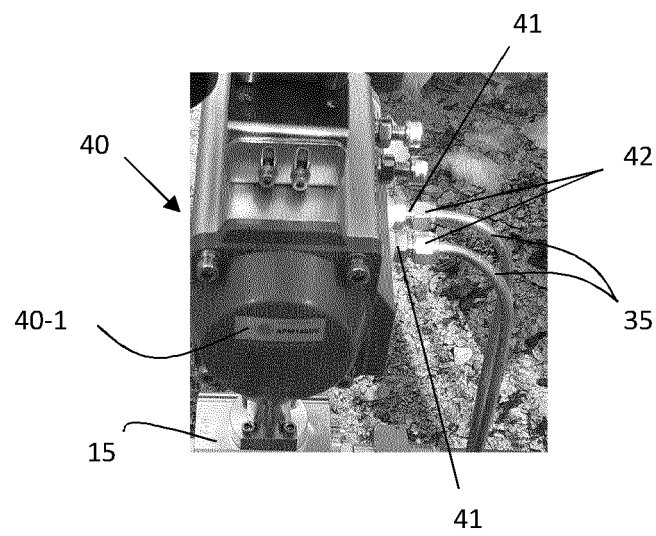


FIG. 4

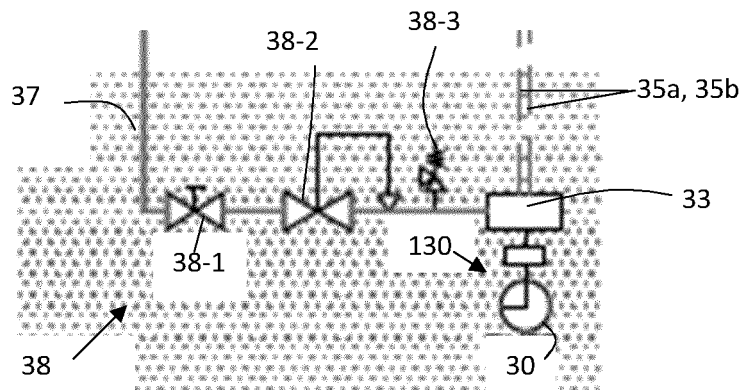


FIG. 5

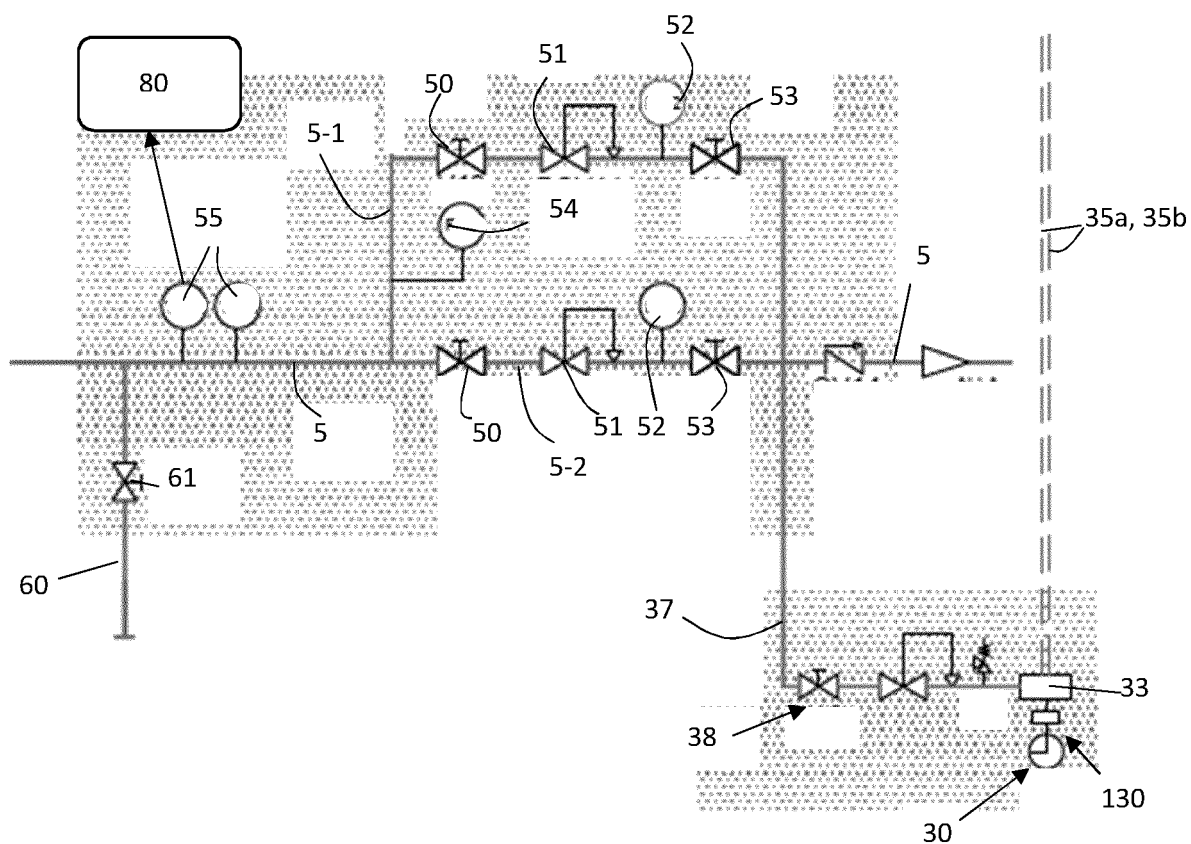
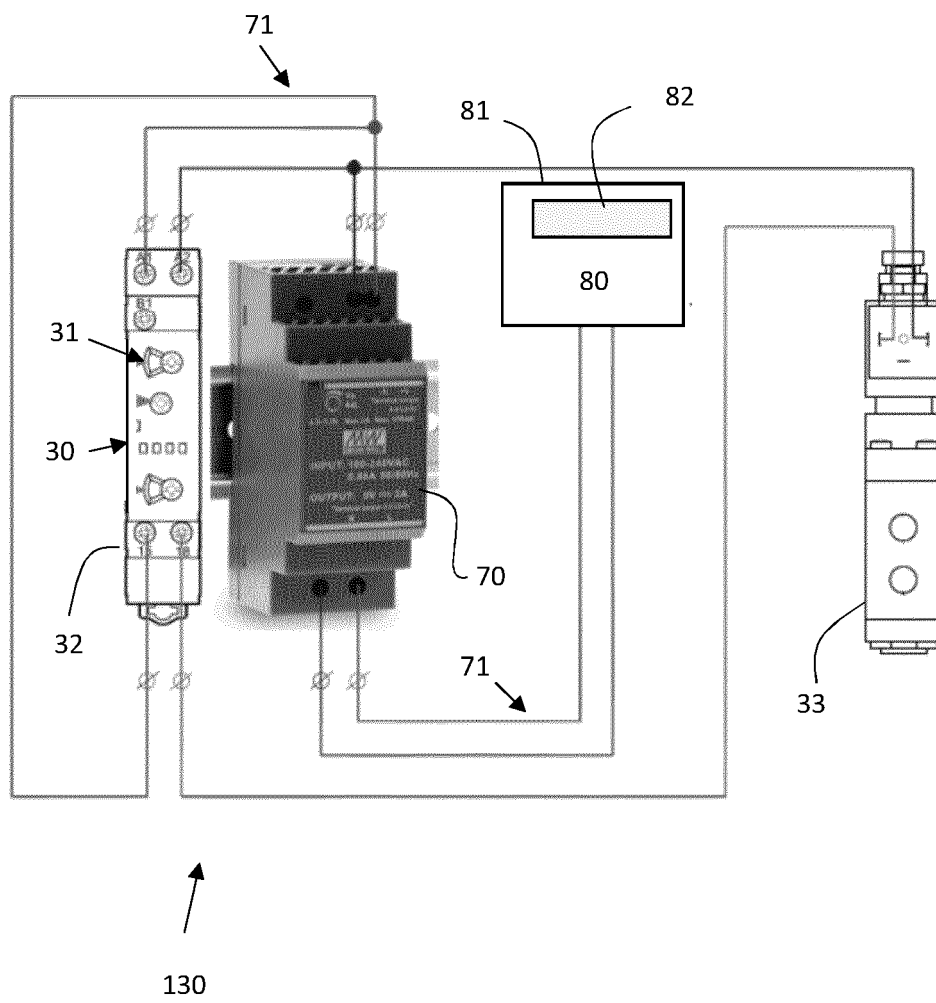


FIG. 6





EUROPEAN SEARCH REPORT

Application Number

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			F17C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 11 October 2022	Examiner Papagiannis, Michail
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			

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