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(72) Inventors:  
• **Taniguchi, Mitsunori**  
**Osaka, 540-6207 (JP)**  
• **Nakai, Kouji**  
**Osaka, 540-6207 (JP)**  
• **Fujiwara, Norihiko**  
**Osaka, 540-6207 (JP)**

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(74) Representative: **Schwabe - Sandmair - Marx**  
**Patentanwälte**  
**Stuntzstraße 16**  
**81677 München (DE)**

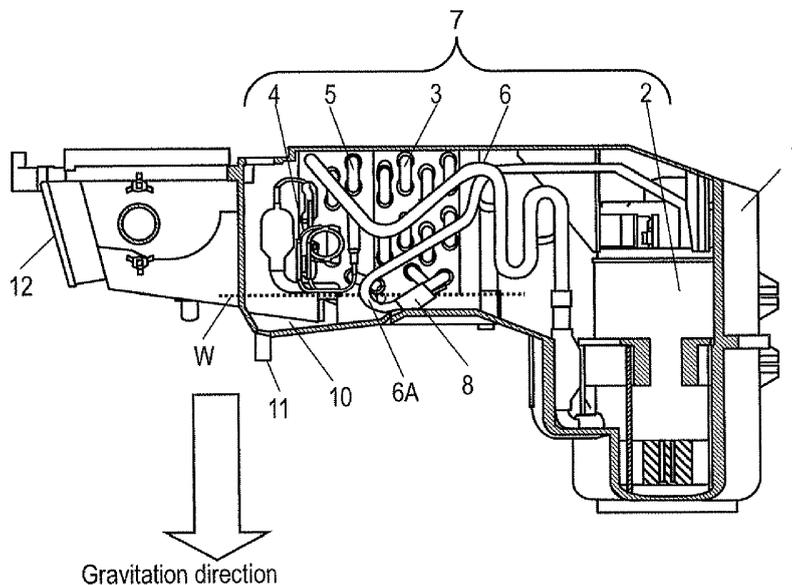
(71) Applicant: **Panasonic Corporation**  
**Kadoma-shi**  
**Osaka 571-8501 (JP)**

(54) **Dehumidifying-warming apparatus and clothes drier**

(57) A heat pump device connecting a compressor, a heat radiator, an expansion mechanism, and a heat absorber by using a pipe through which a refrigerant circulates, a temperature measuring unit that is disposed in a pipe connecting the heat radiator, and a wind circuit through which air of the heat pump device flows inside

from an air inlet at the heat absorber and flows outside from an air outlet at the heat radiator, are included. Further, a drain pan receiving condensed water produced by heat exchange between the air in the wind circuit and air in heat absorber is further included, and the temperature measuring unit is disposed under a boundary position where water of the drain pan overflows.

**FIG. 1**



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## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a dehumidifying-warming device using a heat pump device and a clothes drier using the same.

### BACKGROUND ART

**[0002]** In the related art, as the kind of dehumidifying-warming apparatus, a typical example one has been disclosed in Japanese Patent Unexamined Publication No. 7-178289 (Patent Document 1). Recently, a dehumidifying-warming apparatus has been used, instead of a heater using a clothes drier, in the view of the saving of energy. A heat pump device is used as the dehumidifying-warming apparatus.

**[0003]** Hereinafter, a known dehumidifying-warming apparatus is described. FIG. 7 is a view of a dehumidifying-warming apparatus of the related art, seen from above, FIG. 8 is a side view of the dehumidifying-warming apparatus of the related, and FIG. 9 is a cross-sectional view taken along the line 9-9 of FIG. 7.

**[0004]** Dehumidifying-warming apparatus 51 includes heat pump device 57 including, as shown in FIG. 9, compressor 53, heat radiator 54, heat absorber 55, and expansion mechanism 56, in housing 52. Temperature measuring unit 59 that measures the temperature of a refrigerant discharged from compressor 53 is disposed in pipe 58 connecting compressor 53 with heat radiator 54. Drain pan 60 that receives condensed water produced in heat absorber 55 is disposed under heat absorber 55. The condensed water collected in drain pan 60, as shown in FIG. 8, is discharged from drain outlet 61. Water level sensor 62 that detects the condensed water is disposed on the wall of drain pan 60, as shown in FIG. 8.

**[0005]** The flow of a refrigerant is described by using FIG. 9. In the operation of heat pump device 57, a refrigerant that is compressed by compressor 53 at high temperature and high pressure flows into heat radiator 54 through pipe 58 and exchanges heat with air blown by air blower (not shown). The air is heated and the refrigerant is cooled and liquefied and becomes a high-pressure refrigerant, by the heat exchange. The liquefied refrigerant flows into expansion mechanism 56 and is compressed, such that it becomes a low-temperature and low-pressure refrigerant and flows into heat absorber 55. In this process, the refrigerant exchanges heat with the air blown by the air blower, by heat absorber 55. Meanwhile, the air is cooled and dehumidified. The refrigerant is heated to be a vapor refrigerant and returns to compressor 53.

**[0006]** When the refrigerant discharge temperature is above the temperature of the deterioration temperature of a lubricant in compressor 53, compressor 53 cannot normally operate. Accordingly, when the refrigerant dis-

charge temperature is above the regulated temperature, it needs to stop compressor 53.

**[0007]** Further, when the air is cooled and dehumidified in heat absorber 55, the water vapor in the air builds up condensation and condensed water is produced. The condensed water drops to drain pan 60 disposed under heat absorber 55. The dew condensation water that drops to drain pan 60 is discharged to the outside of dehumidifying-warming apparatus 51 from drain outlet 61. Drain outlet 61 is clogged by foreign substances, abnormal drainage is caused and the condensed water is accumulated in drain pan 60. As a result, the water level in drain pan 60 rises. Water level sensor 62 is disposed in drain pan 60. The water level of the condensed water is detected by water level sensor 62 and the abnormal drainage is determined. Accordingly, for example, it is possible to prevent the condensed water from overflowing drain pan 60.

**[0008]** The flow of the air is now described. The air is sent from air hatch 63 to dehumidifying-warming apparatus 51 by the air blower. The air is first cooled by heat absorber 55. When the temperature of heat absorber 55 is equal to or less than the saturation temperature of the air, the water vapor in the air builds up condensation on the surface of heat absorber 55. Therefore, the air is dehumidified. Thereafter, the air is heated by exchanging heat with the refrigerant that is compressed at high temperature and high pressure, in heat radiator 54. The heated air becomes high-temperature and low-humidity air and discharged from dehumidifying-warming apparatus 51 through exhaust outlet 64.

**[0009]** In the dehumidifying-warming apparatus of the related art, water level sensor 62 that detects the condensed water in drain pan 60 is disposed. Accordingly, a space for disposing water level sensor 62 is needed. Therefore, the apparatus increases in size and the configuration is complicated.

### DISCLOSURE OF THE INVENTION

#### PROBLEM THAT THE INVENTION IS TO SOLVE

**[0010]** The present invention detects the water level of condensed water with a simple configuration.

#### MEANS FOR SOLVING THE PROBLEM

**[0011]** A dehumidifying-warming apparatus of the invention includes a heat pump device including a compressor, a heat radiator, an expansion mechanism, and a heat absorber, and a drain pan receiving condensed water produced by heat exchange between the heat absorber and air. In the dehumidifying-warming apparatus of the present invention, a portion of a pipe connecting the compressor with the heat radiator is led into the drain pan. In the dehumidifying-warming apparatus of the present invention, a temperature measuring unit is disposed at the portion, which is led into the drain pan, of

the pipe. Therefore, the temperature measuring unit measures the temperature of a refrigerant of the heat pump device and also measures the temperature of condensed water when condensed water is accumulated in the drain pan. The water level of the drain pan is detected by the temperature measured by the temperature measuring unit.

#### BRIEF DESCRIPTION OF THE DRAWINGS

##### [0012]

FIG. 1 is a cross-sectional view of a dehumidifying-warming apparatus according to a first embodiment of the present invention.

FIG. 2 is a schematic view of the dehumidifying-warming apparatus according to the first embodiment of the present invention.

FIG. 3 is a view of the dehumidifying-warming apparatus according to the first embodiment of the present invention, seen from above.

FIG. 4 is a time chart showing the operation of the dehumidifying-warming apparatus according to the first embodiment of the present invention.

FIG. 5 is a time chart showing the operation of the dehumidifying-warming apparatus according to the first embodiment of the present invention.

FIG. 6 is a cross-sectional view showing the main parts of a clothes drier equipped with a dehumidifying-warming apparatus, according to a second embodiment of the present invention.

