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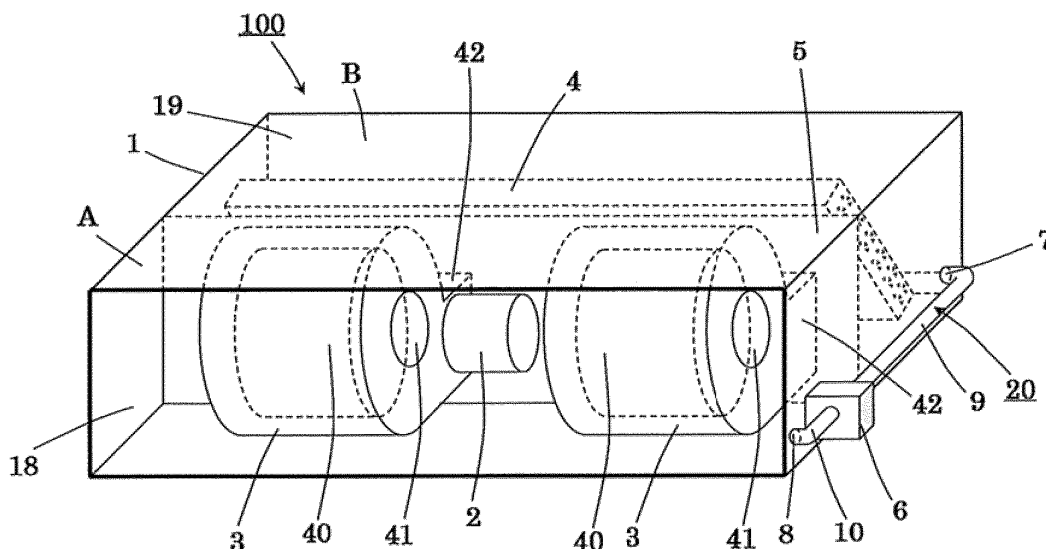
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(54) **REFRIGERANT-SENSING DEVICE AND INDOOR UNIT FOR AIR CONDITIONER**

(57) A refrigerant detection device that can be used in common in device models having different structures, and an indoor unit of an air-conditioning apparatus that uses the refrigerant detection device. The refrigerant detection device and the indoor unit of the air-conditioning apparatus include a refrigerant-detection air passage

having both ends connected to a main air passage extending from a suction port of the indoor unit of the air-conditioning apparatus to an air outlet of the indoor unit, and a refrigerant detection sensor that detects refrigerant in the refrigerant-detection air passage.

FIG. 1



Description

Technical Field

[0001] The present invention relates to an air-conditioning apparatus, and more particularly, to a refrigerant detection device that detects refrigerant leaking from a refrigerant circuit into a housing, and an indoor unit of an air-conditioning apparatus that is provided with the refrigerant detection device.

Background Art

[0002] In an existing air-conditioning apparatus, a sensor that detects leakage of refrigerant from a refrigerant circuit is provided in a housing of the air-conditioning apparatus. For example, according to Patent Literature 1, in an indoor unit of an air-conditioning apparatus that uses refrigerant having a higher density than that of air, a heat exchanger is provided at an air passage in a housing, and a fan covered by a fan casing is provided below the heat exchanger. A refrigerant detection unit is provided in the fan casing and at a higher position than an indoor fan. As the refrigerant detection unit, for example, a semiconductor gas sensor or a hot-wire semiconductor gas sensor is used. In the case where refrigerant leaks from the heat exchanger provided in the housing, while the air-conditioning apparatus is in the stopped state, the entire leakage refrigerant flows into the fan casing, and the refrigerant detection unit can thus promptly and reliably detect leakage of the refrigerant.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2016-29322

Summary of Invention

Technical Problem

[0004] However, in the indoor unit of the air-conditioning apparatus, because of the limited constraints of an internal structure of the indoor unit, it is sometimes impossible to provide the refrigerant detection unit at the air passage in the housing as disclosed in Patent Literature 1, or it is hard to provide the refrigerant detection unit at an optimal position. Furthermore, the indoor unit of the air-conditioning apparatus disclosed in Patent Literature 1 is capable of detecting refrigerant leakage especially when the air-conditioning apparatus is in the stopped state, but it is difficult or impossible for the indoor unit to detect refrigerant leakage when the air-conditioning apparatus is in operation. Furthermore, in device models having different structures, structures of air passages in the housings of the device models are also dif-

ferent, and thus the positions where the refrigerant is detected in the air passages and how to attach the refrigerant detection units are also different. It is therefore necessary to design and manufacture a refrigerant detection unit in accordance with the internal structure of each of device models, and it is hard to use a single refrigerant detection unit in common by the device models.

[0005] The present invention has been made to solve the above problems, and an object of the invention is to provide a refrigerant detection device that can be applied to indoor units of different air-conditioning apparatuses having respective structures, and also an indoor unit of an air-conditioning apparatus that uses the refrigerant detection device. Solution to Problem

[0006] A refrigerant detection device according to one embodiment of the present invention includes a refrigerant-detection air passage having both ends connected to a main air passage extending from a suction port of an indoor unit of an air-conditioning apparatus to an air outlet of the indoor unit; and a refrigerant detection sensor that detects refrigerant in the refrigerant-detection air passage.

[0007] An indoor unit of an air-conditioning apparatus, according to another embodiment of the present invention, includes: a housing formed in a shape of a box and including a suction port and an air outlet; a main air passage extending from the suction port to the air outlet; a fan provided in the main air passage and configured to send air from the suction port to the air outlet; a heat exchanger that transfers heat between the air flowing through the main air passage and refrigerant; and a refrigerant detection device including a refrigerant-detection air passage that branches off from the main air passage and then joins the main air passage, and a refrigerant detection sensor that detects refrigerant in the refrigerant-detection air passage and is provided in the refrigerant-detection air passage.

Advantageous Effects of Invention

[0008] According to the embodiments, the refrigerant detection device can guide air to the outside of the main air passage in the housing of the indoor unit of the air-conditioning apparatus, and to detect refrigerant leakage. Thereby, the refrigerant detection device can be provided in the indoor unit of the air-conditioning apparatus without imposing a restriction on the configuration of the main air passage. Furthermore, since a connection portion between the refrigerant-detection air passage and the main air passage in the indoor unit is made such that it can be applied to devices models of different structures, the refrigerant detection device can be applied to the device models of different structures without the load on designing how to design the refrigerant detection device.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a perspective view of an indoor unit of an air-conditioning apparatus according to embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is an explanatory diagram of air passages in the indoor unit of the air-conditioning apparatus as illustrated in Fig. 1.

[Fig. 3] Fig. 3 is an enlarged view of a refrigerant detection box as illustrated in Fig. 1.

