A variable capacity rotary compressor includes a housing having a compressing chamber, a roller to rotate in the compressing chamber while coming into contact with an inner peripheral surface of the compressing chamber, a vane to move forward and rearward along a guiding groove in accordance with rotation of the roller, the guiding groove being formed in the housing in a radial direction of the compressing chamber, a vane control device to regulate restriction and release of the vane as to whether or not the vane comes into continuous contact with an outer peripheral surface of the roller, and a controller to output a control signal to the vane control device for the variation of a compression capacity, so as to regulate a proportion of restriction and release of the vane, and a capacity variation method using the variable capacity rotary compressor.
FIG. 5

401a – INDOOR UNIT
401b – INDOOR UNIT
401c – INDOOR UNIT
401d – INDOOR UNIT

410 – CONTROLLER
60, 80 – VANE CONTROL DEVICE

VANE

43, 53 – DISCHARGE OF HIGH-PRESSURE REFRIGERANT
450 – SUCTION OF LOW-PRESSURE REFRIGERANT
FIG. 6

- Full On
- Part On

Intermediate Load  Part Load Only  Full Load Only

TIME

CAPABILITY

T_f  T_p
FIG. 7

<table>
<thead>
<tr>
<th>LOAD</th>
<th>$T_f$</th>
<th>$T_p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>20sec</td>
<td>0</td>
</tr>
<tr>
<td>75%</td>
<td>13sec</td>
<td>7sec</td>
</tr>
<tr>
<td>50%</td>
<td>6sec</td>
<td>14sec</td>
</tr>
<tr>
<td>30%</td>
<td>0sec</td>
<td>20sec</td>
</tr>
</tbody>
</table>
FIG. 8

Refrigeration cycle efficiency of novel compressor vs. conventional compressor.
FIG. 9

START

S910 - CALCULATE TOTAL AIR CONDITIONING LOAD BY CHECKING OPERATIONAL STATE OF INDOOR UNIT

S920 - CALCULATE COMPRESSION CAPACITY OF COMPRESSOR CORRESPONDING TO THE CALCULATED TOTAL AIR CONDITIONING LOAD

S930 - DETERMINE PROPORTION OF RESTRICTION AND RELEASE OF VANE CORRESPONDING TO THE CALCULATED COMPRESSION CAPACITY

S940 - VARYING COMPRESSION CAPACITY BY CONTROLLING VANE BASED ON THE DETERMINED PROPORTION OF RESTRICTION AND RELEASE OF THE VANE

END
VARIABLE CAPACITY ROTARY COMPRESSOR AND METHOD OF VARYING CAPACITY THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS


BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention
[0003] The present general inventive concept relates to a variable capacity rotary compressor and a method of varying a capacity thereof, and, more particularly, to a variable capacity rotary compressor in which a continuous capacity variation is possible without stopping operation of the compressor via a regulation in a proportion of a restriction time and/or a release time of a vane provided in the rotary compressor, and a method of varying a capacity of the compressor.

[0004] 2. Description of the Related Art
[0005] In general, variable capacity compressors have a compression capacity that is variable according to a required load, and are generally classified into a constant-speed compressor and a variable-speed compressor.

[0006] A constant-speed compressor is a compressor that is normally rotated at a constant speed, but can vary a capability thereof in two stages by changing a rotating direction of the compressor from forward to reverse or vice versa to achieve a variation in compression capacity. An example of a constant-speed compressor is disclosed in Korean Patent Publication No. 2004-0097746.

[0007] Korean Patent Publication No. 2004-0097746 describes a rotary compressor including a cylinder having a predetermined size of an inner volume, a roller rotating in the cylinder while defining a fluid chamber with an inner peripheral surface of the cylinder, and a plurality of suction ports arranged in the fluid chamber to be spaced apart from one another by a predetermined angle. The plurality of suction ports are selectively opened according to a rotating direction of a drive shaft to allow a compression capacity of the rotary compressor to vary in two stages according to the rotating direction.

[0008] A variable-speed compressor is a compressor that is variable in compression capacity via a regulation of revolutions per minute of the compressor. The regulation of revolutions per minute is achieved by an inverter, which is attached to a motor used to rotate the compressor and adapted to regulate revolutions per minute of the motor. An example of a variable-speed compressor is disclosed in Korean Patent Publication No. 2001-0018242.

[0009] Korean Patent Publication No. 2001-0018242 describes a compressor having an inverter, which detects indoor and outdoor temperatures, calculates an entire load of the compressor and a rotating frequency of an electric motor device by using a temperature difference with a preset indoor temperature, a cooling capacity of an indoor unit being operated, etc., and controls the electric motor device based on the calculated rotating frequency, thereby achieving a variation in the compression capacity of the compressor.

[0010] In the case of the conventional constant-speed compressor as stated above, to achieve a variation in capacity, the compressor has to be stopped for a predetermined time to convert a forward rotation into a reverse rotation or vice versa, and there is a limit in that the capacity variation of the compressor is possible only in two stages. To diversify a compression capacity, it is necessary to bypass a part of a refrigerant to be discharged, which has problems such as deterioration in operational efficiency and an increase in manufacturing costs.

