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(71) Applicant: **Mitsubishi Electric Corporation**
Tokyo 100-8310 (JP)

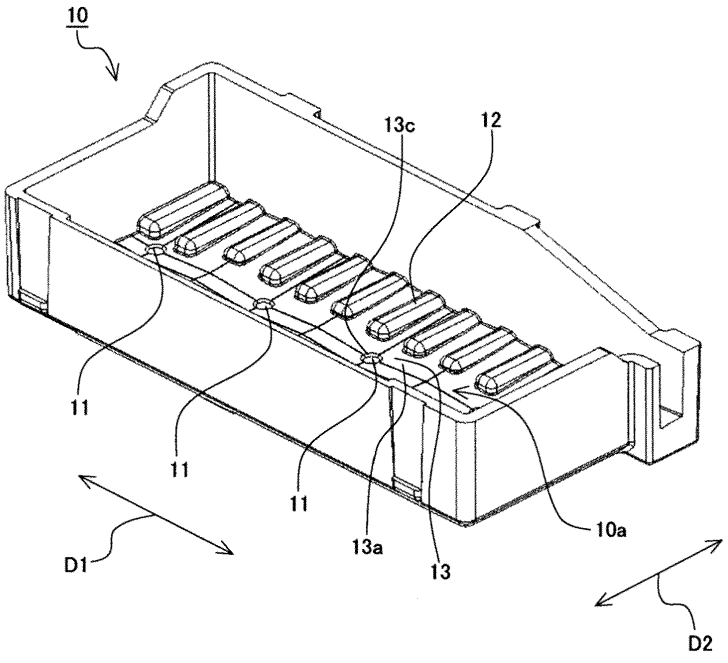
(72) Inventor: **YAMAUCHI, Toshiya**
Tokyo 102-0073 (JP)

(74) Representative: **Diehl & Partner**
Patent- und Rechtsanwaltskanzlei mbB
Erika-Mann-Straße 9
80636 München (DE)

(54) HEAT PUMP WATER HEATER OUTDOOR UNIT

(57) A heat-pump hot-water supply outdoor unit according to the present disclosure includes a box-shaped heat insulator, and a water-refrigerant heat exchanger accommodated in the heat insulator and configured to heat water with refrigerant, wherein an inner bottom portion of the heat insulator has an uneven shape with a protruding portion and a recessed portion, the recessed portion is formed with a drain hole extending through the inner bottom portion, and the water-refrigerant heat exchanger is placed on the protruding portion.

FIG. 6



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Description

Technical Field

[0001] The present disclosure relates to a heat-pump hot-water supply outdoor unit having a water-refrigerant heat exchanger accommodated in a box-shaped heat insulator to reduce heat dissipation from the water-refrigerant heat exchanger to the outside.

Background Art

[0002] Energy-efficient heat-pump hot-water supply systems utilizing heat in the atmosphere are widely used. The heat-pump hot-water supply system includes a heat-pump hot-water supply outdoor unit. In the heat-pump hot-water supply outdoor unit, an evaporator configured to allow refrigerant to absorb heat in the atmosphere, a fan configured to deliver air to the evaporator, a compressor configured to compress the refrigerant, a water-refrigerant heat exchanger configured to heat water using the compressed high-temperature high-pressure refrigerant, and other devices are installed. The water-refrigerant heat exchanger is accommodated in a box-shaped heat insulator to reduce heat dissipation from the water-refrigerant heat exchanger to the outside during operation of the heat-pump hot-water supply outdoor unit. In a case where the water-refrigerant heat exchanger is accommodated in the box-shaped heat insulator, there is a possibility of corrosion of the water-refrigerant heat exchanger as described below. More specifically, when condensation occurs on the surface of the water-refrigerant heat exchanger, water on the surface of the water-refrigerant heat exchanger flows down and collects in an inner bottom portion of the heat insulator. When the water-refrigerant heat exchanger is immersed in the water collecting in the inner bottom portion of the heat insulator, there is a possibility of corrosion of the water-refrigerant heat exchanger. For this reason, it is desirable for the water-refrigerant heat exchanger not to be immersed in the water collecting in the inner bottom portion of the heat insulator. Note that the inner bottom portion of the heat insulator is a bottom portion of the heat insulator on the inner side thereof.

[0003] Taking into the consideration the problem mentioned above, a related art heat-pump hot-water supply outdoor unit has been proposed, which is intended to prevent a water-refrigerant heat exchanger from being immersed in water collecting in an inner bottom portion of a heat insulator (see Patent Literature 1). Specifically, in the heat-pump hot-water supply outdoor unit disclosed in Patent Literature 1, a heat insulator configured to accommodate therein a water-refrigerant heat exchanger is made up of a lower heat insulator and an upper heat insulator. The lower heat insulator has an open top, and has a box shape elongated in the rightward-leftward direction. The upper heat insulator covers the open top of the lower heat insulator.

[0004] The inner bottom portion of the lower heat insulator includes a flat portion. The water-refrigerant heat exchanger is placed on the flat portion. The inner bottom portion of the lower heat insulator is provided with a leaking-water discharge portion to prevent water from collecting in this inner bottom portion. This leaking-water discharge portion includes a through hole extending through the inner bottom portion of the lower heat insulator, and a filling sealing the through hole. According to Patent Literature 1, with this configuration, water having flowed down to the inner bottom portion of the lower heat insulator flows through the through hole while passing through or melting the filling, and is discharged to the outside of the heat insulator.

Citation List

Patent Literature

[0005] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2015-45425

Summary of Invention

Technical Problem

[0006] In the heat-pump hot-water supply outdoor unit disclosed in Patent Literature 1, the leaking-water discharge portion is provided in the flat portion of the inner bottom portion of the lower heat insulator. On the flat portion, the water-refrigerant heat exchanger is placed. Due to this structure, when condensation occurs on the surface of the water-refrigerant heat exchanger, and then water on the surface of the water-refrigerant heat exchanger flows down to the flat portion of the inner bottom portion of the lower heat insulator, the water-refrigerant heat exchanger is immersed in the water for a while until the water is discharged from the leaking-water discharge portion. In the inner bottom portion of the lower heat insulator, a location where the water-refrigerant heat exchanger is placed is the flat portion as described above. Thus, water having flowed down to the flat portion is more likely to collect in this flat portion. Accordingly, until a given amount of water is collected in the flat portion, the water being collected in the flat portion does not flow to the leaking-water discharge portion. Therefore, the heat-pump hot-water supply outdoor unit disclosed in Patent Literature 1 has a problem that the water-refrigerant heat exchanger cannot be sufficiently prevented from being immersed in water collecting in the inner bottom portion of the heat insulator, or cannot be sufficiently prevented from corrosion.

