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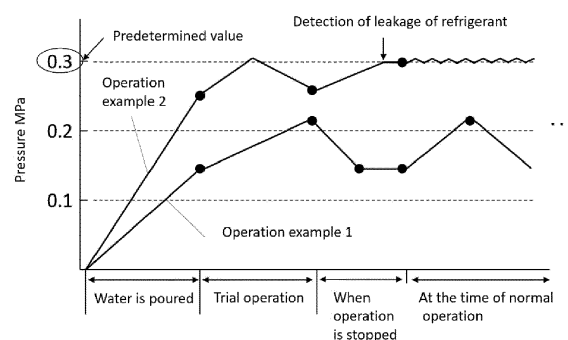
**(54) HEAT MEDIUM CIRCULATION SYSTEM**

(57) [Object] It is an object of the present invention to provide a safe heat medium circulation system capable of detecting initial leakage of refrigerant early when trial operation is completed, and capable of reducing erroneous detection of leakage of refrigerant and according to this, it is possible to early find leakage of refrigerant.

[Solving Means] The heat medium circulation system of the invention includes a heat pump cycle 24 through which refrigerant circulates, a heating cycle 50 through which heat medium heated by the heat pump

cycle 24 circulates between the heat pump cycle 24 and a heating terminal 37, a pressure sensor 27 for detecting pressure of heat medium in the heating cycle 50, and a control device 35. The control device 35 determines that the refrigerant leaks from the heat pump cycle 24 to the heating cycle 50 based on a detected value of the pressure sensor 27 which is detected after a trial operation for operating the heat pump cycle 24 and the heating cycle 50 is completed after water is poured to the heating cycle 50.

[Fig. 2]

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**Description****[TECHNICAL FIELD]**

**[0001]** The present invention relates to a heat medium circulation system.

**[BACKGROUND TECHNIQUE]**

**[0002]** In a conventional heat pump type hydronic heater, if discharge pressure which is detected by discharge pressure detecting means is smaller than first set pressure and discharge superheat degree which is detected by discharge superheat degree detecting means is equal to or greater than predetermined value after predetermined time from actuation of a compressor, a control device determines that refrigerant leaks and refrigerant is insufficient. Further, if discharge pressure which is detected by the discharge pressure detecting means is smaller than second set pressure which is set smaller than the first set pressure, the control device determines that refrigerant leaks and refrigerant is insufficient. Then, the control device stops the operation of the compressor (see patent document 1 for example).

**[PRIOR ART DOCUMENT]****[PATENT DOCUMENT]**

**[0003]** [Patent Document 1] Japanese Patent Application Laid-open No.2013-185803

**[SUMMARY OF THE INVENTION]****[PROBLEM TO BE SOLVED BY THE INVENTION]**

**[0004]** However, to prevent erroneous detection, the conventional configuration has a problem that if more than half refrigerant is not reliably missing, leakage abnormality of refrigerant cannot be detected.

**[0005]** A heat medium circulation system of the present invention solves the above-described problem, and based on a detected value of a pressure sensor which is detected after completion of trial operation in which a heat pump cycle and a heating cycle are operated after water is poured to the heating cycle, it is determined that refrigerant leaks from the heat pump cycle to the heating cycle. According to this, initial leakage of refrigerant can be detected early when the trial operation is completed. Further, erroneous detections of leakage of refrigerant can be reduced. For the reason described above, it is possible to provide a safe heat medium circulation system capable of finding leakage of refrigerant early.

**[MEANS FOR SOLVING THE PROBLEM]**

**[0006]** To solve the conventional problems, a heat medium circulation system of the present invention includes:

a heat pump cycle through which refrigerant circulates; a heating cycle through which heat medium heated by the heat pump cycle circulates between the heat pump cycle and a heating terminal; a pressure sensor for detecting pressure of the heat medium in the heating cycle; and a control device. The control device determines that the refrigerant leaks from the heat pump cycle to the heating cycle based on a detected value of the pressure sensor which is detected after a trial operation for operating the heat pump cycle and the heating cycle is completed after water is poured to the heating cycle.

**[EFFECT OF THE INVENTION]**

**[0007]** According to the heat medium circulation system of the invention, it is possible to early detect initial leakage of refrigerant after trial operation is completed. Further, erroneous detection of leakage of refrigerant can be reduced.

