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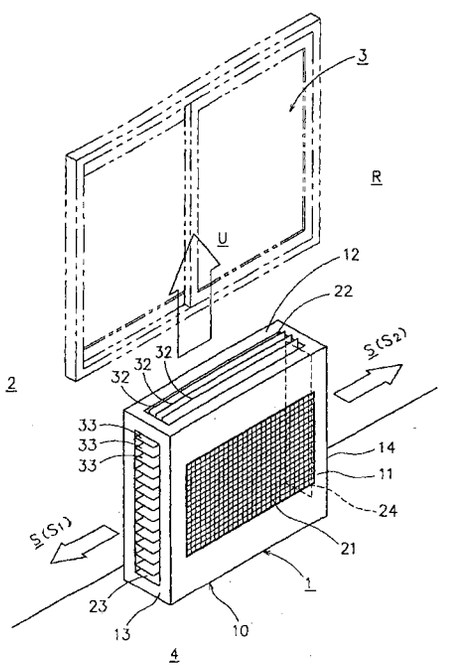
(54) INDOOR AIR CONDITIONER

(57) An indoor air conditioner (1) has an upward outlet (22) and side outlets (23, 24) and capable of providing a cozy air-conditioned space by improving nonuniformity in an indoor temperature distribution, wherein, in cooling operation, the ratio of a left-side blown-off air volume (SC_1) to an upward blown-off air volume (UC) and to a right-side blown-off air volume (SC_2) is set to SC_1:UC:SC_2 = 1:2:1 to 1:4:1, and in a heating operation, the ratio of a left-side blown-off air volume (SW_1) to an upward blown-off air volume (UW) and to a right-side blown-off air volume (SW_2) is set to SW_1:UW:SW_2 = 2:1:2 to 1:1:1.

Fig. 1



EP 1 367 336 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to an indoor air conditioner disposed inside of a room, and more specifically relates to an indoor air conditioner having upward and side outlets.

BACKGROUND ART

[0002] In cooling or heating indoor air by an indoor air conditioner, various attempts have been made to provide the entire indoor air with uniform temperature distribution. However, they have not yet reached to the level of sufficient satisfaction.

[0003] One conventional example of the above-stated attempts is described in Japanese Patent Laid-Open Publication No. 2000-346392 which one of the applicants of the present invention formerly filed. In this application, air is blown off from upward and side portions of a main unit of an indoor air conditioner so as to decrease local nonuniformity of temperature distribution in the vicinity of a wall or window, and decrease vertical difference in indoor temperature distribution.

DISCLOSURE OF THE INVENTION

[0004] The present invention takes a new standpoint of controlling the volume of air blown off from the indoor air conditioner into upward and side directions so as to solve a problem of temperature nonuniformity during indoor cooling and heating operations, and thus to provide an air-conditioned environment as cozy as possible.

[0005] As shown in Fig. 1, the indoor air conditioner of the present invention is composed of air outlets 22, 23, 24 disposed on an upper face 12 and one or both side faces 13, 14 of the main unit, and provided with an air volume control means for controlling the volume of air blown off from the upward outlet 22 and from the side outlets 23, 24.

[0006] Swing flaps 32 and shutters 33 for increasing or decreasing air passage areas at the air outlets are used as means for controlling the air volume.

[0007] The present invention is directed to improve nonuniformity of temperature distribution in indoor cooling and heating operations controlling the volume of air blown off from the upward and side outlets of the indoor air conditioner so as to provide an air-conditioned environment as cozy as possible. For indicating a degree of conformability of air conditioning environment, there are used two indexes: PMV (Predicted Mean Vote) index and PPD (Predicted Percentage of Dissatisfied) index, both of which are designated in the ISO standards.

[0008] The PMV index has four elements regarding environment: temperature, humidity, airflow and radiation, and two elements regarding human: metabolic quantity and clothing quantity. Values of the PMV index corresponds to thermal senses. The PMV value +3 is "hot", +2 is "warm", +1 is "warmish", ±0 is "neither hot nor cold", -1 is "coolish", -2 is "cool", and -3 is "cold". In the ISO standards, it is recommended that the PMV index falls within "the range of -0.5 to +0.5." Therefore, in the present invention, "the range of -0.5 to +0.5" has been adopted as a preferable PMV index range.

[0009] The PPD index is defined as "an index for quantitatively predicting the percentage of people who feel thermally dissatisfied during staying in a given environment." The ISO standards state that the PPD index is desirably 10% or less for coziness in a residential environment of human beings.

[0010] In the present invention, a later-described "PMV cozy zone occupancy" is used in a cooling operation when setting a ratio of an upward blown-off air volume to a side blown-off air volume. Also, a "vertical temperature difference" is used in a cooling operation when setting a blown-off angle of side air.

[0011] In a heating operation, a "PPD index" is used when setting a ratio of an upward blown-off air volume to a side blown-off air volume and setting a blown-off angle of side air.

[0012] It is noted that the "PMV cozy zone occupancy" is defined as "a ratio of the zone (cozy zone) where the PMV index is in the range of -0.5 to +0.5 to an other residual zone in an air-conditioned space (indoor space)".

[0013] Under the above-stated condition, description will be given of control of upward and side blown-off air quantities in the indoor air conditioner of the present invention.

[0014] Fig. 2 is a graph for setting the ratio of an upward blown-off air volume to a side blown-off air volume in cooling operation, and shows the relation between the upward blown-off air volume and the PMV cozy zone occupancy when the side blown-off air volume is set to 1.

