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(71) Applicant: **Mitsubishi Electric Corporation**
Tokyo 100-8310 (JP)

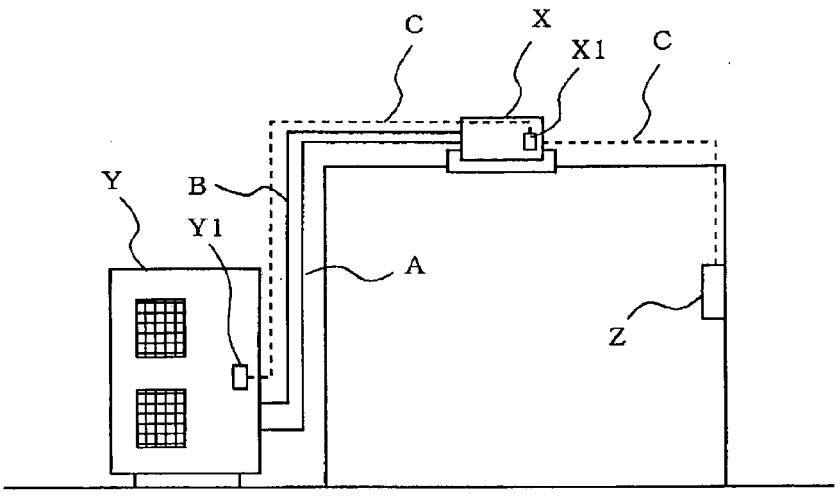
(72) Inventors:
- **Shiba, Hirokuni**
  Tokyo 100-8310 (JP)
- **Kubo, Kazuya**
  Tokyo 100-8310 (JP)
- **Yamamoto, Masayuki**
  Tokyo 100-8310 (JP)
- **Mori, Yasunoir**
  Tokyo 102-0073 (JP)
- **Nishida, Kazunori**
  Tokyo 100-8310 (JP)

(74) Representative: **Pfenning, Meinig & Partner GbR**
Patent- und Rechtsanwälte
Theresienhöhe 13
80339 München (DE)

(54) Air conditioner

(57) An air conditioner is provided with an outdoor unit (Y) having a compressor, an indoor unit (X) connected to the outdoor unit (Y) through extended pipelines (A and B), an indoor control section (X1) that starts an infrared sensor disposed in the indoor unit (X) when an instruction to detect a human body from a remote controller (Z) is received, generates an indoor image on the basis of detection information of the infrared sensor, determines whether a human body is present or not from the image and also determines the number of people if a human body is present, and calculates an operating frequency on the basis of information of the determination result, and an outdoor control section (Y1) that controls the compressor on the basis of the operating frequency calculated by the indoor control section (X1).

F I G. 1



EP 2 395 291 A2

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an air conditioner that controls an outdoor unit in accordance with the number of people in a room detected by an infrared sensor, for example.

BACKGROUND OF THE INVENTION

[0002] With a prior-art air conditioner, when air conditioning is automatically turned ON by a timer or on the basis of schedule data set in advance, a detection operation for presence of a human body is performed by a radiation sensor disposed in an indoor unit, and when no human body is present, air-conditioning capacity is saved to an efficient region and controlled so that an indoor temperature gradually reaches a set temperature (Patent document No. 1, for example)

[0003] [Patent document No.1] JP patent application No.2009-292724 (page 4).

SUMMARY OF THE INVENTION

[0004] With the prior-art air conditioner, while it is being detected that a human body is not present, an operating frequency of a compressor is set in a high operating efficiency state such as 60 Hz, for example, and operation control according to the number of people is not executed.

[0005] The present invention was made in order to solve the above problem and has an object to provide an air conditioner that controls an operation of a compressor in accordance with presence of people or the number of people in a room in which an indoor unit is installed.

[0006] An air conditioner according to the present invention is provided with an outdoor unit having a compressor, an indoor unit connected to the outdoor unit via an extended pipeline, a human detection sensor, a remote controller, an indoor control section that starts the human detection sensor when an instruction to detect a human body is received from the remote controller, generates an image of the inside of the room on the basis of detection information of the human detection sensor, determines whether a human body is present or not from the image, determines the number of the people if a human body is present, and calculates an operating frequency on the basis of information of the determination result, and an outdoor control section that controls the compressor on the basis of the operating frequency calculated by the indoor control section.

