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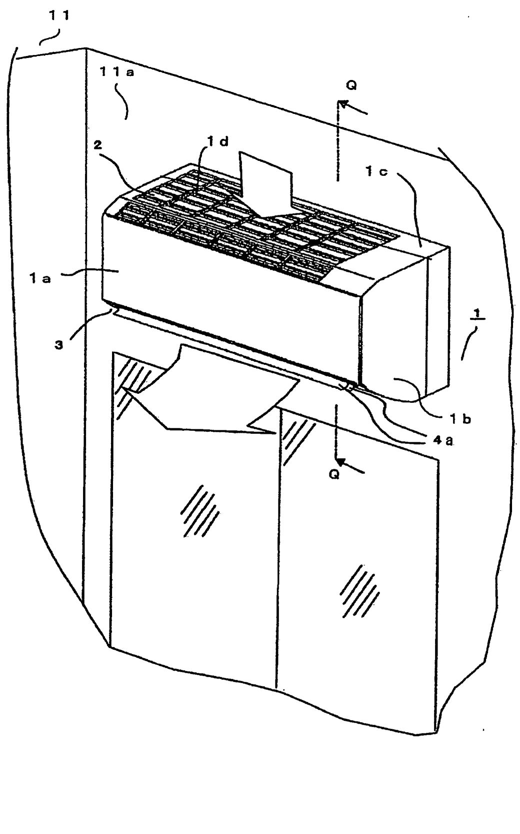
(54) ## AIR CONDITIONER

(57) An inlet 2, a heat exchanger 7, a blow-out port 3, a blower 8 having an impeller 8a, disposed on the downstream side of the heat exchanger 7 and feeding said indoor air from the inlet 2 to the blow-out port 3, with a longitudinal direction of an air conditioner main body 1 as its rotary shaft direction L, a stabilizer 9 that separates a suction-side channel E1 on the upstream side of the impeller 8a and a blow-out-side channel E2 on the downstream side from each other and forms a front face side of the blow-out-side channel E2, a spiral guide wall 10 that forms a rear face side of the blow-out-side channel E2, and a stepped portion 14 disposed in a stepped shape in a blowing direction of the blower 8 at least in a part of the guide wall 10 and having a plurality of steps, each extending in a rotary shaft direction L and indented substantially in a triangular shape on a section perpendicular to the rotary shaft O of the impeller 8a are provided so that separation of a blow-out flow by a negative pressure generated by the step in the stepped shape is prevented, noise is lowered, and energy saving can be realized.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to an air conditioner in which a cross flow fan is mounted as blower means.

Background Art

[0002] A prior-art air conditioner, in which a cross flow fan is mounted, having small holes (dimples) in the surface of a casing, has been disclosed (See Patent Document 1, for example). In this air conditioner in which the cross flow fan is mounted, small holes (dimples) are disposed at equal intervals and in a lattice in a planar side wall in a direction perpendicular to a rotary shaft of the fan in a blow-out grill. By forming the dimples in plural, reduction of separation in a high air-speed region from a fan blow-out portion to a ventilation flue is attempted.
[0003] Also, an air conditioner in which swirl generating means is formed on the surface of a casing has been disclosed (See Patent Document 2, for example). In this air conditioner in which a cross flow fan is mounted, the swirl generating means is disposed on the downstream side, when seen from the fan located on the casing surface, and generates a longitudinal swirl in the air flowing out via the fan. By means of this swirl generating means, the longitudinal swirl is generated in a swirl generation portion, and by agitating an upper layer and a lower layer in the air, separation of the flow from the casing surface is prevented.

Citation List

Patent Literature

[0004]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 8-121396 (pages 4 and 5, Fig. 6)
Patent Literature 2: Japanese Unexamined Patent Application Publication No. 2002-250534 (pages 2 and 3, Fig. 2)

Summary of Invention

Technical Problem

[0005] In the air conditioner described in Patent Literature 1, in which the cross flow fan is mounted, since the dimples (small holes) formed in plural in a lattice in the casing surface are semispherical holes, when a fan blow-out flow passes through the surfaces of dimples, the direction on the dimple downstream side is not set down and might become unstable, which is a problem.
[0006] Also, in the cross flow fan described in Patent Literature 2, since the longitudinal swirl is generated in the swirl generation portion projecting from the casing surface, an upstream-side surface of the swirl generation portion is directed to a stabilizer so as to block the fan blow-out flow. Thus, the flow is disturbed and becomes ventilation resistance, the torque is increased in rotation of the fan, and as a result, an input of a driving fan motor might be deteriorated, which is also a problem.
[0007] The present invention was made in order to solve the above problems and an object thereof is to obtain an air conditioner having a cross flow fan which enable to prevent separation from the casing in an air path that air blowing out of the fan blows into a room through a blow-out port, to reduce noise, and to prevent an increase in an input of a driving fan motor.
Also, prevention of dew splashing generated by cooling the indoor air by the low-temperature air since counterflow of the indoor air is generated by a reduced speed of the blown-out air at both end portions in a direction of a rotary shaft of the fan is also an object.

Solution to Problem

[0008] An air conditioner according to the present invention is provided with an inlet through which indoor air is sucked, a heat exchanger that exchanges heat with the sucked indoor air, a blow-out port through which the heat-exchanged indoor air is blown out into a room, a blower having an impeller, disposed on the downstream side of the heat exchanger between the inlet and the blow-out port, rotated and driven by a motor and feeding the indoor air from the inlet to the blow-out port, with a longitudinal direction of an air conditioner main body as its rotary shaft direction, a stabilizer that separates a suction-side channel on the upstream side of the impeller and a blow-out-side channel on the downstream side from each other and forms a front face side of the blow-out-side channel from the impeller to the blow-out port, a spiral guide wall that forms a rear face side of the blow-out-side channel from the impeller to the blow-out port, and a stepped portion disposed at least in a part of the guide wall and having a plurality of steps, each indented substantially in a triangular shape in a section perpendicular to the rotary shaft of the impeller and extending in the rotary shaft direction, and forming steps in a direction in which the blower feeds the air. Advantageous Effects of Invention

[0009] According to the present invention, an air conditioner can be obtained in which separation from a casing is prevented while a high-speed air flow blown out of the fan flows to the blow-out port, noise is reduced, and energy can be saved.

Also, an air conditioner can be obtained in which, at the both ends in the rotary shaft direction of the fan, the air flow on the center side in the vicinity thereof is drawn and counterflow from inside of the room can be prevented.

Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 relates to Embodiment 1 of the present invention and is an external perspective view illustrating an air conditioner in which a cross flow fan is mounted.

[Fig. 2] Fig. 2 is longitudinal sectional view taken along the Q-Q line in Fig. 1,

[Fig. 3] Fig. 3 is an outline configuration diagram illustrating an impeller of a cross flow fan mounted in the air conditioner according to Embodiment 1.

[Fig. 4] Fig. 4 is a perspective view illustrating a housing forming a part of a main body outer shell integrated with a guide wall of the air conditioner according to Embodiment 1 and the impeller of the cross flow fan.

[Fig. 5] Fig. 5 relates to the air conditioner according to Embodiment 1 and is a perspective view illustrating a housing rear face portion when the impeller of the cross flow fan is removed.

[Fig. 6] Fig. 6 relates to the air conditioner according to Embodiment 1 and is an explanatory diagram illustrating a section of a part in the vicinity of the guide wall in an enlarged manner.

[Fig. 7] Fig. 7 relates to the air conditioner according to Embodiment 1 and is an explanatory diagram illustrating a section of a part of a stepped portion in an enlarged manner.

[Fig. 8] Fig. 8 relates to the air conditioner according to Embodiment 1 and is an explanatory diagram illustrating an action of the stepped portion.

[Fig. 9] Fig. 9 relates to the air conditioner according to Embodiment 1 and is a perspective view in the air conditioner main body illustrating a configuration in which a suction grill is divided in the main body longitudinal direction on an upper part.

[Fig. 10] Figs. 10 relates to the air conditioner according to Embodiment 1 and Fig. 10(a) is an explanatory diagram illustrating distribution of a blow-out air velocity V from the impeller, in which the horizontal direction indicates the rotary shaft direction of the impeller and the vertical direction indicates the air velocity A. Fig. 10(b) is a front view illustrating the guide wall and the housing rear face portion formed integrally with the guide wall, and illustrating without the impeller of the cross flow fan, but the position of the impeller is indicated by a dotted line.

[Fig. 11] Fig. 11 relates to the air conditioner according to Embodiment 1 and is a perspective view illustrating the guide wall and the housing rear face portion formed integrally with the guide wall.

[Fig. 12] Fig. 12 relates to the air conditioner according to Embodiment 1 and is an explanatory diagram, in which the horizontal direction indicates the direction of the impeller rotary shaft and the vertical direction indicates an air velocity V.

[Fig. 13] Fig. 13 relates to an air conditioner according to Embodiment 2 of the present invention and is a front view illustrating a guide wall and a housing rear face portion formed integrally with the guide wall.

[Fig. 14] Fig. 14 relates to the air conditioner according to Embodiment 2 and is a perspective view illustrating the guide wall and the housing rear face portion formed integrally with the guide wall.

[Fig. 15] Fig. 15 relates to the air conditioner according to Embodiment 2 and is an explanatory illustrating a blow-out flow in the vicinity of the guide wall close to an impeller unit body at both ends in the rotary shaft direction on a section perpendicular to a rotary shaft O of a cross flow fan.

[Fig. 16] Fig. 16 relates to the air conditioner according to Embodiment 2 and is a perspective view illustrating the guide wall and the housing rear face portion formed integrally therewith when the impeller of the cross flow fan is removed.

[Fig. 17] Fig. 17 relates to the air conditioner according to Embodiment 2 and is a perspective view illustrating the guide wall and the housing rear face portion formed integrally therewith when the impeller of the cross flow fan is removed.

[Fig. 18] Fig. 18 relates to the air conditioner according to Embodiment 2 and is a perspective view illustrating the housing rear face portion when the impeller of the cross flow fan is removed.

[Fig. 19] Fig. 19 relates to the air conditioner according to Embodiment 2 and is a perspective view illustrating the guide wall and the housing rear face portion formed integrally therewith when the impeller of the cross flow fan is removed.

[Fig. 20] Fig. 20 relates to an air conditioner according to Embodiment 3 and is an exploded perspective view illustrating a guide wall and a housing rear face portion formed integrally therewith when the impeller of the cross flow fan is removed. Description of Embodiments

Embodiment 1.

[0011] Embodiment 1 of the present invention will be described below by referring to the attached drawings. Fig. 1 is an external perspective view of this embodiment, illustrating an air conditioner in which a cross flow fan is mounted as a blower, Fig. 2 is a longitudinal sectional view taken along the Q-Q line in Fig. 1, Fig. 3 is an outline configuration diagram illustrating an impeller of the cross flow fan mounted in the air conditioner according to this embodiment, Fig. 4 is a perspective view illustrating a housing that forms a part of a main body outer shell integrated with a guide wall and the impeller of the cross flow fan of the air conditioner according to this embodiment, Fig. 5 is a perspective view illustrating a housing rear face portion 1c when the impeller 8a of the cross flow fan is removed according to this embodiment, Fig. 6 is an explanatory diagram illustrating a section of a part in the vicinity of the guide wall in an enlarged manner, and Fig. 7 is an explanatory diagram illustrating a section of a part of a stepped portion 14 in an enlarged manner. An air flow is indicated by non-filled arrows in Fig. 1 and by dotted arrows in Figs. 2 and 6. Also, bold arrows RO in Figs. 2 and 4 indicate a rotation direction of the impeller 8a of the cross flow fan 8. Also, reference character O designates a rotary shaft of the impeller 8a and indicates the rotation center in the sectional view.

[0012] As illustrated in Figs. 1 and 2, an air conditioner main body 1 is installed on a wall 11a of a room 11 to be air conditioned. The air conditioner main body 1 is composed of a front panel 1a disposed on the main body front, a housing front face portion 1b, and the housing rear face portion 1c. In an air conditioner main body upper part 1d extending across the housing front face portion 1b and the housing rear face portion 1c, an inlet 2 for indoor air is formed, and moreover, an electric dust collector 6 that electrostatically collects dust, a mesh filter 5 that removes dust, and a heat exchanger 7 are disposed on the upstream side of the impeller 8a of the cross flow fan 8, which is a blower.

