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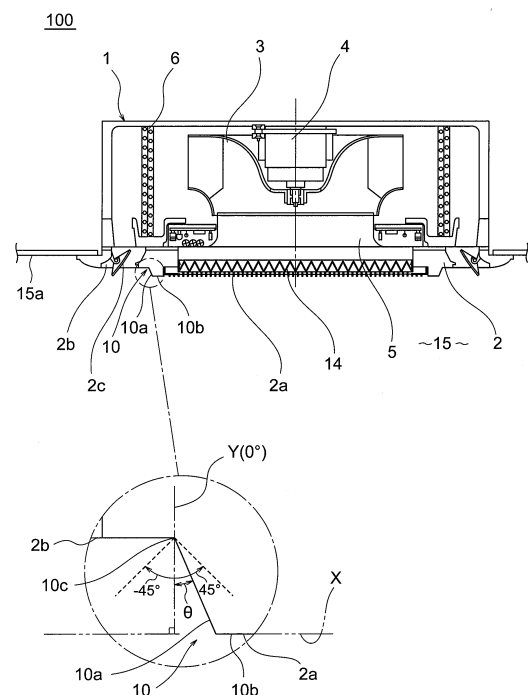
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(54) **AIR-CONDITIONING DEVICE**

(57) Provided is an air-conditioning apparatus (100), including: a case (1) mounted in a ceiling (15a) of a room (15) being a space to be air-conditioned; and a centrifugal fan (3) serving as an air blowing unit and a heat exchanger (6), which are mounted in a ceiling in the case (1), in which at least one air outlet (2b) and at least one air inlet (2a) are formed at a lower portion of the case (1), and in which a step portion (10) projecting toward the space to be air-conditioned is formed between the air inlet (2a) and the air outlet (2b). For example, the air inlet (2a) and a projected end (10b) of the step portion (10) may be positioned so as to be flush with each other, and the air inlet (2a) may be positioned on an inner side of the case (1) with respect to the projected end (10b) of the step portion (10).

FIG. 2



Description

Technical Field

[0001] The present invention relates to an air-conditioning apparatus.

Background Art

[0002] A ceiling-concealed air-conditioning apparatus has an air inlet and air outlets formed at a lower surface of the apparatus facing a room to be air-conditioned. Then, air sucked into a case through the air inlet is adjusted in temperature by a heat exchanger mounted in a ceiling in the case, and is then fed into the room through the air outlets (see Patent Literature 1, Patent Literature 2, and Patent Literature 3).

Citation List

Patent Literature

[0003]

[PTL 1] JP 4684085 B2

[PTL 2] JP 4052264 B2

[PTL 3] JP 3700718 B2

Summary of Invention

Technical Problem

[0004] In the ceiling-concealed air-conditioning apparatus, short cycling in which a part of air blown out downward from each air outlet is attracted to the air inlet to be sucked into the case may occur to generate temperature unevenness in the room, thereby reducing comfort. In particular, when auxiliary air outlets are formed also at corner portions of a decorative panel forming a lower surface of the case as in the air-conditioning apparatus disclosed in Patent Literature 2 and Patent Literature 3, there is a problem in that suction air and air from each auxiliary air outlet interfere with each other so that blown-out air easily flows into the air inlet, and hence short cycling is more liable to occur.

[0005] The present invention has been made in view of the above, and an object of the present invention is to provide an air-conditioning apparatus capable of suppressing inflow of air blown out from each air outlet into an air inlet.

Solution to Problem

[0006] In order to achieve the above-mentioned object, according to one embodiment of the present invention, there is provided an air-conditioning apparatus, including: a case mounted in a ceiling of a space to be air-conditioned; and an air blowing unit and a heat exchanger

mounted in a ceiling in the case, in which at least one air outlet and at least one air inlet are formed at a lower portion of the case, and in which a step portion projecting toward the space to be air-conditioned is formed between the air outlet and the air inlet.

[0007] The air inlet and a projected end of the step portion may be positioned so as to be flush with each other, or the air inlet may be positioned on an inner side of the case with respect to a projected end of the step portion.

[0008] The step portion may have a raised side surface, and a reference line that is a line extending in a direction orthogonal to a formation surface of the air inlet and is a line passing through a base of the raised side surface may form an angle of from -45° to $+45^\circ$ with the raised side surface.

[0009] The step portion may have a raised side surface, and the raised side surface may include an inclined portion that is inclined toward the air outlet in a direction in which the step portion projects toward the space to be air-conditioned.

[0010] The step portion may be formed so as to surround the air inlet.

[0011] The case may include a decorative panel at the lower portion of the case. The decorative panel may have a rectangular perimeter in plan view. The air outlet may include four air outlets formed as main air outlets so as to extend along four sides of the decorative panel. Four auxiliary air outlets may be formed so as to extend along four corner portions of the decorative panel. Each of the auxiliary air outlets may have a smaller opening area than each of the main air outlets. The step portion may be formed between the main air outlets and the air inlet and between the auxiliary air outlets and the air inlet. The raised side surface of the step portion may extend in a loop shape.

Advantageous Effects of Invention

[0012] According to the air-conditioning apparatus of the present invention, the inflow of the air blown out from each air outlet into the air inlet can be suppressed.

Brief Description of Drawings

[0013]

FIG. 1 is a side view for illustrating the internal structure of an air-conditioning apparatus according to a first embodiment of the present invention.

FIG. 2 is a side view for illustrating the internal structure of the air-conditioning apparatus according to the first embodiment.

FIG. 3 is a plan view for illustrating the internal structure of the air-conditioning apparatus according to the first embodiment.

FIG. 4 is an enlarged view for illustrating a periphery of an air outlet in FIG. 2.

FIG. 5 is a view for illustrating a second embodiment of the present invention in the same manner as FIG. 1.

FIG. 6 is a view for illustrating the second embodiment in the same manner as FIG. 2.

FIG. 7 is a view for illustrating a third embodiment of the present invention in the same manner as FIG. 1.

FIG. 8 is a view for illustrating the third embodiment in the same manner as FIG. 2.

FIG. 9 is a view for illustrating a fourth embodiment of the present invention in the same manner as FIG. 2.

FIG. 10 is a view for illustrating a fifth embodiment of the present invention in the same manner as FIG. 1.

Description of Embodiments

[0014] Now, an air-conditioning apparatus according to embodiments of the present invention is described with reference to the accompanying drawings. In the drawings, the same reference symbols represent the same or corresponding parts.

First Embodiment

[0015] FIG. 1 is a side view for illustrating the internal structure of an air-conditioning apparatus according to a first embodiment of the present invention. FIG. 2 is a side view for illustrating the internal structure of the air-conditioning apparatus according to the first embodiment. FIG. 3 is a plan view for illustrating the internal structure of the air-conditioning apparatus. FIG. 4 is an enlarged view for illustrating a periphery of an air outlet in FIG. 2. An air-conditioning apparatus 100 is an indoor unit of a so-called package air conditioner. In FIG. 1, a most part of the air-conditioning apparatus is concealed in a ceiling of a room, and a state in which a lower portion of a case is viewed up from inside the room is illustrated.

[0016] The air-conditioning apparatus 100 includes a case 1 concealed in a ceiling 15a of a space to be air-conditioned (in a room 15). As an example, the case 1 is formed into an approximately rectangular parallelepiped shape. The case 1 has an upper surface 1a, a side surface 1b, and a decorative panel 2 being a lower surface.

