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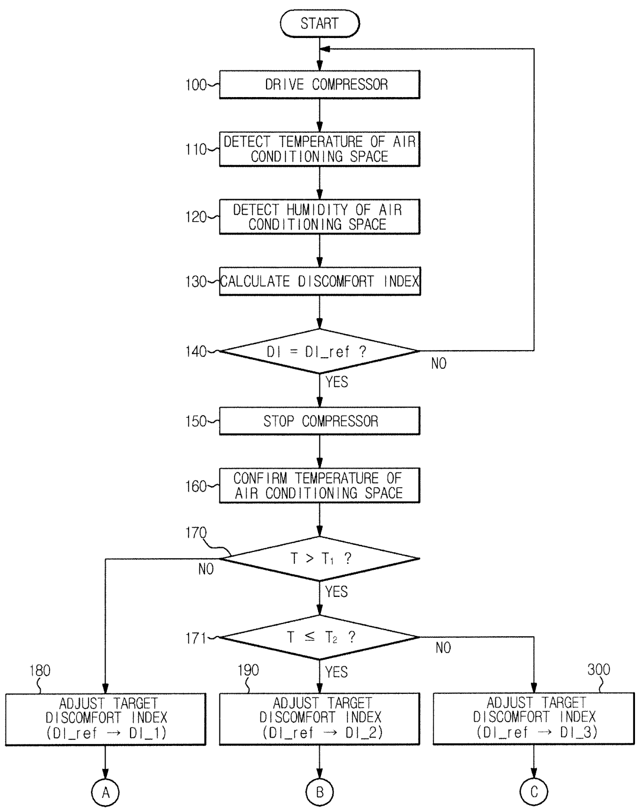
(54) **Control method of air conditioner**

(57) Disclosed herein is a control method of an air conditioner that is capable of controlling a cooling operation by adjusting a target discomfort index according to a temperature or a temperature band of the air conditioning space when a discomfort index of the air conditioning space reaches the target discomfort index, thereby preventing the execution of an unnecessary cooling operation within a range not to affect the comfort of a user and thus reducing power consumption.

FIG. 7



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a control method of an air conditioner, and, more particularly, to a control method of an air conditioner that is capable of performing a cooling operation such that the discomfort index reaches a target discomfort index.

2. Description of the Related Art

[0002] Generally, humidity as well as temperature has an influence on comfort that people feel. In a conventional art, therefore, a cooling operation is controlled using the discomfort index considering both temperature and humidity.

[0003] In the conventional art, temperature and humidity in an air conditioning space to calculate a discomfort index, and a cooling operation is performed such that the calculated discomfort index reaches a target discomfort index. That is, when the discomfort index of the air conditioning space is higher than the target discomfort index, the cooling operation is performed, and, when the discomfort index of the air conditioning space is lower than the target discomfort index, the cooling operation is stopped, thereby maintaining the air conditioning space in a comfortable state.

[0004] The discomfort index is a function having temperature and humidity as variables, and therefore, the discomfort index is decided by the temperature and the humidity. Consequently, temperature may vary although the discomfort index is the same. For example, the discomfort index when the humidity is high and the temperature is low may be the same as the discomfort index when the humidity is low and the temperature is high, although the temperature varies.

[0005] Consequently, the temperature may vary although the discomfort index is the same, and therefore, when the temperature of the air conditioning space is low, the difference between the temperature of the air conditioning space and the skin temperature of people increases, with the result that people feel cold.

[0006] For this reason, when the cooling operation is controlled to maintain the target discomfort index based on only the discomfort index of the air conditioning space not considering the difference between the temperature of the air conditioning space and the skin temperature of people as in the conventional art, the cooling operation is continuously performed, although a user feels cold, with the result that energy is wasted.

SUMMARY OF THE INVENTION

[0007] Therefore, it is an aspect of the invention to provide a control method of an air conditioner that is capable of preventing the execution of an unnecessary cooling operation within a range not to affect the comfort of a user according to a temperature band of an air conditioning space when the discomfort index of the air conditioning space reaches a target discomfort index.

[0008] In accordance with one aspect, the present invention provides a control method of an air conditioner, including performing a cooling operation until a discomfort index of an air conditioning space reaches a target discomfort index, confirming a temperature band of the air conditioning space when the discomfort index has reached the target discomfort index, and adjusting the target discomfort index according to the temperature band of the air conditioning space to control the cooling operation.

[0009] Preferably, the temperature band of the air conditioning space is a low temperature region having a first temperature range, an intermediate temperature region having a second temperature range, or a high temperature region having a third temperature range. At this time, the target discomfort index is upward adjusted within a range not to affect the comfort of people at the low temperature region and the intermediate temperature region. Also, the target discomfort index is upward adjusted with a larger value at the low temperature region than at the intermediate temperature region.

[0010] Preferably, the adjusting the target discomfort index according to the temperature band of the air conditioning space to control the cooling operation includes stopping a compressor and an indoor fan when the temperature band of the air conditioning space is the low temperature region and the discomfort index of the air conditioning space is below the adjusted target discomfort index.

[0011] Preferably, the adjusting the target discomfort index according to the temperature band of the air conditioning space to control the cooling operation includes stopping a compressor and controlling an indoor fan to be driven according to a humidity of the air conditioning space when the temperature band of the air conditioning space is the intermediate temperature region and the discomfort index of the air conditioning space is below the adjusted target discomfort index. At this time, the indoor fan is stopped when the humidity of the air conditioning space is 50 % or more at the time of stopping the compressor, and is driven when the humidity of the air conditioning space is below 50 % at the time of stopping the compressor.

[0012] Preferably, the adjusting the target discomfort index according to the temperature band of the air conditioning space to control the cooling operation includes maintaining the discomfort index of the air conditioning space when the temperature band of the air conditioning space is the high temperature region and stopping a compressor and driving an indoor fan when the discomfort index of the air conditioning space is below the target discomfort index.

[0013] In accordance with another aspect, the present invention provides a control method of an air conditioner, including performing a cooling operation until a discomfort index of an air conditioning space reaches a target discomfort index, adjusting the target discomfort index based on a temperature of the air conditioning space when the discomfort index has reached the target discomfort index, and controlling the cooling operation based on the adjusted target discomfort index.

[0014] Preferably, the adjusted target discomfort index is the maximum discomfort index that can be upward adjusted within a range not to affect the comfort of people in correspondence to the temperature of the air conditioning space. At this time, the adjusted target discomfort index is upward adjusted such that target discomfort index rises as much as the temperature of the air conditioning space lowers.

[0015] Preferably, the controlling the cooling operation includes stopping a compressor when the discomfort index of the air conditioning space is below the adjusted target discomfort index and controlling an indoor fan to be driven according to a humidity of the air conditioning space at the time of stopping the compressor. At this time, the controlling the cooling operation includes stopping the indoor fan when the humidity of the air conditioning space at the time of stopping the compressor is higher than a predetermined humidity and driving the indoor fan when the humidity of the air conditioning space at the time of stopping the compressor is lower than the predetermined humidity.

[0016] Preferably, the controlling the cooling operation includes stopping a compressor when the discomfort index of the air conditioning space is below the adjusted target discomfort index and controlling an indoor fan to be driven according to the temperature of the air conditioning space at the time of stopping the compressor. At this time, the controlling the cooling operation includes stopping the indoor fan when the temperature of the air conditioning space when the discomfort index of the air conditioning space reaches the target discomfort index is below a predetermined temperature and driving the indoor fan when the temperature of the air conditioning space when the discomfort index of the air conditioning space reaches the target discomfort index exceeds the predetermined temperature.

[0017] Additional aspects and/or advantages of the invention 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 invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings, of which:

FIG. 1 is a perspective view illustrating an indoor unit of an air conditioner according to an embodiment of the present invention;

FIG. 2 is a refrigerant cycle diagram of the air conditioner according to the embodiment of the present invention;

FIG. 3 is a control block diagram of the air conditioner according to the embodiment of the present invention;

FIG. 4 is a conceptional view illustrating the adjustment of a target discomfort index according to the temperature of an air conditioning space when the discomfort index reaches the target discomfort index in the air conditioner according to the embodiment of the present invention;

FIG. 5 is a conceptional view illustrating the upward adjustment of the target discomfort index in FIG. 4;

FIG. 6 is a view illustrating the operation of a compressor according to the upward adjusted target discomfort index in the air conditioner according to the embodiment of the present invention;

FIG. 7 is a control flow chart illustrating a process for controlling a cooling operation by adjusting a target discomfort index based on a temperature band of the air conditioning space when the discomfort index of the air conditioning space reaches the target discomfort index in the air conditioner according to the embodiment of the present invention;

FIG. 8 is a control flow chart illustrating a method of controlling a cooling operation by adjusting the discomfort index when the temperature of the air conditioning space when the discomfort index of the air conditioning space reaches the target discomfort in FIG. 7 is within a first temperature band;

FIG. 9 is a control flow chart illustrating a method of controlling a cooling operation by adjusting the discomfort index when the temperature of the air conditioning space when the discomfort index of the air conditioning space reaches the target discomfort in FIG. 7 is within a second temperature band;

FIG. 10 is a control flow chart illustrating a method of controlling a cooling operation by adjusting the discomfort index when the temperature of the air conditioning space when the discomfort index of the air conditioning space reaches the target discomfort in FIG. 7 is within a second temperature band;

FIG. 11 is a control flow chart illustrating a process for controlling a cooling operation by adjusting a target discomfort index based on the temperature of the air conditioning space when the discomfort index of the air conditioning space reaches the target discomfort index in the air conditioner according to the embodiment of the present invention; and FIG. 12 is a control flow chart illustrating a process for controlling a cooling operation by determining whether a target discomfort index can be changed, and, when the target discomfort index can be changed, upward adjusting the target discomfort index in the air conditioner according to the embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] Reference will now be made in detail to the embodiment of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. The embodiment is described below to explain the present invention by referring to the figures. The present invention is applicable to various indoor units of an air conditioner. In the following, an indoor unit having a side suction port and a side discharge port will be described as an example.

[0020] As shown in FIG. 1, an indoor unit of an air conditioner according to an embodiment of the present invention includes a box-type main body 10 open at the front thereof.

[0021] At the lower part of each side of the main body 10 is formed a side suction port 11 to suction indoor air.

[0022] At the upper part of each side of the main body 10, at a region adjacent to an indoor heat exchanger 12, is formed a side discharge port 14 to discharge conditioned air, blown by an indoor fan 13, into the room such that the side discharge port 14 extends vertically with a predetermined length. At the front of the main body 10 is horizontally formed a front discharge port 15. Also, louvers 16 and 17 are hingedly mounted in the discharge ports 14 and 15, respectively, such that the discharge ports 14 and 15 can be opened or closed, or the discharge directions can be adjusted, by adjusting the hinged angles of the louvers 16 and 17.

