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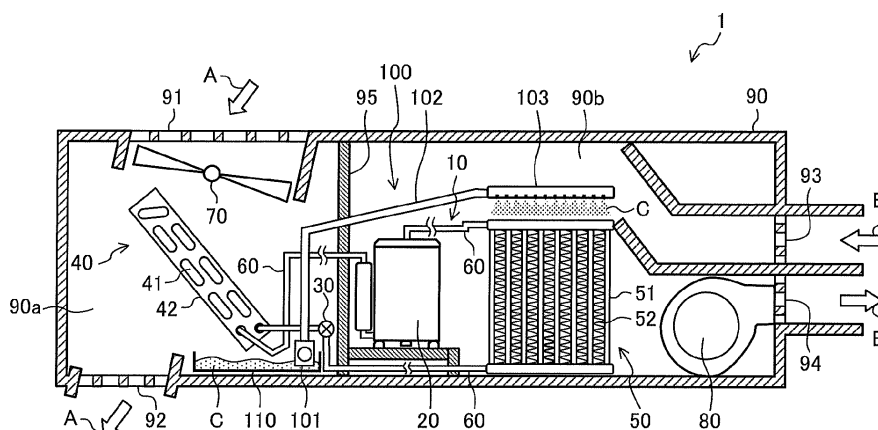
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(54) **AIR CONDITIONING DEVICE**

(57) An air-conditioning apparatus includes a housing, an evaporator, a condenser, and a water sprinkler for sprinkling condensed water to the condenser, the condensed water having been generated at the evaporator. The condenser includes a first header and a second header arranged parallel to each other, a first heat trans-

fer tube and a second heat transfer tube that are arranged parallel to each other and are arranged between the first header and the second header, and a fin disposed between the first heat transfer tube and the second heat transfer tube.

FIG. 1



## Description

### Technical Field

**[0001]** The present disclosure relates to an air-conditioning apparatus that has an evaporator and a condenser inside a housing.

### Background Art

**[0002]** In some technology, a unitary cooling apparatus has been proposed in which an evaporator and a condenser are disposed on the same plane and the evaporator is located higher than the condenser (see, for example, Patent Literature 1). In the unitary cooling apparatus, the evaporator and the condenser are each made of a spine fin tube. The spine fin tube is made by fixing multiple rectangular spine fins to the outer periphery of a circular tube that is circular in cross section.

### Citation List

#### Patent Literature

**[0003]** Patent Literature 1: Japanese Unexamined Patent Application Publication No. 8-61699

### Summary of Invention

#### Technical Problem

**[0004]** In the unitary cooling apparatus disclosed in Patent Literature 1, drain water (condensed water) drips from an evaporator onto a condenser, and the condensed water retained on the condenser evaporates with the heat of high-temperature refrigerant. However, in the unitary cooling apparatus disclosed in Patent Literature 1, the condenser is made of a spine fin tube, and thus it is difficult to retain the condensed water adhering to the spine fin tube. Thus, the amount of the condensed water to evaporate at the condenser is not sufficient, which is considered a problem.

**[0005]** The present disclosure has been made to solve the above problem and aims to provide an air-conditioning apparatus with which it is possible to increase the amount of condensed water to evaporate at a condenser.

### Solution to Problem

**[0006]** An air-conditioning apparatus according to an embodiment of the present disclosure includes a housing having a first air path through which indoor air passes and a second air path through which outdoor air passes; an evaporator disposed in the first air path and configured to exchange heat between the indoor air and refrigerant; a condenser disposed in the second air path and configured to exchange heat between the outdoor air and the refrigerant; and a water sprinkler configured to sprinkle

condensed water to the condenser, the condensed water being generated at the evaporator. The condenser includes a first heat transfer tube and a second heat transfer tube that are arranged parallel to each other, and a fin arranged between the first heat transfer tube and the second heat transfer tube.

### Advantageous Effects of Invention

**[0007]** In the air-conditioning apparatus according to an embodiment of the present disclosure, the condenser includes the first heat transfer tube and the second heat transfer tube that are arranged parallel to each other, and the fin arranged between the first heat transfer tube and the second heat transfer tube. Thus, it is possible to increase the amount of condensed water to evaporate at the condenser.

### Brief Description of Drawings

#### **[0008]**

[Fig. 1] Fig. 1 schematically illustrates a configuration of an air-conditioning apparatus according to Embodiment 1 of the present disclosure.

[Fig. 2] Fig. 2 is a perspective view of a condenser of the air-conditioning apparatus according to Embodiment 1 of the present disclosure.

[Fig. 3] Fig. 3 is a front view of a part of the condenser of the air-conditioning apparatus according to Embodiment 1 of the present disclosure.

[Fig. 4] Fig. 4 schematically illustrates a variation of the configuration of the air-conditioning apparatus according to Embodiment 1 of the present disclosure.

[Fig. 5] Fig. 5 is a perspective view of a condenser of an air-conditioning apparatus according to Embodiment 2 of the present disclosure.

[Fig. 6] Fig. 6 is a top view of the condenser of the air-conditioning apparatus according to Embodiment 2 of the present disclosure.

[Fig. 7] Fig. 7 is a perspective view of a condenser of an air-conditioning apparatus according to Embodiment 3 of the present disclosure.

[Fig. 8] Fig. 8 is a perspective view of a variation of the condenser of the air-conditioning apparatus according to Embodiment 3 of the present disclosure.

[Fig. 9] Fig. 9 is a perspective view of a condenser of an air-conditioning apparatus according to Embodiment 4 of the present disclosure.

[Fig. 10] Fig. 10 is a vertical cross-sectional view of the condenser of the air-conditioning apparatus according to Embodiment 4 of the present disclosure.

[Fig. 11] Fig. 11 schematically illustrates a configuration of an air-conditioning apparatus according to Embodiment 5 of the present disclosure.

[Fig. 12] Fig. 12 schematically illustrates a variation of the configuration of the air-conditioning apparatus

according to Embodiment 5 of the present disclosure.

#### Description of Embodiments

**[0009]** Hereinafter, embodiments of the present disclosure are described with appropriate reference to the drawings. It should be noted that in the drawings referenced below and including Fig. 1, size relationships between structural elements may differ from actual ones. In addition, in the drawings referenced below and including Fig. 1, structural elements illustrated with the same reference sign are the same or equivalent elements throughout the specification. Moreover, forms of the structural elements given throughout the specification are mere examples and are not limited to the given examples.

#### Embodiment 1

##### (Configuration)

**[0010]** Fig. 1 schematically illustrates a configuration of an air-conditioning apparatus according to Embodiment 1 of the present disclosure.

**[0011]** As illustrated in Fig. 1, an air-conditioning apparatus 1 includes a housing 90. The housing 90 has an indoor air inlet 91, an indoor air outlet 92, an outdoor air inlet 93, and an outdoor air outlet 94. The indoor air inlet 91 is an opening for suctioning indoor air A into the housing 90 from inside the room. The indoor air outlet 92 is an opening for blowing the indoor air A into the room. The outdoor air inlet 93 is an opening for suctioning outdoor air B into the housing 90 from outside the room. The outdoor air outlet 94 is an opening for blowing the outdoor air B to outside the room.

**[0012]** A separation plate 95 separates the housing 90 into two spaces, in which a first air path 90a and a second air path 90b are formed. The indoor air A passes through the first air path 90a, and the outdoor air B passes through the second air path 90b. That is, the separation plate 95 separates the housing 90 into the space that communicates with the indoor air inlet 91 and the indoor air outlet 92 and the space that communicates with the outdoor air inlet 93 and the outdoor air outlet 94.

**[0013]** The air-conditioning apparatus 1 includes a refrigerant circuit 10. The refrigerant circuit 10 includes a compressor 20, an expansion valve 30, an evaporator 40, and a condenser 50. The compressor 20, the condenser 50, the expansion valve 30, and the evaporator 40 are connected to each other in sequence via refrigerant pipes 60 to form an annulus, which enables refrigerant to circulate. The refrigerant pipes 60 are made of, for example, aluminum.

**[0014]** The evaporator 40 is disposed in the first air path 90a inside the housing 90. The evaporator 40 exchanges heat between the indoor air A and the refrigerant. The evaporator 40 includes heat transfer tubes 41

and fins 42 connected to the heat transfer tubes 41. The refrigerant flows through the heat transfer tubes 41. It should be noted that Fig. 1 includes a side view of the evaporator 40. The heat transfer tubes 41 correspond to evaporator-side heat transfer tubes, and the fins 42 correspond to evaporator-side fins.

