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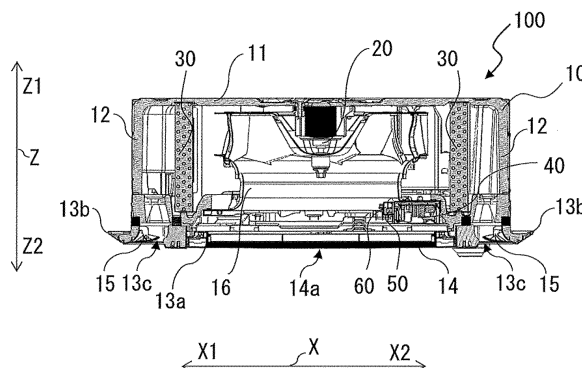
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(54) **INDOOR UNIT FOR AIR CONDITIONER AND AIR CONDITIONER COMPRISING SAME INDOOR UNIT**

(57) An indoor unit of an air-conditioning apparatus includes a suction grille having an air inlet through which air flows in, a decorative panel to which the suction grille is mounted and having an air outlet through which the air flows out, a casing to which the decorative panel is mounted and defining an air passage between the air inlet and the air outlet, a fan located to face the suction grille in the casing and configured to cause the air to flow in through the air inlet and flow out through the air outlet,

a heat exchanger located in the air passage between the fan and the air outlet in the casing and configured to exchange heat between refrigerant flowing in the heat exchanger and the air, and a refrigerant detection sensor configured to detect leakage of the refrigerant. The suction grille is located below the heat exchanger, and the refrigerant detection sensor is located below the heat exchanger and between the suction grille and the fan.

FIG. 2



Description

Technical Field

[0001] The present disclosure relates to an indoor unit of an air-conditioning apparatus including a gas sensor configured to detect refrigerant leakage, and an air-conditioning apparatus including the indoor unit.

Background Art

[0002] Some refrigerants used in some air-conditioning apparatuses are flammable. Thus, if a flammable refrigerant leaks from an indoor unit or other component of an air-conditioning apparatus, the leaking refrigerant may ignite when a concentration of the refrigerant exceeds a certain concentration. Then, to detect leakage of flammable refrigerant such as R32 refrigerant, a proposed indoor unit of an air-conditioning apparatus includes temperature sensors provided at a plurality of locations (see, for example, Patent Literature 1). The indoor unit of an air-conditioning apparatus in Patent Literature 1 detects whether or not refrigerant leaks, from a difference between an air temperature and a refrigerant temperature in a pipe.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2016-191531

Summary of Invention

Technical Problem

[0004] A temperature of refrigerant flowing in an indoor unit of an air-conditioning apparatus significantly changes depending on various operating states such as a cooling operation, a heating operation, and a defrosting operation of an outdoor unit. Thus, in some indoor unit of an air-conditioning apparatus configured to detect a difference between an indoor air temperature and a refrigerant temperature in a pipe and issue a warning, the temperature difference may be significantly arise between the refrigerant temperature that changes and the indoor temperature that does not change during, for example, a defrosting operation of an outdoor unit, and false detection may be caused.

[0005] The present disclosure is applied to solve the above problem, and provides an indoor unit of an air-conditioning apparatus having improved refrigerant detection accuracy when refrigerant leaks from the indoor unit of an air-conditioning apparatus, and an air-conditioning apparatus including the indoor unit.

Solution to Problem

[0006] An indoor unit of an air-conditioning apparatus according to an embodiment of the present disclosure includes a suction grille having an air inlet through which air flows in, a decorative panel to which the suction grille is mounted and having an air outlet through which the air flows out, a casing to which the decorative panel is mounted and defining an air passage between the air inlet and the air outlet, a fan located to face the suction grille in the casing and configured to cause the air to flow in through the air inlet and flow out through the air outlet, a heat exchanger located in the air passage between the fan and the air outlet in the casing and configured to exchange heat between refrigerant flowing in the heat exchanger and the air, and a refrigerant detection sensor configured to detect leakage of the refrigerant. The suction grille is located below the heat exchanger, and the refrigerant detection sensor is located below the heat exchanger and between the suction grille and the fan.

Advantageous Effects of Invention

[0007] In the indoor unit of an air-conditioning apparatus according to an embodiment of the present disclosure, the suction grille is located below the heat exchanger, and the refrigerant detection sensor is located below the heat exchanger and between the suction grille and the fan. Thus, during an operation of the fan, the refrigerant leaking from the casing is diluted, and even if refrigerant leakage cannot be instantly detected, the refrigerant detection sensor can detect the refrigerant contained in the air flowing out through the air outlet and flowing in through the air inlet before a concentration of the refrigerant in a room reaches a flammable range. Also, while the fan is kept stopped, the refrigerant remains on a bottom of the casing, and thus the refrigerant detection sensor can detect the refrigerant leakage. This configuration can improve refrigerant detection accuracy when the refrigerant leaks from the indoor unit of an air-conditioning apparatus.

Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is a bottom view of an indoor unit of an air-conditioning apparatus according to Embodiment 1 of the present disclosure.

[Fig. 2] Fig. 2 is a sectional view of the indoor unit in Fig. 1 taken along the line A-A.

[Fig. 3] Fig. 3 is a bottom view of the indoor unit in Fig. 1, with a suction grille removed.

[Fig. 4] Fig. 4 is a front view of a sensor holder provided in the indoor unit of an air-conditioning apparatus according to Embodiment 1 of the present disclosure.

[Fig. 5] Fig. 5 is a right side view of the sensor holder

in Fig. 4.

[Fig. 6] Fig. 6 is a left side view of the sensor holder in Fig. 4.

[Fig. 7] Fig. 7 is an exploded perspective view of the sensor holder in Fig. 4.

[Fig. 8] Fig. 8 is an exploded perspective view of the sensor holder in Fig. 4, as viewed from a different direction.

[Fig. 9] Fig. 9 is an exploded perspective view of a sensor holder provided in an indoor unit of an air-conditioning apparatus according to Embodiment 2 of the present disclosure.

[Fig. 10] Fig. 10 is an exploded perspective view of the sensor holder provided in the indoor unit of an air-conditioning apparatus according to Embodiment 2 of the present disclosure, as viewed from a different direction.

[Fig. 11] Fig. 11 is a schematic configuration diagram of an air-conditioning apparatus according to Embodiment 3 of the present disclosure.

Description of Embodiments

[0009] An indoor unit 100 of an air-conditioning apparatus and an air-conditioning apparatus 200 including the indoor unit 100 according to embodiments of the present disclosure will be described with reference to the drawings. In the drawings including Fig. 1, relative sizes, shapes, and attributes of components may be different from those of actual components. In the drawings, the same or corresponding components are denoted by the same reference signs throughout the specification. To facilitate understanding, directional terms (for example, "upper", "lower", "right", "left", "front", and "rear") are used merely for convenience of explanation, and these terms are not intended to limit arrangement and orientation of devices or components.

Embodiment 1

[Indoor unit 100]

[0010] Fig. 1 is a bottom view of an indoor unit 100 of an air-conditioning apparatus according to Embodiment 1 of the present disclosure. Fig. 2 is a sectional view of the indoor unit 100 in Fig. 1 taken along the line A-A. An X axis in the drawings including Fig. 1 shows a lateral width direction of the indoor unit 100, a Y axis shows a front-rear direction of the indoor unit 100, and a Z axis shows a vertical direction of the indoor unit 100. More specifically, in a description of the indoor unit 100, an X1 side of the X axis is a left side, an X2 side of the X axis is a right side, a Y1 side of the Y axis is a front side, a Y2 side of the Y axis is a rear side, a Z1 side of the Z axis is an upper side, and a Z2 side of the Z axis is a lower side. Positional relationships (for example, vertical relationship) of components herein are those when the indoor unit 100 is installed to be usable. In this embodi-

ment, a four-direction cassette indoor unit 100 will be described that can be embedded in a ceiling of a room and has air outlets 13c formed in four sides. The indoor unit 100 is connected to an outdoor unit by a refrigerant pipe and forms a refrigerant circuit in which refrigerant circulates for refrigeration or air-conditioning. The refrigerant used in an indoor heat exchanger 30 of the indoor unit 100 has a higher density than a density of air. The refrigerant used in the indoor heat exchanger 30 of the indoor unit 100 is not limited to one having a higher density than the density of air, but refrigerant having a density that is lower than or equal to the density of air may be used.

