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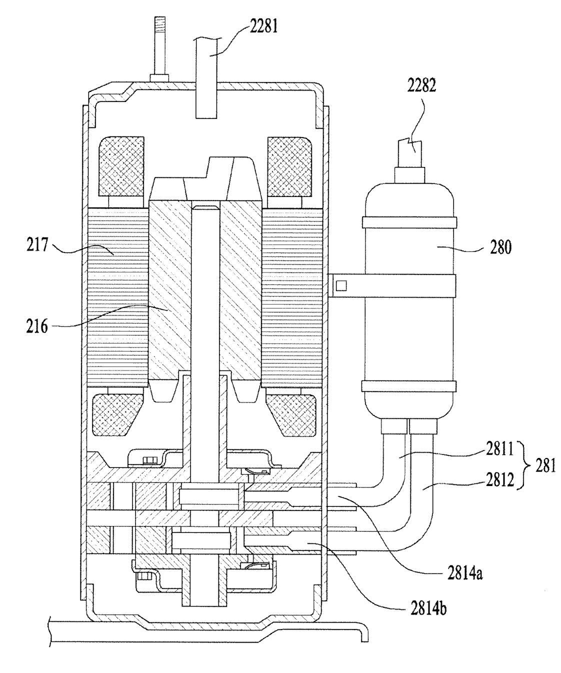
(54) COMPRESSOR FOR A LAUNDRY TREATMENT APPARATUS HAVING A HEAT PUMP AND CORRESPONDING LAUNDRY TREATMENT APPARATUS

(57) A compressor (200) comprising cylinders (2211, 2212), respective eccentric rollers (2231, 2232) and vanes (2241, 2242), the one end of each vane (2241, 2242) radially movable within the corresponding cylinder (2211, 2212), their other end being in contact and reciprocating with the corresponding eccentric roller (2231, 2232), said compressor (200) using a flammable refrigerant, such as R-290, a heat pump (140) using the compressor (200), and a laundry treatment apparatus using the heat pump (140) are disclosed. As the flammable refrigerant is used in accordance with environment regulation, a re-design of the compressor (200), an evaporator (142), a condenser (143) and an expander (145), which constitute the heat pump (140), is required for optimization of the heat pump (140). A laundry treatment apparatus that reflects the re-design is provided.

【FIG. 12】

200



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Description

[0001] The present invention relates to a laundry treatment apparatus using a flammable refrigerant.

[0002] A general laundry treatment apparatus uses a heater or a heat pump to dry laundry. In particular, a laundry treatment apparatus that uses a heat pump dehumidifies and cools the humid air by using an evaporator and a condenser and then heats the air, thereby supplying the dried air of a high temperature to laundry. This laundry treatment apparatus may generate heat of a high temperature through a smaller amount of work than that of a laundry treatment apparatus that uses a heater, and thus has excellent energy efficiency. In this respect, the laundry treatment apparatus that uses a heat pump has been commonly used a lot.

[0003] In order to implement a cooling cycle of such a heat pump, a refrigerant is necessarily required. The refrigerant is a working fluid that is likely to evaporate in a cooling cycle, and serves to take away heat of a low temperature portion and carry the heat to a high temperature portion.

[0004] The refrigerant may be categorized into a natural refrigerant, first generation CFC (Chlorofluorocarbon), second generation HCFC (Hydro Chlorofluorocarbon), third generation HFC(Hydrofluorocarbon), and fourth generation HFO(Hydrofluoroolefin). Among them, CFC and HCFC based refrigerants know as Freon gases have been known as primary materials of ozone depletion, and thus have been regulated by the Montreal Protocol on Substances that Deplete the Ozone Layer.

[0005] The HFC based refrigerant does not deplete the ozone layer but corresponds to a global warming substance. A main example of the HFC based refrigerant includes R-134a used for cars and home electronic appliances. This refrigerant has been categorized as one of six global warming materials by Kyoto Protocol but has been able to be used due to no compulsion. However, as the HFC based refrigerant has been defined as an ozone depletion regulated substance by Montreal Protocol in 1987, the HFC based refrigerant will be prohibited from being used before 2020 in advanced countries and 2030 in developing countries. Also, as the HFC based refrigerant had been included in European F-gas regulation of 2006, the HFO based refrigerant having a low global warming potential (GWP) has emerged as a next generation refrigerant.

[0006] The GWP indicates a level of a greenhouse gas contributing to global warming based on effects of carbon dioxide (CO2) on global warming. That is, the GWP means a value obtained by dividing solar energy absorption of an individual greenhouse gas of 1kg by solar energy absorption of carbon dioxide of 1kg. The GWP is obtained by indexing global warming effects per unit mass. For example, if carbon dioxide is 1, then methane is 21, nitrous oxide is 310, hydrofluorocarbons (HFCs) is 1300, and SF6 is 23900.

[0007] Particularly, in case of EU, if the GWP exceeds 150, sales of closed refrigeration systems for commercial use in EU will be prohibited from 2020, and market sales of centralized refrigeration systems for commercial use, which have GWP exceeding 150 and 40kW, will be prohibited from 2022.

[0008] In order to cope with this, a heat pump using R-290 and a laundry treatment apparatus using the heat pump have been developed. As prior arts, there are European Patent Publication No. EP2871432A1 and EP2985466A1, which relate to a rotary compressor used for a small home appliance and a heat pump. In the prior arts, a roller of a rotary compressor has a height-to-radius ratio of 1.2 to 1.4. In addition, the prior arts disclose that a polyester-based synthetic oil called POE is used as a refrigerant oil in accordance with a change in the number of fins of evaporators and condensers based on R-290 and use of R-290 refrigerant.

[0009] However, the prior arts relate to a rotary compressor using a vane and a heat pump using the same, and relate to use of a single cylinder in which a height-to-radius ratio of a roller in the rotary compressor is 1.2 to 1.4. That is, a refrigerant is compressed using one roller, one vane and one cylinder. As described above, since the height-to-radius ratio of the roller is 1 or more, friction loss with the cylinder is increased, and the amount of a refrigerant leaking between the roller and the cylinder is also increased. Also, since eccentric mass is one, vibration become great. As one cylinder is used, axial load applied to an eccentric roller or an eccentric portion is increased and moment of inertia is great, whereby more bending moment and shearing force are applied to a driving shaft.

[0010] Also, the refrigerant oil used in the prior arts is a POE based synthetic oil. The POE based synthetic oil has a high washing effect and thus washes and emulsifies all kinds of lubricant oils and oxidizing agents generated during coating for rust-proofing and welding to flow the lubricant oils and the oxidizing agents along a cooling cycle, thereby causing malfunction. Also, a problem occurs in that the POE based synthetic oil absorbs water well when it is exposed to water.

[0011] Accordingly, the present invention is directed to a laundry treatment apparatus that substantially obviates one or more problems due to limitation and disadvantages of the related art. A first object of the present invention is to provide a rotary compressor having the same cooling performance as that of the existing R-134a while using R-290 refrigerant. A second object of the present invention is to provide a twin compressor of which roller has a height-to-radius ratio less than 1. A third object of the present invention is to reduce friction loss between a roller and a cylinder and leakage loss of a refrigerant leaking out through gaps of a vane and the roller during compression. A fourth object of the present invention is to reduce vibration and noise by using a twin compressor having symmetric eccentric portions. A fifth object of the present invention is to reduce axial load and moment of inertia applied to a driving shaft. A sixth object of the present invention is to develop an evaporator, a condenser and a capillary tube to have cooling performance equal to or more excellent than the existing R-134a in accordance with compression of R-290 refrigerant. A seventh object of the present invention is to develop a laundry treatment apparatus using oil suitable for cooling performance.

[0012] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0013] If a flammable refrigerant is used, a design of a heat pump should be varied for the same performance as that of the existing R-134a.

First, a change in a design of a compressor is required. When a flammable refrigerant R-290 which is intended to be newly used and the existing refrigerant R-134a are compared with each other, in an evaluation condition of ASHRAE 37(The American Society of Heating, Refrigerating and Air-Conditioning Engineers), R-134a is 1355 kPa and R-290 is 1666 kPa greater than R-134a in a difference between condensed pressure-evaporated pressure, and R-134a is 0.000845 m^3/kg and R-290 is 0.00208 m^3/kg greater than R-134a in specific volume of a refrigerant. Also, for the same cooling capacity, R-290 may reduce displacement or stroke volume as much as 25%. Considering this, the displacement or stroke volume of the compressor may be reduced. Also, it is preferable that the height-to-radius ratio of the eccentric roller used for the compressor is less than 1 to reduce noise, vibration and friction loss and leakage loss in the compressor. To this end, a twin compressor is used.

Second, a change in a size of an evaporation pipe is required. In a state that a volumetric flow is reduced, when a diameter and a length of an evaporation pipe, which are the same as those of the existing pipe, are used, a supersaturated state occurs at an outlet of the evaporator, whereby a negative effect is given to the compressor. Therefore, the length or the diameter of the evaporation pipe should be reduced. If the diameter of the evaporation pipe is reduced, a speed of the refrigerant becomes fast.

Third, a length or a diameter of a condensing pipe should be reduced to prevent the condenser from being supercooled at an outlet.

Fourth, since refrigerant oil for suitable for a change of the refrigerant should be used due to a change of the refrigerant, POE based synthetic oil which is used should be changed to 5GSD type mineral oil due to polarity of R-134a.

Fifth, in order to reduce copper loss and enlarge a slot active surface of a compressor motor used for a compressor, a two-stage stator core having a step difference is used at an upper end of the compressor.

[0014] In detail, there is provided a compressor comprising a case, a first cylinder of a circular shape, arranged inside the case, providing a first chamber, a second cylinder of a circular shape, arranged inside the case, providing a second chamber, a partition arranged between the first cylinder and the second cylinder, partitioning the first chamber from the second chamber, a driving shaft including a first eccentric roller arranged in the first chamber to rotatably adjoin an inner circumferential surface of the first cylinder and a second eccentric roller arranged in the second chamber to rotatably adjoin an inner circumferential surface of the second cylinder, and passing through the first cylinder, the second cylinder and the partition, a first vane having one end fixed to the first cylinder and the other end which is in contact with the first eccentric roller, provided to reciprocate when the first eccentric roller is rotated, a second vane having one end fixed to the second cylinder and the other end which is in contact with the second eccentric roller, provided to reciprocate when the second eccentric roller is rotated, a first inlet port for flowing a refrigerant to the first chamber by passing through the first cylinder, a second inlet port for flowing a refrigerant to the second chamber by passing through the second cylinder, and a discharge portion including a first discharge port discharging the refrigerant of the first chamber and a second discharge port discharging the refrigerant of the second chamber, wherein each of the first eccentric roller and the second eccentric roller has a height-to-radius ratio of 0.75 or more and 0.8 or less.

[0015] In more detail, a displacement or stroke volume of the compressor is 8cc/rev or more and 10cc/rev or less. An effective area of each of the first discharge port and the second discharge port is 25 mm^2 or more and 26 mm^2 or less. A radius of the driving shaft ranges from 5.5 mm to 7.5 mm. A length of each of the first discharge port and the second discharge port is 1.5 mm or more and 2.5 mm or less.

[0016] Also, eccentricities of the first eccentric roller and the second eccentric roller may be arranged to be opposite to each other based on the driving shaft, and the first discharge port and the second discharge port alternately discharge the compressed refrigerant during one time rotation of the driving shaft.

[0017] Also, the compressor may use R-290 as the refrigerant, and may use 5GSD type as oil.

[0018] The compressor further includes a power generator rotating the driving shaft, wherein the power generator includes a compressor motor generating a rotational force by an electromagnetic force, and the compressor motor includes a rotor coupled with the driving shaft and a stator wound in a coil.

[0019] Also, the compressor further includes an oil path for supplying oil to lubricate the driving shaft, the power generator, the first vane, the second vane, the first eccentric roller, the second eccentric roller, the first bearing part, and the second bearing part.

[0020] Also, the compressor further comprises a first bearing part coupled to one surface of the first cylinder arranged to be away from the partition, rotatably supporting the driving shaft, and a second bearing part coupled to one surface of the second cylinder arranged to be away from the partition, rotatably supporting the driving shaft, wherein the first discharge port discharges the refrigerant of the first chamber by passing through the first bearing part, the second discharge port discharges the refrigerant of the second chamber by passing through the second bearing part, the discharge portion further includes a first discharge valve arranged in the first bearing part, discharging the refrigerant only if a pressure of the refrigerant discharged through the first discharge port is a preset pressure or more, and a second discharge valve arranged in the second bearing part, discharging the refrigerant only if a pressure of the refrigerant discharged through the second discharge port is a preset pressure or more.

[0021] If a heat pump is configured using the compressor, the evaporator included in the heat pump includes a plurality of evaporation fins for heat exchange, and an evaporation pipe reciprocating multiple times by passing through the plurality of evaporation fins, wherein the evaporation fins may be hydrophilic-coated to prevent water condensed in the air from being attached to the evaporation fins.

[0022] Also, the condenser included in the heat pump includes a plurality of condensing fins for heat exchange, and a condensing pipe reciprocating multiple times by passing through the plurality of condensing fins, wherein the condensing pipe may be designed to have a diameter smaller than that of the evaporation pipe.

[0023] Also, the refrigerant pipe included in the heat pump includes a suction pipe connecting the evaporator with the compressor, a discharge pipe connecting the compressor with the condenser, and an expander connecting the evaporator with the compressor, and the expander includes a capillary tube for dropping a pressure of the refrigerant, wherein the capillary tube may have a length of 1250mm or more and 1350 or less.

[0024] Also, a laundry treatment apparatus having a drying function based on the heat pump is provided.

[0025] According to the present disclosure, first, a compressor optimized for use of R-290 refrigerant is provided, whereby friction loss between the roller and the cylinder and flow rate loss may be reduced.

Second, the diameter of the evaporation pipe may be changed and a heat-transfer area may be changed, whereby heat transfer efficiency may be enhanced and a supersaturated state at an outlet may be avoided.

Third, the diameter of the condensing pipe may be changed and the heat-transfer area may be changed, whereby heat transfer efficiency may be enhanced and a supercooled state at an outlet may be avoided.

Fourth, a 5GSD-based mineral oil may be used as oil, whereby it is less susceptible to water and the cost may be more saved than a synthetic oil.

Fifth, efficiency of the compressor motor may be enhanced using a two-stage stator core.

Sixth, durability of the product may be enhanced by a design of the heat pump.

[0026] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

[0027] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

FIG. 1 illustrates a laundry treatment apparatus according to one embodiment of the present disclosure;

FIG. 2 illustrates a front supporter, a filter and a front duct;

FIG. 3 illustrates a rear supporter and a rear duct;

FIG. 4 illustrates a coupling relation and arrangement between mechanical components of a base portion according to one embodiment;

FIG. 5 is a schematic view illustrating an air circulating flow of a laundry treatment apparatus according to the present invention;

FIG. 6 illustrates a coupling relation and arrangement between mechanical components of a base portion according to another embodiment;

FIG. 7 illustrates an evaporator, a condenser, a compressor and a refrigerant pipe;

FIG. 8 illustrates a compressor according to one embodiment of the present disclosure;

FIG. 9 is an enlarged view of FIG. 8;

FIG. 10 illustrates one section of a compressor cylinder;

FIG. 11(a) illustrates a stator of an existing compressor motor, FIG. 11(b) illustrates a stator of a compressor motor provided in a laundry treatment apparatus according to the present disclosure, and FIG. 11(c) illustrates a stator core of a compressor motor provided in a laundry treatment apparatus according to the present disclosure;

FIG. 12 illustrates a section of another embodiment of a compressor used in a laundry treatment apparatus according to the present disclosure;

FIG. 13 illustrates a section of other embodiment of a compressor used in a laundry treatment apparatus according to the present disclosure;

FIG. 14 illustrates one embodiment of a condenser used in a laundry treatment apparatus according to the present disclosure;

FIG. 15 illustrates one embodiment of an evaporator used in a laundry treatment apparatus according to the present disclosure; and

FIG. 16(a) illustrates a connection of a refrigerant pipe and an expander, FIG. 16(b) illustrates one embodiment of the expander, FIG. 16(c) illustrates one embodiment of a discharge pipe, and FIG. 16(d) illustrates one embodiment of a suction pipe.

