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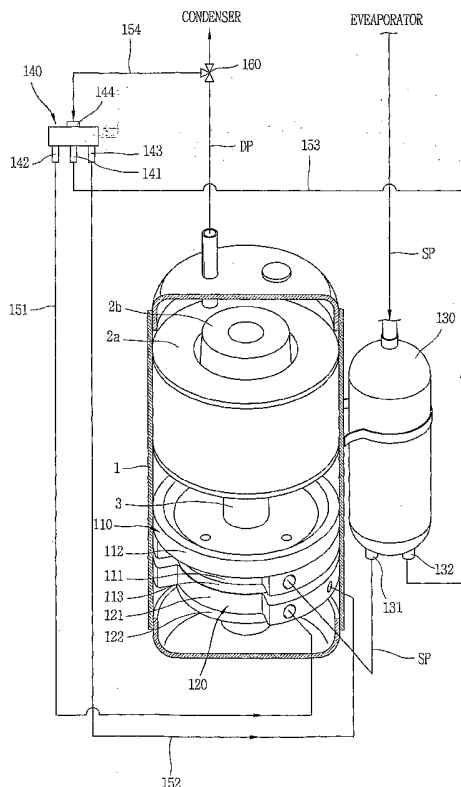
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(54) Title: CAPACITY VARIABLE TYPE TWIN ROTARY COMPRESSOR AND DRIVING METHOD THEREOF AND AIR-CONDITIONER WITH THIS AND DRIVING METHOD THEREOF



(57) Abstract: Disclosed are a capacity variable type twin rotary compressor and a driving method thereof and an air conditioner using the same and a driving method thereof. A vane (124) can quickly and stably maintain contact with a rolling piston (124) even when the vane (124) starts or a compressor switches its driving such that noises resulted from the vane (124) when varying capacity are prevented to thereby greatly reduce noises of a compressor. By alternately driving compression units (110, 120) and allowing capacity to vary according to more than two steps, it is possible to meet various demands for assembly products such as the air conditioner and the enhancing energy efficiency by reducing unnecessary waste of power.

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**CAPACITY VARIABLE TYPE TWIN ROTARY COMPRESSOR AND  
DRIVING METHOD THEREOF AND AIRCONDITIONER WITH THIS  
AND DRIVING METHOD THEREOF**

5

**TECHNICAL FIELD**

The present invention relates to a capacity variable type twin compressor, and particularly, to a capacity variable type twin compressor capable of preventing a vane jumping phenomenon which can occur when varying capacity and capable of various capacity varying driving and a driving method thereof, and an air conditioner having the same and a driving method thereof.

10

**BACKGROUND ART**

In general, a compressor converts a mechanical energy into a compression energy of a compressible fluid, and can be generally divided into a reciprocal type, a scroll type, a centrifugal type and a vane type.

15

A rotary compressor is typically applied to an air conditioner. As functions of the air conditioner are diversified these days, a rotary compressor capable of varying capacity has been demanded. For this, a method by which compressor capacity is varied by controlling the rotation numbers of the compressor is known. However, this method requires for a complicated controller to thereby increase the product price. A capacity varying unit that is cheap and stable needs to be provided. The present invention relates to this.

20

Figure 1 is a twin rotary compressor in accordance with a conventional art, Figure 2 is a block diagram for varying capacity in a conventional capacity variable type twin rotary compressor, and Figures 3 to 6 are plan views a change of a vane according to each driving in the conventional capacity variable type twin rotary compressor.

As shown therein, the conventional twin rotary compressor includes as illustrated in Figure 1: a casing 1 installing a gas intake pipe (SP) and a gas discharge pipe (DP) such that the gas intake pipe (SP) and the gas discharge pipe (DP) communicate with each other; a motor unit 2 comprising a stator 2a and a rotor 2b installed at an upper side of the casing 1 so as to generate a rotating force; and a first compression unit 10 and a second compression unit 20 vertically installed at a lower side of the casing 1, receiving a rotating force being generated from the motor unit 2 by a rotating shaft 3 and individually compressing refrigerant.

As illustrated in Figure 2, one accumulator 4 for separating liquid refrigerant from intake refrigerant is installed between the gas intake pipe (SP) and each of the compression units 10 and 20. A refrigerant switching valve 5, which is a three-way valve, switching the refrigerant and supplying the refrigerant to the second compression unit is installed between an outlet of the accumulator 4 and the gas discharge pipe (DP).

In addition, the outlet of the accumulator 4 is connected with an intake 11a of a first cylinder 11 and an intake-side inlet 5a of the refrigerant switching valve 5, a bypass pipe 32 diverges from the gas discharge pipe (DP) and is connected with a discharge-side inlet 5b of the

refrigerant switching valve 5, and an outlet 5C of the intake side of the refrigerant switching valve 5 is connected to an intake side of the second compression unit 20, all of which are described later.

As illustrated in Figures 1 and 2, the first compression unit 10 includes: the first cylinder 11 having an annular shape and installed inside the casing 1; a main bearing 12 and a middle bearing 13 covering both upper and lower sides of the first cylinder 11, forming a first inner space (V1) and radially supporting the rotating shaft; a first rolling piston 14 rotatably coupled with an upper eccentric part of the rotating shaft 3 and compressing the refrigerant, orbiting in the first inner space (V1) of the first cylinder 11; a first vane (not illustrated) movably coupled with the first cylinder 11 in a radial direction so as to pressingly contact to an outer circumferential surface of the first rolling piston 14 and dividing the first inner space (V1) of the first cylinder 11 into a first intake chamber and a first compression chamber; and a first discharge valve 15 openably coupled to a front end of a first discharge port 12a formed in the vicinity of the center of the main bearing 12 so as to control the discharge of the refrigerant being discharged from the first compression chamber.

The first cylinder 11 forms a first vane slit (not illustrated) reciprocating in the radial direction by inserting the first vane (not illustrated) into one side of an inner circumferential surface forming the first inner space (V1), forms the first intake 11a communicating with the outlet of the accumulator 4 and inducing intake refrigerant at one side of the first vane slit, and forms a first discharge groove 11b discharging refrigerant

gas being discharged from the first compression chamber into the casing 1 at the other side of the first vane slit.

As illustrated in Figures 1 to 3, the second compression unit 20 includes: a second cylinder 21 having an annular shape and installed 5 under the first cylinder 11 inside the casing 1; a middle bearing 13 and a sub-bearing 22 covering both upper and lower sides of the second cylinder 21, forming a second inner space (V2), and supporting the rotating shaft 3 in a radial direction and in an axial direction; a second rolling piston 23 10 rotatably coupled with a lower eccentric part of the rotating shaft 3 and compressing the refrigerant, orbiting in the second inner space (V2) of the second cylinder 21; a second vane (illustrated in Figure 3) 24 movably coupled with the second cylinder 21 in the radial direction so as to 15 pressingly contact to an outer circumferential surface of the second rolling piston 23 and dividing the second inner space (V2) of the second cylinder 21 into a second intake chamber and a second compression chamber; and a second discharge valve 25 openably coupled with a front end of a 20 second discharge port 22a formed in the vicinity of the center of the sub-bearing 22 and controlling the discharge of the refrigerant gas being discharged from the second chamber.

20 The second cylinder 21 forms a second vane slit 21a at one side of an inner circumferential surface forming the second inner space (V2) such that the second vane 24 reciprocates in the radial direction, forms a second intake 21b at one side of the vane slit 21a such that intake refrigerant or discharge refrigerant flows in by connecting a second

refrigerant guide pipe 33 with the outlet 5C of the intake side of the refrigerant switching valve 5, and forms a second discharge groove 21C discharging refrigerant being discharged from the second compression chamber into the casing 1 at the other side of the second vane slit 21a.

5 An expansion groove communicating with the inside of the casing 1 is formed at a rear end of the second vane slit 21a such that the rear side of the second vane 24 is affected by internal pressure of the casing 1, and a permanent magnet 26 is installed at the expansion groove 21d so as to attract the second vane 24. Undescribed numeral reference 31 denotes a  
10 first refrigerant guide pipe.

The driving of the conventional twin rotary compressor will be described.

That is, when power is supplied to the stator 2a of the motor unit 2 to thereby rotate the rotor 2b, the rotating shaft 3 rotates together with the  
15 rotor 2b and transfers a rotary force of the motor unit 2 to the first compression unit 10 and the second compression unit 20. The first compression unit 10 and the second compression unit 20 perform power driving to thereby generate large-capacity cooling capability or only the first compression unit 10 performs power driving and the second  
20 compression unit performs saving driving to thereby generate small capacity cooling capability.

Here, each driving with respect to the second compression unit of the twin rotary compressor will be described in detail.

First, in a starting state as illustrated in Figure 3, by communicating

the inlet 5a and the outlet 5c of the intake side of the refrigerant switching valve 5 with each other, refrigerant gas of balance pressure is drawn into the second inner space (V2) of the second cylinder 21 through the second intake 21b. As pressure inside the casing 1 still maintains  
5 balance pressure (Pb), pressure (PB) of the refrigerant gas pushing the rear end of the second vane 24 and compression chamber pressure (Pb) of the second inner space (V2) maintains an approximate balance state.

Accordingly, the second vane 24 is attracted by a magnetic force of the permanent magnet 24, moves outside of the second vane slit 21a, and  
10 is separated from the second rolling piston 23, so that compression does not occur. In this state, the so-called vane jumping phenomenon that internal pressure of the casing 1 increases so that the second vane 24 is separated from the permanent magnet 26, comes in contact with the second rolling piston 23 and is attached to the permanent magnet 26  
15 again repetitively occurs.

Next, as illustrated in Figure 4, in a power state, as the driving continues in the above-described starting state, pressure inside the casing 1 increases to discharge pressure (Pd), while pressure of the refrigerant gas drawn into the second inner space (V2) decreases to intake pressure  
20 (Ps).

Accordingly, as rear-side pressure of the second vane 24 considerably increases in comparison to front-side pressure, the second vane 24 is separated from the permanent magnet 26 and pressingly contacts with the second rolling piston 23 so that compression of the

refrigerant gas gets started.

Next, in a saving state as illustrated in Figure 5, as the refrigerant switching valve 5 drives to communicate the discharge-side inlet 5b and the intake-side outlet 5c communicate with each other, part of the refrigerant gas of the discharge pressure ( $P_d$ ) flows in the second inner  
5 pace ( $V_2$ ) of the second cylinder 21. Here, as internal pressure of the casing 1 still maintains a discharge pressure ( $P_d$ ) state, the rear-side pressure and the front-side pressure of the second vane 24 becomes in a balanced state. By a magnetic force, the second vane 24 moves to the  
10 rear side where the permanent magnet 26 exists and is separated from the second rolling piston 23. As a result, compression does not occur in the second cylinder 21.

Meanwhile, when a driving state is changed, for example, as illustrated in Figure 5, when the second compression unit 20 is changed  
15 from the saving state to the power state, at the moment when pressure of the refrigerant flowing in the second intake 21b is changed into the intake pressure ( $P_s$ ) from the discharge pressure ( $P_d$ ), contact between the second vane 24 and the second rolling piston 23 becomes unstable and the vane jumping phenomenon occurs again. That is, the pressure of  
20 when the intake-side inlet 5a and the intake-side outlet 5c in the refrigerant switching valve 5 communicate with each other is less reduced than the discharge pressure ( $P_d$ ) and becomes middle pressure ( $P_{d-a}$ ). On the other hand, as pressure inside the casing 1 still maintains the discharge pressure ( $P_d$ ), a force by differential pressure is greater than that by a

magnetic force of the permanent magnet 26. Thus, the second vane 24 overcomes the magnetic force and comes in contact with the second rolling piston 23 to divide the second inner space (V2) into a compression chamber and an intake chamber, such that compression is performed in the inner space (V2) of the second cylinder. However, when the compression chamber pressure of the second inner space (V2) reaches the discharge pressure (Pd) again, the force by the differential pressure becomes greater than the magnetic force. As the second vane 25 is retracted by the permanent magnet 26 and is separated from the second rolling piston 23, compression does not occur and the driving state is changed into the power state.

However, in the conventional capacity variable type twin rotary compressor, as the so-called vane jumping phenomenon that the second vane 24 is detached from the second rolling piston 23 by a disproportion between differential pressure and a magnetic force when the compressor starts or its driving is switched occurs, noises of the compressor are increased. In addition, in order to reduce compressor noises in consideration of this during the starting, the starting must be performed when the second vane 24 is completely separated from the second rolling piston 23, that is, only in a saving mode.

In addition, in the conventional capacity variable type twin rotary compressor, as the second compression unit 20 performs variable driving, while the first compression unit 10 always performs normal driving, it is constructed to perform two-step capacity variable driving, which causes a

limit to various control of functions of the air conditioner and deteriorates energy efficiency by generating cooling capability more than necessary and increasing unnecessary power consumption.

5

### **DISCLOSURE OF THE INVENTION**

Therefore, an object of the present invention is to provide a capacity variable type twin rotary compressor capable of reducing noises of a compressor by eliminating a jumping phenomenon of a vane when the compressor is started or its driving is switched and therefore capable of starting the compressor in a power mode as well as a saving mode and a driving method thereof, and an air conditioner having the same and a driving method thereof.