[0011] The indoor unit 100 uses a refrigeration cycle for circulating the refrigerant to supply conditioned air to an air-conditioned space such as a room. First, with reference to Figs. 1 and 2, an external configuration of the indoor unit 100 will be described. As shown in Fig. 2, the indoor unit 100 includes a casing 10 housing a fan 20, the indoor heat exchanger 30, or other devices. The casing 10 includes a top plate 11 forming a ceiling wall, and side plates 12 forming front, rear, left, and right side walls, and has an open lower portion (in a Z2 direction), which opens to and faces the inside of the room. To the open lower portion of the casing 10, a decorative panel 13 is mounted. The decorative panel 13 is shaped in a substantially rectangular shape, as viewed in plan view.

[0012] The decorative panel 13 is a plate-like part, and has one face facing a ceiling or a wall to which the indoor unit 100 is mounted, and the other face facing the inside of the room to be air-conditioned. As shown in Figs. 1 and 2, an opening 13a as a through hole is opened around a center of the decorative panel 13, and a suction grille 14 is mounted to the opening 13a. The suction grille 14 has an air inlet 14a through which air flows from the inside of the room to be air-conditioned into the casing 10. On a face of the suction grille 14 closer to the casing 10, a filter (not shown) for removing dust from the air having passed through the suction grille 14 is placed. The decorative panel 13 has air outlets 13c formed between outer edges 13b and inner edges defining the opening 13a and through which the air flows out. The air outlets 13c are formed along four sides of the decorative panel 13. Each air outlet 13c has a vane 15 configured to change an airflow. The casing 10 defines an air passage between the air inlet 14a and the air outlets 13c in the casing 10.

[0013] Fig. 3 is a bottom view of the indoor unit 100 in Fig. 1, with the suction grille 14 removed. Next, with reference to Figs. 2 and 3, an internal configuration of the indoor unit 100 will be described. The indoor unit 100 includes a fan 20 configured to cause the air in the room to flow through the air inlet 14a into the indoor unit 100 and cause the air to flow out through the air outlets 13c into the room. The fan 20 is located to face the suction grille 14 in the casing 10. The fan 20 is located in the casing 10 with its rotation axis directed in a vertical direction (Z-axis direction).

[0014] The indoor unit 100 also includes the indoor

heat exchanger 30 located in the air passage between the fan 20 and the air outlets 13c in the casing 10 and configured to exchange heat between refrigerant flowing in the indoor heat exchanger 30 and air flowing in the air passage. The indoor heat exchanger 30 is located in the air passage between the fan 20 and the air outlets 13c in the casing 10. The indoor heat exchanger 30 exchanges heat between the refrigerant flowing in the indoor heat exchanger 30 and the indoor air to produce conditioned air. The indoor heat exchanger 30 is, for example, a fin-and-tube heat exchanger, and is located to surround the fan 20 and located downstream of the fan 20 in a direction of airflow. For example, when the indoor unit 100 of this embodiment is applied to an air-conditioning apparatus 200 described later, the indoor heat exchanger 30 is used as an evaporator during a cooling operation, and is used as a condenser during a heating operation. The fan 20 and the indoor heat exchanger 30 are located downstream of the air inlet 14a and upstream of the air outlets 13c in a direction of the airflow in the casing 10. In the indoor unit 100, the fan 20 is located above the suction grille 14, and the indoor heat exchanger 30 is located radially of the fan 20. In the indoor unit 100, the suction grille 14 is located below the indoor heat exchanger 30.

[0015] The indoor unit 100 includes a bell mouth 16. As shown in Figs. 2 and 3, the bell mouth 16 is located upstream of the fan 20 in a direction of air flowing into the indoor unit 100. The bell mouth 16 regulates the air flowing in through the air inlet 14a of the suction grille 14 and feeds the air to the fan 20.

[0016] The indoor unit 100 includes an electric component box 40 between the bell mouth 16 and the suction grille 14 in the casing 10. The electric component box 40 contains a device such as a controller configured to control the indoor unit 100. A device in the electric component box 40 supplies power to devices in the indoor unit 100, and a device in the electric component box 40 transmits and receives (communicates) signals. In the electric component box 40, a controller 80 configured to process signals from a refrigerant detection sensor 50 and a temperature sensor 70 described later is also located. The controller 80 includes, for example, a memory unit configured to store a program, and a central processing unit (CPU) configured to execute processing in accordance with the program. The controller 80 may be provided in a sensor holder 60 described later. The electric component box 40 is shaped in a substantially cuboid shape. The electric component box 40 is located inside the opening 13a located in the decorative panel 13, as viewed in plan view from the inside of the room toward the ceiling, and longitudinal sides of the electric component box 40 are located along an edge of the decorative panel 13 forming one side of the opening 13a. The electric component box 40 is secured in the casing 10, for example, by a securing part such as a screw.

[0017] The indoor unit 100 also includes the refrigerant detection sensor 50 configured to detect leakage of refrigerant. The refrigerant detection sensor 50 is shaped

in, for example, a cylindrical shape. The refrigerant detection sensor 50 mainly uses a semiconductor as a gas-sensitive element and provides outputs on the basis of an oxygen concentration. For example, the refrigerant detection sensor 50 detects, as a gas concentration, a change in resistance value caused when a metal oxide semiconductor comes into contact with gas contained in air. The refrigerant detection sensor 50 may be driven by power supplied from the indoor unit 100 or power supplied from an external power source in a place where the indoor unit 100 is installed. When the refrigerant detection sensor 50 is not driven by power supplied from the indoor unit 100 or power supplied from the external power source, for example, the electric component box 40 or the sensor holder 60 may contain a battery.

[0018] The refrigerant detection sensor 50 is provided below the indoor heat exchanger 30 and located between the suction grille 14 and the fan 20. Specifically, as shown in Fig. 2, the refrigerant detection sensor 50 is located at a bottom of the indoor unit 100 located below the bell mouth 16 and the indoor heat exchanger 30. The refrigerant detection sensor 50 is located close to the air inlet 14a formed in the suction grille 14. The refrigerant detection sensor 50 is located at the bottom of the indoor unit 100 located below the bell mouth 16 and the indoor heat exchanger 30 for the following reason. As, while the indoor unit 100 is not operated, the vane 15 provided in each air outlet 13c is closed to prevent leakage of the refrigerant from the casing 10 and the refrigerant is thus caused to fill the casing 10, the refrigerant detection sensor 50 is desirably located at the bottom of the indoor unit 100 on which leaking refrigerant accumulates. Also, the refrigerant detection sensor 50 is located close to the air inlet 14a formed in the suction grille 14 for the following reason. During an operation of the fan 20, the refrigerant accumulating on the bottom of the indoor unit 100 is diluted by air flowing into the indoor unit 100, and also, the refrigerant detection sensor 50 uses a semiconductor as a gas-sensitive element and provides outputs on the basis of an oxygen concentration. It is thus difficult for the refrigerant detection sensor 50 to detect leaking refrigerant. To solve the problem, as during the operation of the fan 20, the refrigerant is released through the air outlets 13c into the room, and a refrigerant concentration is thus increased in the room, the refrigerant detection sensor 50 is desirably located close to the air inlet 14a close to the indoor space to be able to detect the refrigerant when the refrigerant is suctioned through the air inlet 14a. The location close to the air inlet 14a refers to a location between the fan 20 and the suction grille 14, and more specifically, between the bell mouth 16 and the suction grille 14 in the direction (Z-axis direction) perpendicular to the ceiling or other location to which the indoor unit 100 is mounted. Further, the location close to the air inlet 14a refers to a location inside the opening 13a located in the decorative panel 13, as viewed in plan view from the inside of the room toward the ceiling. The refrigerant detection sensor 50 is located in the sensor holder 60.

