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(54) **AIR CONDITIONING SYSTEM FOR A CABIN AND METHOD FOR AIR CONDITIONING A CABIN**

(57) A cabin conditioning system for air conditioning cabin space (1), the system comprising an air conditioning device (2) for cooling the cabin temperature, and a control unit (3) for controlling the cabin conditioning system. The system further comprises a first sensor (5) arranged to send signal to the control unit (3) if a hatch (6) to the outdoor is opened or closed, a control valve (7) for

controlling the cooling medium flow to the air conditioning device, a water heater (8) for heating the cooling medium before entering the air conditioning device, and the first sensor (5) is arranged to send a first signal to the control unit, when the hatch is opened, wherein the control unit is arranged to switch on the water heater, for heating the cooling medium..

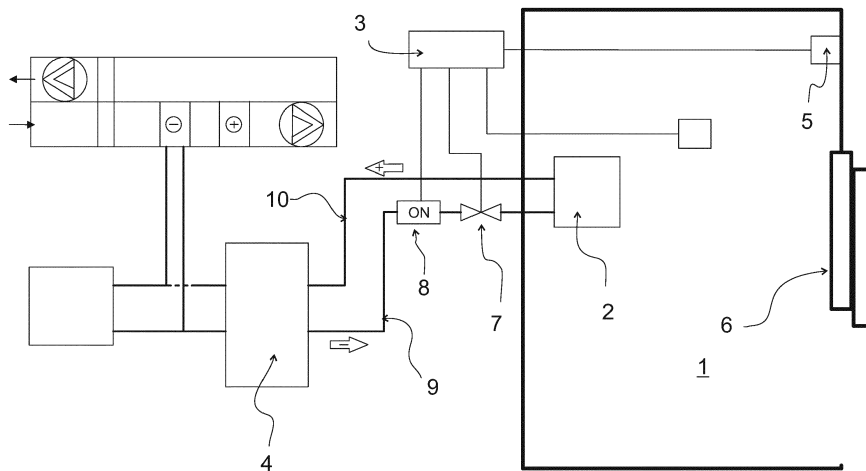


Fig. 2

Description**TECHNICAL FIELD**

[0001] The present invention relates to a system and a method for air conditioning a cabin of a ship.

BACKGROUND OF THE ART

[0002] The travelers and customers of cruise ships have high expectations for the trip. Thus, for example the cabin environment must be comfortable so that the travelers enjoy their time in the cabins. As well known, cruise ships are used in variable conditions like cold, windy, warm and moist. The variable conditions set demanding requirements for the air conditioning systems of the cabins.

[0003] It is known to air condition cabins so that the user may set desired room temperature and the air conditioning system take care of the required tasks to provide the required temperature in the cabin. Known solution is to use so called chilled beams which supply chilled and dehumidified air into the cabin. The ventilation air is conditioned with a heat exchanger in air handling unit before it enters the chilled beam and further into the cabin.

[0004] In one previously known system, the chilled beam comprises a heat exchanger in which a heat exchange fluid, e.g. refrigerant, is circulated. The heat exchange fluid is cooled, for example with another heat exchanger outside the chilled beam, before entering inside the chilled beam and the heat exchanger inside the chilled beam, and the cabin air is cooled when it is circulated from cabin into the chilled beam and through the heat exchanger inside the chilled beam.

[0005] Problems may occur when the user opens a window or a balcony door of the cabin and the hot and moist air enters the cabin and increases the humidity of the cabin air. The humidity in the cabin is condensed on the surface of the chilled beam or its cold heat exchanger, which may lead problems for the cabin structures.

[0006] In known solutions, the condensation is handled for example by collecting the condensed water into a separate container, in which it is converted into vapour or sewer. This may cause problems in the chilled beam where the circulating cabin air is not filtered and the dust in the cabin air is collected to the wet coil surfaces. Eventually the collected dust may clog the heat exchanger in the chilled beam.

OBJECTIVE OF THE INVENTION

[0007] The objective of the device/method is to alleviate the disadvantages mentioned above.

