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(54) **AIR CONDITIONER**

(57) In an air conditioner (100) according to an aspect
of the present invention, flammable refrigerant circulates
in order of a compressor (3), a first heat exchanger (1),
an expansion valve (5), and a second heat exchanger
(6). The compressor (3) stores refrigeration oil and dis-
charges the refrigeration oil with the refrigerant. The re-
frigeration oil circulates with the refrigerant in order of the
compressor (3), the first heat exchanger (1), the expan-
sion valve (5), and the second heat exchanger (6). The
first heat exchanger (1) is located in a first space. The

second heat exchanger (6) is located in a second space.
The air conditioner (100) includes a first sensor (s1), a
second sensor (s2), and a controller (8). The first sensor
(s1) detects the refrigerant in the first space. The second
sensor (s2) detects an odor of the refrigeration oil in the
first space. The controller (8) detects a leak of the refrig-
erant using a first detection signal from the first sensor
(s1) and a second detection signal from the second sen-
sor (s2).

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Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to an air conditioner having a function of detecting a leak of flammable refrigerant.

BACKGROUND ART

10 **[0002]** A conventionally known air conditioner has a function of detecting a leak of flammable refrigerant. For example, WO 2017/187618 (PTL 1) discloses an air conditioner including refrigerant detection means for detecting a concentration of flammable refrigerant in a room. In the air conditioner, when a refrigerant concentration detected by the refrigerant detection means is greater than or equal to a threshold, an air sending fan is operated at a preset airflow rate. This can restrain the formation of a flammable concentration region in the room if refrigerant leaks.

15 CITATION LIST

PATENT LITERATURE

20 **[0003]** PTL 1: WO 2017/187618

SUMMARY OF INVENTION

TECHNICAL PROBLEM

25 **[0004]** Refrigeration oil stored in a compressor is normally discharged from the compressor together with refrigerant to circulate in an air conditioner. If the refrigerant leaks, thus, the refrigeration oil also leaks in many cases. PTL 1, however, does not reflect a situation in which the refrigeration oil would leak with the refrigerant.

[0005] The present invention has been made to solve the above problem and has an object to improve the safety of an air conditioner.

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SOLUTION TO PROBLEM

[0006] The above mentioned objects and problems are solved by the air conditioner according to the claims.

35 **[0007]** In an air conditioner according to an aspect of the present invention, flammable refrigerant circulates in order of a compressor, a first heat exchanger, an expansion valve, and a second heat exchanger. The compressor stores refrigeration oil and discharges the refrigeration oil with the refrigerant. The refrigeration oil circulates with the refrigerant in order of the compressor, the first heat exchanger, the expansion valve, and the second heat exchanger. The first heat exchanger is located in a first space. The second heat exchanger is located in a second space. The air conditioner includes a first sensor, a second sensor, and a controller. The first sensor detects the refrigerant in the first space. The second sensor detects an odor of the refrigeration oil in the first space. The controller detects a leak of the refrigerant using a first detection signal from the first sensor and a second detection signal from the second sensor.

40 **[0008]** In an air conditioner according to another aspect of the present invention, flammable refrigerant circulates in order of a compressor, a first heat exchanger, an expansion valve, and a second heat exchanger. The compressor stores refrigeration oil and discharges the refrigeration oil with the refrigerant. The refrigeration oil circulates with the refrigerant in order of the compressor, the first heat exchanger, the expansion valve, and the second heat exchanger. The first heat exchanger is located in a first space. The second heat exchanger is located in a second space. The air conditioner includes a sensor, a sample containing unit, and a controller. The sensor detects the refrigerant in the first space. The sample containing unit is capable of containing a sample of the refrigeration oil and discharging an odor of the sample to outside. The controller detects a leak of the refrigerant using a detection signal from the sensor.

50 **[0009]** A packaging set for an air conditioner according to still another aspect of the present invention is a packaging set for an air conditioner in which flammable refrigerant circulates in order of a compressor, a first heat exchanger, an expansion valve, and a second heat exchanger. During operation of the air conditioner, the compressor stores refrigeration oil and discharges the refrigeration oil with the refrigerant. The refrigeration oil circulates with the refrigerant in order of the compressor, the first heat exchanger, the expansion valve, and the second heat exchanger. The first heat exchanger is located in a first space. The second heat exchanger is located in a second space. The air conditioner includes a sensor and a controller. The sensor detects the refrigerant in the first space. The controller detects a leak of the refrigerant using a detection signal from the sensor. The packaging set includes a sample of the refrigeration oil and a packaging box. The packaging box contains the sample and at least one of the compressor, the first heat exchanger, the expansion

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valve, the second heat exchanger, the sensor, and the controller.

ADVANTAGEOUS EFFECTS OF INVENTION

[0010] The air conditioner and the packaging set for an air conditioner according to the present invention can detect refrigerant which has leaked to the first space using an odor of the refrigeration oil, and thus, can detect a refrigerant leak in the first space with increased accuracy. This leads to improved safety of the air conditioner.

BRIEF DESCRIPTION OF DRAWINGS

[0011]

Fig. 1 is a functional block diagram showing a configuration of an air conditioner according to Embodiment 1.

Fig. 2 is a schematic external view of an indoor unit of the air conditioner of Fig. 1.

Fig. 3 is a flowchart showing a flow of a refrigerant leak detection process performed by a controller.

Fig. 4 is a flowchart showing another example flow of the refrigerant leak detection process performed by the controller.

Fig. 5 is a plane of coordinates showing the relation between a detection level of a refrigerant sensor and a detection level of an odor sensor, where the X-axis represents a detection level of the refrigerant sensor and the Y-axis represents a detection level of the odor sensor.

Fig. 6 is a flowchart showing a flow of a process of determining a refrigerant leak based on whether a point is included in a refrigerant leak region.

Fig. 7 is a functional block diagram showing a configuration of an air conditioner according to Embodiment 2.

Fig. 8 is a functional block diagram showing a configuration of an air conditioner according to Embodiment 3.

Fig. 9 is a schematic external view of an indoor unit of the air conditioner of Fig. 8.

Fig. 10 is a schematic external view of a sample container of Fig. 9.

Fig. 11 shows how an indoor unit is packaged by a packaging set for an air conditioner according to Embodiment 4.

Fig. 12 shows the packaging set of Fig. 11 which is unpackaged.

DESCRIPTION OF EMBODIMENTS

[0012] Embodiments of the present invention will be described below in detail with reference to the drawings. In the figures, identical or corresponding components are identically denoted and will not be described repeatedly in principle.