[0017] As illustrated in FIG. 3, the side surface 1b includes four main surfaces 21 oriented along two orthogonal axes, and further includes corner portions 22 between corresponding two main surfaces 21. The side surface 1b is formed into a tubular shape extending in a vertical direction. An upper portion of the side surface 1b is closed by the upper surface 1a, and the decorative panel 2 is mounted in a ceiling at a lower portion of the side surface 1b. The case 1 is formed into an approximately box shape by the upper surface 1a, the side surface 1b, and the decorative panel 2.

[0018] At least one air inlet 2a and at least one air outlet

2b are formed at a lower portion of the case 1, namely, the decorative panel 2 according to the first embodiment. As an example, the air-conditioning apparatus 100 according to the first embodiment has one air inlet 2a and four air outlets 2b as described later.

[0019] A centrifugal fan (turbofan) 3 serving as an air blowing unit, a fan motor 4, a bellmouth 5, and a heat exchanger 6 are accommodated in the case 1. The centrifugal fan 3 generates a stream of air that is sucked into the case 1 through the air inlet 2a and blown out into a target space through the air outlets 2b. The heat exchanger 6 is arranged in such an air flow path and is configured to adjust air temperature.

[0020] The air inlet 2a is formed at a central portion of the decorative panel 2 over a wide region in the decorative panel 2. Further, the air inlet 2a according to the first embodiment is formed as a grille-type air inlet, but the present invention is not limited thereto. A filter 14 configured to remove dust from air having passed through the air inlet 2a is arranged on an upstream side of the air inlet 2a (on an inner side of the case 1).

[0021] As an example, according to the first embodiment, the decorative panel 2 and the air inlet 2a each have a rectangular perimeter in plan view.

[0022] The plurality of air outlets 2b are formed in a region between the perimeter of the decorative panel 2 and the perimeter of the air inlet 2a. According to the first embodiment, the four air outlets 2b are formed correspondingly to the four-side perimeters of the decorative panel 2 and the air inlet 2a, and the respective air outlets 2b are formed so as to extend along corresponding sides of the decorative panel 2 and the air inlet 2a except for the corner portions to be described later. Further, the four air outlets 2b are positioned so as to surround the air inlet 2a. Each of the air outlets 2b includes an airflow direction flap 2c configured to adjust a direction of air to be blown out.

[0023] The fan motor 4 is arranged in a central portion inside the case 1. The fan motor 4 is supported on a lower surface of the upper surface 1a of the case 1 (internal space side of the case). The centrifugal fan 3 is mounted to a rotary shaft of the fan motor 4, which extends downward. Further, the bellmouth 5 forming a suction air path directed from the air inlet 2a toward the centrifugal fan 3 is arranged between the centrifugal fan 3 and the air inlet 2a. The centrifugal fan 3 is configured to suck air into the case 1 through the air inlet 2a and blow out the air through the air outlets 2b into the room (room inside) 15 being a target space.

[0024] The heat exchanger 6 is arranged radially outside the centrifugal fan 3. In other words, the heat exchanger 6 is arranged in the air flow path formed by the centrifugal fan 3 inside the case and is configured to exchange heat between the air and refrigerant.

[0025] The heat exchanger 6 includes a plurality of fins arranged at predetermined intervals and a heat transfer tube penetrating the fins. The heat transfer tube is connected to a publicly-known outdoor unit (not shown) by

a connection pipe. With this, cooled refrigerant or heated refrigerant is supplied to the heat exchanger 6. A drain pan 12, which is configured to temporarily store condensed water, is arranged below the heat exchanger 6. Further, an electrical component box 13 configured to accommodate an electronic circuit board is arranged on a back side of the drain pan 12. Configurations and modes of the centrifugal fan 3, the bellmouth 5, and the heat exchanger 6 are not particularly limited, but publicly-known types are used in the first embodiment.

[0026] In such a configuration, rotation of the centrifugal fan 3 causes air in the room 15 to be sucked into the air inlet 2a of the decorative panel 2. Then, the air from which dust is removed in the filter 8 is guided by the bellmouth 5 and sucked into the centrifugal fan 3. Further, in the centrifugal fan 3, the air sucked upward from below is blown out in a horizontal direction and in a radially outward direction. The thus blown out air is subjected to heat exchange and humidity adjustment when passing through the heat exchanger 6, and is thereafter blown out into the room 15 through the respective air outlets 2b while the flow direction is changed to a downward direction.

[0027] A step portion projecting toward the space to be air-conditioned (i.e., downward in the illustrated example) is formed between at least one air inlet and at least one air outlet. According to the first embodiment illustrating a specific example, a step portion 10 projecting toward the space to be air-conditioned is formed between the one air inlet 2a and the four air outlets 2b.

[0028] The step portion 10 has a raised side surface 10a extending from a surface in which the air outlets 2b are formed toward the space to be air-conditioned, and a projected end 10b. The air inlet 2a and the projected end 10b of the step portion 10 are positioned so as to be flush with each other. According to the first embodiment, the air inlet 2a is formed at the same height as the projected end 10b of the step portion 10 when viewed in a height dimension direction of the case 1 (vertical direction in the drawing sheet of FIG. 2).

[0029] Further, when viewed from a lateral side (viewed in FIG. 2), a reference line Y that is a line extending in a direction orthogonal to a formation surface X of the air inlet 2a and is a line passing through a base 10c of the raised side surface suitably forms an angle of from -45° to $+45^\circ$ with the raised side surface 10a.

[0030] Further, the step portion 10 is formed so as to surround the air inlet 2a. The raised side surface 10a of the step portion 10 is formed into a loop shape (as a closed circumference) so as to surround the air inlet 2a.

[0031] According to the air-conditioning apparatus of the first embodiment, which is constructed as described above, the step portion is formed between the air inlet and the air outlets, and hence a creepage distance between the air inlet and the air outlets is increased so that air discharged from each air outlet is less liable to be attracted to the air inlet. In other words, it is possible to suppress inflow of the air blown out from each air outlet

into the air inlet, thereby being capable of suppressing short cycle. Further, the effect of suppressing short cycle is effective when air is blown out downward from the air outlets. For example, when the air-conditioning apparatus is desirably operated to blow air onto a floor surface during heating operation, the air can be blown out downward, and hence comfort is improved.

Second Embodiment

[0032] Next, a second embodiment of the present invention is described with reference to FIG. 5 and FIG. 6. FIG. 5 and FIG. 6 are views for illustrating the second embodiment in the same manner as FIG. 1 and FIG. 2, respectively. The second embodiment is the same as the above-mentioned first embodiment except for parts to be described below.

[0033] As illustrated in FIG. 5 and FIG. 6, in a decorative panel 202 of an air-conditioning apparatus 200 according to the second embodiment, an air inlet 202a is positioned on an inner side of the case 1 with respect to the projected end 10b of the step portion 10 (above the projected end 10b in the illustrated example).

[0034] The thus constructed air-conditioning apparatus according to the second embodiment can also achieve the same advantages as in the above-mentioned first embodiment. In addition, in the second embodiment, the creepage distance between the air inlet and the air outlets can be increased more than in the case of the above-mentioned first embodiment, and hence short circling can be further suppressed.

Third Embodiment

[0035] Next, a third embodiment of the present invention is described with reference to FIG. 7 and FIG. 8. FIG. 7 and FIG. 8 are views for illustrating the second embodiment in the same manner as FIG. 1 and FIG. 2, respectively. The third embodiment is the same as the above-mentioned first embodiment except for parts to be described below.

[0036] In the above-mentioned first and second embodiments, so-called cassette-type indoor units for four-direction blowoff are illustrated as examples, but the present invention is not limited thereto. The third embodiment is an exemplary case where a mode of the blowoff direction is different from that in the first and second embodiments, and relates to a so-called cassette-type indoor unit for two-direction blowoff.