[0011] In the case of the conventional variable-speed compressor, although continuous variation of a compression capacity is possible, the variable-speed compressor requires a high-cost inverter to regulate revolutions per minute of the compressor for achieving the variation of a compression capacity, and therefore has a problem of an increase in manufacturing costs.

SUMMARY OF THE INVENTION

[0012] The present general inventive concept provides a variable capacity rotary compressor which can achieve a continuous capacity variation using a low-cost control device having a simplified configuration, and a capacity variation method using the variable capacity rotary compressor.

[0013] The present general inventive concept also provides a variable capacity rotary compressor to represent a highest efficiency within an entire range of a variable compression capacity, and a method of varying the capacity of the compressor.

[0014] Additional aspects and advantages of the present general inventive concept will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the general inventive concept.

[0015] The foregoing and/or other aspects and utilities of the present general inventive concept may be achieved by providing a variable capacity rotary compressor, including a housing having a compressing chamber, a roller to rotate in the compressing chamber while contacting an inner peripheral surface of the compressing chamber, a vane to move forward and rearward along a guiding groove in accordance with the rotation of the roller, the guiding groove being formed in the housing in a radial direction of the compressing chamber, a vane control device to control whether the vane comes into continuous contact with an outer peripheral surface of the roller by regulating a restriction and a release of the vane, and a controller to output a control signal to the vane control device to regulate proportions of a restriction time and a release time of the vane to vary a compression capacity of the compressor.

[0016] The guiding groove may include a hermetic chamber to receive a rear end of the vane, and the vane control device may regulate the restriction and the release of the vane by regulating a pressure applied into the hermetic chamber based on the control signal.

[0017] The vane control device may include a high-pressure flow path to connect the hermetic chamber to a discharge side of the compressor, a low-pressure flow path to connect the hermetic chamber to a suction side of the compressor, and a flow path selector to selectively connect the hermetic chamber to the high-pressure flow path or low-pressure flow path.
The flow path selector may be a 3-way valve to be
switched by the control signal, and the proportions of the
restriction time and the release time of the vane may be
regulated by modulating a pulse width of the control signal
to be applied to the 3-way valve.

The foregoing and/or other aspects and utilities of the
present general inventive concept may also be achieved
by providing a variable capacity rotary compressor, includ-
ing a housing having a compressing chamber, a roller to
rotate in the compressing chamber contacting an inner
peripheral surface of the compressing chamber, a vane to
move forward and rearward along a guiding groove in
accordance with the rotation of the roller, the guiding groove
being formed in the housing in a radial direction of the
compressing chamber, a vane control device to control
whether the vane comes into continuous contact with an
outer peripheral surface of the roller by regulating a restric-
tion and a release of the vane, and a controller to output a
control signal to the vane control device to regulate a
restriction time and a release time of the vane during a preset
time period to vary a compression capacity of the compres-
sor.

Each of the restriction time and the release time of
the vane may be an integral multiple of one-turn time of the
compressor, and a sum of the restriction time and the release
time may be a time corresponding to one preset time period.

The guiding groove may include a hermetic cham-
ber to receive a rear end of the vane, and the vane control
device may regulate the restriction time and the release
time of the vane by regulating a pressure to be applied into the
hermetic chamber based on the control signal.

The vane control device may include a high-pres-
sure flow path to connect the hermetic chamber to a dis-
charge side of the compressor, a low-pressure flow path to
connect the hermetic chamber to a suction side of the
compressor, and a flow path selector to selectively connect
the hermetic chamber to the high-pressure flow path or
low-pressure flow path.

The flow path selector may be a 3-way valve to be
switched by the control signal, and the restriction time and
the release time of the vane may be regulated by modulating
a pulse width of the control signal to be applied to the 3-way
valve.

The controller may perform a control operation
such that the restriction time of the vane decreases and the
release time of the vane increases within the one time period,
to increase a compression capacity.

The foregoing and/or other aspects and utilities of the
present general inventive concept may also be achieved
by providing a variable capacity rotary compressor, includ-
ing a housing having first and second compressing chambers
separated from each other, first and second rollers to rotate
in the first and second compressing chambers, respectively,
while contacting inner peripheral surfaces of the first and
second compressing chambers, first and second vanes to
move forward and rearward along first and second guiding
grooves, respectively, in accordance with the rotation of the
first and second rollers, respectively, the first and second
guiding grooves being formed in the housing in a radial
direction of the first and second compressing chambers,
respectively, a first vane control device to regulate a restric-
tion time and a release time of the first vane using a pressure
applied to the first vane to control whether the first vane
comes into continuous contact with an outer peripheral
surface of the first roller, and a controller to output a control
signal to the first vane control device to regulate proportions
of a restriction time and a release time of the first vane to
vary a compression capacity of the compressor.

The first guiding groove may include a first her-
metic chamber to receive a rear end of the first vane, and the
pressure to be applied to the first vane may be regulated by
the first vane control device based on the control signal and
applied into the first hermetic chamber.

The first vane control device may include a first
high-pressure flow path to connect the first hermetic cham-
ber to a discharge side of the compressor, a first low-pressure
flow path to connect the first hermetic chamber to a suction
side of the compressor, and a first flow path selector to
selectively connect the first hermetic chamber to the first
high-pressure flow path or first low-pressure flow path.