The refrigerant detection sensor 50 can be replaced by unscrewing the electric component box 40, to which the sensor holder 60 is mounted, to remove the electric component box 40 from the casing 10, and serviceability is thereby improved.

[0019] Fig. 4 is a front view of the sensor holder 60 provided in the indoor unit 100 of an air-conditioning apparatus according to Embodiment 1 of the present disclosure. Fig. 5 is a right side view of the sensor holder 60 in Fig. 4. Fig. 6 is a left side view of the sensor holder 60 in Fig. 4. Fig. 7 is an exploded perspective view of the sensor holder 60 in Fig. 4. Fig. 8 is an exploded perspective view of the sensor holder 60 in Fig. 4, as viewed from a different direction. Next, with reference to Figs. 4 to 8, the sensor holder 60 will be described. An X axis, a Y axis, and a Z axis in Figs. 4 to 6 show axial directions when the sensor holder 60 is provided in the indoor unit 100. In the description below, a direction of coupling a first housing portion 61 and a second housing portion 62 is referred to as a longitudinal direction (Y-axis direction), and a direction perpendicular to a plate-like bottom 61a and a plate-like bottom 62a is referred to a height direction (X-axis direction) in the sensor holder 60. Further, a direction perpendicular to the longitudinal direction (Y-axis direction) and the vertical direction (X-axis direction) is referred to as a transverse direction (Z-axis direction).

[0020] The sensor holder 60 secures the refrigerant detection sensor 50 and the temperature sensor 70 in the casing 10, and protects the refrigerant detection sensor 50 and the temperature sensor 70 from dust or other matter. The sensor holder 60 also prevents contact between a human finger and a detection unit 51 of the refrigerant detection sensor 50 so that the human finger does not touch the detection unit 51 made of metal when the detection unit 51 is energized. The sensor holder 60 is made of resin such as polystyrene (PS). In the sensor holder 60, both the refrigerant detection sensor 50 and the temperature sensor 70 are provided. The refrigerant detection sensor 50 and the temperature sensor 70 are provided together in one sensor holder 60 and thus can be protected by only one cover. Service components of the refrigerant detection sensor 50 can be also protected together with the temperature sensor 70 by one cover. The sensor holder 60 is shaped in a box shape. As shown in Figs. 2 and 3, the sensor holder 60 is fixedly inserted into a side wall 40a of the electric component box 40, which faces the air passage between the air inlet 14a and the fan 20. The refrigerant detection sensor 50 and the temperature sensor 70 are located to protrude from the electric component box 40. The sensor holder 60 is located inside the opening 13a located in the decorative panel 13, as viewed in plan view from the inside of the room toward the ceiling. Also, the sensor holder 60 is located between the suction grille 14 and the fan 20 in the direction (Z-axis direction) perpendicular to the ceiling or other location to which the indoor unit 100 is mounted, and more specifically, located between the suction grille 14 and the bell mouth 16. The sensor holder 60 is inserted

into the electric component box 40. As the sensor holder 60 is inserted into the electric component box 40, there is no need to route a lead wire connected to the sensors, and a length of the lead is thereby reduced. If the lead wire is routed along with a power wire or other wires, a signal output from the refrigerant detection sensor 50 may contain noise. Directly mounting the sensor holder 60 to the electric component box 40 reduces the length of the lead wire, and noise in the signal output from the refrigerant detection sensor 50 is thereby reduced.

[0021] As shown in Fig. 4, the sensor holder 60 includes the first housing portion 61 and the second housing portion 62 along the longitudinal direction (Y-axis direction). As shown in Figs. 8 and 9, the first housing portion 61 houses the refrigerant detection sensor 50, and the second housing portion 62 houses the temperature sensor 70. The temperature sensor 70 is, for example, a thermistor. As shown in Figs. 4 to 9, the first housing portion 61 and the second housing portion 62 are each shaped in a substantially cuboid shape, and the first housing portion 61 and the second housing portion 62 are integrally formed. The bottom 61a of the first housing portion 61 and the bottom 62a of the second housing portion 62 are integrally shaped into a flat plate shape at an outer peripheral surface. A length of the second housing portion 62 in the height direction (X-axis direction) is larger than a length of the first housing portion 61 in the height direction (X-axis direction). A side wall 61e in the transverse direction, the bottom 61a, and a top plate 61b of the first housing portion 61 as well as a side wall 62e in the transverse direction and the bottom 62a of the second housing portions 62 are divided in both directions along the transverse direction (Z-axis direction). Thus, the sensor holder 60 can be divided into two parts in the transverse direction (Z-axis direction), with only a top plate 62b of the second housing portions 62 connected.

[0022] Through holes 61d are opened from the top plate 61b to an upper end of the side wall 61c of the first housing portion 61. The refrigerant detection sensor 50 detects air flowing through the through holes 61d into the first housing portion 61. The through holes 61d are each shaped in a slit shape. The through holes 61d are opened in an end opposite to the second housing portion 62 (Y1 side) in the longitudinal direction (Y-axis direction) of the top plate 61b. The through holes 61d are opened in opposite ends of the top plate 61b in the transverse direction (Z-axis direction). Further, the plurality of through holes 61d are arranged in the longitudinal direction (Y-axis direction) of the first housing portion 61. A width between walls 61f that separate the plurality of through holes 61d from one another in the sensor holder 60 is smaller than a thickness of a human finger. Thus, each through hole 61d is sized so that the human finger does not pass through the through hole 61d. A width of an opening of each through hole 61d is defined so that a human bare hand cannot touch the detection unit 51 of the refrigerant detection sensor 50. The sensor holder 60 is made of resin, and may be touched by an operator. The plurality

of through holes 61d are opened to face the refrigerant detection sensor 50. More specifically, the through holes 61d open only in positions where a cylindrical portion that forms the refrigerant detection sensor 50 is visible through the through holes 61d. When air flows in through the air inlet 14a, the air needs to pass around the cylindrical portion. However, if too much air from the air inlet 14a is suctioned, a warning is issued because of miscellaneous gases. Thus, a minimum necessary opening area is desired. As shown in Figs. 7 and 8, the detection unit 51 of the refrigerant detection sensor 50 is located to face the top plate 61b. As shown in Figs. 2 and 3, when the sensor holder 60 is located in the casing 10, the detection unit 51 of the refrigerant detection sensor 50 is directed perpendicularly to a flow of the air flowing from the air inlet 14a toward the fan 20, and is located not to face a direction of the air suctioned into the casing 10. This is to prevent the detection unit 51 of the refrigerant detection sensor 50 from being clogged with dust or other matter contained in the air suctioned into the casing 10.

[0023] Through holes 62d are opened from the top plate 62b to the side wall 62c of the second housing portion 62. The through holes 62d are each shaped in a slit shape. The through holes 62d are opened from a middle portion 62g toward an end of the side wall 62c in the height direction (X-axis direction). The middle portion 62g is a middle portion in the height direction (X-axis direction). The plurality of through holes 62d are arranged along the longitudinal direction (Y-axis direction) of the top plate 62b. The through holes 62d are opened in opposite ends of the top plate 62b in the transverse direction (Z-axis direction). A width between walls 62f that separate the plurality of through holes 62d from one another in the sensor holder 60 is smaller than the thickness of a human finger. Thus, each through hole 62d is sized so that the human finger does not pass through the through hole 62d. The plurality of through holes 62d are opened to face the temperature sensor 70. The temperature sensor 70 is located in the sensor holder 60, and detects a temperature of the air flowing through the through holes 62d into the second housing portion 62 and thus a temperature of the air flowing in through the air inlet 14a.

[0024] The second housing portion 62 includes a bulging portion 64b shaped in a substantially cuboid shape and bulging from an outer wall surface of the bottom 62a in the height direction (X-axis direction). As shown in Fig. 3, the sensor holder 60 is secured to the electric component box 40 by the bulging portion 64b being inserted into the side wall 40a of the electric component box 40. As shown in Figs. 7 and 8, an end 64b1 of the bulging portion 64b has an opening 64b2. The bulging portion 64b has a through hole 64b3 that provides communication between the opening 64b2 and an internal space of the bulging portion 64b. In the through hole 64b3, a cable connecting the refrigerant detection sensor 50 and the controller 80 housed in the electric component box 40, or a cable for supplying power to the refrigerant detection sensor 50 is located.