[0037] A decorative panel 302 of an air-conditioning apparatus 300 according to the third embodiment is formed into a rectangular shape in front view (when viewed straight up from inside the room). Then, the decorative panel 302 has two air inlets 302a and two air outlets 302b. All of the air inlets 302a and the air outlets 302b extend in a longer side direction of the decorative panel 302.

[0038] The two air inlets 302a are formed between the

two air outlets 302b (in a shorter side direction of the decorative panel 302). Step portions 310 are formed between the air inlets 302a and the air outlets 302b, respectively. Each of the step portions 310 also has a raised side surface 310a and a projected end 310b.

[0039] The air inlets 302a and the projected ends 310b of the step portions 302 may be positioned so as to be flush with each other. Alternatively, the air inlets 302 may be positioned on the inner side of the case with respect to the projected ends 310b of the step portions 302. An exemplary case where the air inlets 302 are positioned on the inner side of the case with respect to the projected ends 310b of the step portions 302 is illustrated in FIG. 7 and FIG. 8.

[0040] The thus constructed air-conditioning apparatus according to the third embodiment can also achieve the same advantages as in the above-mentioned first or second embodiment.

Fourth Embodiment

[0041] Next, a fourth embodiment of the present invention is described with reference to FIG. 9. FIG. 9 is a view for illustrating the fourth embodiment in the same manner as FIG. 2. The fourth embodiment is the same as the above-mentioned first or second embodiment except for parts to be described below.

[0042] In a decorative panel 402 of an air-conditioning apparatus 400 according to the fourth embodiment, a raised side surface 410a of a step portion 410 includes an inclined portion that is inclined toward the air outlet 2b in a direction in which the step portion 410 projects toward the space to be air-conditioned. In the illustrated example of FIG. 9, the entire raised side surface 410a is formed of such an inclined portion. According to the description of FIG. 2 in the above-mentioned first embodiment, in such an inclined portion, the reference line Y forms an angle of -45° or more and less than 0° with the raised side surface 410a. In the illustrated example of FIG. 9, the air inlet is illustrated as in the mode of the first embodiment. However, the fourth embodiment is not limited thereto, but may be carried out by forming the air inlet as in the mode of the second embodiment. A case where the present invention is applied to the cassette-type indoor unit for four-direction blowoff is illustrated in the illustrated example of FIG. 9. However, the fourth embodiment is not limited thereto, but may also be applied to a cassette-type indoor unit for two-direction blow-off.

[0043] The thus constructed air-conditioning apparatus according to the fourth embodiment can also achieve the same advantages as in the above-mentioned first or second embodiment. In addition, in the fourth embodiment, the raised side surface of the step portion includes the inclined portion that is inclined toward the air outlet, and hence it is extremely difficult for air discharged from the air outlets to be directed toward the air inlet. Therefore, there is an advantage of an extremely enhanced

effect of preventing short circling.

Fifth Embodiment

[0044] Next, a fourth embodiment of the present invention is described with reference to FIG. 10. FIG. 10 is a view for illustrating the fifth embodiment in the same manner as FIG. 1. The tenth embodiment is the same as the above-mentioned first, second, or fourth embodiment except for parts to be described below.

[0045] An air-conditioning apparatus 500 according to the fifth embodiment is a so-called cassette-type indoor unit for all-direction blowoff, and a decorative panel 502 of the air-conditioning apparatus 500 has auxiliary air outlets 502d at portions corresponding to the inside of the above-mentioned corner portions 22 (i.e., corner portions of the decorative panel) in plan view. Each of the auxiliary air outlets 502d has a smaller opening area than each of the air outlets (main air outlets) 2b. In other words, each of the four auxiliary air outlets 502d is formed between a corresponding pair of the air outlets (main air outlets) 2b.

[0046] The step portion 10 is formed between the air outlets 2b and the air inlet 2a and between the auxiliary air outlets 502d and the air inlet 2a. The raised side surface of the step portion 10 extends in a loop shape. An inclination mode of the raised side surface of the step portion and a height relationship between the projected end of the step portion and the air inlet 2a only need to satisfy any one of those of the above-mentioned first, second, and fourth embodiments.

[0047] The thus constructed air-conditioning apparatus according to the fifth embodiment can also achieve the same advantages as in the above-mentioned first or second embodiment. In addition, in the fifth embodiment, the auxiliary air outlets are formed so that air can be blown out in all directions, and an effect of suppressing short cycling is achieved in all the directions. Further, force of blowing out an air stream from the auxiliary air outlets tends to be smaller than force of blowing out an air stream from the air outlets (main air outlets), and short cycling is more liable to occur. However, under such a circumstance, according to the fifth embodiment, the effect of suppressing short cycling can also be achieved in blowing out air from the auxiliary air outlets in which such short cycling is liable to occur.

[0048] Although the details of the present invention are specifically described above with reference to the preferred embodiments, it is apparent that persons skilled in the art may adopt various modifications based on the basic technical concepts and teachings of the present invention.

Reference Signs List

[0049] 1 case, 2, 202, 302, 402, 502 decorative panel, 2a, 202a, 302a air inlet, 2b, 302b air outlet, 3 centrifugal fan, 6 heat exchanger, 10, 310, 410 step portion, 10a, 310a, 410a raised side surface, 10b, 310b projected end,

10c base, 22 corner portion, 100, 200, 300, 400, 500 air-conditioning apparatus, 502d auxiliary air outlet

Claims

1. An air-conditioning apparatus, comprising:
 - a case mounted in a ceiling of a space to be air-conditioned; and
 - an air blowing unit and a heat exchanger mounted in a ceiling in the case,
 - wherein at least one air outlet and at least one air inlet are formed at a lower portion of the case, and
 - wherein a step portion projecting toward the space to be air-conditioned is formed between the air outlet and the air inlet.
2. An air-conditioning apparatus according to claim 1, wherein the air inlet and a projected end of the step portion are positioned so as to be flush with each other.
3. An air-conditioning apparatus according to claim 1, wherein the air inlet is positioned on an inner side of the case with respect to a projected end of the step portion.
4. An air-conditioning apparatus according to any one of claims 1 to 3, wherein the step portion has a raised side surface, and wherein a reference line that is a line extending in a direction orthogonal to a formation surface of the air inlet and is a line passing through a base of the raised side surface forms an angle of from -45° to $+45^{\circ}$ with the raised side surface.
5. An air-conditioning apparatus according to any one of claims 1 to 3, wherein the step portion has a raised side surface, and wherein the raised side surface comprises an inclined portion that is inclined toward the air outlet in a direction in which the step portion projects toward the space to be air-conditioned.
6. An air-conditioning apparatus according to any one of claims 1 to 5, wherein the step portion is formed so as to surround the air inlet.
7. An air-conditioning apparatus according to any one of claims 1 to 6, wherein the case comprises a decorative panel at the lower portion of the case, wherein the decorative panel has a rectangular perimeter in plan view,

wherein the air outlet comprises four air outlets formed as main air outlets so as to extend along four sides of the decorative panel, wherein four auxiliary air outlets are formed so as to extend along four corner portions of the decorative panel, wherein each of the auxiliary air outlets has a smaller opening area than each of the main air outlets, wherein the step portion is formed between the main air outlets and the air inlet and between the auxiliary air outlets and the air inlet, and wherein the raised side surface of the step portion extends in a loop shape.