[0015] The graph indicates that the PMV cozy zone occupancy rises while the ratio of the upward blown-off air volume to the side blown-off air volume shifts from 1:1 to 4:1, and that thereafter the PMV cozy zone occupancy decreases.

[0016] In the present invention, the range from 2:1 to 4:1 of the blown-off air volume ratio has been adopted as a preferable range, as a result of comparison between the above-stated and the PMV cozy zone occupancy of 90% or more in radiator air conditioning operation.

[0017] This is explained with reference to examples shown in the drawings. As shown in Figs. 3 and 4, in the cooling operation, air volume control means is operated such that the blown-off air volume UC from an upward outlet is larger than blown-off air volume SC_1, SC_2 from one or both of side outlets.

[0018] In the case where side blown-off air is blown-off only from a side outlet in a side face (Fig. 3), the ratio (air volume ratio) of a blown-off air volume UC from the

upward outlet to a blown-off air volume SC_1 or SC_2 from a side outlet is preferably in the range of UC:SC_1 (or SC_2) = 2:1 to 4:1. It is noted that reference numeral 5 in Fig. 3 denotes a side wall face.

[0019] In the case where side blown-off air S_1, S_2 are blown-off from side outlets 23, 24 on the left and right sides (Fig. 4), the preferable ratio range is SC_1:UC:SC_2 = 1:2:1 to 1:4:1.

[0020] Fig. 5 is a graph for setting a blown-off angle of side blown-off air in the cooling operation, and shows the relation between change of a side blown-off angle and difference of vertical temperature in air-conditioned space.

[0021] In the present invention, the range within 1.5 °C (the range where the side blown-off angle is not smaller than -20 degree) has been adopted as a preferable range of the vertical temperature difference in air-conditioned space during cooling operation.

[0022] In the cooling operation, in order to prevent excessive fall of air temperature in the vicinity of the floor face, it is preferable for the air volume control means to have a function of controlling blown-off air so that air blown-off from the side outlets 23, 24 is blocked and that air only from the upward outlet is blown off.

[0023] Fig. 6 is a graph for setting the ratio of an upward blown-off air volume to a side blown-off air volume in the heating operation, and shows the relation between side air volume and PPD index when upward blown-off air volume is set to 1.

[0024] The graph indicates that the PPD index value is minimum when the ratio of the upward blown-off air volume to the side blown-off air volume is approximately 1:1, and that the PPD index value rises as the side blown-off air volume increases.

[0025] In the present invention, the range in the ratio of the upward blown-off air volume to the side blown-off air volume from 1:1 to 1:2 (PPD index value of approximately 6.7 or lower) has been adopted as a preferable range, from a viewpoint of making the PPD index value better than the PPD index value (total mean value of 7.11) in radiator heating operation.

[0026] This is explained with reference to examples shown in the drawings. As shown in Figs. 7 and 8, in the heating operation, the air volume control means is operated such that blown-off air volume SW_1, SW_2 from side outlet(s) is equal to or larger than the blown-off air volume UW from the upward outlet.

[0027] The ratio (air volume ratio) of the blown-off air volume UW from the upward outlet to the blown-off air volume SW_1, SW_2 from the side outlet (s), UW:SW_1 (or SW_2), is preferably in the range of 1:2 to 1:1 in the case where side blown-off air is blown-off from a side outlet on one side face (Fig. 7). In the case where the side outlets are disposed on the left and right sides (Fig. 8), the ratio (air volume ratio) of a blown-off air volume SW_1 from a left-side outlet to a blown-off air volume UW from an upward outlet and to a blown-off air volume SW_2 from a right-side outlet is preferably ranged from 2:1:2 to 1:1:1.

[0028] Fig. 9 is a graph for setting a blown-off angle of side blown-off air in the heating operation, and shows the relation between the blown-off angle of side blown-off air S_1, S_2 and the PPD index.

[0029] According to the graph, the PPD index value becomes larger as the blown-off angle of the side blown-off air S_1, S_2 increases, and the PPD index value exceeds approximately 6.7 when the blown-off angle is larger than the horizontal (0°).

[0030] In the present invention, in view of this PPD index value, the horizontal (0°) is set to the upper limit of the blown-off angle of the side blown-off air S_1, S_2, so that the blown-off angle does not become larger than the horizontal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

Fig. 1 is a perspective view of an indoor air conditioner in an embodiment according to the present invention;

Fig. 2 is a graph showing relation between upward blown-off air volume and a PMV cozy zone occupancy ratio when side blown-off air volume is set to 1 in a cooling operation;

Fig. 3 is a view showing a state of blowing off air only from a side outlet on one side in the cooling operation;

Fig. 4 is a view showing a state of blowing off air from side outlets on both sides in the cooling operation;

Fig. 5 is a graph showing relation between a side air blown-off angle and difference in indoor vertical temperature in the cooling operation;

Fig. 6 is a graph showing relation between a side blown-off air volume and a PPD index when an upward blown-off air volume is set to 1 in a heating operation;

Fig. 7 is a view showing a state of blowing off air only from a side outlet on one side in the heating operation;

Fig. 8 is a view showing a state of blowing off air from side outlets on both sides in the heating operation; and

Fig. 9 is a graph showing relation between a side blown-off angle and a PPD value in the heating operation.

BEST MODE FOR CARRYING OUT THE INVENTION

[0032] An embodiment of the present invention will be described below. Fig. 1 shows a floor-installation type indoor air conditioner 1 is disposed right under a window 3 as an example. As described above, in the case where the indoor air conditioner 1 is disposed in the vicinity of the window, in particular, excellent heating effect (cold

draft decreasing effect) is obtained against local temperature decrease in the vicinity of a window at the coldest time of year.

