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(54) TEMPERATURE DETECTION DEVICE AND VEHICLE AIR CONDITIONER USING THE SAME

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(57) ABSTRACT

In a vehicle air conditioner, a non-contact temperature sensor is used as a temperature detecting device. The non-contact temperature sensor has a plurality of temperature detection elements for detecting surface temperatures of a plurality of temperature detection ranges in a vicinity of at least one of seats of a passenger compartment in non-contact. The non-contact temperature sensor is provided in a ceiling portion of the passenger compartment in an arrangement area of the ceiling portion between a front end and a rear end of the one seat in a vehicle front-rear direction. Accordingly, even when the size and seated height of the passenger are changed, the temperature detection ranges can contain the passenger, and a passenger's temperature can be stably detected by using the non-contact temperature sensor.

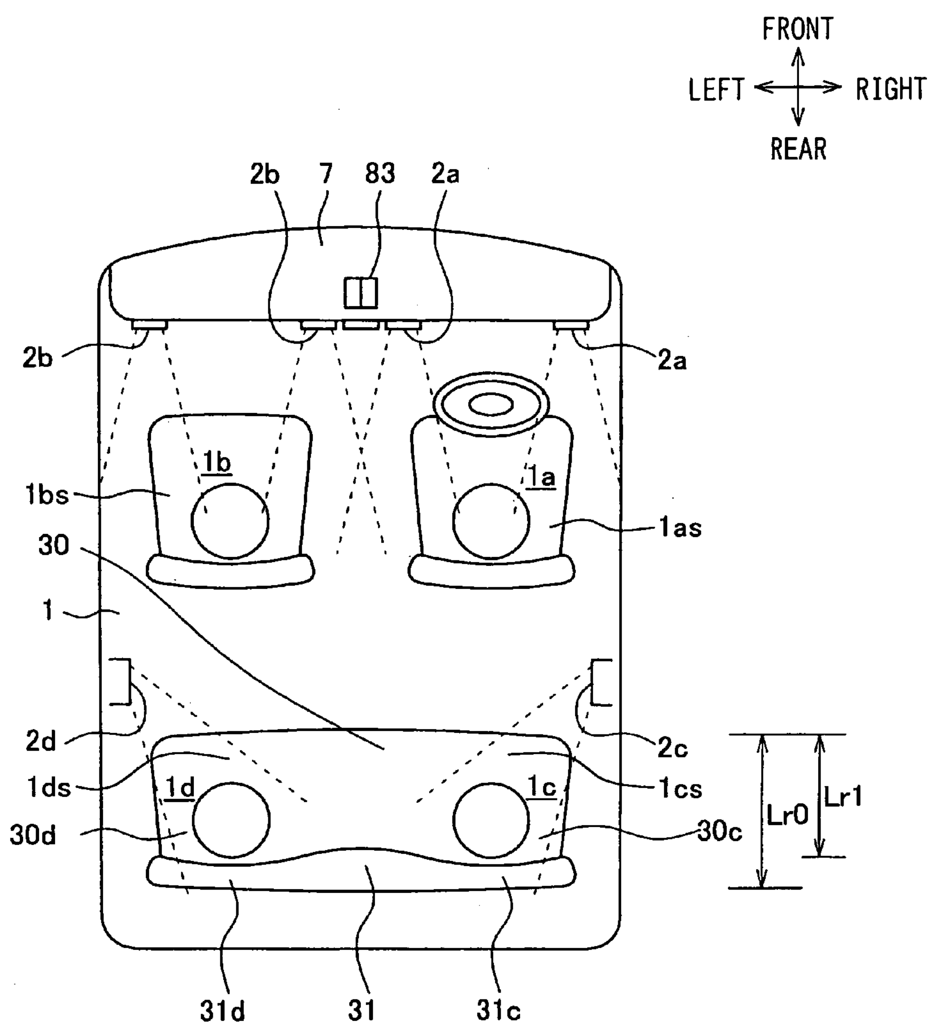


FIG. 1

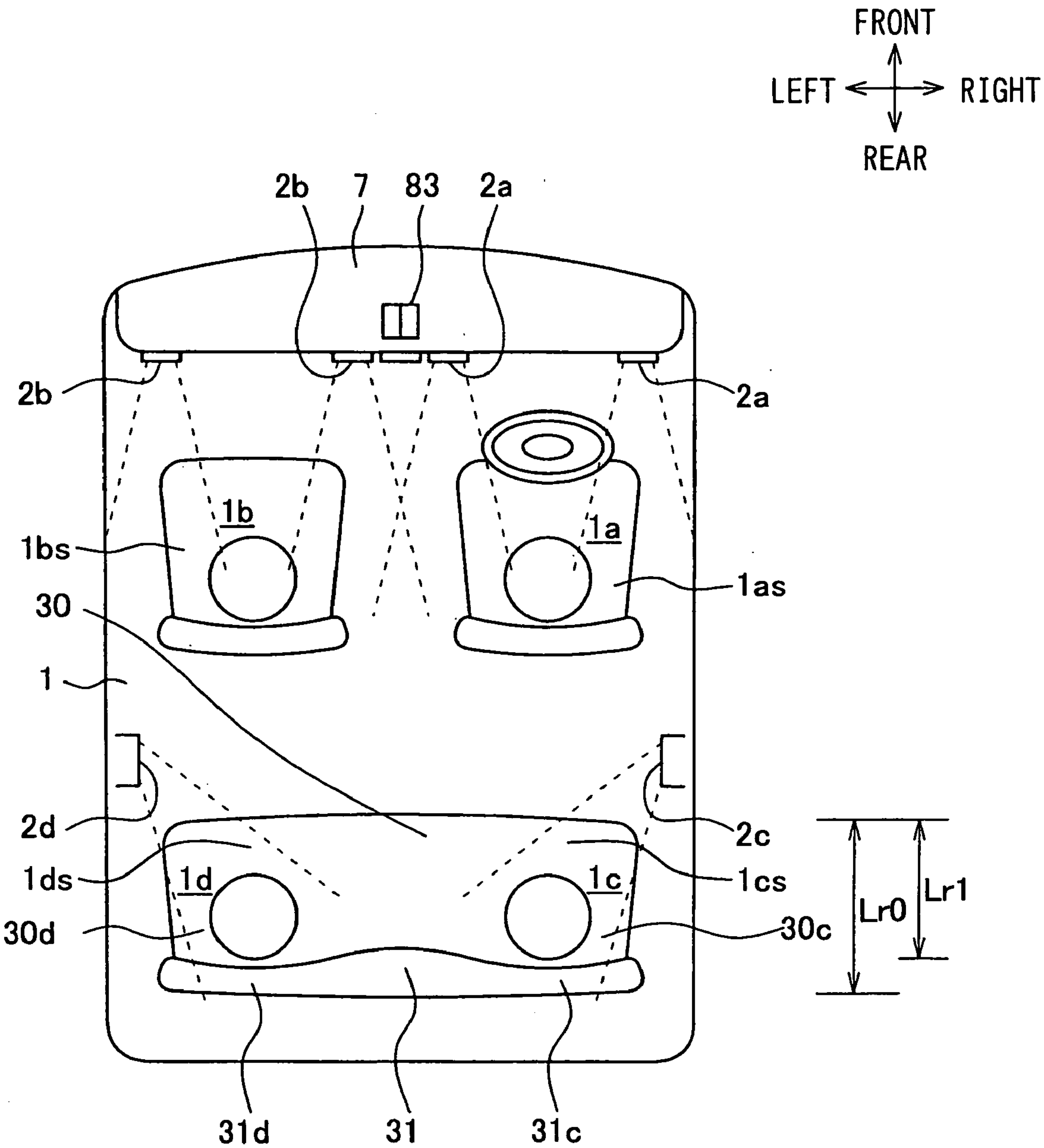

FRONT
LEFT
RIGHT
REAR
2b
7
83
2a
2b
2a
1b
1a
1bs
1as
30
1
2d
2c
1ds
1cs
1d
1c
30d
30c
Lr0
Lr1
31d
31
31c

FIG. 2

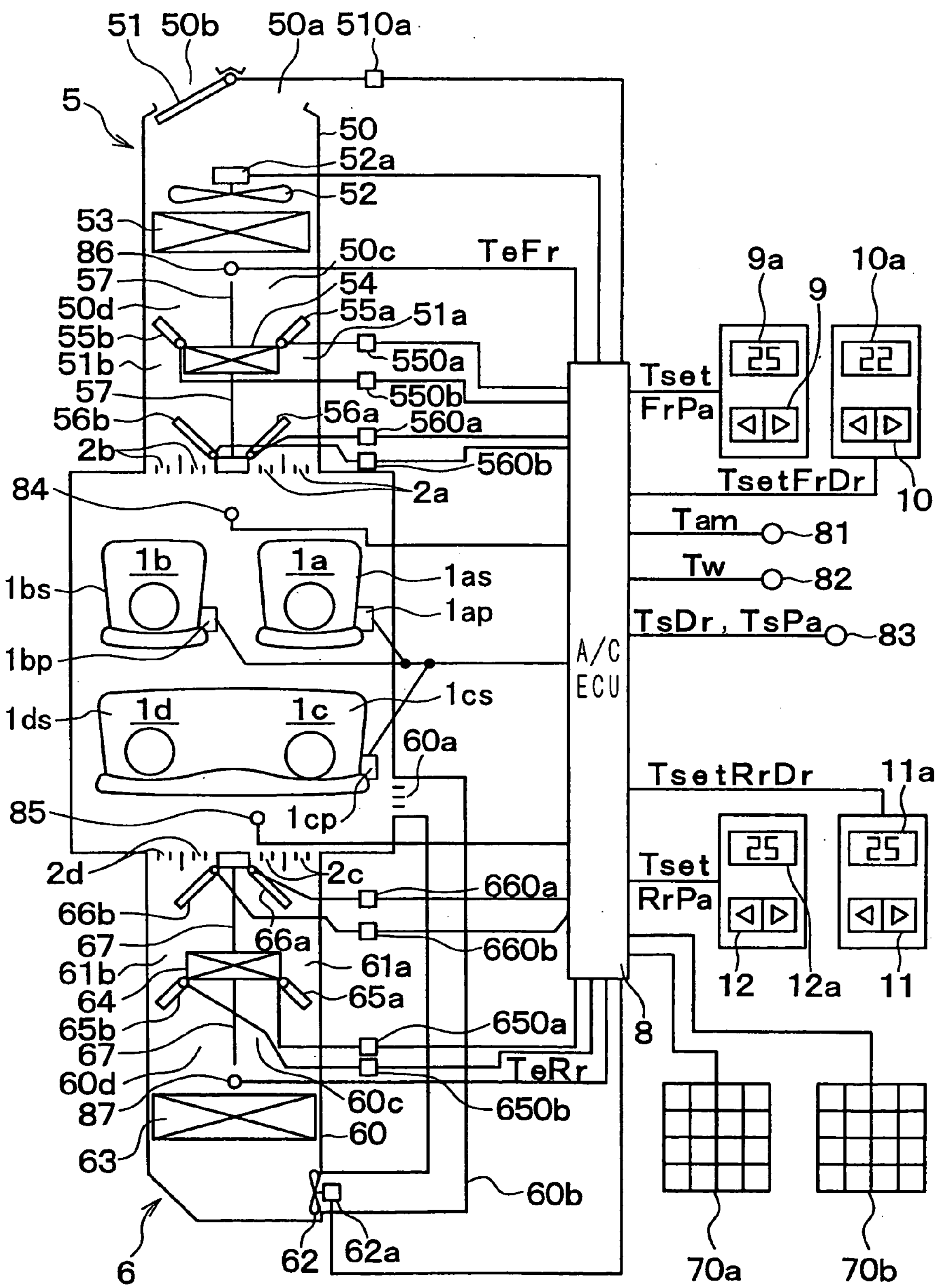

51
50b
50a
510a
5
50
52a
52
53
86
50c
TeFr
57
54
50d
55a
51a
55b
550a
51b
550b
56b
56a
560a
2b
560b
2a
84
1b
1a
1as
1bs
1ap
1bp
1d
1c
1cs
1ds
60a
85
1cp
2d
2c
660a
66b
66a
660b
67
61a
61b
64
65a
65b
650a
67
TeRr
60d
60c
650b
87
60
63
60b
6
62
62a
A/C
ECU
8
9a
10a
9
Tset
FrPa
25
22
TsetFrDr
10
Tam
81
Tw
82
TsDr, TsPa
83
TsetRrDr
11a
Tset
RrPa
25
25
12
12a
11
70a
70b

FIG. 3

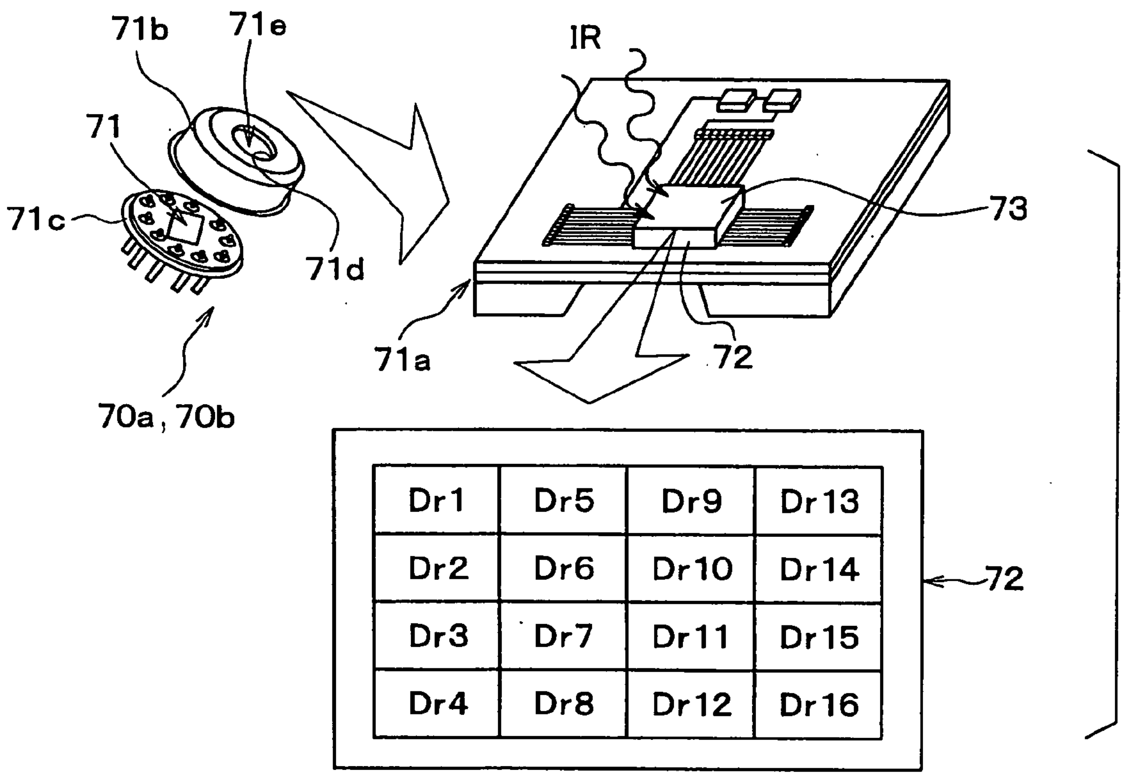

71b
71e
71
71c
71d
70a, 70b
IR
73
71a
72
Dr1
Dr5
Dr9
Dr13
Dr2
Dr6
Dr10
Dr14
Dr3
Dr7
Dr11
Dr15
Dr4
Dr8
Dr12
Dr16
72

FIG. 4A

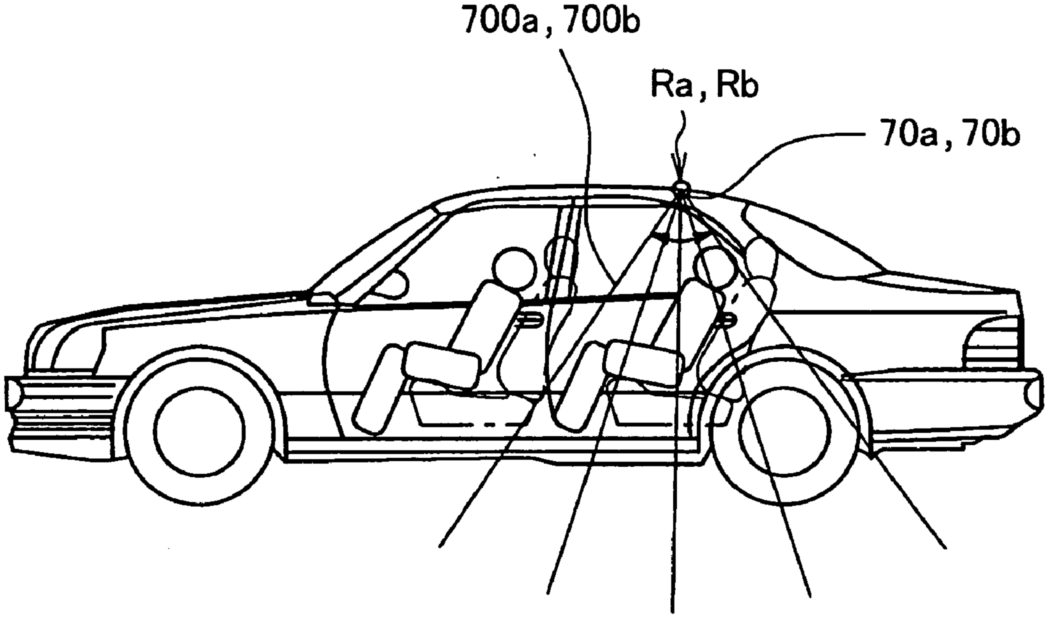


FIG. 4B

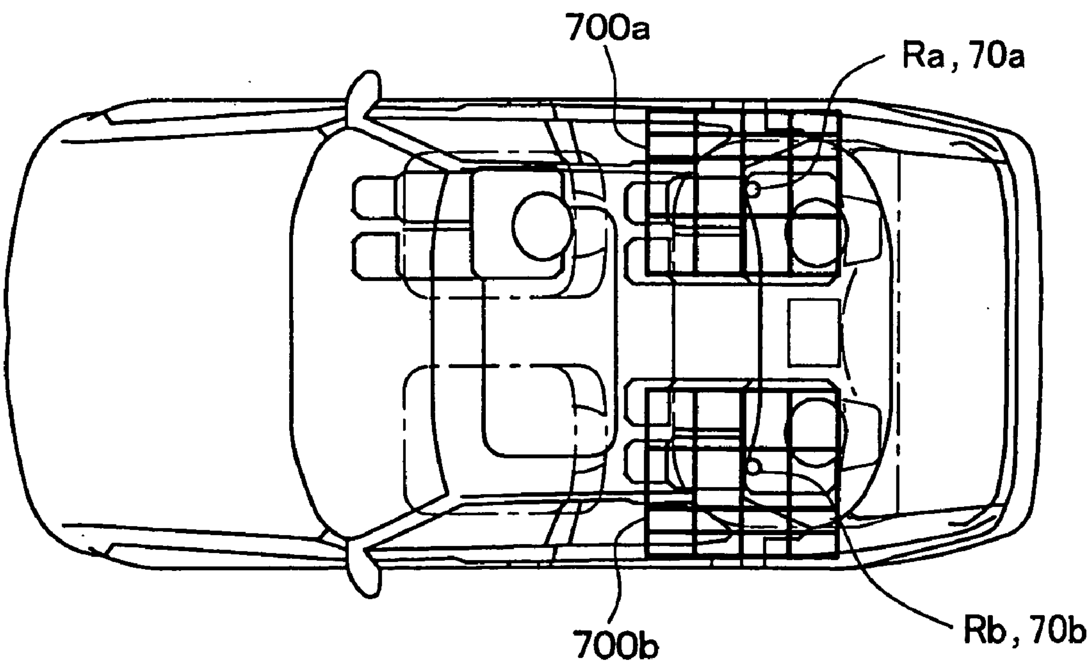


FIG. 5A

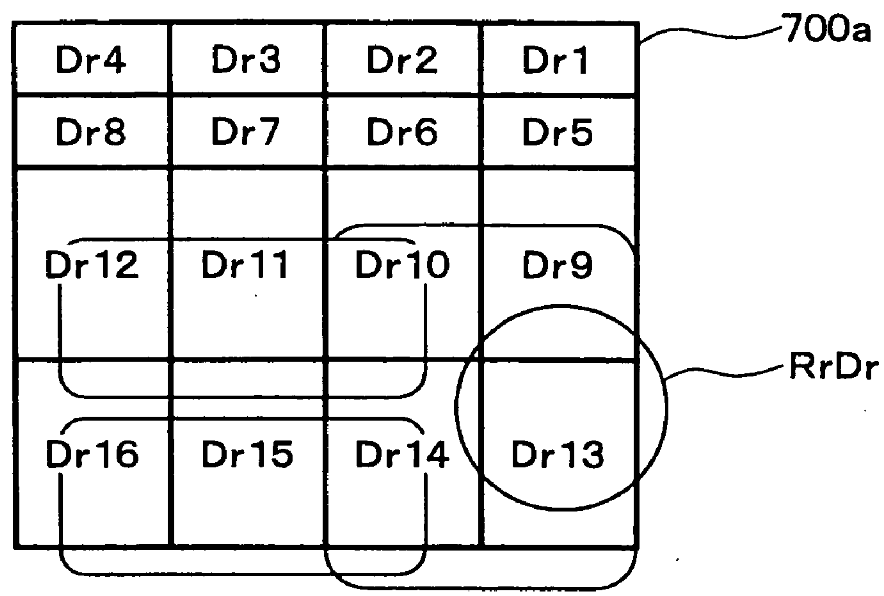

Dr4
Dr3
Dr2
Dr1
700a
Dr8
Dr7
Dr6
Dr5
Dr12
Dr11
Dr10
Dr9
RrDr
Dr16
Dr15
Dr14
Dr13

FIG. 5B

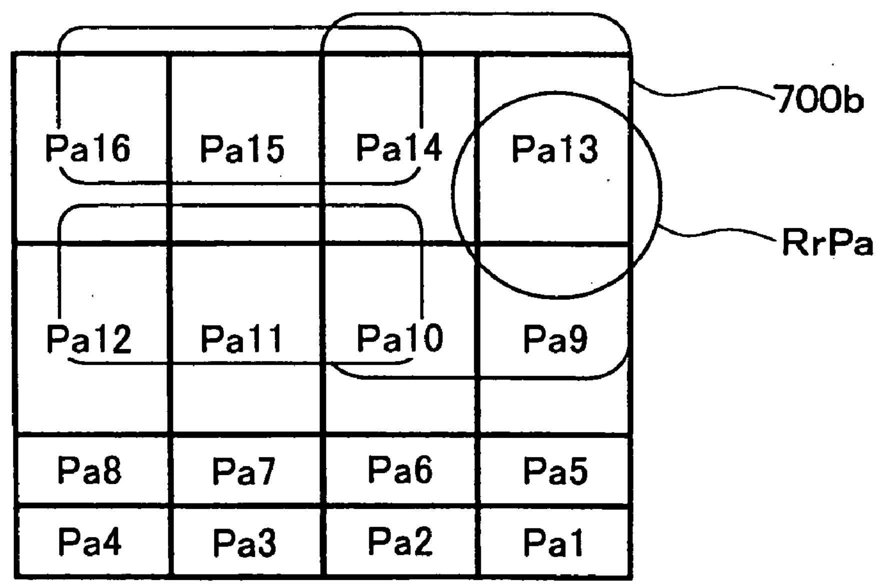

Pa16
Pa15
Pa14
Pa13
700b
RrPa
Pa12
Pa11
Pa10
Pa9
Pa8
Pa7
Pa6
Pa5
Pa4
Pa3
Pa2
Pa1

FIG. 6

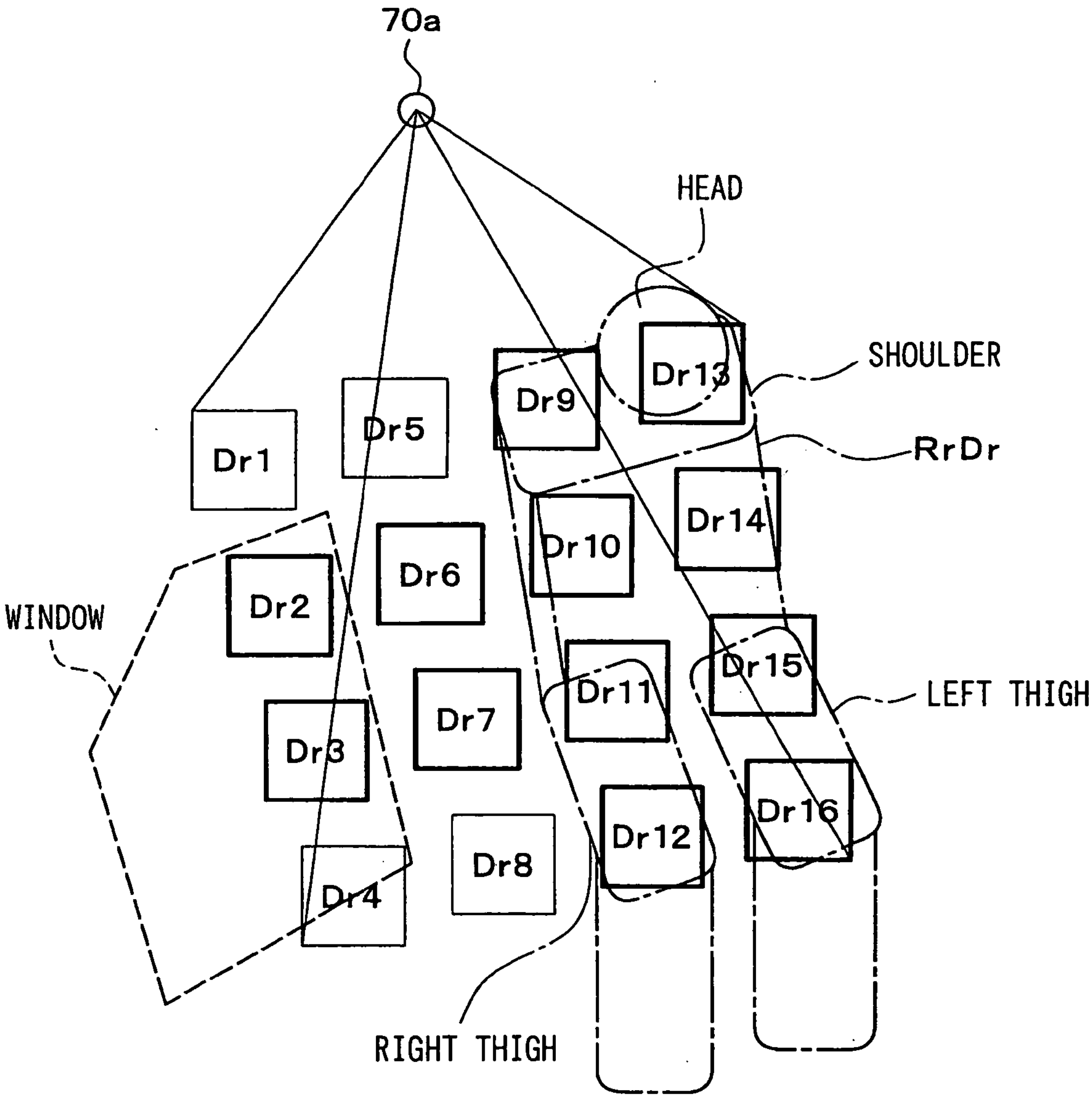

70a
HEAD
SHOULDER
RrDr
WINDOW
LEFT THIGH
RIGHT THIGH
Dr1
Dr2
Dr3
Dr4
Dr5
Dr6
Dr7
Dr8
Dr9
Dr10
Dr11
Dr12
Dr13
Dr14
Dr15
Dr16