[0013] As illustrated in Fig. 2, a stabilizer 9, which has a shape extending to the vicinity of the impeiier 8a, separates a suction-side channel E1 on the upstream side of the impeller 8a and a blow-out-side channel E2 on the downstream side from each other, forms a front face side of the blow-out-side channel E2 from the impeller 8a to a blow-out port 3 and also has such a shape as to be able to temporarily collect droplets dropping from the heat exchanger 7. Also, the rear face side of the blow-out-side channel E2 from the impeller 8a to the blow-out port 3 is constructed by a spiral guide wall 10, and the guide wall 10 is formed integrally with the housing rear face portion 1c. The term "guide wall 10" refers to a portion from a guide-wall start point 10a, which is the closest portion to the impeller 8a on the upstream side, to a guide-wall end point 10b, which is the closest point to the stabilizer 9 on the downstream side. Straight lines connecting the rotation center O to the guide-wall start point 10a and the guide-wall end point 10b, respectively, form a spiral angle θc, which is a predetermined angle. Also, straight lines connecting each position of the guide wall 10 to the rotary shaft center O are formed in the spiral shape from the guide-wall start point 10a to the guide-wall end point 10b such that the lines become longer substantially gradually. In a part of the guide wall 10, a plurality of recess portions are consecutively provided in a stepped shape from the impeller 8a to the blow-out port 3 so as to form a stepped portion 14.

Moreover, at the blow-out port 3, a vertical air-direction vane 4a and a horizontal air-direction vane 4b are mounted rotatably.

[0014] In Fig. 3 illustrating the impeller 8a of the cross flow fan 8, a single blade 8c is shown on the upper side of the rotary shaft O and a view seen from the front is shown on the lower side of the rotary shaft O. As illustrated in Fig. 3, the impeller 8a of the cross flow fan 8 is molded from a thermoplastic resin such as AS, for example. One end portion of the blade 8c extending in a rotary shaft direction L is fastened to an outer peripheral portion of the disk-shaped ring 8b, and a plurality of the blades 8c are disposed along the outer peripheral portion of the ring 8b so as to obtain an impeller unit body 8d. The other end portion of the blade 8c of the one impeller unit body 8d and the back face (the surface on which the blade 8c is not fastened) of the ring 8b of the adjacent impeller unit body 8d are adhered together. After a plurality of impeller unit bodies 8d have been adhered together, the ring 8b that becomes an end portion of the impeller 8a is welded so as to form the impeller 8a.

Moreover, on one end of the impeller 8a, a fan shaft 8f forming the rotary shaft O is fastened using a screw or the like, for example. On the other end of the impeller 8a, a fan boss 8e formed integrally with the ring 8b, and a motor shaft 12a of a motor 12, for example, are fixed by a screw or the like. The both end portions are supported by the fan shaft 8f and the fan boss 8e. With rotation of the motor 12, the impeller is rotated in the rotation direction RO as shown in Fig. 2 around the rotary shaft O as the rotation center, and the indoor air is sucked through the inlet 2 and is blown out into the room through the blow-out port 3. The impeller 8a is contained in the air conditioner main body 1 so that the rotary shaft direction L of the impeller 8a matches the longitudinal direction of the air conditioner main body 1.

[0015] In Figs. 4 and 5, on the downstream side of the guide wall 10, surging blocks 15, for example, are formed as channel reducing members on both end portion sides of the impeller 8a. By means of these surging blocks 15, the width of the blow-out side channel E2 is decreased. By decreasing the width of the flow, lowering of the speed of air flow blown out of the impeller 8a is prevented in the vicinity of the both end portions of the impeller 8a, and counterflow of the air in the room is prevented. Also, the stepped portion 14 is disposed in a part of the guide wall 10. The stepped portion 14 disposed on the guide wall 10 is, as shown in Fig. 5, formed in a part of the impeller 8a in the rotary shaft direction L or at the center part here. In the flow along the guide wall 10, a blown-out flow at the center part in the rotary shaft direction L is a relatively high-speed flow Ff. On the other hand, the blown-out flows at the both end portions of the rotary shaft direction L are blown-out flows Fs, which are slower than the flow at the center part.

[0016] Also, as shown in Fig. 6, the stepped portion 14 has a plurality of steps, each extending in the rotary shaft direction L and indented in a substantially triangular shape in a section perpendicular to the rotary shaft O of the impeller 8a or five steps 14A, 14B, 14C, 14D, and 14E here disposed in parallel in a stepped shape. A step start portion 14a of the step portion 14A located farthest upstream to a step end portion 14d of the step portion 14E located farthest downstream are formed inside from the guide-wall start point 10a to the guide-wall end point 10b. Also, lengths C1, C2, and C3 of line segments O-14a, O-14b, and O-14d connecting the rotation center O of the impeller 8a of the cross flow fan to each of the step start point 14a, a step deepest point 14b, and the step end portion 14d have a relationship of C1 < C2 < C3. Also, in each of the steps 14A, 14B, 14C, 14D, and 14E, the step deepest portion 14b is located close to the step start portion 14a side between the step start portion 14a and the step end portion 14d. That is, a distance h connecting the step start portion 14a to the step deepest portion 14b and a length S connecting the step deepest point 14b to the step end portion 14d are in a relationship of h < S. A plane connecting the step deepest point 14b and the step end portion 14d is a step slope portion 14c, which is a flat inclined plane facing the impeller 8a.

[0017] As shown in Figs. 6 and 7, since the stepped portion 14 disposed on the guide wall 10 satisfies the relationship of C1 < C2 ≤ C3, the step portion is formed in a direction gradually expanding toward downstream of the blow-out-side channel E2 from the rotation center O. For example, the cross flow fan 8 with the impeller 8a of the diameter of 53 mm is used, and in the step 14A farthest upstream side, C1 = 76 mm, C2 = 78 mm, and C3 = 79 mm are set.
In the step 14B connected to the step 14A, C1 = 79 mm is set, and the steps 14C to 14E are formed consecutively.
Also, in each of the plurality of steps 14A, 14B, 14C, 14D, and 14E, the distance h connecting the step start portion 14a to the step deepest portion 14b and the distance S connecting the step deepest point 14b to the step end portion 14d are set in a substantially similar way and they are set approximately at h = 2 mm and S = 15 mm, for example, and formed with h/S of approximately 0.1 to 0.3.
However, since they are formed such that the spiral surface of the guide wall 10 of a configuration in which the stepped portion 14 is not disposed or a spiral virtual surface IM of the guide wall 10 is formed here by connecting the step start portion to the step end portion of each of the steps 14A to 14E, the distances h and S of each step in the stepped portion 14 do not necessarily have to be the same.

[0018] Also, a stepped-portion forming angle θs, which is an angle from the step start portion 14a of the step portion 14A to the step end portion 14d of the step portion 14E around the rotation center O is an angle smaller than a spiral angle θc from the guide-wall start point 10a to the guide-wall end point 10b. Supposing that the stepped-portion forming angle θs formed by a straight line connecting the rotation center O to the step deepest point 14b of the step portion 14A and a straight line connecting the rotation center O to the step end portion 14d of the step portion 14E farthest downstream side is a predetermined angle or approximately 60°, for example, and the guide wall spiral angle θc is approximately 140°, for example, the angle θs is formed so as to be approximately 1/2 the angle θc.

[0019] The stepped portion 14 will be described below in more detail on the basis of Fig. 7. One step constituting the stepped portion 14 has a sectional substantially triangular shape indented from the spiral virtual surface IM of the guide wall 10. That is, the step deepest portion 14b is formed at a position lowered from the step start portion 14a located on the start point 10a side of the guide wall 10 toward the rear face side (in a direction to the right in Fig. 7) of the guide wall 10 by approximately 90 degrees (θ1). Moreover, the step slope 14c, which is a face extending along the virtual surface IM in the direction of approximately 80 degrees (θ2), is formed from the step deepest portion 14b toward the virtual surface IM of the guide wall 10. A portion where the step slope 14c crosses the virtual surface IM is the step end portion 14d. Here, an angle (θ3) formed by the step slope 14c and the virtual surface IM at the step end portion 14d is approximately 10 degrees or less. For example, the step start portion 14a, the step deepest portion 14b, and the step end portion 14d form one step 14B indented to a substantially triangular shape.

[0020] In the air conditioner main body 1 configured as above, if the motor 12 which rotates and drives the impeller 8a is electrified by a power-supply substrate, the impeller 8a of the cross flow fan 8 is rotated in the RO direction. Then, the air in the room 11 is sucked through the inlet 2 disposed in the air conditioner main body upper part 1d, and after dust has been removed by the electric dust collector 6 and the filter 5, the air is heat-exchanged by the heat exchanger 7. That is, the air is heated and used for heating or is cooled and used either for cooling and dehumidification, flows through the suction-side channel E1 and is sucked into the impeller 8a of the cross flow fan 8. After that, the flow blown out of the impeller 8a is guided to the guide wall 10 and the stabilizer 9 and passes through the blow-out-side region E2 toward the blow-out port 3. Then, the flow is blown out into the room 11 for air conditioning. At this time, the direction of the blown-out air is controlled vertically and horizontally by the vertical air-direction vane 4a and the horizontal air-direction vane 4b so as to allow the air to flow through the entire room 11 and to suppress uneven temperature.

[0021] At this time, at the center part in the rotary shaft direction L of the blow-out region E2, the relatively high-speed flow Ff blown out of the impeller 8a and flowing along the guide wall surface collides with the guide wall 10 and is fed to the blow-out port 3. Also, a blow-out air-velocity difference is generated between the adjacent impeller unit bodies 8d in the rotary shaft direction L of the impeller 8a, and a disturbance is caused by shearing friction between the blow-out flows particularly in the vicinity of the ring 8b. The guide wall 10 in the prior-art air conditioner has a merely curved spiral shape. Thus, the collision of the blow-out air and the collision of the disturbance flows on the surface of the guide wall 10 cause pressure fluctuations and noise. Particularly, at the center part of the rotary shaft direction L, the blow-out flow is the high-speed flow Ff, and since the flow Ff collides with the guide wall 10 at a high speed, the noise gets louder.

[0022] Here, in this embodiment, the stepped portion 14 shown in Figs. 5 to 7 is disposed at the center part, for example, of the guide wall 10. Through the center part, the high-speed flow Ff flows, and an action of the stepped portion 14 with respect to this high-speed flow Ff will be described using an explanatory diagram in Fig. 8. As shown in Fig. 8, a part of the high-speed flow Ff flowing along the stepped portion 14 changes its direction at the step start portion 14a of the step 14A farthest upstream side to the step deepest portion 14b and drops into the step 14A and generates a swirl G1. Thus, in the step deepest portion 14b, a negative pressure is generated by the swirl G1. In this state, the high-speed blown-out flow Ff further blown out of the impeller 8a and flowing in the vicinity of the surface of the guide wall 10 is drawn by the negative pressure from the step start portion 14a as shown by a flow X and adheres again to a part on the downstream side of the step slope 14c.

Then, the flow goes toward the step portion 14B provided consecutively to the step portion 14A. A similar phenomenon also occurs at the step start portion 14a of the step portion 14B, and the flow adheres again to the step slope 14c in the middle of the step portion 14B. By means of the stepped portion 14 in which a plurality of steps are formed, the phenomenon that the flow is separated from the surface of the guide wall 10 at the step start portion 14a and adheres again in the middle of the step slope 14c is repeated so that the flow flows as the flow X. Thus, as compared with the blown-out flow Ff in the case without the stepped portion 14, the surface area of the guide wall 10 in contact with the high-speed flow is reduced in the blown-out flow X. As a result, a sound source is decreased. Also, since the negative pressure is generated by the swirl G1, separation on the surface of the guide wall 10 is suppressed.

[0023] Also, a distribution is generated in the flow velocity of the blown-out flow with respect to the rotary shaft direction L. In this embodiment, the stepped portion 14 is disposed so as to extend in the rotary shaft direction L. Thus, the size of the swirl G1 changes along with the rotary shaft direction L, and pressure fluctuations are alleviated in the rotary shaft direction L. Moreover, since the steps are provided consecutively in plural like the steps 14A, 14B, 14C, 14D, and 14E, the pressure fluctuations of the blown-out flow Ff are gradually diffused. As a result, noise can be further reduced.

[0024] Also, by preventing separation of the flow from the surface of the guide wall 10, reduction of an air amount with respect to inputted power can be prevented, which leads to energy saving.

Moreover, due to the relationship of $C1 < C2 \leq C3$, the step end portion 14d does not protrude toward the air path side of the blow-out-side channel E2 from the virtual surface IM of the guide wall 10 but gradually expands in a shape along the spiral virtual surface IM of the guide wall 10, and thus, the step end portion 14d does not disturb the flow in the vicinity of the guide wall 10 having flowed from upstream. Thus, the ventilation resistance is reduced, the motor power can be reduced, and power consumption can be also reduced.

[0025] As a result, by providing the stepped portion 14, a lower noise and higher efficiency can be realized for the cross flow fan, and an air conditioner that is silent and can save energy can be obtained by mounting this cross flow fan.