FIG. 7 is a view of a dehumidifying-warming apparatus of the related art, seen from above.

FIG. 8 is a side view of the dehumidifying-warming apparatus of the related art.

FIG. 9 is a cross-sectional view of the dehumidifying-warming apparatus of the conventional art, taken along the line 9-9 of FIG. 7.

#### PREFERRED EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0013] Hereinafter, embodiments of the present invention will be described with reference to the drawings. The present invention is not limited by the embodiments.

##### EXEMPLIFY EMBODIMENT 1

[0014] FIG. 1 is a cross-sectional view of a dehumidifying-warming apparatus according to a first embodiment of the present invention, FIG. 2 is a schematic view of the dehumidifying-warming apparatus, and FIG. 3 is a view of the dehumidifying-warming apparatus, seen from above.

[0015] In FIG. 1, heat pump 7 composed of compressor 2, heat radiator 3, expansion mechanism 4, heat absorber 5, and pipe 6 that connects them and in which the refrigerant circulates, is disposed in housing 1. The ro-

tation speed of compressor 2 can be changed by an inverter or the like.

[0016] In a portion of pipe 6, temperature measuring unit 8 is disposed at pipe 6A connecting compressor 2 with heat radiator 3. Temperature measuring unit 8 measures the temperature of the refrigerant discharged from compressor 2. The temperature of the refrigerant measured by temperature measuring unit 8 is input to control device 9 that controls the operation of compressor 2. Temperature measuring unit 8 is implemented by a thermistor or the like.

[0017] Drain pan 10 is disposed under heat absorber 5 to receive the condensed water produced by heat absorber 5. The condensed water collected in drain pan 10 is discharged from drain outlet 11. A portion of pipe 6A connecting compressor 2 with heat radiator 3 is led into drain pan 10. Temperature measuring unit 8 is disposed at the portion, which is led into drain pan 10, of pipe 6A. The position of temperature measuring unit 8 may be the bottom or the side in drain pan 10.

[0018] In pipe 6A, temperature measuring unit 8 is mounted such that a portion or the entire portion is disposed in the gravity direction under overflow stream line W that is the boundary position where the condensed water overflows drain pan 10.

[0019] Next, the basic operation of heat pump device 7 is described by using FIG. 2. The refrigerant is first compressed by compressor 2 into a high-temperature and high-pressure state. The high-temperature and high-pressure refrigerant flows into heat radiator 3 through the portion, where temperature measuring unit 8 is attached, of pipe 6A. In heat radiator 3, the air blown by the air blower (not shown) and the refrigerant exchange heat. The air is warmed, while the refrigerant is cooled and liquefied, by the heat exchange. The liquefied high-pressure refrigerant is depressurized into a low-temperature and low-pressure liquefied refrigerant by expansion mechanism 4 and flows into heat absorber 5. In heat absorber 5, the air blown by the air blower and the refrigerant exchange heat. The air is cooled and dehumidified by the heat exchange. Meanwhile, the refrigerant becomes a vapor refrigerant by heating. Thereafter, the vapor refrigerant returns to compressor 2.

[0020] When the refrigerant discharge temperature of compressor 2 is above the regulated temperature, deterioration of the lubricant in compressor 2 is intensified. When the temperature of the refrigerant discharged from compressor 2 is measured by temperature measuring unit 8 and the refrigerant discharge temperature is above the regulated temperature, control device 9 stops the operation of compressor 2. Accordingly, deterioration of the lubricant is prevented.

[0021] In the heat pump cycle, the discharge temperature of the refrigerant discharged from compressor 2 is higher than the condensation temperature. The refrigerant discharge temperature (for example, 80 to 100°C) is measured by temperature measuring unit 8. Since the refrigerant discharge temperature depends on the oper-

ation of compressor 2, the operation of compressor 2 is controlled such that the refrigerant discharge temperature is within a predetermined range. When the rotation speed of the compression 2 is constantly maintained, the fluctuation range of the refrigerant discharge temperature is about  $\pm 1$  degree. That is, the fluctuation range is small in this case.

**[0022]** Next, the flow of the air that is dehumidified and warmed by the dehumidifying-warming apparatus is described. The air in FIG. 1 is fed to the dehumidifying-warming apparatus from air inlet 12 disposed at housing 1 by the air blower (not shown). Thereafter, the air flows into heat absorber 5 and is cooled. When the temperature of the air in heat absorber 5 becomes equal to or less than the saturation temperature, the water vapor in the air builds up condensation on the surface of heat absorber 5. Accordingly, the air is dehumidified. The dehumidified air, thereafter, is heated into high-temperature and low-humidity air by heat radiator 3 and discharged from air outlet 13. Wind circuit 14 is formed such that the air moves as described above in the dehumidifying-warming apparatus.

**[0023]** The condensed water produced by heat absorber 5 drops to drain pan 10. The condensed water collected in drain pan 10 is discharged to the outside of housing 1 from drain outlet 11. In this process, lint, which is very small particle of cloth, or other very small particles of foreign substances are contained in the air blown by the air blower. The lint drops with the condensed water and accumulates in drain pan 10.

**[0024]** Drain outlet 11 through which the condensed water accumulated in drain pan 10 is discharged may be clogged by the lint. In this case, the condensed water is not discharged from drain outlet 11 and accumulates in drain pan 10. When condensed water is further produced by heat absorber 5, the water level of the condensed water in drain pan 10 rises. When the condensed water exceeds the boundary position where the condensed water overflows drain pan 10, the condensed water overflows drain fan 10. That is, water level abnormality of the condensed water is caused by drain abnormality of drain outlet 11, such that the condensed water consequently overflows from drain pan 10. The boundary position where the water overflows from drain pan 10 is shown as overflow stream line W in Fig. 1. Overflow stream line W is the boundary position where water overflows and may be, for example, indicated by a line or may not be substantially indicated, in drain pan 10.

**[0025]** As described above, in the dehumidifying-warming apparatus according to the first embodiment of the present invention, temperature measuring unit 8 disposed at pipe 6A connecting compressor 2 with heat radiator 3 is positioned under, in the gravitation direction, the boundary position where water overflows from drain pan 10.

**[0026]** Therefore, when the water level of the condensed water in drain pan 10 rises, temperature measuring unit 8 comes in contact with the condensed water.

That is, temperature measuring unit 8 comes in contact with the condensed water before the condensed water exceeds overflow stream line W. In general, the temperature of the refrigerant discharged from compressor 2 is, for example, 80 to 100°C. That is, in general, the measured temperature of temperature measuring unit 8 is 80 to 100°C. Meanwhile, when the water level of the condensed water rises due to drain abnormality and temperature measuring unit 8 comes in contact with the condensed water, temperature measuring unit 8 is cooled. That is, the measured temperature of temperature measuring unit 8 decreases. Accordingly, temperature measuring unit 8 is cooled by the condensed water and it is possible to detect the water level abnormality of the condensed water by measuring a temperature change due to the cooling. That is, it is possible to detect the drain abnormality.

**[0027]** That is, temperature measuring unit 8 has two functions of measuring the discharge temperature of the refrigerant and detecting the drain abnormality of the condensed water, in the heat pump cycle. Since temperature measuring unit 8 has the two functions, it is not required, as in the related art, to dispose a water level sensor in the drain pan 10. Therefore, it is possible to simplify the apparatus and decrease the size.

**[0028]** Next, another example of the dehumidifying-warming apparatus according to the first embodiment of the present invention is described. Control device 9 decreases the rotation speed of the compressor 2 for a predetermined time. There are largely two cases that decrease the rotation speed of the compressor 2 for a predetermined time.

**[0029]** First, the first case that decreases the rotation speed of compressor 2 for a predetermined time is described. FIG. 4 is a time chart showing the operation of the dehumidifying-warming apparatus. As shown in FIG. 4, in another example A1 of the dehumidifying-warming apparatus according to the first embodiment of the present invention, control device 9 decreases the rotation speed of the compressor 2 by a predetermined of time, when the measured temperature of temperature measuring unit 8 becomes equal to or less than a first predetermined temperature.

**[0030]** Hereafter, example A1 is described by using FIG. 4. Compressor 2 is operated with a first predetermined rotation speed r1 (for example, 90 rps), which is set at a relatively high rotation range, after starting operating. Compressor 2 is controlled within a predetermined range by control device 9 such that the refrigerant discharge temperature, that is, the measured temperature of temperature measuring unit 8 becomes t1 (for example, 100°C). When the rotation speed of the compressor 2 is kept constant, the fluctuation of the measured temperature of temperature measuring unit 8 is about  $\pm 1$  degree. That is, the fluctuation range of the temperature is small.