The first flow path selector may be a 3-way valve
to be switched by the control signal, and the proportions of
the restriction time and the release time of the first vane may
be regulated by modulating a pulse width of the control signal
to be applied to the 3-way valve.

The second guiding groove may include a second
hermetic chamber to receive a rear end of the second vane,
and the compressor may further include a second vane
control device to regulate a restriction time and a release
time of the second vane by regulating a pressure applied into
the second hermetic chamber based on the control signal.

The first and second compressing chambers may
have different compression capacities.

The foregoing and/or other aspects and utilities of the
present general inventive concept may also be achieved
by providing a method of varying a capacity of a variable
capacity rotary compressor having a housing having a
compressing chamber, a roller to rotate in the compressing
chamber while contacting an inner peripheral surface of the
compressing chamber, and a vane to divide an interior of the
compressing chamber into a low-pressure section and a
high-pressure section and to move forward and rearward in
a radial direction of the compressing chamber in accordance
with rotation of the roller, the method including calculating
an air conditioning load depending on an operational state of
an indoor unit, and varying a compression capacity of the
compressor chamber to correspond to the calculated air
conditioning load by regulating proportions of a restriction
time and a release time of the vane based on the calculated
air conditioning load.

When the vane is restricted, the vane may not come
into continuous contact with an outer peripheral surface of
the roller, and when the restricted vane is released, the vane
may come into continuous contact with the outer peripheral
surface of the roller.

The foregoing and/or other aspects and utilities of the
present general inventive concept may also be achieved
by providing a variable capacity rotary compressor, includ-
ing a body to form a compressing chamber having a roller
therein, a vane moveably disposed in the body to move
between a forward position and a rearward position, and a
controller to generate a control signal to control the vane
according to a release time during which the vane moves
between the forward position and the rearward position and
a restriction time during which the vane remains in the
rearward position to vary a compression capacity of the
compressing chamber while maintaining a continuous
operation of the compressor.
The compressor may further include a vane regulating device to regulate the movement of the vane by releasing the vane from the rearward position and by restricting the vane in the reward position, based on the generated control signal. The controller may generate the control signal to control the restriction time to decrease and the release time to increase within a predetermined compression time period to increase the compression capacity of the compressing chamber while maintaining the continuous operation of the compressor. The controller may generate a second control signal to control the vane according to a release time during which the second vane moves between the second forward position and the second rearward position and a restriction time during which the second vane remains in the second rearward position to vary a compression capacity of the second compressing chamber while maintaining the continuous operation of the compressor.

The compressor may further include a second vane regulating device to regulate the movement of the second vane by releasing the second vane from the rearward position and by restricting the second vane in the reward position, based on the generated control signal. The controller may control the release time and the restriction time corresponding to idling and compressing operations of the compressing chamber so that the compression capacity varies without stopping an operation thereof.

The foregoing and/or other aspects and utilities of the present general inventive concept may also be achieved by providing a method of varying a compression capacity of a variable capacity rotary compressor including a body to form a compressing chamber having a roller therein and a vane moveably disposed in the body to move between a forward position and a rearward position, the method including controlling a release time during which the vane moves between the forward positions and the rearward position and a restriction time during which the vane remains in the reward position to vary a compression capacity of the compressing chamber while maintaining a continuous operation of the compressor.

Detailed Description of the Preferred Embodiments

Reference will now be made in detail to the embodiments of the present general inventive concept, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present general inventive concept by referring to the figures.

Figs. 1, 2, 3A and 3B are views illustrating a variable capacity rotary compressor, according to an embodiment of the present general inventive concept. As illustrated in Fig. 1, the rotary compressor of the present embodiment includes an electric motor device 20 installed in an upper portion of a hermetic container 10, and a compressing device 30 installed in a lower portion of the hermetic container 10 and connected to the electric motor device 20 through a rotating shaft 21.

The electric motor device 20 includes a cylindrical stator 22 secured to an inner surface of the hermetic container 10, and a rotor 23 rotatably installed in the stator 22 and having a central portion coupled to the rotating shaft 21. If power is applied to the electric motor device 20, the rotor 23 rotates to drive the compressing device 30 connected thereto through the rotating shaft 21.

The compressing device 30 includes a housing having an upper first compressing chamber 31 and a lower second compressing chamber 32 separated from each other. The compressing device 30 further includes first and second compressing units 40 and 50 provided in the first and second compressing chambers 31 and 32, respectively, and adapted to be operated by the rotating shaft 21.

The housing of the compressing device 30 includes an upper first body 33 defining the first compressing chamber 31, a lower second body 34 located below the first body 33 to define the second compressing chamber 32, an intermediate plate 35 located between the first and second bodies.
33 and 34 to separate the first and second compressing chambers 31 and 32 from each other, and first and second flanges 36 and 37 configured to close an upper-side opening of the first compressing chamber 31 and a lower-side opening of the second compressing chamber 32, respectively. The first and second flanges 36 and 37 are mounted to a top of the first body 33 and a bottom of the second body 34, respectively, to support the rotating shaft 21 together. The rotating shaft 21 is installed to penetrate the center of both the first and second compressing chambers 31 and 32 and to connect to the first and second compressing units 40 and 50 inside the first and second compressing chambers 31 and 32.