FIG. 7A

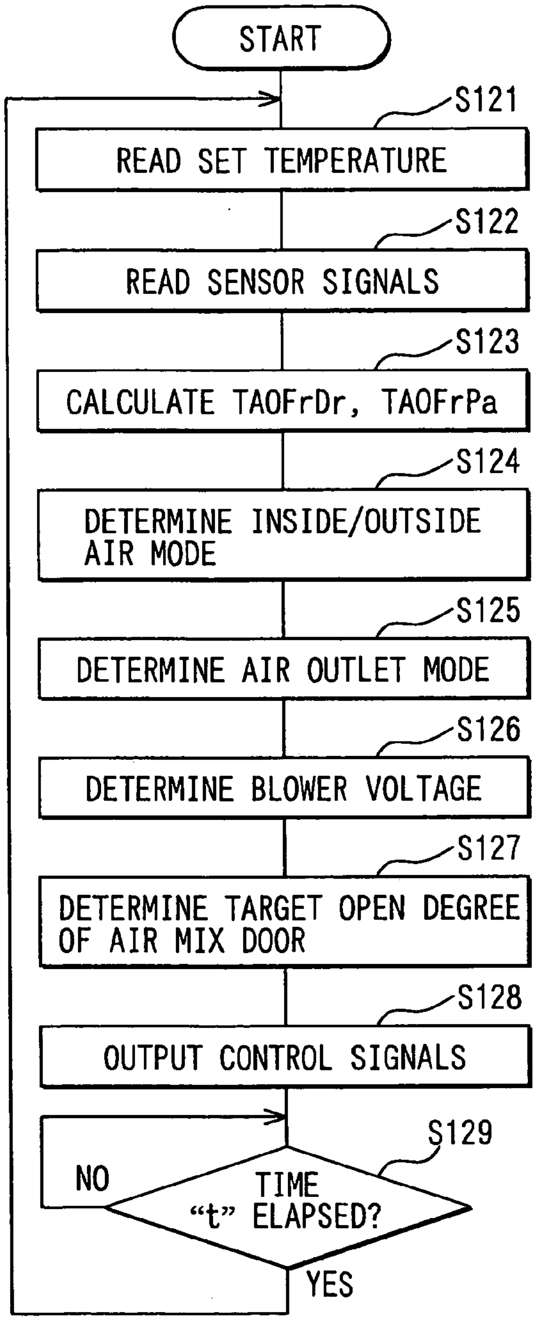

START
S121
READ SET TEMPERATURE
S122
READ SENSOR SIGNALS
S123
CALCULATE TAOFrDr, TAOFrPa
S124
DETERMINE INSIDE/OUTSIDE AIR MODE
S125
DETERMINE AIR OUTLET MODE
S126
DETERMINE BLOWER VOLTAGE
S127
DETERMINE TARGET OPEN DEGREE OF AIR MIX DOOR
S128
OUTPUT CONTROL SIGNALS
S129
TIME "t" ELAPSED?
NO
YES

FIG. 7B

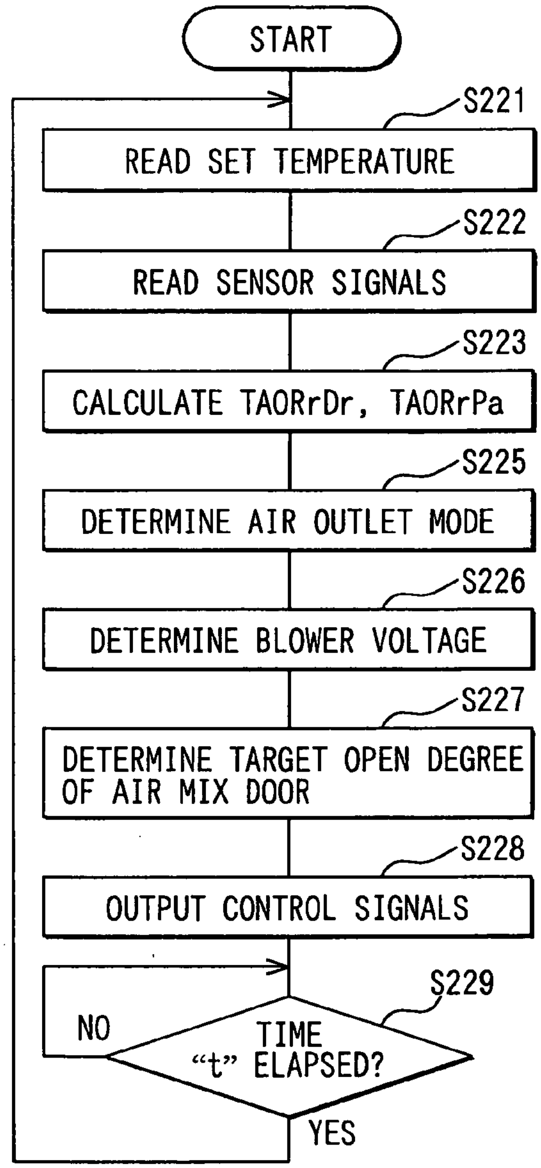

START
S221
READ SET TEMPERATURE
S222
READ SENSOR SIGNALS
S223
CALCULATE TAORrDr, TAORrPa
S225
DETERMINE AIR OUTLET MODE
S226
DETERMINE BLOWER VOLTAGE
S227
DETERMINE TARGET OPEN DEGREE OF AIR MIX DOOR
S228
OUTPUT CONTROL SIGNALS
S229
TIME "t" ELAPSED?
NO
YES

FIG. 8

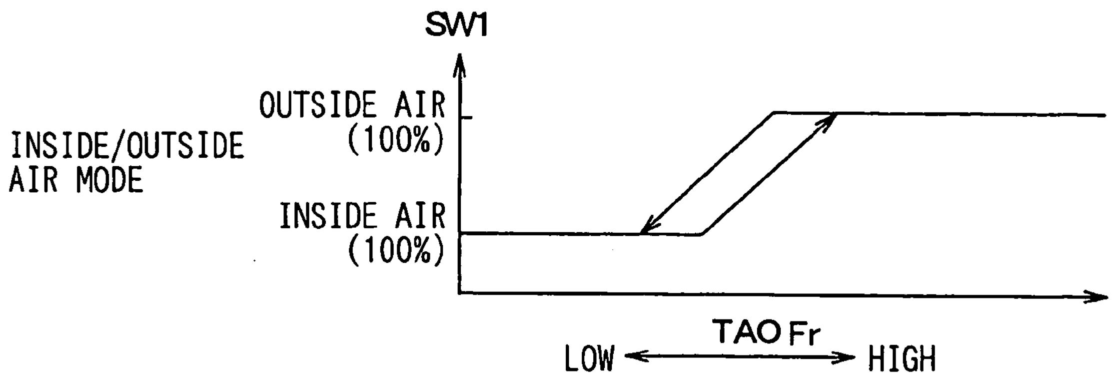


FIG. 9

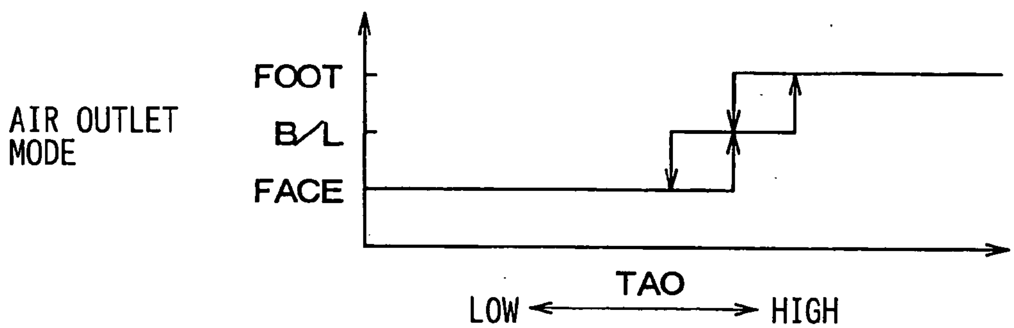


FIG. 10

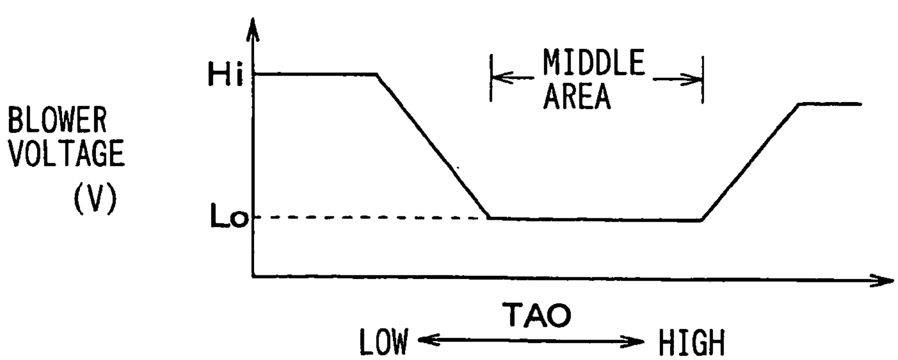


FIG. 11

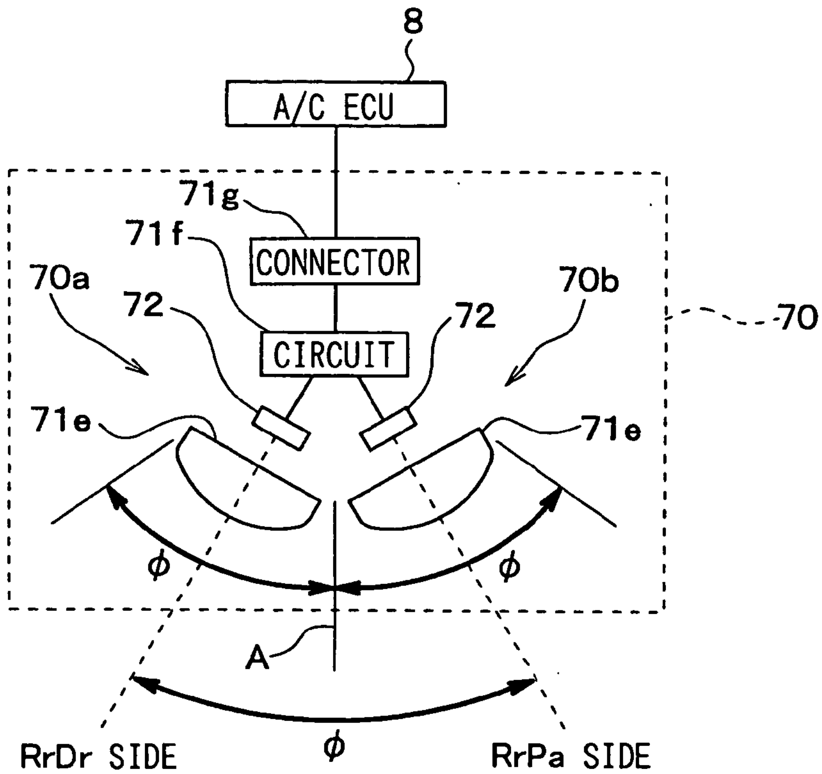

8
A/C ECU
71g
71f
CONNECTOR
70a
72
70b
72
70
CIRCUIT
71e
71e
ϕ
ϕ
A
RrDr SIDE
ϕ
RrPa SIDE

FIG. 13

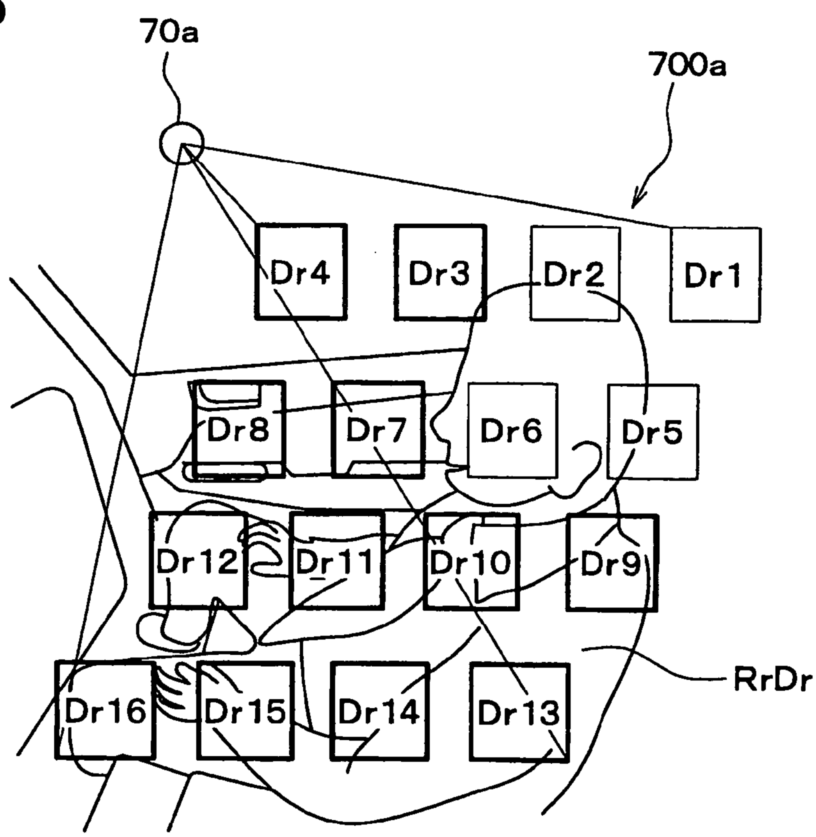

70a
700a
Dr4
Dr3
Dr2
Dr1
Dr8
Dr7
Dr6
Dr5
Dr12
Dr11
Dr10
Dr9
Dr16
Dr15
Dr14
Dr13
RrDr

FIG. 12A

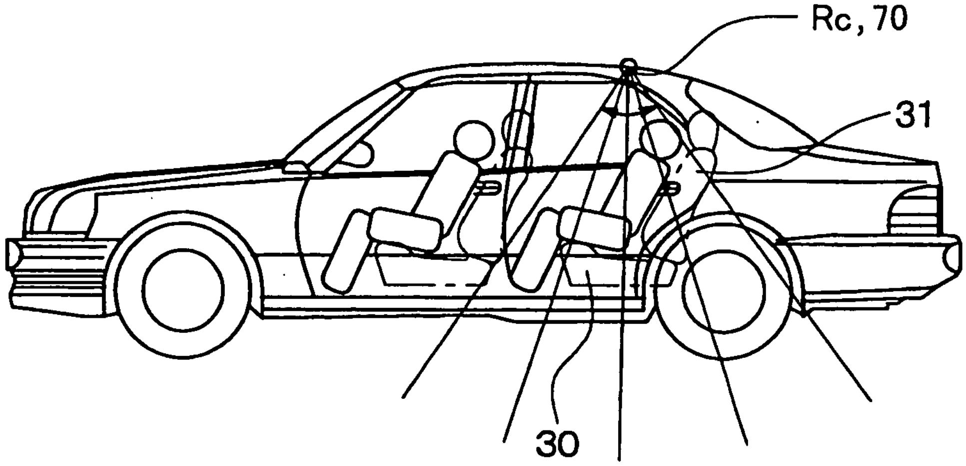


FIG. 12B

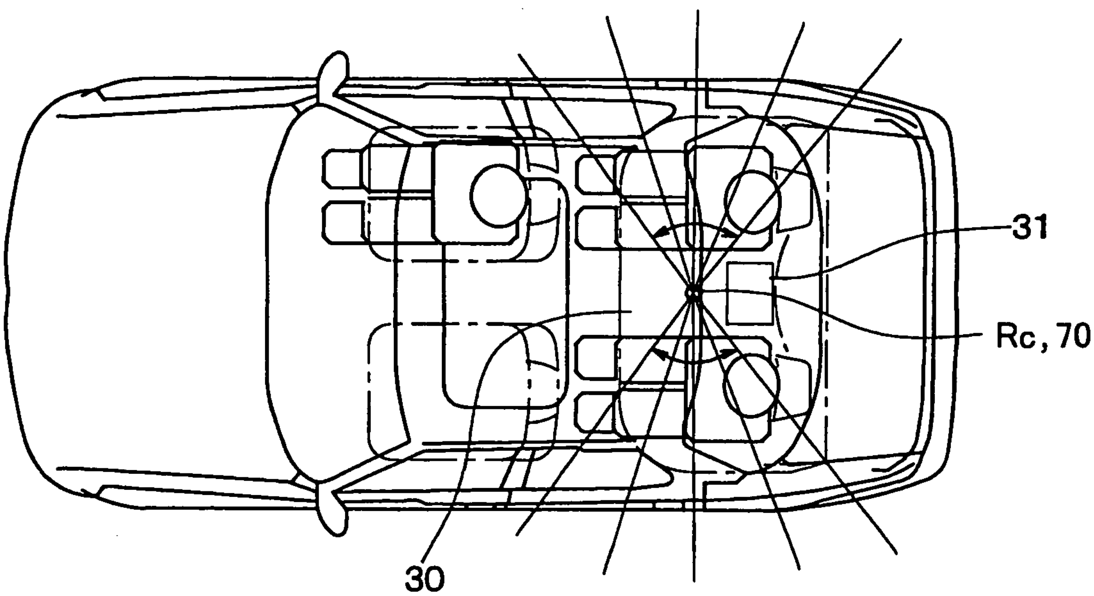


FIG. 14

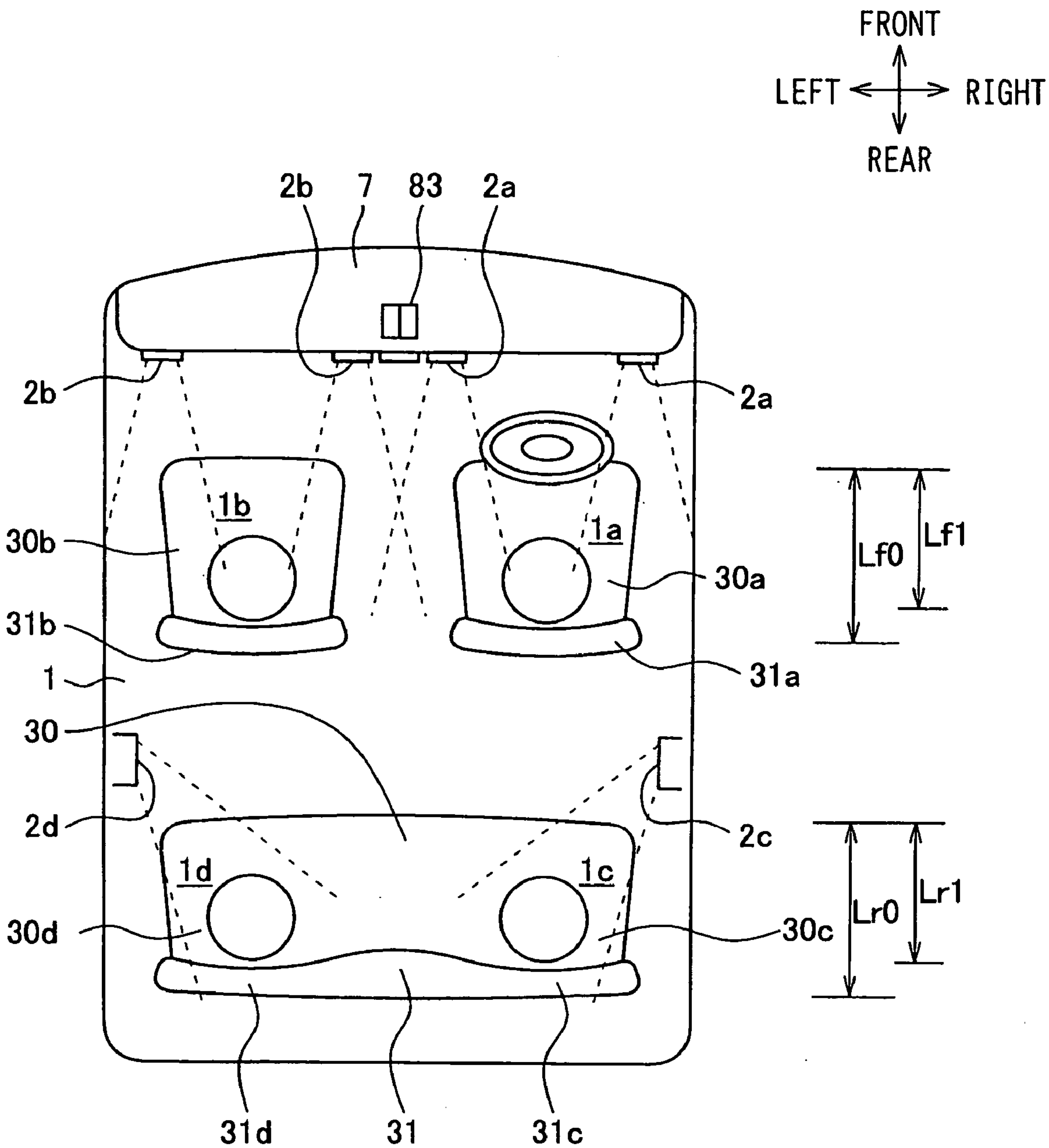

FRONT
LEFT
RIGHT
REAR
2b
7
83
2a
2b
2a
1b
1a
30b
30a
Lf0
Lf1
31b
31a
1
30
2d
2c
1d
1c
30d
30c
Lr0
Lr1
31d
31
31c