In addition, it is another object of the present invention to provide a capacity variable type twin rotary compressor capable of various functions of an air conditioner by allowing capacity of the compressor to vary according to more than two steps and increasing energy efficiency by reducing power consumption and a driving method thereof, and an air conditioner having the same and a driving method thereof.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided a capacity variable type twin rotary compressor comprising: a casing having a particular inner space and connecting a gas discharge pipe such that the gas discharge communicates with the inner space; a first cylinder and a second cylinder fixedly installed at the inner

space of the casing so as to be separated from each other, each having an intake directly connecting a gas intake pipe and a discharge port communicating with the gas discharge port at both sides of a circumferential direction on the basis of each vane slit, and forming an expansion groove at an outer diameter side of one of the vane slit to  
5 separate the expansion groove from the inner space of the casing; a first vane and a second vane slidingly inserted into the vane slits of the cylinders, respectively, in a radial direction; a first rolling piston and a second rolling piston inserted into eccentric parts, respectively, of a  
10 rotating shaft so as to pressingly contact with the respective vanes and compressing refrigerant, orbiting inside the cylinders; a vane-side pressure varying unit directly connected to the expansion groove separated from the inner space of the casing and alternately supplying refrigerant of intake pressure or discharge pressure on occasion demands such that the vane  
15 pressingly contacts with the corresponding rolling piston to perform power driving or the vane is separated from the corresponding rolling piston to perform saving driving; a cylinder-side pressure varying unit installed at the middle of the gas intake pipe having the vane-side pressure varying unit and alternately supplying refrigerant of intake pressure or discharge  
20 pressure to the corresponding cylinder on occasion demands such that the vane together with the vane-side pressure varying unit pressing contacts with or is separated from the rolling piston; and a vane supporting unit installed at the expansion groove of the cylinder to which the vane-side pressure varying unit is connected and supporting the rear side of the

corresponding vane in a direction of the rolling piston.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided a capacity variable type twin rotary compressor

5 comprising: a casing having a particular inner space and connecting a gas discharge pipe such that the gas discharge communicates with the inner space; a first cylinder and a second cylinder fixedly installed at the inner space of the casing so as to be separated from each other, each having an intake directly connecting a gas intake pipe and a discharge port

10 communicating with the gas discharge port at both sides of a circumferential direction on the basis of each vane slit, and each forming an expansion groove at an outer diameter side of the vane slit to separate the expansion groove from the inner space of the casing; a first vane and a second vane slidingly inserted into the vane slits of the cylinders,

15 respectively, in a radial direction; a first rolling piston and a second rolling piston inserted into eccentric parts, respectively, of a rotating shaft so as to pressingly contact with the respective vanes and compressing refrigerant, orbiting inside the cylinders; a first vane-side pressure varying unit and a second vane-side pressure varying unit directly connected to the

20 expansion groove separated from the inner space of the casing and alternately supplying refrigerant of intake pressure or discharge pressure on occasion demands such that the vane pressingly contacts with the corresponding rolling piston to perform power driving or the vane is separated from the corresponding rolling piston to perform saving driving;

a first cylinder-side pressure varying unit and a second cylinder-side pressure varying unit installed at the expansion grooves of the cylinders, respectively, the vane-side pressure varying units are connected with and supporting the rear surfaces of the corresponding vanes in a direction of  
5 the respective rolling pistons.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided a method for driving a capacity variable type twin rotary compressor, comprising: during the starting driving of the cylinder  
10 having the expansion groove separated from the inner space of the casing while the capacity variable type twin rotary compressor is being driven, the corresponding cylinder-side pressure varying unit and the vane-side pressure varying unit are controlled such that the corresponding vane is always in contact with an outer circumferential surface of the rolling piston  
15 by the vane supporting unit and compresses the refrigerant by supplying refrigerant of the same pressure to the intake and the expansion groove of the cylinder.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described  
20 herein, there is provided a method for driving a capacity variable type twin rotary compressor, comprising: during the power driving of the cylinder having the expansion groove separated from the inner space of the casing while the capacity variable type twin rotary compressor is being driven, the corresponding cylinder-side pressure varying unit and the vane-side

pressure varying unit are controlled such that the corresponding vane is always in contact with an outer circumferential surface of the rolling piston by differential pressure between internal pressure of the cylinder and pressure inside the expansion groove and a repulsive force of the corresponding vane supporting unit and compresses the refrigerant by supplying refrigerant of intake pressure to the intake of the cylinder and refrigerant of discharge pressure to the expansion groove of the cylinder.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided a method for driving a capacity variable type twin rotary compressor, comprising: during the saving driving of the cylinder having the expansion groove separated from the inner space of the casing while the capacity variable type twin rotary compressor is being driven, the corresponding cylinder-side pressure varying unit and the vane-side pressure varying unit are controlled such that the corresponding vane overcomes pressure inside the expansion groove and a repulsive force of the vane supporting unit by internal pressure of the cylinder, is pushed toward the rear side and separated from an outer circumferential surface of the rolling piston, and the refrigerant is leaked to an intake chamber from a compression chamber by supplying refrigerant of discharge pressure to the intake of the cylinder and refrigerant of intake pressure to the expansion groove of the cylinder.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described

herein, there is provided a method for driving a capacity variable type twin rotary compressor, comprising: when the saving driving is switched into the power driving in the cylinder having the expansion groove separated from the inner space of the casing while the capacity variable  
5 type twin rotary compressor is being driven, the corresponding cylinder-side pressure varying unit and the vane-side pressure varying unit are controlled such that the corresponding vane is always in contact with an outer circumferential surface of the rolling piston by differential pressure between second middle pressure and first middle pressure and a repulsive  
10 force of the corresponding vane supporting unit and compresses refrigerant by supplying refrigerant of the first middle pressure which is gradually decreased less than discharge pressure to the inner space of the cylinder and refrigerant of the second middle pressure which is gradually increasing greater than intake pressure.

15 To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided an air conditioner having the capacity variable type twin rotary compressor.

To achieve these and other advantages and in accordance with the  
20 purpose of the present invention, as embodied and broadly described herein, there is provided a method for driving an air conditioner having a capacity variable type twin rotary compressor, comprising: detecting room temperature and switching a driving mode of a compressor into a power driving mode when the room temperature reaches [desired temperature +

A°C]; switching the driving mode of the converter into a saving driving mode when the room temperature reaches the desired temperature; and switching the driving mode of the converter into the power driving mode again when the room temperature increases again and exists in [desired  
5 temperature + A°C] for two minutes consecutively and otherwise stopping the compressor if the room temperature decreases and reaches [desired temperature - B°C].

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following  
10 detailed description of the present invention when taken in conjunction with the accompanying drawings.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

The accompanying drawings, which are included to provide a  
15 further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

In the drawings:

20 Figure 1 is a longitudinal sectional view showing an example of a conventional capacity variable type twin rotary compressor;

Figure 2 is a block diagram for varying capacity in the conventional capacity variable type twin rotary compressor;

Figures 3 to 6 are plane views showing a change of a vane

according to each driving state in the conventional capacity variable type twin rotary compressor;

Figure 7 is a block diagram for varying capacity in one example of a capacity variable type twin rotary compressor of the present invention;

5        Figures 8 to 11 are plane views showing a change of a vane according to each driving state in the capacity variable type twin rotary compressor of the present invention;

Figure 12 is a block diagram for varying capacity in another embodiment of the capacity variable type twin rotary compressor of the present invention;

10        Figures 13 to 16 are plane views showing a change of a vane according to each driving state in the another embodiment of the capacity variable type twin rotary compressor of the present invention;

Figure 17 is a flow chart showing a driving method of an air conditioner having the capacity variable type twin rotary compressor of the present invention; and

Figure 18 is a development figure showing one example of the aforementioned air conditioner driving method according to time.

## 20        **MODES FOR CARRYING OUT THE PREFERRED EMBODIMENTS**

Reference will now be made in detail to a capacity variable type twin rotary compressor and a driving method thereof on one embodiment of the present invention, examples of which are illustrated in the accompanying drawings.

Figure 7 is a longitudinal sectional view showing one example of a capacity variable type twin rotary compressor of the present invention, and Figures 8 to 11 are plane views showing a change of a vane according to each driving state in the capacity variable type twin rotary compressor of the present invention.

As illustrated therein, a capacity variable type twin rotary compressor of the present invention includes: a casing 1 installing a gas intake pipe (SP) and a gas discharge pipe (DP) such that the gas intake pipe (SP) and the gas discharge pipe (DP) communicate with each other; a motor unit 2 installed at an upper side of the casing 1 and generating a rotating force; and a first compression unit 110 and a second compression unit 120 vertically installed at a lower side of the casing 1, receiving a rotating force being generated from the motor unit 2 by a rotating shaft 3 and individually compressing refrigerant:

In addition, one accumulator 130 for separating liquid refrigerant from intake refrigerant is installed between the gas intake pipe (SP) and each of the compression units 110 and 120. A refrigerant switching valve 140, which is a four-way valve, switching the refrigerant and supplying the refrigerant to the second compression unit 120 is installed between an outlet of the accumulator 130 and the gas discharge pipe (DP).

In addition, a first outlet 131 of the accumulator 130 is connected with an intake 111b of a first cylinder 111 to be described later and a second outlet 132 of the accumulator 130 is connected with an intake-side inlet 141 of a refrigerant switching valve 140 to be described later via a

third refrigerant guide pipe 153.

The first compression unit 110 includes: the first cylinder 111 having an annular shape and installed inside the casing 1; a main bearing 112 and a middle bearing 113 covering both upper and lower sides of the first cylinder 111, forming a first inner space (V1) and radially supporting the rotating shaft 3; a first rolling piston 114 rotatably coupled with an upper eccentric part of the rotating shaft 3 and compressing the refrigerant, orbiting in the first inner space (V1) of the first cylinder 111; a first vane (not illustrated) 115 movably coupled with the first cylinder 111 in a radial direction so as to pressingly contact to an outer circumferential surface of the first rolling piston 114 and dividing the first inner space (V1) of the first cylinder 111 into a first intake chamber and a first compression chamber; a first vane spring 116 which is a compression spring so as to elastically support the rear side of the first vane 115; and a first discharge valve 15 (illustrated in Figure 1) openably coupled to a front end of a first discharge port 12a (illustrated in Figure 1) formed in the vicinity of the center of the main bearing 112 so as to control the discharge of the refrigerant being discharged from the compression chamber of the first inner space (V1).

The first cylinder 111 forms a first vane slit 111a (not illustrated) at one side of an inner surface forming the first inner space (V1) such that the first vane 115 reciprocates in the radial direction, forms the first intake 111b at one side in a circumferential direction on the basis of the first vane slit 111a so as to induce the refrigerant into the first inner space (V1), and forms a first discharge groove 111c at the other side of the circumferential

direction on the basis of the first vane slit 111a in an axial direction so as to discharge the refrigerant into the casing 1.

The first vane slit 111a slidably inserts and installs the first vane 115 thereinto in the radial direction, and by forming a first expansion groove 111d at the rear end, installs the first vane spring 116 formed of a compression spring so as to elastically support the first vane 115 at the rear side, that is, at the first expansion groove 111d.

The first intake 111b is radially formed so as to penetrate the first cylinder 111 from its outer circumferential surface to its inner circumferential surface, and its inlet end directly communicates with the first outlet 131 of the accumulator 130. In addition, the first intake 111b and the first discharge groove 111c can be formed on the same axis as respect to a second discharge groove 121c to be described later. However, in order to precisely control the compressor, it is preferable that they are formed on the same axis.

Meanwhile, though not illustrated in the drawing, the first vane 115 can be supported by permanent magnets with the same polarity facing each other except for the first vane spring.

The second compression unit 120 includes: a second cylinder 121 having an annular shape and installed under the first cylinder 111 inside the casing 1; a middle bearing 113 and a sub-bearing 122 covering both upper and lower sides of the second cylinder 21, forming a second inner space (V2), and supporting the rotating shaft 3 in a radial direction and in an axial direction; a second rolling piston 123 rotatably coupled with a

lower eccentric part of the rotating shaft 3 and compressing the refrigerant, orbiting in the second inner space (V2) of the second cylinder 121; a second vane (illustrated in Figure 3) 124 movably coupled with the second cylinder 121 in the radial direction so as to pressingly contact to an  
5 outer circumferential surface of the second rolling piston 123 and dividing the second inner space (V2) of the second cylinder 121 into a second intake chamber and a second compression chamber; a second vane spring 125 which is a compression spring so as to elastically support the rear side of the second vane 124; and a second discharge valve 25  
10 (illustrated in Figure 1) openably coupled with a front end of a second discharge port 22a formed in the vicinity of the center of the sub-bearing 122 and controlling the discharge of the refrigerant gas being discharged from the second chamber.

The second cylinder 121 forms a second vane slit 121a at one side  
15 of an inner circumferential surface forming the second inner space (V2) such that the second vane 124 reciprocates in the radial direction, forms a second intake 121b at one side of a circumferential direction on the basis of the vane slit 121a in the radial direction so as to induce the refrigerant into the second inner space (V2), and forms a second discharge groove  
20 121c at the other side of circumferential direction on the basis of the second vane slit 121a in the radial direction so as to discharge the refrigerant into the casing 1.

The second vane slit 121a slidably inserts and installs the second vane 124 therein in the radial direction, and forms a second expansion

groove 121d so as to be separated from the inner space of the casing 1.  
In addition, the second vane spring 125 comprising a compression spring  
so as to elastically support the second vane 124 is installed at the second  
expansion groove 121d, and a vane-side outlet 143 of the refrigerant  
5 switching valve 140 to be described later is connected with its inlet end,  
that is, with the second expansion groove 121d via a second refrigerant  
guide pipe 152.

In addition, preferably, a second stopper (not illustrated) for limiting  
a retraction distance of the second vane 124 is provided to prevent the  
10 second vane spring 125 from being compressed to make its turn portions  
come in contact with each other.

The second intake 121b is radially formed to penetrate the second  
cylinder 121 from an outer circumferential surface to an inner  
circumferential surface, and its inlet end is connected to a cylinder-side  
15 outlet 142 of the refrigerant switching valve 140 to be described later via a  
first refrigerant guide pipe 151.

Though not illustrated in the drawing, the second vane 115 can be  
supported by permanent magnets (not illustrated) with the same polarity  
facing each other except for the second vane spring.

20 Meanwhile, the refrigerant switching valve 140 forms the intake-side  
inlet 141 and connects the intake-side inlet 141 to the first outlet 131 of the  
accumulator 130, forms the intake-side inlet 141 and connects the  
intake-side inlet 141 to the second intake 121b of the second cylinder 121,  
forms the vane-side outlet 143 and connects the vane-side outlet 143 to

the vane slit 121a of the second cylinder 121, and forms the discharge-side inlet 144 and connects the discharge-side inlet 144 to a bypass pipe 154 diverging from the middle of the gas discharge pipe (DP).

Portions of the present invention identical to those in the conventional art are given the same reference numerals.

Undescribed reference numerals 2a, 2b and 160 denote a stator, a rotor, a discharge-side opening or closing valve for connecting or disconnecting the gas discharge pipe with/from the bypass pipe, respectively.

The capacity variable type twin rotary compressor of the present invention has the following operational effect.

That is, if the rotor 2b rotates as power is supplied to the stator 2a of the motor unit 2, the rotating shaft 3 rotates together with the rotor 2b and transfers a rotating force of the motor unit 2 to the first compression unit 110 and the second compression unit 120. The second compression unit 120 performs power driving according to capacity necessary for an air conditioner to generating large-capacity cooling capability or performs saving driving to generate small-capacity cooling capability.

Here, the operation of the capacity variable type twin rotary compressor of the present invention will be described in more detail on the assumption that the first compression unit 110 performs normal power driving, while the second compression unit 120 repeats variable driving according to capacity necessary for an air conditioner.

For example, in the first compression unit 110, it is controlled that

refrigerant of balance pressure ( $P_b$ ) is always supplied to the intake 111b of the cylinder 111 and that the first vane 115 is always in contact with an outer circumferential surface of the first rolling piston 114 by the first vane spring 116 to separate the compression chamber and the intake chamber of the first inner space (V1) from each other. Thus, compression is normally performed.