[0033] The indoor air conditioner 1 is comprised of an induction port 21 formed on a front face 11 of a main unit, an upward outlet 22 formed on a top face 12 of the main unit, and side outlets 23, 24 formed on both-side faces 13, 14. The upward outlet 22 and the side outlets 23, 24 respectively have swing flaps 32 and shutters 33 for controlling quantities and angles of blown-off air.

[0034] As a result of analyzing tests, there is a tendency that difference of vertical temperature decreases and the PMV cozy zone occupancy ratio becomes higher as the air blown-off angle of side blown-off air S_1, S_2 becomes upwardly larger and as volume of the upward blown-off air increases in the cooling operation (Fig. 3, Fig- 4).

[0035] In an embodiment shown in Figs. 3 and 4 (in a cooling operation), the air volume ratio is controlled to become UC:SC_1 = 4:1 to 2:1 or SC_1:UC:SC_2 = 1:4:1 to 1:2:1, and also the shutters 33 for the side outlets 23, 24 are controlled to be opened and closed so as to provide an air blown-off angle in the range of -20° to +45°. In the case where temperature excessively decreases in the vicinity of the floor surface, the shutters 33 in the side outlets 23, 24 may be completely closed.

[0036] An embodiment in a heating operation is then explained. In the heating operation, the ratio of side blown-off air volume (SW_1, SW_2) to upward blown-off air volume (UW) is set to 2:1 to 1:1 (in the case of Fig. 7) or 2:1:2 to 1:1:1 (in the case of Fig. 8) as stated above. In the above-shown embodiment, the side air blown-off angle is preferably in the range of 0° (horizontal) to -45° in the heating operation.

[0037] The indoor air conditioner of the present invention having the upward outlet and the side outlets make it possible to optimally set the ratio of the side blown-off air volume to the volume of upward blown-off air in each of cooling operation and heating operation. Thereby, the indoor air conditioner of the present invention has an effect of providing an air-conditioned space where non-uniformity in temperature distribution is improved in comparison with the conventional conditioners.

Claims

1. An indoor air conditioner (1) having an upward outlet (22) formed on a top face (12) of a main unit and a side outlet (23, 24) formed on at least one side face (13, 14) of the main unit, the indoor air conditioner (1) comprising:

air volume control means for controlling blow of air so that a blown-off air volume (UC) from the upward outlet (22) is larger than a blown-off air volume (SC_1, SC_2) from the side outlet (23, 24) in a cooling operation.

2. The indoor air conditioner as defined in Claim 1, wherein the air volume control means is a swing flap (32) or a shutter (33).

3. The indoor air conditioner as defined in Claim 1 or 2, wherein

a ratio of the blown-off air volume (UC) from the upward outlet (22) to the blown-off air volume (SC_1, SC_2) from the side outlet (23, 24) is set to 2:1 to 4:1 in a case where a side blown-off air (S_1, S_2) is blown-off from the side outlet (23, 24) on one of side faces (13, 14) of the main unit.

4. The indoor air conditioner as defined in Claim 1 or 2, wherein

a ratio of a blown-off air volume (SC_1) from a left side outlet (23) to the blown-off air volume (UC) from the upward outlet (22) and to a blown-off air volume (SC_2) from a right side outlet (24) is set to 1:2:1 to 1:4:1 in a case where the side outlets (23, 24) are disposed on both the left and right side faces (13, 14) of the main unit.

5. The indoor air conditioner as defined in any one of Claims 1 to 4, wherein

an air blown-off angle from the side outlet (23, 24) is set to be not less than -20°.

6. The indoor air conditioner as defined in any one of Claims 1 to 5, wherein

the air volume control means is capable of controlling blow of air so that air from the side outlet (23, 24) is blocked and air only from the upward outlet (22) is blown-off.

7. An indoor air conditioner having an upward outlet (22) formed on a top face (12) of a main unit and a side outlet (23, 24) formed on a side face (13, 14) of the main unit, the indoor air conditioner comprising:

air volume control means for controlling blow of air so that a blown-off air volume (SW_1, SW2) from the side outlet (23, 24) is be equal to or larger than a blown-off air volume (UW) from an upward outlet (22) in a heating operation.

8. The indoor air conditioner as defined in Claim 7, wherein

the air volume control means is a swing flap (32) or a shutter (33).

9. The indoor air conditioner as defined in Claim 7 or 8, wherein

a ratio of the blown-off air volume (UW) from the upward outlet (22) to the blown-off air volume (SW_1, SW_2) from the side outlet (23, 24) is set to 1:2 to 1:1 in a case where a side blown-off air (S_1, S_2)

is blown-off from the side outlet (23, 24) on one of side faces (13, 14) of the main unit.

10. The indoor air conditioner as defined in Claim 7 or 8, wherein

a ratio of a blown-off air volume (SW_1) from a left-side outlet (23) to the blown-off air volume (UW) from the upward outlet (22) and to a blown-off air volume (SW_2) from a right-side outlet (24) is set to 2:1:2 to 1:1:1 in a case where the side outlets (23, 24) are disposed on both the left and right side faces (13, 14) of the main unit.

11. The indoor air conditioner as defined in any one of Claims 7 to 10, wherein

an air blown-off angle from the side outlet (23, 24) is set to be not larger than the horizontal zero.