[0053] The first and second compressing units 40 and 50 include first and second eccentric portions 41 and 51 located around the rotating shaft 21 inside the first and second compressing chambers 31 and 32, and first and second rollers 42 and 52 rotatably coupled to outer peripheral surfaces of the first and second eccentric portions 41 and 51, respectively, to rotate in contact with inner peripheral surfaces of the first and second compressing chambers 31 and 32. The first eccentric portion 41 and second eccentric portion 51 are arranged in opposite eccentric directions with respect to the rotational shaft 21 to maintain a balance therebetween.

[0054] The first and second compressing units 40 and 50 further include first and second vanes 43 and 53, respectively. The first and second vanes 43 and 53 serve to divide the first and second compressing chambers 31 and 32 as they perform forward and rearward movements in a radial direction of the first and second compressing chambers 31 and 32 according to rotations of the first and second rollers 42 and 52. The first and second vanes 43 and 53, as illustrated in FIGS. 1 and 2, are received in first and second vane guiding grooves 44 and 54 that extend lengthwise in the radial direction of the first and second compressing chambers 31 and 32, such that forward and rearward movements of the first and second vanes 43 and 53 are guided by the first and second vane guiding grooves 44 and 54, respectively. A vane spring 55 is installed in the second vane guiding groove 54 and adapted to pressure the second vane 53 toward the second roller 52 to allow the second vane 53 to divide the second compressing chamber 32.

[0055] As illustrated in FIG. 2, a first hermetic chamber 46 is formed at a rear side of the first vane guiding groove 44 and adapted to receive a rear end of the first vane 43. The first hermetic chamber 46 is separated from an inner space of the hermetic container 10 by the intermediate plate 35 and the first flange 36. The first hermetic chamber 46 is able to receive a predetermined amount of gas, and is defined by a cylindrical expanded portion 46a having a diameter larger than a width of the first vane 43. The rear end of the first vane 43 may be formed with a curved surface 43a to reduce a generation of noise when the rear end of the first vane 43 collides with the cylindrical expanded portion 46a of the first hermetic chamber 46 during a rearward movement of the first vane 43. To enhance the noise reduction effect, a vibration absorbing member (not illustrated) may be mounted at a collision position of the rear end of the first vane 43 or cylindrical expanded portion 46a.

[0056] In the present embodiment, a first vane control device 60 is provided to apply a suction pressure into the first hermetic chamber 46 to restrict the first vane 43 in a rearwardly moved state, or to apply a discharge pressure into the first hermetic chamber 46 to release the restricted first vane 43, thereby allowing forward and rearward movements of the first vane 43. By apply the suction pressure into the first hermetic chamber 46 to restrict the first vane 43 and applying the discharge pressure into the first hermetic chamber 46 to release the restricted first vane 43, the first vane control device 60 causes a compressing operation or idling rotation in the first compressing chamber 31, thereby enabling a variation in compression capacity. The detailed configuration and operation of the first vane control device 60 is described below.

[0057] The first and second bodies 33 and 34 have suction holes 73 connected to suction pipes 71 and 72 to introduce gas into the first and second compressing chambers 31 and 32, and discharge holes 75 and 76 (see FIG. 1), respectively, to discharge the gas, which was compressed in the respective first and second compressing chambers 31 and 32, into the hermetic container 10. If the compressor operates, the interior of the hermetic container 10 is kept at a high pressure by the compressed gas discharged through the discharge holes 75 and 76. The compressed gas inside the hermetic container 10 is guided to an outside through a discharge pipe 77 (see FIG. 1) that is located on a top of the hermetic container 10. Here, the gas to be suctioned first passes through an accumulator 78, prior to being guided to the suction holes 73 of the respective compressing chambers 31 and 32 through the suction pipes 71 and 72.

[0058] The vane control device 60, as illustrated in FIG. 1, includes a first connecting pipe 61 directly connected to the first hermetic chamber 46 at the rear side of the first vane guiding groove 44, a first high-pressure pipe 62 connecting the first connecting pipe 61 to the discharge pipe 77, a first low-pressure pipe 63 connecting the first connecting pipe 61 to a suction pipe 70, and a first flow path selector 64 to selectively communicate the first connecting pipe 61 with the first high-pressure pipe 62 or first low-pressure pipe 63. A flow path extended through the first high-pressure pipe 62, the first flow path selector 64, and the first connecting pipe 61 defines a high-pressure flow path to the a discharge pressure into the first hermetic chamber 46. Also, a flow path extended through the first low-pressure pipe 63, the first flow path selector 64, and the first connecting pipe 61 defines a low-pressure flow path to transmit the suction pressure into the first hermetic chamber 46. The first flow path selector 64 is installed at a position where the first connecting pipe 61, the first high-pressure pipe 62, and the first low-pressure pipe 63 are connected to one another, and an example thereof may include an electrically-operated 3-way valve. The first connecting pipe 61 has an exit connected to the first flange 36, and the first flange 36 has a communication path 36a to directly communicate the first connecting pipe 61 with the first hermetic chamber 46. In another example, the first connecting pipe 61 of the first vane control device 60 may be connected to the intermediate plate 35, and the intermediate plate 35 may have a communication path communicating with the first hermetic chamber 46.