At the same time, as illustrated in Figures 7 and 8, when the second compression unit 120 is in a starting state, the intake-side inlet 141 of the refrigerant switching valve 140 communicates with the cylinder-side outlet 142 and the accumulator 130 is connected with the second intake 121b of the second cylinder 121 via the third refrigerant guide pipe 153, whereby the refrigerant gas of balance pressure ( $P_b$ ) which will be gradually decreased is drawn into the second inner space (V2) through the second intake 121b of the second cylinder 121. On the other hand, as the discharge-side inlet 144 of the refrigerant switching valve 140 communicates with the vane-side outlet 143 and the gas discharge pipe (DP) is connected with the second expansion groove 111d through the bypass pipe 154, the refrigerant gas of balance pressure which will be gradually increased is drawn into an outer diameter side of the vane slit 121a of the second cylinder 121, that is, into the second expansion groove 121d. However, as pressure inside the casing 1 still maintains the balance pressure, pressure ( $P_b$ ) flowing into the second expansion groove 121d through the gas discharge pipe (DP), the vane-side outlet 143 of the refrigerant switching valve 140 and the second refrigerant guide pipe 152

and therefore pushing the rear end of the second vane 124, and compression chamber pressure ( $P_b$ ) of the second inner space ( $V_2$ ) maintain an approximate balanced state. Accordingly, the second vane 124 is pushed by a repulsive force ( $F$ ) of the vane supporting unit 125 comprising the compression spring or a magnetic substance, moves toward the shaft center and is compressed by an outer circumferential surface of the second rolling piston 123. As a result, normal compression is performed by preventing the so-called vane jumping phenomenon that the second vane 124 and the second rolling piston 123 are continuously detached from each other.

Next, as illustrated in Figures 7 and 9, when the second compression unit 120 is in a power state, as the refrigerant switching valve 140 maintains the same state as the starting state as described above, it is controlled that refrigerant of the intake pressure ( $P_s$ ) is always supplied to the second intake 121b of the second cylinder 121, while refrigerant of the discharge pressure ( $P_d$ ) is always supplied to an outer diameter side of the vane slit 121a, that is, to the second expansion groove 121d. Accordingly, the second vane 124 is pushed by differential pressure between the second expansion groove 121d of the outer diameter side of the vane slit 121a and the intake chamber and the repulsive force ( $F$ ) of the second vane supporting unit 125 and therefore maintains a state in which the second vane 124 is compressed by the outer circumferential surface of the second rolling piston 123. As a result, normal compression is continued.

Next, as illustrated in Figures 7 and 10, when the second compression unit 120 is in a saving state, as the discharge side inlet 144 and the cylinder side outlet 142 of the refrigerant switching valve 140 communicate with each other and the gas discharge pipe (DP) and the intake 121b of the second cylinder 121 are connected with each other via the bypass pipe 154, refrigerant gas of discharge pressure ( $P_d$ ) is drawn into the second inner space (V2) through the intake 121b of the second cylinder 121. On the other hand, as the intake-side inlet 141 of the refrigerant switching valve 140 and the vane-side outlet 143 communicate with each other the accumulator 130 and the second expansion groove 121d are connected with each other via the third refrigerant guide pipe 153, the refrigerant gas of intake pressure ( $P_s$ ) is drawn into the second expansion groove 121d of the second cylinder 121 through the second refrigerant guide pipe 152. Here, since pressure of the refrigerant gas drawn through the intake 121b of the second cylinder 121 is greater than power obtained by adding pressure of the refrigerant gas drawn into the second expansion groove 121d and the repulsive force of the second vane supporting unit 125, the second vane 124 is retracted toward the rear side and separated from the second rolling piston 123, and therefore compression does not occur in the second cylinder 121.

Next, as illustrated in Figures 7 and 11, when a driving state of the second compression unit 121 is changed from a saving state to a power state, as the discharge-side inlet 144 of the refrigerant switching valve 140 is switched and communicates with the vane-side outlet 143 from the

cylinder-side outlet 142 and the gas discharge pipe (DP) is connected with the second expansion groove 221d via the bypass pipe 154, refrigerant gas of middle pressure ( $P_{s+b}$ ) which will be gradually in a discharge pressure ( $P_d$ ) state is drawn into the second expansion groove 5 121d of the second cylinder 121 via the second refrigerant guide pipe 152. On the other hand, as the intake-side inlet 141 of the refrigerant switching valve 140 is switched and communicates with the cylinder-side outlet 142 from the vane-side outlet 143 and the accumulator 130 is connected to the intake 121b of the second cylinder 121 via the third refrigerant guide pipe 10 153, the refrigerant gas which will be gradually in a second pressure ( $P_{d-a}$ ) state is drawn into the second inner space ( $V_2$ ) through the first refrigerant guide pipe 151 and the intake 121b of the second cylinder 121. Here, when the driving is switched, since an unstable state in which the second middle pressure ( $P_{d-a}$ ) is higher than the first middle pressure 15 ( $P_{s+b}$ ) and then is reversed continues, the vane jumping phenomenon that the second vane 124 is attached to and detached from the outer circumferential surface of the second rolling piston 123 may occur.

However, since the repulsive force ( $F$ ) of the second vane supporting unit 125 supporting the second vane 124 is greater than 20 differential pressure between the second middle pressure ( $P_{d-a}$ ) and the first middle pressure ( $P_{s+b}$ ), the second vane 124 is always in contact with the outer circumferential surface of the second rolling piston 123.

Accordingly, noises by the vane jumping can be prevented from occurring.

Meanwhile, another embodiment of the capacity variable type twin rotary compressor of the present invention will be described as follows.

That is, in the aforementioned one embodiment, one compression unit from the first compression unit and the second compression unit comprises a pressure varying unit and a vane-side pressure varying unit so as to increase and decrease compressor capacity by varying a driving state of the compression unit. However, in the present embodiment, both the first compression unit and the second compression unit have cylinder-side pressure varying units and the vane-side pressure varying units, respectively, so as to independently control driving states of both of the compression units, such that the compressor capacity can be increased and decreased by varying according to more than two steps.

Figure 12 is a block diagram for varying capacity in another embodiment of the capacity variable type twin rotary compressor of the present invention and Figures 13 to 16 are plane views showing a change of a vane according to each driving state in the another embodiment of the capacity variable type twin rotary compressor of the present invention.

As illustrated therein, the capacity variable type twin rotary compressor according to the present invention includes: a casing 1 installing a gas intake pipe (SP) and a gas discharge pipe (DP) such that the gas intake pipe (SP) and the gas discharge pipe (DP) communicate with each other; a motor unit 2 installed at an upper side of the casing 1 and generating a rotating force; and a first compression unit 210 and a second compression unit 220 vertically installed at a lower side of the

casing 1, receiving a rotating force being generated from the motor unit 2 by a rotating shaft 3 and individually compressing refrigerant.

In addition, one accumulator 230 for separating liquid refrigerant from intake refrigerant is installed between the gas intake pipe (SP) and each of the compression units 210 and 220. A first refrigerant switching valve 240, which is a four-way valve, switching the refrigerant and supplying the refrigerant to the first compression unit 210 and the second compression unit 220 is installed between an outlet of the accumulator 230 and the gas discharge pipe (DP).

In addition, a first outlet 131 of the accumulator 130 is connected with an intake-side inlet 241 of a first refrigerant switching valve 240 to be described later via a third refrigerant guide pipe 263, and a second outlet 232 of the accumulator 230 is connected to an intake-side inlet 251 of a second refrigerant switching valve 250 to be described later via a seventh refrigerant guide pipe 267.

The first compression unit 210 includes: the first cylinder 211 having an annular shape and installed inside the casing 1; a main bearing 212 and a middle bearing 213 covering both upper and lower sides of the first cylinder 211, forming a first inner space (V1) and radially supporting the rotating shaft 3; a first rolling piston 214 rotatably coupled with an upper eccentric part of the rotating shaft 3 and compressing the refrigerant, orbiting in the first inner space (V1) of the first cylinder 211; a first vane (not illustrated) 215 movably coupled with the first cylinder 211 in a radial direction so as to pressingly contact to an outer circumferential surface of

the first rolling piston 214 and dividing the first inner space (V1) of the first cylinder 211 into a first intake chamber and a first compression chamber; a first vane spring 216 which is a compression spring so as to elastically support the rear side of the first vane 215; and a first discharge valve 15 (illustrated in Figure 1) openably coupled to a front end of a first discharge port 12a (illustrated in Figure 1) formed in the vicinity of the center of the main bearing 212 so as to control the discharge of the refrigerant being discharged from the compression chamber of the first inner space (V1).

10 The first cylinder 211 forms a first vane slit 211a at one side of an inner surface forming the first inner space (V1) such that the first vane 215 reciprocates in the radial direction, forms the first intake 211b at one side of the first vane slit 211a in a radial direction so as to induce the refrigerant into the first inner space (V1), and forms a first discharge groove 211c at  
15 the other side of the other side of the first vane slit 211a so as to discharge the refrigerant into the casing 1.

The first vane slit 211a slidably inserts and installs the first vane 215 thereinto in the radial direction, and forms a first expansion groove 221d at the outer diameter side so as to be separated from the inner  
20 space of the casing 1.

In addition, the first vane spring 216 formed of a compression spring so as to elastically support the first vane 215 is installed at the rear side of the first vane slit 211a, that is, at the first expansion groove 21d, and a vane-side outlet 243 of the first refrigerant switching valve 240 to be

described later is connected with its inlet end, that is, with the second expansion groove 221d via a second refrigerant guide pipe 252. In addition, the first vane slit 211a and a second vane slit 221a to be described later can be not formed on the same axis. However, in order to precisely control the compressor, it is preferable that they are formed on the same axis. In addition, preferably, a first stopper (not illustrated) for limiting a retraction distance of the first vane 125 is provided to the first vane slit 211a to prevent the second vane spring 225 from being compressed to make its turn portions come in contact with each other.

The first intake 211b is radially formed so as to penetrate the first cylinder 211 from its outer circumferential surface to its inner circumferential surface, and its inlet end directly communicates with a cylinder-side outlet 242 of the first refrigerant switching valve 240 via the first refrigerant guide pipe 261.

In addition, the first intake 211b and the first discharge groove 211c can not be formed on the same axis as respect to a second discharge groove 221c to be described later. However, in order to precisely control the compressor, it is preferable that they are formed on the same axis.

Meanwhile, though not illustrated in the drawing, the first vane 215 can be supported by permanent magnets with the same polarity facing each other except for the first vane spring.

The second compression unit 120 includes: a second cylinder 121 having an annular shape and installed under the first cylinder 111 inside the casing 1; a middle bearing 113 and a sub-bearing 122 covering both

upper and lower sides of the second cylinder 21, forming a second inner space (V2), and supporting the rotating shaft 3 in a radial direction and in an axial direction; a second rolling piston 123 rotatably coupled with a lower eccentric part of the rotating shaft 3 and compressing the refrigerant, orbiting in the second inner space (V2) of the second cylinder 121; a second vane (illustrated in Figure 3) 124 movably coupled with the second cylinder 121 in the radial direction so as to pressingly contact to an outer circumferential surface of the second rolling piston 123 and dividing the second inner space (V2) of the second cylinder 121 into a second intake chamber and a second compression chamber; a second vane spring 125 which is a compression spring so as to elastically support the rear side of the second vane 124; and a second discharge valve 25 (illustrated in Figure 1) openably coupled with a front end of a second discharge port 22a formed in the vicinity of the center of the sub-bearing 122 and controlling the discharge of the refrigerant gas being discharged from the second chamber.

The second cylinder 121 forms a second vane slit 121a at one side of an inner circumferential surface forming the second inner space (V2) such that the second vane 124 reciprocates in the radial direction, forms a second intake 121b at one side of a circumferential direction on the basis of the vane slit 121a in the radial direction so as to induce the refrigerant into the second inner space (V2), and forms a second discharge groove 121c at the other side of circumferential direction on the basis of the second vane slit 121a in the radial direction so as to discharge the

refrigerant into the casing 1.

The second vane slit 121a slidably inserts the second vane 124 thereinto in the radial direction, and forms a second expansion groove 221d at the outer diameter side so as to be separated from the casing 1. In addition, the second vane spring 225 comprising a compression spring so as to elastically support the second vane 224 is installed at the rear side of the second vane slit 221a, that is, at the second expansion groove 221d, and a vane-side outlet 253 of a second refrigerant switching valve 250 to be described later is connected with its inlet end via a fifth refrigerant guide pipe 266.

In addition, preferably, a second stopper (not illustrated) for limiting a retraction distance of the second vane 224 is provided to prevent the second vane spring 225 from being compressed to make its turn portions come in contact with each other.

The second intake 221b is radially formed to penetrate the second cylinder 221 from an outer circumferential surface to an inner circumferential surface, and its inlet end is connected to a cylinder-side outlet 252 of the refrigerant switching valve 250 to be described later via a fourth refrigerant guide pipe 265.

Though not illustrated in the drawing, the second vane 224 can be supported by permanent magnets (not illustrated) with the same polarity facing each other except for the first vane spring.

Meanwhile, the first refrigerant switching valve 240 forms the intake-side inlet 241 and connects the intake-side inlet 241 to the first

outlet 231 of the accumulator 230, forms the first cylinder-side outlet 242 and connects the first cylinder-side outlet 242 to the first intake 211b of the first cylinder 211, forms the first vane-side outlet 243 and connects the first vane-side outlet 243 to a second expansion groove 211d of the first cylinder 211, and forms the first discharge-side inlet 244 and connects the first discharge-side inlet 244 to a first bypass pipe 264 diverging from the middle of the gas discharge pipe (DP).

In addition, the second refrigerant switching valve 250 forms the intake-side inlet 251 and connects the intake-side inlet 251 to the second outlet 232 of the accumulator 230, forms the second cylinder-side outlet 252 and connects the second cylinder-side outlet 252 to the intake 221b of the second cylinder 221, forms the second vane-side outlet 253 and connects the second vane-side outlet 253 to the second expansion groove 221d of the second cylinder 221, and forms the second discharge-side inlet 254 and connects the second discharge-side inlet 254 to a second bypass pipe 268 diverging from the middle of the gas discharge pipe (DP).

Portions of the present invention identical to those in the conventional art are given the same reference numerals..

Undescribed reference numerals 2a, 2b, 271 and 272 denote a stator, a rotor, a discharge-side opening or closing valve for connecting or disconnecting the gas discharge pipe with/from a first bypass pipe and for connecting or disconnecting the gas discharge pipe with/from a second bypass pipe, respectively.

The capacity variable type twin rotary compressor of the present

invention has the following operational effect.