[0008] In particular, it is an objective of the present device and method to provide an air conditioning system for air conditioning a cabin space.

SUMMARY

[0009] According to a first aspect, the present invention provides a cabin conditioning system for air conditioning cabin space. The system comprises an air conditioning device for cooling the cabin temperature, and a control unit for controlling the cabin conditioning system. The system further comprises a first sensor arranged to send signals to the control unit if a hatch to the outdoor is opened or closed, a control valve for controlling the cooling medium flow to the air conditioning device, a water heater for heating the cooling medium before entering the air conditioning device, and the first sensor is arranged to send a first signal to the control unit, when the hatch is opened, wherein the control unit is arranged to switch on the water heater, for heating the cooling medium.

[0010] The advantage of the system is that it prevents condensation within an air conditioning device in a cabin if a sudden burst of warm and/or moist air is entered inside the cabin, e.g. when a balcony door or a window is opened. Further, the system does not require any channels or piping for the water caused by condensation inside the air conditioning device.

[0011] In an embodiment of the system, the control unit is arranged to close the control valve, when the hatch is opened, and open the control valve, when the hatch is closed.

[0012] In an embodiment of the system, the sensor is arranged to send a second signal to the control unit, when the hatch is closed, wherein the control unit is arranged to switch off the water heater.

[0013] In an embodiment of the system, the hatch is a door.

[0014] In an embodiment of the system, the hatch is a window.

[0015] In an embodiment of the system, the system comprises plurality of sensors for measuring at least one air characteristic inside the cabin space.

[0016] In an embodiment of the system, the water heater is an electric heater.

[0017] In an embodiment of the system, the system comprises a user interface provided inside the cabin for controlling the air conditioning system.

[0018] In an embodiment of the system, the air conditioning device is a chilled beam.

[0019] In an embodiment of the system, the air conditioning device is a fan-coil unit.

[0020] In an embodiment of the system, the air conditioning device is a cooling panel.

[0021] In an embodiment of the system, the control unit is arranged to switch off the water heater when the control valve is closed.

[0022] According to a second aspect, the present invention provides a method for preventing condensation of an air conditioning device in a previously described system, comprising steps of recognizing the opening of a hatch, which leads to outdoors, switching on a water

heater for heating a cooling medium before entering the air conditioning device.

[0023] In an embodiment, the method comprises a further step of closing a control valve, and switching off the water heater, when the control valve is closed.

[0024] In an embodiment the method comprises further steps of recognizing the closing of the hatch and opening the control valve.

[0025] In an embodiment the method comprises measuring humidity of the cabin room air and opening the control valve if the humidity of the cabin air is desired or less.

[0026] It is to be understood that the aspects and embodiments of the invention described above may be used in any combination with each other. Several of the aspects and embodiments may be combined together to form a further embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The accompanying drawings, which are included to provide a further understanding of the invention and constitute a part of this specification, illustrate embodiments of the invention and together with the description help to explain the principles of the invention. In the drawings:

Fig. 1 shows a diagram of a cabin conditioning system for air conditioning a cabin space,

Fig. 2 shows a diagram of the cabin conditioning system for air conditioning a cabin space when a hatch is open, and

Fig. 3 shows a diagram of the cabin conditioning system for air conditioning a cabin space when the hatch is closed again.

DETAILED DESCRIPTION

[0028] A cabin is a room or a living space inside a marine vessel, i.e. a cruise ship or oil rig etc., which operates on waters, i.e. ocean, lake, river etc.

[0029] Humidity of the cabin air is measured typically by measuring cabin air relative humidity and cabin air temperature. From that cabin air dew point temperature can be calculated, which means that the surfaces in cabin or inside the air conditioning device in cabin at that temperature or colder can cause condensation of water from cabin air to these surfaces. When cabin air is at desired humidity, control valve can be opened and surfaces cooled by cooling medium stays in temperature where condensation doesn't occur.

[0030] Figure 1 shows a diagram of a cabin conditioning system for air conditioning a cabin space 1. The system comprises an air conditioning device 2, which is arranged to condition the room air inside the cabin.

