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## (54) HEAT PUMP HOT WATER SUPPLYING OUTDOOR UNIT

(57) A heat pump water-heater outdoor unit includes a bottom plate, a compressor disposed on the bottom plate, a muffler fixed to an outer surface of the compressor, and an internal heat exchanger fixed to the outer surface of the compressor. The internal heat exchanger is disposed on a side opposite to the muffler with the compressor positioned between the internal heat exchanger and the muffler. Preferably, the muffler is fixed to a muffler holder fixed to the outer surface of the compressor. The internal heat exchanger is fixed to an internal heat exchanger holder fixed to the outer surface of the compressor. The internal heat exchanger is fixed at a position where the height of the center of gravity of the internal heat exchanger is equal to the height of the center of gravity of the muffler.

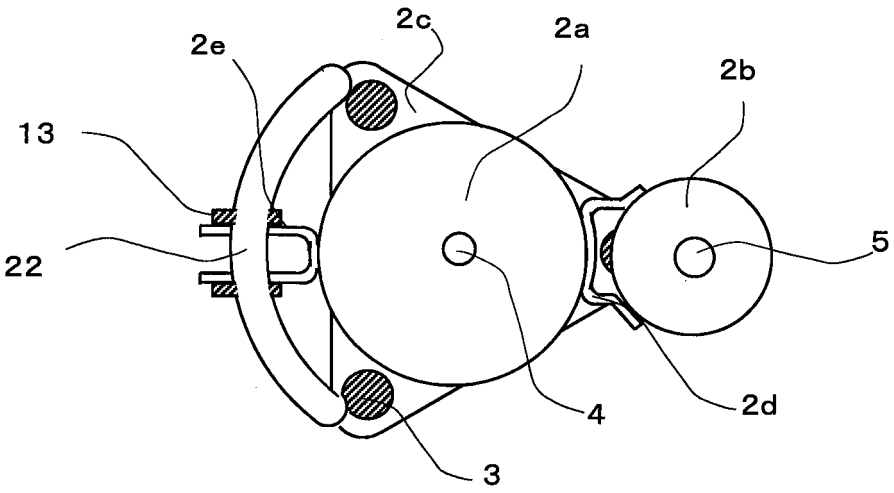


FIG. 10

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## Description

[Technical Field]

**[0001]** The present invention relates to a heat pump water-heater outdoor unit.

[Background Art]

**[0002]** A heat pump water-heater system which uses heat of the air is widely used. In a heat pump water-heater outdoor unit of the heat pump water-heater system, an evaporator which causes a refrigerant to absorb the heat of the air, a propeller fan which blows air to the evaporator, a compressor which compresses the refrigerant, and a water-refrigerant heat exchanger which heats water with the compressed refrigerant having high temperature and high pressure are mounted.

**[0003]** When the refrigerant sucked into the compressor is insufficient, noise may be generated. For example, PTL 1 proposes a refrigeration apparatus which includes a muffler on the suction side of the compressor in order to reduce noise generated during operation of the compressor. The muffler can reduce pulsation of the flow of the refrigerant on the suction side of the compressor, and hence the noise of the compressor caused by the insufficient refrigerant is suppressed.

[Citation List]

[Patent Literature]

**[0004]** [PTL 1] Japanese Patent Application Publication No. 2007-271211

[Summary of Invention]

[Technical Problem]

**[0005]** The compressor disposed inside the heat pump water-heater outdoor unit is driven at a frequency of about several tens of rps (Hz) to about one hundred rps (Hz) during the operation of the compressor. Accordingly, strong vibration is generated in the compressor with a frequency component equal to the integral multiple of the frequency. The generated vibration is transmitted to various components such as a heat exchanger via an intake pipe and a discharge pipe connected to the compressor, and low-frequency sound and noise are thereby generated from the individual portions of a case.

**[0006]** In the apparatus described in PTL 1 mentioned above, the muffler is integrally fixed to a side wall of the compressor. In such a structure, the center of gravity of the entire compressor including the muffler is displaced to the side of the muffler. In this case, a moment in a direction which tilts the compressor to the side of the muffler acts, and hence there is a possibility that specific abnormal vibration will be generated in the compressor. Such vibration of the compressor may increase the low-frequency sound and the noise generated from the individual portions of the case.

**[0007]** The present invention has been made in order to solve the above-described problem, and an object thereof is to provide a heat pump water-heater outdoor unit capable of reducing low-frequency sound and noise emitted from the individual portions of an apparatus by suppressing vibration generated in a compressor.

[Solution to Problem]

**[0008]** A heat pump water-heater outdoor unit according to the present invention includes a bottom plate, a compressor disposed on the bottom plate, a muffler fixed to an outer surface of the compressor, and an internal heat exchanger fixed to the outer surface of the compressor. The internal heat exchanger is disposed on the side opposite to the muffler with the compressor positioned between the internal heat exchanger and the muffler.

[Advantageous Effects of Invention]

**[0009]** According to the heat pump water-heater outdoor unit of the present invention, the internal heat exchanger and the muffler are fixed to the compressor. At this point, the internal heat exchanger is disposed on the side opposite to the muffler with the compressor positioned between the internal heat exchanger and the muffler. According to such a configuration, it is possible to cause the center of gravity of the entire compressor including the internal heat exchanger and the muffler to approach the center of the compressor, and hence specific abnormal vibration generated in the compressor is suppressed. With this, it becomes possible to reduce the low-frequency sound and the noise emitted from the individual portions of the apparatus.

[Brief Description of Drawings]

**[0010]**

FIG. 1 is a front view showing the internal structure of a heat pump water-heater outdoor unit 1 of Embodiment 1.

FIG. 2 is an external perspective view of the heat pump water-heater outdoor unit 1 of Embodiment 1 when viewed obliquely from the front.

FIG. 3 is an external perspective view of the heat pump water-heater outdoor unit 1 of Embodiment 1 when viewed obliquely from behind.

FIG. 4 is a view showing a refrigerant circuit and a water circuit of a heat pump water-heater system including the heat pump water-heater outdoor unit 1 of Embodiment 1.

FIG. 5 is an enlarged view of the peripheral configuration of a compressor shown in FIG. 1 when viewed from the side of the front.

FIG. 6 is a view of the peripheral configuration of the compressor shown in FIG. 5 when viewed from an A direction.

FIG. 7 is a view of the peripheral configuration of the compressor shown in FIG. 5 when viewed from a B direction.

FIG. 8 is a front view showing the internal structure of the heat pump water-heater outdoor unit 1 of Embodiment 2.

FIG. 9 is an enlarged view of the peripheral configuration of the compressor shown in FIG. 1 when viewed from the side of the front.

FIG. 10 is a view of the peripheral configuration of the compressor shown in FIG. 9 when viewed from a C direction.

FIG, 11 is a view of the peripheral configuration of the compressor shown in FIG. 9 when viewed from a D direction.

[Description of Embodiments]

**[0011]** Hereinbelow, embodiments will be described with reference to the drawings. Note that common elements in the drawings are designated by the same reference numerals, and the duplicate description thereof will be simplified or omitted. In addition, the present disclosure can include any combinations of, among configurations described in the following embodiments, configurations which can be combined.

Embodiment 1.

**[0012]** FIG. 1 is a front view showing the internal structure of a heat pump water-heater outdoor unit 1 of Embodiment 1. FIG. 2 is an external perspective view of the heat pump water-heater outdoor unit 1 of Embodiment 1 when viewed obliquely from the front. FIG. 3 is an external perspective view of the heat pump water-heater outdoor unit 1 of Embodiment 1 when viewed obliquely from behind. FIG. 4 is a view showing a refrigerant circuit and a water circuit of a heat pump water-heater system which includes the heat pump water-heater outdoor unit 1 of Embodiment 1.

**[0013]** The heat pump water-heater outdoor unit 1 of the present embodiment is installed outdoors. The heat pump water-heater outdoor unit 1 heats a liquid heating medium. The heating medium in the present embodiment is water. The heat pump water-heater outdoor unit 1 heats water to generate hot water. The heating medium in the present invention may also be brine other than water such as, e.g., a calcium chloride aqueous solution, an ethylene glycol aqueous solution, or alcohol.

**[0014]** As shown in FIG. 1, the heat pump water-heater outdoor unit 1 includes a base 17 serving as a bottom plate which forms a bottom portion of a case. On the base 17, when viewed from the front, a machine chamber 14 is formed on the right, and a blower chamber 15 is formed on the left. The machine chamber 14 and the blower chamber 15 are separated from each other by a partition plate 16 which extends in a vertical direction.

**[0015]** As shown in FIGS. 2 and 3, the case forming the outer shell of the heat pump water-heater outdoor unit 1 further includes a front panel 18, a side panel 19, and a top panel 20. The front panel 18 is constituted by a front surface portion 18a which covers the front surface of the heat pump water-heater outdoor unit 1, and a left side surface portion 18b which covers the left side surface thereof. The side panel 19 is constituted by a rear surface portion 19a which covers part of the rear surface of the heat pump water-heater outdoor unit 1, and a right side surface portion 19b which covers the right side surface thereof. These constituent elements of the case are formed from, e.g., sheet metal material. The exterior surface of the heat pump water-heater outdoor unit 1 is covered with the case except an air-refrigerant heat exchanger 7 disposed on the side of the rear surface. An opening for discharging air having passed through the blower chamber 15 is formed in the front panel 18, and a lattice 18c is attached to the opening. Note that FIG. 1 shows a state in which the individual portions of the case other than the base 17 are detached. In addition, in FIG. 1, depiction of part of constituent devices is omitted.