[0026] The step start portion 14a and the step end portion 14d are located on the spiral virtual surface IM of the guide wall 10, and the step deepest portion 14b is located at a portion indented toward the rear face side of the guide wall 10 from the virtual surface IM. Here, since the guide wall 10 is in the spiral shape, $C1 < C3$ is satisfied all the time. Satisfaction of $C1 < C2$ indicates that the step deepest portion 14b is located at the portion indented toward the rear face side of the guide wall 10 from the step start portion 14a. Also, the relationship of $C2 \leq C3$ indicates that the position of the step deepest portion 14b is not largely indented from the virtual surface IM. Supposing that a circle passing through the step end portion 14d of one step is drawn around the rotation center of the impeller 8a on the section shown in Fig. 8, for example, it is only necessary that the step be formed so that the step deepest portion 14d is located inside the circle. Then, it is only necessary that the steps 14A, 14B, 14C, 14D and 14E be formed with a minimum indent width (= C2 - C1) sufficient to generate the swirl G1 and to create a negative pressure in this portion. If a step with a large indent width is provided, a large swirl is generated in this portion, and the large swirl rather disturbs the blown-out flow flowing along the guide wall 10.

[0027] Also, in the configuration with $h<S$, on the section perpendicular to the rotary shaft direction L as shown in Fig. 8, the step deepest portion 14b is located closer to the step start portion 14a than the step end portion 14d. That is, in Fig. 7, a step has a triangular section with $\theta 1 > \theta 3$. Thus, the swirl G1 can easily occur at a portion close to the step start portion 14a. Moreover, the length of the slope 14c is set longer so as to have a shape which makes re-adhesion easy.

Also, h/S is preferably set to 0.1 to 0.3. If h/S is smaller than 0.1, the indent is too small and the swirl becomes small, and the effect of re-adhesion is also small. On the other hand, if h/S is larger than 0.3, the indent is too large and the swirl becomes large, which rather disturbs the flow.

[0028] Also, examples of θ1, θ2, and θ3 are shown, but the examples are not limiting. The shape is preferably such that the swirl G1 can easily occur from the flow in the vicinity of the guide wall 10. In that meaning, θ1 and θ2 are preferably approximately 90° so that the swirl G1 can easily occur from that shape. Particularly, if θ2 is 90° or less, the swirl G1 occurs in the vicinity of the step deepest portion 14b, and the flow drawn by the negative pressure can be made to smoothly adhere to the slope 14c again, which is preferable. The angle θ3 is set small so that the flow of the step slope 14c can flow smoothly to the step start portion 14a of the subsequent step.

[0029] During manufacture, if the entire guide wall 10 is to be manufactured integrally using a die, the shape needs to be such that separation from the die is possible. For example, when a straight line passing through the step start portion 14a of each step and indicating a die separation direction is drawn on the section perpendicular to the rotary shaft direction L, if the step deepest portion 14b is above this straight line, that is, if the portion has a shape located at the portion bitten into the rear face side of the guide wall 10, the separation becomes impossible. Thus, the step deepest portion 14b is preferably located below the straight line passing through the step start portion 14a and indicating the die separation direction. However, if another method of manufacture is used, the above does not necessarily apply.

[0030] Also, in this embodiment, the stepped portion 14 is adapted to have five steps, but it is not limited to five, and it is only necessary that two or more steps are provided in parallel. Also, in Fig. 8, for example, the stepped portion 14 is configured such that the adjacent step end portion 14d of the step 14A on the upstream side and the step start portion 14a of the step 14B consecutively connected on the downstream side are consecutively connected substantially at the same positions. The configuration is not limited thereto, but a plurality of steps may be provided with some separation between the step end portion 14d of the step 14A on the upstream side and the step start portion 14a of the step 14B on the downstream side, for example. That is, the similar effect can be obtained as long as the plurality of steps are provided with a predetermined interval and in the stepped shape at least continuously.

[0031] Also, the stepped portion 14 may be located anywhere as long as it is between the guide wall start point 10a and the guide wall end point 10b. However, on the side immediately downstream of the guide wall start point 10a, a swirl and the like can be easily generated depending on the shape of the guide wall start point 10a, and the flow can become unstable. In order to obtain an effective advantage from the stepped portion 14, the stepped portion 14 is preferably provided at a portion such that a flow along the guide wall 10 can be obtained to some degree. As shown in Fig. 2, by providing the stepped portion 14 in the vicinity of the flow substantially along the guide wall 10, the action to suppress separation of the flow along the guide wall 10 can be effectively exerted.

[0032] Fig. 9 is a perspective view according to this embodiment and illustrates a configuration in which the inlet 2 is divided in the main body longitudinal direction in the air conditioner main body upper part 1d. As shown in Fig. 9, the inlet 2 is divided by a dividing portion 2C in the vicinity of the center in the rotary shaft direction into a first inlet 2A and a second inlet 2B. When the electric dust collector 2 and an additional filter and the like are asymmetrically disposed on the upstream side of the heat exchanger 7 and suction ventilation resistance becomes different between right and left in the configuration, the dividing portion 2C might be disposed in the vicinity of the center.

[0033] In this configuration example, as shown in Figs. 6 to 8, by forming the stepped portion 14 extending to the impeller rotary shaft direction L on the guide wall 10, a lower noise and higher efficiency of the cross flow fan 8 can be realized, and an air conditioner that is silent and can save energy can be obtained. If the inlet 2 is divided into two parts in the rotary shaft direction L of the impeller 8a and is composed by the first inlet 2A and the second inlet 2B, the dividing portion 2C that divides the inlet 2 into two parts works as resistance. Thus, suction and blow-out of the impeller 8a become difficult on the downstream side of the dividing portion 2C. Thus, at a position corresponding to the downstream of the dividing portion 2C, a blow-out air velocity might be slower than that in the other regions. Fig. 10(a) illustrates a distribution of a blow-out air velocity V from the impeller 8a. The horizontal direction indicates the impeller rotary shaft direction L, while the vertical direction indicates the air velocity V. As illustrated in the figure, the air velocity V is lowered in the downstream portion of the dividing portion 2C.

[0034] Fig. 10(b) is a front view illustrating the guide wall 10 and the housing rear face portion 1c configured integrally therewith without the impeller 8a of the cross flow fan, but the position of the impeller 8a is shown by a dotted line. In Figs. 10(a) and 10(b), the position of the rotary shaft direction L is substantially matched. Also, Fig. 11 is a perspective view illustrating the guide wall 10 and the housing rear face portion 1c configured integrally therewith. In this configuration example, a stepped portion 16 is divided into right and left two parts, that is, a first stepped portion 16A and a second stepped portion 16B corresponding to the first and second inlets 2A and 2B. That is, the stepped portion 16 is not formed in a center part B corresponding to the dividing portion 2C in the vicinity of the center in the rotary shaft direction L. Detailed sectional shapes of the first and second stepped portions 16A and 16B are similar to the stepped portion 14 in Figs. 2 and 6 to 8.

[0035] The first and second stepped portions 16A and 16B are formed in portions where the blow-out air velocity of the impeller 8a is relatively high or portions where the blow-out air velocity is Vs or more, for example, which is the guide wall 10. That is, the blow-out air velocity becomes high at positions corresponding to the downstreams of the first and second inlets 2A and 2B, and the flow in the vicinity of the surface of the guide wall shown in Fig. 6 also collides with the guide wall 10 at a high speed. The larger the surface area of the guide wall 10 with which the high-speed flow is in contact, the larger the noise becomes, and a swirl is generated in the vicinities of the step deepest portions of the stepped portions 16A and 16B so that negative pressures are generated in the vicinities. Then, while separation of the high-speed flow flowing through the surface of the guide wall 10 is suppressed, the surface area of the guide wall 10 with which the high-speed flow is in contact is reduced. As a result, the noise can be reduced.

[0036] Moreover, the first and second stepped portions 16A and 16B extend to the rotary shaft direction L, respectively, and are disposed on the whole surface, for example, of a portion considered to be collided by the high-speed flow. The blow-out air velocity is distributed in the rotary shaft direction L, and the sizes of the swirls generated by the stepped portions 16A and 16B are also changed along the rotary shaft direction L. Thus, the pressure fluctuations are alleviated in the rotary shaft direction L, and the noise can be further reduced. Also, the stepped portion 16 is formed by consecutively providing a plurality of steps: five steps in Figs. 10 and 11, for example. Thus, the pressure fluctuations of the blow-out flow are gradually diffused toward the blow-out port 3 in the blow-out region E2, and the noise can be further reduced.

[0037] Particularly, the stepped portions 16A and 16B are not formed in a portion B where the blow-out air velocity is low. If the blow-out air velocity is low, the noise caused by collision against the guide wall 10 does not matter much. If the stepped portion 16 is formed in this portion, the flow might be disturbed by the generated swirl. Thus, in this configuration example, the first and second stepped portions 16A and 16B are disposed only in portions where the blow-out flows are at a high speed so as to reduce the noise caused by the high-speed flow.

[0038] Depending on the configuration of the upstream side of the impeller 8a, the distribution of the blow-out air velocity V from the impeller 8a might become the one shown in Fig. 12. In Fig. 12, the horizontal direction indicates the rotary shaft direction L of the impeller 8a, while the vertical direction indicates the air velocity V At this time, too, by providing the stepped portion 1B in which a plurality of steps are consecutively provided in a stepped shape in the portion where the blow-out flow is at a high speed or the guide wall 10 in the portion where the blow-out air velocity V becomes Vs or more, for example, the noise caused by the high-speed flow can be reduced.

Here, since the value Vs as the threshold value is different also depending on an air feeding amount of the cross flow fan 8,

[0039] In the above, for convenience of the explanation, the stepped portion 16 is assumed to be disposed in a portion where the blow-out air velocity V becomes the predetermined air velocity Vs or more. This predetermined air velocity value Vs is different depending on the sizes of the air conditioner and the cross flow fan and the configuration of an air path. Thus, they cannot be set uniformly but can be set empiricaiiy, experimentally or through simulation. Also, since the blow-out air velocity becomes the lowest at the both end portions in the rotary shaft direction L, a value not less than an intermediate value of the air velocity at the both end portions and the air velocity of the fastest portion, for example, may be set as Vs.

[0040] As described above, by providing the inlet 2 through which the indoor air is sucked, the heat exchanger 7 that exchanges heat with the sucked indoor air, the blow-out port 3 through which the heat-exchanged indoor air is blown out into the room, the blower 8 having the impeller 8a, disposed on the downstream side of the heat exchanger 7 between the inlet 2 and the blow-out port 3 and rotated and driven by the motor 12, with the longitudinal direction of the air conditioner main body 1 as the rotary shaft direction L and feeding the indoor air from the inlet 2 to the blow-out port 3, the stabilizer 9 that separates the suction-side channel E1 on the upstream side of the impeller 8a and the blow-out-side channel E2 on the downstream side from each other and forms the front face side of the blow-out-side channel E2 from the impeller 8a to the blow-out port 3, the spiral guide wall 10 that forms the rear face side of the blow-out-side channel E2 from the impeller 8a to the blow-out port 3, and the stepped portion 14 disposed at least in a part of the guide wall 10 and having a plurality of the steps 14A, 14B, 14C, 14D, and 14E, each indented substantially in a triangular shape in the section perpendicular to the rotary shaft O of the impeller 8a and extending in the rotary shaft direction L, and forming steps in a direction in which the blower 8 feeds the air, such an advantage is exerted that an air conditioner in which separation of the flow on the surface of the guide wall 10 is suppressed, and the pressure fluctuations are diffused so as to lower the noise can be obtained.

[0041] Also, on the section perpendicular to the rotary shaft O of the impeller 8a, the steps are configured such that the upstream-side end portion of one step in the stepped portion 14 is made the step start portion 14a, the portion indented to the deepest substantially in the shape of a triangle of the step is made the step deepest portion 14b, the downstream-side end portion of the step is made the step end portion 14d, and the relationship among the length C1 connecting the rotation center O of the impeller 8a to the step start portion 14a, the length C2 connecting the rotation center O of the impeller 8a to the step deepest portion 14b and the length C3 connecting the rotation center O of the impeller 8a to the step end portion 14d is $C1 < C2 \leq C3$, so the ventilation resistance can be reduced without disturbing the flow in the vicinity of the guide wall 10, and such an advantage is exerted that an air conditioner that can reduce the power consumption can be obtained.