[0028] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Meanwhile, elements or control method of apparatuses which will be described below are only intended to describe the embodiments of the present invention and are not intended to restrict the scope of the present invention. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0029] Specific terms used in this specification are provided for convenience of description and are not limited to exemplary embodiments. For example, the expressions "in a direction", "along a direction", "parallel", "orthogonal", "center", "concentric" or "coaxial" indicating relative or absolute arrangement strictly indicate a relative displacement state having an angle or distance equivalent to a level of obtaining same functions or allowance as well as such arrangement.

[0030] For example, the expressions "same", "being the same as" and "equivalent" indicating that objects are the same state strictly indicate a state that allowance or a difference in a level of obtaining same functions exists, as well as the same state.

[0031] For example, the expressions indicating a shape, such as a rectangular shape or a cylindrical shape, may not only indicate a shape such as a rectangular shape or a cylindrical shape in a geometrically strict sense but also indicate a shape including a rugged portion or a chamfering portion in a range that the same effect is obtained.

[0032] Meanwhile, it is to be understood that the expressions "prepare an element", "provided with an element", "comprise an element", "include an element" or "has an element" are not intended to exclude the presence of another element.

[0033] Also, in this specification, the same or similar reference numerals will be given to the same or similar elements even in case of different embodiments, and their repeated description will be omitted.

[0034] Even in case of different embodiments, a structure applied to any one embodiment may equally be applied to another one embodiment unless functionally contradictory.

[0035] It is to be understood that the singular expression used in this specification includes the plural expression unless defined differently on the context.

[0036] In description of the embodiments disclosed in this specification, if detailed description of the disclosure known in respect of the present disclosure is determined to make the subject matter of the embodiments disclosed in this specification obscure, the detailed description will be omitted.

[0037] The accompanying drawings are only intended to facilitate understanding of the embodiments disclosed in this specification, and it is to be understood that technical spirits disclosed in this specification are not limited by the accompanying drawings and the accompanying drawings include all modifications, equivalents or replacements included in technical spirits and technical scope of the present disclosure.

[0038] The present disclosure relates to a laundry treatment apparatus using a flammable refrigerant, such as R-290.

[0039] As described above, a fourth generation HFO refrigerant has advantages in that it is (i) nontoxic and stable, (ii) indicates a suitable solubility for a mineral oil which is a refrigerant oil, and (iii) has no risk of destroying the ozone layer and has a very low GWP. On the other hand, the fourth generation HFO refrigerant such as R-290 has flammability. Therefore, if the fourth generation HFO refrigerant leaks out and a flammable refrigerant has a concentration of 1.8% or more, there is a risk of ignition or explosion while the refrigerant is being used. If the refrigerant is used for home appliances, a maximum charge for a flammable refrigerant is limited to 150g by international regulation for a maximum refrigerant charge. Therefore, a re-design of a heat pump used in the existing laundry treatment apparatus is required for performance such as that of the existing R-134a.

[0040] In other words, R-290 is similar to R-134a in view of critical pressure and critical temperature but is greater than R-134a as much as 1.2 times in a difference between an evaporation pressure and a condensed pressure and its specific heat is also greater than R-134a (R-134a is 0.000845 m^3/kg, and R-290 is 0.00208 m^3/kg). Also, considering latent heat of evaporation, stroke volume of R-290 may be reduced as much as 25% for same cooling capacity. Also, if latent heat of evaporation is high, freezing efficiency is high even in case of a small amount of refrigerant. In this respect, R-290 may be a good refrigerant that replaces R-134a.

[0041] However, considering this, a re-design of a refrigerant pipe that includes a compressor, an evaporator, a condenser and an evaporator of a heat pump is required. At the same time, various safe designs for sensing leakage and avoiding explosion are required.

[0042] FIG. 1 is a schematic view illustrating an external appearance of one embodiment of a laundry treatment apparatus 100 that performs a drying function by using a heat pump that uses a flammable refrigerant, for example, R-290. Referring to FIG. 1, the laundry treatment apparatus includes a cabinet 101 that is a main body of a cuboid type laundry treatment apparatus, wherein a circular inlet 106 is provided on a front surface 103 of the cabinet 101. A control panel 104 for controlling various functions of a dryer and displaying an operation state may be provided at a top portion of the front surface 103.

[0043] A door 109 rotatably coupled to the cabinet 101 to open or close the inlet 106 may be provided on the front surface 103 of the cabinet. Whether the door 108 is opened or closed may be identified using a non-contact sensor based on a magnet instead of the existing electric contact type sensor. This is to prevent a risk of explosion from occurring even if a flammable refrigerant such as R-290 leaks out when the flammable refrigerant is used. That is, the existing electric contact type sensor may generate a spark when an electric contact point is pushed, and the flammable refrigerant may be exploded by such spark.

[0044] In order to prevent such explosion from occurring in advance, a magnetic portion 1082 provided at one side of a door, which is operable in a non-contact type without using an electric contact point, and a sensing portion 1083 arranged on the front surface 103 of the cabinet and provided at a position corresponding to the magnetic portion 1082 may be provided.

[0045] The sensing portion 1083 may include a reed switch for sensing a magnetic force of the magnetic portion 1082. Therefore, as the door 108 approaches the inlet 106, even though the magnetic portion 1082 is not in contact with the sensing portion 1083, the reed switch is turned on by the magnetic force of the magnetic portion 1082, whereby the sensing portion 1083 may operate to sense the door.

[0046] The cabinet 101 includes a cylindrical drum 110 communicated with the inlet 105 to accommodate laundry. A base portion 130 may be provided at a lower portion of the drum 110, wherein mechanical components including a duct 120 circulating the air of the drum 110 and a heat pump 140 humidifying and cooling the air inside the duct and then heating the air are arranged in the base portion 130. The base portion 130 may not only provide a bottom surface of the cabinet 101 but also provide a space where mechanical components which will perform various functions of the laundry treatment apparatus 100 may be provided. This will be described with reference to FIGS. 4 to 7.

[0047] Also, the door 108 may include a light-transmitting portion. Therefore, even in a state that the door 108 is closed, the inside of the drum 110 may visually be exposed through the light-transmitting portion.

[0048] The drum 110 has a cylindrical shape, and may be provided with a front side and a rear side, which are all opened. However, this is only exemplary, and the front side may be opened and the rear side may be closed. This may be varied depending on an operation method of the drum 110.

[0049] For example, a drum driving shaft (not shown) for rotating the drum in a rear direction of the drum may be provided, and may directly be coupled to a drum motor to rotate the drum 110 through the drum motor. Also, the drum driving shaft for driving the drum in the rear direction of the drum may be coupled to the drum. Instead of the drum, the drum driving shaft may be rotated using the driving motor, a pulley and a belt connecting the pulley with the drum driving shaft. In this case, since the drum 110 does not need a rear supporter for supporting and rotating the drum at the rear side of the drum, the rear side of the drum may not be required to be opened. Therefore, the rear side of the drum may be blocked without being opened, and the drum driving shaft for rotating the drum may be coupled to the rear surface of the drum.

[0050] Hereinafter, the laundry treatment apparatus will be described based on the embodiment in which the front side and the rear side of the drum 110 are opened and the drum 110 may be rotated by a front supporter 104 and a rear supporter 105. The front supporter 104 and the rear supporter 105 may respectively be arranged at the front side and the rear side of the drum 110 to rotatably support the drum 110.

[0051] Referring to FIG. 2, an opening portion 1042 corresponding to an opening at the front side of the drum 110 is formed at the front supporter 104 to allow a target for treatment to be inserted thereinto, and an outlet 1041 communicated with the 1210 is formed at a circumference portion of a lower side. The front duct 1210 is downwardly extended to the base portion and coupled with a filter holder 1242 (see FIG. 4) to form an inlet duct. Although FIG. 2 illustrates that the front duct 1210 includes a front duct connector 1212 and a filter guide 1211, the front duct 121 may include a front duct connector 1212 only.

[0052] Therefore, the air that has dried the target for treatment in the drum 1030 passes through a fan (not shown) arranged in a fan holder 127 (See FIG. 4) after passing through the inlet duct where the front duct 1210 is coupled with the filter holder 1242 (see FIG. 4). Afterwards, after the air dried by passing through the evaporator 142 and the condenser 143 becomes the heated air, the heated air passes through a rear duct 230 and circulates the drum.

[0053] The filter guide 1211 is provided in the front supporter 104 and inserted into the outlet 1041. The filter guide 1211 may be provided in a circumference portion of the front supporter 104. The filter 124 may detachably be coupled into the filter guide 1211 to filter lint in the air discharged through the opening at the front side of the drum 110. Also, the filter 124 may include a plurality of filters. That is, unlike FIG. 2, an inner filter may be inserted into an outer filter and the outer filter may be inserted into the filter guide 1211 such that the filter may pass through the outlet 1041. Also, the number of holes of a mesh net per unit area of the outer filter may be different from the number of holes of a mesh net per unit area of the inner filter. In one embodiment, the mesh net of the inner filter may be denser than that of the outer filter. The filter 124 may be provided in the front duct connector 1212 by being inserted thereinto along the filter guide 1211. Also, since the filter holder 1242 having a size corresponding to the front duct connector 1212 exists in the base portion 130, the filter holder 1242 may be coupled with the front duct connector 1212 to constitute an inlet duct which is an air circulating path. Unlike the filter holder 1242, if the filter 124 includes a front duct connector 1212 in the front duct 1210 without the filter guide 1211, the filter may be installed in the filter holder 1242 to filter the air containing debris come out from the drum 110 through the outlet 1041.

[0054] FIG. 3 is a conceptual view illustrating a rear structure of the drum shown in FIG. 1. Referring to FIG. 3, a rear drum support ring 1053 corresponding to a rear opening (not shown) of the drum 110 may be formed to be protruded on the front surface of the rear supporter 105 that faces the drum 110. The rear drum support ring 1053 may be inserted into the rear opening of the drum 110 to rotatably support the drum. However, this is only exemplary to rotate the drum. The rear drum support ring 1053 may rotate the drum in another way unlike the case that the main body of the drum is supported and rotated by the rear supporter 105. For example, a drum driving shaft for rotating the drum may be provided at the rear side of the drum, and may connected to the drum motor 180 (see FIG. 4), whereby the drum 110 may directly be rotated by the drum motor 180. Also, the drum driving shaft for driving the drum at the rear side of the drum may be coupled with the drum. Instead of the drum, the drum driving shaft may be rotated using the driving motor, the pulley and the belt connecting the pulley with the drum driving shaft.

[0055] Hereinafter, one embodiment in which the rear supporter is provided as shown in FIG. 3 will be described. The rear drum support ring 1053 corresponding to the rear opening (not shown) of the drum 110 may be formed to be protruded on the front surface of the rear supporter 105. The rear drum support ring 1053 may be inserted into the rear opening (not shown) to rotatably support the drum 110.

[0056] At least two or more drum rollers 115 are rotatably provided in the rear supporter 105. The drum rollers 115 rotatably support the drum 110 at the lower portion of the drum 110.

[0057] In order to prevent the air from leaking out toward a gap between the rear opening (not shown) and the rear drum support ring 1053, a sealing pad (not shown) may be arranged to cover a connection portion. The sealing pad (not shown) is formed to cover and surround the rear opening of the drum 110 and the rear drum support ring 1053.

[0058] An inlet 1051 corresponding to the rear opening (not shown) of the drum 110 is formed in the rear supporter 105. The inlet 1051 may be formed at an eccentric position toward one side based on a vertical reference line that passes through the center of the rear supporter 105. Also, the inlet 1051 may be formed above a horizontal reference line that passes through the center of the rear supporter 105.

[0059] Unlike the above example, the inlet 1051 may be formed in all areas corresponding to the rear opening (not shown). A rear duct 230 connecting the rear duct connector 1231 for discharging the air that has passed through the inlet 1051 and the condenser with the inlet 1051 may be provided in the rear supporter 105. If the fan is located after the air has passed through the condenser, then rear duct 230 may connect the inlet 1051 with the rear duct connector 1231, and the rear duct connector 1231 may connect a fan discharge outlet 1272 with the rear duct 230. The air flows from fan discharge outlet 1272 by passing through the fan and moves into the rear duct 230.

[0060] A rear protrusion 1052 which is backward protruded may be formed in a portion of the rear supporter 105, in which the rear duct 230 is not arranged. Therefore, a front surface of the rear supporter 105 may have a shape relatively recessed toward the rear side. Therefore, an inner space of the drum 1030 may be more obtained.

[0061] The rear duct 230 may be formed to be upwardly extended and configured to guide the heated air, which has been dried after passing through a heat exchanger, to the inlet 1051 of the rear supporter 105.

[0062] FIG. 4 illustrates arrangement of a water supply 160 for cleaning a duct 120 arranged at the base portion 130 which is the lower portion of the drum 110, a heat pump 140 including a compressor 200, a drum motor 180 and an evaporator 142.

[0063] The duct 120 that serves to circulate the air is arranged in the base portion 130. The duct may be categorized as follows. The duct may be categorized into a second path based on the evaporator 142 and the condenser 143, a first path restricted by the front duct 1210 and the fan holder 127, and a third path restricted by the rear duct connector 1231 and the rear duct 230. Therefore, the air inside the drum 110 may be discharged through the first path, may be humidified and exchanged with heat in the second path, and may enter the drum 110 through the third path.

[0064] The second path may be formed using the bottom surface of the base portion 130 as a bottom surface and using a cover plate 128, which forms a ceiling of the second path by covering the evaporator 142 and the condenser 143, and a cover side (not shown) as a top portion. Unlike this example, the second path may be formed as one single member to move the air.

[0065] The first path may form a path through the air discharged from the outlet 1041 enters, and may be extended toward the bottom surface of the base portion 130. The second path may be extended toward a rear one side of the base portion 130 in the form of a straight line. The third path may upwardly be extended from one side of the base portion 130 to the inlet 1051.

[0066] The second path may be extended from the base portion 130 in the form of a straight line to prevent a heat exchange rate from being deteriorated and reduce path resistance.

[0067] Some of the components constituting the heat pump 140 may be provided inside the duct 120, particularly on the second path, wherein the heat pump 140 may include a compressor 200, an evaporator 142, a condenser 143, and a refrigerant pipe 146 that includes an expander 145.

[0068] The duct 120 becomes a path of the air, which dries a drying target by passing through the drum 110, inside the cabinet 101. Particularly, the duct 120 is formed in the form of duct inside the cabinet 101 from the front side to the rear side of the cabinet 101.

[0069] The evaporator 121 and the condenser 124 are provided in the duct 120, and expander and the compressor are arranged in the base portion 130 of the cabinet 101 outside the circulating path. In this case, the evaporator 121 is provided to be closer to the first path from the duct 120 than the condenser 124. Therefore, the air flowing from the filter holder 1242 sequentially passes through the evaporator 121 and the condenser 124 of the duct 120 in view of an air flow, whereby cooling (condensing) and re-heating are performed.

[0070] Laundry inside the drum 110 rotated by the drum motor 180 inside the cabinet 101 is dried by the heated air discharged through the rear duct 230. The air used for drying contains water evaporated from the laundry and thus becomes the humid air and then is discharged to the duct 120 and a lint filter holder 112 communicated with the outlet 1041 at the front side of the drum 110 close to the door 108.

[0071] Meanwhile, the heat pump 140 means a device that cools and heats the air circulating the circulating path through heat exchange with the refrigerant. The evaporator 142, the compressor 200, the condenser 143 and the expander 145 of the heat pump 140 are sequentially connected with one another by the refrigerant pipe 146 through which the refrigerant flows. The components of the heat pump 140, which directly perform heat exchange with the circulating air, are the evaporator 142 and the condenser 143.

