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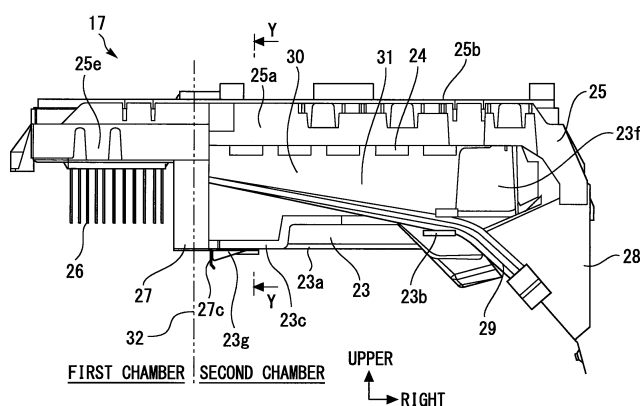
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(54) **HEAT PUMP APPARATUS**

(57) A heat pump apparatus includes an electrical unit (17) including an electrical part for driving at least one of a blower configured to blow air to an air-to-refrigerant heat exchanger and a compressor configured to compress a refrigerant. The electrical unit (17) includes an electrical circuit board (24) including an upper surface, a lower surface, and the electrical part mounted on the lower surface, a receiving tray (23) including a receiving portion (23a) that covers at least a part of the electrical circuit board (24) from below, a framework that holds the

electrical circuit board (24) and the receiving tray (23), and an opening (30), which is formed between the frame-work and the receiving portion (23a) of the receiving tray (23) and through which air is capable of passing. A space between the electrical circuit board (24) and the receiving portion (23a) of the receiving tray (23) is an inner space (31) of the electrical unit (17). The inner space (31) of the electrical unit (17) communicates with outside of the electrical unit (17) via the opening (30).

FIG. 4



Description

[Technical Field]

5 **[0001]** The present invention relates to a heat pump apparatus.

[Background Art]

10 **[0002]** A heat pump apparatus disclosed in PTL 1 described below has the following configuration. The bracketed numerals are reference numerals in PTL 1. An electrical equipment box (20) accommodates a control board (21) that controls a heat pump unit (1). The electrical equipment box (20) is arranged in a blowing chamber (16). Paragraph 0024 in PTL 1 includes a wording of "even when mounted parts such as an electrolytic capacitor (26) fall from the control board (21), the mounted parts fall into a metal receiving tray (27) on the inner bottom portion of the electrical equipment box (20), and hence damage is not caused to other functional parts below the electrical equipment box (20)". Paragraph 15 0027 in PTL 1 includes a wording of "the electrical equipment box (20) is a molded article made of flame-resistant resin, and hence gaps are not formed in the corner portions of the electrical equipment box (20) and there is no fear of water entering the electrical equipment box (20). Therefore, the electrical equipment box (20) can be provided on the blowing chamber (16) side exposed to wind and rain".

20 [Citation List]

[Patent Literature]

25 **[0003]** [PTL 1] Japanese Patent Application Laid-open No. 2010-38419

[Summary of Invention]

[Technical Problem]

30 **[0004]** The heat pump apparatus disclosed in PTL 1 has the following problem. The electrical equipment box (20) provided on the blowing chamber (16) side exposed to wind and rain is sealed, and hence the inside of the electrical equipment box (20) is easily filled with heat and becomes high in temperature. As a result, the lifespan of the electrical parts provided on the control board (21) tends to be short.

35 **[0005]** The present invention has been provided in view of the problem as described above, and an object thereof is to provide a heat pump apparatus capable of preventing damage on other parts even when an electrical part falls from an electrical circuit board and capable of preventing the periphery of the electrical circuit board from being filled with heat.

[Solution to Problem]

40 **[0006]** A heat pump apparatus according to the present invention includes: an air-to-refrigerant heat exchanger configured to exchange heat between air and a refrigerant; a blower configured to blow air to the air-to-refrigerant heat exchanger; a compressor configured to compress the refrigerant; and an electrical unit including an electrical part for driving at least one of the blower and the compressor. The electrical unit includes: an electrical circuit board including an upper surface, a lower surface, and the electrical part mounted on the lower surface; a receiving tray including a 45 receiving portion that covers at least a part of the electrical circuit board from below; a framework that holds the electrical circuit board and the receiving tray; and an opening which is formed between the framework and the receiving portion of the receiving tray and through which air is capable of passing. A space between the electrical circuit board and the receiving portion of the receiving tray is an inner space of the electrical unit. The inner space of the electrical unit communicates with outside of the electrical unit via the opening.

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[Advantageous Effects of Invention]

55 **[0007]** According to the present invention, the damage on the other parts can be prevented even when the electrical part falls from the electrical circuit board, and the periphery of the electrical circuit board can be prevented from being filled with heat.

[Brief Description of Drawings]

[0008]

Fig. 1 is a piping system diagram of a hot-water storing hot-water supplying system including a heat pump apparatus according to Embodiment 1.

Fig. 2 is a perspective view illustrating an external appearance of the heat pump apparatus according to Embodiment 1.

Fig. 3 is an exploded perspective view of the heat pump apparatus according to Embodiment 1.

Fig. 4 is a front view of an electrical unit of the heat pump apparatus according to Embodiment 1.

Fig. 5 is a bottom view of the electrical unit illustrated in Fig. 4.

Fig. 6 is a perspective view of a receiving tray included in the electrical unit illustrated in Fig. 4 seen from diagonally above.

Fig. 7 is a perspective view of the receiving tray illustrated in Fig. 6 seen from diagonally below.

Fig. 8 is a perspective view of a board support included in the electrical unit illustrated in Fig. 4 seen from diagonally above.

Fig. 9 is a perspective view of the board support illustrated in Fig. 8 seen from diagonally below.

Fig. 10 is a perspective view of a heat sink and a heat sink support included in the electrical unit illustrated in Fig. 4 seen from diagonally above.

Fig. 11 is a perspective view of the heat sink and the heat sink support illustrated in Fig. 10 seen from diagonally below.

Fig. 12 is a perspective view of a terminal block support included in the electrical unit illustrated in Fig. 4 seen from diagonally above.

Fig. 13 is a perspective view of the terminal block support illustrated in Fig. 12 seen from diagonally below.

Fig. 14 is a cross-sectional view taken along line Y-Y in Fig. 4.

Fig. 15 is a view illustrating the details of section A in Fig. 14.

Fig. 16 is a view illustrating the details of section B in Fig. 14.

Fig. 17 is a cross-sectional view taken along line X-X in Fig. 5.

Fig. 18 is a view illustrating the details of section C in Fig. 17.

Fig. 19 is a view illustrating the details of section D in Fig. 17.

[Description of Embodiments]

[0009] An embodiment is described below with reference to the drawings. In the drawings, common elements are denoted by the same reference characters, and overlapping descriptions are simplified or omitted.

Embodiment 1

[0010] Fig. 1 is a piping system diagram of a hot-water storing hot-water supplying system 90 including a heat pump apparatus 1 according to Embodiment 1. As illustrated in Fig. 1, the hot-water storing hot-water supplying system 90 includes the heat pump apparatus 1 and a tank unit 91. The heat pump apparatus 1 is provided outdoors. The tank unit 91 may be provided outdoors or may be provided indoors.

[0011] The heat pump apparatus 1 includes a compressor 2, a heat exchanger 3, a first expansion valve 4a, a second expansion valve 4b, an air-to-refrigerant heat exchanger 5, an internal heat exchanger 6, and a blower 7. The heat pump apparatus 1 includes a refrigerant circuit, and performs the operation of a refrigerating cycle, that is, a heat pump cycle. The compressor 2 compresses low-pressure refrigerant gas. The refrigerant may be any one of carbon dioxide, ammonia, propane, isobutane, fluorocarbon such as HFC, HFO-1123, and HFO-1234yf, for example. The heat exchanger 3 exchanges heat between the high-pressure and high-temperature refrigerant discharged from the compressor 2 and water or other liquid heat media. The liquid heat medium may be a calcium chloride solution, an ethylene glycol solution, or alcohol, for example.

[0012] The first expansion valve 4a and the second expansion valve 4b are examples of decompression devices that decompress a high-pressure refrigerant, to thereby obtain a low-pressure refrigerant. The decompressed low-pressure refrigerant is placed in the gas-liquid two-phase state. The air-to-refrigerant heat exchanger 5 is a heat exchanger that exchanges heat between the low-pressure refrigerant and the air in the atmosphere. In the air-to-refrigerant heat exchanger 5, the low-pressure refrigerant evaporates by absorbing the heat in the air. The heat exchange in the air-to-refrigerant heat exchanger 5 can be facilitated by blowing air to the air-to-refrigerant heat exchanger 5 by the blower 7. The internal heat exchanger 6 includes a high-pressure passage and a low-pressure passage. The internal heat exchanger 6 exchanges heat between a high-pressure refrigerant passing through the high-pressure passage and a low-pressure refrigerant passing through the low-pressure passage. The low-pressure refrigerant gas that has evaporated

in the air-to-refrigerant heat exchanger 5 is sucked to the compressor 2 via the low-pressure passage of the internal heat exchanger 6.

[0013] The refrigerant circuit in this embodiment includes a first path 8 in which the refrigerant that has passed through the heat exchanger 3 reaches the air-to-refrigerant heat exchanger 5 via the high-pressure passage of the internal heat exchanger 6, and a second path 9 in which the refrigerant that has passed through the heat exchanger 3 reaches the air-to-refrigerant heat exchanger 5 without passing through the internal heat exchanger 6. The first expansion valve 4a is provided in the first path 8 downstream of the high-pressure passage of the internal heat exchanger 6. The second expansion valve 4b is provided in the second path 9. By adjusting the opening degree of the first expansion valve 4a and the second expansion valve 4b, the ratio of the flow rate of the refrigerant reaching the air-to-refrigerant heat exchanger 5 from the heat exchanger 3 via the internal heat exchanger 6 and the flow rate of the refrigerant reaching the air-to-refrigerant heat exchanger 5 from the heat exchanger 3 without passing through the internal heat exchanger 6 can be changed.

[0014] The tank unit 91 includes a hot water storage tank 92, a water pump 93, a flow path switching valve 94, and a bypass passage 95. The heat pump apparatus 1 and the tank unit 91 are connected to each other via external piping 96 and 97.

[0015] Water before heating and hot water after heating are accommodated in the hot water storage tank 92. In the hot water storage tank 92, thermal stratification in which the temperature on the upper side is high and the temperature on the lower side is low is formed due to the difference in specific gravity of water in accordance with the temperature. A hot water supply pipe (not shown) for supplying hot water to terminals such as a hot water supply faucet, a shower, and a bathtub is connected to the upper portion of the hot water storage tank 92. A water supply pipe (not shown) that supplies water from water sources such as waterworks is connected to the lower portion of the hot water storage tank 92. When hot water is supplied from the hot water storage tank 92, the hot water in the upper portion of the hot water storage tank 92 is sent out to the hot water supply pipe by the water pressure applied to the inside of the hot water storage tank 92 from the water supply pipe. Water flows into the hot water storage tank 92 from the water supply pipe by the same amount as the hot water flowing out to the hot water supply pipe, and hence the hot water storage tank 92 is maintained in a state of being filled with water.

[0016] The lower portion of the hot water storage tank 92 is connected to an inlet of the water pump 93 via a conduit. An outlet of the water pump 93 is connected to the flow path switching valve 94. The flow path switching valve 94 is connected to a water inlet of the heat exchanger 3 of the heat pump apparatus 1 via the external piping 96.