**[BRIEF DESCRIPTION OF THE DRAWINGS]****[0008]**

**Fig. 1** is a block diagram of a heat medium circulation system in an embodiment of the present invention; **Fig. 2** is a diagram for describing detection of leakage of refrigerant of the heat medium circulation system; **Fig. 3** is a diagram for describing detection of leakage of refrigerant of the heat medium circulation system; and **Fig. 4** is a diagram for describing detection of leakage of refrigerant of the heat medium circulation system.

**[MODE FOR CARRYING OUT THE INVENTION]**

**[0009]** A heat medium circulation system of the present invention includes: a heat pump cycle through which refrigerant circulates; a heating cycle through which heat medium heated by the heat pump cycle circulates between the heat pump cycle and a heating terminal; a pressure sensor for detecting pressure of the heat medium in the heating cycle; and a control device. The control device determines that the refrigerant leaks from the heat pump cycle to the heating cycle based on a detected value of the pressure sensor which is detected after a trial operation for operating the heat pump cycle and the heating cycle is completed after water is poured to the heating cycle.

**[0010]** According to this, it is possible to early detect initial leakage of refrigerant after trial operation is completed. Further, erroneous detection of leakage of refrigerant can be reduced.

**[0011]** The control device may determine that the refrigerant leaks from the heat pump cycle to the heating cycle based on the detected value of the pressure sensor which is detected when the trial operation is stopped.

**[0012]** According to this, based on the initial leakage

of refrigerant, it is possible to early detect abnormality.

**[0013]** The control device may determine that the refrigerant leaks from the heat pump cycle to the heating cycle based on the detected value of the pressure sensor detected during normal operation which operates the heat pump cycle and the heating cycle.

**[0014]** According to this, it is possible to reduce erroneous detections of leakage of refrigerant.

**[0015]** When a detected value of the pressure sensor is equal to or greater than the predetermined value, the control device may determine that refrigerant leaks from the heat pump cycle to the heating cycle.

**[0016]** If it is not determined that abnormality occurs (refrigerant leaks) until pressure reaches a constant value (predetermined value), erroneous detection of leakage of refrigerant from the heat pump cycle to the heating cycle is reduced.

**[0017]** The control device may determine that refrigerant leaks from the heat pump cycle to the heating cycle based on a magnitude of a difference between a detected value of the pressure sensor and a preset reference value.

**[0018]** Detection accuracy of leakage of refrigerant is enhanced, and erroneous detection of leakage of refrigerant is reduced.

**[0019]** The reference value may be a detected value of the pressure sensor which is detected when the operation is stopped after the trial operation is completed.

**[0020]** According to this, it is possible to set a reference value suitable to pressure of a water circuit which is set when the system is installed. Therefore, it is possible to set an optimal reference value which is suitable to using environment of a customer.

**[0021]** Further, the control device may include an operation history storage device for storing operation history. Only when the operation history storage device has operation history, the control device may determine that refrigerant leaks from the heat pump cycle to the heating cycle.

**[0022]** Leakage of refrigerant is detected only when there is operation history in times past. According to this, it is possible to prevent erroneous detection caused by pressure rise at the time of the trial operation.

**[0023]** A warning device for warning about leakage of refrigerant may further be included. The control device may operate the warning device when it is determined that refrigerant leaks from the heat pump cycle to the heating cycle.

**[0024]** According to this, when it is detected that refrigerant leaks, it is possible to inform a user or a repairer of leakage of refrigerant.

**[0025]** The warning device may be provided in a remote controller or in an information terminal which can communicate with the control device through a network.

**[0026]** According to this, it is possible to more appropriately inform a user and a repairer of leakage of refrigerant remotely.

**[0027]** An embodiment will be described below with

reference to the drawings. However, description which is detail more than necessary will be omitted in some cases. For example, detailed description of already well known matters, or redundant description of substantially the same configuration will be omitted in some cases. This is for preventing the following description from becoming redundant more than necessary, and for making it easy for a person skilled in the art to understand the present disclosure.

**[0028]** The accompanying drawing and the following description are provided so that a person skilled in the art can sufficiently understand the present disclosure, and it is not intended that they limit the subject matter described in claims.

(First Embodiment)

**[0029]** A configuration of a heat medium circulation system 100 of a first embodiment will be described below using Fig. 1.

**[0030]** The heat medium circulation system 100 of the embodiment includes a heat pump cycle 24 through which refrigerant circulates, and a heating cycle 50 through which heat medium heated in the heat pump cycle 24 circulates between the heat pump cycle 24 and a heating terminal 37.

