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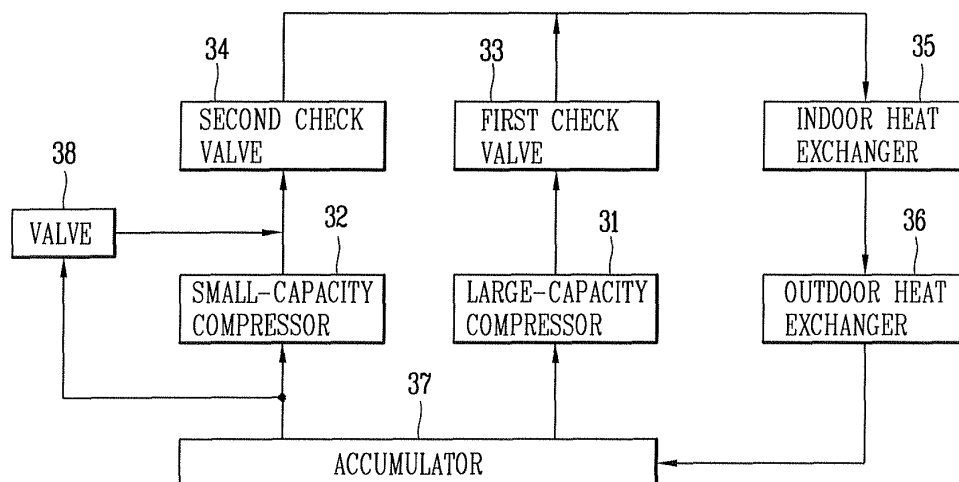
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(54) **AIR-CONDITIONER AND OPERATION CONTROL METHOD THEREOF**

(57) An air-conditioner includes a small-capacity compressor and a large-capacity compressor for compressing a refrigerant to a high temperature high pressure gaseous refrigerant; a valve for connecting a suction

opening of a refrigerant channel of the large-capacity compressor and a discharge passage of a refrigerant channel of the large-capacity compressor; and a controller for controlling the small-capacity compressor, the large-capacity compressor and the valve.

FIG. 3



## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

**[0001]** The present invention relates to an air-conditioner and, more particularly, to a method for controlling an operation of the air-conditioner.

#### 2. Description of the Background Art

**[0002]** In general, an air-conditioner includes a compressor for compressing a low temperature low pressure gaseous refrigerant to a high temperature high pressure gaseous refrigerant; a condenser for changing the high temperature high pressure gaseous refrigerant after being compressed in the compressor into middle temperature high pressure liquid-state refrigerant; an electronic expansion valve for changing the middle temperature high pressure liquid-state refrigerant to low temperature low pressure liquid-state refrigerant; an evaporator for changing the low temperature low pressure liquid-state refrigerant to a gaseous refrigerant; and a four-way valve for changing a channel of the refrigerant according to a cooling mode or heating mode.

**[0003]** In the air-conditioner, a role of an indoor heat exchanger and an outdoor heat exchanger is changed according to the cooling or heating mode. In the heating mode, the indoor heat exchanger serves as the condenser and the outdoor heat exchanger serves as the evaporator, and in the cooling mode, the indoor heat exchanger serves as the evaporator and the outdoor heat exchanger serves as the condenser.

**[0004]** Recently, output capacity of the air-conditioner can be varied according to a cooling load or a heating load by using a plurality of compressors each having different capacity, so cooling and heating efficiency can be optimized.

**[0005]** Figure 1 shows the construction of an air-conditioner in accordance with a conventional art.

**[0006]** As shown in Figure 1, the conventional air-conditioner includes: first and second compressors 11 and 12, each having different capacity, for compressing low temperature low pressure gaseous refrigerant to a high temperature high pressure gaseous refrigerant; an outdoor heat exchanger 14 for heat-exchanging the high temperature high pressure gaseous refrigerant with outdoor air so as to be condensed to a middle temperature high pressure liquid-state refrigerant; an outdoor fan 14A for blowing air toward the outdoor heat exchanger; an electronic expansion valve 15 for changing the middle temperature high pressure liquid-state refrigerant that has passed through the outdoor heat exchanger 14 to a low temperature low pressure liquid-state refrigerant; an indoor heat exchanger 16 for heat-exchanging the low temperature low pressure liquid-state refrigerant that has passed the electronic expansion valve with indoor air; an

indoor fan 16A for blowing air toward the indoor heat exchanger 16; and an accumulator 17 for extracting only the gaseous refrigerant from the refrigerant that has passed through the indoor heat exchanger 16 and supplying it to the first and second compressors 11 and 12.