[0007] The present disclosure has been achieved to solve the above problems, and an object thereof is to provide a heat-pump hot-water supply outdoor unit that can significantly prevent a water-refrigerant heat exchanger accommodated in a box-shaped heat insulator from being immersed in water even when condensation

occurs on the water-refrigerant heat exchanger, compared to the related-art heat-pump hot-water supply outdoor unit.

Solution to Problem

[0008] A heat-pump hot-water supply outdoor unit according to an embodiment of the present disclosure includes: a box-shaped heat insulator; and a water-refrigerant heat exchanger accommodated in the heat insulator and configured to heat water with refrigerant, wherein an inner bottom portion of the heat insulator has an uneven shape with a protruding portion and a recessed portion, the recessed portion is formed with a drain hole extending through the inner bottom portion, and the water-refrigerant heat exchanger is placed on the protruding portion.

Advantageous Effects of Invention

[0009] In a heat-pump hot-water supply outdoor unit according to an embodiment of the present disclosure, when condensation occurs on the surface of a water-refrigerant heat exchanger, and then water on the surface of the water-refrigerant heat exchanger flows down to an inner bottom portion of a heat insulator, the water is collected in a recessed portion of the inner bottom portion. Thereafter, the water being collected in the recessed portion is discharged from a drain hole formed on the recessed portion to the outside of the heat insulator. With this configuration, the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure can significantly prevent the water-refrigerant heat exchanger accommodated in a heat insulator with a box shape from being immersed in water even when condensation occurs on the water-refrigerant heat exchanger, compared to the related art heat-pump hot-water supply outdoor unit.

Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 is a piping system diagram illustrating a heat-pump hot-water supply system including a heat-pump hot-water supply outdoor unit according to an embodiment of the present disclosure.

[Fig. 2] Fig. 2 is a perspective view of the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure when the heat-pump hot-water supply outdoor unit is viewed from the front right side.

[Fig. 3] Fig. 3 is an exploded perspective view of the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure when the heat-pump hot-water supply outdoor unit is viewed from the front right side.

[Fig. 4] Fig. 4 is a perspective view of a bottom plate, an upper heat insulator, a lower heat insulator, a water-refrigerant heat exchanger, and other devices included in the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure when these elements are viewed from the front right side.

[Fig. 5] Fig. 5 is a perspective view of the bottom plate, the lower heat insulator, the water-refrigerant heat exchanger, and other devices included in the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure when these elements are viewed from the front right side.

[Fig. 6] Fig. 6 is a perspective view of the lower heat insulator included in the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure when the lower heat insulator is viewed from the front right side.

[Fig. 7] Fig. 7 is a vertical cross-sectional view of the lower heat insulator included in the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure, along the vertical plane parallel to the width direction of the lower heat insulator.

[Fig. 8] Fig. 8 is a vertical cross-sectional view of the lower heat insulator included in the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure, along the vertical plane parallel to the longitudinal direction of the lower heat insulator.

Description of Embodiment

[0011] An example of a heat-pump hot-water supply outdoor unit according to an embodiment of the present disclosure will be described hereinafter with reference to the drawings. Note that the common components among the drawings are denoted by the same reference signs, and overlapping descriptions are thus simplified or omitted. The heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure may include all combinations of configurations that can be combined among the configurations described in the following embodiment.

Embodiment

[0012] Fig. 1 is a piping system diagram illustrating a heat-pump hot-water supply system including a heat-pump hot-water supply outdoor unit according to an embodiment of the present disclosure. As illustrated in Fig. 1, a heat-pump hot-water supply system 90 includes a heat-pump hot-water supply outdoor unit 1 and a tank unit 91. The heat-pump hot-water supply outdoor unit 1 is located outdoors. The tank unit 91 may be either located outdoors or located indoors.

[0013] The heat-pump hot-water supply outdoor unit 1 includes a compressor 2, a water-refrigerant heat exchanger 3, a first expansion valve 4a, a second expan-

sion valve 4b, an evaporator 5, an internal heat exchanger 6, and a fan 7. The heat-pump hot-water supply outdoor unit 1 includes a refrigerant circuit and performs operation in a refrigeration cycle, that is, in a heat-pump cycle. The compressor 2 compresses low-pressure refrigerant. For example, the refrigerant may be carbon dioxide. The water-refrigerant heat exchanger 3 includes a refrigerant pipe 3b and a water pipe 3a. High-temperature high-pressure refrigerant discharged from the compressor 2 flows through the refrigerant pipe 3b. Water supplied from the tank unit 91 flows through the water pipe 3a. The water-refrigerant heat exchanger 3 exchanges heat between high-temperature high-pressure refrigerant flowing through the refrigerant pipe 3b and water flowing through the water pipe 3a. That is, water flowing through the water pipe 3a is heated by high-temperature high-pressure refrigerant flowing through the refrigerant pipe 3b.

[0014] The first expansion valve 4a and the second expansion valve 4b are examples of a pressure-reducing device configured to reduce the pressure of high-pressure refrigerant to obtain low-pressure refrigerant. The low-pressure refrigerant whose pressure has been reduced is brought into a two-phase gas-liquid state. The evaporator 5 is a heat exchanger configured to exchange heat between the low-pressure refrigerant and the atmosphere. In the evaporator 5, the low-pressure refrigerant absorbs heat in the atmosphere and evaporates. The fan 7 delivers air to the evaporator 5. This can help heat exchange in the evaporator 5. The internal heat exchanger 6 includes a high-pressure flow path and a low-pressure flow path. The internal heat exchanger 6 exchanges heat between high-pressure refrigerant flowing through the high-pressure flow path and low-pressure refrigerant flowing through the low-pressure flow path. The low-pressure refrigerant having evaporated in the evaporator 5 is absorbed into the compressor 2 via the low-pressure flow path of the internal heat exchanger 6.

[0015] The tank unit 91 includes a water storage tank 92, a pump 93, a flow-path switching valve 94, and a bypass pipe 95. The heat-pump hot-water supply outdoor unit 1 and the tank unit 91 are connected to each other through an external pipe 96 and an external pipe 97.