[0042] Also, on the section perpendicular to the rotary shaft O of the impeller 8a, the steps are configured such that the upstream-side end portion of one step in the stepped portion 14 is made the step start portion 14a, the portion indented to the deepest in a substantially triangular shape of the step is made the step deepest portion 14b, the downstream-side end portion of the step is made the step end portion 14d, and the relationship between the length h connecting the step start portion 14a to the step deepest portion 14b and the length S connecting the step deepest portion 14b to the step end portion 14d is h<S, the swirl G1 is reliably generated in the vicinity of the step deepest portion 14b so as to generate a negative pressure, and such an advantage is exerted that an air conditioner with a lower noise can be obtained.

[0043] Also, in the rotary shaft direction L of the impeller 8a, by providing the stepped portion 14 on the guide wall 10 at a portion where the air flow blown out of the impeller 8a flows at a high speed, the surface area of the guide wall 10 with which the high-speed flow is in contact is reduced, and such an advantage is exerted that an air conditioner in which noise can be lowered can be obtained.

[0044] Also, since the inlet 2 is divided into two parts in the rotary shaft direction L of the impeller 8a and is composed by the first inlet 2A and the second inlet 2B, and the first stepped portion 16A disposed on the guide wall 10 at the position corresponding to the downstream of the first inlet 2A and the second stepped portion 16B disposed on the guide wall 10 at the position corresponding to the downstream of the second inlet 2B are provided, the stepped portions 16A and 16B are disposed on the portion of the guide wall 10 with which the high-speed flow is in contact and the surface area of the guide wall 10 with which the high-speed flow is in contact is reduced so that an advantage is exerted that an air conditioner in which noise can be lowered can be obtained.

Embodiment 2.

[0045] An air conditioner according to Embodiment 2 of the present invention will be described below by referring to the attached drawings. This embodiment relates to the guide wall 10 in the vicinity of the both end portions in the rotary shaft direction L of the impeller 8a. Fig. 13 relates to the air conditioner of this embodiment and is a front view illustrating the guide wall 10 and the housing rear face portion 1c formed integrally therewith without the impeller 8a of the cross flow fan, but the position of the impeller 8a is shown by a dotted line. Also, Fig. 14 is a perspective view illustrating the guide wall 10 and the housing rear face portion 1c formed integrally therewith. The same reference numerals in the figures as those in Embodiment 1 designate the same or corresponding portions.

[0046] As illustrated in Figs. 13 and 14, stepped portions 17A and 17B in this embodiment are disposed in the vicinity where a blow-out flow Fs flows at a low speed or at both end portions in the rotary shaft direction L of the guide wall 10, for example. The stepped portions 17A and 17B disposed adjacently to the side walls of the both end portions are formed by a plurality of steps: five steps, for example, consecutively provided in a stepped shape. The sectional shape perpendicular to the rotary shaft O is a triangular indented shape similarly to that in Fig. 7. In this configuration, since surging blocks 15 are provided at both end portions of the guide wall 10 as channel reducing members, the stepped portions 17A and 17B are disposed adjacently to the surging blocks 15. Also, each of the stepped portions 17A and 17B is configured such that one end portion is located inside the surging blocks 15 while the other end portion is extended at least to the second impeller unit body 8d, which is the second one from the end portion of the impeller 8a in the rotary shaft direction L. That is, the stepped portion 17A is disposed so as to go across an impeller unit body 8d1 and a part of an impeller unit body 8d2 adjacent to the inner side of the impeller unit body 8d1 on the fan shaft side of the impeller 8a. Also, the stepped portion 17B is disposed so as to go across an impeller unit body 8d3 and a part of an impeller unit body 8d4 adjacent to the inner side of the impeller unit body 8d3 on the fan motor side.

[0047] The flow in the vicinity of the guide wall 10 blown out of the impellers 8d1 and 8d3 at the both end portions in the rotary shaft direction L of the impeller 8a in Fig. 13 can easily become the low-speed and unstable flow Fs as compared with the high-speed flow Ff blown out of the vicinity of the center in the impeller rotary shaft direction L. Fig. 15 is an explanatory diagram illustrating a blown-out flow in the vicinity of the guide wall 10 in the vicinity of the impeller unit bodies 8d1 and 8d3 at both end portions in the rotary shaft direction L on the section perpendicular to the rotary shaft O of the impeller 8a. In this figure, the dotted line Ff indicates a fast flow, while the line Fs indicates a slow flow. If the air conditioner main body is operated for a long time, dust contained in the air of the room 11 is accumulated in the filter 5, and ventilation resistance of the cross flow fan 8 is increased, the air velocity of the blown-out flows from the both end portions in the rotary shaft direction L of the impeller 8a is lowered. Looking at the vicinity of the guide wall 10, the high-speed flow Ff does not reach the guide wall 10 but passes through a position away from the guide wall 10, while the low-speed flow Fs flows close to the guide wall 10. If the air velocity of the blown-out flows at the both end portions is lowered as above, this region might become an extremely low-speed region and the air in the room at high humidity might counterflow through the blow-out port 3. If the counterflow occurs, condensation is caused at the blow-out port 3 having been cooled during the cooling operation, and the condensed water might be splashed out to the room 11 together with the blow-out flow of the impeller 8a and stain the floor in the worst case.

[0048] In this embodiment, the stepped portions 17A and 17B are disposed at the both end portions in the rotary shaft direction L of the impeiier 8a. The low-speed and unstable flow Fs in the vicinity of the guide wall 10 caused when dust is accumulated in the filter 5, for example, is drawn to a step slope portion 17c as a flow Y due to a negative pressure caused by the swirl G1 generated in the step deepest portion 17b. Then, the flow adheres again and flows along the step slope portion 17c to the step end portion 17d. Since the low-speed and unstable flow Fs is brought into contact with the guide wall 10 as above, the flow to be separated from the surface of the guide wall 10 is diffused along the surface of the guide wall 10, whereby the separation is made difficult.

[0049] Also, on the impeller unit bodies 8d1 and 8d3 at the both end portions of the impeller 8a, the stepped portions 17A and 17B are formed, respectively, to the positions of the adjacent impeller unit bodies 8d2 and 8d4. When the blown-out flow close to the impeller unit bodies 8d1 and 8d3 and the blown-out flow close to the impeller unit bodies 8d2 and 8d4 are compared, the flow relatively becomes a negative pressure on the impeller unit bodies 8d1 and 8d3 and becomes a high pressure on the impeller unit bodies 8d2 and 8d4.

The flow blown out of the impeller unit bodies 8d2 and 8d4 pass through the impeller unit bodies 8d1 and 8d3 at the both end portions where the flow relatively becomes a negative pressure and is drawn to the both end portions in the rotary shaft direction L through the step deepest portions 17b of the stepped portions 17A and 17B. Thus, the blown-out flow can be diffused to the directions of the both end portions of the impeller 8a, and the air velocity at this portion can be raised, whereby counterflow from the inside of the room can be reliably prevented.

[0050] As a result, a cross flow fan in which counterflow phenomenon hardly occurs even if dust is accumulated in the filter, for example, can be obtained, and by mounting this cross flow fan, a high-quality air conditioner can be obtained.

[0051] As described above, by providing the stepped portions 17 at the both end portions in the rotary shaft direction L of the guide wall 10 so that they are adjacent to the side walls connected to the both end portions in the rotary shaft direction L of the guide wall 10, the flow is diffused so that the flow flows along the guide wall 10 by the negative pressure generated in the step deepest portion 17b, occurrence of the counterflow in the vicinity is prevented, and a high-quality air conditioner can be obtained, which is advantageous.

[0052] Also, the impeller 8a of the blower 8 is configured by fastening the impeller unit bodies 8d obtained by dividing the impeller into a plurality of parts in the rotary shaft direction L, and by configuring such that the lengths of the stepped portions 17A and 17B in the rotary shaft direction L disposed at the both end portions in the rotary shaft direction L of the guide wall 10 are extended to the adjacent impeller unit bodies 8d2 and 8d4 fastened to the impeller unit bodies 8d1 and 8d3 at the both end portions, respectively, the flow in the rotary shaft direction L passing through the step deepest portion 17b is drawn so as to reliably reduce the extremely low-speed region, and an air conditioner capable of preventing counterflow can be obtained, which is advantageous.

[0053] Fig. 16 relates to an air conditioner according to this embodiment and is a perspective view illustrating the guide wall 10 and the housing rear face portion 1c formed integrally therewith when the impeller 8a of the cross flow fan is removed. In this configuration example, a stepped portion 18 extending from one end portion to the other end portion of the impeller rotary shaft direction L is formed. By means of the stepped portion 18, effects of a lower noise and energy saving as described in Embodiment 1 can be obtained at the center part in the rotary shaft direction L, and a high-quality air conditioner capable of preventing counterflow from the inside of a room can be obtained at the both end portions in the rotary shaft direction L. As illustrated in Fig. 16, by forming the stepped portion 18 on the entire guide wall 10 in the rotary shaft direction L inside the side walls of the guide wall 10 or inside the surging blocks 15, here, the working effects of both Fig. 8 and Fig. 15 can be obtained. That is, at the center part in the rotary shaft direction L where the blown-out flow is at a high speed, the surface area of the guide wall 10 with which the high-speed flow Ff is in contact is decreased, and separation from the surface of the guide wall 10 is suppressed, and thus, a lower noise and energy saving can be realized. Moreover, at the both end portions where the blown-out flow is at a low speed and unstable, the blown-out flow Fs is diffused to the surface side of the guide wall 10 so that the counterflow from the inside of the room can be prevented, and a high-quality air conditioner can be obtained.

[0054] As described above, by forming the stepped portion 18 so as to extend from one end portion to the other end portion of the guide wall 10 in the rotary shaft direction L, the separation of the blown-out flow is prevented by the negative pressure generated in the stepped portion 18, and an air conditioner capable of lowering noise, saving energy and preventing counterflow can be obtained, which is advantageous.

[0055] Fig. 17 relates to an air conditioner according to this embodiment and is a perspective view illustrating the guide wall 10 and the housing rear face portion 1c formed integrally therewith when the impeller 8a of the cross flow fan is removed. In this configuration example, a stepped portion 19 extending from one end portion to the other end portion of the impeller rotary shaft direction L is formed. And a plurality of partitions that divide the stepped portion 19 at several spots in the rotary shaft direction L: three dividing ribs 13, for example, are disposed so as to divide the stepped portion 19 into four parts. The dividing ribs 13 are partitions that extend in a direction perpendicular to the rotary shaft O and have wall surfaces connecting step start portions 19a and step end portions 19d of the respective stepped portions 19 disposed at the center part and the both end portions.

[0056] As illustrated in Fig. 16, by providing the stepped portion 18 extending from the center part over to the whole of both end portions, as described above, an advantage that the blown-out flow can be diffused from the center part to the both end portions can be obtained. On the other hand, depending on a difference between the high-speed flow Ff of the blown-out flow in the center part and the low-speed flow Fs of the blown-out flow at the both end portions, the flow might flow too much from the center part to the both end portions. Thus, in the configuration example shown in Fig. 17, the dividing ribs 13 extending in the direction perpendicular to the rotary shaft direction L are disposed. The faces of the dividing ribs 13 facing the impeller 8a are formed so as to substantially match the virtual surface of the guide wall 10 on which the stepped portion 19 is not disposed. By means of the dividing ribs 13, the high-speed flow Ff flowing in the center part is prevented from flowing excessively to the both end portions via the stepped portion 19. Between the face of the dividing rib 13 facing the impeller 8a and the impeller 8a, a space where the stepped portion 19 is not formed is present. Thus, the flow from the center side to the both end sides is suppressed to some degree. That is, by means of the dividing ribs 13, the flow from the center side to the both end sides is forced to the direction orthogonal to the rotary shaft O and regulated. As described above, the flow on the guide wall 10 in the vicinity of the both end portions can be further made stable, and a higher quality air conditioner can be obtained.

[0057] On the section perpendicular to the rotary shaft O a start position 13A of the dividing rib 13, which is a partition start portion, is set similar to the start position of the stepped portion 19, and an end position 13B of the dividing rib 13, which is a partition end portion, is set similar to the end position of the stepped portion 19. That is, the dividing ribs 13 are disposed in a range of a stepped-portion forming angle θs. The diving rib 13 has a function to prevent excessive flow of the high-speed flow on the center side from flowing to the portion of the low-speed flow at the both end portions via the stepped portion 19. Thus, on the face along the surface of the guide wall 10 in a direction perpendicular to the rotary shaft O it is only necessary that the rib is disposed so as to include at least a portion on which the stepped portion 19 is formed.

The position at which the dividing rib 13 is disposed in the rotary shaft direction L is not limited to that in Fig. 16. An advantage to regulate and stabilize the flow on the guide wall 10 in the vicinity of the both end portions can be obtained as long as at least one rib each is disposed in the vicinity of the both end portions.

