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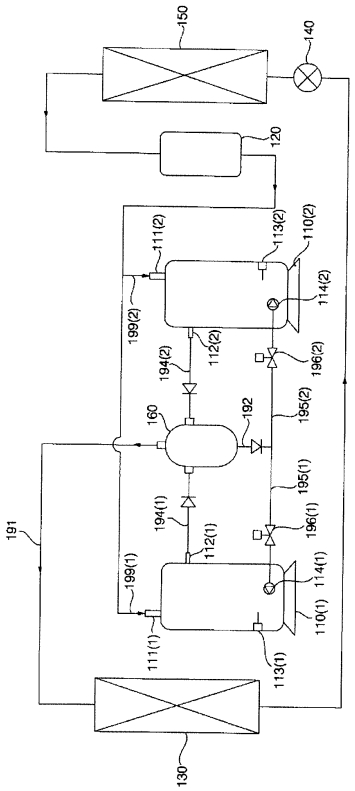
(54) **AIR CONDITIONER**

(57) The present invention relates to an air conditioner in which oils mixed in the refrigerant compressed by a plurality of compressors are separated together and recovered in an efficient manner. An air conditioner according to an embodiment of the present invention comprises: a plurality of compressors for compressing refrigerant; an oil separator connected to the plurality of compressors so as to separate oils mixed with the refrigerant compressed by the plurality of compressors; an oil discharge pipe connected to the oil separator so as to discharge the oils separated by the oil separator, and a plurality of oil recovery pipes branched from the oil discharge pipe so as to recover the oils separated by the oil separator to the plurality of compressors.

Fig. 1



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Description

[Technical Field]

[0001] The present invention relates to an air conditioner, and more particularly, to an air conditioner in which oil mixed with refrigerant compressed by a plurality of compressors is separated altogether for recovering the oil, effectively.

[Background Art]

[0002] In general, the air conditioner is a machine for cooling or heating a room by using a refrigerating cycle including a compressor, an outdoor heat exchanger, an expansion device, and an indoor heat exchanger. That is, the air conditioner may have a room cooler for cooling the room, and a room heater for heating the room. And, the air conditioner may be a room cooling and heating air conditioner for cooling or heating the room.

[0003] In the air conditioners, there may be an ordinary air conditioner in which one indoor unit is connected to one outdoor unit, or a multi-type air conditioner in which a plurality of the indoor units are connected to at least one outdoor unit.

[0004] In general, the multi-type air conditioner is used for selective air conditioning of a plurality of spaces partitioned in a building, and provided with a plurality of compressors for selective operation of the compressors as many as required numbers of the compressors according to a total air conditioning load.

[0005] The compressor, a machine for compressing the refrigerant, has a large amount of the oil for preventing friction portions of operational parts from wearing, cooling a portion of heat generated in compression, spreading fatigue of metal parts, and preventing the refrigerant compressed thus from leaking by forming an oil film at a sealing line. The oil in the compressor is mixed with the refrigerant as the refrigerant is compressed in the compressor. If the refrigerant flows in a state the oil is mixed with the refrigerant, the oil is collected at one side of a flow passage to interfere with a refrigerant flow, to reduce the amount of the oil in the compressor making a performance of the compressor poor.

[0006] Consequently, the air conditioner has an oil separator provided thereto for separating the oil from the refrigerant discharged from the compressor and returning the oil to the compressor. If the compressor is provided in plural, the oil separator is also provided in plural for the plurality of the oil separators to separate the oil from the plurality of compressors, respectively.

[0007] If the plurality of compressors are operated altogether, since respective oil separators separate and recover the refrigerant from respective compressors, differences of oil levels take place among the compressors. If shortage of the oil takes place, the shortage of oil is liable to cause something wrong at the compressor. And, if the oil is excessive, required power of a motor in the compressor may be increased, reducing efficiency of the compressor.

[Disclosure]

[Technical Problem]

[0008] To solve the problems, an object of the present invention is to provide an air conditioner in which oil mixed with refrigerant compressed by a plurality of compressors is separated altogether for recovering the oil, effectively.

[0009] Additional advantages, objects, and features of the disclosure 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.

[Technical Solution]

[0010] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, an air conditioner includes a plurality of compressors for compressing refrigerant, an oil separator connected to the plurality of compressors for separating oil mixed with the refrigerant as the compressed refrigerant is mixed with the oil at the plurality of compressors, an oil discharge pipeline connected to the oil separator for discharging the oil separated at the oil separator, and a plurality of oil recovery pipelines which are branches from the oil discharge pipeline for recovering the oil separated at the oil separator to the plurality of compressors.

[0011] Details of other embodiments are included to the detailed description of the present invention and attached drawings.

[Advantageous Effects]

[0012] The air conditioner of the present invention has one or more than one of following advantageous effects.

[0013] First, since the oil mixed with the refrigerant compressed at the plurality of compressors is separated with one oil separator altogether and recovered to the compressor which requires the oil, the air conditioner of the present invention has an advantage of resolving imbalance of the oil.

[0014] Second, since the oil mixed with the refrigerant compressed at the plurality of compressors is separated with one oil separator altogether, the air conditioner of the present invention also has an advantage of enabling to reduce an amount of the oil the compressor has.

[0015] Third, since the oil mixed with the refrigerant compressed at the plurality of compressors is introduced one oil separator efficiently, the air conditioner of the present invention also has an advantage of efficient separation of the oil mixed with the refrigerant.

[0016] Fourth, since the oil level sensor provided in the compressor, the air conditioner of the present invention

also has an advantage of controlling the recovery of the oil according to an oil level.

[0017] Fifth, since the compressor has the oil pump provided thereto, the air conditioner of the present invention also has an advantage of efficient recovery of the oil.

[0018] Sixth, since the oil is recovered to the refrigerant inlet port of the compressor, the air conditioner of the present invention also has an advantage of efficient recovery of the oil.

[0019] The advantages of the present invention are not limited to the effects described above, but other advantages not described herein will become apparent to persons skilled in this field of art from recitation of the claims.