[0007] In the present invention, the human detection sensor is started when an instruction to detect a human body is received from the remote controller, an image of the inside of the room is generated on the basis of the detection information of the human detection sensor, it is determined if a human body is present or not from the image, the number of people is determined as well when a human body is present, and the operating frequency of the compressor is calculated on the basis of the information of the determination result. As a result, as compared with the prior-art case in which the operating frequency of the compressor is controlled on the basis of temperature information, required cooling/heating capacity can be provided earlier, and thus, comfort felt by human beings can be improved, excess or shortage of the capacity can be solved as soon as possible, and energy can be saved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a schematic diagram illustrating an entire configuration of an air conditioner illustrating an embodiment of the present invention;
Fig. 2 is a perspective view illustrating an appearance of an indoor unit of the air conditioner according to the embodiment of the present invention;
Fig. 3 is a sectional view illustrating a side face of the indoor unit in Fig. 2 in a cut-away manner;
Fig. 4 is a perspective view illustrating an installation example of the indoor unit in Fig. 2;
Figs. 5 are flowcharts illustrating an operation of the air conditioner according to the embodiment of the present invention;
Fig. 6 is a correlation diagram between a detected number of people and a required operating frequency of a compressor in the embodiment of the present invention; and
Fig. 7 is a correlation diagram between the detected number of people and a required maximum operating frequency of the compressor in the embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] Fig. 1 is a schematic diagram illustrating an entire configuration of an air conditioner according to an embodiment of the present invention, Fig. 2 is a perspective view illustrating an appearance of an indoor unit of the air conditioner according to the embodiment of the present invention, Fig. 3 is a sectional view illustrating a side face of the indoor unit in Fig. 2 in a cut-away manner, and Fig. 4 is a perspective view illustrating an installation example of the indoor unit in Fig. 2.

The air conditioner in Embodiment 1 is, as shown in Fig. 1, composed of an indoor unit X, an outdoor unit Y, a remote controller Z, a liquid extended pipeline A and a gas extended pipeline B that connect the indoor unit X and the outdoor unit Y, a communication line C wired between the remote controller Z and an indoor control section X1 of the indoor unit X and between the indoor control section X1 and an outdoor control section Y1 of the outdoor unit Y, respectively, and an infrared sensor

5 (See Fig. 2), for example, which is a human detection sensor. The above-described indoor unit X is installed mainly in a building or is embedded in a ceiling, for example (See Fig. 4). It was described above that the remote controller Z and the indoor control section X1 are connected to each other by the communication line C, but information transmission/reception may be conducted via radio communication therebetween. The infrared sensor 5 is disposed on a decorative panel 2 of the indoor unit X, to be described later.

[0010] When an operation instruction (cooling operation, heating operation, dehumidification operation and the like) is received from the remote controller Z, the indoor control section X1 transmits the operation instruction to the outdoor control section Y1 of the outdoor unit Y and also drives a fan motor 6, which will be described later, on the basis of the operation instruction. Also, when an instruction to detect a human body from the remote controller Z such as an instruction to start an initial operation after an installation of this air conditioner or an instruction to obtain a background image inside the room, for example, is received, the indoor control section X1 starts the infrared sensor 5, generates a heat image inside the room on the basis of detection information of the infrared sensor 5 and stores the heat image as a background image.

[0011] Also, when an instruction to detect a human body from the remote controller Z or an instruction to start an energy-saving operation, for example, is received after the background image was obtained, the indoor control section X1 starts the infrared sensor 5 and generates a heat image inside the room on the basis of the detection information of the infrared sensor 5. Then, the indoor control section X1 determines whether a human body is present or not by comparing the heat image with the background image inside the room stored in advance and determines the number of people if a human body is present and calculates an operating frequency of the compressor of the outdoor unit Y on the basis of the information of the determination result. The determination of the number of human bodies and the calculation of the operating frequency will be described in detail when an operation is described.