[0016] In the water storage tank 92, water to be heated and water having been heated is stored. In the water storage tank 92, due to the difference in specific gravity of water caused by a temperature difference, thermal layering occurs where higher-temperature water is stored on top of lower-temperature water. To the top portion of the water storage tank 92, a hot-water feed pipe (not illustrated) is connected to supply hot water to terminals including, for example, a hot-water tap, a shower, and a bath. To the bottom portion of the water storage tank 92, a water feed pipe (not illustrated) is connected to supply water from the source such as the tap. When hot water is supplied from the water storage tank 92, hot water in the top portion of the water storage tank 92 is delivered to the hot-water feed pipe by a water pressure acting on the interior of the water storage tank 92 from the water feed pipe. An equal amount of water to the amount of hot water having flowed out to the hot-water feed pipe, flows into the water storage tank 92 from the water feed pipe, so that the water storage tank 92 is kept filled with water.

[0017] The bottom portion of the water storage tank 92 connects to an inlet of the pump 93 through a conduit. An outlet of the pump 93 connects to the flow-path switching valve 94. The flow-path switching valve 94 connects to the water pipe 3a of the water-refrigerant heat exchanger 3 in the heat-pump hot-water supply outdoor unit 1 through the external pipe 96.

[0018] The heat-pump hot-water supply system 90 can perform thermal storage operation to store water heated by the heat-pump hot-water supply outdoor unit 1 in the water storage tank 92. The thermal storage operation is performed in the following manner. The compressor 2, the fan 7, and the pump 93 are operated. Water flowing out from the bottom portion of the water storage tank 92 flows through the pump 93, the flow-path switching valve 94, and the external pipe 96, and flows into the water-refrigerant heat exchanger 3 in the heat-pump hot-water supply outdoor unit 1. This water is heated by refrigerant in the water-refrigerant heat exchanger 3 and becomes hot. The hot water heated in the water-refrigerant heat exchanger 3 reaches the temperature of approximately 65 to 90 degrees C, for example. The hot water having flowed out from the water-refrigerant heat exchanger 3 flows through the external pipe 97 to return to the tank unit 91, and then flows through a tank top pipe 98 into the top portion of the water storage tank 92.

[0019] The flow-path switching valve 94 is capable of switching between flow paths such that water discharged from the pump 93 flows into the tank top pipe 98 through the bypass pipe 95, instead of flowing into the heat-pump hot-water supply outdoor unit 1.

[0020] Fig. 2 is a perspective view of the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure when the heat-pump hot-water supply outdoor unit is viewed from the front right side. Fig. 3 is an exploded perspective view of the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure when the heat-pump hot-water supply outdoor unit is viewed from the front right side. As illustrated in Fig. 2, the heat-pump hot-water supply outdoor unit 1 includes a plurality of leg portions 25. The leg portions 25 are fixed to the ground or the floor.

[0021] As illustrated in Fig. 3, the heat-pump hot-water supply outdoor unit 1 includes a bottom plate 18, a front panel 19, a side panel 20, and a top panel 21. The bottom plate 18, the front panel 19, the side panel 20, and the top panel 21 form the outer casing of the heat-pump hot-water supply outdoor unit 1, that is, a housing of the heat-pump hot-water supply outdoor unit 1. It is preferable that the bottom plate 18, the front panel 19, the side panel 20, and the top panel 21 are made of metal. The bottom plate 18 is equivalent to the base or frame of the heat-pump hot-water supply outdoor unit 1. Constituent de-

vices including the compressor 2 are installed on the bottom plate 18. The leg portions 25 are fixed to the underside of the bottom plate 18.

[0022] The front panel 19 covers the front side and the left side of the heat-pump hot-water supply outdoor unit 1. The side panel 20 covers a part of the rear side and the right side of the heat-pump hot-water supply outdoor unit 1. The top panel 21 covers the top side of the heat-pump hot-water supply outdoor unit 1. The evaporator 5 is located to cover the rear side and the left side of the heat-pump hot-water supply outdoor unit 1.

[0023] The interior of the outer casing of the heat-pump hot-water supply outdoor unit 1 is divided into a machine chamber 14 and a fan chamber 15 in which the fan 7 is located. A partition plate 16 divides the interior of the outer casing of the heat-pump hot-water supply outdoor unit 1 into the machine chamber 14 and the fan chamber 15. In the machine chamber 14, the compressor 2, the refrigerant pipe, and other devices are located. The compressor 2 is covered with acoustic insulation (not illustrated). In the fan chamber 15, the fan 7 is located between the evaporator 5 and the front panel 19. The fan 7 according to the present embodiment includes a propeller fan. In the fan chamber 15, a case 8 is located below the fan 7. The water-refrigerant heat exchanger 3 is accommodated in the case 8 in a state of being covered with an upper heat insulator 9 and a lower heat insulator 10 which are described later.

[0024] The front panel 19 is formed with an opening at a position where the opening faces the fan 7. A grille 24 configured to cover this opening is attached to the front panel 19. When the fan 7 is operated, the outside air, that is, the atmosphere passes through the evaporator 5 and flows into the fan chamber 15, and is discharged from the grille 24 to the outside of the heat-pump hot-water supply outdoor unit 1.

[0025] The heat-pump hot-water supply outdoor unit 1 includes an electrical-component storage box 17. The electrical-component storage box 17 is located in the space, occupying a part of the upper portion of the fan chamber 15 and the upper portion of the machine chamber 14. In the electrical-component storage box 17, electrical components are accommodated, including, for example, an inverter power supply to control driving of a motor of the compressor 2 and a motor of the fan 7. There is a terminal block near the electrical-component storage box 17. The terminal block is used to connect external electric wires to the electrical components in the electrical-component storage box 17. The service panel 22 is removably attached to the side panel 20. The service panel 22 protects the terminal block. Below the service panel 22, a connection-portion cover 23 is removably attached to the side panel 20. The connection-portion cover 23 protects a connection portion (not illustrated) to which the external pipe 96 and the external pipe 97 are connected.

[0026] Fig. 4 is a perspective view of a bottom plate, an upper heat insulator, a lower heat insulator, a water-refrigerant heat exchanger, and other devices included in the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure when these components are viewed from the front right side. As illustrated in Fig. 4, the bottom plate 18 has, for example, a shape formed with a plurality of irregularities, steps, and inclined surfaces with a height difference of approximately 1 centimeter. The bottom plate 18 may be formed by pressing which is, for example, drawing. The bottom plate 18 has impermeable properties.

[0027] The bottom plate 18 is formed with a drain port (not illustrated). It is desirable for this drain port to be located at the lowest position in the bottom plate 18. Since during operation of the heat-pump hot-water supply outdoor unit 1, the temperature of the evaporator 5 is relatively low, water contained in the air passing through the evaporator 5 may condense on the surface of the evaporator 5. The condensed water falls by gravity. The bottom plate 18 receives the water. The water flows toward the position of the drain port due to the height difference formed on the bottom plate 18, and is discharged downward from the bottom plate 18 through the drain port.