[Description of Drawings]

[0020]

FIG. 1 illustrates a block diagram of an air conditioner in accordance with a preferred embodiment of the present invention;

FIG. 2 illustrates a perspective view of an oil separator in accordance with a preferred embodiment of the present invention, having a cut-away portion;

FIG. 3 illustrates a section of the oil separator in FIG. 2 across a line A-A';

FIG. 4 illustrates a side view of the oil separator in FIG. 2; and

FIG. 5 illustrates a block diagram of an air conditioner in accordance with another preferred embodiment of the present invention.

[Best Mode]

[0021] Advantages, features, and methods for achieving those will become apparent upon reviewing embodiments described later together with attached drawings. However, the present invention is, not limited to embodiments disclosed hereinafter, but may be embodied in modes different from one another, and the embodiments are provided to make disclosure of the present invention perfect, and to notify persons skilled in this field of art of a scope of present invention, perfectly. The present invention will only be defined with a scope of the claim of the present invention. Throughout the specification, the same reference numbers will refer to the same or like parts.

[0022] The air conditioner in accordance with a preferred embodiment of the present invention will be described with reference to the attached drawings.

[0023] FIG. 1 illustrates a block diagram of an air conditioner in accordance with a preferred embodiment of the present invention.

[0024] The air conditioner in accordance with a preferred embodiment of the present invention includes a plurality of compressors 110 for compressing refrigerant, a condenser 130 for the refrigerant compressed thus to be condensed as the refrigerant heat exchanges with air, an expansion device 140 for the refrigerant condensed thus to be expanded, an evaporator 150 for the refrigerant expanded thus to be vaporized as the refrigerant heat exchanges with the air, and an oil separator 160 for separating oil from the refrigerant compressed by, and discharged from, the plurality of compressors 110. There may be a gas-liquid separator 120 between the evaporator 150 and the plurality of compressors 110 for separating liquid refrigerant from gas refrigerant.

[0025] If the air conditioner is operated in a room cooler, the condenser 130 corresponds to the outdoor unit heat exchanger which is arranged outdoors for heat exchange between the refrigerant and outdoor air, and the evaporator 150 corresponds to the indoor heat exchanger which is arranged indoors for heat exchange between the refrigerant and room air. If the air conditioner is operated in a room heater, the condenser 130 corresponds to the indoor heat exchanger which is arranged in the room for heat exchange between the refrigerant and the room air, and the evaporator 150 corresponds to the outdoor heat exchanger which is arranged outdoors for heat exchange between the refrigerant and the outdoor air.

[0026] The plurality of compressors 110 compress the low temperature and low pressure refrigerant being introduced thereto to high temperature and high pressure refrigerant. The plurality of compressors 110 may have a variety of structures applied thereto, wherein inverter type compressors or constant speed compressors may be employed. In the embodiment, the plurality of compressors 110 include a first compressor 110(1) and a second compressor 110(2). It is preferable that both of the first compressor 110(1) and the second compressor 110(2) are the inverter type compressors which vary compression performances with operation states.

[0027] The compressor 110 includes a refrigerant inlet port 111 for introducing the refrigerant therethrough, a refrigerant outlet port 112 for discharging compressed refrigerant therethrough, an oil level sensor 113 for measuring a height of the oil in the compressor 110, and an oil pump 114 for making the oil to flow into the compressor 110.

[0028] The refrigerant inlet port 111, a port for introduction of the refrigerant, is connected to a suction pipeline 119. The refrigerant which passes the gas-liquid separator 120 and flows through the suction pipeline 199 is introduced to the refrigerant inlet port 111. The first compressor 110(1) includes a first refrigerant inlet port 111(1), and the second compressor 110(2) includes a second refrigerant inlet port 111(2). The first refrigerant inlet port 111(1) is connected to a first suction pipeline 199(1), and the second refrigerant inlet port 111(2) is connected to a second suction pipeline 199(2).

[0029] The refrigerant outlet port 112 discharges the refrigerant compressed in the compressor. The refrigerant outlet port 112 is connected to a refrigerant discharge pipeline 194. The refrigerant outlet port 112 discharges the oil in the compressor 110 together with the compressed refrigerant. The refrigerant mixed with the oil be-

ing discharged from the refrigerant outlet port 112 flows to the oil separator 160 through the refrigerant discharge pipeline 194. The first compressor 110(1) includes a first refrigerant outlet port 112(1), and the second compressor 110(2) includes a second refrigerant outlet port 112(2). The first refrigerant outlet port 112(1) is connected to the first refrigerant discharge pipeline 194(1), and the second refrigerant outlet port 112(2) is connected to the second refrigerant discharge pipeline 194(2).

[0030] The oil level sensor 113 measures a height of the oil in the compressor 110. The compressor 110 has the oil provided therein for lubrication and cooling of machine parts required for compression of the refrigerant. The oil is filled on a bottom of the compressor 110 and pumped when the compressor 110 is driven. The oil level sensor 113 measures the height of the oil on the bottom in the compressor 110. Depending on the height of the oil measured by the oil level sensor 113, whether an oil recovery valve 196 to be described later is opened or closed is determined. The first compressor 110(1) includes a first oil level sensor 113(1), and the second compressor 110(2) includes a second oil level sensor 113(2).

[0031] The oil pump 114 is connected to an oil recovery pipeline 195 for introduction of the oil separated at the oil separator 160 to an inside of the compressor 110. The oil pump 114 is provided in the compressor 110 for filling the oil separated at the oil separator 160 to the bottom of the compressor 110. It is preferable that the oil pump 114 is provided to place in the compressor 110 lower than the oil level sensor 113. The first compressor 110(1) includes a first oil pump 114(1) and the second compressor 110(2) includes a second oil pump 114(2).

[0032] It is preferable that the oil pump 114 is a trochoid pump for pressurized transfer of the oil. It is preferable that the oil pump 114 is provided if the compressor 110 is of a high pressure type, and the oil pump may be omitted if the compressor 110 is of a low pressure type. It is preferable that the oil recovery pipeline 195 is connected to the compressor 110 directly if the compressor 110 is of the low pressure type.