**[0031]** There are largely two reasons that the measured temperature of temperature measuring unit 8 de-

creases. The first reason is a decrease in temperature due to fluctuation of the heat pump cycle caused by a change in the rotation speed of the compressor 2. As the rotation speed of the compressor 2 changes, the heat pump cycle fluctuates and the temperature of the refrigerant decreases. Another reason that the measured temperature of temperature measuring unit 8 decreases is when the condensed water comes in contact with first temperature measuring unit 8 by the drain abnormality.

**[0032]** In the section c of FIG. 4, the refrigerant discharge temperature measured by temperature measuring unit 8 decreases from t1 to t5. However, the decrease is very small, such that it is impossible to determine whether it is a temperature decrease due to fluctuation of the heat pump cycle or a temperature decrease due to the contact of temperature measuring unit 8 with the condensed water accumulated in drain pan 10.

**[0033]** When the refrigerant discharge temperature decreases to a first predetermined temperature t5 (for example, 80°C), in section d, control device 9 decreases the rotation speed of the compressor 2 from a first predetermined rotation speed r1 to a second predetermined rotation speed r2 for a predetermined time. Accordingly, the measured temperature of temperature measuring unit 8 considerably decreases from t5. When temperature measuring unit 8 comes in contact with the condensed water, the measured temperature of temperature measuring unit 8 easily decreases when the circulating volume of the refrigerant is small, that is, a heat-capacity flow rate is small, as compared with when the circulating volume of the refrigerant is normal, that is, the heat-capacity flow rate is large. When the measured temperature of temperature measuring unit 8 falls below a second predetermined temperature t3 (for example, 60°C), it is determined that the temperature is decreased by the contact of temperature measuring unit 8 with the condensed water accumulated in drain pan 10. That is, it is determined that temperature measuring unit 8 is in contact with the condensed water. When the reason that the measured temperature of temperature measuring unit 8 is decreased is the fluctuation of the heat pump cycle caused by the change in the rotation speed of the compressor 2, the measured temperature of temperature measuring unit 8 is temperature corresponding to rotation speed r2. That is, when the measured temperature of temperature measuring unit 8 falls below the temperature corresponding to rotation speed r2 of compressor 2, it is determined that temperature measuring unit 8 comes in contact with the condensed water. It is possible to prevent the condensed water from overflowing drain pan 10 on the basis of the determination.

**[0034]** Another example A2 of the dehumidifying-warming apparatus according to the first embodiment of the present invention is described. In example A2, when the measured temperature of temperature measuring unit 8 is equal to or less than first predetermined temperature t5, control device 9 decreases the rotation speed of compressor 2 for a predetermined time, and when the

measured temperature is equal to or less than second predetermined temperature t3 lower than first predetermined temperature t5, control device 9 stops the rotation of compressor 2.

**[0035]** In FIG. 4, compressor 2 is set at rotation speed r1 and operated such that the measure temperature of temperature measuring unit 8 is maintained at t1. The heat-capacity flow rate due to circulation of the refrigerant is large while compressor 2 operates at first predetermined rotation speed r1. In the section c of FIG. 4, the refrigerant discharge temperature, that is, the measured temperature of temperature measuring unit 8 decreases from predetermined temperature t1 to t5. However, the decrease is very small, such that it is impossible to determine whether it is a temperature decrease due to fluctuation of the heat pump cycle or a temperature decrease due to the contact of temperature measuring unit 8 with the condensed water accumulated in drain pan 10. The rotation speed of the compressor 2 is decreased from first predetermined rotation speed r1 to second predetermined rotation speed r2. Accordingly, the circulating volume of the refrigerant decreases and the heat-capacity flow rate is decreased. When temperature measuring unit 8 comes in contact with the condensed water, the measured temperature of temperature measuring unit 8 easily decreases when the circulating volume of the refrigerant is small, that is, a heat-capacity flow rate is small, as compared with when the circulating volume of the refrigerant is normal, that is, the heat-capacity flow rate is large. Accordingly, since the measured temperature of temperature measuring unit 8 considerably decreases, it is more easily detected that the drain abnormality is generated. Therefore, detection accuracy of the drain abnormality by using temperature measuring unit 8 increases.

**[0036]** In section d of FIG. 4, when the measured temperature of temperature measuring unit 8 is equal to or less than first predetermined temperature t5, control device 9 decreases the rotation speed of the compressor 2 to r2. In this case, the measured temperature of temperature measuring unit 8 is expected to be temperature corresponding to rotation speed r2 of compressor 2. However, when temperature measuring unit 8 comes in contact with the condensed water, the measured temperature of temperature measuring unit 8 further decreases. Accordingly, when the measured temperature of temperature measuring unit 8 falls below second predetermined temperature t3 lower than first predetermined temperature t5, it is determined that temperature measuring unit 8 is in contact with the condensed water accumulated in drain pan 10 and control device 9 stops the operation of compressor 2. Since the operation of compressor 2 is stopped, it is possible to prevent the condensed water from overflowing drain pan 10.

**[0037]** Next, the second case that decreases the rotation speed of the compressor 2 is described. In another example B1 of the dehumidifying-warming apparatus according to the first embodiment of the present invention,

control device 9 operates compressor 2 at first rotation speed r1 and decreases the compressor to second rotation speed r2 lower than first rotation speed r1, after a predetermined time passes. Control device 9 controls the rotation speed of the compressor 2 such that first rotation speed and second rotation speed are alternately repeated.

**[0038]** Example B1 according to the first embodiment of the present invention is different from example A1 in that the rotation speed of compressor 2 is alternately repeated to first rotation speed r1 and second rotation speed r2. Therefore, the condensed water is prevented from overflowing drain pan 10.

**[0039]** FIG. 5 is a time chart showing the operation of the dehumidifying-warming apparatus, which shows changes in the refrigerant discharge temperature, that is, the measured temperature of temperature measuring unit 8 and in the rotation speed of compressor 2. The refrigerant discharge temperature gradually increases after the operation is started.

**[0040]** Control device 9 sets the rotation speed of the compressor 2 to first predetermined rotation speed r1 (for example, 90 rps) after a predetermined time passes from starting of the operation, and operates the compressor for a predetermined time. Accordingly, heat pump device 7 performs dehumidification-dry of the air. After the measured temperature of temperature measuring unit 8 reaches t1 (for example, 100°C) and predetermined time T1 (for example, 20 to 30 minutes) passes, control device 9 decreases the rotation speed of compressor 2 within predetermined time T2 (for example, 20 to 30 seconds). As the rotation speed of compressor 2 decreases, the generation of condensed water is decreased. The condensed water accumulated in drain pan 10 is gradually discharged for predetermined time T2.

**[0041]** Compressor 2 is operated with a first predetermined rotation speed r1 (for example, 90 rps), which is set at a relatively high rotation range. In this process, the refrigerant discharge temperature is set at t1 (for example, 100°C). The refrigerant discharge temperature, that is, the measured temperature of temperature measuring unit 8 fluctuates with the operation of compressor 2 and is controlled within a predetermined range by control device 9. When the rotation speed of compressor 2 is kept constant, the fluctuation of the measured temperature of temperature measuring unit 8 is about  $\pm 1$  degree. That is, the fluctuation range of the temperature is small.

**[0042]** As shown in FIG. 5, control device 9 sets the rotation speed of compressor 2 to first predetermined rotation speed r1 after a predetermined time passes from starting of the operation, and operates the compressor for a predetermined time. Accordingly, heat pump device 7 performs dehumidification-dry of the air. After the measured temperature of temperature measuring unit 8 reaches t1 (for example, 100°C) and predetermined time T1 (for example, 20 to 30 minutes) passes, control device 9 decreases the rotation speed of compressor 2 within predetermined time T2 (for example, 20 to 30 seconds).

The rotation speed of compressor 2 falls below first predetermined rotation speed and the compressor operates at second rotation speed r2 (for example, 45 rps), for predetermined time T2.

**[0043]** When the condensed water is normally discharged, the refrigerant discharge temperature decreases from t1 to t2. In section a, the refrigerant discharge temperature, that is, the measured temperature of temperature measuring unit 8 decreases to t2 that is temperature according to second predetermined rotation speed r2, with the decrease in the rotation speed. In this case, since temperature measuring unit 8 is not in contact with the condensed water, the measured temperature of temperature measuring unit 8 is higher than third predetermined temperature t6 (for example, 60°C). In this case, it is possible to determine that drain abnormality is not generated. Thereafter, compressor 2 operates at the initial first predetermined rotation speed r1 after predetermined time T2 (for example, 20 to 30 seconds). That is, compressor 2 intermittently operates between rotation speed r1 and r2.