**[0007]** The air-conditioner also includes check valves 11A and 12A for preventing the refrigerant discharged from a small-capacity compressor 11 from flowing back to a large-capacity compressor 12 or the refrigerant discharged from the large compressor 12 from flowing back to the small-capacity compressor 11; and a four-way valve 13 for setting the role of the indoor heat exchanger and the outdoor heat exchanger by switching a channel of the refrigerant that has passed through the first and second compressors 11 and 12.

**[0008]** In cooling a room, the refrigerant is discharged from two compressors, passes through the check valve and then is condensed in the outdoor heat exchanger. The condensed refrigerant passes through the electronic expansion valve and is evaporated in the indoor heat exchanger. Thereafter, the evaporated refrigerant passes through a common accumulator and then is returned to the compressor. Herein, the operation of the conventional air-conditioner includes two stages. That is, in the first stage, only the first compressor 11 is operated, and in the second stage, both the first and second compressors 11 and 12 are operated. Namely, the conventional air-conditioner is operated by two stages.

**[0009]** Herein, after the compressor is stopped from operation, when the compressor needs to be re-operated, a pressure of the suction opening side and a pressure of the discharge passage should be balanced. However, in the conventional air-conditioner, when the compressor is stopped from operation, the pressure at the discharge passage and the pressure at the suction opening will not be quickly balanced but be slowly equal due to oil and the refrigerant inside the compressor, causing a problem of platen pressure problem, and maximum 30 minutes are taken until the pressure of the suction opening and the pressure of the discharge passage are the same.

**[0010]** Thus, in the conventional compressor and the method for controlling the operation of the compressor, after the small-capacity compressor is operated, when the large-capacity compressor is actuated, it cannot be immediately actuated due to the platen pressure problem in the can of the large-capacity compressor. That is, the large-capacity compressor is actuated at a point when the pressure of the discharge passage of the large-capacity compressor and the pressure of the suction opening become equal after the certain time (maximum 30 minutes) elapses. Therefore, the capability of coping with a load of the air-conditioner deteriorates.

### SUMMARY OF THE INVENTION

**[0011]** Therefore, one object of the present invention is to provide an air-conditioner capable of enhancing load coping capability by shortening time to make a pressure

of a discharge passage of a large-capacity compressor and a pressure of a suction opening of the large-capacity compressor equal before the large-capacity compressor is started for operation while a small-capacity compressor is being operated.

**[0012]** Another object of the present invention is to provide a method for controlling an operation of the air-conditioner, in which a small-capacity compressor and a large-capacity compressor are all operated to perform a cooling operation several times repeatedly, and then, when an indoor load is increased while only the small-capacity compressor is operated for cooling a room, a pressure of a discharge passage of the large-capacity compressor and a pressure of a suction opening of the small-capacity compressor are made to be equal and then the large-capacity compressor is started for perform a cooling operation, whereby the cooling operation of the air-conditioner is performed in a high power saving mode.

**[0013]** 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 including: a small-capacity compressor and a large-capacity compressor for compressing a refrigerant to a high temperature high pressure gaseous refrigerant; a valve for connecting a suction opening of a refrigerant channel of the large-capacity compressor and a discharge passage of a refrigerant channel of the large-capacity compressor; and a controller for controlling the small-capacity compressor, the large-capacity compressor and the valve.

**[0014]** To achieve the above object, there is also provided a method for controlling an operation of an air-conditioner including: a first step in which in case of a cooling operation, a small-capacity compressor and a large-capacity compressor are actuated, and then, when a value of a room temperature varied by the actuated small-capacity compressor and large-capacity compressor is smaller than a value obtained by subtracting a pre-set first temperature from a desired temperature set by a user, the small-capacity compressor and the large-capacity compressor are stopped; a second step in which in a state than the small-capacity compressor and the large-capacity compressor are stopped, when the value of the room temperature is greater than a value obtained by adding a pre-set second temperature to the desired temperature, it goes back to the first step; a third step in which the first and second steps are repeatedly performed as many as the pre-set number of times; a fourth step in which only the small-capacity compressor is controlled to satisfy a relation of (desired temperature - pre-set first temperature  $\leq$  room temperature  $\leq$  (desired temperature - pre-set second temperature)); a fifth step in which when the value of the room temperature is greater than a value obtained by adding a pre-set third temperature to the desired temperature, a valve is operated for a certain time and then stopped; and a sixth step in which the large-capacity compressor is actuated.

**[0015]** The foregoing and other objects, features, as-

pects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0016]** The accompanying drawings, which are included to provide a 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.