[0025] Next, an operation of the indoor unit 100 will be described. When the fan 20 is driven in the indoor unit 100, indoor air is suctioned through the air inlet 14a and cleaned by the filter, flows through the bell mouth 16 into an impeller of the fan 20, and flows through between a plurality of blades toward an outer periphery of the impeller. The air having flowed out from the impeller is cooled or heated by heat exchange with the refrigerant flowing in the indoor heat exchanger 30, and blown through the air outlets 13c into the room as cool or warm air. In this case, if the refrigerant leaks, the refrigerant is blown through the air outlets 13c into the room, and the blown refrigerant is suctioned through the air inlet 14a. Then, the refrigerant detection sensor 50 detects presence of the refrigerant when the refrigerant leaking into the room is suctioned. On the other hand, while the fan 20 in the indoor unit 100 is kept stopped, the refrigerant fills the casing 10 even if the refrigerant leaks from any pipes in the casing 10, and the refrigerant detection sensor 50, which is located at the bottom of the indoor unit 100 on which the leaking refrigerant accumulates, detects the refrigerant.

[0026] As described above, in the indoor unit 100 of an air-conditioning apparatus, the suction grille 14 is located below the indoor heat exchanger 30, and the refrigerant detection sensor 50 is located below the indoor heat exchanger 30 and between the suction grille 14 and the fan 20. During the operation of the fan 20, the refrigerant leaking from the casing 10 is often diluted, and instant detection of refrigerant leakage may be thus prevented. However, even in such a case, the refrigerant detection sensor 50 can detect the refrigerant contained in the air flowing out through the air outlets 13c and flowing in through the air inlet 14a before a concentration of the refrigerant in the room reaches a flammable range. Also, while the fan 20 is kept stopped, the refrigerant remains on the bottom of the casing 10, and thus the refrigerant detection sensor 50 can detect refrigerant leakage. Thus, the indoor unit 100 of an air-conditioning apparatus has improved refrigerant detection accuracy when the refrigerant leaks. Therefore, with the indoor unit 100, a safe air-conditioning apparatus can be achieved in which the refrigerant detection sensor 50 detects refrigerant leakage to prevent the concentration of the refrigerant from reaching a lower limit ignition concentration.

[0027] Also, in the indoor unit 100 of an air-conditioning apparatus, the detection unit 51 of the refrigerant detection sensor 50 is directed perpendicularly to the flow of the air flowing from the air inlet 14a toward the fan 20. Thus, the refrigerant detection sensor 50 is located not to face the direction of the air suctioned into the casing 10. This configuration can prevent the detection unit 51 of the refrigerant detection sensor 50 from being clogged with dust or other matter contained in the air suctioned into the casing 10.

[0028] The indoor unit 100 of an air-conditioning apparatus includes the sensor holder 60 shaped in a box

shape and configured to secure the refrigerant detection sensor 50 in the casing 10, and the refrigerant detection sensor 50 is located in the sensor holder 60. Thus, the refrigerant detection sensor 50 can be located below the indoor heat exchanger 30 and between the suction grille 14 and the fan 20 in the casing 10. Also, the refrigerant detection sensor 50 can be protected from accumulation of dust or other matter. Further, contact between an operator's finger and the detection unit 51 of the refrigerant detection sensor 50 can be prevented so that the operator's finger does not touch the detection unit 51 made of metal when the detection unit 51 is energized.

[0029] In the indoor unit 100 of an air-conditioning apparatus, the sensor holder 60 is located between the suction grille 14 and the fan 20. Thus, as described above, the refrigerant detection sensor 50 can be protected from dust, or prevented from being touched by an operator, and also the indoor unit 100 of an air-conditioning apparatus has improved refrigerant detection accuracy when the refrigerant leaks. Therefore, with the indoor unit 100, a safe air-conditioning apparatus can be achieved in which the refrigerant detection sensor 50 detects refrigerant leakage to prevent the concentration of the refrigerant from reaching a lower limit ignition concentration.

[0030] Also, the indoor unit 100 of an air-conditioning apparatus includes the electric component box 40 containing the controller configured to control the indoor unit 100 of an air-conditioning apparatus, and the sensor holder 60 is secured to the side wall 40a of the electric component box 40. The refrigerant detection sensor 50 can be replaced by unscrewing the electric component box 40, to which the sensor holder 60 is mounted, to remove the electric component box 40 from the casing 10, and serviceability is thereby improved.

[0031] Further, in the indoor unit 100 of an air-conditioning apparatus, the plurality of through holes 61d are opened in the sensor holder 60 to face the refrigerant detection sensor 50, and the width between the walls 61f that separate the plurality of through holes 61d from one another in the sensor holder 60 is smaller than the thickness of a human finger. This configuration can prevent contact between an operator's finger and the detection unit 51 of the refrigerant detection sensor 50 so that the operator's finger does not touch the detection unit 51 made of metal when the detection unit 51 is energized.

[0032] The indoor unit 100 of an air-conditioning apparatus further includes the temperature sensor 70 configured to detect the temperature of the air flowing in through the air inlet 14a, and the temperature sensor 70 is located in the sensor holder 60. Thus, the indoor unit 100 of an air-conditioning apparatus can also measure the temperature, and has further improved accuracy of various measurements such as detection of refrigerant leakage.

Embodiment 2

[0033] Fig. 9 is an exploded perspective view of a sen-

sor holder 60 provided in an indoor unit 100 of an air-conditioning apparatus according to Embodiment 2 of the present disclosure. Fig. 10 is an exploded perspective view of the sensor holder 60 provided in the indoor unit 100 of an air-conditioning apparatus according to Embodiment 2 of the present disclosure, as viewed from a different direction. The same components as in the indoor unit 100 in Figs. 1 to 8 are denoted by the same reference signs and descriptions of the components are omitted. With reference to Figs. 9 and 10, the indoor unit 100 of Embodiment 2 will be described. As described above, both a refrigerant detection sensor 50 and a temperature sensor 70 are provided in the sensor holder 60. The refrigerant detection sensor 50 is separated from the temperature sensor 70 in one sensor holder 60. In the refrigerant detection sensor 50, for example, a voltage is applied to a gas-sensitive element to promote a chemical reaction, and a temperature of the gas-sensitive element reaches 300 to 400 degrees C. Thus, in the indoor unit 100 of Embodiment 2, a partition 63 is provided between the refrigerant detection sensor 50 and the temperature sensor 70 in the sensor holder 60 to prevent an influence on a temperature detected by the temperature sensor 70 configured to detect a temperature of air suctioned from the room. In the sensor holder 60, the partition 63 separates a space in a first housing portion 61 from a space in a second housing portion 62. The partition 63 is formed by two plates 63a, 63b that separate the space housing the refrigerant detection sensor 50 from the space housing the temperature sensor 70. The plates 63a, 63b, which form the partition 63, are located to face each other with a space between the plates 63a, 63b. The partition 63 may be formed by integrated plates 63a, 63b not by the plates 63a, 63b with the space between the plates 63a, 63b.

[0034] As described above, in the indoor unit 100 of an air-conditioning apparatus, the partition 63 separates the space in the first housing portion 61 from the space in the second housing portion 62 in the sensor holder 60. Thus, the indoor unit 100 can prevent an influence of both the refrigerant detection sensor 50 and the temperature sensor 70, both of which are provided in the sensor holder 60, on a temperature detected by the temperature sensor 70.