[0017] The hot-water storing hot-water supplying system 90 can perform heat accumulating operation in which the hot water heated by the heat pump apparatus 1 is caused to flow into the hot water storage tank 92. In the heat accumulating operation, the following is performed. The compressor 2, the blower 7, and the water pump 93 are operated. The water flowing out from the lower portion of the hot water storage tank 92 flows into the heat exchanger 3 of the heat pump apparatus 1 through the water pump 93, the flow path switching valve 94, and the external piping 96. The water is heated by the refrigerant in the heat exchanger 3 and becomes hot water. The temperature of the hot water heated in the heat exchanger 3 may be from about 65°C to about 90°C, for example. The hot water flowing out from the heat exchanger 3 returns to the tank unit 91 through the external piping 97, and flows into the upper portion of the hot water storage tank 92 through a tank upper portion pipe 98.

[0018] The flow path switching valve 94 can switch the flow path so that the water discharged from the water pump 93 flows into the tank upper portion pipe 98 through the bypass passage 95 instead of the heat pump apparatus 1.

[0019] The use of the heat pump apparatus 1 is not limited to the use for supplying hot water as in the illustrated example. The heat pump apparatus 1 may heat a liquid heat medium for space heating, for example. For example, the liquid heat medium heated by the heat pump apparatus 1 may be supplied to at least one heating unit out of a floor heating panel provided under the floor, a radiator or a panel heater provided on an indoor wall surface, and a fan convector.

[0020] Fig. 2 is a perspective view illustrating the external appearance of the heat pump apparatus 1 according to Embodiment 1. As illustrated in Fig. 2, the heat pump apparatus 1 includes a front panel 19, a side panel 20, a top panel 21, a grille 12, and leg portions 41. The heat pump apparatus 1 is fixed to a ground surface or a floor surface via the leg portions 41. In the description below, the "upper direction", the "front direction", and the "right direction" are defined as indicated by the arrows in Fig. 2 in order to facilitate the understanding of the drawings. The direction opposite to the "upper direction" is the "lower direction". The direction opposite to the "front direction" is the "rear direction". The direction opposite to the "right direction" is the "left direction".

[0021] Fig. 3 is an exploded perspective view of the heat pump apparatus 1 according to Embodiment 1. As illustrated in Fig. 3, the heat pump apparatus 1 further includes a partition plate 16, an electrical unit 17, and a bottom plate 18. The bottom plate 18, the front panel 19, the side panel 20, and the top panel 21 correspond to a casing of the heat pump apparatus 1. The casing of the heat pump apparatus 1 is preferred to be made of metal. The partition plate 16 and the electrical unit 17 are provided in the casing of the heat pump apparatus 1. The bottom plate 18 corresponds to the base of the heat pump apparatus 1. Component devices such as the compressor 2 are mounted on the bottom plate 18. The leg portions 41 are fixed to the lower surface of the bottom plate 18.

[0022] The front panel 19 covers the front surface and the left side surface of the heat pump apparatus 1. The side panel 20 covers a part of the rear surface and the right side surface of the heat pump apparatus 1. The top panel 21 covers the upper surface of the heat pump apparatus 1.

[0023] The air-to-refrigerant heat exchanger 5 is provided so as to cover a large part of the rear surface and the left side surface of the heat pump apparatus 1. The blower 7 is provided between the air-to-refrigerant heat exchanger 5 and the front panel 19. The blower 7 in this embodiment includes a propeller fan. The inner space of the casing of the heat pump apparatus 1 is partitioned into a first chamber 14 and a second chamber 15 by the partition plate 16. The blower 7 is accommodated in the first chamber 14. In the second chamber 15, the compressor 2, the refrigerant piping, and the like are provided. A case 13 is provided below the blower 7. The heat exchanger 3 is accommodated in the case 13 in a state of being covered with a heat insulating material.

[0024] The front panel 19 has an opening in a position facing the blower 7. The grille 12 that covers the opening is mounted on the front panel 19. When the blower 7 is operated, the outside air flows into the first chamber 14 through the air-to-refrigerant heat exchanger 5, and is exhausted to the front side of the heat pump apparatus 1 through the grille 12.

[0025] A large part of the electrical unit 17 is located in the upper portion in the second chamber 15. The remaining parts of the electrical unit 17 are located in the upper portion in the first chamber 14. The electrical unit 17 includes an electrical part for driving at least one of the compressor 2 and the blower 7. Typically, the electrical unit 17 may include an electrical part such as an inverter power supply that drives and controls a motor of the compressor 2 and a motor of the blower 7. In this embodiment, the electrical unit 17 includes a terminal block. The terminal block is used when external electric wiring is connected. A service panel 22 is removably mounted on the side panel 20. The service panel 22 protects the terminal block. A connection portion cover 42 is removably mounted on the side panel 20 so as to be below the service panel 22. The connection portion cover 42 protects a connection portion (not shown) connected to the external piping 96 and 97.

[0026] Fig. 4 is a front view of the electrical unit 17 of the heat pump apparatus 1 according to Embodiment 1. Fig. 5 is a bottom view of the electrical unit 17 illustrated in Fig. 4. As illustrated in those views, the electrical unit 17 includes a receiving tray 23, an electrical circuit board 24, a board support 25, a heat sink 26, a heat sink support 27, and a terminal block support 28 in this embodiment.

[0027] In the description below, the electrical part for driving at least one of the compressor 2 and the blower 7 is simply referred to as an "electrical part". The electrical circuit board 24 includes an electrical part mounted on the lower surface thereof. The electrical circuit board 24 may include other electrical parts mounted on the upper surface thereof. The electrical circuit board 24 is held by the board support 25. As illustrated in Fig. 4, the receiving tray 23 includes a receiving portion 23a located below the electrical circuit board 24. As illustrated in Fig. 5, the receiving portion 23a covers at least a part of the electrical circuit board 24 from below.

[0028] According to this embodiment, the following effect can be obtained. Even when an electrical part falls from the electrical circuit board 24 for some reason, the electrical part can be received by the receiving portion 23a of the receiving tray 23. Therefore, a situation in which the electrical part that has fell further falls down and damages other devices can be reliably prevented. When the electrical unit 17 is seen from below, the receiving portion 23a of the receiving tray 23 only needs to cover a region of the electrical circuit board 24 on which the electrical parts that may fall are mounted. When the electrical unit 17 is seen from below, there may be a part of the electrical circuit board 24 that is not covered by the receiving portion 23a of the receiving tray 23.

[0029] The heat sink 26 includes a plurality of heat dissipating fins for dissipating heat generated by the electrical circuit board 24. The heat sink 26 is held by the heat sink support 27. The heat sink support 27 is fixed to the board support 25. The terminal block support 28 holds a terminal block 34 described below. The terminal block 34 has a terminal to which an electrical wire (not shown) from the outside of the heat pump apparatus 1 is connected. The "electrical wire from the outside of the heat pump apparatus 1" is, for example, electric wiring that connects the heat pump apparatus 1 and the tank unit 91 to each other, or an electricity supplying wire that supplies electricity to the heat pump apparatus 1.

[0030] In this embodiment, the board support 25, the heat sink support 27, and the terminal block support 28 correspond to the framework of the electrical unit 17. The receiving tray 23 is held by the framework. As illustrated in Fig. 4, an opening 30 through which air is capable of passing is formed in the board support 25 that is the framework, and the receiving portion 23a of the receiving tray 23. The space between the electrical circuit board 24 and the receiving portion 23a of the receiving tray 23 is an inner space 31 of the electrical unit 17. The inner space 31 of the electrical unit 17 communicates with the outside of the electrical unit 17 via the opening 30 in a ventilatable manner. As a result, the following effects can be obtained. The inner space 31 of the electrical unit 17 that is the space that the electrical circuit board 24 faces is prevented from being filled with heat. The temperature of the electrical circuit board 24 can be reduced. The deterioration of the electrical circuit board 24 due to heat can be prevented or alleviated. The lifespan of the electrical circuit board 24 can be prevented from being reduced.

[0031] In Fig. 4, the part of the electrical unit 17 on the left side with respect to a border line 32 is located in the first chamber 14. That is, the heat sink 26 is located in the first chamber 14. Meanwhile, a part of the electrical unit 17 on the right side with respect to the border line 32 is located in the second chamber 15. That is, the opening 30 in the

electrical unit 17 is located in the second chamber 15. The air blown by the blower 7 flows in the first chamber 14. The dissipation of the heat from the heat sink 26 can be facilitated by the flow of the air.

[0032] The inner space 31 of the electrical unit 17 does not communicate with the inner space of the first chamber 14. The inner space 31 of the electrical unit 17 communicates with the inner space of the second chamber 15 via the opening 30 in a ventilatable manner. Dirt and rainwater enter the first chamber 14 together with the air from the outside. The second chamber 15 is covered so that the dirt and rainwater from the outside does not enter. The inner space 31 of the electrical unit 17 does not communicate with the inner space of the first chamber 14, and hence the dirt and rainwater in the first chamber 14 can be prevented from entering the inner space 31 of the electrical unit 17. Therefore, according to this embodiment, the dirt and rainwater can be reliably prevented from adhering onto the electrical circuit board 24.

[0033] The opening 30 is formed in the front surface of the electrical unit 17. As illustrated in Fig. 5, in this embodiment, the electrical unit 17 includes a second opening 33, which is formed in a position opposite to the opening 30 and through which the air is capable of passing. The second opening 33 is formed in the rear surface of the electrical unit 17. The inner space 31 of the electrical unit 17 communicates with the outside of the electrical unit 17 via the second opening 33 in a ventilatable manner. According to this embodiment, the air in the inner space 31 of the electrical unit 17 can flow in one direction through the opening 30 and the second opening 33, and hence the inner space 31 of the electrical unit 17 can be prevented from being filled with heat in a more reliable manner.

[0034] The electrical unit 17 includes an electrical wire 29 extending from the electrical circuit board 24 to the outside of the electrical unit 17. The receiving tray 23 includes a sandwiching portion 23b that sandwiches the electrical wire 29. The sandwiching portion 23b protrudes from a side wall of the receiving tray 23. According to this embodiment, the electrical wire 29 can be easily installed in an appropriate position by providing the sandwiching portion 23b. The electrical wire 29 extends to the outside of the electrical unit 17 from the electrical circuit board 24 through the opening 30. According to this embodiment, the operation of extending and installing the electrical wire 29 to the outside of the electrical unit 17 can be easily performed by forming the opening 30.

[0035] Fig. 6 is a perspective view of the receiving tray 23 included in the electrical unit 17 illustrated in Fig. 4 seen from diagonally above. Fig. 7 is a perspective view of the receiving tray 23 illustrated in Fig. 6 seen from diagonally below. As illustrated in the views, the receiving portion 23a of the receiving tray 23 includes a horizontal receiving surface. As in the illustrated example, a level difference, an inclined surface, and the like may be formed on a part of the receiving portion 23a of the receiving tray 23. The receiving tray 23 in this embodiment is made of flame-retardant plastic. Alternatively, at least a part the receiving tray 23 may be made of metal.

[0036] As illustrated in Fig. 6, the receiving portion 23a of the receiving tray 23 includes a rising edge 23c. The rising edge 23c is formed on a large part of the periphery of the receiving portion 23a. According to this embodiment, the electrical part that has fell from the electrical circuit board 24 to the receiving portion 23a of the receiving tray 23 can be reliably prevented from falling out of the receiving portion 23a by the rising edge 23c.