[Fig. 4] Fig. 4 is an enlarged view of an inlet port and the periphery thereof in a refrigerant detection device as illustrated in Fig. 1.

[Fig. 5] Fig. 5 is a perspective view of a refrigerant detection device according to embodiment 2 of the present invention.

[Fig. 6] Fig. 6 is a perspective view of an indoor unit of an air-conditioning apparatus according to embodiment 3 of the present invention.

Description of embodiments

[0010] Embodiments of the present invention will be described with reference to the drawings. In each of the figures in the drawings, components, etc., which are the same as or similar to those in a previous figure are denoted by the same reference signs. The same is true of the entire text of the specification. Furthermore, forms of components described in the entire specification are merely examples, and the present invention is not limited as described in the specification. Particularly, each of combinations of components is not limited to a combination of components provided in a single embodiment, that is, a component provided in an embodiment can be applied to another embodiment. Furthermore, with respect to a plurality of devices of the same kind that are distinguished from each other by reference signs including suffixes, in the case where it is not particularly necessary to distinguish the devices from each other, there is a case where they are denoted by the reference signs not including the suffixes. Also, in the figures, there is a case where the relationship in size between components may be different from an actual one.

Embodiment 1

[0011] Fig. 1 is a perspective view of an indoor unit 100 of an air-conditioning apparatus according to embodiment 1 of the present invention. Fig. 2 is an explanatory diagram of air passages in the indoor unit 100 of the air-conditioning apparatus as illustrated in Fig. 1. Figs. 1 and 2 schematically illustrate the indoor unit 100 of the air-conditioning apparatus. The indoor unit 100 of the air-conditioning apparatus includes a housing 1 formed in the shape of a box, and the inside of the housing 1 is partitioned into a fan chamber A and a heat-exchanger

chamber B by a fan plate 5. In the fan chamber A, a motor 2 and two fan casings 3 are provided. In each of the fan casings 3, a fan 40 is provided. An opening port is provided at the housing 1, and the fan chamber A is provided with a suction port 18 for taking in air from the outside of the indoor unit 100 of the air-conditioning apparatus. In embodiment 1, the suction port 18 is provided in an end surface of the housing 1; however, it can be provided at any location as long as air can be taken from the outside of the housing 1 into the fan chamber A by the fan 40 through the suction port 18.

[0012] A heat exchanger 4 is provided in the heat-exchanger chamber B. An air outlet 19 is provided in an end surface of the housing 1 that is located at the heat exchanger chamber B. From the air outlet 19, air is blown after subjected to heat exchange in the heat exchanger 4. The location of the air outlet 19 can be arbitrarily changed.

[0013] The fan casing 3 is attached to the fan plate 5. An air-sending port 42 is provided in the fan plate 5. From the air-sending port 42, air is blown from the fan 40 into the heat-exchanger chamber B. Furthermore, the fan casing 3 is provided with an intake port 41 for taking air flowing in the fan chamber A into the fan casing 3. The fan 40 is provided in the fan casing 3 is driven by a motor 2 to take in air flowing in the fan chamber A from the intake port 41 of the fan casing 3, and to blow out air into the heat-exchanger chamber B through the air-sending port 42. The air blown into the heat-exchanger chamber B exchanges heat, in the heat exchanger 4, with refrigerant flowing through a heat transfer tube 30 in the heat exchanger 4, and is blown out from the air outlet 19. That is, a main air passage 50 is formed in the housing 1 to extend from the suction port 18 to the air outlet 19 via the fan 40 and the heat exchanger 4.

[0014] At a side surface of the heat-exchanger chamber B, a refrigerant detection device 20 is provided to take in air flowing in the main air passage 50 provided in the housing 1, and to detect whether refrigerant is contained in the air or not. The refrigerant detection device 20 includes a pipe 9 connected to the main air passage 50, a refrigerant detection box 6 in which a refrigerant detection sensor 11 is provided, and a pipe 10 connected to the main air passage 50 to return air flowing through the refrigerant detection sensor 11 to the main air passage 50. In a side surface of the housing 1 that is located at the heat-exchanger chamber B, an inlet port 7 is provided to take in air flowing through the main air passage 50. Furthermore, in a side surface of the housing 1 which is located at the fan chamber A, an air return port 8 is provided to return air from a refrigerant-detection air passage 60 to the main air passage 50. An air passage that branches off from the main air passage 50 in the housing 1 and extends from the inlet port 7 to the air return port 8 to send air to the refrigerant detection sensor 11 and to return air to the main air passage 50 will be referred to as the refrigerant-detection air passage 60.

[0015] Material of the pipe 9 and the pipe 10 may be

resin or metal as long as it has a satisfactory strength and does not affect detection of refrigerant. Furthermore, the pipes 9 and 10 are formed of soft material that can be freely changed in shape; and in the housing 1, attachment of the pipe 9 to the inlet port 7 and attachment of the pipe 10 to the air return port are achieved by the same attachment structure, and at least one of the lengths and shapes of the pipes 9 and 10 in the refrigerant detection device 20 is changed, whereby a refrigerant-detection air passage 60 that branches off from the main air passage 50 and then re-join the main air passage 50 can be made in indoor units of various types of air-conditioning apparatuses. In embodiment 1, as illustrated in Fig. 1, the refrigerant detection device 20 is provided outside the housing 1, but may be provided in the housing 1. For example, in a structure such as the structure of a machine chamber in which no main air passage 50 is provided in the housing 1, the refrigerant detection device 20 may be provided in the machine chamber.

[0016] Air taken in from the inlet port 7 flows through the pipe 9, and through the pipe 10 via the refrigerant detection box 6, and is returned to the main air passage 50 through the air return port 8. In the main air passage 50, when the fan 40 is driven, the pressure of air on a downstream side of the fan 40, that is, on a side where the air-sending port 42 is located, is raised higher than the pressure of air on an upstream side of the fan 40, that is, a side where the intake port 41 is located. The inlet port 7 is provided in the heat-exchanger chamber B whose air pressure is high, and the air return port 8 is provided in the fan chamber A whose air pressure is low, and because of the difference between these air pressures, air easily flows into the refrigerant-detection air passage 60.