**[0044]** As the rotation speed of compressor 2 decreases to second predetermined rotation speed r2 from first predetermined rotation speed r1, the circulating volume of the refrigerant decreases and the heat-capacity flow rate is decreased. When the heat-capacity flow rate is decreased and temperature measuring unit 8 comes in contact with the condensed water, the measured temperature of temperature measuring unit 8 significantly decreases. Therefore, the detection accuracy of drain abnormality by temperature measuring unit 8 is improved.

**[0045]** The heat-capacity flow rate due to circulation of the refrigerant is large while compressor 2 operates at first predetermined rotation speed r1. The measured temperature of temperature measuring unit 8 is decreased from t1 to t4 by the contact with the condensed water, but the heat-capacity flow rate is large, such that the reduction amount is small. The heat-capacity flow rate is decreased by reducing the rotation speed of compressor 2 from r1 to r2. Accordingly, t4 is considerably decreased. That is, as the difference between t1 and t4 increases, drain abnormality is easily detected by temperature measuring unit 8, such that detection accuracy of the sensor is improved.

**[0046]** Predetermined time T1 where compressor 2 operates at first predetermined rotation speed r1 is, for example, tens of minutes (preferably, 20 to 30 minutes). When operation time T1 is shorter than tens of minutes, the refrigerant temperature may not sufficiently increase. That is, the dehumidification-dry of the air by heat pump device 7 may not be sufficiently performed. It is preferable that predetermined time T1 is time before the condensed water accumulated in drain pan 10 overflows. Accordingly, predetermined time T1 is appropriately determined by the size of the drain pan or the production speed of the condensed water.

**[0047]** Predetermined time T2 where compressor 2

operates at second predetermined rotation speed r2 is, for example, tens of seconds (preferably, 20 to 30 seconds). When predetermined time T2 is shorter than tens of seconds, the temperature of the refrigerant may not sufficiently decrease and the detection accuracy may be decreased. When predetermined time T2 is longer than tens of seconds, the temperature of the refrigerant excessively decreases and the air may not be sufficiently warmed. Predetermined time T2 is set to a time where the air can be sufficiently warmed and the dry efficiency is not decreased as much as possible.

**[0048]** Not being limited thereto, predetermined times T1 and T2 are appropriately determined in accordance with the performance or the rotation speed of compressor 2, the size of drain pan 10, and the production speed or drain speed of the condensed water. Predetermined times T1 and T2 are repeated to each other for a plurality of number of times. Accordingly, overflowing of the condensed water is detected even if foreign substances clog during the operation of compressor 2. Compressor 2 operates for predetermined time T1 with the rotation speed set to r1, and then operates for predetermined time T2 with the rotation speed set to r2. When compressor 2 is intermittently operated, rotation speed of r1 and r2 may be the same rotation speed every time, or may be changed to different rotation speed. Further, when compressor 2 is intermittently operated, predetermined times T1 and T2 may be the same rotation speed every time, or may be changed to different times. Accordingly, overflowing of the condensed water is detected even if foreign substances clog during the operation of compressor 2.

**[0049]** Another example B2 of the dehumidifying-warming apparatus according to the first embodiment of the present invention is described by using FIG. 5. In example B2, control device 9 sets compressor 2 with at first rotation speed r1, and operates it. After a predetermined time passes, compressor 2 is decreased to second rotation speed r2 lower than first rotation speed r1, and first rotation speed r1 and second rotation speed r2 are alternately repeated. Further, control device 9 stops the operation of compressor 2 when the measured temperature of temperature measuring unit 8 is equal to or less than third predetermined temperature t6. In section b of FIG. 5, the refrigerant discharge temperature, that is, the measured temperature of temperature measuring unit 8 falls below t6 that is the third predetermined temperature. This is because temperature measuring unit 8 comes in contact with the condensed water accumulated in drain pan 10 and the heat is taken to the condensed water, such that the temperature decreases. In this case, control device 9 determines that there is drain abnormality and stops the operation of compressor 2. Therefore, it is possible to prevent the condensed water from overflowing from drain pan 10.

**[0050]** Example B2 according to the first embodiment of the present invention is different from example A1 in that the rotation speed of compressor 2 is alternately repeated to first rotation speed r1 and second rotation

speed r2 and the operation of compressor 2 is stopped when the measured temperature of temperature measuring unit 8 is equal to or less than third predetermined temperature. That is, the condensed water is prevented from overflowing not by reducing the rotation speed and keeping the operation of compressor 2, but by stopping the operation of compressor 2.

**[0051]** In the first embodiment of the present invention, the temperature where the operation of compressor 2 is stopped is third predetermined temperature t6 (for example, 60°C). The third predetermined temperature is appropriately determined in accordance with the performance or the rotation speed of compressor 2, the size of drain pan 10, and the production speed or the drain speed of the condensed water. Further, the third predetermined temperature may be predetermined temperature that is a value lower than the minimum value of the measured temperature of temperature measuring unit 8 and higher than the refrigerant condensation temperature. Accordingly, it is possible to more rapidly determine drain abnormality.

**[0052]** As described above, temperature measuring unit 8 disposed in pipe 6A connecting compressor 2 with heat radiator 3 is disposed in drain pan 10. Further, control device 9 decreases the rotation speed of compressor 2 after a predetermined time passes. Therefore, it is possible to increase the detection accuracy of drain abnormality, using temperature measuring unit 8. Further, it is possible to increase the detection accuracy by changing the rotation speed of compressor 2 within a predetermined gap. Further, it is possible to decrease the operation that decreases the rotation speed of compressor 2 and stabilize the operation of compressor 2.

## EXEMPLAY EMBODIMENT 2

**[0053]** FIG. 6 is a cross-sectional view showing the main parts of a clothes drier equipped with a dehumidifying-warming apparatus, according to a second embodiment of the present invention. The configuration of the dehumidifying-warming apparatus is the same as that of the first embodiment, the same reference numerals are given, and the detailed description uses that of the first embodiment.

**[0054]** A clothes drier according to the embodiment is described by using a washing-drying machine further provided with a washing function. The washing-drying machine shown in FIG. 6, performs a drying step, after washing, rinsing, and dewatering. Water tank 22 storing wash water is elastically supported in housing 21 of washing-drying machine. Drum 23 is rotatably disposed in water tank 22. Drum 23 functions as washing tub, dewater tub, and drying tub. Opening (not shown) through which laundry, such as clothes, is put into drum 23 is disposed at the front side of drum 23. Door 25 is disposed opposite to opening of drum 23, at housing 21. The rotary shaft of drum 23 is inclined upward toward the front portion, as shown by a dashed line of FIG. 6.

**[0055]** Drum 23 is driven forward/backward by motor 26 mounted at the rear side of water tank 22. A predetermined amount of wash water that is set in accordance with the amount of put laundry is supplied into drum 23. Thereafter, drum 23 stirs the laundry in drum 23 and rotates for a predetermined time at a speed where beat-washing that drops the laundry in drum 23 is performed. In dewatering, drum 23 rotates at a speed where the laundry sticks to the inner circumferential surface of drum 23 by the centrifugal force. The wash water separated from the laundry is discharged to the outside of housing 21 from water tank 22.

**[0056]** Drum 23 performs an operation of unraveling the laundry sticking to the inner circumferential surface of drum 23 in dewatering before drying. Thereafter, drum 23 rotates and stirs the laundry in drum 23. In this process, the air that is dehumidified and warmed for drying by the dehumidifying-warming apparatus is injected into drum 23. In detail, air blower 29 sends the high-temperature air for drying that is discharged from air outlet 13 of the dehumidifying-warming apparatus into water tank 22 from induction inlet 27 disposed at the upper portion of the rear side of water tank 22.

**[0057]** A number of through-holes (not shown) are formed through the inner circumferential surface of drum 23. The air for drying injected into water tank 22 flows into drum 23 from the through-holes. The air for drying takes the water from the laundry and becomes humid by coming in contact with the laundry stirred in drum 23. Accordingly, the laundry is dried. The humidity air flows into water tank 22 from the through-holes and flows to wind circuit 14 of the dehumidifying-warming apparatus through air inlet 12 from induction outlet 28 disposed at the upper portion of the front side of water tank 22.

**[0058]** Thereafter, the humidity air is cooled and dehumidified again by heat absorber 5, heated into high-temperature and low-humidity air for drying in heat radiator 3, and inducted to induction inlet 27 from air outlet 13. Accordingly, the air for drying that is dehumidified and warmed by the dehumidifying-warming apparatus flows into drum 23 from induction inlet 27. Thereafter, the air for drying circulates circulation air path 30 returning to the dehumidifying-warming apparatus from induction outlet 28 and dries the laundry in drum 23. The arrow C of FIG. 6 shows circulation of the air.