[0023] The indoor heat exchanger 12 is mounted in the upper part of the main body 10, to perform heat exchange with indoor air. The indoor heat exchanger 12 is mounted inside the upper space of the main body 10 at a predetermined inclination such that the air is heat-exchanged by the indoor heat exchanger 12 while passing through the indoor heat exchanger 12. The indoor fan 13 is mounted in the lower part of the main body 10, at a region corresponding to the side suction ports 11, to blow cool air, heat-exchanged by the indoor heat exchanger 12, into the room. The indoor fan 13 is operated such that air suctioned into the main body 10 through the side suction ports 11 of the main body 10 can flow to the side discharge ports 14 of the main body 10 via the indoor heat exchanger 12.

[0024] Consequently, indoor air is suctioned through the side suction ports 11 and is blown to the indoor heat exchanger 12 by the indoor fan 13. The indoor heat exchanger 12 exchanges heat with the blown indoor air to absorb heat from the indoor air and thus produce cool air. The cool air is discharged through the side discharge ports 14 and/or the front discharge port 15 to cool the room.

[0025] As shown in FIG. 2, the air conditioner, including the above-described indoor unit, according to the embodiment of the present invention is constructed in a structure in which a compressor 20 to compress a refrigerant, an outdoor heat exchanger 21 configured to function as a condenser to condense the refrigerant, an electric expansion valve 22 to expand the refrigerant into low temperature and low pressure, and the indoor heat exchanger 12 configured to function as an evaporator to evaporate the refrigerant are connected to one another by a refrigerant pipe to constitute a closed circuit.

[0026] A high-temperature and high-pressure gas refrigerant, discharged from the compressor 20, passes through the outdoor heat exchanger 21, functioning as the condenser, in the direction indicated by an arrow. At this time, heat is transmitted to outdoor air surrounding the outdoor heat exchanger 21 by an outdoor fan 23, with the result that the refrigerant is changed into a room-temperature and high-pressure liquid refrigerant. The room-temperature and high-pressure liquid refrigerant passes through the electric expansion valve 22, by which the refrigerant is changed into a low-temperature and low-pressure liquid refrigerant. The low-temperature and low-pressure liquid refrigerant passes through the indoor heat exchanger 12. At this time, heat is absorbed from indoor air surrounding the indoor heat exchanger 12 by the indoor fan 13, with the result that the refrigerant is changed into a low-pressure gas refrigerant, which is forwarded to the compressor 20. This cycle is repeated to cool indoor air and thus cool the room.

[0027] The compressor applied to the embodiment of the present invention may be a fixed-capacity compressor of which the compression capacity is fixed or a variable-capacity compressor of which the compression capacity is variable. The compressor applied to the embodiment of the present invention may include one or more fixed-capacity compressors or one or more variable-capacity compressors. The compressor applied to the embodiment of the present invention may be constructed in a structure having both the fixed-capacity compressor and the variable-capacity compressor. The variable-capacity compressor includes a variable rotational frequency compressor and a pulse width modulation compressor. The variable rotational frequency compressor changes the frequency of electric current supplied to the compressor, through the control of an inverter, to control the rotational frequency of a motor and thus vary the compression capacity of the compressor. The capacity of the pulse width modulation compressor is varied according to a duty control signal deciding loading time to discharge the refrigerant and unloading time not to discharge the refrigerant.

[0028] As shown in FIG. 3, the air conditioner with the above-described construction according to the embodiment of the present invention includes a controller 30 to perform an overall control operation.

[0029] To the input side of the controller 30 are electrically connected an input unit 31, a temperature detection unit 32, and a humidity detection unit 33. To the output side of the controller 30 is electrically connected a compressor drive unit 34. Also, a storage unit 35 is electrically connected to the input and output side of the controller 30.

[0030] The input unit 31 includes operation modes (automatic, cooling, dehumidification, and comfort) of the air conditioner and a plurality of function keys. In addition, the input unit 31 further includes a start/stop key to allow a user to input an operation start signal and an operation stop signal of the air conditioner.

[0031] The controller 30 is a microprocessor to control the overall operation of the air conditioner according to an operation signal inputted by the input unit 31. The controller 30 controls a cooling operation by performing the cooling operation, calculating the discomfort index of an air conditioning space from the temperature and humidity of the air conditioning space, recognizing the temperature of the air conditioning space when the calculated discomfort index reaches a target discomfort index, and adjusting the target discomfort index based on the recognized temperature of the air conditioning space.

[0032] The temperature detection unit 32 is mounted in a space defined between the side suction ports 11 of the main body 10 and the indoor heat exchanger 12. The temperature detection unit 32 detects the temperate of air suctioned through the side suction ports 11 and outputs the detected temperature of the air to the controller 30.

[0033] The humidity detection unit 33 is mounted in a space defined between the side suction ports 11 of the main body 10 and the indoor heat exchanger 12. The humidity detection unit 33 detects the humidity of air suctioned through the side suction ports 11 and outputs the detected humidity of the air to the controller 30.

[0034] The compressor drive unit 34 receives a control signal outputted from the controller 30 to control the compressor 20 on or off depending upon the determination as to whether the discomfort index, calculated from the temperature of the air conditioning space detected by the temperature detection unit 32 and the humidity of the air conditioning space detected by the humidity detection unit 33 during the cooling operation, has reached the target discomfort index.

[0035] The storage unit 35 stores discomfort indices corresponding to temperatures or temperature bands of the air conditioning space when the discomfort index reaches the target discomfort index to prevent the execution of an unnecessary cooling operation within a range not to affect the comfort of a user and thus reduce power consumption.

[0036] Also, the air conditioner according to the embodiment of the present invention further includes a display unit 36 to display the state of the cooling operation and the discomfort index of the air conditioning space, and a wind direction control unit 37 and an indoor fan drive unit 38 configured to operate during the cooling operation, which are electrically connected to the output side of the controller 30.

[0037] The display unit 36 displays the state of the cooling operation and the discomfort index of the air conditioning space when a user inputs the cooling operation through the input unit 31.

[0038] The wind direction control unit 37 controls the louvers 16 and 17 to be driven such that air discharged through the side discharge ports 14 and the front discharge port 15 is directed upward and downward or left and right, and therefore, the air uniformly spreads throughout the air conditioning space.

[0039] The indoor fan drive unit 38 controls the indoor fan 13 to be driven by receiving a control signal outputted from the controller 30 according to the amount of wind set by the user through the input unit 31 and controlling the rotational frequency of the indoor fan 13 such that air heat-exchanged by the indoor heat exchanger 12 is blown into the room. The velocity of the indoor fan 13 is variable. The indoor fan drive unit 38 controls the rotational frequency of the indoor fan 13, according to a signal from the controller 30, to provide various winds, such as a turbo wind having the maximum amount of wind, a low wind, etc.

[0040] Consequently, when a user commands a cooling operation through the input unit 31, the controller 30 opens the discharge ports 14 and 15 through the wind direction control unit 37 and drives the compressor 20 to cool the air conditioning space through a cooling cycle.

[0041] The discomfort index of the air conditioning space is calculated from the temperature and humidity of the air conditioning space respectively detected by the temperature detection unit 32 and the humidity detection unit 33 during the cooling of the air conditioning space. When the calculated discomfort index reaches a target discomfort index, the target discomfort index is upwardly adjusted to be a discomfort index previously set according to the temperature or temperature band of the air conditioning space when the calculated discomfort index reaches the target discomfort index, or the target discomfort index is maintained unchanged. Consequently, when the temperature or temperature band of the air conditioning space when the discomfort index reaches the target discomfort index is a level in which the skin temperature of people is lowered or maintained when people are in a space having the same temperature and humidity for a long time in summer, the target discomfort index is increased to perform a relatively low cooling operation and thus reduce unnecessary power consumption.

[0042] Generally, the discomfort index DI is calculated by the following equation [1].

$$DI = 9/5Tr - 0.55(1 - Hr)(9/5Tr - 26) + 32 \qquad [1]$$

[0043] Where, Tr (°C) is dry-bulb temperature, and Hr (%) is relative humidity. The dry-bulb temperature is detected by the temperature detection unit 32, and the relative humidity is detected by the humidity detection unit 33. It is known that, when the discomfort index is more than 85, most people feel uncomfortable, and, when the discomfort index is less than 70, most people do not feel uncomfortable.

[0044] FIG. 4 is a conceptional view illustrating the adjustment of a target discomfort index according to the temperature of an air conditioning space when the discomfort index reaches the target discomfort index in the air conditioner according to the embodiment of the present invention. FIG. 5 is a conceptional view illustrating the upward adjustment of the target discomfort index DI_3 to a new target discomfort index DI_1 in FIG. 4. For convenience of description, the target discomfort index is defined to be set to DI_3 at the beginning of a cooling operation.

[0045] Referring to FIGS. 4 and 5, the discomfort index of the air conditioning space gradually lowers, during the cooling operation, with the result that the discomfort index of the air conditioning space reaches the target discomfort index DI_3, which means that a point P0 on the discomfort index of the air conditioning space at the beginning of the cooling operation moves to another point P1, P2, or P3 on the target discomfort index DI_3 by the cooling operation. The discomfort index is a function having temperature and humidity as variables, and therefore, the discomfort index is decided by the temperature and the humidity. Consequently, temperature may vary although the discomfort index is the same. For example, the points P1, P2, and P3 have different temperatures and humidities although the points have the same discomfort index. The point P1 has a temperature of T1 and a humidity of H1. The point P2 has a temperature of T2 higher than T1 and a humidity of H2 lower than H1. The point P3 has a temperature of T3 higher than T2 and a humidity of H3 lower than H2.

[0046] For example, when the temperature T1 of the point P1 is low, and therefore, the difference between the temperature T1 and the skin temperature of people increases, people may feel cold. When the skin temperature of people is between 33 °C and 34 °C, people feel comfortable. On the other hand, when the skin temperature of people is less than 33 °C, people feel cold. When temperature T1 of the point P1 is within a temperature band in which the skin temperature of people becomes below 33 °C , people feel cold.

[0047] Consequently, when the temperature T1 of the point P1 is low, the target discomfort index is adjusted such that people do not feel cold, and, at the same time, the execution of an unnecessary operation is prevented, thereby reducing power consumption. That is, the target discomfort index DI_3 is upward adjusted to a new target discomfort index DI_1 such that the point P1 on the target discomfort index DI_3 moves to a point P1', having a higher temperature T1', on the new target discomfort index. At this time, the target discomfort index is upward adjusted such that target discomfort index rises as much as the temperature of the point P1 lowers.