That is, if the rotor 2b rotates as power is supplied to the stator 2a of the motor unit 2, the rotating shaft 3 rotates together with the rotor 2b and transfers a rotating force of the motor unit 2 to the first compression unit 210 and the second compression unit 220. Both the first compression unit 210 and the second compression unit 220 perform power driving according to capacity necessary for an air conditioner. Otherwise, one from the first compression unit 210 the second compression unit 220 performs power driving and the other compression unit performs saving driving to thereby generate phased small-capacity cooling capability.

Here, the operation of the capacity variable type twin rotary compressor of the present invention will be described in more detail on the assumption that the first compression unit 210 performs normal power driving, while the second compression unit 220 repeats variable driving according to capacity necessary for an air conditioner.

In Figures 13 to 16, the second compression unit performs variable driving even though either the first compression unit or the second compression unit can performs variable driving.

That is, in the first compression 210, as the first discharge-side inlet 244 of the first refrigerant switching valve 240 communicates with the first cylinder-side outlet 242 and the first intake-side inlet 241 communicates with the first vane-side outlet 243, it is controlled that refrigerant of discharge pressure ( $P_d$ ) is always supplied to the first intake 211b of the first cylinder 211 and refrigerant of intake pressure ( $P_s$ ) is always supplied

to the second expansion groove 211d of the first cylinder 211 such that the first vane 215 is always in contact with the outer circumferential surface of the first rolling piston 214 to separate the compression chamber and the intake chamber of the first inner space (V1) from each other.

5 At the same time, as illustrated in Figures 12 and 13, when the second compression unit 220 is in a starting state, the intake-side inlet 251 of the refrigerant switching valve 250 communicates with the cylinder-side outlet 252 and the intake 251 of the second refrigerant switching valve 250 of the second cylinder 221 is connected with the accumulator 230 via a  
10 sixth refrigerant guide pipe 267, whereby the refrigerant gas of balance pressure (Pb) which will be gradually decreased is drawn into the second inner space (V2) through the intake 221b of the second cylinder 221. On the other hand, as the discharge-side inlet 254 of the refrigerant switching valve 250 communicates with the vane-side outlet 253 and the gas  
15 discharge pipe (DP) is connected with the second expansion groove 221d through the second bypass pipe 268, the refrigerant gas of balance pressure which will be gradually increased is drawn into the second expansion groove 221d of the second cylinder 221. Here, as internal pressure of the casing 1 gradually increases, refrigerant of higher pressure  
20 is supplied to the second expansion groove 221d connected with this.

Accordingly, the second vane 224 is pushed toward the shaft center by pressure applied at its rear surface and a repulsive force (F) of the vane supporting unit 225 comprising the compression spring or a magnetic substance, and is compressed by an outer circumferential surface of the

second rolling piston 223. As a result, normal compression is performed by preventing the so-called vane jumping phenomenon that the second vane 224 and the second rolling piston 223 are continuously detached from each other.

5           Next, as illustrated in Figures 12 and 14, in order that the second compression unit 220 is in a power state, as the refrigerant switching valve 250 maintains the same state as the starting state as described above, it is controlled that refrigerant of the intake pressure ( $P_s$ ) is always supplied to the intake 221b of the second cylinder 121, while refrigerant of the  
10 discharge pressure ( $P_d$ ) is always supplied to the second expansion groove 221d. Accordingly, the second vane 224 is pushed by differential pressure between the second expansion groove 221d and the intake chamber and the repulsive force ( $F$ ) of the second vane supporting unit 225 comprising the compression spring or the magnetic body and  
15 maintains a state in which the second vane 224 is compressed by the outer circumferential surface of the second rolling piston 223. As a result, normal compression is continued.

          Next, as illustrated in Figures 12 and 15, as the second compression unit 220 is in a saving state, as the discharge side inlet 254  
20 and the cylinder side outlet 252 of the second refrigerant switching valve 250 communicate with each other, the refrigerant gas of the discharge pressure ( $P_d$ ) passes the gas discharge pipe (DP), the second bypass pipe 268, the cylinder-side outlet 252 of the second refrigerant switching valve 250 and the fourth refrigerant guide pipe 265 and is guided to the

intake 221b of the second cylinder 22, and the refrigerant is drawn into the second inner space (V2) through the intake 221b of the second cylinder 221. On the other hand, as the intake-side inlet 251 of the refrigerant switching valve 250 and the vane-side outlet 253 communicate  
5 with each other and the accumulator 230 and the second expansion groove 221d of the second cylinder 221 are connected with each other via the sixth refrigerant guide pipe 267, the refrigerant gas of intake pressure ( $P_s$ ) is drawn into the rear side of the second vane 224, that is, into the second expansion groove 221b of the second cylinder 221. Here, since  
10 pressure of the refrigerant gas drawn through the intake 221b of the second cylinder 221 is greater than power obtained by adding pressure of the refrigerant gas drawn into the second expansion groove 221b and the repulsive force ( $F$ ) of the second vane supporting unit 225, the second vane 224 is retracted toward the rear side and separated from the second  
15 rolling piston 223, and therefore compression does not occur in the second cylinder 221.

Next, as illustrated in Figures 12 and 16, when a driving state of the second compression unit 220 is changed from a saving state to a power state, as the discharge-side inlet 254 of the second refrigerant switching  
20 valve 250 is switched and communicates with the vane-side outlet 253 from the cylinder-side outlet 252 and the gas discharge pipe (DP) is connected with the second expansion groove 221d via the second bypass pipe 268, refrigerant gas of first middle pressure ( $P_{s+b}$ ) which will be gradually in a discharge pressure ( $P_d$ ) state is drawn into the second

expansion groove 221d of the second cylinder 221. On the other hand, as the intake-side inlet 251 of the second refrigerant switching valve 250 is switched and communicates with the cylinder-side outlet 252 from the vane-side outlet 253 and the accumulator 230 is connected to the intake 5 221b of the second cylinder 221 via the sixth refrigerant guide pipe 267, the refrigerant gas which will be gradually in a second pressure ( $P_{d-a}$ ) state is drawn into the second inner space ( $V_2$ ) through the intake 221b of the second cylinder 121. Here, when its driving is changed, since an unstable state in which the second middle pressure ( $P_{d-a}$ ) is higher than 10 the first middle pressure ( $P_{s+b}$ ) and then is reversed continues for a certain pressure section, the vane jumping phenomenon that the second vane 224 is attached to and detached from the outer circumferential surface of the second rolling piston 223 may occur. However, since the repulsive force ( $F$ ) of the second vane supporting unit 225 supporting the 15 second vane 224 is greater than differential pressure between the second middle pressure ( $P_{d-a}$ ) and the first middle pressure ( $P_{s+b}$ ), the second vane 224 is always in contact with the outer circumferential surface of the second rolling piston 223. Accordingly, noises by the vane jumping can be prevented from occurring.

20 Meanwhile, as described above, as occasion demands, the second compression unit 220 performs normal power driving, while the first compression unit 210 performs variable driving, whereby capacity of the compressor can be varied. In this case, in a state that the second refrigerant switching valve 250 is manipulated identically with the first

refrigerant switching valve 240 in the aforementioned one embodiment, the first refrigerant switching valve 240 is manipulated identically with the second refrigerant switching valve 250 of the above-described one embodiment to thusly perform starting, power, saving and driving-switched states.

Through this, the capacity of the compressor can be controlled by being divided into three steps. For example, when the first compression unit 210 is set to 60% and the second compression unit is set to 40% of the entire capacity, both compression units 210 and 220 perform normal driving to thereby obtain 100% cooling capability, the entire capacity of the compressor. On the other hand, if the first compression unit 210 performs driving in a normal state and the second compression unit in a saving state, 40% cooling capability can be obtained. If the first compression unit 210 performs driving in a saving state and the second compression unit 220 in a normal state, 60% cooling capability can be obtained.

A description will be made when such a compressor applied to an air conditioner is operated.

That is, as illustrated in Figure 17, room temperature is detected using a temperature sensor mounted on an indoor heat exchanger of the air conditioner. If the room temperature reaches [desired temperature + 0.5°], a relay (not illustrated) of MICOM is turned off and the compressor is changed into a power driving mode.

Next, if the room temperature increases again and exists in [desired temperature + 0.5°] for two minutes consecutively, the compressor is

changed into the power driving mode again. On the other hand, if the room temperature decreases and reaches [desired temperature  $-1.0^{\circ}$ ], the compressor is stopped.

Here, after the compressor is changed into a saving driving mode and saving driving is performed, if compressor is stopped twice consecutively due to a decrease in the room temperature, the compressor is changed into a consecutive saving driving mode. If a time for the saving driving mode of the compressor exceeds a particular period of time, the compressor is immediately changed into the power driving mode and then is returned to the early stage, preferably.

For reference, Figure 18 is a development diagram showing one example of the aforementioned air conditioner driving method according to time.

As described so far, in the capacity variable type twin rotary compressor, in a starting state and a driving-switched state in which the driving of a vane can be unstable, it is constructed that the vane can quickly and stably come in contact with a rolling piston, such that noises resulted from the vane when varying capacity are prevented from occurring to thereby significantly reduce compressor noises and the compressor can start without noises resulted from vane jumping even in a power mode to thereby quickly set room temperature to pleasant temperature when applied to an air conditioner.

In addition, as it is constructed that both the first compression unit and the second unit can be controlled, compressor capacity can be varied

according to more than two steps when capacity of each compression unit differs, whereby it is possible to meet various demands for assembly products such as the air conditioner and to reduce power consumption by reducing unnecessary waste of power.

5           The present invention can greatly reduce noises of a compressor by preventing noises, meet various demands of assembly products such as air conditioners by allowing capacity of the compressor to vary according to more than two steps variable and increase energy efficiency by reducing unnecessary power consumption.

10           As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as  
15 defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalence of such metes and bounds are therefore intended to be embraced by the appended claims.

**CLAIMS**

1. A capacity variable type twin rotary compressor comprising:  
a casing having a particular inner space and connecting a gas discharge pipe such that the gas discharge communicates with the inner space;  
5 space;  
a first cylinder and a second cylinder fixedly installed at the inner space of the casing so as to be separated from each other, each having an intake directly connecting a gas intake pipe and a discharge port communicating with the gas discharge port at both sides of a  
10 circumferential direction on the basis of each vane slit, and forming an expansion groove at an outer diameter side of one of the vane slit to separate the expansion groove from the inner space of the casing;  
a first vane and a second vane slidingly inserted into the vane slits of the cylinders, respectively, in a radial direction;  
15 a first rolling piston and a second rolling piston inserted into eccentric parts, respectively, of a rotating shaft so as to pressingly contact with the respective vanes and compressing refrigerant, orbiting inside the cylinders;  
a vane-side pressure varying unit directly connected to the  
20 expansion groove separated from the inner space of the casing and alternately supplying refrigerant of intake pressure or discharge pressure on occasion demands such that the vane pressingly contacts with the corresponding rolling piston to perform power driving or the vane is separated from the corresponding rolling piston to perform saving driving;

a cylinder-side pressure varying unit installed at the middle of the gas intake pipe having the vane-side pressure varying unit and alternately supplying refrigerant of intake pressure or discharge pressure to the corresponding cylinder on occasion demands such that the vane together  
5 with the vane-side pressure varying unit pressing contacts with or is separated from the rolling piston; and

a vane supporting unit installed at the expansion groove of the cylinder to which the vane-side pressure varying unit is connected and supporting the rear side of the corresponding vane in a direction of the  
10 rolling piston.

2. The compressor of claim 1, wherein the first cylinder and the second cylinder form their vane slits, intakes and discharge ports on the same axis.  
15

3. The compressor of claim 2, wherein a tangent line of the first vane and the first rolling piston is formed on the same axis as the tangent line of the second vane and the second rolling piston.

20 4. The compressor of claim 1, wherein the vane-side pressure varying unit is connected to one refrigerant switching valve having a discharge-side inlet connected to the gas discharge pipe, an intake-side inlet connected with the gas intake pipe and a vane-side outlet connected with the expansion groove of the cylinder via a plurality of pipes.

5. The compressor of claim 1, wherein the cylinder-side pressure varying unit is connected to one refrigerant switching valve having a discharge-side inlet connected to the gas discharge pipe, an intake-side inlet connected with the gas intake pipe and a vane-side outlet connected with the intake of the cylinder via a plurality of pipes.

6. The compressor of claim 1, wherein the vane-side pressure varying unit and the cylinder-side pressure varying unit are connected to one refrigerant switching valve having a discharge-side inlet connected with the gas discharge pipe, an intake-side inlet connected with the gas intake pipe, a cylinder-side outlet connected with the intake of the cylinder and a vane-side outlet connected with the expansion groove via a plurality of pipes.

15

7. The compressor of claim 1, wherein the vane supporting unit is a compression spring that supports the vane in the radial direction of the cylinder by an elastic force.

20

8. The compressor of claim 7, wherein a stopper is provided at the rear of the vane so as to limit a retraction distance of the vane by preventing the compression spring from being compressed to make its turn portions come in contact with each other.

9. The compressor of claim 1, wherein the vane supporting unit includes magnetic bodies with the same polarity facing each other at the rear end of the vane and the vane slit facing the rear end supports the vane in the radial direction of the cylinder.

5

10. A capacity variable type twin rotary compressor comprising:

a casing having a particular inner space and connecting a gas discharge pipe such that the gas discharge communicates with the inner space;

10 a first cylinder and a second cylinder fixedly installed at the inner space of the casing so as to be separated from each other, each having an intake directly connecting a gas intake pipe and a discharge port communicating with the gas discharge port at both sides of a circumferential direction on the basis of each vane slit, and each forming  
15 an expansion groove at an outer diameter side of the vane slit to separate the expansion groove from the inner space of the casing;

a first vane and a second vane slidingly inserted into the vane slits of the cylinders, respectively, in a radial direction;

20 a first rolling piston and a second rolling piston inserted into eccentric parts, respectively, of a rotating shaft so as to pressingly contact with the respective vanes and compressing refrigerant, orbiting inside the cylinders;

a first vane-side pressure varying unit and a second vane-side pressure varying unit directly connected to the expansion groove

separated from the inner space of the casing and alternately supplying refrigerant of intake pressure or discharge pressure on occasion demands such that the vane pressingly contacts with the corresponding rolling piston to perform power driving or the vane is separated from the corresponding rolling piston to perform saving driving;

5 a first cylinder-side pressure varying unit and a second cylinder-side pressure varying unit installed at the expansion grooves of the cylinders, respectively, the vane-side pressure varying units are connected with and supporting the rear surfaces of the corresponding vanes in a direction of  
10 the respective rolling pistons.

11. The compressor of claim 10, wherein the first cylinder and the second cylinder form their vane slits, intakes and discharge ports on the same axis.

15

12. The compressor of claim 11, wherein a tangent line of the first vane and the first rolling piston is formed on the same axis as the tangent line of the second vane and the second rolling piston.