[0012] When an operation instruction from the remote controller Z is received through the indoor control section X1, the outdoor control section Y1 controls the compressor with the operating frequency according to the operation instruction and when the operating frequency calculated by the indoor control section X1 is received, the outdoor control section Y1 controls the compressor on the basis of the operating frequency. That is, the more the operating frequency is increased, the higher the rotation speed of the compressor is raised, while the more the operating frequency is decreased, the lower the rotation speed of the compressor is lowered. In the above-described outdoor unit Y, a heat exchanger, an expansion valve and the like are disposed in addition to the above-described compressor.

[0013] An appearance of the indoor unit X is, as shown in Fig. 2, composed of a box-shaped cabinet 1, the decorative panel 2 in a square shape disposed below the cabinet 1, a square-shaped inlet 3b disposed at the center of the decorative panel 2, four rectangular blow-out ports 3a disposed in the decorative panel 2 so as to surround the inlet 3b, and wind-direction flaps 4 that are disposed on the blow-out ports 3a and change the wind direction in the vertical direction. On a lower face at a corner of the decorative panel 2, the infrared sensor 5 is mounted.

[0014] In the cabinet 1 of the indoor unit X, as shown in Fig. 3, a fan motor 6 having a load shaft directed downward arranged at the center of the top face of the cabinet 1, a turbo fan 7 mounted on the load shaft of the fan motor 6, a heat exchanger 8 arranged so as to surround the turbo fan 7, an inner cover 9 arranged so as to surround the heat exchanger 8, a drain pan 10 installed below the heat exchanger 8 and receiving condensed water generated during heat exchange, and a temperature sensor 13 that detects a temperature of air sucked through the inlet 3b are disposed. The above-described inner cover 9 is provided to insulate the air heat-exchanged by the heat exchanger 8 from outside the unit, and the heat exchanger 8 and the drain pan 10 constitute an air path on an outer periphery of the heat exchanger 8. The air path communicates with the blow-out port 3a. Below the drain pan 10, an opening portion communicating with the inlet of the turbo fan 7 is disposed.

[0015] On the inlet 3b of the decorative panel 2, an air filter 11 that prevents intrusion of dusts and the like into the unit and a grill 12 that supports the air filter 11 and also functions as a blind are disposed. Moreover, between the air filter 11 and the turbo fan 7, a bell mouth 14 that introduces sucked air into the turbo fan 7 smoothly is disposed.

[0016] The above-described infrared sensor 5 is composed of a multi-eye infrared sensor or a plurality of infrared sensors and installed within a sensor case 5b. The sensor case 5b is contained in a housing 5a having an outer shape of a substantially cone formed at one corner of a decorative panel 2 and mounted on the vertical direction axis of a motor 5c, capable of rotating in 360 degrees. The infrared sensor 5 is composed of a plurality of detection sections, and the detection sections are exposed from a hole 5d disposed in a projection portion of the housing 5a and arranged in parallel with a normal line of a circle of the hole 5d.

[0017] Subsequently, an operation on the basis of a human body detection of the infrared sensor 5 in the air conditioner configured as above will be described using Fig. 5. Description on a basic operation of the air conditioner will be omitted.

Figs. 5 are flowcharts illustrating an operation of the air conditioner according to the embodiment of the present invention. Fig. 5A is a flowchart when obtaining a background image inside the room in which the indoor unit X is installed, and Fig. 5B is a flowchart illustrating detection

of the number of people present in the same room and calculation of the operating frequency of the compressor according to the number of people.

[0018] When start of an initial operation is detected from a switch operation of the remote controller Z (S1), the indoor control section X1 rotates the infrared sensor 5 by 360 degrees at a rate of approximately once in several minutes to several seconds by a motor driving force (S2). At this time, the indoor control section X1 generates a two-dimensional heat image on the basis of detection information (indoor information) of the infrared sensor 5 obtained by a trajectory axis by the rotation and the axis in the alignment direction of the infrared sensor 5 (S3) and stores it as a background image (S4). The background image may be obtained either during the operation of the air conditioner or during the stop thereof.

[0019] When start of an energy-saving operation is detected from the switch operation of the remote controller Z after the background image was obtained (S11), the indoor control section X1 rotates the infrared sensor 5 once as described above (S12) and generates the two-dimensional heat image on the basis of the detection information of the infrared sensor 5 obtained at this time (S13). Then, the indoor control section X1 obtains a difference between the two-dimensional heat image and the background image stored in advance (S14) and performs grouping of pixels from the difference so as to sort out an image assumed to be an object (S15).