[0048] As shown in FIG. 6, the compressor is stopped until the discomfort index of the air conditioning space reaches the upward adjusted target discomfort index DI_1, thereby reducing power consumption.

[0049] Hereinafter, a description will be given of a process for controlling a cooling operation by adjusting a target discomfort index based on a temperature band of the air conditioning space when the discomfort index of the air conditioning space reaches the target discomfort index in the air conditioner according to the embodiment of the present invention.

[0050] Referring to FIG. 7, the compressor 20 is driven with the beginning of an operation at Operation 100. At this time, when the compressor 20 includes a plurality of compressors, all the compressors are driven such that the air conditioner is operated with the maximum capacity. When the compressor 20 is a variable capacity compressor, the compressor is driven with the maximum power. While the compressor 20 is driven, the indoor fan 13 is driven at a turbo wind mode providing the maximum amount of wind to rapidly cool the air conditioning space.

[0051] After the compressor 20 is driven, the temperature and humidity of the air conditioning space are detected at Operations 110 and 120, respectively, and the discomfort index of the air conditioning space is calculated at Operation 130. At this time, the discomfort index of the air conditioning space is calculated by the previously-described equation [1].

[0052] After the discomfort index of the air conditioning space is calculated, it is determined at Operation 140 whether the discomfort index DI of the air conditioning space has reached a target discomfort index DI_ref (for example, 70). When it is determined at Operation 140 that the discomfort index DI of the air conditioning space has not reached the target discomfort index DI_ref, the procedure returns to Operation 100, and subsequent operations are performed.

[0053] On the other hand, when it is determined at Operation 140 that the discomfort index DI of the air conditioning space has reached the target discomfort index DI_ref, the compressor 20 is stopped at Operation 150, and the temperature of the air conditioning space when the discomfort index DI of the air conditioning space has reached the target discomfort index DI_ref is confirmed at Operation 160. At this time, the temperature of the air conditioning space is detected by the temperature detection unit 32 or confirmed through the recognition of the temperature when the discomfort index DI of the air conditioning space has reached the target discomfort index DI_ref.

[0054] After the temperature of the air conditioning space when the discomfort index DI of the air conditioning space has reached the target discomfort index DI_ref is confirmed, it is determined which one of predetermined temperature bands T≤T1, T1<T≤T2, and T>T2 the temperature T of the air conditioning space belongs to at Operations 170 and 171. That is, it is determined whether the temperature T of the air conditioning space exceeds a first predetermined temperature T1 at Operation 170. When it is determined at Operation 170 that the temperature T of the air conditioning space is equal to or less than the first predetermined temperature T1, it is determined that the temperature band of the air conditioning space is a first temperature band T≤T1 (for example, T1 is 24 °C), and the target discomfort index is upward adjusted from D_ref (for example, 70) to DI_1 (for example, 74) at Operation 180. Here, the first temperature band T≤T1 is a low temperature region at which the skin temperature of people goes down below the optimum temperature, 33 to 34 °C, when people are in the air conditioning space for a long time in summer.

[0055] On the other hand, when it is determined at Operation 170 that the temperature T of the air conditioning space exceeds the first predetermined temperature T1, it is determined at Operation 171 whether the temperature T of the air conditioning space is equal to or less than a second predetermined temperature T2. When it is determined at Operation 171 that the temperature T of the air conditioning space is equal to or less than the second predetermined temperature T2, it is determined that the temperature band of the air conditioning space is a second temperature band T1<T≤T2 (for example, T1 is 24 °C and T2 is 26 °C), and the target discomfort index is upward adjusted from D_ref (for example, 70) to DI_2 (for example, 72) at Operation 190. Here, the second temperature band T1<T≤T2 is an intermediate temperature region at which the skin temperature of people goes down below the optimum temperature, 33 to 34 °C, but is higher than the first temperature band T≤T1 when people are in the air conditioning space for a long time in summer.

[0056] On the other hand, when it is determined at Operation 171 that the temperature T of the air conditioning space exceeds the second predetermined temperature T2, it is determined that the temperature band of the air conditioning space is a third temperature band T>T2, and the target discomfort index is upward adjusted from D_ref (for example, 70) to DI_3 (for example, 70) at Operation 300. Here, the third temperature band T>T2 (for example, T2 is 26 °C) is a high temperature region at which the skin temperature of people is between or higher than 33 to 34 °C when people are in the air conditioning space for a long time in summer. The target discomfort index DI_ref and the adjusted target discomfort index DI_3 may be the same. In this case, the existing target discomfort index is maintained. This is because the cooling operation is performed with the maximum capacity at the beginning of the operation in the embodiment of the present invention, with the result that, although the target discomfort index is downward adjusted it is difficult to maintain the downward adjusted target discomfort index, and, although the downward adjusted target discomfort index is maintained, the effect is almost the same at discomfort indices lower than a specific discomfort index (for example, 70). According to circumstances, however, it is possible to downward adjust the target discomfort index.

[0057] Meanwhile, at the low temperature region at which the temperature of the air conditioning space is the first temperature band T≤T1, as shown in FIG. 8, the target discomfort index is upward adjusted from D_ref to DI_1, the temperature and humidity of the air conditioning space are detected at Operation 181, and the discomfort index of the air conditioning space is calculated at Operation 182.

[0058] After the discomfort index of the air conditioning space is calculated, it is determined at Operation 183 whether the discomfort index DI of the air conditioning space is equal to or less than the adjusted target discomfort index DI_1. When it is determined at Operation 183 that the discomfort index DI of the air conditioning space is equal to or less than the adjusted target discomfort index DI_1, the compressor 20 is stopped at Operation 184. The compressor remains stopped until the discomfort index DI of the air conditioning space reaches the adjusted target discomfort index DI_1, thereby reducing power consumption. Also, the indoor fan 13 is stopped, at Operation 185, with the stoppage of the compressor 20. Since the humidity of the air conditioning space is high at the low temperature region when the compressor is stopped, both the indoor fan 13 and the compressor 20 are stopped to prevent humidification in the air conditioning space during the stoppage of the compressor 20.

[0059] On the other hand, when it is determined at Operation 183 that the discomfort index DI of the air conditioning space exceeds the adjusted target discomfort index DI_1, the compressor 20 is driven at Operation 186, and the indoor fan 13 is driven to provide a low wind at Operation 187. At this time, the compressor 20 is driven with normal power, not with the maximum power. This is because the discomfort index approaches the newly changed target discomfort index, and therefore, it is advantageous to prevent the compressor and the indoor fan from being frequently turned on/off by weakly driving the compressor and the indoor fan such that the discomfort index reaches the target discomfort index rather than by maximally driving the compressor and the indoor fan such that the discomfort index reaches the target discomfort index.

[0060] After Operation 185 or Operation 187 is performed, the procedure returns to Operation 181, and subsequent operations are performed.

[0061] Also, at the intermediate temperature region at which the temperature of the air conditioning space is the second temperature band T1<T≤T2, as shown in FIG. 9, the target discomfort index is upward adjusted from D_ref to DI_2, the temperature and humidity of the air conditioning space are detected at Operation 111, and the discomfort index of the

air conditioning space is calculated at Operation 192.

[0062] After the discomfort index of the air conditioning space is calculated, it is determined at Operation 193 whether the discomfort index DI of the air conditioning space is equal to or less than the adjusted target discomfort index DI_2. When it is determined at Operation 193 that the discomfort index DI of the air conditioning space is equal to or less than the adjusted target discomfort index DI_2, it is determined at Operation 194 whether the humidity of the air conditioning space is below a predetermined humidity H_ref (for example, 50 %).

[0063] When it is determined at Operation 194 that the humidity of the air conditioning space is equal to or more than the predetermined humidity, the compressor 20 is stopped at Operation 195, and the indoor fan 13 is stopped at Operation 196. At this time, the reason to stop the indoor fan 13 is that it is necessary to prevent the humidification in the air conditioning space since the humidity of the air conditioning space is high when the compressor is stopped.

[0064] Also, when it is determined at Operation 194 that the humidity of the air conditioning space is below the predetermined humidity, the compressor 20 is stopped at Operation 197, and the indoor fan 13 is driven to provide a low wind at Operation 198. At this time, the reason to drive the indoor fan 13 such that the low wind is provided by the indoor fan 13 is that it is necessary to humidify the air conditioning space, such that the air conditioning space is not in an excessively dry state, since the humidity of the air conditioning space is relatively low when the compressor is stopped.

[0065] On the other hand, when it is determined at Operation 193 that the discomfort index DI of the air conditioning space exceeds the adjusted target discomfort index DI_2, the compressor 20 is driven at Operation 199, and the indoor fan 13 is driven to provide a low wind at Operation 200. At this time, the compressor 20 is driven with normal power, not with the maximum power.

[0066] Also, at the high temperature region at which the temperature of the air conditioning space is the third temperature band T>T2, as shown in FIG. 10, the target discomfort index is upward adjusted from D_ref to DI_3, the temperature and humidity of the air conditioning space are detected at Operation 301, and the discomfort index of the air conditioning space is calculated at Operation 302.

[0067] After the discomfort index of the air conditioning space is calculated, it is determined at Operation 303 whether the discomfort index DI of the air conditioning space is equal to or less than the adjusted target discomfort index DI_3. When it is determined at Operation 303 that the discomfort index DI of the air conditioning space is equal to or less than the adjusted target discomfort index DI_3, the compressor 20 is stopped at Operation 304, and the indoor fan 13 is driven to provide a low wind at Operation 305. At this time, the reason to drive the indoor fan 13 such that the low wind is provided by the indoor fan 13 is that it is necessary to humidify the air conditioning space, such that the air conditioning space is not in an excessively dry state, although the compressor 20 is stopped, since the humidity of the air conditioning space is low.

[0068] On the other hand, when it is determined at Operation 303 that the discomfort index DI of the air conditioning space exceeds the adjusted target discomfort index DI_3, the compressor 20 is driven at Operation 306, and the indoor fan 13 is driven to provide a low wind at Operation 307. At this time, the compressor 20 is driven with normal power, not with the maximum power.

[0069] Hereinafter, a description will be given of a process for controlling a cooling operation by adjusting a target discomfort index based on the temperature of the air conditioning space when the discomfort index of the air conditioning space reaches the target discomfort index according to another embodiment of the present invention.

[0070] Referring to FIG. 11, the compressor 20 is driven with the beginning of an operation at Operation 400. At this time, when the compressor 20 includes a plurality of compressors, all the compressors are driven such that the air conditioner is operated with the maximum capacity. When the compressor 20 is a variable capacity compressor, the compressor is driven with the maximum power. While the compressor 20 is driven, the indoor fan 13 is driven at a turbo wind mode providing the maximum amount of wind to rapidly cool the air conditioning space.