[0072] The refrigerant circulating the heat pump 140 is evaporated by the evaporator 142 by absorbing heat from the humid air of a high temperature come out of the drum. Therefore, the circulating air is cooled, and water contained in the air is condensed and dropped to the bottom surface of the duct type circulating path by gravity.

[0073] Meanwhile, the refrigerant circulating the pipe of the heat pump 140 is evaporated by the evaporator 142, compressed to a high temperature and a high pressure by the compressor 200, and then condensed by the condenser 143 through heat transfer to the cooled circulating air. Therefore, the circulating air is heated and becomes the dried air of a high temperature and then is discharged to the drum 110 by the rear duct 230.

[0074] Also, the cooled refrigerant is expanded by the expander 145 and becomes the state that it may absorb heat from the evaporator 142. The expander 145 may be provided as an expansion valve, or may be provided as a capillary tube that uses an orifice phenomenon. Also, a filter dryer 1465 may be provided to filter debris inside the refrigerant.

[0075] Meanwhile, the condensed water generated by the evaporator 142 may be dropped to the bottom surface where the evaporator and the condenser are arranged, and then may primarily be collected in a condensed water collector (not shown). The collected condensed water may enter a condensed water storage 161 arranged to adjoin the compressor 200.

[0076] The condensed water entering the condensed water storage 161, stored in the condensed water storage 161 may be supplied to a control valve (not shown) provided on the cover plate 128 by a water pump 165. The condensed water supplied through a water supply pipe 166 connected between the water pump 165 and the control valve (not shown) may be discharged through a drainage port 168 and a plurality of water supply ports 1611, 1612 and 1613 provided in the control valve (not shown). The condensed water may be supplied to a spray pipe 167 through the plurality of water supply ports 1611, 1612 and 1613.

[0077] The spray pipe 170 has a pipe shape of which center is bent, and a discharge hole (not shown) of the spray pipe 170 is arranged to be protruded through the base of the cover plate 128, that is, the bottom surface of the base portion 130 by passing through the cover plate 128. The discharge hole (not shown) of the spray pipe 170 may be provided on the base of the cover plate 128 to spray the condensed water to the evaporator 142. The discharge hole of the spray pipe 170 does not need to spray the condensed water to all areas of the evaporator, and may spray the condensed water to only an area where debris contained the air discharged from the drum may be stacked.

[0078] The drum motor 180 for driving the drum 110 may be provided in the base portion 130. The position of the drum motor 180 may be varied depending on a driving method of the drum 110. If the drum motor 180 is directly coupled with the drum driving shaft of the drum 110 at the rear side of the drum, the drum motor 180 should be arranged at the rear side of the drum and thus may be arranged in the base portion 130. However, if the drum 110 is rotated using a belt, the position of the drum motor 180 at the lower portion of the drum may be varied depending on a portion of the drum to which the drum motor 180 and the belt (not shown) for transferring a driving force of the drum motor 180 to the drum 11 transfer a rotational force. For example, if the cylindrical main body of the drum is rotated, the drum motor 180 may be arranged at a center lower portion of the drum as shown. However, if the drum driving shaft is rotated, the drum motor 180 may be arranged at a rear lower portion of the drum. Hereinafter, the drum motor 180, the fan, and a box fan 2001 for cooling the compressor 200 will be described later with reference to FIG. 7.

[0079] FIG. 5 illustrates air circulation and refrigerant circulation of the laundry treatment apparatus according to one embodiment of the present disclosure. Although the fan is arranged at the first path portion of the duct 120 in one embodiment of the present disclosure, the fan holder 127 (See Fig. 4) may be provided to be arranged at a position next to the condenser 143 to discharge the air to the rear duct 230 as the case may be.

[0080] FIG. 6 illustrates one embodiment in which the fan holder 127 and the fan 1273 (not shown) arranged inside the fan holder 127 are provided next to the evaporator 142 and the condenser 143 to supply the air to the rear duct 230.

[0081] FIG. 7 illustrates the evaporator 142 and the condenser 143 by removing the cover plate 128 from the duct 120. The drum motor 180, the fan 1273 and the box fan 2001 will be described with reference to FIG. 7.

[0082] The drum motor 180 is intended to generate a driving force for ration of the drum 110, and a belt (not shown) for transferring the driving force of the drum motor 180 to the drum 110 may be connected to the drum motor 180. The belt may be arranged to surround the circumference of the drum 110.

[0083] Also, a pulley 181 and a spring (not shown) may be used to control a tension applied to the belt. The pulley 181 may be configured to apply a certain tension to the belt. The pulley 181 may rotatably be provided in either a drum motor holder (not shown) arranged in the base portion 130 to allow the drum motor to be provided therein or a bracket (not shown) provided in the drum motor holder.

[0084] In order to control the tension of the belt, the drum motor 180 may be configured to be rotated within a certain angle based on one shaft and restored to an initial position by an elastic force of a spring. To this end, the drum motor 180 may be provided in the drum motor holder to be rotated based on one shaft, and the spring may be connected with each of the drum motor holder and the drum motor 180.

[0085] Meanwhile, the fan 1273 may be provided in the shaft of the drum motor 180. In one embodiment of the present disclosure, the belt may be connected to the shaft provided at one side of the drum motor 180, and the fan 1273 may be provided in the shaft provided at the other side of the drum motor 180.

[0086] Therefore, the shafts provided at both sides of the drum motor 180 are rotated in the same direction and at the same speed. If two shafts are provided in one drum motor 180, many advantageous may be obtained in view of power consumption of the laundry treatment apparatus. Power consumption may be reduced to a half of the case that the drum motor 180 for rotation of the drum 110 and the drum motor for rotation of the fan 1273 are respectively provided.

[0087] The time when rotation of the fan 1273 is required is equal to the time when the drum 110 is rotated. This is because that the dried air of a high temperature may be supplied to the drum 110 and the humid air of a high temperature may be discharged from the drum 110 when the drum 110 is rotated. Therefore, the state that rotation of any one of the drum 110 and the fan 1273 is not required does not occur.

[0088] The box fan 2001 may be provided to adjoin the compressor 200. The box fan 2001 may be configured to generate wind toward the compressor 200 or suck and ventilate the air in the vicinity of the compressor 200. The temperature of the compressor 200 may be lowered by the box fan 2001, and as a result, compression efficiency may be improved. In one embodiment of the present disclosure, the box fan 2001 is arranged at the rear side of the compressor 200 and thus is close to the rear surface of the cabinet.

[0089] A cabinet discharge hole (not shown) for exchanging the air outside the cabinet with the air inside the cabinet may be formed in the cabinet 101 where the box fan 2001 is arranged. Preferably, the cabinet discharge hole (not shown) may be formed on the rear surface of the cabinet where the box fan 2001 is arranged. However, since the cabinet 101 does not have a sealed structure, a gap generated during coupling may form the cabinet discharge hole, and the air inside the cabinet may be exchanged with the air outside the cabinet by the cabinet discharge hole.

[0090] The box fan 2001 may be provided for another purpose of use. That is, if the flammable refrigerant, for example, R-290 is used, a safety solution for preventing explosion from occurring is required. If the flammable refrigerant leaks out and is collected inside the cabinet due to its density heavier than the air, the flammable refrigerant may be exploded by electric spark. In order to prevent such explosion from occurring, the air flows to a place where the flammable refrigerant is expected to be collected, whereby a concentration of the flammable refrigerant may be lowered to a concentration less than an explosive concentration or the flammable refrigerant is able to be discharged to the outside of the cabinet.

[0091] The place where leakage of the refrigerant is expected is in the vicinity of the compressor 200 where much vibration occurs and many junctions are formed. Therefore, the leaked refrigerant may be collected in the vicinity of the compressor 200 except the duct 120 in the base portion 130. At this time, if the fan 2001 is used, it may circulate the air inside the cabinet 101 and as a result dilute the concentration of the leaked refrigerant. Also, the leaked refrigerant may be discharged to the outside through the cabinet discharge hole or the air outside the cabinet may enter the inside of the cabinet to lower the concentration of the leaked refrigerant. Therefore, the fan 2001 may not only cool the compressor but also prevent explosion of the flammable refrigerant from occurring through dilution of the leaked flammable refrigerant by guiding air circulation or air exchange during leakage of the flammable refrigerant.

[0092] FIGS. 8 to 13 relate to the compressor 200 of the heat pump provided in the laundry treatment apparatus that uses a flammable refrigerant in accordance with one embodiment of the present disclosure.

[0093] The compressor 200 of the heat pump according to one embodiment of the present disclosure is a rotary type compressor, and has an external appearance provided with a compressor case 203 of a cylindrical shape, and first and second caps 201 and 202 covering both ends of the case to form a sealed inner space. Also, the compressor 200 may include a compressor bottom clamp 290 coupling the compressor case 203 to the base portion 130. Unlike this example, the external appearance of the compressor 200 may be provided with first and second caps 201 and 202 of a semi-spherical shape, and the first and second caps 201 and 202 may be provided to be welded with the case in a single body.

[0094] The compressor 200 may include a compressor motor 210 arranged inside the compressor case 203, generating a power, and a compressing portion 220 compressing the refrigerant by using the power. The compressor motor 210 may be supplied with a power through a terminal 218 arranged in the compressor case 203 or the first cap 201 or the second cap 202. In FIG. 8, the compressor motor 210 may be arranged at an upper portion of the compressor, and the compressing portion 220 may be arranged at a lower portion of the compressor. However, the positions of the compressor motor 210 and the compression portion 220 may be changed to each other if necessary.

[0095] The compressor motor 210 includes a stator 217 fixed to the compressor case 203, a rotor 216 rotatably supported inside the stator 217, and a driving shaft 214 forcibly inserted into the rotor 216. The rotor 216 is rotated by an electromagnetic force, and the driving shaft 214 transfers a rotational force of the rotor 216 to the compressing portion 220.

[0096] A refrigerant inlet 281 for sucking the refrigerant may be provided at one side of the compressor case 203, and may be connected to an accumulator 280 for separating a vapor state from a liquid state of the refrigerant. A compressor discharge pipe 2281 for discharging the compressed refrigerant may be provided in the first cap 101. Also, a certain amount of oil (or refrigerant oil) may be filled in the second cap 202 to lubricate and cool a member that performs a friction motion.

[0097] At this time, an end of the driving shaft 214 is soaked in oil. Therefore, if the oil is supplied along an oil path (not shown) arranged inside the driving shaft 214, the oil may be dissolved in the refrigerant and circulated together with the refrigerant. Therefore, the refrigerant circulated in the heat pump is strictly a mixed fluid of oil and refrigerant.

[0098] The existing single cylinder type compressing portion 220 may be comprised of a cylinder fixed to the case, a roller arranged inside the cylinder, and upper and lower bearings respectively provided at upper and lower portions of the cylinder. The cylinder should be designed to have an inner volume of a predetermined size and a sufficient strength tolerable for a pressure of the compressed fluid. The cylinder accommodates an eccentric roller formed at the driving shaft inside the inner volume. The eccentric roller is a coupled body of an eccentric cam and a roller. Therefore, the eccentric roller has a center spaced from the rotation center of the driving shaft at a certain distance.

[0099] A groove extended from an inner circumferential surface of the cylinder at a certain depth may be formed. The groove may be provided with a vane, which is adjacent to the eccentric roller to divide the inner volume into a 1-1th chamber and a 1-2th chamber. The 1-1th chamber and the 1-2th chamber may provide a space changed depending on motion of the eccentric roller, compressing the refrigerant therein, without having a fixed volume.

[0100] However, in case of the flammable refrigerant, for example, when R-290 is compared with R-134a, R-134a is 0.000845 m^3/kg and R-290 is 0.00208 m^3/kg greater than R-134a as much as 2.5 times in a specific volume of a liquid state. Generally, R-134a of 500g is charged in the laundry treatment apparatus but R-290 of 150g or less is charged therein by regulation. Therefore, a total volume considering the charged amount is reduced in R-290. Since an error may occur in the charged amount during an actual manufacturing process of the laundry treatment apparatus, the refrigerant of 145g or less may preferably be charged in the laundry treatment apparatus. In an evaluation condition of ASHRAE 37(The American Society of Heating, Refrigerating and Air-Conditioning Engineers), R-134a is 1355 kPa and R-290 is 1666 kPa greater than R-134a in a difference between condensed pressure-evaporated pressure. Therefore, considering the difference between condensed pressure-evaporated pressure, R-290 may reduce a stroke volume as much as 25% for similar cooling capacity. Therefore, an approximate stroke volume is 8cc or more and 10cc or less per one revolution of the compressor. If the stroke volume exceeds 10cc, a heat emission problem of the compressor may occur, and if the stroke volume is less than 8cc, a sufficient heat exchange cannot be performed due to a small amount of the refrigerant. Therefore, the existing R-134a may be replaced with the flammable refrigerant, and the stroke volume of the compressor should be 8cc/rev or more and 10cc/rev or less for optimal performance.

[0101] In order to compress such a flammable refrigerant, a numerical value of the roller that compresses the refrigerant should be designed considering the stroke volume, thereby using the existing single cylinder. Since a radius of the compressor roller cannot be increased for arrangement in the base portion 130 of the laundry treatment apparatus, a height-to-radius ratio (hr:rr, see FIG. 10) of the eccentric roller in the range of 1.2 or more and 1.6 or less is generally used for the single cylinder. However, if the height-to-radius ratio of the roller is increased for compression, friction loss inside the cylinder adjacent to the cylindrical outer circumferential surface of the roller is increased. Also, the refrigerant inside both chambers partitioned from each other by interposing the vane may leak between a gap between the vane and the roller, between the vane and the cylinder or between the vane and the bearing. This is referred to as leakage loss. Therefore, if the height is increased, a greater gap occurs, whereby leakage loss of the refrigerant is increased. Particularly, this loss is relatively great in the rotary compressor that uses the vane. In order to reduce this loss, it may be preferable to use the roller having a height-to-radius ratio less than 1.

[0102] Therefore, considering that much compression work per unit mass based on a great specific volume of the flammable refrigerant is required, friction loss between the eccentric roller and the cylinder, fluid loss during compression, and a space where the compressor is provided, a compressor is used, which includes a roller having a height-to-radius ratio less than 1 but reduces a compression work per unit mass and simultaneously compresses the refrigerants to reduce friction loss and fluid loss.

[0103] To this end, referring to FIG. 8, the compressing portion 220 of the compressor 200 used in the laundry treatment apparatus according to one embodiment of the present disclosure may include two cylinders 2211 and 2212 fixed to the compressor case 203, two eccentric rollers 2231 and 2232 respectively arranged inside the cylinders, and a partition 2223 partitioning the two cylinders from each other to prevent the refrigerants from being mixed. The first cylinder 2211 may be coupled with a first bearing part 2251 on an opposite side of a side that meets the partition, and the second cylinder 2212 may be coupled with a second bearing part 2252 on an opposite side of a side that meets the partition.

[0104] The respective cylinders 2211 and 2212 should be designed to have chambers 2291 and 2292 having a volume of a predetermined size and have a sufficient strength tolerable for a pressure of the compressed fluid. Also, the cylinders 2211 and 2212 may accommodate the first eccentric roller 2231 and the second eccentric roller 2232, which are formed in the driving shaft, inside the chambers 2291 and 2292. The first eccentric roller 2231 and the second eccentric roller 2232 are a kind of eccentric cams and have a center L2 (see FIG. 10) spaced apart from a rotation center L1 (see FIG. 10) of the driving shaft as much as a certain distance. The first eccentric roller 2231 and the second eccentric roller 2232 may be members that the eccentric portion and the roller are coupled with each other, but may be a single member.

[0105] The respective cylinders 2211 and 2212 may be provided with cylinder grooves 2211a and 2212a (see FIG. 9) extended from inner circumferential surfaces at a certain depth. A first vane 2241 and a second vane 2242 may respectively be provided in the first cylinder groove 2211a and the second cylinder groove 2212a, and may respectively adjoin the first eccentric roller 2231 and the second eccentric roller 2232 to divide each inner volume into two. Referring to FIG. 10, the first chamber 2291 may be divided into a 1-1th chamber 2291a and a 1-2th chamber 2291b by the first vane 2241 and the first eccentric roller 2231. The divided chambers 2291a and 2291b may provide a space changed depending on motion of the first eccentric roller, compressing the refrigerant entering there, without having a fixed volume.