[0059] Now, an operation of the first vane control device 60 will be described.

[0060] As illustrated in FIGS. 1 and 2, when the first flow path selector 64 operates to communicate the first high-pressure pipe 62 to the first connecting pipe 61, the discharge pressure is applied to the first hermetic chamber 46.

[0061] Accordingly, the first vane 43 is pushed toward the first compressing chamber 31 by the discharge pressure, thus causing the first vane 43 to perform forward and rearward
movements in accordance with eccentric rotation of the first roller 42 as illustrated in FIG. 3. On the other hand, when the first flow path selector 64 operates to communicate the first low-pressure pipe 63 to the first connecting pipe 61, the suction pressure is applied to the first hermetic chamber 46. In this case, as illustrated in FIG. 3A, the first vane 43 is stopped at its rearwardly moved state, thus causing an idling rotation in the first compressing chamber 31 (referred to as a "restriction state"). Specifically, if the suction pressure is applied to the first hermetic chamber 46, a pressure in the first compressing chamber 31 is changed to be larger than or equal to a pressure in the first hermetic chamber 46. This is because a slight compressing operation is caused in the first compressing chamber 31 by eccentric rotation of the first roller 42 in addition to the suction pressure applied to the first compressing chamber 31.

[0062] When the first compressing chamber 31 and first hermetic chamber 46 are in a pressurized state according to the suction pressure, the first vane 43 is moved rearward in accordance with eccentric rotation of the first roller 42, and is restricted so as not to be moved forward. As a result, a division of refrigerant suction and discharge sections in the first compressing chamber 31 disappears, resulting in a refrigerant being introduced into the first compressing chamber 31 to circulate only along the first compressing chamber 31 with no substantial compression stroke (idling operation). In FIG. 3A, an arrow illustrated in the first vane 43 represents a force applied to the first vane 43 by a pressure difference, and an arrow illustrated in the first connecting pipe 61 represents a variation in the pressure of the refrigerant that is caused as the first connecting pipe 61 is disconnected from the first high-pressure pipe 62 to communicate with the first low-pressure pipe 62.

[0063] Conversely, if the discharge pressure is applied to the first hermetic chamber 46, a pressure in the first hermetic chamber 46 is changed to be larger than that of the first compressing chamber 31, thus causing the first vane 43 to move forward and rearward in accordance with eccentric rotation of the first roller 42 to achieve a compressing operation in the first compressing chamber 31 (referred to as a "restriction release state"), that is, compressing operation.

[0064] In the present embodiment, as stated above, the operation of the first vane 43 is selectively restricted under a control of the first vane control device 60 to cause a compressing operation or an idling rotation in the first compressing chamber 31, thereby enabling a variation in compression capacity. Specifically, if a digital control signal is applied to the first flow path selector 64 to regulate a proportion of a restriction time and/or a release time of the first vane 43, a compression capacity of the first compressing chamber 31 is variable from 0% to 100% based on a total compression capacity. The variation of the compression capacity is described below with reference to FIGS. 6 and 7.

[0065] FIG. 7 is a table illustrating a control example of a of restriction time and a release time of a vane of the variation of a compression capacity of FIG. 1 according to a required load, according to an embodiment of the present general inventive concept. The table of FIG. 7 was obtained under the following conditions: a capacity varying period was 20 sec., two compressing chambers having different compression capacities were prepared, only one of the compressing chambers being provided with a vane control device, and a capacity ratio of one compressing chamber (having the vane control device) to the other compressing chamber (having no vane control device) was 7:3.

[0066] Referring to FIGS. 1-3 and 7, a compression capacity of the upper first compressing chamber 31 may vary at predetermined time periods, and each time period may be a sum of a time T_f required to release the first vane 43 and a time T_p required to restrict the first vane 43. In FIG. 7, each predetermined period is set up to 20 sec. Where a compression capacity of the upper first compressing chamber 31 varies at predetermined time periods (each period is the sum of a time T_f required to release the first vane 43 and a time T_p required to restrict the first vane 43, in FIG. 7, each period being set up to 20 sec.), the compression capacity of the upper first compressing chamber 31 can vary by regulating the times T_f and T_p, thus enabling a variation in a total compression capacity.

[0067] Here, the compression capacity of the upper first compressing chamber 31 is calculated in consideration of the second compressing chamber 32 performing a compressing operation continuously. For example, to guarantee a capacity up to 50%, the upper first compressing chamber 31 charges 20% of the total capacity except for the compression capacity of the lower second compressing chamber 32. In this case, the time T_f that is a time required to perform a compressing operation in the upper first compressing chamber 31 should be regulated to occupy a proportion of approximately 6/20 (which corresponds to a time required to release the first vane 43 of 6 sec.) of the predetermined time period 20. Such a proportion regulation is necessary where a load is larger than 30%, but smaller than 100%, and can be performed simply by modulating a pulse width of a digital control signal to be applied to the first flow path selector 64. An example of the control signal in the case of a load between 30% and 100% is illustrated in FIG. 6 in a region designated as "intermediate load".