[0071] After the compressor 20 is driven, the temperature and humidity of the air conditioning space are detected at Operations 410 and 420, respectively, and the discomfort index of the air conditioning space is calculated at Operation 430. At this time, the discomfort index of the air conditioning space is calculated by the previously-described equation [1].

[0072] After the discomfort index of the air conditioning space is calculated, it is determined at Operation 440 whether the discomfort index DI of the air conditioning space has reached a target discomfort index DI_ref. When it is determined at Operation 440 that the discomfort index DI of the air conditioning space has not reached the target discomfort index DI_ref, the procedure returns to Operation 400, and subsequent operations are performed.

[0073] On the other hand, when it is determined at Operation 440 that the discomfort index DI of the air conditioning space has reached the target discomfort index DI_ref, the compressor 20 is stopped at Operation 450, and the temperature of the air conditioning space when the discomfort index DI of the air conditioning space has reached the target discomfort index DI_ref is confirmed at Operation 460. At this time, the temperature of the air conditioning space is detected by the temperature detection unit 32 or confirmed through the recognition of the temperature when the discomfort index DI of the air conditioning space has reached the target discomfort index DI_ref.

[0074] After the temperature of the air conditioning space when the discomfort index DI of the air conditioning space has reached the target discomfort index DI_ref is confirmed, it is determined at Operation 470 whether the discomfort index is a discomfort index DI changeable in correspondence to the temperature T of the air conditioning space. At this time, the storage unit 35 stores discomfort indices corresponding to temperatures of the air conditioning space. Here, the discomfort index changeable in correspondence to the temperature T of the air conditioning space means the maximum discomfort index that can be upward adjusted within a range not to affect the comfort of people considering the skin temperature of people. Generally, the upward adjustable discomfort index is large at a low temperature region and small at a high temperature region.

[0075] After the discomfort index DI corresponding to the temperature T of the air conditioning space is confirmed, the target discomfort index is adjusted from D_ref to DI' at Operation 480.

[0076] After the target discomfort index is adjusted, the temperature and humidity of the air conditioning space are detected at Operation 490, respectively, and the discomfort index of the air conditioning space is calculated at Operation 500.

[0077] After the discomfort index of the air conditioning space is calculated, it is determined at Operation 510 whether the discomfort index DI of the air conditioning space is equal to or less than the adjusted target discomfort index DI'. When it is determined at Operation 510 that the discomfort index DI of the air conditioning space is equal to or less than the adjusted target discomfort index DI', the compressor 20 is stopped at Operation 520. The compressor remains stopped until the discomfort index DI of the air conditioning space reaches the adjusted target discomfort index DI_1, thereby reducing power consumption. While the compressor 20 is stopped, the operation of the indoor fan 13 may be controlled. The indoor fan 13 is driven based on the humidity of the air conditioning space. Specifically, when the humidity of the air conditioning space is high, the indoor fan 13 is stopped to prevent the humidification in the air conditioning space while the compressor 20 is stopped. When the humidity of the air conditioning space is low, the indoor fan 13 is driven at a low wind mode to humidify the air conditioning space while the compressor 20 is stopped. Alternatively, it is possible to determine whether to drive the indoor fan, while the compressor is stopped, not based on the humidity of the air conditioning space but based on a specific reference temperature or a predetermined reference temperature band. Specifically, when the temperature at the time of the discomfort index reaching the target discomfort index is lower than the reference temperature or at the low temperature region, the indoor fan may not be driven, since the room humidity is high, whereas, when the temperature at the time of the discomfort index reaching the target discomfort index is higher than the reference temperature or at the high temperature region, the indoor fan may be driven, since the room humidity is low (see FIG. 4).

[0078] On the other hand, when it is determined at Operation 510 that the discomfort index DI of the air conditioning space exceeds the adjusted target discomfort index DI', the compressor 20 is driven at Operation 530.

[0079] Hereinafter, a description will be given of a process for controlling a cooling operation by cooling the air conditioning space, determining whether the discomfort index of the air conditioning space has reached a target discomfort index, determining whether the target discomfort index can be changed according to the temperature of the air conditioning space when the discomfort index of the air conditioning space has reached the target discomfort index, and upward adjusting the target discomfort index when target discomfort index can be changed.

[0080] Referring to FIG. 12, the compressor 20 is driven with the beginning of an operation at Operation 600. At this time, when the compressor 20 includes a plurality of compressors, all the compressors are driven such that the air conditioner is operated with the maximum capacity. When the compressor 20 is a variable capacity compressor, the compressor is driven with the maximum power. While the compressor 20 is driven, the indoor fan 13 is driven at a turbo wind mode providing the maximum amount of wind to rapidly cool the air conditioning space.

[0081] After the compressor 20 is driven, the temperature and humidity of the air conditioning space are detected at Operations 610 and 620, respectively, and the discomfort index of the air conditioning space is calculated at Operation 630. At this time, the discomfort index of the air conditioning space is calculated by the previously-described equation [1].

[0082] After the discomfort index of the air conditioning space is calculated, it is determined at Operation 640 whether the discomfort index DI of the air conditioning space has reached a target discomfort index DI_ref. When it is determined at Operation 640 that the discomfort index DI of the air conditioning space has not reached the target discomfort index DI_ref, the procedure returns to Operation 600, and subsequent operations are performed.

[0083] On the other hand, when it is determined at Operation 640 that the discomfort index DI of the air conditioning space has reached the target discomfort index DI_ref, the compressor 20 is stopped at Operation 650, and the temperature of the air conditioning space when the discomfort index DI of the air conditioning space has reached the target discomfort index DI_ref is confirmed at Operation 660. At this time, the temperature of the air conditioning space is detected by the temperature detection unit 32 or confirmed through the recognition of the temperature when the discomfort index DI of the air conditioning space has reached the target discomfort index DI_ref.

[0084] After the temperature of the air conditioning space when the discomfort index DI of the air conditioning space has reached the target discomfort index DI_ref is confirmed, it is determined at Operation 670 whether it is necessary to change the target discomfort index, which is possible through the confirmation of the temperature of the air conditioning space. For example, when the temperature of the air conditioning space is within the high temperature region, it is determined that it is not necessary to change the target discomfort index. When the temperature of the air conditioning space is within the low temperature region or the intermediate temperature region, it is determined that it is necessary to change the target discomfort index.

[0085] When it is determined at Operation 670 that it is necessary to change the target discomfort index, the target discomfort index to be changed, corresponding to the temperature T or the temperature band of the air conditioning space, is confirmed and the target discomfort index is changed into the confirmed target discomfort index at Operation 680, and the cooling operation is controlled using the changed target discomfort index at Operation 690. Here, the target discomfort index to be changed may be set to be a fixed value according to the temperature band (see the embodiment of FIG. 7) or to be individual values according to the temperature (see the embodiment of FIG. 11).

[0086] On the other hand, when it is determined at Operation 670 that it is not necessary to change the target discomfort index, the existing target discomfort index is maintained at Operation 700, and the existing cooling operation is maintained at Operation 710. Here, whether to drive the indoor fan while the compressor is stopped may be controlled according to the humidity of the air conditioning space or the temperature band at the target discomfort index, as in the previous embodiments.

[0087] As apparent from the above description, the control method of the air conditioner according to the present invention has the effect of controlling a cooling operation by adjusting a target discomfort index according to a temperature band of the air conditioning space when the discomfort index of the air conditioning space reaches the target discomfort index, thereby preventing the execution of an unnecessary cooling operation within a range not to affect the comfort of a user and thus reducing power consumption.

[0088] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

Claims

1. A control method of an air conditioner, comprising:

performing a cooling operation until a discomfort index of an air conditioning space reaches a target discomfort index;
when the discomfort index has reached the target discomfort index, confirming a temperature band of the air conditioning space; and
adjusting the target discomfort index according to the temperature band of the air conditioning space to control the cooling operation.

2. The control method according to claim 1, wherein the temperature band of the air conditioning space is a low temperature region having a first temperature range, an intermediate temperature region having a second temperature range, or a high temperature region having a third temperature range.

3. The control method according to claim 2, wherein the target discomfort index is upward adjusted within a range not to affect the comfort of people at the low temperature region and the intermediate temperature region.

4. The control method according to claim 3, wherein the target discomfort index is upward adjusted with a larger value at the low temperature region than at the intermediate temperature region.

5. The control method according to claim 1, wherein the adjusting the target discomfort index according to the temperature band of the air conditioning space to control the cooling operation includes stopping a compressor and an indoor fan when the temperature band of the air conditioning space is the low temperature region and the discomfort index of the air conditioning space is below the adjusted target discomfort index.

6. The control method according to claim 1, wherein the adjusting the target discomfort index according to the temperature band of the air conditioning space to control the cooling operation includes stopping a compressor and controlling an indoor fan to be driven according to a humidity of the air conditioning space when the temperature band of the air conditioning space is the intermediate temperature region and the discomfort index of the air conditioning space is below the adjusted target discomfort index.

7. The control method according to claim 6, wherein the indoor fan is stopped when the humidity of the air conditioning space is 50 % or more at the time of stopping the compressor, and is driven when the humidity of the air conditioning space is below 50 % at the time of stopping the compressor.

8. The control method according to claim 1, wherein the adjusting the target discomfort index according to the temperature band of the air conditioning space to control the cooling operation includes maintaining the discomfort index of the air conditioning space when the temperature band of the air conditioning space is the high temperature region and stopping a compressor and driving an indoor fan when the discomfort index of the air conditioning space is below the target discomfort index.

9. A control method of an air conditioner, comprising:

performing a cooling operation until a discomfort index of an air conditioning space reaches a target discomfort index;
when the discomfort index has reached the target discomfort index, adjusting the target discomfort index based a temperature of the air conditioning space; and controlling the cooling operation based on the adjusted target discomfort index.

10. The control method according to claim 9, wherein the adjusted target discomfort index is the maximum discomfort index that can be upward adjusted within a range not to affect the comfort of people in correspondence to the temperature of the air conditioning space.

11. The control method according to claim 10, wherein the adjusted target discomfort index is upward adjusted such that target discomfort index rises as much as the temperature of the air conditioning space lowers.

12. The control method according to claim 9, wherein the controlling the cooling operation includes stopping a compressor when the discomfort index of the air conditioning space is below the adjusted target discomfort index and controlling an indoor fan to be driven according to a humidity of the air conditioning space at the time of stopping the compressor.

13. The control method according to claim 12, wherein the controlling the cooling operation includes stopping the indoor fan when the humidity of the air conditioning space at the time of stopping the compressor is higher than a predetermined humidity and driving the indoor fan when the humidity of the air conditioning space at the time of stopping the compressor is lower than the predetermined humidity.