[0058] As described above, by providing the partitions 13 extending in the direction perpendicular to the rotary shaft O and having wall surfaces connecting the step start portions 19a and the step end portions 19d of the respective stepped portions 19 disposed at the center part and the both end portions between the center part and the both end portions in the rotary shaft direction L of the guide wall 10 so as to prevent excessive flow of the high-speed flow flowing in the center part to the both end portions via the stepped portion 19, the effect of the stepped portion 19 can be effectively exerted, a stable flow is obtained, and a high-quality air conditioner can be obtained, which is advantageous.

[0059] Fig. 18 relates to an air conditioner according to this embodiment and is a perspective view illustrating the guide wall 10 and the housing rear face portion 1c formed integrally therewith when the impeller 8a of the cross flow fan is removed. In this configuration example, stepped portions 20 and 21 are divided into three parts in the rotary shaft direction L, and the stepped-portion forming angle θs and the slope length S of each of the steps are varied by the center-part stepped portion 20 and the both-end-portion stepped portions 21. For example, a step start portion and a step end portion are shifted in the blowing direction, respectively, by the stepped-portion forming angle θs(c) of the center-part stepped portion 20 and the stepped-portion forming angle θs(e) of the both-end-portion stepped portion 21, and a relationship of θs(c) < θs(e) is set. Moreover, in both the center-part stepped portion 20 and the both-end-portion stepped portions 21, the slope lengths Sc and Se, which are step widths of the plurality of steps, are gradually made longer from the upstream side to the downstream side.

[0060] As described above, the flow surrounding the guide wall 10 is a high-speed flow in the center part in the rotary shaft direction L and becomes a low-speed flow at the both end portions. Thus, the start position of the both-end-portion stepped portion 21 is configured on the upstream side from the start position of the center-part stepped portion 20. The flow at the both end portions in the flow having a speed distribution blown out of the impeller 8a generates a swirl at the both-end-portion stepped portion 21 and becomes a negative pressure in the step deepest portion.

As a result, the flow in the center part flowing close to the both end portions is drawn to the both end portions and becomes a flow having a component toward the both end portions. Thus, in the rotary shaft direction L, the speed difference in the blown-out flows is somewhat lowered, and since the low-speed flow in the vicinity of the both end portions is diffused to the both end portion sides of the guide wall 10, the counterflow from the inside of the room can be prevented further reliably.

[0061] Also, since the positions of the step deepest portions of the both-end-portion stepped portion 21 and the center-part stepped portion 20 are shifted from each other, the flow from the center part to the both end portions is prevented from becoming excess. That is, even without disposing a dividing rib as shown in Fig. 17 at a boundary portion between the center-part stepped portion 20 and the both-end-portion stepped portions 21, an action to regulate the flow from the center part side to the both end portion sides can be exerted.

[0062] Also, the slope lengths of the stepped portions 20 and 21 are configured different from each other. Here, the slope length Sc of the center-part stepped portion 20 and the slope length Se of the both-end-portion stepped portion 21 are changed independently so as to become gradually longer from the upstream side to the downstream side, respectively. On the section perpendicular to the rotary shaft O the spiral guide wall 10 is in a shape forming a channel whose channel width gets gradually larger.

If the slope length S of the stepped portion is made longer on the downstream side as the spiral shape is expanded, a flow immediately before the air-direction vane can be regulated on the downstream portion. After that, when ventilation resistance is changed by the air-direction vane and blown out into the room, the blow-out direction can be controlled easily. Also, the portion has a shape that can be removed easily from a molding die when the housing rear face portion 1c is molded and configured so that die separation is easy.

[0063] On the other hand, the slope lengths Sc and Se of the stepped portions 20 and 21 can be changed so that the lengths get gradually shorter from the upstream side to the downstream side. In this case, the blown-out flow whose speed is gradually lowered can be diffused by a negative pressure generated in the vicinity of the step deepest portions of the stepped portions 20 and 21 so that the flow flows along the guide wall 10. Thus, a wide blown-out flow can be blown out into the room through the blow-out port 3. As described above, a blown-out flow with a favorable feeling, not a partially concentrated and biased flow, can be obtained.

[0064] In Fig. 18, the shapes of the stepped portions 20 and 21 are changed in accordance with a difference in velocity of the blown-out flows and ventilation resistances of the impeller 8a in the rotary shaft direction L, and the surface shape of the guide wall 10 is optimized. As a result, noise can be further reduced, energy can be saved, and moreover, counterflow is prevented and a high-quality air conditioner can be obtained.

[0065] Fig. 19 relates to an air conditioner according to this embodiment and is a perspective view illustrating the guide wall 10 and the housing rear face portion 1c formed integrally therewith when the impeller 8a of the cross flow fan is removed. In this configuration example, stepped portions 22 and 23 are divided into two parts in the rotary shaft direction L, and the stepped-portion forming angle θs and the slope length S of each of the steps are varied by the stepped portion 22 on the left side and the stepped portion 23 on the right side in the figure.

[0066] For example, in the suction-side channel E1, a high-performance filter capable of collecting finer dust than the electric dust collector 6 and the filter 5 might be equipped on the upstream side of the heat exchanger 7. If such a high-performance filter is equipped, the ventilation resistance on the downstream side is raised, which generates a low-speed flow easily. Thus, as shown in Fig. 19, by increasing the stepped-portion forming angle θs as in the stepped portion 22 in a portion where the ventilation resistance is high on the left side in the figure, the low-speed blown-out flow can be diffused to the surface of the guide wall 10. Also, in a portion where the ventilation resistance is low on the upstream side, by decreasing the stepped-portion forming angle θs as in the stepped portion 23, a separation preventing action and a diffusion action required at the position of the flow can be obtained. Also, at a boundary portion between the stepped portion 22 and the stepped portion 23, the positions of the deepest portions of the plural steps are shifted in the configuration, whereby the flow in the rotary shaft O direction can be controlled so as not to become excessive, and the blown-out flow can be regulated to the direction directly going to the rotary shaft O.

As described above, by optimizing the shapes of the stepped portions 22 and 23 in accordance with the difference in the ventilation resistance in the rotary shaft direction L of the impeller 8a, noise can be further reduced, energy can be saved, and a higher quality air conditioner can be obtained.

[0067] Here, as for the optimization of the shape of the stepped portion shown in Figs. 18 and 19, the stepped portion is divided into plural parts in the rotary shaft direction L, and the positions of the step start portions in the divided plural stepped portions are made different between the adjacent stepped portions. Also, the positions of the step start portions in the divided plural stepped portions are made different are made different between the adjacent stepped portions. Also, the positions of the step deepest portions in the divided plural stepped portions are made different between the adjacent stepped portions. Also, the positions of the step end portions in the divided plural stepped portions are made different between the adjacent stepped portions. As described above, by configuring such that the positions are made different between the adjacent stepped portions, the flow from the center part to the both end portions can be regulated. Also, by means of the stepped portions formed in a portion of the high-speed flow in the center part, noise can be reduced while considering the surface area of the flow along the guide wall 10. Also, by means of the stepped portions formed in portions of the low-speed flow at the both end portions, the flow can be diffused so as to flow along the guide wall 10, whereby counterflow from the inside of the room can be prevented, and a reliable air conditioner can be obtained.

[0068] As described above, by dividing the stepped portion in the rotary shaft direction L, the shapes of the stepped portions can be changed in the rotary shaft direction L in the configuration in accordance with the air velocity and the air amount inflowing along the guide wall 10.

It is needless to say that not all of the positions of the step start portions, the positions of the step deepest portions and the positions of the step end portions are changed at the adjacent stepped portions, but by changing at least one position, optimization can be realized to some degree in accordance with the ventilation resistance in that portion. Also, a rectification effect to some degree in the rotary shaft direction L can be obtained. On the contrary, the rectification effect can be controlled by a way of changing.

Also, by configuring the adjacent stepped portions in totally the same manner and by slightly shifting the step start positions of the uppermost stream side of the stepped portions, the positions of the step start portions, the positions of the step deepest portions, and the positions of the step end portions can be changed.

[0069] As described above, by dividing the stepped portion in plural parts in the rotary shaft direction L and by making the positions of the step start portions, the positions of the step deepest portions or the positions of the step end portions in the divided plural stepped portions 20, 21, 22, and 23 different between the adjacent stepped portions 20 and 21 or between the adjacent stepped portions 22 and 23, the surface shape of the guide wall 10 can be optimized in accordance with the ventilation resistance in the rotary shaft direction L, and moreover, an air conditioner in which noise can be lowered, energy can be saved, and a quality can be improved can be obtained, which is advantageous.

[0070] Also, by changing the length S connecting the step deepest portion to the step end portion of one step constituting the stepped portion so that the length gets gradually longer or shorter from the upstream side to the downstream side for the plurality of steps, the following effects can be provided.

That is, by changing the length S connecting the step deepest portion to the step end portion of one step so that the length gets gradually longer from the upstream side to the downstream side for the plurality of steps, in addition to the effect obtained by providing the stepped portion, such an effect can be obtained that an air conditioner can be obtained in which the blow-out direction can be easily controlled, and separation from a die during manufacture is easy.

Also, by changing the length S connecting the step deepest portion to the step end portion of one step so that the length gets gradually longer from the upstream side to the downstream side for the plurality of steps, in addition to the effect obtained by providing the stepped portion, a blow-out flow can be diffused to the channel of the blow-out-side channel E2 and in addition to the effect obtained by providing the stepped portion, counterflow is reliably prevented, and a reliable air conditioner can be obtained, which is advantageous.

[0071] In Embodiment 1, all the slope portion lengths S of the steps constituting the stepped portion are set the same, but they may be changed so that the lengths get gradually longer or shorter from the upstream side to the downstream side. Also, as in the stepped portions 16A and 16B in Figs. 10 and 11 and the stepped portions 17A and 17B in Figs. 13 and 14, in the stepped portion configured by being divided into a plurality of parts in the rotary shaft direction L, the positions of the step start portions, the positions of the step deepest portions or the positions of the step end portions in the divided plural stepped portions may be configured different between the divided stepped portions.

[0072] Also, in Embodiment 1 and Embodiment 2, the step deepest portions in the plural steps constituting the stepped portion are configured parallel with the rotary shaft direction L, but the configuration is not limited to that. The step deepest portion may be configured such that the step deepest portion is slightly inclined to the rotary shaft direction L. As long as the stepped portion is configured extending in the rotary shaft direction L, the size of the swirl G1 is changed in this direction, the pressure fluctuations are alleviated, and noise can be lowered.

Also, the plurality of steps are arranged substantially in parallel, but they may be slightly inclined instead of arrangement in parallel with each other. As long as the stepped portion is configured substantially in the stepped shape on the section in a direction perpendicular to the rotary shaft O, the pressure fluctuations of the blow-out flow are gradually diffused in the blow-out direction, and noise is lowered.

Embodiment 3.

[0073] An air conditioner according to Embodiment 3 of the present invention will be described using the attached drawings. Major configurations and corresponding reference numerals are the same as those in Embodiment 1 or Embodiment 2. Fig. 20 is a partially exploded perspective view illustrating of the housing rear face portion 1c. The housing rear face portion 1c has a lower base 10c formed on a rear face portion of the guide wall 10 and also has a plurality of lower fitting portions or projecting and recessed guide holes 10d, for example, on the guide wall surface side thereof. A surface piece 25 of the guide wall is composed of five portions 25a, 25b, 25c, 25d, and 25e in the rotary shaft direction L, here, for example. Each of the back faces of the surface pieces 25a, 25b, 25c, 25d, and 25e is configured capable of being fitted in the guide holes 10d so that the surface pieces can be fitted with the lower fitting portions 10d of the lower base 10c corresponding to a fixed position of the guide wall. Step portions 26b and 26d with the configuration of any of those described in Embodiment 1 and Embodiment 2 are disposed.

[0074] The stepped portion is divided into both end portions 25a and 25e, a center portion 25c, intermediate portions 25b and 25d between the both end portions and the center portion in the rotary shaft direction L, and the surface shape of the guide wall 10 in each portion is determined accordance with the ventilation resistance distribution on the suction region E1 side by a simulation or the like, for example.

In the case of Fig. 20, the stepped portion 26 is not disposed in the both end portions 25a and 25e and the center portion 25c, for example, but the stepped portions 26b and 26d are disposed on the intermediate portions 25b and 25d between the both end portions and the center portion. The respective surface pieces 25a, 25b, 25c, 25d, and 25e are configured integrally or separately, and the back face of each surface piece is fitted in the guide hole 10d, which is a lower fitting portion of the lower base 10c corresponding to the fixed position of the guide wall 10, whereby the surface pieces are fastened to the housing rear face portion 1c.