[0068] The above mentioned predetermined time period can be appropriately set up as desired by a user. The shorter the predetermined time period, the more rapidly a response dealing with a load variation can be performed, but this has a problem of excessive noise, etc. On the other hand, the longer the predetermined time period, the slower the response dealing with a load variation, but this has an advantage such as a reduction in noise, etc.

[0069] The phrase "full load only" of FIG. 6 refers to a state in which both of the upper first and lower second compressing chambers 31 and 32 perform a compressing operation as a result of applying the discharge pressure into the first hermetic chamber 46 to cause forward and rearward movements of the first vane 43. In the "full load only" state, only a control signal corresponding to a value of "full" is applied to the first flow path selector 64. On the other hand, the phrase "part load only" of FIG. 6 refers to a state in which the upper first compressing chamber 31 performs an idling rotation as a result of applying the suction pressure into the first hermetic chamber 46 to restrict the first vane 43 and only the lower second compressing chamber 32 performs a compressing operation. In the "part load only" state, only a control signal corresponding to a value of "part" is applied to the first flow path selector 64. When the control signal related to the value of "full" is applied, the first flow path selector 64 connects the first connecting pipe 61 to the first high-pressure pipe 62, whereas, when the control signal...
related to the value of "part" is applied, the first flow path selector 64 connects the first connecting pipe 61 to the first low-pressure pipe 63.

[0070] In the rotary compressor consistent with the present embodiment, as stated above, the lower second compressing chamber 32 performs a compressing operation continuously. Therefore, a capacity variation range departs from the compression capacity of the lower second compressing chamber 32, and the rotary compressor realizes a partial capacity variation.

[0071] FIG. 4 is a sectional view illustrating a variable capacity rotary compressor, according to another embodiment of the present general inventive concept. The compressor of the present embodiment may include a second vane control device 80 to control a restriction of the second vane 53 as well as the first vane control device 60. In the compressor of the present embodiment, accordingly, a second hermetic chamber 56 is defined at a rear side of the second vane guiding groove 54. The second vane control device 80 includes a second connecting pipe 81 connected to the second flange 37 to directly communicate with the second hermetic chamber 56, a second high-pressure pipe 82 extending from the first high-pressure pipe 62 to be connected to the second connecting pipe 81, a second low-pressure pipe 83 extending from the first low-pressure pipe 63 to be connected to the second connecting pipe 81, and a second flow path selector 84 to selectively communicate the second connecting pipe 81 with the second high-pressure pipe 82 or with second low-pressure pipe 83. An operation principle of the second vane control device 80 is the same as or similar to that of the first vane control device 60.

[0072] Differently from the previous embodiment illustrated in FIGS. 1-3B, the rotary compressor of the present embodiment can realize a capacity variation even in the lower second compressing chamber 32, and thus a capacity variation thereof of the lower second compressing chamber 32 in the present embodiment can be within a range from 0% to 100% of a maximum capacity of the compressor. However, in this case, there is a more complicated structure and increased manufacturing costs as compared to the previous embodiment. As will be appreciated, of course, in the case where a compressor having a single compressing chamber is provided with a vane control device to control a vane, a capacity variation is possible within the entire range from 0% to 100%.

[0073] FIG. 8 is a graph illustrating a relationship between an efficiency and compression capacity of the variable capacity rotary compressor of FIG. 4, according to an embodiment of the present general inventive concept. As can be understood from the dashed line of FIG. 8 representing an efficiency of a conventional constant-speed compressor, the efficiency of the conventional compressor is high in the case where a second-stage compression capacity coincides with an air conditioning load. However, at points A and B where the compression capacity does not coincide with the air conditioning load, a part of the refrigerant being discharged has to be bypassed to forcibly fulfill a required load, resulting in deterioration in efficiency. On the other hand, in the rotary compressor consistent with the present embodiment ("novel compressor" in FIG. 8), as a result of regulating proportions of a restriction time and a release time of the first and second vanes 43 and 53 using the first and second vane control devices 60 and 80, a high efficiency can be realized without a bypass of the refrigerant required to forcibly raise the compression capacities at the points A and B. Also, the conventional constant-speed compressor should be stopped for a predetermined time required to vary a compression capacity, but the rotary compressor of the present embodiment can achieve a variation in compression capacity without being stopped, and thus is more efficient than the conventional compressor.

[0074] Hereinafter, a method of varying a capacity of a compressor, according to an embodiment of the present general inventive concept, will be described with reference to FIGS. 5 and 9.

[0075] Assuming a multi-type air conditioner having a plurality of indoor units 401a to 401d, a controller 410 calculates a desired total air conditioning load using an operational state of the plurality of indoor units 401a to 401d, a temperature difference between a preset temperature and each indoor temperature, a cooling capacity of each indoor unit, etc. and operation S910. Then, the controller 410 calculates a compression capacity of a compressor 450 corresponding to the calculated total air conditioning load at operation S920. Specifically, with reference to FIGS. 1-3B, in consideration of the fact that the lower second compressing chamber 32 is continuously kept in a pressurized state, a compression capacity to be achieved in the upper first compressing chamber 31 is calculated (operation S920). Moreover, referring to FIG. 4, since both the upper first and the lower second compressing chambers 31 and 32 can realize a capacity variation, a compression capacity to be achieved in each of the upper first and the lower second compressing chambers 31 and 32 is calculated in consideration of the compression capacities of the upper first and lower second compressing chambers 31 and 32 and a total compression capacity (operation S920).