[0020] The indoor control section X1 determines whether an average temperature T of the sorted-out image portion is a threshold value Ta or more and a threshold value Tb or less (S16). If the average temperature T is not within the range, the indoor control section X1 determines that a human body is not present in the room, and proceeds to determine whether there is a subsequent grouping or not (S19). Also, if the average temperature T is the threshold value Ta or more and the threshold value Tb or less, the indoor control section X1 determines whether the number of pixels in that portion is a threshold value Sa or more (S17). If the number of pixels is less than the threshold value Sa, the indoor control section X1 determines that there is no human body in the room and proceeds to determine whether there is another grouping or not similarly to the above (S19). If it is determined that the number of pixels is the threshold value Sa or more, the indoor control section X1 determines that there is a human body in the room (S18) and determines whether there is a subsequent grouping or not (S19).

[0021] The indoor control section X1 repeats the above-described operation if there is a subsequent grouping (S16 to S19) and performs this operation until there is no more subsequent grouping. The indoor control section X1 confirms the number of people from the confirmed human bodies when the operation is repeatedly performed (S20). Then, the indoor control section X1 calculates an operating frequency Hzm of the compressor required from the outdoor unit Y by a formula determined in advance according to the number of people (S21), transmits the operating frequency Hzm to the outdoor control section Y1 via the communication line C (S22), and operates the compressor of the outdoor unit Y by the operating frequency Hzm (S23).

[0022] As described above, in this embodiment, when start of the energy saving operation is detected, the infrared sensor 5 is started, a heat image is generated on the basis of the detection information of the infrared sensor 5, and the heat image is compared with the background image stored in advance so as to determine whether a human body is present or not. Then, if the human body is present, the number of people is determined, the operating frequency is calculated on the basis of the information of the determination result, and the compressor is controlled by the operating frequency. As a result, as compared with the case in which the operating frequency of the compressor is controlled on the basis of the temperature information, required cooling/heating capacity can be provided earlier, and thus, comfort felt by human beings is improved, excess or shortage of the capacity can be solved as soon as possible, and energy saving can be realized.

[0023] In this embodiment, the operating frequency of the compressor is determined in accordance with the number of people present in the room as shown in Fig. 6, but not limited to that. For example, as shown in Fig. 7, it may be so configured that the number of people is divided into three stages, that is, 0 people, 1 to 10 people, and 10 people or more, the maximum value of the operating frequency of the compressor in each case is determined in advance, which one of the three stages is specified from the number of people on the basis of the detection by the infrared sensor 5 and the maximum frequency value is determined, and the compressor of the outdoor unit Y is operated by the maximum frequency value.

[0024] The following contents are also performed at the same time in order to further save energy. After the number of people in the target room is detected using the infrared sensor, a set temperature of the remote controller Z is changed in accordance with the number of people. For example, suppose that a user has set the set temperature at 27°C during cooling. Subsequently, the number of people in the target indoor space is detected using the infrared sensor 5, the temperature is raised by 2°C in the case of 0 people, the temperature is raised by 1 °C in the case of 1 to 10 people, and the temperature is left as it is in the case of 10 people or more, and the result is transmitted to the outdoor control section Y1 of the outdoor unit Y via the communication line C. This mode is made effective only if the user has selected an energy saving operation by the remote controller Z.

DESCRIPTION OF THE NUMERALS

[0025] X: indoor unit, X1: indoor control section, Y: outdoor unit, Y1: outdoor control section, Z: remote control-

ler, A: liquid extended pipeline, B: gas extended pipeline, C: communication line, 1: cabinet, 2: decorative panel, 3a: blow-out port, 3b: inlet, 4: wind-direction flap, 5a: housing, 5b: sensor case, 5c: motor, 5d: hole of housing, 6: fan motor, 7 turbo fan, 8: heat exchanger, 9: inner cover, 10: drain pan, 11: air filter, 12: grill, 13: temperature sensor, 14: bell mouth.