Embodiment 3

[Air-conditioning apparatus 200]

[0035] Fig. 11 is a schematic configuration diagram of an air-conditioning apparatus 200 according to Embodiment 3 of the present disclosure. An indoor unit 100 used in the air-conditioning apparatus 200 according to Embodiment 3 is the same as the indoor unit 100 shown in Figs. 1 to 10 in Embodiments 1 and 2. The air-conditioning apparatus 200 according to Embodiment 3 transfers heat between outdoor air and indoor air via refrigerant to heat or cool a room for air conditioning. The air-condi-

tioning apparatus 200 according to Embodiment 3 includes an outdoor unit 150 and the indoor unit 100. In the air-conditioning apparatus 200, the outdoor unit 150 and the indoor unit 100 are connected by refrigerant pipes 300, 400 to form a refrigerant circuit in which the refrigerant circulates. The refrigerant pipe 300 is a gas pipe through which gas-phase refrigerant flows, and the refrigerant pipe 400 is a liquid pipe through which liquid-phase refrigerant flows. Two-phase gas-liquid refrigerant may be allowed to flow through the refrigerant pipe 400. In the refrigerant circuit of the air-conditioning apparatus 200, a compressor 31, a flow switching device 32, an outdoor heat exchanger 33, an expansion valve 34, and an indoor heat exchanger 30 are successively connected by the refrigerant pipes. The refrigerant used in the air-conditioning apparatus 200 has a higher density than the density of air. The refrigerant used in the air-conditioning apparatus 200 is not limited to one having a higher density than the density of air, but refrigerant having a density that is lower than or equal to the density of air may be used.

(Outdoor unit 150)

[0036] The outdoor unit 150 includes the compressor 31, the flow switching device 32, the outdoor heat exchanger 33, and the expansion valve 34. The compressor 31 compresses suctioned refrigerant and discharges the refrigerant. The compressor 31 may include an inverter device, and a capacity of the compressor 31 may be changed by changing an operation frequency using the inverter device. The capacity of the compressor 31 represents an amount of refrigerant fed per unit time. The flow switching device 32 is, for example, a four-way valve that switches directions of a refrigerant flow. The air-conditioning apparatus 200 uses the flow switching device 32 to switch flows of the refrigerant in accordance with an instruction from a controller (not shown), and a heating operation or a cooling operation is thereby performed.

[0037] The outdoor heat exchanger 33 exchanges heat between the refrigerant and outdoor air. The outdoor heat exchanger 33 is used as an evaporator during the heating operation, and exchanges heat between low pressure refrigerant flowing in from the refrigerant pipe 400 and the outdoor air to evaporate the refrigerant to be gasified. The outdoor heat exchanger 33 is used as a condenser during the cooling operation, and exchanges heat between the refrigerant compressed by the compressor 31 and flowing in from the flow switching device 32 and the outdoor air to condense the refrigerant to be liquefied. The outdoor heat exchanger 33 includes an outdoor fan 36 to improve efficiency of heat exchange between the refrigerant and the outdoor air. An inverter device may be mounted to the outdoor fan 36 to change an operation frequency of a fan motor to change a rotational speed of the fan. The expansion valve 34 is an expansion device (flow rate control unit). The expansion valve 34, which is used as an expansion valve, adjusts

a flow rate of the refrigerant flowing through the expansion valve 34, and adjusts pressure of the refrigerant by changing its opening degree. For example, when the expansion valve 34 is an electronic expansion valve, the opening degree is adjusted in accordance with an instruction from a controller (not shown) or other devices.

(Indoor unit 100)

[0038] The indoor unit 100 includes the indoor heat exchanger 30 configured to exchange heat between the refrigerant and the indoor air, and an indoor fan 37 configured to adjust a flow of air subjected to heat exchange at the indoor heat exchanger 30. The indoor heat exchanger 30 is used as a condenser during the heating operation, and exchanges heat between the refrigerant flowing in from the refrigerant pipe 300 and the indoor air to condense the refrigerant to be liquefied and cause the refrigerant to flow toward the refrigerant pipe 400. The indoor heat exchanger 30 is used as an evaporator during the cooling operation, and exchanges heat between the refrigerant reduced in pressure by the expansion valve 34 and the indoor air to evaporate the refrigerant to be gasified by causing the refrigerant to draw heat from the air and cause the refrigerant to flow toward the refrigerant pipe 300. The indoor fan 37 is provided to face the indoor heat exchanger 30. An operation speed of the indoor fan 37 is set by a user. An inverter device may be mounted to the indoor fan 37 to change an operation frequency of a fan motor to change a rotational speed of the fan.

[Exemplary operations of air-conditioning apparatus 200]

[0039] Next, the cooling operation as an exemplary operation of the air-conditioning apparatus 200 will be described. High temperature and high pressure gas refrigerant compressed and discharged by the compressor 31 flows through the flow switching device 32 into the outdoor heat exchanger 33. The gas refrigerant having flowed into the outdoor heat exchanger 33 is condensed by heat exchange with outdoor air blown from the outdoor fan 36, and flows out from the outdoor heat exchanger 33 as low temperature refrigerant. The refrigerant flowing out from the outdoor heat exchanger 33 is expanded and reduced in pressure by the expansion valve 34, and turned into low temperature and low pressure two-phase gas-liquid refrigerant. The two-phase gas-liquid refrigerant flows into the indoor heat exchanger 30 of the indoor unit 100, is evaporated by heat exchange with indoor air blown from the indoor fan 37, and flows out from the indoor heat exchanger 30 as low temperature and low pressure gas refrigerant. At this time, the indoor air cooled by the refrigerant receiving heat from the indoor air is blown as air-conditioned air (blown air) through the air outlets 13c of the indoor unit 100 into the room (air-conditioned space). The gas refrigerant flowing out from the indoor heat exchanger 30 flows through the flow switching device 32, and is suctioned by the compressor

31 and again compressed. The above operation is repeated.

[0040] Next, the heating operation as an exemplary operation of the air-conditioning apparatus 200 will be described. High temperature and high pressure gas refrigerant compressed and discharged by the compressor 31 flows through the flow switching device 32 into the indoor heat exchanger 30 of the indoor unit 100. The gas refrigerant having flowed into the indoor heat exchanger 30 is condensed by heat exchange with indoor air blown from the indoor fan 37, and flows out from the indoor heat exchanger 30 as low temperature refrigerant. At this time, the indoor air heated by receiving heat from the gas refrigerant is blown as air-conditioned air (blown air) through the air outlets 13c of the indoor unit 100 into the room (air-conditioned space). The refrigerant flowing out from the indoor heat exchanger 30 is expanded and reduced in pressure by the expansion valve 34, and turned into low temperature and low pressure two-phase gas-liquid refrigerant. The two-phase gas-liquid refrigerant flows into the outdoor heat exchanger 33 of the outdoor unit 150, is evaporated by heat exchange with outdoor air blown from the outdoor fan 36, and flows out from the outdoor heat exchanger 33 as low temperature and low pressure gas refrigerant. The gas refrigerant flowing out from the outdoor heat exchanger 33 flows through the flow switching device 32, and is suctioned by the compressor 31 and again compressed. The above operation is repeated.

[0041] As described above, the air-conditioning apparatus 200 includes the indoor unit 100 according to Embodiment 1 or 2, and thus the air-conditioning apparatus 200 having an advantage of Embodiment 1 or 2 can be obtained. The air-conditioning apparatus 200 according to Embodiment 3 includes the indoor unit 100 according to Embodiment 1 or 2, and thus a safe air-conditioning apparatus 200 can be achieved in which the refrigerant detection sensor 50 detects refrigerant leakage to prevent the concentration of the refrigerant from reaching a lower limit ignition concentration.

[0042] The embodiments of the present disclosure are not limited to Embodiments 1 to 3, but various changes may be made. For example, in Embodiment 1, the through holes 61d, 62d are each shaped in the slit shape, but a plurality of circular through holes may be provided. Such circular through holes each have an opening diameter smaller than the thickness of a human finger. Also, the four-direction cassette indoor unit 100 having the air outlets 13c formed in four sides has been described, but the indoor unit 100 may include the air outlet 13c in one side or the air outlets 13c in two or more sides. The ceiling-embedded indoor unit 100 has been described, but the indoor unit 100 is not limited to a ceiling-embedded indoor unit. The indoor unit 100 may be, for example, a wall-mounted indoor unit.