[0076] Based on the calculated compression capacity of each compressing chamber, a proportion of a restriction time and/or a release time of a vane (e.g., the first vane 43 and second vane 53 illustrated in FIGS. 1 and 4) is determined at operation S930. It will be appreciated that a more efficient variation in compression capacity can be achieved if the proportion of the restriction time and the release time of the vane is preset in consideration of a control time period and stored as a table. The controller 410 applies control signals, which correspond to the preset proportions of the restriction time and the release time of the vanes, to a vane control device (e.g., the vane control devices 60 and 80 illustrated in FIGS. 1 and 4), to enable a variation in compression capacity. As a result of performing the restriction and release of the vane (e.g., the vanes 43 and 53) based on the preset proportions upon receiving the control signals applied thereto, a required compression stroke and idling rotation are repeated by a predetermined rate, resulting in a compression capacity corresponding to the air conditioning load (step S940).

[0077] As apparent from the above description, a variable capacity rotary compressor according to embodiments of the present general inventive concept enables a continuous variation in compression capacity with low costs.

[0078] Further, a variable capacity rotary compressor according to embodiments of the present general inventive concept enables a compressing operation with a highest efficiency within an entire range of a variable capacity.

[0079] Furthermore, a variable capacity rotary compressor according to embodiments of the present general inventive
concept enables a continuous variation in capacity without performing stopping operation of the compressor.

Although a few embodiments of the present general inventive concept have been shown and described, it will be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the general inventive concept, the scope of which is defined in the appended claims and their equivalents.

What is claimed is:

1. A variable capacity rotary compressor, comprising: a housing having a compressing chamber; a roller to rotate in the compressing chamber while contacting an inner peripheral surface of the compressing chamber; a vane to move forward and rearward along a guiding groove in accordance with the rotation of the roller, the guiding groove being formed in the housing in a radial direction of the compressing chamber; a vane control device to control whether the vane comes into continuous contact with an outer peripheral surface of the roller by regulating a restriction and a release of the vane; and a controller to output a control signal to the vane control device to regulate proportions of a restriction time and a release time of the vane to vary a compression capacity of the compressor.

2. The compressor according to claim 1, wherein: the guiding groove comprises a hermetic chamber to receive a rear end of the vane; and the vane control device regulates the restriction and the release of the vane by regulating a pressure applied into the hermetic chamber based on the control signal.

3. The compressor according to claim 2, wherein the vane control device comprises:
a high-pressure flow path to connect the hermetic chamber to a discharge side of the compressor; a low-pressure flow path to connect the hermetic chamber to a suction side of the compressor; and a flow path selector to selectively connect the hermetic chamber to the high-pressure flow path or low-pressure flow path.

4. The compressor according to claim 3, wherein the flow path selector is a 3-way valve to be switched by the control signal, and the proportions of the restriction time and the release time of the vane are regulated by modulating a pulse width of the control signal to be applied to the 3-way valve.

5. A variable capacity rotary compressor, comprising: a housing having a compressing chamber; a roller to rotate in the compressing chamber while contacting an inner peripheral surface of the compressing chamber; a vane to move forward and rearward along a guiding groove in accordance with the rotation of the roller, the guiding groove being formed in the housing in a radial direction of the compressing chamber; a vane control device to control whether the vane comes into continuous contact with an outer peripheral surface of the roller by regulating a restriction and a release of the vane; and a controller to output a control signal to the vane control device to regulate a restriction time and a release time of the vane during a preset time period to vary a compression capacity of the compressor.

6. The compressor according to claim 5, wherein: each of the restriction time and the release time of the vane is an integral multiple of one-turn time of the compressor; and a sum of the restriction time and the release time is a time corresponding to one preset time period.

7. The compressor according to claim 5, wherein: the guiding groove comprises a hermetic chamber to receive a rear end of the vane; and the vane control device regulates the restriction time and the release time of the vane by regulating a pressure to be applied into the hermetic chamber based on the control signal.

8. The compressor according to claim 7, wherein the vane control device comprises:
a high-pressure flow path to connect the hermetic chamber to a discharge side of the compressor; a low-pressure flow path to connect the hermetic chamber to a suction side of the compressor; and a flow path selector to selectively connect the hermetic chamber to the high-pressure flow path or low-pressure flow path.

9. The compressor according to claim 8, wherein the flow path selector is a 3-way valve to be switched by the control signal, and the restriction time and the release time of the vane are regulated by modulating a pulse width of the control signal to be applied to the 3-way valve.

10. The compressor according to claim 5, wherein the controller performs a control operation such that the restriction time of the vane decreases and the release time of the vane increases within the one time period to increase a compression capacity.