FIG. 15A

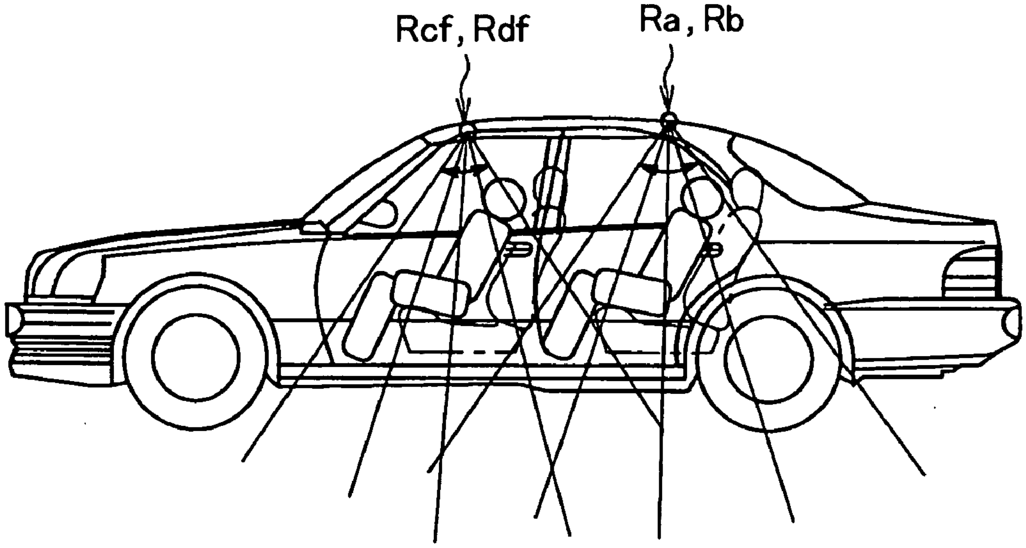


FIG. 15B

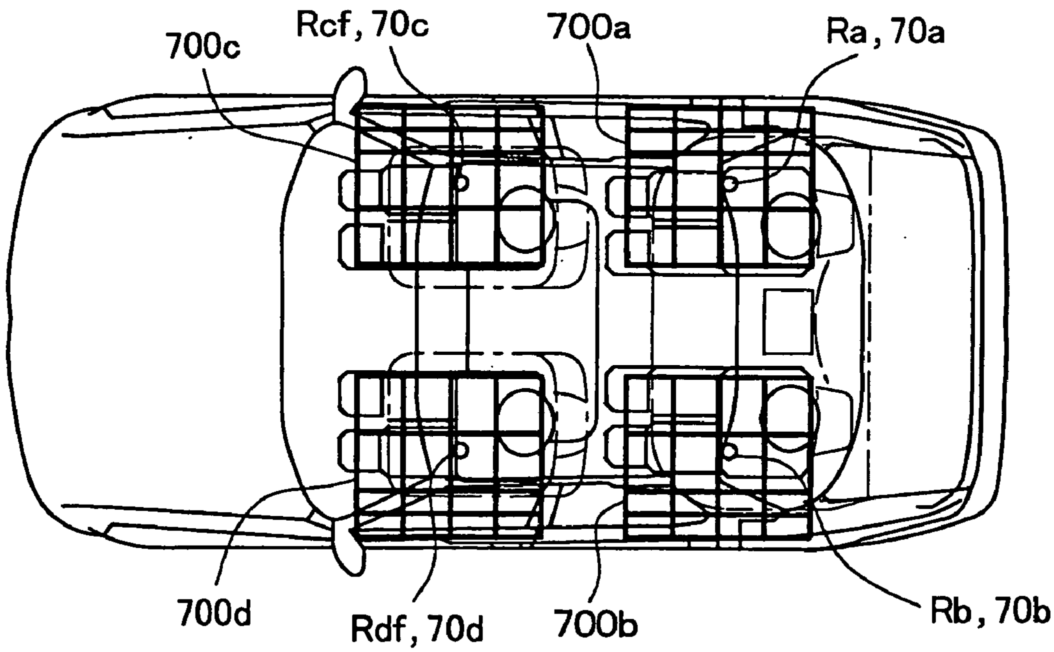


FIG. 16A

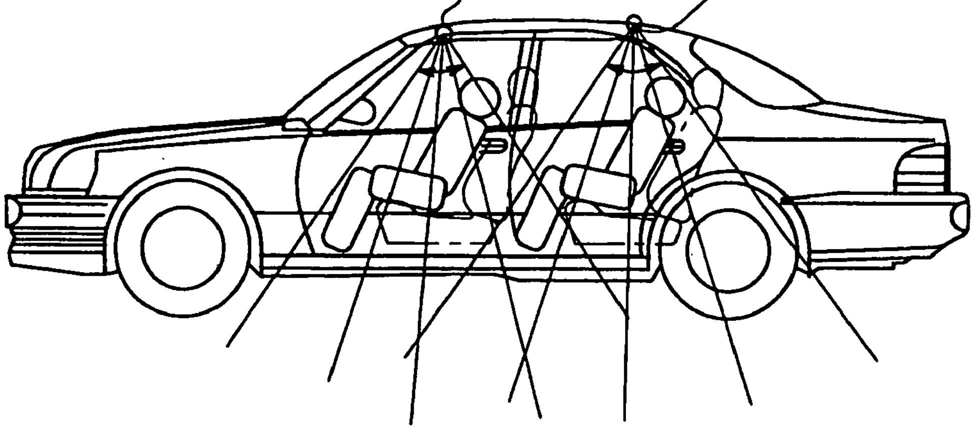


FIG. 16B

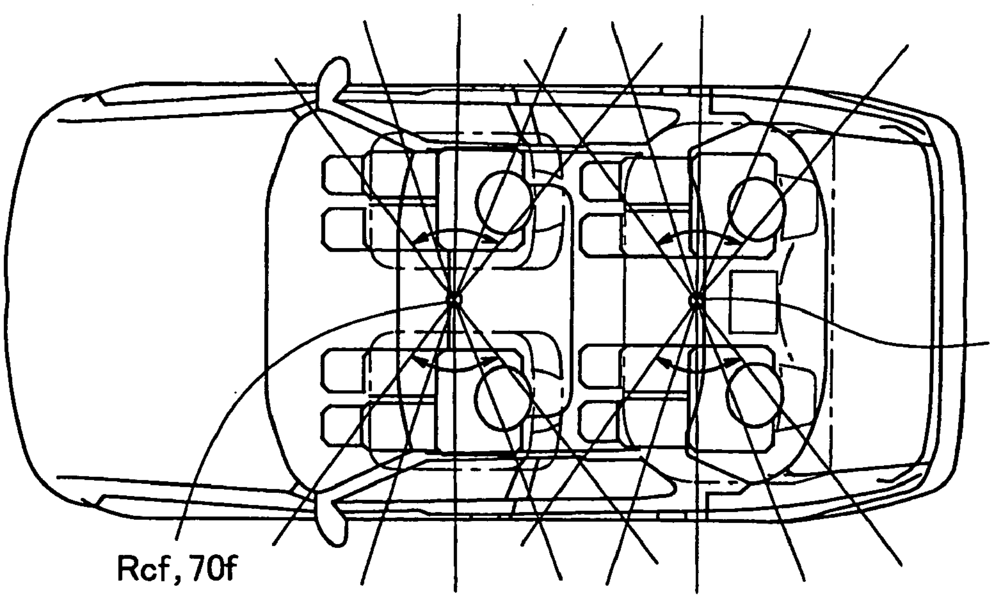


FIG. 17

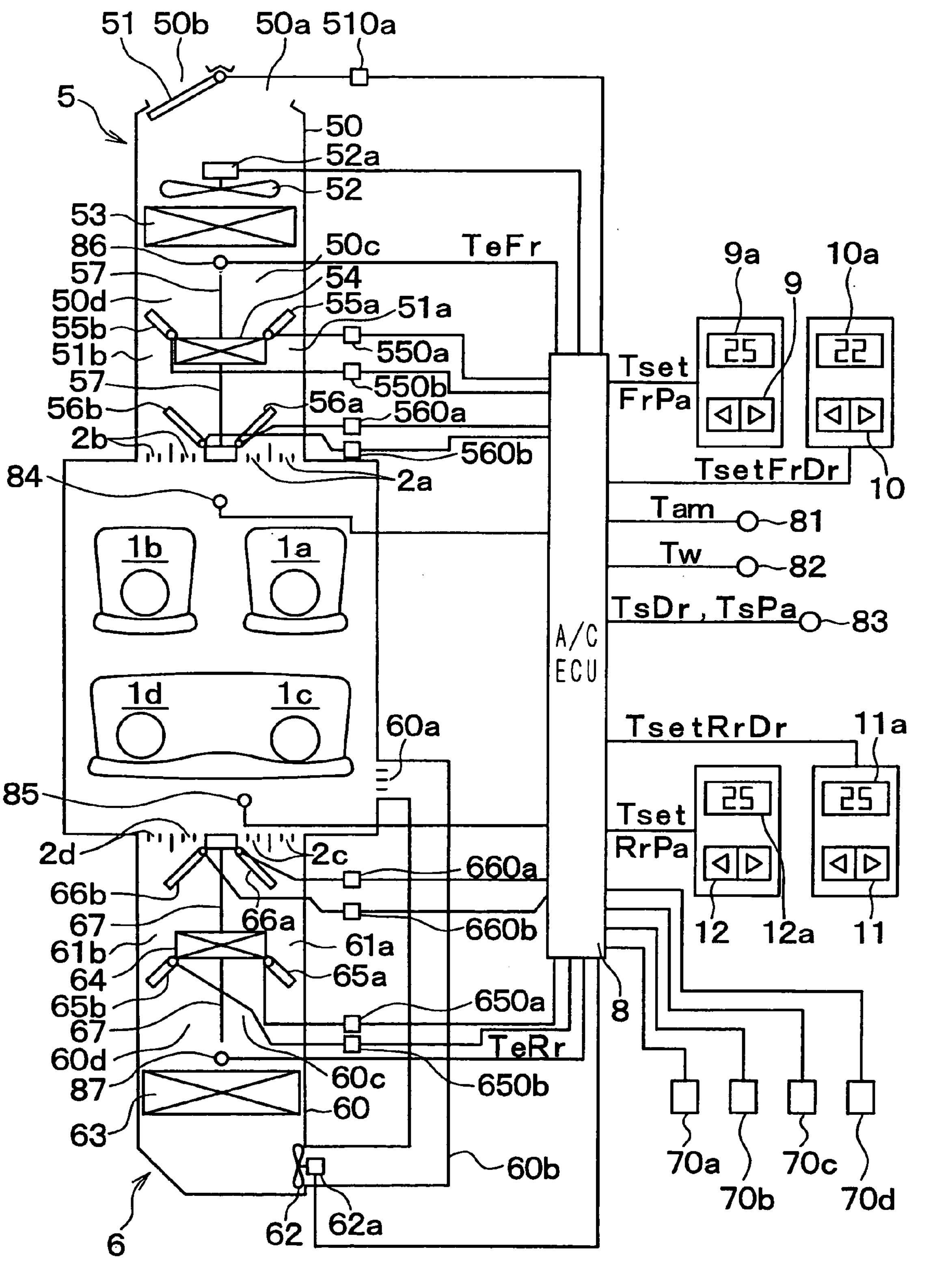

51
50b
50a
510a
5
50
52a
52
53
86
50c
TeFr
57
54
50d
55a
51a
55b
550a
51b
550b
57
Tset
FrPa
56a
56b
560a
2b
560b
2a
84
9a
9
10a
25
22
TsetFrDr
10
Tam
81
Tw
82
TsDr , TsPa
83
1b
1a
1d
1c
A/C
ECU
60a
TsetRrDr
11a
85
Tset
RrPa
25
25
2d
2c
660a
66b
67
66a
660b
61b
61a
12
12a
11
64
65a
65b
650a
67
TeRr
8
60d
87
60c
650b
63
60
70a
70b
70c
70d
60b
6
62
62a

FIG. 18

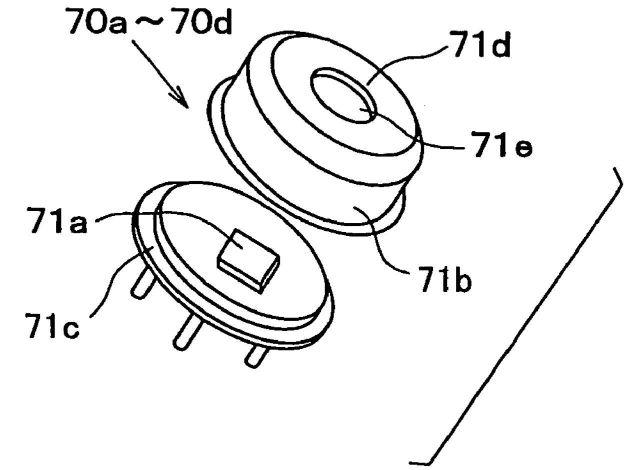


FIG. 19

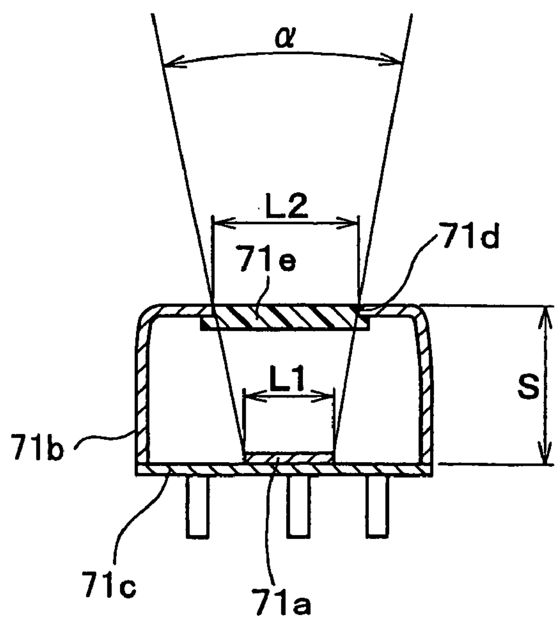


FIG. 20A

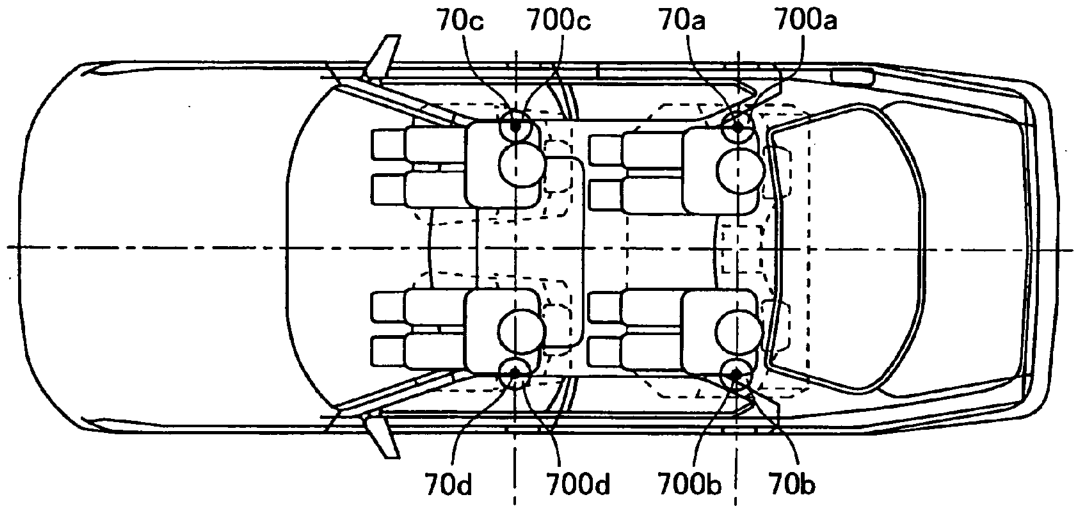


FIG. 20B

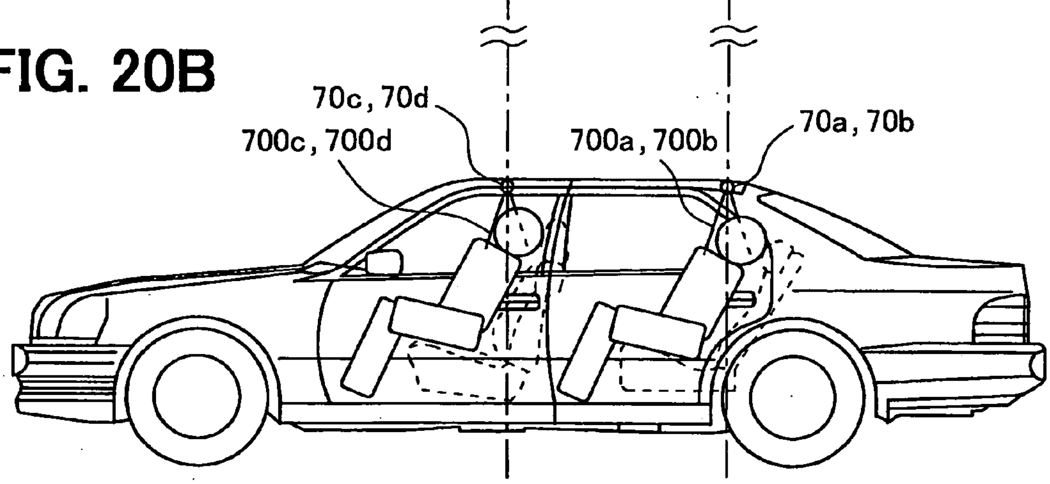


FIG. 21

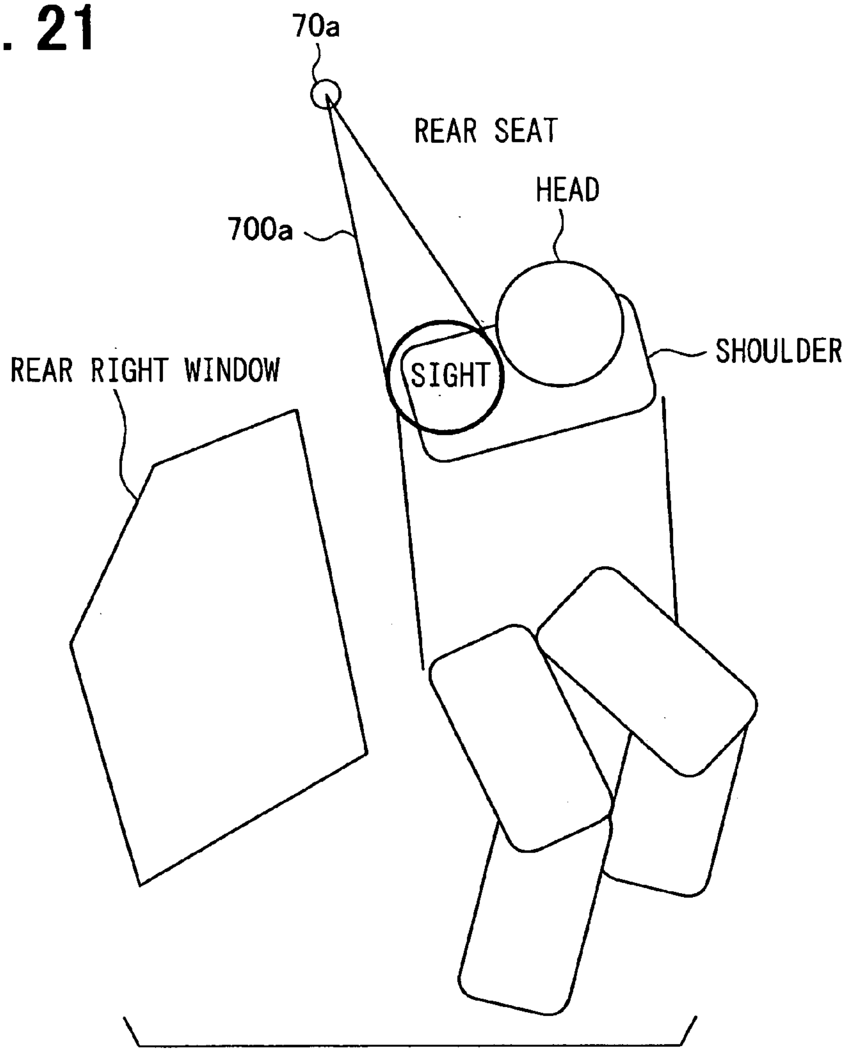

70a
REAR SEAT
HEAD
700a
SHOULDER
REAR RIGHT WINDOW
SIGHT

FIG. 22

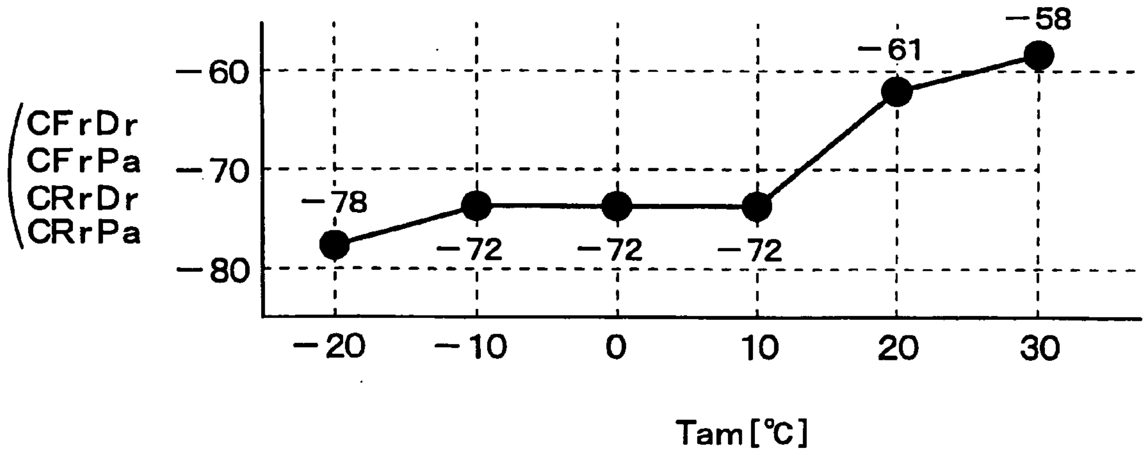

−58
−61
−60
−70
−80
CFrDr
CFrPa
CRrDr
CRrPa
−78
−72
−72
−72
−20
−10
0
10
20
30
Tam[℃]

FIG. 23

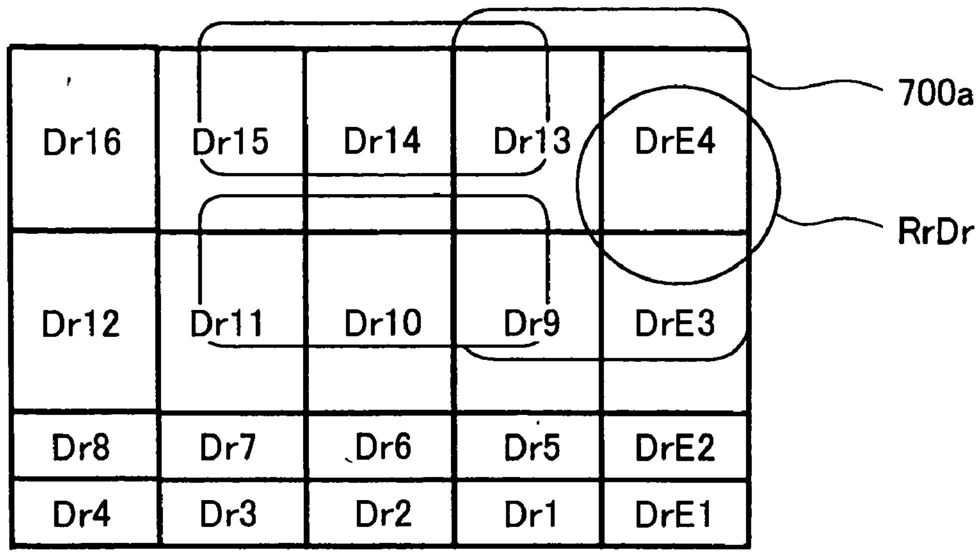

Dr16
Dr15
Dr14
Dr13
DrE4
Dr12
Dr11
Dr10
Dr9
DrE3
Dr8
Dr7
Dr6
Dr5
DrE2
Dr4
Dr3
Dr2
Dr1
DrE1
700a
RrDr

FIG. 24

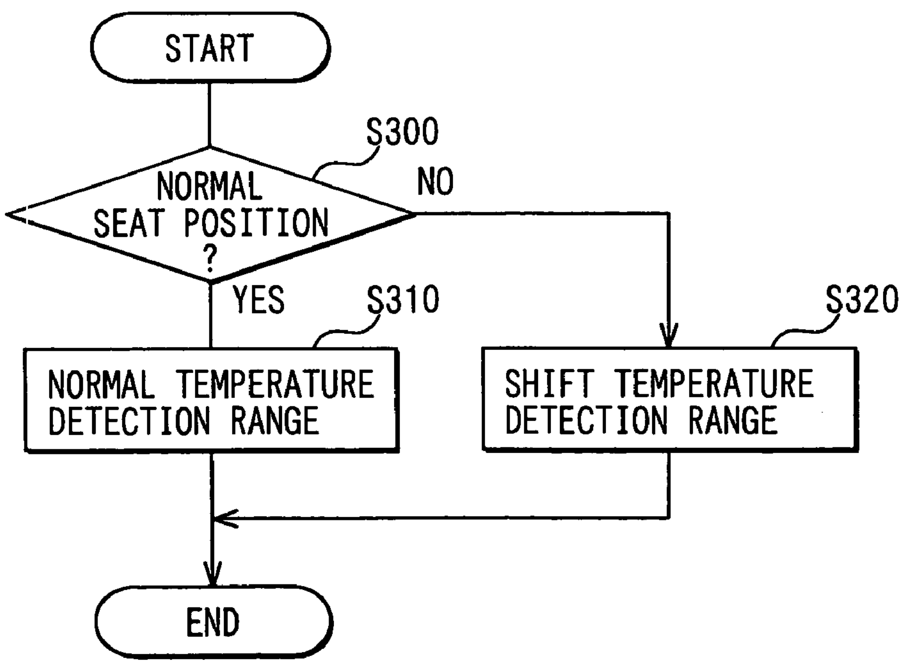

START
S300
NORMAL SEAT POSITION ?
NO
YES
S310
S320
NORMAL TEMPERATURE DETECTION RANGE
SHIFT TEMPERATURE DETECTION RANGE
END