**[0031]** The heat pump cycle 24 is composed by connecting a compressor 20, a water-refrigerant heat exchanger 21, decompression means 22 and an air heat exchanger 23 to one another.

**[0032]** The heating cycle 50 includes a heating terminal 37, a circulation pump 25, water-going temperature detecting means 34, water-entering temperature detecting means 33, a flow rate sensor 26, a pressure sensor 27, a relief valve 28, a purge valve 29 and a heater unit 30. The heating terminal 37 heats a home using hot water which is heated by the water-refrigerant heat exchanger 21. The circulation pump 25 circulates hot water between the water-refrigerant heat exchanger 21 and the heating terminal 37. The water-going temperature detecting means 34 detects going-temperature of circulation water. The water-entering temperature detecting means 33 detects returning-temperature of circulation water. The flow rate sensor 26 detects a circulation flow rate of heat medium which flows through the heating cycle 50. The pressure sensor 27 detects pressure of heat medium which flows through the heating cycle 50. The pressure sensor 27 is placed between the circulation pump 25 and the water-refrigerant heat exchanger 21. The relief valve 28 discharges heat medium flowing through the heating cycle 50 to outside of the cycle. The purge valve 29 discharges air existing in the heating cycle 50 to outside of the cycle. The heater unit 30 operates as an auxiliary heat source when ability of the heat pump is insufficient.

**[0033]** In the heat medium circulation system 100 of this embodiment, high pressure refrigerant compressed by the compressor 20 is sent to the water-refrigerant heat exchanger 21. Here, R32 is used as the refrigerant, but

other refrigerants can also be used. The water-refrigerant heat exchanger 21 is composed of a heat exchanger formed from laminated stainless steel plates. The circulation pump 25 sends circulation water to the water-refrigerant heat exchanger 21 through a hot water returning pipe 32. In the water-refrigerant heat exchanger 21, heated refrigerant and circulation water exchange heat and circulation hot water is produced. The circulation hot water is sent to the heating terminal 37 through a hot water-going pipe 31. The heating terminal 37 carries out the heating operation.

**[0034]** The circulation hot water which radiates heat in the heating terminal 37 is sent to the water-refrigerant heat exchanger 21 through the hot water returning pipe 32 by the circulation pump 25, and the circulation hot water is again heated. In the heat medium circulation system 100 of the embodiment, the water-refrigerant heat exchanger 21 is placed outside (more specifically, outdoor unit 44), and the circulation pump 25 and a control device 35 are placed inside (more specifically, indoor unit 43) .

**[0035]** In this embodiment, the pressure sensor 27 which detects pressure of heat medium is placed between the circulation pump 25 and the water-refrigerant heat exchanger 21.

**[0036]** The control device 35 determines that refrigerant leaks from the heat pump cycle 24 to the heating cycle 50 based on a detected value of the pressure sensor 27 when the operation of the heat medium circulation system 100 is stopped.

**[0037]** As a reason why refrigerant leaks from the outdoor unit 44 and intrudes into the indoor unit 43, there exists only a fact that a partition wall of the water-refrigerant heat exchanger 21 is damaged. Therefore, when the water-refrigerant heat exchanger 21 which is placed outdoor is damaged due to freezing or the like, it can be determined that refrigerant leaks at the heat pump cycle 24. According to this, it is possible to detect leakage of refrigerant in the early stages.

**[0038]** In this embodiment, the purge valve 29 for discharging air existing in the heating cycle 50 and the relief valve 28 for discharging hot water when pressure in the circulation water circuit exceeds 0.3 MPa for example are placed in the heating cycle 50.

**[0039]** According to this configuration, it is possible to control such that the heating cycle 50 is filled with circulation hot water and pressure of the circulation hot water becomes equal to or smaller than the predetermined value (0.3 MPa in this embodiment).

**[0040]** As described above, the control device 35 determines that refrigerant leaks from the heat pump cycle 24 to the heating cycle 50 based on the detected value of the pressure sensor 27 which is detected after the trial operation for operating the heat pump cycle 24 and the heating cycle 50 is completed after water is poured to the heating cycle 50. When the control device 35 determines that refrigerant leaks, the control device 35 operates a warning device (not shown). According to this, it

is possible to reliably inform a user and a repairer of leakage of refrigerant.