[0028] A hopper or the like configured to receive water discharged from the drain port may be provided at the installation location of the heat-pump hot-water supply outdoor unit 1. The bottom plate 18 is formed with the drain port, and thus the following effects can be obtained. Condensed water and the like generated on the surface of the evaporator 5 is collected by the bottom plate 18, and then discharged from the drain port to the outside of the heat-pump hot-water supply outdoor unit 1. This can avoid water from leaking from a section other than the drain port. This can ensure that a user avoids misunderstanding that water leaks from the heat-pump hot-water supply outdoor unit 1.

[0029] The water-refrigerant heat exchanger 3 is accommodated in a box-shaped heat insulator, and can thus reduce heat dissipation to the outside during operation of the heat-pump hot-water supply outdoor unit 1. The box-shaped heat insulator according to the present embodiment is divided into two, an upper part and a lower part. The heat insulator is made up of the lower heat insulator 10 and the upper heat insulator 9. The lower heat insulator 10 has a box shape to accommodate therein the water-refrigerant heat exchanger 3. The upper heat insulator 9 has a lid-like shape to cover the topside of the lower heat insulator 10.

[0030] Fig. 5 is a perspective view of the bottom plate, the lower heat insulator, the water-refrigerant heat exchanger, and other devices included in the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure when these elements are viewed from the front right side. Note that a D1 direction illustrated by the arrow in Fig. 5 represents the rightward-leftward direction of the heat-pump hot-water supply outdoor unit 1. That is, the D1 direction represents the rightward-leftward direction of the lower heat insulator 10 and the water-refrigerant heat exchanger 3. A D2 direction

illustrated by the arrow in Fig. 5 represents the forward-rearward direction of the heat-pump hot-water supply outdoor unit 1. That is, the D2 direction represents the forward-rearward direction of the lower heat insulator 10 and the water-refrigerant heat exchanger 3.

[0031] The interior space of the lower heat insulator 10 has an approximately cuboid shape elongated in the rightward-leftward direction. The water-refrigerant heat exchanger 3 is placed on an inner bottom portion 10a of the lower heat insulator 10. Note that the inner bottom portion 10a of the lower heat insulator 10 is a bottom portion of the lower heat insulator 10 on the inner side thereof. The water-refrigerant heat exchanger 3 is a pipe-like heat exchanger such as a double-pipe heat exchanger. The water-refrigerant heat exchanger 3 has such a structure that the water-refrigerant heat exchanger 3 is layered in the upward-downward direction while being bent into a rectangular shape corresponding to the shape of the interior space of the lower heat insulator 10. That is, when the water-refrigerant heat exchanger 3 is viewed in plan, the rightward-leftward direction thereof is the longitudinal direction, and the forward-rearward direction thereof is the width direction.

[0032] Fig. 6 is a perspective view of the lower heat insulator included in the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure when the lower heat insulator is viewed from the front right side. Fig. 7 is a vertical cross-sectional view of the lower heat insulator included in the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure, taken along the vertical plane parallel to the width direction of the lower heat insulator. Fig. 8 is a vertical cross-sectional view of the lower heat insulator included in the heat-pump hot-water supply outdoor unit according to the embodiment of the present disclosure, taken along the vertical plane parallel to the longitudinal direction of the lower heat insulator.

[0033] The inner bottom portion 10a of the lower heat insulator 10 has an uneven shape with a protruding portion 12 and a recessed portion 13. More specifically, the inner bottom portion 10a of the lower heat insulator 10 includes a plurality of protruding portions 12 extending in a direction oriented in the width direction when the lower heat insulator 10 is viewed in plan. The protruding portions 12 are located apart from each other with a predetermined spacing. Between the protruding portions 12, a section lower than the protruding portions 12 is formed. This section is represented as the recessed portion 13. The recessed portion 13 is formed with at least one drain hole 11 extending through the inner bottom portion 10a. Note that in the present embodiment 1, a plurality of drain holes 11 are formed. The water-refrigerant heat exchanger 3 is placed on the protruding portions 12.

[0034] Due to this configuration, in the heat-pump hot-water supply outdoor unit 1 according to the present embodiment, when condensation occurs on the surface of the water-refrigerant heat exchanger 3, and then water on the surface of the water-refrigerant heat exchanger 3 flows down to the inner bottom portion 10a of the lower heat insulator 10, the water collects in the recessed portion 13 of the inner bottom portion 10a. Thereafter, the water collecting in the recessed portion 13 is discharged from the drain holes 11 formed on the recessed portion 13 to the outside of the lower heat insulator 10. The water-refrigerant heat exchanger 3 is raised by the protruding portions 12 relative to the recessed portion 13. Due to this configuration, the heat-pump hot-water supply outdoor unit 1 according to the present embodiment can significantly prevent the water-refrigerant heat exchanger 3 accommodated in a box-shaped heat insulator from being immersed in water even when condensation occurs on the water-refrigerant heat exchanger 3, compared to the conventional heat-pump hot-water supply outdoor unit. That is, the heat-pump hot-water supply outdoor unit 1 according to the present embodiment can significantly prevent the water-refrigerant heat exchanger 3 from corrosion, compared to the related-art heat-pump hot-water supply outdoor unit.

[0035] Note that water discharged from the drain holes 11 to the outside of the lower heat insulator 10 flows down to the bottom plate 18. The water having flowed down to the bottom plate 18 flows toward the position of the drain port due to the height difference formed on the bottom plate 18, and is discharged downward from the bottom plate 18 through the drain port.

[0036] In the present embodiment, the recessed portion 13 includes an inclined surface 13a that is inclined downward toward the drain hole 11. The inclined surface 13a included in the recessed portion 13 allows water to be collected in the recessed portion 13 to be more quickly discharged from the drain hole 11 to the outside of the lower heat insulator 10, compared to the case where the recessed portion 13 does not include the inclined surface 13a. With this configuration, the inclined surface 13a included in the recessed portion 13 can more significantly prevent the water-refrigerant heat exchanger 3 from being immersed in the water, compared to the above case. That is, the inclined surface 13a included in the recessed portion 13 can more significantly prevent the water-refrigerant heat exchanger 3 from corrosion, compared to the above case. Note that the recessed portion 13 according to the present embodiment includes a plurality of inclined surfaces 13a, however, when the recessed portion 13 includes at least one inclined surface 13a, the effects described above can be obtained.