[0106] The refrigerant supplied to the first chamber 2291 and the second chamber 2292 is supplied through a first inlet port 2814a and a second inlet port 2814b that respectively pass through the first cylinder 2211 and the second cylinder 2212. If the refrigerant that has passed through the accumulator 280 is supplied through the refrigerant inlet 281, the refrigerant is supplied into the first cylinder 2211 and the second cylinder 2212 through the first inlet port 2814a and the second inlet port 2814b, which are diverged in the form of Y.

[0107] Although FIG. 8 illustrates that one inlet port is diverged into the first inlet port 2814a and the second inlet port 2814b inside the compressor, this is only exemplary. The first inlet port 2814a and the second inlet port 2814b may not be provided to be inclined. In the same manner as FIG. 12, the refrigerant may enter the first chamber 2291 and the second chamber 2292 after being diverged in the accumulator 280.

[0108] Referring to FIG. 9, an operation principle of the rotary compressor will be described. FIG. 9 briefly illustrates a section (Dotted Rectangle 8B in FIG. 8) of the first cylinder. The first cylinder 2211 may include a first cylinder groove 2211a for elastically fixing one end of the first vane 2241. The other end of the first vane 2241 is always in contact with the first eccentric roller 2231. This is because of an elastic force of the elastic member 2233. Therefore, the first chamber 2291 is diverged into the two chambers, that is, the 1-1th chamber 2291a and the 1-2th chamber 2291b by the first vane 2241.

[0109] The driving shaft 214 may include a first oil path 261 for supplying oil for lubrication therein. The first eccentric roller 2231 may be coupled to the driving shaft 214. If the driving shaft 214 is rotated, the first eccentric roller 2231 performs cloud motion along the inner circumferential surface of the first cylinder 2211. Therefore, the volumes of the 1-1th chamber 2291a and the 1-2th chamber 2291b continue to be changed. The refrigerant enters one chamber, and the refrigerant is compressed in the other chamber. If the refrigerant is compressed at a preset pressure or more, a first discharge valve 2271a is opened to discharge the compressed refrigerant through a discharge port 2271 (see FIG. 10). The discharged refrigerant enters the condenser 143 after passing through a discharge pipe 1461 through a compressor discharge pipe 2281.

[0110] Although FIG. 10 briefly illustrates the first discharge valve 2271a, the first discharge valve 2271a may be provided on the discharge port 2271 and therefore may operate in the same manner as a check valve that is opened at only a preset pressure or more.

[0111] Referring to FIG. 10, the first discharge port 2271 may be provided to pass through the first bearing part 2251, and the first discharge valve 2271a may be provided on an outer surface of the first bearing part 2251 which is not in contact with the first cylinder 2211. The first discharge valve 2271a may be inserted into a groove of the first bearing part to open or close the first discharge port by considering an effective area of the first discharge port and a length of the first discharge port.

[0112] In FIG. 8., The first eccentric roller 2231 and the second eccentric roller 2232 may be provided to be eccentric in directions opposite to each other based on the driving shaft 214. The first eccentric roller 2231 and the second eccentric roller 2232 may alternately compress and discharge the refrigerant, which may reduce the vibration caused by changing pressure. Also, the first eccentric roller 2231 and the second eccentric roller 2232 may have the same eccentric level along the radial direction of the driving shaft to reduce vibration and noise due to eccentricity. In addition, axial load applied due to the change of the discharge pressure may be reduced.

[0113] In this way, if the refrigerant is compressed using the two cylinders, the height-to-radius ratio of the existing eccentric roller may be less than 1. Therefore, a size of the radius is reduced as compared with the case that one eccentric roller having a height-to-radius ratio less than 1 is used, whereby an area is less occupied. Since moment of inertia of a force applied to compress the same volume is reduced by the reduced radius and the height, a necessary rotational force is reduced.

[0114] Also, friction loss and leakage loss may be reduced as compared with the existing compressor having a height-to-radius ratio of 1.2 to 1.6.

[0115] Considering that the stroke volume of the compressor should be 8cc/rev or more and 10cc/rev or less, the height-to-radius ratio of the eccentric rollers 2231 and 2232 may be 0.75 or less and 0.8 or less. The height-to-radius ratio is the result obtained by considering the range of the aforementioned stroke volume in the compressor having two cylinders, so-called a twin compressor and reflecting critical temperature of R-290, specific volume, leakage loss of the compressed refrigerant, hydrodynamic loss such as pipeline friction inside the compressor, and a valve switching time of the discharge valve. For example, if the height-to-radius ratio of the eccentric rollers 2231 and 2232 exceeds 0.8, the discharge valves 2271a and 2272a are opened for a long time to discharge a desired stroke volume or more. If the height-to-radius ratio of the eccentric rollers 2231 and 2232 is less than 0.75, the compressed refrigerant is discharged and pressure drop inside the chambers 2291 and 2292 occurs at a fast speed, whereby the desired stroke volume may not be discharged. That is, a response speed of the discharge valve may be a parameter that affects this design. Considering these parameters, the height-to-radius ratio of the eccentric rollers 2231 and 2232 may be 0.75 or more and 0.8 or less.

[0116] Conditions required for optimal performance of the heat pump will be described with reference to FIG. 10. FIG. 10 illustrates a section of a portion of 8A comprised of a dotted line of FIG. 8. Supposing that a straight line passing through the center of the driving shaft 214 is L1 and the center of the first eccentric roller 2231 is L2, L2 is spaced apart from L1 at a predetermined distance. It is preferable that an effective area of each of the first discharge port 2271 and the second discharge port is 25 mm^2 or more and 26 mm^2 or less considering the critical pressure (4.25Mpa) and the critical temperature (97 °C) of the flammable refrigerant R-290.

[0117] Also, it is preferable that lengths of the first discharge port 2271 and the second discharge port are respectively 1.5 mm or more and 2.5 mm or less. This is because that friction loss occurs if the length of the discharge port is too thick and the discharge port is not tolerable for an inner pressure if the length of the discharge port is too thin.

[0118] Also, considering eccentric load and rpm generated by the first eccentric roller 2231 and the second eccentric roller 2232, a radius rs of the driving shaft 214 ranges from 5.5 mm to 7.5 mm in case of cast iron which is a material generally used as the driving shaft.

[0119] If the eccentric roller is not a single member but assembled by coupling of the cam corresponding to the eccentric portion and the roller, it may be preferable that the cam has a height lower than that of the roller. This is to reduce unexpected friction with the bearing and the partition due to tolerance during assembly. For example, if the height hr of the roller is 12mm, the height of the cam may be set to 8.5mm.

[0120] The oil path required for lubrication of the compressor will briefly be described with reference to FIGS. 8 and 10. The oil path (not shown) that includes a first oil path 261 passing through the driving shaft 214 in a shaft direction of the driving shaft 214 may be formed along the driving shaft 214, the first bearing part 2251 and the second bearing part 2252.

[0121] The first oil path 261 may be formed from one end to the other end of the driving shaft 214 to substantially pass through the driving shaft 214 along the shaft direction of the driving shaft 214. Also, an oil and an oil pump (not shown) are provided at one end of the direction of the base portion 130 in the first oil path 261. The oil pump (not shown) may be a kind of a centrifugal pump.

[0122] The oil pump is soaked in the oil, and therefore the oil may enter the first path 261 through the oil pump. The oil may enter the first oil path 261 through the oil pump 111. Afterwards, the oil may be pumped along the first oil path 261 and then scattered at the end of the driving shaft 214 to be supplied to each of the driving shaft 214, the first bearing part 2251 and the second bearing part 2252.

[0123] Also, the first oil path 261 may further include an oil hole (not shown) that may be communicated with the first oil path 261 in a circumferential direction of the driving shaft in the vicinity of the first eccentric roller 2231 and the second eccentric roller 2232 to supply oil to the first eccentric roller 2231 and the second eccentric roller 2232. Also, the oil path may include a second oil path (not shown) communicated with the oil hole to supply the oil to the first bearing part 2251 and the second bearing part 2252. The second oil path may be formed as a groove formed on an inner circumferential surface of the first bearing part 2251 and the second bearing part 2252.

[0124] The oil (refrigerant oil) used for the compressor is first used for lubrication and attenuation of friction and abrasion at a driving portion such as the bearing for lubrication and the driving shaft and a contact motion portion of the eccentric roller and the cylinder. Second, the oil may serve as a sealing action. Third, the oil may serve as a cooling action such as removal of friction heat. Fourth, the oil may serve as a rust inhibiting function for inhibiting oxidation of metal.

[0125] Since the oil is used by being mixed with the flammable refrigerant, the oil should have a suitable solubility, and is preferable to have excellent viscosity and a high flammable point. The reason why the oil should have a suitable solubility is that the amount of the oil discharged from the compressor is a factor that remarkably affects performance and reliability of the compressor and the system. If the oil is more dissolved in the refrigerant and therefore the excessive amount of oil is discharged from the compressor, problems may occur in that efficiency is deteriorated by temperature increase and reliability of the pump is deteriorated by abnormal high pressure due to an oil compression. As heat exchange at a condenser is disturbed, a function of an expansion valve is deteriorated, and an oil film is formed in an evaporation pipe, reduction in heat exchange capability and pressure loss may occur.

[0126] Particularly, R-134a has polarity and therefore is not well dissolved in a mineral oil which is the existing oil. Therefore, a polyester based oil (hereinafter, POE based oil) which is a synthetic oil has been used. The POE based oil which is a synthetic oil may be good in view of lubrication, but has problems as follows. First, since the POE based oil has a high water content rate when exposed to the air, due to good absorption, the POE based oil should necessarily be sealed. Therefore, since the POE based oil has moisture when leakage occurs, a problem of abrasion may occur. Second, the POE based oil has good cleaning effect but washes and emulsifies all kinds of lubricant oils and oxidizing materials generated during coating for rust inhibition and welding to flow along a cooling cycle, thereby causing malfunction.

[0127] Therefore, R-290 which is the flammable refrigerant has no polarity and therefore a mineral oil having a suitable solubility (40% or more and 60% or less in the range of temperature and pressure during operation of the compressor), excellent kinematic viscosity, and a high flammable point may be used. A type of such mineral oil includes 5GSD. The kinematic viscosity of 5GSD is 95.11 mm^2/s based on 40 °C, which is higher than the existing 4GSD as much as twice or more, and the flammable point is 194 °C, whereby the mineral oil may be used with safety. Also, the mineral oil has good miscibility in the range of -50 °C to 90 °C and double-layer separability of oil and refrigerant is very low. Also, the mineral oil has a low pour point of about -25 °C, and therefore is suitable for the oil of the heat pump for the laundry treatment apparatus. An oil enclosing volume (or oil-filled amount) of the 5GSD type may preferably be 220cc.

[0128] FIG. 11 relates to a compressor motor 210. FIGS. 11(a) and 11(c) illustrate a stator 217 and a stator core of the existing compressor motor.

[0129] Referring to FIG. 8, the compressor motor 210 includes a stator 217, a rotor 216 and a driving shaft 214. The stator 217 of the compressor motor may include a lamination deposited with a ring shaped electronic steel sheet (electric steel sheet or silicon steel sheet) and a coil 215 wound in the lamination. The rotor 216 of the compressor motor include a lamination deposited with an electronic steel sheet. The driving shaft 214 passes through the center of the rotor 216 of the compressor motor, and is fixed to the rotor 216 of the compressor motor. If a current is applied to the compressor 200, the rotor 216 of the compressor motor is rotated by a mutual electromagnetic force between the stator 217 of the compressor motor 210 and the rotor 216 of the compressor motor, and the driving shaft 214 fixed to the rotor 216 of the compressor motor is also rotated together with the rotor 216.

[0130] Therefore, the rotational force of the compressor motor 210 may control performance of the compressor. The number of winding times of the coil 215 per unit area may be increased for performance improvement. However, this may have a limitation in a narrow space. Therefore, in case of the compressor motor 210 according to one embodiment of the present disclosure in FIG. 11(b), the stator may include a two-stage core 2171 having a step difference as shown in FIG. 11(d). As a result, a slot effective area may be increased, whereby loss caused by copper loss may be reduced, and a magnetic flux flow may be increased. Therefore, efficiency of the compressor may be improved, and a material cost may be reduced as compared with the existing core having no step difference.

[0131] FIG. 13 relates to a multi-stage compressor that compresses a refrigerant at multiple stages unlike a twin compressor. Since the case that the refrigerant is compressed at multiple stages needs a work smaller than that of the case that the refrigerant is compressed at once to obtain a desired pressure, performance of the heat pump may be improved correspondingly. To this end, the second cylinder 2212 may compress the refrigerant at a low pressure, and the first cylinder 2211 may compress the refrigerant at a high pressure. This is only exemplary, and the functions of the first cylinder 2211 and the second cylinder 2212 may mutually be changed. In FIG. 13, the refrigerant may enter the second cylinder 2212 through the second inlet 2812, and the refrigerant compressed in the second cylinder 2212 may enter the first cylinder 2211 through an intermediate connector 2813 and the first inlet 2811 after being discharged through a third inlet 2810. The first cylinder again compresses the refrigerant at a pressure higher than that of the second cylinder to reach a desired condensed pressure and then discharge the refrigerant to the condenser through the compressor discharge pipe 2281.

[0132] FIG. 14 relates to the condenser 143 of the heat pump 140 provided in the laundry treatment apparatus that uses the flammable refrigerant according to one embodiment of the present disclosure.

[0133] The condenser 143 arranged inside the duct 120 may heat the air by transferring heat generated by condensing the refrigerant compressed by the compressor 200 to the air passing through the condenser 143. The condenser 143 may include a first condenser plate 1431 and a second condenser plate 1432, which are arranged at both sides of the duct 120. A condensing pipe 1433 through which the refrigerant flows is supported through the first condenser plate 1431 and the second condenser plate 1432. The condensing pipe is a pipe connected by repeatedly reciprocating between the first condenser plate 1431 and the second condenser plate 1432 while maintaining a certain interval, and may connect the first condenser plate 1431 with the second condenser plate 1432. Also, a plurality of condensing fins 1434 may be provided between the first condenser plate 1431 and the second condenser plate 1432 in the same direction as the first condenser plate and the second condenser plate.

[0134] Therefore, when the condensing pipe 1433 reciprocates between the first condenser plate 1431 and the second condenser plate 1432, the condensing pipe 1433 passes through the condensing fins 1434, and the condensing fins 1434 may be coupled with one another such that heat exchange may be performed between the portion through which the condensing pipe 1433 passes and the condensing pipe 1433. Therefore, when the refrigerant of a high temperature passes through the condensing pipe 1433, heat is transferred to the plurality of condensing fins 1434 and the plurality of condensing fins 1434transfers the heat from the refrigerant to the air passing through the plurality of condensing fins 1434.

[0135] In other words, when the air moves in an arrow direction (a direction from the first path to the third path, a direction from the front side to the rear side of the duct, or a length direction of the duct), the refrigerant of a high temperature passing through the condensing pipe 1433 provided in a direction crossing both sides of the duct may transfer heat to the air of a relatively low temperature.

[0136] Since R-290 has a specific volume greater than that of R-134a but has a charging amount smaller than that of R-134a, a total volume is reduced. Therefore, if the condensing pipe 1433 having the same diameter and the same length as those of the condenser used for R-134a is used, a super-cooling state occurs at an outlet 1433b of the condensing pipe. In order to avoid the super-cooling state, the condensing pipe 1433 may be designed to have a small diameter. Preferably, the diameter of the condensing pipe 1433 may be 5mm.