Fig. 1

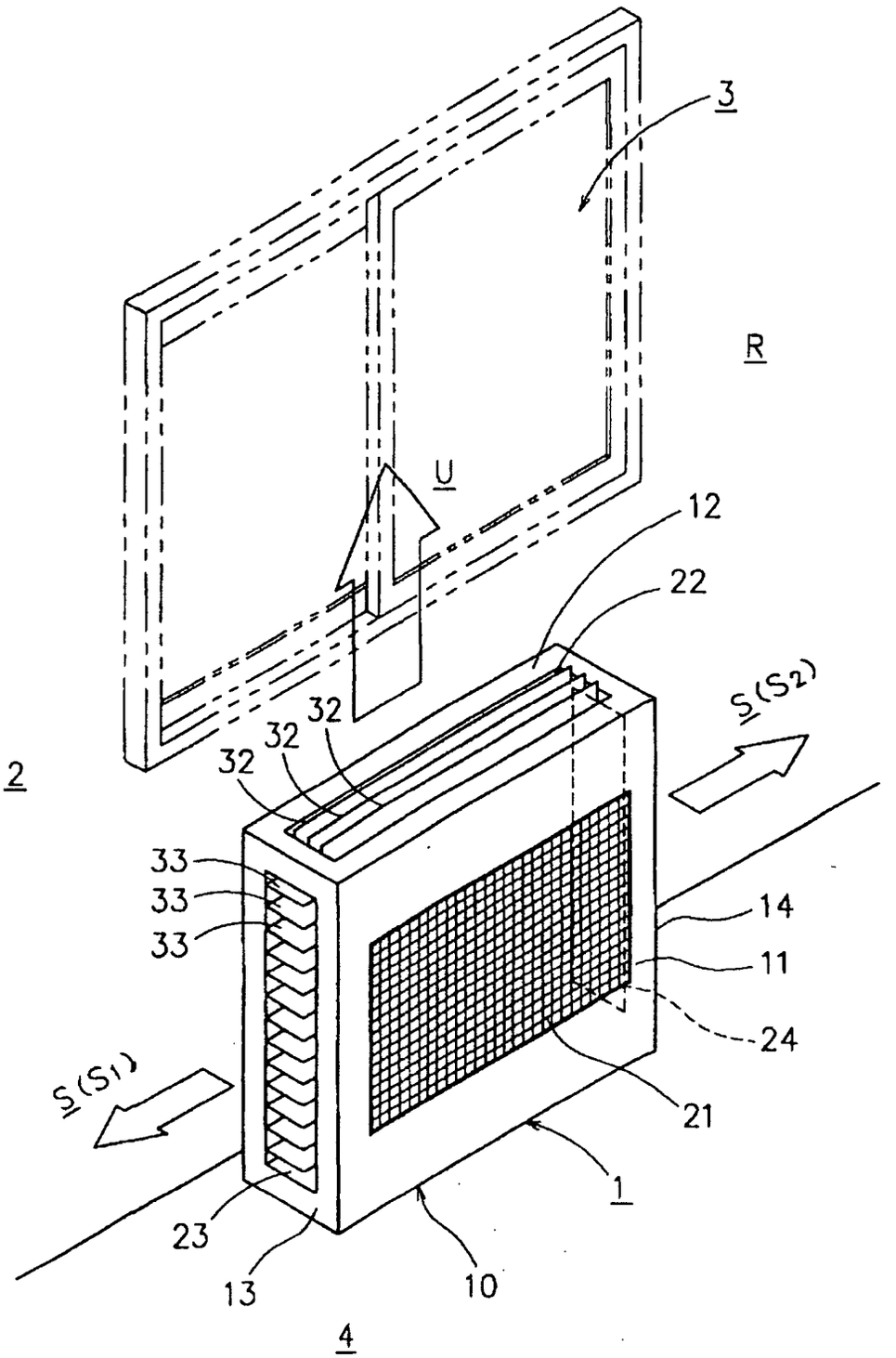


Fig. 2

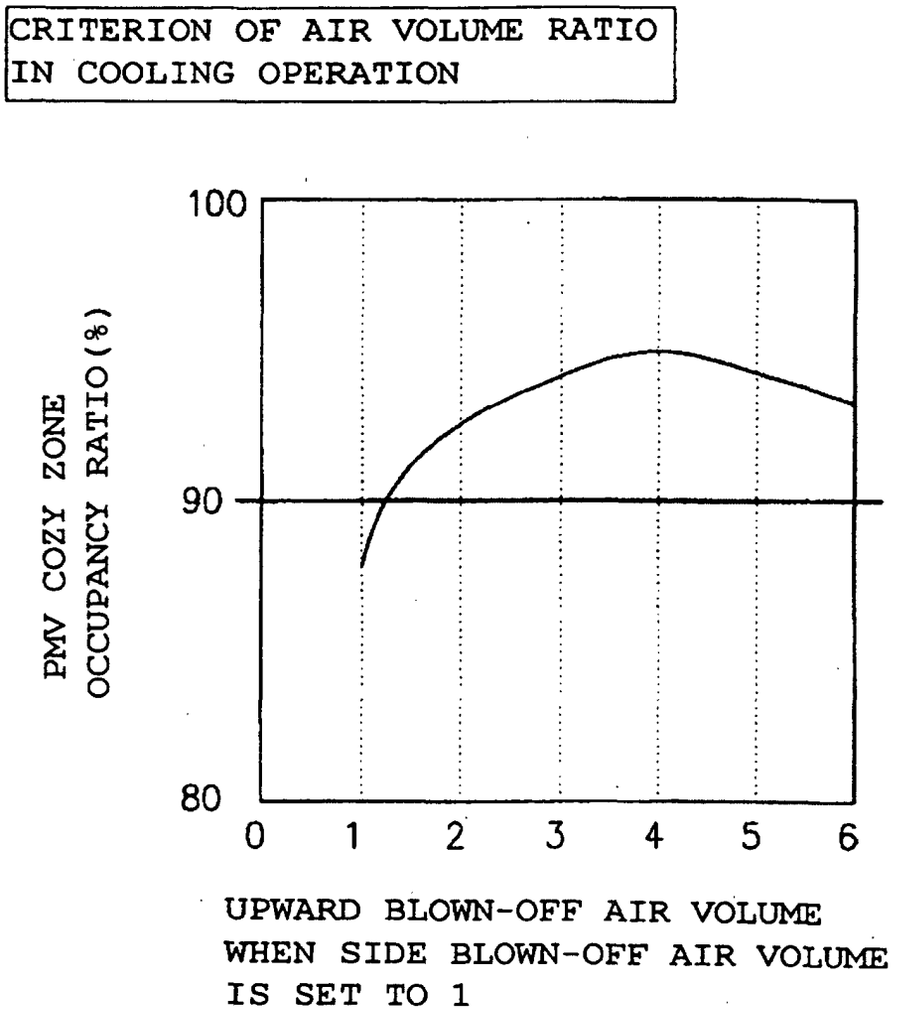

CRITERION OF AIR VOLUME RATIO IN COOLING OPERATION
PMV COZY ZONE OCCUPANCY RATIO(%)
100
90
80
0
1
2
3
4
5
6
UPWARD BLOWN-OFF AIR VOLUME WHEN SIDE BLOWN-OFF AIR VOLUME IS SET TO 1