**[0015]** The inside of each of the heat transfer tubes 41 has a refrigerant path. The heat transfer tubes 41 are, for example, circular tubes that are circular in a cross section perpendicular to the axis of the refrigerant path. It should be noted that the heat transfer tubes 41 are not limited to circular tubes and may be flat tubes that are flat in a cross section perpendicular to the axis of the refrigerant path.

**[0016]** The fins 42 are, for example, plate fins. It should be noted that the fins 42 are not limited to plate fins and may be corrugated fins.

**[0017]** The heat transfer tubes 41 and the fins 42, which form the evaporator 40, are made of aluminum.

**[0018]** An indoor-air-sending device 70 is disposed in the first air path 90a. The indoor-air-sending device 70 suctions the indoor air A through the indoor air inlet 91 and blows the indoor air A into the room through the indoor air outlet 92. The indoor-air-sending device 70 is, for example, a propeller fan. It should be noted that the indoor-air-sending device 70 is not limited to a propeller fan and may be, for example, a cross-flow fan.

**[0019]** Inside the housing 90, an indoor-side drain pan 110 is disposed below the evaporator 40 and stores condensed water C generated at the evaporator 40.

**[0020]** The condenser 50 is disposed in the second air path 90b. The condenser 50 exchanges heat between the outdoor air B and the refrigerant. The configuration of the condenser 50 is described later.

**[0021]** An outdoor-air-sending device 80 is disposed in the second air path 90b. The outdoor-air-sending device 80 suctions the outdoor air B through the outdoor air inlet 93 and blows the outdoor air B to outside the room through the outdoor air outlet 94. The outdoor-air-sending device 80 is, for example, a sirocco fan. It should be noted that the outdoor-air-sending device 80 is not limited to a sirocco fan and may be, for example, a propeller fan.

**[0022]** The first air path 90a and the second air path 90b in the housing 90 are adjacent to each other in the horizontal direction inside the housing 90. That is, the evaporator 40 and the condenser 50 are apart from each other in the horizontal direction inside the housing 90.

**[0023]** The compressor 20 is disposed in the second air path 90b. The expansion valve 30 is disposed in the first air path 90a. It should be noted that the compressor 20 may be disposed in the second air path 90b. The expansion valve 30 may be disposed in the second air path 90b.

**[0024]** The inside of the housing 90 accommodates the compressor 20, the expansion valve 30, the evaporator 40, and the condenser 50. In the air-conditioning apparatus 1, the housing 90 has the first air path 90a,

through which the indoor air A passes, and the second air path 90b, through which the outdoor air B passes. That is, the air-conditioning apparatus 1 is a unitary air-conditioning apparatus.

**[0025]** The air-conditioning apparatus 1 includes a water sprinkler 100. The water sprinkler 100 includes a water pump 101, a water pipe 102, and a water-sprinkling portion 103. The water-sprinkling portion 103 is disposed above the condenser 50 inside the housing 90. The water pump 101 is disposed in the indoor-side drain pan 110. The water pipe 102 connects the water pump 101 and the water-sprinkling portion 103 to each other. With the water sprinkler 100, the water pump 101 suctions the condensed water C stored in the indoor-side drain pan 110. Then, the water pipe 102 allows the suctioned condensed water C to flow to the water-sprinkling portion 103. The water-sprinkling portion 103 sprinkles the condensed water C onto the condenser 50. That is, the water sprinkler 100 sprinkles the condensed water C generated at the evaporator 40 onto the condenser 50.

**[0026]** Fig. 2 is a perspective view of the condenser of the air-conditioning apparatus according to Embodiment 1 of the present disclosure.

**[0027]** It should be noted that in Fig. 2, the z-direction corresponds to the vertical direction. The x-direction is the direction in which the outdoor air B passes through the condenser 50. The y-direction is the direction perpendicular to the z-direction and the y-direction. The x-direction and the y-direction are parallel to a horizontal plane.

**[0028]** As illustrated in Fig. 2, the condenser 50 includes heat transfer tubes 51, fins 52, a first header 53, and a second header 54.

**[0029]** The heat transfer tubes 51 are arranged parallel to each other and are arranged between the first header 53 and the second header 54. The heat transfer tubes 51 are disposed in such a manner that, for example, the longitudinal direction of the heat transfer tubes 51 is identical to the vertical direction. The inside of each of the heat transfer tubes 51 has a refrigerant path. The heat transfer tubes 51 are flat tubes that are flat in a cross section perpendicular to the axis of the refrigerant path. The heat transfer tubes 51 are disposed in such a manner that the long axis of the flat cross section is in the direction in which the outdoor air B flows.

**[0030]** The first header 53 and the second header 54 are arranged parallel to each other. The first header 53 and the second header 54 are disposed in such a manner that, for example, the longitudinal direction of the first header 53 and the second header 54 is identical to the horizontal direction. The first header 53 is located higher than the second header 54. The first header 53 is connected to one end portion of each of the heat transfer tubes 51. Moreover, the water sprinkler 100 sprinkles the condensed water C onto the top of the first header 53. The second header 54 is connected to the other end portion of each of the heat transfer tubes 51. The refrigerant that has flowed into the first header 53 diverges into

streams, and the refrigerant streams then flow into the refrigerant paths of the heat transfer tubes 51. The refrigerant streams are mixed in the second header 54, and confluent refrigerant flows out from the second header 54.

**[0031]** Each of the fins 52 is disposed between the heat transfer tubes 51. The fins 52 are, for example, corrugated fins.

**[0032]** Fig. 3 is a front view of a part of the condenser of the air-conditioning apparatus according to Embodiment 1 of the present disclosure.

**[0033]** As illustrated in Fig. 3, the heat transfer tubes 51 include a first heat transfer tube 51-1 and a second heat transfer tube 51-2. The first heat transfer tube 51-1 and the second heat transfer tube 51-2 are arranged adjacent and parallel to each other. The fin 52 is disposed between the first heat transfer tube 51-1 and the second heat transfer tube 51-2.

**[0034]** The first header 53, the second header 54, the heat transfer tubes 51, and the fins 52, which form the condenser 50, are made of aluminum.

(Operation)

**[0035]** Hereinafter, operation of the air-conditioning apparatus 1 is described.

**[0036]** When a cooling operation starts, the compressor 20, the indoor-air-sending device 70, and the outdoor-air-sending device 80 start operating. The compressor 20 suctions low-temperature, low-pressure refrigerant and discharges high-temperature, high-pressure refrigerant. The high-temperature, high-pressure refrigerant discharged from the compressor 20 flows into the condenser 50. Then, the refrigerant that has flowed into the condenser 50 exchanges heat with the outdoor air B sent from the outdoor-air-sending device 80 and rejects heat. Thus, the temperature of the refrigerant decreases, and the refrigerant becomes liquid-state refrigerant, which then flows out from the condenser 50. The expansion valve 30 reduces the pressure of the refrigerant that has flowed out from the condenser 50. The refrigerant becomes two-phase gas-liquid refrigerant, which then flows into the evaporator 40. The refrigerant that has flowed into the evaporator 40 exchanges heat with the indoor air A sent from the indoor-air-sending device 70. The refrigerant receives heat, evaporates, and becomes gas-state refrigerant, which then flows out from the evaporator 40. The compressor 20 suctions the refrigerant that has flowed out from the evaporator 40.

**[0037]** When the indoor air A passes through the evaporator 40, moisture contained in the indoor air A condenses into the condensed water C. The condensed water C generated at the evaporator 40 is stored in the indoor-side drain pan 110 disposed below the evaporator 40. In the water sprinkler 100, the water pump 101 suctions the condensed water C stored in the indoor-side drain pan 110. Then, the water pipe 102 allows the suctioned condensed water C to flow to the water-sprinkling portion

103. The water-sprinkling portion 103 sprinkles the condensed water C onto the condenser 50. Specifically, the water sprinkler 100 sprinkles the condensed water C onto the top of the first header 53.