[0075] By configuring as above, a combination of the surface pieces can be changed by the plurality of surface pieces 25a, 25b, 25c, 25d, and 25e formed by dividing the surface of the guide wall 10 into plural pieces. In manufacture of the guide wall 10 in a shape different depending on an environmental situation of use, since the housing rear face portion 1c can be made common, standardized and easily changed, the guide wall 10 can be widely used in accordance with

a change in the environmental situation. Moreover, the guide wall 10 in the shape suitable for the environmental situation can be configured.
As a result, noise can be lowered, energy can be saved, and a higher quality air conditioner can be obtained.

[0076] Also, by forming as above, even with the configuration in which the ventilation resistance is different in the impeller longitudinal direction L, the specification can be handled by making the housing rear face portion 1c common and by changing the surface piece 25 of the guide wall. Thus, by providing a stepped portion at least in a part of the guide wall 10, an air conditioner with a lower noise, saved energy and high reliability can be configured, and moreover, manufacture of a large-scale die for the whole and molding is not necessary, specification change is made easy, a manufacturing cost can be reduced. As a result, an inexpensive product can be provided.

[0077] In Fig. 20, the guide wall 10 is divided into five pieces in the rotary shaft direction L, and the surface pieces 25a, 25b, 25c, 25d, and 25e of the guide wall are configured to be fitted in the lower base 10c of the guide wall. As a result, the shape of each piece can be designed freely. Also, by measuring noise during an operation state and counterflow state in an operation, the design can be easily changed so as to be further optimized.
The division is not limited to five pieces but may be made in a rotation direction of the impeller 8a, for example, that is, a direction perpendicular to the rotary shaft O.
Also, the configuration of the fitting portion 10c is not limited to the fitting between the projections and the recesses but the fitting may be completed by claws. Or other configurations may be used.

[0078] As described above, by providing the inlet 2 through which the indoor air is sucked, the heat exchanger 7 that exchanges heat with the sucked indoor air, the blow-out port 3 through which the heat-exchanged indoor air is blown out into the room, the blower 8 having the impeller 8a, disposed on the downstream side of the heat exchanger 7 between the inlet 2 and the blow-out port 3, rotated and driven by the motor 12 and feeding the indoor air from the inlet 2 to the blow-out port 3, with the longitudinal direction of an air conditioner main body 1 as its rotary shaft direction L, the stabilizer 9 that separates the suction-side channel E1 on the upstream side of the impeller 8a and the blow-out-side channel E2 on the downstream side from each other and forms the front face side of the blow-out-side channel E1 from the impeller 8a to the blow-out port 3, the spiral guide wall 10 that forms a rear face side of the blow-out-side channel E2 from the impeller 8a to the blow-out port 3, and the lower base 10c disposed on the lower layer of the surface of the guide wall 10 and having the lower fitting portions 10d on the surface side of the guide wall 10, in which the surface of the guide wall 10 is formed by a plurality of divided surface pieces 25a, 25b, 25c, 25d, and 25e, the respective back face of the surface pieces 25a, 25b, 25c, 25d, and 25e is formed so as to be fitted in the lower fitting portions 10d on the lower base 10c corresponding to the fixed position of the guide wall, and a combination of the surface pieces 25a, 25b, 25c, 25d, and 25e is made changeable so that the surface of the guide wall 10 is formed in an optimal shape according to the ventilation resistance, an air conditioner capable of energy saving with a lower noise and high reliability can be obtained, and moreover, even in the configuration with different ventilation resistances in the rotary shaft direction L, the housing rear face portion 1c is made common and it is only necessary that the guide wall pieces 16 are changed, manufacture of a large-scale die for the whole and molding are not necessary, specification change can be handled easily, a manufacturing cost can be reduced, and as a result, an inexpensive product can be provided.

[0079] Also, if at least one surface piece 25b or 25d in the plurality of surface pieces 25a, 25b, 25c, 25d, and 25e has at least any one stepped portion in the stepped portions described in Embodiment 1 or 2, specification change can be handled easily in manufacture of an air conditioner capable of energy saving with a lower noise and high reliability, an air conditioner with usability can be obtained, which is advantageous.

Reference Signs List

[0080]

1	air conditioner main body
1c	housing rear face portion
1d	air conditioner main body upper part
2	inlet
2A, 2B	first and second inlets
3	blow-out port
5	filter

6	electric dust collector
7	heat exchanger
8	blower
8a	impeller
8d	impeller unit body
8d1, 8d3	impeller unit bodies at both end portions of impeller
8d2, 8d4	impeller unit bodies inside and adjacent to both end portions of impeller
9	stabilizer
10	guide wall
10a	guide wall start point
10b	guide wall end point
10c	lower base
10d	fitting portion
12	motor
13	partition
14	stepped portion
14A, 14B, 14C, 14D, 14E	one step
14a	step start portion
14b	step deepest portion
14c	step slope portion
14d	step end portion
15	channel reducing member
16, 17, 18, 19, 20, 21, 22, 23	stepped portion
25	surface piece of guide wall
26	stepped portion
C1	distance between impeller rotary shaft center O and step start portion 14a
C2	distance between impeller rotary shaft center O and step deepest portion 14b
C3	distance between impeller rotary shaft center O and step end portion 14d
E1	impeller suction-side channel

E2	Impeller blow-out-side channel
Ff	high-speed blow-out flow
Fs	low-speed blow-out flow
G1	swirl
L	impeller rotary shaft direction
O	impeller rotary shaft (rotation center)
RO	impeller rotation direction
S	length between step deepest portion and step end portion (slope portion length)
h	length between step start portion and step deepest portion
θc	guide wall spiral angle
θs	stepped-portion forming angle

Claims

1. An air conditioner comprising:

an inlet (2) through which indoor air is sucked;
a heat exchanger (7) that exchanges heat with said sucked indoor air;
a blow-out port (3) through which said heat-exchanged indoor air is blown out into a room;
a blower (8) having an impeller (8a), being disposed on the downstream side of said heat exchanger (7) between said inlet (2) and said blow-out port (3) with a longitudinal direction of an air conditioner main body (1) serving as the rotary shaft direction (L) thereof, and being rotated and driven by a motor (12) and feeds said indoor air from said inlet (2) to said blow-out port (3),;
a stabilizer (9) that separates a suction-side channel on the upstream side of said impeller (8a) and a blow-out-side channel on the downstream side from each other and configures a front face side of said blow-out-side channel from said impeller (8a) to said blow-out port (3);
a spiral guide wall (10) that configures a rear face side of said blow-out-side channel from said impeller (8a) to said blow-out port (3); and
a stepped portion (14) disposed at least in a part of said guide wall (10) and having a plurality of steps provided in parallel, each having a substantially indented triangular shape in a section perpendicular to the rotary shaft of said impeller (8a) and extending in said rotary shaft direction (L), and forming steps in said direction in which said blower (8) feeds the air.

2. The air conditioner of claim 1, wherein
in a section perpendicular to the rotary shaft of said impeller (8a), an upstream-side end portion of one step of said stepped portion (14) is made to be a step start portion (14a), a portion indented the deepest in a substantially triangular shape of said step is made to be a step deepest portion (14b), a downstream-side end portion of said step is made to be a step end portion (14d), and said step is configured such that a relationship among a length C1 connecting the rotation center O of said impeller (8a) to said step start portion (14a), a length C2 connecting the rotation center O of said impeller (8a) to said step deepest portion (14b), and a length C3 connecting the rotation center O of said impeller (8a) to said step end portion (14d) is $C1 < C2 \leq C3$.

3. The air conditioner of claim 1 or 2, wherein
in a section perpendicular to the rotary shaft of said impeller (8a), an upstream-side end portion of one step of said stepped portion (14) is made to be a step start portion (14a), a portion indented the deepest in a substantially triangular shape of said step is made to be a step deepest portion (14b), a downstream-side end portion of said step is made to be a step end portion (14d), and said step is configured such that a relationship between a length

h connecting said step start portion (14a) to said step deepest portion (14b) and a length S connecting said step deepest portion (14b) to said step end portion (14d) is h < S.

4. The air conditioner of any one of claims 1 to 3, wherein
in the rotary shaft direction (L) of said impeller (8a), said stepped portion (14) is disposed on the guide wall (10) of a portion where the speed of an air flow blown out of said impeller (8a) becomes high.

5. The air conditioner of claim 4, wherein
said inlet (2) is divided into two parts in the rotary shaft direction (L) of said impeller (8a) and is configured by a first inlet (2A) and a second inlet (2B), and a first stepped portion disposed on said guide wall (10) at a position corresponding to the downstream of said first inlet (2A) and a second stepped portion disposed on said guide wall (10) at a position corresponding to the downstream of said second inlet (2B) are provided.

6. The air conditioner of any one of claims 1 to 5, wherein
said stepped portions (14) are disposed at both end portions in said rotary shaft direction (L) of said guide wall (10) so as to be adjacent to side walls connected to the both end portions in said rotary shaft direction (L) of said guide wall (10).

7. The air conditioner of claim 6, wherein
said impeller (8a) of said blower (8) is configured by adhering plurally divided impeller (8a) unit bodies in said rotary shaft direction (L), and a length in said rotary shaft direction (L) of said stepped portions (14) disposed at both end portions in said rotary shaft direction (L) of said guide wall (10) is configured to overlap and extend to the adjacent impeller (8a) unit bodies fastened respectively to said impeller (8a) unit bodies at said both end portions.

8. The air conditioner of any one of claims 1 to 4, wherein
said stepped portion (14) is formed so as to extend from one end portion to the other end portion of said guide wall (10) in said rotary shaft direction (L).

9. The air conditioner of claim 8, wherein
between a center part and both end portions in said rotary shaft direction (L) of said guide wall (10), partitions (13) extending in a direction perpendicular to said rotary shaft and having wall surfaces connecting step start portions (14a) to step end portions (14d) of the respective stepped portions (14) disposed at said center part and said both end portions are disposed so that a high-speed flow flowing in said center part is prevented from flowing excessively to said both end portions via said stepped portion (14).

10. The air conditioner of claim 8, wherein
said stepped portion (14) is divided into plural parts in said rotary shaft direction (L), and positions of said step start portions (14a), positions of said step deepest portions (14b) or positions of said step end portions (14d) in the divided plural stepped portions (14) are configured to be different between the adjacent stepped portions (14).

11. The air conditioner of any one of claims 2 to 10, wherein
a length S connecting said step deepest portion (14b) to said step end portion of one step constituting said stepped portion (14) changes so as to become gradually longer or shorter from the upstream side to the downstream side for the plurality of steps.

12. An air conditioner comprising:

an inlet (2) through which indoor air is sucked;
a heat exchanger (7) that exchanges heat with said sucked indoor air;
a blow-out port (3) through which said heat-exchanged indoor air is blown out into a room;
a blower (8) having an impeller (8a), being disposed on the downstream side of said heat exchanger (7) between said inlet (2) and said blow-out port (3) with a longitudinal direction of an air conditioner main body (1) serving as the rotary shaft direction (L) thereof, and being rotated and driven by a motor (12) and feeds said indoor air from said inlet (2) to said blow-out port (3),;
a stabilizer (9) that separates a suction-side channel on the upstream side of said impeller (8a) and a blow-out-side channel on the downstream side from each other and configures a front face side of said blow-out-side channel from said impeller (8a) to said blow-out port (3);
a spiral guide wall (10) that configures a rear face side of said blow-out-side channel from said impeller (8a) to

said blow-out port (3); and
a lower base disposed on the lower layer of the surface of said guide wall (10) and having a lower fitting portion on the surface side of said guide wall (10), wherein
the surface of said guide wall (10) is composed of a plurality of surface pieces obtained by dividing the surface of the guide wall (10) into plural pieces, the respective back faces of said surface pieces are formed so as to be fitted in the lower fitting portion of said lower base corresponding to the fixed position of said guide wall (10), and a combination of the surface pieces are made changeable.

13. The air conditioner of claim 12, wherein
at least one surface piece of said plurality of surface pieces has the stepped portion (14) according to any one of claims 1 to 11.