Fig. 3

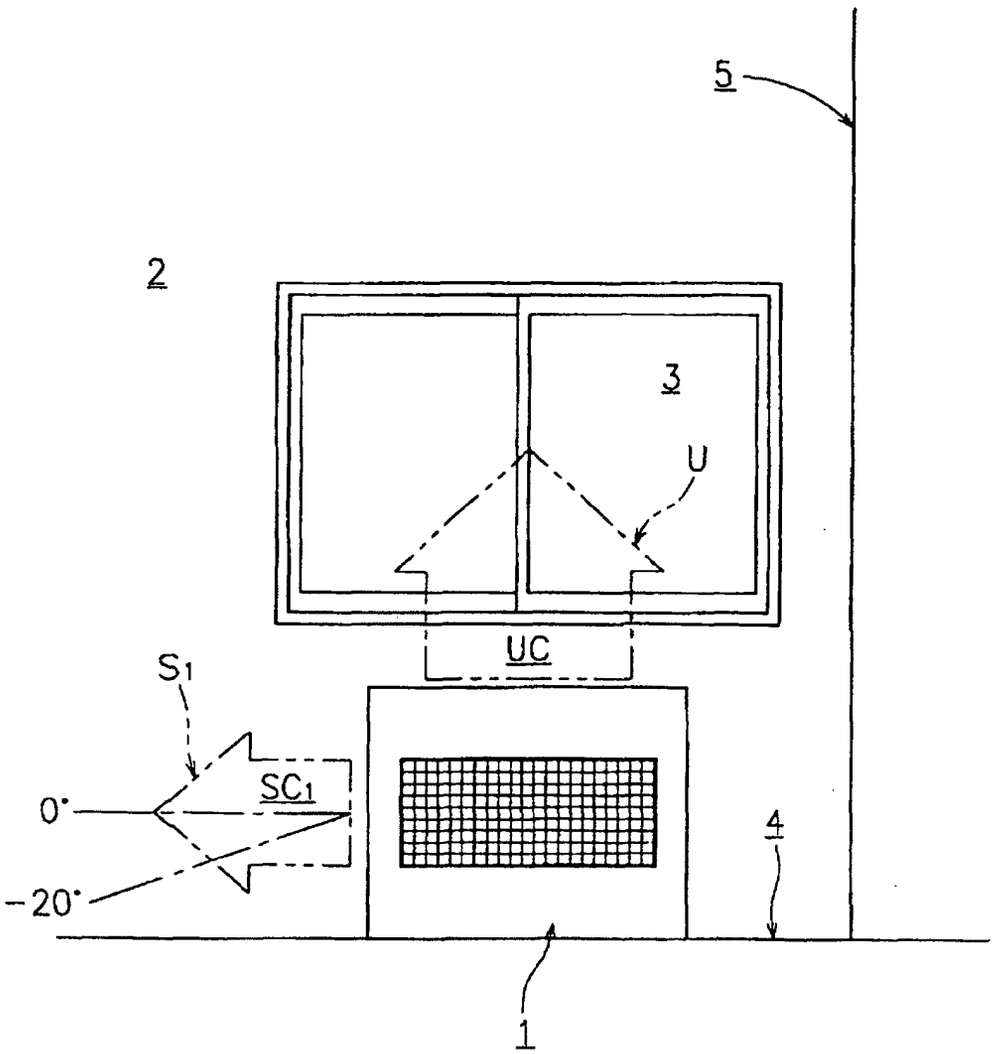


Fig. 4

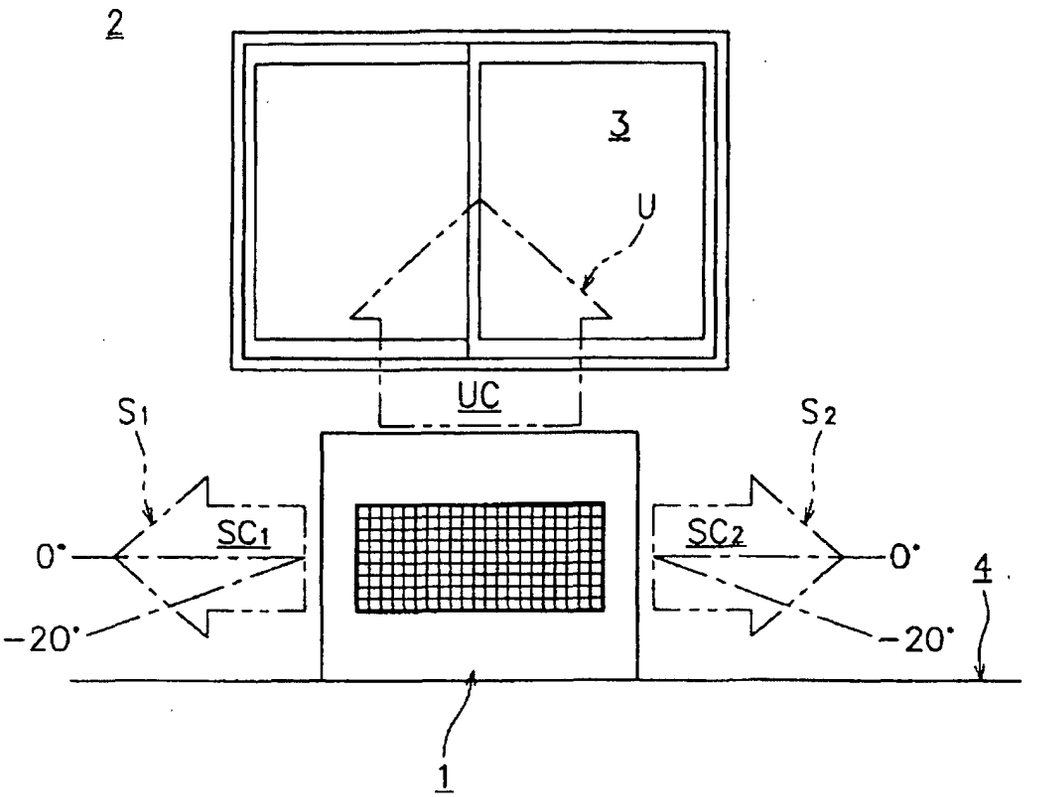


Fig. 5

CRITERION OF SIDE BLOWING-OFF ANGLE IN COOLING OPERATION

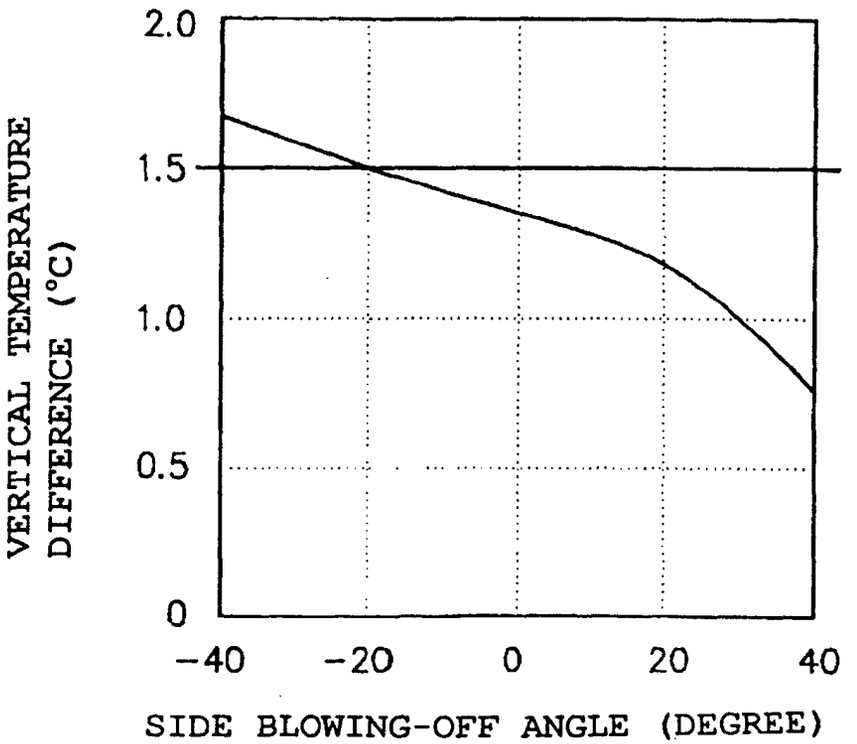


Fig. 6

CRITERION OF AIR VOLUME RATIO IN HEATING OPERATION

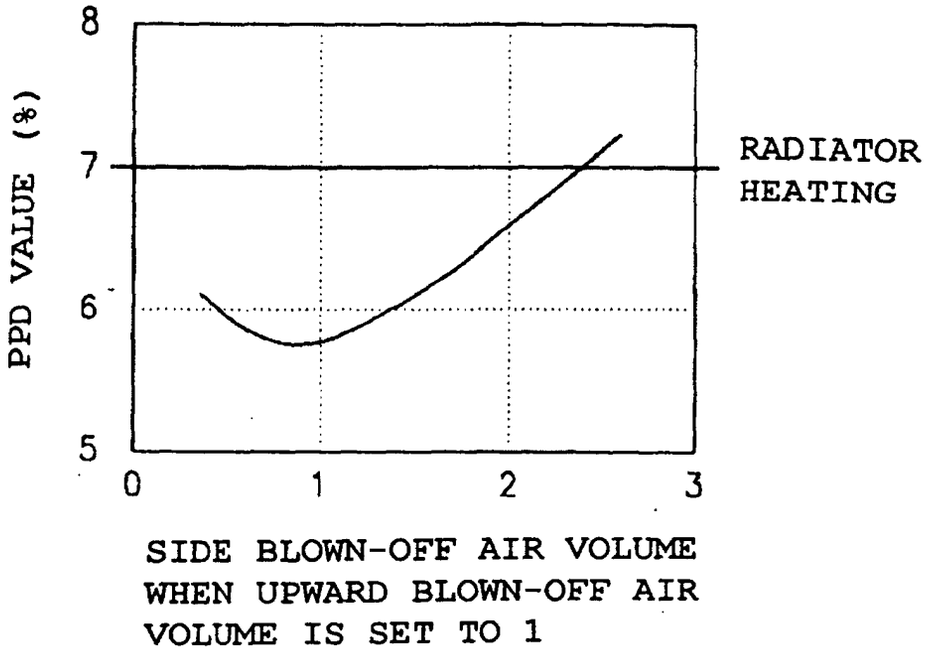


Fig. 7