[0017] For example, in the case where refrigerant for use in the air-conditioning apparatus is refrigerant, such as fluorocarbon-based refrigerant, which has a higher specific gravity than air when it is in a gas state, it is appropriate that the inlet port 7 is provided at lower part of the housing 1. By contrast, in the case where the refrigerant for use in the air-conditioning apparatus is refrigerant, such as ammonia, which is lighter than air when it is in a gas state, the inlet port 7 may be provided at upper part of the housing 1. In embodiment 1, for example, the inlet port 7 is provided at the lower part of the housing 1 as illustrated in Fig. 1. Furthermore, in embodiment 1, the inlet port 7 is provided in only one of side surfaces of the housing 1, but inlet ports 7 may be provided at side surfaces of the housing 1 or on upper and lower surfaces of the housing 1, for example, in accordance with the structure of the indoor unit 100 of the air-conditioning apparatus. Also, as in the inlet port 7, the position of the air return port 8 or the numbers of air return ports 8 can be changed as appropriate in accordance with the refrigerant for use in the air-conditioning apparatus or the structure of the indoor unit 100 of the air-conditioning apparatus.

[0018] In embodiment 1, the inlet port 7 and the air

return port 8 are circular, but may be formed in another shape. Furthermore, the opening areas of the inlet port 7 and the air return port 8 are determined in consideration of, for example, the lengths and strengths of the pipes 9 and 10, and a flow velocity at which the refrigerant detection sensor 11 can easily perform detection.

[0019] Fig. 3 is an enlarged view of the refrigerant detection box 6 as illustrated in Fig. 1. In Fig. 3, the refrigerant detection box 6 is illustrated, with its top and front plates removed. The refrigerant detection box 6 is provided with the refrigerant detection sensor 11 that detects the density of the refrigerant, and a control unit 12 which processes a signal from the refrigerant detection sensor 11. The refrigerant detection sensor 11 may be driven by power supplied from the indoor unit 100 of the air-conditioning apparatus or power supplied from an external power supply at an actual place where the indoor unit 100 of the air-conditioning apparatus is installed. In the case where the refrigerant detection sensor 11 is a refrigerant detection sensor which cannot be driven by power supplied from the indoor unit 100 or the external power supply, a battery may be incorporated in the refrigerant detection box 6. Furthermore, referring to Fig. 3, the refrigerant detection sensor 11 and the control unit 12 are fixed at a bottom surface of the refrigerant detection box 6 in a vertical direction, but the refrigerant detection sensor 11 and the control unit 12 may be fixed at another surface or other surfaces.

[0020] Referring to Fig. 1, the refrigerant detection box 6 is fixed at the housing 1 of the indoor unit 100 of the air-conditioning apparatus, but may be freely provided outside the housing 1. For example, the refrigerant detection box 6 can be provided at a ceiling surface in the case where the indoor unit is a ceiling-suspended indoor unit, and can be provided at a floor surface in the case where the indoor unit is a floor-installed indoor unit. The refrigerant detection box 6 can be provided at an optimal position in consideration of environments of the actual place where the indoor unit 100 of the air-conditioning apparatus is installed and the ease of maintenance of the refrigerant detection box 6. Furthermore, as described above, the refrigerant detection device 20 can be installed in the housing 1, for example, in the machine chamber, and thus, the refrigerant detection device 20 may be installed at a position in the machine chamber where maintenance can be easily performed.

[0021] In the case where the refrigerant detection device 20 is fixed at the housing 1 of the indoor unit 100, the pipes 9 and 10 are fixed to the inlet port 7 and the air return port 8, respectively, by screws or the like, thereby enabling the refrigerant detection device 20 only to be replaced by a new one.

[0022] Furthermore, as illustrated in Fig. 3, in order that an upper surface and a front surface of the refrigerant detection box 6 be removed and replacement and inspection of the refrigerant detection sensor 11 and the control unit 12 be performed, it suffices that elements forming the upper surface and front surface of the refrig-

erant detection sensor 11 are fixed by screws or the like, such that they can be freely removed.

[0023] Fig. 4 is an enlarged view of the inlet port 7 and the periphery thereof in the refrigerant detection device 20 as illustrated in Fig. 1. Fig. 4 illustrates the housing 1 of the indoor unit 100, but omits a top surface and a side surface of the housing 1. Referring to Fig. 4, in the heat exchanger 4, a plurality of heat transfer tubes 30 are arranged and end portions of the heat transfer tubes 30 are connected by, for example, U-shaped pipes 31, thereby forming a refrigerant flow passage. A plurality of fins 33 are attached to the plurality of heat transfer tubes 30, and heat is exchanged between air and refrigerant flowing through the heat transfer tubes 30 by causing air to flow between the fins 33. In the indoor unit 100, there is a possibility that refrigerant may leak from connection portions 32 where the heat transfer tubes 30 and the U-shaped pipes 31 are connected by, for example, brazing.

[0024] As illustrated in Fig. 4, brazed connected parts between the heat transfer tubes 30 and the U-shaped pipes 31 are concentratedly located at an end portion of the heat exchanger 4, and if refrigerant leakage occurs, the density of refrigerant in air around the end portion of the heat exchanger 4 tends to increase. Therefore, in the indoor unit 100 according to embodiment 1, a shielding plate 13 is provided in such a manner as to project in the same direction as the U-shaped pipes 31 project from an end portion of the heat exchanger 4 where the fins 33 are provided, and blocks part of the main air passage 50. Furthermore, the shielding plate 13 is provided in such a manner as to project from an end portion of a surface of the heat exchanger 4 that faces a downstream side of the main air passage 50, and in parallel with the surface. The shielding plate 13 blocks the flow of air passing through a region at the end portion of the heat exchanger 4 where the U-shaped pipes 31 are provided. The heat exchanger 4 is inclined relative to the flow direction of air in the main air passage 50. Thus, as indicated in Fig. 4, air flowing from an upstream side of the main air passage 50 strikes the shielding plate 13 after passing through the end portion of the heat exchanger 4, and then flows along a surface of the shielding plate 13 as indicated by arrows in Fig. 4. The shielding plate 13 blocks part of the main air passage 50 in the main air passage 50 on a downstream side of the inlet port 7. Thereby, a flow passage is provided in such a manner as to guide air passing through the end portion of the heat exchanger 4 such that the air is collected at the inlet port 7, and the indoor unit 100 of the air-conditioning apparatus can improve the accuracy of detection of refrigerant leakage.

<Advantages of Embodiment 1>

[0025]

(1) The refrigerant detection device 20 according to embodiment 1 includes the refrigerant-detection air

passage 60 having end portions both connected to the main air passage 50, which extends from the suction port 18 of the indoor unit 100 of the air-conditioning apparatus to the air outlet 19, and the refrigerant detection sensor 11 that detects refrigerant in the refrigerant-detection air passage 60.

(2) The indoor unit 100 of the air-conditioning apparatus according to embodiment 1 includes the box-shaped housing 1 including the suction port 18 and the air outlet 19, the main air passage 50 extending from the suction port 18 to the air outlet 19, the fan 40 provided at the main air passage 50 to send air from the suction port 18 to the air outlet 19, the heat exchanger 4 which transfers heat between air flowing through the main air passage 50 and refrigerant, and the refrigerant detection device 20. The refrigerant detection device 20 includes the refrigerant-detection air passage 60 that branches off from the main air passage 50 and then joins the main air passage 50. At the refrigerant-detection air passage 60, the refrigerant detection sensor 11 that detects refrigerant in the refrigerant-detection air passage 60 is provided.