FIG. 1

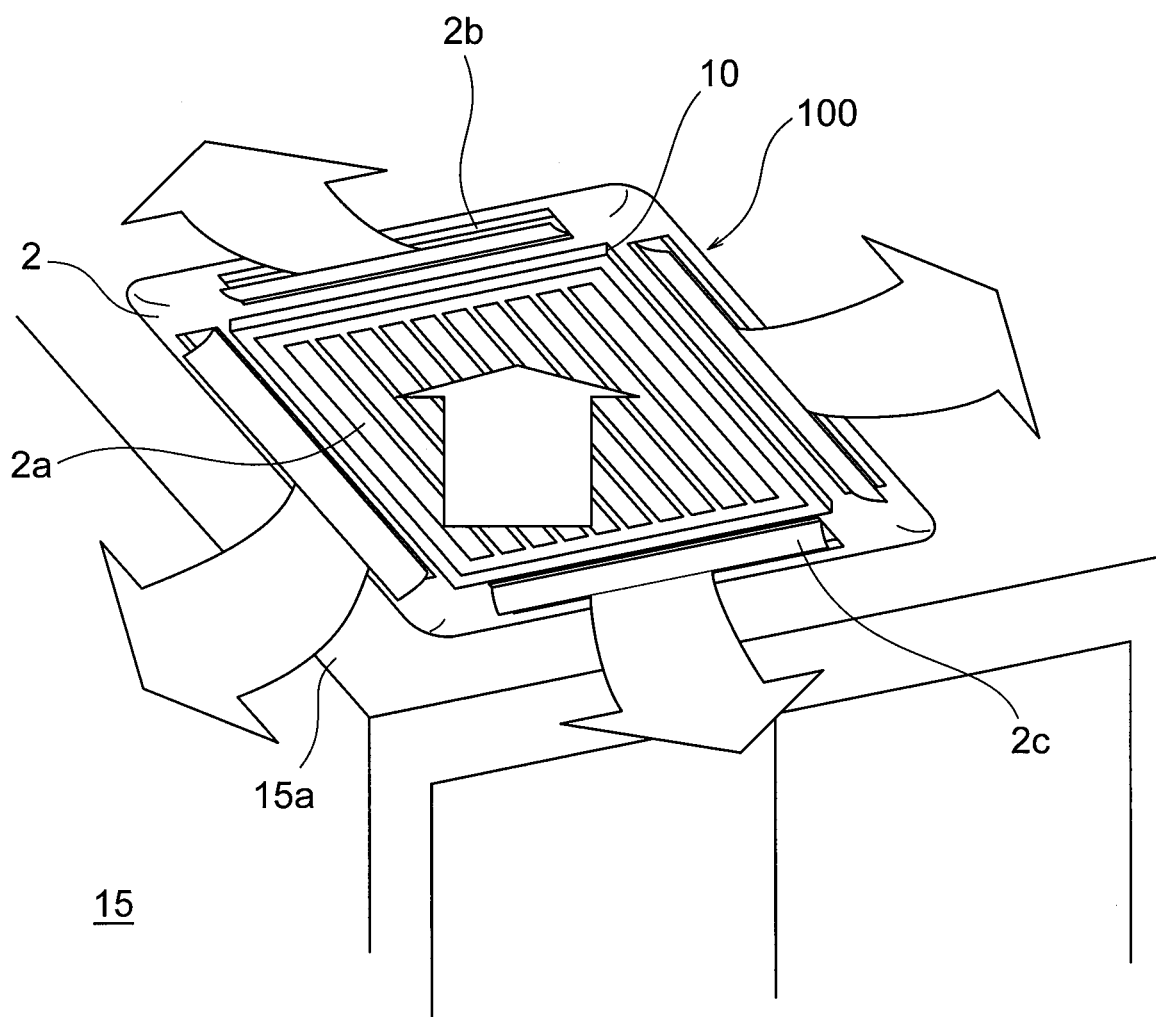


FIG. 2

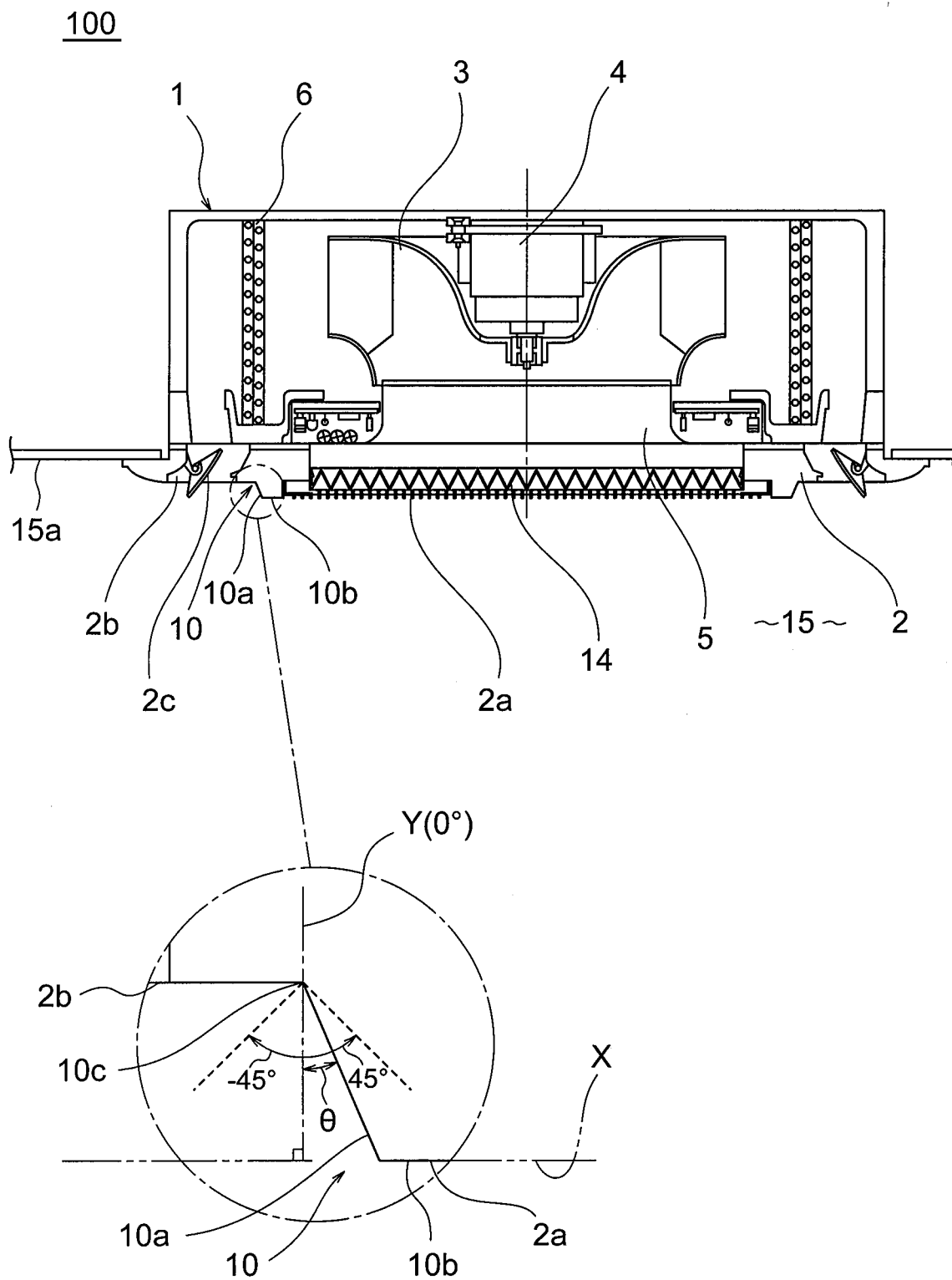


FIG. 3

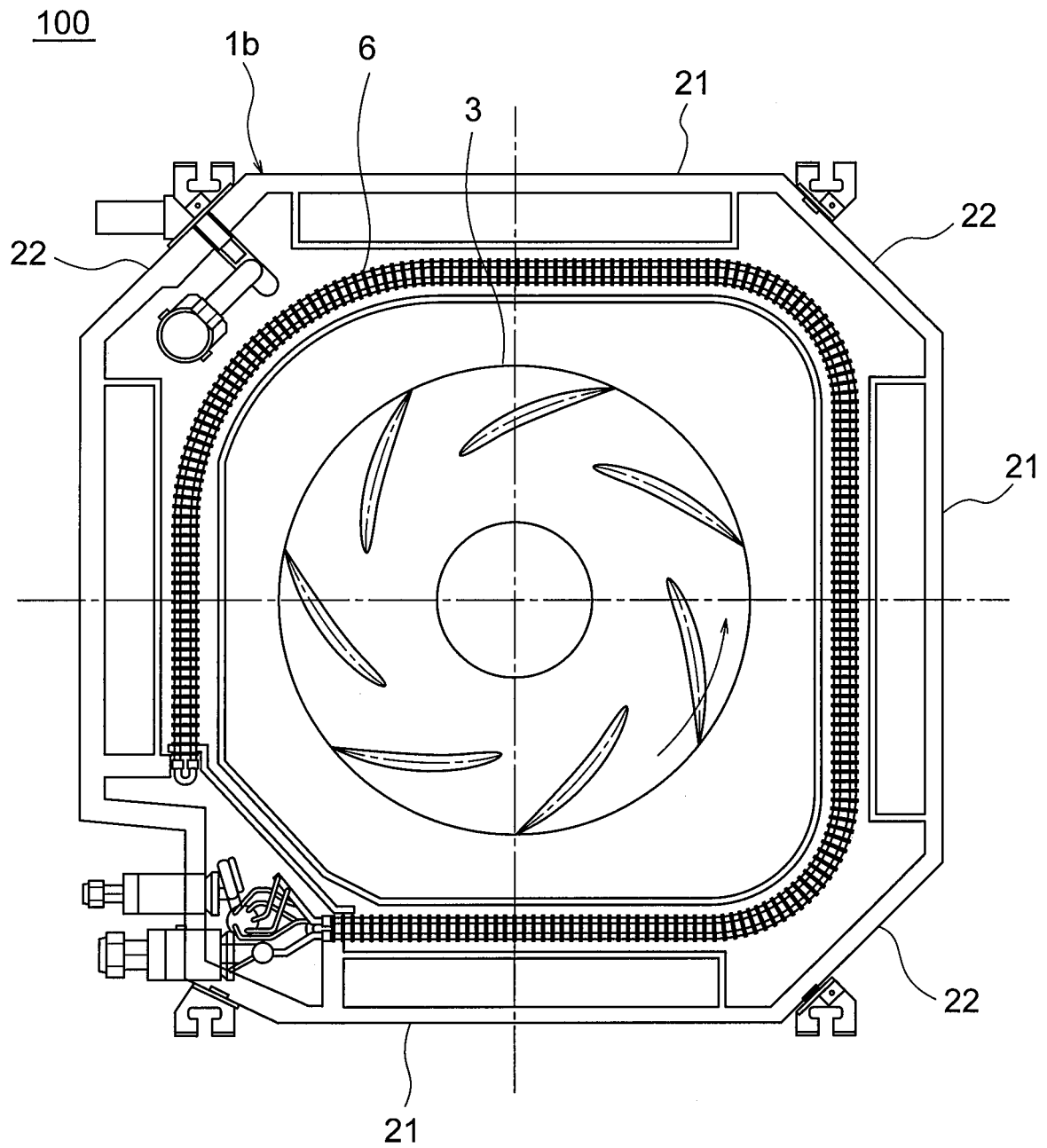


FIG. 4

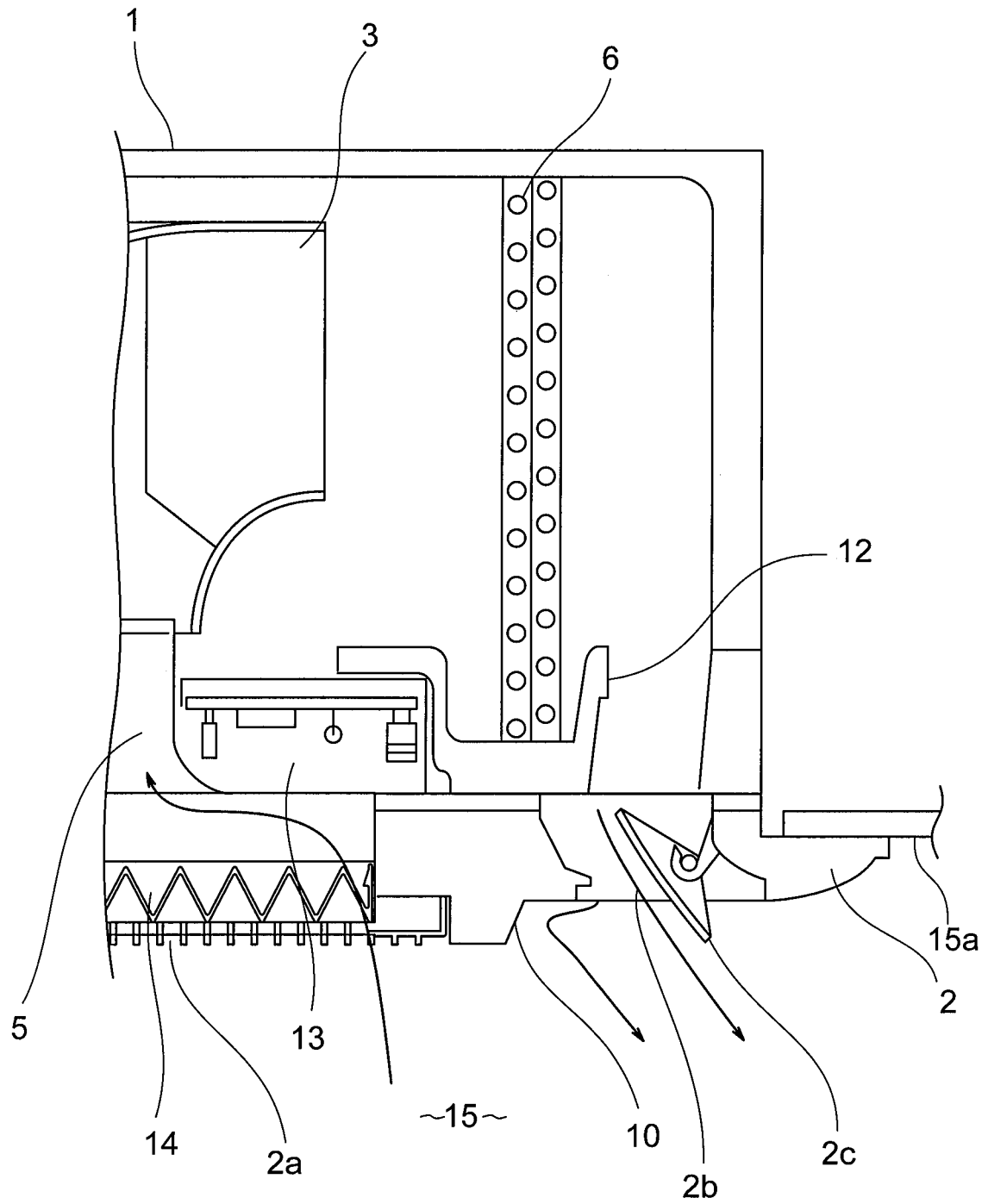


FIG. 5

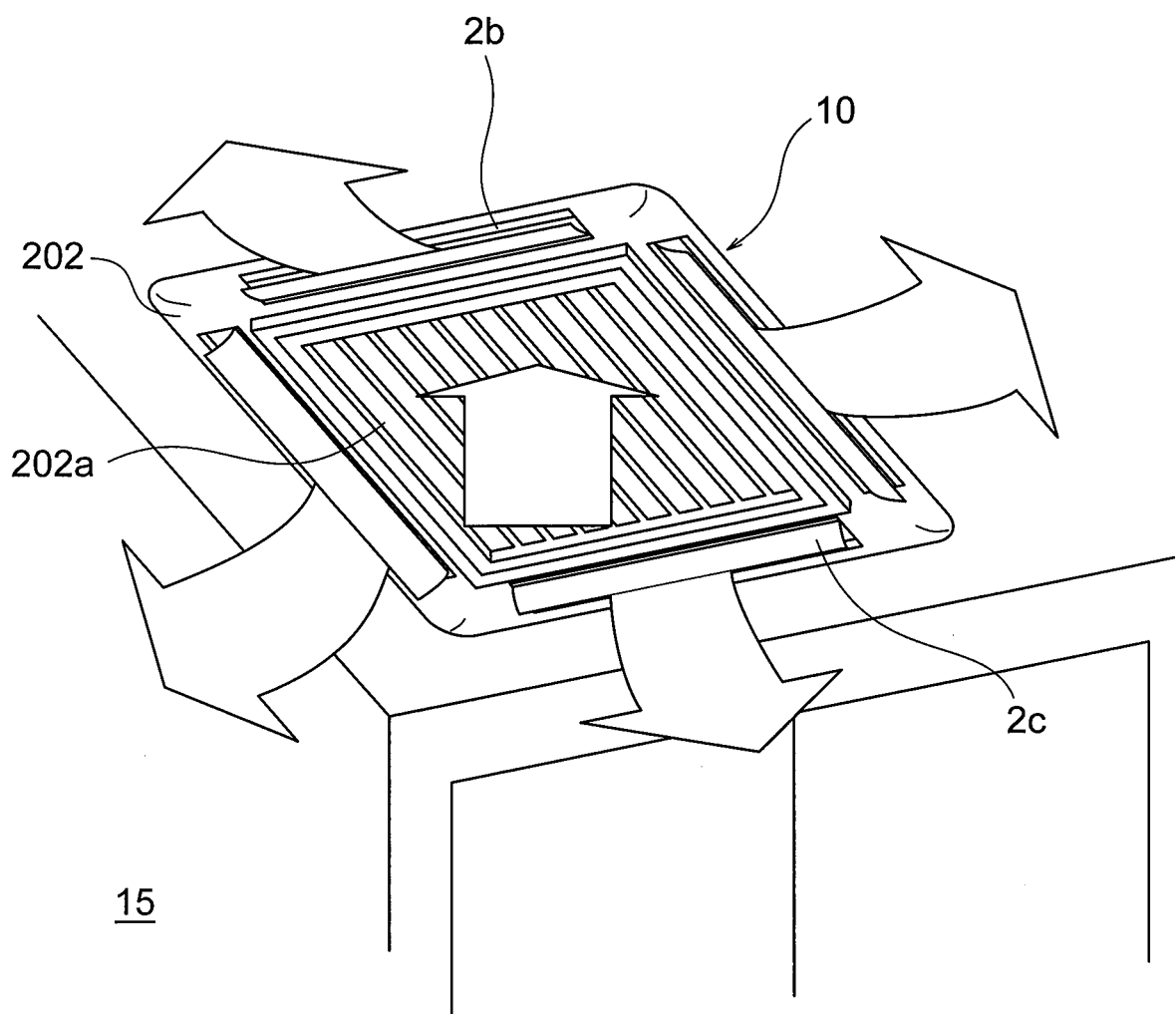


FIG. 6

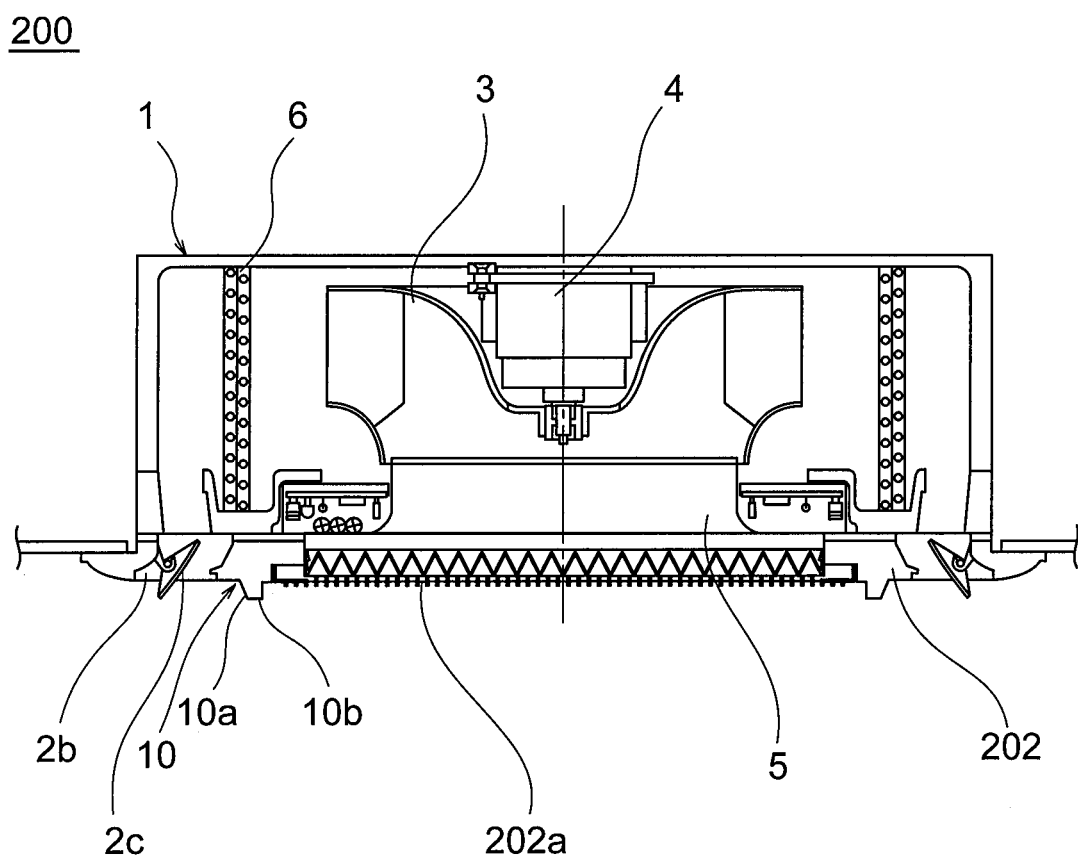


FIG. 7

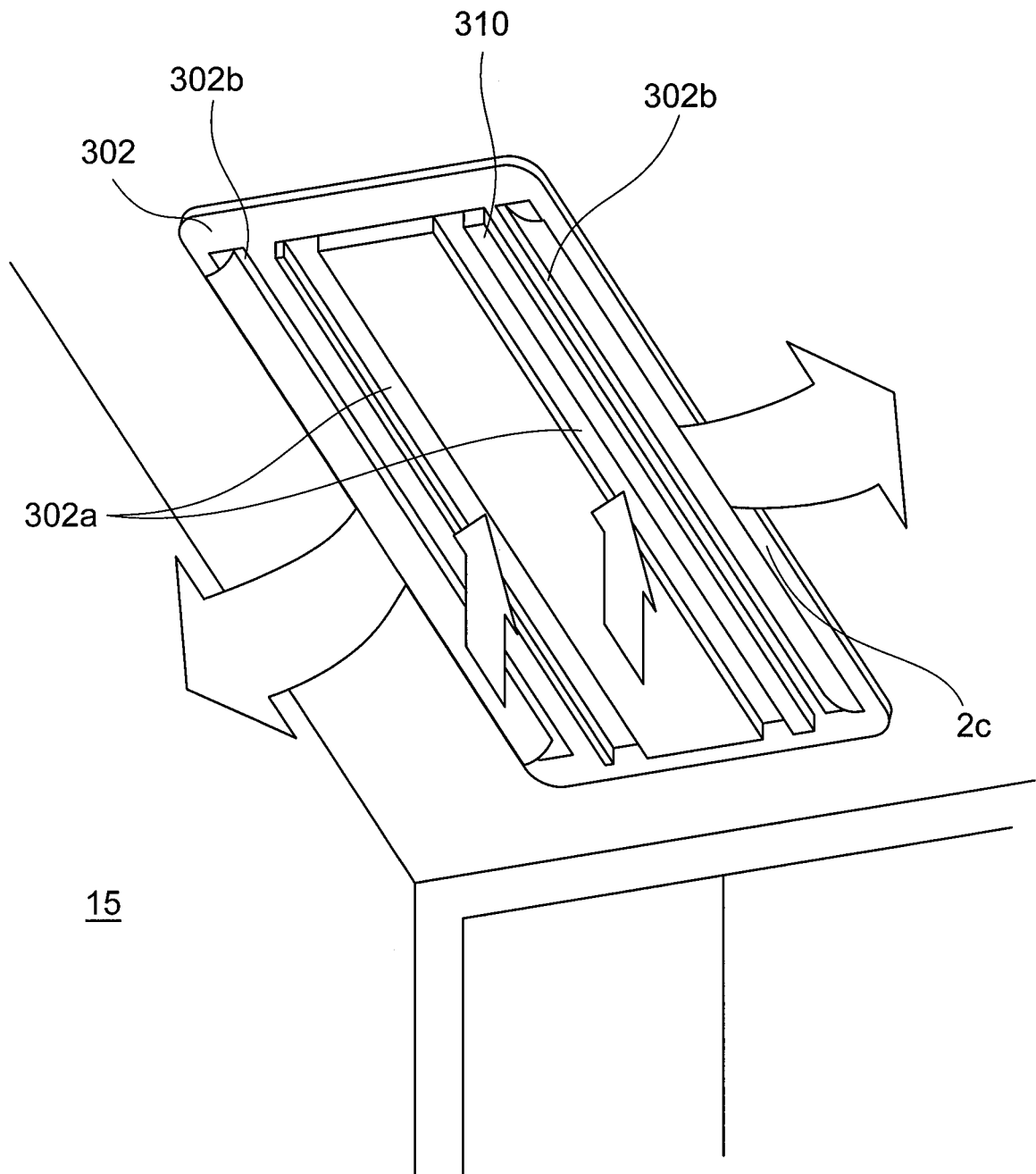


FIG. 8

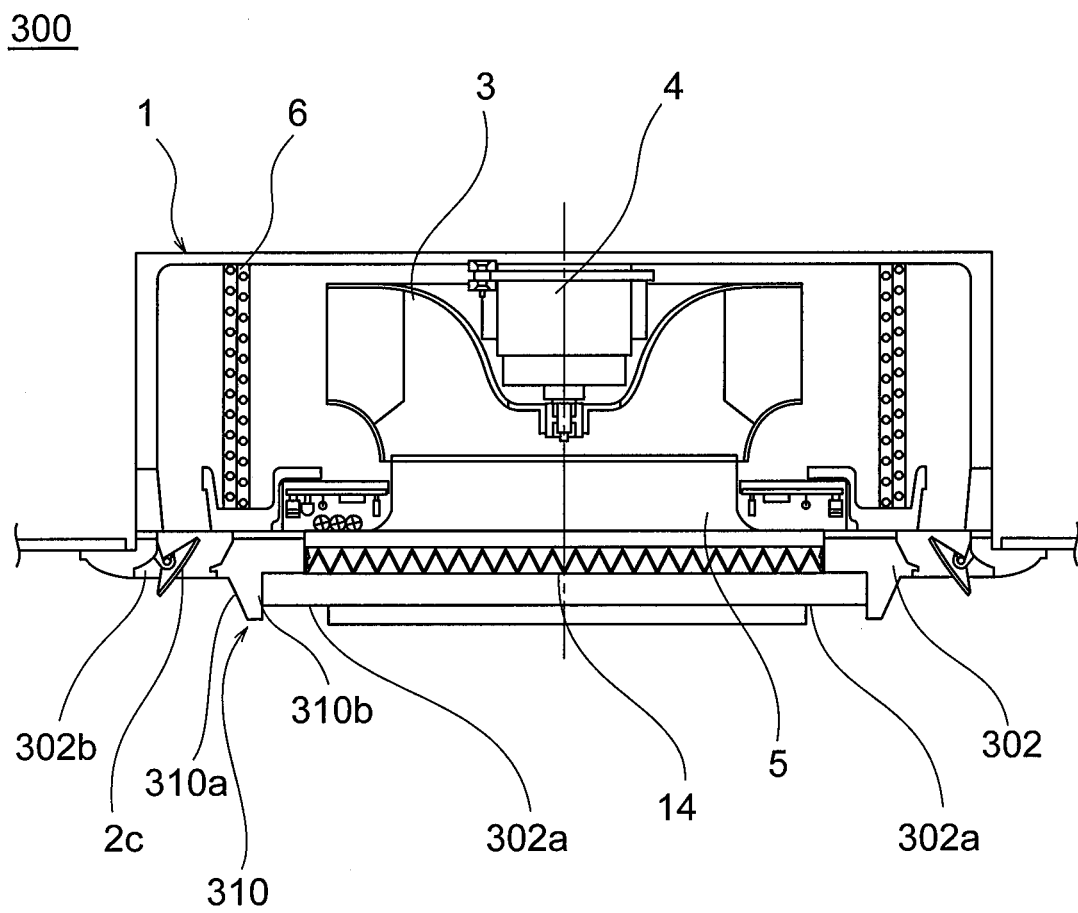


FIG. 9

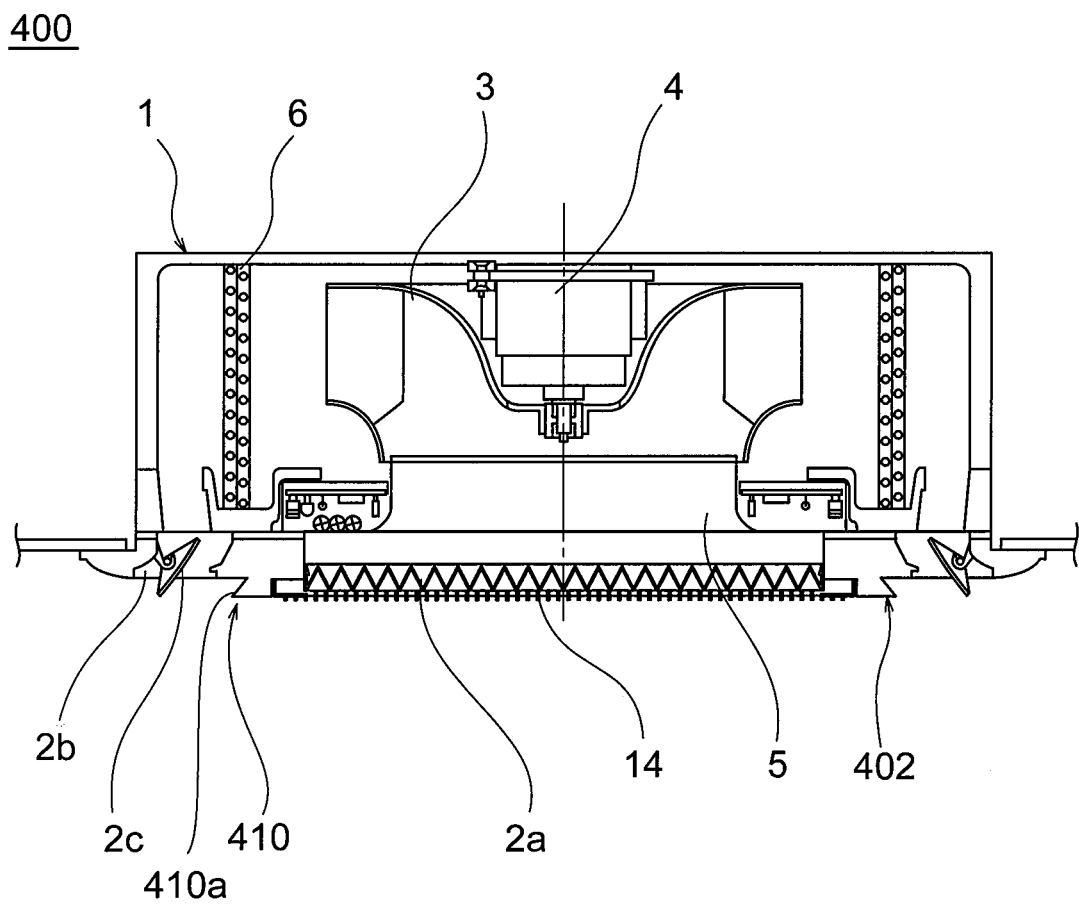