[0137] If the diameter of the condensing pipe 1433 is reduced, the refrigerant flowing inside the condensing pipe 1433 passes at a faster speed, whereby the amount of heat transfer per hour is increased. Also, if the diameter of the condensing pipe 1433 is reduced, a moving sectional area where the air actually passes is increased in the condenser 143, whereby more air may pass through the condenser 143. Therefore, fin per inch (FPI) indicating the number of fins per inch of the condensing fins 1434 may preferably be more increased than FPI in the existing R-134a. For example, 16 FPI may be used in the existing R-134a, whereas 18 FPI may be used in the condenser of R-290.

[0138] Also, since the amount of heat transfer is increased, a length of the condenser 143 along the flow direction, which is identical with the length L of the first condenser plate 1431 or the second condenser plate 1432, may be provided to be shorter than that of the condenser used in R-134a. This means miniaturization of the condenser 143. That is, an inner volume of the condenser 143 is reduced by 50% as compared with an inner volume of the condenser of R-134a.

[0139] Also, condensing pipes passing through the first condenser plate 1431 and the second condenser plate 1432 may be more arranged at the side of the duct 120 due to a reduction of the diameter of the condensing pipe. For example, if eight and five (8R $\times$ 5C) condensing pipes are arranged based on a length direction L and a height direction T of the first condenser plate in the existing R-134a, eight and six (8R $\times$ 6C) condensing pipes may be arranged based on a length direction L and a height direction T of the first condenser plate in R-290. Also, dL and dT that mean distances of adjacent condensing pipes 1431 may equally be set.

[0140] If the amount of heat transfer is increased, a pressure difference ΔP of the air passing through the condenser 143 is increased, whereby a moving speed of the air may be increased. Preferably, the moving speed of the air may be 2~3m/s.

[0141] FIG. 15 relates to the evaporator 142 of the heat pump 140 provided in the laundry treatment apparatus that uses the flammable refrigerant according to the one embodiment of the present disclosure.

[0142] The evaporator 142 arranged inside the duct 120 is a device that transfers heat to the refrigerant through heat exchange with the humid air of a high temperature from the drum 110 and again evaporates the refrigerant. At this time, the humid air of a high temperature becomes the dehumidified air of a relatively low temperature while passing through the evaporator 142.

[0143] The evaporator 142 may include a first evaporator plate 1421 and a second evaporator plate 1422, which are arranged at both sides of the duct 120. An evaporation pipe 1423 where the refrigerant flows therein is supported through the first evaporator plate 1421 and the second evaporator plate 1422. The evaporation pipe 1423 is a pipe connected by repeatedly reciprocating between the first evaporator plate 1421 and the second evaporator plate 1422 while maintaining a certain interval, and may connect the first evaporator pipe 1421 with the second evaporator pipe 1422. Also, a plurality of evaporation fins 1424 may be provided between the first evaporator plate 1421 and the second evaporator plate 1422 in the same direction as the first evaporator plate 1421 and the second evaporator plate 1422.

[0144] Therefore, when the evaporation pipe 1423 reciprocates between the first evaporator plate 1421 and the second evaporator plate 1422, the evaporation pipe 1423 passes through the evaporation fins 1424, and the evaporation fins 1424 may be coupled with one another such that heat exchange may be performed between the portion through which the evaporation pipe 1423 passes and the evaporation pipe 1423. Therefore, when the air of a relatively high temperature passes through the evaporator 142, heat is transferred by the plurality of evaporation fins 1424 and again transferred to the evaporation pipe 1423 through which the refrigerant of a relatively low temperature passes.

[0145] In other words, when the air moves in an arrow direction (a direction from the first path to the third path, a direction from the front side to the rear side of the duct, or a length direction of the duct), heat from the air of a relatively high temperature may be transferred to the refrigerant of a low temperature passing through the evaporation pipe 1423 provided in a direction crossing both sides of the duct.

[0146] Since R-290 has a specific volume greater than that of R-134a but has a charging amount smaller than that of R-134a, a total volume is reduced. Therefore, if the evaporation pipe 1423 having the same diameter and the same length as those of the evaporator used for the existing R-134a is used, a supersaturated evaporation state occurs at an outlet 1422b of the evaporation pipe. This increases energy consumption of the compressor or damages the compressor. In order to avoid energy consumption or damage of the compressor, the evaporation pipe 1423 may be designed to have a small diameter. However, the diameter of the evaporation pipe 1423 may be designed to be greater than that of the condensing pipe 1433. This is because that a temperature difference between the refrigerant and the air exchanged with heat in the condenser is greater than that in the evaporator. Therefore, in order that a flow speed of the refrigerant in the evaporator is reduced for sufficient heat transfer, the diameter of the evaporation pipe 1423 may be designed to be greater than that of the condensing pipe 1433. Preferably, the diameter of the evaporation pipe 1423 may be 7.94mm.

[0147] The refrigerant of a lower temperature passes through the inside of the evaporation pipe 1423 having a reduced diameter at a faster speed, whereby the amount of heat transfer per hour is increased. Also, if the diameter of the evaporation pipe 1423 is reduced, a moving sectional area where the air actually passes is increased in the evaporator 142, whereby more air may pass through the evaporator 142 and therefore heat transfer may be improved.

[0148] If the amount of heat transfer is increased, a pressure difference ΔP of the air passing through the evaporator 142 is increased, whereby a moving speed of the air may be increased. Preferably, the moving speed of the air may be 2~3 m/s.

[0149] To this end, the evaporation fin 1424 may have a thickness thinner than that of the evaporation fin in R-134a. For example, if the thickness of the existing evaporation fin 1424 is 0.14mm, the thickness of the evaporation fin 1424 in R-290 may be 0.13mm or less, preferably 0.1mm. Also, the dehumidified moisture may be attached to the evaporation fin 1423. This deteriorates heat exchange performance of the evaporation fin 1424. Therefore, to avoid deterioration of heat exchange performance, the evaporation fin 1424 may be hydrophilic-coated.

[0150] Also, since the amount of heat transfer is increased, a length of the evaporator 142 along the flow direction, which is identical with the length L of the first evaporator plate 1421 or the second evaporator plate 1422, may be provided to be shorter than that of the evaporator used in R-134a. This means miniaturization of the evaporator 142. That is, an inner volume of the evaporator 142 is reduced by 30% as compared with an inner volume of the evaporator of R-134a.

[0151] Also, evaporation pipes 1423 passing through the first evaporator plate 1421 and the second evaporator plate 1422 may be more arranged at the side of the duct 120 due to a reduction of the diameter of the evaporation pipe 1423. In R-290, five and four (5R x 4C) evaporation pipes may be arranged based on a length direction L and a height direction T of the first evaporation plate 1421. Also, dL and dT that mean distances of adjacent evaporation pipes 1423 may be constant.

[0152] A condensing pipe inlet 1431a and a condensing pipe outlet 1431b may be connected with an evaporation pipe inlet 1421a and an evaporation pipe outlet 1421b by the expander 145 outside the duct 120 by passing through the side of the duct 120, and the compressor 200 and the refrigerant pipe 146.

[0153] FIG. 16 relates to the refrigerant pipe 146 circulating the flammable refrigerant in the heat pump 140 provided in the laundry treatment apparatus that uses the flammable refrigerant according to one embodiment of the present disclosure.

[0154] FIG. 16(a) illustrates connection of the refrigerant pipe and the expander, FIG. 16(b) illustrates one embodiment of the expander, FIG. 16(c) illustrates one embodiment of the discharge pipe, and FIG. 16(d) illustrates one embodiment of a suction pipe.

[0155] Referring to FIG. 16(a), the refrigerant pipe circulating the refrigerant may include a discharge pipe 1461 connecting the compressor 200 with the condenser 143, a expander 145 connecting the condenser 143 with the evaporator 142, and a suction pipe 1462 connecting the evaporator 142 with the accumulator 280 of the compressor 200.

[0156] FIG. 16(b) illustrates the expander 145 used in the laundry treatment apparatus according to one embodiment of the present disclosure. A shape and a length of the pipe may be modified unless mentioned especially. The expander 145 may include an expansion valve or a capillary tube 1464 for expanding the condensed refrigerant. Also, the condensed refrigerant may pass through the filter dryer 1465 prior to the capillary tube 1464 to remove debris that may be contained therein. An evaporator connector 1451a of the expander connected with the inlet 1421a of the evaporation pipe enlarges a diameter of the expander by considering the diameter of the evaporation pipe 1423 to connect the expander with the evaporation pipe 1423. The diameter of the expander has a shape gradually enlarged with at least one or more step differences not a continuous tapered enlargement. This is to allow the refrigerant not to leak out by coupling the inlet 1421a of the evaporation pipe with the evaporator connector 1451 of the expander through a wide surface contact. Preferably, the inlet 1421a of the evaporation pipe and the evaporator connector 1451 a of the expander may be connected with each other by welding.

[0157] Also, the capillary tube 1464 may have a length shorter than that of the capillary tube 1464 used in R-134a because a pressure drop rate per capillary tube length of R-190 is faster than that of R-134a and is similar to that of Freon gas. Therefore, the length of the capillary tube 1464 may preferably be 1300mm. However, in case of R-290, since an error may occur in the charging amount in the compressor, the capillary tube 1463 may be provided with a length ranging from 1250mm to 1350mm.

[0158] FIG. 16(c) illustrates the discharge pipe 1461 used in the laundry treatment apparatus according to one embodiment of the present disclosure. A condenser connector 1461a of the discharge pipe connected with the inlet 1431a of the condensing pipe has a diameter gradually reduced by a step difference of at least once or more to adapt to the diameter of the condensing pipe. This is to allow the refrigerant not to leak out by coupling the inlet 1431a of the condensing pipe with the condenser connector 1461a of the discharge pipe through a wide surface contact. Preferably, the inlet 1431a of the condensing pipe and the condenser connector 1461a of the discharge pipe may be connected with each other by welding.

[0159] FIG. 16(d) illustrates one embodiment of a suction pipe 1462 used in the laundry treatment apparatus according to one embodiment of the present disclosure. An evaporator connector 1462a of the suction pipe 1462 connected with the outlet 1421b of the evaporation pipe has a diameter gradually reduced by a step difference of at least once or more to adapt to the diameter of the evaporation pipe 1423. This is to allow the refrigerant not to leak out by coupling the outlet 1421b of the evaporation pipe with the evaporator connector 1462a of the suction pipe through a wide surface contact. Preferably, the outlet 1421b of the evaporation pipe and the evaporator connector 1462a of the suction pipe may be connected with each other by welding.

[0160] It will be apparent to those skilled in the art that the present invention may be embodied in other specific forms without departing from the spirit and essential characteristics of the invention. Thus, the above embodiments are to be considered in all respects as illustrative and not restrictive. The scope of the invention should be determined by reasonable interpretation of the appended claims and all change which comes within the equivalent scope of the invention are included in the scope of the invention.

Claims

1. A compressor comprising:

a case (203);
a first cylinder (2211) of a circular shape, arranged inside the case, providing a first chamber (2291) therein;
a second cylinder (2212) of a circular shape, arranged inside the case, providing a second chamber (2292) therein;
a partition (2223) arranged between the first cylinder and the second cylinder, partitioning the first chamber from the second chamber;
a driving shaft (214) including a first eccentric roller (2231) arranged in the first chamber to rotatably adjoin an inner circumferential surface of the first cylinder and a second eccentric roller (2232) arranged in the second chamber to rotatably adjoin an inner circumferential surface of the second cylinder, and passing through the first cylinder, the second cylinder and the partition;
a first vane (2241) having one end fixed to the first cylinder and the other end which is in contact with the first eccentric roller, provided to reciprocate when the first eccentric roller is rotated;
a second vane (2242) having one end fixed to the second cylinder and the other end which is in contact with the second eccentric roller, provided to reciprocate when the second eccentric roller is rotated;
a first inlet port (2814a) for flowing a refrigerant to the first chamber by passing through the first cylinder;
a second inlet port (2814b) for flowing a refrigerant to the second chamber by passing through the second cylinder; and
a discharge portion including a first discharge port (2271) for discharging the refrigerant of the first chamber and a second discharge port for discharging the refrigerant of the second chamber,
wherein each of the first eccentric roller and the second eccentric roller has a height-to-radius ratio of 0.75 or more and 0.8 or less.

2. The compressor according to claim 1, further comprising:

a first bearing part (2251) coupled to one surface of the first cylinder arranged away from the partition, rotatably supporting the driving shaft; and
a second bearing part (2252) coupled to one surface of the second cylinder arranged away from the partition, rotatably supporting the driving shaft,
wherein the first discharge port is adapted to discharge the refrigerant of the first chamber by passing through the first bearing part,
the second discharge port is adapted to discharge the refrigerant of the second chamber by passing through the second bearing part,
the discharge portion further includes:

a first discharge valve (2271a) arranged at the first bearing part, configured for discharging the refrigerant only if a pressure of the refrigerant discharged through the first discharge port is a preset pressure or more; and
a second discharge valve arranged at the second bearing part, configured for discharging the refrigerant only if a pressure of the refrigerant discharged through the second discharge port is a preset pressure or more.

3. The compressor according to claim 1 or 2, wherein a displacement or stroke volume of the compressor is 8cc/rev or more and 10cc/rev or less.

4. The compressor according to any one of claims 1 to 3, wherein an effective area of each of the first discharge port and the second discharge port is 25 mm^2 or more and 26 mm^2 or less.

5. The compressor according to any one of claims 1 to 4, wherein a length of each of the first discharge port and the second discharge port is 1.5mm or more and 2.5mm or less.

6. The compressor according to any one of claims 1 to 5, wherein a radius of the driving shaft ranges from 5.5mm to 7.5mm.

7. The compressor according to any one of claims 1 to 6, being configured to operate with a flammable refrigerant.

8. The compressor according to claim 7, wherein the flammable refrigerant is R-290.

9. The compressor according to any one of claims 1 to 8, further including a power generator configured for rotating the driving shaft, and an oil path for supplying oil to lubricate the driving shaft, the power generator, the first vane, the second vane, the first eccentric roller, the second eccentric roller, the first bearing part, and/or the second bearing part.

10. The compressor according to claim 9, wherein the oil path is adapted to operate with 5GSD type oil.

11. A heat pump comprising:

a duct (120) adapted for inflow and outflow of the air;
an evaporator (142) arranged inside the duct, being configured for cooling the air entering the duct;
a condenser (143) arranged inside the duct, being configured for heating the air that has passed through the evaporator;
the compressor (200) according to any one of claims 1 to 10, arranged outside the duct, being configured for compressing a refrigerant that has passed through the evaporator and supplying the compressed refrigerant to the condenser; and
a refrigerant pipe (146) communicating with the evaporator, the condenser and the compressor to allow the refrigerant to move therein.

12. The heat pump according to claim 11, further comprising an expander (145) connecting the evaporator with the compressor, being configured for expanding refrigerator, wherein the expander includes a capillary tube (1464) having a length of 1250mm or more and 1350 or less, so as to drop a pressure of the refrigerant.

13. The heat pump according to claim 11 or 12, wherein the evaporator (142) includes:

a plurality of evaporation fins (1424) for heat exchange, having a plate shape; and
an evaporation pipe (1423) winding back and forth multiple times passing through the plurality of evaporation fins (1424),
wherein the evaporator (142) is configured for heat exchanging the refrigerant having passed through the condenser (143) with the air and then discharging it to the compressor (200), and
wherein the evaporation fins (1424) are hydrophilic-coated to prevent water condensed in the air from being attached to the evaporation fins (1424).