[0033] And, the oil pump 114 may be a pump, not provided separately, but provided in the compressor 110 for pumping the oil from the bottom of the compressor to an upper side. It is preferable that such a pump is a trochoid pump for pressurized transfer of the oil to the upper side. As the oil is made pressurized transfer to the upper side from the inside of the compressor 110, the compressor 110 draws in the oil from the oil recovery pipeline 195. In this case, the oil recovery pipeline 195 is connected to the oil pump 144, not directly.

[0034] The oil separator 160 is connected to the plurality of compressors 110 for having the refrigerant compressed at the plurality of compressors 110 introduced thereto in forms of arcs and mixed as the refrigerant swirls that separates the oil from the refrigerant. A detailed structure of the oil separator 160 will be described later with reference to FIGS. 2 to 4. The oil separator 160 is provided singular and connected both to the first compressor 110(1) and the second compressor 110(2).

[0035] The oil separator 160 and the plurality of compressors 110 are connected with a plurality of refrigerant discharge pipelines 194. The plurality of refrigerant discharge pipelines 194 are connected to the refrigerant outlet ports 112 of the plurality of compressors 110, respectively. It is preferable that the plurality of refrigerant discharge pipelines 194 have check valves provided thereto for preventing the refrigerant from flowing in a reverse direction, respectively. The plurality of refrigerant discharge pipelines 194 include a first refrigerant discharge pipeline 194(1) which connects the first compressor 110(1) to the oil separator 160, and a second refrigerant discharge pipeline 194(2) which connects the second compressor 110(2) to the oil separator 160.

[0036] The oil separated at the oil separator 160 is discharged to an oil discharge pipeline 192. The oil discharge pipeline 192 is connected to the oil separator 160 for discharging the oil separated at the oil separator 160. The oil discharge pipeline 192 is branched to a plurality of the oil recovery pipelines 195. It is preferable that the oil discharge pipeline 192 has a check valve provided thereto for preventing the oil from flowing in a reverse direction.

[0037] The refrigerant having the oil separated therefrom at the oil separator 160 is discharged to a discharge pipeline 191. The refrigerant discharged to a discharge pipeline 191 thus flows to the condenser 13. The discharge pipeline 191 connects the oil separator 160 to the condenser 130.

[0038] The oil recovery pipeline 195 is a pipeline for flowing of the oil separated at the oil separator 160 until the oil is recovered to the compressor 110. The oil recovery pipeline 195 connects the oil discharge pipeline 192 to the compressor 110. The oil recovery pipeline 195 is connected to the compressor 110, and may be connected to the oil pump 114, directly.

[0039] The oil recovery pipeline 195 is provided in plural, and the plurality of the oil recovery pipelines 195 are connected to the oil discharge pipeline 192. The plurality of the oil recovery pipelines 195 are branches from the oil discharge pipeline 192 for recovering the oil separated at the oil separator 160 to the plurality of compressors 110.

[0040] The plurality of the oil recovery pipelines 195 include a first oil recovery pipeline 195(1) connected between the oil discharge pipeline 192 and the first compressor 110(1), and a second oil recovery pipeline 195(2) connected between the oil discharge pipeline 192 and the second compressor 110(2).

[0041] The oil recovery valve 196 is mounted to the oil recovery pipeline 195 for opening/closing the oil recovery pipeline 195. The oil recovery valve 196 allows or blocks recovery of the oil separated at the oil separator 160 to the compressor 110. The oil recovery valve 196 is opened or closed depending on the height of the oil measured at the oil level sensor 113. If the oil in the compressor 110 connected to the oil recovery pipeline 195 having the oil

recovery valve 196 provided thereto is below the oil level sensor 113, the oil recovery valve 196 is opened, and, if above the oil level sensor 113, the oil recovery valve 196 is closed.

[0042] The oil recovery valve 196 is provided in plural, and the plurality of oil recovery valves 196 are mounted to the plurality of the oil recovery pipelines 195 for opening/closing the plurality of the oil recovery pipelines 195, respectively. The plurality of oil recovery valves 196 include a first oil recovery valve 196(1) mounted to the first oil recovery pipeline 195(1), and a second oil recovery valve 196(2) mounted to the second oil recovery pipeline 195(2).

[0043] The first oil recovery valve 196(1) is opened when the height of the oil in the first compressor 110(1) is below the first oil level sensor 113(1), and is closed when above the first oil level sensor 113(1). Alikely, the second oil recovery valve 196(2) is opened when the height of the oil in the second compressor 110(2) is below the second oil level sensor 113(2), and is closed when above the second oil level sensor 113(2).

[0044] The gas-liquid separator 120 separates gas refrigerant and liquid refrigerant from the refrigerant evaporated at the evaporator 150. The gas refrigerant separated at the gas-liquid separator 120 flows to the plurality of suction pipelines 199. The plurality of suction pipelines 199 include a first suction pipeline 199(1) connected to the first compressor 110(1) and a second suction pipeline 199(2) connected to the second compressor 110(2).

[0045] The operation of the air conditioner of the present invention having the foregoing configuration will be described.

[0046] The refrigerant compressed at the plurality of compressors 110 is discharged through respective refrigerant outlet ports 112 together with the oil. The refrigerant and oil discharged through the refrigerant outlet ports 112 of the plurality of compressors 110 is introduced to the oil separator 160 through the plurality of refrigerant discharge pipelines 194.

[0047] The oil separator 160 separates the oil from the refrigerant. The refrigerant having the oil separated therefrom at the oil separator 160 is discharged to the discharge pipeline 191. The oil separated at the oil separator 160 thus is discharged to the oil discharge pipeline 192.

[0048] The oil discharged to the oil discharge pipeline 192 thus flows varied with the oil heights in the plurality of compressors 110 measured at the plurality of the oil level sensors 113.

[0049] If the oil height in the first compressor 110(1) is below the first oil level sensor 113(1), and the oil height in the second compressor 110(2) is above the second oil level sensor 113(2), the first oil recovery valve 196(1) is opened, and the second oil recovery valve 196(2) is closed. In this case, the oil separated at the oil separator 160 thus is recovered to the first compressor 110(1), entirely. That is, the oil separated at the oil separator 160 thus is recovered to the first compressor 110(1) by the first oil pump 114(1) through the oil discharge pipeline 192 and the first oil recovery pipeline 195(1).