[0037] In the present embodiment, each of the drain holes 11 is formed at a lower end portion 13c of the inclined surface 13a. In other words, in the recessed portion 13 according to the present embodiment and including the inclined surfaces 13a, each of the drain holes 11 is formed at a valley portion formed by the inclined surfaces 13a. The drain hole 11 formed at the lower end portion 13c of the inclined surface 13a allows water collecting in the recessed portion 13 to be further quickly discharged from the drain hole 11 to the outside of the lower heat insulator 10, and can further prevent the water-refrigerant

heat exchanger 3 from corrosion. That is, the drain hole 11 formed at the lower end portion 13c of the inclined surface 13a can further prevent the water-refrigerant heat exchanger 3 from corrosion. Note that when at least one of the drain holes 11 is formed at the lower end portion 13c of the inclined surface 13a, the effects described above can be obtained.

[0038] In the present embodiment, when the lower heat insulator 10 is viewed in plan, a part of the protruding portion 12 is positioned at an apex 13b of the inclined surface 13a. That is, a part of the protruding portion 12 is located at the highest point of the recessed portion 13. The protruding portion 12 located in this manner can minimize the protrusion height of the protruding portion 12 from the recessed portion 13, and can thus reduce material cost for the lower heat insulator 10.

[0039] In the recessed portion 13 according to the present embodiment and including the inclined surfaces 13a, at least some of the plurality of inclined surfaces 13a are inclined in the forward-rearward direction, while at least some of the plurality of inclined surfaces 13a are inclined in the rightward-leftward direction. Note that, in the present embodiment, all the inclined surfaces 13a are inclined in both the forward-rearward direction and the rightward-leftward direction. The heat-pump hot-water supply outdoor unit 1 may be installed while being inclined in the rightward-leftward direction. The heat-pump hot-water supply outdoor unit 1 may also be installed while being inclined in the forward-rearward direction. Furthermore, the heat-pump hot-water supply outdoor unit 1 may be installed while being inclined in both the rightward-leftward direction and the forward-rearward direction. In a case where the recessed portion 13 includes the inclined surfaces 13a, the inclination direction of the inclined surfaces 13a is defined as described above, so that even when the heat-pump hot-water supply outdoor unit 1 is installed while being inclined in any direction, water collecting in the recessed portion 13 can still be discharged further quickly to the outside of the lower heat insulator 10.

[0040] Note that, while the inner bottom portion 10a of the lower heat insulator 10 according to the present embodiment includes the protruding portions 12, the inner bottom portion 10a may include any number of protruding portions 12. For example, the protruding portion 12 is formed into an approximately frame-like shape in plan view, so that the water-refrigerant heat exchanger 3 can be placed on a single protruding portion 12. In a case where the inner bottom portion 10a includes the protruding portions 12, it is preferable to position each of the protruding portions 12 in the manner as illustrated in Figs. 6 and 8. More specifically, it is preferable that the protruding portions 12 are spaced apart from each other in a direction oriented in the longitudinal direction of the water-refrigerant heat exchanger 3 when the water-refrigerant heat exchanger 3 is viewed in plan. Positioning the protruding portions 12 in this manner can prevent distortion of the water-refrigerant heat exchanger 3. That is, this positioning can prevent the water-refrigerant heat exchanger 3 from being distorted and thus from being immersed in water collecting in the recessed portion 13.

[0041] In the present embodiment, a corner portion 12a of the protruding portion 12 has an arc shape protruding outward on the protruding portion 12 in vertical cross-section. The corner portion 12a of the protruding portion 12 has the shape as described above, so that the contact area between the water-refrigerant heat exchanger 3 and the top surface of the protruding portion 12 can be decreased. The corner portion 12a of the protruding portion 12 has the shape as described above, so that water having flowed from the water-refrigerant heat exchanger 3 down to the top surface of the protruding portion 12 hardly stays on the top surface of the protruding portion 12. For this reason, the corner portion 12a of the protruding portion 12 has the shape as described above, and this can thus reduce the period of time during which the water-refrigerant heat exchanger 3 contacts water, and accordingly can further prevent the water-refrigerant heat exchanger 3 from corrosion.

[0042] The heat-pump hot-water supply outdoor unit 1 according to the present embodiment includes a box-shaped heat insulator, and the water-refrigerant heat exchanger 3 accommodated in the heat insulator and configured to heat water with refrigerant. The inner bottom portion 10a of the lower heat insulator 10 of the heat insulator has an uneven shape with the protruding portion 12 and the recessed portion 13. The recessed portion 13 is formed with the drain hole 11 extending through the inner bottom portion 10a. The water-refrigerant heat exchanger 3 is placed on the protruding portion 12 of the inner bottom portion 10a.

[0043] In the heat-pump hot-water supply outdoor unit 1 according to the present embodiment, when condensation occurs on the surface of the water-refrigerant heat exchanger 3, and then water on the surface of the water-refrigerant heat exchanger 3 flows down to the inner bottom portion 10a of the lower heat insulator 10, the water is collected in the recessed portion 13 of the inner bottom portion 10a. Thereafter, the water collecting in the recessed portion 13 is discharged from the drain holes 11 formed on the recessed portion 13 to the outside of the lower heat insulator 10. The water-refrigerant heat exchanger 3 is raised by the protruding portions 12 relative to the recessed portion 13. Due to this configuration, the heat-pump hot-water supply outdoor unit 1 according to the present embodiment can significantly prevent the water-refrigerant heat exchanger 3 accommodated in a box-shaped heat insulator from being immersed in water even when condensation occurs on the water-refrigerant heat exchanger 3, compared to the conventional heat-pump hot-water supply outdoor unit. That is, the heat-pump hot-water supply outdoor unit 1 according to the present embodiment can significantly prevent the water-refrigerant heat exchanger 3 from corrosion, compared to the conventional heat-pump hot-water supply outdoor unit.

Reference Signs List

[0044]

1	heat-pump hot-water supply outdoor unit
2	compressor
3	water-refrigerant heat exchanger
3a	water pipe
3b	refrigerant pipe
4a	first expansion valve
4b	second expansion valve
5	evaporator
6	internal heat exchanger
7	fan
8	case
9	upper heat insulator
10	lower heat insulator
10a	inner bottom portion
11	drain hole
12	protruding portion
12	a corner portion
13	recessed portion
13a	inclined surface
13b	apex
13c	lower end portion
14	machine chamber
15	fan chamber
16	partition plate
17	electrical-component storage box
18	bottom plate
19	front panel
20	side panel
21	top panel
22	service panel
23	connection-portion cover
24	grille
25	leg portion
90	heat-pump hot-water supply system
91	tank unit
92	water storage tank
93	pump
94	flow-path switching valve
95	bypass pipe
96	external pipe
97	external pipe
98	tank top pipe

Claims

1. A heat-pump hot-water supply outdoor unit comprising:

a box-shaped heat insulator; and
a water-refrigerant heat exchanger accommodated in the heat insulator and configured to heat water with refrigerant, wherein
an inner bottom portion of the heat insulator has an uneven shape with a protruding portion and a recessed portion,
the recessed portion is formed with a drain hole extending through the inner bottom portion, and
the water-refrigerant heat exchanger is placed on the protruding portion.