Because of the above configuration, the refrigerant detection device 20 can be provided without narrowing the main air passage 50 in the indoor unit 100 of the air-conditioning apparatus. Furthermore, air flowing through the main air passage 50 can be guided to the refrigerant detection sensor 11 without being hindered. Furthermore, the refrigerant detection device 20 can be provided outside the main air passage 50 of the indoor unit 100 of the air-conditioning apparatus or outside the housing 1, and can thus be also applied to the indoor unit 100 of another air-conditioning apparatus having a different internal structure from that of the above air-conditioning apparatus, simply by changing the lengths and shapes of the pipes 9 and 10. Therefore, even if the refrigerant detection device 20 is applied to the indoor unit 100 of another air-conditioning apparatus having a different internal structure from that of the above air-conditioning apparatus, it can be more easily designed how the refrigerant detection device 20 is installed at the indoor unit 100.

(3) In the refrigerant detection device 20 according to embodiment 1, the refrigerant-detection air passage 60 includes the pipes 9 and 10, and the refrigerant detection box 6 connected to the pipes 9 and 10, one end portion of each of the pipes 9 and 10 being connected to the main air passage 50. The refrigerant detection sensor 11 is provided in the refrigerant detection box 6.

Because of such a configuration, since the refrigerant detection sensor 11 is provided in the refrigerant detection box 6 that is provided independent of the housing 1, it is possible to easily perform maintenance of the refrigerant detection sensor 11, such as inspection and replacement of the refrigerant de-

tection sensor 11, while obtaining the advantages (1) and (2) as described above. Furthermore, since the refrigerant detection box 6 is detachable from the pipes 9 and 10, if the refrigerant detection sensor 11 or the control unit 12 is broken, the refrigerant detection box 6 in which the refrigerant detection sensor 11 and the control unit 12 are provided can be easily replaced by a new one.

(4) In the indoor unit 100 of the air-conditioning apparatus according to embodiment 1, the refrigerant-detection air passage 60 causes the intake port 41 of the fan 40 and the air-sending port 42 of the fan 40 to communicate with each other.

In such a configuration, air flows from the air-sending port 42 of the fan 40 where the pressure is high to the intake port 41 where the pressure is low, through the refrigerant-detection air passage 60, and thus when the indoor unit 100 of the air-conditioning apparatus is in operation, air in the main air passage 50 naturally flows into the refrigerant detection box 6. Thus, the indoor unit 100 of the air-conditioning apparatus may achieve a structure for guiding air into the refrigerant detection sensor 11 with a simple structure, and can also obtain advantages as described in the above items (1) and (2).

(5) With the indoor unit 100 of the air-conditioning apparatus according to embodiment 1, the refrigerant-detection air passage 60 includes the inlet port 7 for taking in air from the main air passage 50, and the air return port 8 for returning the taken-in air to the main air passage 50. At the main air passage 50, a plurality of inlet ports 7 are provided.

Therefore, since the plurality of inlet ports 7 can be provided at locations in the main air passage 50, where refrigerant leakage highly likely occurs, the indoor unit 100 of the air-conditioning apparatus can detect refrigerant leakage at a higher accuracy.

(6) In the indoor unit 100 of the air-conditioning apparatus according to embodiment 1, the housing 1 includes the heat-exchanger chamber B where the heat exchanger 4 is provided, and the fan chamber A where the fan 40 is provided, and the refrigerant-detection air passage connects the heat-exchanger chamber B and the fan chamber A.

Because of such a configuration, air flows through the refrigerant-detection air passage 60, from the heat-exchanger chamber B where the pressure is high and refrigerant leakage may occur, to the fan chamber A where the pressure is low, and thus when the indoor unit 100 of the air-conditioning apparatus is in operation, air in the main air passage 50 naturally flows into the refrigerant detection box 6. Therefore, the indoor unit 100 of the air-conditioning apparatus can guide air into the refrigerant detection sensor 11 with a simple structure, and also obtain the advantages as described in the above items (1) and (2).

(7) In the indoor unit 100 of the air-conditioning ap-

paratus according to embodiment 1, the heat exchanger 4 is provided with the shielding plate 13 at an end portion of the heat exchanger 4. The shielding plate 13 blocks part of the main air passage 50, and guides air passing through the end portion of the heat exchanger 4 to a connection port between the main air passage 50 and the refrigerant-detection air passage 60.

Because of such a configuration, air passing through the end portion of the heat exchanger 4, where refrigerant leakage may occur in the main air passage 50, can be easily guided to the inlet port 7. Therefore, the indoor unit 100 of the air-conditioning apparatus can accurately and promptly detect refrigerant leakage.

(8) In the indoor unit 100 of the air-conditioning apparatus according to embodiment 1, the refrigerant-detection air passage 60 is installed outside the housing 1.

[0026] Because of such a configuration, it is not particularly necessary to provide space for providing the refrigerant-detection air passage 60, in the housing 1 of the indoor unit 100 of the air-conditioning apparatus. Furthermore, also in the case of applying the refrigerant detection device 20 to the indoor unit 100 of another air-conditioning apparatus having a different internal structure from that of the above air-conditioning apparatus 20, the refrigerant detection device 20 can be applied without being affected by the difference between the internal structures of the housings 1 of the above different air-conditioning apparatuses 20, and the housing 1 does not need to be enlarged for provision of the refrigerant detection device 20. Furthermore, since the refrigerant detection device 20 is provided outside the housing 1 of the indoor unit 100, maintenance of the refrigerant detection sensor 11 and peripheral components, which form the refrigerant detection device 20, can be easily performed regardless of the internal structure of the indoor unit 100 or the position or size of an inspection port.

Embodiment 2

[0027] A refrigerant detection device 220 of an indoor unit 200 of an air-conditioning apparatus according to embodiment 2 is obtained by adding a small fan to the refrigerant detection device 20 of the indoor unit 100 of the air-conditioning apparatus according to embodiment 1. Embodiment 2 will be described by referring mainly to the differences between embodiments 1 and 2. Matters not particularly described regarding embodiment 2 are the same as or similar to those in embodiment 1, and functions and components in embodiment 2 which are the same as those in embodiment 1 will be denoted by the same reference signs.