[0050] If the oil height in the first compressor 110(1) is above the first oil level sensor 113(1), and the oil height in the second compressor 110(2) is below the second oil level sensor 113(2), the first oil recovery valve 196(1) is closed, and the second oil recovery valve 196(2) is opened. In this case, the oil separated at the oil separator 160 thus is recovered to the second compressor 110(2), entirely. That is, the oil separated at the oil separator 160 thus is recovered to the second compressor 110(2) by the second oil pump 114(2) through the oil discharge pipeline 192 and the second oil recovery pipeline 195(2).

[0051] If the oil height in the first compressor 110(1) is below the first oil level sensor 113(1), and the oil height in the second compressor 110(2) is below the second oil level sensor 113(2), the first oil recovery valve 196(1) is opened, and the second oil recovery valve 196(2) is also opened. In this case, the oil separated at the oil separator 160 thus is recovered to the first compressor 110(1) and the second compressor 110(2). That is, the oil separated at the oil separator 160 thus is discharged to the oil discharge pipeline 192, such that oil flowing to the first oil recovery pipeline 195(1) is recovered to the first compressor 110(1) by the first oil pump 114(1), and oil flowing to the second oil recovery pipeline 195(2) is recovered to the second compressor 110(2) by the second oil pump 114(2).

[0052] FIG. 2 illustrates a perspective view of an oil separator in accordance with a preferred embodiment of the present invention, having a cut-away portion, FIG. 3 illustrates a section of the oil separator in FIG. 2 across a line A-A', and FIG. 4 illustrates a side view of the oil separator in FIG. 2.

[0053] The oil separator 160 in accordance with a preferred embodiment of the present invention includes a cylindrical case 161 having a circular horizontal direction section, a plurality of suction pipes 164 for introduction of the refrigerant having the oil mixed therewith into the case 161, a refrigerant discharge pipe 163 inserted in the case 161 from a top side thereof in a vertical direction for discharging the refrigerant to an inside of the case 161, and an oil outlet pipe 165 connected to a lower side of the case 161 for discharging the oil from the inside of the case 161.

[0054] The cylindrical case 161 forms an enclosed housing space. The case 161 has a circular horizontal direction section. In this case, the horizontal direction section of the case 161 may not be a perfect circle, but have a form which is close to a circle, substantially.

[0055] In this case, the horizontal direction means a direction perpendicular to a direction of gravity that is a height direction of the cylindrical case 161, and a vertical direction means a height direction of the case 161 which is the gravity direction.

[0056] The case 161 has a side having a plurality of the suction pipes 164 connected thereto, the top side having the refrigerant discharge pipe 163 connected

thereto, and the lower side having the oil outlet pipe 165 connected thereto. The case 161 is supported by a supporting member 162 on a ground surface. It is preferable that the supporting member 162 is coupled to a ground surface of the outdoor unit (Not shown) having the compressor 110 of the air conditioner mounted thereto.

[0057] The plurality of the suction pipes 164 are connected to the case 161 for serving as passages to introduce the refrigerant having the oil contained therein into the case 161. The plurality of the suction pipes 164 guide the refrigerant compressed at the plurality of compressors 110 so as to be introduced into the case 161 and mixed therein. The plurality of the suction pipes 164 are connected to the plurality of refrigerant discharge pipelines 194 to which the refrigerant compressed at the plurality of compressors 110 is discharged, respectively. Respective suction pipes 164 and refrigerant discharge pipelines 194 may be formed as one unit respectively or may be connected to connection portions of the case 161, respectively.

[0058] The plurality of suction pipes 164 are inserted in the side of the case 161. It is preferable that the plurality of suction pipes 164 are connected to the case 161 on an upper side of the side of the case 161.

[0059] Referring to FIG. 3, each of the plurality of suction pipes 164 is bent in the case 161 in conformity with an inside surface of the case 161. The plurality of suction pipes 164 guide the refrigerant having the oil mixed therewith so as to be introduced to, and to swirl within, the case 161.

[0060] Upon passing the bent suction pipes 164, the refrigerant having the oil mixed therewith swirls such that the oil having relatively large mass moves toward an inside surface of the case 161 which is a radial direction by centrifugal force. When the oil comes into contact with the inside surface of the case 161, the oil flows down in the vertical direction that is the gravity direction along the inside surface of the case 161 and discharged through the oil outlet pipe 165.

[0061] The plurality of suction pipes 164 are formed in arc forms in the case 161, respectively. In this case, it is preferable that the plurality of suction pipes 164 have curvatures the same with the horizontal direction section of the case 161 in the horizontal direction, respectively. The refrigerant compressed at the compressor 110 is introduced to the case 161 in the arc form according to the arc formed suction pipe 164, and swirls to separate the oil from the refrigerant.

[0062] The suction pipe 164 has the arc form formed started from a suction pipe connection portion 164b at which the suction pipe 164 is connected to the case 161 to a suction pipe end portion 164a through which the oil is discharged. It is preferable that the suction pipe 164 has the arc with a center angle below 90° started from the suction pipe connection portion 164b to the suction pipe end portion 164a.

[0063] If the refrigerant having the oil mixed therewith flows in the arc formed suction pipe 164, flows of the refrigerant entangle to cause collision among oil particles owing to a secondary flow, which leads to form large liquid drops. The oil which becomes to have the large liquid drops becomes to have stronger centrifugal force to allow easy separation of the oil. In this case, if the suction pipe is too long, since liquid drops become too large which are liable to be accumulated in the suction pipe 164, it is preferable that the suction pipe 164 in the case 161 has the arc form with the center angle below 90°. Moreover, it is preferable that each of the plurality of suction pipes 164 has the arc form with the center angle below 90° for preventing the plurality of suction pipes 164 from interfering with one another in the case 161.

[0064] Referring to FIG. 4, each of the plurality of suction pipes 164 may be bent within the case 161 in the horizontal direction as well as to an upper side in conformity with the inside surface of the case 161. In this case, the upper side is a direction opposite to the gravity direction. The suction pipe 164 may have the suction pipe end portion 164a formed to be positioned higher than the suction pipe connection portion 164b.