20 13. The compressor of claim 10, wherein the vane-side pressure varying units are connected to a plurality of refrigerant switching valves, each having a discharge-side inlet connected to the gas discharge pipe, an intake-side inlet connected with the gas intake pipe and a vane-side outlet connected with the expansion groove of the cylinder, via a plurality

of pipes, respectively.

14. The compressor of claim 10, wherein the cylinder-side pressure varying unit are connected to a plurality of refrigerant switching  
5 valves, each having a discharge-side inlet connected to the gas discharge pipe, an intake-side inlet connected with the gas intake pipe and a vane-side outlet connected with the intake of the cylinder, via a plurality of pipes.

10 15. The compressor of claim 10, wherein the vane-side pressure varying units and the cylinder-side pressure varying units are connected to a plurality of refrigerant switching valves, each having a discharge-side inlet connected with the gas discharge pipe, an intake-side inlet connected with the gas intake pipe, a cylinder-side outlet connected with the intake of  
15 the cylinder and a vane-side outlet connected with the expansion groove, via a plurality of pipes.

16. The compressor of claim 10, wherein the vane supporting unit is a compression spring that supports the vane in the radial direction  
20 of the cylinder by an elastic force.

17. The compressor of claim 16, wherein a stopper is provided at the rear of the vane so as to limit a retraction distance of the vane by preventing the compression spring from being compressed to make its

turn portions come in contact with each other.

18. The compressor of claim 10, wherein the vane supporting unit includes magnetic bodies with the same polarity facing each other at the rear end of the vane and the vane slit facing the rear end and supports the vane in the radial direction of the cylinder.

19. The compressor of one of claims 10 to 18, wherein the first cylinder and the second cylinder have the same capacity.

20. The compressor of one of claims 10 to 18, wherein the first cylinder and the second cylinder have different capacities from each other.

21. A method for driving a capacity variable type twin rotary compressor, comprising:

during the starting driving of the cylinder having the expansion groove separated from the inner space of the casing while the capacity variable type twin rotary compressor according to one of claim 1 or claim 10 is being driven, the corresponding cylinder-side pressure varying unit and the vane-side pressure varying unit are controlled such that the corresponding vane is always in contact with an outer circumferential surface of the rolling piston by the vane supporting unit and compresses the refrigerant by supplying refrigerant of the same pressure to the intake and the expansion groove of the cylinder.

22. A method for driving a capacity variable type twin rotary compressor, comprising:

5 during the power driving of the cylinder having the expansion groove separated from the inner space of the casing while the capacity variable type twin rotary compressor according to one of claim 1 or claim 10 is being driven, the corresponding cylinder-side pressure varying unit and the vane-side pressure varying unit are controlled such that the corresponding vane is always in contact with an outer circumferential  
10 surface of the rolling piston by differential pressure between internal pressure of the cylinder and pressure inside the expansion groove and a repulsive force of the corresponding vane supporting unit and compresses the refrigerant by supplying refrigerant of intake pressure to the intake of the cylinder and refrigerant of discharge pressure to the expansion groove  
15 of the cylinder.

23. A method for driving a capacity variable type twin rotary compressor, comprising:

20 during the saving driving of the cylinder having the expansion groove separated from the inner space of the casing while the capacity variable type twin rotary compressor according to one of claim 1 or claim 10 is being driven, the corresponding cylinder-side pressure varying unit and the vane-side pressure varying unit are controlled such that the corresponding vane overcomes pressure inside the expansion groove and

a repulsive force of the vane supporting unit by internal pressure of the cylinder, is pushed toward the rear side and separated from an outer circumferential surface of the rolling piston, and the refrigerant is leaked to an intake chamber from a compression chamber by supplying refrigerant  
5 of discharge pressure to the intake of the cylinder and refrigerant of intake pressure to the expansion groove of the cylinder.

24. A method for driving a capacity variable type twin rotary compressor, comprising:

10 when the saving driving is switched into the power driving in the cylinder having the expansion groove separated from the inner space of the casing while the capacity variable type twin rotary compressor according to one of claim 1 or claim 10 is being driven, the corresponding cylinder-side pressure varying unit and the vane-side pressure varying unit  
15 are controlled such that the corresponding vane is always in contact with an outer circumferential surface of the rolling piston by differential pressure between second middle pressure and first middle pressure and a repulsive force of the corresponding vane supporting unit and compresses refrigerant by supplying refrigerant of the first middle pressure which is  
20 gradually decreased less than discharge pressure to the inner space of the cylinder and refrigerant of the second middle pressure which is gradually increasing greater than intake pressure.

25. An air conditioner having the capacity variable type twin

rotary compressor of claim 1 or claim 10.

26. A method for driving an air conditioner having a capacity variable type twin rotary compressor, comprising:

5 detecting room temperature in the air conditioner of claim 25 and switching a driving mode of a compressor into a power driving mode when the room temperature reaches [desired temperature + A°C];

switching the driving mode of the converter into a saving driving mode when the room temperature reaches the desired temperature; and

10 switching the driving mode of the converter into the power driving mode again when the room temperature increases again and exists in [desired temperature + A°C] for two minutes consecutively and otherwise stopping the compressor if the room temperature decreases and reaches [desired temperature - B°C].

15

27. The method of claim 26, further comprising:

switching the driving mode of the converter into a continuous saving driving mode if the compressor is stopped by a particular number of times due to a decrease of room temperature after the driving mode of the compressor is switched to the saving driving mode and the saving driving is performed.

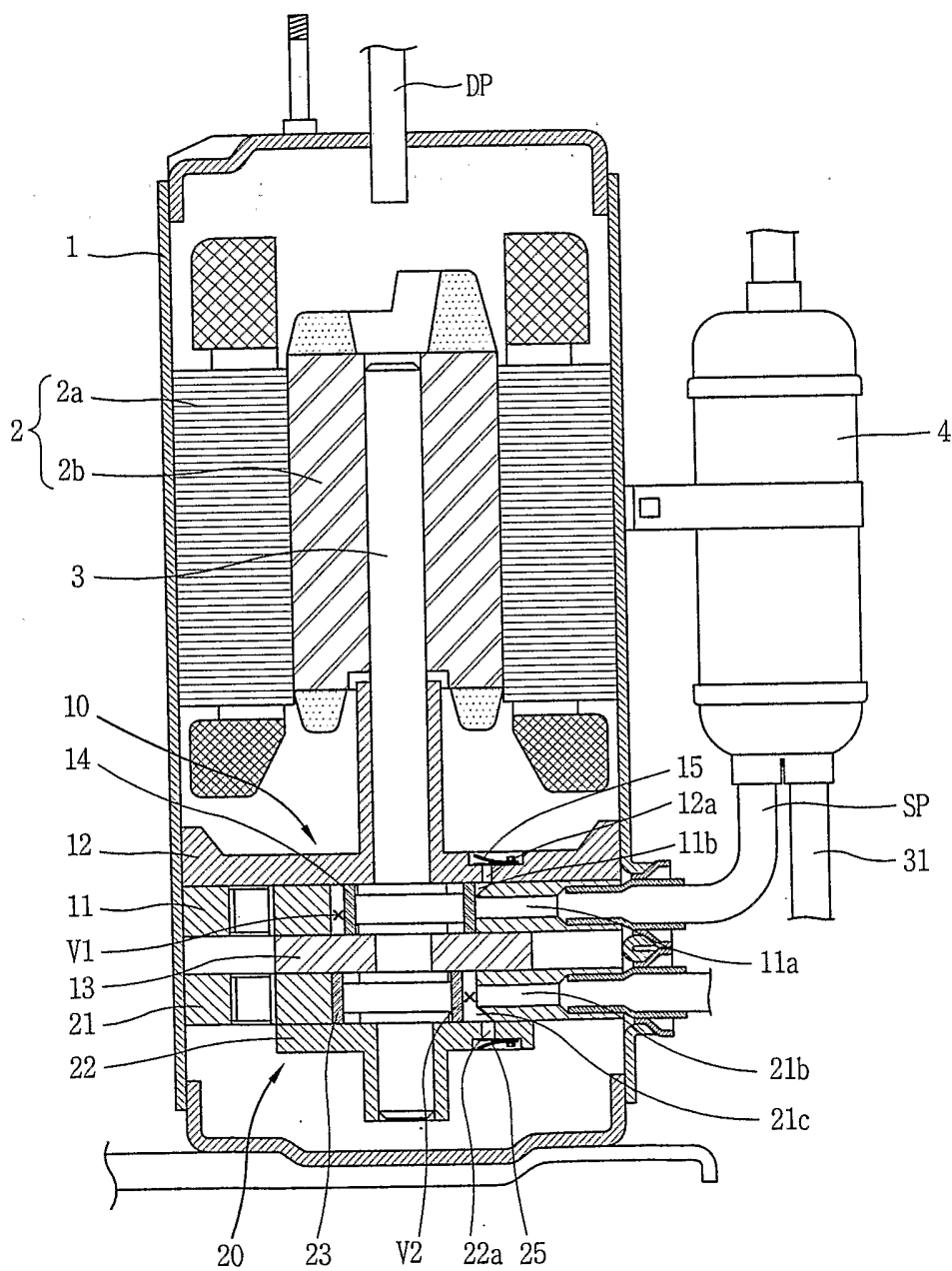
20

28. The method of claim 26 or claim 27, further comprising:

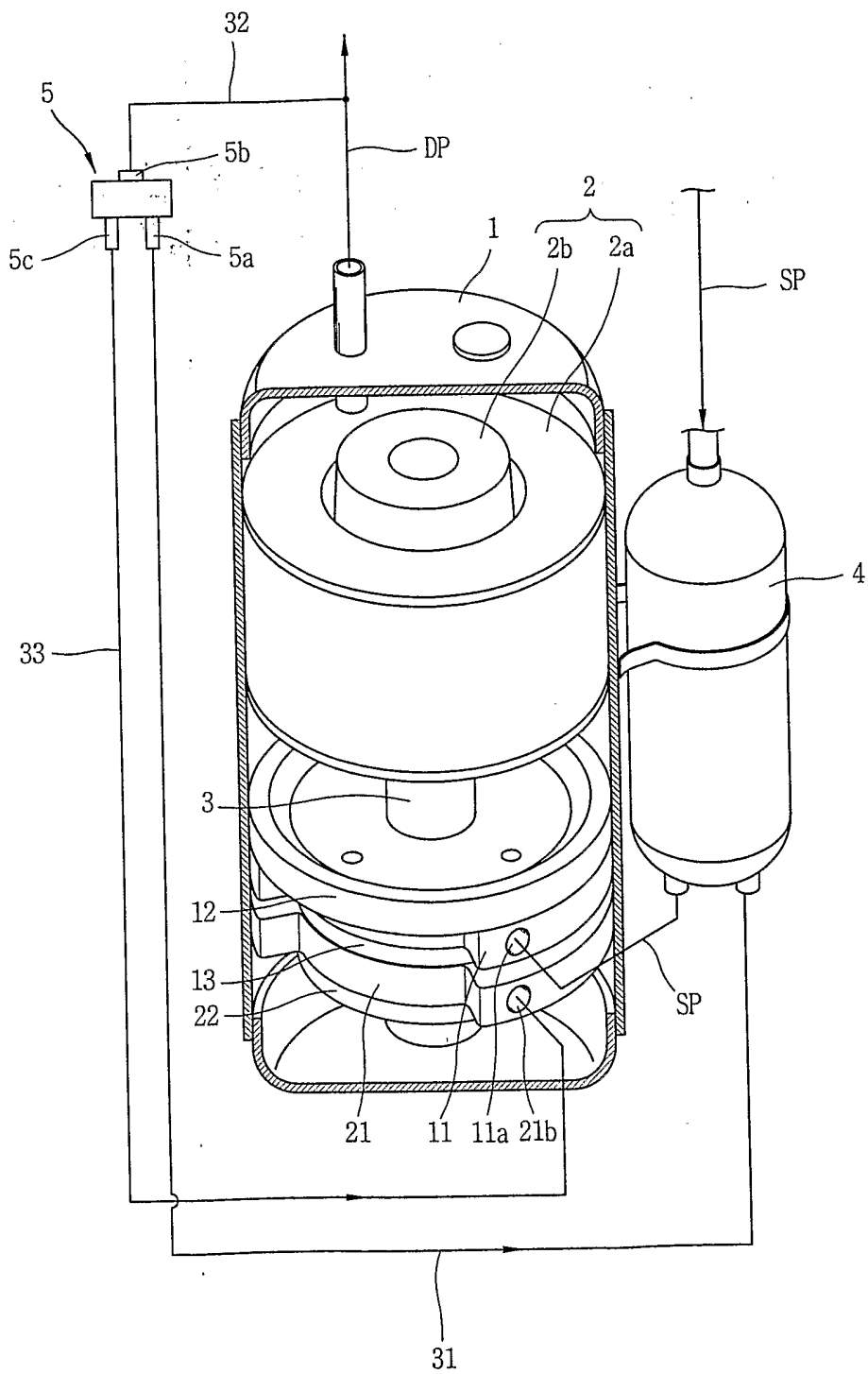
if a time for the saving driving mode of the compressor exceeds a

particular time during the driving of the compressor, switching the mode of the compressor into the power driving mode immediately and returning to the early stage.