### EXEMPLAY EMBODIMENT 3

**[0059]** In a clothes drier according to a third embodiment of the present invention, control device 9 includes a fast dry mode. In the fast dry mode, control device 9 decreases the rotation speed of compressor 2 for a predetermined time and stops the operation of compressor 2 when the measured temperature of temperature measuring unit 8 decreases to a fourth predetermined temperature. The other configuration is the same as that of the first embodiment, the same reference numerals are given to the same components, and the detailed description

uses that of the first embodiment.

**[0060]** The fast dry mode is an operation mode that finishes drying for a shorter time than normal drying. In the fast dry mode, compressor 2 operates with a high rotation speed (for example, 100 rps). In the fast dry mode, when R134a is used as a refrigerant, the condensation temperature of the refrigerant in heat radiator 3 reaches 70°C. This is higher than the condensation temperature in a normal dry mode.

**[0061]** Meanwhile, in this case, the evaporation temperature of the refrigerant in heat absorber 5 is 15°C. This is lower than the evaporation temperature in a normal dry mode. Since the evaporation temperature is low, the surface temperature of the fins disposed at heat absorber 5 is also low. Accordingly, the amount of condensed water in heat absorber 5 increases. Therefore, in the fast dry mode, control device 9 more frequently decreases the rotation speed of compressor 2 (for example, about 1 time per 10 minutes) than the normal dry mode. Further, the frequency of reducing the rotation of compressor 2 is not limited thereto, but is appropriately determined in accordance with the performance or the rotation speed of the compressor, the size of the drain pan, and the production speed or drain speed of the condensed water. Further, the fourth predetermined temperature may be the same temperature as the first predetermined temperature and is appropriately determined in accordance with the performance or the rotation speed of the compressor, the size of the drain pan, and the production speed or the drain speed of the condensed water.

**[0062]** Since compressor 2 rotates at a high speed in the fast dry mode by the configuration, the heat-capacity flow rate of the refrigerant increases. Therefore, the temperature drop when temperature measuring unit 8 comes in contact with the condensed water decreases. In the embodiment, it is possible to accurately detect drain abnormality by reducing the rotation speed of compressor 2 for a predetermined time. Accordingly, when the measured temperature of temperature measuring unit 8 decreases to a predetermined temperature, it is determined that drain abnormality is generated. It is possible to prevent the condensed water from overflowing by stopping compressor 2.

**[0063]** Next, another example of the third embodiment of the present invention is described. In the fast dry mode, when the measured temperature of temperature measuring unit 8 decreases to a fourth predetermined temperature, control device 9 decreases the rotation speed of compressor 2 for a predetermined time. Therefore, the heat-capacity flow rate of the refrigerant decreases, and when temperature measuring unit 8 and the condensed water are in contact with each other, the measured temperature of temperature measuring unit 8 decreases again. Accordingly, the accuracy in detection of water level abnormality in drain pan 10 is improved. Further, while the rotation speed of compressor 2 is decreased for a predetermined time, when the measured tempera-

ture of temperature measuring unit 8 falls below a fifth predetermined temperature lower than the fourth predetermined temperature by the decrease in the rotation speed of compressor 2, control device 9 stops the operation of compressor 2.

**[0064]** When temperature measuring unit 8 comes in contact with the condensed water, the measured temperature of temperature measuring unit 8 easily decreases when the circulating volume of the refrigerant decreases, that is, a heat-capacity flow rate is small, as compared with when the circulating volume of the refrigerant is normal, that is, the heat-capacity flow rate is large. Accordingly, when temperature measuring unit 8 comes in contact with the condensed water, the measured temperature of temperature measuring unit 8 considerably decreases, such that it becomes easier to detect that drain abnormality is generated. Therefore, detection accuracy of the drain abnormality by temperature measuring unit 8 increases.

**[0065]** Further, it is possible to stabilize the operation of compressor 2 by reducing the operation that decreases the rotation speed of compressor 2. It is possible to efficiently perform the drying operation by making the rotation of compressor 2 stable.

**[0066]** Further, in the third embodiment of the present invention, a washing-drying machine having a washing function was described. However, a clothes drier that only dries clothes without the washing function can be implemented in the same way.

## Claims

### 1. A dehumidifying-warming apparatus comprising:

a heat pump device including a compressor, a heat radiator, an expansion mechanism, and a heat absorber; a temperature measuring unit disposed in a pipe connecting the compressor with the heat radiator; and a drain pan for receiving condensed water produced by heat exchange while the heat absorber exchanges heat with air, wherein the temperature measuring unit is positioned under a boundary position where the condensed water overflows from the drain pan.

2. The dehumidifying-warming apparatus of claim 1, wherein a control device for controlling operation of the compressor decreases a rotation speed of the compressor for a predetermined time, when the temperature of the temperature measuring unit is equal to or less than a first predetermined temperature.

3. The dehumidifying-warming apparatus of claim 2, wherein the control device decreases the rotation speed of the compressor for the predetermined time

when the temperature of the temperature measuring unit is equal to or less than the first predetermined temperature, and stops the operation of the compressor when the temperature is equal to or less than a second predetermined temperature lower than the first predetermined temperature.

4. The dehumidifying-warming apparatus of claim 1, wherein a control device for controlling the operation of the compressor decreases a rotation speed for a predetermined time, after another predetermined time has elapsed from the start of operating the compressor.

5. The dehumidifying-warming apparatus of claim 4, wherein the control device operates the compressor at a first rotation speed, decreases the compressor to a second rotation speed lower than the first rotation speed after the other predetermined time has elapsed, and alternately repeats the first rotation speed and the second rotation speed.

6. The dehumidifying-warming apparatus of claim 4, wherein the control device operates the compressor at the first rotation speed, decreases the compressor to the second rotation speed lower than the first rotation speed after the other predetermined time has elapsed, alternately repeats the first rotation speed and the second rotation speed, and stops the operation of the compressor when the temperature of the temperature determining unit is equal to or less than a third predetermined temperature.

7. A clothes drier including the dehumidifying-warming apparatus of any one of claims 1 to 6.

8. The clothes drier of claim 7, wherein a control device for controlling operation of the compressor has a fast dry mode, and the control device decreases a rotation speed of the compressor for a predetermined time when the fast dry mode is set, and stops the operation of the compressor when the temperature of the temperature measuring unit is equal to or less than a fourth predetermined temperature.

9. The clothes drier of claim 7, wherein a control device for controlling operation of the compressor has a fast dry mode, and the control device decreases a rotation speed of the compressor when the fast dry mode is set and the temperature of the temperature measuring unit is equal to or less than the fourth predetermined temperature, and stops the operation of the compressor when the temperature is equal to or less than a fifth predetermined temperature lower than the fourth predetermined temperature.