**[0016]** As shown in FIG. 1, a compressor 2 for compressing a refrigerant, a muffler 2b for suppressing pulsation of a sucked refrigerant, an internal heat exchanger 11 for performing heat exchange between a high-pressure refrigerant and a low-pressure refrigerant, an expansion valve 10 (not shown) for decompressing the refrigerant, and refrigerant pipes such as an intake pipe 5 and a discharge pipe 4 for connecting above components are incorporated into the machine chamber 14 as refrigerant circuit components.

**[0017]** The compressor 2 includes a cylindrical shell 2a. The compressor 2 includes a compression portion (not shown) and a motor (not shown) which are disposed inside the shell 2a. The compression portion performs compression operation of the refrigerant. The compression portion may be any of, e.g., reciprocation-type, scroll-type, and rotary-type compression portions. The motor drives the compression portion. The motor of the compressor is driven with electric power supplied from the outside. The refrigerant is sucked into the compressor 2 through the intake pipe 5. The discharge pipe 4 which discharges the refrigerant compressed inside the compressor 2 is connected to the upper portion of the compressor 2. The detail of an installation structure of the compressor 2 will be described later.

**[0018]** The muffler 2b is coupled to the side surface of the shell 2a of the compressor 2 via a muffler holder 2d. The details of an installation structure of the muffler 2b will be described later. Similarly to the shell 2a of the compressor 2, the outer shape of the muffler 2b may be cylindrical. The muffler 2b is connected to some midpoint of the intake pipe 5. Low-pressure refrigerant gas is sucked into the compressor 2 through the intake pipe 5 and the muffler 2b. High-pressure refrigerant gas com-

pressed in the compressor 2 is discharged to the discharge pipe 4.

**[0019]** The internal heat exchanger 11 is formed into a rectangular shape by bending in a state in which a long high-pressure refrigerant pipe and a long low-pressure refrigerant pipe are in intimate contact with each other. In the internal heat exchanger 11, heat is exchanged between the refrigerant in the high-pressure refrigerant pipe and the refrigerant in the low-pressure refrigerant pipe. With this, the low-pressure refrigerant is heated in the internal heat exchanger 11. As shown in FIG. 1, the machine chamber 14 is formed as space which is long in an up-and-down direction. Consequently, the internal heat exchanger 11 is coupled to the side surface of the shell 2a of the compressor 2 via an internal heat exchanger holder 2e such that the lengthwise direction of the rectangle matches the up-and-down direction of the machine chamber 14. Note that the detail of an installation structure of the internal heat exchanger 11 will be described later.

**[0020]** In the expansion valve 10, a coil incorporation member is mounted to an outer surface of a main body of the expansion valve 10. An internal flow path resistance adjustment portion is operated by energizing a coil from the outside, and the flow path resistance of the refrigerant is thereby adjusted. It is possible to adjust the pressure of the high-pressure refrigerant on the upstream side of the expansion valve 10 and the pressure of the low-pressure refrigerant on the downstream side thereof by using the expansion valve 10.

**[0021]** The blower chamber 15 has space larger than the machine chamber 14 for securing an air path. A blower 6 is incorporated into the blower chamber 15. The blower 6 includes two to three propeller blades, and a motor which rotationally drives the propeller blades. The motor and the propeller blades rotate with electric power supplied from the outside. On the side of the rear surface of the blower chamber 15, the air-refrigerant heat exchanger 7 serving as a first heat exchanger is installed so as to face the blower 6. The air-refrigerant heat exchanger 7 includes a large number of fins formed of aluminum thin plates, and a long refrigerant pipe which is in intimate contact with a large number of the fines formed of aluminum thin plates and is folded back several times. The air-refrigerant heat exchanger 7 has a flat outer shape which is bent into an L shape. The air-refrigerant heat exchanger 7 is installed so as to extend from the rear surface of the heat pump water-heater outdoor unit 1 to the left side surface thereof. An end portion of the air-refrigerant heat exchanger 7 on the side of the rear surface extends to the rear side of the machine chamber 14. Accordingly, the partition plate 16 has a flat outer shape which is bent into an L shape, and is installed so as to separate space from the front surface of the heat pump water-heater outdoor unit 1 to the end portion of the air-refrigerant heat exchanger 7 on the side of the rear surface. In the air-refrigerant heat exchanger 7, heat is exchanged between the refrigerant in the refrigerant pipe and air around the fins. The amount of air flowing between and passing through the individual fines is increased and adjusted by the blower 6, and the amount of heat exchange is thereby increased and adjusted.

**[0022]** A water-refrigerant heat exchanger 8 is installed on the base 17 in the lower portion of the blower chamber 15. The water-refrigerant heat exchanger 8 is stored and installed in a storage container 12 having a rectangular parallelepiped shape in a state in which the water-refrigerant heat exchanger 8 is covered with a heat insulating material. The water-refrigerant heat exchanger 8 is formed by bending so as to be able to be stored in the storage container 12 in a state in which a long water pipe and a long refrigerant pipe are in intimate contact with each other. In the water-refrigerant heat exchanger 8, heat is exchanged between a refrigerant in the refrigerant pipe and water, i.e., a heating medium in the water pipe. In the water-refrigerant heat exchanger 8, water, i.e., the heating medium is heated. The blower 6 is disposed above the water-refrigerant heat exchanger 8.

**[0023]** An outlet portion of the compressor 2 is connected to a refrigerant inlet portion of the water-refrigerant heat exchanger 8 via the discharge pipe 4. A refrigerant outlet portion of the water-refrigerant heat exchanger 8 is connected to a high-pressure refrigerant inlet portion of the internal heat exchanger 11 in the machine chamber 14 via a refrigerant pipe. A high-pressure refrigerant outlet portion of the internal heat exchanger 11 is connected to an inlet portion of the expansion valve 10 in the machine chamber 14 via a refrigerant pipe. An outlet portion of the expansion valve 10 is connected to a refrigerant inlet portion of the air-refrigerant heat exchanger 7 via a refrigerant pipe. A refrigerant outlet portion of the air-refrigerant heat exchanger 7 is connected to a low-pressure refrigerant inlet portion of the internal heat exchanger 11 via a refrigerant pipe. A low-pressure refrigerant outlet portion of the internal heat exchanger 11 is connected to an inlet portion of the compressor 2 via the intake pipe 5. Other refrigerant circuit components may be mounted to some midpoints of the individual refrigerant pipes.

**[0024]** An electrical component storage box 9 is installed in the upper portion of the machine chamber 14. An electronic substrate 24 is stored in the electrical component storage box 9. Electronic components and electrical components which constitute modules which drive and control the compressor 2, the expansion valve 10, and the blower 6 are mounted to the electronic substrate 24. Each module performs the control in the following manner. The number of revolutions of the motor of the compressor 2 is changed to the number of revolutions of about several tens of rps (Hz) to about one hundred rps (Hz). The opening of the expansion valve 10 is changed. The number of revolutions of the blower 6 is changed to the number of revolutions of about several hundred rpm to about one thousand rpm. The electrical component storage box 9 is provided with a terminal block 9a for connection of external electrical wiring. As shown in

FIGS. 2 and 3, the terminal block 9a and a service panel 27 for protecting a water inlet valve 28 and a hot water outlet valve 29 described later are attached to the right side surface portion 19b.

**[0025]** A refrigerant is sealed in sealed space of the refrigerant circuit provided in the heat pump water-heater outdoor unit 1. The refrigerant may be, e.g., a $CO_2$ refrigerant.

**[0026]** Next, a description will be given of the water circuit of the heat pump water-heater outdoor unit 1 and a hot water storage apparatus 33. As shown in FIG. 1, water circuit components including an internal pipe 30 and an internal pipe 31 are incorporated into the machine chamber 14. The water inlet valve 28 and the hot water outlet valve 29 are provided on the right portion of the base 17 such that the water inlet valve 28 is positioned below the hot water outlet valve 29. The internal pipe 30 connects the water inlet valve 28 and a water inlet portion of the water-refrigerant heat exchanger 8. The internal pipe 31 connects a hot water outlet portion of the water-refrigerant heat exchanger 8 and the hot water outlet valve 29.

**[0027]** As shown in FIG. 4, the heat pump water-heater system is constituted by the heat pump water-heater outdoor unit 1 and the hot water storage apparatus 33. The hot water storage apparatus 33 includes a hot water storage tank 34 having a capacity of, e.g., about several hundred liters, and a water pump 35 for sending water in the hot water storage tank 34 to the heat pump water-heater outdoor unit 1. The heat pump water-heater outdoor unit 1 and the hot water storage apparatus 33 are connected via an external pipe 36, an external pipe 37, and electrical wiring (not shown).