14. The control method according to claim 9, wherein the controlling the cooling operation includes stopping a compressor when the discomfort index of the air conditioning space is below the adjusted target discomfort index and controlling an indoor fan to be driven according to the temperature of the air conditioning space at the time of stopping the compressor.

15. The control method according to claim 14, wherein the controlling the cooling operation includes stopping the indoor fan when the temperature of the air conditioning space when the discomfort index of the air conditioning space reaches the target discomfort index is below a predetermined temperature and driving the indoor fan when the temperature of the air conditioning space when the discomfort index of the air conditioning space reaches the target discomfort index exceeds the predetermined temperature.

FIG. 1

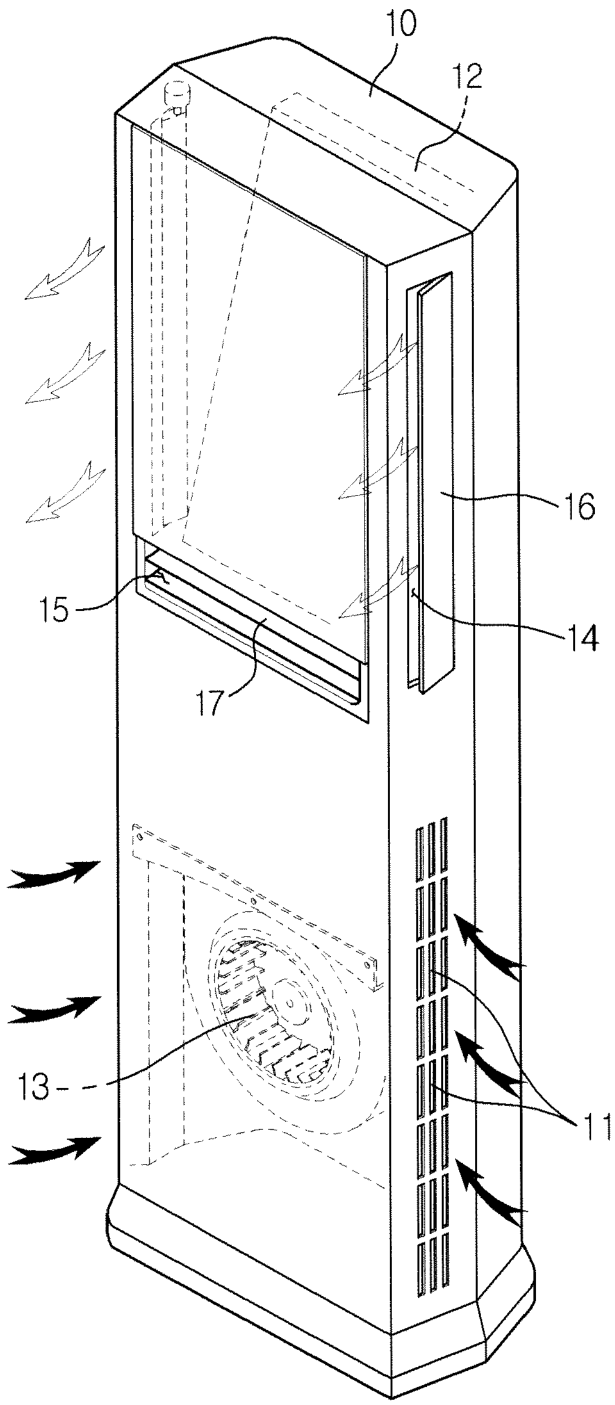


FIG. 2

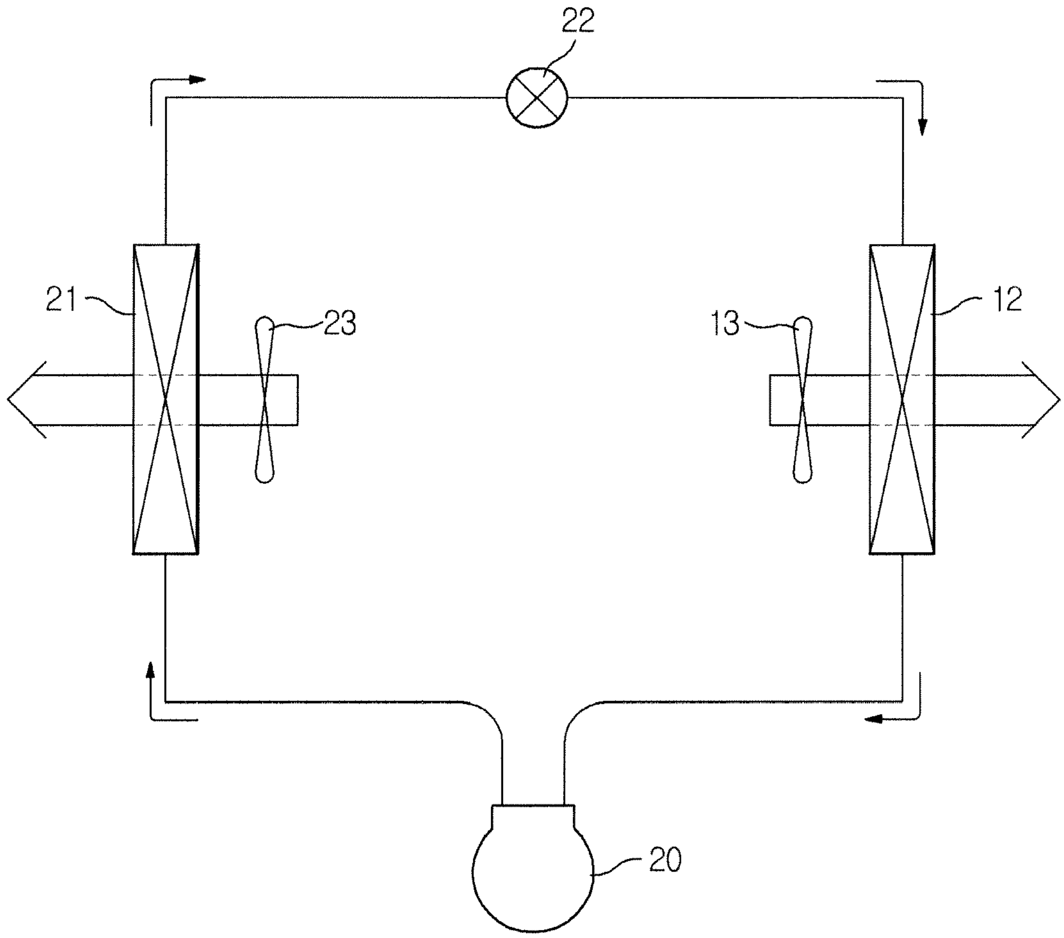


FIG. 3

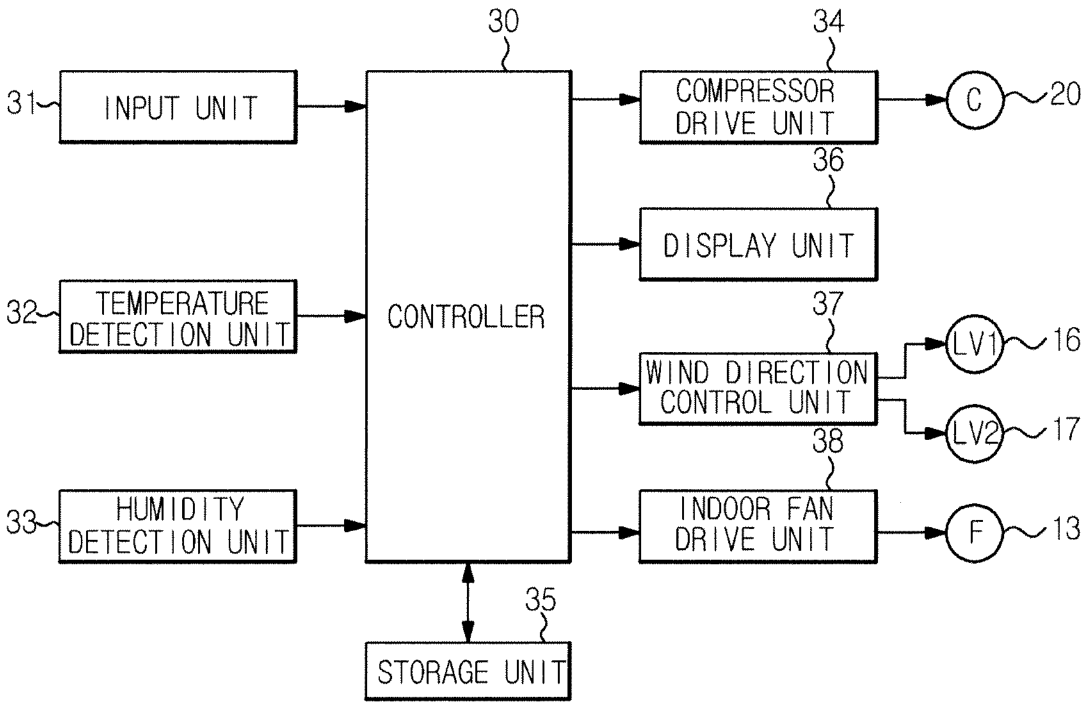

30
34
31
INPUT UNIT
COMPRESSOR DRIVE UNIT
C
20
36
DISPLAY UNIT
32
TEMPERATURE DETECTION UNIT
CONTROLLER
37
WIND DIRECTION CONTROL UNIT
LV1
16
LV2
17
38
33
HUMIDITY DETECTION UNIT
INDOOR FAN DRIVE UNIT
F
13
35
STORAGE UNIT