Embodiment 1

[0013] Fig. 1 is a functional block diagram showing a configuration of an air conditioner 100 according to Embodiment 1. Fig. 2 is a schematic external view of an indoor unit 10 of air conditioner 100 of Fig. 1. In air conditioner 100, refrigerant including flammable R290 (propane) is used. Air conditioner 100 includes a heating mode, a cooling mode, and a defrosting mode as operation modes. As shown in Fig. 1, air conditioner 100 includes indoor unit 10 and an outdoor unit 11. Both of indoor unit 10 and outdoor unit 11 are supplied with electric power from a main power supply Ps1 (first power supply).

[0014] Indoor unit 10 is located indoors (in a first space). Indoor unit 10 includes an indoor heat exchanger 1 (first heat exchanger), an indoor fan 2, a refrigerant sensor s1 (first sensor), and an odor sensor s2 (second sensor). Outdoor unit 11 is located outdoors (in a second space). Outdoor unit 11 includes a compressor 3, a four-way valve 4, an expansion valve 5, an outdoor heat exchanger 6 (second heat exchanger), an outdoor fan 7, and a controller 8. Compressor 3 stores refrigeration oil for lubrication of a compression mechanism. The refrigeration oil is a refrigeration oil with a unique odor and includes, for example, PAG (PolyAlkylene Glycol).

[0015] In the heating mode, controller 8 controls four-way valve 4 to form a flow path such that the refrigerant circulates in order of compressor 3, indoor heat exchanger 1, expansion valve 5, and outdoor heat exchanger 6. In the heating mode, indoor heat exchanger 1 functions as a condenser, and outdoor heat exchanger 6 functions as an evaporator.

[0016] In the cooling mode and the defrosting mode, controller 8 controls four-way valve 4 to form a flow path such that the refrigerant circulates in order of compressor 3, outdoor heat exchanger 6, expansion valve 5, and indoor heat exchanger 1. In the cooling mode and the defrosting mode, indoor heat exchanger 1 functions as an evaporator, and outdoor heat exchanger 6 functions as a condenser.

[0017] Controller 8 controls a drive frequency of compressor 3 to control an amount of the refrigerant to be discharged per unit time by compressor 3. Controller 8 controls a degree of opening of expansion valve 5. Controller 8 controls an air delivery rate per unit time of each of indoor fan 2 and outdoor fan 7.

[0018] In indoor unit 10, refrigerant sensor s1 and odor sensor s2 are located leeward of indoor heat exchanger 1 in a direction in which indoor fan 2 blows air. Refrigerant sensor s1 outputs a detection signal (first detection signal) indicative of a concentration of the refrigerant to controller 8. Odor sensor s2 outputs a detection signal (second detection signal) indicative of an odor of the refrigeration oil to controller 8.

[0019] The refrigeration oil stored in compressor 3 is normally discharged from compressor 3 with the refrigerant and circulates through air conditioner 100. Accordingly, if the refrigerant leaks, the refrigeration oil also leaks in many cases.

[0020] In Embodiment 1, thus, a refrigerant leak in a room is detected using a concentration of the refrigerant and an odor of the refrigeration oil. As an odor of the refrigeration oil is used in addition to a concentration of the refrigerant, a refrigerant leak can be detected with a higher degree of accuracy than when a refrigerant leak is detected using only a concentration of the refrigerant, leading to improved safety of the air conditioner.

[0021] Fig. 3 is a flowchart showing a flow of a refrigerant leak detection process performed by controller 8. The process shown in Fig. 3 is invoked on a regular or irregular basis by a main routine (not shown) that controls an operation of air conditioner 100. A step will also be referred to as S below. A detection level L1 refers to a level of a detection signal of refrigerant sensor s1, and a detection level L2 refers to a level of a detection signal of odor sensor s2.

[0022] As shown in Fig. 3, controller 8 determines whether detection level L1 of a concentration of the refrigerant in the room is greater than a threshold A1 (first threshold) at S11. When detection level L1 is greater than threshold A1 (YES at S11), controller 8 performs a safety ensuring process at S14 and then returns the process to the main routine. In the safety ensuring process, for example, the following are performed: a process of making the distribution of refrigerant in the room uniform by agitating indoor air by indoor fan 2 to thereby dilute the concentration of the refrigerant, generation of an alarm sound, flashing of a lamp, and display of a message.

[0023] When detection level L1 of the concentration of the refrigerant in the room is smaller than or equal to threshold A1 (NO at S11), controller 8 determines whether detection level L2 of the refrigeration oil in the room is greater than a threshold B1 (second threshold) at S12. When detection level L2 of the refrigeration oil in the room is greater than threshold B1 (YES at S12), controller 8 performs the safety ensuring process at S14 and then returns the process to the main routine. When detection level L2 of the refrigeration oil in the room is smaller than or equal to threshold B1 (NO at S12), controller 8 returns the process to the main routine.

[0024] In Fig. 3, determination of a refrigerant leak using a concentration of the refrigerant (S11) and determination of a refrigerant leak using an odor of the refrigeration oil (S12) are performed at different steps. The determination of a refrigerant leak may be performed using a concentration of the refrigerant and an odor of the refrigeration oil at the same step, and for example, the process shown in Fig. 4 may be performed in place of the process shown in Fig. 3. In Fig. 4, the determination of a refrigerant leak (S13) using a concentration of the refrigerant and an odor of the refrigeration oil is performed when detection level L1 is smaller than or equal to threshold A1 in the determination of a refrigerant leak using a concentration of the refrigerant (NO at S11) and when detection level L2 is smaller than or equal to threshold B1 in the determination of a refrigerant leak using an odor of the refrigeration oil (NO at S12).

[0025] At the initiation of S13, detection level L1 is smaller than or equal to threshold A1 and detection level L2 is smaller than or equal to threshold B1, and accordingly, the condition for determining a refrigerant leak needs to be set at S13 in the range in which detection level L1 is smaller than or equal to threshold A1 and detection level L2 is smaller than or equal to threshold B1. In Fig. 4, thus, a threshold A2 (third threshold) is smaller than threshold A1, and a threshold B2 (fourth threshold) is smaller than threshold B1.

[0026] As shown in Fig. 4, none of the conditions of S11 and S12 are satisfied (NO at S11 and NO at S12), controller 8 determines at S13 whether detection level L1 is greater than threshold A2 and whether detection level L2 is greater than threshold B2. When detection level L1 is greater than threshold A2 and detection level L2 is greater than threshold B2 (YES at S13), controller 8 performs the safety ensuring process at S14 and returns the process to the main routine. When detection level L1 is smaller than or equal to threshold A2 or detection level L2 is smaller than or equal to threshold B2 (NO at S13), controller 8 returns the process to the main routine.