[0065] If the refrigerant having the oil mixed therewith flows along the suction pipe 164 and is discharged therefrom, since the refrigerant flows in a form of a helix while swirling downward by the gravity, the oil is separated from the refrigerant. In this case, if the refrigerant flows along the suction pipe 164 which is bent upward and is discharged upward, extending a swirling time period of the refrigerant longer than a case when the refrigerant is discharged horizontally, more oil can be separated.

[0066] If each of the plurality of suction pipes 164 is bent upward, each of the plurality of suction pipes 164 will have an arc formed projected form to a horizontal plane in the case 161, and will also have the arc formed projected form to a vertical plane. In this case, it is preferable that each of the plurality of suction pipes 164 has the form projected to the horizontal plane the same with a curvature of the horizontal direction section of the case 161.

[0067] The plurality of suction pipes 164 include a first suction pipe 164(1) inserted in the side of the case 161, and a second suction pipe 164(2) inserted in an opposite side of the first suction pipe 164(1) in the side of the case 161.

[0068] The first suction pipe 164(1) guides the refrigerant compressed at the first compressor 110(1) to be introduced to an inside of the case 161, and the second suction pipe 164(2) guides the refrigerant compressed at the second compressor 110(2) to be introduced to an inside of the case 161. The first suction pipe 164(1) is connected to the first refrigerant discharge pipeline 194(1), and the second suction pipe 164(2) is connected to the second refrigerant discharge pipeline 194(2).

[0069] The first suction pipe connection portion 164b(1) of the first suction pipe 164(1), and the second suction pipe connection portion 164b(2) of the second suction pipe 164(2) are arranged symmetrically opposite to each other with respect to the refrigerant discharge

pipe 163. The first suction pipe connection portion 164b (1) and the second suction pipe connection portion 164b (2) are arranged on a line which passes a center of the horizontal section of the case 161. That is, the first suction pipe connection portion 164b(1) and the second suction pipe connection portion 164b(2) are arranged on a diametral line of the horizontal direction section of the case 161.

[0070] The first suction pipe 164(1) and the second suction pipe 164(2) are bent in the same direction within the case 161. Both of the first suction pipe 164(1) and the second suction pipe 164(2) are bent in a clockwise direction or an anticlockwise direction when seen in the horizontal direction. In the embodiment, both of the first suction pipe 164(1) and the second suction pipe 164(2) are bent in the anticlockwise direction when seen from above to guide the refrigerant to swirl in the anticlockwise direction. Moreover, both of the first suction pipe 164(1) and the second suction pipe 164(2) may be bent upward within the case 161.

[0071] The first suction pipe 164(1) and the second suction pipe 164(2) are formed to be symmetry to each other with respect to the refrigerant discharge pipe 163. It is preferable that the first suction pipe 164(1) and the second suction pipe 164(2) are formed to have the same length and bent in the same direction within the case 161.

[0072] The first suction pipe end portion 164a(1) of the first suction pipe 164(1) and the second suction pipe end portion 164a(2) of the second suction pipe 164(2) are arranged on opposite sides to each other with respect to the refrigerant discharge pipe 163. The first suction pipe end portion 164a(1) and the second suction pipe end portion 164a(2) are arranged on a line passing through a center of the horizontal direction section of the case 161. That is, the first suction pipe end portion 164a(1) and the second suction pipe end portion 164a(2) are arranged on a diametral line of the horizontal direction section of the case 161.

[0073] The refrigerant discharge pipe 163 is inserted in the case 161 from a top side thereof in a vertical direction. It is preferable that the refrigerant discharge pipe 163 has an end portion which draws-in the refrigerant arranged lower than the plurality of suction pipes 164. The refrigerant passed through the plurality of suction pipes 164 flows in a helical form as the refrigerant swirls downward and is mixed, and, if the oil is separated, the refrigerant is discharged to an outside of the case 161 through the refrigerant discharge pipe 163.

[0074] The refrigerant discharge pipe 163 is connected to the discharge pipeline 191. The refrigerant discharge pipe 163 may be formed as one unit with the discharge pipeline 191 or may be connected to a case 161 connection portion. The refrigerant discharged to the refrigerant discharge pipe 163 flows to the condenser 130 along the discharge pipeline 191.

[0075] The oil outlet pipe 165 is connected to a lower side of the case 161. The oil which is separated from the refrigerant, flowed down on the inside surface of the case 161, and collected on a bottom of the case 161 is discharged to an outside of the case 161 through the oil outlet pipe 165.

[0076] The oil outlet pipe 165 is connected to the oil discharge pipeline 192. The oil outlet pipe 165 and the oil discharge pipeline 192 may be formed as one unit. The oil discharged to the oil outlet pipe 165 is recovered to the plurality of compressors 110 through the oil discharge pipeline 192, and the plurality of oil recovery pipelines 195.

[0077] The operation of the oil separator in accordance with the present invention having the foregoing configuration will be described.

[0078] The refrigerant containing the oil discharged from the first compressor 110(1) is introduced to an inside of the case 161 through the first suction pipe 164(1), and the refrigerant containing the oil discharged from the second compressor 110(2) is introduced to the inside of the case 161 through the second suction pipe 164(2).

[0079] The refrigerant introduced through the first suction pipe 164(1), and the refrigerant introduced through the second suction pipe 164(2) is mixed as the refrigerant flows downward while swirling in the same direction. If the refrigerant containing the oil swirls in the helical form, the oil is brought into contact with the inside surface of the case 161 by centrifugal force, flows down on the inside surface, and is discharged through the oil outlet pipe 165. The refrigerant having the oil separated therefrom is discharged through the refrigerant discharge pipe 163.

[0080] FIG. 5 illustrates a block diagram of an air conditioner in accordance with another preferred embodiment of the present invention.

[0081] A plurality of oil recovery pipelines 295 in the air conditioner in accordance with another preferred embodiment of the present invention are connected to refrigerant inlet ports 211 of a plurality of compressors 210, respectively. In this case, the plurality of compressors 210 are of a low pressure type which does not require the oil pump, separately.