Reference Signs List

[0043]

- | | |
|----|---|
| 5 | 10 casing 11 top plate 12 side plate 13 decorative panel |
| | 13a opening 13b outer edge 13c air outlet 14 suction grille |
| 10 | 14a air inlet 15 vane 16 bell mouth 20 fan 30 indoor heat exchanger 31 compressor 32 flow switching device 33 outdoor heat exchanger 34 expansion valve 36 outdoor fan 37 indoor fan 40 electric component box 40a side wall 50 refrigerant detection sensor 51 detection unit 60 sensor holder 61 first housing portion 61a bottom |
| 15 | 61b top plate 61c side wall 61d through hole 61e side wall |
| | 61f wall 62 second housing portion 62a bottom 62b top plate |
| 20 | 62c side wall 62d through hole 62e side wall 62f wall 62g middle portion 63 partition 63a plate 63b plate 64b bulging portion |
| | 64b1 end 64b2 opening 64b3 through hole 70 temperature sensor 80 controller 100 indoor unit 150 outdoor unit 200 air-conditioning apparatus 300 refrigerant pipe 400 refrigerant pipe |
| 25 | |

Claims

- | | |
|----|---|
| 30 | 1. An indoor unit of an air-conditioning apparatus, the indoor unit comprising: |
| | a suction grille having an air inlet through which air flows in; |
| 35 | a decorative panel to which the suction grille is mounted and having an air outlet through which the air flows out; |
| | a casing to which the decorative panel is mounted and defining an air passage between the air inlet and the air outlet; |
| 40 | a fan located to face the suction grille in the casing and configured to cause the air to flow in through the air inlet and flow out through the air outlet; |
| 45 | a heat exchanger located in the air passage between the fan and the air outlet in the casing and configured to exchange heat between refrigerant flowing in the heat exchanger and the air; and |
| 50 | a refrigerant detection sensor configured to detect leakage of the refrigerant, |
| | the suction grille being located below the heat exchanger, |
| 55 | the refrigerant detection sensor being located below the heat exchanger and between the suction grille and the fan. |
| | 2. The indoor unit of an air-conditioning apparatus of |

claim 1, wherein a detection unit of the refrigerant detection sensor is directed perpendicularly to a flow of the air flowing from the air inlet toward the fan.

3. The indoor unit of an air-conditioning apparatus of claim 1 or 2, the indoor unit further comprising a sensor holder shaped in a box shape and configured to secure the refrigerant detection sensor in the casing, the refrigerant detection sensor being located in the sensor holder. 5 10
4. The indoor unit of an air-conditioning apparatus of claim 3, wherein the sensor holder is located between the suction grille and the fan. 15
5. The indoor unit of an air-conditioning apparatus of claim 3 or 4, the indoor unit further comprising an electric component box containing a controller configured to control the indoor unit of an air-conditioning apparatus, the sensor holder being secured to a side wall of the electric component box. 20
6. The indoor unit of an air-conditioning apparatus of any one of claims 3 to 5, wherein a plurality of through holes are opened in the sensor holder to face the refrigerant detection sensor, and a width between walls of the sensor holder separating the plurality of through holes from one another is smaller than a thickness of a human finger. 25 30
7. The indoor unit of an air-conditioning apparatus of any one of claims 3 to 6, the indoor unit further comprising a temperature sensor configured to detect a temperature of the air flowing in through the air inlet, the temperature sensor being located in the sensor holder. 35 40
8. The indoor unit of an air-conditioning apparatus of claim 7, wherein the sensor holder includes a first housing portion housing the refrigerant detection sensor, and a second housing portion housing the temperature sensor, and a partition separates a space in the first housing portion from a space in the second housing portion. 45
9. The indoor unit of an air-conditioning apparatus of any one of claims 1 to 8, wherein the casing is to be located in a ceiling. 50
10. An air-conditioning apparatus, comprising the indoor unit of an air-conditioning apparatus of any one of claims 1 to 9. 55