14. The heat pump according to claim 13, wherein the condenser (143) includes:

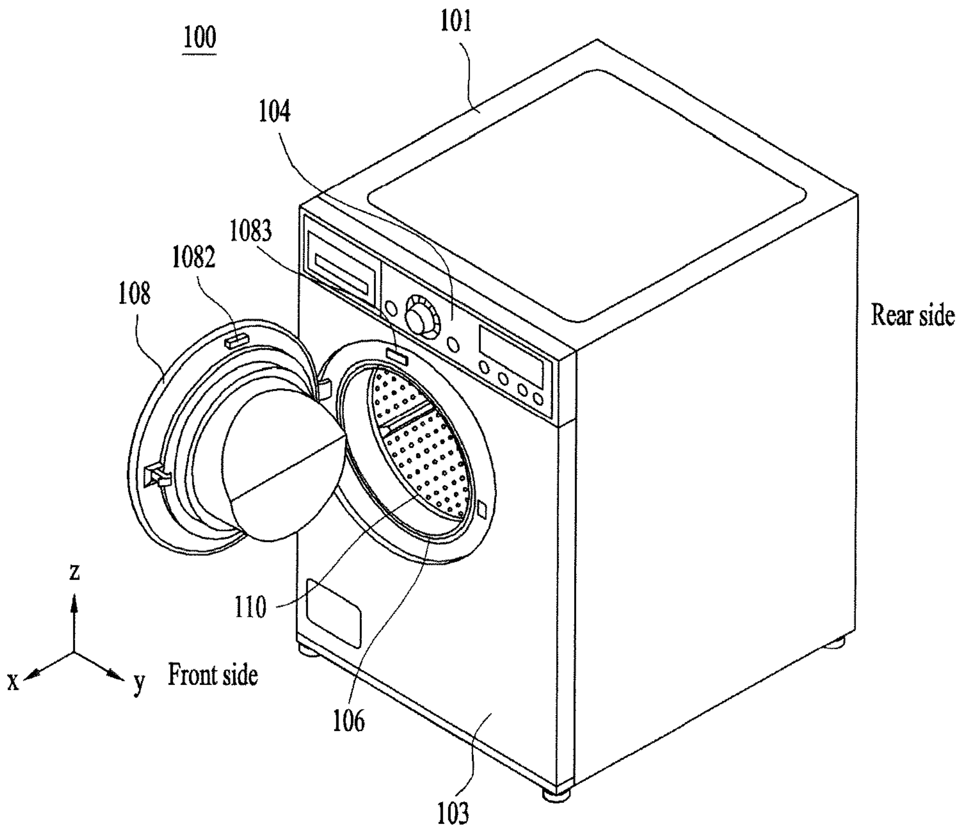
a plurality of condensing fins (1434) for heat ex-

change, having a plate shape; and
a condensing pipe (1433) winding back and forth multiple times passing through the plurality of condensing fins (1434),
wherein the condenser (143) is configured for heat exchanging the refrigerant having passed through the compressor (200) with the air and then discharging it to the evaporator (142), and
wherein the condensing pipe (1433) has a diameter smaller than that of the evaporation pipe (1423).

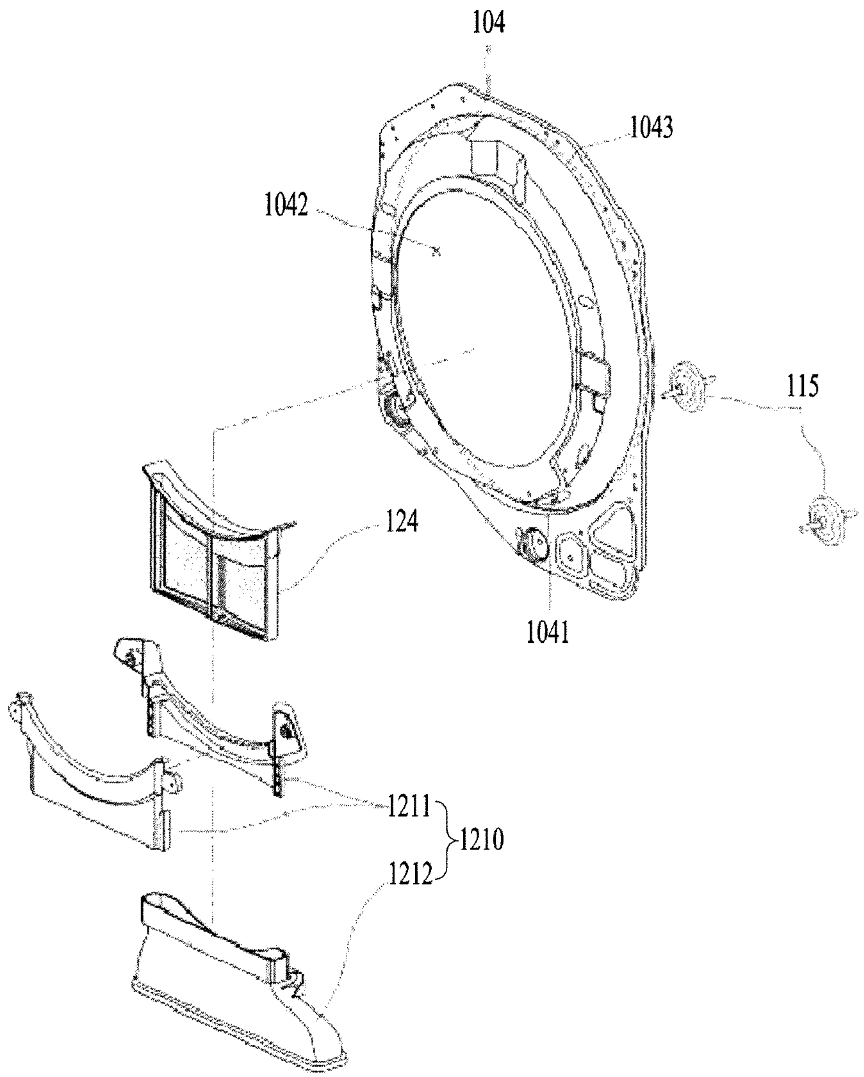
15. A laundry treatment apparatus comprising:

a cabinet (101) forming an external appearance;
a drum (110) of a cylindrical shape arranged inside the cabinet; and
the heat pump according to any one of claims 11 to 14,
wherein the duct (120) is configured for circulating air in the drum.

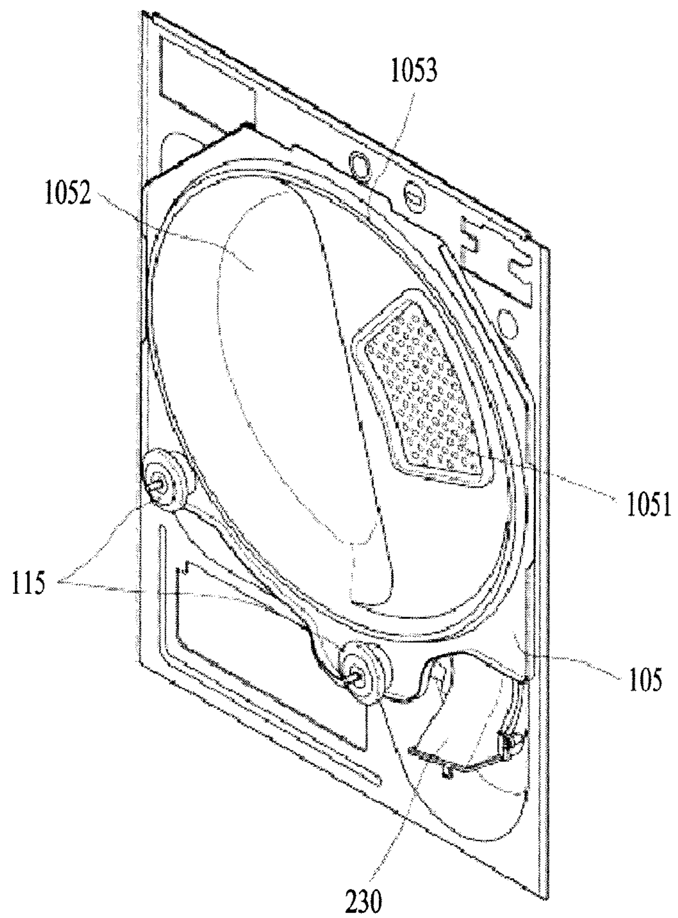
【FIG. 1】



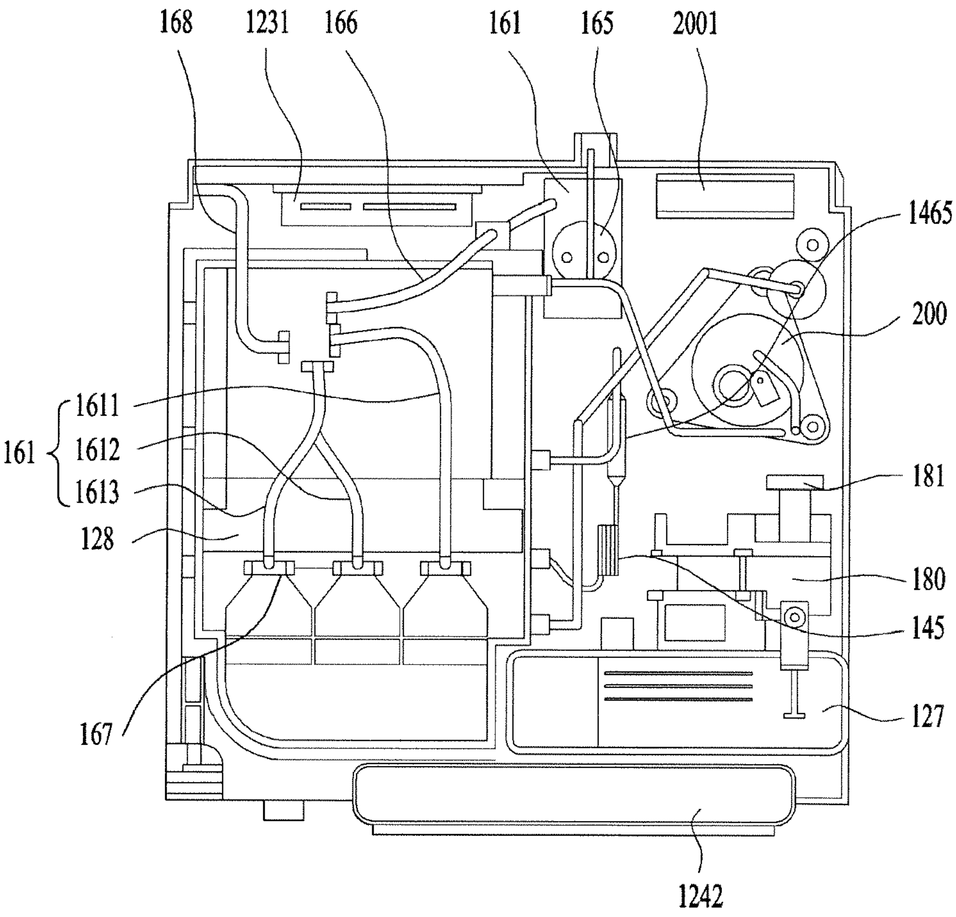
【FIG. 2】



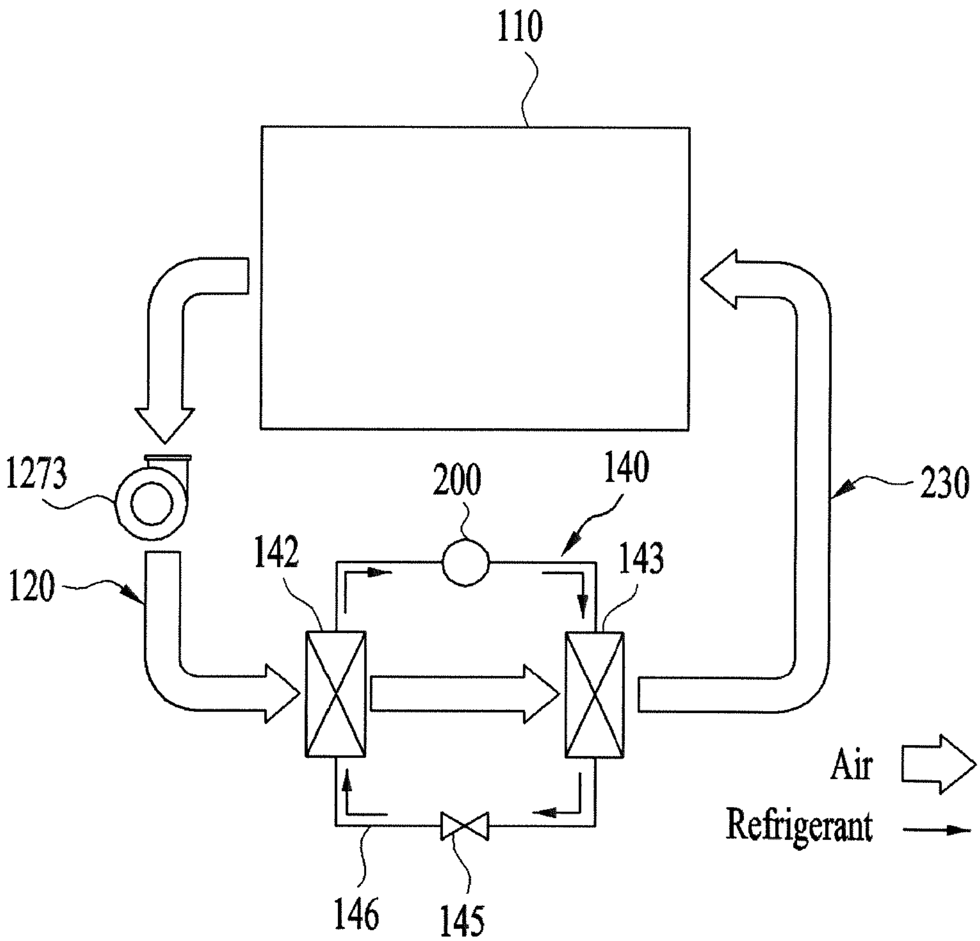
【FIG. 3】



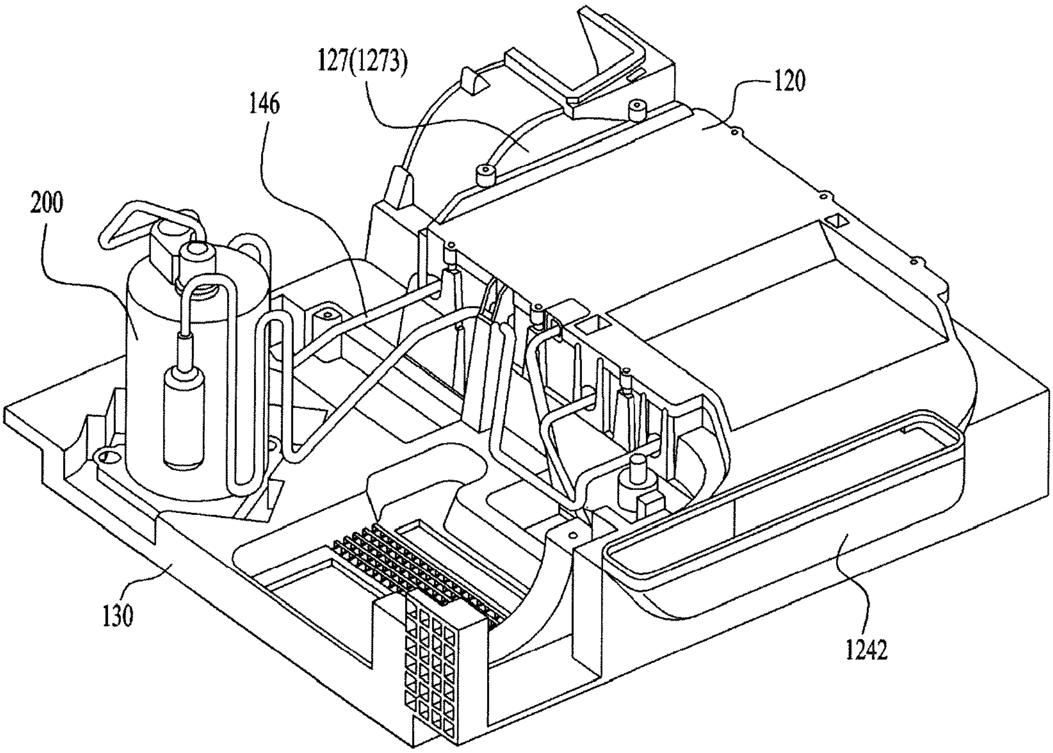
【FIG. 4】


168
1231
166
161
165
2001
1465
200
161
1611
1612
1613
128
181
180
145
167
127
1242