**[0017]** In the drawings:

Figure 1 shows the construction of an air-conditioner in accordance with a conventional art;

Figure 2 is a graph showing a relation between actuation of a small-capacity compressor and a large-capacity compressor of the air-conditioner and a pressure in accordance with the conventional art; Figure 3 is a block diagram of an air-conditioner in accordance with the present invention;

Figures 4A and 4B are flow charts of a method for controlling an operation of the air-conditioner in accordance with the present invention; and

Figure 5 is a graph showing a waveform of a room temperature in the method for controlling an operation of the air-conditioner in accordance with the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0018]** An air-conditioner capable of enhancing load coping capability by shortening time to make a pressure of a discharge passage of a large-capacity compressor and a pressure of a suction opening of the large-capacity compressor equal before the large-capacity compressor is started for operation while a small-capacity compressor is being operated, and a method for controlling an operation of an air-conditioner in which a small-capacity compressor and a large-capacity compressor are all operated to perform a cooling operation several times repeatedly, and then, when an indoor load is increased while only the small-capacity compressor is operated for cooling a room, a pressure of a discharge passage of the large-capacity compressor and a pressure of a suction opening of the small-capacity compressor are made to be equal and then the large-capacity compressor is started for perform a cooling operation, whereby the cooling operation of the air-conditioner is performed in a high power saving mode, in accordance with a preferred embodiment of the present invention will now be described with reference to Figures 3 to 5.

**[0019]** Figure 3 is a block diagram of an air-conditioner in accordance with the present invention.

**[0020]** As shown in Figure 3, an air-conditioner in ac-

cordance with the present invention includes: a small-capacity compressor 31 and a large-capacity compressor 32 for compressing a refrigerant to a high temperature high pressure gaseous refrigerant; first check valve 33 and second check valve 34 respectively installed at a discharge passage of a refrigerant channel of the small-capacity compressor and the large-capacity compressor; an indoor heat exchanger 35 connected to the first and second check valves; an outdoor heat exchanger 36 connected to the indoor heat exchanger; an accumulator 37 connected to the outdoor heat exchanger; a valve for connecting the suction opening and the discharge passage of the refrigerant channel of a compressor having greater compression capacity among the small-capacity compressor and the large-capacity compressor; and a controller (not shown) for controlling the valve.

**[0021]** A method for controlling an operation of the air-conditioner in accordance with the present invention will now be described with reference to Figures 4A and 4B.

**[0022]** As shown in Figures 4A and 4B, the method for controlling an operation of the air-condition includes: a first step in which in case of a cooling operation, a small-capacity compressor and a large-capacity compressor are actuated, and then, when a value of a room temperature varied by the actuated small-capacity compressor and large-capacity compressor is smaller than a value obtained by subtracting a pre-set first temperature from a desired temperature set by a user, the small-capacity compressor and the large-capacity compressor are stopped; a second step in which in a state than the small-capacity compressor and the large-capacity compressor are stopped, when the value of the room temperature is greater than a value obtained by adding a pre-set second temperature to the desired temperature, it goes back to the first step; a third step in which the first and second steps are repeatedly performed as many as the pre-set number of times; a fourth step in which only the small-capacity compressor is controlled to satisfy a relation of (desired temperature — pre-set first temperature  $\leq$  room temperature  $\leq$  (desired temperature - pre-set second temperature)); a fifth step in which when the value of the room temperature is greater than a value obtained by adding a pre-set third temperature to the desired temperature, a valve is operated for a certain time and then stopped; and a sixth step in which the large-capacity compressor is actuated.

**[0023]** The operation of the air-conditioner will be described in detail as follows. The air-conditioner of the present invention is operated by two stages.

**[0024]** First, when a user selects a cooling operation, the small-capacity compressor 31 compresses the gaseous refrigerant. The compressed refrigerant flows to the indoor heat exchanger 35 after passing through the first check valve 33.

**[0025]** While the small-capacity compressor 31 is being operated, if the large-capacity compressor 32 is de-

sired to be operated, the valve 38 is operated for a certain time before operating the large-capacity compressor 32. The operation of the large-capacity compressor 32 is performed when an indoor load is increased. In other words, the room temperature is controlled only by the small-capacity compressor 31, and then, when the room temperature goes gradually up to be higher by a pre-set certain temperature than a desired temperature as set by the user, the large-capacity compressor 32 is then actuated. The reason of operating the valve 38 for a certain time is to make the pressure of the suction opening of the large-capacity compressor 32 into which the refrigerant flows and the pressure of the discharge passage of the large-capacity compressor 32 from which the refrigerant is discharged equal. The certain time during which the valve 38 is operated is preferably 1 minute and 30 seconds as obtained from experimentation.

**[0026]** If the two compressors of the air-conditioner have the same compression capacity, the valve can be installed at either side of the two compressors.

**[0027]** After passing through the small-capacity compressor 31 and the large-capacity compressor 32, the refrigerant flows through the first and second check valves 33 and 34, and then to the outdoor heat exchanger 36 through the refrigerant channel. The refrigerant is then introduced from the outdoor heat exchanger 36 to the accumulator 37 and then to the small-capacity compressor 31 or to the large-capacity compressor 32. Through the processes, cooling or heating is performed.