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FIG. 1



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FIG. 2



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FIG. 3

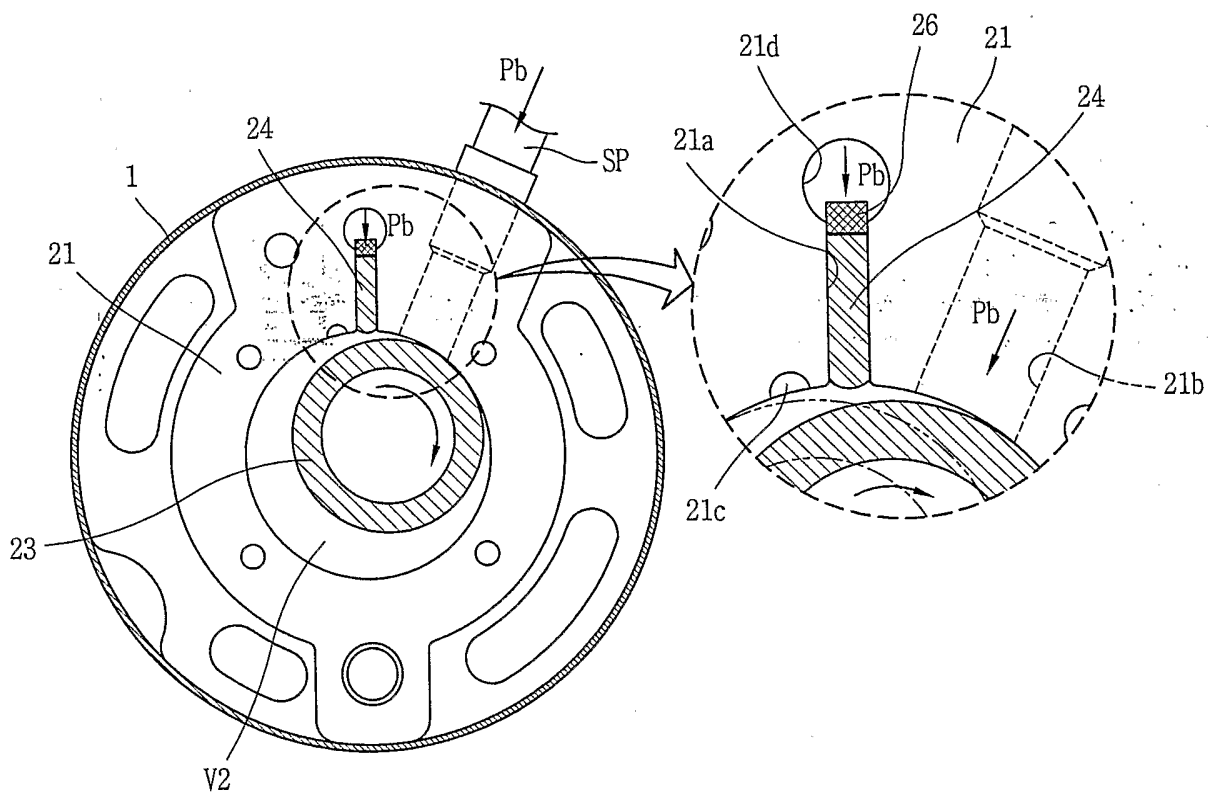
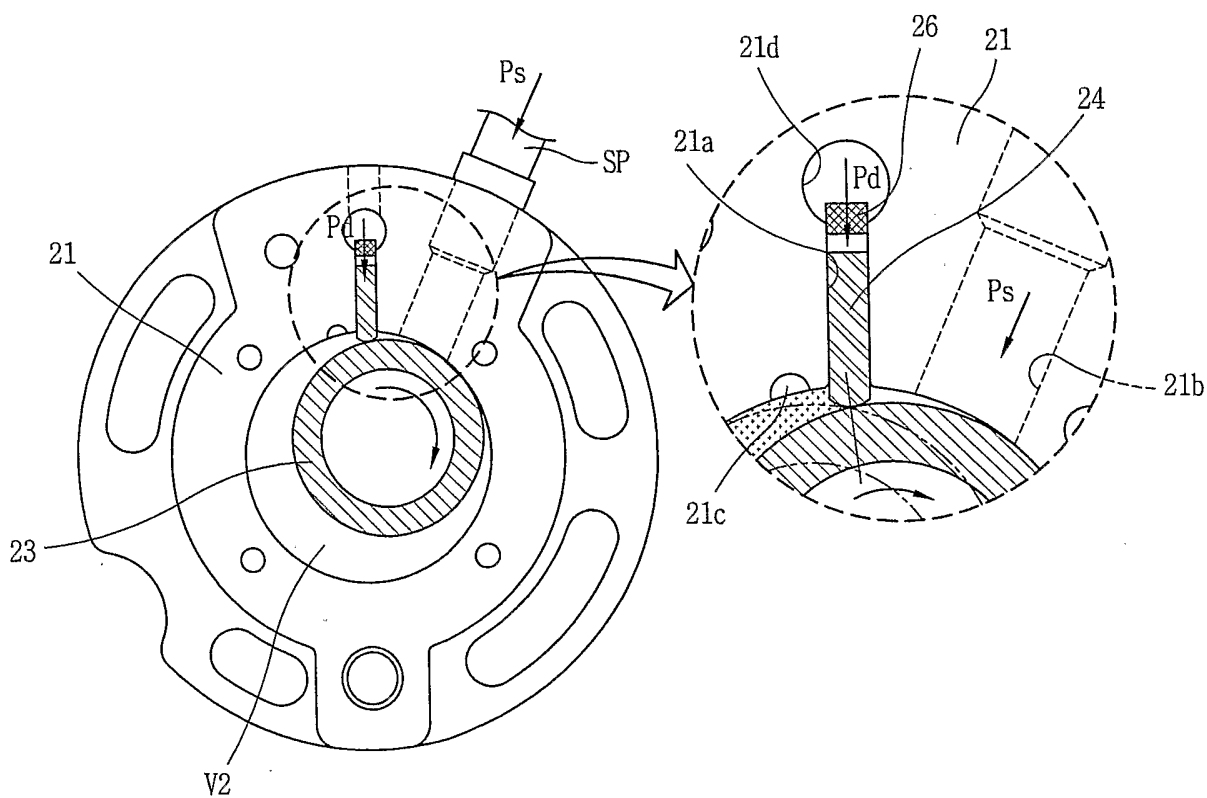


FIG. 4



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FIG. 5

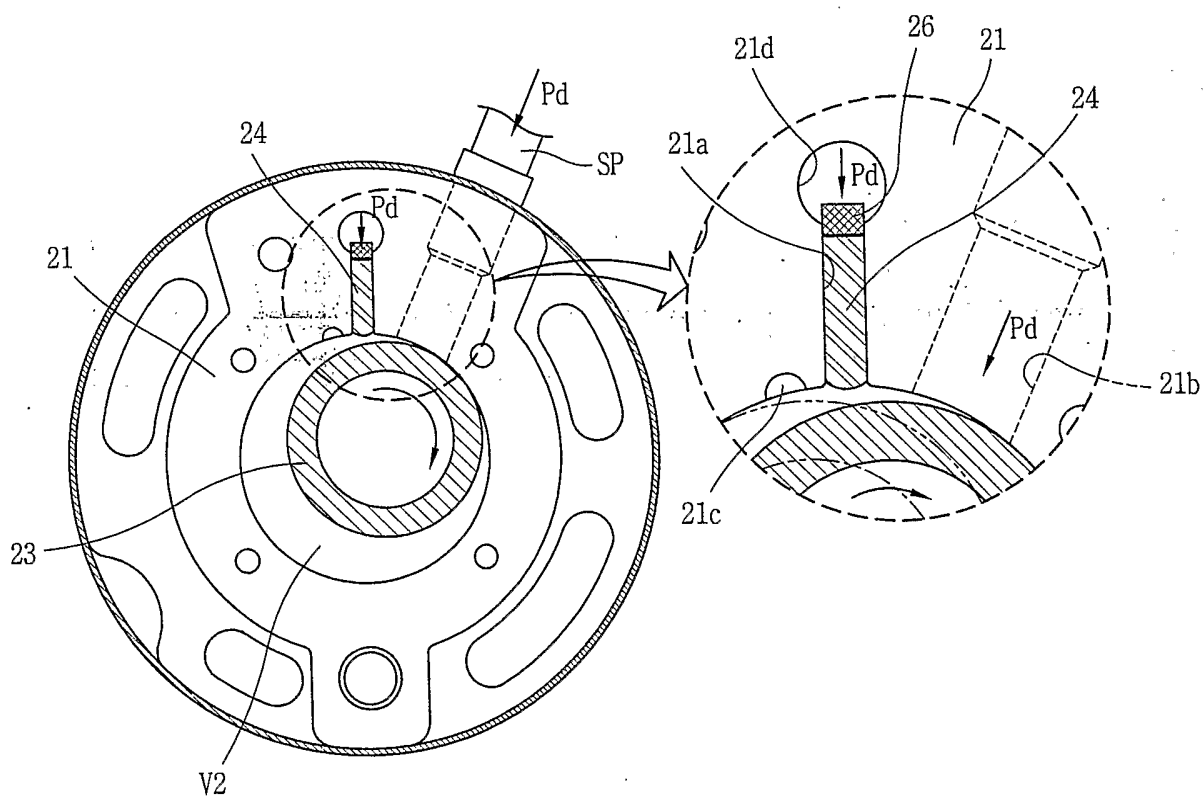
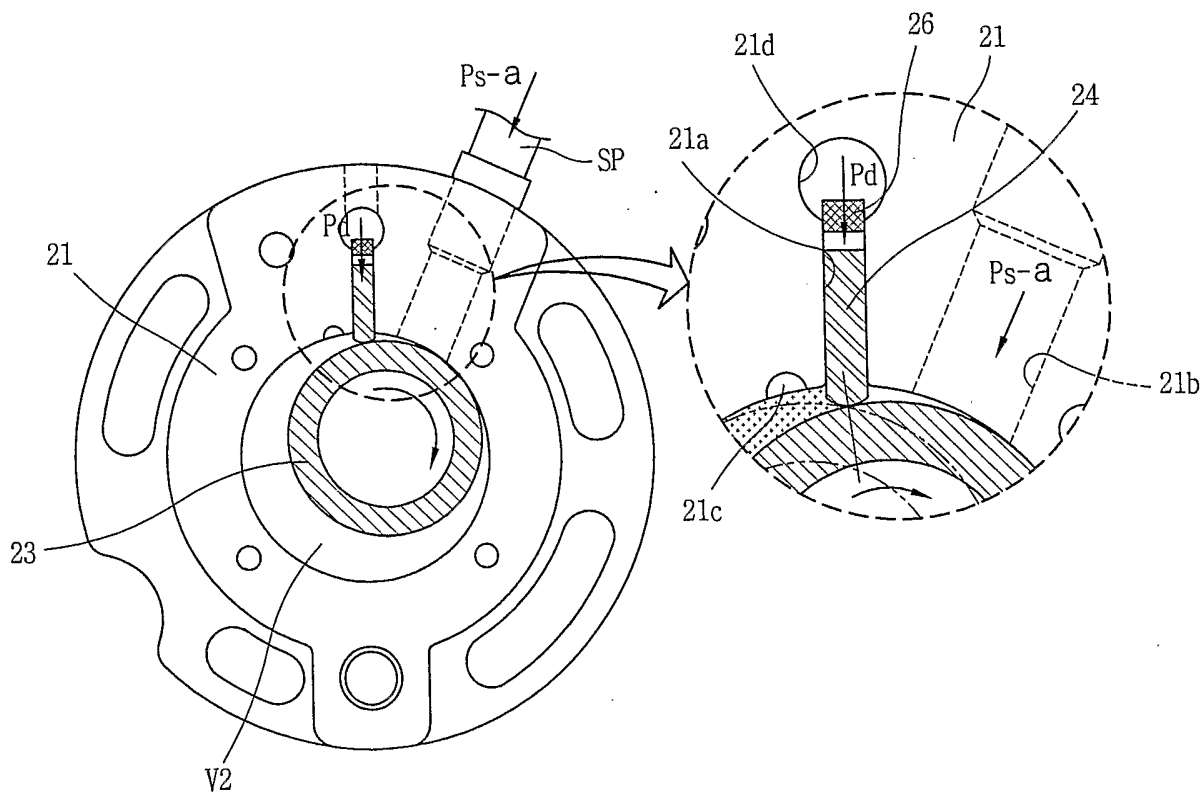
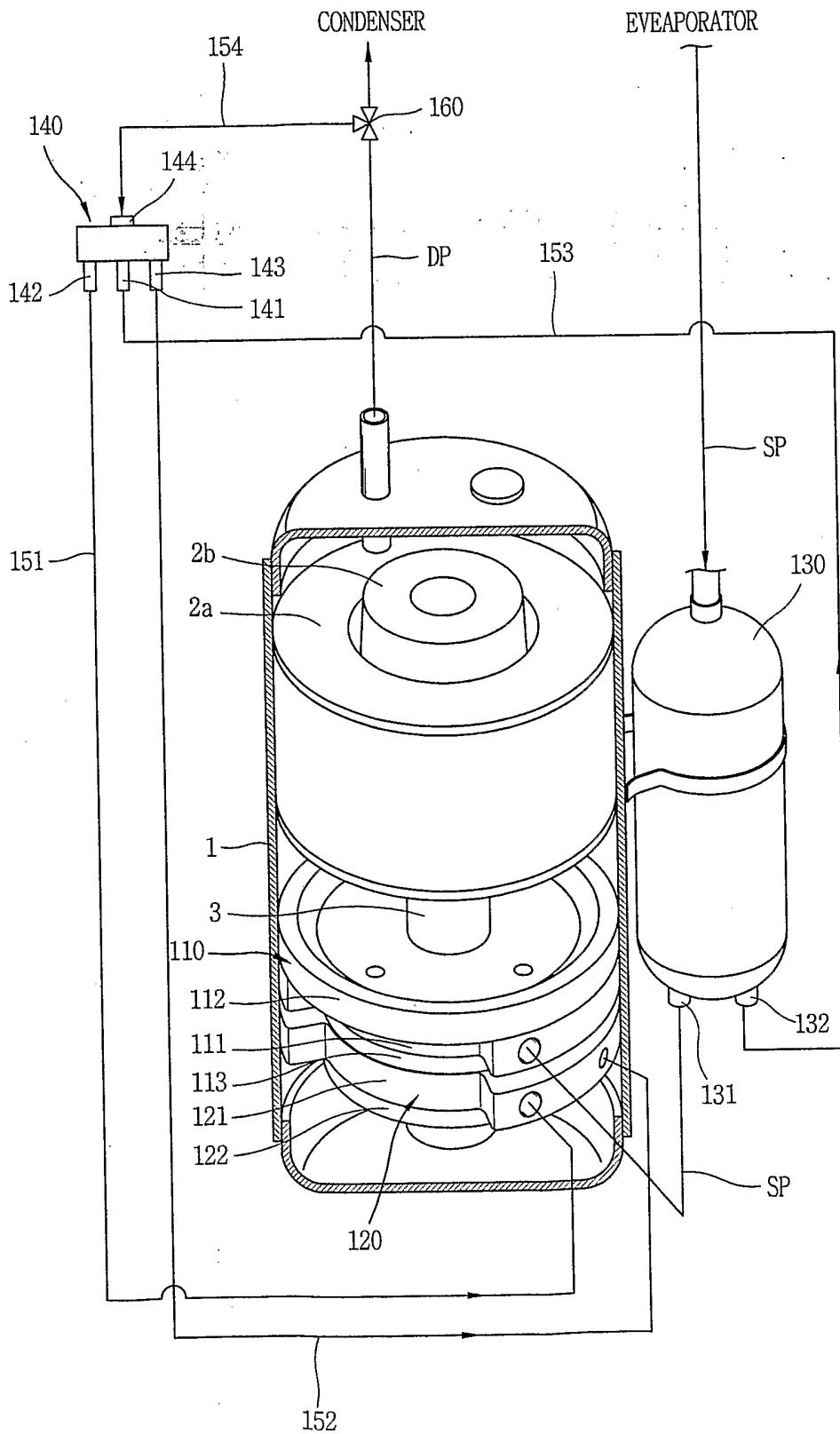