FIG. 1

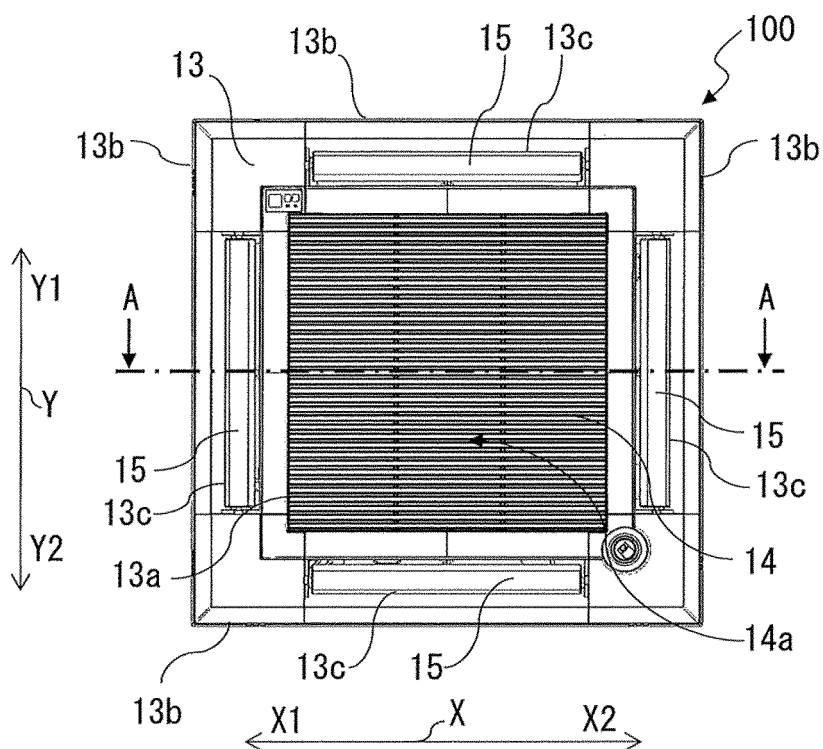


FIG. 2

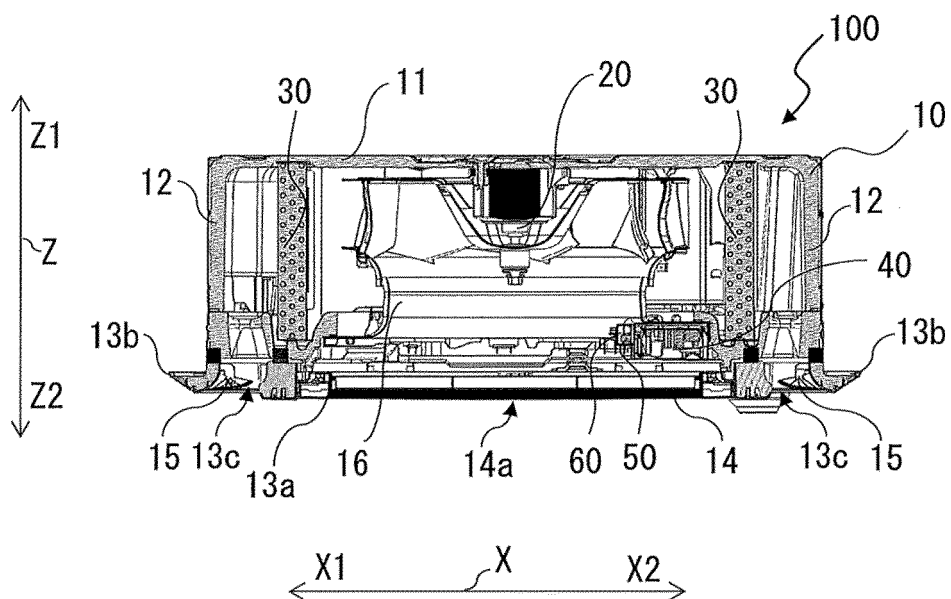


FIG. 3

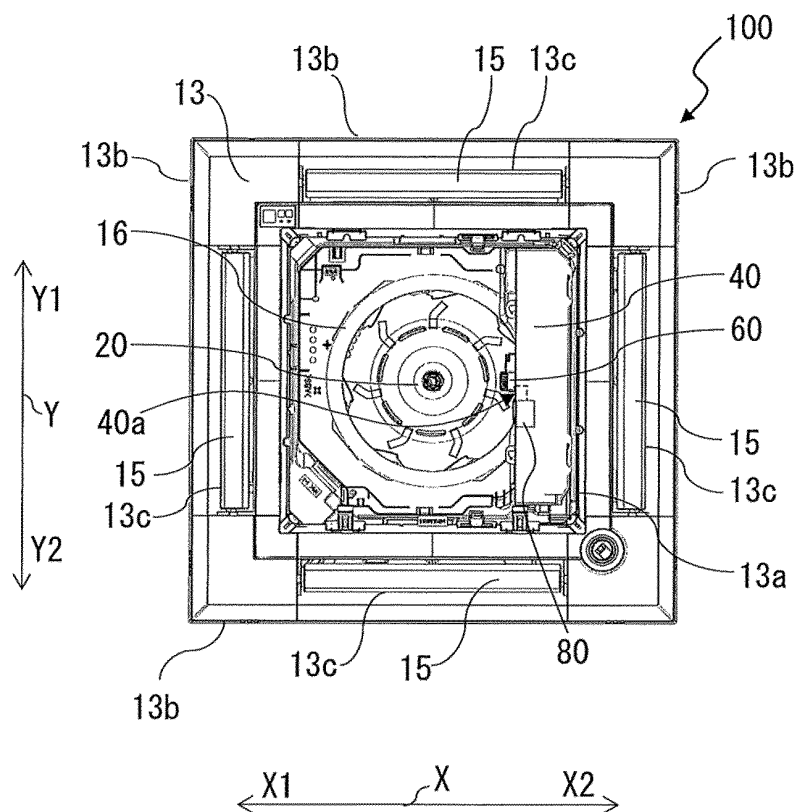


FIG. 4

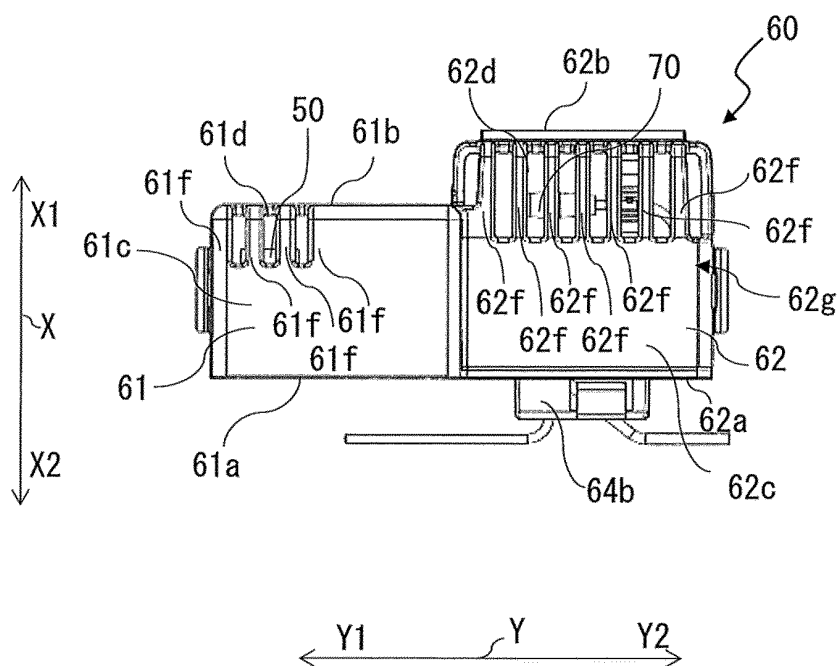


FIG. 5

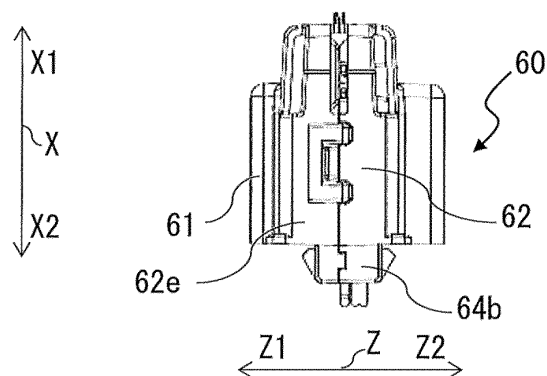


FIG. 6

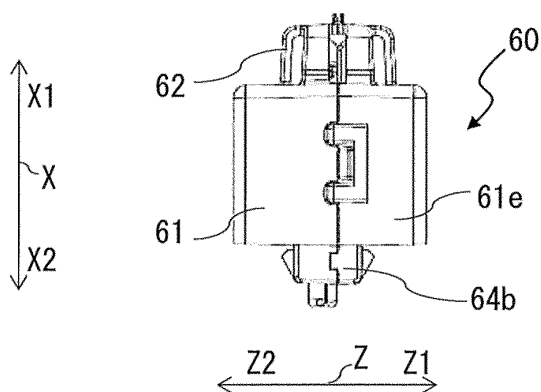


FIG. 7

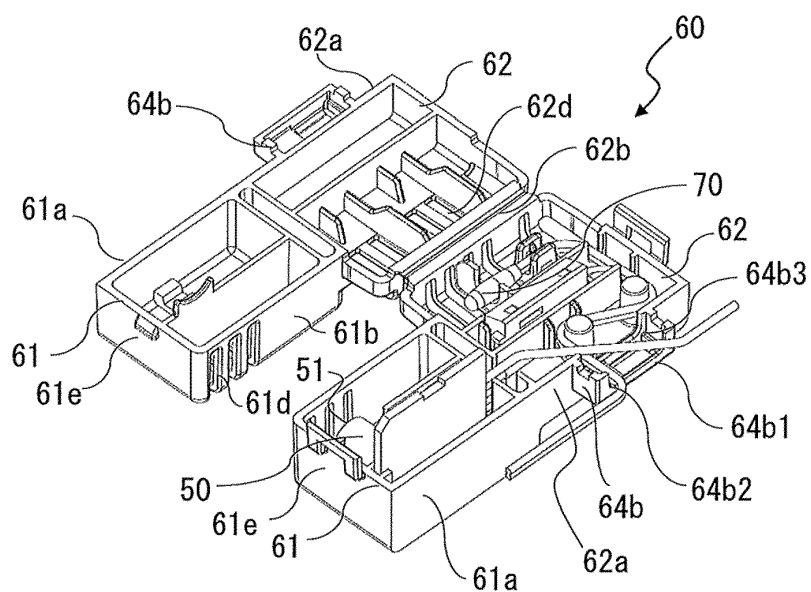


FIG. 8

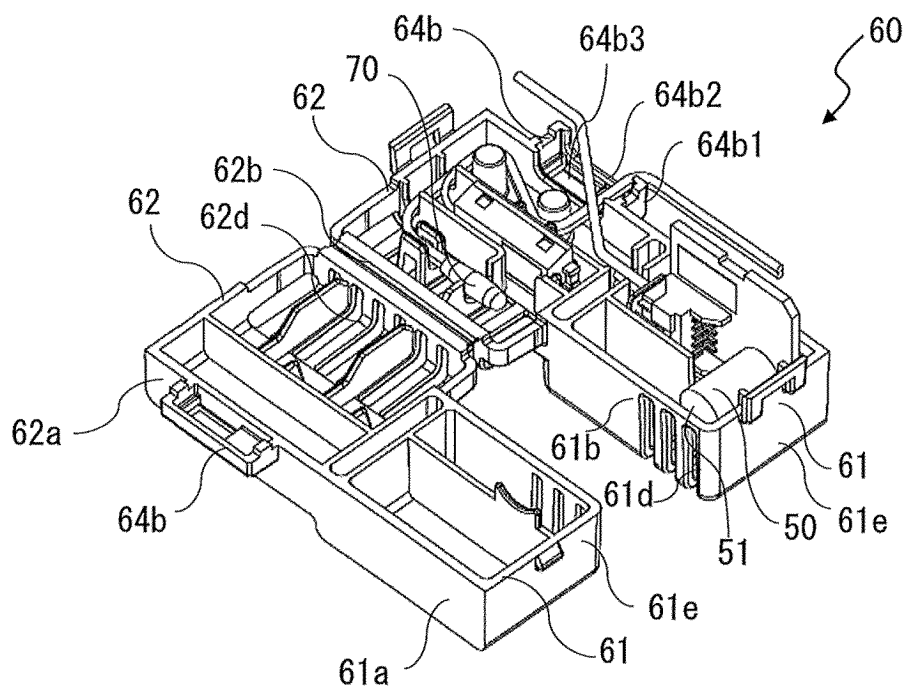


FIG. 9

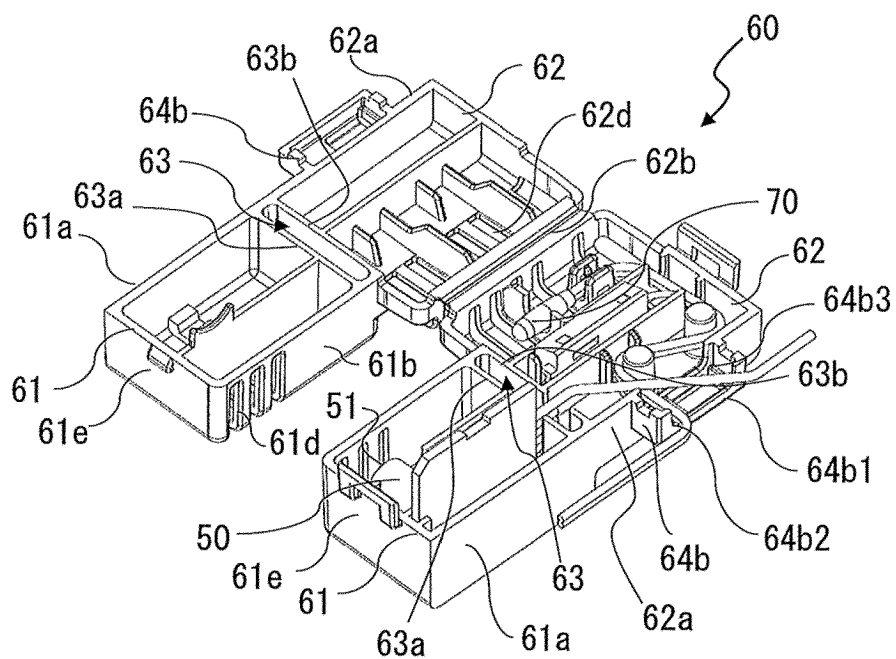


FIG. 10

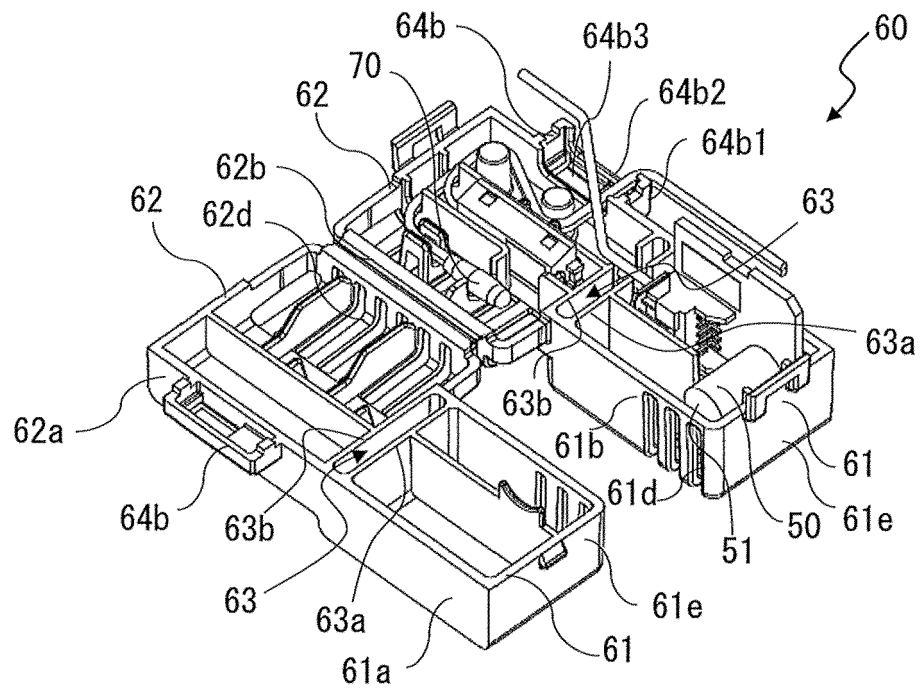
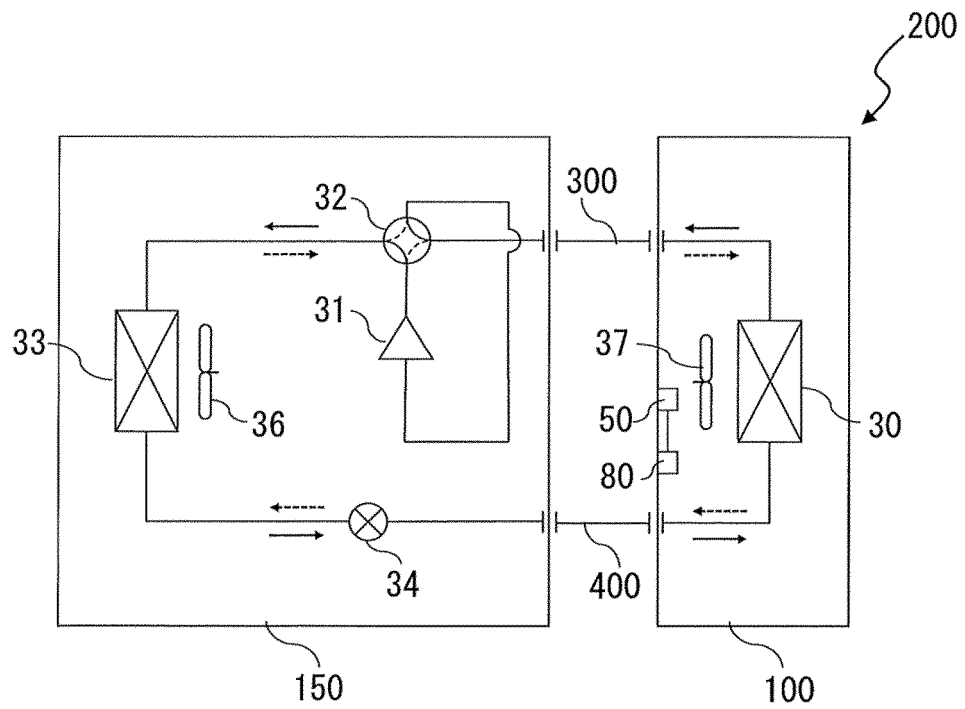


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/005963

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. F24F13/20 (2006.01) i, F24F11/80 (2018.01) i, F25B49/02 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. F24F13/20, F24F11/80, F25B49/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2016/158847 A1 (DAIKIN INDUSTRIES, LTD.) 06	1-2, 9-10
Y	October 2016, claims, paragraphs [0027]-[0034], [0044]-[0063], fig. 1-13 (Family: none)	3-8
Y	JP 2016-090109 A (DAIKIN INDUSTRIES, LTD.) 23 May 2016, paragraphs [0039]-[0049], fig. 10-13 & WO 2016/067818 A1	3-8
Y	WO 2017/110904 A1 (MITSUBISHI ELECTRIC CORP.) 29 June 2017, paragraphs [0041]-[0102], fig. 5-11 (Family: none)	3-8
Y	JP 2016-070568 A (HITACHI APPLIANCES, INC.) 09 May 2016, paragraph [0024], fig. 1, 2 (Family: none)	5, 7-8



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search
23.04.2018Date of mailing of the international search report
15.05.2018Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/005963

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2014-224611 A (PANASONIC CORP.) 04 December 2014, claims 3-4, paragraphs [0017]-[0052], fig. 1 & WO 2013/038703 A1	8
A	WO 2015/194596 A1 (MITSUBISHI ELECTRIC CORP.) 23 December 2015, entire text, all drawings & US 2017/0198936 A1 & EP 3159633 A1	1-10

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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