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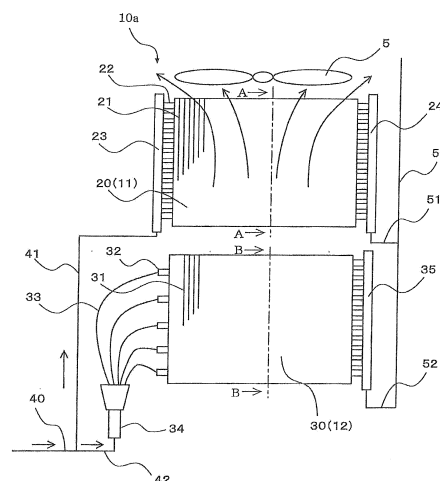
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(54) **OUTDOOR UNIT AND INDOOR UNIT FOR AIR CONDITIONER**

(57) Provided is an outdoor unit of an air-conditioning apparatus including a casing having an air inlet and an air outlet, and forming an outer shell, a fan provided inside the casing, and configured to suck outside air from the air inlet and exhaust the outside air from the air outlet, and a heat exchanger provided inside the casing, and configured to exchange heat between the outside air sucked by the fan and refrigerant, the heat exchanger including a first heat exchanger main body including a plurality of fins arranged in parallel at an interval and a plurality of flat pipes passing through the plurality of fins in a direction of parallel arrangement of the plurality of fins, the refrigerant flowing inside the plurality of flat pipes, and a second heat exchanger main body including a plurality of fins arranged in parallel at an interval and a plurality of circular pipes passing through the plurality of fins in a direction of parallel arrangement of the plurality of fins, the refrigerant flowing inside the plurality of circular pipes, in which the first heat exchanger main body is arranged closer to the fan than is the second heat exchanger

er main body.

FIG. 2



DescriptionTechnical Field

5 **[0001]** The present invention relates to an outdoor unit and an indoor unit of an air-conditioning apparatus that have improved energy efficiency.

Background Art

10 **[0002]** In a related-art air-conditioning apparatus, liquid refrigerant condensed in a heat exchanger that acts as a condenser mounted in an indoor unit is decompressed by an expansion valve into a two-phase gas-liquid state in which gas refrigerant and the liquid refrigerant are mixed and then flows into a heat exchanger that acts as an evaporator mounted in an outdoor unit. When the refrigerant in the two-phase gas-liquid state flows into the heat exchanger that acts as the evaporator, refrigerant distribution performance to the heat exchanger degrades. Consequently, to improve
15 the refrigerant distribution performance, there is given a method of using a header as a distributing device for the heat exchanger mounted in the outdoor unit and adjusting a structure inside the header such as a projection amount of a branch pipe into the header, a partition plate inside the header, and formation of an ejection hole.

[0003] Even when the structure inside the header is adjusted as described above, however, distribution of the two-phase gas-liquid refrigerant inside the header is greatly affected by a mass velocity of the refrigerant. For example, when
20 a high-output operation is performed, the refrigerant of a higher flow rate is distributed to an upper part of the header than to a lower part of the header. When a low-output operation is performed, the refrigerant of a higher flow rate is distributed to the lower part of the header than to the upper part of the header. Then, there is a problem in that heat exchange performance of the heat exchanger degrades due to the degradation of the refrigerant distribution performance, which brings about a reduction in energy efficiency of the air-conditioning apparatus. In addition, air of a higher flow rate
25 flows in a portion closer to a fan in the outdoor unit of the air-conditioning apparatus. Consequently, when the refrigerant of a higher flow rate is distributed to the lower part of the header, which is farther from the fan than the upper part of the header, than to the upper part of the header, there is a problem in that the refrigerant distribution performance and the heat exchange performance of the heat exchanger further degrade to bring about a further reduction in the energy efficiency.

30 **[0004]** To improve the energy efficiency of the air-conditioning apparatus, the distribution of the two-phase gas-liquid refrigerant is required to be uniformized. As its method, there has been known a method of providing a turbulence promoting member configured to agitate the refrigerant inside the header (see Patent Literature 1). In Patent Literature 1, the two-phase gas-liquid refrigerant inside the header is agitated by the turbulence promoting member to uniformize the distribution of the two-phase gas-liquid refrigerant.
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Citation ListPatent Literature

40 **[0005]**

Patent Literature 1: Japanese Unexamined Patent Application Publication JP 5-203 286

Summary of Invention

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Technical Problem

[0006] With the related-art method as disclosed in Patent Literature 1, a structure configured to agitate the refrigerant is provided in the header to improve the refrigerant distribution performance. However, there is a problem in that the
50 structure inside the header becomes complex to lead to an increase in cost.

[0007] The present invention has been made to solve the problem described above, and has an object to provide an outdoor unit and an indoor unit of an air-conditioning apparatus with improved energy efficiency and a reduced increase in cost.

55 Solution to Problem

[0008] According to one embodiment of the present invention, there is provided an outdoor unit of an air-conditioning apparatus including a casing having an air inlet and an air outlet, and forming an outer shell, a fan provided inside the

casing, and configured to suck outside air from the air inlet and exhaust the outside air from the air outlet, and a heat exchanger provided inside the casing, and configured to exchange heat between the outside air sucked by the fan and refrigerant, the heat exchanger including a first heat exchanger main body including a plurality of fins arranged in parallel at an interval and a plurality of flat pipes passing through the plurality of fins in a direction of parallel arrangement of the plurality of fins, the refrigerant flowing inside the plurality of flat pipes, and a second heat exchanger main body including a plurality of fins arranged in parallel at an interval and a plurality of circular pipes passing through the plurality of fins in a direction of parallel arrangement of the plurality of fins, the refrigerant flowing inside the plurality of circular pipes, in which the first heat exchanger main body is arranged closer to the fan than is the second heat exchanger main body.

Advantageous Effects of Invention

[0009] In the outdoor unit of the air-conditioning apparatus according to one embodiment of the present invention, the first heat exchanger main body including the flat pipes having high heat exchange performance as heat transfer pipes is arranged closer to the fan where a contribution rate to heat exchange performance is high, whereas the second heat exchanger main body including the circular pipes having low heat exchange performance and high refrigerant distribution performance with low manufacturing cost as heat transfer pipes is arranged at a position far from the fan where the contribution rate to the heat exchange performance is low. Consequently, the energy efficiency can be improved while the increase in cost is reduced.

Brief Description of Drawings

[0010]

- FIG. 1 is a perspective view of an outdoor unit of an air-conditioning apparatus according to Embodiment 1 of the present invention.
- FIG. 2 is a schematic side view of a heat exchanger of Embodiment 1 of the present invention and a periphery of the heat exchanger.
- FIG. 3 is a sectional view taken along the line A-A of FIG. 2.
- FIG. 4 is another example of the sectional view taken along the line A-A of FIG. 2.
- FIG. 5 is a sectional view taken along the line B-B of FIG. 2.
- FIG. 6 is a schematic view of a distributor of Embodiment 1 of the present invention.
- FIG. 7 is a schematic view for illustrating a distributing device different from the distributor of Embodiment 1 of the present invention.
- FIG. 8 is a graph for showing an air flow rate in a height direction of the heat exchanger of Embodiment 1 of the present invention.
- FIG. 9 is a schematic side view of a heat exchanger of Embodiment 2 of the present invention and a periphery of the heat exchanger.
- FIG. 10 is a schematic side view for illustrating another example of the heat exchanger of Embodiment 2 of the present invention and the periphery of the heat exchanger.
- FIG. 11 is a schematic side view for illustrating a further example of the heat exchanger of Embodiment 2 of the present invention and the periphery of the heat exchanger.
- FIG. 12 is a schematic side view of a heat exchanger of Embodiment 3 of the present invention and a periphery of the heat exchanger.
- FIG. 13 is a perspective view of an outdoor unit of an air-conditioning apparatus according to Embodiment 4 of the present invention.
- FIG. 14 is a schematic side view of a heat exchanger of Embodiment 4 of the present invention.
- FIG. 15 is a schematic view for illustrating a part of a configuration when an internal heat exchanger is used as a quality control device for an outdoor unit of an air-conditioning apparatus.
- FIG. 16 is a first view for illustrating another example of FIG. 2.
- FIG. 17 is a second view for illustrating a further example of FIG. 2.
- FIG. 18 is a third view for illustrating a still further example of Fig 2.
- FIG. 19 is a schematic side view of a heat exchanger of Embodiment 5 of the present invention and a periphery of the heat exchanger.
- FIG. 20 is a schematic side view of a heat exchanger of Embodiment 6 of the present invention and a periphery of the heat exchanger.
- FIG. 21 is a schematic side view of a heat exchanger of Embodiment 7 of the present invention and a periphery of the heat exchanger.
- FIG. 22 is a schematic side view of a heat exchanger of Embodiment 8 of the present invention and a periphery of

the heat exchanger.

FIG. 23 is a first schematic view for illustrating an indoor unit of an air-conditioning apparatus according to Embodiment 9 of the present invention, in which a turbofan is mounted.

FIG. 24 is a second schematic view for illustrating the indoor unit of the air-conditioning apparatus according to Embodiment 9 of the present invention, in which the turbofan is mounted.

Description of Embodiments

[0011] Embodiments of the present invention are described below with reference to the drawings. Note that, the present invention is not limited to the embodiments described below. Moreover, in the drawings referred to below, the size relationship between components may be different from the reality in some cases.

Embodiment 1

[0012] FIG. 1 is a perspective view of an outdoor unit 100a of an air-conditioning apparatus according to Embodiment 1 of the present invention. FIG. 2 is a schematic side view of a heat exchanger 10a of Embodiment 1 of the present invention and a periphery of the heat exchanger 10a. FIG. 3 is a sectional view taken along the line A-A of FIG. 2. FIG. 4 is a view for illustrating another example of the sectional view taken along the line A-A of FIG. 2. FIG. 5 is a sectional view taken along the line B-B of FIG. 2. The arrows in FIG. 1 indicate flow of air, whereas the arrows in FIG. 2 indicate flow of refrigerant or flow of air in a heating operation.

[0013] Although the terms for directions (for example, "upper", "lower", "right", "left", "front", and "rear") are suitably used in the following description for easy understanding, the terms are used merely for description and do not limit the invention of the present application. Further, in Embodiment 1, the terms "upper", "lower", "right", "left", "front", and "rear" are used under a state in which the outdoor unit 100a is viewed from a front side. The same applies to Embodiment 2 to Embodiment 4 described later.

[0014] The outdoor unit 100a of the air-conditioning apparatus according to Embodiment 1 accommodates the heat exchanger 10a illustrated in FIG. 2.

[0015] The outdoor unit 100a of the air-conditioning apparatus is of top flow type, and a refrigeration cycle is formed by circulating refrigerant between the outdoor unit 100a and an indoor unit (not shown). The outdoor unit 100a is used, for example, as an outdoor unit for a multiple air-conditioning system for a building and is installed on a top of a building or in other places.

[0016] The outdoor unit 100a includes, as illustrated in FIG. 1, a casing 1 formed in a box-like shape, an air inlet 2 formed of an opening formed in a side surface of the casing 1, the heat exchanger 10a arranged in the casing 1 along the air inlet 2, an air outlet 3 formed of an opening formed in an upper surface of the casing 1, a fan guard 4 provided to allow ventilation through the fan guard 4 to cover the air outlet 3, and a fan 5 arranged inside the fan guard 4 and configured to suck outside air from the air inlet 2 and exhaust the outside air from the air outlet 3.

[0017] The heat exchanger 10a mounted in the outdoor unit 100a of the air-conditioning apparatus is configured to exchange heat between the outside air sucked by the fan 5 from the air inlet 2 and the refrigerant. The heat exchanger 10a is arranged, as illustrated in FIG. 2, below the fan 5 and includes an upper heat exchanger 11 and a lower heat exchanger 12. The upper heat exchanger 11 and the lower heat exchanger 12 are arranged in an up-and-down direction on a front view or a side view. More specifically, the upper heat exchanger 11 is arranged on an upper side closer to the fan 5, whereas the lower heat exchanger 12 is arranged on a lower side farther from the fan 5.

[0018] The upper heat exchanger 11 includes an upper heat exchanger main body 20 including a plurality of fins 21 arranged in parallel at intervals, and a plurality of heat transfer pipes, inside which the refrigerant flows, arranged in a direction of parallel arrangement of the fins 21 to pass through the fins 21, a first upper header 23 connected to one end of each of the plurality of heat transfer pipes, and a second upper header 24 connected to another end of each of the plurality of heat transfer pipes. The first upper header 23 is connected to an upstream side of the upper heat exchanger main body 20 in a heating operation, whereas the second upper header 24 is connected to a downstream side of the upper heat exchanger main body 20 in the heating operation. Hereinafter, a distributing device connected to the upstream side of the upper heat exchanger main body 20 or a lower heat exchanger main body 30 in the heating operation is referred to as "upstream-side distributing device".

[0019] Meanwhile, the lower heat exchanger 12 includes the lower heat exchanger main body 30 including a plurality of fins 31 arranged in parallel at intervals, and a plurality of heat transfer pipes, inside which the refrigerant flows, arranged in a direction of parallel arrangement of the fins 31 to pass through the fins 31, a distributor 34, capillary tubes 33 connecting one end of each of the plurality of heat transfer pipes to the distributor 34, and a lower header 35 connected to another end of each of the plurality of the heat transfer pipes. The distributor 34 is connected to an upstream side of the lower heat exchanger main body 30 through the capillary tubes 33 in the heating operation, whereas the lower header 35 is connected to a downstream side of the lower heat exchanger main body 30 in the heating operation.

[0020] The first upper header 23 of the upper heat exchanger 11 is connected to a first branch pipe 41 branching from a first pipe 40 through which two-phase gas-liquid refrigerant, which is a mixture of gas refrigerant and liquid refrigerant, passes in the heating operation. The second upper header 24 of the upper heat exchanger 11 is connected to a first branch pipe 51 branching from a second pipe 50 through which the gas refrigerant passes in the heating operation.

[0021] Meanwhile, the distributor 34 of the lower heat exchanger 12 is connected to a second branch pipe 42 branching from the first pipe 40. Further, the lower header 35 of the lower heat exchanger 12 is connected to a second branch pipe 52 branching from the second pipe 50.