FIG. 1

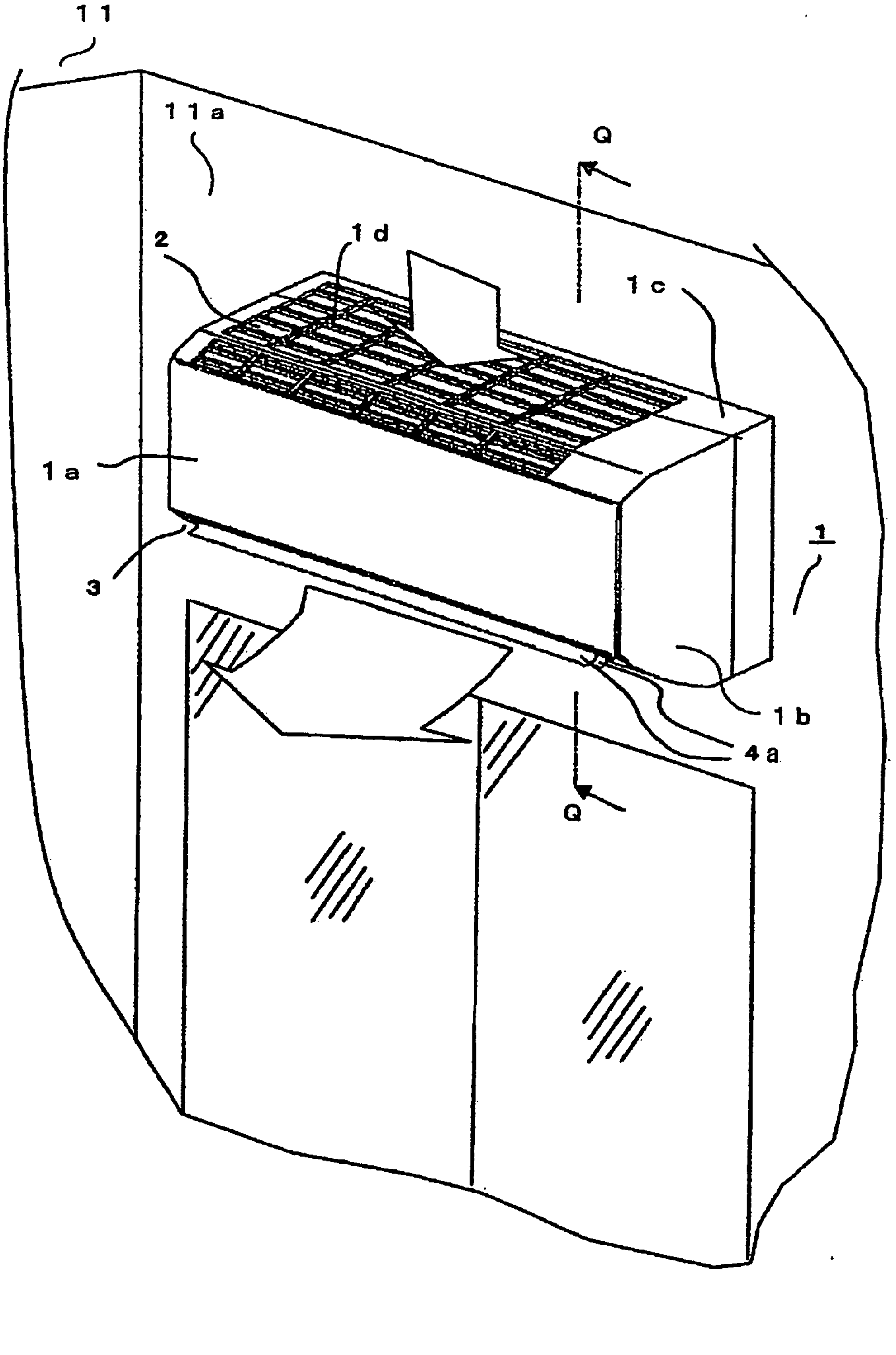
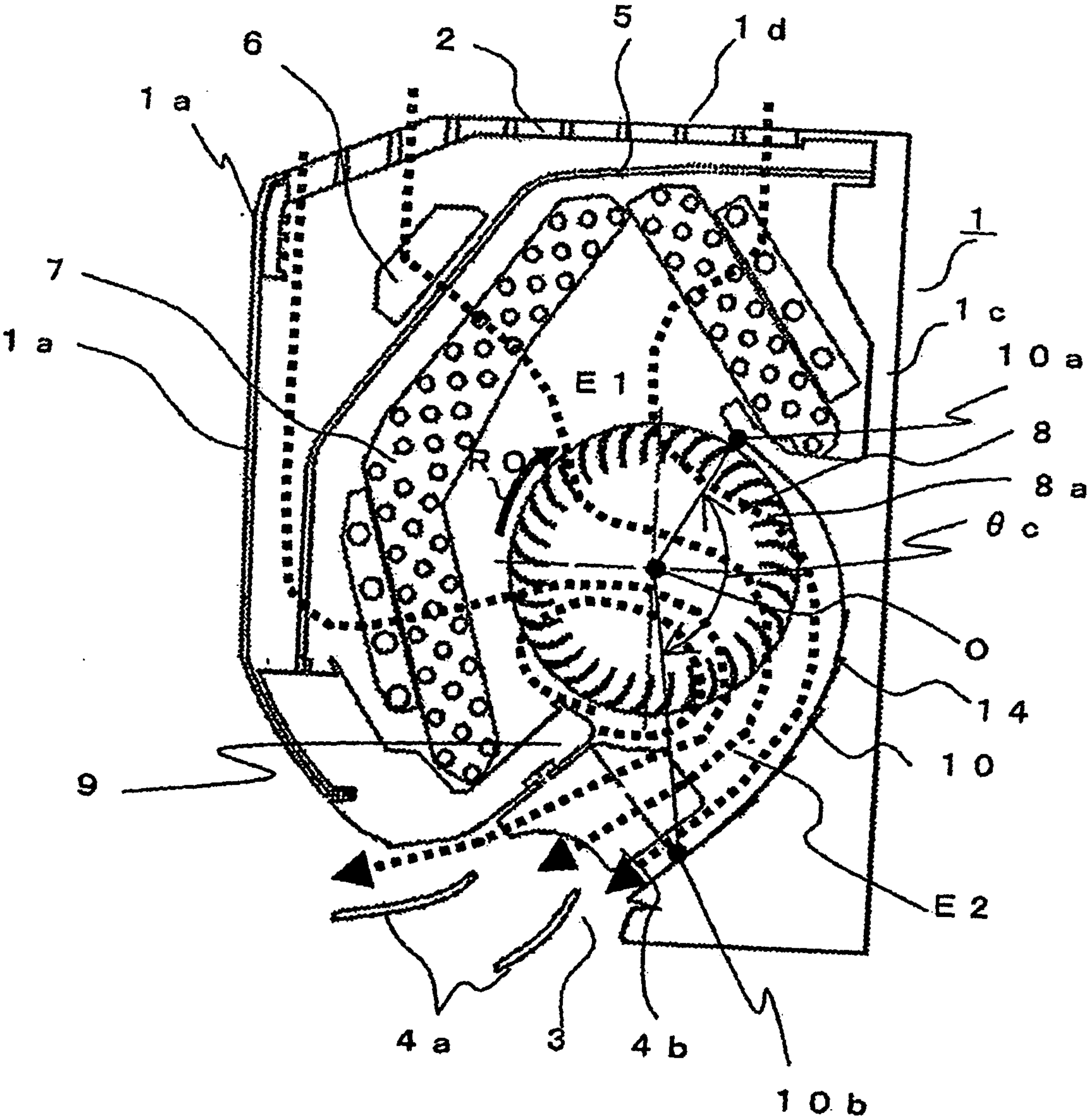
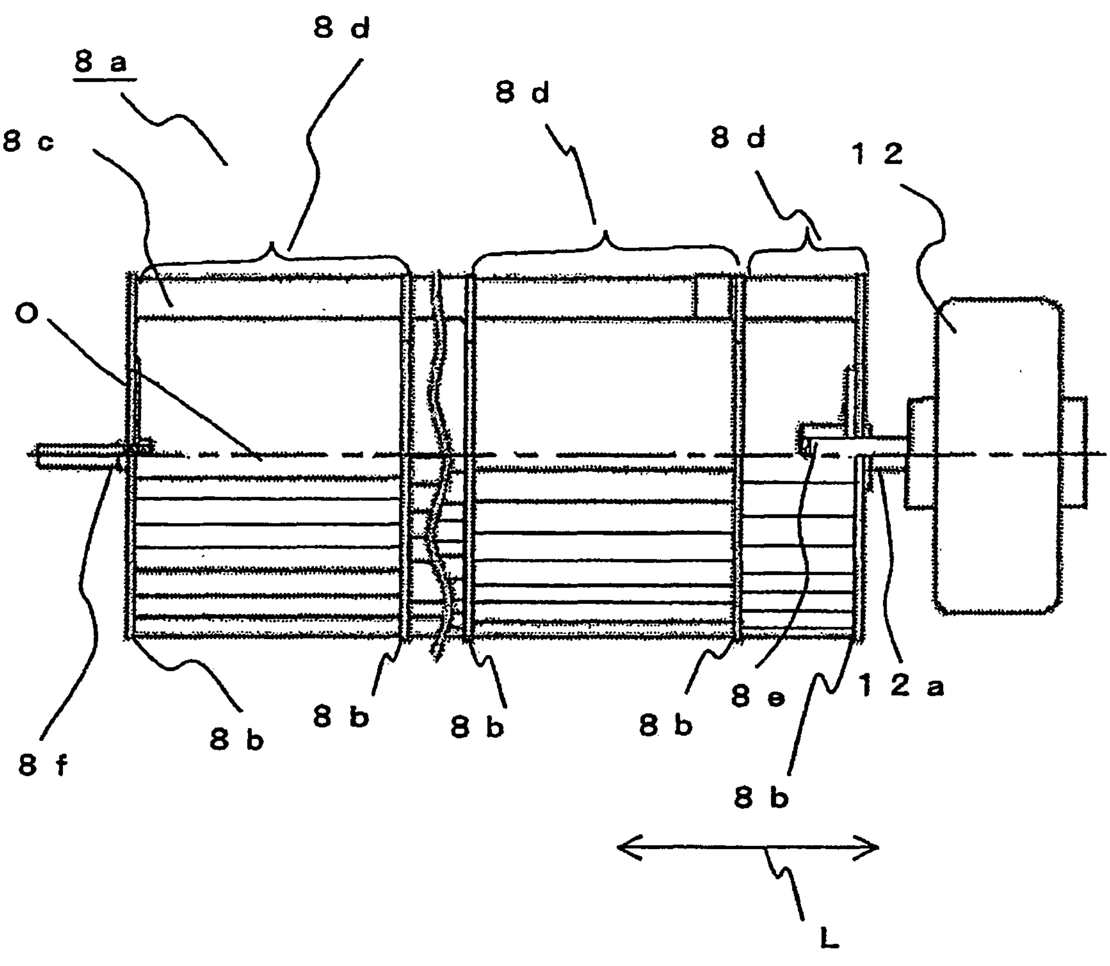