[0028] Fig. 5 is a perspective view of the refrigerant detection device 220 according to embodiment 2 of the present invention. The refrigerant detection device 20,

as well as the refrigerant detection device 20 according to embodiment 1, is attached to the indoor unit 200 of the air-conditioning apparatus. The refrigerant detection device 220 includes a fan box 14 provided with a fan that sends air in the refrigerant-detection air passage 60, in addition to the refrigerant detection box 6 of embodiment 1. Because of provision of the fan and a motor in the fan box 14, even when the differential pressure between the inlet port 7 and the air return port 8 is small, and air in the refrigerant-detection air passage 60 does not smoothly flow or does not flow at all, such as in a weak-wind mode in which the amount of air flowing in the main air passage 50 in the housing 1 is small or in the case where the operation of the indoor unit 100 is stopped, air in the main air passage 50 can be sent to the refrigerant detection sensor 11 by forcibly sending air in a direction from the inlet port 7 toward the air return port 8. Therefore, also when the indoor unit 200 of the air-conditioning apparatus is operated in a weak-wind mode or when the indoor unit 200 is in the stopped state, refrigerant leakage can be detected by the refrigerant detection device 220.

[0029] By provision of the fan at the refrigerant-detection air passage 60, even in the case where the rotation speed of the fan 40 of the indoor unit 200, the amount of air sent from the fan 40, etc., are changed, the flow rate of air passing through the refrigerant detection box 6 can be adjusted to a flow rate suitable for detection, by adjusting the rotation speed of the fan in the refrigerant-detection air passage 60.

[0030] It should be noted that referring to Fig. 5, the fan box 14 is provided at the pipe 9 between the inlet port 7 and the refrigerant detection box 6, but the fan box 14 may be provided at the pipe 10 between the refrigerant detection box 6 and the air return port 8.

<Advantages of Embodiment 2>

[0031]

(9) In the refrigerant detection device 220 according to embodiment 2, the refrigerant-detection air passage 60 includes a fan which sends air from one of end portions of the refrigerant-detection air passage 60 to the other end portion.

(10) In the indoor unit 200 of the air-conditioning apparatus according to embodiment 1, the refrigerant-detection air passage 60 includes a fan that sends air from one of end portions of the refrigerant-detection air passage 60 to the other end portion.

Because of such a configuration, even when the difference in pressure between the inlet port 7 and the air return port 8 is small in the stopped state of the indoor unit 100 of the air-conditioning apparatus or in the weak-wind mode of the indoor unit 100 of the air-conditioning apparatus, air in the main air passage 50 can be sent to the refrigerant detection sensor 11 by driving the fan. Therefore, even when the indoor unit 100 of the air-conditioning apparatus is

in the stopped state or in the weak-wind mode, refrigerant can be detected by the refrigerant detection device 20.

(11) In the refrigerant detection device 220 or the indoor unit 200 of the air-conditioning apparatus according to embodiment 2, the refrigerant-detection air passage 60 further includes the pipes 9 and 10 and the fan box 14 connected to the pipes 9 and 10, one end portion of each of the pipes 9 and 10 being connected to the main air passage 50. The fan is provided in the fan box 14.

[0032] By virtue of the above configuration, in the indoor unit 100 of the air-conditioning apparatus, the fan of the refrigerant detection device 20 can be easily inspected and replaced by a new one.

Embodiment 3

[0033] A refrigerant detection device 320 of an indoor unit 300 of an air-conditioning apparatus according to embodiment 3 is achieved by adding protrusion pipes 15 and 16 to the refrigerant detection device 20 of the indoor unit 100 of the air-conditioning apparatus according to embodiment 1. The protrusion pipes 15 and 16 protrude into the main air passage 50 from the inlet port 7 and the air return port 8, respectively. Embodiment 3 will be described by referring mainly to the differences between embodiments 1 and 3. Matters not particularly described in embodiment 3 are assumed to be the same as or similar to those in embodiment 1, and components which have the same functions and structures as those in embodiment 1 will be denoted by same reference signs.

[0034] Fig. 6 is a perspective view of the indoor unit 300 of the air-conditioning apparatus according to embodiment 3 of the present invention. It should be noted that in embodiments 1 and 2, the inlet port 7 and the air return port 8 are provided on a side of the main air passage 50 in the housing 1. By contrast, in the indoor unit 300 of the air-conditioning apparatus according to embodiment 3, the protrusion pipes 15 and 16 are further provided to protrude into the main air passage 50 in the indoor unit 300, and the inlet port 7 and the air return port 8 are provided at distal ends of the protrusion pipe 15 and 16, respectively. Because of such a structure, it is possible to change the position at which air in the main air passage 50 is taken in and the position where air having flowed through the refrigerant-detection air passage 60 is returned.

[0035] As illustrated in Fig. 6, short protrusion pipes 15 and 16 are each provided to straightly extend into the main air passage 50 from a connection portion between the main air passage 50 and the refrigerant-detection air passage 60. The protrusion pipe 15 includes the inlet port 7 at its distal end portion, and for example, is located close to an end portion of the heat exchanger 4. Also, the protrusion pipe 15 is formed to easily take in refrigerant leaking from the connection portion 32 between the

heat transfer tube 30 and the U-shaped pipe 31 at the end portion of the heat exchanger 4. It should be noted that the shape of the protrusion pipe 15 may be changed as appropriate, and the position of the distal end portion of the protrusion pipe 15 may be changed as appropriate to a position where refrigerant leakage can be easily detected. It is also possible to detect refrigerant leakage at a plurality of positions in the main air passage 50 by branching the distal end portion of the protrusion pipe 15 into two or more, and therefore possible to further improve the accuracy of the detection by the refrigerant detection device 320.

<Advantages of Embodiment 3>

[0036] (12) In the indoor unit 300 of the air-conditioning apparatus according to embodiment 1, the refrigerant-detection air passage 60 includes the protrusion pipes 15 and 16 protruding into the main air passage 50, and the protrusion pipe 15 includes, at the distal end portion thereof, the inlet port 7 for taking in air from the main air passage 50.

[0037] Thereby, because of provision of the protrusion pipe 15 especially at the inlet port 7, air in the main air passage 50 can be taken in at a position where refrigerant leakage can be more easily detected. By branching the distal end portion of the protrusion pipe 15 into two or more, detection for refrigerant leakage can be performed at a plurality of positions in the main air passage 50, and the accuracy of detection by the refrigerant detection device 320 can be further improved.