**[0041]** The warning device may be provided in a remote controller 42. Alternatively, the warning device may be provided in an information terminal 41 which can communicate with the control device 35 through a network circuit 40 such as the Internet for example. According to this, a user and a repairer can recognize its status. The control device 35 may be connected to the network circuit 40 through an HEMS (Home Energy Management System) controller 38 and a network transceiver 39. Examples of the information terminal 41 are a tablet terminal, a cell-phone and a smartphone. Detection of the above-described leakage of refrigerant may be carried out not by the control device 35, but by a server which can communicate with the control device 35 through the network circuit 40 such as the Internet.

**[0042]** Next, a way to detect leakage of refrigerant of the heat pump cycle 24 of this embodiment will be described using Fig. 2. An operation example 1 in Fig. 2 shows transition of pressure detected by the pressure sensor 27 when the heat medium circulation system 100 is operated in a state (normal state) where refrigerant does not leak. An operation example 2 in Fig. 2 shows transition of pressure detected by the pressure sensor 27 when the heat medium circulation system 100 is operated in a state where refrigerant leaks.

**[0043]** In the embodiment, the heat medium is water, but the heat medium is not limited to water. Immediately after the heat medium circulation system 100 is installed, the heating cycle 50 is not filled with water which is the heat medium. By pour water into the heating cycle 50, air existing in the heating cycle 50 before water is poured is pushed out, and this air is discharged outside of the heating cycle 50 from the purge valve 29.

**[0044]** Next, the heat medium circulation system 100 installed in a service space is actually operated, and a trial operation for checking whether there is a problem in the heat medium circulation system 100 or the installing operation is carried out. If the trial operation is started, pressure detected by the pressure sensor 27 rises due to influence of the operated compressor 20 and the circulation pump 25. At this time, when pressure detected by the pressure sensor 27 almost exceeds or actually exceeds a predetermined value (0.3 MPa in this embodiment), the control device 35 operates the relief valve 28 to bring the pressure to a value equal to or smaller than the predetermined value (0.3 MPa) .

**[0045]** During time after the trial operation is completed and before next normal operation is started, the heat medium circulation system 100 is stopped. When refrigerant does not leak, a pressure value detected by the pressure sensor 27 is lowered with time after the trial operation is completed as shown in the operation example 1, and the heat medium circulation system is brought into the steady state. At this time, the control device 35 does not determine that refrigerant leaks in the heat medium circulation system 100. When refrigerant leaks on the other hand,

the pressure value detected by the pressure sensor 27 rises after the operation is stopped as shown in the operation example 2, and the pressure reaches the predetermined value (0.3 MPa) in due course for detecting leakage of refrigerant. According to this, the control device 35 determines that refrigerant leaks in the heat medium circulation system 100.

**[0046]** In the heat medium circulation system 100 of this embodiment, when the detected value of the pressure sensor 27 is equal to or greater than the predetermined value (0.3 MPa this time), the control device 35 determines that refrigerant leaks from the heat pump cycle 24 to the heating cycle 50. By setting, as the predetermined value, a numeric value by which it is obviously possible to determine that refrigerant leaks, it is possible to prevent erroneous detection.

**[0047]** This embodiment is described above that when the detected value of the pressure sensor 27 is equal to or greater than the predetermined value, the control device 35 determines that refrigerant leaks from the heat pump cycle 24 to the heating cycle 50, but the present invention is not limited to the embodiment. The control device 35 may determine that refrigerant leaks from the heat pump cycle 24 to the heating cycle 50 based on a magnitude of a difference between the detected value of the pressure sensor 27 and a preset reference value.

**[0048]** In the operation example 2, detection of leakage of refrigerant is carried out when the operation is stopped immediately after the trial operation, but the invention is not limited to this. The detection of leakage of refrigerant is carried out in the above-described method also when the operation is stopped after normal operation.

**[0049]** Detection of leakage of refrigerant at the time of normal operation of the heat medium circulation system 100 will be described using Figs. 3 and 4.

**[0050]** An operation example 3 in Fig. 3 shows transition of pressure detected by the pressure sensor 27 when the heat medium circulation system 100 is operated in a state where refrigerant leaks. In the operation example 3, the control device 35 detects leakage of refrigerant from the heat pump cycle to the heating cycle when a difference between a detected value of the pressure sensor 27 at the time of normal operation and a reference value becomes larger than a predetermined value.