**[0028]** The method for controlling the operation of the air-conditioner will be described in detail with reference to Figure 5.

**[0029]** Figure 5 is a graph showing a waveform of a room temperature in the method for controlling an operation of the air-conditioner in accordance with the present invention.

**[0030]** As shown in Figure 5, when the user selects the cooling operation and the air-conditioner starts its operation, the controller (not shown) actuates both the small-capacity compressor 31 and the large-capacity compressor 32 in order to lower the room temperature before operation of the air-conditioner, namely, in order to resolve the indoor load (step S401).

**[0031]** The controller compares a value of the room temperature changed by the operated small-capacity compressor 31 and large-capacity compressor 32 and a value obtained by subtracting a pre-set first temperature from a desired temperature set by the user (step S402).

**[0032]** If the value of the room temperature is smaller than the value obtained by subtracting the pre-set first temperature from the desired temperature, the controller stops operation of the small-capacity compressor 31 and the large-capacity compressor 32 (step S403).

**[0033]** If the value of the room temperature is greater than the value obtained by subtracting the pre-set first temperature from the desired temperature, the controller keeps operating of the small-capacity compressor 31 and the large-capacity compressor 32. The pre-set first tem-

perature is preferably 0.5°C.

**[0034]** After the small-capacity compressor 31 and the large-capacity compressor 32 are stopped, the controller compares the increased value of the room temperature and a value obtained by adding a pre-set second temperature to the desired temperature (step S404).

**[0035]** If the increased value of the room temperature is greater than the value obtained by adding the pre-set second temperature to the desired temperature, the controller actuates the small-capacity compressor 31 and the large-capacity compressor 32 again (step S401). If the increased value of the room temperature is smaller than the value obtained by adding the pre-set second temperature to the desired temperature, the controller maintains the stop state of the smaller-capacity compressor 31 and the large-capacitor compressor 32.

**[0036]** By repeatedly performing the steps S401 to S404 for a certain number of times, the indoor load can be resolved. Herein, the certain number of times is preferably two times.

**[0037]** After repeated performing the steps S401 to S404 for the certain number of times, if the increased value of the room temperature is greater than a value obtained by adding the pre-set second temperature to the desired temperature, the small-capacity compressor is actuated (step S405). Herein, the pre-set second temperature is preferably 0.5°C.

**[0038]** While the small-capacity compressor is being operated, the value of the room temperature and the value obtained by subtracting the pre-set first temperature from the desired temperature (step S406).

**[0039]** If the value of the room temperature is smaller than the value obtained by subtracting the pre-set first temperature from the desired temperature, the small-capacity compressor is stopped (step S407), or otherwise, the small-capacity compressor is continuously operated.

**[0040]** After the small-capacity compressor is stopped, the controller compares the value of the room temperature and the value obtained by adding the pre-set second temperature to the desired temperature (step S408).

**[0041]** If the value of the room temperature is smaller than the value obtained by adding the pre-set second temperature to the desired temperature, the small-capacity compressor 31 is maintained in the stop stage.

**[0042]** If the value of the room temperature is greater than the value obtained by adding the pre-set second temperature to the desired temperature, the controller actuates the small-capacity compressor 31 again (step S409).

**[0043]** After the small-capacity compressor 31 is actuated, the value of the room temperature and a value obtained by adding a pre-set third temperature to the desired temperature are compared (step S410). Herein, the pre-set third temperature is preferably greater than the pre-set first and second temperatures.

**[0044]** If the value of the room temperature is greater than the value obtained by adding the pre-set third temperature to the desired temperature, in order to make the

pressure of the suction opening of the large-capacity compressor 32 and the pressure of the discharge passage of the large-capacity compressor 32 equal, the valve 38 is operated for a certain time and then stopped (step S411).

**[0045]** If the value of the room temperature is smaller than the value obtained by adding the pre-set third temperature to the desired temperature, operation of the small-capacity compressor 31 is maintained. Herein, the reason why the value of the room temperature is greater than the value obtained by adding the pre-set third temperature to the desired temperature is because it can happen that the room temperature is gradually increased when the room temperature is controlled only by the small-capacity compressor 31. The certain time is preferably about 1 minute and 30 seconds (the optimum time obtained through experimentation).

**[0046]** After the valve 38 is stopped, the large-capacity compressor 32 is actuated to reduce the increased indoor load (step S412).

**[0047]** If the two compressors of the air-conditioner in accordance with the present invention have the same capacity, the two compressors can be operated regardless of an actuation order.

**[0048]** For a heating operation, the air-conditioner is operated according to the same control method.

**[0049]** As so far described, the air-conditioner and the method for controlling an operation of the air-conditioner of the present invention have the following advantages.