[0027] In Figs. 3 and 4, the condition for determining a refrigerant leak is the condition that detection level L1 of the concentration of the refrigerant or detection level L2 of the refrigeration oil is greater than a threshold. The condition for determining a refrigerant leak may be determined based on whether a point specified by detection level L1 and detection level L2 is included in a refrigerant leak region in which a refrigerant leak should be determined on a plane of coordinates indicating the relation between detection level L1 and detection level L2.

[0028] Fig. 5 is a plane of coordinates indicating the relation between detection level L1 and detection level L2, where the X-axis indicates detection level L1 of a concentration of the refrigerant and the Y-axis indicates detection level L2 of the refrigeration oil. The refrigerant leak region shown in Fig. 5 is represented by Expression (1) below. Detection level L1 and detection level L2 that satisfy Expression (1) are included in the refrigerant leak region. Threshold A2 of detection level L1 and threshold B2 of detection level L2 in Fig. 4 are respectively set to, for example, a detection level L1 and a detection level L2 of point P3 on a boundary line (a straight line connecting a point P1 (A1, 0) and a point P2 (0, B1)) between the refrigerant leak region and a refrigerant no-leak region (a region that does not satisfy Expression (1)).

[0029] [Math 1]

$$\frac{X}{A1} + \frac{Y}{B1} \geq 1 \quad \dots (1)$$

[0030] Fig. 6 is a flowchart showing a flow of the process of determining a refrigerant leak using Expression (1). The flowchart shown in Fig. 6 is a flowchart obtained by replacing S11 and S12 of Fig. 3 with S10. As shown in Fig. 6, controller 8 determines whether detection level L1 and detection level L2 satisfy Expression (1). When detection level L1 and detection level L2 satisfy Expression (1) (YES at S10), controller 8 performs the safety ensuring process at S14 and returns the process to the main routine. When detection level L1 and detection level L2 do not satisfy Expression (1) (No at S10), controller 8 returns the process to the main routine.

[0031] As described above, the air conditioners according to Embodiment 1 and Modifications 1 and 2 can have improved safety.

Embodiment 2

[0032] Embodiment 1 has described the case where the refrigerant sensor and the odor sensor are supplied with electric power from a power supply of an air conditioner. Embodiment 2 will describe a case where at least one of the refrigerant sensor and the odor sensor is supplied with electric power from a power supply different from the power supply of the air conditioner. Such a configuration can detect a refrigerant leak because at least one of the refrigerant sensor and the odor sensor operates even when the air conditioner is not supplied with electric power (when the air conditioning apparatus and the power supply are not connected or when a power failure occurs).

[0033] Fig. 7 is a functional block diagram showing a configuration of an air conditioner 200 according to Embodiment 2. The configuration of air conditioner 200 is a configuration obtained by adding an auxiliary power supply Ps2 (second power supply) to the configuration of air conditioner 100 of Fig. 1 and replacing refrigerant sensor s1 and odor sensor s2 respectively with a refrigerant sensor s21 and an odor sensor s22. The other components are similar, description of which will not be repeated.

[0034] As shown in Fig. 7, auxiliary power supply Ps2 supplies electric power to odor sensor s22. Auxiliary power supply Ps2 includes, for example, a battery. Odor sensor s22 informs a refrigerant leak by, for example, an alarm sound, flashing of a lamp, or display of a message when detection level L2 exceeds threshold B1. The sensor that is supplied with electric power from auxiliary power supply Ps2 when power supply from main power supply Ps1 is stopped (e.g., when a cord of air conditioner 200 is pulled out of main power supply Ps1 or when a power failure occurs) may be refrigerant sensor s21. In this case, when detection level L1 exceeds threshold A1, refrigerant sensor s21 informs a refrigerant leak by, for example, an alarm sound, flashing of a lamp, or display of a message. At least one of refrigerant sensor s1 and odor sensor s22 operates even when power supply from main power supply Ps1 is stopped, and accordingly, the operating sensor can detect a refrigerant leak.

[0035] In order to secure electric power of auxiliary power supply Ps2 without fail in case of emergency when power supply from main power supply Ps1 stops, preferably, the sensor that is supplied with electric power from auxiliary power supply Ps2 receives electric power from main power supply Ps1 and does not consume the electric power of auxiliary power supply Ps2 during normal operation, and receives electric power from auxiliary power supply Ps2 in case of emergency. Also, for increased accuracy of detecting a refrigerant leak, more preferably, both of refrigerant sensor s1 and odor sensor s2 are supplied with electric power from auxiliary power supply Ps2 such that both of refrigerant sensor s1 and odor sensor s2 operate also when power supply from main power supply Ps1 is stopped.

[0036] As described above, the air conditioner according to Embodiment 2 can detect a refrigerant leak even when no electric power is supplied to the air conditioner, and accordingly, can have more improved safety than in Embodiment 1.

Embodiments 3 and 4

[0037] Embodiments 1 and 2 have described the case where an odor of the refrigeration oil is detected by a sensor. Embodiments 3 and 4 will describe a configuration that causes a user to recognize an odor of the refrigeration oil, so that the user himself/herself can become aware of a leak of the refrigeration oil into the room.

[0038] It is known that R290 included in the refrigerant used in the air conditioning apparatus according to Embodiment 1 is almost odorless. Also, the refrigerant that circulates in the air conditioning apparatus is required to be chemically stable, and accordingly, an odorant is not normally added to the refrigerant. This makes it difficult for the user to perceive an odor of the refrigerant which has leaked into the room in many cases.

[0039] On the other hand, a refrigeration oil, for example, a PAG oil has a unique odor, and accordingly, the user can become aware of that an unfamiliar odor is included in the room in case of a leak of the refrigeration oil from the air conditioner with the refrigerant. However, the user frequently does not recognize that such an odor is the odor of the refrigeration oil.

[0040] In Embodiments 3 and 4, thus, a sample of the refrigeration oil used for lubrication of a compressor of an air conditioner is used to cause the user to recognize an odor of the refrigeration oil in advance. When perceiving the odor in the room, the user can become aware of a leak of the refrigeration oil into the room. The user himself/herself can become aware of an odor of the refrigeration oil in the room in addition to the determination of a refrigerant leak using a concentration of the refrigerant by the air conditioning apparatus, leading to more improved safety of the air conditioning apparatus than when the user does not know an odor of the refrigeration oil. Also, the user himself/herself can become aware of a refrigerant leak even when no electric power is supplied to the air conditioning apparatus. Further, manufacturing cost can be lower in Embodiments 3 and 4, which need no odor sensor, than in Embodiments 1 and 2.