FIG. 1

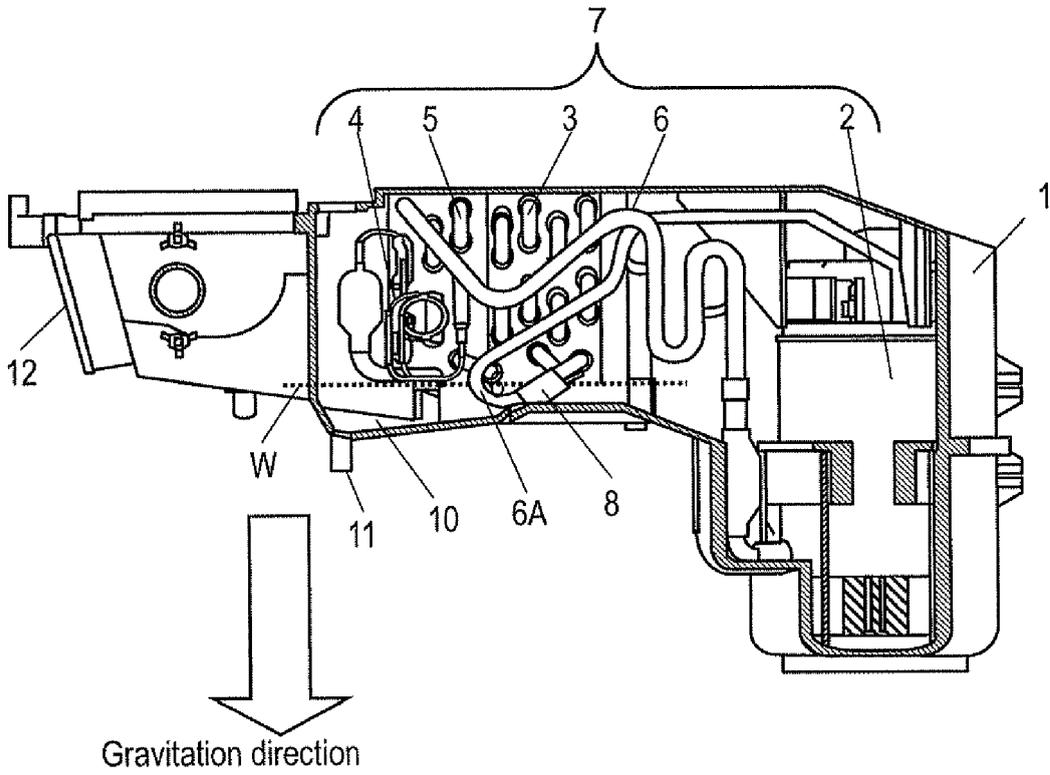


FIG. 2

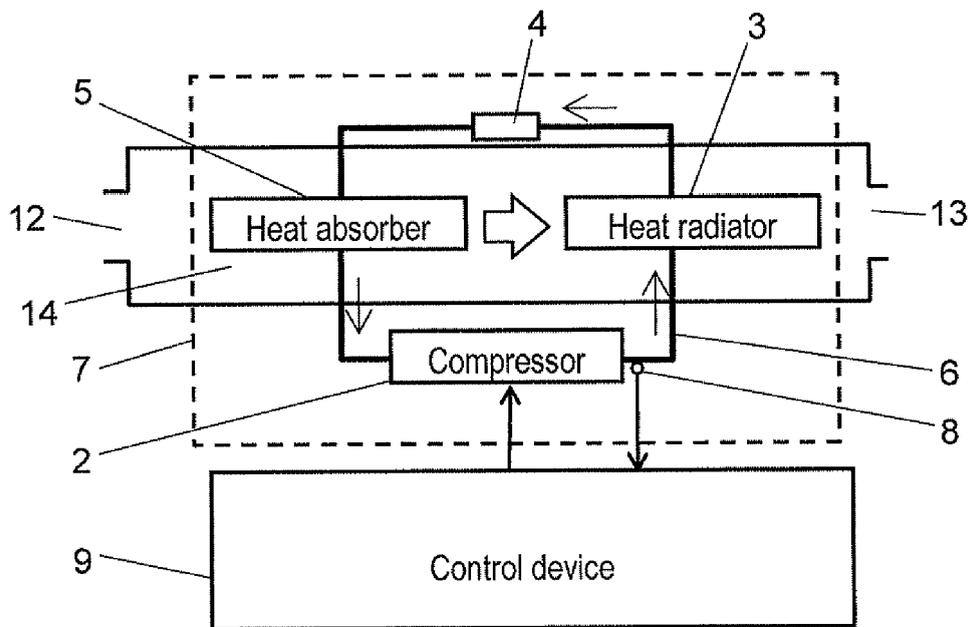


FIG. 3

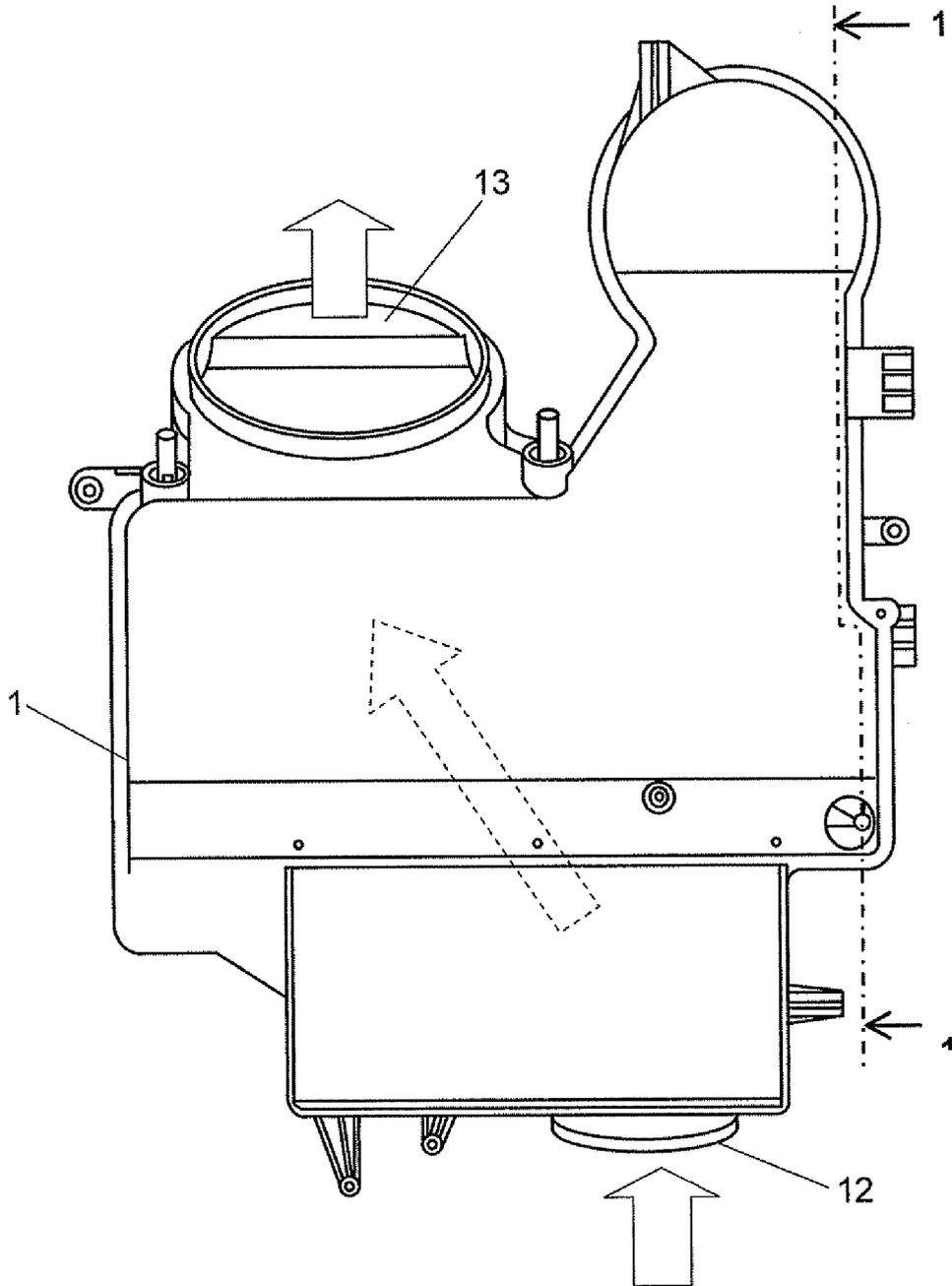


FIG. 4

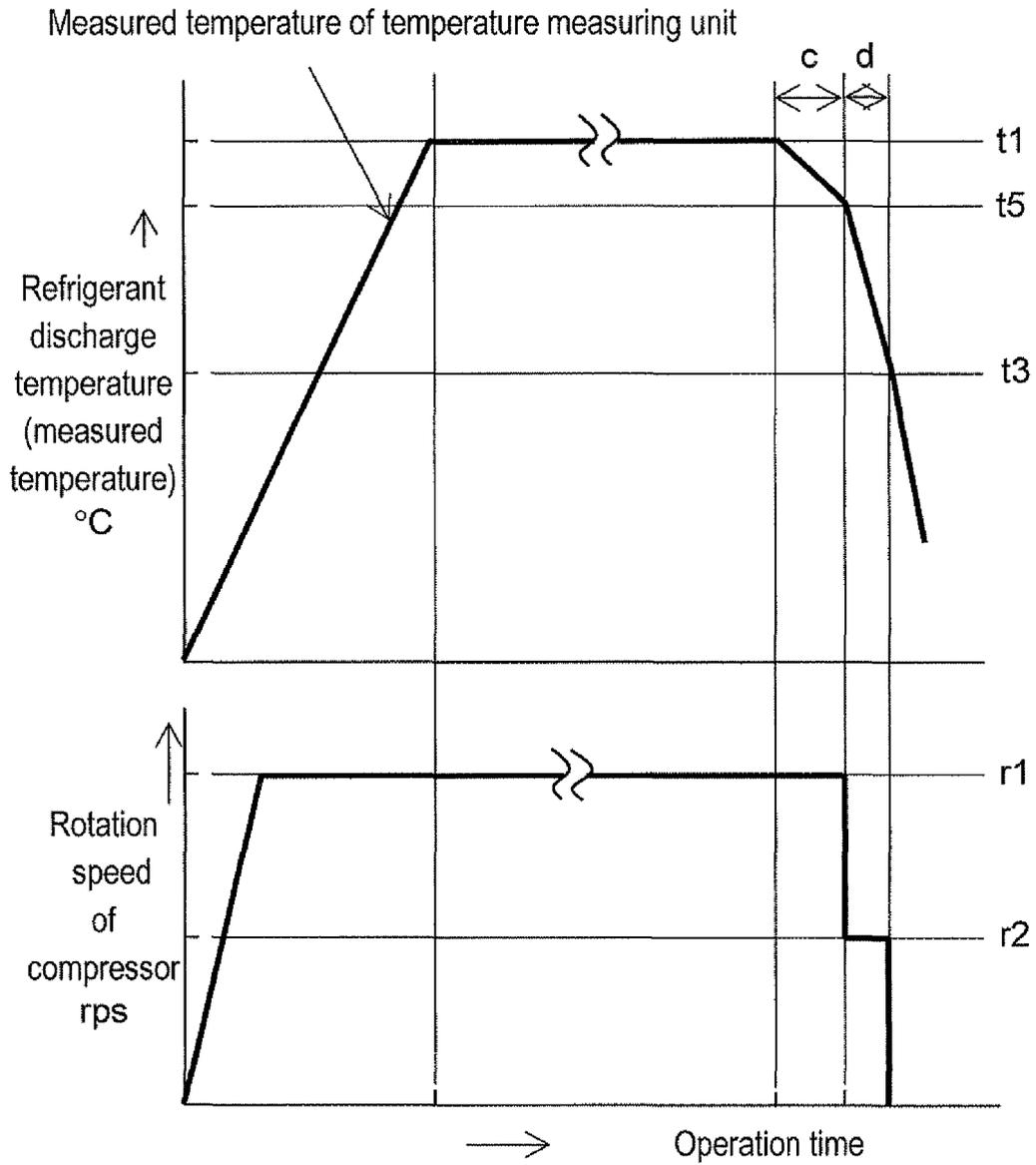