**[0028]** The lower portion of the hot water storage tank 34 is connected to an inlet of the water pump 35 via a pipe 38. The external pipe 36 connects an outlet of the water pump 35 and the water inlet valve 28 of the heat pump water-heater outdoor unit 1. The external pipe 37 connects the hot water outlet valve 29 of the heat pump water-heater outdoor unit 1 and the hot water storage apparatus 33. The external pipe 37 can communicate with the upper portion of the hot water storage tank 34 via a pipe 39 in the hot water storage apparatus 33.

**[0029]** The hot water storage apparatus 33 further includes a mixing valve 40. A hot water supply pipe 41 branched from the pipe 39, a water supply pipe 42 through which water supplied from a water source such as a water supply passes, and a hot water supply pipe 43 through which hot water supplied to a user side passes are connected to the mixing valve 40. The mixing valve 40 adjusts supplied hot water temperature by adjusting a mixing ratio of hot water, i.e., high-temperature water flowing in from the hot water supply pipe 41 and water, i.e., low-temperature water flowing in from the water supply pipe 42. Hot water obtained by the mixing by the mixing valve 40 is sent to terminals on the user side such as, e.g., a bathtub, a shower, a faucet, and a dishwasher through the hot water supply pipe 43. A water supply pipe 44 branched from the water supply pipe 42 is connected to the lower portion of the hot water storage tank 34. Water flowing in from the water supply pipe 44 is stored on the lower side in the hot water storage tank 34.

**[0030]** Next, a description will be given of the operation of the heat pump water-heater outdoor unit 1 in heat storage operation. The heat storage operation is operation in which hot water is accumulated in the hot water storage tank 34 by sending hot water heated in the heat pump water-heater outdoor unit 1 to the hot water storage apparatus 33. The heat storage operation is as follows. The compressor 2, the blower 6, and the water pump 35 are operated. The rotation speed of the motor of the compressor 2 can change in a range of about several tens of rps (Hz) to about one hundred rps (Hz). With this, it is possible to adjust and control heating capability by changing the flow rate of the refrigerant.

**[0031]** It is possible to adjust and control the amount of heat exchange between the refrigerant and air in the air-refrigerant heat exchanger 7 by changing the rotation speed of the motor of the blower 6 to the rotation speed of about several hundred rpm to about one thousand rpm to change the flow rate of air passing through the air-refrigerant heat exchanger 7. Air is sucked into the air-refrigerant heat exchanger 7 installed behind the blower 6 from the rear of the air-refrigerant heat exchanger 7, passes through the air-refrigerant heat exchanger 7, passes through the blower chamber 15, and is discharged toward the front of the front panel 18 on a side opposite to the air-refrigerant heat exchanger 7.

**[0032]** The expansion valve 10 adjusts the degree of the flow path resistance of the refrigerant. With this, it is possible to adjust and control the pressure of each of the high-pressure refrigerant on the upstream side of the expansion valve 10 and the low-pressure refrigerant on the downstream side thereof. The rotation speed of the compressor 2, the rotation speed of the blower 6, and the degree of the flow path resistance of the expansion valve 10 are controlled in accordance with the installation environment and use conditions of the heat pump water-heater outdoor unit 1.

**[0033]** The low-pressure refrigerant is sucked into the compressor 2 through the intake pipe 5 and the muffler 2b. The muffler 2b muffles pulsating noise of the refrigerant sucked into the compressor 2. The low-pressure refrigerant is compressed in the compression portion in the compressor 2 to become a high-temperature high-pressure refrigerant. The high-temperature high-pressure refrigerant is discharged to the discharge pipe 4 from the compressor 2. The high-temperature high-pressure refrigerant flows into the refrigerant inlet portion of the water-refrigerant heat exchanger 8 through the discharge pipe 4. The high-temperature high-pressure refrigerant exchanges heat with water in the water-refrigerant heat exchanger 8 to heat water and generate hot water. The refrigerant is reduced in enthalpy and temperature while the refrigerant passes through the water-refrigerant heat exchanger 8. The high-pressure refrig-

erant lowered in temperature flows into the high-pressure refrigerant inlet portion of the internal heat exchanger 11 from the refrigerant outlet portion of the water-refrigerant heat exchanger 8 through the refrigerant pipe. The high-pressure refrigerant exchanges heat with the low-pressure refrigerant in the internal heat exchanger 11, and is further lowered in temperature by being reduced in enthalpy. The high-pressure refrigerant lowered in temperature flows into the inlet portion of the expansion valve 10 from the high-pressure refrigerant outlet portion of the internal heat exchanger 11 through the refrigerant pipe. The high-pressure refrigerant is lowered in temperature by being decompressed in the expansion valve 10 to become a low-temperature low-pressure refrigerant. The low-temperature low-pressure refrigerant flows into the inlet portion of the air-refrigerant heat exchanger 7 from the outlet portion of the expansion valve 10 through the refrigerant pipe. The low-temperature low-pressure refrigerant exchanges heat with air in the air-refrigerant heat exchanger 7, is increased in enthalpy, flows into the refrigerant pipe from the outlet portion of the air-refrigerant heat exchanger 7, and flows into the low-pressure refrigerant inlet portion of the internal heat exchanger 11. The low-pressure refrigerant exchanges heat with the high-pressure refrigerant in the internal heat exchanger 11, and is increased in enthalpy. The low-pressure refrigerant having flowed into the intake pipe 5 from the outlet portion of the internal heat exchanger 11 is sucked into the compressor 2. Thus, the refrigerant circulates, and a heat pump cycle is performed.

**[0034]** At the same time, by driving the water pump 35, water in the lower portion in the hot water storage tank 34 is caused to flow into the water inlet portion of the water-refrigerant heat exchanger 8 through the pipe 38, the external pipe 36, the water inlet valve 28, and the internal pipe 30. The water exchanges heat with the refrigerant in the water-refrigerant heat exchanger 8 and is heated, and hot water is generated. The hot water flows into the upper portion of the hot water storage tank 34 through the internal pipe 31, the hot water outlet valve 29, the external pipe 37, and the pipe 39. By performing the heat storage operation described above, hot water having high temperature is gradually accumulated from the upper portion toward the lower portion in the hot water storage tank 34.

**[0035]** Note that hot water heated in the heat pump water-heater outdoor unit 1 may be directly supplied to the user side without being stored in the hot water storage tank 34. In addition, the heating medium heated in the heat pump water-heater outdoor unit 1 may be used for indoor heating or the like.

**[0036]** According to the present embodiment, the following effects are obtained by providing the internal heat exchanger 11. It is possible to perform heat exchange from the high-pressure refrigerant having passed through the water-refrigerant heat exchanger 8 to the low-pressure refrigerant having passed through the air-refrigerant heat exchanger 7. With this, it is possible to increase the thermal efficiency of the heat pump cycle.

[Characteristics of heat pump water-heater outdoor unit of embodiment 1]

**[0037]** Next, with reference to FIGS. 5 to 7, a description will be given of the characteristic configuration of the heat pump water-heater outdoor unit 1 of Embodiment 1. The heat pump water-heater outdoor unit 1 of Embodiment 1 is characterized in the installation structure of each of the compressor 2, the muffler 2b, and the internal heat exchanger 11. FIG. 5 is an enlarged view of the peripheral configuration of the compressor shown in FIG. 1 when viewed from the side of the front. In addition, FIG. 6 is a view of the peripheral configuration of the compressor shown in FIG. 5 when viewed from an A direction. Further, FIG. 7 is a view of the peripheral configuration of the compressor shown in FIG. 5 when viewed from a B direction. Hereinbelow, with reference to these drawings, a description will be given of the installation structure of each of the compressor 2, the muffler 2b, and the internal heat exchanger 11.

(Installation structure of compressor)

**[0038]** First, the installation structure of the compressor 2 will be described. A leg member 2c is fixed to the bottom portion of the shell 2a of the compressor 2. The compressor 2 is mounted on the base 17 via the leg member 2c. The leg member 2c has a strength which allows the leg member 2c to support the weight of the compressor 2 and a component fixed to the compressor 2. The leg member 2c is preferably made of metal. The leg member 2c in the embodiment is a triangular plate member. In addition, the leg member 2c is disposed so as not to come into contact with the internal heat exchanger 11 described later. The leg member 2c is preferably disposed such that one side of the triangular shape thereof is parallel to the internal heat exchanger 11 in a top view. The upper surface of the leg member 2c is joined to the bottom surface of the shell 2a of the compressor 2. The leg member 2c may also be welded to the shell 2a of the compressor 2.

**[0039]** The heat pump water-heater outdoor unit 1 includes a plurality of vibration isolation mounts 3. The vibration isolation mount is formed by using, e.g., a rubber material or a metal spring material. The vibration isolation mounts 3 are disposed between the upper surface of the base 17 and the lower surface of the leg member 2c. The vibration isolation mount 3 is disposed at each of three corner portions of the triangular leg member 2c. The outer shape of the vibration isolation mount 3 may be cylindrical. The compressor 2 is installed on the upper surface of the base 17 with the vibration isolation mounts 3 interposed between the compressor 2 and the base 17.

**[0040]** Note that, a plurality of pins for coupling the compressor 2 to the base 17 may be installed on the base 17. For example, in the case where three pins pro-

trude upward, the vibration isolation mount 3 is formed into a cylindrical shape having a hole through which the pin can pass. The pin passes through the hole of the vibration isolation mount 3 and a hole provided in the leg member 2c. The pin is screwed with a bolt which is not shown. The vibration isolation mounts 3 are held between the base 17 and the leg member 2c, and the compressor 2 is thereby coupled to the base 17 via the vibration isolation mounts 3.