[0022] Although the heat transfer pipes of the upper heat exchanger 11 of Embodiment 1 are flat pipes 22 illustrated in FIG. 3, each having a flat sectional shape, multi-hole flat pipes 22a illustrated in FIG. 4, each having a flat sectional shape and a plurality of holes formed inside, may also be used. Although both of the flat pipes 22 illustrated in FIG. 3 and the multi-hole flat pipes 22a illustrated in FIG. 4 have smooth surfaces, a grooved surface, which is grooved to enlarge a heat transfer area, may be formed. Further, the heat transfer pipes of the lower heat exchanger 12 of Embodiment 1 are circular pipes 32 illustrated in FIG. 5, each having a circular sectional shape.

[0023] FIG. 16 is a first view for illustrating another example of FIG. 2, and FIG. 17 is a second view for illustrating a further example of FIG. 2.

[0024] Although there is a clearance between the upper heat exchanger 11 and the lower heat exchanger 12 in Embodiment 1 as illustrated in FIG. 2, the upper heat exchanger 11 and the lower heat exchanger 12 may be brought into close contact with each other in practice as illustrated in FIG. 16 to drain water drops on surfaces of the fins of the upper heat exchanger 11. Further, integrated fins, which are seamless between the upper heat exchanger 11 and the lower heat exchanger 12, may be shared by the upper heat exchanger 11 and the lower heat exchanger 12 as illustrated in FIG. 17.

[0025] Each of the flat pipes 22 illustrated in FIG. 3 and the multi-hole flat pipes 22a illustrated in FIG. 4 has a larger heat transfer area per unit volume of the refrigerant than each of the circular pipes 32 illustrated in FIG. 5. Consequently, heat exchange performance is high. Because of a small sectional area, however, a flow resistance and a pressure loss increase. Thus, the number of paths corresponding to the heat transfer pipes is required to be increased to reduce an increase in the pressure loss. In this case, a technology of effectively distributing the refrigerant to a large number of the heat transfer pipes is left to be achieved. Meanwhile, although each of the circular pipes 32 illustrated in FIG. 5 has lower heat exchanger performance than each of the flat pipes 22 illustrated in FIG. 3 and each of the multi-hole flat pipes 22a illustrated in FIG. 4, manufacturing cost is low. Because of a large sectional area, however, the flow resistance and the pressure loss decrease. Consequently, there is provided an advantage in that the number of paths corresponding to the heat transfer pipes can be reduced to facilitate the improvement of the distribution.

[0026] Next, flow of the refrigerant in the heating operation of the outdoor unit 100a of the air-conditioning apparatus of Embodiment 1 is described with reference to FIG. 2.

[0027] In the heating operation, the two-phase gas-liquid refrigerant passes through the first pipe 40 to be split into the first branch pipe 41 and the second branch pipe 42. After the two-phase gas-liquid refrigerant flowing into the second branch pipe 42 flows into the distributor 34 to be homogenized, the homogenized two-phase gas-liquid refrigerant passes through the capillary tubes 33 to flow into the lower heat exchanger main body 30. The two-phase gas-liquid refrigerant flowing into the lower heat exchanger main body 30 exchanges heat with the outside air sucked from the air inlet 2 to be gasified and then flows out to the lower header 35.

[0028] Meanwhile, the two-phase gas-liquid refrigerant flowing into the first branch pipe 41 flows into the first upper header 23 where the two-phase gas-liquid refrigerant is distributed to the flat pipes 22. The two-phase gas-liquid refrigerant flows from the flat pipes 22 into the upper heat exchanger main body 20. The two-phase gas-liquid refrigerant flowing into the upper heat exchanger main body 20 exchanges heat with the outside air sucked from the air inlet 2 to be gasified and then flows out to the second upper header 24.

[0029] FIG. 6 is a schematic view of the distributor 34 of Embodiment 1 of the present invention.

[0030] The distributor 34 illustrated in FIG. 6 includes a distributor main pipe portion 61, a distributor expanding portion 62, and a distributor flow-splitting member 63. The distributor main pipe portion 61 includes an area sudden reduction portion 64. Further, one end of each of the capillary tubes 33 is connected to the distributor 34.

[0031] The two-phase gas-liquid refrigerant flows into the distributor 34 to be expanded in the area sudden reduction portion 64 of the distributor main pipe portion 61. The gas refrigerant and the liquid refrigerant are agitated in the distributor expanding portion 62 to be homogenized. The homogenized gas refrigerant and liquid refrigerant are distributed to the capillary tubes 33 by the distributor flow-splitting member 63. Another ends of the capillary tubes 33 are each connected to a corresponding one of the circular pipes 32 of the lower heat exchanger 12. A refrigerant flow rate in each of the circular pipes 32 can be controlled by adjusting a length of a corresponding one of the capillary tubes 33.

[0032] FIG. 7 is a schematic view for illustrating a distributing device different from the distributor 34 of Embodiment 1 of the present invention. The arrow in FIG. 7 indicates a direction of gravitational force.

[0033] Although the distributing device connected to an upstream side of the lower heat exchanger main body 30 in the heating operation is the distributor 34 illustrated in FIG. 6, a header 70 illustrated in FIG. 7 may also be used.

[0034] The header 70 illustrated in FIG. 7 has a structure of distributing the two-phase gas-liquid refrigerant flowing into the header 70 to the circular pipes 32, which are the plurality of heat transfer pipes arranged in parallel in the direction of gravitational force. Then, the two-phase gas-liquid refrigerant flows upward in a vertical direction inside the header 70 as an upward flow and is split into the plurality of circular pipes 32 at a right angle to the flow inside the header 70.

[0035] The distributor 34 generally has higher refrigerant distribution performance than the header as the distributing device. When the distributor 34 is used for the heat exchanger including the flat pipes 22 as the heat transfer pipes, however, the number of paths increases. Consequently, the number of branch portions of the distributor 34 is required to be increased or a plurality of the distributors 34 are required to be used. Consequently, there is a disadvantage in that routing of the pipes becomes complicated.

[0036] Meanwhile, with the header, the routing of the pipes is easy. Automation such as automatic brazing is easy to apply, and the header can be manufactured at low cost. However, the gravitational force acts on the two-phase gas-liquid refrigerant. Consequently, when, for example, the refrigerant flow rate is small, there is a problem in that the liquid refrigerant of a higher flow rate having a high density flows unevenly into lower ones of the heat transfer pipes. Consequently, the header has a disadvantage in that the refrigerant distribution performance is generally lower than the distributor 34.

[0037] Further, in comparison to the distributor 34, the header does not include the area sudden reduction portion 64 and other portions unlike the distributor 34. Further, the capillary tubes 33 are not connected to the header. Thus, the pressure loss is small. Hence, for the heat exchanger main body including the flat pipes 22 as the heat transfer pipes, the number of paths increases. Consequently, the header having a small pressure loss, with which the routing of the pipes is easy, is more suitable as the upstream-side distributing device. Meanwhile, the heat exchanger main body including the circular pipes 32 as the heat transfer pipes has a small number of paths, and hence the routing of the pipes is not complicated. Thus, the distributor 34 having high refrigerant distribution performance is more suitable. As described above, there are the upstream-side distributing device suitable for the heat exchanger main body including the flat pipes 22 as the heat transfer pipes and the upstream-side distributing device suitable for the heat exchanger main body including the circular pipes 32 as the heat transfer pipes.

[0038] FIG. 8 is a graph for showing an air flow rate in a height direction of the heat exchanger 10a of Embodiment 1 of the present invention.

[0039] The heat exchanger 10a of Embodiment 1 is mounted in the top flow-type outdoor unit 100a. Consequently, the fan 5 is arranged above the heat exchanger 10a. Air passes through the clearance in the heat exchanger 10a by the fan 5 and the air exchanges heat. The fan 5 is arranged above the upper heat exchanger 11, and hence an air flow rate distribution inside the outdoor unit 100a becomes larger in an upper part in the heat exchanger 10a, which is closer to the fan 5, than in a lower part in the heat exchanger 10a as shown in FIG. 8. Specifically, air of a higher flow rate flows in the upper heat exchanger 11 arranged on the upper side than in the lower heat exchanger 12 arranged on the lower side. Consequently, when the upper heat exchanger 11 and the lower heat exchanger 12 have the same front surface area, the upper heat exchanger 11 has a higher contribution rate to the heat exchange performance of the outdoor unit 100a than the lower heat exchanger 12.

[0040] Consequently, the upper heat exchanger 11 including the flat pipes 22 having the high heat exchange performance as the heat transfer pipes is arranged in the upper part of the outdoor unit 100a in which air of a high flow rate flows, specifically, at a position closer to the fan 5, whereas the lower heat exchanger 12 including the circular pipes 32 having low heat exchange performance and high refrigerant distribution performance as the heat transfer pipes is arranged in the lower part of the outdoor unit 100a in which air of a low flow rate flows, specifically, at a position farther from the fan 5. In this manner, the heat exchange performance can be efficiently improved. As a result, energy efficiency of the outdoor unit 100a of the air-conditioning apparatus can be improved.

[0041] Further, higher heat exchange performance can be obtained by causing the refrigerant of a higher flow rate to flow in the upper heat exchanger 11, which is arranged at a position where air of a high flow rate flows. Consequently, suitable ones are each used as the upstream-side distributing device for a corresponding one of the heat exchanger including the flat pipes 22 as the heat transfer pipes and for the heat exchanger including the circular pipes 32 as the heat transfer pipes. Specifically, the header is used as the distributing device for the heat exchanger including the flat pipes 22 as the heat transfer pipes, specifically, the upper heat exchanger 11, whereas the distributor 34 is used as the distributing device for the heat exchanger including the circular pipes 32 as the heat transfer pipes, specifically, for the lower heat exchanger 12.

[0042] A flow resistance of the distributing device is larger in the distributor 34 than in the header. Consequently, by using the distributing devices as described above, the refrigerant of a higher flow rate can be caused to flow in the upper heat exchanger 11. Consequently, a refrigerant distribution characteristic, can be improved to improve the heat exchange performance of the heat exchanger 10a. Further, the refrigerant flow rate in the header can be controlled by changing the length of each of the capillary tubes 33 connected to the distributor 34. Consequently, the above-mentioned use of the distributor 34 and the header is more preferred.

[0043] FIG. 18 is a third view for illustrating a still further example of FIG. 2.

[0044] Although the distributor 34 is connected to the circular pipes 32 and the header is connected to the flat pipes 22 in Embodiment 1 as illustrated in FIG. 2, the connection described above is merely an example. For example, a distributing device of the same type may be mounted to each of a set of the circular pipes 32 and a set of the flat pipes 22 as illustrated in FIG. 18. Alternatively, the distributor 34 may be connected to the flat pipes 22, whereas the header may be connected to the circular pipes 32.

[0045] Further, manufacturing cost of the flat pipes 22 is generally higher than manufacturing cost of the circular pipes 32. Consequently, by arranging the upper heat exchanger 11 including the flat pipes 22 having high heat exchange performance as the heat transfer pipes at a position close to the fan 5 where the contribution rate to the heat exchange performance of the outdoor unit 100a is high, the heat exchanger 10a with high cost performance can be provided.

[0046] As described above, in the outdoor unit 100a of the air-conditioning apparatus of Embodiment 1, the upper heat exchanger 11 including the flat pipes 22 having the high heat exchange performance as the heat transfer pipes is arranged at the position close to the fan 5 where the contribution rate to the heat exchange performance is high, whereas the lower heat exchanger 12 including the circular pipes 32 having the low heat exchange performance and the high refrigerant distribution performance with the low manufacturing cost as the heat transfer pipes is arranged at a position far from the fan 5 where the contribution rate to the heat exchange performance is low. In this manner, the energy efficiency can be improved while an increase in cost is reduced.

Embodiment 2

[0047] Embodiment 2 of the present invention is described below. Description of the overlapping components to those of Embodiment 1 is (partially) omitted. Parts identical with or corresponding to those of Embodiment 1 are denoted by the same reference signs.

[0048] FIG. 9 is a schematic side view of a heat exchanger 10b of Embodiment 2 of the present invention and a periphery of the heat exchanger 10b. The arrows in FIG. 9 indicate flow of the refrigerant or flow of the air in the heating operation.

[0049] An outdoor unit 100b of the air-conditioning apparatus according to Embodiment 2 includes a gas-liquid separator 80 on an upstream side of the heat exchanger 10b. The gas-liquid separator 80 is used to control a quality of the refrigerant and is connected to a third pipe 82 through which the two-phase gas-liquid refrigerant flows, a fourth pipe 83 through which the gas refrigerant separated in the gas-liquid separator 80 flows, and the first pipe 40 through which the liquid refrigerant separated in the gas-liquid separator 80 flows. The fourth pipe 83 is connected to a bypass flow rate control valve 85. The bypass flow rate control valve 85 is connected to a fifth pipe 84. The fifth pipe 84 is connected to the second pipe 50. Further, the second pipe 50 is connected to a compressor 81.

[0050] FIG. 15 is a schematic view for illustrating a part of a configuration when an internal heat exchanger 110 is used as the quality control device for the outdoor unit of the air-conditioning apparatus.

[0051] Although the gas-liquid separator 80 corresponds to "quality control device" of the present invention, the gas-liquid separator 80 is merely an example of a device configured to control the quality, and the quality control device of the present invention is not limited to this example. As other quality control devices, the internal heat exchanger 110 as illustrated in FIG. 15 or other heat exchangers configured to exchange heat with a low-temperature heat source or other heat sources may be used.

[0052] As illustrated in FIG. 15, the refrigerant passes through a pipe 111 to flow into the internal heat exchanger 110. The refrigerant flowing into the internal heat exchanger 110 is self-cooled by a part of the refrigerant that is bypassed to a pipe 116 connected to an outlet of a heat exchanger 117, and passes through a pipe 112 under a reduced quality state to flow into the heat exchanger 117. Meanwhile, the bypassed refrigerant passes through a pipe 115. A bypass flow rate is controlled by a valve 114 installed on a pipe 113. The valve 114 installed on the pipe 113 is not limited to a valve and only needs to be a flow resistor such as a capillary tube, a narrow pipe, and a float valve.

[0053] Next, flow of the refrigerant in the heating operation of the outdoor unit 100b of the air-conditioning apparatus according to Embodiment 2 is described with reference to FIG. 9.

[0054] In the heating operation, the two-phase gas-liquid refrigerant passes through the third pipe 82 to flow into the gas-liquid separator 80. The two-phase gas-liquid refrigerant flowing into the gas-liquid separator 80 is separated into the gas refrigerant and the liquid refrigerant. The gas refrigerant separated in the gas-liquid separator 80 passes through the fourth pipe 83, the bypass flow rate control valve 85, the fifth pipe 84, and the second pipe 50 to flow into the compressor 81. Meanwhile, the liquid refrigerant separated in the gas-liquid separator 80 passes through the first pipe 40 to be split into the first branch pipe 41 and the second branch pipe 42.