2. The heat-pump hot-water supply outdoor unit of claim 1, wherein the recessed portion includes an inclined surface that is inclined downward toward the drain hole.

3. The heat-pump hot-water supply outdoor unit of claim 2, wherein when the heat insulator is viewed in plan, a part of the protruding portion is positioned at an apex of the inclined surface.

4. The heat-pump hot-water supply outdoor unit of claim 2 or 3, wherein the drain hole is formed at a lower end portion of the inclined surface.

5. The heat-pump hot-water supply outdoor unit of any one of claims 2 to 4, wherein
the recessed portion includes a plurality of the inclined surfaces,
at least some of a plurality of the inclined surfaces are inclined in a forward-rearward direction, and
at least some of a plurality of the inclined surfaces are inclined in a rightward-leftward direction.

6. The heat-pump hot-water supply outdoor unit of any one of claims 1 to 5, wherein
the inner bottom portion includes a plurality of the protruding portions, and
a plurality of the protruding portions are spaced apart from each other in a direction oriented in a longitudinal direction of the water-refrigerant heat exchanger when the water-refrigerant heat exchanger is viewed in plan.

7. The heat-pump hot-water supply outdoor unit of any one of claims 1 to 6, wherein a corner portion of the protruding portion has an arc shape protruding outward on the protruding portion in vertical cross-section.