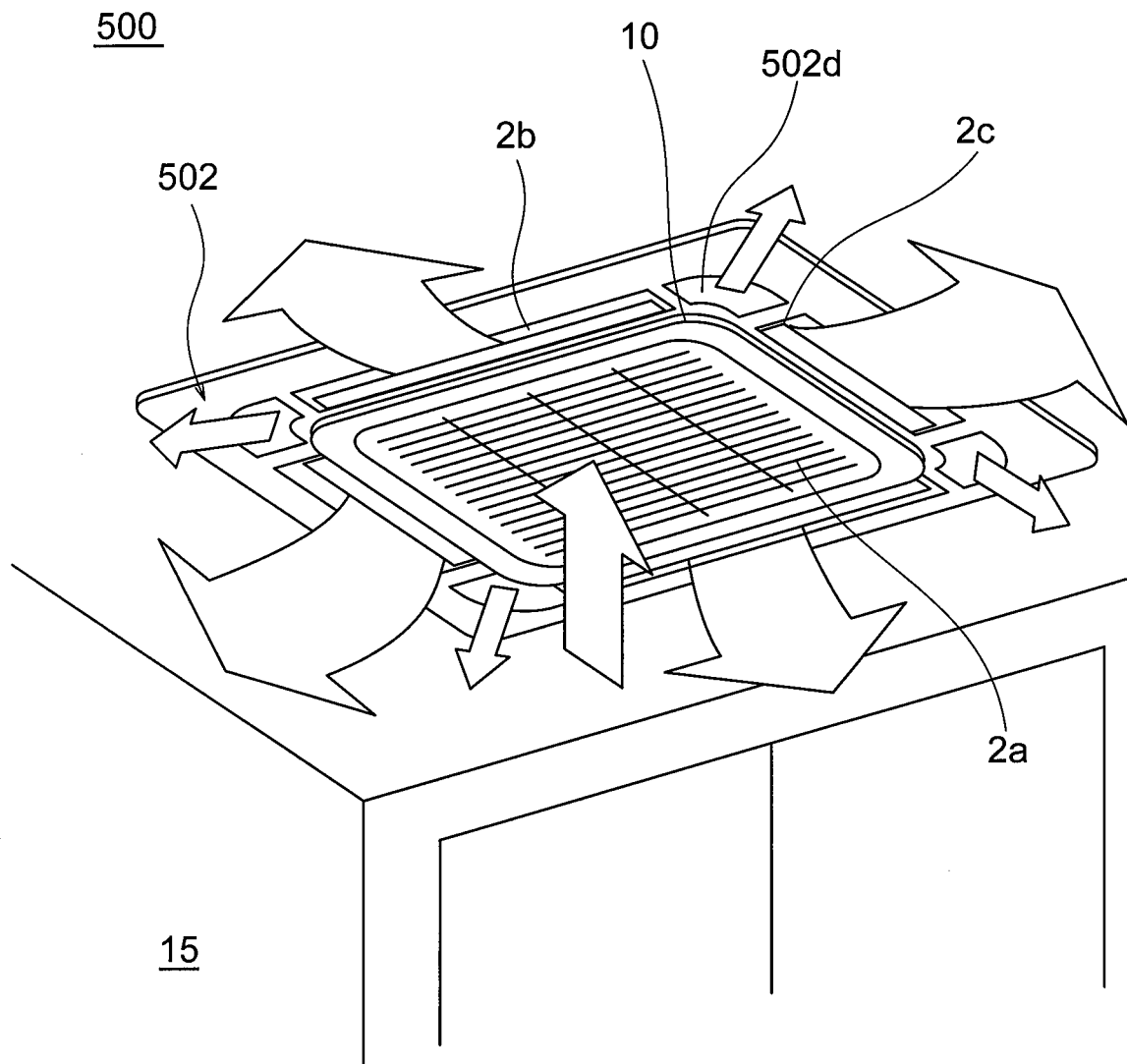


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/050068

A. CLASSIFICATION OF SUBJECT MATTER

F24F13/08(2006.01) i

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)

F24F13/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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.
X Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 9432/1993 (Laid-open No. 69642/1994) (Matsushita Refrigeration Co.), 30 September 1994 (30.09.1994), entire text (Family: none)	1-4, 6 7
X Y	JP 9-145143 A (Mitsubishi Electric Corp.), 06 June 1997 (06.06.1997), paragraph [0043]; fig. 2 (Family: none)	1, 3, 5 7

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

* Special categories of cited documents:

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Date of the actual completion of the international search

24 February, 2014 (24.02.14)

Date of mailing of the international search report

04 March, 2014 (04.03.14)

Name and mailing address of the ISA/
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Facsimile No.

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Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/050068

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 11-166747 A (Mitsubishi Heavy Industries, Ltd.), 22 June 1999 (22.06.1999), entire text (Family: none)	1, 3, 5-6 7
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Y	JP 2005-156045 A (Daikin Industries, Ltd.), 16 June 2005 (16.06.2005), claims; paragraphs [0005], [0051] & US 2006/0276123 A1 & EP 1688678 A1 & WO 2005/052465 A1	7
A	JP 10-160238 A (Mitsubishi Electric Corp.), 19 June 1998 (19.06.1998), entire text (Family: none)	1-7

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 4684085 B [0003]
- JP 4052264 B [0003]
- JP 3700718 B [0003]