FIG. 5

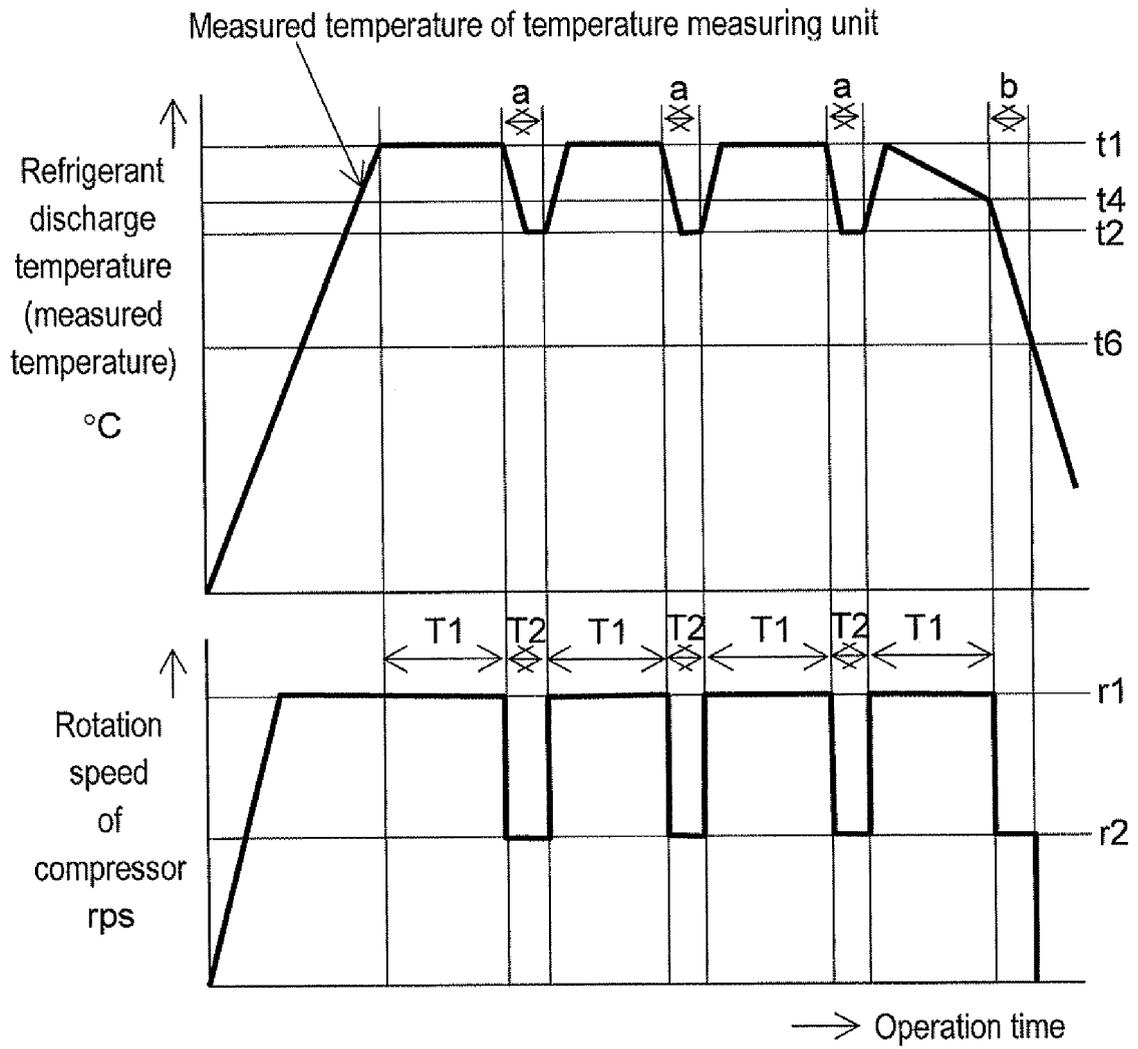


FIG. 6

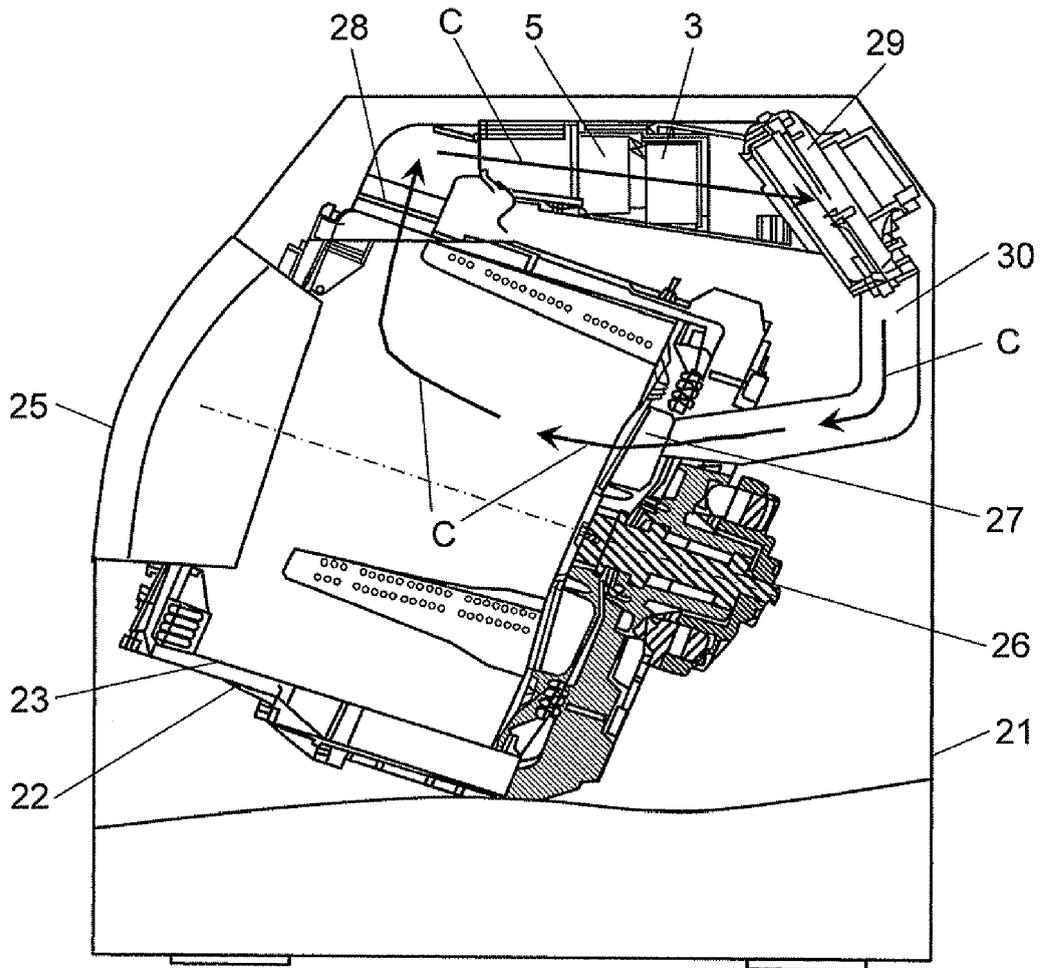


FIG. 7

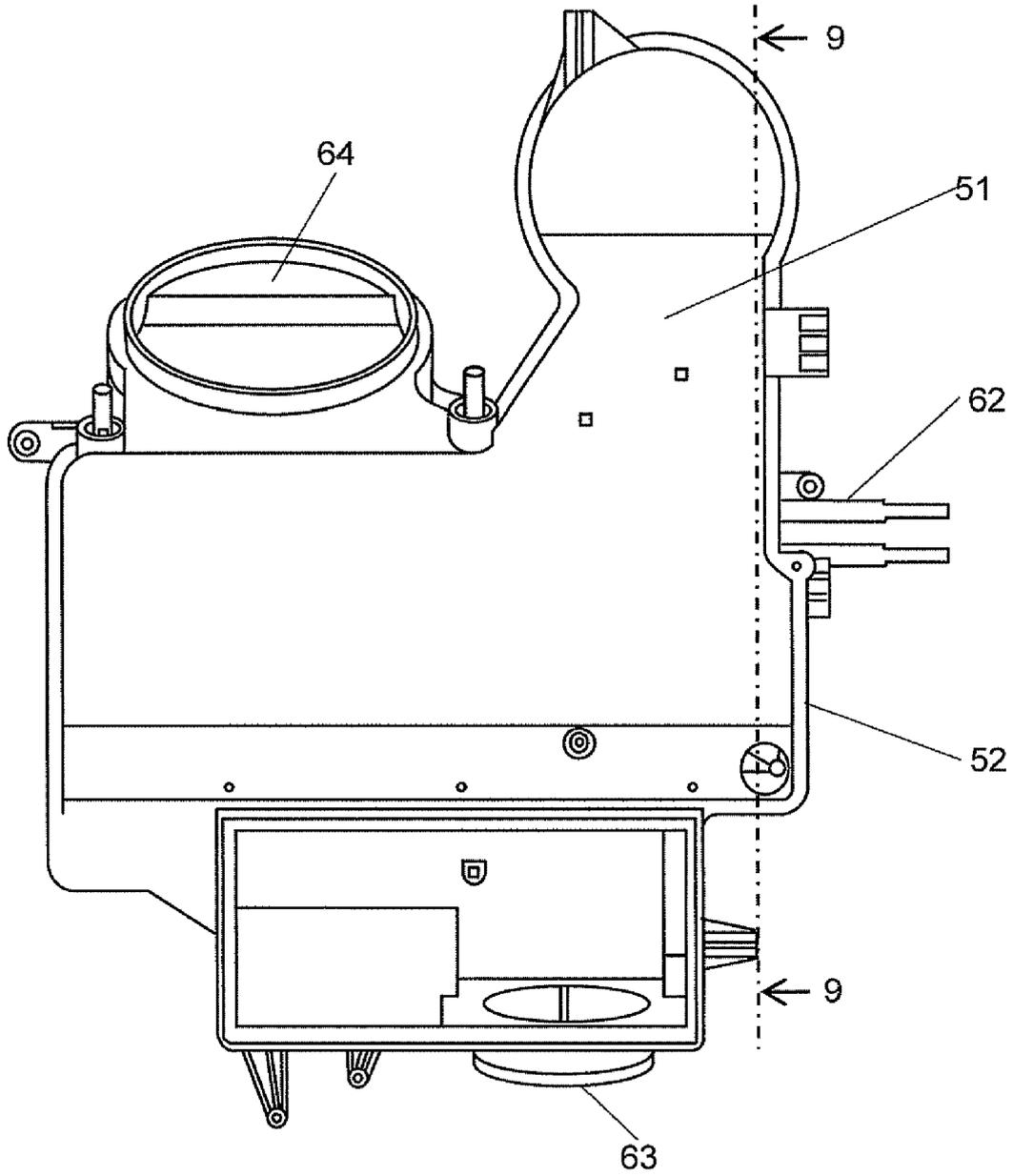


FIG. 8