[0055] The liquid refrigerant flowing into the second branch pipe 42 flows into the distributor 34 to be homogenized and then passes through the capillary tubes 33 to flow into the lower heat exchanger main body 30. The liquid refrigerant flowing into the lower heat exchanger main body 30 exchanges heat with the outside air sucked from the air inlet 2 to be gasified and then flows out to the lower header 35. Meanwhile, the liquid refrigerant flowing into the first branch pipe 41 flows into the first upper header 23 to be distributed to the flat pipes 22 and then flows from the flat pipes 22 into the

upper heat exchanger main body 20. The two-phase gas-liquid refrigerant flowing into the upper heat exchanger main body 20 exchanges heat with the outside air sucked from the air inlet 2 to be gasified and then flows out to the second upper header 24.

[0056] A flow rate ratio of the refrigerant flowing into the first branch pipe 41 and the refrigerant flowing into the second branch pipe 42 is determined by a total flow resistance of the first branch pipe 41, the first upper header 23, the flat pipes 22, the second upper header 24, and the first branch pipe 51 and a total flow resistance of the second branch pipe 42, the distributor 34, the capillary tubes 33, the circular pipes 32, the lower header 35, and the second branch pipe 52. In particular, by controlling the length of each of the capillary tubes 33, the flow rate ratio of the refrigerant flowing into the first branch pipe 41 and the refrigerant flowing into the second branch pipe 42 can be effectively controlled.

[0057] In this case, when a large amount of gas is contained in the refrigerant flowing into the first branch pipe 41, specifically, a gas refrigerant flow rate/total refrigerant flow rate ratio (hereinafter referred to as "quality") is large, the gas is liable to be accumulated in an upper part of the first upper header 23. Hence, the liquid refrigerant is liable to unequally flow into the flat pipes 22. Consequently, by reducing the flow rate of the gas refrigerant flowing into the first upper header 23 with the use of the gas-liquid separator 80, the distribution performance for the refrigerant flowing into the first upper header 23 is improved to improve the heat exchange performance.

[0058] Although the two-phase gas-liquid refrigerant is separated into the gas refrigerant and the liquid refrigerant by the gas-liquid separator 80 in Embodiment 2, the flow rate of gas refrigerant flowing into the first upper header 23 only needs to be reduced even without perfect separation between the gas refrigerant and the liquid refrigerant. Further, the pressure loss generated during the passage through the distributing device and the heat transfer pipes can be reduced as a whole by using the gas-liquid separator 80. Thus, the control of the flow rate ratio with the capillary tubes 33 is facilitated.

[0059] FIG. 10 is a schematic side view for illustrating another example of the heat exchanger 10b of Embodiment 2 of the present invention and the periphery of the heat exchanger 10b. FIG. 11 is a schematic side view for illustrating a further example of the heat exchanger 10b of Embodiment 2 of the present invention and the periphery of the heat exchanger 10b. The arrows in FIG. 10 and FIG. 11 indicate flow of refrigerant or flow of air in the heating operation.

[0060] The gas-liquid separator 80 is not limited to be arranged at a position illustrated in FIG. 9. The gas-liquid separator 80 may be arranged in the first branch pipe 41 as illustrated in FIG. 10 or may be arranged in the second branch pipe 42 as illustrated in FIG. 11. Further, it is more preferred to arrange a plurality of the gas-liquid separators 80 because a control range for the refrigerant flow rate in the first branch pipe 41 and the second branch pipe 42 is increased.

Embodiment 3

[0061] Embodiment 3 of the present invention is described below. Description of the overlapping components to those of Embodiment 1 is (partially) omitted. Parts identical with or corresponding to those of Embodiment 1 are denoted by the same reference signs.

[0062] FIG. 12 is a schematic side view of a heat exchanger 10c of Embodiment 3 of the present invention and a periphery of the heat exchanger 10c. The arrows in FIG. 12 indicate flow of the refrigerant or flow of the air in a cooling operation.

[0063] The heat exchanger 10c of Embodiment 3 includes at least two kinds of heat transfer pipes, which are the flat pipes 22 and the circular pipes 32, connected in series through an intermediate header 26.

[0064] The heat exchanger 10c is arranged below the fan 5 and includes the upper heat exchanger main body 20, the lower heat exchanger main body 30, a header 25, the intermediate header 26, the distributor 34, and the capillary tubes 33.

[0065] The upper heat exchanger main body 20 includes the plurality of fins 21 arranged in parallel at intervals and the plurality of flat pipes 22 passing through the fins 21 in a direction of parallel arrangement of the fins 21, inside which the refrigerant flows. The lower heat exchanger main body 30 includes a plurality of fins 31 arranged in parallel at intervals and the plurality of circular pipes 32 passing through the fins 31 in a direction of parallel arrangement of the fins 31, inside which the refrigerant flows. The upper heat exchanger main body 20 and the lower heat exchanger main body 30 are arranged in the up-and-down direction on a front view or a side view. The upper heat exchanger main body 20 is arranged on an upper side closer to the fan 5, whereas the lower heat exchanger main body 30 is arranged on a lower side farther from the fan 5.

[0066] Specifically, the plurality of flat pipes 22 of the upper heat exchanger main body 20 and the plurality of circular pipes 32 of the lower heat exchanger main body 30 are arranged in parallel in the direction of gravitational force.

[0067] One ends of the plurality of flat pipes 22 of the upper heat exchanger main body 20 are connected to the header 25, whereas one ends of the plurality of circular pipes 32 of the lower heat exchanger main body 30 are connected to the distributor 34 through the capillary tubes 33. Further, another ends of the plurality of flat pipes 22 of the upper heat exchanger main body 20 and another ends of the plurality of circular pipes 32 of the lower heat exchanger main body 30

30 are connected to the intermediate header 26. A distributing device connected to the upstream side of the upper heat exchanger main body 20 in the cooling operation is the header 25, whereas a distributing device connected to the upstream side of the lower heat exchanger main body 30 in the cooling operation is the distributor 34.

[0068] Further, the header 25 is connected to a first pipe 91 through which the gas refrigerant passes in the cooling operation, whereas the distributor 34 is connected to a second pipe 92 through which the liquid refrigerant passes in the cooling operation.

[0069] Next, flow of the refrigerant in the cooling operation of an outdoor unit 100c of the air-conditioning apparatus of Embodiment 3 is described with reference to FIG. 12.

[0070] In the cooling operation, high-temperature and high-pressure gas refrigerant passes through the first pipe 91 to flow into the header 25 to be distributed to the flat pipes 22 and then flows from the flat pipes 22 into the upper heat exchanger main body 20. The gas refrigerant flowing into the upper heat exchanger main body 20 exchanges heat with the outside air sucked from the air inlet 2 to reject heat and turn into a two-phase gas-liquid state and then flows into the intermediate header 26. The two-phase gas-liquid refrigerant in the intermediate header 26 flows into the circular pipes 32 of the lower heat exchanger main body 30 to further exchange heat with an air in the periphery of the circular pipes 32 to turn into a liquid single phase.

[0071] At this time, when the flat pipes 22 are used for the heat exchanger through which the two-phase gas-liquid refrigerant containing the liquid refrigerant at a larger ratio flows as in the case of the lower heat exchanger 12 including the circular pipes 32 as the heat transfer pipes, a reduction in heat transfer coefficient in the single liquid phase is more noticeable with the flat pipes 22 than with the circular pipes 32 in a case where a height of the heat exchanger is the same. Consequently, the circular pipes 32 are used for the heat exchanger through which the refrigerant containing the liquid refrigerant at a larger ratio flows, whereas the flat pipes 22 are used for the heat exchanger through which the refrigerant in a gas single phase and the refrigerant in the two-phase gas-liquid state flow. In this manner, the disadvantage of the flat pipes 22 in a liquid single phase portion can be compensated for, thereby being capable of providing the heat exchanger excellent in cost performance.

Embodiment 4

[0072] Embodiment 4 of the present invention is described below. Description of the overlapping components to those of Embodiment 1 is (partially) omitted. Parts identical with or corresponding to those of Embodiment 1 are denoted by the same reference signs.

[0073] FIG. 13 is a perspective view of an outdoor unit 100d of the air-conditioning apparatus according to Embodiment 4 of the present invention, and FIG. 14 is a schematic side view of a heat exchanger 10d of Embodiment 4 of the present invention. The arrows in FIG. 14 indicate flow of air.

[0074] The outdoor unit 100d of the air-conditioning apparatus according to Embodiment 4 of the present invention accommodates the heat exchanger 10d illustrated in 14.

[0075] The outdoor unit 100d of the air-conditioning apparatus is of side flow type and a refrigeration cycle is formed by circulating the refrigerant between the outdoor unit 100d and an indoor unit (not shown). The outdoor unit 100d is used, for example, as an outdoor unit for a multiple air-conditioning system for a building and is installed on a top of a building or in other places.

[0076] The outdoor unit 100d includes, as illustrated in FIG. 13, a casing 101 formed in a box-like shape, an air inlet (not shown) formed of an opening formed in a back surface of the casing 101, the heat exchanger 10d arranged inside the casing 101 on a side closer to the back surface, an air outlet 103 formed of an opening formed in a front surface of the casing 101, a fan guard 104 provided to allow ventilation through the fan guard 104 to cover the air outlet 103, and a fan 105 arranged inside the fan guard 104 and configured to suck the outside air from the air inlet and exhaust the outside air from the air outlet 103.

[0077] The heat exchanger 10d mounted in the outdoor unit 100d of the air-conditioning apparatus is configured to exchange heat between the outside air sucked from the air inlet by the fan 105 and the refrigerant. The heat exchanger 10d is arranged closer to the back surface than the fan 105.

[0078] The heat exchanger 10d includes a front-surface heat exchanger main body 120 including the fins 21 and the flat pipes 22 and a back-surface heat exchanger main body 130 including the fins 31 and the circular pipes 32. The front-surface heat exchanger main body 120 and the back-surface heat exchanger main body 130 are arranged in a fore-and-aft direction on a front view. More specifically, the front-surface heat exchanger main body 120 is arranged on a front surface side of the outdoor unit 100d, which is closer to the fan 105, whereas the back-surface heat exchanger main body 130 is arranged on a back surface side of the outdoor unit 100d, which is farther from the fan 105.

[0079] By arranging the front-surface heat exchanger main body 120 including the flat pipes 22 having high heat exchange performance as the heat transfer pipes in a front row that is closer to the fan 105 and the back-surface heat exchanger main body 130 including the circular pipes 32 as the heat transfer pipes in a back row as in Embodiment 4, the heat exchange performance can be improved with high cost performance in the front row in which a temperature

difference between the refrigerant and the outside air is large.

[0080] The upper heat exchanger main body 20 and the front-surface heat exchanger main body 120 correspond to "first heat exchanger main body" of the present invention, whereas the lower heat exchanger main body 30 and the back-surface heat exchanger main body 130 correspond to "second heat exchanger main body" of the present invention. Further, the front surface of the casing 101 corresponds to "side surface of a casing" of the present invention.

Embodiment 5

[0081] Embodiment 5 of the present invention is described below. Description of the overlapping components to those of Embodiment 1 is (partially) omitted. Parts identical with or corresponding to those of Embodiment 1 are denoted by the same reference signs.

[0082] FIG. 19 is a schematic side view of a heat exchanger 10e of Embodiment 5 of the present invention and a periphery of the heat exchanger 10e. The arrows in FIG. 19 indicate flow of the refrigerant or flow of the air in the heating operation.

[0083] The heat exchanger 10e of Embodiment 5 includes the first upper header 23 connected to a refrigerant flow upstream side of the upper heat exchanger main body 20, a first lower header 140 connected to a refrigerant flow upstream side of the lower heat exchanger main body 30, and a flow control valve 150 on an upstream side of the first lower header 140. The refrigerant flow rate in the upper heat exchanger main body 20 and the lower heat exchanger main body 30 is controlled by a valve opening degree.

[0084] Although an expansion valve is described herein as an example of a mechanism configured to control the refrigerant flow rate, the expansion valve is merely an example. Any mechanism such as a capillary tube and a float valve may be used as long as the flow resistance is changed to control the refrigerant flow rate. Further, although the header is connected as the distributing device connected to the upper heat exchanger main body 20 or the lower heat exchanger main body 30 merely as an example of Embodiment 5, the distributing device is not limited to this example.

A plurality of the distributors or the header and the distributor may be used together.

[0085] According to Embodiment 5, in the heating operation, the flow rate of the refrigerant flowing through the lower heat exchanger main body 30 including the circular pipes 32 is controlled by the flow control valve 150 to control the distribution, while the heat exchange contribution rate of the lower heat exchanger main body 30 can be changed. For example, even in a low-load operation, the heat exchanger that can stably supply the refrigerant of a higher flow rate to the upper heat exchanger main body 20 having a larger heat exchange contribution rate and is excellent in cost performance can be provided.

Embodiment 6

[0086] Embodiment 6 of the present invention is described below. Description of the overlapping components to those of Embodiment 1 is (partially) omitted. Parts identical with or corresponding to those of Embodiment 1 are denoted by the same reference signs.

[0087] FIG. 20 is a schematic side view of a heat exchanger 10f of Embodiment 6 of the present invention and a periphery of the heat exchanger 10f. The arrows in FIG. 20 indicate flow of the refrigerant or flow of the air in the heating operation.

[0088] In the heat exchanger 10f of Embodiment 6, a header connected to the upstream side of the lower heat exchanger main body 30 including the circular pipes 32 and the upper heat exchanger main body 20 including the flat pipes 22 in the heating operation is a single upstream header 160 without being divided in an up-and-down direction, and a header connected to the downstream side in the heating operation is a single downstream header 170 without being divided in the up-and-down direction. Specifically, the single upstream header 160 and the single downstream header 170 are connected over the upper heat exchanger main body 20 and the lower heat exchanger main body 30.

[0089] As described above, the headers are not divided in the up-and-down direction. As a result, the number of pipes can be reduced or the need of mounting the plurality of headers is eliminated. Thus, the cost performance can be improved.