[0041] Embodiment 3 will describe an air conditioner including a sample containing unit for refrigeration oil in the indoor unit. Embodiment 4 will describe a packaging set for an air conditioner in which a sample container for refrigeration oil separate from the air conditioner is packed with the air conditioner.

Embodiment 3

[0042] Fig. 8 is a functional block diagram showing a configuration of an air conditioner 300 according to Embodiment 3. The configuration of air conditioner 300 is a configuration obtained by replacing indoor unit 10 and controller 8 of air conditioner 100 of Fig. 1 respectively with an indoor unit 30 and a controller 38. The configuration of indoor unit 30 is a configuration obtained by removing odor sensor s2 from the configuration of indoor unit 10 and detachably attaching a sample container 31 (sample containing unit) as shown in Fig. 9. Controller 38 determines a refrigerant leak using a concentration of the refrigerant upon receipt of a detection signal from refrigerant sensor s1 but does not determine a refrigerant leak using an odor of the refrigeration oil. When detection level L1 of the concentration of refrigerant is greater than threshold A1, controller 38 performs the safety ensuring process. The other components are similar, description of which will not be repeated.

[0043] Fig. 10 is a schematic external view of sample container 31 of Fig. 9. As shown in Fig. 10, sample container 31 includes a main body 311 made of resin and a cap 312 made of resin. Main body 311 contains a sponge Spg impregnated with a sample of the refrigeration oil which is used for lubrication of compressor 3 of Fig. 8. When cap 312 is attached to main body 311 (Fig. 10(a)), the odor of the refrigeration oil is sealed within sample container 31 and can hardly leak out of sample container 31. Sample container 31 is attached to air conditioner 300 in the state shown in Fig. 10(a). Sample container 31 can release an odor of a sample of the refrigeration oil to outside with cap 312 detached from main body 311 (Fig. 10(b)). The user detaches sample container 31 from air conditioner 300 and removes cap 312 from main body 311 as shown in Fig. 10(b), and then checks an odor of the refrigeration oil.

[0044] As described above, the air conditioner according to Embodiment 3 can have improved safety and be manufactured at a lower cost than in Embodiments 1 and 2.

Embodiment 4

[0045] Fig. 11 shows how an indoor unit 40 is packed by a packaging set 400 for an air conditioner according to Embodiment 4. The appearance of indoor unit 40 is similar to that of indoor unit 10 shown in Fig. 2. Also, indoor unit 40 includes no odor sensor, similarly to indoor unit 30 shown in Fig. 8. As shown in Fig. 11, indoor unit 40 is covered with buffers 42 and 43 at its opposite ends and is contained in a packaging box 41. As packaging box 41 is slid in the longitudinal direction of indoor unit 40, packaging set 400 is unpacked.

[0046] Fig. 12 shows packaging set 400 of Fig. 11 which is unpacked. As shown in Fig. 12, indoor unit 40 has on its back surface a remote control Rm, and an instruction manual and sample container 31 for the refrigeration oil that are wrapped together. Sample container 31 is similar to that shown in Fig. 10 and contains a sponge impregnated with the refrigeration oil. The user can check an odor of the refrigeration oil with sample container 31.

[0047] As described above, the packaging set for an air conditioner according to Embodiment 4 can provide improved safety to the air conditioner and also reduce a manufacturing cost of the air conditioning apparatus more than in Embodiments 1 and 2.

[0048] The present invention further includes the following embodiments:

1. An air conditioner in which flammable refrigerant circulates in order of a compressor, a first heat exchanger, an expansion valve, and a second heat exchanger,

the compressor being configured to store refrigeration oil and discharge the refrigeration oil with the refrigerant, the refrigeration oil circulating with the refrigerant in order of the compressor, the first heat exchanger, the expansion valve, and the second heat exchanger, the first heat exchanger being located in a first space, the second heat exchanger being located in a second space,

the air conditioner comprising:

a first sensor configured to detect the refrigerant in the first space;
a second sensor configured to detect an odor of the refrigeration oil in the first space; and
a controller configured to detect a leak of the refrigerant using a first detection signal from the first sensor
and a second detection signal from the second sensor.

2. The air conditioner according to embodiment 1, wherein the controller is configured to detect a leak of the refrigerant when the first detection signal is greater than a first threshold, when the second detection signal is greater than a second threshold, and when the first detection signal is greater than a third threshold and the second detection signal is greater than a fourth threshold.

3. The air conditioner according to embodiment 2, wherein the third threshold is smaller than the first threshold, and the fourth threshold is smaller than the second threshold.

4. The air conditioner according to embodiment 2 or 3, wherein the first sensor is configured to be supplied with electric power from a first power supply, the second sensor is configured to be supplied with electric power from a second power supply, the controller is configured to be supplied with electric power from the first power supply, and the second sensor is configured to notify a leak of the refrigerant when the second detection signal exceeds the second threshold.

5. An air conditioner in which flammable refrigerant circulates in order of a compressor, a first heat exchanger, an expansion valve, and a second heat exchanger, the compressor being configured to store refrigeration oil and discharge the refrigeration oil with the refrigerant, the refrigeration oil circulating with the refrigerant in order of the compressor, the first heat exchanger, the expansion valve, and the second heat exchanger, the first heat exchanger being located in a first space, the second heat exchanger being located in a second space, the air conditioner comprising:

a sensor configured to detect the refrigerant in the first space;
a sample containing unit configured to contain a sample of the refrigeration oil and discharge an odor of the sample to outside; and
a controller configured to detect a leak of the refrigerant using a detection signal from the sensor.

6. The air conditioner according to embodiment 5, wherein the sample containing unit is located in the first space.

7. The air conditioner according to any one of embodiments 1 to 6, wherein the first space is located indoors.

8. The air conditioner according to any one of embodiments 1 to 7, wherein the refrigerant includes R290, and the refrigeration oil includes polyalkylene glycol.