[0031] The system comprises a piping in which the cooling medium is circulated so that a first pipe is for

providing cooling medium to the air conditioning device 2, and a second pipe is for retrieving heated cooling medium from the air conditioning device 2 into the supplying device.

[0032] The cabin conditioning system may comprise a supplying device, for supplying cooling medium into the system, which may be for example a pump or a fan.

[0033] According to one embodiment, the air conditioning device 2 may be a chilled beam through which air is diffused into the cabin space. The chilled beam has a box-like structure having at least a bottom wall and side walls. The chilled beam may further comprise a ceiling wall. The chilled beam may also be a circular with one continuous side wall. The chilled beam may comprise a heat exchanger having at least one heat exchanger coil in which the cooling medium is arranged to circulate. Further, the heat exchanger may comprise a number of lamellas and openings arranged between adjacent lamellas. The air is diffused into the room between said lamellas, wherein the diffused air is conditioned, and through an opening or openings or perforations in at least one of the walls or between adjacent walls.

[0034] According to one embodiment, the chilled beam is arranged to circulate the cabin air, wherein chilled beam comprises at least one inlet for the cabin air to enter the chilled beam, in which the cabin air is conditioned and then diffused back into the cabin space.

[0035] According to one embodiment, the chilled beam is connected to the supply air system of the ship/vessel etc. so that the fresh air from the supply air system is conditioned inside the chilled beam and then introduced into the cabin space through the chilled beam.

[0036] The chilled beam may comprise an outlet connected to an exhaust air channel outside of the cabin. At least part of the circulated room air, introduced inside the chilled beam, may be exhausted out of the cabin space through the outlet.

[0037] The chilled beam may be arranged to circulate the cabin air and to introduce the fresh supply air into the cabin space. The amount of circulated cabin air may be adjusted for example by having an adjusting means (e.g. at least one adjusting plate and/or a fan), which controls the flow of cabin air and/or the amount of supply air entering into the chilled beam. By the adjusting means, the ratio of the circulated cabin air and the fresh supply air may vary from 0:100 to 100:0.

[0038] The chilled beam may be arranged at the side wall of the cabin or it may be arranged at the ceiling of the cabin. According to an embodiment, the chilled beam is arranged party inside the cabin ceiling.

[0039] The air condition device may also be a radiant panel, e.g. cooling panel, which condition the room air via radiation and/or convection. The cooling panel may comprise at least one circuit, e.g. a piping, in which the cooling medium is circulated. The radiant panel may comprise at least two separate circuits, wherein one is for cooling and another is for heating the cabin space. The radiant panel may be a separate element arranged

at the ceiling, hanging from the ceiling or at the side wall of the cabin.

[0040] The radiant panel may also be an integrated part of the wall or ceiling.

[0041] The air conditioning device 2 may also be combination of the chilled beam and the radiant panel, wherein the chilled beam comprises at least one circuit for cooling medium, which is arranged at the proximity of the chilled beam wall, which is facing the cabin space. The chilled beam, with a radiant panel as part of it, may comprise one circuit for the cooling medium, which circulated through the heat transfer coil and the piping of the radiant panel. Also, two separate cooling medium circuits for the heat transfer coil and the piping of the radiant panel may be provided.

[0042] In an embodiments, two separate cooling medium circuits for the heat transfer coil and the piping of the radiant panel may be provided in the chilled beam or in the combination of the chilled beam and the radiant panel.

[0043] The air conditioning device 2 may also be a fan-coil unit, comprising a heat exchanger or coil and a fan.

[0044] The cabin conditioning system comprises a control unit 3 for controlling the cabin conditioning system. The control unit 3 is arranged to receive signals from sensors and adjust the cabin conditioning system based on the signals. The signals may be received from at least one sensor arranged to sense if a hatch 6 to the cabin is opened or closed. If the sensor notices that the hatch 6 is opened, it sends signal to the control unit 3, and the control unit 3 adjusts the cabin conditioning system.