[0090] Although each of the header connected to the upstream side of the upper heat exchanger main body 20 and the lower heat exchanger main body 30 in the heating operation and the header connected to the downstream side in the heating operation is a single header in Embodiment 6, the number of headers is not limited to this configuration. For example, the upstream sides may be connected to the single header, whereas the downstream sides may be connected to a plurality of headers that are separated from each other in the up-and-down direction. The upstream sides may be connected to the distributing device other than the header such as the distributor, whereas the downstream sides may be connected to a plurality of headers that are separated from each other in the up-and-down direction. Further, the upstream sides may be connected to a plurality of headers, distributors, or other distributing devices that are separated from each other in the up-and-down direction, whereas the downstream sides may be connected to a single header.

Embodiment 7

[0091] Embodiment 7 of the present invention is described below. Description of the overlapping components to those of Embodiment 1 is (partially) omitted. Parts identical with or corresponding to those of Embodiment 1 are denoted by the same reference signs.

[0092] FIG. 21 is a schematic side view of a heat exchanger 10g of Embodiment 7 of the present invention and a periphery of the heat exchanger 10g. The arrows in FIG. 21 indicate flow of the refrigerant or flow of the air in the heating operation.

[0093] The heat exchanger 10g of Embodiment 7 includes an anticorrosion sheet 180 inserted between the upper heat exchanger main body 20 and the lower heat exchanger main body 30. The anticorrosion sheet 180 is provided to decrease a progression rate of erosion of the lower heat exchanger main body 30 due to water discharge or other factors when, for example, dissimilar metals are provided in an up-and-down direction as in the case where the flat pipes 22 are made of aluminum and the circular pipes 32 are copper pipes or other metal pipes. Instead of providing the anticorrosion sheet 180, it is effective to make the upper heat exchanger main body 20 and the lower heat exchanger main body 30 of an identical material.

Embodiment 8

[0094] Embodiment 8 of the present invention is described below. Description of the overlapping components to those of Embodiment 1 is (partially) omitted. Parts identical with or corresponding to those of Embodiment 1 are denoted by the same reference signs.

[0095] FIG. 22 is a schematic side view of a heat exchanger 10h of Embodiment 8 of the present invention and a periphery of the heat exchanger 10h. The arrows in FIG. 22 indicate flow of the refrigerant or flow of the air in the heating operation.

[0096] In the heat exchanger 10h of Embodiment 8, in the heating operation, the lower heat exchanger main body 30 including the circular pipes 32 is arranged at a position farther from the fan 5 than the upper heat exchanger main body 20 including the flat pipes 22. In at least one of the upper heat exchanger main body 20 and the lower heat exchanger main body 30, the heat transfer pipes of the heat exchanger are arranged approximately vertically, specifically, are oriented in the vertical direction. In this manner, the refrigerant flowing through the header connected to the upper heat exchanger main body 20 or the lower heat exchanger main body 30 is little affected by a head difference of the header. Thus, the distribution can be improved.

[0097] Further, the flat pipes 22 having relatively high heat transfer performance are used at the positions closer to the fan 5, whereas the circular pipes 32 having relatively low heat transfer performance and high cost performance are arranged at the positions farther from the fan 5. In this manner, the heat exchanger excellent in cost performance can be provided. Further, although the header into which the refrigerant flows is positioned below the heat exchanger main body in FIG. 22, the position of the header is merely an example. For example, the refrigerant inflow position may be an upper portion of the heat exchanger main body or a lower portion of the upper heat exchanger main body 20 and an upper portion of the lower heat exchanger main body 30.

Embodiment 9

[0098] Embodiment 9 of the present invention is described below.

[0099] FIG. 23 is a first schematic view for illustrating an indoor unit 100e of the air-conditioning apparatus according to Embodiment 9 of the present invention, in which a turbofan 250 is mounted. FIG. 24 is a second schematic view for illustrating the indoor unit 100e of the air-conditioning apparatus according to Embodiment 9 of the present invention, in which the turbofan 250 is mounted. The arrows in FIG. 23 and FIG. 24 indicate flow of air.

[0100] The indoor unit 100e of the air-conditioning apparatus according to Embodiment 9 accommodates the turbofan 250 illustrated in FIG. 23 and FIG. 24. Further, a first heat exchanger 200 and a second heat exchanger 210 are mounted in a periphery of the turbofan 250. The first heat exchanger 200 is arranged in an upper part of the indoor unit 100e, which is above the second heat exchanger 210, specifically, arranged closer to a distal end of the turbofan 250.

[0101] The turbofan 250 is rotated by a motor 230. By the rotation of the turbofan 250, air flows into the indoor unit 100e along a bellmouth 240 and is blown in a distal direction by the turbofan 250. The blown air exchanges heat as passing through the first heat exchanger 200 and the second heat exchanger 210, which are arranged in the periphery of the turbofan 250, and is blown along an air passage formed by a ceiling member 190. Further, a drain pan 220 is arranged in a lower part of the second heat exchanger 210 to provide a structure of accumulating condensed water generated in the heat exchanger.

[0102] An air flow rate distribution in the indoor unit 100e according to Embodiment 9 is as illustrated in FIG. 24. The flat pipes 22 having relatively high heat exchange performance are used for the first heat exchanger 200, which is closer

to the distal end of the turbofan 250, in which an air flow rate is large, whereas the circular pipes 32 having relatively low heat exchange performance and high cost performance are used for the second heat exchanger 210, which is farther from the distal end of the turbofan 250, in which the air flow rate is small.

[0103] A refrigerant circuit of the first heat exchanger 200 and a refrigerant circuit of the second heat exchanger 210 may be connected in parallel or in series. It is more preferred that the second heat exchanger 210 be used as a heat exchanger for the liquid single phase in the cooling operation. Further, although a clearance is illustrated between the first heat exchanger 200 and the second heat exchanger 210 in FIG. 23 and FIG. 24, it is more preferred that the first heat exchanger 200 and the second heat exchanger 210 be held in contact with each other because a water discharge path for the fins is ensured.

[0104] Further, a configuration of the indoor unit 100e according to Embodiment 9 is also applicable to the outdoor unit.

Reference Signs List

[0105]

1	casing
2	air inlet
3	air outlet
4	fan guard
5	fan
10a	heat exchanger
10b	heat exchanger
10c	heat exchanger
10d	heat exchanger
10e	heat exchanger
10f	heat exchanger
10g	heat exchanger
10f	heat exchanger
11	upper heat exchanger
12	lower heat exchanger
20	upper heat exchanger main body
21	fin
22	flat pipe
22a	multi-hole flat pipe
23	first upper header
24	second upper header
25	header
26	intermediate header
30	lower heat exchanger main body
31	fin
32	circular pipe
33	capillary tube
34	distributor
35	lower header
40	first pipe
41	first branch pipe
42	second branch pipe
50	second pipe
51	first branch pipe
52	second branch pipe
61	distributor main pipe portion
62	distributor expanding portion
63	distributor flow-splitting member
64	area sudden reduction portion
70	header
80	gas-liquid separator
81	compressor
82	third pipe

	83	fourth pipe
	84	fifth pipe
	85	bypass flow rate control valve
	91	first pipe
5	92	second pipe
	100a	outdoor unit
	100b	outdoor unit
	100c	outdoor unit
	100d	indoor unit
10	100e	indoor unit
	101	casing
	103	air outlet
	104	fan guard
	105	fan
15	110	internal heat exchanger
	111	pipe
	112	pipe
	113	pipe
	114	valve
20	115	pipe
	116	pipe
	117	heat exchanger
	120	front-surface heat exchanger main body
	130	back-surface heat exchanger main body
25	140	first lower header
	150	flow control valve
	160	upstream header
	170	downstream header
	180	anticorrosion sheet
30	190	ceiling member
	200	first heat exchanger
	210	second heat exchanger
	220	drain pan
	230	motor
35	240	bellmouth
	250	turbofan

Claims

- 40
1. An outdoor unit of an air-conditioning apparatus, comprising:
- a casing having an air inlet and an air outlet, and forming an outer shell;
 - a fan provided inside the casing, and configured to suck outside air from the air inlet and exhaust the outside
 - 45 air from the air outlet; and
 - a heat exchanger provided inside the casing, and configured to exchange heat between the outside air sucked by the fan and refrigerant,
 - the heat exchanger including
 - a first heat exchanger main body including a plurality of fins arranged in parallel at an interval and a plurality
 - 50 of flat pipes passing through the plurality of fins in a direction of parallel arrangement of the plurality of fins, the refrigerant flowing inside the plurality of flat pipes, and
 - a second heat exchanger main body including a plurality of fins arranged in parallel at an interval and a plurality of circular pipes passing through the plurality of fins in a direction of parallel arrangement of the plurality of fins, the refrigerant flowing inside the plurality of circular pipes,
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- the first heat exchanger main body being arranged closer to the fan than is the second heat exchanger main body.
2. The outdoor unit of an air-conditioning apparatus of claim 1,

further comprising:

- a header connected to an upstream side of the first heat exchanger main body in a heating operation; and
- a distributor connected to an upstream side of the second heat exchanger main body in the heating operation through a capillary tube.

3. The outdoor unit of an air-conditioning apparatus of claim 1 or 2, further comprising a quality control device provided on an upstream side of the heat exchanger in a heating operation, and configured to control a quality of the refrigerant.

4. The outdoor unit of an air-conditioning apparatus of any one of claims 1 to 3, wherein the first heat exchanger main body and the second heat exchanger main body are arranged in an up-and-down direction on a front view, the first heat exchanger main body is arranged on or above the second heat exchanger main body, and the first heat exchanger main body and the second heat exchanger main body are connected in series through an intermediate header.

5. The outdoor unit of an air-conditioning apparatus of claim 4, wherein the outdoor unit is of top flow type having the air outlet formed in an upper surface of the casing.

6. The outdoor unit of an air-conditioning apparatus of any one of claims 1 to 3, wherein the first heat exchanger main body and the second heat exchanger main body are arranged in a fore-and-aft direction on a front view.

7. The outdoor unit of an air-conditioning apparatus of claim 6, wherein the outdoor unit is of side flow type having the air outlet formed in a side surface of the casing.

8. The outdoor unit of an air-conditioning apparatus of any one of claims 1 to 6, wherein at least any one of the first heat exchanger main body and the second heat exchanger main body has a mechanism of controlling a flow rate of the refrigerant flowing through the first heat exchanger main body and the second heat exchanger main body in a heating operation.

9. The outdoor unit of an air-conditioning apparatus of any one of claims 1 to 8, wherein a distributing device is connected to at least one of an upstream side and a downstream side of the first heat exchanger main body and the second heat exchanger main body in a heating operation over the first heat exchanger main body and the second heat exchanger main body.

10. The outdoor unit of an air-conditioning apparatus of any one of claims 1 to 9, further comprising an anticorrosion sheet inserted between the first heat exchanger main body and the second heat exchanger main body.

11. The outdoor unit of an air-conditioning apparatus of any one of claims 1 to 10, wherein the first heat exchanger main body and the second heat exchanger main body are made of an identical material.

12. The outdoor unit of an air-conditioning apparatus of any one of claims 1 to 6 and 8 to 11, wherein heat transfer pipes of at least one of the first heat exchanger main body and the second heat exchanger main body are arranged in a vertical direction.

13. An outdoor unit of an air-conditioning apparatus, comprising:

- a casing having an air inlet and an air outlet, and forming an outer shell;
- a turbofan provided inside the casing, and configured to suck outside air from the air inlet and exhaust the outside air from the air outlet; and
- a heat exchanger provided inside the casing, and configured to exchange heat between the outside air sucked by the turbofan and refrigerant, the heat exchanger including
- a first heat exchanger main body including a plurality of fins arranged in parallel at an interval and a plurality of flat pipes passing through the plurality of fins in a direction of parallel arrangement of the plurality of fins, the refrigerant flowing inside the plurality of flat pipes, and

- a second heat exchanger main body including a plurality of fins arranged in parallel at an interval and a plurality of circular pipes passing through the plurality of fins in a direction of parallel arrangement of the plurality of fins, the refrigerant flowing inside the plurality of circular pipes,

5 the first heat exchanger main body being arranged closer to a distal end of the turbofan than is the second heat exchanger main body.

14. The outdoor unit of an air-conditioning apparatus of claim 13,
10 wherein the first heat exchanger main body and the second heat exchanger main body are connected in series.

15. The outdoor unit of an air-conditioning apparatus of claim 13,
wherein the first heat exchanger main body and the second heat exchanger main body are connected in parallel.

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

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- a casing having an air inlet and an air outlet, and forming an outer shell;
 - a turbofan provided inside the casing, and configured to suck outside air from the air inlet and exhaust the outside air from the air outlet; and
 - a heat exchanger provided inside the casing, and configured to exchange heat between the outside air sucked
- 20 by the turbofan and refrigerant,
the heat exchanger including
- a first heat exchanger main body including a plurality of fins arranged in parallel at an interval and a plurality of flat pipes passing through the plurality of fins in a direction of parallel arrangement of the plurality of fins, the refrigerant flowing inside the plurality of flat pipes, and
 - a second heat exchanger main body including a plurality of fins arranged in parallel at an interval and a plurality
- 25 of circular pipes passing through the plurality of fins in a direction of parallel arrangement of the plurality of fins,
the refrigerant flowing inside the plurality of circular pipes,

30 the first heat exchanger main body being arranged closer to a distal end of the turbofan than is the second heat exchanger main body.

17. The indoor unit of an air-conditioning apparatus of claim 16,
wherein the first heat exchanger main body and the second heat exchanger main body are connected in series.

35 18. The indoor unit of an air-conditioning apparatus of claim 16,
wherein the first heat exchanger main body and the second heat exchanger main body are connected in parallel.