**[0038]** It should be noted that the water sprinkler 100 may include, for example, a water-level sensor for detecting the level of the condensed water C stored in the indoor-side drain pan 110. When the level of the condensed water C exceeds a predetermined level, the water pump 101 may be caused to operate.

**[0039]** The condensed water C sprinkled on the top of the first header 53 flows out from the edges of the first header 53 and flows down along the surfaces of the heat transfer tubes 51 and the fins 52. That is, the condensed water C flows in the negative z-direction in Figs. 2 and 3. After flowing out from the first header 53 to the fins 52, the condensed water C flows down along the surfaces of the fins 52.

**[0040]** When the fins 52 are corrugated fins, the condensed water C that has flowed out from the first header 53 to the fins 52 flows down, following the curves of the fins 52, which are corrugated fins. That is, the length of the route that the condensed water C flows along the surface of each of the fins 52 is more than the distance between the first header 53 and the second header 54.

**[0041]** When flowing down along the surfaces of the heat transfer tubes 51 and the fins 52, the condensed water C is heated by the refrigerant in the heat transfer tubes 51 and thus evaporates into vapor. The vapor, together with the outdoor air B, passes through the second air path 90b and flows to outside the room through the outdoor air outlet 94.

(Advantageous effects)

**[0042]** As described above, in Embodiment 1, the air-conditioning apparatus 1 includes the evaporator 40, the condenser 50, and the water sprinkler 100. The evaporator 40 exchanges heat between the indoor air A and the refrigerant. The condenser 50 exchanges heat between the outdoor air B and the refrigerant. The water sprinkler 100 sprinkles the condensed water C generated at the evaporator 40 onto the condenser 50. The condenser 50 includes the first header 53, the second header 54, the heat transfer tubes 51, and the fins 52. The first header 53 and the second header 54 are arranged parallel to each other. The heat transfer tubes 51 are arranged parallel to each other and are arranged between the first header 53 and the second header 54. The fins 52 are disposed between the heat transfer tubes 51.

**[0043]** Thus, the condensed water C sprinkled from the water sprinkler 100 onto the condenser 50 is easily retained on the surfaces of the fins 52 disposed between the heat transfer tubes 51. Thus, it is possible to increase the amount of the condensed water C to evaporate at the condenser 50. In addition, the air-conditioning apparatus 1 includes the water sprinkler 100. Thus, even when the evaporator 40 and the condenser 50 are apart from

each other in the horizontal direction, the air-conditioning apparatus 1 can sprinkle the condensed water C generated at the evaporator 40 onto the condenser 50. Thus, it is possible to more flexibly determine the positional relationship between the evaporator 40 and the condenser 50 inside the housing 90.

**[0044]** In Embodiment 1, the first header 53 and the second header 54 extend in the horizontal direction, and the first header 53 is located higher than the second header 54. The water sprinkler 100 is configured to sprinkle the condensed water C onto the top of the first header 53.

**[0045]** Thus, the condensed water C sprinkled on the top of the first header 53 flows down to the second header 54 along the surfaces of the heat transfer tubes 51 and the fins 52. That is, the condensed water C flows along the entire surface of the condenser 50, which makes it possible to increase the amount of the condensed water C to evaporate at the condenser 50.

**[0046]** Moreover, in Embodiment 1, the fins 52 are corrugated fins.

**[0047]** Thus, the condensed water C that has flowed out from the first header 53 to the fins 52 flows down, following the curves of the fins 52, which are corrugated fins. That is, the length of the route that the condensed water C flows along the surface of each of the fins 52 is more than the distance between the first header 53 and the second header 54. Thus, compared with when the fins 52 are plate fins, the duration for which the condensed water C receives heat from the fins 52 is longer, which facilitates evaporation of the condensed water C. Accordingly, it is possible to increase the amount of the condensed water C to evaporate at the condenser 50.

**[0048]** Moreover, in Embodiment 1, the first header 53, the second header 54, the heat transfer tubes 51, and the fins 52, which form the condenser 50, are made of aluminum.

**[0049]** Thus, compared with when the condenser 50 is copper or iron, it is possible to lighten the condenser 50.

**[0050]** Moreover, in Embodiment 1, the heat transfer tubes 41 and the fins 42, which form the evaporator 40, are made of aluminum.

**[0051]** Thus, compared with when the evaporator 40 is copper or iron, it is possible to lighten the evaporator 40. In addition, compared with when the evaporator 40 is made of copper or iron, it is possible to more effectively prevent ions of a metal nobler than aluminum, such as copper ions, from dissolving into the condensed water C generated at the evaporator 40. Thus, it is possible to prevent galvanic corrosion in the condenser 50 that may occur when the condensed water C generated at the evaporator 40 is sprinkled onto the condenser 50 made of aluminum.

**[0052]** In Embodiment 1, the refrigerant pipes 60 are made of aluminum.

**[0053]** Thus, compared with when the refrigerant pipes 60 are made of copper or iron, it is possible to lighten the evaporator 40. In addition, compared with when the re-

frigerant pipes 60 are made of copper or iron, it is possible to more effectively prevent ions of a metal nobler than aluminum, such as copper ions, from dissolving into the condensed water C generated at the evaporator 40. Thus, it is possible to prevent galvanic corrosion in the condenser 50 that may occur when the condensed water C generated at the evaporator 40 is sprinkled onto the condenser 50 made of aluminum.

**[0054]** Moreover, when the evaporator 40, the condenser 50, and the refrigerant pipes 60 are made of aluminum, dissimilar metal welding is not necessary in the manufacturing of the refrigerant circuit 10, which enables manufacturability of the refrigerant circuit 10 to be improved.

**[0055]** It should be noted that in Embodiment 1, the condenser 50 includes the heat transfer tubes 51 arranged parallel to each other and arranged between the first header 53 and the second header 54. However, the configuration of the condenser in the present disclosure is not limited to the illustrated configuration. Instead of the heat transfer tubes 51, the condenser 50 may include, for example, circular tubes that are circular in a cross section perpendicular to the axis of a refrigerant path. Moreover, the fins 52 are not limited to corrugated fins and may be plate fins.

**[0056]** Even with such a configuration, it is possible to increase the amount of the condensed water C to evaporate at the condenser 50.

(Variation)

**[0057]** In the above description, the water sprinkler 100 includes the water pump 101, the water pipe 102, and the water-sprinkling portion 103. However, the configuration of the water sprinkler 100 is not limited to the illustrated configuration. Any configuration is applicable as long as the water sprinkler 100 can sprinkle the condensed water C generated at the evaporator 40 onto the condenser 50.

**[0058]** Fig. 4 schematically illustrates a variation of the configuration of the air-conditioning apparatus according to Embodiment 1 of the present disclosure.

**[0059]** As illustrated in Fig. 4, an outdoor-side drain pan 120 is disposed below the condenser 50 inside the housing 90. A water pipe 121 connects the indoor-side drain pan 110 and the outdoor-side drain pan 120 to each other. The water pipe 121 allows the condensed water C stored in the indoor-side drain pan 110 to flow to the outdoor-side drain pan 120. The outdoor-side drain pan 120 stores the condensed water C generated at the evaporator 40. A water sprinkler 130 is disposed in the outdoor-side drain pan 120.

**[0060]** The water sprinkler 130 is discoid, and the outer periphery of the water sprinkler 130 has blades for retaining the condensed water C. The water sprinkler 130 is driven by a driving unit such as a motor and rotates, which enables the blades on the outer periphery to splash and sprinkle the condensed water C stored in the out-

door-side drain pan 120 to a side face of the condenser 50.

**[0061]** Even with such a configuration, the condensed water C sprinkled from the water sprinkler 130 to the condenser 50 is retained on the fins 52, which makes it possible to increase the amount of the condensed water C to evaporate at the condenser 50.

**[0062]** It should be noted that the water sprinkler 130 may be disposed upstream of the condenser 50 in the second air path 90b. This enables the condensed water C sprinkled by the water sprinkler 130 to flow with the outdoor air B, which ensures that the condensed water C adheres to the condenser 50.

Embodiment 2

**[0063]** Hereinafter, a configuration of an air-conditioning apparatus 1 in Embodiment 2 is described, focusing on differences from Embodiment 1. It should be noted that the same reference sign is assigned to an element identical to that described in Embodiment 1, and explanations for common elements are omitted.

**[0064]** Fig. 5 is a perspective view of a condenser of an air-conditioning apparatus according to Embodiment 2 of the present disclosure.