(Installation structure of muffler)

**[0041]** Next, the installation structure of the muffler 2b will be described. The muffler holder 2d is joined to the outer surface of the shell 2a of the compressor 2. The muffler holder 2d has a strength which allows the muffler holder 2d to support the weight of the muffler 2b. The muffler holder 2d is preferably made of metal. The muffler holder 2d has a fixed body portion fixed to the outer surface of the compressor 2, and fixed arm portions fixed to the muffler 2b. The fixed body portion is bent so as to extend along a circumferential direction of the side surface of the compressor 2. The fixed arm portions extend outward in a radial direction of the shell 2a of the compressor 2 so as to hold the muffler 2b therebetween from both ends of the fixed body portion. That is, the muffler holder 2d has a shape obtained by bending a plate material into an M shape. The fixed body portion of the muffler holder 2d is, for example, welded to the outer surface of the shell 2a of the compressor 2. The muffler 2b is, for example, welded to the fixed arm portions of the muffler holder 2d.

(Installation structure of internal heat exchanger)

**[0042]** Next, the installation structure of the internal heat exchanger 11 will be described. The internal heat exchanger holder 2e is joined to the outer surface of the shell 2a of the compressor 2. The internal heat exchanger holder 2e has a strength which allows the internal heat exchanger holder 2e to support the weight of the internal heat exchanger 11. The internal heat exchanger holder 2e is preferably made of metal. The internal heat exchanger holder 2e has a fixed body portion fixed to the outer surface of the compressor 2, and fixed arm portions fixed to the internal heat exchanger 11. The fixed body portion is constituted by a flat surface which faces the side surface of the compressor 2. The fixed arm portions perpendicularly extend outward in the radial direction of the shell 2a of the compressor 2 in a perpendicular direction from both ends of the fixed body portion. That is, the internal heat exchanger holder 2e has a shape obtained by bending a plate material into a U shape. The fixed body portion of the internal heat exchanger holder 2e is, for example, welded to the outer surface of the shell 2a of the compressor 2. At this point, the internal heat exchanger holder 2e is fixed at a position where the internal heat exchange holder 2e is rotated by 180° along the circumferential direction of the outer surface of the compressor 2 from the muffler holder 2d. The internal heat exchanger 11 is fixed to the fixed arm portions of the internal heat exchanger holder 2e. According to such an arrangement, the internal heat exchanger 11 is fixed at a position which corresponds to the back side of the compressor 2 when viewed from the side of the muffler 2b, i.e., a position on a side opposite to the muffler 2b with the compressor 2 positioned between the internal heat exchanger 11 and the muffler 2b.

**[0043]** The internal heat exchanger 11 is formed into a spiral shape by bending in the state in which the long high-pressure refrigerant pipe and the long low-pressure refrigerant pipe are in intimate contact with each other. The internal heat exchanger 11 may be a joint pipe in which the high-pressure refrigerant pipe and the low-pressure refrigerant pipe are in intimate contact with and are joined to each other, or a double pipe. The pipe formed by bending is bundled and fastened by metal band members 21.

**[0044]** As shown in FIG. 1, the machine chamber 14 is formed as the space which is long in the up-and-down direction. Accordingly, the internal heat exchanger 11 is fixed to the fixed arm portions of the internal heat exchanger holder 2e such that the lengthwise direction of the rectangle matches the up-and-down direction of the machine chamber 14. The central portion of the internal heat exchanger 11 is provided with a fixing portion for fixing the fixed arm portions of the internal heat exchanger holder 2e. The internal heat exchanger 11 is fixed to the fixed arm portions of the internal heat exchanger holder 2e in a state in which elastic members 13 are interposed between the internal heat exchanger 11 and the fixed arm portions.

**[0045]** The internal heat exchanger 11 and the muffler 2b are also characterized in an arrangement in the up-and-down direction. That is, the internal heat exchanger 11 and the muffler 2b are fixed at positions where a height of a center of gravity of the internal heat exchanger 11 is equal to a height of a center of gravity of the muffler 2b. In addition, the lower end position of the internal heat exchanger 11 is a position where the lower end of the internal heat exchanger 11 does not come into contact with the upper surface of the base 17, and is below the upper end position of the vibration isolation mount 3.

**[0046]** A description will be given of the outline of function of the heat pump water-heater outdoor unit 1 having the above configuration.

**[0047]** The compressor 2 disposed inside the heat pump water-heater outdoor unit 1 is driven at a frequency of about several tens of rps (Hz) to about one hundred rps (Hz) during the operation. Accordingly, in the compressor 2, strong vibration is generated with a frequency component equal to the integral multiple of the frequency. The generated vibration is transmitted to various components such as the air-refrigerant heat exchanger 7 via the intake pipe 5 and the discharge pipe 4 connected to the compressor 2, and low-frequency sound and noise

are thereby generated from the individual portions of the case. In particular, mass components such as the muffler 2b and the internal heat exchanger 11 are fixed to the compressor 2. Consequently, the center of gravity is displaced from the central axis of the shell 2a by the mass of the components, and a moment in a direction which tilts the compressor 2 thereby acts on the compressor 2. When the tilt of the compressor 2 occurs due to the action of such a moment, there is a possibility that specific abnormal vibration will be generated in the compressor 2. In this case, there is a possibility that low-frequency sound and noise emitted from the entire case by the vibration of the compressor 2 will not be suppressed.

**[0048]** To cope with this, in the heat pump water-heater outdoor unit 1 of Embodiment 1, the internal heat exchanger 11 is fixed on the side opposite to the muffler 2b with the compressor 2 positioned between the internal heat exchanger 11 and the muffler 2b. According to such a configuration, the center of gravity of the entire compressor 2 including the internal heat exchanger 11 and the muffler 2b approaches the central axis of the shell 2a, and hence the moment acting on the compressor is reduced. With this, it is possible to suppress the generation of the abnormal vibration caused by the tilt of the compressor 2, and hence the generation of the low-frequency sound and the noise is suppressed.

**[0049]** When the height of the center of gravity of the internal heat exchanger 11 is significantly different from the height of the center of gravity of the muffler 2b, the change of a moment in the case where the compressor 2 is tilted becomes significant. To cope with this point, the heat pump water-heater outdoor unit 1 of Embodiment 1 is configured such that the height of the center of gravity of the internal heat exchanger 11 is equal to the height of the center of gravity of the muffler 2b. With this, it is possible to suppress an increase in the tilt of the compressor 2 caused by the change of the moment.

**[0050]** The internal heat exchanger 11 is fixed to the fixed arm portions of the internal heat exchanger holder 2e in the state in which the elastic members 13 are interposed therebetween. According to such a configuration, vibration transmitted from the compressor 2 to the internal heat exchanger 11 is damped, and hence vibration generated in the internal heat exchanger 11 is suppressed. In addition, in the internal heat exchanger 11, the pipe bent into the spiral shape is fastened by the band members 21. With this, the vibration generated in the internal heat exchanger 11 is further suppressed.

**[0051]** The leg member 2c is shaped so as not to come into contact with the internal heat exchanger 11, and hence it is possible to adopt the shape of the internal heat exchanger 11 in which the internal heat exchanger 11 extends downward beyond the upper end position of the vibration isolation mount 3. With this, it becomes possible to effectively extend the total length of the internal heat exchanger 11 in the lengthwise direction.

**[0052]** The vibration isolation mount 3 is disposed between the upper surface of the base 17 and the lower surface of the leg member 2c. With this, it is possible to effectively damp the vibration of the compressor disposed on the upper surface of the leg member 2c.

[A modification of heat pump water-heater outdoor unit of embodiment 1]

**[0053]** Additionally, the heat pump water-heater outdoor unit 1 of Embodiment 1 may adopt an embodiment modified in the following manner.

**[0054]** The shape of the muffler holder 2d is not limited as long as the shape thereof allows the muffler 2b to be fixed to the side surface of the shell 2a of the compressor 2. In addition, the shape of the internal heat exchanger holder 2e is not limited as long as the shape thereof allows the internal heat exchanger 11 to be fixed to the side surface of the shell 2a of the compressor 2. Note that this applies to the heat pump water-heater outdoor unit 1 of Embodiment 2 described later.

Embodiment 2.

**[0055]** Next, a description will be given of Embodiment 2 with reference to FIGS. 8 to 11. In the description of Embodiment 2, points different from those in Embodiment 1 described above will be mainly described, and the description of the same or corresponding portions will be simplified or omitted.

**[0056]** FIG. 8 is a front view showing the internal structure of the heat pump water-heater outdoor unit 1 of Embodiment 2. FIG. 9 is an enlarged view of the peripheral configuration of the compressor shown in FIG. 1 when viewed from the side of the front. In addition, FIG. 10 is a view of the peripheral configuration of the compressor shown in FIG. 9 when viewed from a C direction. Further, FIG. 11 is a view of the peripheral configuration of the compressor shown in FIG. 9 when viewed from a D direction. Hereinbelow, with reference to these drawings, a description will be given of characteristics of the heat pump water-heater outdoor unit 1 of Embodiment 2.