Reference Signs List

[0038]

1 housing 2 motor 3 fan casing 4 heat exchanger 5 fan plate 6 refrigerant detection box 7 inlet port 8 air return port 9 pipe 10 pipe 11 refrigerant detection sensor 12 control unit 13 shielding plate 14 fan box 15 protrusion pipe 16 protrusion pipe 18 suction port 19 air outlet 20 refrigerant detection device 30 heat transfer tube 31 U-shaped pipe 32 connection portion 33 fin 40 fan 41 intake port 42 air-sending port 50 main air passage 60 refrigerant-detection air passage 100 indoor unit 200 indoor unit 220 refrigerant detection device 300 indoor unit 320 refrigerant detection device A fan chamber B heat-exchanger chamber

Claims

1. A refrigerant detection device comprising:

a refrigerant-detection air passage having both

ends connected to a main air passage extending from a suction port of an indoor unit of an air-conditioning apparatus to an air outlet of the indoor unit; and

a refrigerant detection sensor configured to detect refrigerant in the refrigerant-detection air passage.

2. The refrigerant detection device of claim 1, wherein the refrigerant-detection air passage includes:

a pipe having one end connected to the main air passage, and
a refrigerant detection box connected to the pipe, and
wherein the refrigerant detection sensor is provided in the refrigerant detection box.

3. The refrigerant detection device of claim 1 or 2, wherein the refrigerant-detection air passage includes a fan configured to send air from one of ends of the refrigerant-detection air passage to the other.

4. The refrigerant detection device of claim 3, wherein the refrigerant-detection air passage further includes:

a pipe having one end connected to the main air passage, and
a fan box connected to the pipe, and
the fan is provided in the fan box.

5. An indoor unit of an air-conditioning apparatus, comprising:

a housing formed in a shape of a box and including a suction port and an air outlet;
a main air passage extending from the suction port to the air outlet;
a fan provided in the main air passage and configured to send air from the suction port to the air outlet;
a heat exchanger configured to transfer heat between the air flowing through the main air passage and refrigerant; and
a refrigerant detection device including a refrigerant-detection air passage that branches off from the main air passage and then joins the main air passage, and a refrigerant detection sensor configured to detect refrigerant in the refrigerant-detection air passage and provided in the refrigerant-detection air passage.

6. The indoor unit of the air-conditioning apparatus of claim 5, wherein the refrigerant-detection air passage is provided to cause an air-sending port side and an intake port side of the fan to communicate

with each other.

7. The indoor unit of the air-conditioning apparatus of claim 5 or 6,
wherein the refrigerant-detection air passage includes
an inlet port configured to take in the air from the main air passage, and
an air return port configured to return the taken-in air to the main air passage, and
a plurality of the inlet ports are provided in the main air passage. 5 10
8. The indoor unit of the air-conditioning apparatus of any one of claims 5 to 7,
wherein the housing includes a heat-exchanger chamber in which the heat exchanger is provided, and an fan chamber in which the fan is provided, and wherein the refrigerant-detection air passage causes the heat-exchanger chamber and a fan chamber to communicate with each other. 15 20
9. The indoor unit of the air-conditioning apparatus of claim 8,
wherein the heat exchanger is provided with a shielding plate at an end portion of the heat exchanger, the shielding plate being configured to block part of the main air passage, and
wherein the shielding plate guides the air passing through the end portion of the heat exchanger to a connection port between the main air passage and the refrigerant-detection air passage. 25 30
10. The indoor unit of the air-conditioning apparatus of any one of claims 5 to 9,
wherein the refrigerant-detection air passage includes a fan configured to send the air from one of ends of the refrigerant-detection air passage to the other end. 35 40
11. The indoor unit of the air-conditioning apparatus of claim 10,
wherein the refrigerant-detection air passage further includes:
a pipe having one end connected to the main air passage, and
a fan box connected to the pipe, and
wherein the fan is provided in the fan box. 45 50
12. The indoor unit of the air-conditioning apparatus of any one of claims 5 to 11,
wherein the refrigerant-detection air passage includes:
a protrusion pipe protruding into the main air passage, and
wherein the protrusion pipe includes, at a distal 55

end portion thereof, an inlet port configured to take in the air from the main air passage.

13. The indoor unit of the air-conditioning apparatus of any one of claims 5 to 12, wherein the refrigerant-detection air passage is provided outside the housing.