**[0065]** Fig. 6 is a top view of the condenser of the air-conditioning apparatus according to Embodiment 2 of the present disclosure.

**[0066]** As illustrated in Figs. 5 and 6, a condenser 50 includes fins 52a each disposed between heat transfer tubes 51. The fins 52a are, for example, corrugated fins. A water sprinkler 100 sprinkles condensed water C onto the top of a first header 53.

**[0067]** When the condenser 50 is viewed from above, the end portions of each of the fins 52a protrude from the edges of the first header 53. That is, as illustrated in Fig. 6, the length of each of the fins 52a in the x-direction is more than the length of the first header 53 in the x-direction.

**[0068]** It should be noted that in the example illustrated in Fig. 6, both end portions of each of the fins 52a protrude from the edges of the first header 53. However, the configuration of the condenser 50 is not limited to the illustrated configuration. One of the end portions of each of the fins 52a may protrude from the edge of the first header 53.

**[0069]** As described above, in Embodiment 2, when the condenser 50 is viewed from above, the end portions of each of the fins 52 protrude from the edges of the first header 53.

**[0070]** This facilitates adhesion of the condensed water C to the surfaces of the fins 52a when the condensed water C sprinkled on the top of the first header 53 flows out from the edges of the first header 53 and flows down along the surfaces of the fins 52a. Thus, the condensed water C sprinkled from the water sprinkler 100 onto the condenser 50 is easily retained on the surfaces of the fins 52a. Thus, it is possible to increase the amount of

the condensed water C to evaporate at the condenser 50.

#### Embodiment 3

**[0071]** Hereinafter, a configuration of an air-conditioning apparatus 1 in Embodiment 3 is described, focusing on differences from Embodiments 1 and 2. It should be noted that the same reference sign is assigned to an element identical to that described in Embodiments 1 and 2, and explanations for common elements are omitted.

**[0072]** Fig. 7 is a perspective view of a condenser of an air-conditioning apparatus according to Embodiment 3 of the present disclosure.

**[0073]** As illustrated in Fig. 7, the top of a first header 53a of a condenser 50 is a curved surface that protrudes upward from a horizontal plane. Specifically, regarding the protruded curved top of the first header 53a, in the direction in which outdoor air B flows, a center portion of the top protrudes upward, and end portions of the top are inclined downward. With such a configuration, condensed water C sprinkled on the top of the first header 53a flows down along the curved surface.

**[0074]** It should be noted that in the example illustrated in Fig. 7, in the curved surface, both end portions of the top of the first header 53a are inclined downward toward both edges of the top. However, the shape of the top is not limited to the illustrated shape. The top of the first header 53a may be a curved surface having edges, one of which is inclined downward toward the other edge.

**[0075]** As described above, in Embodiment 3, the top of the first header 53a is a curved surface that protrudes upward from a horizontal plane.

**[0076]** Thus, even when the condensed water C is sprinkled from above the condenser 50, the condensed water C is less likely to be retained on the top of the first header 53a. Thus, the condensed water C sprinkled from the water sprinkler 100 onto the condenser 50 more easily reaches the fins 52. Thus, it is possible to increase the amount of the condensed water C to evaporate at the condenser 50.

(Variation)

**[0077]** Fig. 8 is a perspective view of a variation of the condenser of the air-conditioning apparatus according to Embodiment 3 of the present disclosure.

**[0078]** As illustrated in Fig. 8, the top of a first header 53b of the condenser 50 is made of slopes and inclined to a horizontal plane. Specifically, in the direction in which the outdoor air B flows, the top of the first header 53b is inclined downward from the center, which is the apex of the top, toward both edges of the top. Hence, the top is made of the slopes. With such a shape of the top, the condensed water C sprinkled on the top of the first header 53b flows down along the slopes.

**[0079]** It should be noted that in the example illustrated in Fig. 8, the top of the first header 53b is inclined downward from the center toward both edges. However, the

shape of the top is not limited to the illustrated shape. The top of the first header 53b may be a slope, that is, a surface with one edge higher than the other edge.

**[0080]** Even with such a slope, the condensed water C is less likely to be retained on the top of the first header 53b. Thus, the condensed water C sprinkled from the water sprinkler 100 onto the condenser 50 more easily reaches the fins 52. Thus, it is possible to increase the amount of the condensed water C to evaporate at the condenser 50.

#### Embodiment 4

**[0081]** Hereinafter, a configuration of an air-conditioning apparatus 1 in Embodiment 4 is described, focusing on differences from Embodiments 1 to 3. It should be noted that the same reference sign is assigned to an element identical to that described in Embodiments 1 to 3, and explanations for common elements are omitted.

**[0082]** Fig. 9 is a perspective view of a condenser of an air-conditioning apparatus according to Embodiment 4 of the present disclosure.

**[0083]** Fig. 10 is a vertical cross-sectional view of the condenser of the air-conditioning apparatus according to Embodiment 4 of the present disclosure. It should be noted that Fig. 10 illustrates a cross section of a condenser 50 cut along the xy-plane.

**[0084]** As illustrated in Figs. 9 and 10, a second header 54a of the condenser 50 has a water-storage portion 56 that is a depression in the top of the second header 54a. Specifically, a frame portion 55 protrudes upward from the top of the second header 54a, and the water-storage portion 56 is formed in the inside portion surrounded by the frame portion 55.

**[0085]** A water sprinkler 100 sprinkles condensed water C onto the top of a first header 53. The condensed water C sprinkled on the top of the first header 53 flows out from the edges of the first header 53 and flows down along the surfaces of the heat transfer tubes 51 and fins 52. When flowing down along the surfaces of the heat transfer tubes 51 and the fins 52, the condensed water C is heated by refrigerant in the heat transfer tubes 51 and evaporates into vapor. When a portion of the condensed water C reaches the second header 54a without evaporating, the condensed water C is stored in the water-storage portion 56 formed in the top of the second header 54a. The condensed water C stored in the water-storage portion 56 is heated by refrigerant in the second header 54a and evaporates into vapor. The vapor, together with the outdoor air B, passes through a second air path 90b and flows to outside a room through an outdoor air outlet 94.

**[0086]** As described above, in Embodiment 4, the second header 54a has the water-storage portion 56, which is a depression in the top of the second header 54a.

**[0087]** Thus, even when a portion of the condensed water C reaches the second header 54a without evaporating, it is possible to prevent the condensed water C

from flowing out from and below the condenser 50. Moreover, the condensed water C stored in the water-storage portion 56 is heated by the refrigerant in the second header 54a to accelerate evaporation of the condensed water C. Thus, it is possible to increase the amount of the condensed water C to evaporate at the condenser 50.

**[0088]** Furthermore, it is not necessary to provide a drain pan that is a separate component from the condenser 50 to store the condensed water C that flows out from and below the condenser 50. Thus, it is possible to reduce the number of components.

#### Embodiment 5

**[0089]** Hereinafter, a configuration of an air-conditioning apparatus 1 in Embodiment 5 is described, focusing on differences from Embodiments 1 to 4. It should be noted that the same reference sign is assigned to an element identical to that described in Embodiments 1 to 4, and explanations for common elements are omitted.

**[0090]** Fig. 11 schematically illustrates a configuration of an air-conditioning apparatus according to Embodiment 5 of the present disclosure.

**[0091]** As illustrated in Fig. 11, the air-conditioning apparatus 1 includes an ion-exchange resin 140. The ion-exchange resin 140 is configured to remove a metal that is nobler than aluminum and is contained in condensed water C generated at an evaporator 40. In an equilibrium reaction caused by ion exchange, the ion-exchange resin 140 exchanges a pre-absorbed ion for a target substance to absorb the target substance. For instance, as the target substance, the ion-exchange resin 140 absorbs copper ions contained in the condensed water C and removes the copper ions from the condensed water C.

**[0092]** The ion-exchange resin 140 is disposed inside a water pipe 102. The ion-exchange resin 140 removes a metal nobler than aluminum from the condensed water C that passes through the water pipe 102. It should be noted that the position of the ion-exchange resin 140 is not limited to the illustrated position, and the ion-exchange resin 140 may be disposed in an indoor-side drain pan 110, a water pump 101, or a water-sprinkling portion 103.