[0045] The cooling medium flow in the system may be adjusted by a control valve 7, which is controlled by the control unit 3. The control valve 7 may be opened when the cabin space is needed to be conditioned. When the cabin space is temperature is desired, the control valve 7 may be closed and the cooling medium flow to the air conditioning device 2 is prevented. The control valve 7 may also be closed when for example maintenance work for the air conditioning device 2 is needed.

[0046] The control valve 7 may be located within the first piping 9, which leads the cooling medium into the air conditioning device 2. According to one embodiment, the control valve is located within the second piping 10, which leads the cooling medium from the air conditioning device 2.

[0047] When a hatch 6, such as a balcony door or a window, of the cabin is opened, warm and moist outside air is entered into the cabin space. Such sudden rise in temperature and humidity in the cabin air causes condensation at the cold surfaces. The condensed water may cause damages to the cooling devices or the cabin structure. By closing the cooling in the air conditioning device 2 by closing the cooling medium flow through the control valve 2, the temperature of the device, and parts of it, rises but it is very slow and lots of condense water is formed.

[0048] Thus, it is important to rise the temperatures of

the cold surfaces above the dew point of the cabin space fast to prevent the condensation and the damages caused by it. To achieve faster temperature rise of the air conditioning device 2, and parts of it, the cabin conditioning system comprises a water heater 8 arranged within the piping leading to the air conditioning device 2. The water heater 8 is arranged to heat the cooling medium, flowing into the air conditioning device 2, when needed. By switching on the water heater 8, the temperature of the cooling medium rises fast, and the heated cooling medium flows into the air conditioning device 2 and heats the air conditioning device 2 and the parts of it.

[0049] The water heater 8 may be arranged before the control valve 7 in the cooling medium flowing direction when the control valve 7 is located within the first piping 9.

[0050] The water heater 8 may be an electric heater arranged around the piping or inside the piping in connection with the cooling medium.

[0051] The cabin conditioning system may comprise a second heat exchanger 4 arranged within the cooling medium piping, i.e. the first piping 9 and the second piping 10. The second heat exchanger 4 is arranged to transfer thermal energy from the heated cooling medium in the second piping 10 into the cooling medium in the first piping 9. The second heat exchanger 4 may be provided before the water heater 8 in the flow direction of the cooling medium towards the air conditioning device 2.

[0052] In figure 1, the hatch 6 of the cabin is closed and the cabin conditioning system conditions the cabin air. The water heater 8 is off, the control valve 7 is open, and the cooling medium is flowing via the first piping 9 into the air conditioning device. The heated cooling medium from the air conditioning device, circulates out of the air conditioning device via the second piping 10.

[0053] In figures, the control valve 7 is located within the first piping 9, but it may be alternatively located within the second piping 10.

[0054] In figure 2, the hatch 6 is opened, and warm and moist outdoor air is entering cabin space 1. The first sensor 5 has recognized the opening of the hatch 6 and sent a first signal to the control unit 3. The control unit 3 switched on the water heater 8 and may close the control valve 7. The closing of the control valve 7 may take several minutes, and, during that time, the water heater 8 heats the cooling medium flowing into the air conditioning device. While the control valve 7 is closing, the water heater 8 has enough time to heat the cooling medium, which further heats the air condition device along its parts and, thus, the water condensation at the surfaces of the air conditioning device may be minimized or prevented. When the control valve 7 is fully closed, the water heater 8 may be switched off.

[0055] In an embodiment, the closing of the control valve 7 is timed. For example, the control valve 7 may be timed to close in 4 minutes, wherein the water heater 8 has enough time to heat the cooling medium and further the air conditioning device temperature above the dew point of the cabin air.

[0056] In an embodiment, the air conditioning device 2 comprises a temperature sensor for measuring the surface temperature of the air conditioning device 2, and the control valve 7 may be closed when the temperature of the air conditioning device has fallen below the dew point of the cabin air 1.

[0057] The air conditioning device may comprise a condensation watch arranged to watch if condensation is formed on the surface of the air conditioning device or parts of it.