FIG. 4

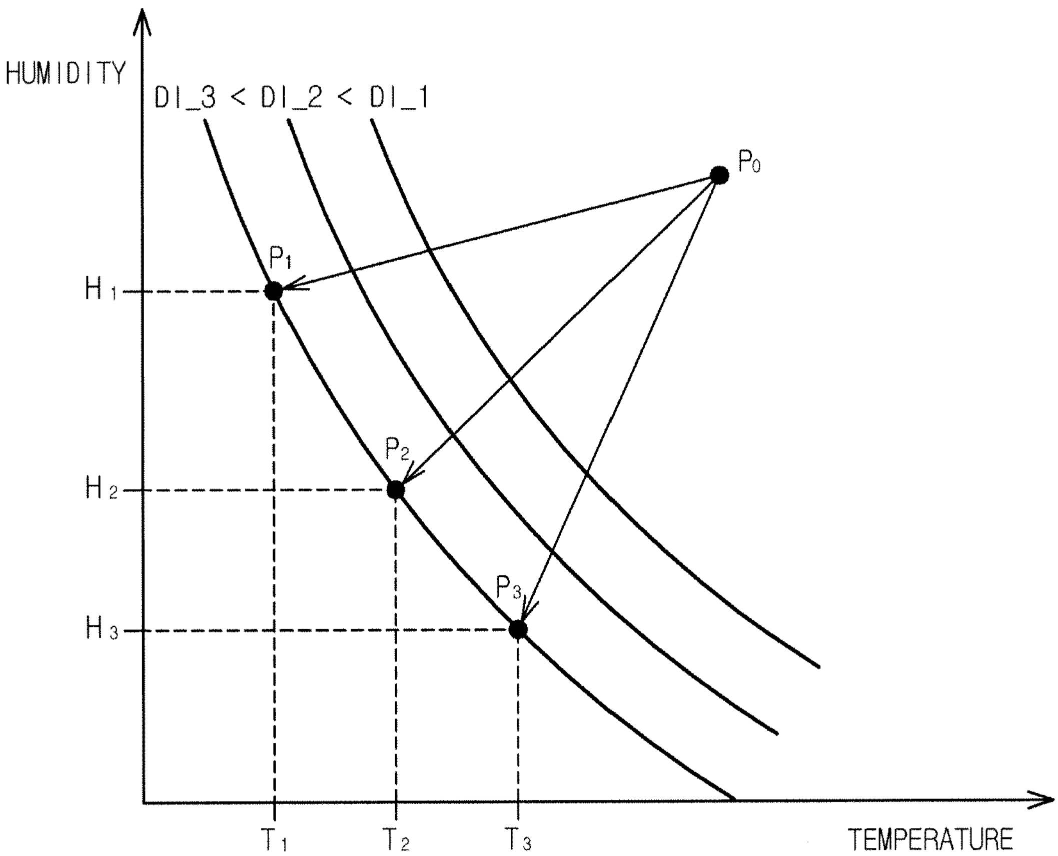


FIG. 5

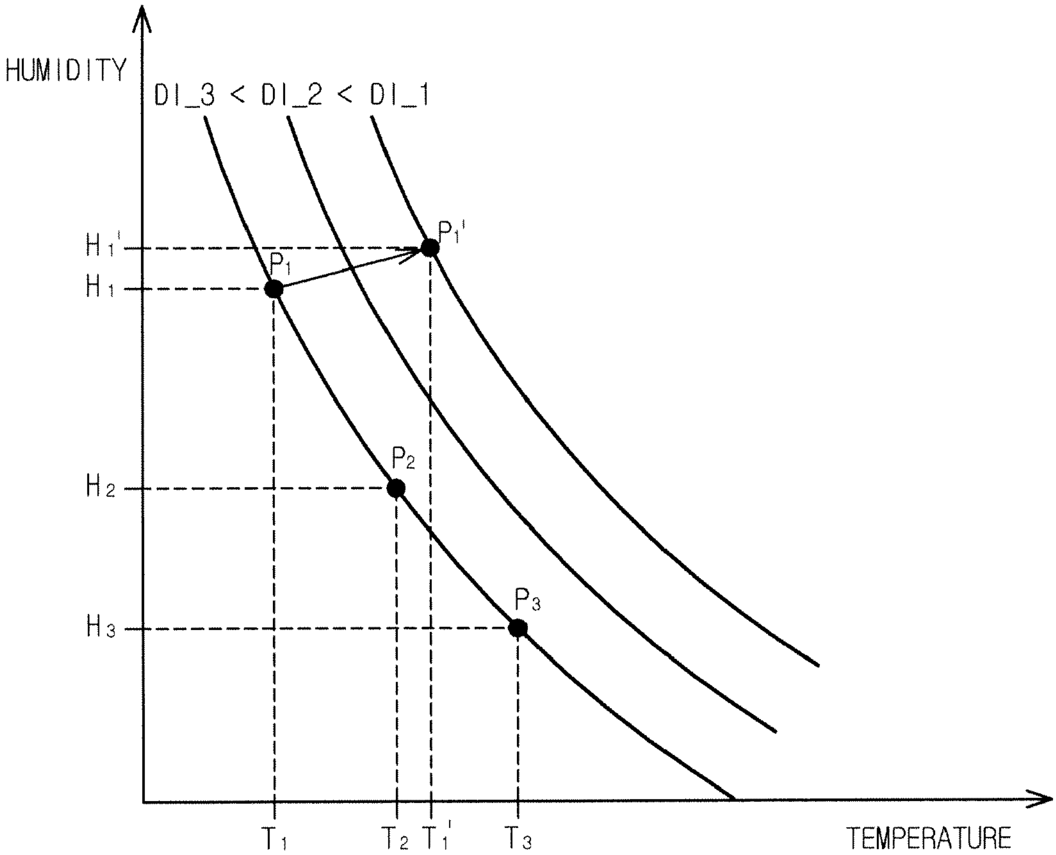

HUMIDITY
DI_3 < DI_2 < DI_1
H1'
H1
H2
H3
P1'
P1
P2
P3
T1
T2
T1'
T3
TEMPERATURE

FIG. 6

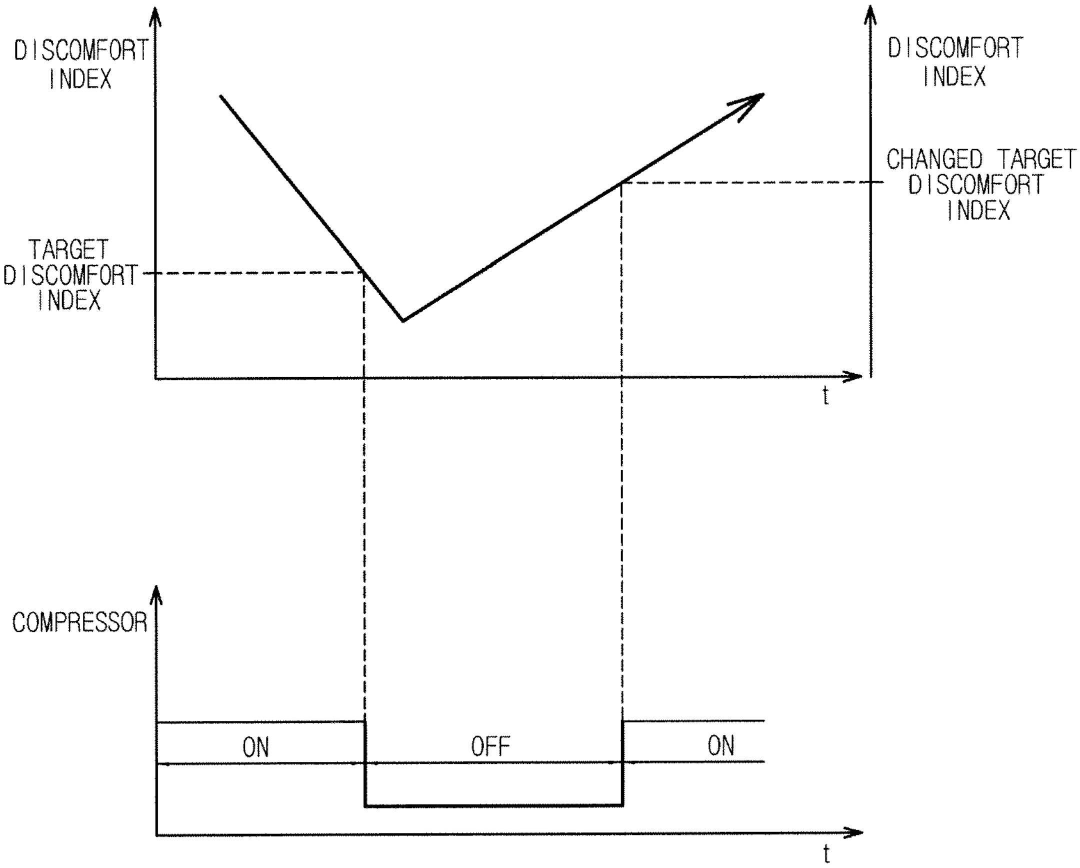

DISCOMFORT INDEX
DISCOMFORT INDEX
CHANGED TARGET DISCOMFORT INDEX
TARGET DISCOMFORT INDEX
t
COMPRESSOR
ON
OFF
ON
t

FIG. 7

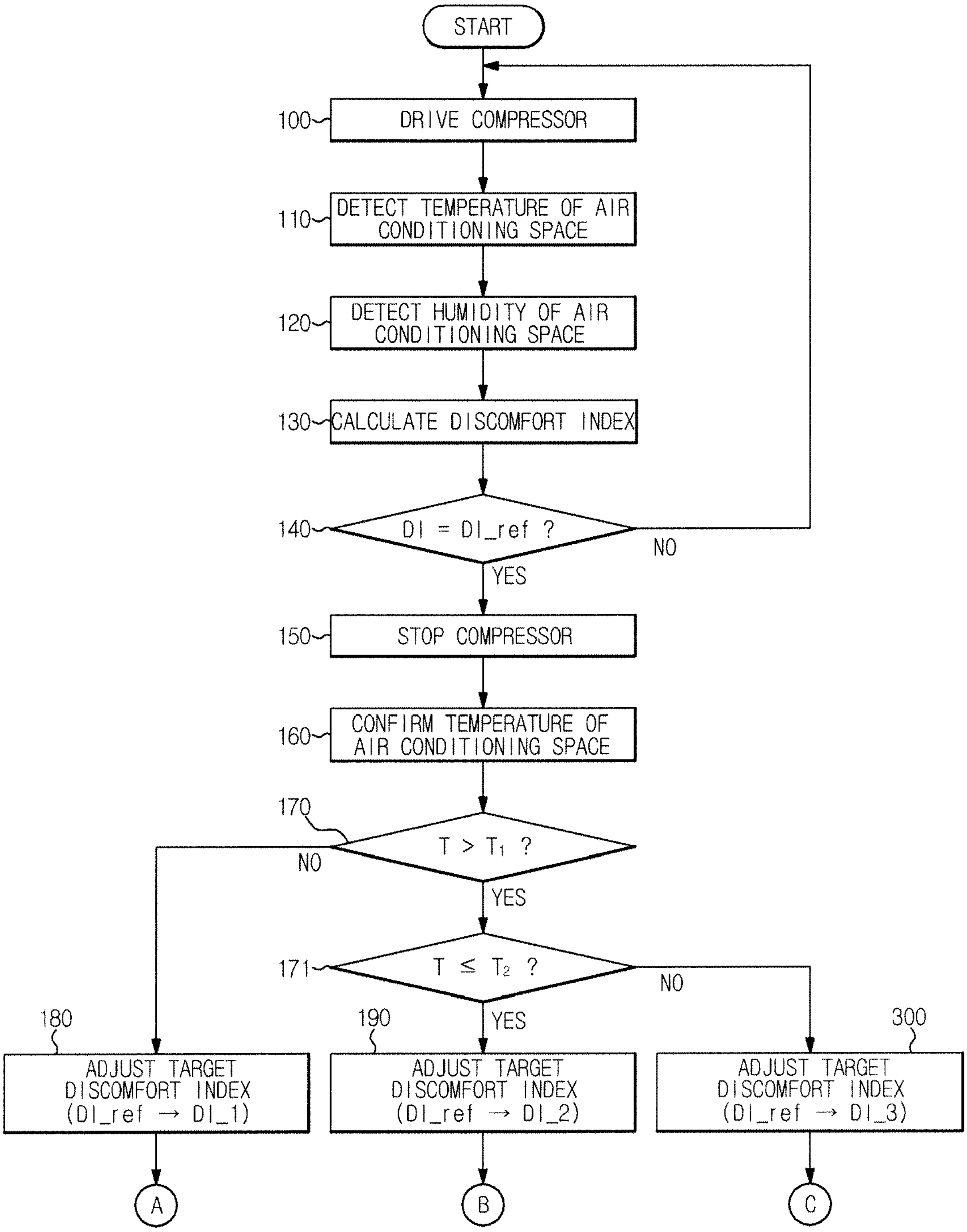

START
100
DRIVE COMPRESSOR
110
DETECT TEMPERATURE OF AIR CONDITIONING SPACE
120
DETECT HUMIDITY OF AIR CONDITIONING SPACE
130
CALCULATE DISCOMFORT INDEX
140
DI = DI_ref ?
NO
YES
150
STOP COMPRESSOR
160
CONFIRM TEMPERATURE OF AIR CONDITIONING SPACE
170
T > T1 ?
NO
YES
171
T ≤ T2 ?
NO
YES
180
ADJUST TARGET DISCOMFORT INDEX (DI_ref → DI_1)
190
ADJUST TARGET DISCOMFORT INDEX (DI_ref → DI_2)
300
ADJUST TARGET DISCOMFORT INDEX (DI_ref → DI_3)
A
B
C

FIG. 8

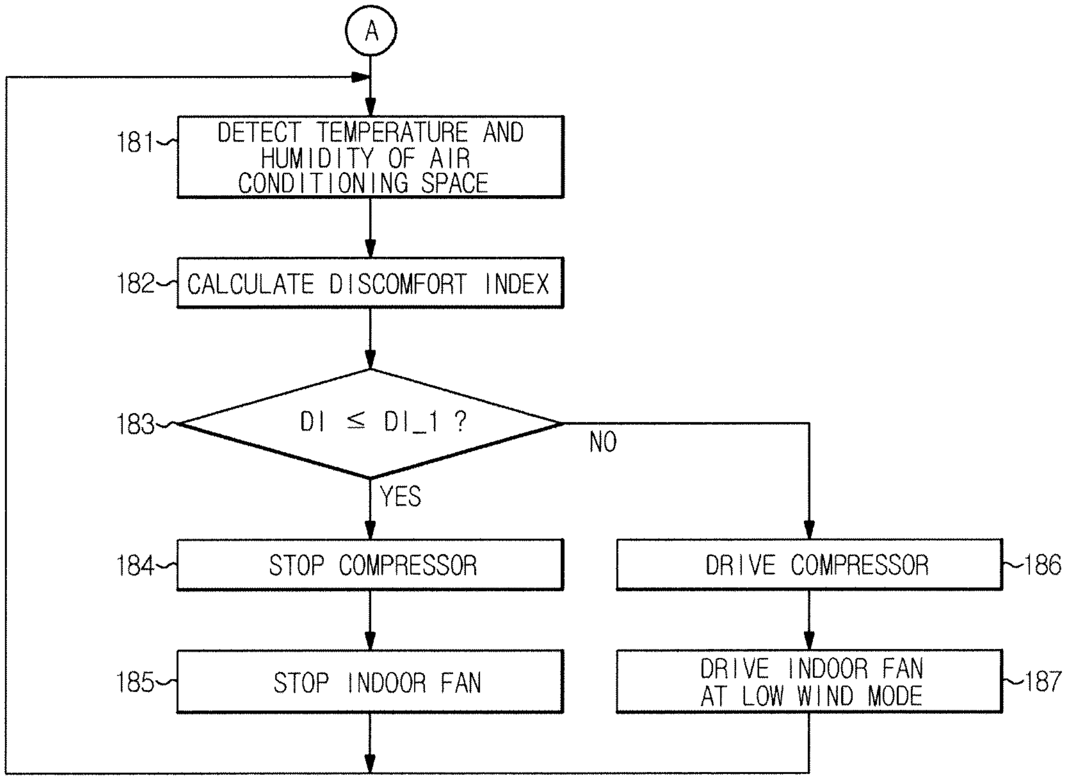