FIG. 25A

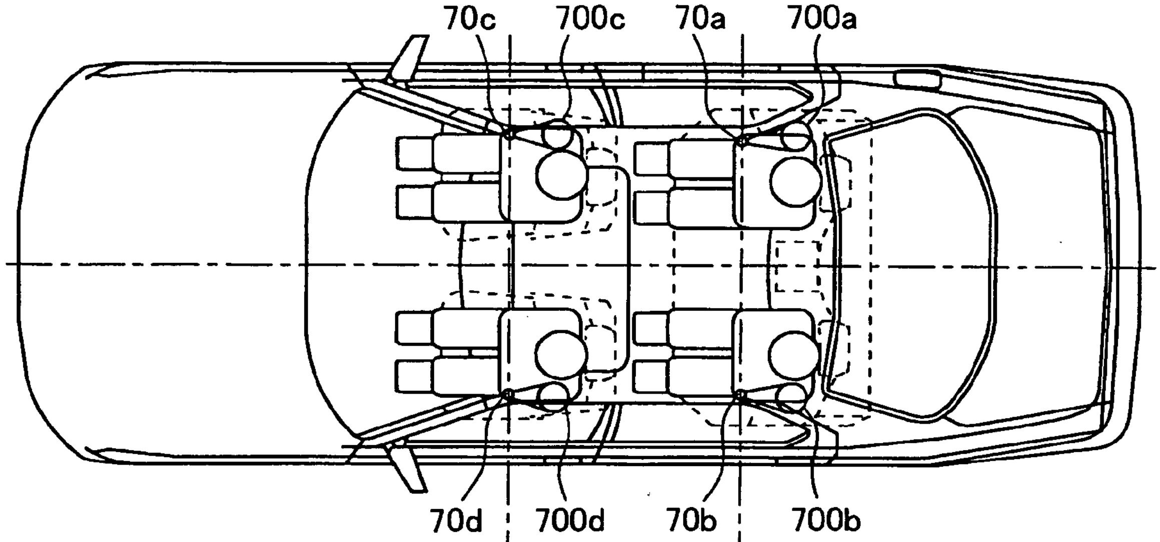


FIG. 25B

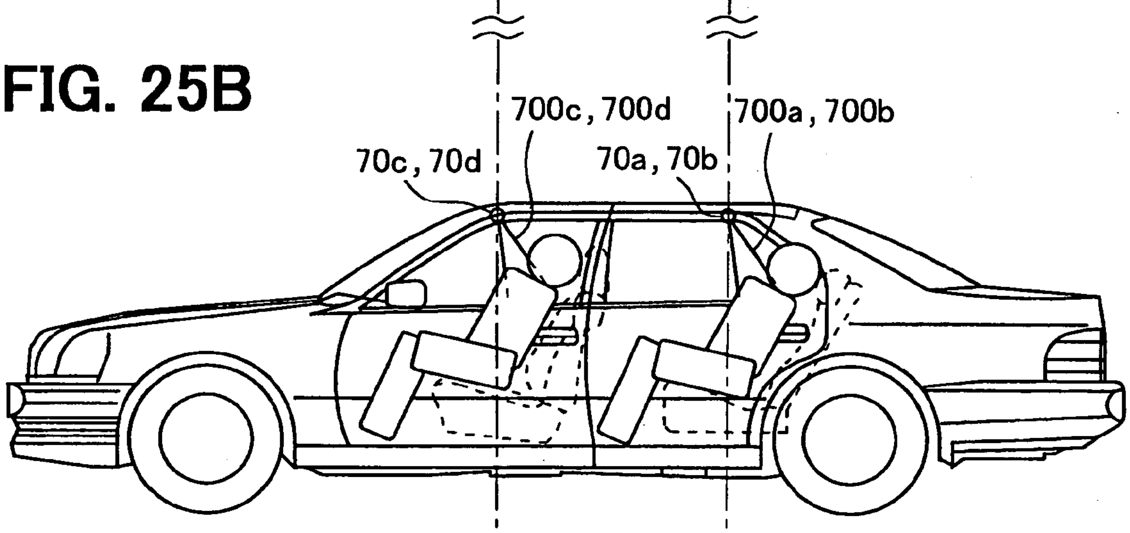


FIG. 26A

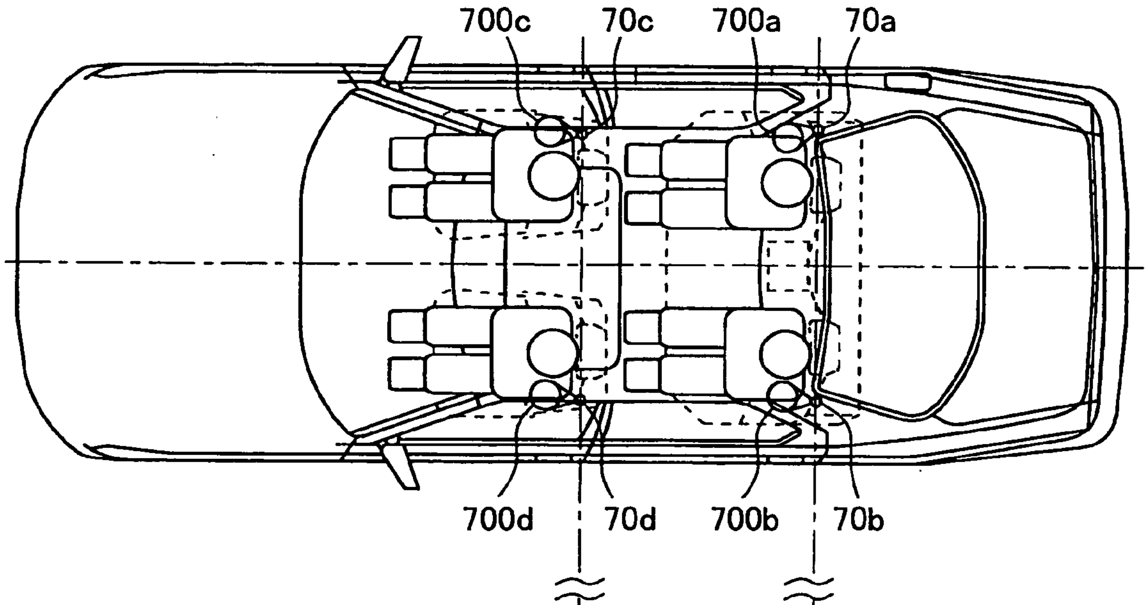


FIG. 26B

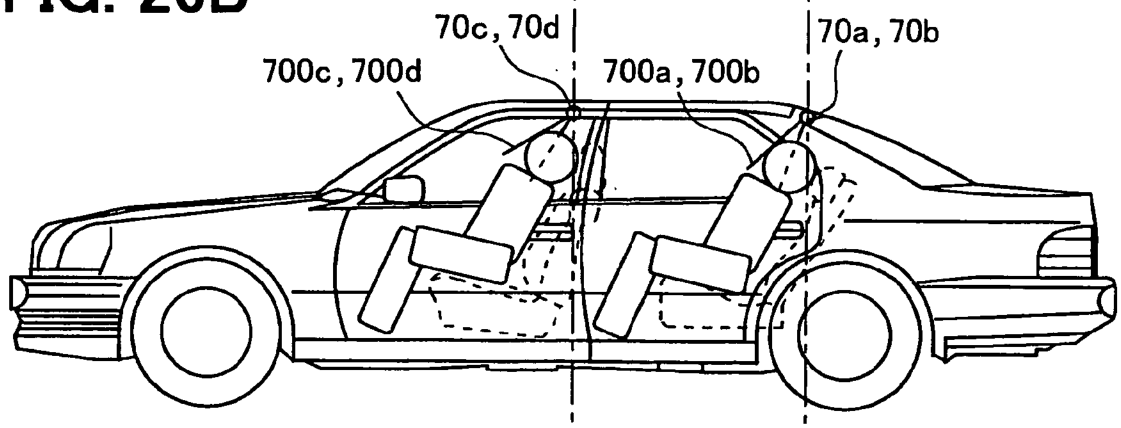


FIG. 27A

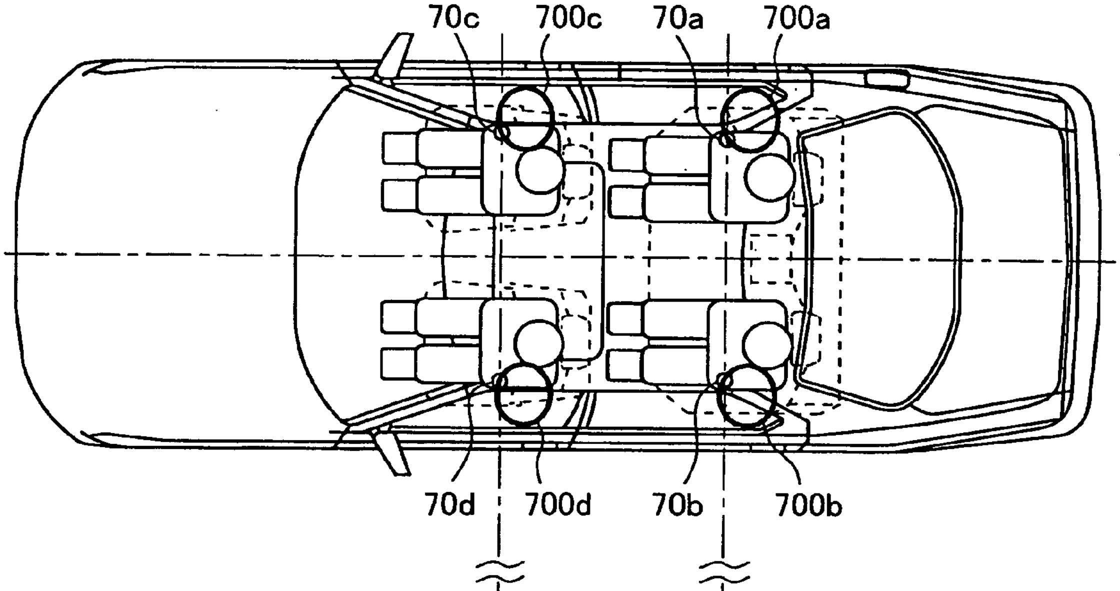


FIG. 27B

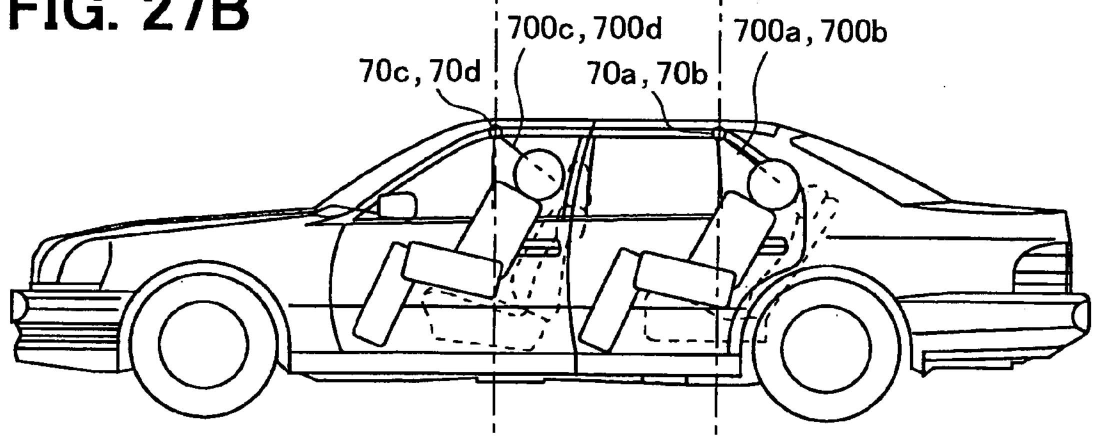


FIG. 28A

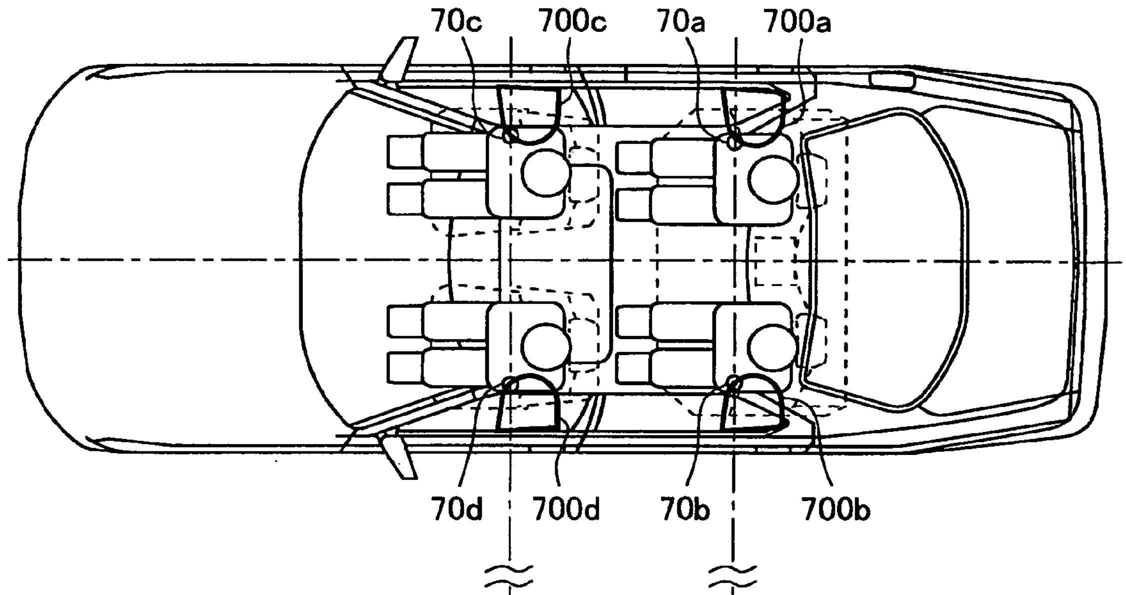
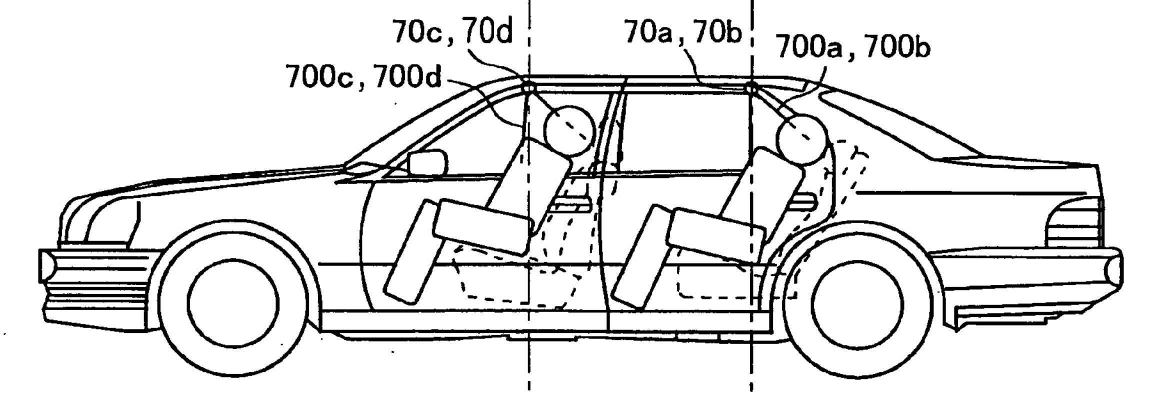


FIG. 28B



TEMPERATURE DETECTION DEVICE AND VEHICLE AIR CONDITIONER USING THE SAME

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is based on Japanese Patent Applications No. 2003-379551 filed on Nov. 10, 2003, and No. 2004-120337 filed on Apr. 15, 2004, the disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to a temperature detection device and a vehicle air conditioner having a non-contact temperature sensor which detects a surface temperature of a passenger of a passenger compartment in non-contact. More particularly, the present invention relates to a vehicle air conditioner which controls an air conditioning state in the passenger compartment in accordance with the surface temperature detected by the non-contact temperature sensor.

BACKGROUND OF THE INVENTION

[0003] In a conventional air conditioning system described in U.S. Pat. No. 6,550,686, a matrix IR sensor is arranged in a passenger compartment to detect a temperature distribution on the face portion of a driver or a passenger. However, in this system, because the matrix IR sensor is attached to a ceiling portion around a rearview mirror, the surface temperature of the passenger is slantingly detected from a front upper side. In this case, a temperature detection range of the IR matrix sensor may be offset from a passenger's area to be detected.

[0004] In a system described in JP-A-2-158412, a rear IR sensor used as a non-contact temperature sensor is disposed at a back portion of a front seat to detect a surface temperature of a passenger on a rear seat. However, in this case, the rear IR sensor may not stably detect the surface temperature of the passenger on the rear seat in accordance with a front seat position or the passenger's seating position on the rear seat.

SUMMARY OF THE INVENTION

[0005] In view of the above-described problems, it is an object of the present invention to provide a temperature detection device and a vehicle air conditioner having a non-contact temperature sensor (IR sensor), which can prevent a target object to be temperature-detected from being shifted from a temperature detection range of the non-contact temperature sensor.

[0006] It is another object of the present invention to provide a temperature detection device and a vehicle air conditioner having a non-contact temperature sensor which can stably detect a surface temperature of a passenger regardless a seat position or a passenger's seating position.

[0007] According to the present invention, a temperature detection device for a vehicle air conditioner includes a non-contact temperature sensor having a plurality of temperature detection elements for detecting surface temperatures of a plurality of temperature detection ranges in a vicinity of at least one of seats of a passenger compartment in non-contact. Generally, the non-contact temperature sensor is disposed to detect a surface temperature of a passenger seated on the one seat and to send a detected temperature signal to the air conditioner. In the temperature detection device, the non-contact temperature sensor is provided in a ceiling portion of the passenger compartment in an arrangement area of the ceiling portion between a front end and a rear end of the one seat in a vehicle front-rear direction. That is, the arrangement area of the non-contact temperature sensor on the ceiling portion is a vertically projecting area of the one seat between the front end and the rear end in the vehicle front-rear direction. Accordingly, the temperature detection elements of the non-contact temperature sensor detect the surface temperature downwardly from a direct upper side of the passenger. Thus, a position change of the shoulder portion and the thigh port of the passenger on the temperature detection range of the non-contact temperature sensor can be made smaller. As a result, each position of the passenger can be stably detected by using the non-contact temperature sensor.

[0008] Preferably, the arrangement area is an area of the ceiling portion between a frontmost end of a seat cushion portion of the one seat to a rearmost end of a seat back portion of the one seat, and the non-contact temperature sensor has a sight center line that is substantially perpendicular to the vehicle front-rear direction. Generally, the sight center line of the non-contact temperature sensor is in a range $-2°$ and $+2°$ of a vertical line perpendicular to the front-rear direction.

[0009] More preferably, the arrangement area is an area of the ceiling portion between a frontmost end and a rearmost end of the seat cushion portion of the one seat. In this case, because the non-contact temperature sensor views the passenger on the seat downwardly from a direct upper side of the passenger, the temperature detection ranges of the non-contact temperature sensor readily contain the passenger on the one seat.

[0010] For example, the temperature detection elements of the non-contact temperature sensor are arranged to detect surface temperatures of at least the shoulder portion and the thigh portion of the passenger on the one seat. Alternatively, the temperature detection elements of the non-contact temperature sensor are arranged to detect a surface temperature of a passenger on the one seat, a surface temperature of a side window adjacent to the passenger, and a surface temperature of a trim panel between the passenger and the side window.

[0011] The one seat can be a front seat having right and left seat portions or a rear seat having right and left seat portions in the passenger compartment. In this case, the non-contact temperature sensor includes a right matrix IR sensor having a plurality of right temperature detection elements which are arranged such that temperature detection ranges of the right temperature detection elements include at least a passenger on the right seat portion of the one seat, and a left matrix IR sensor having a plurality of left temperature detection elements which are arranged such that temperature detection ranges of the left temperature detection elements include at least a passenger on the left seat portion of the one seat. More preferably, the right matrix IR sensor is provided in the ceiling portion above the right seat portion, and the left matrix IR sensor is provided in the ceiling portion above the left seat portion. Still more preferably, the right matrix IR sensor is provided in the ceiling portion at a position shifted from a center of the right seat portion to a side window adjacent to the right seat portion in a vehicle width direction.

[0012] Further, the right matrix IR sensor can be provided in the ceiling portion above a seat cushion portion of the right seat portion, and the left matrix IR sensor can be provided in the ceiling portion above a seat cushion portion of the left seat portion. Alternatively, the right matrix IR sensor and the left matrix IR sensor can be arranged in the ceiling portion adjacent to each other in an approximate center position in the vehicle width direction.

[0013] When the temperature detection device is used for a vehicle air conditioner including an air conditioning unit which adjusts an air conditioning state in the passenger compartment and a control unit for controlling operation of the air conditioning unit, the control unit calculates a target temperature of air to be blown into the passenger compartment based on the surface temperature of a passenger detected by the non-contact temperature sensor, and controls the air conditioning unit based on the target temperature. In this case, an air conditioning operation comfortable to the passenger can be performed.

[0014] More preferably, the control unit calculates a passenger's temperature on the one seat by a weighting calculation of the surface temperature of the passenger on the seat, a surface temperature of a side window adjacent to the passenger, and a surface temperature of a trim panel between the passenger and the side window, which are detected by the non-contact temperature sensor. Further, the control unit calculates the target temperature based on the passenger's temperature obtained by the weighting calculation. Therefore, the target temperature, in which the solar radiation reflected to the passenger from the side window is also considered, can be calculated, and comfortable air-conditioning can be provided.

[0015] More preferably, the weighting calculation has a first weighting coefficient relative to the surface temperature of the passenger, a second weighting coefficient relative to the surface temperature of the side window, and a third weighting coefficient relative to the surface temperature of the trim panel. In this case, the first weighting coefficient is the largest value among the first, second and third weighting coefficients, and the second coefficient is the smallest value among the first, second and third weighting coefficients.

[0016] According to the present invention, the non-contact temperature sensor is provided above a passenger's seating position of the one seat at a side of a side window adjacent to the passenger's seating position from a center of the passenger's seating position, the non-contact temperature sensor has a predetermined temperature detection range which includes at least an upper portion of the shoulder of the passenger on the side of the side window, and the air conditioner has a control unit which controls an air conditioning state of the passenger compartment based on the temperature detected by the non-contact temperature sensor. Here, the shoulder portion includes the portion of the clavicle on the front of the body and the portion of the scapula on the rear of the body. Accordingly, the surface temperature of the passenger can be stably detected regardless a seat position or a passenger's seating position.

[0017] In this case, the non-contact temperature sensor can be provided above the passenger's seating position of the one seat at a front side in the passenger's seating position. Alternatively, the non-contact temperature sensor can be provided above the passenger's seating position of the one seat at a rear side in the passenger's seating position.

[0018] Further, the temperature detection range of the non-contact temperature sensor can include the upper portion of the shoulder adjacent to the side window and a trim panel portion around the side window. Alternatively, the temperature detection range of the non-contact temperature sensor includes the upper portion of the shoulder adjacent to the side window and the side window. Alternatively, the temperature detection range of the non-contact temperature sensor includes the upper portion of the shoulder at a side end of the face portion of the passenger. That is, the temperature detection range of the non-contact temperature sensor is set to include the upper portion of the shoulder while without including the face portion of the passenger.

[0019] Preferably, the temperature detection ranges to be used are shifted in accordance with positions of the seats in the vehicle front-rear direction. Accordingly, even when the seat positions are shifted in the vehicle front-rear direction, the surface temperature of the passenger can be always stably detected.

[0020] Further, the present invention can be suitably used for an air conditioner having an air conditioning unit for respectively independently adjusting air conditioning states of first and second air conditioning zones positioned at right and left sides of a front seat in the passenger compartment, and third and fourth air conditioning zones positioned at right and left sides of a rear seat in the passenger compartment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Other objects, features and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings, in which:

[0022] **FIG. 1** is a schematic diagram showing an air blowing-out port arrangement and a seat arrangement in a passenger compartment according to a first embodiment of the present invention;

[0023] **FIG. 2** is a schematic diagram showing an entire structure of a vehicle air conditioner according to the first embodiment;

[0024] **FIG. 3** is a view showing a structure of a matrix IR sensor (non-contact temperature sensor) according to the first embodiment;

[0025] **FIGS. 4A and 4B** are a side view and a top view showing arrangement positions of right and left matrix IR sensors, according to the first embodiment;

[0026] **FIGS. 5A and 5B** are schematic diagrams showing temperature detection ranges of the right and left matrix IR sensors, according to the first embodiment;

[0027] **FIG. 6** is a view showing the temperature detection range of the right matrix IR sensor, according to the first embodiment;

[0028] **FIG. 7A** is a flow diagram for performing a front air conditioning control of an air conditioning controller, and

FIG. 7B is a flow diagram for performing a rear air conditioning control of the air conditioning controller;

[0029] **FIG. 8** is a graph showing a control map for determining an inside/outside air introduction mode in the front air conditioning control in **FIG. 7A**;

[0030] **FIG. 9** is a graph showing a control map for determining an air outlet mode in the front air conditioning control in **FIG. 7A** and in the rear air conditioning control in **FIG. 7B**;

[0031] **FIG. 10** is a graph showing a control map for determining a blower voltage in the front air conditioning control in **FIG. 7A** and in the rear air conditioning control in **FIG. 7B**;

[0032] **FIG. 11** is a schematic diagram showing a non-contact temperature sensor having right and left matrix IR sensors according to a second embodiment of the present invention;

[0033] **FIGS. 12A and 12B** are a side view and a top view showing an arrangement position of the non-contact temperature sensor having the right and left matrix IR sensors, according to the second embodiment;

[0034] **FIG. 13** is a view showing the temperature detection range of the right matrix IR sensor, according to the second embodiment;

[0035] **FIG. 14** is a schematic diagram for explaining arrangement areas of matrix IR sensors, according to a third preferred embodiment of the present invention;

[0036] **FIGS. 15A and 15B** are a side view and a top view showing arrangement positions of the matrix IR sensors, according to the third embodiment;

[0037] **FIGS. 16A and 16B** are a side view and a top view showing arrangement positions of front and rear non-contact temperature sensors each having right and left matrix IR sensors, according to a fourth preferred embodiment of the present invention;

[0038] **FIG. 17** is a schematic diagram showing an entire structure of a vehicle air conditioner according to a fifth embodiment of the present invention;

[0039] **FIG. 18** is a disassembled perspective view showing a structure of an IR sensor (non-contact temperature sensor) according to the fifth embodiment;

[0040] **FIG. 19** is a schematic cross-sectional view showing the non-contact temperature sensor according to the fifth embodiment;

[0041] **FIGS. 20A and 20B** are a top view and a side view showing arrangement positions of the non-contact temperature sensors according to the fifth embodiment;

[0042] **FIG. 21** is a schematic perspective view showing an example of a temperature detection range of the non-contact temperature sensor according to the fifth embodiment;

[0043] **FIG. 22** is a graph showing a correction map of correction coefficients (CFrDr, CFrPa, CRrDr, CRrPa) in accordance with an outside air temperature (Tam), according to the fifth embodiment;

[0044] **FIG. 23** is a view showing a shifted temperature detection range of a non-contact temperature sensor according to a modification of the present invention;

[0045] **FIG. 24** is a flow diagram showing a control operation for selecting temperature detection areas in accordance with a seat position in a vehicle front-rear direction, according to the modification;

[0046] **FIGS. 25A and 25B** are a top view and a side view showing arrangement positions of non-contact temperature sensors according to another modification of the fifth embodiment;

[0047] **FIGS. 26A and 26B** are a top view and a side view showing arrangement positions of non-contact temperature sensors according to a further another modification of the fifth embodiment;

[0048] **FIGS. 27A and 27B** are a top view and a side view showing arrangement positions of non-contact temperature sensors according to a further another modification of the fifth embodiment; and

[0049] **FIGS. 28A and 28B** are a top view and a side view showing arrangement positions of non-contact temperature sensors according to a further another modification of the fifth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0050] (First Embodiment)

[0051] The first embodiment of the present invention will be now described with reference to **FIGS. 1-10**. In the first embodiment, the present invention is typically applied to an air conditioner for a vehicle for independently controlling each of air-conditioning operations of air conditioning zones **1***a*, **1***b*, **1***c*, **1***d* located leftward and rightward on the front seat side and located leftward and rightward on the rear seat side within a vehicle compartment interior **1** (passenger compartment).