[0082] The plurality of oil recovery pipelines 295 include a first oil recovery pipeline 295(1) connected to a first refrigerant inlet port 211(1) of a first compressor 210(1), and a second oil recovery pipeline 295(2) connected to a second refrigerant inlet port 211 (2) of a second compressor 210(2).

[0083] The refrigerant inlet port 211 is connected both to a suction pipeline 299 and an oil recovery pipeline 295 for having the refrigerant flowing to a suction pipeline 299 passed through the gas-liquid separator 120 and the oil flowing to the oil recovery pipeline 295 separated at an oil separator 260 introduced thereto.

[0084] Since the first oil recovery pipeline 295(1) is connected to a first suction pipeline 299(1), the first oil recovery pipeline 295(1) may be connected to the first refrigerant inlet port 211(1), and, since the second oil recovery pipeline 295(2) is connected to a second suction pipeline 299(2), the second oil recovery pipeline 295(2) may be connected to the second refrigerant inlet port

211(2).

[0085] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Claims

1. An air conditioner comprising:

a plurality of compressors for compressing refrigerant;
an oil separator connected to the plurality of compressors for separating oil mixed with the refrigerant as the compressed refrigerant is mixed with the oil at the plurality of compressors;
an oil discharge pipeline connected to the oil separator for discharging the oil separated at the oil separator; and
a plurality of oil recovery pipelines which are branches from the oil discharge pipeline for recovering the oil separated at the oil separator to the plurality of compressors.

2. The air conditioner as claimed in claim 1, further comprising a plurality of oil recovery valves mounted to the plurality of oil recovery pipelines for opening/closing the plurality of oil recovery pipelines, respectively.

3. The air conditioner as claimed in claim 2, wherein the compressor includes an oil level sensor for measuring an oil height in the compressor.

4. The air conditioner as claimed in claim 3, wherein the plurality of oil recovery valves are opened or closed depending on oil heights measured at the oil level sensors of the plurality of compressors, respectively.

5. The air conditioner as claimed in claim 3, wherein the oil recovery valve is opened when the oil in the compressor connected thereto is below the oil level sensor.

6. The air conditioner as claimed in claim 3, wherein the oil recovery valve is closed when the height of the oil in the compressor connected thereto is above the oil level sensor.

7. The air conditioner as claimed in claim 1, wherein the compressor includes an oil pump connected to the oil recovery pipeline for introduction of the oil to an inside of the compressor.

8. The air conditioner as claimed in claim 7, wherein the oil pump is provided in the compressor.

9. The air conditioner as claimed in claim 1, wherein the compressor includes a refrigerant inlet port for introduction of the refrigerant to the compressor and the oil recovery pipeline is connected to the refrigerant inlet port.

10. The air conditioner as claimed in claim 1, wherein the compressor includes a refrigerant outlet port for discharging compressed refrigerant, and further includes a plurality of refrigerant discharge pipelines connected between the refrigerant outlet ports of the plurality of compressors and the oil separator, respectively.

11. The air conditioner as claimed in claim 1, wherein the oil separator separates the oil mixed with the refrigerant as the refrigerant compressed at the plurality of compressors is introduced in arc forms and mixed while the refrigerant swirls.

12. The air conditioner as claimed in claim 1, wherein the oil
separator includes;
a cylindrical case,
a plurality of suction pipes for introduction of the refrigerant compressed at the plurality of compressors to an inside of the case,
a refrigerant discharge pipe inserted in the case from a top side thereof in a vertical direction for discharging the refrigerant from the inside of the case, and
an oil outlet pipe connected to a lower side of the case for discharging the oil from the inside of the case.

13. The air conditioner as claimed in claim 12, further comprising a plurality of refrigerant discharge pipelines connected between the compressors and the plurality of suction pipes, respectively.

14. The air conditioner as claimed in claim 12, wherein the plurality of suction pipes are connected to an upper side of a side of the case.

15. The air conditioner as claimed in claim 12, wherein each of the plurality of suction pipes is bent in the case in conformity with an inside surface of the case.

16. The air conditioner as claimed in claim 12, wherein each of the plurality of suction pipes is formed in an arc form in the case.

17. The air conditioner as claimed in claim 12, wherein each of the plurality of suction pipes is formed in an arc with a center angle of below 90° started from a connection portion at which the suction pipe is con-

nected to the case to an oil discharge end portion.

18. The air conditioner as claimed in claim 12, wherein each of the plurality of suction pipes has an end portion through which the oil is discharged formed to position higher than the connection portion at which the suction pipe is connected to the case.

Fig. 1

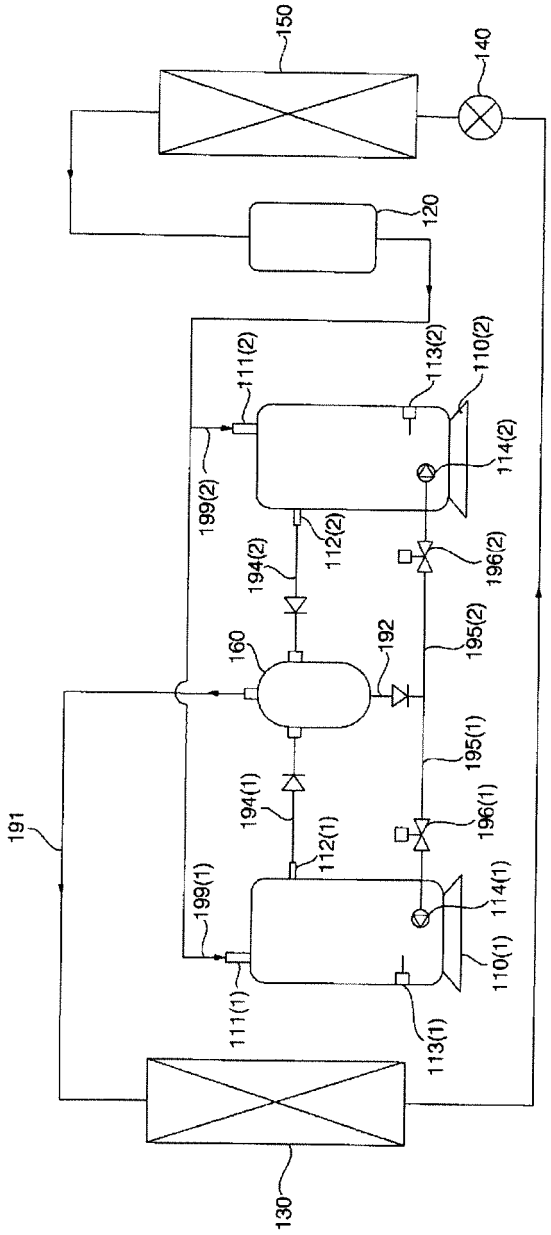
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Fig. 2