A
181
DETECT TEMPERATURE AND HUMIDITY OF AIR CONDITIONING SPACE
182
CALCULATE DISCOMFORT INDEX
183
DI ≤ DI_1 ?
NO
YES
184
STOP COMPRESSOR
185
STOP INDOOR FAN
DRIVE COMPRESSOR
186
DRIVE INDOOR FAN AT LOW WIND MODE
187

FIG. 9

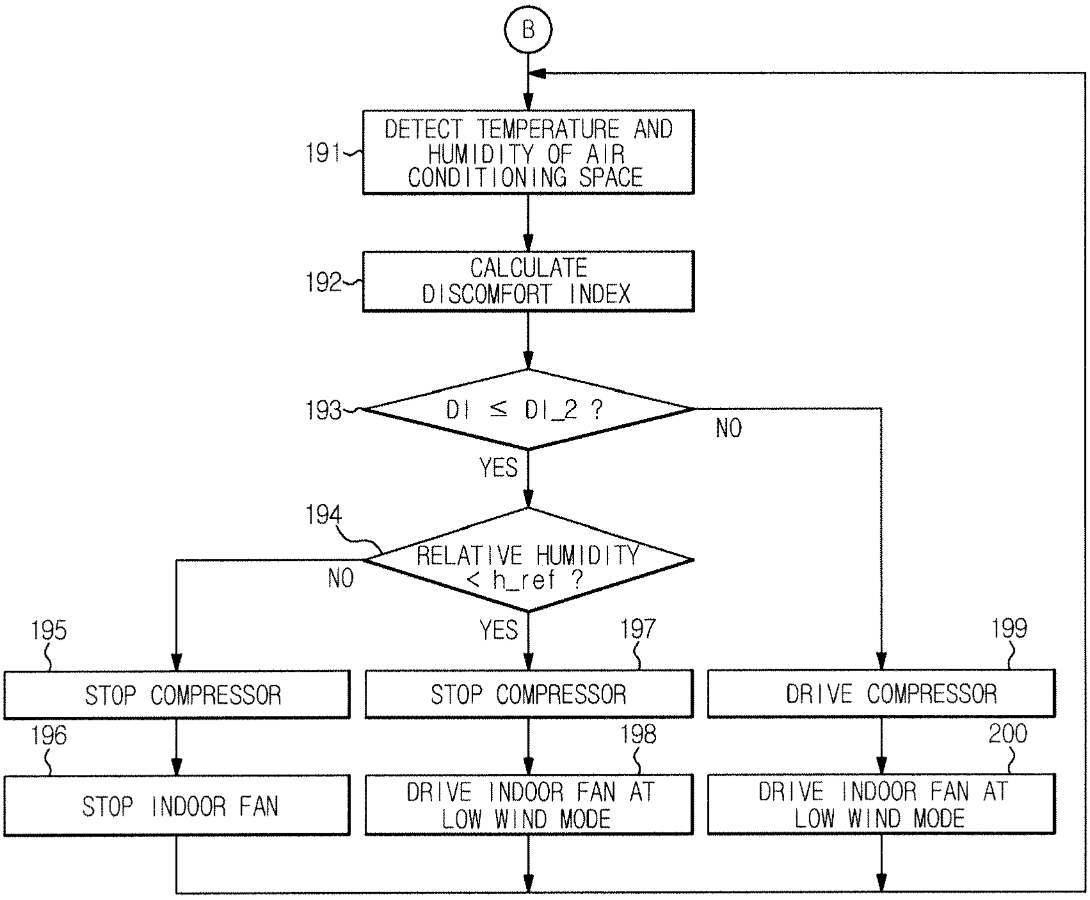

B
191
DETECT TEMPERATURE AND HUMIDITY OF AIR CONDITIONING SPACE
192
CALCULATE DISCOMFORT INDEX
193
DI ≤ DI_2 ?
NO
YES
194
RELATIVE HUMIDITY < h_ref ?
NO
YES
195
STOP COMPRESSOR
196
STOP INDOOR FAN
197
STOP COMPRESSOR
198
DRIVE INDOOR FAN AT LOW WIND MODE
199
DRIVE COMPRESSOR
200
DRIVE INDOOR FAN AT LOW WIND MODE

FIG. 10

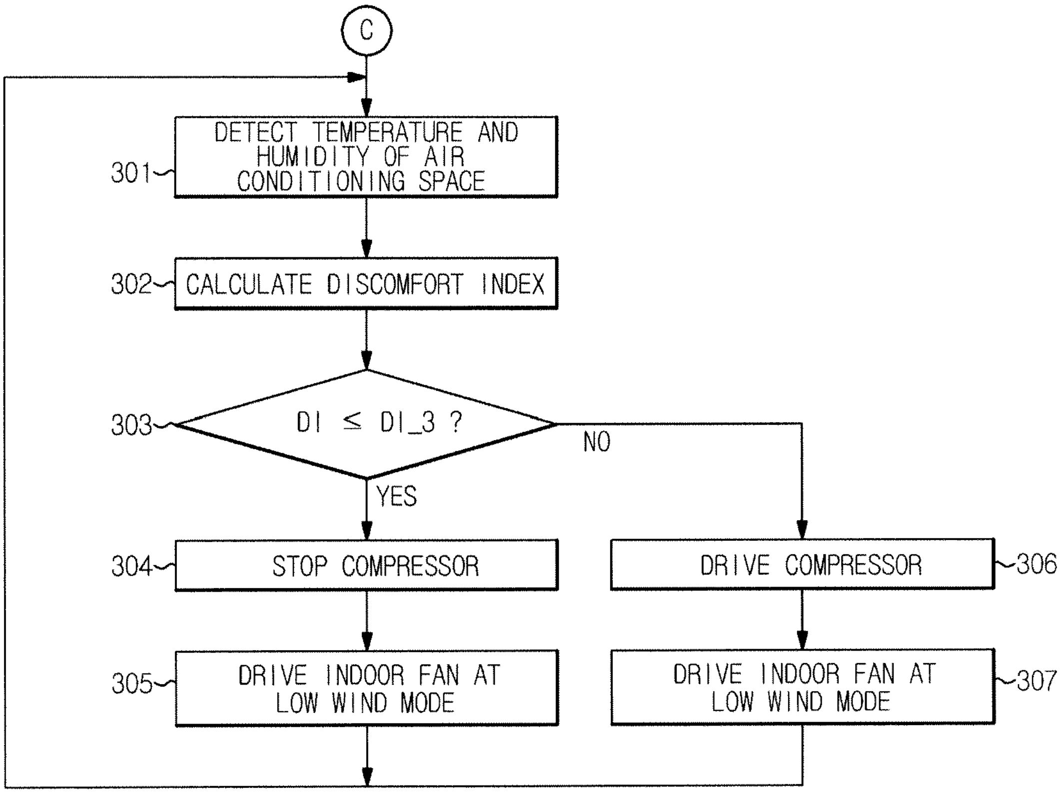

C
DETECT TEMPERATURE AND HUMIDITY OF AIR CONDITIONING SPACE
301
CALCULATE DISCOMFORT INDEX
302
DI ≤ DI_3 ?
303
NO
YES
STOP COMPRESSOR
304
DRIVE COMPRESSOR
306
DRIVE INDOOR FAN AT LOW WIND MODE
305
DRIVE INDOOR FAN AT LOW WIND MODE
307