**[0057]** As shown in these drawings, the heat pump water-heater outdoor unit 1 of Embodiment 2 is characterized in that the heat pump water-heater outdoor unit 1 includes an internal heat exchanger 22 shaped so as to be arcuately curved along the shell 2a of the compressor 2. More specifically, as shown in FIG. 10, the internal heat exchanger 22 is shaped arcuately so as to be concentric with the shell 2a of the compressor 2 in a top view. According to such a shape, it is possible to use space in the machine chamber 14 more effectively than in the case where the internal heat exchanger 22 has a linear shape in a top view. With this, it becomes possible to extend the length of the internal heat exchanger 22 in a widthwise direction while suppressing increases in the dimensions and the weight of the heat pump water-heater outdoor unit 1, and an increase in the material cost of the heat pump water-heater outdoor unit 1.

**[0058]** For the purpose of suppressing heat radiation

and noise from the compressor 2, there are cases where a heat insulating material also serving as a sound absorbing material is provided around the compressor 2 including the muffler 2b and the internal heat exchanger 22. In the heat pump water-heater outdoor unit 1 of Embodiment 2, the internal heat exchanger 22 is curved, and hence it is possible to prevent an increase in the dimensions of the heat insulating material.

[Reference Signs List]

**[0059]**

| | |
|---|---|
| 1 | Heat pump water-heater outdoor unit |
| 2 | Compressor |
| 2a | Shell |
| 2b | Muffler |
| 2c | Leg member |
| 2d | Muffler holder |
| 2e | Internal heat exchanger holder |
| 3 | Vibration isolation mount |
| 4 | Discharge pipe |
| 5 | Intake pipe |
| 6 | Blower |
| 7 | Air-refrigerant heat exchanger |
| 8 | Water-refrigerant heat exchanger |
| 9 | Electrical component storage box |
| 9a | Terminal block |
| 10 | Expansion valve |
| 11 | Internal heat exchanger |
| 12 | Storage container |
| 13 | Elastic member |
| 14 | Machine chamber |
| 15 | Blower chamber |
| 16 | Partition plate |
| 17 | Base |
| 18 | Front panel |
| 18a | Front surface portion |
| 18b | Left side surface portion |
| 18c | Lattice |
| 19 | Side panel |
| 19a | Rear surface portion |
| 19b | Right side surface portion |
| 20 | Top panel |
| 21 | Band member |
| 22 | Internal heat exchanger |
| 24 | Electronic substrate |
| 27 | Service panel |
| 28 | Water inlet valve |
| 29 | Hot water outlet valve |
| 30 | Internal pipe |
| 31 | Internal pipe |
| 33 | Hot water storage apparatus |
| 34 | Hot water storage tank |
| 35 | Water pump |
| 36 | External pipe |
| 37 | External pipe |
| 38 | Pipe |
| 39 | Pipe |
| 40 | Mixing valve |
| 41 | Hot water supply pipe |
| 42 | Water supply pipe |
| 43 | Hot water supply pipe |
| 44 | Water supply pipe |

## Claims

1. A heat pump water-heater outdoor unit comprising:

   a bottom plate;
   a compressor disposed on the bottom plate;
   a muffler fixed to an outer surface of the compressor; and
   an internal heat exchanger fixed to the outer surface of the compressor,
   **characterized in that** the internal heat exchanger is disposed on a side opposite to the muffler with the compressor positioned between the internal heat exchanger and the muffler.

2. The heat pump water-heater outdoor unit according to claim 1,
   wherein the internal heat exchanger is fixed at a position where a height of a center of gravity of the internal heat exchanger is equal to a height of a center of gravity of the muffler.

3. The heat pump water-heater outdoor unit according to claim 1 or 2, further comprising a muffler holder fixed to the outer surface of the compressor,
   wherein the muffler is fixed to the muffler holder.

4. The heat pump water-heater outdoor unit according to any one of claims 1 to 3, further comprising an internal heat exchanger holder fixed to the outer surface of the compressor,
   wherein the internal heat exchanger is fixed to the internal heat exchanger holder.

5. The heat pump water-heater outdoor unit according to claim 4, further comprising an elastic member provided so as to be interposed between the internal heat exchanger holder and the internal heat exchanger.

6. The heat pump water-heater outdoor unit according to any one of claims 1 to 5,
   wherein the internal heat exchanger includes:

   a pipe which is bent into a spiral shape; and
   a band member to bundle and fasten the pipe.

7. The heat pump water-heater outdoor unit according to any one of claims 1 to 6, comprising:

a leg member fixed to a bottom surface of the compressor; and
a plurality of vibration isolation mounts provided so as to be interposed between the leg member and the bottom plate,
wherein the leg member is shaped so as not to overlap the internal heat exchanger in a top view.

**8.** The heat pump water-heater outdoor unit according to any one of claims 1 to 7,
wherein the internal heat exchanger is shaped so as to be curved along the outer surface of the compressor.

**9.** The heat pump water-heater outdoor unit according to claim 8,
wherein the internal heat exchanger is formed arcuately so as to be concentric with the outer surface of the compressor in a top view.