[0037] As illustrated in Fig. 6, the receiving tray 23 includes a protruding portion 23d that protrudes to the front direction, a protruding portion 23e that protrudes to the rear direction, and protruding portions 23f that protrude to the upper direction. The protruding portions 23f are formed on the front portion and the rear portion. As illustrated in Fig. 7, the receiving tray 23 includes protruding portions 23g that protrudes to the lower direction from the lower surface of the receiving portion 23a. In the illustrated example, a pair of the protruding portions 23g are arranged in the front-rear direction. An embayment portion 23h is formed in the right portion of the receiving tray 23. The receiving tray 23 includes a protruding portion 23i that protrudes to the front direction from the edge of the embayment portion 23h, and a protruding portion 23j that protrudes to the rear direction from the edge of the embayment portion 23h. The protruding portion 23i and the protruding portion 23j are in positions opposed to each other across the embayment portion 23h. The functions of the protruding portions 23d, 23e, 23f, 23g, 23i, and 23j are described below. As illustrated in Fig. 5, in the electrical unit 17, the terminal block support 28 enters the embayment portion 23h of the receiving tray 23.

[0038] Fig. 8 is a perspective view of the board support 25 included in the electrical unit 17 illustrated in Fig. 4 seen from diagonally above. Fig. 9 is a perspective view of the board support 25 illustrated in Fig. 8 seen from diagonally below. As illustrated in Fig. 8, the board support 25 includes an outer frame portion 25a that is substantially a rectangle in planar view, and an upper surface portion 25b that covers the upper surface.

[0039] As illustrated in Fig. 9, the board support 25 includes a fixing structure 25c for fixing the electrical circuit board 24. The electrical circuit board 24 is fixed to a position on the inner side of the outer frame portion 25a and a place below the upper surface portion 25b. The board support 25 includes a pair of recessed portions 25d for receiving the front end portions of the pair of protruding portions 23f of the receiving tray 23. In Fig. 9, out of the recessed portions 25d, only the recessed portion 25d on the front side is seen, and the recessed portion 25d on the rear side is hidden and cannot be seen. The board support 25 includes a pair of fixing portions 25e for fixing the heat sink support 27. The board support 25 has a pair of holes 25f for receiving screws that fix the terminal block support 28. The board support 25 in this embodiment is made of flame-retardant plastic. Alternatively, at least a part of the board support 25 may be made of metal.

[0040] Fig. 10 is a perspective view of the heat sink 26 and the heat sink support 27 included in the electrical unit 17 illustrated in Fig. 4 seen from diagonally above. Fig. 11 is a perspective view of the heat sink 26 and the heat sink support

27 illustrated in Fig. 10 seen from diagonally below. As illustrated in those views, the heat sink support 27 has an upside-down L-shape when seen from the front. The heat sink support 27 has a pair of slit holes 27a for engaging with the fixing portions 25e of the board support 25. The heat sink support 27 is fixed to the board support 25 by fitting tabs protruding from the inner walls of the fixing portions 25e of the board support 25 in the slit holes 27a in the heat sink support 27.

[0041] As illustrated in Fig. 10, the heat sink support 27 includes a protruding portion 27b protruding in the front direction, a protruding portion 27c protruding in the lower direction, and a sustaining portion 27d. The heat sink support 27 in this embodiment is made with use of a thin metal plate.

[0042] Fig. 12 is a perspective view of the terminal block support 28 included in the electrical unit 17 illustrated in Fig. 4 seen from diagonally above. Fig. 13 is a perspective view of the terminal block support 28 illustrated in Fig. 12 seen from diagonally below. The terminal block support 28 in this embodiment is made with use of a thin metal plate. The terminal block 34 is mounted on the terminal block support 28. As illustrated in Fig. 12, the terminal block support 28 has a pair of through holes 28a through which screws pass. The terminal block support 28 is fixed to the board support 25 by tightening the screws passing through the through holes 28a with respect to the holes 25f in the board support 25.

[0043] The terminal block support 28 includes a sustaining portion 28c and a sustaining portion 28d. By placing the protruding portion 23i and the protruding portion 23j (see Fig. 7) of the receiving tray 23 on the sustaining portion 28c and the sustaining portion 28d of the terminal block support 28, a part of the weight of the receiving tray 23 can be supported by the terminal block support 28.

[0044] Fig. 14 is a cross-sectional view taken along line Y-Y in Fig. 4. In Fig. 14, the illustration of the electrical part mounted on the lower surface of the electrical circuit board 24 that may fall off is omitted. Fig. 15 is a view illustrating the details of section A in Fig. 14. Fig. 16 is a view illustrating the details of section B in Fig. 14. As illustrated in Fig. 15, the receiving tray 23 is prevented from moving to the front direction with respect to the heat sink support 27 by bringing the protruding portion 23d of the receiving tray 23 in contact with an inner wall 27e of the heat sink support 27. As illustrated in Fig. 16, the receiving tray 23 is prevented from moving to the rear direction with respect to the heat sink support 27 by bringing the protruding portion 23e of the receiving tray 23 in contact with the protruding portion 27b of the heat sink support 27. According to those configurations, the receiving tray 23 can be reliably positioned with respect to the heat sink support 27 in terms of the front-rear direction without the use of a screw. In this embodiment, the protruding portion 23d and the protruding portion 23e correspond to a first contact portion that positions the receiving tray 23 with respect to the heat sink support 27 that is the framework in terms of a first horizontal direction, that is, the front-rear direction.

[0045] Fig. 17 is a cross-sectional view taken along line X-X in Fig. 5. As illustrated in Fig. 17, a part of the weight of the receiving tray 23 can be supported by the heat sink support 27 by placing the left end portion of the receiving tray 23 on the sustaining portion 27d of the heat sink support 27. As described above, the weight of the right portion of the receiving tray 23 is supported by the terminal block support 28. According to those configurations, the board support 25, the heat sink support 27, and the terminal block support 28 that are the framework can reliably support the weight of the receiving tray 23 without the use of a screw.

[0046] Fig. 18 is a view illustrating the details of section C in Fig. 17. In Fig. 18, the illustration of the electrical part mounted on the lower surface of the electrical circuit board 24 that may fall off is omitted. Fig. 19 is a view illustrating the details of section D in Fig. 17. As illustrated in Fig. 18, the receiving tray 23 is prevented from moving to the left direction with respect to the heat sink support 27 by bringing the protruding portions 23g of the receiving tray 23 in contact with the protruding portion 27c of the heat sink support 27. As illustrated in Fig. 19, the receiving tray 23 is prevented from moving to the right direction with respect to the board support 25 by inserting the front end portions of the protruding portions 23f of the receiving tray 23 into the recessed portions 25d in the board support 25.

[0047] In this embodiment, the protruding portions 23g and the protruding portions 23f correspond to a second contact portion that positions the receiving tray 23 with respect to the board support 25 and the heat sink support 27 that are the framework in terms of a second horizontal direction. The second horizontal direction is a direction orthogonal to the first horizontal direction. In this embodiment, the left-right direction corresponds to the second horizontal direction. The recessed portions 25d of the board support 25 correspond to a positioning portion that positions the receiving tray 23 in the horizontal direction.

[0048] In this embodiment, the receiving tray 23 is held by the board support 25, the heat sink support 27, and the terminal block support 28 that are the framework without the use of a screw. Therefore, the receiving tray 23 can be manually mounted on the electrical unit 17 in an easy manner at the time of assembly. At that time, the receiving tray 23 can be easily and reliably positioned in an appropriate position with respect to the framework without the use of a screw by providing the first contact portion, the second contact portion, and the positioning portion described above.

[Reference Signs List]

[0049]

5	1	heat pump apparatus
	2	compressor
	3	heat exchanger
	5	air-to-refrigerant heat exchanger
	7	blower
10	14	first chamber
	15	second chamber
	16	partition plate
	17	electrical unit
	23	receiving tray
15	23a	receiving portion
	23b	sandwiching portion
	23c	rising edge
	23d, 23e, 23f, 23g, 23i, 23j	protruding portion
	24	electrical circuit board
20	25	board support
	25d	recessed portion
	25e	fixing portion
	25f	hole
	26	heat sink
25	27	heat sink support
	27b, 27c	protruding portion
	27d	sustaining portion
	28	terminal block support
	28a	through hole
30	28c, 28d	sustaining portion
	29	electrical wire
	30	opening
	31	inner space
	32	border line
35	33	second opening
	34	terminal block
	90	hot-water storing hot-water supplying system
	92	hot water storage tank
	93	water pump
	94	flow path switching valve
	95	bypass passage

40 Claims

1. A heat pump apparatus, comprising:

45 an air-to-refrigerant heat exchanger configured to exchange heat between air and a refrigerant;
a blower configured to blow air to the air-to-refrigerant heat exchanger;
a compressor configured to compress the refrigerant; and
an electrical unit comprising an electrical part for driving at least one of the blower and the compressor, wherein:

50 the electrical unit comprises:

an electrical circuit board comprising an upper surface, a lower surface, and the electrical part mounted on the lower surface;
a receiving tray comprising a receiving portion that covers at least a part of the electrical circuit board from below;
a framework that holds the electrical circuit board and the receiving tray; and
55 an opening which is formed between the framework and the receiving portion of the receiving tray and through which air is capable of passing;

a space between the electrical circuit board and the receiving portion of the receiving tray is an inner space of the

electrical unit; and
the inner space of the electrical unit communicates with outside of the electrical unit via the opening.

2. The heat pump apparatus according to claim 1, wherein the receiving portion of the receiving tray has a rising edge.

3. The heat pump apparatus according to claim 1 or 2, wherein:

the receiving tray comprises a first contact portion and a second contact portion that are in contact with the framework;

the first contact portion positions the receiving tray with respect to the framework in terms of a first horizontal direction; and

the second contact portion positions the receiving tray with respect to the framework in terms of a second horizontal direction orthogonal to the first horizontal direction.

4. The heat pump apparatus according to any one of claims 1 to 3, wherein the receiving tray is held by the framework without use of a screw.

5. The heat pump apparatus according to any one of claims 1 to 4, further comprising an electrical wire extending to outside of the electrical unit from the electrical circuit board, wherein the receiving tray comprises a sandwiching portion that sandwiches the electrical wire.

6. The heat pump apparatus according to any one of claims 1 to 5, further comprising an electrical wire extending to outside of the electrical unit from the electrical circuit board via the opening.

7. The heat pump apparatus according to any one of claims 1 to 6, further comprising a casing comprising a first chamber accommodating the blower, and a second chamber accommodating the compressor, wherein the inner space of the electrical unit does not communicate with an inner space of the first chamber and communicates with an inner space of the second chamber via the opening.

8. The heat pump apparatus according to any one of claims 1 to 7, wherein:

the electrical unit comprises a second opening which is formed in a position opposite to the opening and through which air is capable of passing; and

the inner space of the electrical unit communicates with outside of the electrical unit via the second opening.

9. The heat pump apparatus according to any one of claims 1 to 8, wherein:

the electrical unit comprises:

a terminal block comprising a terminal to which an electrical wire from outside of the heat pump apparatus is connected; and

a heat sink configured to dissipate heat generated by the electrical circuit board;

the framework comprises:

a board support that holds the electrical circuit board;

a heat sink support fixed to the board support, the heat sink support holding the heat sink; and

a terminal block support fixed to the board support, the terminal block support holding the terminal block; and

at least one of the heat sink support and the terminal block support comprises a sustaining portion that sustains a weight of the receiving tray.

10. The heat pump apparatus according to claim 9, wherein the board support comprises a positioning portion that positions the receiving tray in terms of a horizontal direction.

11. The heat pump apparatus according to any one of claims 1 to 10, further comprising a heat exchanger configured to exchange heat between the refrigerant compressed by the compressor and water or another liquid heat medium.