**[0051]** Here, the reference value may be a detected value of the pressure sensor 27 when the operation is stopped after trial operation of the heat medium circulation system 100 is stopped. According to this, by carrying out trial operation after the heat medium circulation system 100 is installed in a user's house, the reference value of leakage of refrigerant can be set. Hence, it is possible to set optimal reference value which is suitable for using environment of respective users, and it is possible to detect leakage of refrigerant with higher precision.

**[0052]** When the detected value of the pressure sensor 27 is equal to or greater the predetermined value, the control device 35 may determine that refrigerant leaks from the heat pump cycle 24 to the heating cycle 50.

**[0053]** Operation examples 4 and 5 in Fig. 4 show transition of pressure detected by the pressure sensor 27 when the heat medium circulation system 100 is operated under environment which is different from that of the operation example 3.

**[0054]** As described above, when the difference between a detected value of the pressure sensor 27 at the time of normal operation and a reference value is greater than a predetermined value, or when a detected value of the pressure sensor 27 at the time of normal operation is greater than a predetermined value, the control device 35 determines that refrigerant leaks from the heat pump cycle 24 to the heating cycle 50. In the operation examples 4 and 5, since the difference between the detected value of the pressure sensor 27 and the reference value is smaller than the predetermined value and the detected value of the pressure sensor 27 is smaller than the predetermined value, the control device 35 does not determine that refrigerant leaks.

**[0055]** The control device 35 may include an operation history storage device 70 which stores operation history. Only when the operation history storage device 70 stores information that there is operation history, the control device 35 may determine that refrigerant leaks from the heat pump cycle 24 to the heating cycle 50.

**[0056]** With this configuration, detection of leakage of refrigerant is carried out only when there is operation history in times past. According to this, it is possible to prevent erroneous detection caused when pressure rises at the time of trial operation. For example, in the operation example 2 in Fig. 2, although the detected value of the pressure sensor 27 exceeds the predetermined value (0.3 MPa this time), since there is no operation history in the operation history storage device 70 at the time of the trial operation, leakage of refrigerant is not detected.

#### [INDUSTRIAL APPLICABILITY]

**[0057]** As described above, according to the heat medium circulation system of the present invention, it is possible to early find leakage of refrigerant from the heat pump cycle to the heating cycle, prevent erroneous detection, and inform a user of the leakage. From the standpoint of enhancement of safety of a user, usability as a heating system is enhanced.

#### [EXPLANATION OF SYMBOLS]

##### [0058]

|    |                                  |
|----|----------------------------------|
| 20 | compressor                       |
| 21 | water-refrigerant heat exchanger |
| 22 | decompression means              |
| 23 | air heat exchanger               |
| 24 | heat pump cycle                  |
| 25 | circulation pump                 |
| 26 | flow rate sensor                 |
| 27 | pressure sensor                  |

28 relief valve  
 29 purge valve  
 30 heater unit  
 31 hot water-going pipe  
 32 hot water returning pipe  
 33 water-entering temperature detecting means  
 34 water-going temperature detecting means  
 35 control device  
 37 heating terminal  
 38 HEMS controller  
 39 network transceiver  
 40 network circuit (the Internet)  
 41 information terminal  
 42 remote controller  
 43 indoor unit  
 44 outdoor unit  
 50 heating cycle  
 70 operation history storage device  
 100 heat medium circulation system

## Claims

### 1. A heat medium circulation system comprising:

a heat pump cycle (24) through which refrigerant circulates;  
 a heating cycle (50) through which heat medium heated by the heat pump cycle (24) circulates between the heat pump cycle (24) and a heating terminal (37);  
 a pressure sensor (27) for detecting pressure of the heat medium in the heating cycle (50); and  
 a control device (35), wherein  
 the control device (35) determines that the refrigerant leaks from the heat pump cycle (24) to the heating cycle (50) based on a detected value of the pressure sensor (27) which is detected after a trial operation for operating the heat pump cycle (24) and the heating cycle (50) is completed after water is poured to the heating cycle (50).

2. The heat medium circulation system according to claim 1, wherein the control device (35) determines that the refrigerant leaks from the heat pump cycle (24) to the heating cycle (50) based on the detected value of the pressure sensor (27) which is detected when the trial operation is stopped.

3. The heat medium circulation system according to claim 1 or 2, wherein the control device (35) determines that the refrigerant leaks from the heat pump cycle (24) to the heating cycle (50) based on the detected value of the pressure sensor (27) detected during normal operation which operates the heat pump cycle (24) and the heating cycle (50).