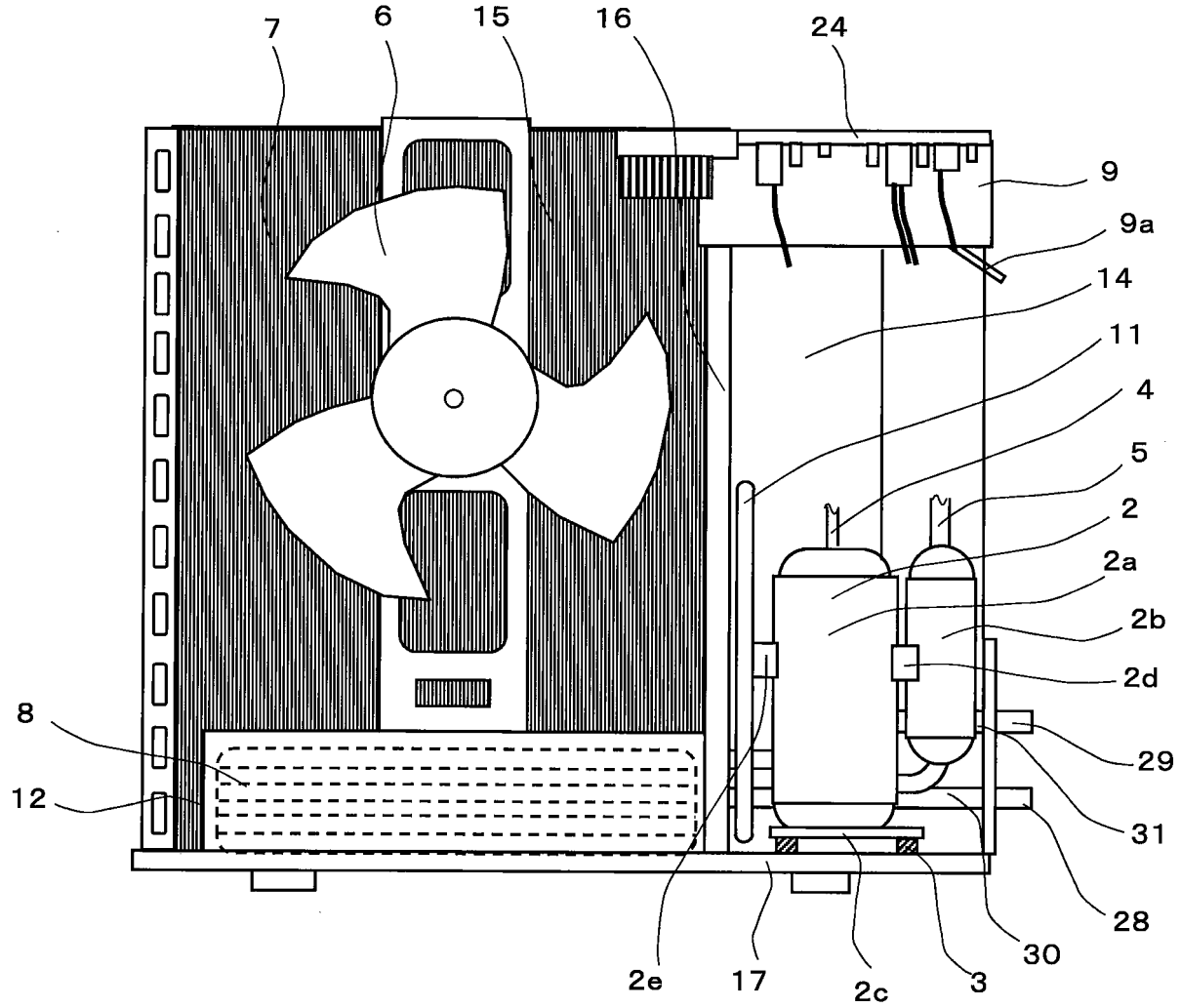


FIG. 1

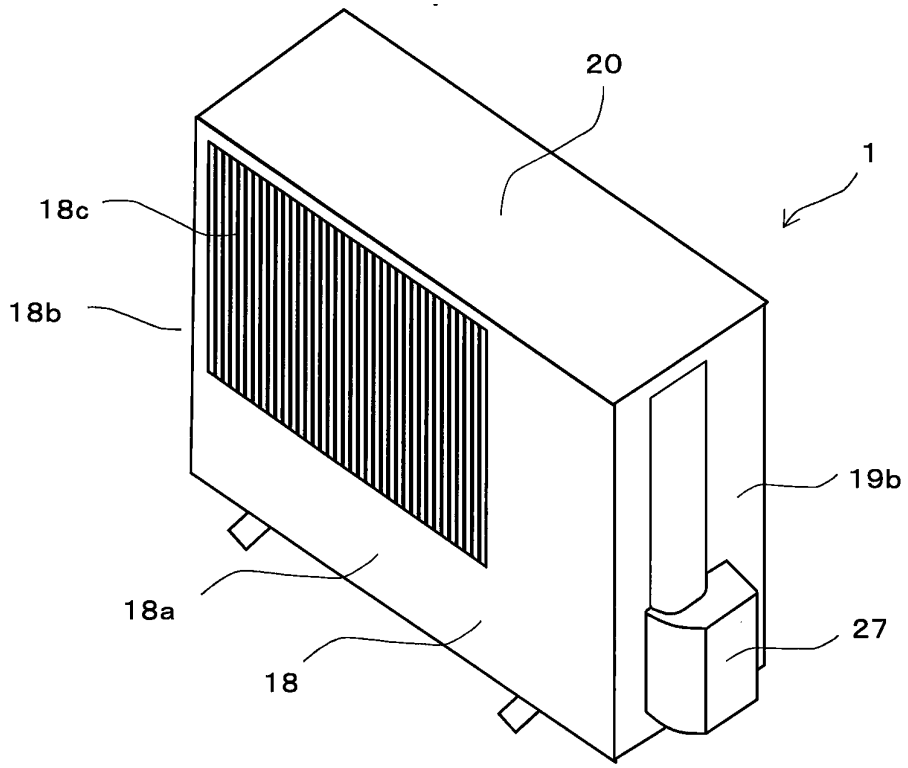


FIG. 2

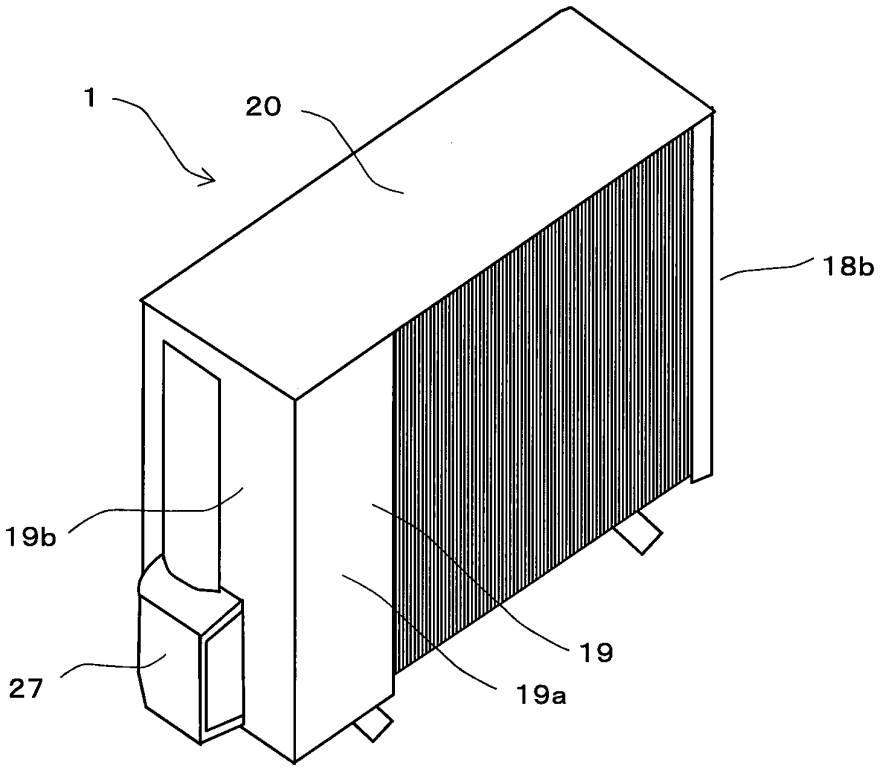


FIG. 3

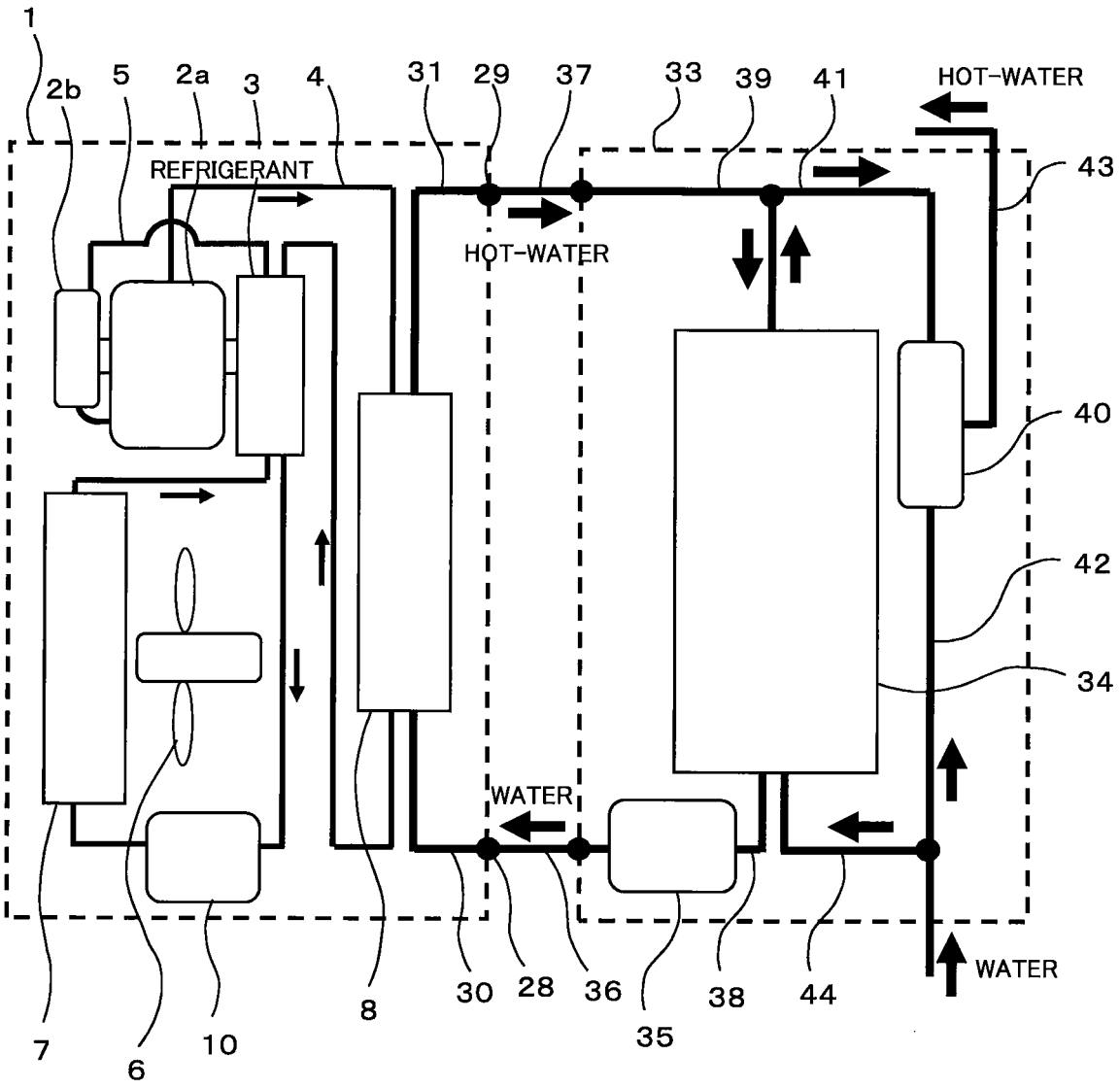
1
2b
5
2a
3
4
31
29
37
33
39
41
HOT-WATER
43
REFRIGERANT
HOT-WATER
40
42
34
WATER
WATER
7
6
10
8
30
28
36
35
38
44