[0058] In figure 3, the hatch 6 is again closed, and no more warm and moist outdoor air is entering the cabin space 1. The first sensor 5 has recognized that the hatch 6 is closed and sent a second signal to the control unit 3. The control unit 3 has started to open the control valve 7, but the water heater 8 is switched on until the excess moisture in the cabin has been taken away by the ventilation. The water heater 8 is switched off when the humidity of the cabin air is under desired or when pre-determined time from the closing of the hatch has passed. When the water heater 8 is switched off, the system is working again according to figure 1.

[0059] The cabin conditioning system may comprise plurality of sensors for measuring at least one air characteristic inside the cabin space 1. The air characteristic may be at least one of the following: air temperature in the cabin or outside the cabin, humidity, unwanted particles, carbon-monoxide etc.. The sensors are connected to the control unit and control unit is arranged to adjust the air conditioning system based on the signals received from the sensors.

[0060] According to one embodiment, the cabin conditioning system comprises humidity sensor for measuring the humidity of the cabin air. When the hatch is closed, the system may wait until the humidity of the cabin air is lowered back to desired level before opening the control valve 7 and starting to condition the cabin air. The humidity of the cabin air is lowered by the ventilation when the hatch 6 is closed.

[0061] According to one embodiment, the air conditioning system comprises one sensor for measuring cabin air temperature and one sensor for measuring cabin air humidity. When humidity of the cabin air is risen, for example caused by opening a bath room door, the control unit compare the humidity level to the temperature of the cabin air, and switch on the water heater if there is possibility for condensation. Further, the control unit is arranged to switch off the water heater if there is no risk for condensation.

[0062] In one embodiment, the closing of the control valve 7 is timed. For example, the control valve 7 may be timed to close in 10 minutes after the hatch 6 is closed. During that time, the ventilation of the cabin has taken away the excess moisture.

[0063] The cabin conditioning system may be operated by a user interface 11 provided inside the cabin. The user may set desired values for example regarding room temperature or the system may be turned on and off. The

user interface may be a display with separate buttons, or it may be a touch display, through which the user may adjust the cabin conditioning system.

[0064] According to an embodiment, the cabin conditioning system may be used for heating the cabin space 1. When the temperature of the cabin space is lower than desired, the control unit 3 may switch on the water heater 8 and keep the control valve 7 open. The cooling medium flow inside the first piping towards the air conditioning device 2 is heated and the heat is transferred into the cabin air by the chilled beam and/or the radiant panel. The cabin conditioning system may comprise a temperature sensor for measuring the cabin air temperature and send signals to the control unit 3, based on the temperature, which adjusts the cabin conditioning system for heating or cooling the cabin space 1. Also, the user interface may be used for setting desired temperature and/or to ask more hot or cold air into the cabin space.

[0065] Although the invention has been described in conjunction with a certain type of device, it should be understood that the invention is not limited to any certain type of device. While the present inventions have been described in connection with a number of exemplary embodiments, and implementations, the present inventions are not so limited, but rather cover various modifications, and equivalent arrangements, which fall within the purview of prospective claims.

30 Claims

1. A cabin conditioning system for air conditioning cabin space (1), the system comprising

- an air conditioning device (2) for cooling the cabin temperature, and
- a control unit (3) for controlling the cabin conditioning system, and

characterized in that the system further comprises

- a first sensor (5) arranged to send signal to the control unit (3) if a hatch (6) to the outdoor is opened or closed,
- a control valve (7) for controlling the cooling medium flow to the air conditioning device,
- a water heater (8) for heating the cooling medium before entering the air conditioning device, and

the first sensor (5) is arranged to send a first signal to the control unit, when the hatch is opened, wherein the control unit is arranged to switch on the water heater for heating the cooling medium.

2. The cabin conditioning system according to claim 1, characterized in that the control unit is arranged to

close the control valve (7), when the hatch is opened, and open the control valve (7), when the hatch is closed.