Claims

1. An air conditioner comprising:

an outdoor unit (Y) having a compressor;
an indoor unit (X) connected to said outdoor unit (Y) via an extended pipeline;
a human detection sensor;
a remote controller (Z);
an indoor control section (X1) that starts said human detection sensor when an instruction to detect a human body is received from said remote controller (Z), generates an indoor image on the basis of detection information of the human detection sensor, determines whether a human body is present or not from the image and also determines the number of people when the human body is present, and calculates an operating frequency on the basis of information of the determination results; and
an outdoor control section (Y1) that controls said compressor on the basis of the operating frequency calculated by said indoor control section (X1).

2. The air conditioner of claim 1, wherein
said indoor control section (X1) starts said human detection sensor when an instruction to detect a human body is received from said remote controller (Z), generates an indoor image on the basis of detection information of the human detection sensor, determines whether a human body is present or not by comparing the image with a background image of the inside of a room stored in advance and also determines the number of people when the human body is present, and calculates an operating frequency of said compressor on the basis of information of the determination results.

3. The air conditioner of claim 2, wherein
said indoor control section (X1) starts said human detection sensor when an instruction from said remote controller (Z) is an instruction to obtain the background image of the inside of the room, generates an indoor image on the basis of the detection information of the human detection sensor and stores the image as a background image.

4. The air conditioner of any one of claims 1 to 3, wherein
said indoor control section (X1) changes the indoor temperature set by said remote controller (Z) in accordance with the determined number of people.

5. The air conditioner of any one of claims 1 to 4, wherein
said indoor control section (X1) changes the maximum operating frequency of said compressor in accordance with the determined number of people.

6. The air conditioner of any one of claims 1 to 5, wherein
said human detection sensor is a multi-eye infrared sensor or a plurality of infrared sensors.