FIG. 6



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FIG. 7





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FIG. 10

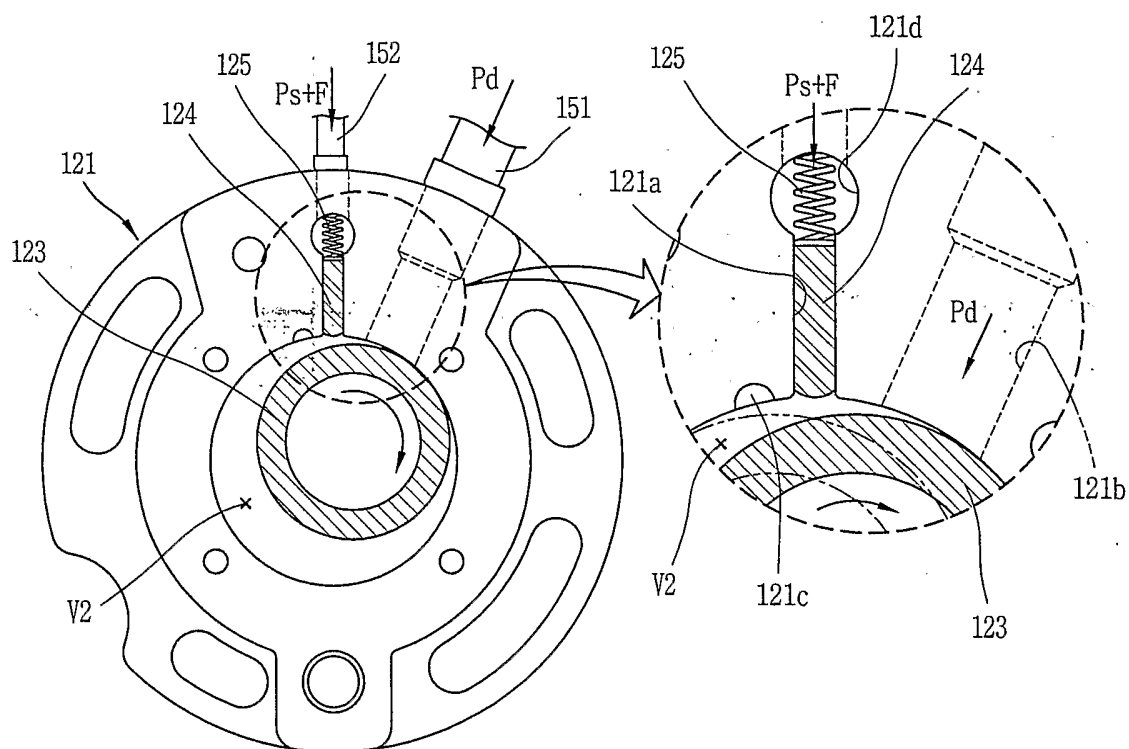
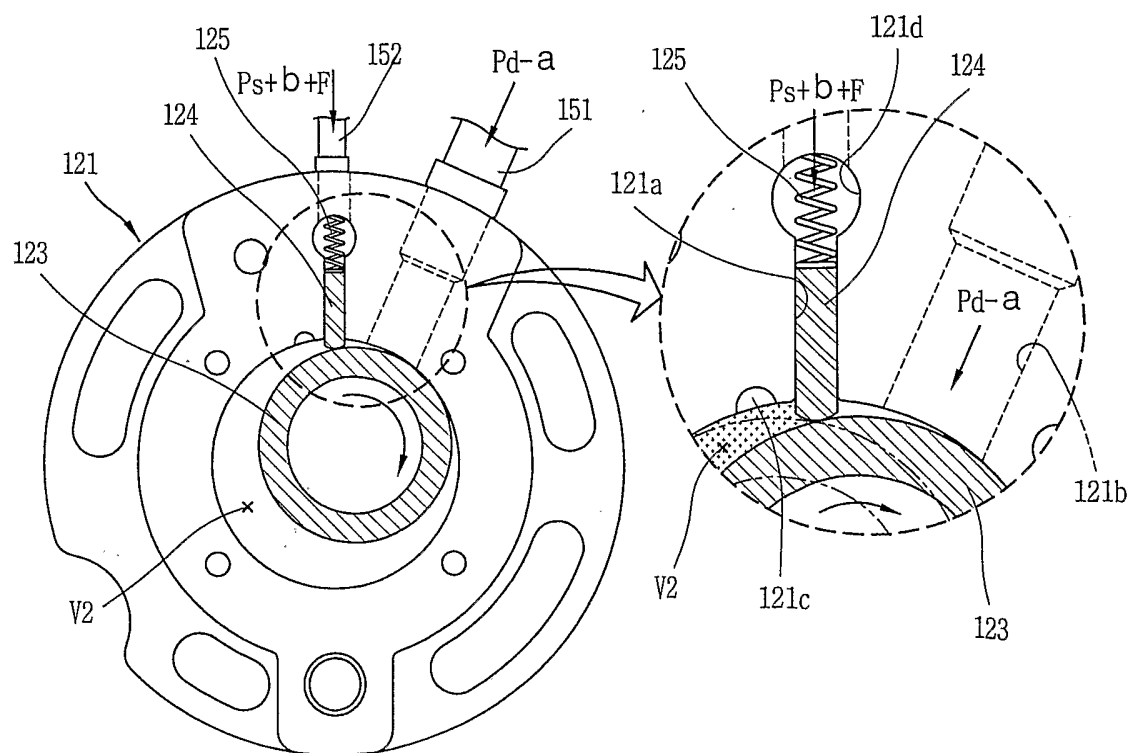


FIG. 11



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FIG. 12

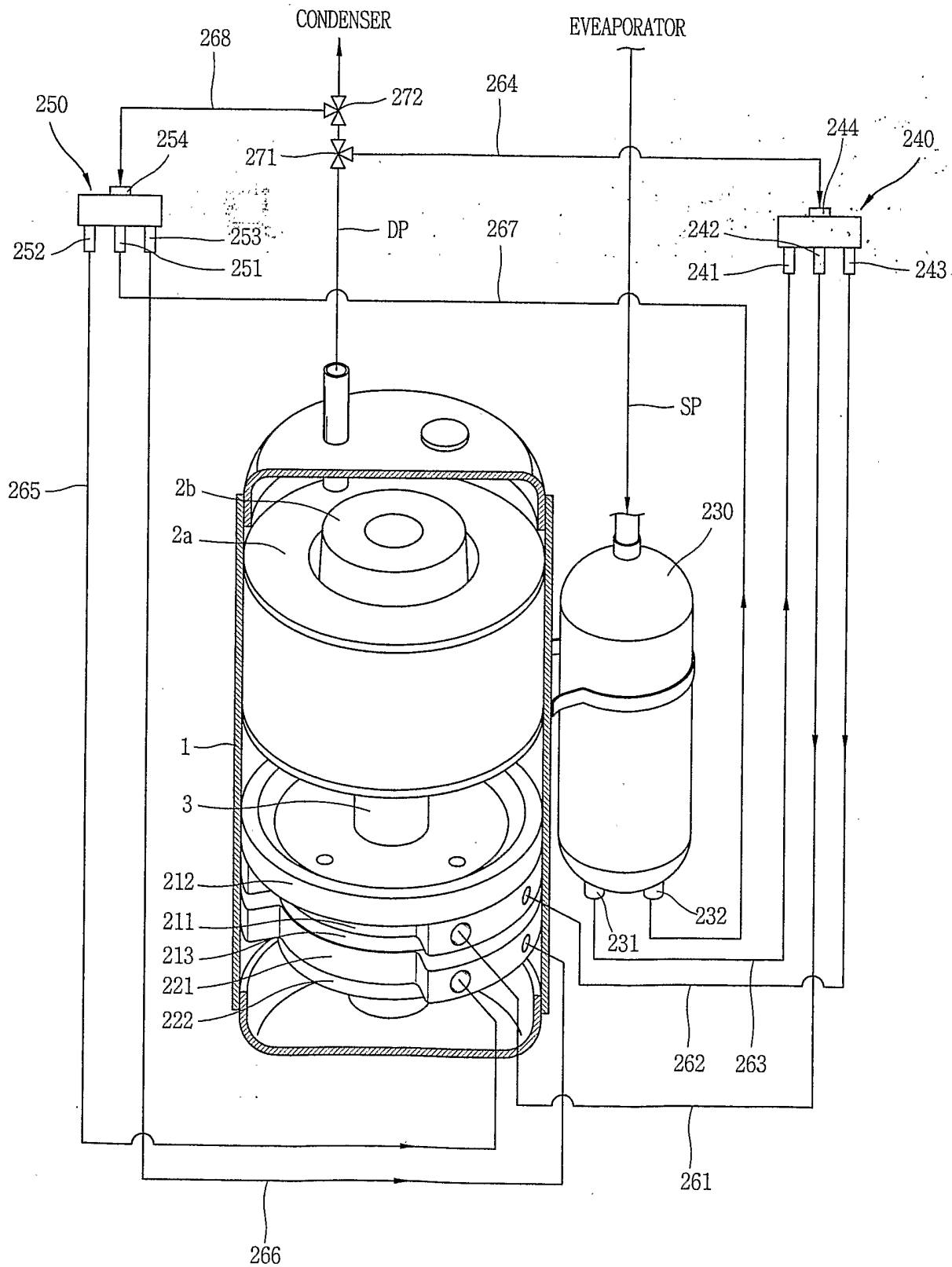


FIG. 13

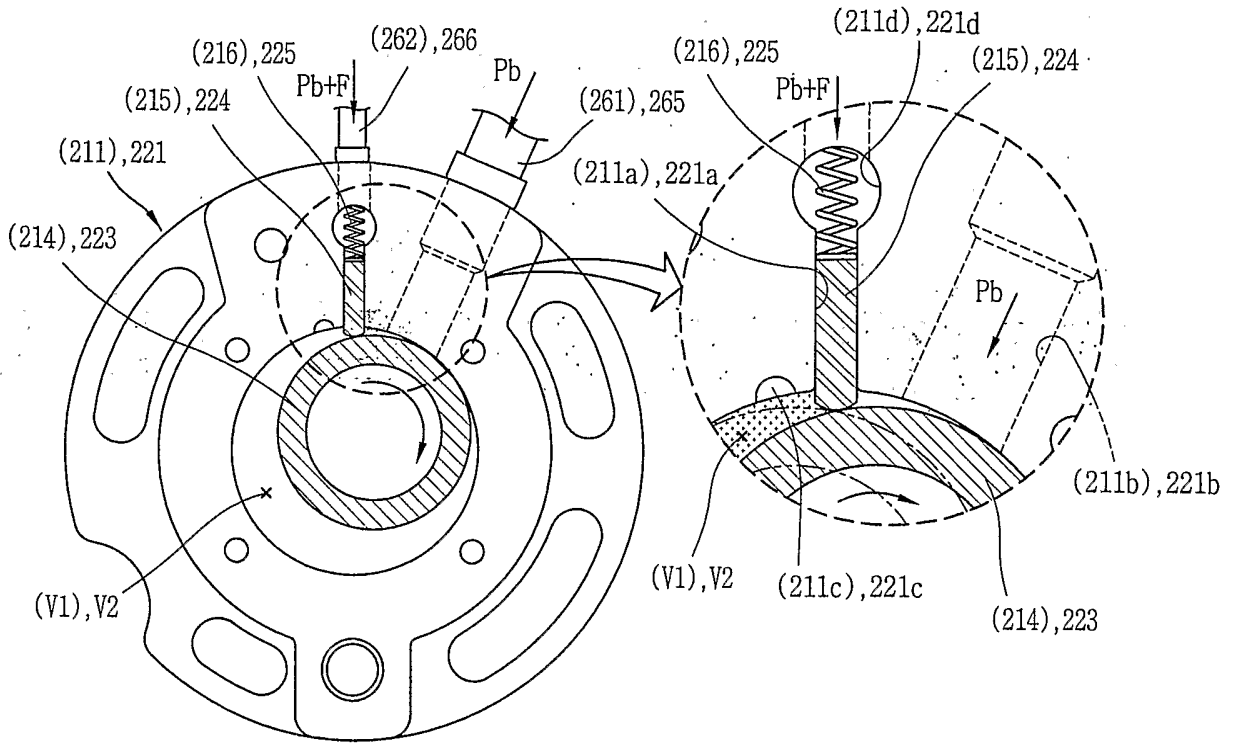
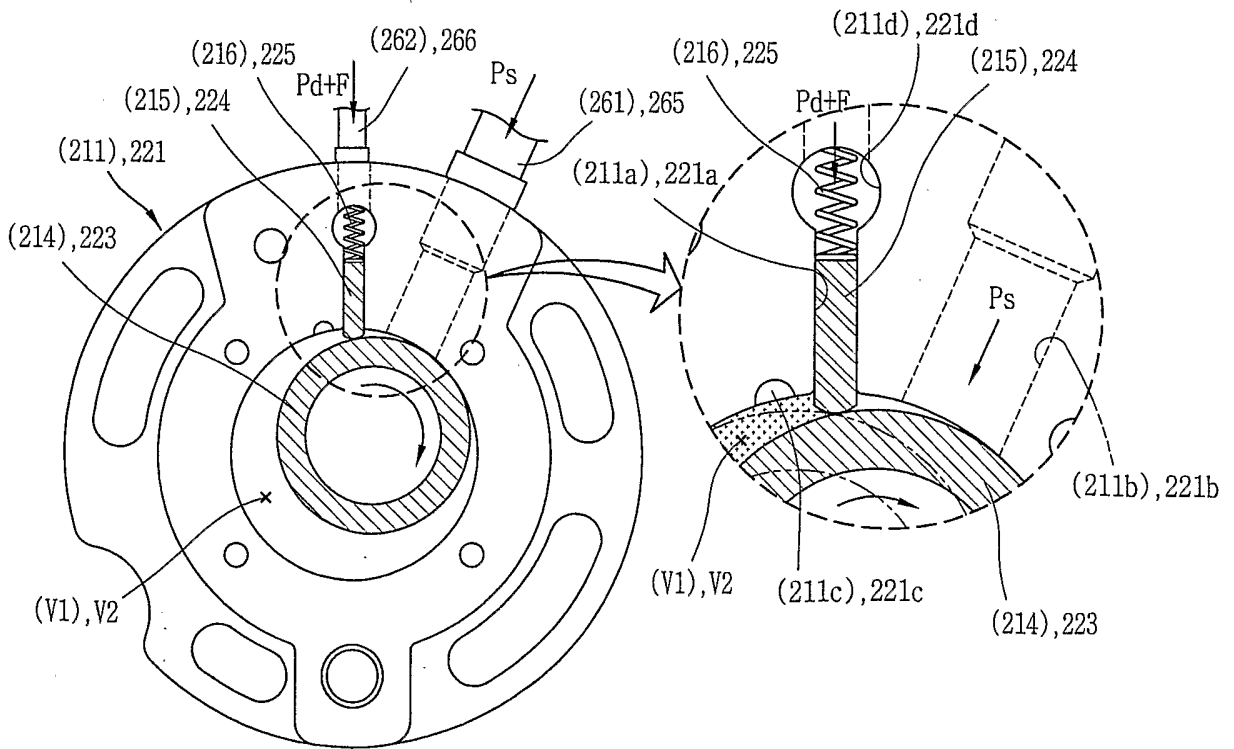