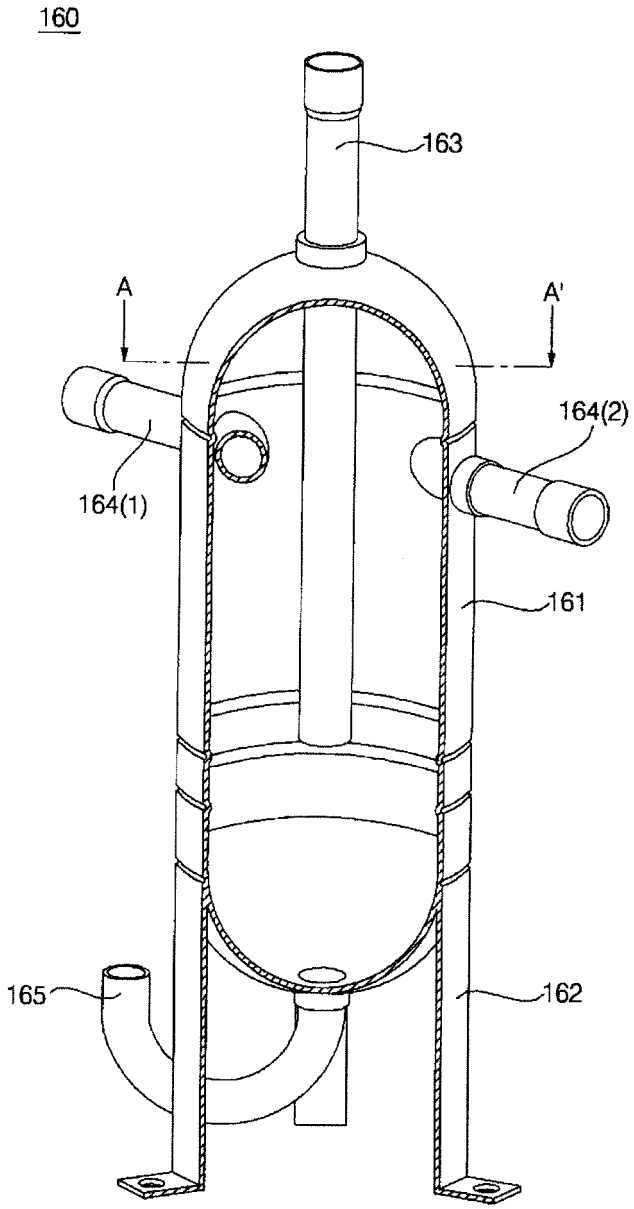


Fig. 3

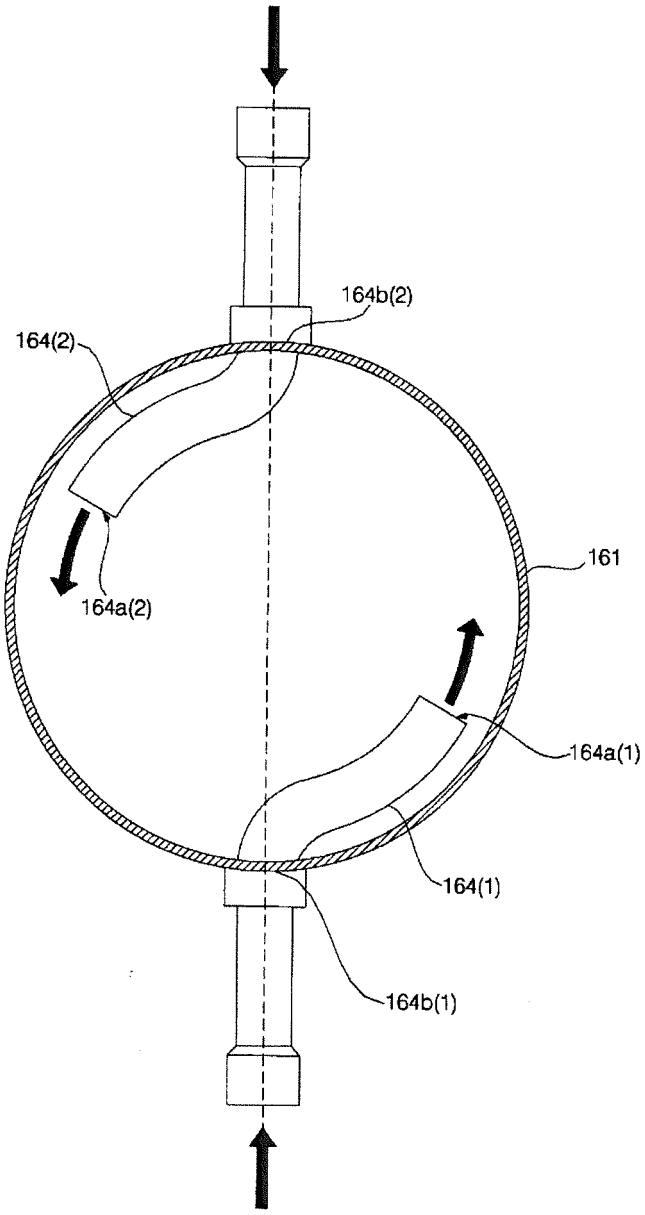


Fig. 4

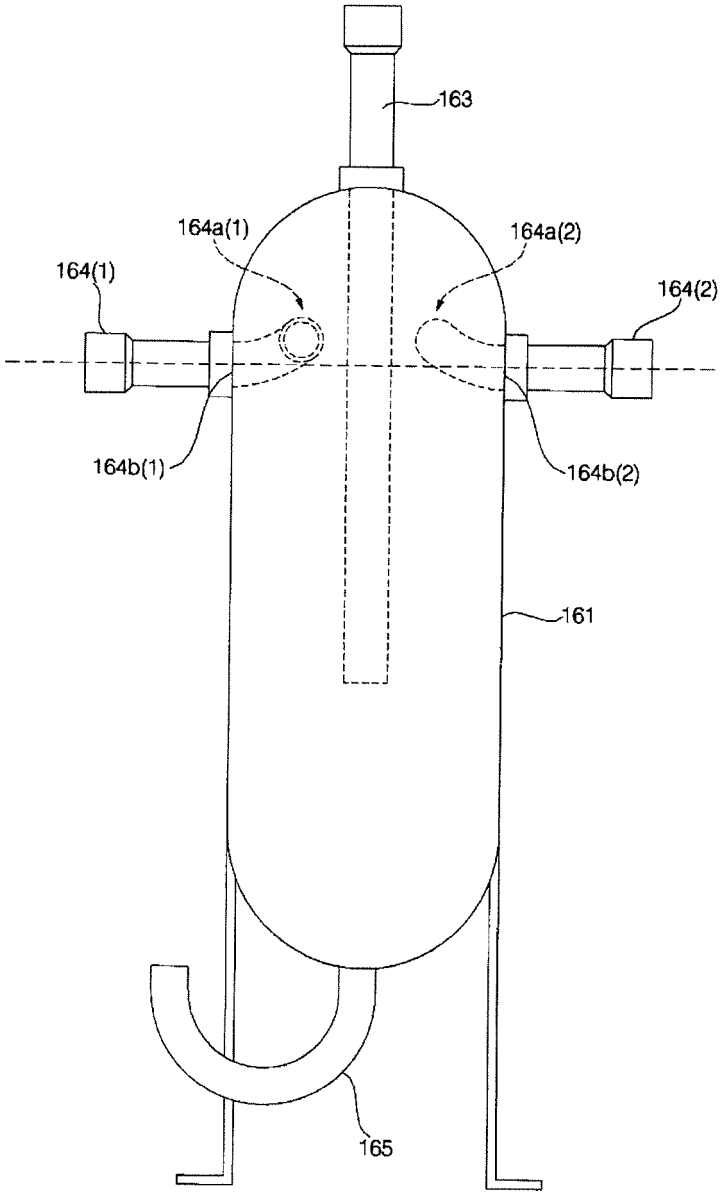
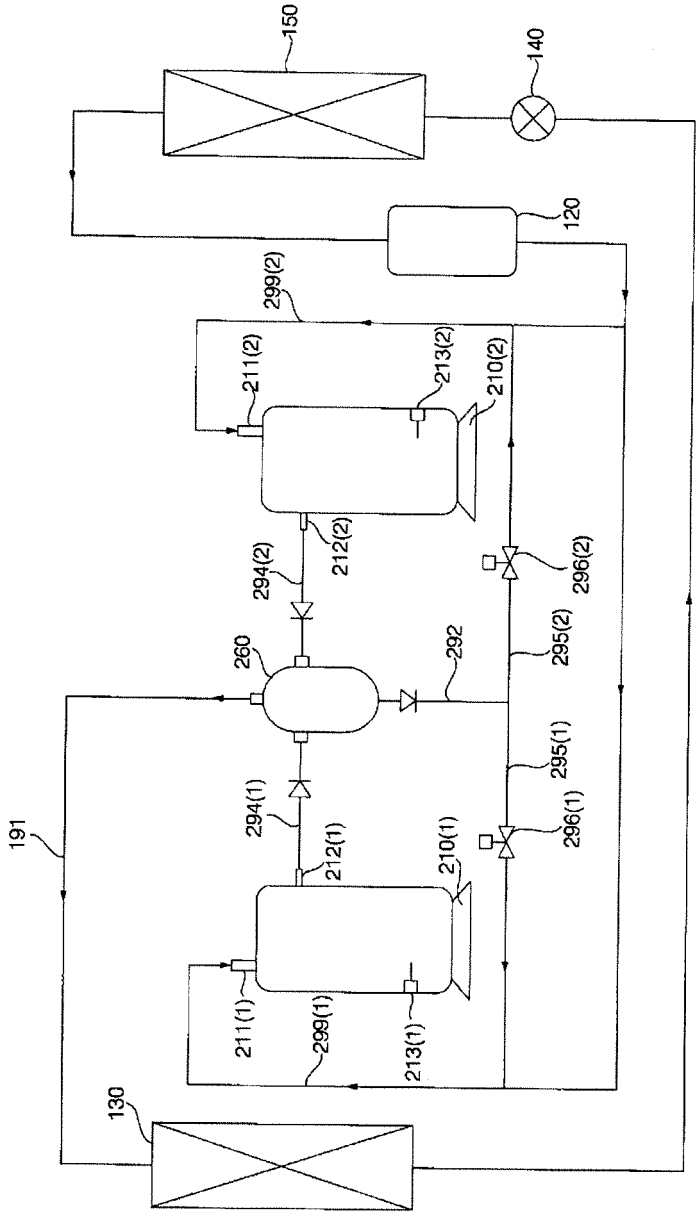


Fig. 5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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2012/008589

A. CLASSIFICATION OF SUBJECT MATTER

F25B 43/02(2006.01)i, F25B 1/00(2006.01)i, F24F 1/00(2011.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F25B 43/02; F25B 43/00; F04B 39/10; F04B 49/10

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

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

eKOMPASS (KIPO internal) & Keywords: oil separation, revolving, a plurality of, compressor, level, oil pump, rotation, collecting pipe, discharge pipe

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2009-150368 A (SAMSUNG ELECTRONICS CO LTD) 09 July 2009 See abstract, paragraphs [0022]-[0027] and figures 1-3.	1-18
Y	KR 10-2007-0106875 A (SAMSUNG ELECTRONICS CO., LTD.) 06 November 2007 See abstract, paragraphs [0023]-[0038] and figures 1-4.	1-18

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

* Special categories of cited documents:
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 MARCH 2013 (04.03.2013)	**05 MARCH 2013 (05.03.2013)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 139 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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