FIG. 1

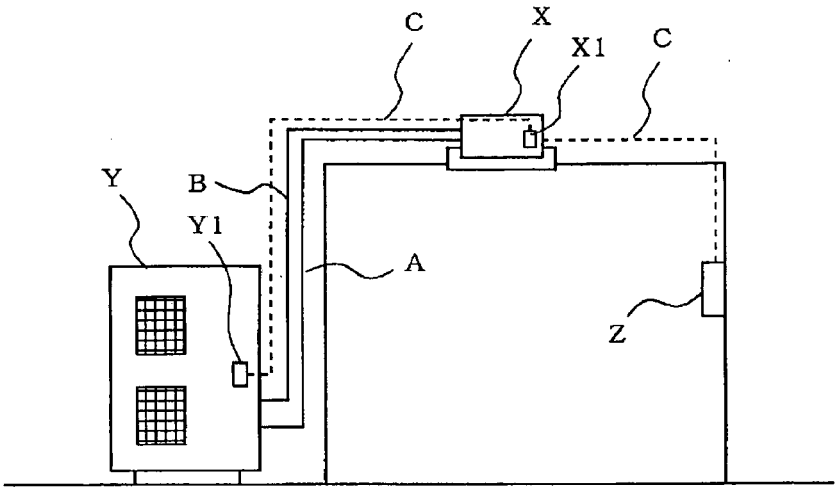


FIG. 2

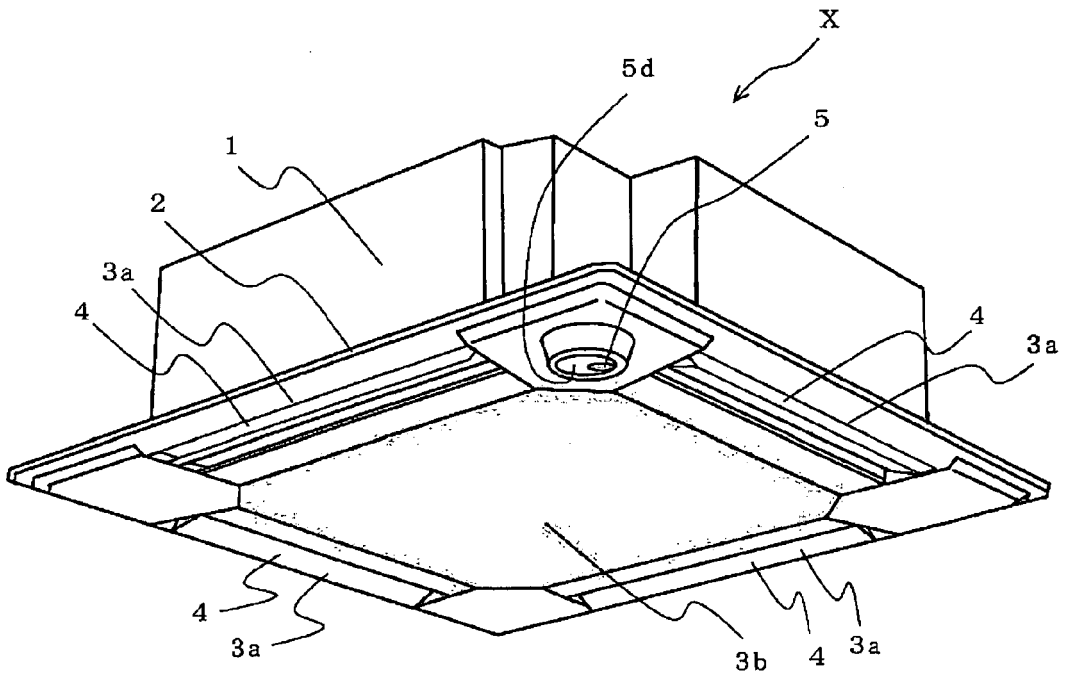


FIG. 3

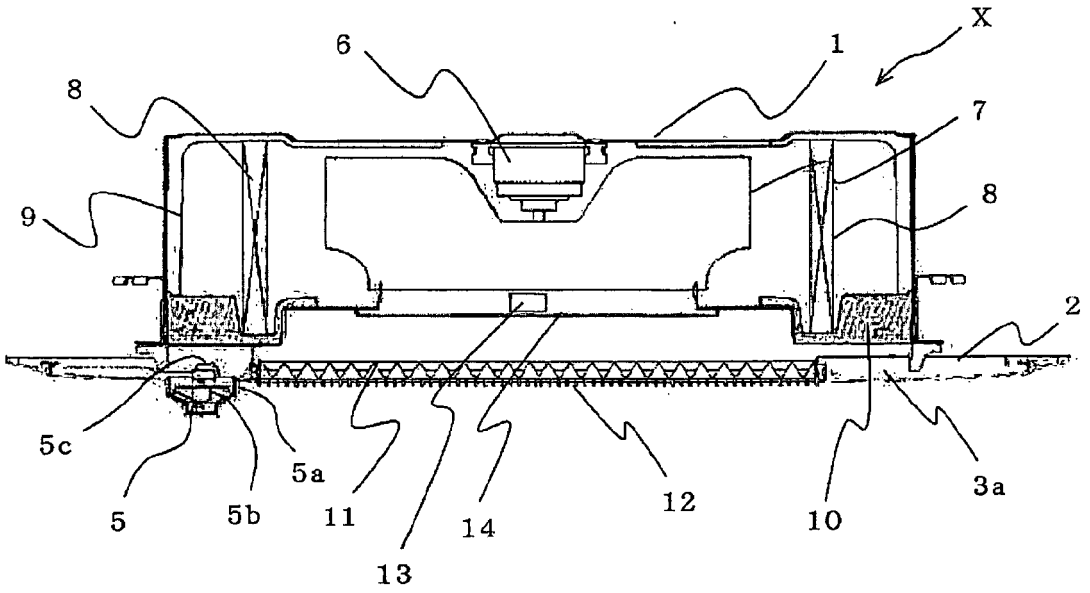


FIG. 4

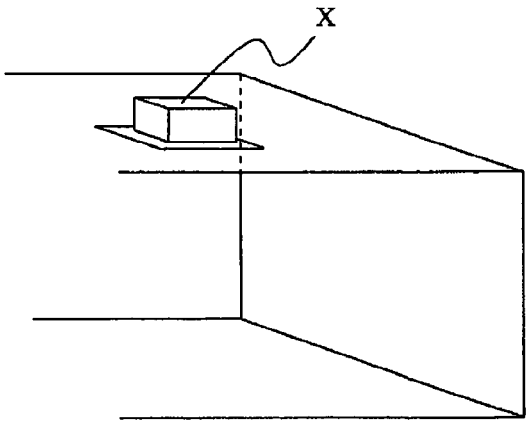


FIG. 5

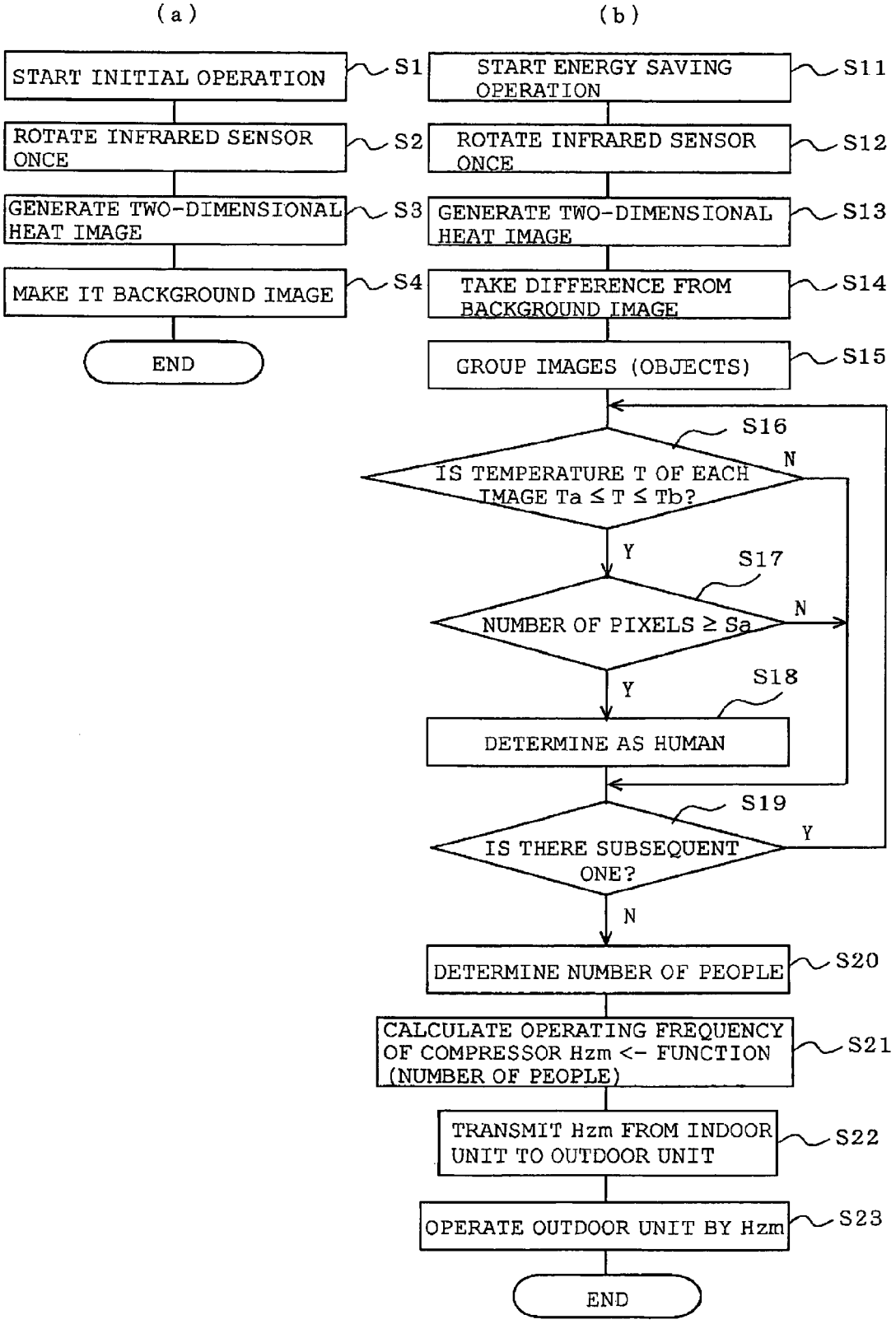

(a)
START INITIAL OPERATION
S1
ROTATE INFRARED SENSOR ONCE
S2
GENERATE TWO-DIMENSIONAL HEAT IMAGE
S3
MAKE IT BACKGROUND IMAGE
S4
END
(b)
START ENERGY SAVING OPERATION