FIG. 1

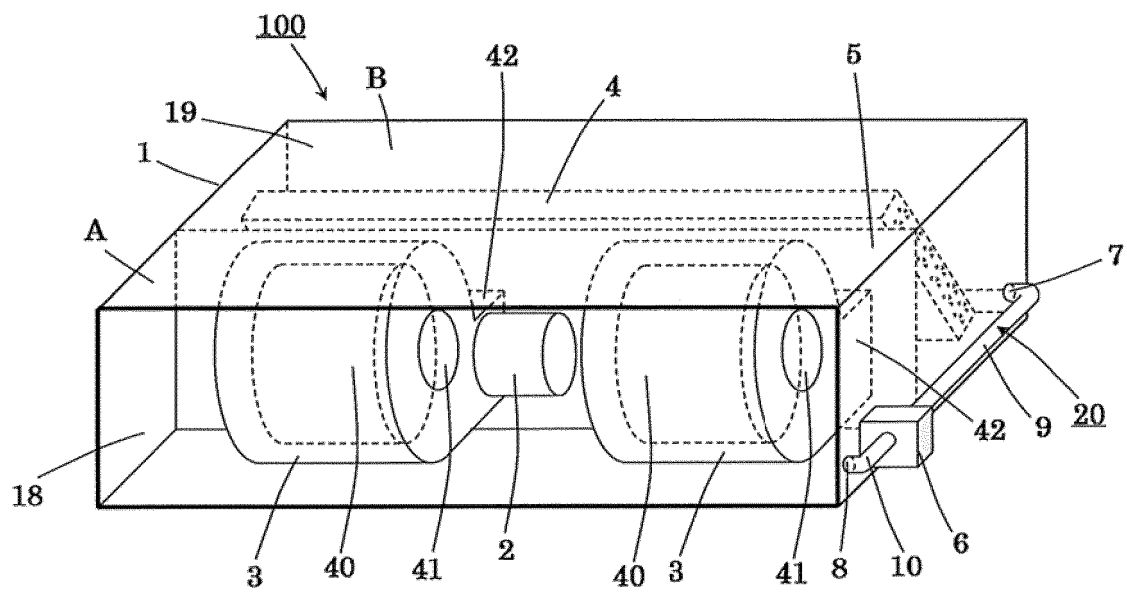


FIG. 2

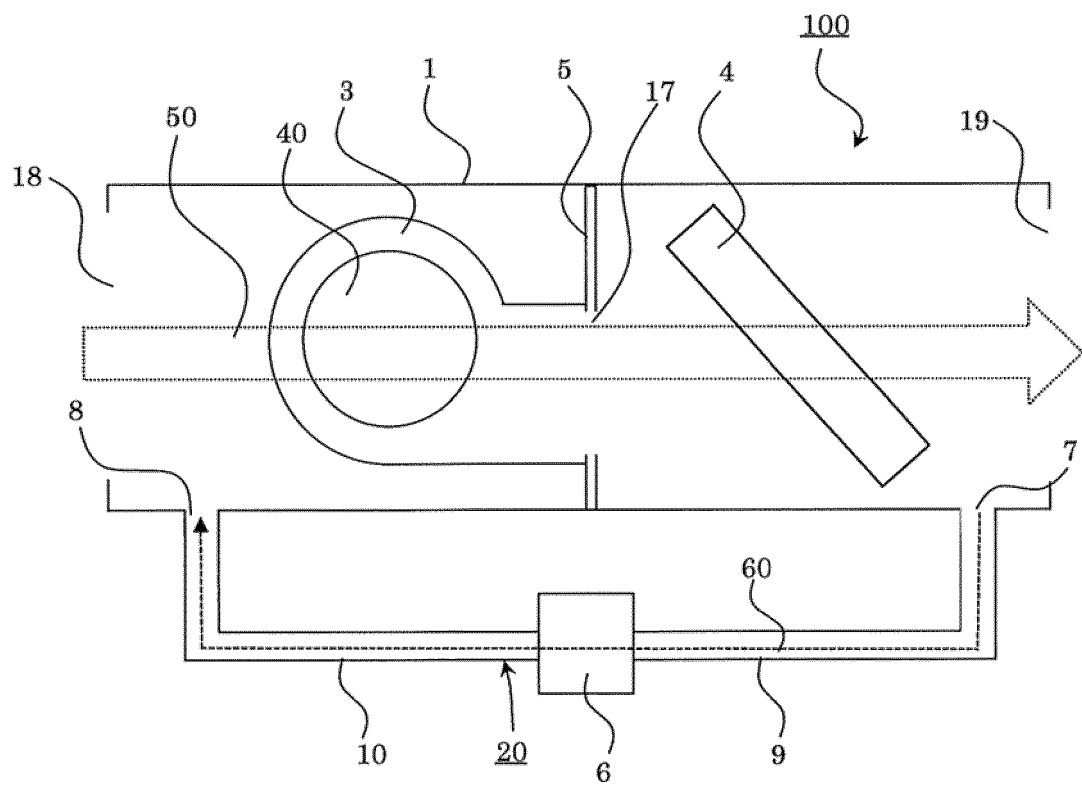


FIG. 3

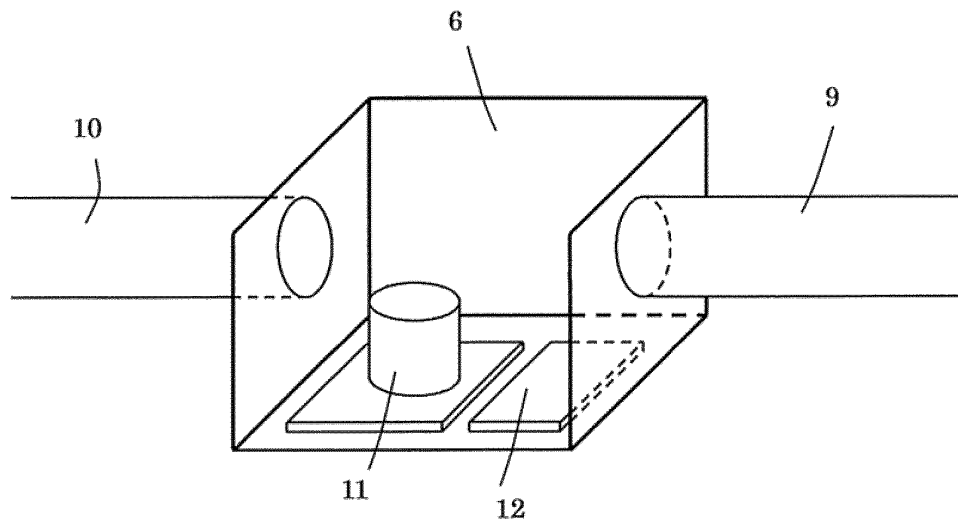


FIG. 4

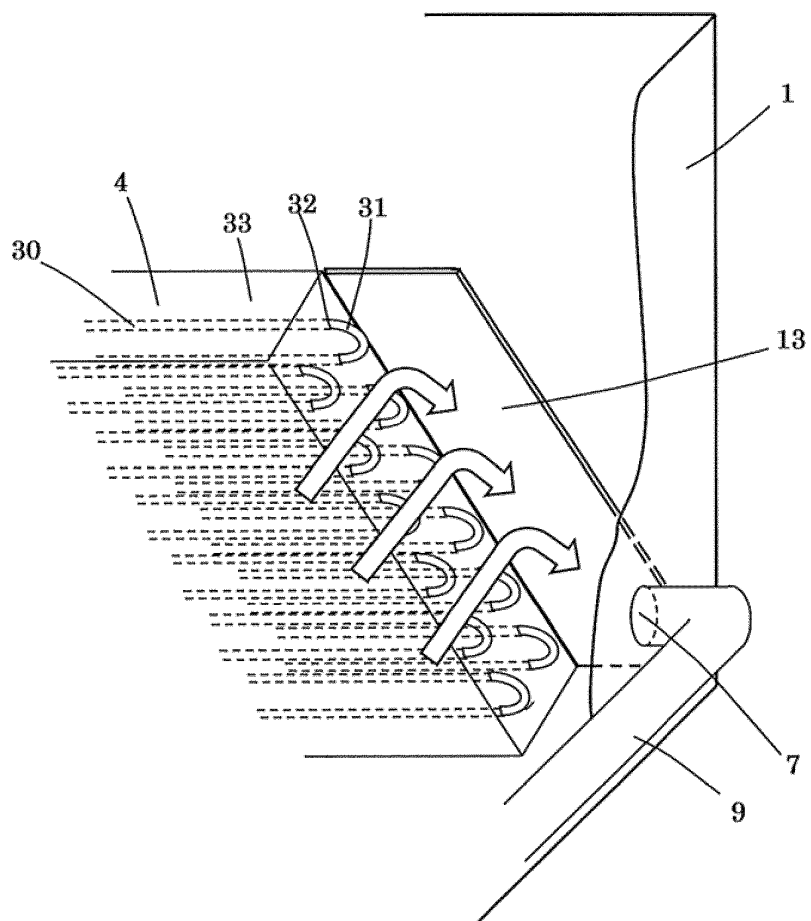


FIG. 5

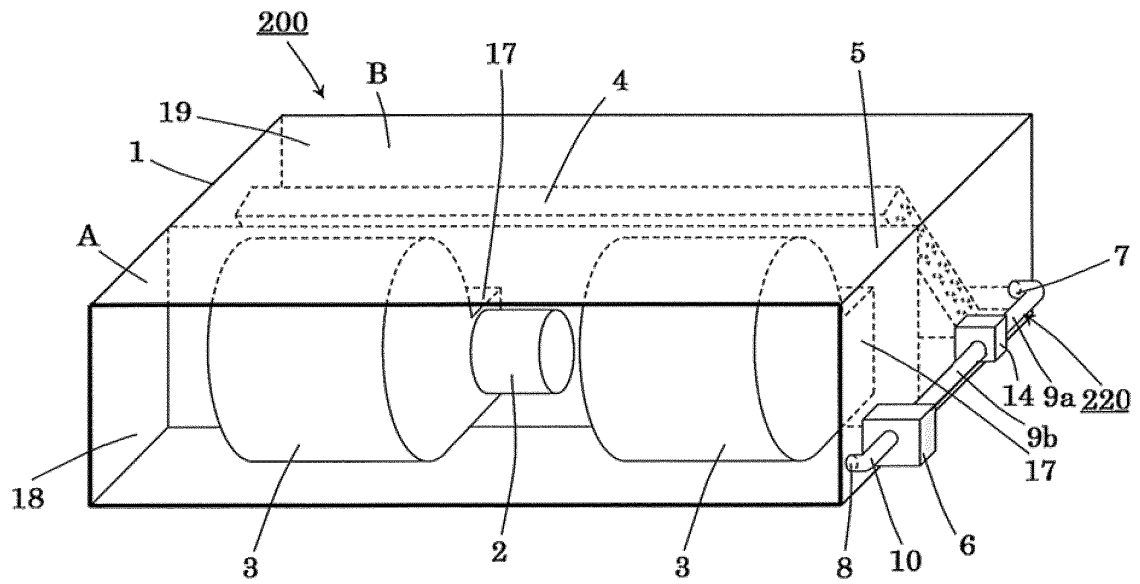
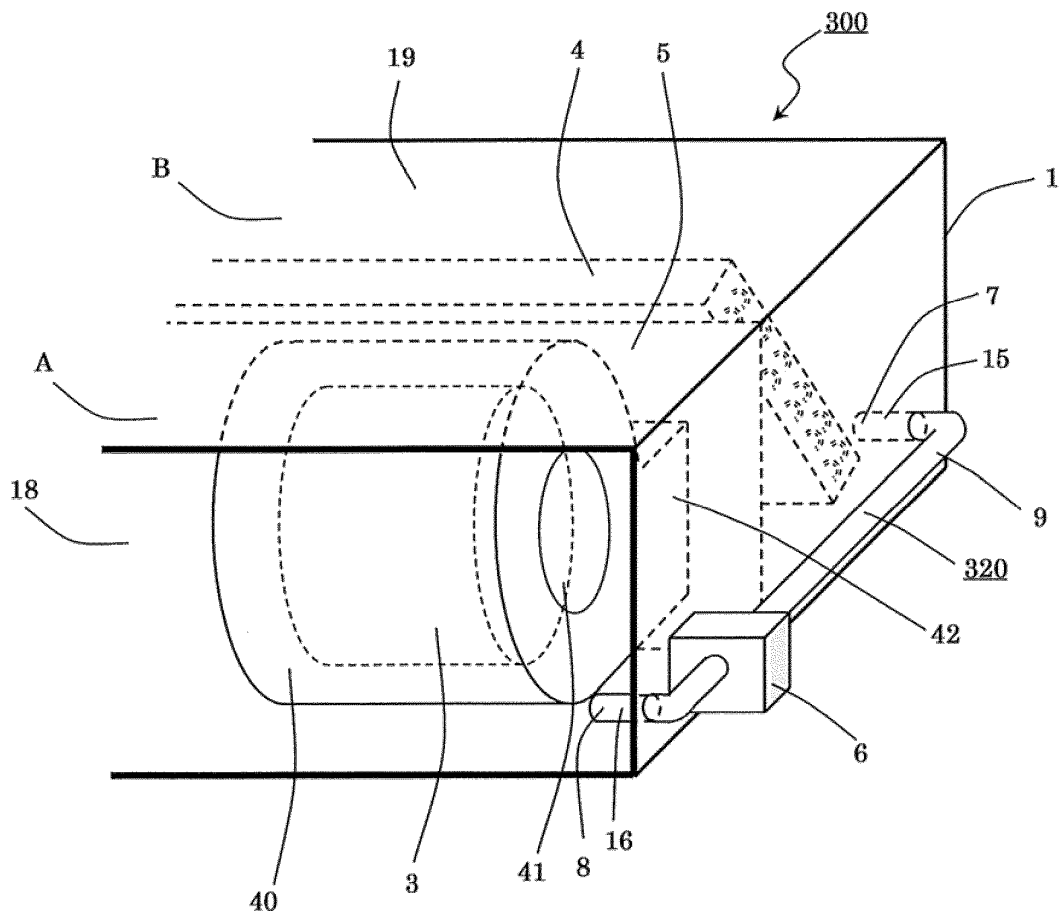


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/016195

A. CLASSIFICATION OF SUBJECT MATTER

F24F11/02(2006.01)i, F24F1/00(2011.01)i, F24F13/20(2006.01)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)

F24F11/02, F24F1/00, F24F13/20, F25B49/02

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017

Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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 Y A	JP 2017-53514 A (Johnson Controls-Hitachi Air Conditioning Technology (Hong Kong) Ltd.), 16 March 2017 (16.03.2017), paragraphs [0010] to [0059]; fig. 1 to 29 (Family: none)	1, 5, 7 2-4, 10-13 6, 8-9
Y	JP 2009-258950 A (Panasonic Corp.), 05 November 2009 (05.11.2009), paragraph [0029]; fig. 1, 3 (Family: none)	2-4
Y	JP 2000-186848 A (Daikin Industries, Ltd.), 04 July 2000 (04.07.2000), paragraphs [0010] to [0011]; fig. 1 (Family: none)	2-4

☒ 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
18 July 2017 (18.07.17)

Date of mailing of the international search report
25 July 2017 (25.07.17)

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Tokyo 100-8915, Japan

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/016195

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	JP 2003-176941 A (Kazuo TAKA), 27 June 2003 (27.06.2003), paragraph [0010]; fig. 1 (Family: none)	4, 11-13
Y	JP 2003-504640 A (Carrier Corp.), 04 February 2003 (04.02.2003), paragraphs [0018], [0021] & US 6471136 B1 column 4, lines 37 to 44; column 5, lines 30 to 32 & WO 2001/006248 A2 & CN 1359462 A	13
A	WO 2015/029094 A1 (Keiji MASUDA), 05 March 2015 (05.03.2015), paragraphs [0072] to [0074]; fig. 12 & JP 5633986 B1	1-13

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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