**[0093]** As described above, in Embodiment 5, the air-conditioning apparatus 1 includes the ion-exchange resin 140 for removing a metal that is nobler than aluminum and is contained in the condensed water C generated at the evaporator 40.

**[0094]** Thus, before the condensed water C is sprinkled on a condenser 50, the ion-exchange resin 140 can remove ions of a metal nobler than aluminum, which makes it possible to decrease the amount of ions of the metal, which is nobler than aluminum, contained in the condensed water C. Accordingly, even when heat transfer tubes 41 and fins 42 of the condenser 50 are made of aluminum, it is possible to prevent galvanic corrosion in the condenser 50.

(Variation)

**[0095]** The configuration of the water sprinkler 100 is not limited to the configuration illustrated in Fig. 11. Any configuration is applicable as long as the water sprinkler 100 can sprinkle the condensed water C generated at the evaporator 40 onto the condenser 50. Moreover, changes can be made to the ion-exchange resin 140 as long as the ion-exchange resin 140 can remove a metal that is nobler than aluminum and is contained in the condensed water C, before the water sprinkler 100 sprinkles the condensed water C on the condenser 50.

**[0096]** Fig. 12 schematically illustrates a variation of the configuration of the air-conditioning apparatus according to Embodiment 5 of the present disclosure.

**[0097]** In the air-conditioning apparatus 1 in the variation, the ion-exchange resin 140 is added to the variation (Fig. 4) of the configuration of the air-conditioning apparatus 1 described in Embodiment 1.

**[0098]** As illustrated in Fig. 12, the ion-exchange resin 140 is disposed in an outdoor-side drain pan 120. The ion-exchange resin 140 removes a metal nobler than aluminum from the condensed water C stored in the outdoor-side drain pan 120. It should be noted that the position of the ion-exchange resin 140 is not limited to the illustrated position, and the ion-exchange resin 140 may be disposed in the indoor-side drain pan 110, a water pipe 121, or a water sprinkler 130.

**[0099]** Even with such a configuration, it is possible to decrease the amount of ions of the metal, which is nobler than aluminum, contained in the condensed water C. Accordingly, even when the heat transfer tubes 41 and the fins 42 of the condenser 50 are made of aluminum, it is possible to prevent galvanic corrosion in the condenser 50.

**[0100]** It should be noted that in Embodiments 1 to 5, the condenser 50 includes the first header 53 and the second header 54. However, the configuration of the condenser in the present disclosure is not limited to the illustrated configuration. The condenser 50 may be, for example, a serpentine heat exchanger made by bending a heat transfer tube into a serpentine tube.

**[0101]** It should be noted that in Embodiments 1 to 5, the air-conditioning apparatus 1 that performs a cooling operation to cool the indoor air A is described. However, the operation of the air-conditioning apparatus in the present disclosure is not limited to the cooling operation. By causing the evaporator 40 to cool the indoor air A, the air-conditioning apparatus 1 may perform a dehumidifying operation to remove moisture contained in the indoor air A.

#### Reference Signs List

**[0102]** 1 air-conditioning apparatus 10 refrigerant circuit 20 compressor 30 expansion valve 40 evaporator 41 heat transfer tube 42 fin 50 condenser 51 heat transfer tube 51-1 first heat transfer tube 51-2 second heat trans-



fer tube 52 fin 52a fin 53 first header 53a first header 53b  
 first header 54 second header 54a second header 55  
 frame portion 56 water-storage portion 60 refrigerant pipe  
 70 indoor-air-sending device 80 outdoor-air-sending de-  
 vice 90 housing 90a first air path 90b second air path 91  
 indoor air inlet 92 indoor air outlet 93 outdoor air inlet 94  
 outdoor air outlet 95 separation plate 100 water sprinkler  
 101 water pump 102 water pipe 103 water-sprinkling por-  
 tion 110 indoor-side drain pan 120 outdoor-side drain  
 pan 121 water pipe 130 water sprinkler 140 ion-exchange  
 resin A indoor air B outdoor air C condensed water

## Claims

### 1. An air-conditioning apparatus, comprising:

a housing having a first air path through which  
 indoor air passes and a second air path through  
 which outdoor air passes;  
 an evaporator disposed in the first air path and  
 configured to exchange heat between the indoor  
 air and refrigerant;  
 a condenser disposed in the second air path and  
 configured to exchange heat between the out-  
 door air and the refrigerant; and  
 a water sprinkler configured to sprinkle con-  
 densed water to the condenser, the condensed  
 water being generated at the evaporator,  
 the condenser including  
 a first heat transfer tube and a second heat trans-  
 fer tube that are arranged parallel to each other,  
 and  
 a fin arranged between the first heat transfer  
 tube and the second heat transfer tube.

2. The air-conditioning apparatus of claim 1,  
 wherein the condenser includes a first header and a  
 second header arranged parallel to each other, and  
 the first heat transfer tube and the second heat trans-  
 fer tube are arranged parallel to each other and are  
 arranged between the first header and the second  
 header.

3. The air-conditioning apparatus of claim 2,  
 wherein the first header and the second header ex-  
 tend in a horizontal direction,  
 the first header is located higher than the second  
 header, and  
 the water sprinkler is configured to sprinkle the con-  
 densed water onto a top of the first header.

4. The air-conditioning apparatus of claim 2 or 3,  
 wherein, when the condenser is viewed from above,  
 an end portion of the fin protrudes from an edge of  
 the first header.

5. The air-conditioning apparatus of any one of claims

2 to 4,

wherein a top of the first header is a slope inclined  
 to a horizontal plane or a curved surface that pro-  
 trudes upward from the horizontal plane.

6. The air-conditioning apparatus of any one of claims  
 2 to 5,  
 wherein the second header has a water-storage por-  
 tion that is a depression in a top of the second header.

7. The air-conditioning apparatus of any one of claims  
 2 to 6,  
 wherein the first header, the second header, the first  
 heat transfer tube, the second heat transfer tube,  
 and the fin are made of aluminum.

8. The air-conditioning apparatus of any one of claims  
 1 to 7,  
 wherein the fin is a corrugated fin.

9. The air-conditioning apparatus of any one of claims  
 1 to 8,  
 wherein the evaporator includes  
 a plurality of evaporator-side heat transfer tubes  
 through which the refrigerant flows, and  
 a plurality of evaporator-side fins connected to the  
 plurality of evaporator-side heat transfer tubes, and  
 the plurality of evaporator-side heat transfer tubes  
 and the plurality of evaporator-side fins are made of  
 aluminum.

10. The air-conditioning apparatus of any one of claims  
 1 to 9, comprising  
 a refrigerant circuit in which a compressor, the con-  
 denser, an expansion valve, and the evaporator are  
 connected to each other via refrigerant pipes to en-  
 able the refrigerant to circulate,  
 wherein the refrigerant pipes are made of aluminum.

11. The air-conditioning apparatus of any one of claims  
 1 to 10, comprising  
 an ion-exchange resin for removing a metal that is  
 nobler than aluminum and is contained in the con-  
 densed water generated at the evaporator.