**[0050]** That is, since the time taken for making the pressure of the discharge passage of the large-capacity compressor and the pressure of the suction opening of the large-capacity compressor equal before the large-capacity compressor is actuated while the small-capacity compressor is being operated, the load coping capability can be enhanced.

**[0051]** In addition, after the small-capacity compressor and the large-capacity compressor are all operated to perform a cooling operation and the cooling operation is repeatedly performed for a certain number of times, when an indoor load is increased while only the small-capacity compressor is operated to perform a cooling operation, the pressure of the discharge passage of the large-capacity compressor and the pressure of the suction opening of the small-capacity compressor are made to be equal and then the large-capacity compressor is actuated to perform a cooling operation. Accordingly, the cooling operation of the air-conditioner can be performed in the high power saving mode.

**[0052]** 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 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. An air-conditioner comprising:

a small-capacity compressor and a large-capacity compressor for compressing a refrigerant to a high temperature high pressure gaseous refrigerant;  
a valve for connecting a suction opening of a refrigerant channel of the large-capacity compressor and a discharge passage of a refrigerant channel of the large-capacity compressor; and  
a controller for controlling the small-capacity compressor, the large-capacity compressor and the valve.

### 2. The air-conditioner of claim 1, wherein while the small-capacitor compressor is being operated, the controller operates the valve for a certain time before actuating the large-capacity compressor, and then, the controller operates the large-capacity compressor.

### 3. The air-conditioner of claim 1, wherein the controller performs a controlling operation by the following steps comprising:

a first step in which, in case of a cooling operation, a small-capacity compressor and a large-capacity compressor are actuated, and then, when a value of a room temperature varied by the actuated small-capacity compressor and large-capacity compressor is smaller than a value obtained by subtracting a pre-set first temperature from a desired temperature set by a user, the small-capacity compressor and the large-capacity compressor are stopped;  
a second step in which in a state than the small-capacity compressor and the large-capacity compressor are stopped, when the value of the room temperature is greater than a value obtained by adding a pre-set second temperature to the desired temperature, it goes back to the first step;  
a third step in which the first and second steps are repeatedly performed as many as the pre-set number of times;  
a fourth step in which only the small-capacity compressor is controlled to satisfy a relation of (desired temperature - pre-set first temperature  $\leq$  room temperature  $\leq$  (desired temperature - pre-set second temperature);  
a fifth step in which when the value of the room temperature is greater than a value obtained by

adding a pre-set third temperature to the desired temperature, a valve is operated for a certain time and then stopped; and  
a sixth step in which the large-capacity compressor is actuated.

### 4. The air-conditioner of claim 2, wherein the certain time is 1 minute and 30 seconds.

### 5. The air-conditioner of claim 3, wherein the certain time is 1 minute and 30 seconds.

### 6. The air-conditioner of claim 3, wherein the pre-set first and second temperatures are 0.5°C.

### 7. The air-conditioner of claim 3, wherein the pre-set third temperature is greater than the pre-set first and second temperatures.

### 8. The air-conditioner of claim 3, wherein the pre-set number of times is two times.

### 9. A method for controlling an operation of an air-conditioner comprising:

operating a small-capacity compressor;  
making the pressure of a suction end of a refrigerant channel and a pressure of a discharge end of the refrigerant channel of a large-capacity compressor equal while the small-capacity compressor is being operated; and  
actuating the large-capacity compressor after making the two pressures equal.

### 10. A method for controlling an operation of an air-conditioner comprising:

a first step in which, in case of a cooling operation, a small-capacity compressor and a large-capacity compressor are actuated, and then, when a value of a room temperature varied by the actuated small-capacity compressor and large-capacity compressor is smaller than a value obtained by subtracting a pre-set first temperature from a desired temperature set by a user, the small-capacity compressor and the large-capacity compressor are stopped;  
a second step in which in a state than the small-capacity compressor and the large-capacity compressor are stopped, when the value of the room temperature is greater than a value obtained by adding a pre-set second temperature to the desired temperature, it goes back to the first step;  
a third step in which the first and second steps are repeatedly performed as many as the pre-set number of times;  
a fourth step in which only the small-capacity

compressor is controlled to satisfy a relation of (desired temperature - pre-set first temperature  $\leq$  room temperature  $\leq$  (desired temperature - pre-set second temperature);

a fifth step in which when the value of the room temperature is greater than a value obtained by adding a pre-set third temperature to the desired temperature, a valve is operated for a certain time and then stopped; and  
a sixth step in which the large-capacity compressor is actuated.