FIG. 1

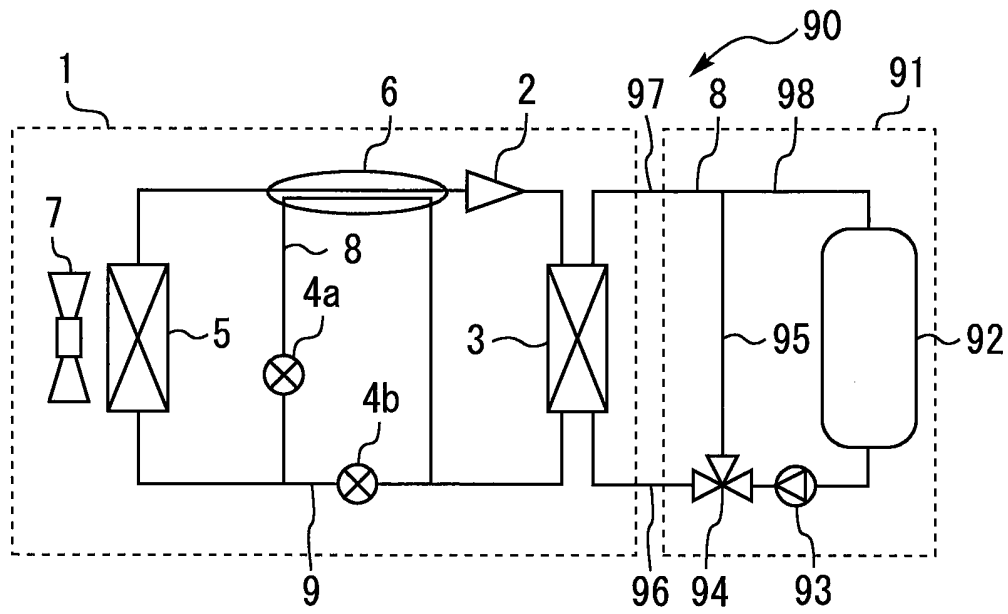


FIG. 2

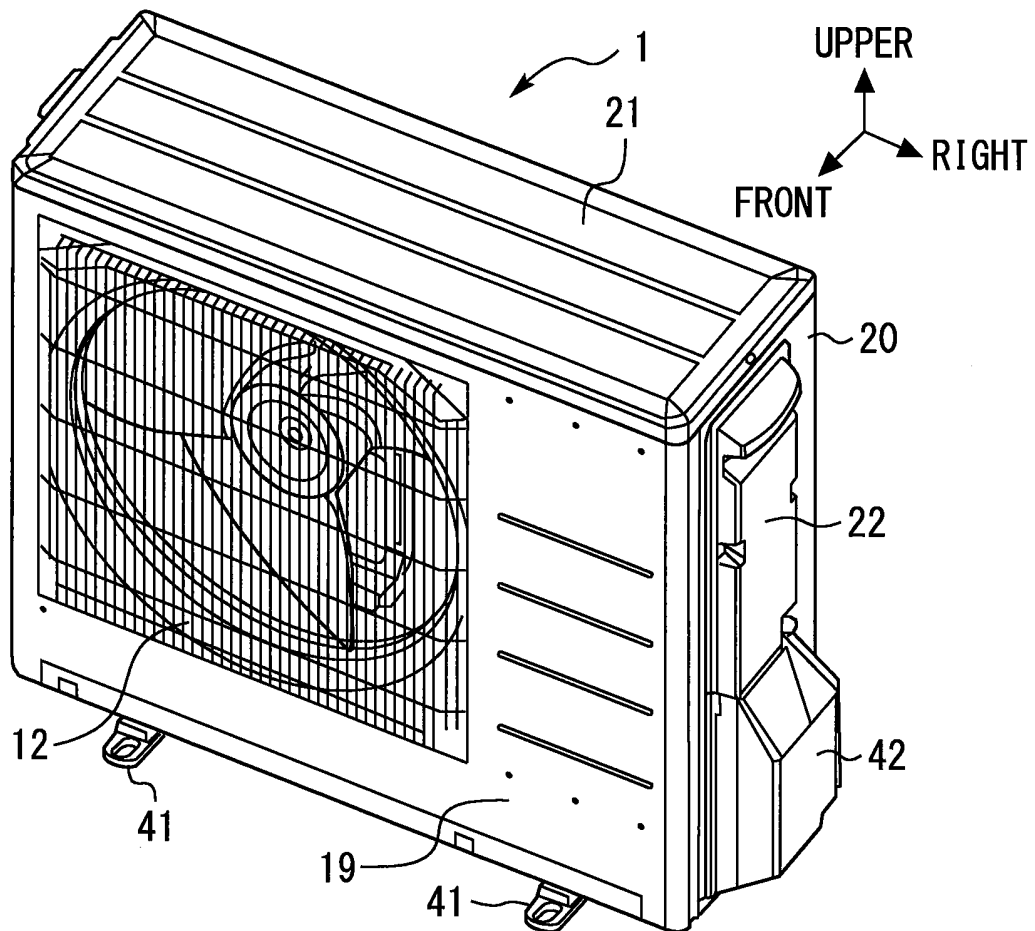


FIG. 3

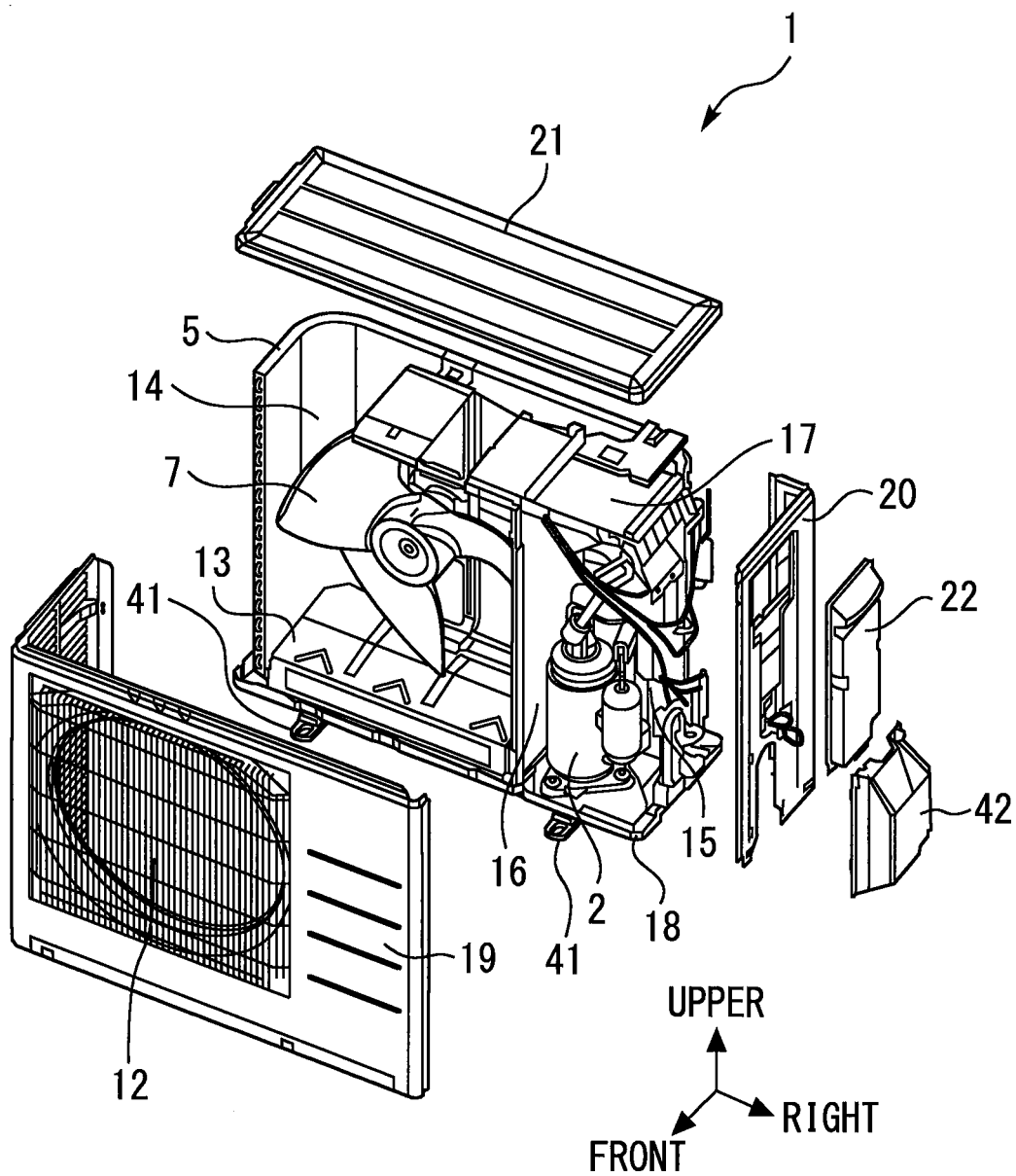


FIG. 4

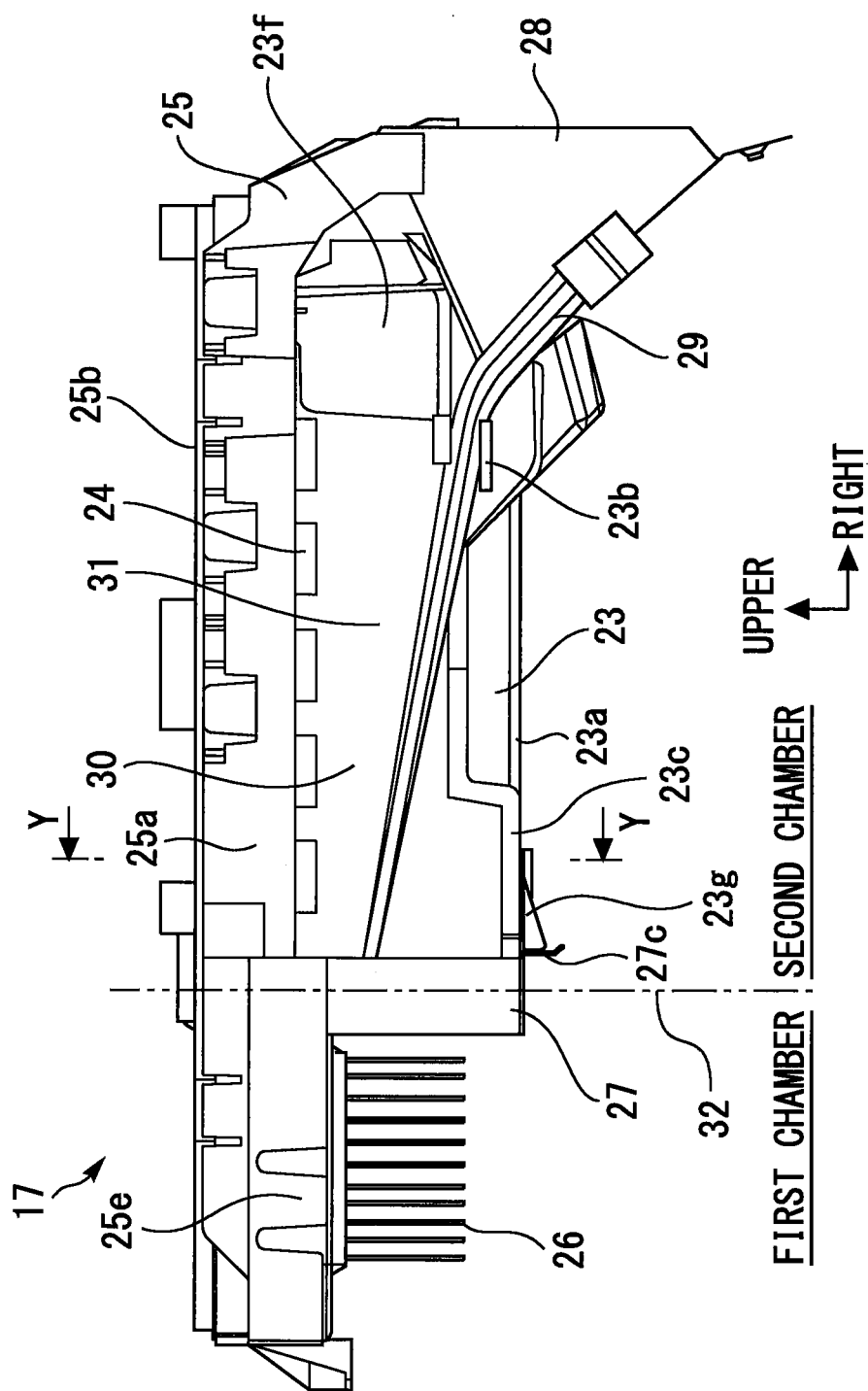


FIG. 5

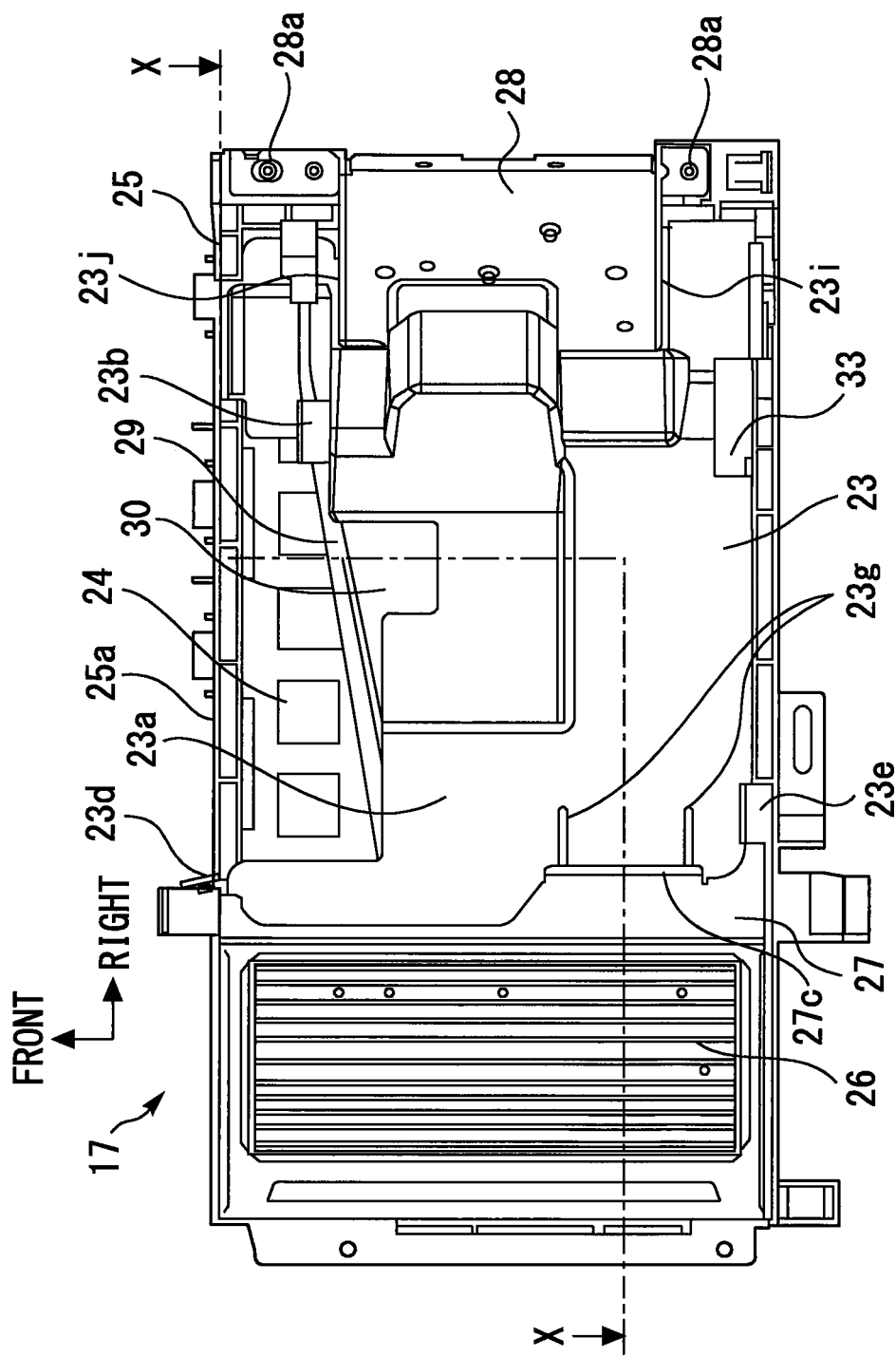


FIG. 6

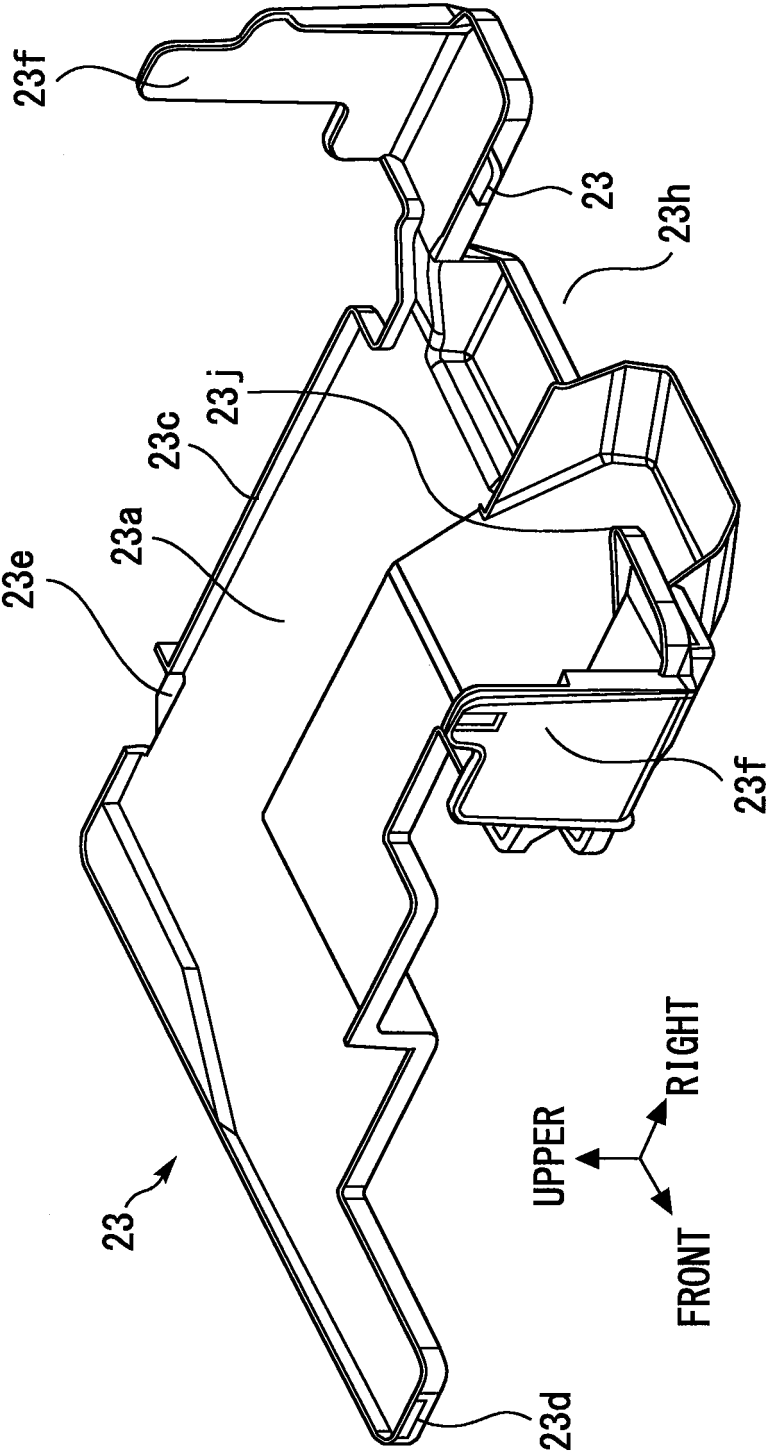


FIG. 7

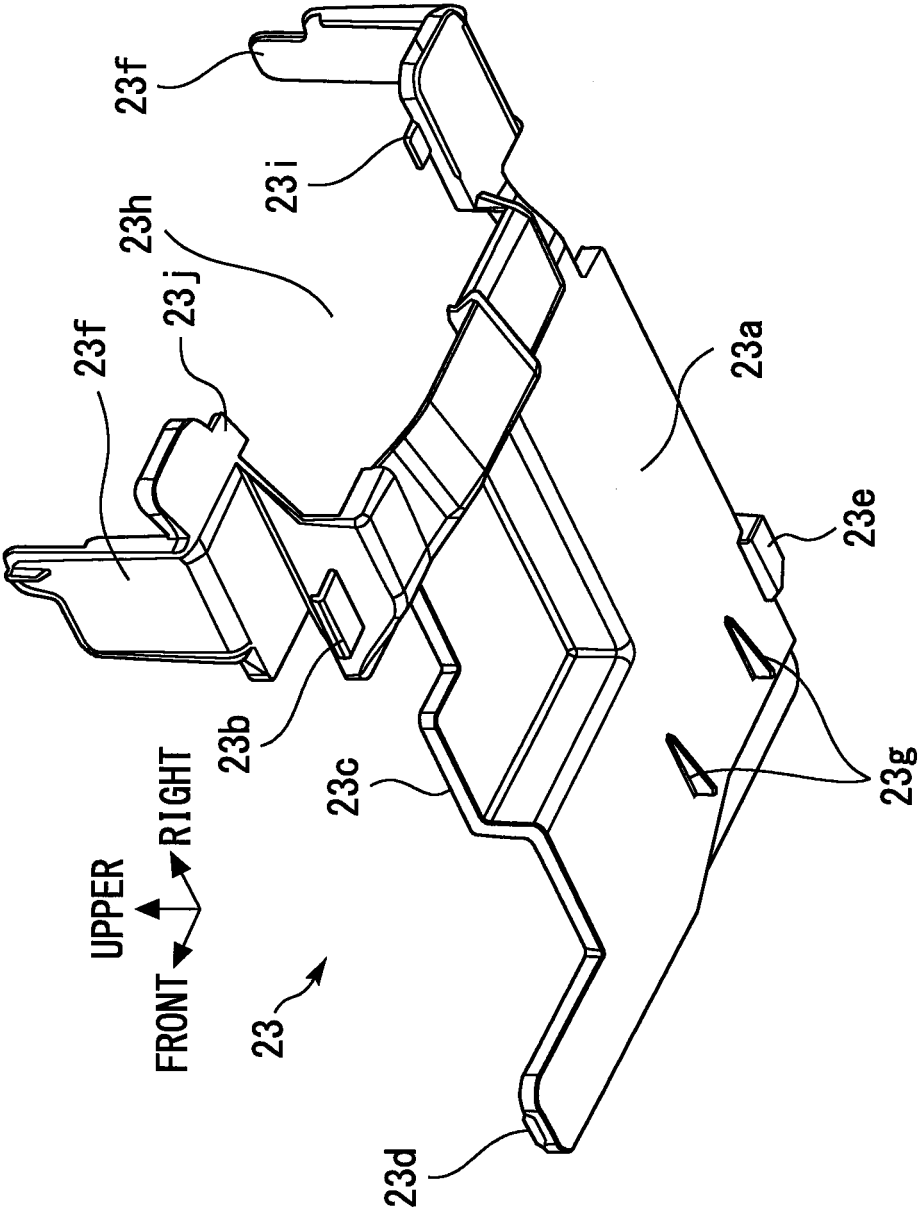


FIG. 8