FIG. 1

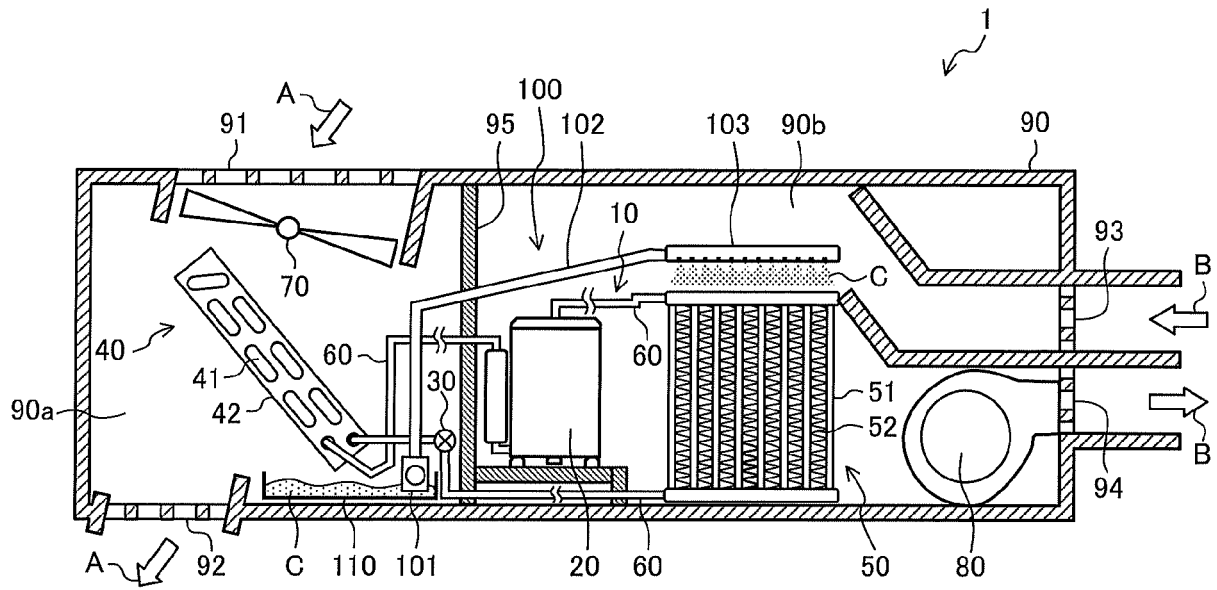


FIG. 2

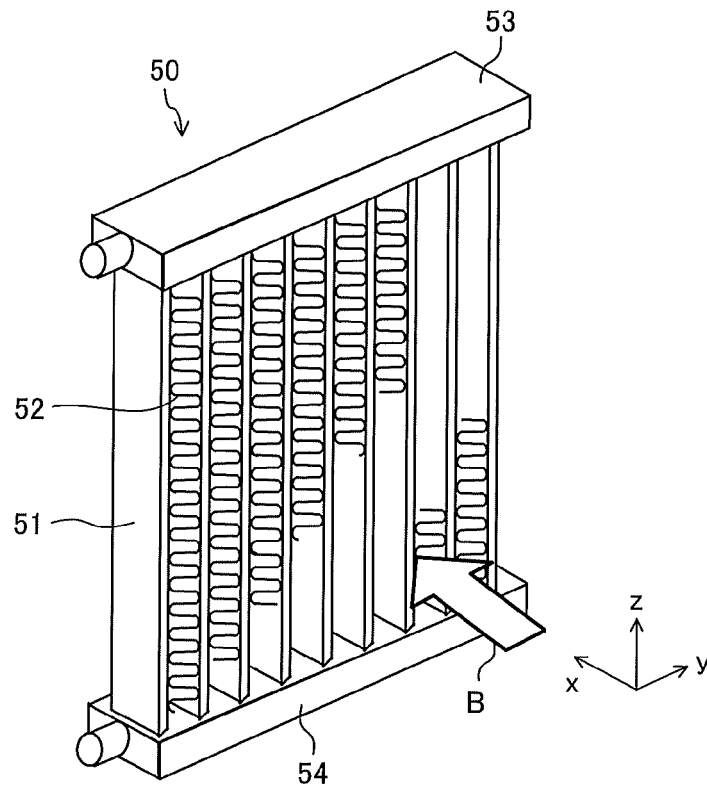


FIG. 3

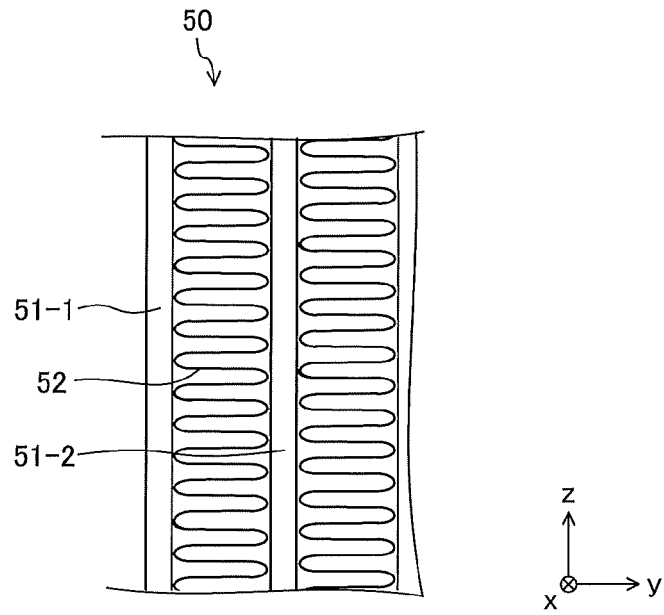


FIG. 4

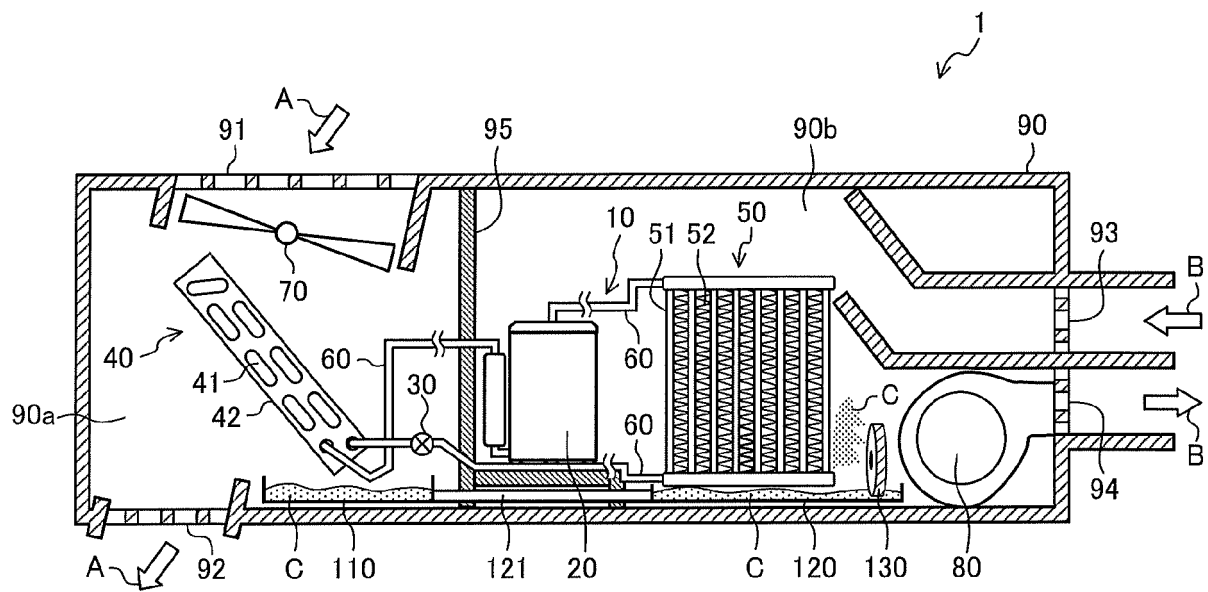


FIG. 5

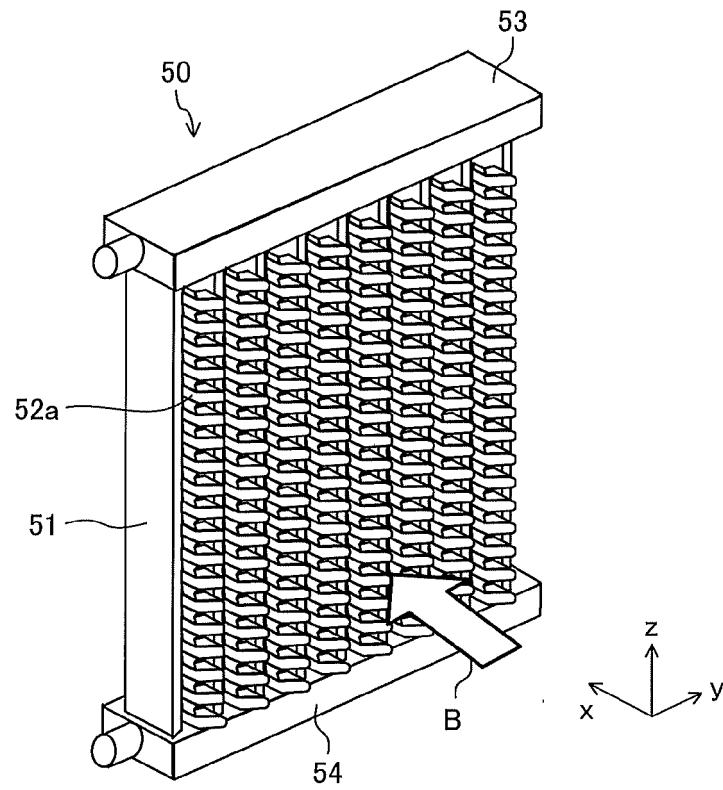


FIG. 6

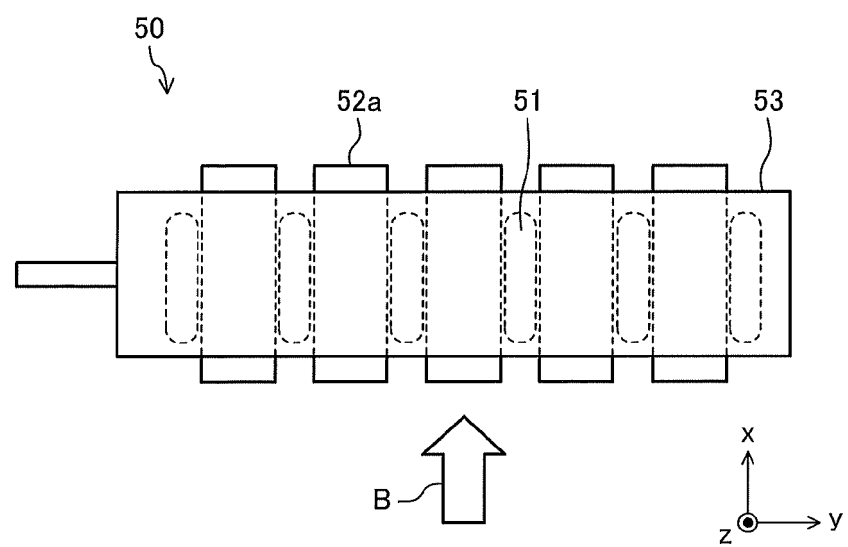


FIG. 7

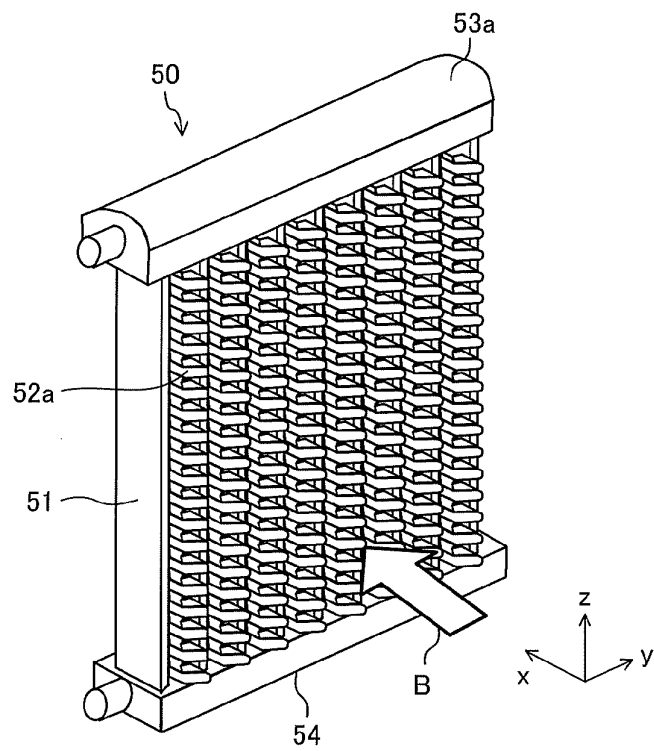


FIG. 8

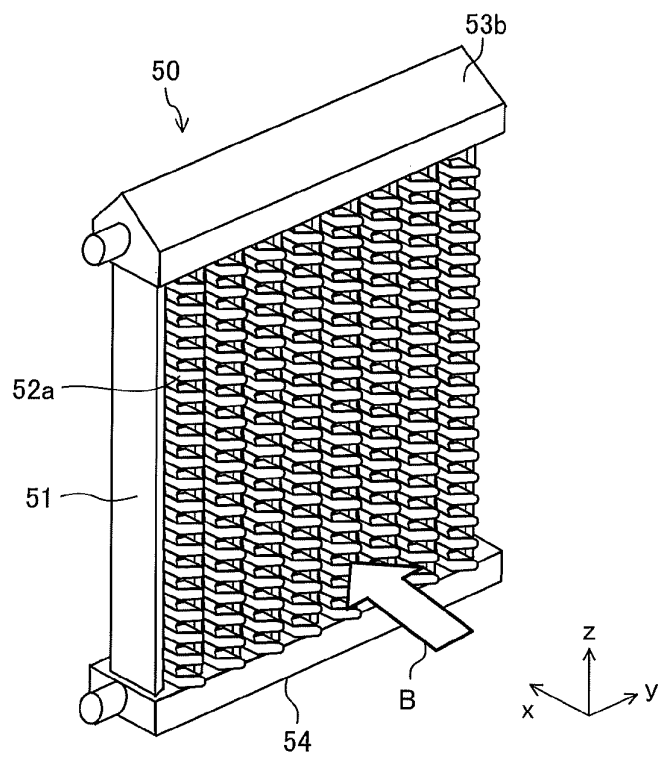


FIG. 9

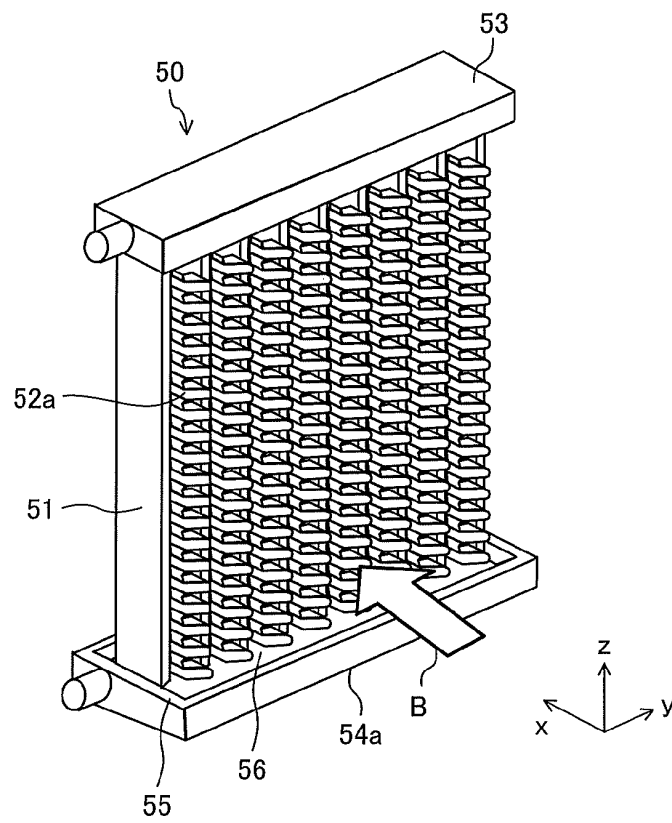


FIG. 10

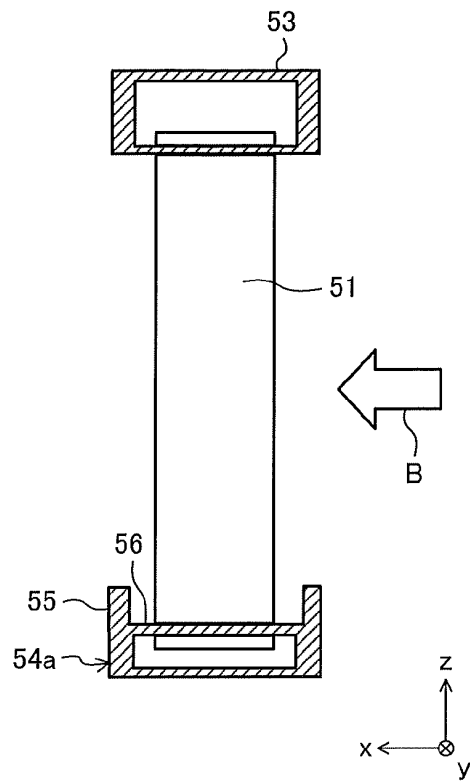


FIG. 11

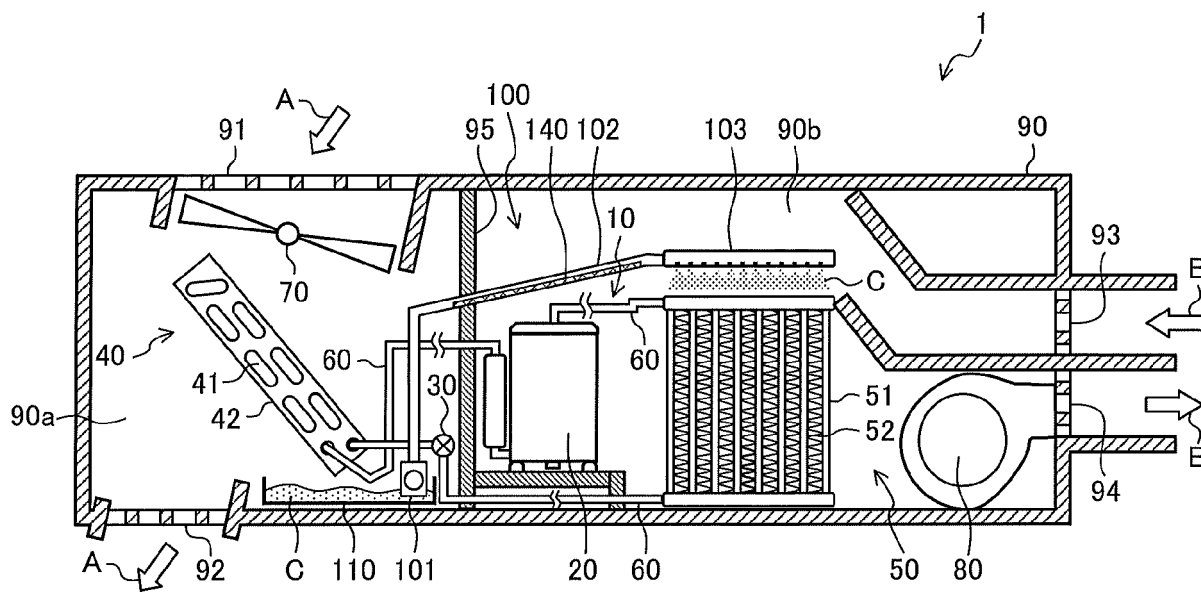
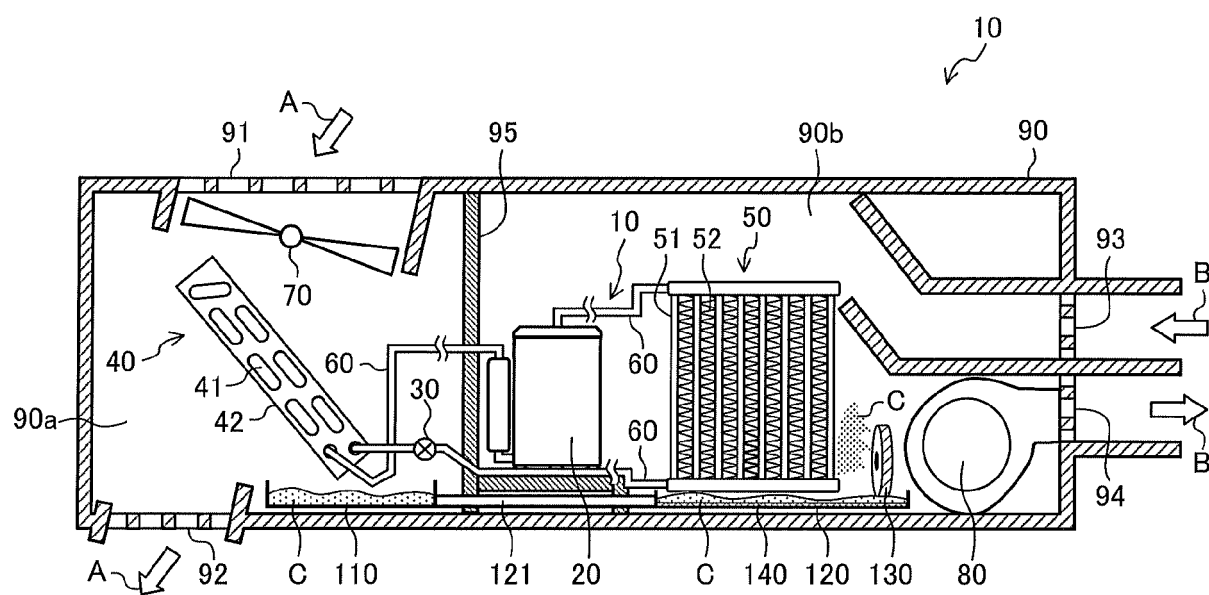


FIG. 12



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/015224

## A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. F24F13/22 (2006.01) i, F25B39/04 (2006.01) i, F28F1/30 (2006.01) i,  
F28F21/08 (2006.01) i, F28F25/00 (2006.01) i

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

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. F24F13/22, F25B39/04, F28F1/30, F28F21/08, F28F25/00

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

Published examined utility model applications of Japan 1922-1996  
Published unexamined utility model applications of Japan 1971-2018  
Registered utility model specifications of Japan 1996-2018  
Published registered utility model applications of Japan 1994-2018