S11
ROTATE INFRARED SENSOR ONCE
S12
GENERATE TWO-DIMENSIONAL HEAT IMAGE
S13
TAKE DIFFERENCE FROM BACKGROUND IMAGE
S14
GROUP IMAGES (OBJECTS)
S15
S16
IS TEMPERATURE T OF EACH IMAGE Ta ≤ T ≤ Tb?
N
Y
S17
NUMBER OF PIXELS ≥ Sa
N
Y
S18
DETERMINE AS HUMAN
S19
IS THERE SUBSEQUENT ONE?
Y
N
DETERMINE NUMBER OF PEOPLE
S20
CALCULATE OPERATING FREQUENCY OF COMPRESSOR Hzm <- FUNCTION (NUMBER OF PEOPLE)
S21
TRANSMIT Hzm FROM INDOOR UNIT TO OUTDOOR UNIT
S22
OPERATE OUTDOOR UNIT BY Hzm
S23
END

FIG. 6

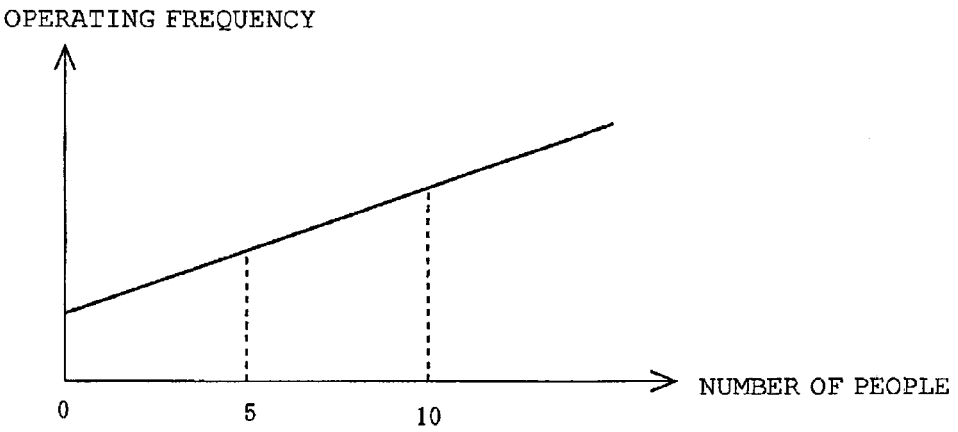
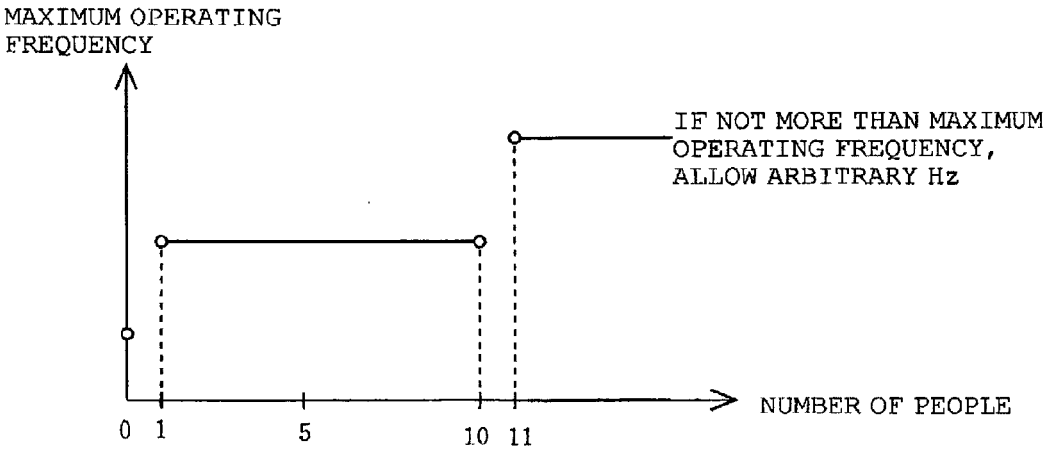

OPERATING FREQUENCY
NUMBER OF PEOPLE
0
5
10

FIG. 7


MAXIMUM OPERATING FREQUENCY
IF NOT MORE THAN MAXIMUM OPERATING FREQUENCY, ALLOW ARBITRARY Hz
NUMBER OF PEOPLE
0
1
5
10
11

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2009292724 A **[0003]**