9. A packaging set for an air conditioner in which flammable refrigerant circulates in order of a compressor, a first heat exchanger, an expansion valve, and a second heat exchanger, during operation of the air conditioner,

the compressor being configured to store refrigeration oil and discharge the refrigeration oil with the refrigerant, the refrigeration oil circulating with the refrigerant in order of the compressor, the first heat exchanger, the expansion valve, and the second heat exchanger, the first heat exchanger being located in a first space, the second heat exchanger being located in a second space, the air conditioner including:

a sensor configured to detect the refrigerant in the first space; and
a controller configured to detect a leak of the refrigerant using a detection signal from the sensor,

the packaging set comprising:

a sample of the refrigeration oil; and

a packaging box for containing the sample and at least one of the compressor, the first heat exchanger, the expansion valve, the second heat exchanger, the sensor, and the controller.

10. The packaging set for an air conditioner according to embodiment 9, wherein the packaging box contains the sample and at least the first heat exchanger.

11. The packaging set for an air conditioner according to embodiment 9 or 10, wherein the first space is located indoors.

12. The packaging set for an air conditioner according to any one of embodiments 9 to 11, wherein the refrigerant includes R290, and the refrigeration oil includes polyalkylene glycol.

[0049] The embodiments disclosed herein are also intended to be implemented in combination as appropriate within a consistent scope. It should be understood that the embodiments disclosed herein are illustrative and non-restrictive in every respect. The scope of the present invention is defined by the terms of the claims, rather than the description above, and is intended to include any modifications within the meaning and scope equivalent to the terms of the claims.

REFERENCE SIGNS LIST

[0050] 1 indoor heat exchanger; 2 indoor fan; 3 compressor; 4 four-way valve; 5 expansion valve; 6 outdoor heat exchanger; 7 outdoor fan; 8, 38 controller; 10, 30, 40 indoor unit; 11 outdoor unit; 31 sample container; 41 packaging box; 42, 43 buffer; 100, 200, 300 air conditioner; 311 main body; 312 cap; 400 packaging set; A1, A2, B1, B2 threshold; Ps1 main power supply; Ps2 auxiliary power supply; Rm remote control; Spg sponge; s1, s21 refrigerant sensor; s2, s21 odor sensor.

Claims

1. An air conditioner (100) in which flammable refrigerant circulates in order of a compressor (3), a first heat exchanger (1), an expansion valve (5), and a second heat exchanger (6), the compressor (3) being configured to store refrigeration oil and discharge the refrigeration oil with the refrigerant, the refrigeration oil circulating with the refrigerant in order of the compressor (3), the first heat exchanger (1), the expansion valve (5), and the second heat exchanger (6), the first heat exchanger (1) being located in a first space, the second heat exchanger (6) being located in a second space, the air conditioner (100) comprising:

a first sensor (s1) configured to detect the refrigerant in the first space;

a second sensor (s2) configured to detect an odor of the refrigeration oil in the first space; and

a controller (8) configured to detect a leak of the refrigerant using a first detection signal from the first sensor (s1) and a second detection signal from the second sensor (s2),

wherein the controller (8) is configured to detect a leak of the refrigerant when the first detection signal is greater than a first threshold (A1), when the second detection signal is greater than a second threshold (B1), and when the first detection signal is greater than a third threshold (A2) and the second detection signal is greater than a fourth threshold (B2),

wherein

the first sensor (s1) is configured to be supplied with electric power from a first power supply (Ps1),

the second sensor (s2) is configured to be supplied with electric power from a second power supply (Ps2),

the controller (8) is configured to be supplied with electric power from the first power supply (Ps1), and

the second sensor (s2) is configured to notify a leak of the refrigerant when the second detection signal exceeds the second threshold (B1).

2. The air conditioner (100) according to claim 1, wherein

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the third threshold (A2) is smaller than the first threshold (A1), and the fourth threshold (B2) is smaller than the second threshold (B1).

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FIG. 1

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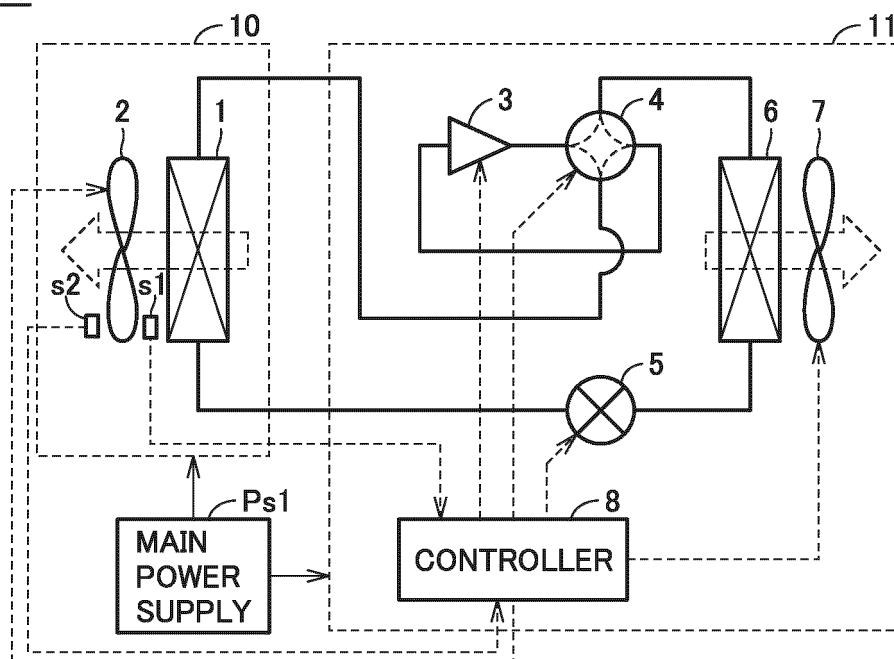


FIG.2

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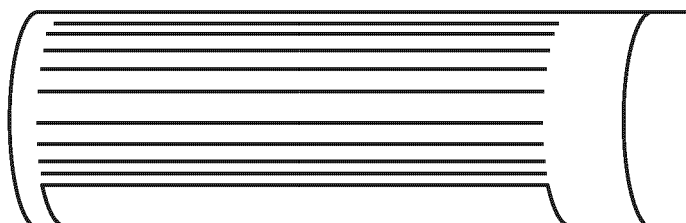