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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Microfilm of the specification and drawings	1
Y	annexed to the request of Japanese Utility Model Application No. 065022/1974 (Laid-open No. 154650/1975) (TOKYO SHIBAURA ELECTRIC CO., LTD.) 22 December 1975, description, page 2, line 20 to page 7, line 4, fig. 1-5 (Family: none)	1-11
Y	JP 2003-106561 A (DENSO CORP.) 09 April 2003, paragraphs [0021]-[0054], [0059]-[0063], fig. 1-3, 6 (Family: none)	1-11
Y	JP 2010-054111 A (SHARP CORP.) 11 March 2010, paragraphs [0013], [0026]-[0037], fig. 1-4 & US 2010/0050682 A1, paragraphs [0038]-[0049], fig. 1-4 & CN 101660814 A	1-11

☒ 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  
26.06.2018

Date of mailing of the international search report  
10.07.2018

Name and mailing address of the ISA/  
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Tokyo 100-8915, Japan

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/015224

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 2010-139196 A (SHARP CORP.) 24 June 2010, paragraphs [0002]-[0007], fig. 8 (Family: none)	1-11
Y	JP 2006-105415 A (DAIKIN INDUSTRIES, LTD.) 20 April 2006, paragraphs [0013], [0019], fig. 1, 2 (Family: none)	1-11
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 095473/1975 (Laid-open No. 009247/1977) (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 22 January 1977, description, page 2, lines 3-15, all drawings (Family: none)	3