[0052] **FIG. 1** is a schematic diagram showing the arrangement of the air conditioning zones **1***a*, **1***b*, **1***c*, **1***d*. The air conditioning zone **1***a* is located on the right-hand side in the front seat air conditioning zone. The air conditioning zone **1***b* is located on the left-hand side in the front seat air conditioning zone. The air conditioning zone **1***c* is located on the right-hand side in the rear seat air conditioning zone. The air conditioning zone **1***d* is located on the left-hand side in the rear seat air conditioning zone. The arrows of **FIG. 1** show front, rear, left and right directions of the vehicle. **FIGS. 1 and 2** show a vehicle state having a right steering wheel. Therefore, the air conditioning zone **1***a* is a driver's seat side zone, and the air conditioning zone **1***b* is a front-passenger's seat side zone. A front right seat **1***as*, a front left seat **1***bs*, a rear right seat **1***cs* and a rear left seat **1***ds* are placed in the air conditioning zones **1***a*, **1***b*, **1***c* and **1***d*, respectively.

[0053] Further, in **FIG. 1**, Lr**0** indicates a rear seat moving range in a vehicle front-rear direction (vehicle forward-backward direction). Seat position adjusting mechanisms are provided in the front right seat **1***as* and the front left seat **1***bs* to change seat positions in a accordance with a passenger's frame. In addition, as shown in **FIG. 2**, seat position detection units **1**_ap_, **1**_bp_ and **1**_cp_ are disposed to detect fixed positions of the seats **1**_as_, **1**_bs_, **1**_cs_ and **1**_ds_ after being moved.

[**0054**] As shown in **FIG. 1**, the rear seat includes a seat cushion portion **30** for supporting the buttock portion of the passenger on the rear seat, and a seat back portion **31** for supporting the back portion of the passenger on the rear seat. The seat cushion portion **30** contacting the buttock portion of the passenger includes right and left seat cushions **30**_c_, **30**_d_, and the seat back portion **31** contacting the back portion of the passenger includes right and left seat backs **31**_c_, **31**_d_.

[**0055**] **FIG. 2** is an entire constructional view showing the entire construction of the vehicle air conditioner in this embodiment. This vehicle air conditioner is constructed with a front seat air conditioning unit **5** for respectively independently air-conditioning the air conditioning zones **1**_a_, **1**_b_, and a rear seat air conditioning unit **6** for respectively independently air-conditioning the air conditioning zones **1**_c_, **1**_d_.

[**0056**] The front seat air conditioning unit **5** is arranged inside an instrument panel **7** (dashboard). The rear seat air conditioning unit **6** is arranged most backward in the passenger compartment **1**. The front seat air conditioning unit **5** has a duct **50** for sending and blowing air to the passenger compartment **1**. An inside air introducing inlet **50**_a_ for introducing inside air (i.e., air inside the passenger compartment) from the passenger compartment **1** and an outside air introducing inlet **50**_b_ for introducing outside air (i.e., air outside the passenger compartment) from the vehicle compartment exterior are provided in this duct **50**.

[**0057**] Further, an inside-outside air switching door **51** for selectively opening and closing the outside air introducing inlet **50**_b_ and the inside air introducing inlet **50**_a_ is arranged in the duct **50**. A servo motor **510**_a_ as a driving means is connected to this inside-outside air switching door **51**.

[**0058**] Further, a centrifugal type blower **52** for generating an air flow toward the passenger compartment **1** is arranged on an air downstream side of the outside air introducing inlet **50**_b_ and the inside air introducing inlet **50**_a_ within the duct **50**. The centrifugal type blower **52** is constructed with a vane wheel and a blower motor **52**_a_ for rotating this vane wheel. In **FIG. 2**, an axial vane wheel is indicated to simplify the drawing. However, actually, a centrifugal vane wheel is used in the blower **52**.

[**0059**] Furthermore, an evaporator **53** as an air cooling means for cooling the air is arranged on an air downstream side of the centrifugal type blower **52** within the duct **50**. A heater core **54** as an air heating means is arranged on an air downstream side of this evaporator **53** within the duct **50**.

[**0060**] A partition plate **57** is arranged on an air downstream side of the evaporator **53** within the duct **50**. This partition plate **57** partitions the interior of the duct **50** into a driver seat side passage **50**_c_ and an assistant driver seat side passage **50**_d_ (front-passenger's seat side passage).

[**0061**] Here, a bypass passage **51**_a_ is formed on a one side of the heater core **54** in the driver seat side passage **50**_c_. Through the bypass passage **51**_a_, cool air cooled by the evaporator **53** bypasses the heater core **54** in the driver seat side passage **50**_c_.

[**0062**] A bypass passage **51**_b_ is formed on the other side of the heater core **54** in the assistant driver seat side passage **50**_d_. Through the bypass passage **51**_b_, cool air cooled by the evaporator **53** bypasses the heater core **54** in the assistant driver seat side passage **50**_d_.

[**0063**] Air mix doors **55**_a_, **55**_b_ are arranged on an air upstream side of the heater core **54**. The air mix door **55**_a_ adjusts the ratio of an air amount passing through the heater core **54** and an amount passing through the bypass passage **51**_a_ in the driver seat side passage **50**_c_, in accordance with an open degree of the air mix door **55**_a_. Therefore, conditioned air to be blown to the front right side air-conditioning zone **1**_a_ can be adjusted.

[**0064**] Further, the air mix door **55**_b_ adjusts the ratio of an air amount passing the heater core **54** and an air amount passing the bypass passage **51**_b_ in the assistant driver seat side passage **50**_d_, in accordance with an open degree of the air mix door **55**_b_. Therefore, conditioned air to be blown to the front left side air-conditioning zone **1**_a_ can be adjusted.

[**0065**] Here, servo motors **550**_a_, **550**_b_ as driving means are respectively connected to the air mix doors **55**_a_, **55**_b_. The open degrees of the air mix doors **55**_a_, **55**_b_ are respectively adjusted by the servo motors **550**_a_, **550**_b_.

[**0066**] Further, the evaporator **53** is a cooling heat exchanger constituting a well-known refrigerating cycle together with a compressor, a condenser, a liquid receiver and a pressure reducing device that are unillustrated. In the evaporator **53**, low-pressure refrigerant is evaporated by absorbing heat from an evaporation latent heat from air flowing in the duct **50**, so that air flowing through the evaporator **53** in the duct **50** is cooled.

[**0067**] The compressor is connected to an engine of the vehicle through an unillustrated electromagnetic clutch. The operation of this compressor is stopped and controlled by controlling connection and disconnection of the electromagnetic clutch.

[**0068**] The heater core **54** is a heat exchanger using engine cooling water (hot water) of the vehicle as a heat source. This heater core **54** heats the cool air after being cooled by the evaporator **53**.

[**0069**] Further, a driver seat side face blowing-out port **2**_a_ is opened on an air downstream side of the heater core **54** in the duct **50**. The driver seat side face blowing-out port **2**_a_ blows out the conditioned air toward the upper half of the body of a driver sitting on the driver seat from the driver seat side passage **50**_c_.

[**0070**] Here, a blowing-out port switching door **56**_a_ for opening and closing the face blowing-out port **2**_a_ is arranged at an air upstream portion of the face blowing-out port **2**_a_ in the duct **50**. This blowing-out port switching door **56**_a_ is opened and closed by a servo motor **560**_a_ as a driving means.

[**0071**] A driver seat side foot blowing-out port for blowing-out the conditioned air to the lower half of the body of the driver from the driver seat side passage **50**_c_ and a driver seat side defroster blowing-out port for blowing-out the conditioned air to a driver seat side area on the inner surface of a front windshield are arranged in the duct **50** although these blowing-out ports are omitted in the drawings.

[0072] Blowing-out port switching doors for opening and closing the respective blowing-out ports are arranged in air upstream portions of the driver seat side foot blowing-out port and the driver seat side defroster blowing-out port. The respective blowing-out port switching doors are opened and closed by the servo motors.

[0073] Further, a front-passenger's seat side face blowing-out port **2**_b_ is opened on an air downstream side of the heater core **54** in the duct **50**. The front-passenger's seat side face blowing-out port **2**_b_ blows out the conditioned air toward the upper half of the body of a passenger sitting on the front-passenger's seat from the front-passenger's seat side passage **50**_d_.

[0074] Here, a blowing-out port switching door **56**_b_ for opening and closing the face blowing-out port **2**_b_ is arranged at an air upstream portion of the face blowing-out port **2**_b_ in the duct **50**. This blowing-out port switching door **56**_b_ is opened and closed by a servo motor **560**_b_ as a driving means.

[0075] Further, the face blowing-out ports **2**_a_, **2**_b_ are arranged on a dashboard **7** to be divided into a center face air outlet at a center area in a vehicle right-left direction (vehicle width direction) and a side face air outlet at right and left sides.

[0076] A front-passenger's seat side foot blowing-out port for blowing-out the conditioned air to the lower half of the body of the front passenger from the front-passenger's seat side passage **50**_d_, and a front-passenger's seat side defroster blowing-out port for blowing-out the conditioned air to a front-passenger's seat side area on the inner surface of the front windshield are arranged in the duct **50** although these blowing-out ports are omitted in the drawings.

[0077] Blowing-out port switching doors for opening and closing the respective blowing-out ports are arranged in air upstream portions of the front-passenger's seat side foot blowing-out port and the front-passenger's seat side defroster blowing-out port. The blowing-out port switching doors are operatively linked by a servo motor **560**_b_.

[0078] Further, the rear seat air conditioning unit **6** has a duct **60** for sending and blowing air to the rear seat area in the passenger compartment **1**. Only the inside air is introduced from the passenger compartment **1** into an inside air introducing duct **60**_b_ through an inside air introducing inlet **60**_a_.

[0079] Here, a centrifugal type blower **62** for generating an air flow toward the passenger compartment **1** is arranged on an air downstream side of the inside air introducing duct **60**_b_. The centrifugal type blower **62** is constructed with a vane wheel and a blower motor **62**_a_ for rotating this vane wheel. The vane wheel of the blower **62** is indicated in **FIG. 2** as an axial vane wheel. However, actually, the vane wheel of the blower **62** is a centrifugal vane wheel.

[0080] Further, an evaporator **63** as an air cooling means for cooling the introduced air is arranged on an air downstream side of the centrifugal type blower **62** within the duct **60**. A heater core **64** as an air heating means for heating the air is arranged on an air downstream side of this evaporator **53**.

[0081] A partition plate **67** is arranged on a downstream portion of the evaporator **63** within the duct **60**. This partition plate **67** partitions the interior of the duct **60** into a rear right side passage **60**_a_ (i.e., driver's seat side passage) and a rear left side passage **60**_d_ (i.e., front-passenger's seat side passage).

[0082] Here, a bypass passage **61**_a_ is formed on a one side of the heater core **64** in the rear right side passage **60**_c_. Through the bypass passage **61**_a_, cool air cooled by the evaporator **63** bypasses the heater core **64** in the rear right side passage **60**_c_.

[0083] A bypass passage **61**_b_ is formed on the other side of the heater core **64** in the rear left seat side passage **60**_d_. Through the bypass passage **61**_b_, the cool air cooled by the evaporator **63** bypasses the heater core **64** in the rear left seat side passage **60**_d_.

[0084] Air mix doors **65**_a_, **65**_b_ are arranged on an air upstream side of the heater core **64**. The air mix door **65**_a_ adjusts the ratio of an air amount passing through the heater core **64** and an air amount passing through the bypass passage **61**_a_ in the cool air circulated in the rear right seat side passage **60**_c_, in accordance with an open degree of the air mix door **65**_a_.

[0085] The air mix door **65**_b_ adjusts the ratio of an air amount passing through the heater core **64** and an air amount passing through the bypass passage **61**_b_ in the cool air passing the rear left seat side passage **60**_d_, in accordance with an open degree of the air mix door **65**_b_.

[0086] Servo motors **650**_a_, **650**_b_ as a driving means are respectively connected to the air mix doors **65**_a_, **65**_b_. The open degrees of the air mix doors **65**_a_, **65**_b_ are respectively adjusted by the servo motors **650**_a_, **650**_b_.

[0087] Here, the evaporator **63** is piped and connected in parallel with the above evaporator **53**, and is a heat exchanger constituting one constructional element of the above well-known refrigerating cycle.

[0088] The heater core **64** is a heat exchanger using the engine cooling water (warm water) of the vehicle as a heat source. The heater core **64** is connected to the above heater core **54** in parallel therewith, and heats the cool air after being cooled by the evaporator **63**.

[0089] Further, a rear right face blowing-out port **2**_c_ is opened on an air downstream side of the heater core **64** in the rear right air passage **60**_c_ within the duct **60**. The rear right face blowing-out port **2**_c_ blows out the conditioned air toward the upper half of the body of a passenger sitting on the right-hand side (i.e., the rear side of the driver seat) of a rear seat from the rear right side passage **60**_d_.

[0090] A rear left face blowing-out port **2**_d_ is opened on an air downstream side of the heater core **64** in the rear left side passage **60**_d_ within the duct **60**. This face blowing-out port **2**_d_ blows out the conditioned air toward the upper half of the body of a passenger sitting on the left-hand side (i.e., the rear side of the assistant driver seat) of the rear seat from the rear left side passage **60**_d_.

[0091] Here, a blowing-out port switching door **66**_a_ for opening and closing the rear right face blowing-out port **2**_c_ is arranged in an air upstream portion of the rear right face blowing-out port **2**_c_. This blowing-out port switching door **66**_a_ is opened and closed by a servo motor **660**_a_ as a driving means.

[0092] Similarly, a blowing-out port switching door **66**_b_ for opening and closing the rear left face blowing-out port **2**_d_ is arranged in an air upstream portion of the rear left face blowing-out port **2**_d_. This blowing-out port switching door **66**_b_ is opened and closed by a servo motor **660**_b_ as a driving means.

[0093] A rear right side foot blowing-out port for blowing out the conditioned air to the lower half of the body of the rear seat right-hand side passenger from the rear right side passage **60**_d_ is arranged in the duct **60** although this rear right side foot blowing-out port is omitted in the drawings.

[0094] Further, a blowing-out port switching door for opening and closing this foot blowing-out port is arranged in an air upstream portion of the rear right side foot blowing-out port. This blowing-out port switching door is opened and closed by the servo motor.

[0095] Similarly, a rear left side foot blowing-out port for blowing out the conditioned air to the lower half of the body of the rear seat left-hand side passenger from the rear left side passage **60**_d_ is arranged in the duct **60** although this foot blowing-out port is omitted in the drawings. A blowing-out port switching door for opening and closing this rear left side foot blowing-out port is arranged in an air upstream portion of this rear left side foot blowing-out port. This foot blowing-out port switching door is opened and closed by the servo motor.

[0096] Further, an electronic controller (hereinafter called an air conditioning ECU **8**) for controlling each of the air conditioning operations of the front seat air conditioning unit **5** and the rear seat air conditioning unit **6** is provided in the vehicle air conditioner.

[0097] An outside air temperature sensor **81**, a cooling water temperature sensor **82**, a solar radiation sensor **83**, inside air temperature sensors **84**, **85**, evaporator temperature sensors **86**, **87** and the seat position detection units **1**_ap_, **1**_bp_, **1**_cp_ are connected to the air conditioning ECU **8**.

[0098] The outside air temperature sensor **81** detects an outside air temperature Tam outside the passenger compartment. The cooling water temperature sensor **82** detects a cooling water temperature Tw of the engine. The solar radiation sensor **83** is disposed an inner side of the front windshield at an approximate center in the vehicle right-left direction. Generally, the solar radiation sensor **83** is a two-dimension type. The solar radiation sensor **83** detects each of a solar radiation amount irradiated to the front right air conditioning zone **1**_a_ and a solar radiation amount irradiated to the front left air conditioning zone **1**_b_, and outputs solar radiation signals TsDr and TsPa corresponding to the detected solar radiation amount to the air conditioning ECU **8**.

[0099] The inside air temperature sensor **84** detects an air temperature in the air conditioning zones **1**_a_, **1**_b_, and outputs an inside air temperature signal TrFr corresponding to the detected inside air temperature to the air conditioning ECU **8**. Similarly, the inside air temperature sensor **85** detects an air temperature in the air conditioning zones **1**_c_, **1**_d_, and outputs an inside air temperature signal TrRr corresponding to the detected inside air temperature to the air conditioning ECU **8**.

[0100] The evaporator temperature sensor **86** detects an air temperature blown immediately after passing through the evaporator **53**, and output an evaporator temperature signal TeFr corresponding to the detected temperature of the evaporator **86** to the air conditioning ECU **8**. The evaporator temperature sensor **87** detects an air temperature blown immediately after passing through the evaporator **63**, and output an evaporator temperature signal TeRr corresponding to the detected temperature of the evaporator **87** to the air conditioning ECU **8**.

[0101] Temperature setting switches **9**, **10**, **11**, **12** are provided for setting desirable temperatures TsetFrDr, TsetFrPa, TsetRrDr, TsetRrPa of the air conditioning zones **1**_a_, **1**_b_, **1**_c_, **1**_d_, respectively, by a passenger. The temperature setting switches **9-12** are connected to the air-conditioning ECU **8**. Displays **9**_a_, **10**_a_, **11**_a_, **12**_a_ as desirable temperature display means for displaying the setting contents of the desirable temperatures, etc. are respectively arranged in the vicinity of the temperature setting switches **9**, **10**, **11**, **12**.

[0102] As the non-contact temperature sensors **70**_a_, **70**_b_, matrix IR sensors are used. The matrix IR sensor **70**_a_ is disposed to detect a surface temperature of the rear right side air-conditioning zone **1**_c_, and the matrix IR sensor **70**_b_ is disposed to detect a surface temperature of the rear left side air-conditioning zone **1**_d_.

[0103] Each of the matrix IR sensors **70**_a_, **70**_b_ is constructed with a thermopile detection element which detects an electromotive force change corresponding to a change of inputted infrared rays as a temperature change. Next, structure of the right and left matrix IR sensor **70**_a_, **70**_b_ will be now described with reference to **FIGS. 3-5B**. Both the right and left matrix IR sensors **70**_a_ and **70**_b_ have the same structure.

[0104] Hear, the structure of the right matrix IR sensor **70**_a_ will be now described with reference to **FIG. 3** as an example. The matrix IR sensor **70**_a_ (**70**_b_) includes a detection portion **71**. The detection portion **71** has a substrate **71**_a_, a sensor chip **72** arranged on the substrate **71**_a_, and an infrared ray absorbing film **73** disposed to cover the sensor chip **72**. The detection portion **71** is disposed on a seat **71**_c_, and is covered by a cup-shaped case **71**_b_. A square window **71**_d_ is provided in a bottom portion of the case **71**_b_, and a lens **71**_e_ is provided in the square window **71**_d_. The infrared-ray absorbing film **73** absorbs infrared rays radiated through the lens **71**_e_ from a detecting object, and converts it to heat.

[0105] On the sensor chip **72**, sixteen thermoelectric couple portions Dr**1**-Dr**16** are arranged in a matrix shape with vertical four rows and horizontal four lines. The thermoelectric couple portions Dr**1**-Dr**16** are temperature detecting elements each of which converts heat generated from the infrared ray absorbing film **73** to electric voltage (i.e., electric energy). In this embodiment, the matrix IR sensor **70**_a_, **70**_b_ is attached to the ceiling portion to be pointed downwardly such that a sight center line of the matrix IR sensor **70**_a_, **70**_b_ is substantially perpendicular to the vehicle front-rear direction. More specifically, the slight center line of the matrix IR sensor **70**_a_, **70**_b_ can be positioned in a range between a position shifted from the vertical direction to a vehicle front side by 2° to a position shifted from the vertical direction to a vehicle rear side by 2°.

[0106] **FIGS. 4A and 4B** show arrangement positions of the matrix IR sensors **70**_a_, **70**_b_ and temperature detection ranges **700**_a_, **700**_b_ to be temperature-detected. **FIG. 5A** is an enlarged view of the temperature detection range **700**_a_, and **FIG. 5B** is an enlarged view of the temperature detection range **700**_b_. **FIG. 6** shows corresponding positions of a rear right passenger, the vehicle rear right side door and window, on the thermoelectric couple portions Dr**1**-Dr**16**.

[**0107**] The right matrix IR sensor **70**_a_ is disposed in the ceiling portion of the passenger compartment such that the infrared ray absorbing film **73** is arranged approximately horizontally. Therefore, the temperature detection range **700**_a_ is formed on a direct vertical lower side of the right matrix IR sensor **70**_a_. Similarly, the left matrix IR sensor **70**_b_ is disposed in the ceiling portion of the passenger compartment such that the infrared-ray absorbing film **73** is arranged approximately horizontally. Therefore, the temperature detection range **700**_b_ is formed on a direct vertical lower side of the right matrix IR sensor **70**_b_.

[**0108**] As shown in **FIGS. 4A and 4B**, the right matrix IR sensor **70**_a_ is arranged at a position Ra in a rear right arrangement area on the vehicle ceiling portion. That is, the rear right arrangement area is a projection area of the range Lr**0** (see **FIG. 1**) from the frontmost end of the seat cushion portion **30**_c_ to the rearmost end of the seat back portion **31**_c_, projected vertically on the ceiling portion. The range Lr**0** corresponds to the rear seat range in the vehicle front-rear direction. Further, the arrangement position Ra in the ceiling portion is provided in the rear right arrangement area to be offset from a center of the rear right seat in the vehicle width direction (vehicle right-left direction) to a rear right window side. Similarly, the left matrix IR sensor **70**_b_ is arranged at a position Rb in a rear left arrangement area on the vehicle ceiling portion. That is, the rear left arrangement range is a projection area of the range Lr**0** (see **FIG. 1**) from the frontmost end of the seat cushion portion **30**_d_ to the rearmost end of the seat back portion **31**_d_, projected vertically on the ceiling portion. The range Lr**0** corresponds to the rear seat range in the vehicle front-rear direction. Further, the arrangement position Rb in the ceiling portion is provided in the rear left arrangement area to be offset from a center of the rear left seat in the vehicle width direction (vehicle right-left direction) to a rear left window side. When the rear seat slides by the seat position adjustment mechanism, the range Lr**0** can be enlarged.

[**0109**] Specifically, the right matrix IR sensor **70**_a_ is arranged so that at least the shoulder portion and the thigh portion of a rear seat passenger are positioned on the temperature detection range **700**_a_. Similarly, the left matrix IR sensor **70**_b_ is arranged so that at least the shoulder portion and the thigh portion of a rear seat passenger are positioned on the temperature detection range **700**_b_. That is, the right and left matrix IR sensors **70**_a_, **70**_b_ are non-contact temperature sensors for detecting the surface temperatures of passengers on the right and rear left seats, respectively. The air conditioning ECU **8** calculates a surface temperature of each portion of the passenger compartment based on output signals from the right and left matrix IR sensors **70**_a_, **70**_b_.

[**0110**] Each of the right and left matrix IR sensors **70**_a_ and **70**_b_ can be position within an upper projection area of a range Lr**1** (see **FIG. 1**) that is a range between the front end and the rear end of the seat cushion portion **30**_c_, vertically projected on the ceiling portion. In this case, it can more effectively restrict the positions of the shoulder portion and the thigh portion of the passenger from being offset from the temperature detection range **700**_a_, **700**_b_.

[**0111**] In the first embodiment, the right matrix IR sensor **70**_a_ can be arranged so that the temperature detection range **700**_a_ includes at least the right side surfaces of the right shoulder portion of the passenger on the rear right seat, and a trim panel portion and a window portion of the rear right door. To obtain the temperature detection range **700**_a_, the right matrix IR sensor **70**_a_ is preferably arranged at a window side on the ceiling portion Ra, with respect to the center of the rear right seat or the rear left seat. When the right matrix IR sensor **70**_a_ is positioned at the right window side more than the center of the right seat position of the passenger, the right side surface of the passenger and the trim panel portion and the window portion of the rear right door can be easily contained in the temperature detection range **700**_a_. Generally, the right side surface of the passenger and the trim panel portion and the window portion of the rear right door are easily affected by solar radiation from the right side.

[**0112**] Similarly, the left matrix IR sensor **70**_b_ can be arranged so that the temperature detection range **700**_b_ includes at least the left side surfaces of the left shoulder portion of the passenger on the rear left seat, a trim panel portion and a window portion of the rear left door. To obtain the temperature detection range **700**_b_, the left matrix IR sensor **70**_b_ is preferably arranged at a window side on the ceiling portion Rb, with respect to the center of the rear right seat or the rear left seat. When the left matrix IR sensor **70**_b_ is positioned at the left window side more than the center of the left seat position of the passenger, the left side surface of the passenger and the trim panel portion and the window portion of the rear left door can be easily contained in the temperature detection range **700**_b_. Generally, the left side surface of the passenger and the trim panel portion and the window portion of the rear left door are easily affected by solar radiation from the left side.