FIG. 1

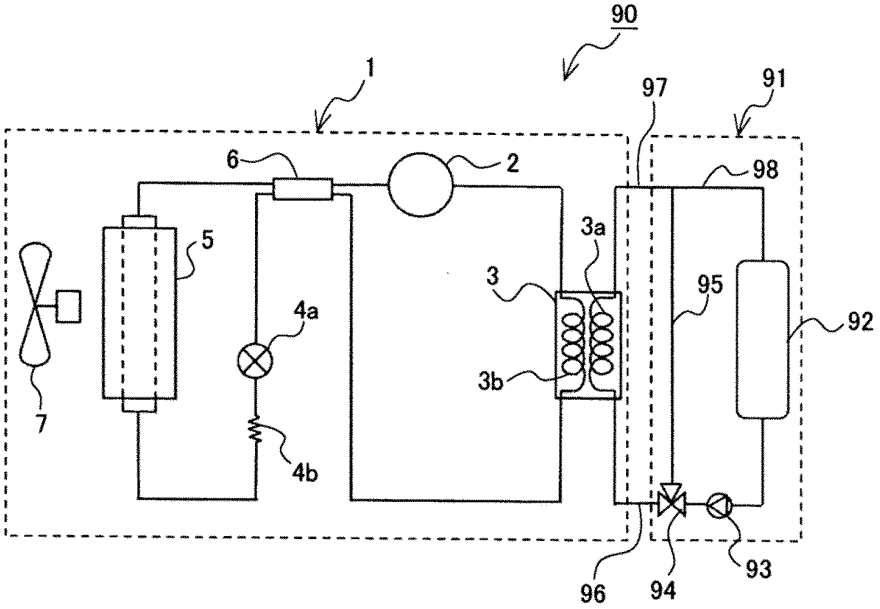


FIG. 2

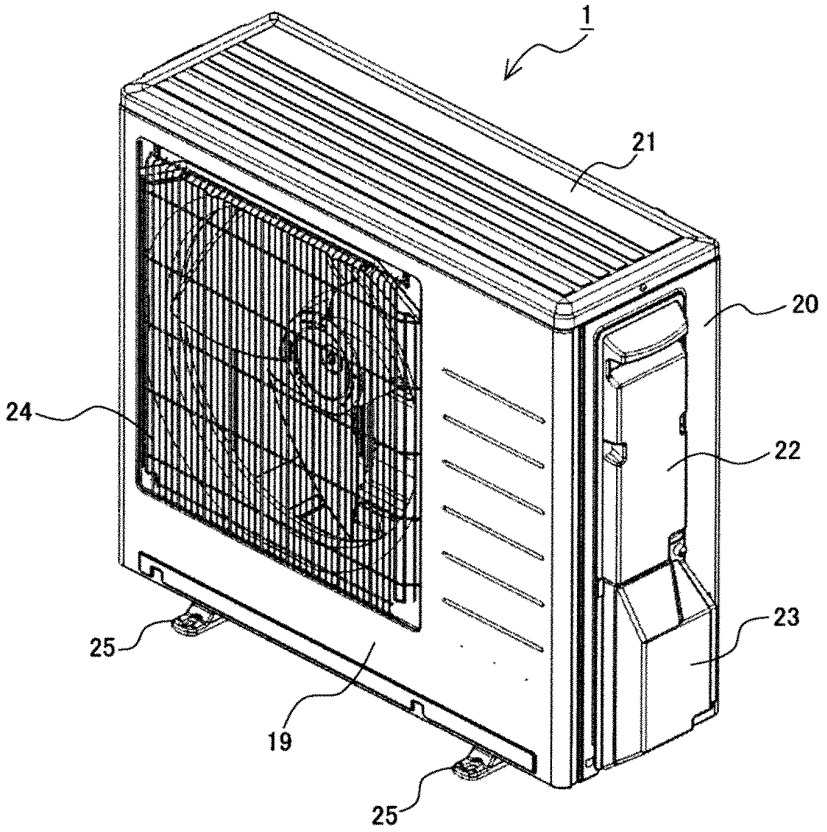


FIG. 3

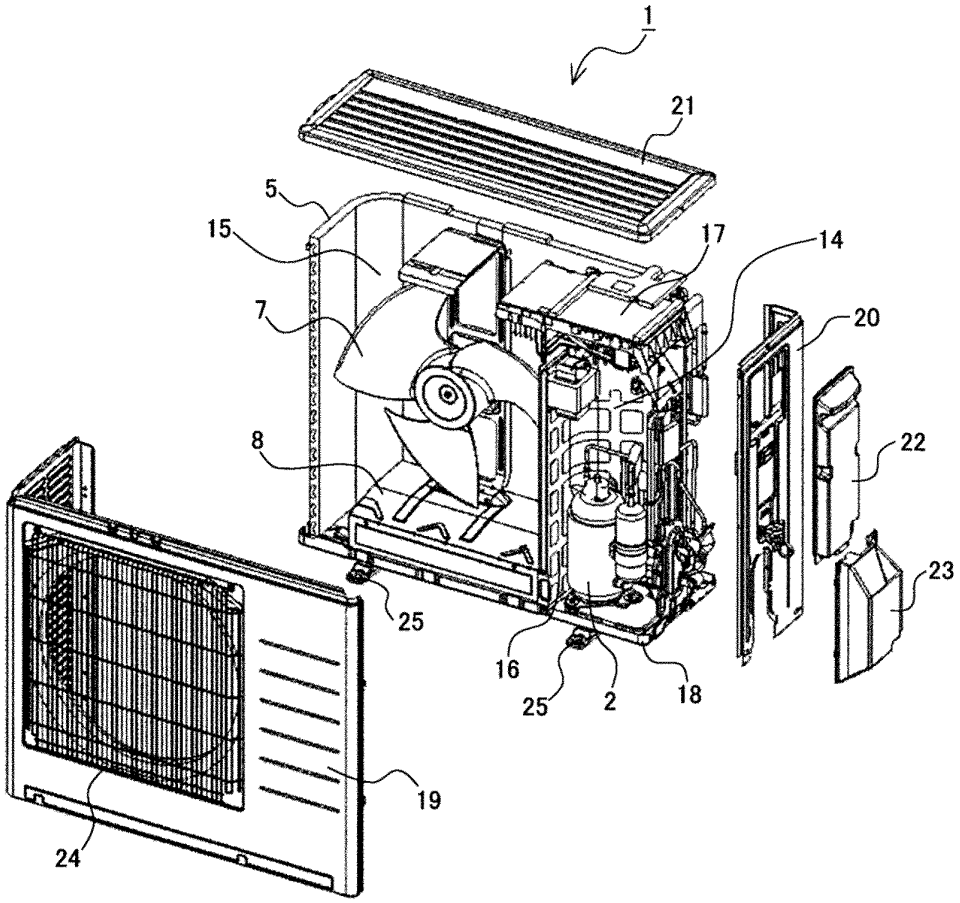


FIG. 4

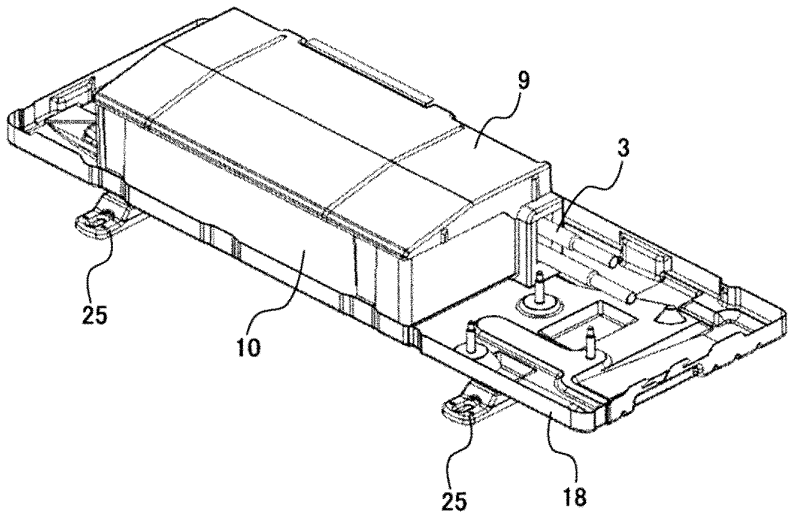


FIG. 5

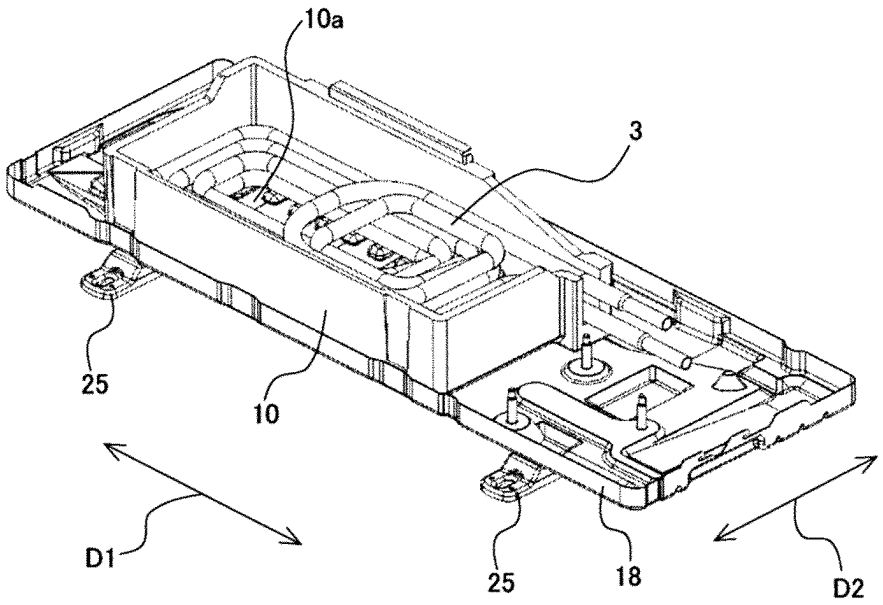


FIG. 6

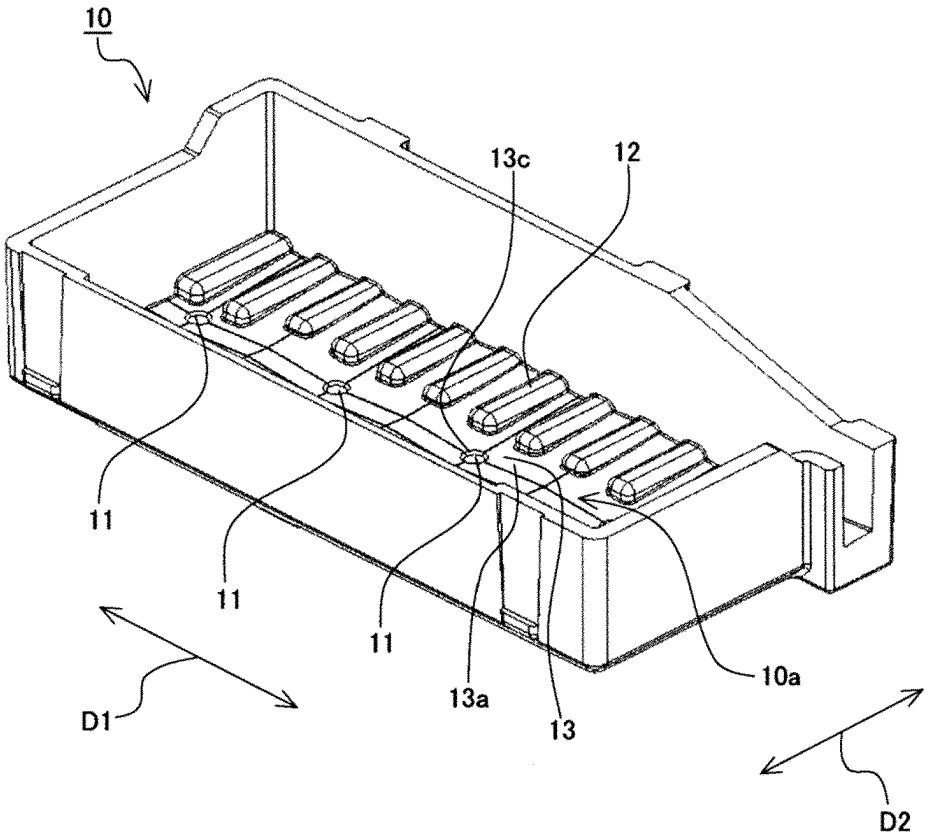
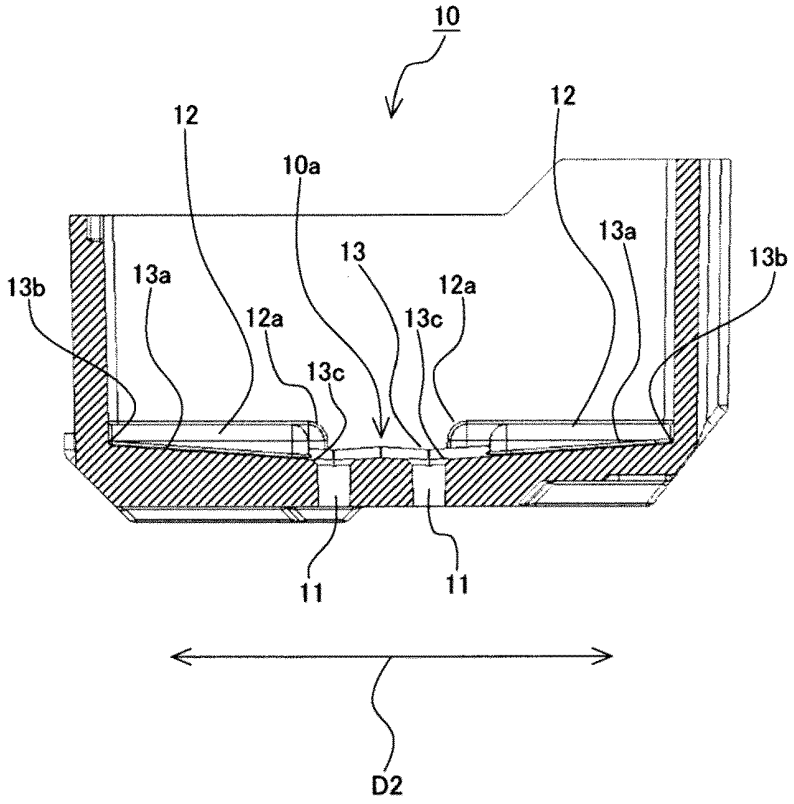


FIG. 7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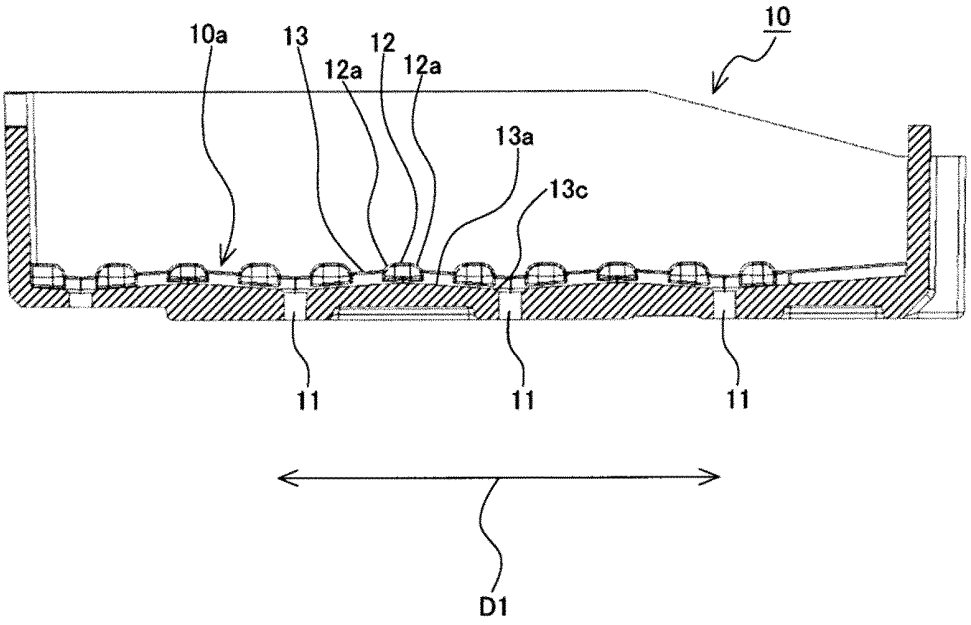
D2

FIG. 8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12a
13a
13c
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D1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/027274

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F24H9/02(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. F24H9/02, F24F1/16, F24F1/36, F24H1/00, F24H9/00, F25B30/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2018
Registered utility model specifications of Japan 1996-2018
Published registered utility model applications of Japan 1994-2018

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2015-45425 A (NORITZ CORP.) 12 March 2015, paragraphs [0037]-[0051], fig. 3-5 (Family: none)	1-5 6, 7
Y	JP 2016-223740 A (CORONA CORP.) 28 December 2016, paragraphs [0038]-[0045], fig. 4-7 (Family: none)	1-5
A	JP 2005-147619 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 09 June 2005, entire text, all drawings (Family: none)	1-7
A	JP 2015-206551 A (CORONA CORP.) 19 November 2015, entire text, all drawings (Family: none)	1-7

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13.09.2018	02.10.2018
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/027274

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2014-20585 A (PANASONIC CORP.) 03 February 2014, entire text, all drawings (Family: none)	1-7
A	JP 2011-133149 A (PANASONIC CORP.) 07 July 2011, entire text, all drawings (Family: none)	1-7
A	JP 2014-31902 A (MITSUBISHI ELECTRIC CORP.) 20 February 2014, entire text, all drawings & CN 203454407 U	1-7

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2015045425 A **[0005]**