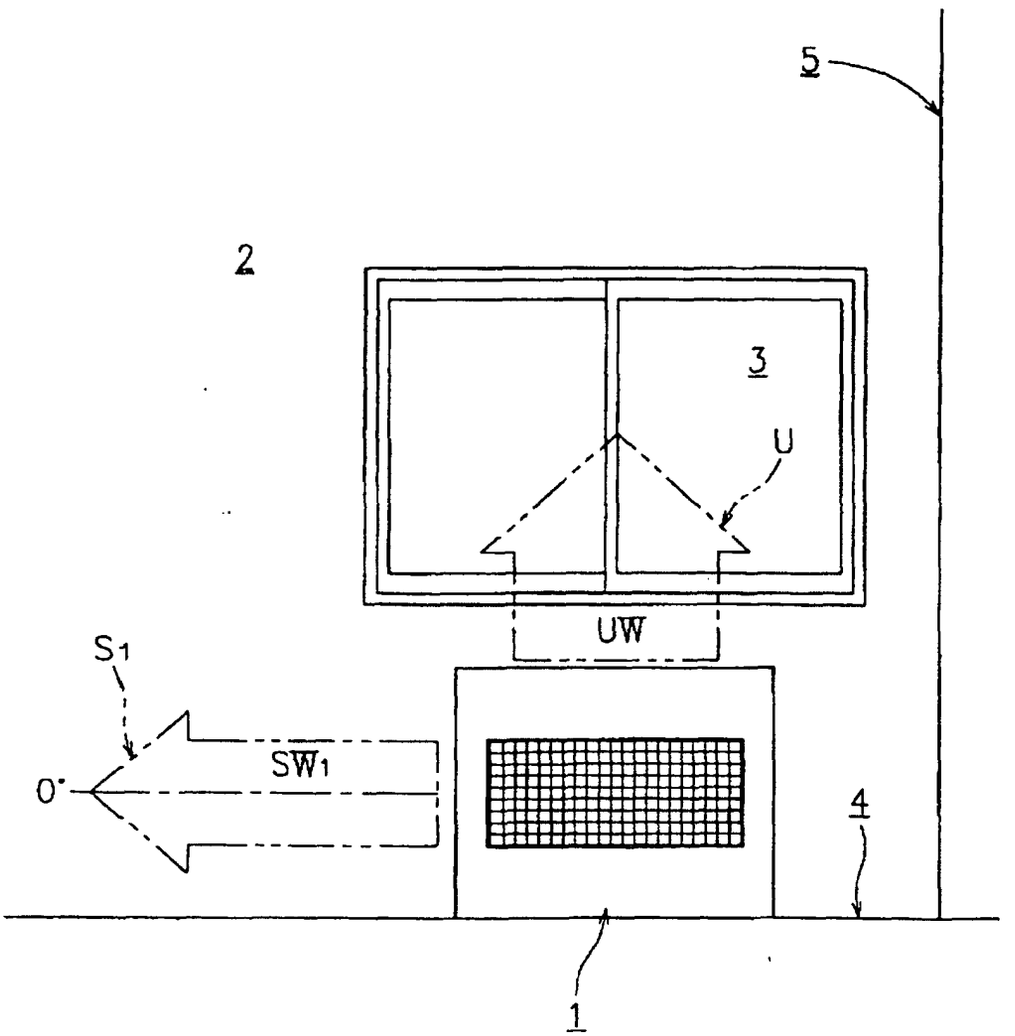


Fig. 8

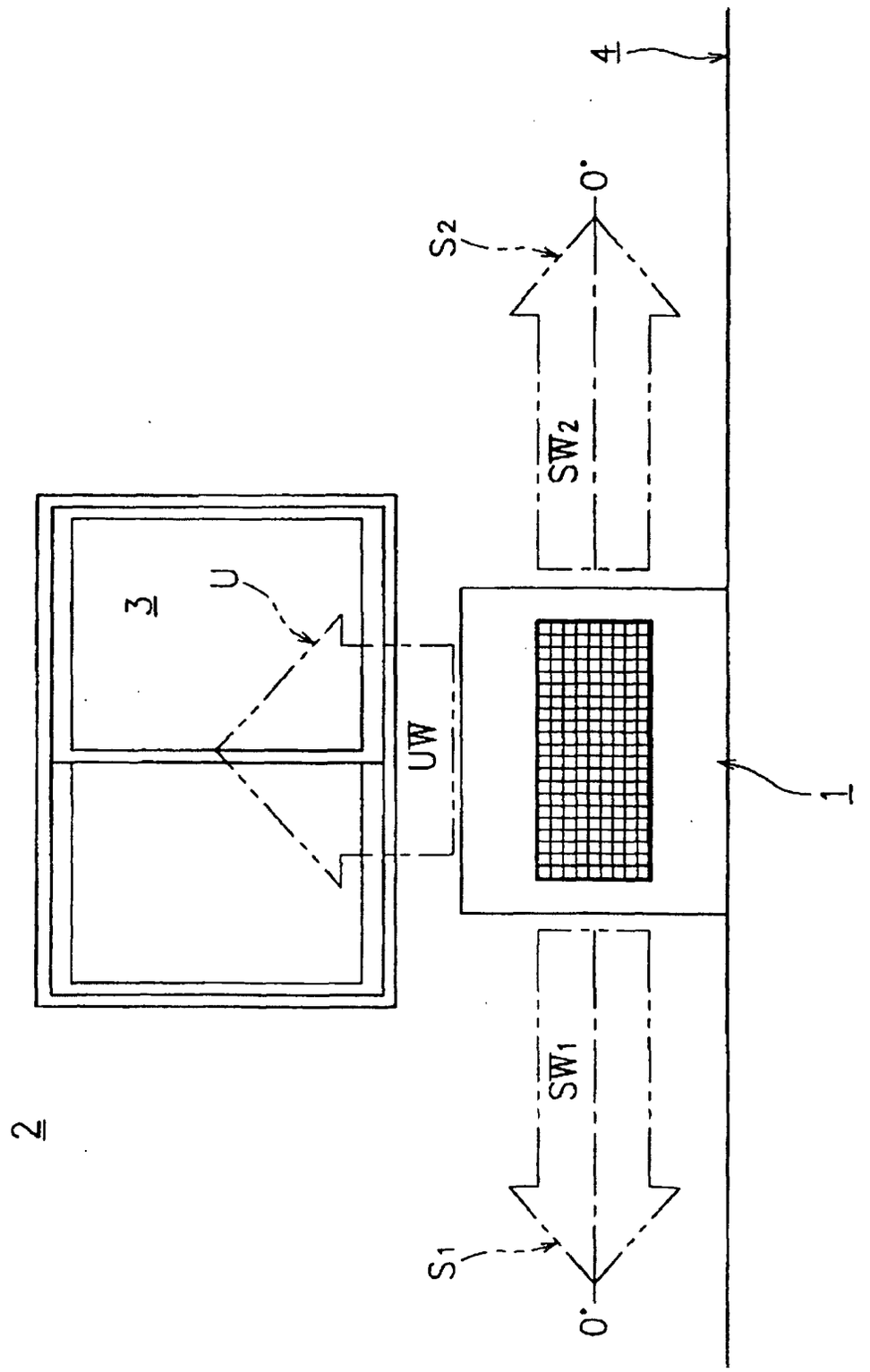
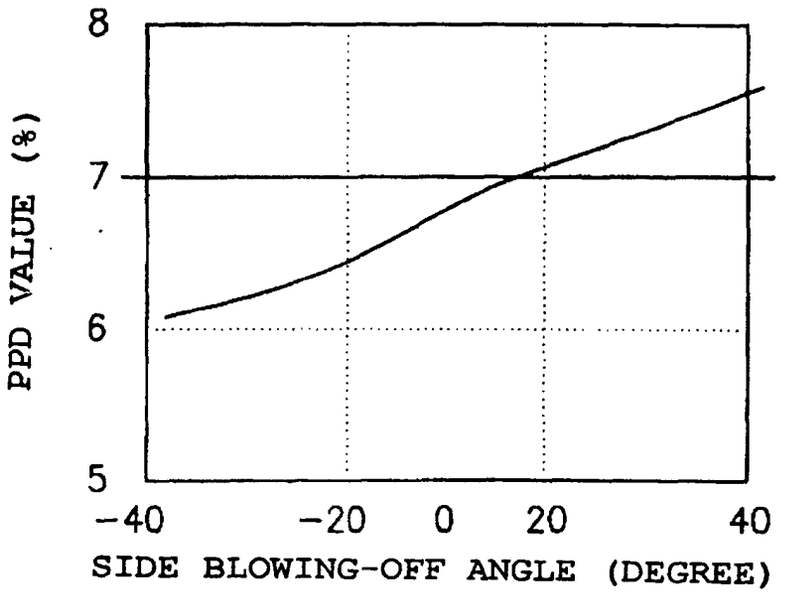


Fig. 9

CRITERION OF SIDE BLOWING-OFF ANGLE IN HEATING OPERATION



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/11344

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F24F11/04, F24F11/02, F24F1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F24F11/04, F24F11/02, F24F1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2002
Kokai Jitsuyo Shinan Koho 1971-2002 Jitsuyo Shinan Toroku Koho 1996-2002

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 10-141741 A (Daikin Industries, Ltd.), 29 May, 1998 (29.05.98), Full text (Family: none)	1-11
Y	JP 4-344037 A (Hitachi, Ltd.), 30 November, 1992 (30.11.92), (Family: none)	1-11

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 April, 2002 (02.04.02)	30 April, 2002 (30.04.02)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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