4. The heat medium circulation system according to

any one of claims 1 to 3, wherein the control device (35) determines that the refrigerant leaks from the heat pump cycle (24) to the heating cycle (50) when the detected value of the pressure sensor (27) is equal to or greater than a predetermined value.

5. The heat medium circulation system according to any one of claims 1 to 3, wherein the control device (35) determines that the refrigerant leaks from the heat pump cycle (24) to the heating cycle (50) based on a magnitude of a difference between the detected value of the pressure sensor (27) and a preset reference value.

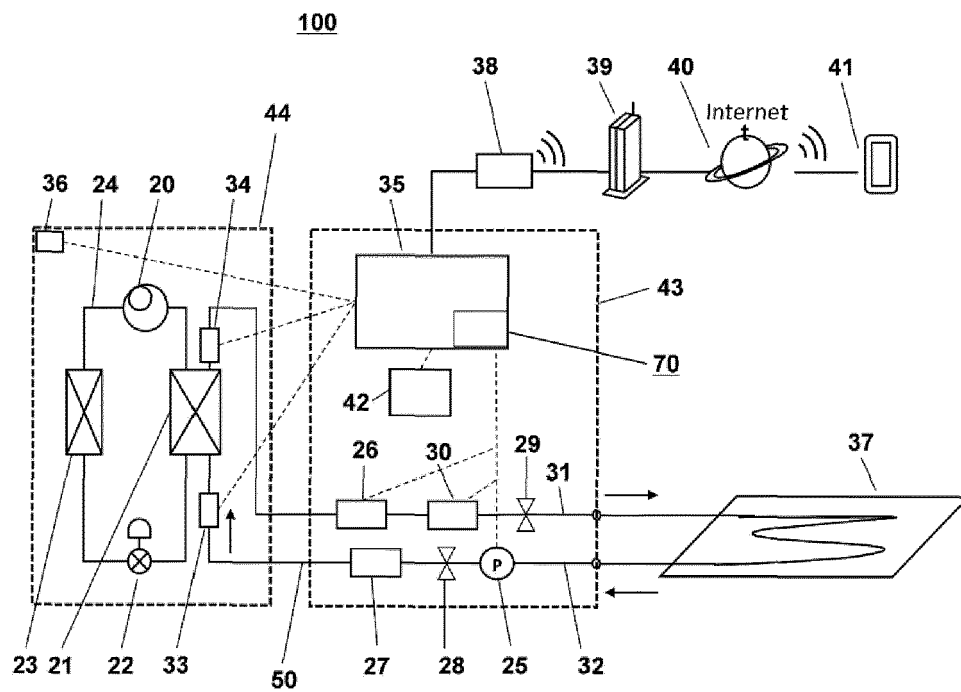
6. The heat medium circulation system according to claim 5, wherein the reference value is the detected value of the pressure sensor (27) which is detected when operation is stopped after the trial operation is completed.

7. The heat medium circulation system according to any one of claims 1 to 5, wherein the control device (35) includes an operation history storage device (70) which stores operation history, and the control device (35) determines that the refrigerant leaks from the heat pump cycle (24) to the heating cycle (50) only when the operation history storage device (70) stores information that there is the operation history.

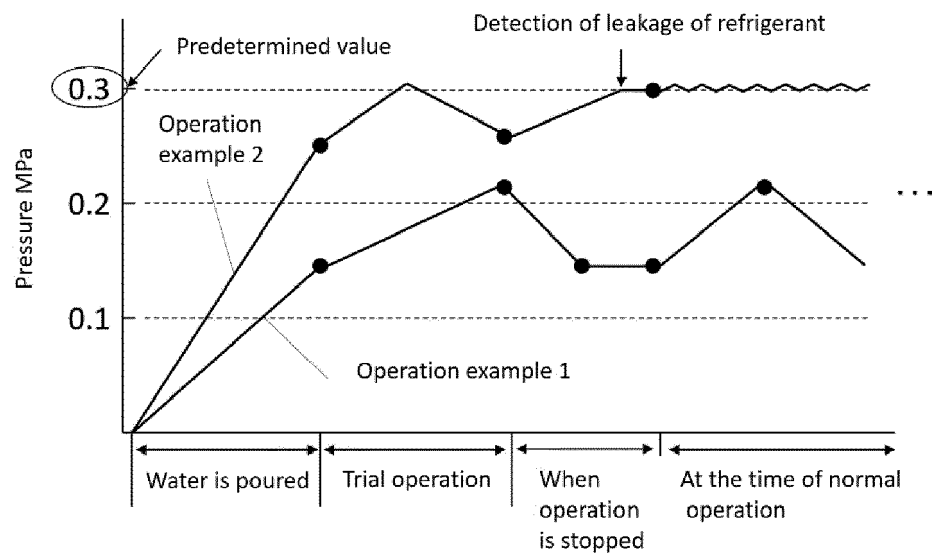
8. The heat medium circulation system according to any one of claims 1 to 7, further comprising a warning device for informing of the leakage of the refrigerant, wherein the control device (35) operates the warning device when the control device (35) determines that the refrigerant leaks from the heat pump cycle (24) to the heating cycle (50).