FIG.3

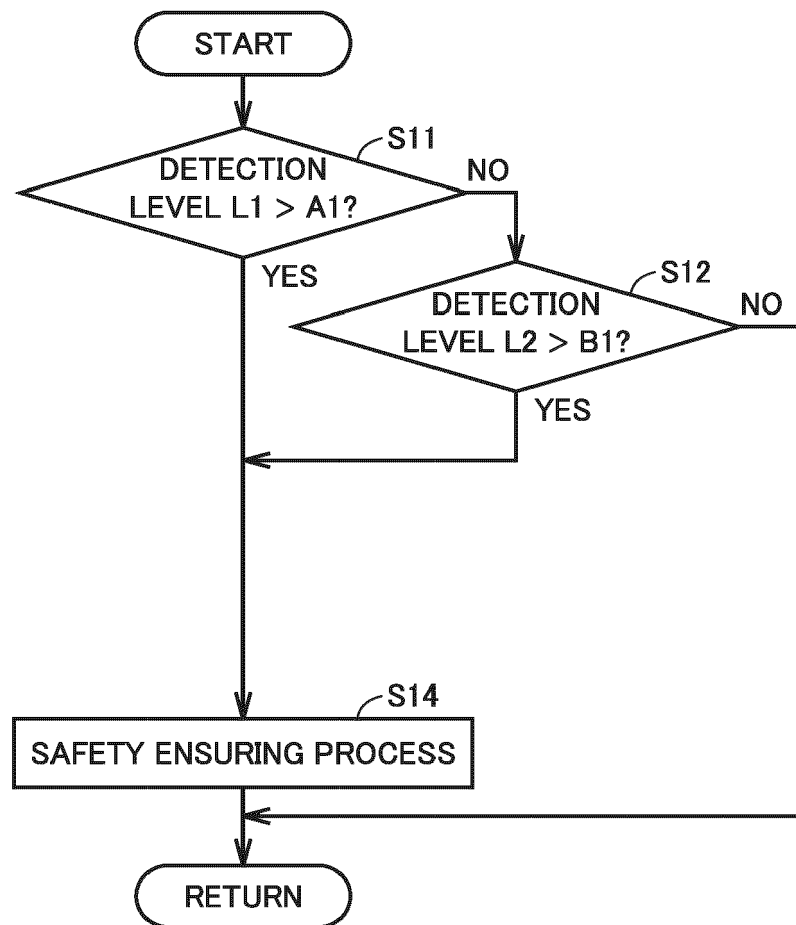


FIG.4

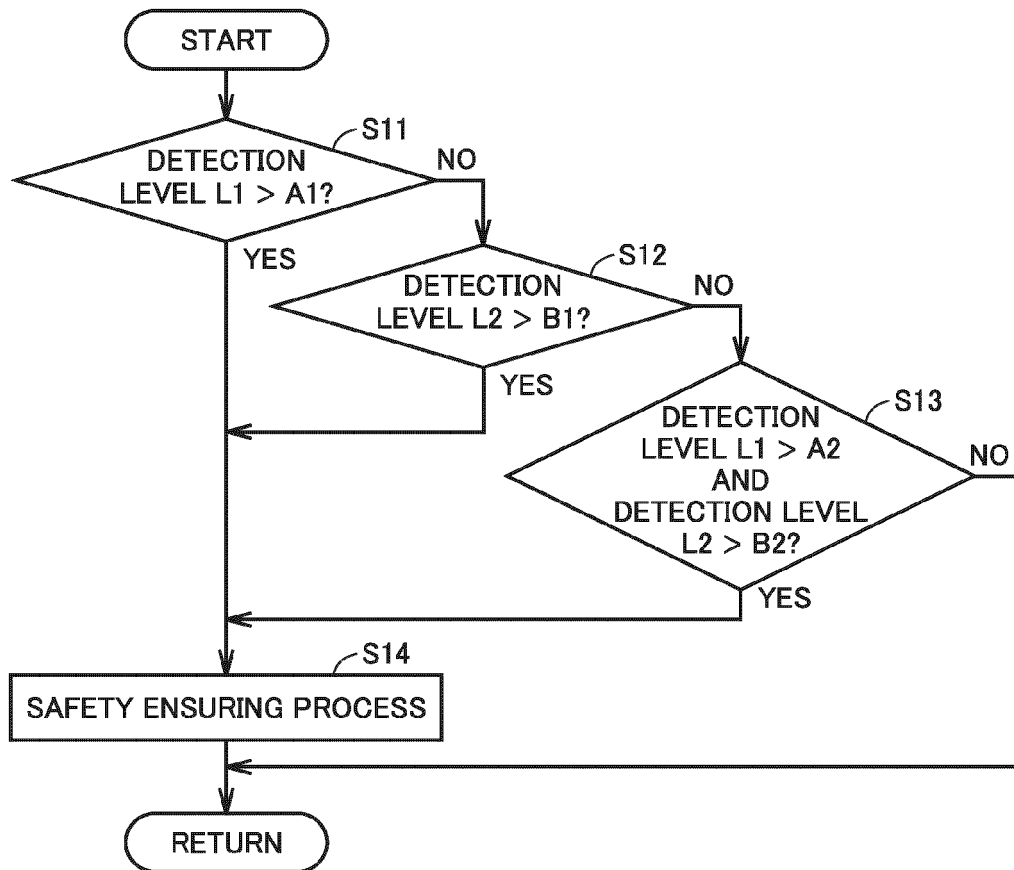


FIG.5

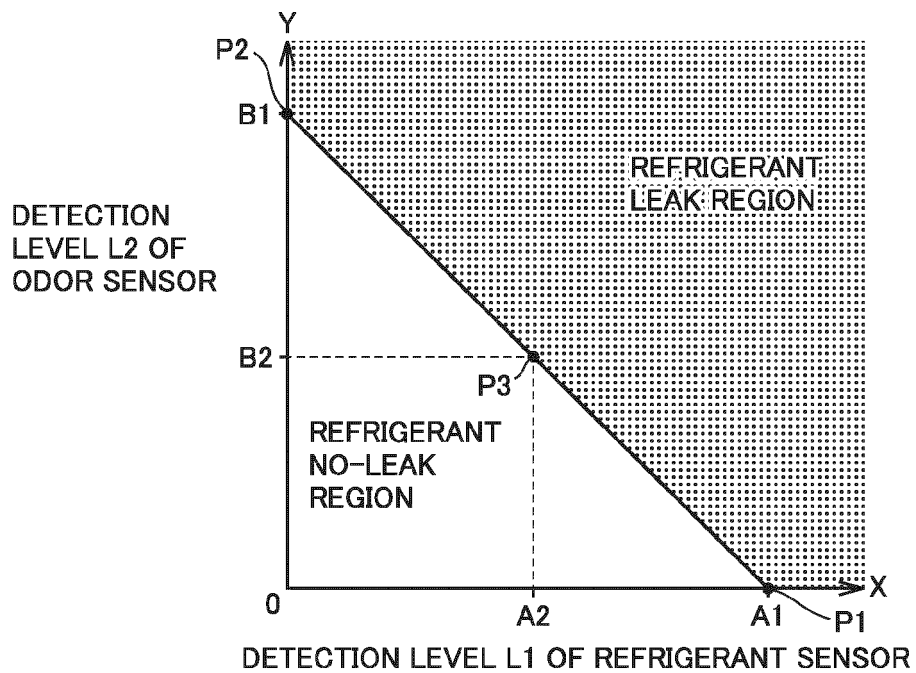


FIG.6

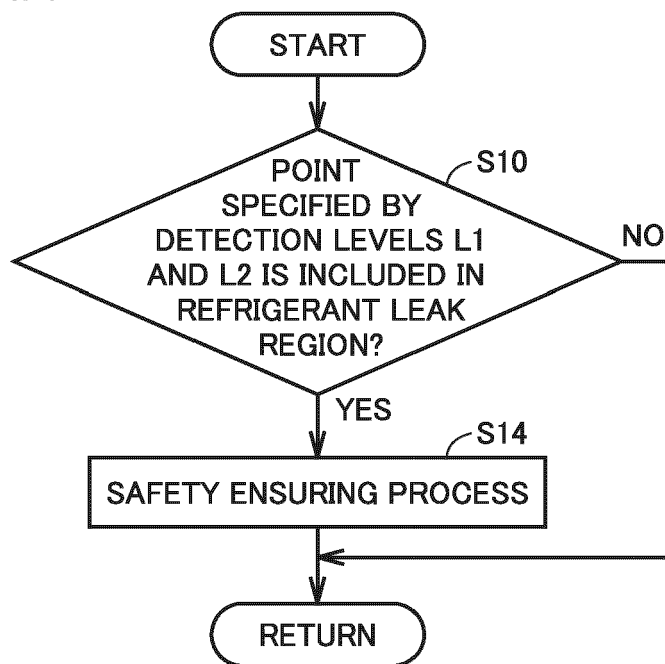