- 11.** The method of claim 10, wherein the fourth step comprises:

a step in which after the small-capacity compressor is actuated, if the value of the room temperature varied by the actuated small-capacity compressor is smaller than the value obtained by subtracting the pre-set first temperature from the desired temperature, the small-capacity compressor is stopped; and  
a step in which with the small-capacity compressor stopped, if the value of the room temperature is greater than the value obtained by adding the pre-set second temperature to the desired temperature, the small-capacity compressor is actuated.

- 12.** The method of claim 10, wherein the certain time is 1 minute and 30 seconds.

- 13.** The method of claim 10, wherein the pre-set first and second temperatures are 0.5°.

- 14.** The method of claim 10, wherein the pre-set third temperature is greater than the pre-set first and second temperatures.

- 15.** The method of claim 10, wherein the pre-set number is two times.

- 16.** An air-conditioner comprising:

a small-capacity compressor and a large-capacity compressor for compressing a refrigerant to a high temperature high pressure gaseous refrigerant;  
a valve for connecting a suction opening of a refrigerant channel of the large-capacity compressor and a discharge passage of a refrigerant channel of the large-capacity compressor; and  
a controller for performing a controlling operation by the following steps comprising:

a first step in which, in case of a heating operation, a small-capacity compressor and a large-capacity compressor are actu-

ated, and then, when a value of a room temperature varied by the actuated small-capacity compressor and large-capacity compressor is smaller than a value obtained by subtracting a pre-set first temperature from a desired temperature set by a user, the small-capacity compressor and the large-capacity compressor are stopped;  
a second step in which in a state than the small-capacity compressor and the large-capacity compressor are stopped, when the value of the room temperature is greater than a value obtained by adding a pre-set second temperature to the desired temperature, it goes back to the first step;  
a third step in which the first and second steps are repeatedly performed as many as the pre-set number of times;  
a fourth step in which only the small-capacity compressor is controlled to satisfy a relation of (desired temperature - pre-set first temperature  $\leq$  room temperature  $\leq$  (desired temperature - pre-set second temperature);  
a fifth step in which when the value of the room temperature is greater than a value obtained by adding a pre-set third temperature to the desired temperature, a valve is operated for a certain time and then stopped; and  
a sixth step in which the large-capacity compressor is actuated.