FIG. 11

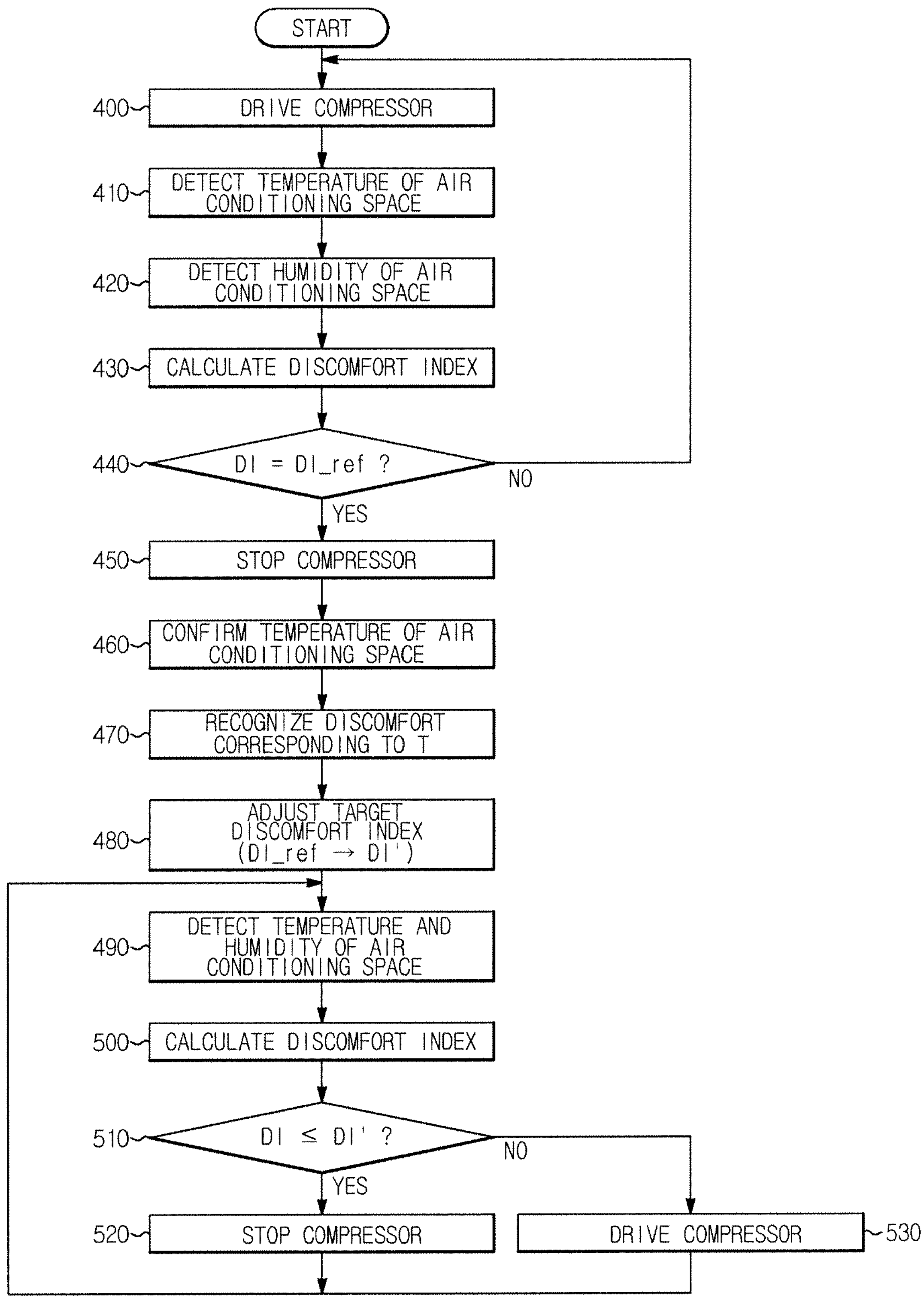
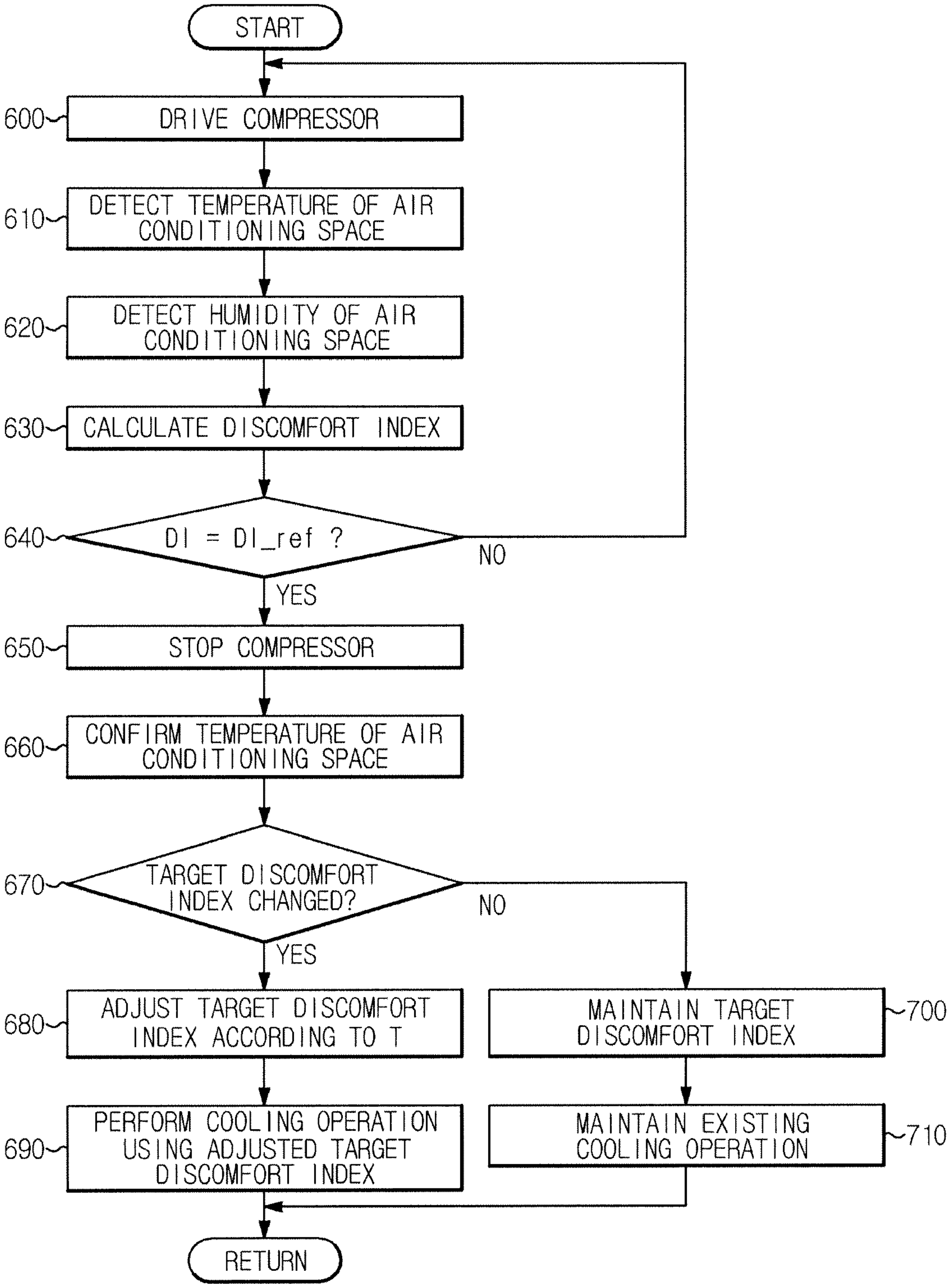

START
400
DRIVE COMPRESSOR
410
DETECT TEMPERATURE OF AIR CONDITIONING SPACE
420
DETECT HUMIDITY OF AIR CONDITIONING SPACE
430
CALCULATE DISCOMFORT INDEX
440
DI = DI_ref ?
NO
YES
450
STOP COMPRESSOR
460
CONFIRM TEMPERATURE OF AIR CONDITIONING SPACE
470
RECOGNIZE DISCOMFORT CORRESPONDING TO T
480
ADJUST TARGET DISCOMFORT INDEX (DI_ref → DI')
490
DETECT TEMPERATURE AND HUMIDITY OF AIR CONDITIONING SPACE
500
CALCULATE DISCOMFORT INDEX
510
DI ≤ DI' ?
NO
YES
520
STOP COMPRESSOR
DRIVE COMPRESSOR
530

FIG. 12


START
600
DRIVE COMPRESSOR
610
DETECT TEMPERATURE OF AIR CONDITIONING SPACE
620
DETECT HUMIDITY OF AIR CONDITIONING SPACE
630
CALCULATE DISCOMFORT INDEX
640
DI = DI_ref ?
NO
YES
650
STOP COMPRESSOR
660
CONFIRM TEMPERATURE OF AIR CONDITIONING SPACE
670
TARGET DISCOMFORT INDEX CHANGED?
NO
YES
680
ADJUST TARGET DISCOMFORT INDEX ACCORDING TO T
700
MAINTAIN TARGET DISCOMFORT INDEX
690
PERFORM COOLING OPERATION USING ADJUSTED TARGET DISCOMFORT INDEX
710
MAINTAIN EXISTING COOLING OPERATION
RETURN