FIG.7

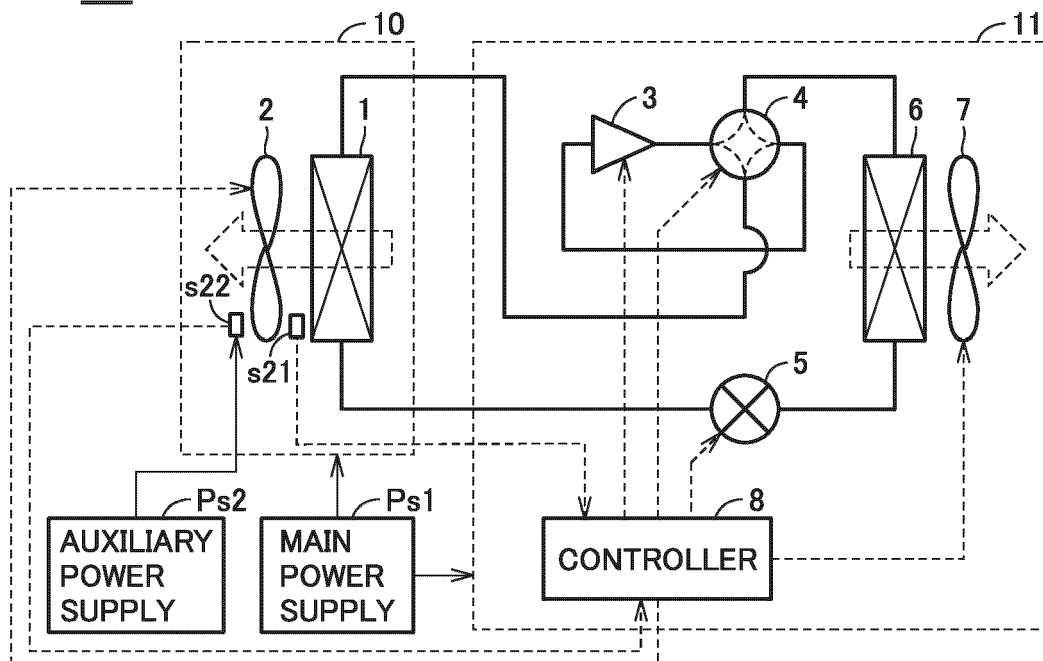
200

FIG.8

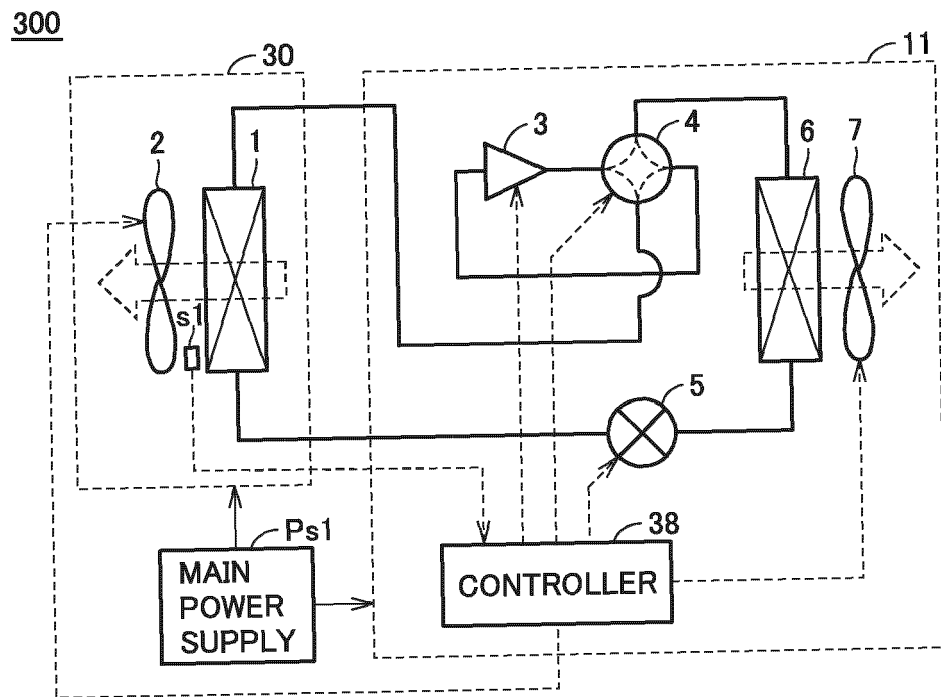


FIG.9

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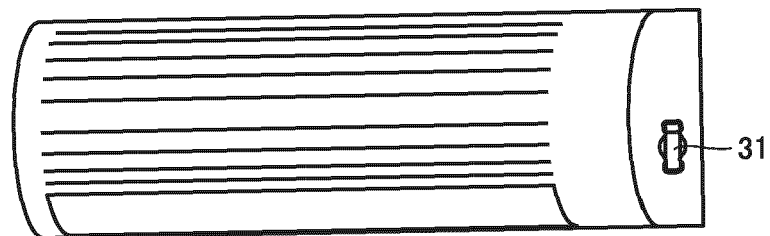