FIG. 1

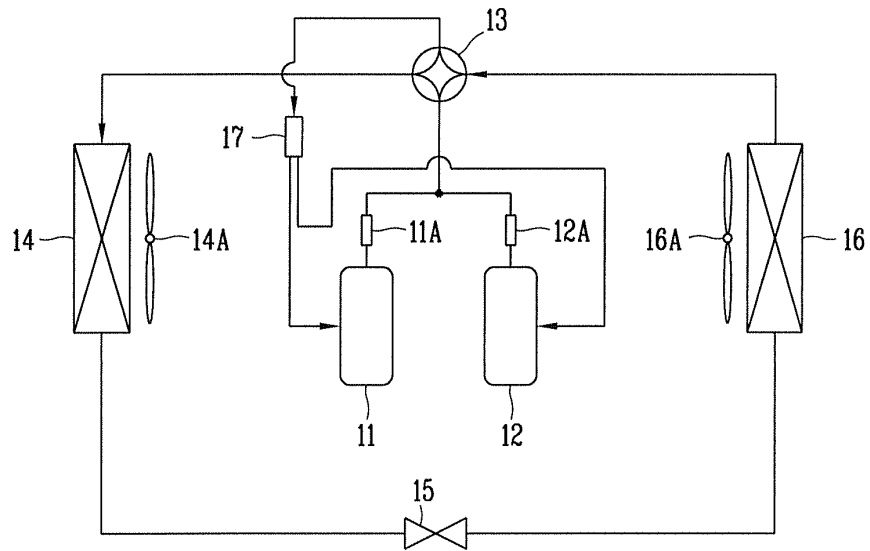


FIG. 2

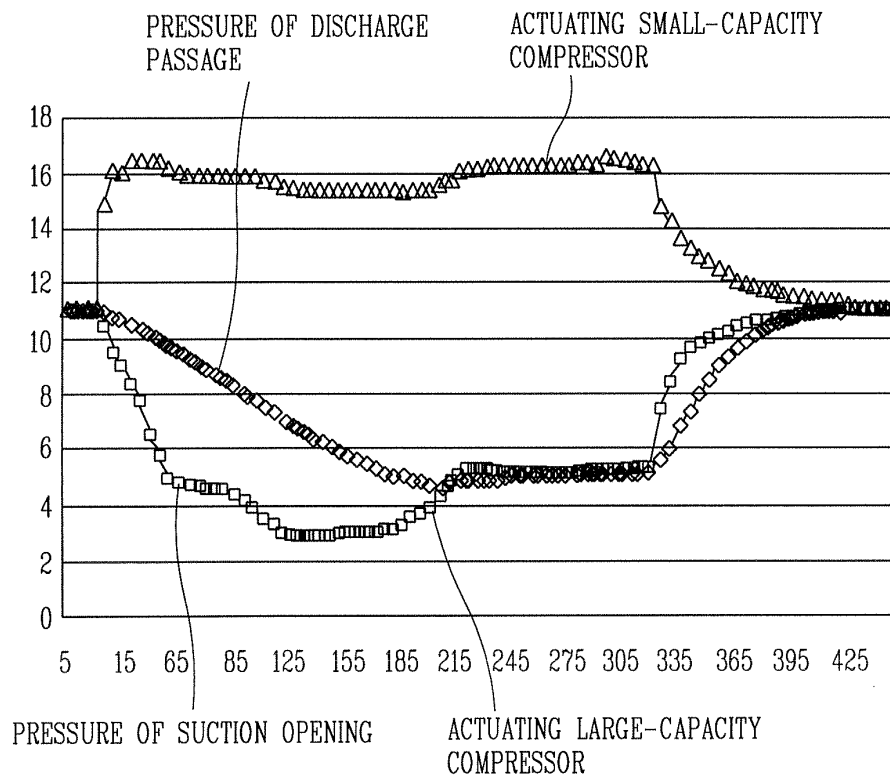


FIG. 3

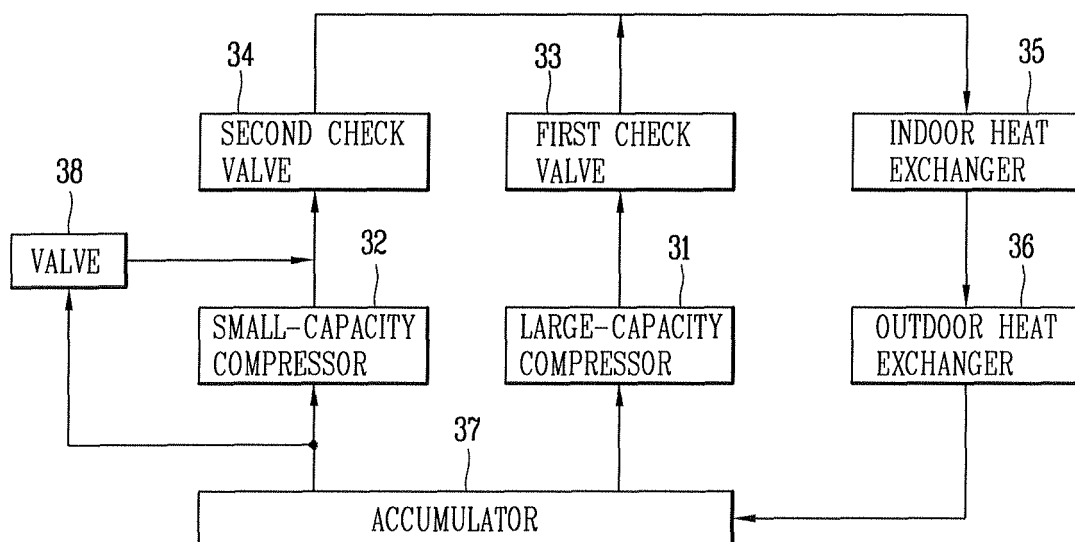