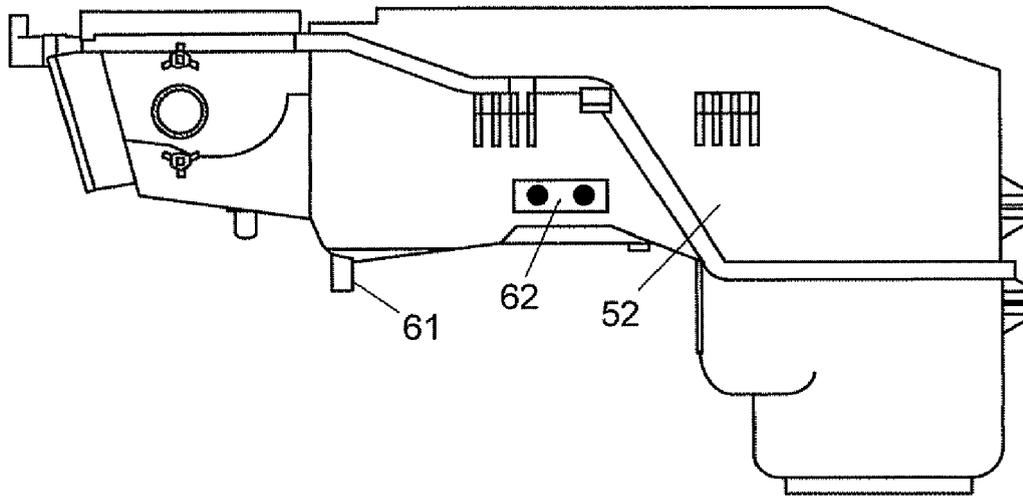
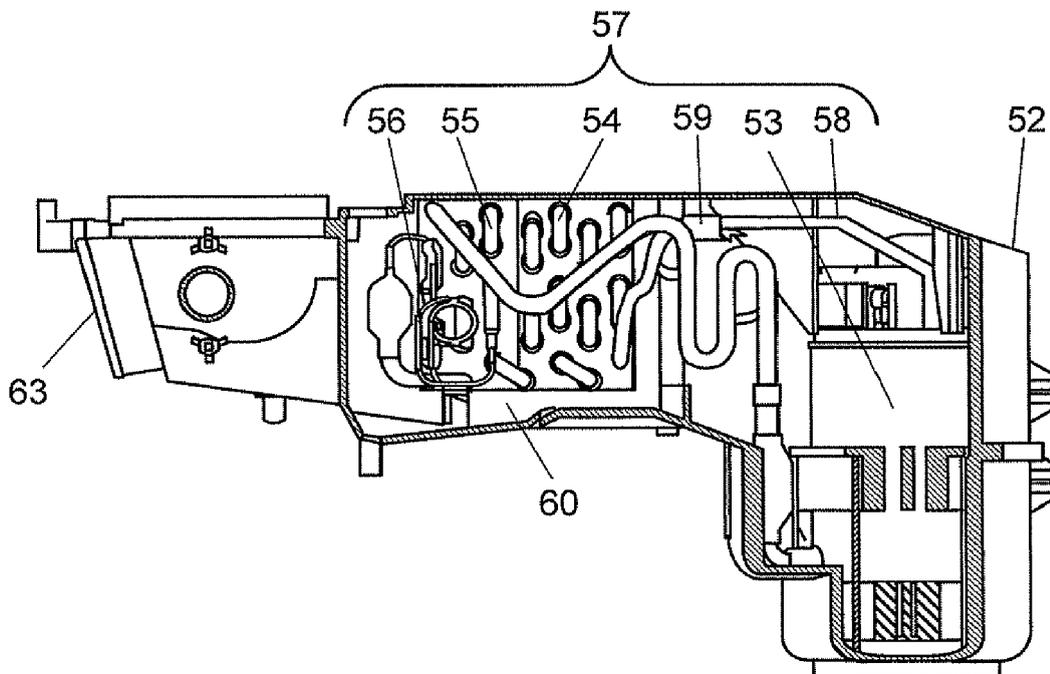


FIG. 9



**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

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