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FIG. 1

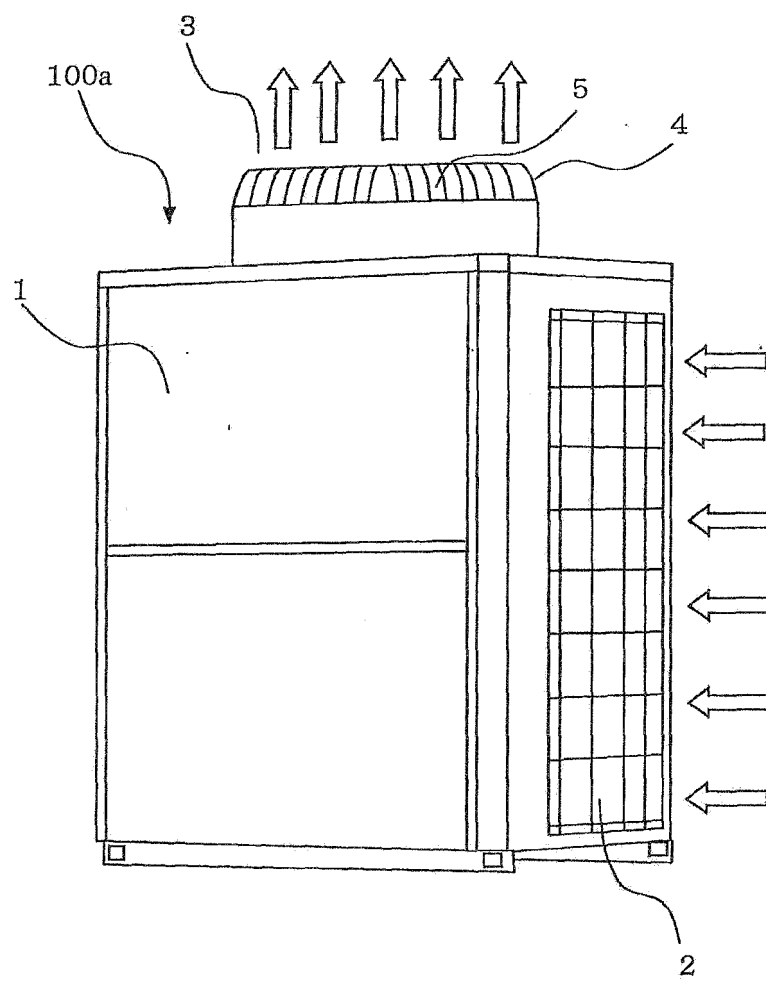


FIG. 2

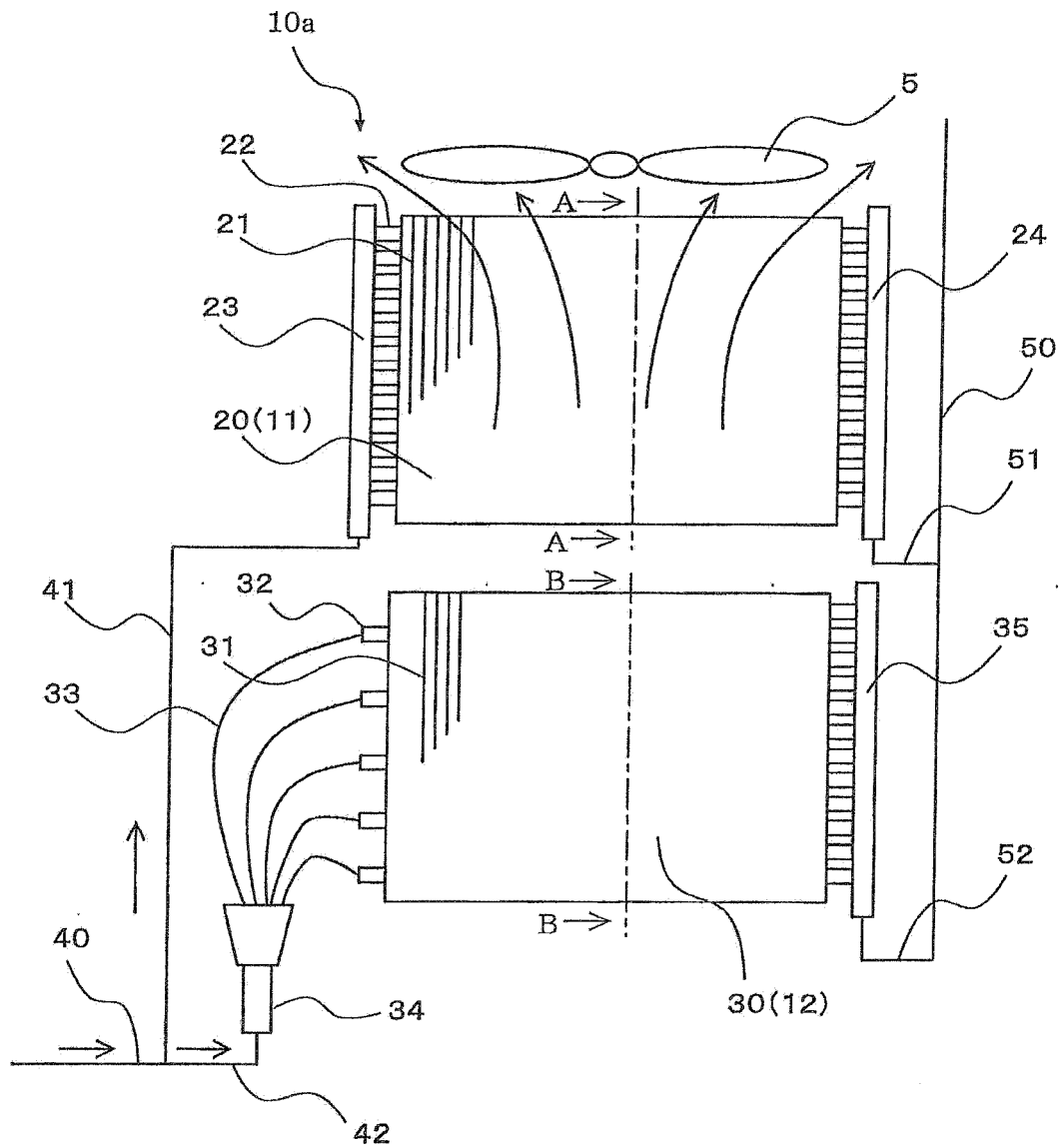


FIG. 3

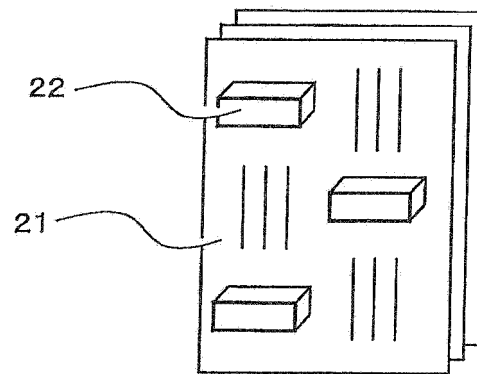


FIG. 4

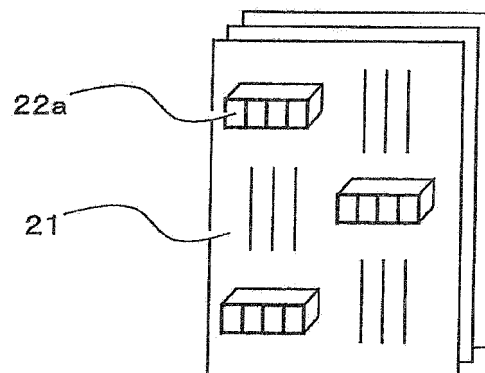


FIG. 5

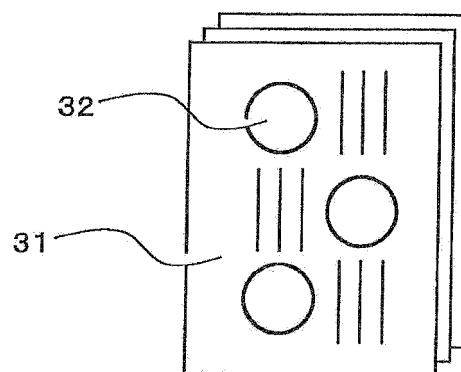


FIG. 6

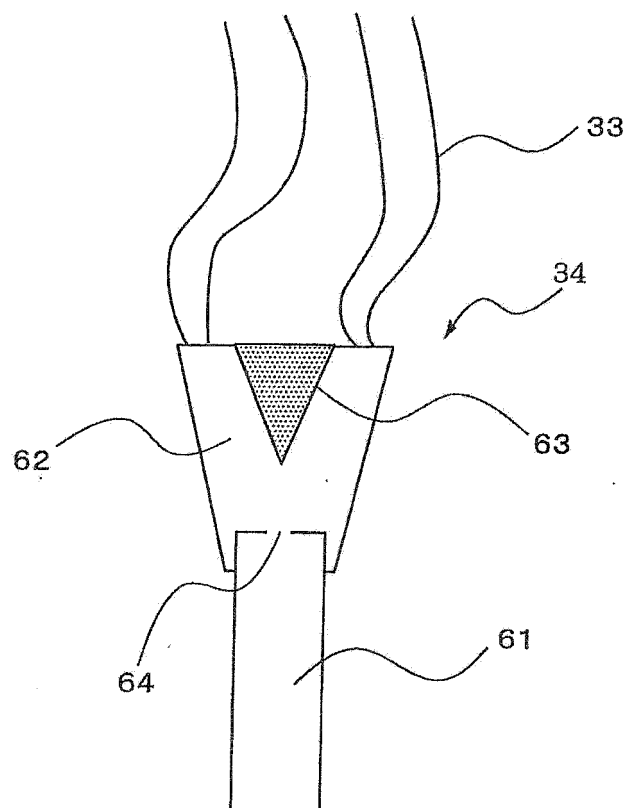


FIG. 7

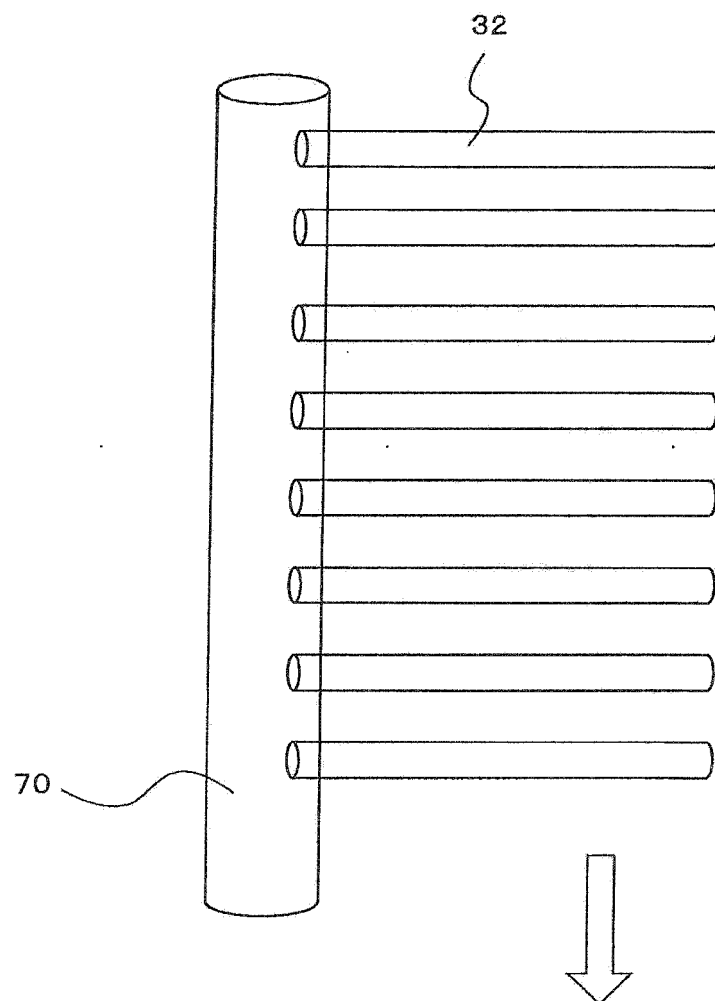


FIG. 8

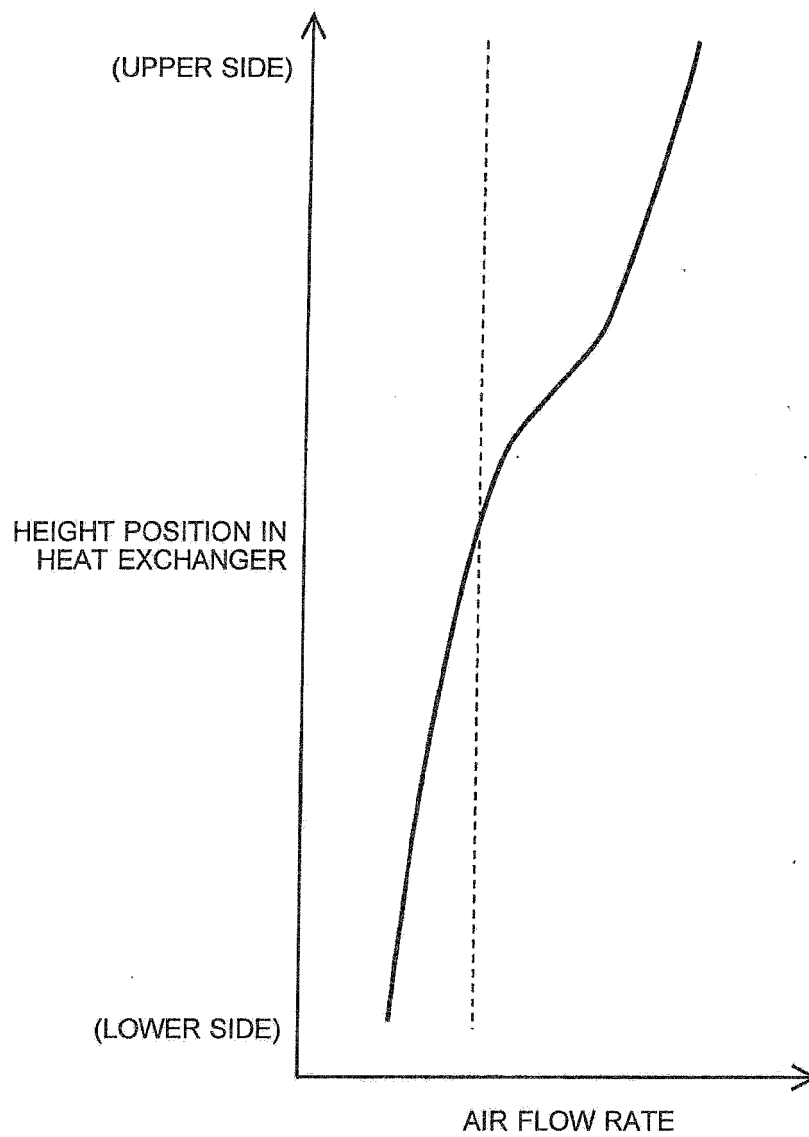


FIG. 9

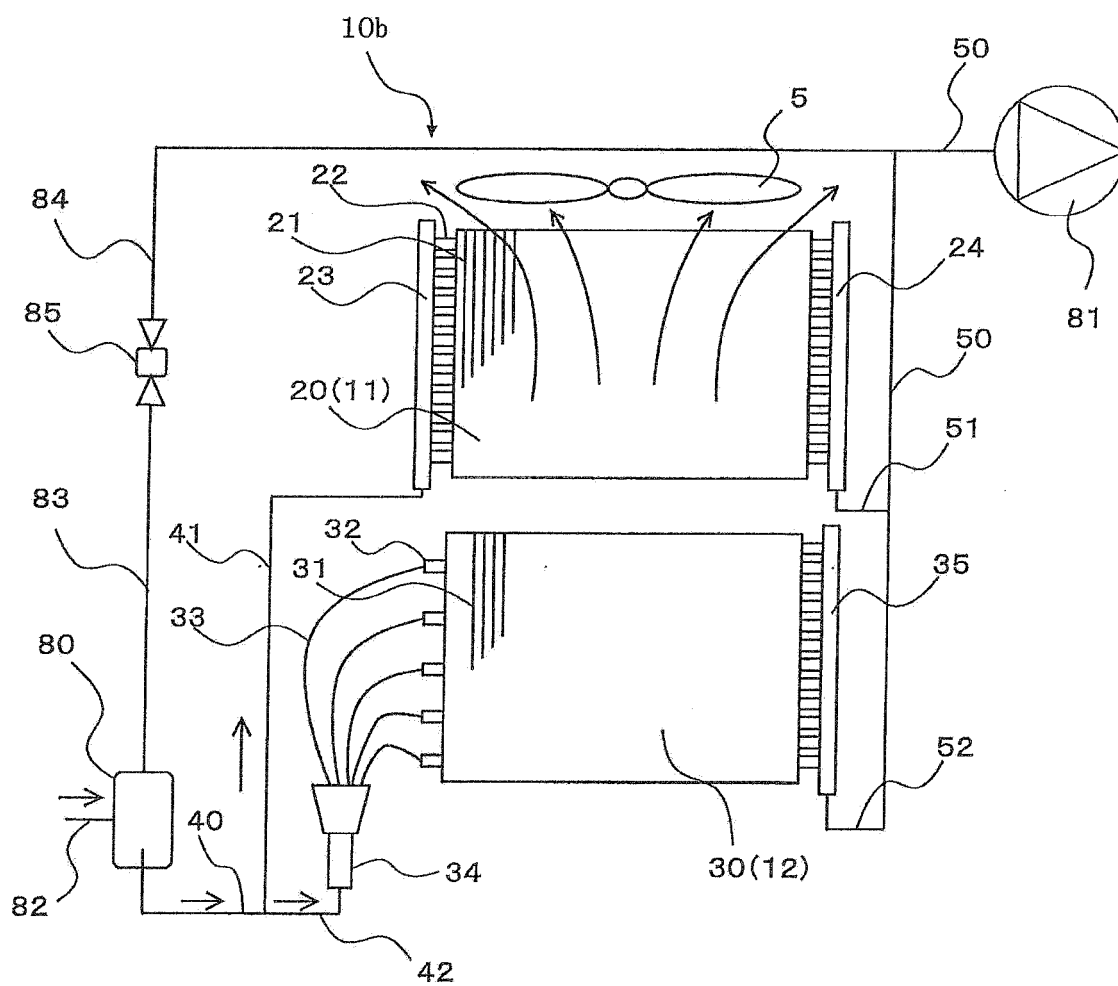


FIG. 10

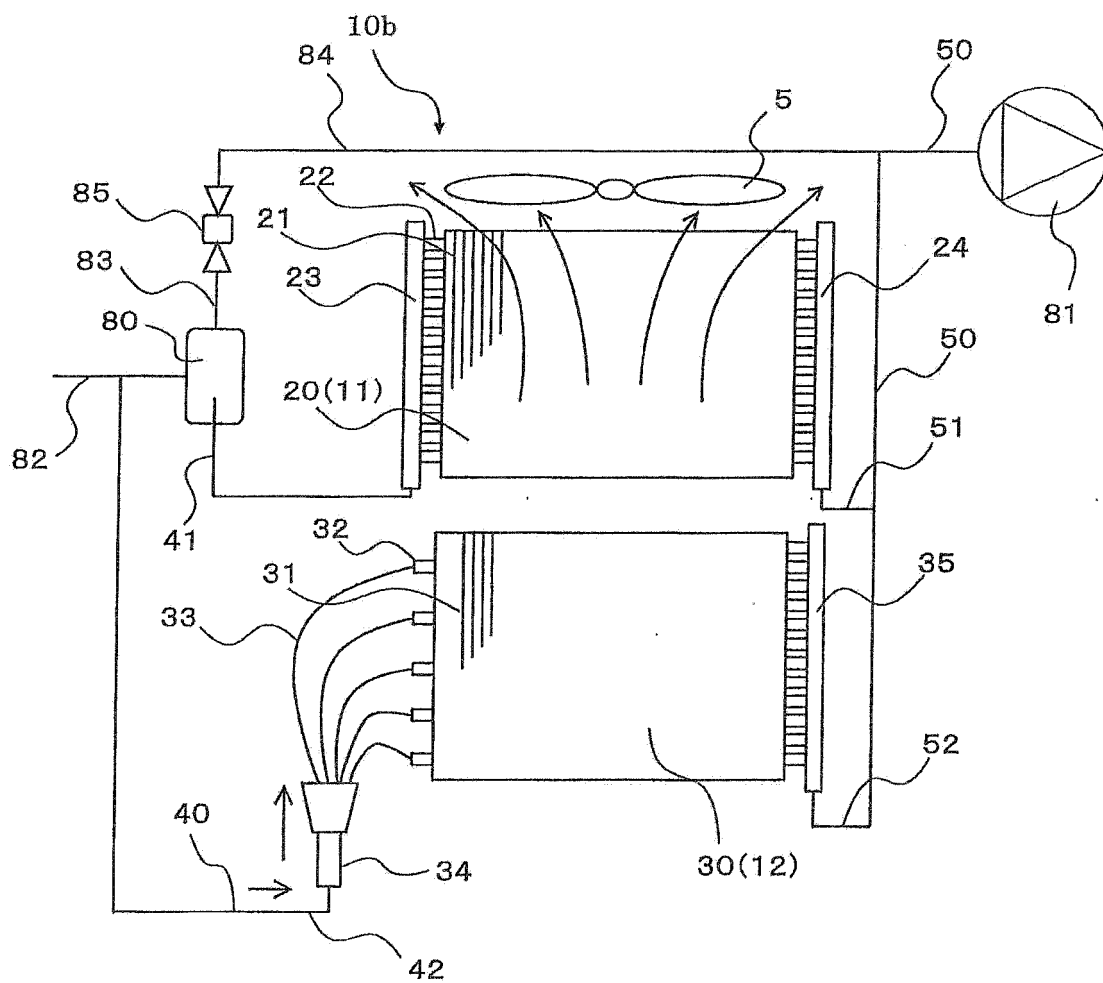


FIG. 11

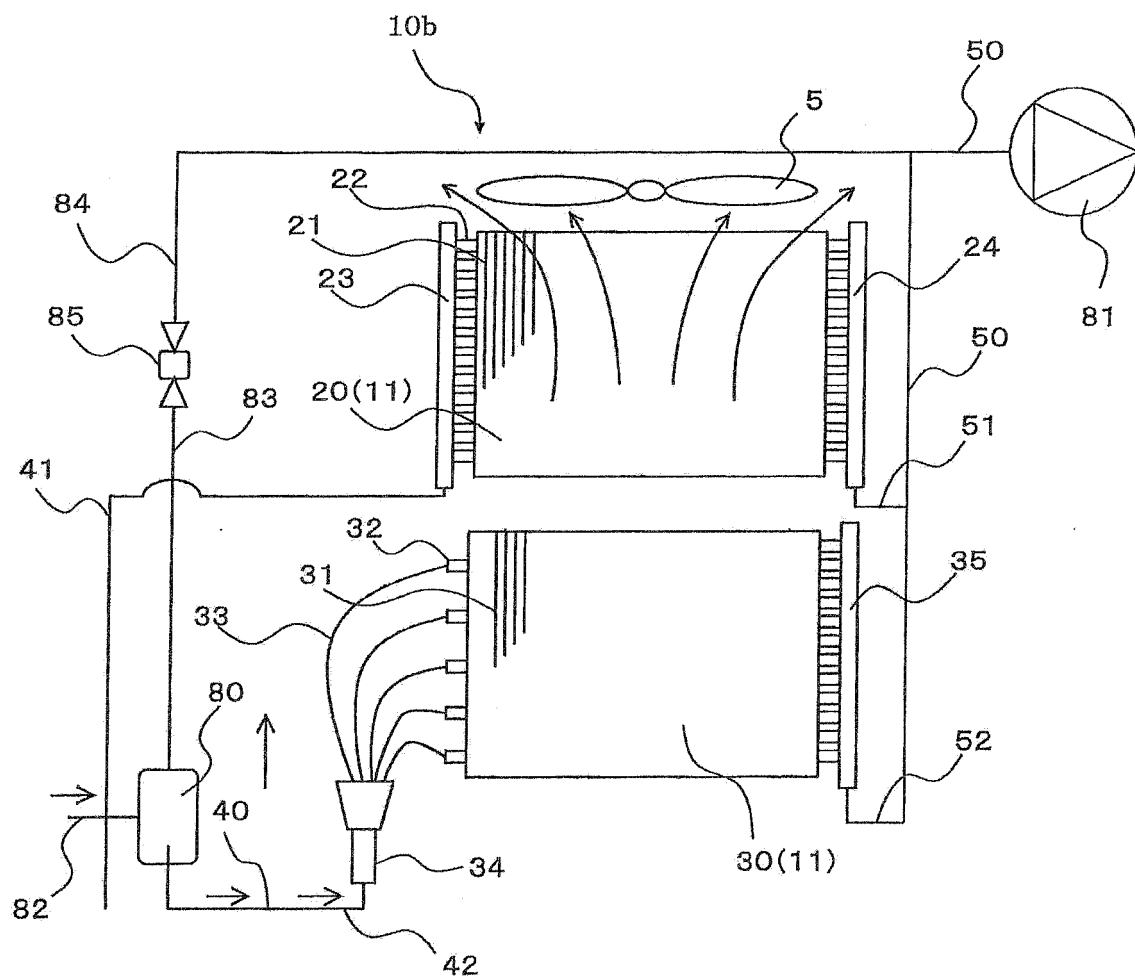


FIG. 12

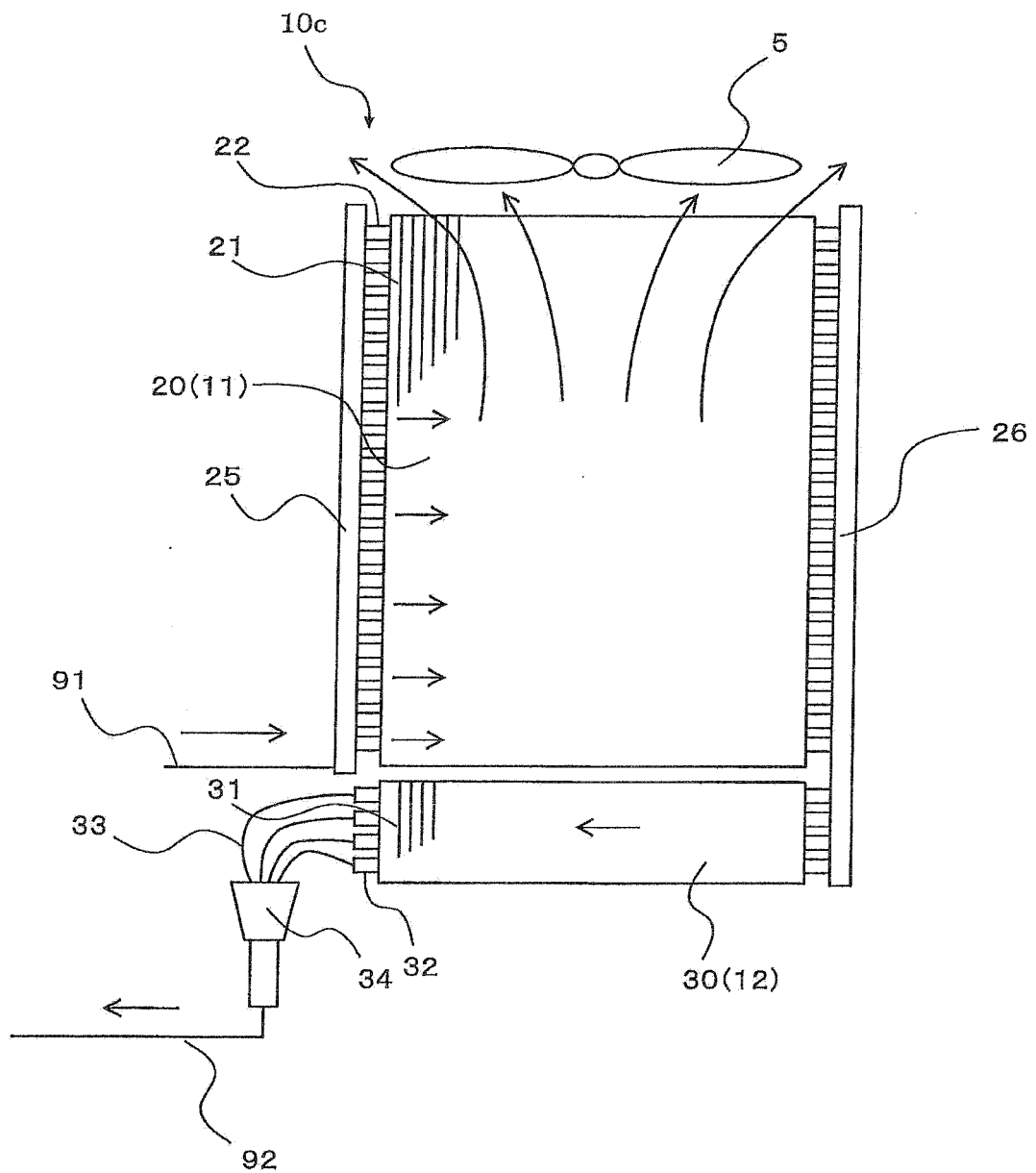


FIG. 13

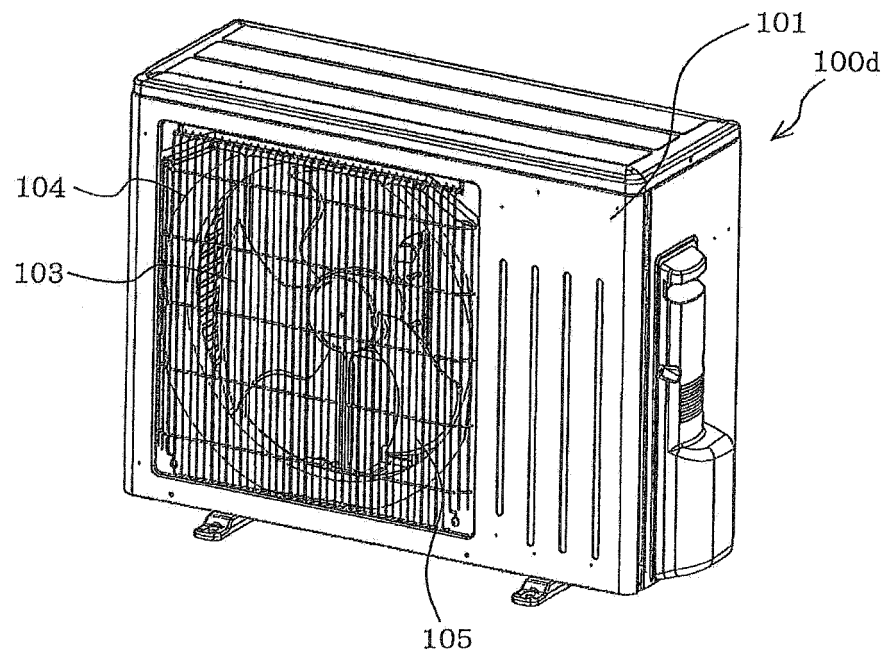


FIG. 14

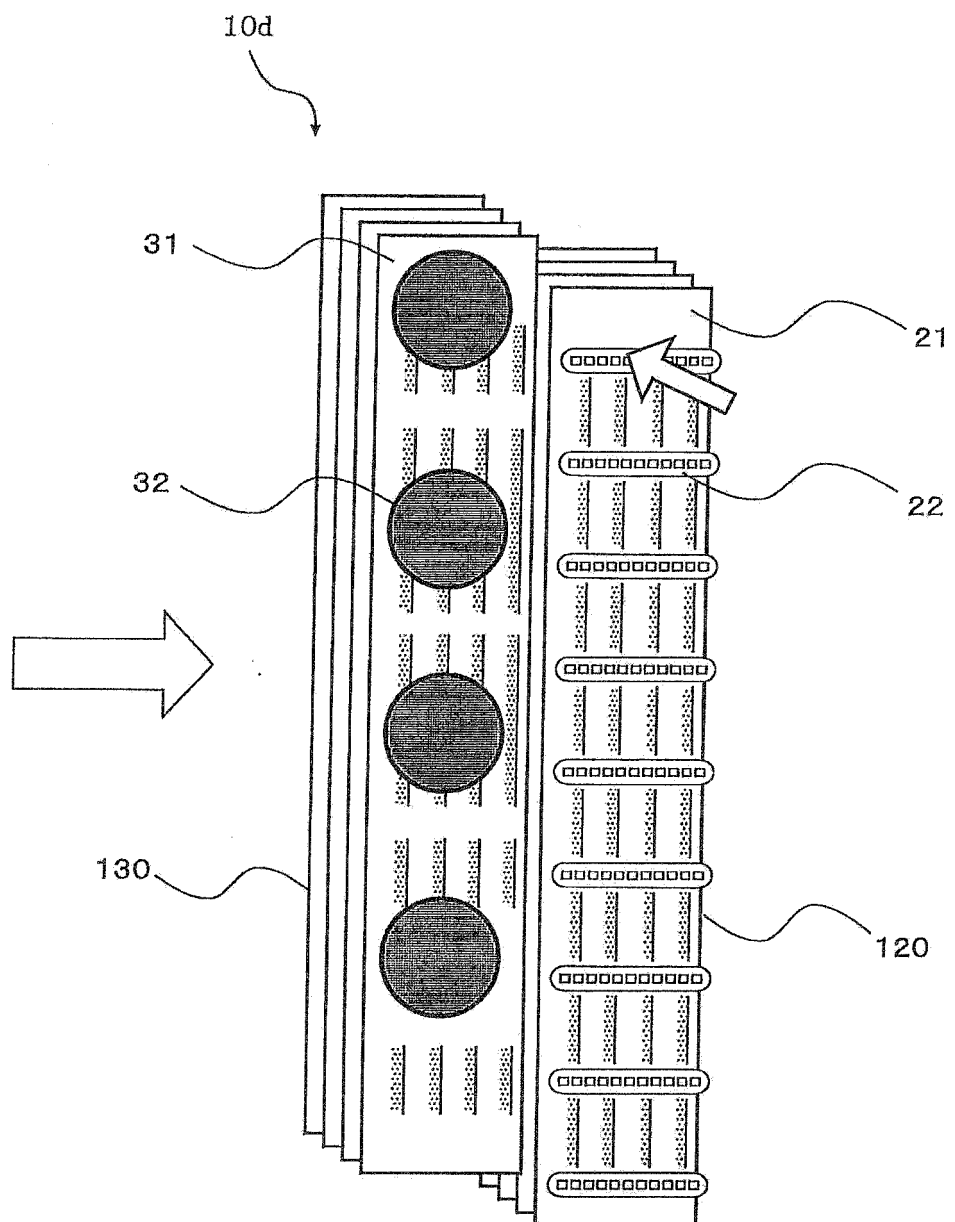


FIG. 15

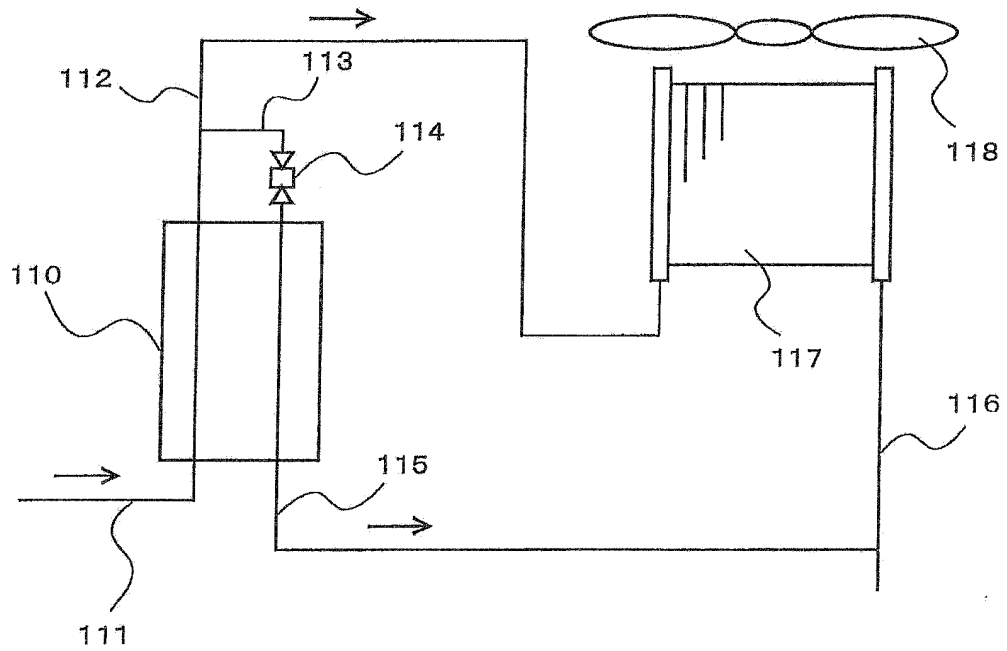


FIG. 16

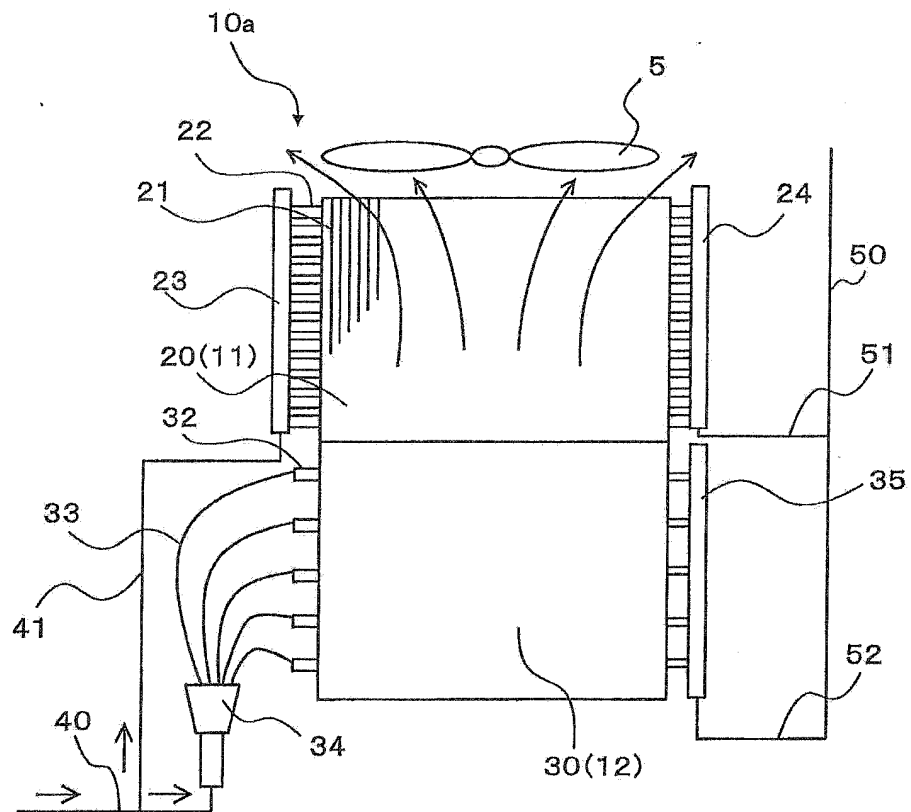


FIG. 17

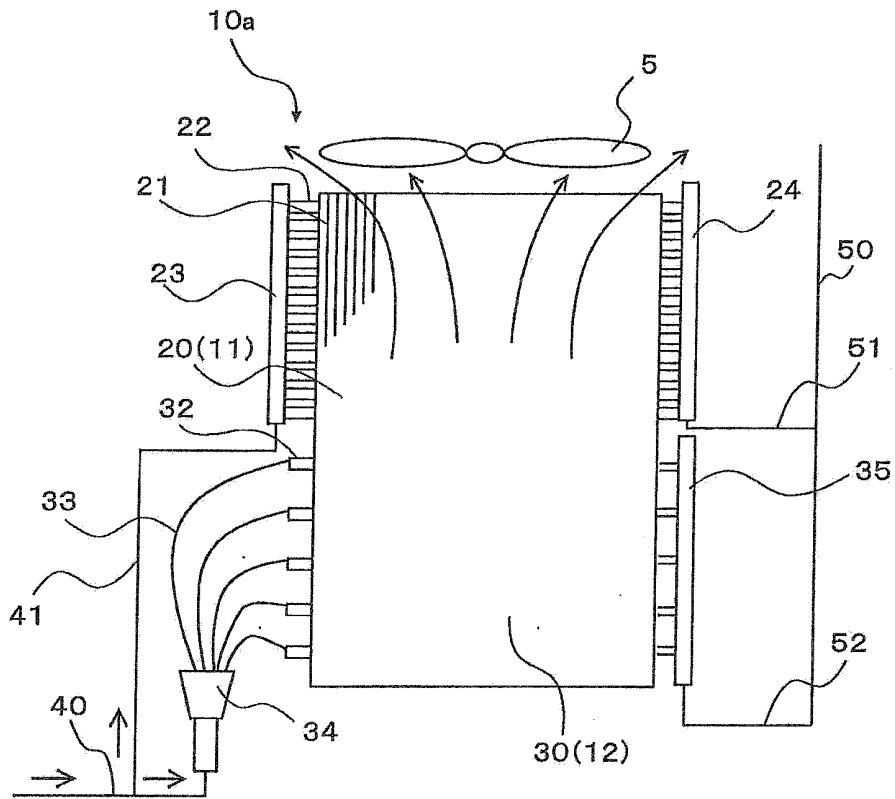