FIG. 4

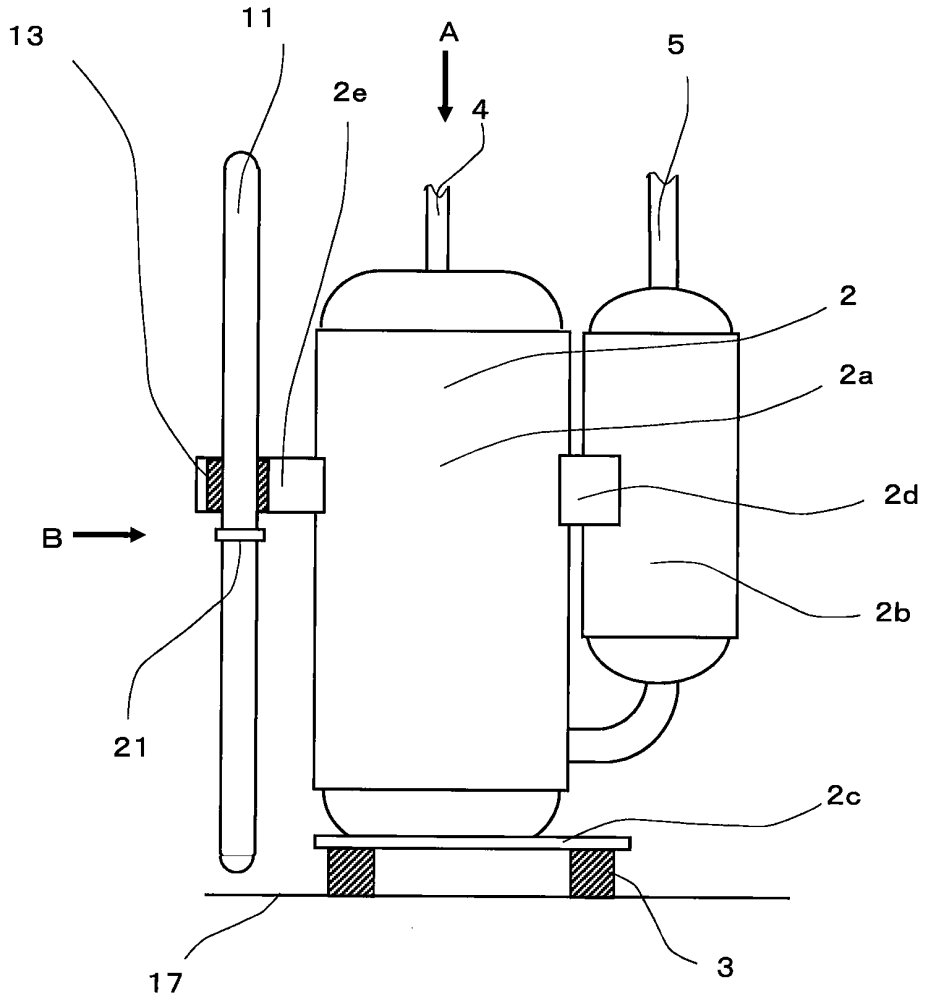


FIG. 5

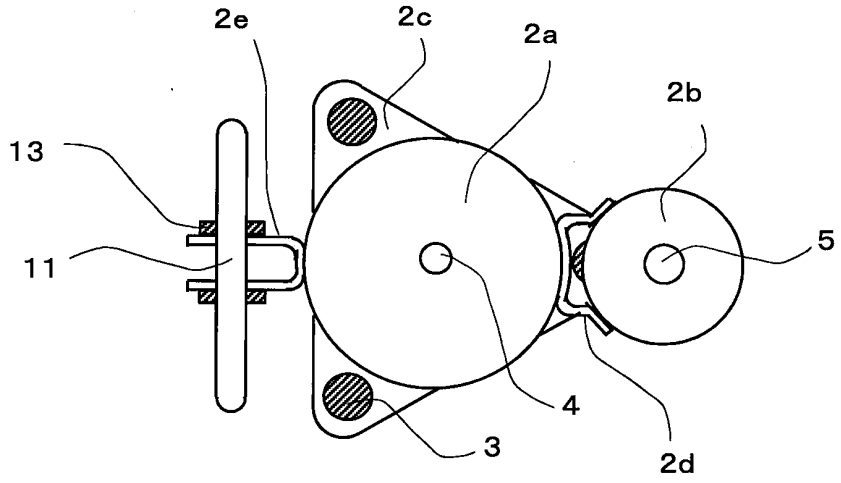


FIG. 6

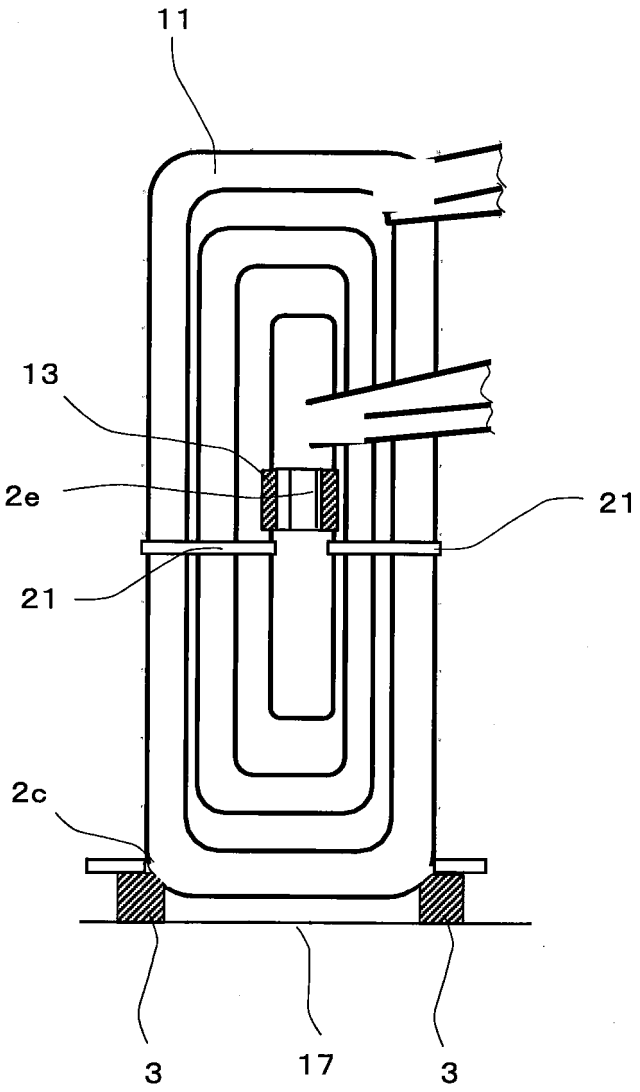


FIG. 7

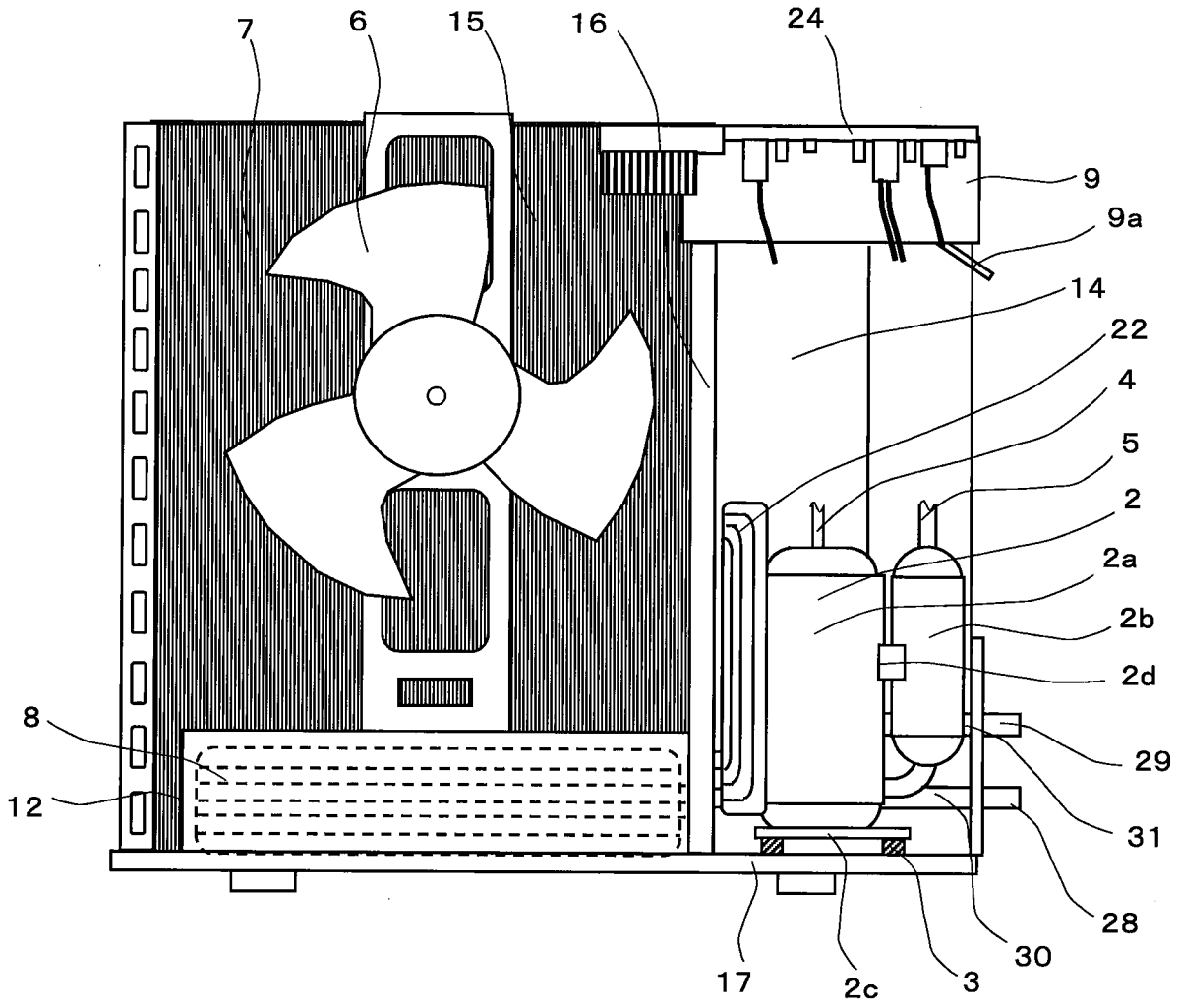


FIG. 8

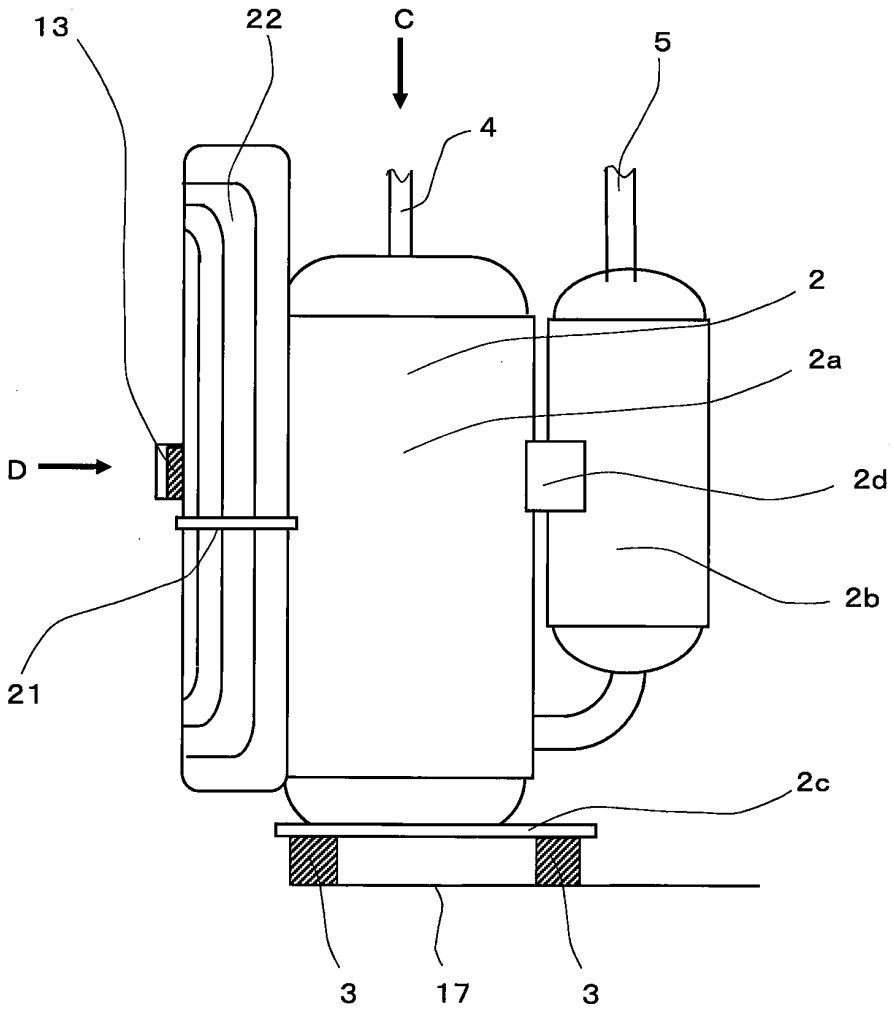


FIG. 9

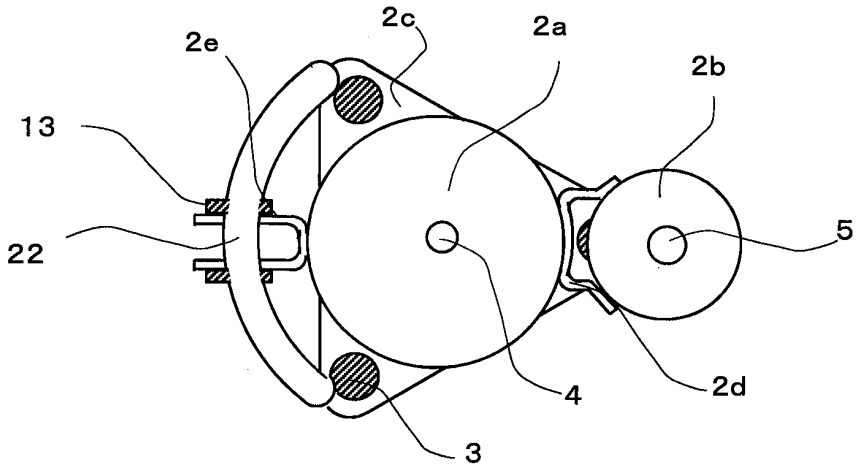


FIG. 10

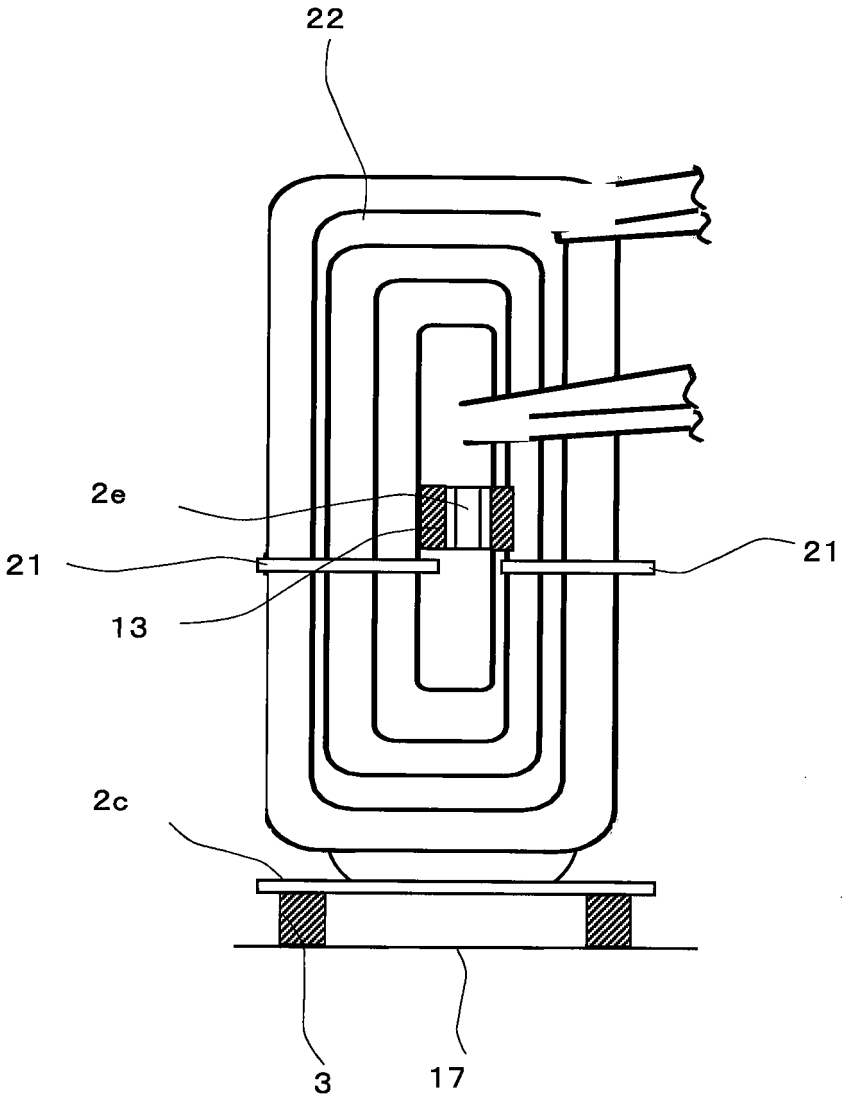


FIG. 11

**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/JP2017/046728

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F25B41/00(2006.01)i, F24H4/02(2006.01)i, F25B1/00(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. F25B1/00, F25B13/00, F25B41/00, F24H4/02

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. |
|---|---|---|
| A | JP 2007-271211 A (DAIKIN INDUSTRIES, LTD.) 18 October 2007, entire text, all drawings & WO 2007/114187 A1 & EP 2009371 A1 | 1-9 |
| A | JP 2010-48466 A (DAIKIN INDUSTRIES, LTD.) 04 March 2010, entire text, all drawings (Family: none) | 1-9 |
| A | JP 2010-121844 A (PANASONIC CORPORATION) 03 June 2010, entire text, all drawings (Family: none) | 1-9 |

☒ 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<br>26.02.2018 | Date of mailing of the international search report<br>13.03.2018 |
| Name and mailing address of the ISA/<br>Japan Patent Office<br>3-4-3, Kasumigaseki, Chiyoda-ku,<br>Tokyo 100-8915, Japan | Authorized officer<br><br>Telephone No. |

Form PCT/ISA/210 (second sheet) (January 2015)

**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/JP2017/046728

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 2006-90658 A (DENSO CORPORATION) 06 April 2006, entire text, all drawings (Family: none) | 1-9 |
| A | JP 2005-337700 A (FUJI ELECTRIC RETAIL SYSTEMS) 08 December 2005, entire text, all drawings (Family: none) | 1-9 |

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- JP 2007271211 A **[0004]**