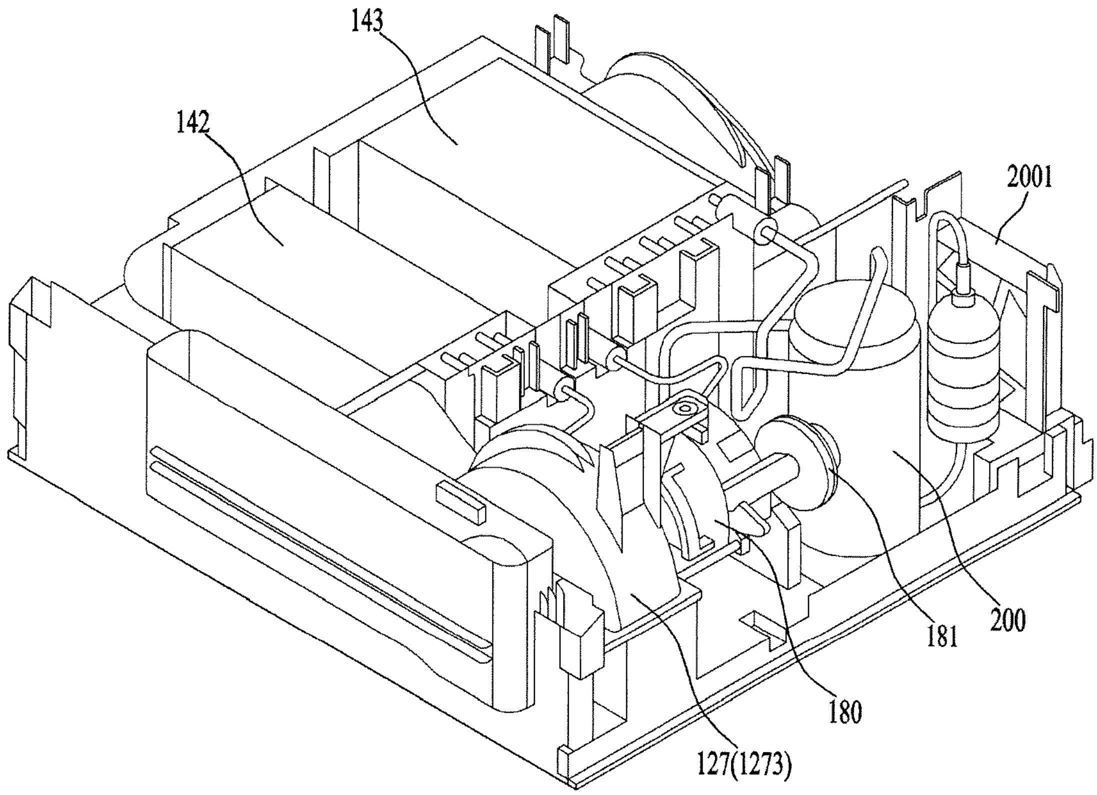
【FIG. 5】



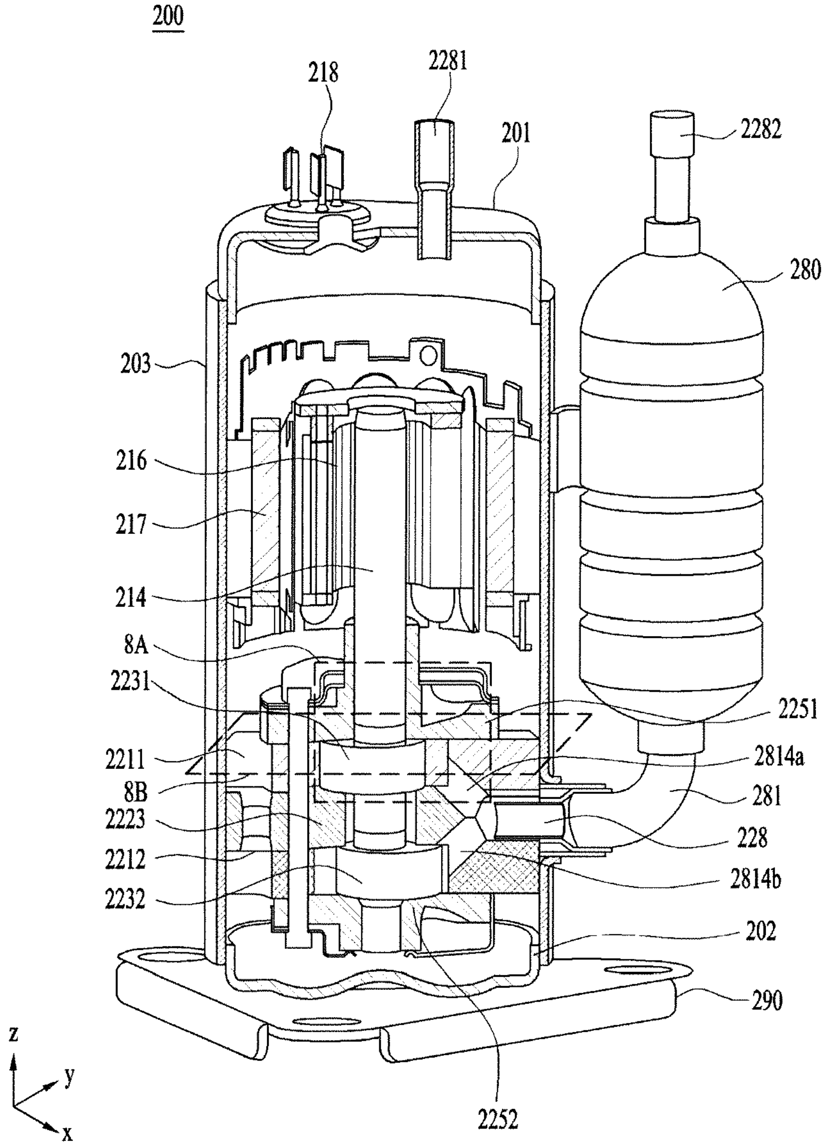
【FIG. 6】



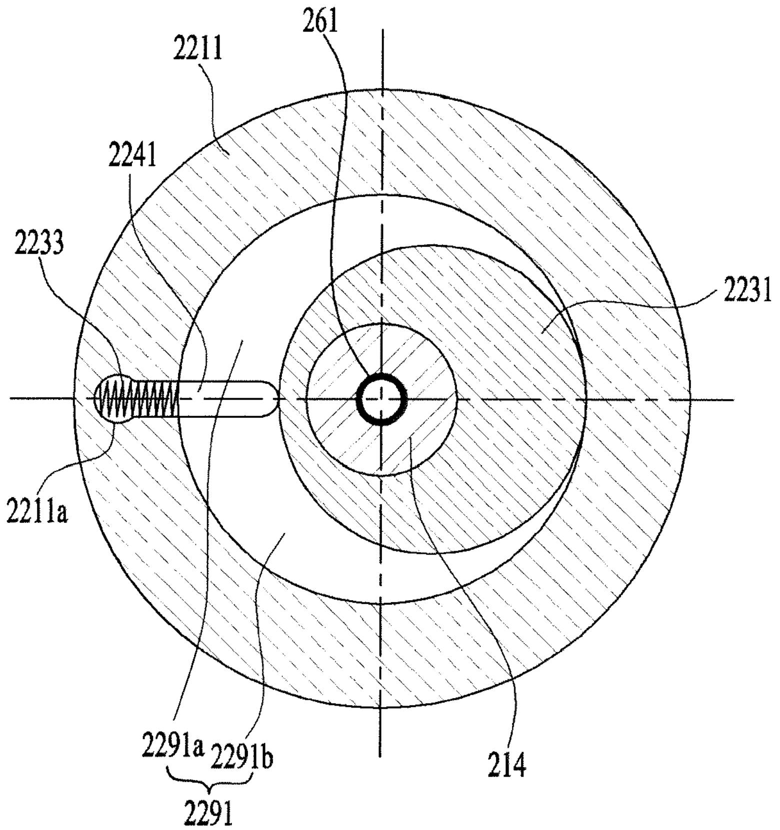
【FIG. 7】



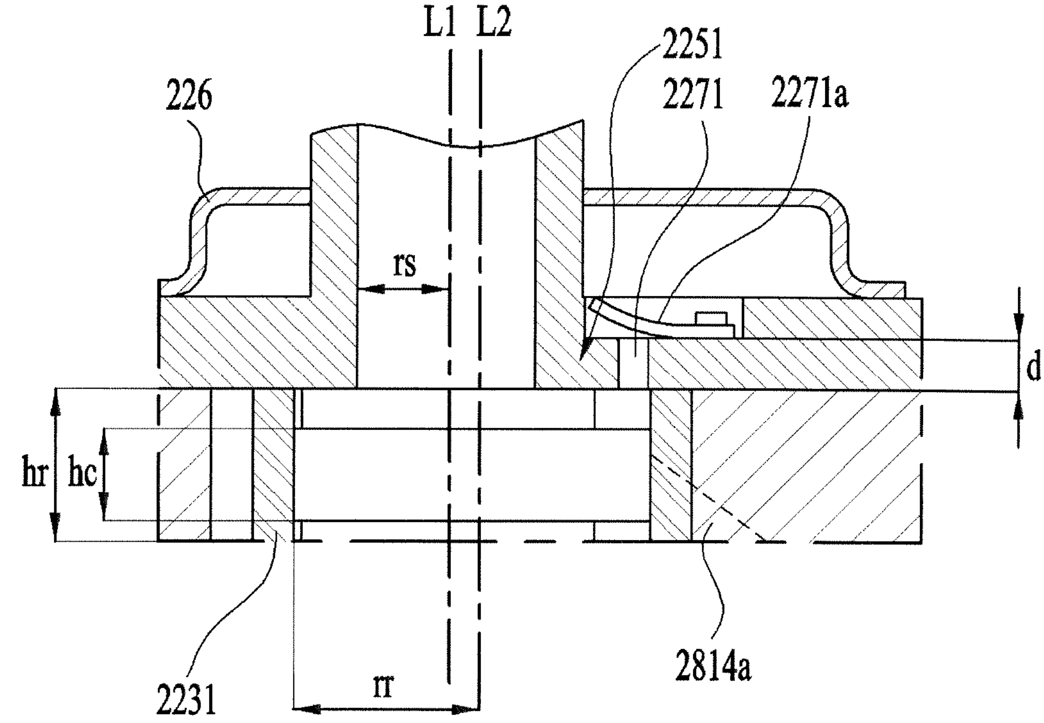
【FIG. 8】


200
218
2281
201
2282
280
203
216
217
214
8A
2231
2251
2211
2814a
8B
281
2223
228
2212
2814b
2232
202
290
2252
z
y
x