[**0113**] As shown in **FIGS. 4A**, **4B**, **5**A and **5**B, the temperature detection ranges **700**_a_, **700**_b_ indicated in the matrix shape correspond to radiation ranges of infrared rays collected on temperature detection elements by the lends **71**_e_ of the matrix IR sensors **70**_a_, **70**_b_ on the same sight. In **FIG. 5A**, the temperature detection areas of the temperature detection range **700**_a_ indicated by the Dr**1**-Dr**16** correspond to the temperature detection areas of the thermoelectric couple portions Dr**1**-Dr**16** that are the temperature detection elements of the right matrix IR sensor **70**_a_. In **FIG. 5B**, the temperature detection areas of the temperature detection range **700**_b_ indicated by the Pa**1**-Pa**16** correspond to the temperature detection areas of the thermoelectric couple portions Pa**1**-Pa**16** that are the temperature detection elements of the left matrix IR sensor **70**_b_. The temperature detection ranges **700**_a_, **700**_b_ indicated in **FIGS. 4B, 5A** and **5**B are the general flat shapes when being viewed from a vehicle top side.

[**0114**] **FIG. 6** shows a detail example of the temperature detection range **700**_a_ in the rear right air-conditioning zone **1**_c_, due to the right matrix IR sensor **70**_a_. The temperature detection range **700**_b_ in the rear left air-conditioning zone **1**_d_ is substantially symmetrical to the temperature detection range **700**_a_ with respect to a center line in the vehicle width direction.

[**0115**] As shown in **FIG. 6**, the surface temperature of the rear right window is mainly detected by the thermoelectric couple portions Dr**2** and Dr**3** among the rightmost thermoelectric couple portions Dr**1**-Dr**4**. The surface temperatures of trim panels of the rear right window and the passenger compartment on the rear right side are generally detected by the thermoelectric couple portions Dr**6** and Dr**7**. That is, the surface temperatures of the trim panel portions of the rear right doors and the rear right pillar portion are generally detected by the thermoelectric couple portions Dr**6** and Dr**7**. The surface temperature of the upper portion of a rear right passenger RrDr including the head portion and the shoulder portion of a rear right passenger RrDr are generally detected by the thermoelectric couple portions Dr**9** and Dr**13**, among the inside two lines of the thermoelectric couple portions Dr**9**-Dr**12** and Dr**13**-Dr**16**. The surface temperature of the stomach portion of the rear right passenger RrDr is generally detected by the thermoelectric couple portions Dr**10** and Dr**14**, among the inside two lines of the thermoelectric couple portions Dr**9**-Dr**12** and Dr**13**-Dr**16**. Further, the surface temperature of the right thigh portion of the rear right passenger RrDr is generally detected by the thermoelectric couple portions Dr**11** and Dr**12**, and the surface temperature of the left thigh portion of the rear right passenger RrDr is generally detected by the thermoelectric couple portions Dr**15** and Dr**16**, among the inside two lines of the thermoelectric couple portions Dr**9**-Dr**12** and Dr**13**-Dr**16**. That is, the surface temperature of the rear right passenger RrDr including the upper portion and the thigh portion of the rear right passenger RrDr can be detected by the inside two lines of the thermoelectric couple portions Dr**9**-Dr**12** and Dr**13**-Dr**16**.

[**0116**] The right half body of the rear right passenger RrDr is readily affected by the solar radiation, as compared with the left half body of the rear right passenger RrDr. In this embodiment, because the right matrix IR sensor **70***a* is disposed in the ceiling portion at the arrangement position Ra on the side of the window above the rear right seat cushion **30***c*, the thermoelectric couple portions Dr**9**-Dr**12** can readily detect the surface temperature of the right half body of the rear right passenger RrDr.

[**0117**] Similarly, the surface temperature of the rear left window is mainly detected by the thermoelectric couple portions Pa**2** and Pa**3** among the leftmost thermoelectric couple portions Pa**1**-Pa**4**. The surface temperatures of trim panels of the rear right window and the passenger compartment on the rear left are generally detected by the thermoelectric couple portions Pa**6** and Pa**7**. That is, the surface temperatures of the trim panel portions of the rear left doors and the rear left pillar portion are generally detected by the thermoelectric couple portions Pa**6** and Pa**7**. The surface temperature of the upper portion of a rear lest passenger RrPa including the head portion and the shoulder portion of the rear left passenger RrPa are generally detected by the thermoelectric couple portions Pa**9** and Pa**13**, among the inside two lines of the thermoelectric couple portions Pa**9**-Pa**12** and Pa**13**-Pa**16**. The surface temperature of the stomach portion of the rear right passenger RrPa is generally detected by the thermoelectric couple portions Pa**10** and Pa**14**, among the inside two lines of the thermoelectric couple portions Pa**9**-Pa**12** and Pa**13**-Pa**16**. Further, the surface temperature of the right thigh portion of the rear left passenger RrPa is generally detected by the thermoelectric couple portions Pa**11** and Pa**12**, and the surface temperature of the left thigh portion of the rear left passenger RrPa is generally detected by the thermoelectric couple portions Pa**15** and Pa**16**, among the inside two lines of the thermoelectric couple portions Pa**9**-Pa**12** and Pa**13**-Pa**16**. That is, the surface temperature of the rear left passenger RrPa including the upper portion and the thigh portion of the rear left passenger Rrpa can be detected by the inside two lines of the thermoelectric couple portions Pa**9**-Pa**12** and Pa**13**-Pa**16**.

[**0118**] In this embodiment, because the left matrix IR sensor **70***b* is disposed in the ceiling portion at the arrangement position Rb on the side of the window above the rear left seat cushion **30***d*, the thermoelectric couple portions Pa**9**-Pa**12** can readily detect the surface temperature of the left half body of the rear right passenger RrPa.

[**0119**] Thus, the right and left matrix IR sensors **70***a*, **70***b* can stably detect surface temperatures of the rear right passenger RrDr and the rear left passenger RrPa from the upper sides of the rear right passenger RrDr and the rear left passenger RrPa.

[**0120**] Accordingly, even when the frame and the seated height of the passenger on the rear seat are changed, the position of the shoulder portion of a passenger on the rear seat in each temperature detection range of the matrix IR sensors **70***a*, **70***b* is not largely changed. Accordingly, even when the temperature detection range is fixed relative to the rear seat position, the surface temperature of at least the shoulder portion of the passenger can be stably detected. Further, a position of the thigh portion of the passenger on each of right and rear left seats, relative to the temperature detection range, is almost constant regardless of the frame change of the body of the passenger. Thus, the thigh portion of the passenger on the rear seat can be also stably detected. Accordingly, the surface temperature of the passenger on the rear seat can be accurately detected regardless of the front seat position and the front seat cover.

[**0121**] Further, the right and left matrix IR sensors **70***a*, **70***b* are arranged in the ceiling portion at the sides of the right and rear left windows from the seat centers in the vehicle width direction. Therefore, surface temperatures of the trim panels of the rear door windows and the trim panels between the rear door windows and a passenger on the rear seat can be also detected by the matrix IR sensors **70***a*, **70***b*.

[**0122**] The air conditioning ECU **8** is a well-known device constructed with an analog/digital converter, a microcomputer, etc. The air conditioning ECU **8** is constructed such that output signals respectively outputted from sensors **81**, **82**, **83**, **84**, **85**, **86**, **87** and switches **9**, **10**, **11**, **12** are analog/digital-converted by the analog/digital converter and are inputted to the microcomputer.

[**0123**] The microcomputer is a well-known microcomputer constructed with a memory such as a ROM, a RAM, etc., and a CPU (central processing unit), etc. When an ignition switch is turned on, electric power is supplied from an unillustrated battery to the microcomputer.

[**0124**] The operation of this embodiment will next be described with reference to **FIGS. 7A** to **10**. **FIGS. 7A and 7B** are flow charts showing front and rear automatic air conditioning controls of the air conditioning ECU **8**. When electrical power is supplied to the air conditioning ECU **8**, the microcomputer of the air conditioning ECU **8** executes a computer program stored to the memory in accordance with the flow charts shown in **FIGS. 7A and 7B**. The execution of this computer program is generally started when the ignition switch is turned on.

[0125] First, a front air conditioning control will be now described.

[0126] At step S121 in FIG. 7A, front right and left set temperature signals TsetFrDr, TsetFrPa from the temperature setting switch 8, 10 are input. Then, at step S122, an outside air temperature signal Tam from the outside air temperature sensor 81, solar radiation signals TsDr, TsPa from the solar radiation sensor 83 and an inside air temperature signal TrFr from the inside air temperature sensor 84 are input.

[0127] Next, at step S123, a target blowing-out temperature TAOFrDr of air blown out to the air conditioning zone 1*a* in the passenger compartment is calculated in accordance with the formula (1) by using the set temperature signal TsetFrDr, the outside air temperature signal Tam, the solar radiation signal TsDr and the inside air temperature signal TrFr. The target blowing-out temperature TAOFrDr is a necessary target temperature for maintaining the temperature of the front right air conditioning zone 1*a* (driver's seat air conditioning zone) at the set temperature TsetFrDr.

$$TAOFrDr=KsetFrDr\times TsetFrDr-KrFr\times TrFr-Kam\times Tam-KsDr\times TsDr+CFrDr \quad (1)$$

[0128] wherein, KsetFrDr is a front right temperature setting gain, KrFr is a front inside air temperature gain, Kam is an outside air temperature gain, KsDr is a right solar radiation gain, and CFrDr is a front right correction constant.

[0129] Further, a target blowing-out temperature TAOFrPa of air blown out to the air conditioning zone 1*b* in the passenger compartment is calculated in accordance with the formula (2) by using the set temperature signal TsetFrPa, the outside air temperature signal Tam, the solar radiation signal TsPa and the inside air temperature signal TrPa. The target blowing-out temperature TAOFrPa is a necessary target temperature for maintaining the temperature of the front left air conditioning zone 1*b* (front passenger's seat air conditioning zone) at the set temperature TsetFrPa.

$$TAOFrPa=KsetFrPa\times TsetFrPa-KrFr\times TrFr-Kam\times Tam-KsPa\times TsPa+CFrPa \quad (2)$$

[0130] wherein, KsetFrPa is a front left temperature setting gain, KrFr is a front inside air temperature gain, Kam is an outside air temperature gain, KsPa is a left solar radiation gain, and CFrPa is a front left correction constant.

[0131] Next, at step S124, one of an inside air circulation mode and an outside air introduction mode is selected as an inside/outside air introducing mode based on the control map shown in FIG. 8, in accordance with an average front target blowing-out temperature TAOFr. The average front target blowing-out temperature TAOFr is an average value of the TAOFrPa and TAOFrDr. In the inside air circulation mode, the inside/outside air switching door 51 fully closes the outside air introduction port 50*b* and fully opens the inside air introduction port 50*a*, so that inside air of the passenger compartment is introduced only from the inside air introduction port 50*a*. In the outside air introduction mode, the inside/outside air switching door 51 fully opens the outside air introduction port 50*b* and fully closes the inside air introduction port 50*a*, so that outside air of the passenger compartment is introduced from the outside air introduction port 50*b*. Specifically, as shown in FIG. 8, when the average front target blowing-out temperature TAOFr is lower than a first predetermined temperature, the inside air introduction mode is set. When the average front target blowing-out temperature TAOFr is higher than a second predetermined temperature that is higher than the first predetermined temperature, the outside air introduction mode is set. When the average front target blowing-out temperature TAOFr is between the first predetermined temperature and the second predetermined temperature, an inside/outside air mixing mode can be set. In the inside/outside air mixing mode, both the inside air and the outside air are introduced.

[0132] Next, at step S125, an air outlet mode for the front right air conditioning zone and an air outlet mode for the front left air conditioning zone are respectively independently determined in accordance with the graph in FIG. 9 based on the TAOFrDr (TAO) and the TAOFrPa (TAO). As shown in FIG. 9, the air outlet mode for the air conditioning zone 1*a* is automatically changed in this order of a face mode (FACE), a bi-level mode (B/L) and a foot mode (FOOT) as the TAOFrDr (TAO) increases. Similarly, the air outlet mode for the air conditioning zone 1*b* is automatically changed in this order of the face mode (FACE), the bi-level mode (B/L) and the foot mode (FOOT) as the TAOFrPa (TAO) increases. In the face mode, conditioned air is blown only from the face air outlet 2*a* (2*b*) toward an upper side of a passenger on the front seat in the passenger compartment. In the foot mode, the foot air outlet is fully opened so that conditioned air is blown only from the foot air outlet. Further, in the bi-level mode, conditioned air is blown from both the face air outlet 2*a* (2*b*) and the foot air outlet.

[0133] When the air outlet is determined for each air conditioning zone 1*a* or 1*b*, the servomotors of the air outlet port switching doors are controlled so that the determined air outlet mode is set for each air conditioning zone 1*a* or 1*b*.

[0134] Next, at step S126, a blower voltage applied to the blower motor 52*a* is determined in accordance with control map shown in FIG. 10, based on the average front target blowing-out temperature TAOFr (TAO) that is the average value between the TAOFrDr and the TAOFrPa.

[0135] As shown in FIG. 10, when the average front target blowing-out temperature TAOFr (TAO) is in a middle temperature area, the blower voltage is set at a constant value so that the air amount blown from the blower 52 is set at a constant amount. When the average front target blowing-out temperature TAOFr (TAO) is larger than the middle temperature area, the blower voltage is set larger as the average front target blowing-out temperature TAOFr (TAO) becomes larger. In contrast, when the average front target blowing-out temperature TAOFr (TAO) is smaller than the middle temperature area, the blower voltage is set larger as the average front target blowing-out temperature TAOFr (TAO) becomes smaller.

[0136] Next, at step S127, target open degrees θ1, θ2 of the air mix doors 55*a*, 55*b* are calculated in accordance with formula (3) and formula (4).

$$\theta 1=[(TAOFrDr-TeFr)/(Tw-TeFr)]\times 100\ (\%) \quad (3)$$

$$\theta 2=[(TAOFrPa-TeFr)/(Tw-TeFr)]\times 100\ (\%) \quad (4)$$

[0137] In the formulas (3) and (4), TeFr is an evaporator air temperature detected by the evaporator temperature sensor 86, and Tw is a water temperature detected by the water temperature sensor 82. When θ1=0% and θ2=0%, the air mix doors **55**a, **55**b are operated at the maximum cooling position so that all air after passing through the front evaporator **53** in the air passages **50**c, **50**d flows through the bypass passages **51**a, **51**b. In contrast, when θ1=100% and θ2=100%, the air mix doors **55**a, **55**b are operated at the maximum heating position so that all air after passing through the front evaporator **53** in the air passages **50**c, **50**d flows through the heater core **54**.

[**0138**] Then, at step S**128**, the control signals of the blower voltage, the target open degrees θ1, θ2, the inside/outside air mode and the air outlet mode determined above are output to the servomotors **510**a, **550**a, **550**b, **560**a and **560**b and the blower motor **52**a, so as to control operation of the inside/outside air switching door **51**, the air mix doors **55**a, **55**b, the air outlet mode switching doors **56**a, **56**b and the blower **52**.

[**0139**] After a predetermined time "t" passes at step S**129**, the control program returns to step S**121**, and the automatic control of the air conditioning zones **1**a, **1**b are performed by repeating the above control operation.

[**0140**] Next, a rear air conditioning control will be now described.

[**0141**] At step S**221** in **FIG. 7B**, rear right and left set temperature signals TsetRrDr, TsetRrPa from the temperature setting switch **11**, **12** are input. Then, at step S**222**, the outside air temperature signal Tam from the outside air temperature sensor **81**, solar radiation signals TsDr, TsPa from the solar radiation sensor **83** and an inside air temperature signal TrRr from the inside air temperature sensor **85** are input. In addition, at step S**222**, a rear right temperature Tiric and a rear left temperature Tir**1**d are input.

[**0142**] The rear right temperature Tir**1**c is calculated in accordance with the following formula (5) by using a rear right window surface temperature TirWRrDr, a rear right trim panel temperature TirINRrDr and a rear right passenger's temperature TirRrDr. As shown in the formula (5), relative to the parameters TirWRrDr, TirINRrDr and TirRrDr, weightings 0.2, 0.3 and 0.5 are added, respectively, and the rear right Tir**1**c is calculated.

$$Tir1c=0.2\times TirWRrDr+0.3\times TirINRrDr+0.5\times TirRrDr \quad (5)$$

[**0143**] Further, the rear right window surface temperature TirWRrDr, the rear right trim panel temperature TirINRrDr and the rear right passenger's temperature TirRrDr in formula (5) are calculated by using average calculations shown in formulas (6), (7) and (8).

$$TirWRrDr=(TDr2+TDr3)/2 \quad (6)$$

$$TirINRrDr=(TDr6+TDr7)/2 \quad (7)$$

$$TirRrDr=(TDr9+TDr10+TDr11+TDr12+TDr13+TDr14+TDr15+TDr16)/8 \quad (8)$$

[**0144**] In formulas (6), (7) and (8), TDr2, TDr3, TDr6, TDr7, TDr9, TDr10, TDr11, TDr12, TDr13, TDr14, TDr15 and TDr16 are detected temperatures of the thermoelectric couple portions Dr**2**, Dr**3**, Dr**6**, Dr**7**, Dr**9**, Dr**10**, Dr**11**, Dr**12**, Dr**13**, Dr**14**, Dr**15** and Dr**16**, respectively.

[**0145**] Next, at step S**223**, a rear right target blowing-out temperature TAORrDr of air blown out to the air conditioning zone **1**c in the passenger compartment is calculated in accordance with the formula (9) by using the set temperature signal TsetRrDr, the outside air temperature signal Tam, the solar radiation signal TsDr and the inside air temperature signal TrRr. The rear right target blowing-out temperature TAORrDr is a necessary target temperature for maintaining the temperature of the rear right air conditioning zone **1**c at the set temperature TsetRrDr.

$$TAORrDr=KsetRrDr\times TsetRrDr-KirRrDr\times Trir1c-KrRr\times TrRr-KsDr\times TsDr-Kam\times Tam+CRrDr \quad (9)$$

[**0146**] wherein, KsetRrDr is a rear right temperature setting gain, KrRr is a rear inside air temperature gain, Kam is the outside air temperature gain, KsDr is a right solar radiation gain, and CRrDr is a rear right correction constant.

[**0147**] Similarly, the rear left temperature Tir**1**d is calculated in accordance with the following formula (10) by using a rear left window surface temperature TirWRrPa, a rear left trim panel temperature TirINRrPa and a rear left passenger's temperature TirRrPa. As shown in formula (10), relative to the parameters TirWRrPa, TirINRrPa and TirRrPa, weightings 0.2, 0.3 and 0.5 are added, respectively, and the rear left Tirld is calculated.

$$Tir1d=0.2\times TirWRrPa+0.3\times TirINRrPa+0.5\times TirRrPa \quad (10)$$

[**0148**] Further, the rear left window surface temperature TirWRrPa, the rear left trim panel temperature TirINRrPa and the rear left passenger's temperature TirRrPa in formula (10) are calculated by using average calculations shown in formulas (11), (12) and (13).

$$TirWRrPa=(TPa2+TPa3)/2 \quad (11)$$

$$TirINRrPa=(TPa6+TPa7)/2 \quad (12)$$

$$TirRrPa=(TPa9+TPa10+TPa11+TPa12+TPa13+TPa14+TPa15+TPa16)/8 \quad (13)$$

[**0149**] In formulas (11), (12) and (13), TPa2, TPa3, TPa6, TPa7, TPa9, TPa10, TPa11, TPa12, TPa13, TPa14, TPa15 and TPa16 are detected temperatures of the thermoelectric couple portions Pa**2**, Pa**3**, Pa**6**, Pa**7**, Pa**9**, Pa**10**, Pa**11**, Pa**12**, Pa**13**, Pa**14**, Pa**15** and Pa**16**, respectively.

[**0150**] Next, at step S**223**, a rear left target blowing-out temperature TAORrPa of air blown out to the air conditioning zone **1**d in the passenger compartment is calculated in accordance with the formula (14) by using the set temperature signal TsetRrPa, the outside air temperature signal Tam, the solar radiation signal TsPa and the inside air temperature signal TrRr. The rear left target blowing-out temperature TAORrPa is a necessary target temperature for maintaining the temperature of the rear left air conditioning zone **1**d at the set temperature TsetRrPa.

$$TAORrPa=KsetRrPa\times TsetRrPa-KirRrPa\times Trir1d-KrRr\times TrRr-KsPa\times TsPa-Kam\times Tam+CRrPa \quad (14)$$

[**0151**] wherein, KsetRrPa is a rear right temperature setting gain, KrRr is the rear inside air temperature gain, Kam is the outside air temperature gain, KsPa is a left solar radiation gain, and CRrPa is a rear left correction constant.

[**0152**] Next, at step S**225**, an air outlet mode for the rear right air conditioning zone **1**c and an air outlet mode for the rear left air conditioning zone **1**d are respectively independently determined in accordance with the graph in **FIG. 9** based on the TAORrDr (TAO) and the TAORrPa (TAO). As shown in **FIG. 9**, the air outlet mode for the air conditioning zone **1**c is automatically changed in this order of a face mode (FACE), a bi-level mode (B/L) and a foot mode (FOOT) as the TAORrDr (TAO) increases. Similarly, the air outlet mode for the air conditioning zone **1**d is automatically changed in this order of the face mode (FACE), the bi-level mode (B/L) and the foot mode (FOOT) as the TAORrPa (TAO) increases.

[0153] In the rear face mode, the face air outlet **2**c (**2**d) is opened by the switching door **66**a (**66**b) so that conditioned air is blown only from the face air outlet **2**c (**2**d) toward an upper side of a passenger on the rear seat in the passenger compartment. In the foot mode, the foot air outlet is fully opened so that conditioned air is blown only from the rear foot air outlet toward the lower side of the passenger on the rear seat in the passenger compartment. Further, in the bi-level mode, both the face air outlet **2**c (**2**d) and the foot air outlet are opened so that conditioned air is blown from both the face air outlet **2**c (**2**d) and the foot air outlet toward the upper and lower sides of the passenger on the rear seat in the passenger compartment.

[0154] Next, at step S**226**, a blower voltage applied to the blower motor **62**a is determined in accordance with control map shown in **FIG. 10**, based on the average rear target blowing-out temperature TAORr (TAO) that is the average value between the TAORrDr and the TAORrPa.

[0155] As shown in **FIG. 10**, when the average rear target blowing-out temperature TAORr (TAO) is in a middle temperature area, the blower voltage is set at a constant value so that the air amount blown from the blower **62** is set at a constant amount. When the average rear target blowing-out temperature TAORr (TAO) is larger than the middle temperature area, the blower voltage is set larger as the average front target blowing-out temperature TAORr (TAO) becomes larger. In contrast, when the average front target blowing-out temperature TAORr (TAO) is smaller than the middle temperature area, the blower voltage is set larger as the average front target blowing-out temperature TAORr (TAO) becomes smaller.

[0156] Next, at step S**227**, target open degrees θ3, θ4 of the air mix doors **65**a, **65**b are calculated in accordance with formula (15) and formula (16).

$$\theta 3=[(TAORrDr-TeRr)/(Tw-TeRr)]\times 100\ (\%) \tag{15}$$

$$\theta 4=[(TAORrPa-TeRr)/(Tw-TeRr)]\times 100\ (\%) \tag{16}$$

[0157] In the formulas (15) and (16), TeRr is an evaporator air temperature detected by the evaporator temperature sensor **87**, and Tw is the water temperature detected by the water temperature sensor **82**. When θ3=0% and θ4=0%, the air mix doors **65**a, **65**b are operated at the maximum cooling position so that all air after passing through the rear evaporator **63** in the air passages **60**c, **60**d flows through the bypass passages **61**a, **61**b. In contrast, when θ3=100% and θ4=100%, the air mix doors **65**a, **65**b are operated at the maximum heating position so that all air after passing through the rear evaporator **63** in the air passages **60**c, **60**d flows through the heater core **64**.

[0158] Then, at step S**228**, the control signals of the blower voltage, the target open degrees θ3, θ4, the inside/outside air mode and the air outlet mode determined above are output to the servomotors **650**a, **650**b, **660**a and **660**b and the blower motor **62**a, so as to control operation of the air mix doors **65**a, **65**b, the air outlet mode switching doors **66**a, **66**b and the blower **62**.

[0159] After a predetermined time "t" passes at step S**229**, the control program returns to step S**221**, and the automatic control of the air conditioning zones **1**c, **1**d are performed by repeating the above control operation.

[0160] As described above, in the first embodiment, the surface temperature of the rear seat passenger on the rear seat and the surface temperatures of the rear right and left windows and trim panels of the rear right and left doors are detected by the matrix IR sensors **70**a, **70**b which are arranged in the ceiling portion above the seat cushion portion and the seat back portions of the rear seat. Therefore, the shoulder portion and the thigh portion of the passenger on the rear seat can be stably detected without depending on the frame of the passenger's body.

[0161] Furthermore, because the matrix IR sensors **70**a, **70**b are disposed in the ceiling portion above the right and rear left seats at right and rear left window sides, the matrix IR sensors **70**a, **70**b can easily detect the surface temperatures of the rear windows and the trim panels around the rear doors in the same detection range as the surface temperature of the passenger on the rear seat.

[0162] In the calculation of the rear right target blowing-out temperature TAORrDr of air blown to the rear right air conditioning zone **1**c, the influence of the side solar radiation from the rear right window is corrected by weighting calculation due to the rear right window surface temperature TirWRrDr and the rear right trim panel temperature TirINDr. In addition, a temperature increase of the thigh portion of the rear seat passenger relative to the side solar radiation from the rear right window is also corrected. Accordingly, the influence of the solar radiation to the rear right passenger can be accurately estimated.

[0163] Similarly, in the calculation of the rear left target blowing-out temperature TAORrPa of air blown to the rear left air conditioning zone **1**d, the influence of the side solar radiation from the rear left window is corrected by weighting calculation due to the rear left window surface temperature TirWRrPa and the rear left trim panel temperature TirINPa. In addition, a temperature increase of the thigh portion of the rear seat passenger relative to the side solar radiation from the rear left window is also corrected. Accordingly, the influence of the solar radiation to the rear left passenger can be accurately estimated.