FIG. 18

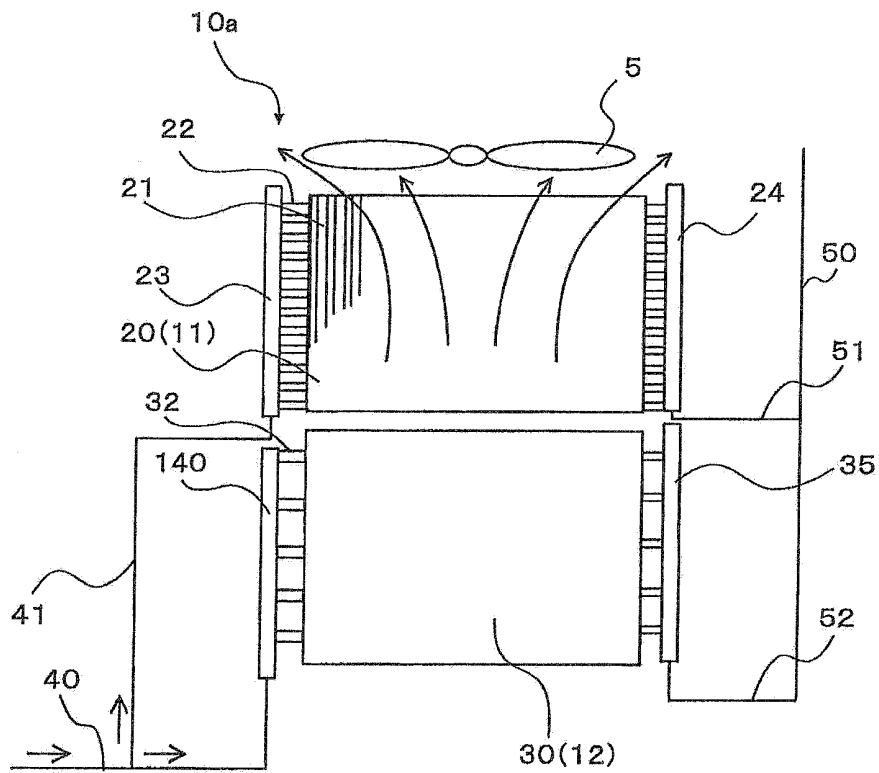


FIG. 19

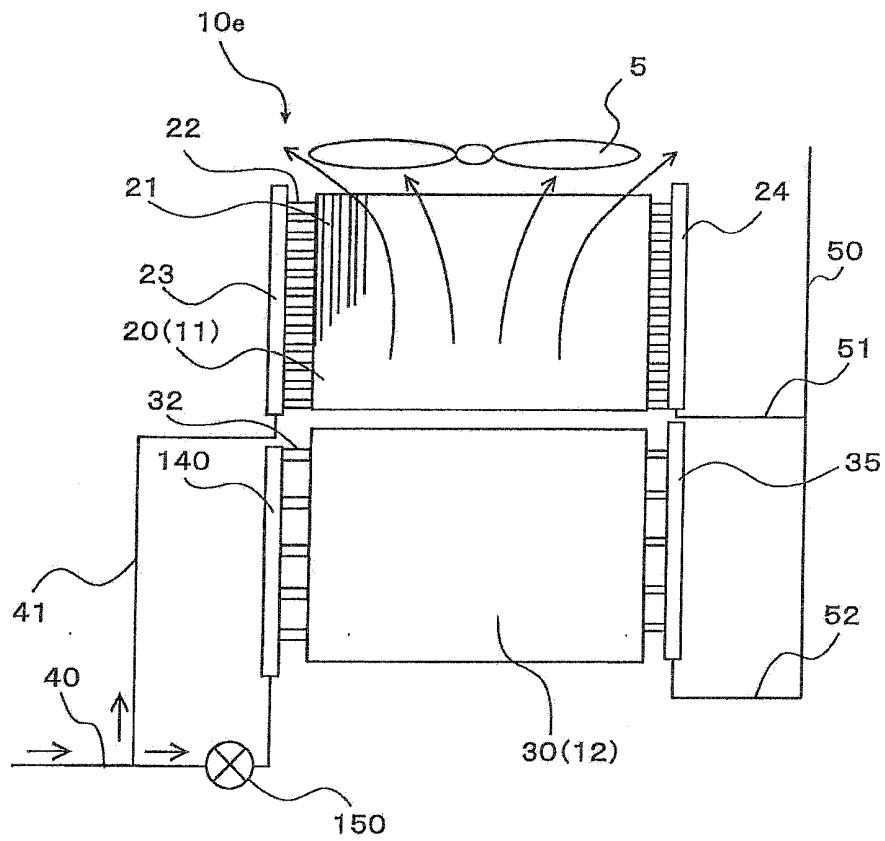


FIG. 20

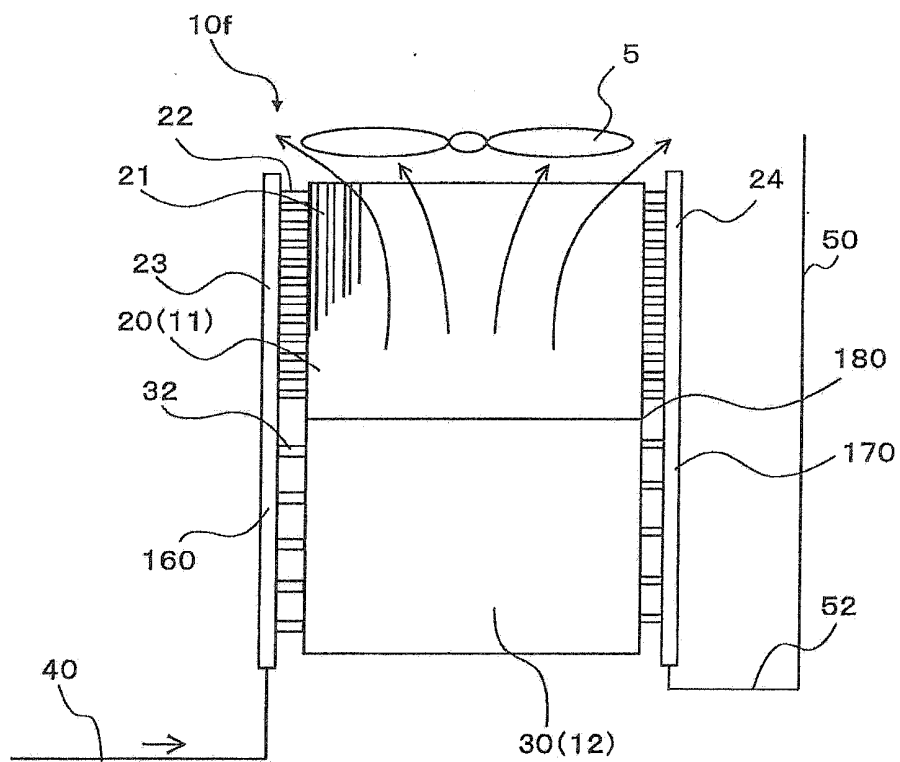


FIG. 21

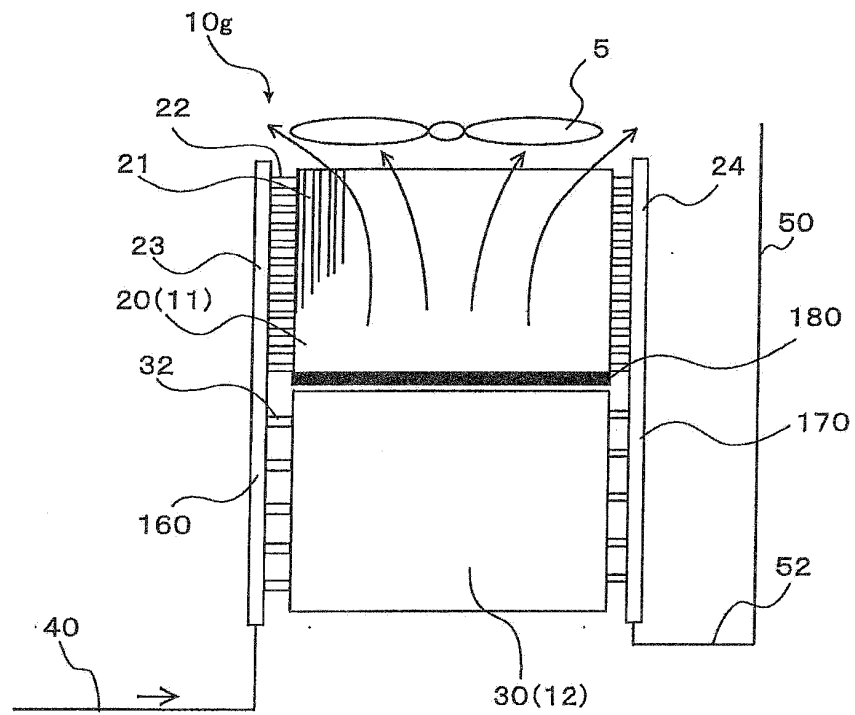


FIG. 22

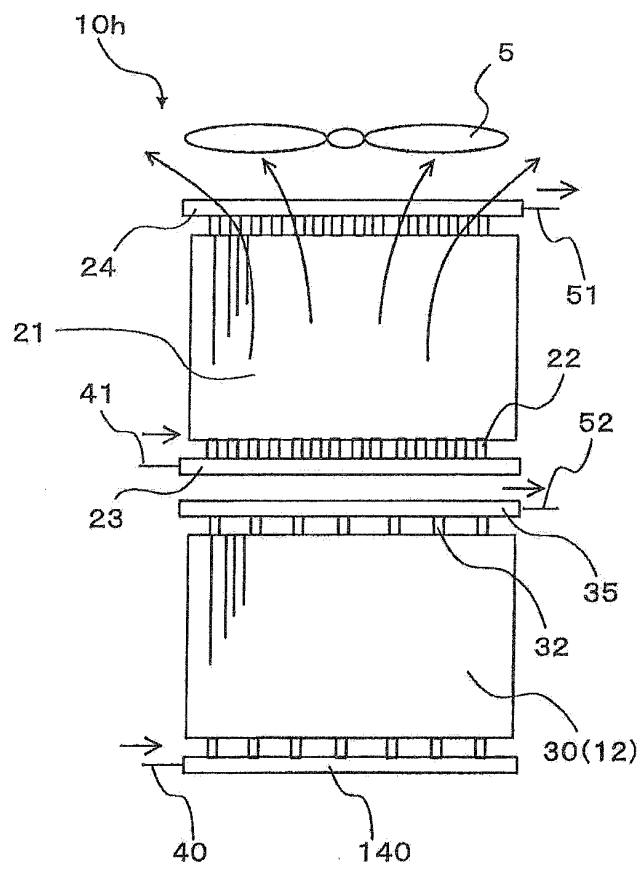


FIG. 23

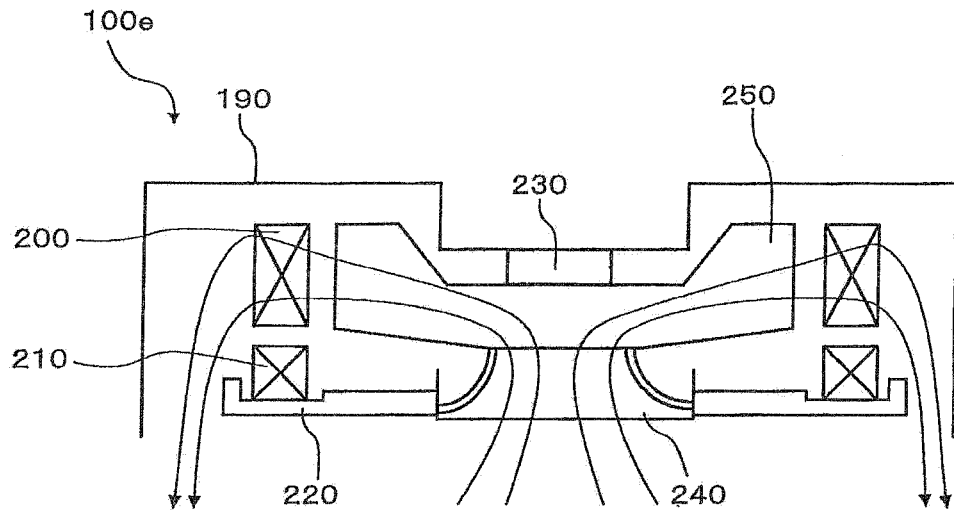
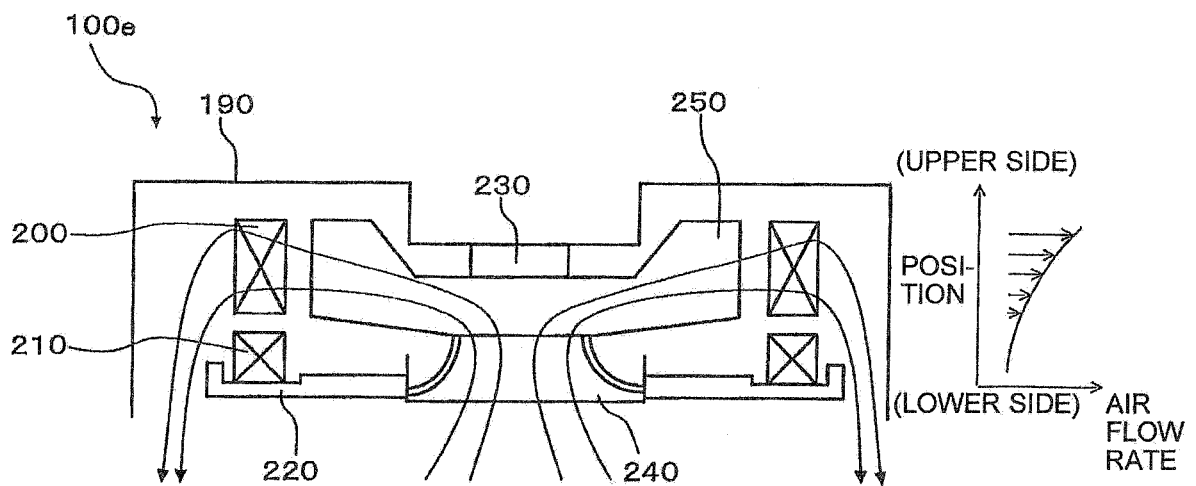


FIG. 24



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/061662

A. CLASSIFICATION OF SUBJECT MATTER

F24F1/16(2011.01)i, F24F1/18(2011.01)i, F24F1/50(2011.01)i, F24F13/30(2006.01)i, F25B39/02(2006.01)i, F25B41/00(2006.01)i, F28D1/053(2006.01)i, F28F9/26(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)

F24F1/16, F24F1/18, F24F1/50, F24F13/30, F25B39/02, F25B41/00, F28D1/053, F28F9/26

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 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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.