9. The heat medium circulation system according to claim 8, wherein the warning device is provided in a remote controller(42) or in an information terminal (41) which can communicate with the control device (35) through a network.

[Fig. 1]

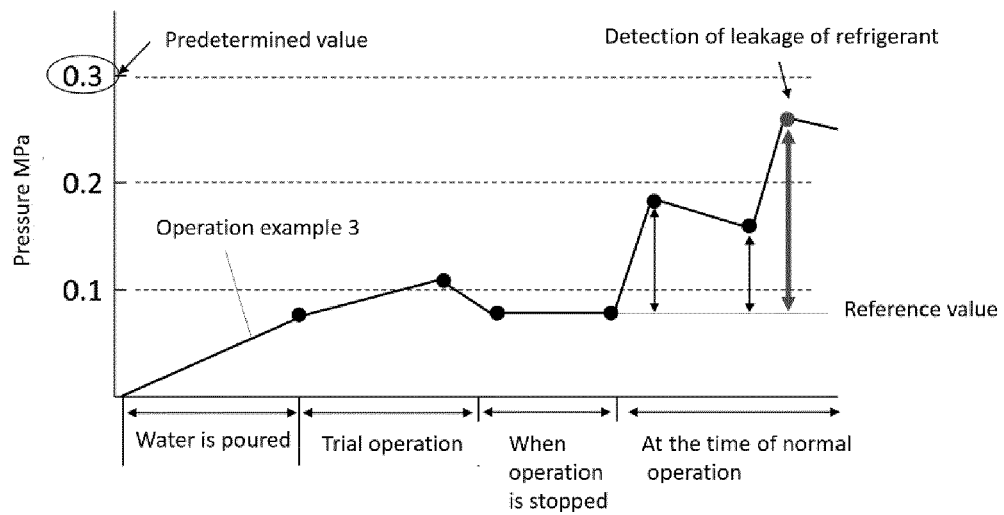


[Fig. 2]

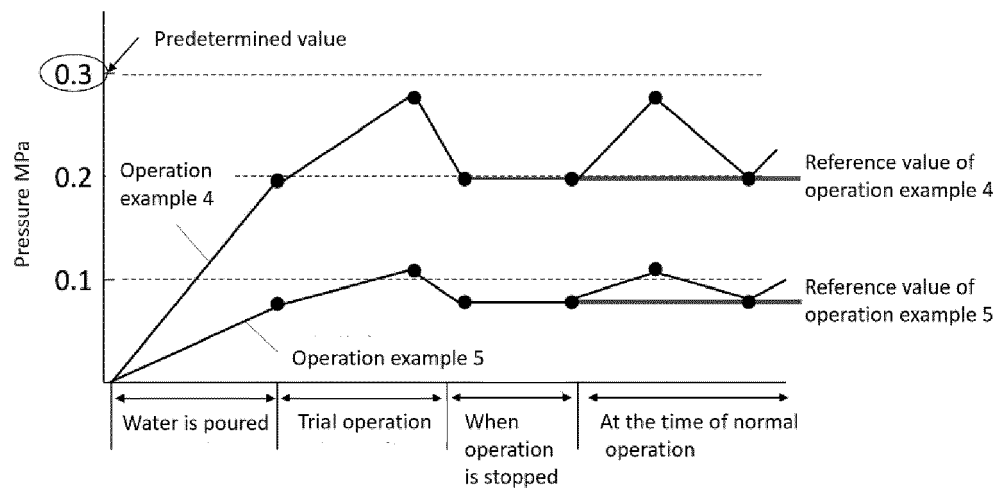




[Fig. 3]



[Fig. 4]