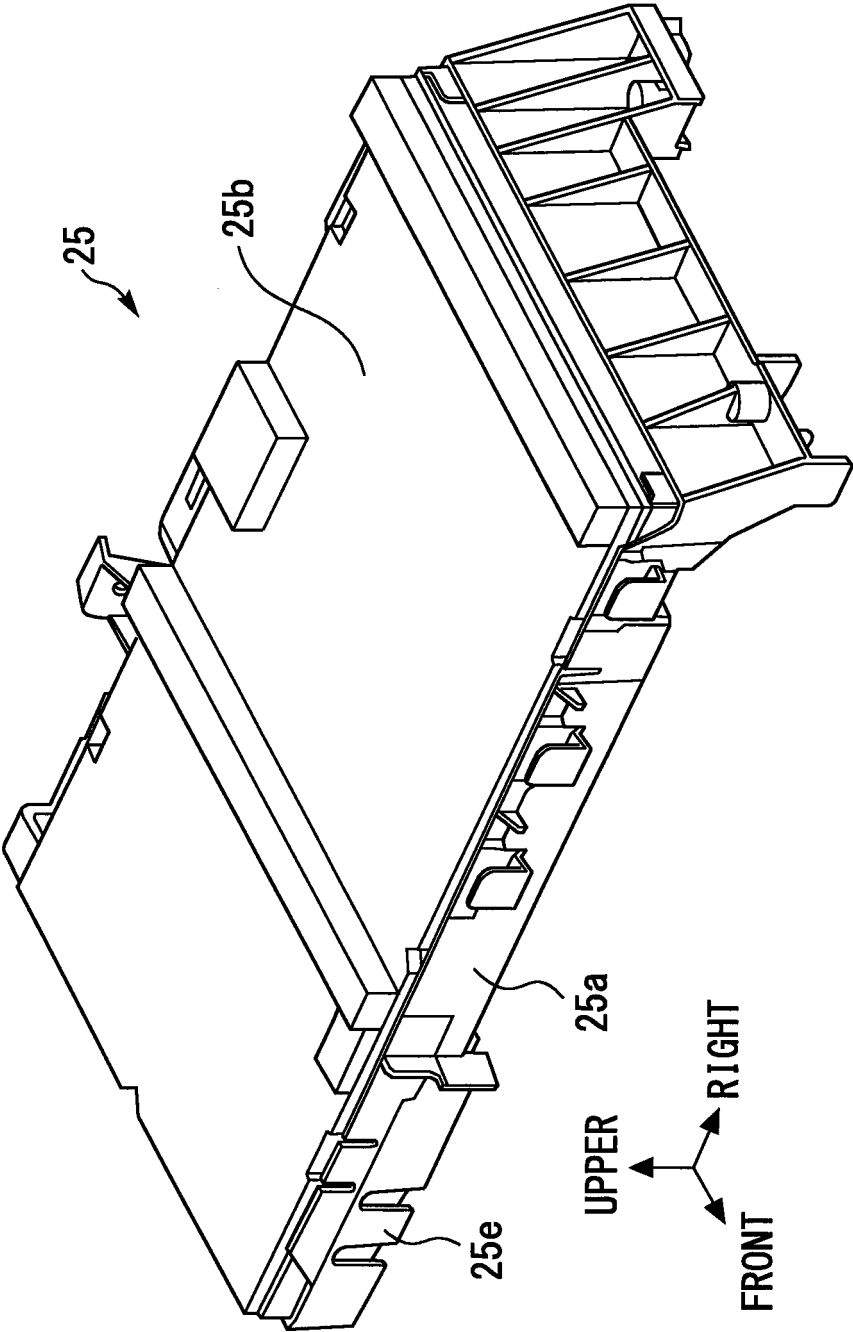


FIG. 9

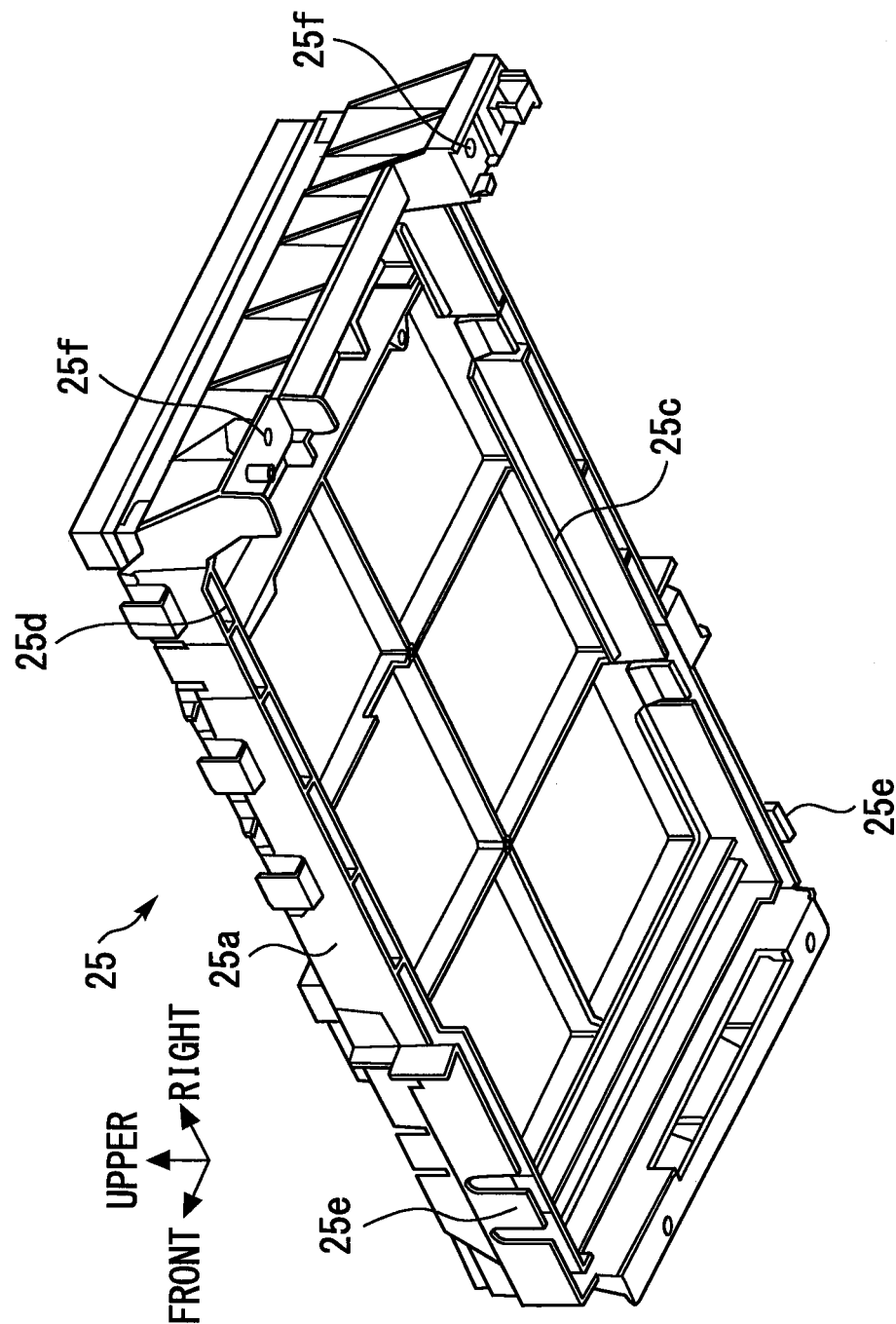


FIG. 10

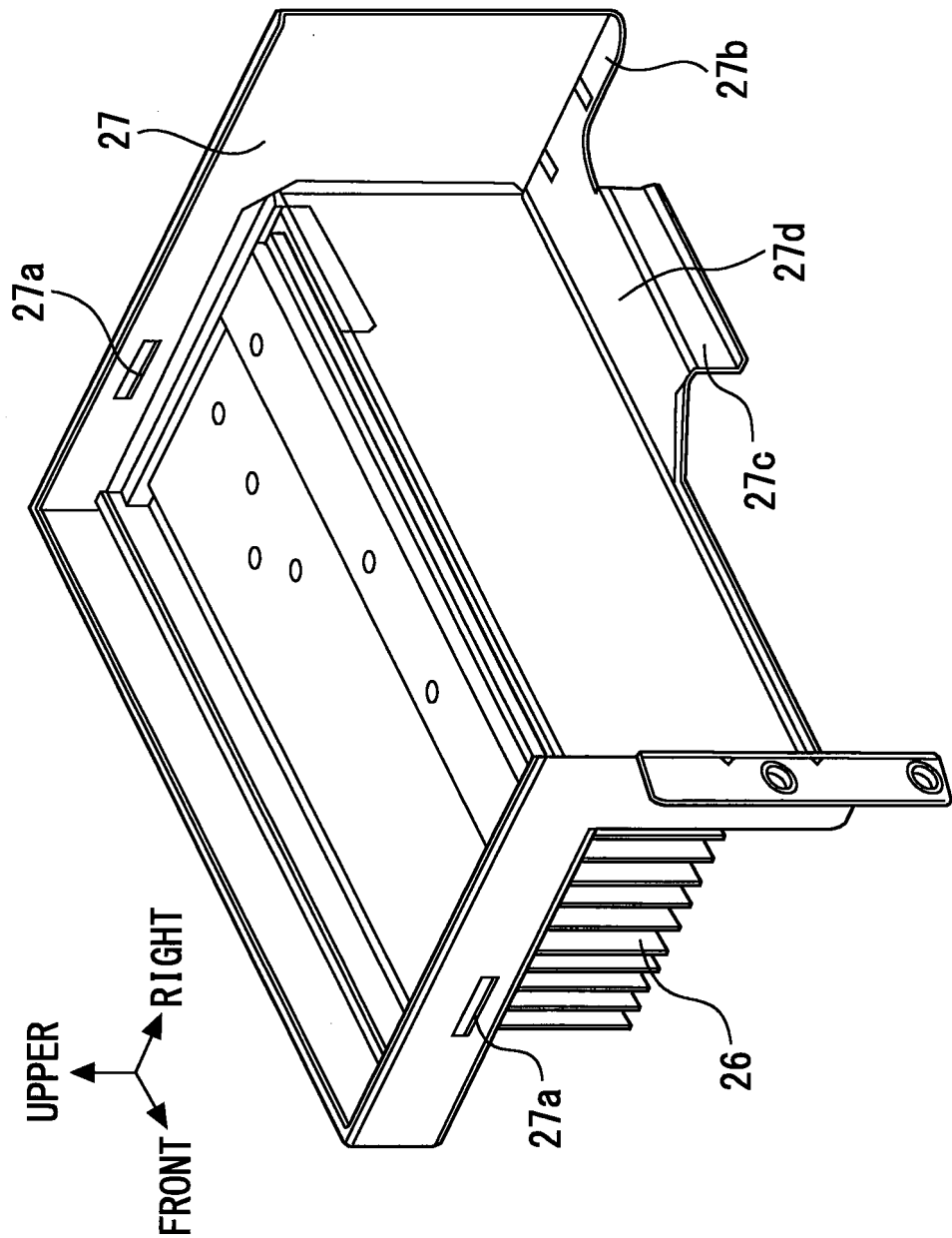


FIG. 1 1

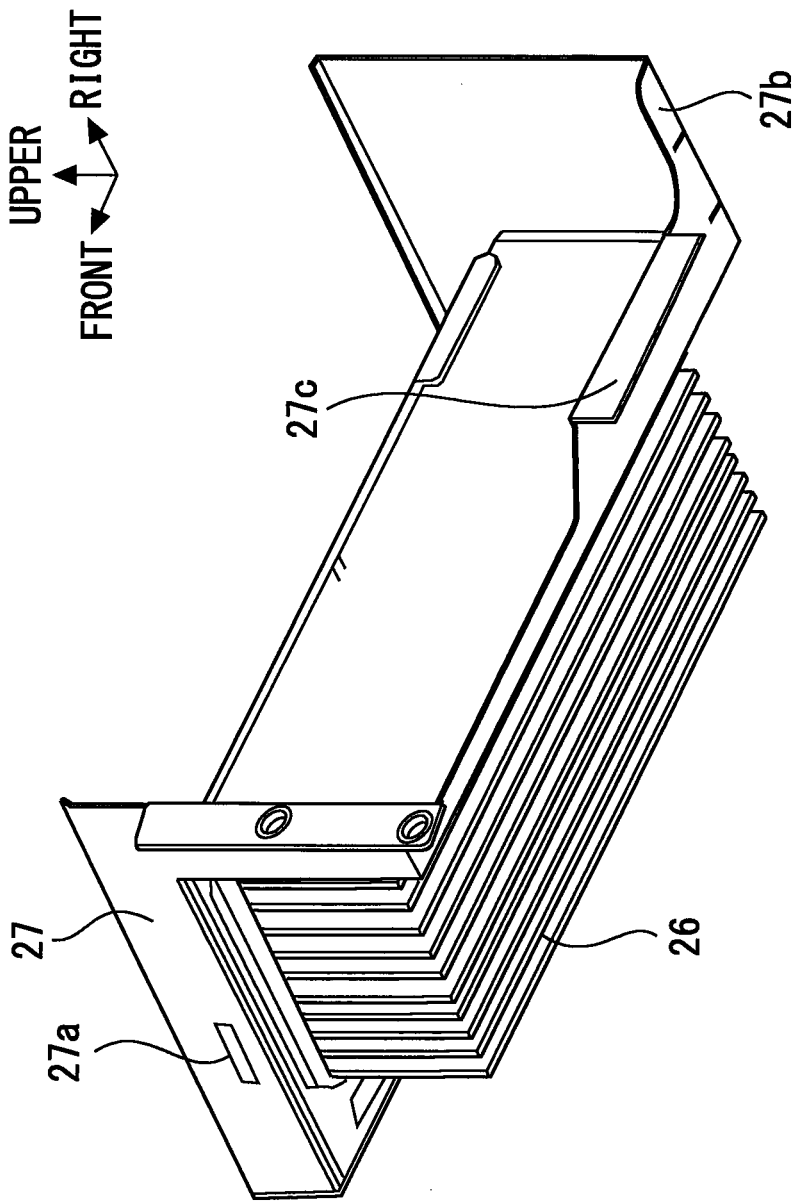


FIG. 1 2

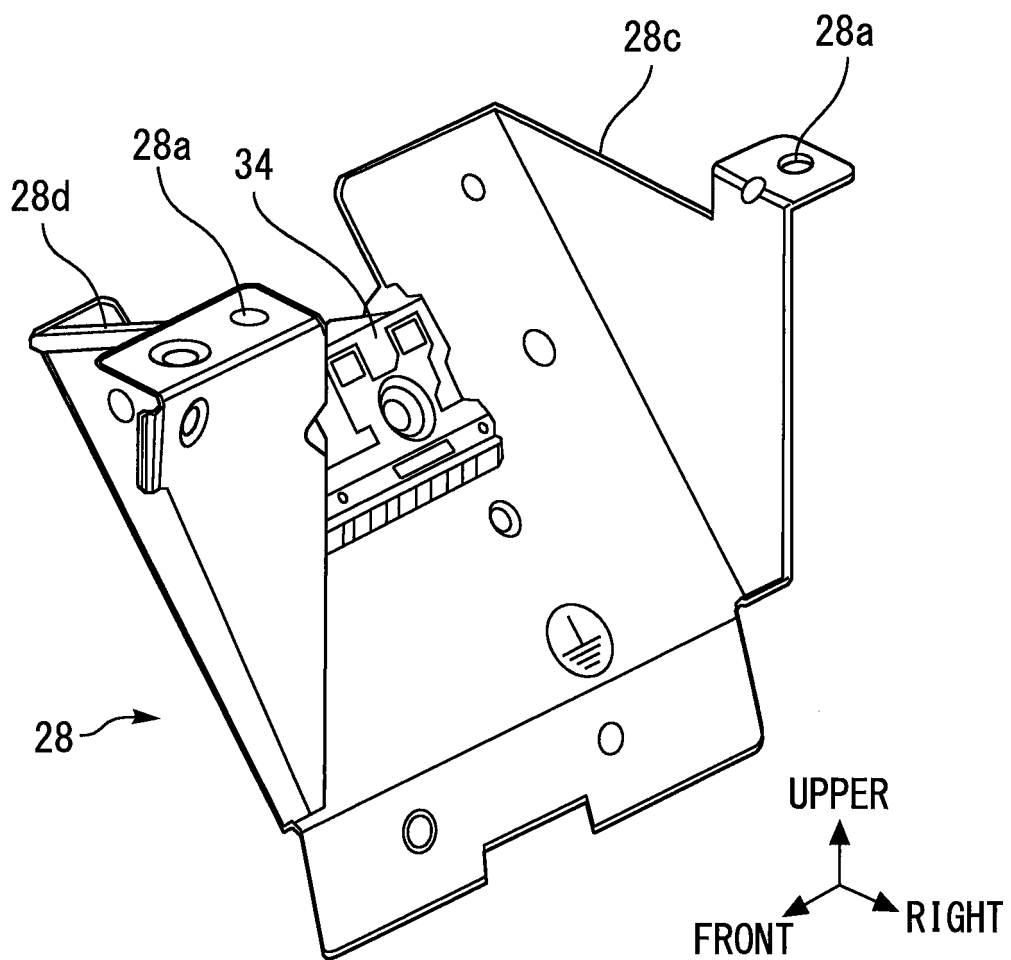


FIG. 13

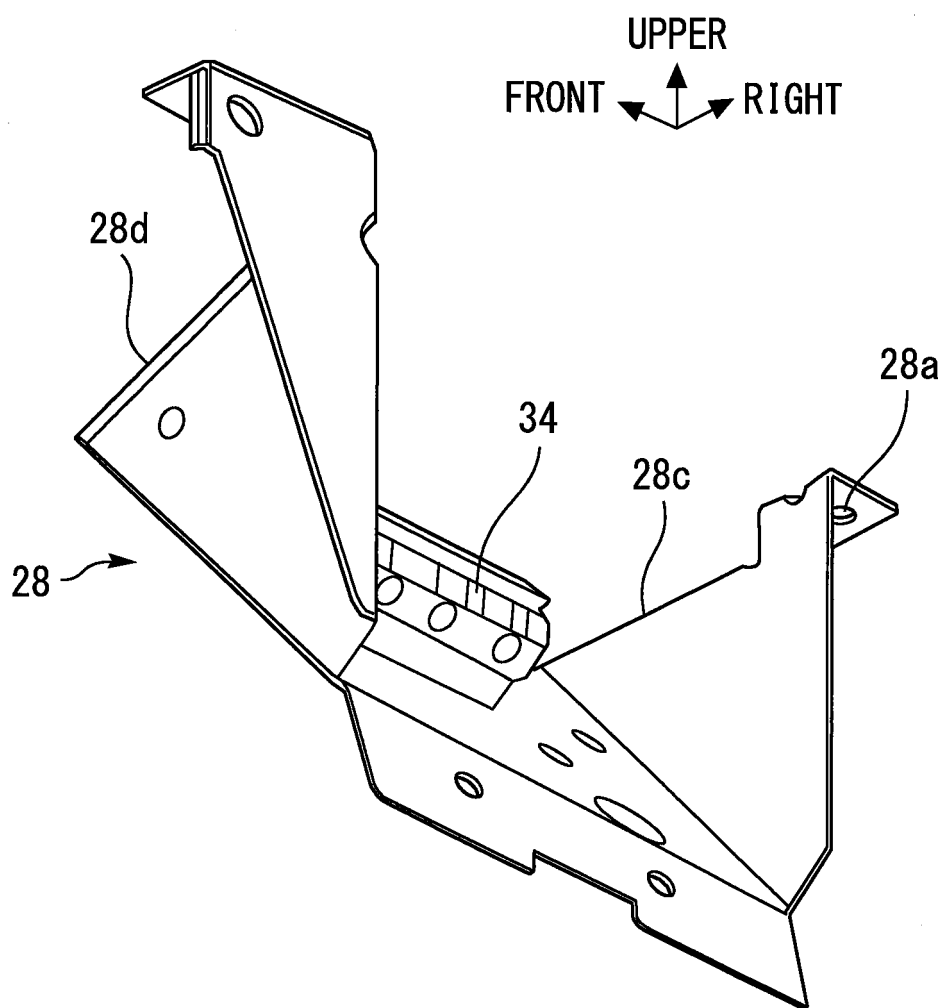


FIG. 14

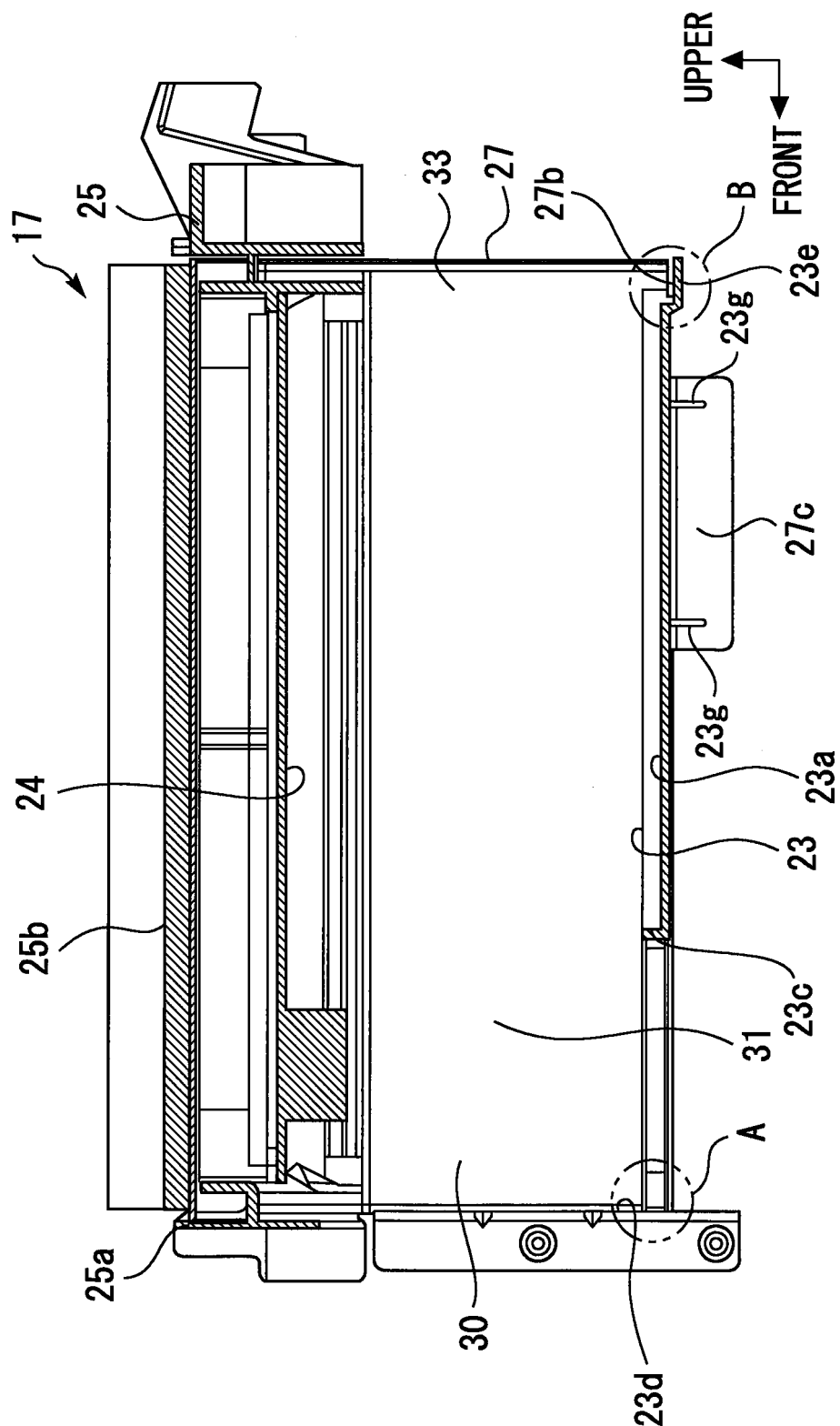


FIG. 1 5

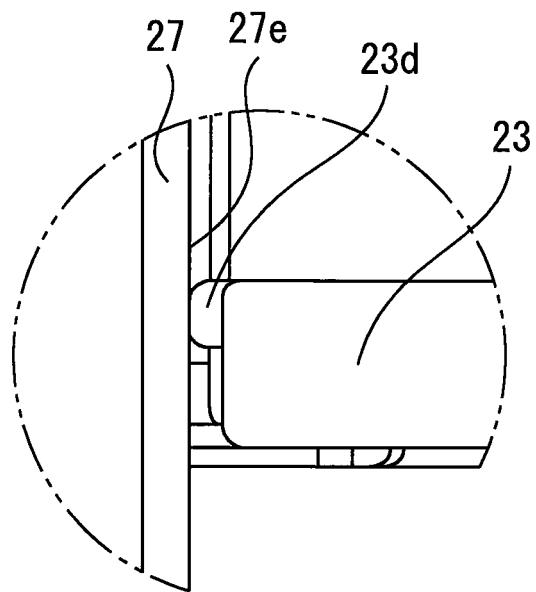