[0164] Because the rear right and left target blowing-out temperatures TAORrDr and TAORrPa are detected respectively independently. Therefore, comfortable air conditioning performance for the passengers on the rear right seat and the rear left seat of the passenger compartment can be improved.

[0165] (Second Embodiment)

[0166] The second embodiment of the present invention of the present invention will be now described with reference to **FIGS. 11-13**. In the second embodiment, the structure of matrix sensors **70**a, **70**b that are a non-contact temperature sensor **70** is different from that of the above-described first embodiment.

[0167] As shown in **FIG. 11**, the non-contact temperature sensor **70** of the second embodiment includes the right matrix IR sensor **70**a arranged to face toward the rear right passenger RrDr, and the left matrix IR sensor **70**b arranged to face toward the rear left passenger RrPa. The right matrix IR sensor **70**a and the left matrix IR sensor **70**b are arranged on the ceiling portion adjacent to each other. The matrix IR sensors **70***a*, **70***b* are contained in a single package (casing), and the package is arranged at a suitable position in the passenger compartment. Both the matrix IR sensors **70***a*, **70***b* have the same structure.

[**0168**] Infrared rays, radiated from a detecting subject of a temperature detection range on the same sight of the rear right air conditioning zone **1***c*, enters to the right matrix IR sensor **70***a* through a right lens **71***e*. Further, infrared rays, radiated from a detecting subject of a temperature detection range on the same sight of the rear left air conditioning zone **1***d*, enters to the left Matrix IR sensor **70***b* through the left lens **71***e*.

[**0169**] As shown in **FIGS. 12A and 12B**, the non-contact temperature sensor **70** is arranged in the ceiling portion approximately at a center position Rc in the vehicle right-left direction within an area Lr**0** (see **FIG. 1**) between the front end of the seat cushion portion **30** of the rear seat and the seat back portion **31** of the rear seat. More preferably, the non-contact temperature sensor **70** is arranged in the ceiling portion approximately at the center position Rc in the vehicle right-left direction in an area Lr1 (see **FIG. 1**) between the front end of the seat cushion portion **30** of the rear seat and the rear end of the seat cushion portion **30** of the rear seat. Accordingly, the non-contact temperature sensor **70** is positioned to view the passengers on the rear right and left seats from an upper side of the passengers directly above the rear seat. Therefore, it can restrict positions of the shoulder portion and the thigh portions of the rear seat passengers from being offset from the temperature detection range of the right and left matrix IR sensors **70***a*, **70***b*.

[**0170**] Further, a sensor chip **72** and the right lens **71***e* of the right matrix IR sensor **70***a* of the non-contact temperature sensor **70** are arranged to face to the rear right passenger and to be tilted to a right outside by a predetermined angle ϕ relative to the center line A of **FIG. 11** perpendicular to the vehicle right-left direction. Similarly, a sensor chip **72** and the left lens **71***e* of the left matrix IR sensor **70***b* of the non-contact temperature sensor **70** are arranged to face to the rear left passenger and to be tilted to a left outside by a predetermined angle ϕ relative to the center line A of **FIG. 11** perpendicular to the vehicle right-left direction. That is, the center line of the non-contact temperature sensor **70** is set to be substantially perpendicular to the vehicle front-rear direction.

[**0171**] As shown in **FIGS. 11, 12A** and **12**B, infrared rays are entered in a range of the predetermined angle ϕ (e.g., 70°) from the vicinities of the rear right passenger and the rear left passenger, with respect to the surface of the right sensor chip **72** of the right matrix IR sensor **70***a* and the surface of the left sensor chip **72** of the left matrix IR sensor **70***b*. The surface of the right sensor chip **72** is the detection surface of the right matrix IR sensor **70***a*, and the surface of the left sensor chip **72** is the detection surface of the left matrix IR sensor **70***b*.

[**0172**] Similarly to the temperature detection portion **71** of the matrix IR sensor of the above-described first embodiment, each of the right matrix IR sensor **70***a* and the left right matrix IR sensor **70***b* is constructed with 16 temperature detection elements. The 16 temperature detection elements include the infrared ray absorbing film **73**, and the thermoelectric couple portions Dr**1**-Dr**16**, Pa**1**-Pa**16**.

[**0173**] Electrical signals generated from the temperature detection elements of the right matrix IR sensor **70***a* and the left matrix IR sensor **70***b* are input to a sensor process circuit **71***f* shown in **FIG. 11**. As shown in **FIG. 11**, the sensor process circuit **71***f* is connected to an input side of the air conditioning ECU **8** through a connector **71***g*.

[**0174**] Next, the temperature detection range of the non-contact temperature sensor **70** according to the second embodiment of the present invention will be now described. **FIG. 13** shows a temperature detection range **700***a* of the right matrix IR sensor **70** in the non-contact temperature sensor **70**. As shown in **FIG. 13**, the 16 temperature detection elements of the right matrix IR sensor **70***a* facing toward the rear right passenger RrDr are arranged in four rows and four lines. Specifically, the thermoelectric couple portions of the right matrix IR sensor **70***a* are arranged in four lines of Dr**1**-Dr**4**, Dr**5**-Dr**8**, Dr**9**-Dr**12** and Dr**13**-Dr**16** in this order from the rightmost portion of the rear right window side to a center portion (inner side) in the vehicle right-left direction. Further, in each line of the thermoelectric couple portions, Dr**1**, Dr**2**, Dr**3** and Dr**4** are arranged in this order from a vehicle rear side to a vehicle front side, Dr**5**, Dr**6**, Dr**7** and Dr**8** are arranged in this order from the vehicle rear side to the vehicle front side, Dr**9**, Dr**10**, Dr**11** and Dr**12** are arranged in this order from the vehicle rear side to the vehicle front side, and Dr**13**, Dr**14**, Dr**15** and Dr**16** are arranged in this order from the vehicle rear side to the vehicle front side.

[**0175**] The temperature detection range **700***b* of the left matrix IR sensor **70***b* arranged to face the rear left passenger RrPa is set symmetrically to the temperature detection range **700***a* of **FIG. 13**, with respect to the center line in the vehicle right-left direction. Similarly to the right matrix IR sensor **70***a*, 16 temperature detection elements of the left matrix IR sensor **70***b* facing toward the rear left passenger RrPa are arranged in four rows and four lines. Specifically, the thermoelectric couple portions are arranged in four lines of Pa**1**-Pa**4**, Pa**5**-Pa**8**, Pa**9**-Pa**12** and Pa**13**-Pa**16** in this order from the rightmost portion of the rear left window side to the center portion (inner side) in the vehicle right-left direction.

[**0176**] Temperatures TDr3, TDr4 corresponding to the surface temperature of the rear right window are detected by the thermoelectric couple portions Dr**3**, Dr**4** positioned right side among the thermoelectric couple portions Dr**1**, Dr**2**, Dr**3**, Dr**4**. Then, a rear right window surface temperature TirWRrDr is calculated in accordance with the formula (17).

$$TirWRrDr=(TDr3+TDr4)/2 \tag{17}$$

[**0177**] Further, temperatures TDr7, TDr8 corresponding to the surface temperature of the trim panel of the rear right door are detected by the thermoelectric couple portions Dr**7**, Dr**8**. Then, a surface temperature TirINRrDr of the rear right trim panel is calculated in accordance with the formula (18).

$$TirINRrDr=(TDr7+TDr8)/2 \tag{18}$$

[**0178**] In addition, temperatures TDr9-TDr16 corresponding to the surface temperature of the rear right passenger RrDr are detected by the thermoelectric couple portions Dr**9**-Dr**16**. Then, a surface temperature TirRrDr of the rear right side passenger is calculated in accordance with the formula (19).

$$TirRrDr=(TDr9+TDr10+TDr11+TDr12+TDr13+TDr14TDr15+TDr16)/8 \tag{19}$$

[0179] Similarly, temperatures TPa3, TPa4 corresponding to the surface temperature of the rear right window are detected by the thermoelectric couple portions Pa**3**, Pa**4** positioned at left side among the thermoelectric couple portions Pa**1**, Pa**2**, Pa**3**, Pa**4**. Then, a rear left window surface temperature TirWRrPa is calculated in accordance with the formula (20).

$$TirWRrPa=(TPa3+TPa4)/2 \tag{20}$$

[0180] Further, temperatures TPa7, TPa8 corresponding to the surface temperature of the trim panel of the rear left door are detected by the thermoelectric couple portions Pa**7**, Pa**8**. Then, a surface temperature TirINRrPa of the rear left trim panel is calculated in accordance with the formula (21).

$$TirINRrPa=(TPa7+TPa8)/2 \tag{21}$$

[0181] In addition, temperatures TPa9-TPa16 corresponding to the surface temperature of the rear left passenger RrPa are detected by the eight thermoelectric couple portions Pa**9**-Pa**16**. Then, a surface temperature TirRrPa of the rear left side passenger is calculated in accordance with the formula (22).

$$TirRrPa=(TPa9+TPa10+TPa11+TPa12+TPa13+TPa14\ TPa15+TPa16)/8 \tag{22}$$

[0182] In the second embodiment, because the non-contact temperature sensor **70** is arranged in the ceiling portion approximately at the center position Rc so that the right and left matrix IR sensors **70***a*, **70***b* face toward the rear right and left passengers. Accordingly, even when the frame of the passenger body on the rear seat is changed, a position change of the shoulder portion and the thigh portion of the rear passenger in the temperature detection range **700***a*, **700***b* can be made smaller.

[0183] Furthermore, the sensor process circuit **71***f* for processing the detection signals of both the right and left matrix IR sensors **70***a*, **70***b* is used in common for both the right and left matrix IR sensors **70***a*, **70***b*. Therefore, the structure of the non-contact temperature sensor **70** can be made simple.

[0184] The control operation of the second embodiment will be now described. Similarly to the above-described first embodiment, air conditioning control is performed in accordance with the flow charts shown in **FIGS. 7A and 7B** and control maps shown in **FIGS. 8-10**. Specifically, at steps **S123** in **FIG. 7A** and step **S223** in **FIG. 7B**, a rear right target blowing-out temperature TAORrDr and a rear left target blowing-out temperature TAORrPa are calculated in accordance with the above formulas (5) and (10). In formulas (5) and (10), the calculations of the rear right temperature Tir**1**c and the rear left temperature Tir**1**d are similar to that of the above-described first embodiment. However, in the second embodiment, the rear right and left window surface temperatures TirWRrDr, TirWRrPa, the trim panel surface temperatures TirINRrDr, TirINRrPa of the rear doors and the passenger's surface temperatures TirRrDr, TirRrPa are calculated as described above in formulas (17)-(19) and (20)-(22). The other control operations are similar to those of the above-described first embodiment.

[0185] In the second embodiment, similarly to the matrix IR sensor **70***a*, **70***b* of the first embodiment, the matrix IR sensor **70***a*, **70***b* can be attached to the ceiling portion to be pointed downwardly such that a sight center line of the non-contact temperature sensor **70** including the right and left matrix IR sensors **70***a*, **70***b* is substantially perpendicular to the vehicle front-rear direction. More specifically, the slight center line of the matrix IR sensor **70** can be positioned in a range between a position shifted from the vertical direction to a vehicle front side by 2° to a position shifted from the vertical direction to a vehicle rear side by 2°.

[0186] (Third Embodiment)

[0187] The third embodiment of the present invention will be now described with reference to **FIGS. 14, 15A** and **15**B.

[0188] In the above-described first embodiment, the air conditioning control for each front air conditioning zone **1***a*, **1***b* is performed without using the detected surface temperature of the non-contact temperature sensor. However, matrix IR sensors **70***c*, **70***d* having the same structure as the matrix IR sensors **70***a*, **70***b* of the first embodiment can be used for the air conditioning zones **1***a*, **1***b*. In this case, an air conditioning control for the air conditioning zone **1***a* and an air conditioning control for the air conditioning zone **1***b* can be respectively independently performed by using the surface temperatures detected by the matrix IR sensors **70***c*, **70***d*.

[0189] As shown in **FIGS. 14, 15A** and **15**B, the matrix IR sensor **70***c* is disposed in the ceiling portion at a position Rcf above the front right passenger in a range Lf**0**, on a front right window side from the center portion of the front right seat. Here, the range Lf**0** is a range between the front end of the seat cushion portion **30***a*, **30***b* and the rear end of the seat back portion **31***a*, **31***b* of the front seat. More preferably, the matrix IR sensor **70***c* is arranged in the ceiling portion in a range Lf**1** between the front end and the rear end of the seat cushion portion **30***a*, **30***b* of the front seat. In this case, the matrix IR sensor **70***c* readily detects the surface temperature of the passenger on the front right seat, the surface temperatures of the trim panel portion and window portion of the front right door. That is, the temperature detecting range **700***c* of the matrix IR sensor **70***c* readily contains the surface temperature of the passenger on the front right seat, the surface temperatures of the trim panel portion and window portion of the front right door.

[0190] Similarly, the matrix IR sensor **70***d* is disposed in the ceiling portion at a position Rdf above the front left passenger in the range Lf**0**, on a front left window side from the center portion of the front left seat. More preferably, the matrix IR sensor **70***d* is arranged in the ceiling portion in the range Lf**1** (see **FIG. 14**). In this case, the matrix IR sensor **70***d* readily detects the surface temperature of the passenger on the front left seat, the surface temperatures of the trim panel portion and window portion of the front left door. That is, the temperature detecting range **700***d* of the matrix IR sensor **70***d* readily contains the surface temperature of the passenger on the front left seat, the surface temperatures of the trim panel portion and window portion of the front left door.

[0191] The thermoelectric couple portions of the front matrix IR sensors **70***c*, **70***d* are indicated by the same reference numbers Dr**1**-Dr**16**, Pa**1**-Pa**16** of the rear matrix IR sensors **70***a*, **70***b* indicated in **FIGS. 5 and 6** of the above-described first embodiment.

[0192] Further, the front target blowing-out temperature TAOFrDr for the front air conditioning zone **1***a* and the front target blowing-out temperature TAOFrPr for the front air conditioning zone **1***b* are calculated similarly to the TAORrDr and TAORrPa of the above-described first embodiment.

[**0193**] The front right target blowing-out temperature TAOFrDr of air blown out to the air conditioning zone **1***a* in the passenger compartment is calculated in accordance with the formula (23) by using the set temperature signal TsetFrDr, the outside air temperature signal Tam, the solar radiation signal TsDr, the inside air temperature signal TrRr and a front right surface temperature Tir**1**a of the matrix IR sensor **70***c*. The target blowing-out temperature TAOFrDr is a necessary target temperature for maintaining the temperature of the front right air conditioning zone **1***a* at the set temperature TsetFrDr.

$$TAOFrDr=KsetFrDr\times TsetFrDr-KirFrDr\times Tir1a-KrFr\times TrFr-KsDr\times TsDr-Kam\times Tam+CFrDr \quad (23)$$

[**0194**] wherein, KsetFrDr is a front right temperature setting gain, KrFr is a front inside air temperature gain, Kam is the outside air temperature gain, KsDr is a right solar radiation gain, and CFrDr is a front right correction constant.

[**0195**] Here, the front right surface temperature Tirla is calculated in accordance with the following formula (24) by using a front right window surface temperature TirWFrDr, a front right trim panel temperature TirINFrDr and a front right passenger's temperature TirFrDr.

$$Tir1a=0.2\times TirWFrDr+0.3\times TirINFrDr+0.5\times TirFrDr \quad (24)$$

[**0196**] The front right window surface temperature TirWFrDr, the front right trim panel temperature TirINFrDr and the front right passenger's temperature TirFrDr can be calculated by using the average calculation shown in the formulas (17), (18) and (19).

[**0197**] The front left target blowing-out temperature TAOFrPr of air blown out to the air conditioning zone **1***b* in the passenger compartment is calculated in accordance with the formula (25) by using the set temperature signal TsetFrPr, the outside air temperature signal Tam, the solar radiation signal TsDr, the inside air temperature signal TrFr and a front left surface temperature Tirlb of the matrix IR sensor **70***d*. The target blowing-out temperature TAOFrPr is a necessary target temperature for maintaining the temperature of the front left air conditioning zone **1***b* at the set temperature TsetFrPr.

$$TAOFrPa=KsetFrPa\times TsetFrPa-KirFrPa\times Tir1b-KrFr\times TrFr-KsPa\times TsPa-Kam\times Tam+CFrPa \quad (25)$$

[**0198**] wherein, KsetFrPa is a front left temperature setting gain, KrFr is a front inside air temperature gain, Kam is the outside air temperature gain, KsPa is a left solar radiation gain, and CFrPa is a front left correction constant.

[**0199**] Here, the front left surface temperature Tirlb is calculated in accordance with the following formula (26) by using a front left window surface temperature TirWFrPa, a front left trim panel temperature TirINFrPa and a front left passenger's temperature TirFrPa.

$$Tir1d=0.2\times TirWFrPa+0.3\times TirINFrPa+0.5\times TirFrPa \quad (26)$$

[**0200**] The front left window surface temperature TirWFrPa, the front left trim panel temperature TirINFrPa and the front left passenger's temperature TirFrPa can be calculated by using the average calculation shown in the formulas (20), (21) and (22).

[**0201**] The other front air conditioning controls using the front target blowing-out temperatures TAOFrDr, TAOFrPa are similar to those of the above-described first embodiment.

[**0202**] In the third embodiment, the temperatures of the driver and front passenger on the front seats and the temperatures of the trim panels and windows of the front right and left doors are detected, and the target air temperatures for the air conditioning zones **1***a*, **1***b* are calculated to consider both the passenger's temperatures and the solar radiation. Therefore, comfortable air conditioning can be provided for each of the air conditioning zones **1***a*, **1***b*.

[**0203**] In the third embodiment, the rear air conditioning operation is similar to that of the above-described first embodiment.

[**0204**] (Fourth Embodiment)

[**0205**] The fourth embodiment of the present invention will be now described with reference to **FIGS. 16A and 16B**.

[**0206**] In the above-described second embodiment, the air conditioning control for each air conditioning zone **1***a*, **1***b* is performed without using the detected surface temperature of the non-contact sensor. However, a non-contact temperature sensor **70***f* having the same structure as the non-contact temperature sensor **70** of the second embodiment can be used for the air conditioning zones **1***a*, **1***b*. In this case, an air conditioning control for the air conditioning zone **1***a* and an air conditioning control for the air conditioning zone **1***b* can be respectively independently performed by using the surface temperature detected by the non-contact temperature sensor **70***f*.

[**0207**] As shown in **FIGS. 16A and 16B**, the non-contact temperature sensor **70***f* is disposed in the ceiling portion at a center position Rcf in the vehicle right-left direction on a vehicle front seat side within the range Lf**0**. More preferably, the non-sensor **70***f* is arranged in the ceiling portion in the range Lf**1** between the front end and the rear end of the seat cushion portion **30***a*, **30***b*. In this case, the non-contact temperature sensor **70***f* readily detects the surface temperature of the passenger on each front seat, the surface temperatures of the trim panel portion and window portion of the front door, similarly to the above-described second embodiment. That is, the non-contact temperature sensor **70***f* has right and left matrix IR sensors **70***a*, **70***b*, similarly to those of non-contact temperature sensor **70** of the above-described second embodiment. Therefore, the temperature detection range **700***a* of the front right matrix IR sensor **70***a* of the non-contact temperature sensor **70***f* readily contains the shoulder portion and the thigh portion of the driver on the front right seat, the surface temperatures of trim panel portion and window portion of the front right door. Similarly, the temperature detection range **700***b* of the front left matrix IR sensor **70***b* of the non-contact temperature sensor **70***f* readily contains the shoulder portion and the thigh portion of the front passenger on the front left seat, the surface temperatures of trim panel portion and window portion of the front left door.

[**0208**] The thermoelectric couple portions of the front matrix IR sensors **70***a*, **70***b* of the non-contact temperature sensor **70***f* are indicated by the same reference numbers Dr**1**-Dr**16**, Pa**1**-Pa**16** of the rear matrix IR sensors **70***a*, **70***b* of the non-contact temperature sensor **70** of the above-described second embodiment.

[**0209**] Further, the front target blowing-out temperature TAOFrDr for the front air conditioning zone **1**_a_ and the front target blowing-out temperature TAOFrPr for the front air conditioning zone **1**_b_ are calculated similarly to the TAORrDr and TAORrPa of the above-described second embodiment.

[**0210**] The target blowing-out temperature TAORrDr of air blown out to the air conditioning zone **1**_a_ in the passenger compartment is calculated in accordance with the formula (23) by using the set temperature signal TsetFrDr, the outside air temperature signal Tam, the solar radiation signal TsDr, the inside air temperature signal TrRr and a front right surface temperature Tir**1**a of the matrix IR sensor **70**_a_ of the non-contact temperature sensor **70**_f_. The target blowing-out temperature TAOFrDr is a necessary target temperature for maintaining the temperature of the front right air conditioning zone **1**_a_ at the set temperature TsetFrDr.

[**0211**] The target blowing-out temperature TAOFrPr of air blown out to the air conditioning zone **1**_b_ in the passenger compartment is calculated in accordance with the formula (25) by using the set temperature signal TsetFrPr, the outside air temperature signal Tam, the solar radiation signal TsDr, the inside air temperature signal TrFr and a front left surface temperature Tir**1**b of the matrix IR sensor **70**_b_ of the non-contact temperature sensor **70**_f_. The target blowing-out temperature TAOFrPr is a necessary target temperature for maintaining the temperature of the front left air conditioning zone **1**_b_ at the set temperature TsetFrPr.

[**0212**] The other front air conditioning controls using the front target blowing-out temperatures TAOFrDr, TAOFrPa are similar to those of the above-described first embodiment.

[**0213**] In the fourth embodiment, the temperatures of the driver and front passenger on the front seats and the temperatures of the trim panels and windows of the front right and left doors are detected by using the non-contact temperature sensor **70**_f_, and the target air temperatures for the air conditioning zones **1**_a_, **1**_b_ are calculated to consider both the passenger's temperatures and the solar radiation. Therefore, comfortable air conditioning can be provided for each of the air conditioning zones **1**_a_, **1**_b_.

[**0214**] In the fourth embodiment, the rear air conditioning operation is same as the that of the above-described second embodiment.

[**0215**] (Fifth Embodiment)

[**0216**] The fifth embodiment of the present invention will be now described with reference to **FIGS. 17-22**. In the above-described first and second embodiments, the front air conditioning control is performed without using a surface temperature detected by the non-contact temperature sensor. However, in the third embodiment, the front right and left air conditioning controls are performed also using surface temperature detected by a non-contact temperature sensor.

[**0217**] In the fifth embodiment, IR sensors **70**_a_, **70**_b_, **70**_c_ and **70**_d_ used as the non-contact temperature sensors are disposed to detect the surface temperatures of the air conditioning zones **1**_a_-**1**_d_. Specifically, as shown in **FIGS. 20A, 20B**, the non-contact temperature sensor **70**_a_ is disposed to detect the surface temperature of the rear right air conditioning zone **1**_c_, the non-contact temperature sensor **70**_b_ is disposed to detect the surface temperature of the rear left air conditioning zone **1**_d_, the non-contact temperature sensor **70**_c_ is disposed to detect the surface temperature of the front right air conditioning zone **1**_a_, and the non-contact temperature sensor **70**_d_ is disposed to detect the surface temperature of the front left air conditioning zone **1**_b_.

[**0218**] The IR sensors **70**_a_-**70**_d_ have the same structure shown in **FIGS. 18 and 19**. As shown in **FIGS. 18 and 19**, each of the IR sensors **70**_a_-**70**_b_ includes a square detection portion **71**_a_ (detection element) disposed on a substrate **71**_c_. The detection portion **71**_a_ is disposed to detect infrared rays and is covered by a cup-shaped case **71**_b_. A square window **71**_d_ is provided in a bottom portion of the case **71**_b_, and a cover **71**_e_ is provided in the window **71**_d_. Further, the detection portion **71**_a_ is disposed to be separated from the window **71**_d_ by a suitable distance S so that a temperature detecting angle α (sight angle) can be adjusted. Accordingly, the temperature detection range (sight range) of each IR sensor **70**_a_, **70**_b_, **70**_c_, **70**_d_ can be set to a predetermined shape by adjusting the shape of the window **71**_d_ and the distance S. In **FIG. 19**. L**1** indicates a length of the temperature detection portion **71**_c_, L**2** is a length of the window **71**_d_.

[**0219**] **FIGS. 20A and 20B** show the arrangement positions of the IR sensors **70**_a_-**70**_d_. As shown in **FIGS. 20A and 20B**, the IR sensors **70**_a_-**70**_d_ are arranged in the ceiling portion at window sides more than position centers (body centers of passengers) of the seats in the air conditioning zones **1**_a_-**1**_d_. Furthermore, the IR sensors **70**_a_, **70**_b_ are disposed in the ceiling portion above the area Lr**0** between the front end of the seat cushion portion **30**_c_, **30**_d_ and the rear end of the seat back portion **31**_c_, **31**_d_. More preferably, the IR sensors **70**_a_, **70**_b_ are disposed in the ceiling portion above the area Lr**1** between the front end of the seat cushion portion **30**_c_, **30**_d_ and the rear end of the seat cushion portion **30**_c_, **30**_d_. Similarly, the IR sensors **70**_c_, **70**_d_ are disposed in the ceiling portion above an area Lf**0** between the front end of the seat cushion portion **30**_a_, **30**_b_ and the rear end of the seat back portion **31**_a_, **31**_b_. More preferably, the IR sensors **70**_c_, **70**_d_ are disposed in the ceiling portion above the area Lf**1** between the front end of the seat cushion portion **30**_a_, **30**_b_ and the rear end of the seat cushion portion **30**_a_, **30**_b_.