3. The cabin conditioning system according to claim 1 or 2, **characterized in that** the first sensor (5) is arranged to send a second signal to the control unit (3), when the hatch is closed, wherein the control unit is arranged to switch off the water heater (8). 5
4. The cabin conditioning system according to any of claims 1 to 3, **characterized in that** the hatch (6) is a door. 10
5. The cabin conditioning system according to any of claims 1 to 3, **characterized in that** the hatch (6) is a window. 15
6. The cabin conditioning system according to any of the preceding claims, **characterized in that** the system comprises a plurality of sensors for measuring at least one air characteristic inside the cabin space (1). 20
7. The cabin conditioning system according to any of the preceding claims, **characterized in that** the water heater (8) is an electric heater. 25
8. The cabin conditioning system according to any of the preceding claims, **characterized in that** the system comprises a user interface (11) provided inside the cabin for controlling the air conditioning system. 30
9. The cabin conditioning system according to any of the preceding claims, **characterized in that** the air conditioning device (2) is a chilled beam. 35
10. The cabin conditioning system according to any of the preceding claims, **characterized in that** the air conditioning device (2) is a fan-coil unit. 40
11. The cabin conditioning system according to any of claims 1 to 8, **characterized in that** the air conditioning device (2) is a cooling panel. 45
12. The cabin conditioning system according to claim 2, **characterized in that** the control unit (3) is arranged to switch off the water heater (8) when the control valve (7) is closed. 50
13. Method for preventing condensation of an air conditioning device (2) in a system according to any of claims 1 to 12 comprising steps of: 55
 - recognizing the opening of a hatch (6), which leads to outdoors, and
 - switching on a water heater (8) for heating a cooling medium before entering the air condi-

tioning device (2).

14. The method according to claim 13, **characterized in that** the method comprises a further steps of:
 - closing a control valve (7), and
 - switching off the water heater (8), when the control valve is closed.
15. The method according to claim 14, **characterized in that** the method comprises further steps of
 - recognizing the closing of the hatch (6), and
 - opening the control valve (7).
16. The method according to any of claims claim 12-14, **characterized in that** the method comprises
 - measuring humidity of the cabin room air, and
 - opening the control valve (7) if the humidity of the cabin air is desired or less.