FIG.10

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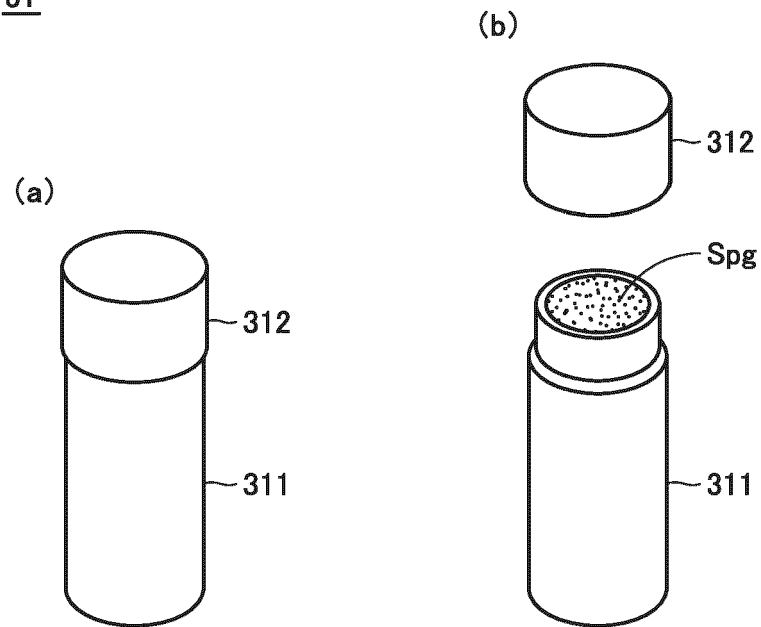


FIG.11

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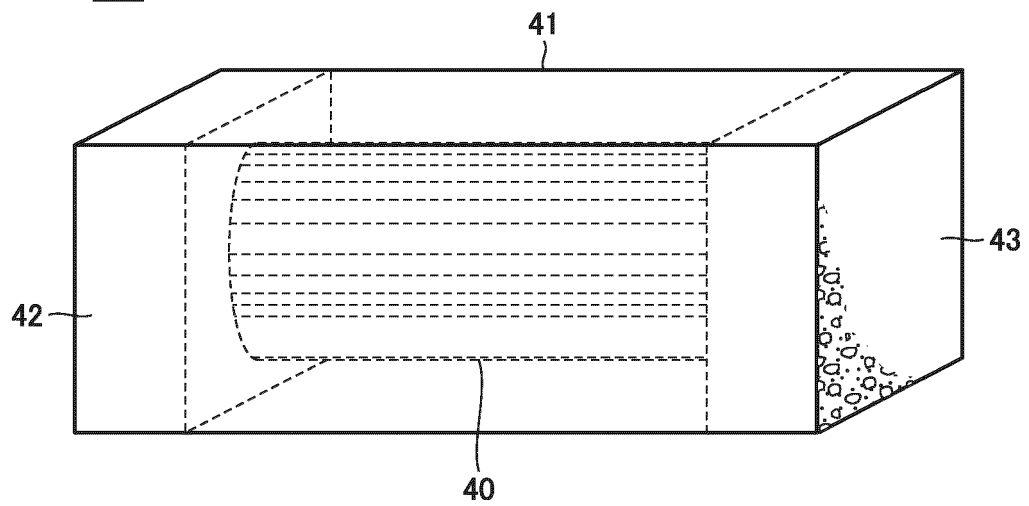
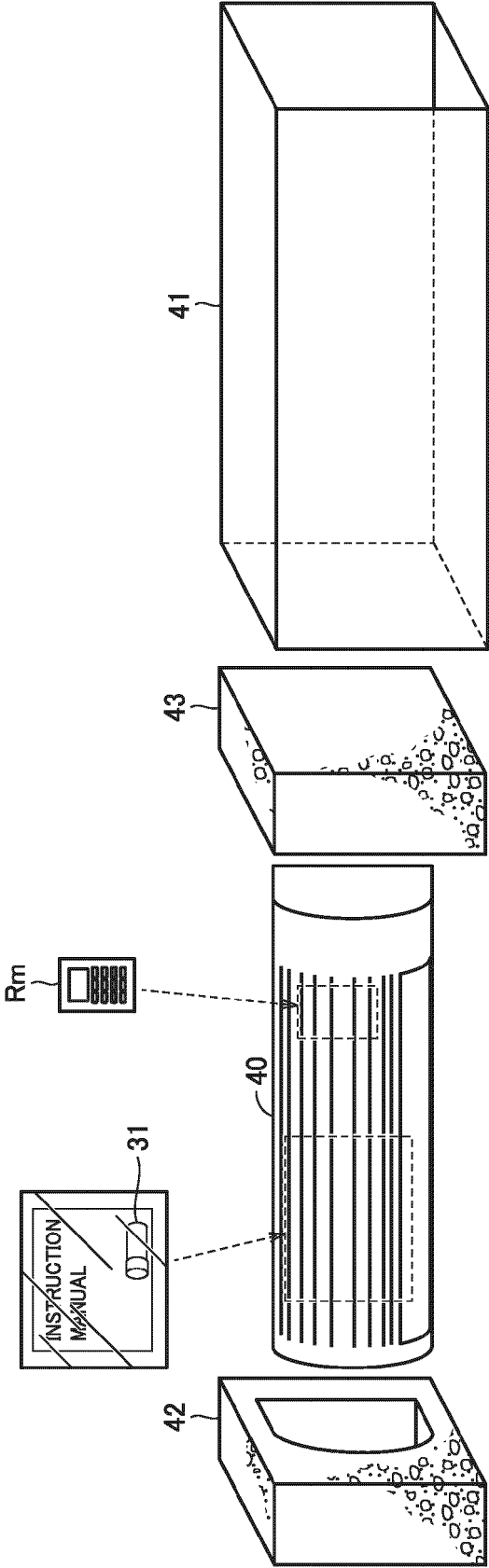


FIG.12

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