[**0220**] Further, in the fifth embodiment, the IR sensors **70**_a_-**70**_d_ are arranged so that each of the temperature detection ranges (sight ranges) **700**_a_-**700**_d_ of the IR sensors **70**_a_-**70**_d_ faces toward the upper surface of the shoulder portion of a passenger on the window side.

[**0221**] **FIG. 21** is an example showing the sight range (temperature detection range) of the rear right IR sensor **70**_a_. As shown in **FIG. 21**, the upper portion of the rear right shoulder portion of the rear right passenger adjacent to the rear right window is mainly contained in the temperature detection range of the rear right IR sensor **70**_a_.

[**0222**] In the fifth embodiment, each of the IR sensors **70**_a_-**70**_d_ is disposed to view the shoulder portion adjacent to the side window from the vehicle ceiling portion downwardly in a vertical direction. Accordingly, even when the position of the shoulder portion of the passenger is changed in the vertical direction due to a change of the seated height or the posture of the passenger, it can restrict the shoulder portion of the passenger from being offset from the temperature detection range. Thus, the surface temperature of the shoulder portion of the passenger on each seat can be stably detected.

[0223] In the fifth embodiment, as shown in **FIG. 17**, detected surface temperatures of the IR sensors **70***a*-**70***d* are also input to the air conditioning ECU **8**.

[0224] Next, calculations of right and left target blowing-out temperatures TAOFrDr, TAOFrPa for performing front air conditioning control will be now described. In the fifth embodiment, the surface temperatures detected by the IR sensors **70***c*, **70***d* are used instead of the inside air temperature TrFr, as compared with the above-described first embodiment.

[0225] The target blowing-out temperature TAOFrDr of air blown out to the air conditioning zone **1***a* in the passenger compartment is calculated in accordance with the formula (27) by using the set temperature signal TsetFrDr, the outside air temperature signal Tam, the solar radiation signal TsDr and the surface temperature signal TirFrDr. The target blowing-out temperature TAOFrDr is a necessary target temperature for maintaining the temperature of the front right air conditioning zone **1***a* (driver's seat air conditioning zone) at the set temperature TsetFrDr. Here, the surface temperature signal TirFrDr is sent from the IR sensor **70***c* (non-contact temperature sensor).

$$TAOFrDr=KsetFrDr\times TsetFrDr-KirFrDr\times TirFrDr-Kam\times Tam-KsDr\times TsDr+CFrDr \tag{27}$$

[0226] wherein, KsetFrDr is a front right temperature setting gain (e.g., KsetFrDr=7.0), KirFrDr is a front right surface temperature gain (e.g., KirFrDr=3.0), Kam is an outside air temperature gain (e.g., Kam=1.1), KsDr is right solar radiation gain (e.g., KsDr=0.42), and CFrDr is a front right correction constant. In this embodiment, the CFrDr is set to be corrected based on the graph of **FIG. 22**. Generally, the correction constant is set so that the target air temperature TAO becomes lower as the outside air temperature Tam increases.

[0227] The target blowing-out temperature TAOFrPa of air blown out to the air conditioning zone **1***b* in the passenger compartment is calculated in accordance with the formula (28) by using the set temperature signal TsetFrPa, the outside air temperature signal Tam, the solar radiation signal TsPa and the surface temperature signal TirFrPa. The target blowing-out temperature TAOFrPa is a necessary target temperature for maintaining the temperature of the front left air conditioning zone **1***b* (front passenger's seat air conditioning zone) at the set temperature TsetFrPa. Here, the surface temperature signal TirFrPa is sent from the IR sensor **70***d* (non-contact temperature sensor).

$$TAOFrPa=KsetFrPa\times TsetFrPa-KirFrPa\times TirFrPa-Kam\times Tam-KsPa\times TsPa+CFrPa \tag{28}$$

[0228] wherein, KsetFrPa is a front left temperature setting gain (e.g., KsetFrPa=7.0), KirFrPa is a front left surface temperature gain (e.g., KirFrDr=3.0), Kam is an outside air temperature gain (e.g., Kam=1.1), KsPa is left solar radiation gain (e.g., KsDr=0.42), and CFrPa is a front left correction constant. In this embodiment, the CFrPa is also set to be corrected based on the graph of **FIG. 22**.

[0229] The other front air-conditioning control operations using the target blowing-out temperatures TAOFrDr, TAOFrPa are similar to those of the above-described first embodiment.

[0230] Next, calculations of right and left target blowing-out temperatures TAORrDr, TAORrPa for performing rear air conditioning control will be now described. In this embodiment, the surface temperatures detected by the IR sensors **70***a*, **70***b* are also used.

[0231] The target blowing-out temperature TAORrDr of air blown out to the air conditioning zone **1***c* in the passenger compartment is calculated in accordance with the formula (29) by using the set temperature signal TsetRrDr, the outside air temperature signal Tam, the solar radiation signal TsDr and the surface temperature signal TirRrDr. The target blowing-out temperature TAORrDr is a necessary target temperature for maintaining the temperature of the rear right air conditioning zone **1***c* at the set temperature TsetRrDr. Here, the surface temperature signal TirRrDr is sent from the IR sensor **70***a* (non-contact temperature sensor).

$$TAORrDr=KsetRrDr\times TsetRrDr-KirRrDr\times TirRrDr-Kam\times Tam-KsDr\times TsDr+CRrDr \tag{29}$$

[0232] wherein, KsetRrDr is a rear right temperature setting gain (e.g., KsetRrDr=7.0), KirRrDr is a rear right surface temperature gain (e.g., KirRrDr=3.0), Kam is an outside air temperature gain (e.g., Kam=1.1), KsDr is right solar radiation gain (e.g., KsDr=0.42), and CRrDr is a rear right correction constant. In this embodiment, the CRrDr is set to be corrected based on the graph of **FIG. 22**.

[0233] Further, the target blowing-out temperature TAORrPa of air blown out to the air conditioning zone **1***d* in the passenger compartment is calculated in accordance with the formula (30) by using the set temperature signal TsetRrPa, the outside air temperature signal Tam, the solar radiation signal TsPa and the surface temperature signal TirRrPa. The target blowing-out temperature TAORrPa is a necessary target temperature for maintaining the temperature of the rear left air conditioning zone **1***d* at the set temperature TsetRrPa. Here, the surface temperature signal TirRrPa is sent from the IR sensor **70***b* (non-contact temperature sensor).

$$TAORrPa=KsetRrPa\times TsetRrPa-KirRrPa\times TirRrPa-Kam\times Tam-KsPa\times TsPa+CFrPa \tag{30}$$

[0234] wherein, KsetRrPa is a rear left temperature setting gain (e.g., KsetRrPa=7.0), KirRrPa is a rear left surface temperature gain (e.g., KirRrPa=3.0), Kam is an outside air temperature gain (e.g., Kam=1.1), KsPa is left solar radiation gain (e.g., KsPa=0.42), and CRrPa is a rear left correction constant. In this embodiment, the CRrPa is also set to be corrected based on the graph of **FIG. 22**.

[0235] The other rear air-conditioning control operations using the target blowing-out temperatures TAORrDr, TAORrPa are similar to those of the above-described first embodiment.

[0236] According to the fifth embodiment, the IR sensor **70***c* is arranged above the right-window side shoulder portion of the passenger on the front right seat, and the IR sensor **70***d* is arranged above the left-window side shoulder portion of the passenger on the front left seat, the IR sensor **70***a* is arranged above the right-window side shoulder portion of the passenger on the rear right seat, the IR sensor **70***d* is arranged above the left-window side shoulder portion of the passenger on the rear left seat. Accordingly, even if the shoulder position of the passenger is changed in the vertical direction, it can restrict the upper portion of the passenger's shoulder portion of the temperature detecting object from being offset from the temperature detection range of each IR sensor **70**a-**70**d. Therefore, the temperature of the shoulder portion of the passenger can be accurately detected.

[**0237**] Because the target blowing-out temperature of air to be blown to the passenger compartment is calculated using the detected temperatures of the IR sensors **70**a-**70**d, and is corrected by estimating a clothing amount of each passenger in accordance with the outside air temperature Tam. Therefore, air conditioning operation comfortable for each passenger in the passenger compartment can be performed.

[**0238**] (Other Embodiments)

[**0239**] Although the present invention has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications will become apparent to those skilled in the art.

[**0240**] In the above-described first embodiment, as shown in **FIG. 5A**, the temperature detection range **700**a to be detected is fixed and is divided by 16 ranges Dr**1**-Dr**16**. However, the temperature detection range **700**a to be detected can be expanded and can be divided into Dr**1**-Dr**16** and DrE**1**-DrE**4** in accordance with seat positions detected by the seat position detection units **1**ap, **1**bp, **1**cp (see **FIG. 2**). For example, when the seat position of the rear right seat of the passenger compartment is normal, the air conditioning control is performed in accordance with the ranges Dr**1**-Dr**16** of the temperature detection range **700**a. In contrast, for example, when the seat position of the rear right seat is detected to be shifted to a vehicle rear side from the normal position, the temperature detection range **700**a is shifted to the vehicle rear side so that air conditioning control is performed by also using the ranges DrE**1**-DrE**4** as the temperature detection range **700**a.

[**0241**] **FIG. 24** shows a control process for determining a using area of the temperature detection range **700**a when the seat (e.g., rear right seat) is shifted in a vehicle front-rear direction from the normal position. At step **S300**, it is determined whether or not the position of the seat (e.g., rear right seat) detected by the seat position detection unit **1**ap, **1**bp and **1**cp is in the normal position. When the detected seat position is in the normal position, air conditioning control is performed using the general ranges Dr**1**-Dr**16** of the temperature detection range **700**a at step **S310**. In contrast, when the seat position is determined to be shifted to the vehicle rear side, the ranges DrE**1**, DrE**2**, DrE**3** and DrE**4** are used instead of the ranges Dr**4**, Dr**8**, Dr**12** and Dr**16** in the temperature detection range **700**a. That is, the temperature detection range to be used in the air conditioning control can be selected in accordance with the seat position in the vehicle front-rear direction.

[**0242**] Similarly to the temperature detection range **700**a, the temperature detection range **700**b, **700**c, **700**d can be shifted in accordance with the seat position in the vehicle front-rear direction.

[**0243**] In the above-described first to fourth embodiments, the matrix IR sensors **70**a, **70**b, **70**c, **70**d each having plural thermoelectric couple portions arranged in the matrix shape are used as the non-contact temperature sensor. However, a non-contact temperature sensor having a single temperature detection element can be used. In this case, the passage of the infrared rays can be scanned in the second dimension along the temperature detection range. For example, the structure of the non-contact temperature sensor described in JP-9-159531 can be used.

[**0244**] In the above-described embodiments, a passenger's seating state such as a presence or an absence of a passenger, and a passenger's position can be determined based on a temperature distribution of the temperature detection range of the IR sensor **70**a, **70**b, **70**c, **70**d. Further, this determination can be also used in other devices except to the air conditioning device.

[**0245**] In the above-described fifth embodiment, the IR sensor **70**a, **70**b, **70**c, **70**d (non-contact temperature sensors) is arranged in the ceiling portion above the shoulder portion on the side-window side of each passenger. However, in the fifth embodiment, the arrangement position of each IR sensor **70**a, **70**b, **70**c, **70**d can be changed. Even when the arrangement position of each IR sensor **70**a is changed, the other parts can be made similarly to those of the above-described fifth embodiment.

[**0246**] For example, as shown in **FIGS. 25A, 25B**, each of the IR sensors **70**a-**70**d can be arranged in the ceiling portion on a side of the side window from a center portion of a passenger on each seat in the vehicle width direction, at a vehicle front side from the center portion of the passenger on each seat. In this case, the IR sensor **70**a, **70**b, **70**c, **70**d detects the passenger slanting-downwardly from the vehicle front side. Accordingly, even when the position of the shoulder portion of the passenger in the vertical direction is changed, the temperature of the upper portion of the shoulder portion of the passenger can be accurately detected without being offset from the temperature detection range **700**a, **700**b, **700**c, **700**d.

[**0247**] Alternatively, as shown in **FIGS. 26A, 26B**, each of the IR sensors **70**a-**70**d can be arranged in the ceiling portion on the side of the side window from a center portion of a passenger on each seat in the vehicle width direction, at a vehicle rear side from the center portion of the passenger on each seat. In this case, the IR sensor **70**a, **70**b, **70**c, **70**d detects the passenger slanting-downwardly from the vehicle rear side. Accordingly, even when the position of the shoulder portion of the passenger in the vertical direction is changed, the temperature of the upper portion of the shoulder portion of the passenger can be accurately detected without being offset from the temperature detection range **700**a, **700**b, **700**c, **700**d. Further, in this case, the IR sensor **70**a, **70**b, **70**c, **70**d is positioned to be separated from the sight range of the passenger. Therefore, a passenger's feeling to be watched by the sensor **70**a, **70**b, **70**c, **70**d can be removed.

[**0248**] Further, in the fifth embodiment, as shown in **FIGS. 27A, 27B**, the temperature detection range **700**a, **700**b, **700**c, **700**d of the IR sensor **70**a, **70**b, **70**c, **70**d can be made to include not only the upper portion of the shoulder portion of the passenger but also the trim panel and the side window. In this case, the temperature detection range **700**a, **700**b, **700**c, **700**d of the IR sensor **70**a, **70**b, **70**c, **70**d can be arranged at an end side of the face portion of the passenger to not include the face portion of the passenger. Accordingly, the temperature of the passenger can be stably detected without being affected by an individual difference of the passenger' face portion, such as the here state and here length.

[0249] When the distance S between the detection portion **71***a* and the window portion **71***d* of the IR sensor **70***a*, **70***b*, **70***c*, **70***d* shown in **FIG. 19** is set shorter, the temperature detection range (i.e., sight range) of the IR sensor **70***a*, **70***b*, **70***c*, **70***d* becomes larger. Alternatively, in **FIG. 19**, the sight direction of the IR sensors **70***a*, **70***b*, **70***c*, **70***d* can be set to be tilted toward the side window. In this case, the target blowing-out temperature can be calculated in accordance with the passenger's temperature and the temperature of the trim panel. Further, by setting the distance between the detection portion **71***a* and the window portion **71***d* of the IR sensor **70***a*, **70***b*, **70***c*, **70***d* shown in **FIG. 19** to be shorter, or by setting the sight direction of the IR sensors **70***a*, **70***b*, **70***c*, **70***d* to be tilted toward the side window, the temperature detection range **700***a*, **700***b*, **700***c*, **700***d* of the IR sensor **70***a*, **70***b*, **70***c*, **70***d* can be set to include not only the shoulder portion of the passenger but also the trim portion and the window portion of the side door, as shown in **FIGS. 28A and 28B**.

[0250] Such changes and modifications are to be understood as being within the scope of the present invention as defined by the appended claims.

What is claimed is:

1. A temperature detection device for a vehicle having a plurality of seats in a passenger compartment, the temperature detection device comprising:

a non-contact temperature sensor having a plurality of temperature detection elements for detecting surface temperatures of a plurality of temperature detection ranges in a vicinity of at least one of the seats in non-contact, wherein:

the non-contact temperature sensor is disposed to detect a surface temperature of a passenger seated on the one seat and to send a detected temperature signal to an air conditioner; and

the non-contact temperature sensor is provided in a ceiling portion of the passenger compartment in an arrangement area of the ceiling portion between a front end and a rear end of the one seat in a vehicle front-rear direction.

2. The temperature detection device according to claim 1, wherein:

the arrangement area is an area of the ceiling portion between a frontmost end of a seat cushion portion of the one seat to a rearmost end of a seat back portion of the one seat; and

the non-contact temperature sensor has a sight center line that is substantially perpendicular to the front-rear direction.

3. The temperature detection device according to claim 1, wherein the arrangement area is an area of the ceiling portion between a frontmost end and a rearmost end of a seat cushion portion of the one seat.

4. The temperature detection device according to claim 1, wherein the temperature detection elements of the non-contact temperature sensor are arranged to detect surface temperatures of at least the shoulder portion and the thigh portion of a passenger on the one seat.

5. The temperature detection device according to claim 1, wherein the temperature detection elements of the non-contact temperature sensor are arranged to detect a surface temperature of a passenger on the one seat, a surface temperature of a side window adjacent to the passenger, and a surface temperature of a trim panel between the passenger and the side window.

6. The temperature detection device according to claim 1, wherein:

the one seat is a front seat having right and left seat portions or a rear seat having right and left seat portions in the passenger compartment; and

the non-contact temperature sensor includes

a right matrix IR sensor having a plurality of right temperature detection elements which are arranged such that temperature detection ranges of the right temperature detection elements include at least a passenger on the right seat portion of the one seat, and

a left matrix IR sensor having a plurality of left temperature detection elements which are arranged such that temperature detection ranges of the left temperature detection elements include at least a passenger on the left seat portion of the one seat.

7. The temperature detection device according to claim 6, wherein:

the right matrix IR sensor is provided in the ceiling portion above the right seat portion; and

the left matrix IR sensor is provided in the ceiling portion above the left seat portion.

8. The temperature detection device according to claim 7, wherein:

the right matrix IR sensor is provided in the ceiling portion at a position shifted from a center of the right seat portion to a side window adjacent to the right seat portion.

9. The temperature detection device according to claim 6, wherein:

the right matrix IR sensor is provided in the ceiling portion above a cushion portion of the right seat portion; and

the left matrix IR sensor is provided in the ceiling portion above a cushion portion of the left seat portion.

10. The temperature detection device according to claim 6, wherein the right matrix IR sensor and the left matrix IR sensor are arranged in the ceiling portion adjacent to each other in an approximate center position in a vehicle right-left direction.

11. The temperature detection device according to claim 1, wherein the air conditioner including

an air conditioning unit which adjusts an air conditioning state in the passenger compartment, and

a control unit for controlling operation of the air conditioning unit; and

wherein the control unit calculates a target temperature of air to be blown into the passenger compartment based on a surface temperature of a passenger detected by the non-contact temperature sensor, and controls the air conditioning unit based on the target temperature.

12. The temperature detection device according to claim 11, wherein:

the control unit calculates a passenger's temperature on the one seat by a weighting calculation of the surface temperature of the passenger on the seat, a surface temperature of a side window adjacent to the passenger, and a surface temperature of a trim panel between the passenger and the side window, which are detected by the non-contact temperature sensor; and

the control unit calculates the target temperature based on the passenger's temperature.

13. The temperature detection device according to claim 12, wherein:

the weighting calculation has a first weighting coefficient relative to the surface temperature of the passenger, a second weighting coefficient relative to the surface temperature of the side window, and a third weighting coefficient relative to the surface temperature of the trim panel; and

the first weighting coefficient is the largest value among the first, second and third weighting coefficients, and the second coefficient is the smallest value among the first, second and third weighting coefficients.

14. The temperature detection device according to claim 1, wherein:

the non-contact temperature sensor is provided above a passenger's seating position of the one seat at a side of a side window adjacent to the passenger's seating position from a center of the passenger's seating position;

the non-contact temperature sensor has a predetermined temperature detection range which includes at least an upper portion of the shoulder of the passenger on the side of the side window; and

the air conditioner has a control unit which controls an air conditioning state of the passenger compartment based on the temperature detected by the non-contact temperature sensor.

15. The temperature detection device according to claim 14, wherein the non-contact temperature sensor is provided above the passenger's seating position of the one seat at a front side in the passenger's seating position.

16. The temperature detection device according to claim 14, wherein the non-contact temperature sensor is provided above the passenger's seating position of the one seat at a rear side in the passenger's seating position.

17. The temperature detection device according to claim 14, wherein the temperature detection range of the non-contact temperature sensor includes the upper portion of the shoulder adjacent to the side window and a trim panel portion around the side window.

18. The temperature detection device according to claim 14, wherein the temperature detection range of the non-contact temperature sensor includes the upper portion of the shoulder adjacent to the side window and the side window.

19. The temperature detection device according to claim 14, wherein the temperature detection range of the non-contact temperature sensor includes the upper portion of the shoulder at a side end of the face portion of the passenger in the temperature detection range.

20. The temperature detection device according to claim 1, wherein:

the non-contact temperature sensor includes a right sensor portion that is provided above a right passenger's seating portion of the one seat at a side of a right side window from a center of the right passenger's seating portion, a left sensor portion that is provided above a left passenger's seating portion of the one seat at a side of a left side window from a center of the left passenger's seating portion;

the right sensor portion has a predetermined temperature detection range which includes at least an upper portion of the shoulder of a passenger on the right passenger's seating portion; and

the left sensor portion has a predetermined temperature detection range which includes at least an upper portion of the shoulder of a passenger on the left passenger's seating portion.

21. The temperature detection device according to claim **14**, wherein the air conditioning control unit calculates a target temperature of air to be blown to the passenger compartment based on the temperature detected by the non-contact temperature sensor, and controls the air conditioning state in the temperature detection range based on the target temperature.

22. The temperature detection device according to claim 1, wherein the temperature detection ranges to be used are changed in accordance with positions of the seats in the vehicle front-rear direction.

23. An air conditioner for a vehicle having a front right seat, a front left seat, a rear right seat and a rear left seat in a passenger compartment, the air conditioner comprising:

an air conditioning unit for respectively independently adjusting air conditioning states of first and second air conditioning zones positioned at right and left sides of a front seat in the passenger compartment, and third and fourth air conditioning zones positioned at right and left sides of a rear seat in the passenger compartment;

a front non-contact temperature sensor having a front right matrix IR sensor for detecting a temperature of a passenger on the front right seat, and a front left matrix IR sensor for detecting a temperature of a passenger on the front left seat;

a rear non-contact temperature sensor having a rear right matrix IR sensor for detecting a temperature of a passenger on the rear right seat, and a rear left matrix IR sensor for detecting a temperature of a passenger on the rear left seat; and

a control unit for controlling the air conditioning unit by using the temperatures detected by the front right matrix IR sensor, the front left matrix IR sensor, the rear right matrix IR sensor and the rear left matrix IR sensor, wherein:

the front non-contact temperature sensor is provided in a ceiling portion of the passenger compartment in an arrangement area of the ceiling portion between a front end and a rear end of the front right and left seats in a vehicle front-rear direction; and the rear non-contact temperature sensor is provided in the ceiling portion of the passenger compartment in an arrangement area of the ceiling portion between a front end and a rear end of the rear right and left seats in the vehicle front-rear direction.

24. The air conditioner according to claim 23, wherein:

the front right matrix IR sensor is disposed in the ceiling portion above the front right seat;

the front left matrix IR sensor is disposed in the ceiling portion above the front left seat;

the rear right matrix IR sensor is disposed in the ceiling portion above the rear right seat;

the rear left matrix IR sensor is disposed in the ceiling portion above the rear left seat;

the control unit calculates a first target temperature of air to be blown to the first air conditioning zone based on a temperature of a passenger detected by the front right matrix IR sensor, and controls the air conditioning state in the first air conditioning zone based on the first target temperature;

the control unit calculates a second target temperature of air to be blown to the second air conditioning zone based on a temperature of a passenger detected by the front left matrix IR sensor, and controls the air conditioning state in the second air conditioning zone based on the second target temperature;

the control unit calculates a third target temperature of air to be blown to the third air conditioning zone based on a temperature of a passenger detected by the rear right matrix IR sensor, and controls the air conditioning state in the third air conditioning zone based on the third target temperature; and

the control unit calculates a fourth target temperature of air to be blown to the fourth air conditioning zone based on a temperature of a passenger detected by the rear left matrix IR sensor, and controls the air conditioning state in the fourth air conditioning zone based on the fourth target temperature.

25. An air conditioner for a vehicle having a plurality of seats, the air conditioner comprising:

a non-contact temperature sensor having a plurality of temperature detection elements for detecting surface temperatures of a plurality of temperature detection ranges in a vicinity of at least one of the seats in non-contact;

an air conditioning unit for adjusting an air conditioning state of a passenger compartment; and

a control unit for controlling the air conditioning unit based on a temperature detected by the non-contact temperature sensor,

wherein the non-contact temperature sensor is provided in a ceiling portion of the passenger compartment in an arrangement area of the ceiling portion between a front end and a rear end of the one seat in a vehicle front-rear direction.

26. The air conditioner according to claim 25, wherein:

the arrangement area is an area of the ceiling portion between a frontmost end of a seat cushion portion of the one seat to a rearmost end of a seat back portion of the one seat; and

the non-contact temperature sensor has a sight center line that is substantially perpendicular to the front-rear direction.

27. The air conditioner according to claim 25, wherein the arrangement area is an area of the ceiling portion between a frontmost end and a rearmost end of a seat cushion portion of the one seat.

28. The air conditioner according to claim 25, wherein the temperature detection elements of the non-contact temperature sensor are arranged to detect a surface temperature of at least the shoulder portion of a passenger on the one seat.

29. The air conditioner according to claim 25, wherein the control unit calculates a target temperature of air to be blown into the passenger compartment based on a surface temperature of a passenger detected by the non-contact temperature sensor, and controls the air conditioning unit based on the target temperature.

30. The air conditioner according to claim 29, wherein:

the control unit calculates a passenger's temperature on the one seat by a weighting calculation of the surface temperature of the passenger on the seat, a surface temperature of a side window adjacent to the passenger, and a surface temperature of a trim panel between the passenger and the side window, which are detected by the non-contact temperature sensor; and

the control unit calculates the target temperature based on the passenger's temperature.

31. The air conditioner according to claim 30, wherein:

the weighting calculation has a first weighting coefficient relative to the surface temperature of the passenger, a second weighting coefficient relative to the surface temperature of the side window, and a third weighting coefficient relative to the surface temperature of the trim panel; and

the first weighting coefficient is the largest value among the first, second and third weighting coefficients, and the second coefficient is the smallest value among the first, second and third weighting coefficients.

32. The air conditioner according to claim 25, wherein the control unit selects the temperature detection ranges to be used in accordance with positions of the seats in the vehicle front-rear direction.

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