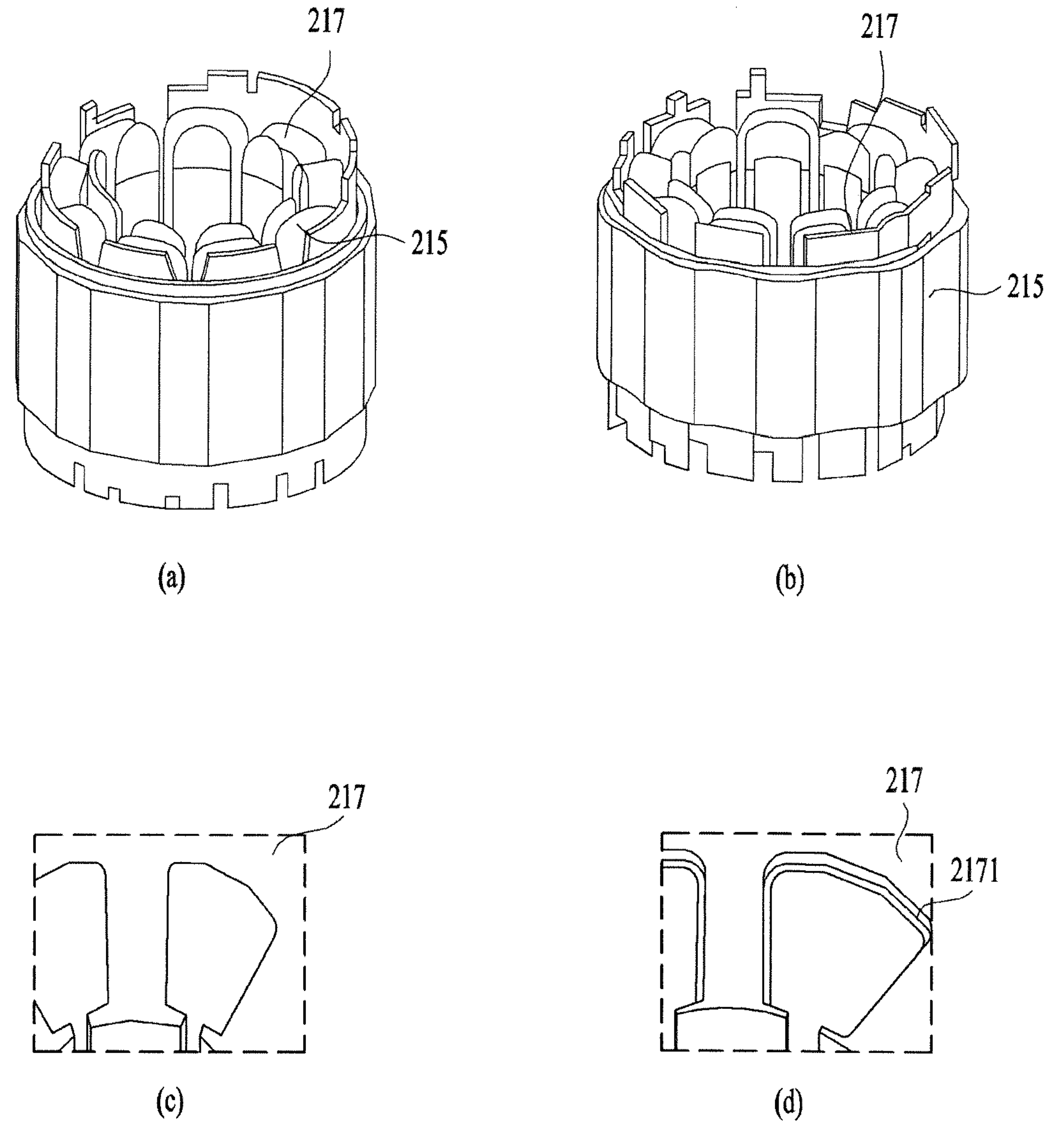
【FIG. 9】



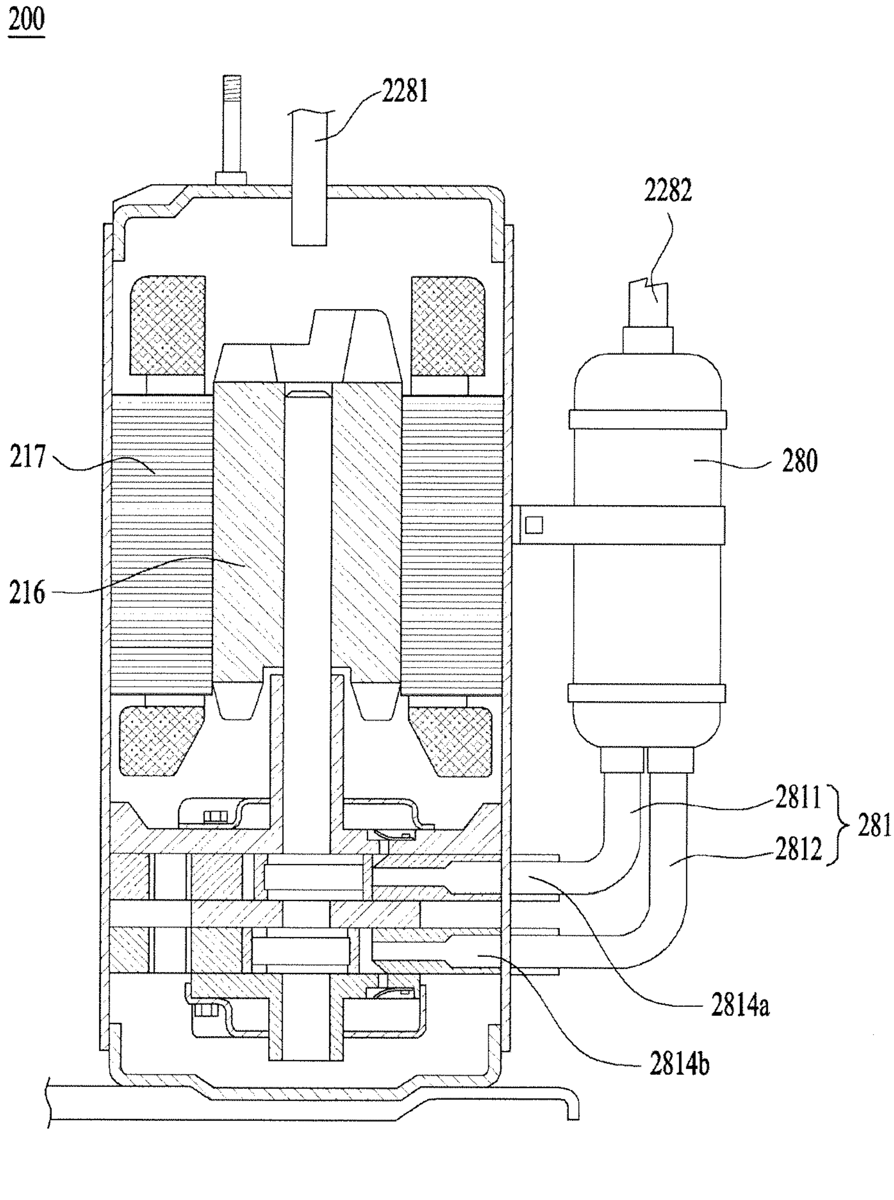
【FIG. 10】



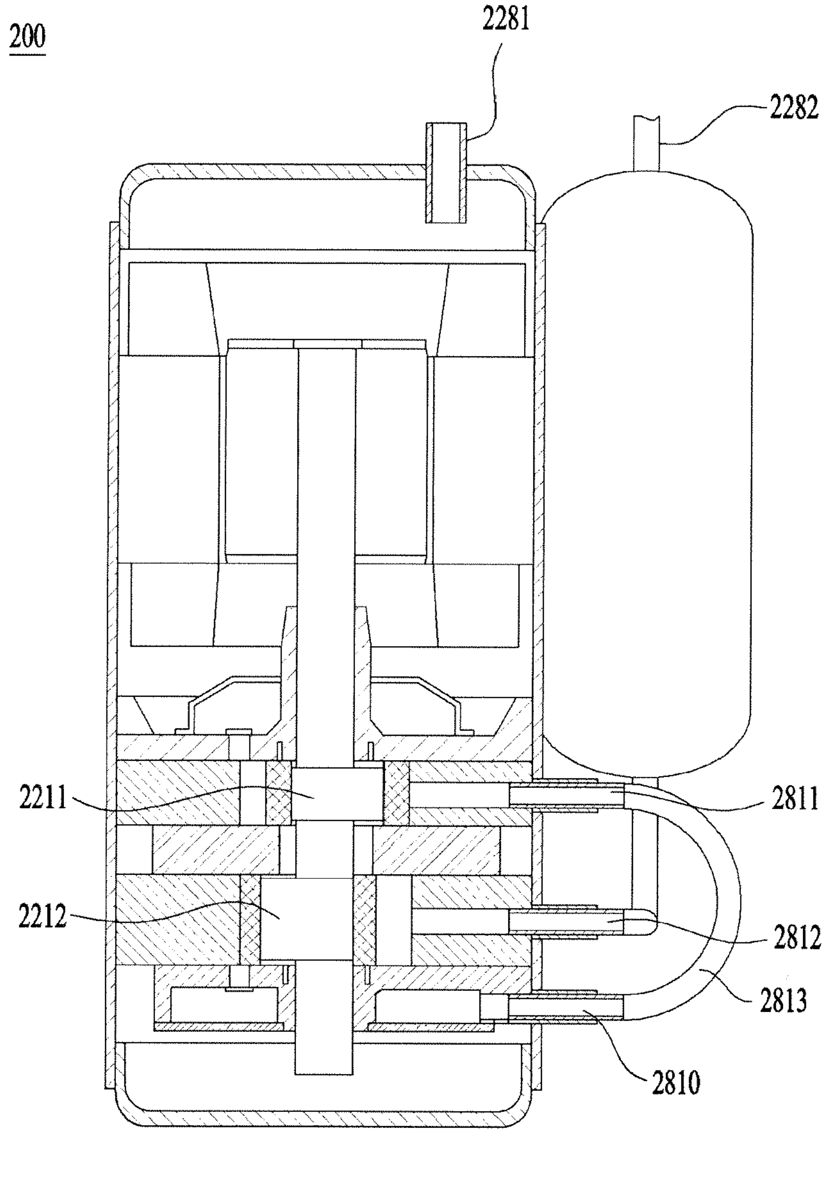
【FIG. 11】



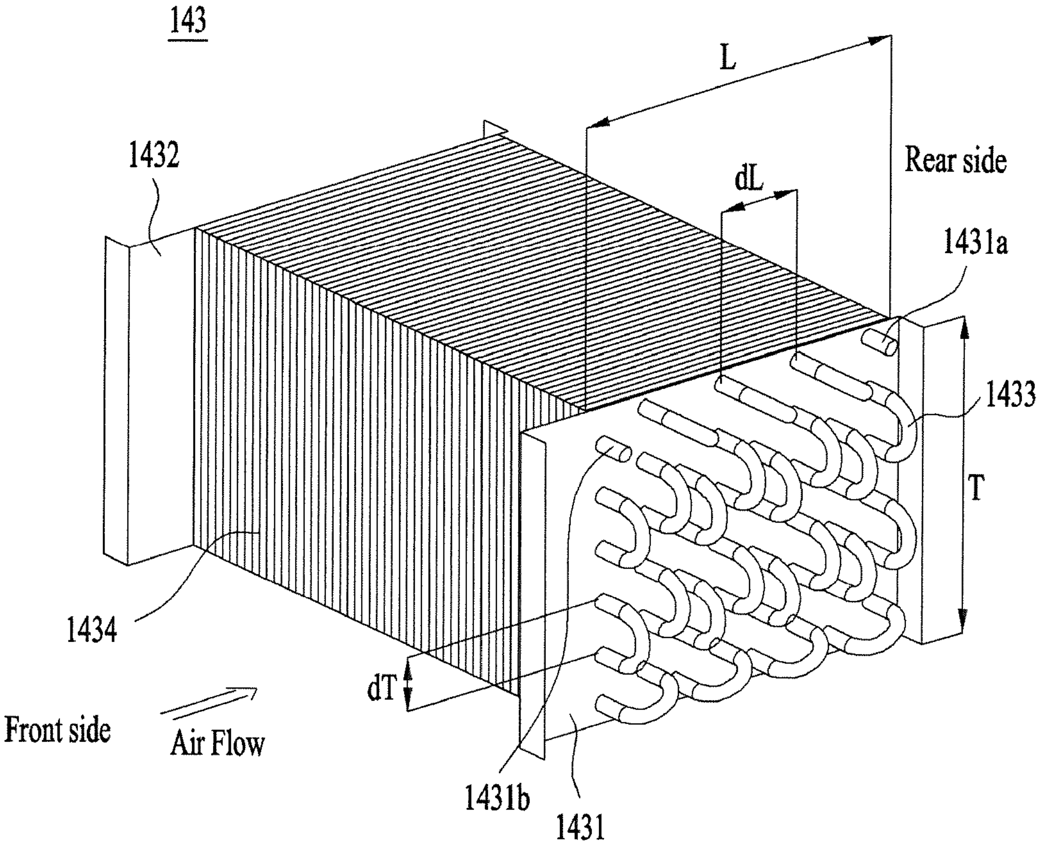
【FIG. 12】



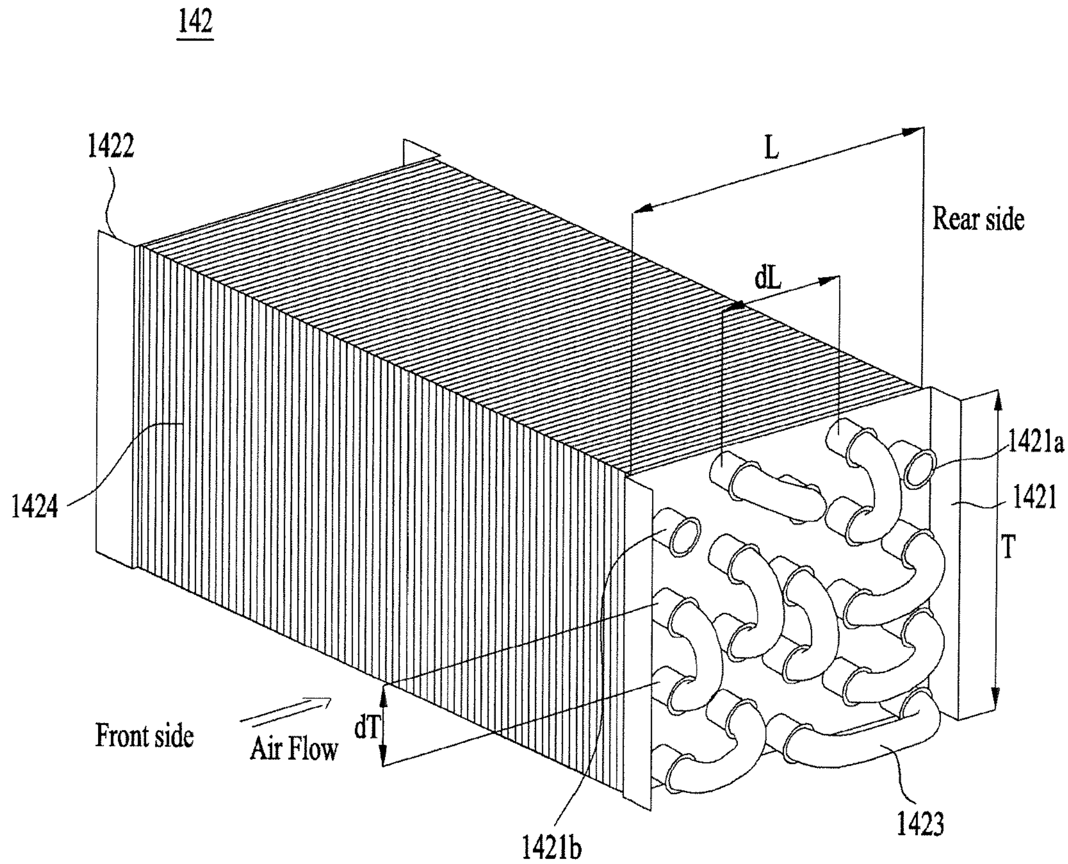
【FIG. 13】



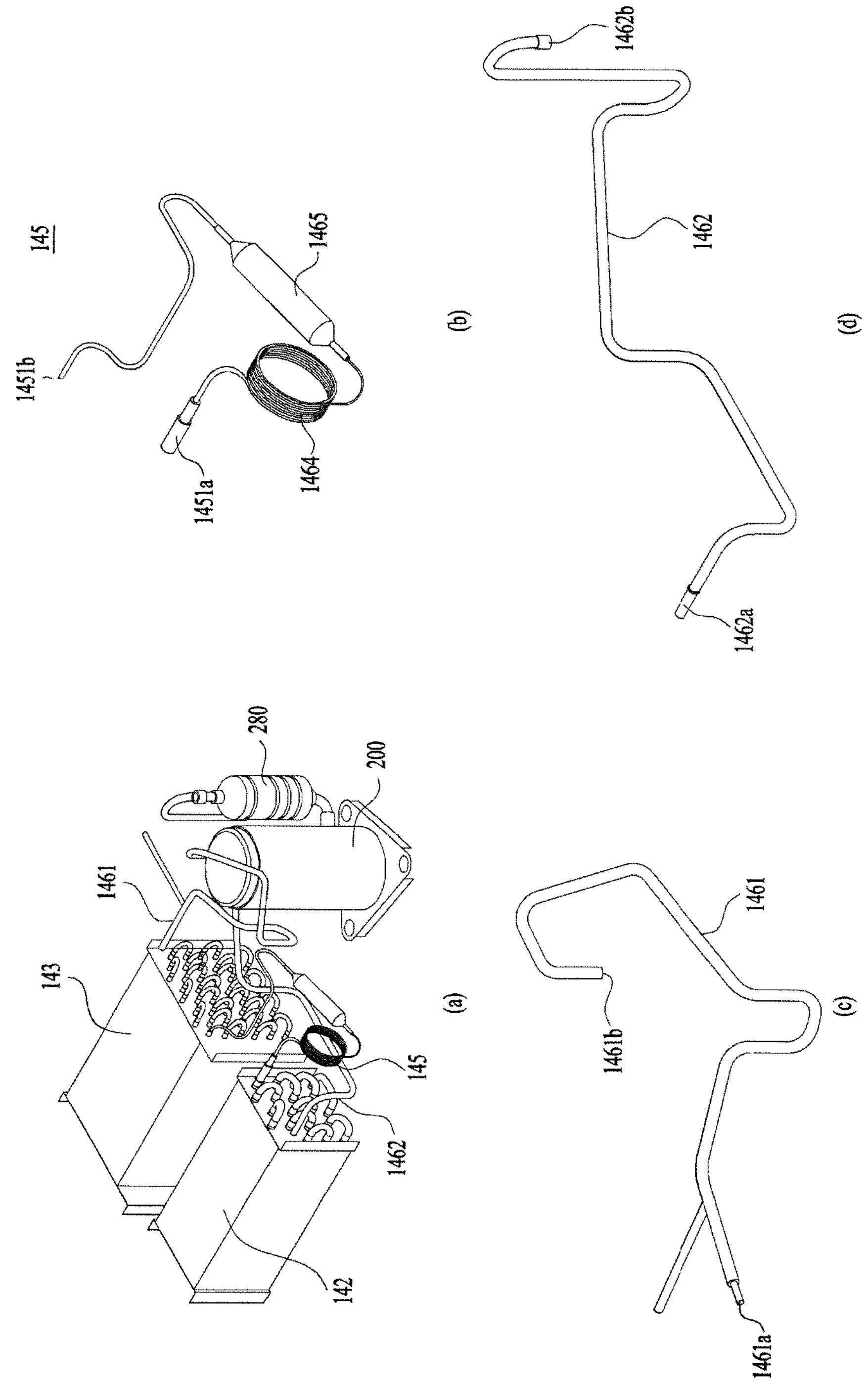
【FIG. 14】


143
L
1432
Rear side
dL
1431a
1433
T
1434
dT
Front side
Air Flow
1431b
1431

【FIG. 15】


142
1422
L
Rear side
dL
1421a
1424
1421
T
Front side
Air Flow
dT
1421b
1423

【FIG. 16】


145
1451b
1465
1451a
1464
(b)
1462b
1462
1462a
(d)
143
1461
280
200
145
1462
142
(a)
1461b
1461
1461a
(c)

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 20 18 2565

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y A	US 2004/107595 A1 (SANYO ELECTRIC CO [US]) 10 June 2004 (2004-06-10) * paragraphs [0006], [0026], [0029]; claims; figures * -----	1,3-12, 15 3,4,7,8, 12-14 2	INV. D06F58/20 ADD. F04C18/356 F04C23/00
X A	US 2012/174618 A1 (PANASONIC CORP [JP]) 12 July 2012 (2012-07-12) * paragraphs [0065], [0120]; claims; figures * -----	1-10 11-15	
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Place of search	Date of completion of the search	Examiner
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