FIG. 1 6

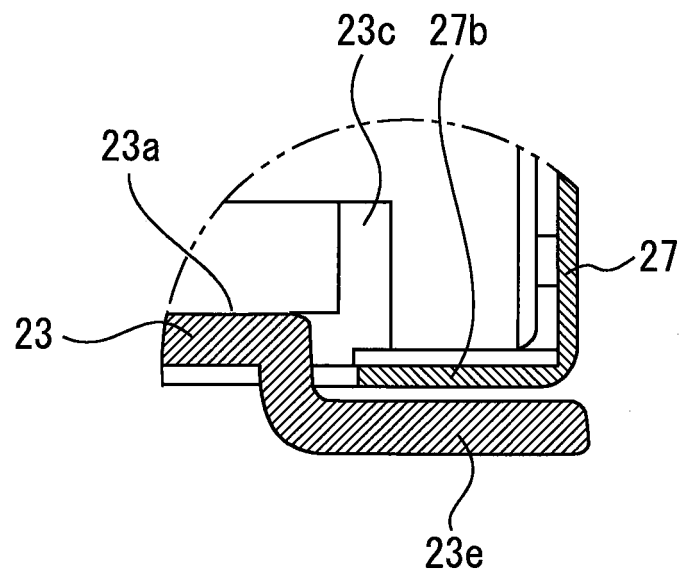


FIG. 17

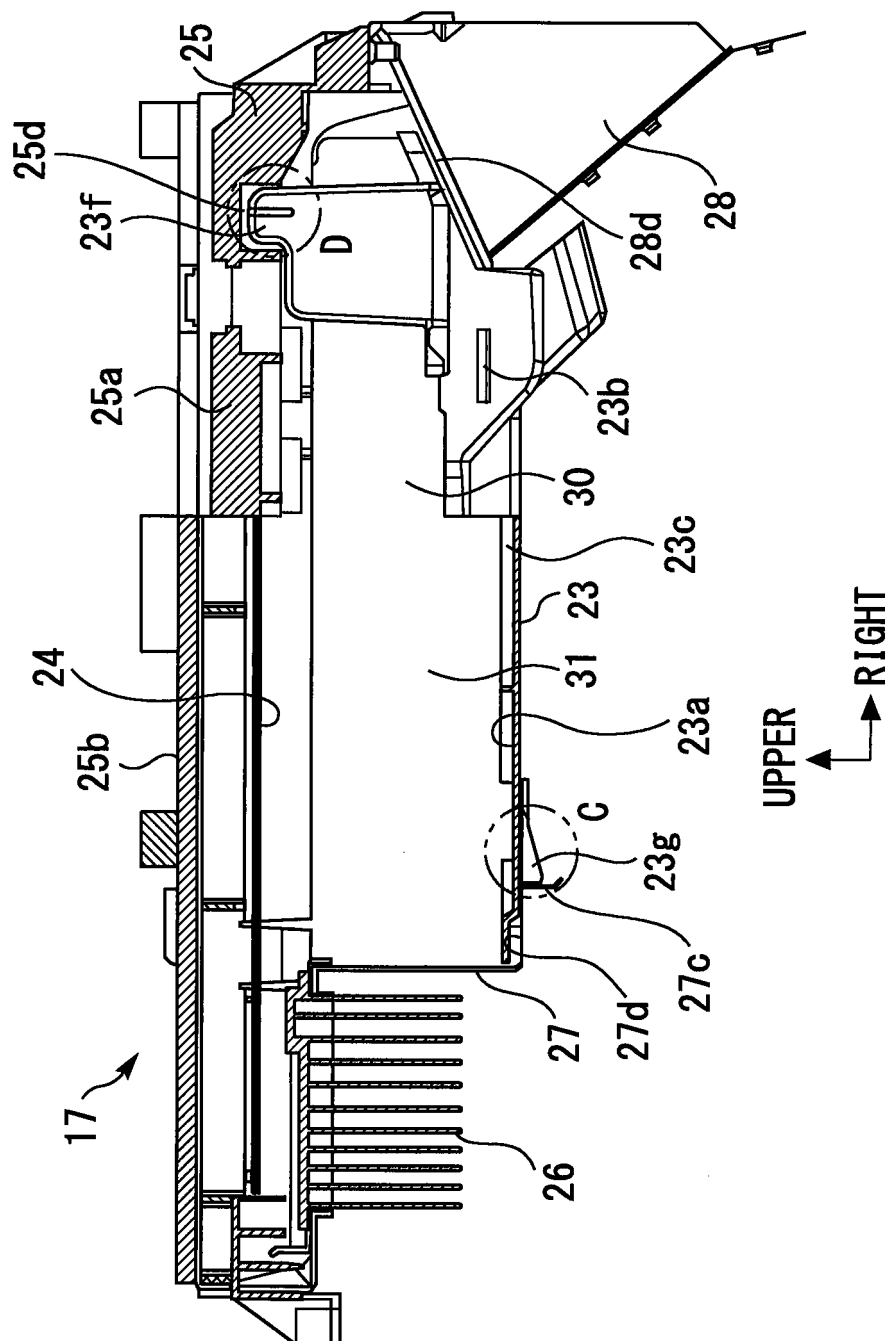


FIG. 1 8

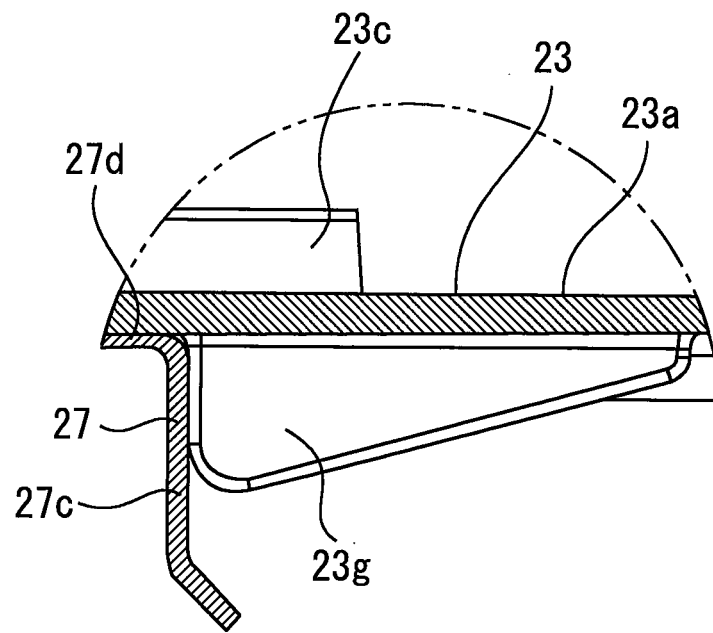
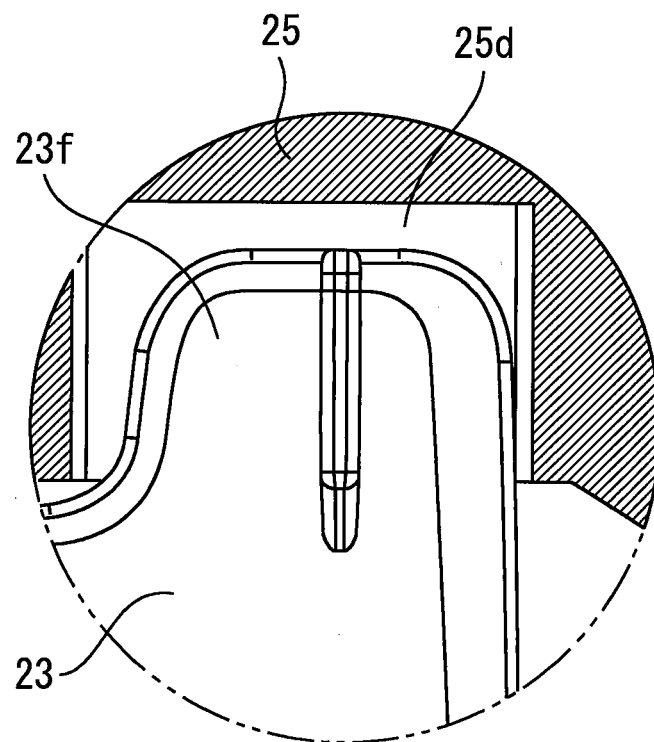


FIG. 1 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/010754

A. CLASSIFICATION OF SUBJECT MATTER

F25B49/02(2006.01)i, F24H4/02(2006.01)i, F24H9/20(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)

F25B49/02, F24H4/02, F24H9/20

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017
 Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2010-038514 A (Corona Corp.), 18 February 2010 (18.02.2010), paragraphs [0012] to [0040]; fig. 1 to 11 (Family: none)	1-4, 6-8, 11 5, 9-10
Y A	JP 2010-181095 A (Corona Corp.), 19 August 2010 (19.08.2010), paragraphs [0008] to [0032]; fig. 1 to 6 (Family: none)	1-4, 6-8, 11 5, 9-10

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

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search
01 June 2017 (01.06.17)Date of mailing of the international search report
13 June 2017 (13.06.17)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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