## EUROPEAN SEARCH REPORT

Application Number

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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)                  |
| X                                                                                                                                                                                                                                                      | EP 2 759 787 A1 (MITSUBISHI ELECTRIC CORP [JP]) 30 July 2014 (2014-07-30)<br>* paragraphs [0013] - [0046]; figures 1-4 * | 1-9                                                                                                                                                                                                                                                                                   | INV.<br>F24D3/18<br>F24D19/10<br>F24F11/36<br>F24H15/104 |
| A                                                                                                                                                                                                                                                      | EP 3 822 545 A1 (VIESSMANN WERKE KG [DE]) 19 May 2021 (2021-05-19)<br>* the whole document *                             | 1-9                                                                                                                                                                                                                                                                                   | F24H15/12<br>F24H15/242<br>F24H15/395<br>F24H15/421      |
| A                                                                                                                                                                                                                                                      | EP 3 647 687 A1 (MITSUBISHI ELECTRIC CORP [JP]) 6 May 2020 (2020-05-06)<br>* the whole document *                        | 1-9                                                                                                                                                                                                                                                                                   | F24H15/45<br>F24H15/457                                  |
| A                                                                                                                                                                                                                                                      | JP 2009 236425 A (DENSO CORP) 15 October 2009 (2009-10-15)<br>* the whole document *                                     | 1-9                                                                                                                                                                                                                                                                                   |                                                          |
|                                                                                                                                                                                                                                                        |                                                                                                                          |                                                                                                                                                                                                                                                                                       | TECHNICAL FIELDS SEARCHED (IPC)                          |
|                                                                                                                                                                                                                                                        |                                                                                                                          |                                                                                                                                                                                                                                                                                       | F24D<br>F24F<br>F24H                                     |
| The present search report has been drawn up for all claims                                                                                                                                                                                             |                                                                                                                          |                                                                                                                                                                                                                                                                                       |                                                          |
| Place of search<br><b>Munich</b>                                                                                                                                                                                                                       |                                                                                                                          | Date of completion of the search<br><b>20 January 2023</b>                                                                                                                                                                                                                            | Examiner<br><b>Schwaiger, Bernd</b>                      |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |                                                                                                                          | T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>.....<br>& : member of the same patent family, corresponding document |                                                          |

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

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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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| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---------------------|----------------------------|---------------------|
| <b>EP 2759787 A1</b>                      | <b>30-07-2014</b>   | <b>CN 103797317 A</b>      | <b>14-05-2014</b>   |
|                                           |                     | <b>EP 2759787 A1</b>       | <b>30-07-2014</b>   |
|                                           |                     | <b>JP 5818900 B2</b>       | <b>18-11-2015</b>   |
|                                           |                     | <b>JP WO2013038577 A1</b>  | <b>23-03-2015</b>   |
|                                           |                     | <b>US 2014196483 A1</b>    | <b>17-07-2014</b>   |
|                                           |                     | <b>WO 2013038577 A1</b>    | <b>21-03-2013</b>   |
| <hr/>                                     |                     |                            |                     |
| <b>EP 3822545 A1</b>                      | <b>19-05-2021</b>   | <b>DE 102019130932 A1</b>  | <b>20-05-2021</b>   |
|                                           |                     | <b>EP 3822545 A1</b>       | <b>19-05-2021</b>   |
| <hr/>                                     |                     |                            |                     |
| <b>EP 3647687 A1</b>                      | <b>06-05-2020</b>   | <b>CN 110770518 A</b>      | <b>07-02-2020</b>   |
|                                           |                     | <b>EP 3647687 A1</b>       | <b>06-05-2020</b>   |
|                                           |                     | <b>JP 6887496 B2</b>       | <b>16-06-2021</b>   |
|                                           |                     | <b>JP WO2019003268 A1</b>  | <b>16-01-2020</b>   |
|                                           |                     | <b>US 2020363110 A1</b>    | <b>19-11-2020</b>   |
|                                           |                     | <b>WO 2019003268 A1</b>    | <b>03-01-2019</b>   |
| <hr/>                                     |                     |                            |                     |
| <b>JP 2009236425 A</b>                    | <b>15-10-2009</b>   | <b>JP 5358999 B2</b>       | <b>04-12-2013</b>   |
|                                           |                     | <b>JP 2009236425 A</b>     | <b>15-10-2009</b>   |
| <hr/>                                     |                     |                            |                     |

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 2013185803 A [0003]