FIG. 4A

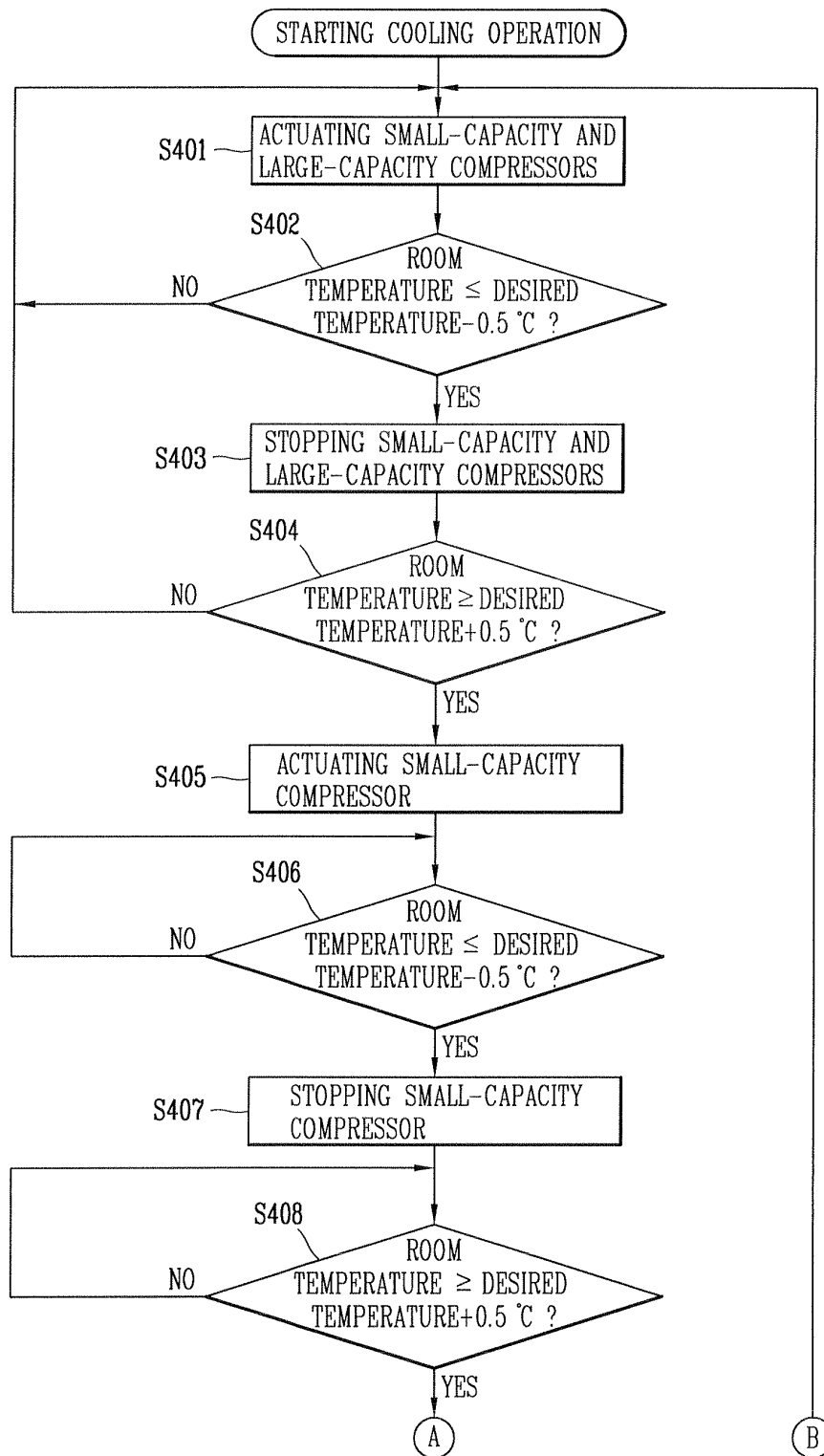


FIG. 4B

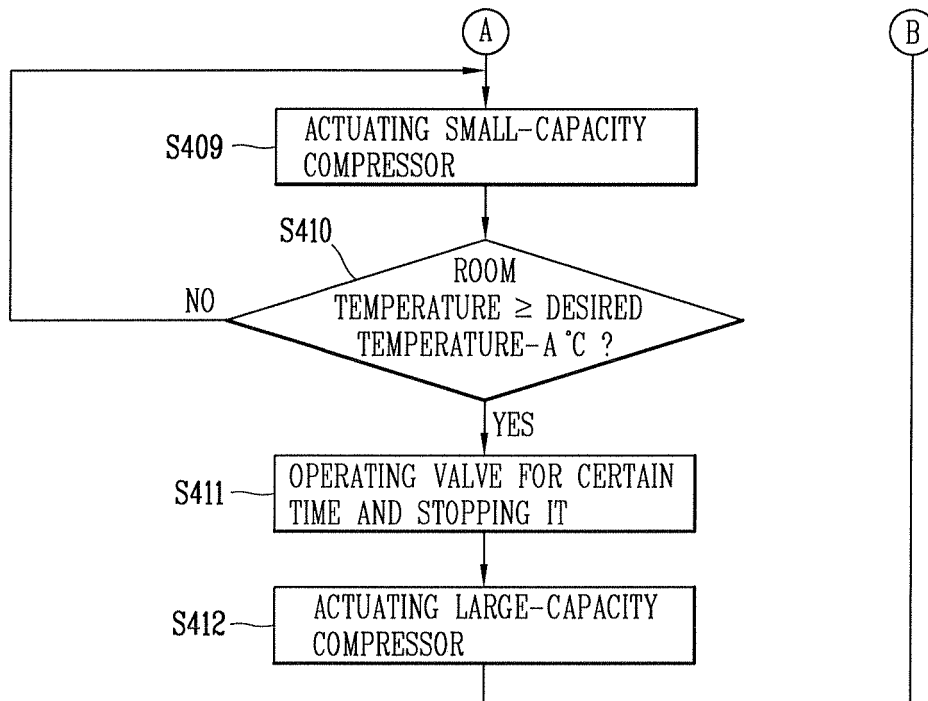


FIG. 5