FIG. 14



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FIG. 15

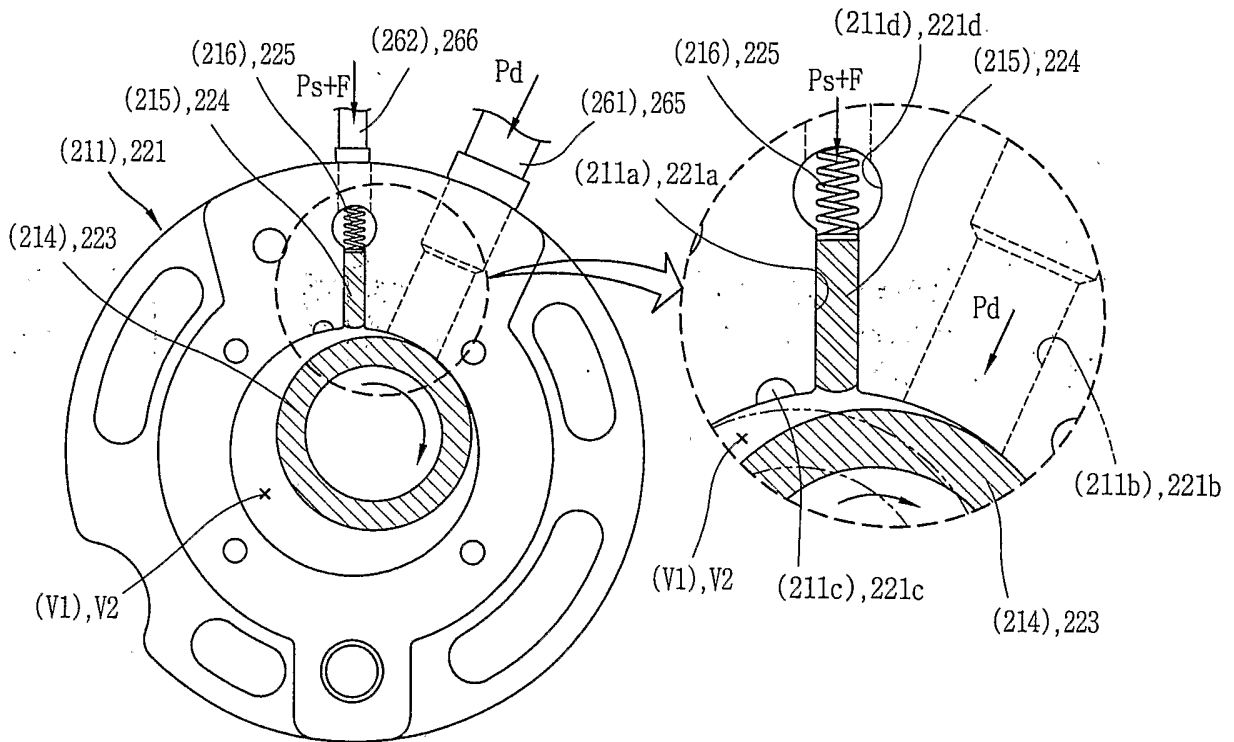
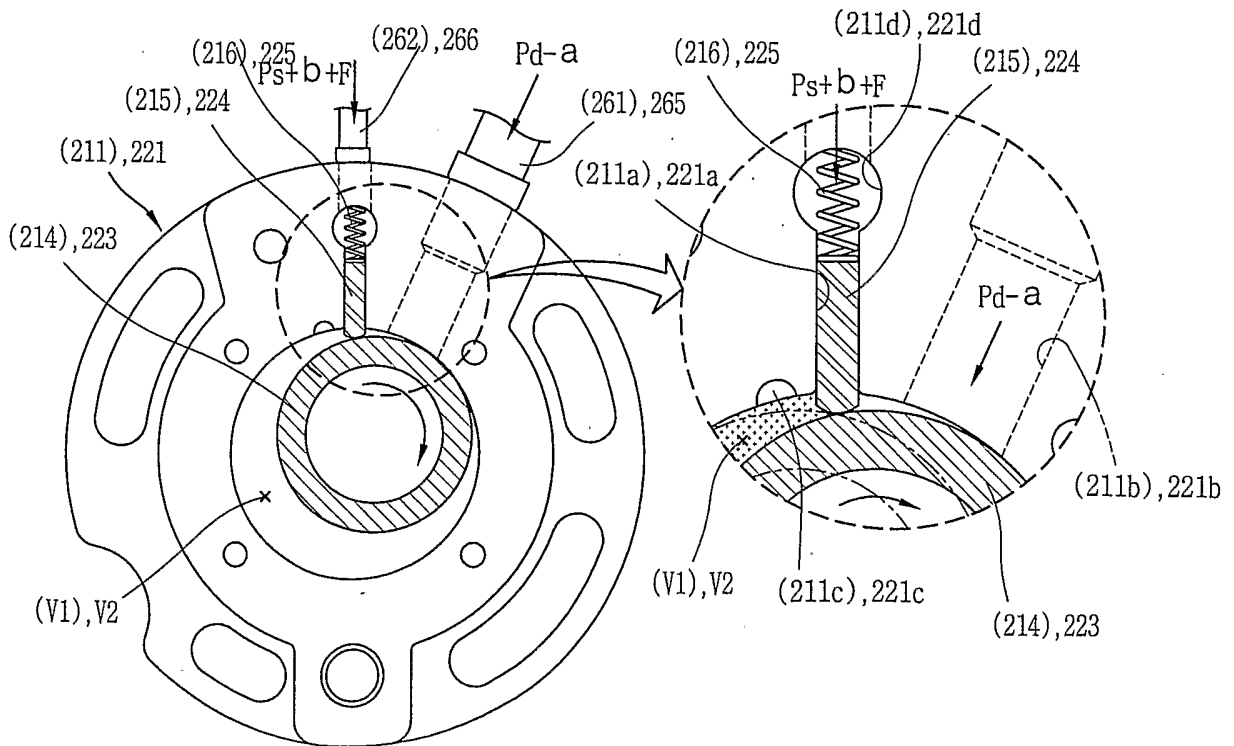
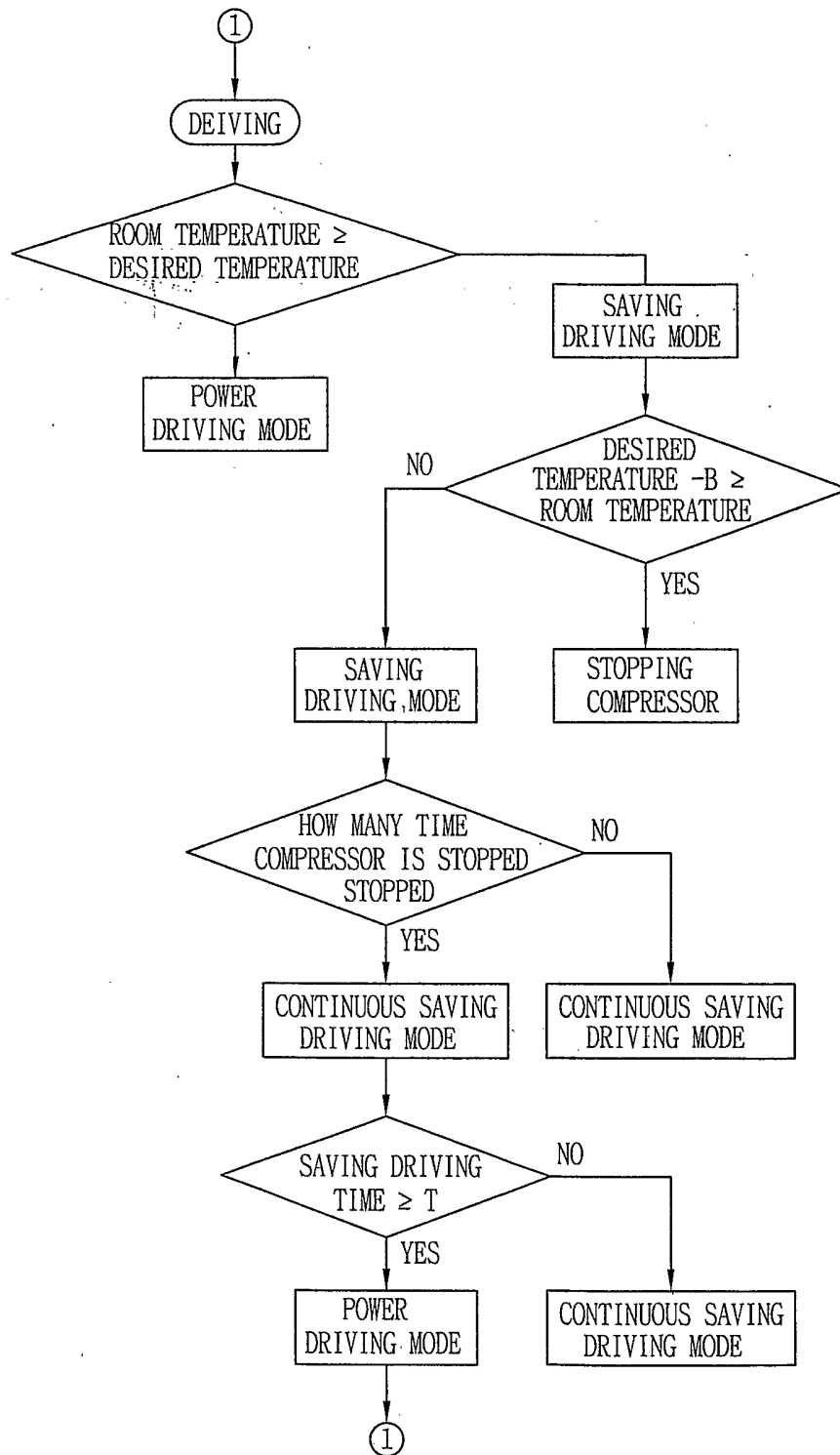


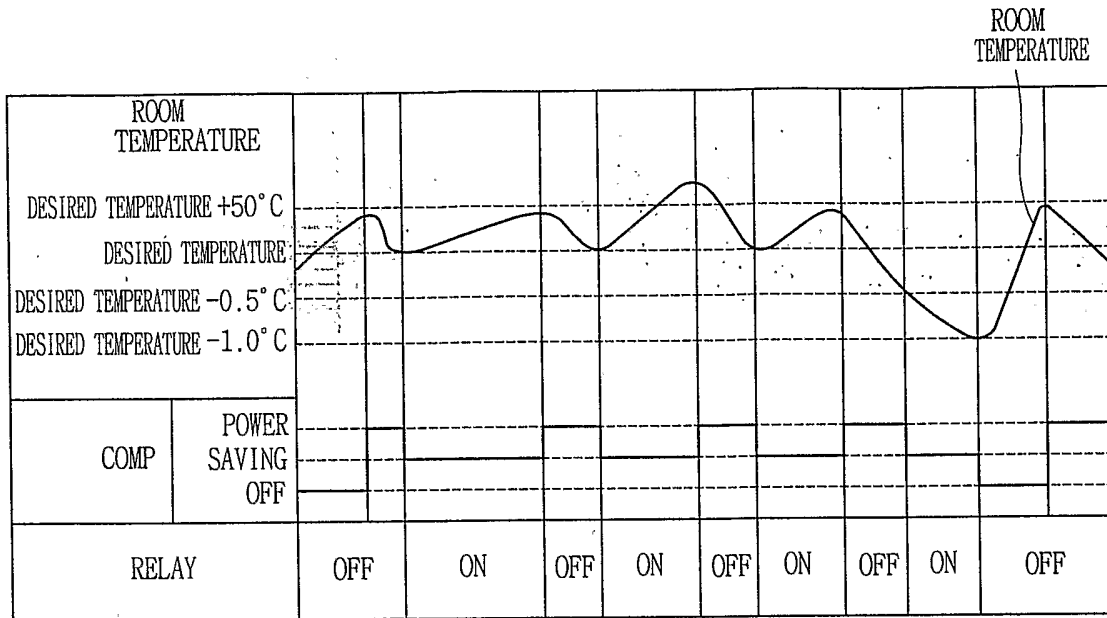
FIG. 16



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FIG. 17



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 FIG. 18



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/KR 2005/002580

A. CLASSIFICATION OF SUBJECT MATTER IPC <sup>7</sup> : F04C 18/356, F04C 23/00 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) IPC <sup>7</sup> : F04C		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched ----		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPODOC		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WO 20050611901 A1 (TOSHIBA CARRIER CORPORATION) 7 July 2005 (07.07.2005) <i>abstract, figures 1-3.</i>	1, 4-7
A	<i>abstract, figures 1-3.</i> --	10, 16, 20
A	Patent Abstracts of Japan vol. 013, no. 591 (M-913) 26 December 1989 (26.12.1989) & JP 1247786 A (Toshiba Corp) 03.10.1989 <i>abstract, figure 1.</i> --	1, 4, 7, 10, 16
A	US 20040009083 A1 (KIM et al.) 15 January 2004 (15.01.2004) <i>abstract, figures 2-4, paragraphs 0022-0038.</i> --	1, 4-8, 10, 16, 17
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "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 22 November 2005 (22.11.2005)		Date of mailing of the international search report 5 December 2005 (05.12.2005)
Name and mailing address of the ISA/ AT <b>Austrian Patent Office</b> Dresdner Straße 87, A-1200 Vienna Facsimile No. +43 / 1 / 534 24 / 535		Authorized officer HÖRZER K. Telephone No. +43 / 1 / 534 24 / 359

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/KR 2005/002580

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5131826 A1 (BOUSSICAULT) 21 July 1992 (21.07.1992) <i>abstract, figures 1, 2, column 3, line 48 - column 5, line 41.</i>  ---	1, 4, 7-10, 16-18

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/KR 2005/002580**

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
A			none		
US	A 20040009083		none		
US	A 5131826	1992-07-21	JP	A 3179188	1991-08-05
			EP	A1 0430789	1991-06-05
			DE	D1 69002591D	1993-09-09
			AT	T 92589T	1993-08-15
			CA	A1 2029796	1991-05-29
WO A 20050611901			none		