Y A	JP 2014-142138 A (Toshiba Corp.), 07 August 2014 (07.08.2014), paragraphs [0010] to [0032]; fig. 1 to 6 (Family: none)	1, 3-5, 8-18 2, 6-7
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 85416/1983 (Laid-open No. 189062/1984) (Mitsubishi Electric Corp.), 14 December 1984 (14.12.1984), specification, page 2, line 8 to page 3, line 8; fig. 2 to 3 (Family: none)	1, 3-5, 8-12

☒ 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 June 2016 (23.06.16)

Date of mailing of the international search report
05 July 2016 (05.07.16)

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
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Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/061662

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 2012-181013 A (Mitsubishi Electric Corp.), 20 September 2012 (20.09.2012), paragraphs [0027] to [0034]; fig. 5 (Family: none)	3-5, 8-12
Y	JP 2014-137157 A (Mitsubishi Electric Corp.), 28 July 2014 (28.07.2014), fig. 2 & EP 2754974 A2 fig. 2 & CN 103925654 A	4-5, 8-12
Y	JP 2013-139971 A (Mitsubishi Electric Corp.), 18 July 2013 (18.07.2013), paragraph [0032]; fig. 7 (Family: none)	12
Y	JP 2002-147781 A (Hitachi, Ltd.), 22 May 2002 (22.05.2002), paragraphs [0052] to [0053]; fig. 16 (Family: none)	13-18
A	JP 2010-133656 A (Sharp Corp.), 17 June 2010 (17.06.2010), entire text; all drawings (Family: none)	1, 6-7
A	WO 2012/035845 A1 (Sharp Corp.), 22 March 2012 (22.03.2012), entire text; all drawings & JP 2012-63089 A & CN 103097828 A	1
A	JP 2011-163741 A (Daikin Industries, Ltd.), 25 August 2011 (25.08.2011), entire text; all drawings & US 2012/0318487 A1 & WO 2011/099256 A & EP 2535677 A1	2

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Patent documents cited in the description

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