11. A variable capacity rotary compressor, comprising: a housing having first and second compressing chambers separated from each other; first and second rollers to rotate in the first and second compressing chambers, respectively, while respectively contacting inner peripheral surfaces of the first and second compressing chambers; first and second vanes to move forward and rearward along first and second guiding grooves, respectively, in accordance with the rotation of the first and second rollers, respectively, the first and second guiding grooves being formed in the housing in a radial direction of the first and second compressing chambers, respectively;
a first vane control device to regulate a restriction time and a release time of the first vane using a pressure applied to the first vane to control whether the first vane comes into continuous contact with an outer peripheral surface of the first roller; and a controller to output a control signal to the first vane control device to regulate proportions of a restriction time and a release time of the first vane to vary a compression capacity of the compressor.

12. The compressor according to claim 11, wherein: the first guiding groove comprises a first hermetic chamber to receive a rear end of the first vane; and the pressure to be applied to the first vane is regulated by the first vane control device based on the control signal and applied into the first hermetic chamber.

13. The compressor according to claim 12, wherein the first vane control device comprises:
a first high-pressure flow path to connect the first hermetic chamber to a discharge side of the compressor; 
a first low-pressure flow path to connect the first hermetic chamber to a suction side of the compressor; and 
a first flow path selector to selectively connect the first hermetic chamber to the first high-pressure flow path or 
first low-pressure flow path.

14. The compressor according to claim 13, wherein the 
first flow path selector is a 3-way valve to be switched by the 
controller, and the proportions of the restriction time and 
the release time of the first vane are regulated by modulating 
a pulse width of the control signal to be applied to the 3-way 
valve.

15. The compressor according to claim 11, wherein: 
the second guiding groove comprises a second hermetic 
chamber to receive a rear end of the second vane; and 
the compressor further comprises a second vane control 
device to regulate a restriction time and a release time 
of the second vane by regulating a pressure applied into 
the second hermetic chamber based on the control 
signal.

16. The compressor according to claim 15, wherein the 
first and second compressing chambers have different 
compression capacities.

17. A method of varying a capacity of a variable capacity 
rotary compressor having a housing having a compressing 
chamber, a roller to rotate in the compressing chamber while 
contacting an inner peripheral surface of the compressing 
chamber, and a vane to divide an interior of the compressing 
chamber into a low-pressure section and a high-pressure 
section and to move forward and rearward in a radial 
direction of the compressing chamber in accordance with the 
rotation of the roller, the method comprising: 
calculating an air conditioning load depending on an 
operational state of an indoor unit; and 
varying a compression capacity of the compressing chamber 
to correspond to the calculated air conditioning load 
by regulating proportions of a restriction time and a 
release time of the vane based on the calculated air 
conditioning load.

18. The compressor according to claim 17, wherein: 
when the vane is restricted, the vane does not come into 
continuous contact with an outer peripheral surface of 
the roller; and 
when the restricted vane is released, the vane comes into 
continuous contact with the outer peripheral surface of 
the roller.

19. A variable capacity rotary compressor, comprising: 
a body to form a compressing chamber having a roller 
therein; 
a vane moveably disposed in the body to move between 
a forward position and a rearward position; and 
a controller to generate a control signal to control the vane 
according to a release time during which the vane 
moves between the forward position and the rearward 
position and a restriction time during which the vane 
remains in the rearward position to vary a compression 
capacity of the compressing chamber while maintaining 
a continuous operation of the compressor.

20. The compressor according to claim 19, further com-
prising:

21. The compressor according to claim 19, wherein the 
controller generates the control signal to control the restric-
tion time to decrease and the release time to increase within 
a predetermined compression time period to increase the 
compression capacity of the compressing chamber while 
maintaining the continuous operation of the compressor.

22. The compressor according to claim 19, wherein the 
controller generates the control signal to control the restric-
tion time to increase and the release time to decrease within 
a predetermined compression time period to decrease the 
compression capacity of the compressing chamber while 
maintaining the continuous operation of the compressor.

23. The compressor according to claim 19, further com-
prising:

a second compressing chamber; and 
a second vane disposed in the compressing chamber to 
move between a second forward position and a 
second rearward position.

24. The compressor according to claim 23, wherein the 
controller maintains a constant compression capacity of the 
second compressing chamber.

25. The compressor according to claim 23, wherein the 
controller generates a second control signal to control the 
second vane according to a release time during which the 
second vane moves between the second forward position and 
the second rearward position and a restriction time 
during which the second vane remains the second rearward 
position to vary a compression capacity of the second 
compressing chamber while maintaining the continuous 
operation of the compressor.

26. The compressor according to claim 19, further com-
prising:

a second vane regulating device to regulate the movement of 
the vane by releasing the vane from the rearward position 
and by restricting the vane in the reward position, based 
on the generated control signal.

27. The compressor according to claim 19, wherein the 
controller controls the release time and the restriction time 
corresponding to idling and compressing operations of the 
compressing chamber so that the compressing capacity 
vary without stopping an operation thereof.

28. A method of varying a compression capacity of a 
variable capacity rotary compressor including a body to 
form a compressing chamber having a roller therein and a 
vane moveably disposed in the body to move between 
a forward position and a rearward position, the method 
comprising:

controlling a release time during which the vane moves 
between the forward positions and the rearward posi-
tion and a restriction time during which the vane 
remains in the reward position to vary a compression 
capacity of the compressing chamber while maintain-
ing a continuous operation of the compressor.