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 070590/1992 (Laid-open No. 035831/1994) (SANDEN CORP.) 13 May 1994, paragraphs [0017], [0018], fig. 3 (Family: none)	3, 6
Y	JP 2010-038439 A (SHARP CORP.) 18 February 2010, paragraphs [0006], [0015], fig. 1, 2 (Family: none)	4
Y	JP 2016-050719 A (FUJITSU GENERAL LTD.) 11 April 2016, paragraph [0003], fig. 6 (Family: none)	4
Y	JP 2017-009191 A (T RAD CO., LTD.) 12 January 2017, paragraph [0016], fig. 8 (Family: none)	5
Y	JP 2010-112667 A (MITSUBISHI ELECTRIC CORP.) 20 May 2010, paragraph [0034] & US 2010/0116461 A1, paragraph [0049] & EP 2184549 A2 & AU 2009202973 A & CN 101737868 A	10
Y	JP 2011-080121 A (MITSUBISHI ALUMINUM CO., LTD.) 21 April 2011, paragraphs [0012], [0017] (Family: none)	10

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/015224

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 053959/1973 (Laid-open No. 004543/1975) (KURITA WATER INDUSTRIES LTD.) 17 January 1975, description, page 2, line 14 to page 5, line 19, fig. 1, 2 (Family: none)	11
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 108487/1973 (Laid-open No. 055743/1975) (SHARP CORP.) 27 May 1975, description, page 1, line 12 to page 4, line 13, fig. 1-4 (Family: none)	11

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**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 8061699 A [0003]