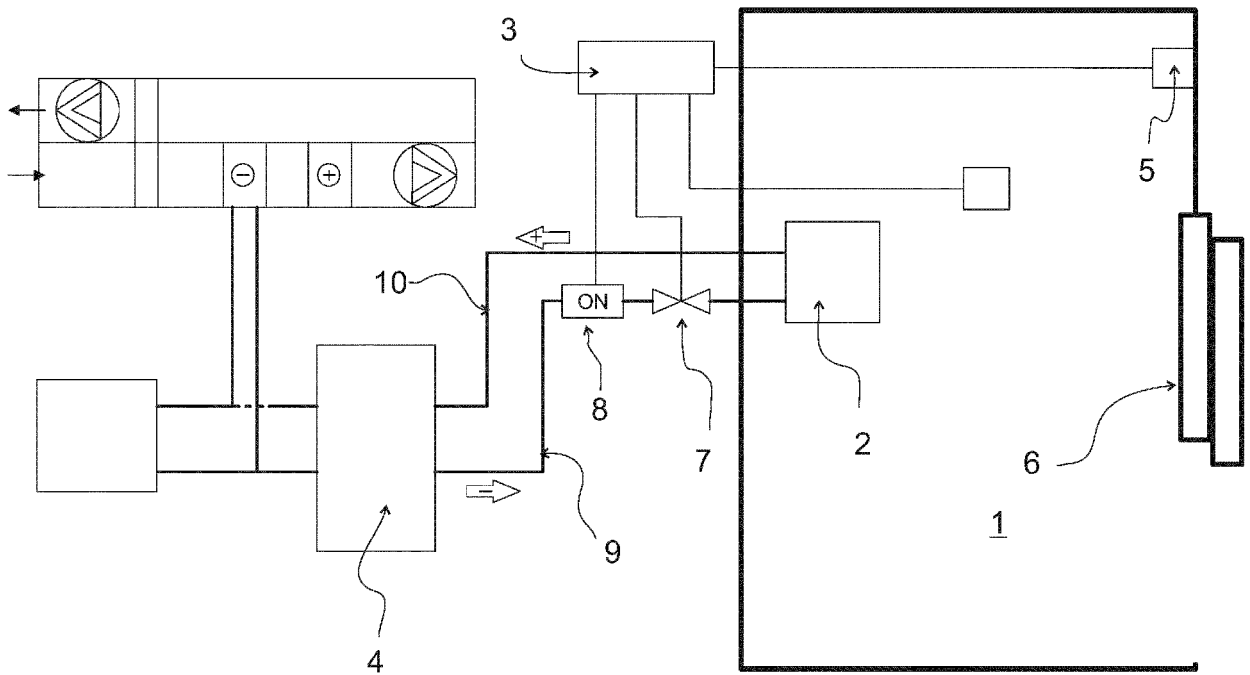


Fig. 2

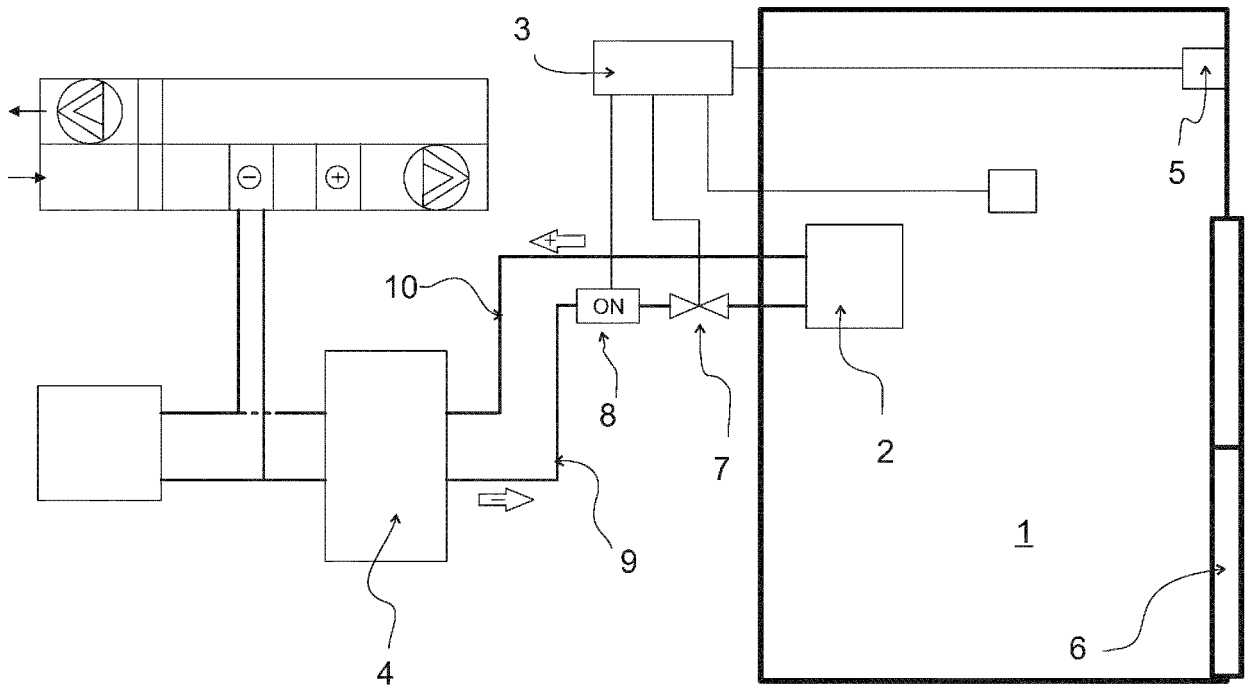


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 19 19 4911

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 10 2017 125758 A1 (EMCO KLIMA GMBH [DE]) 9 May 2019 (2019-05-09) * the whole document * -----	1-16	INV. B63J2/04 F24F11/83 F24F13/22
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
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Place of search		Date of completion of the search	Examiner
Munich		10 February 2020	Decking, Oliver
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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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 19 19 4911

5 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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10-02-2020

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82