FIG. 2



F I G. 3



F I G. 4

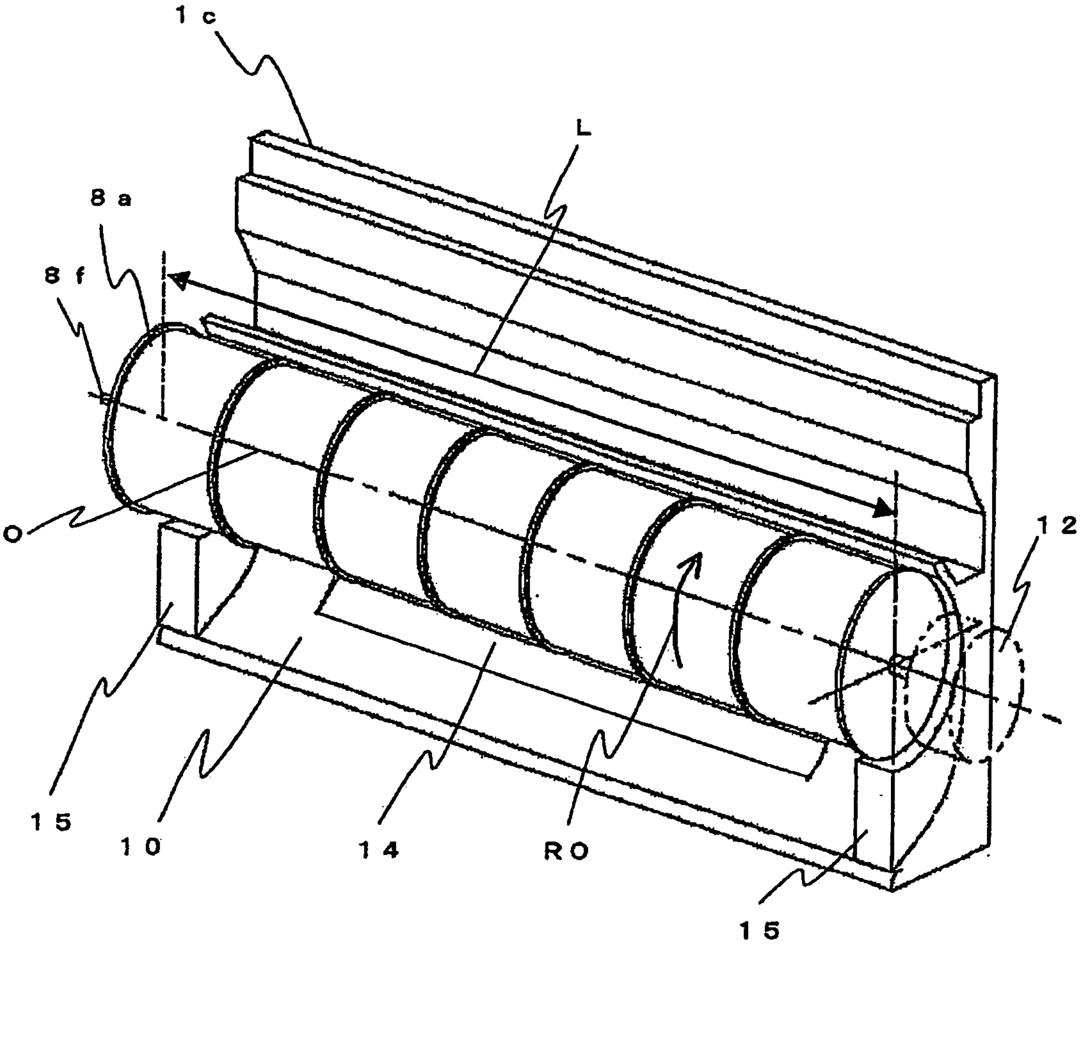
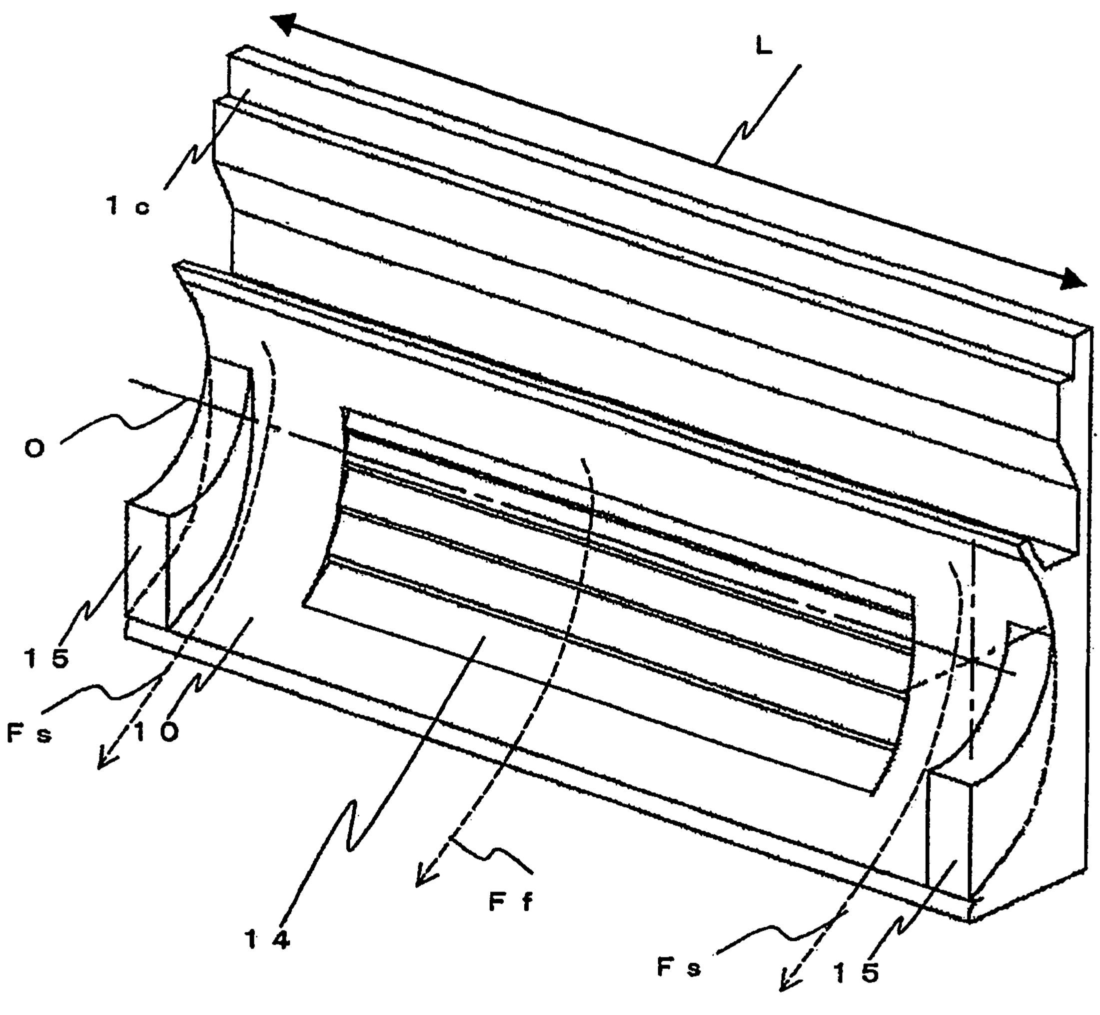


FIG. 5



F I G. 6

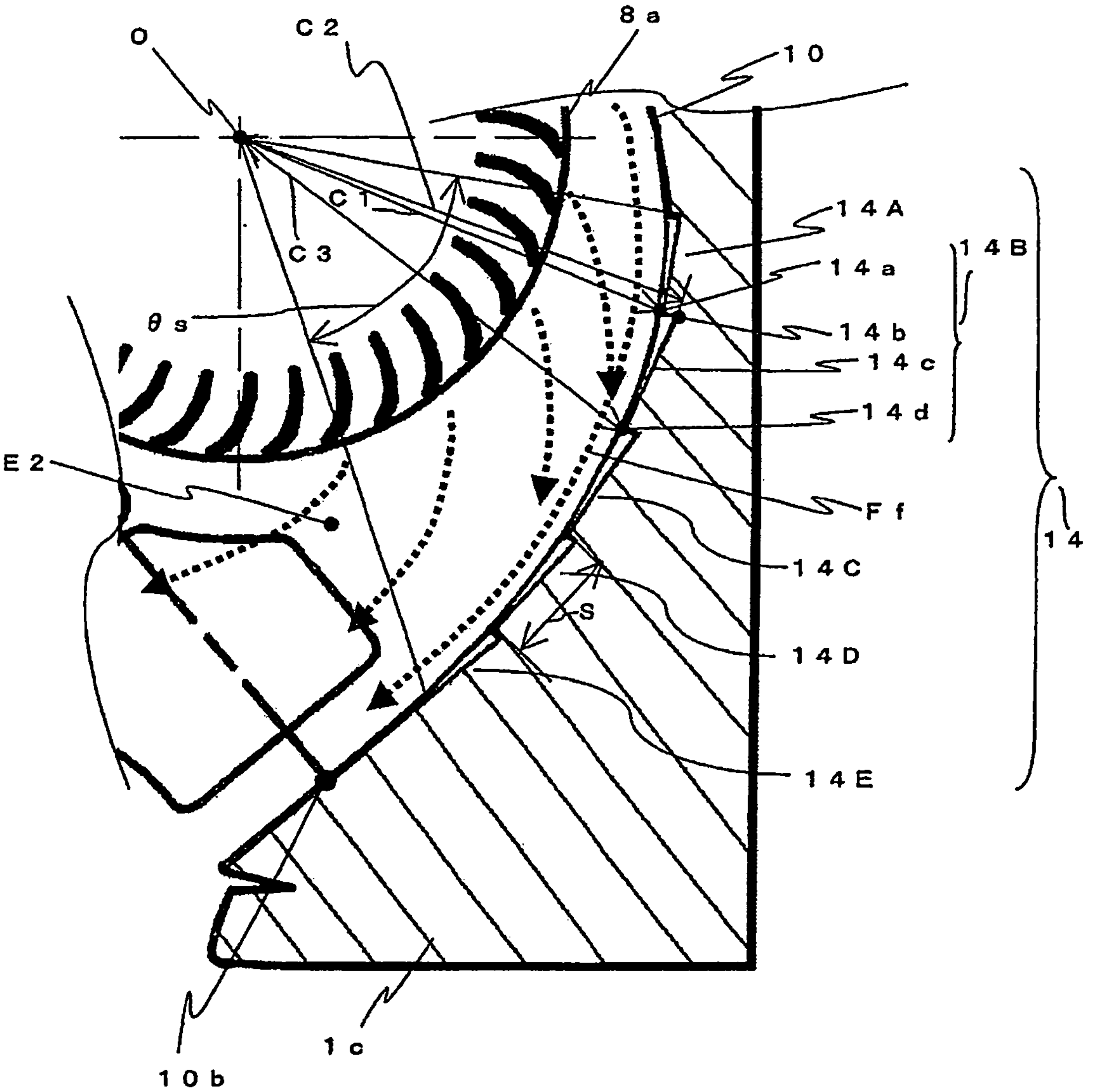
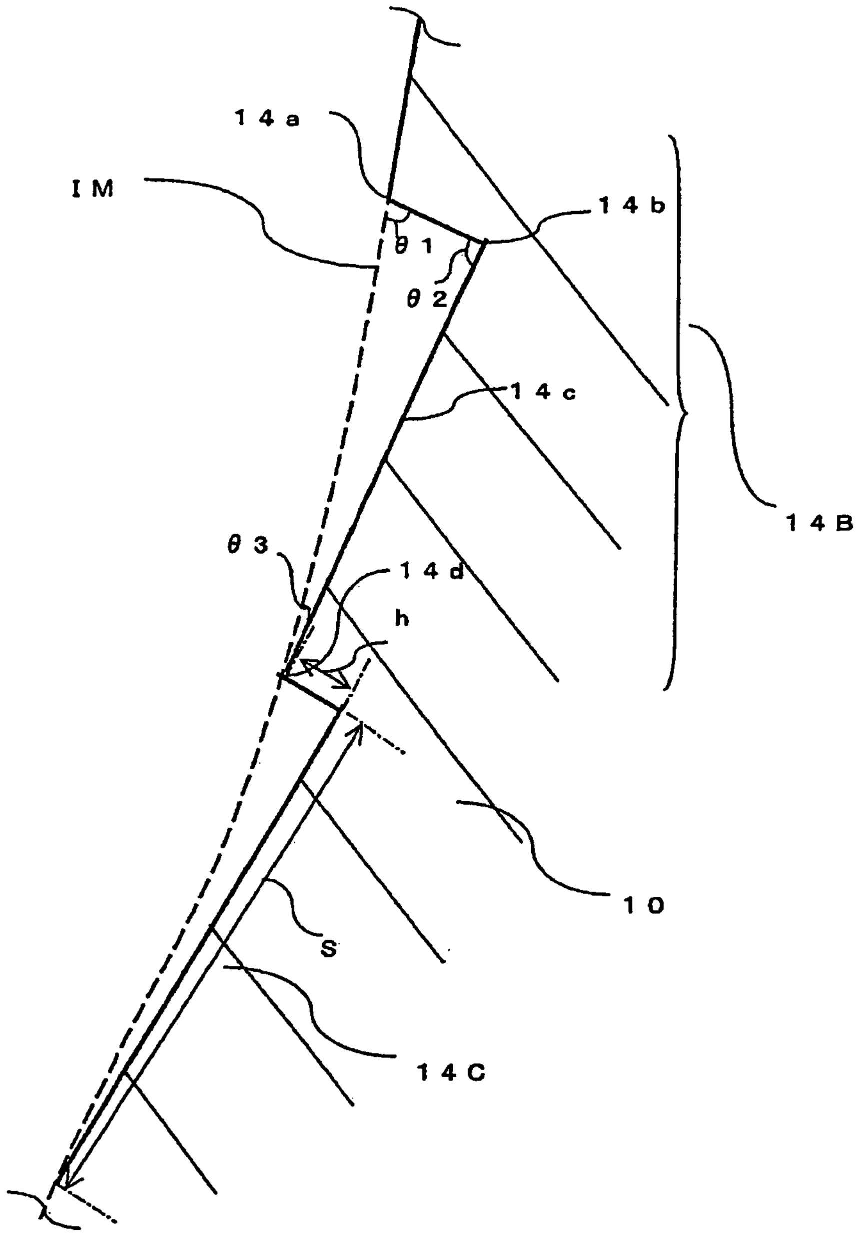

O
C 2
8 a
1 0
1 4 A
C 1
1 4 B
C 3
1 4 a
θ s
1 4 b
1 4 c
1 4 d
E 2
F f
1 4
1 4 C
S
1 4 D
1 4 E
1 0 b
1 c

FIG. 7



F I G. 8

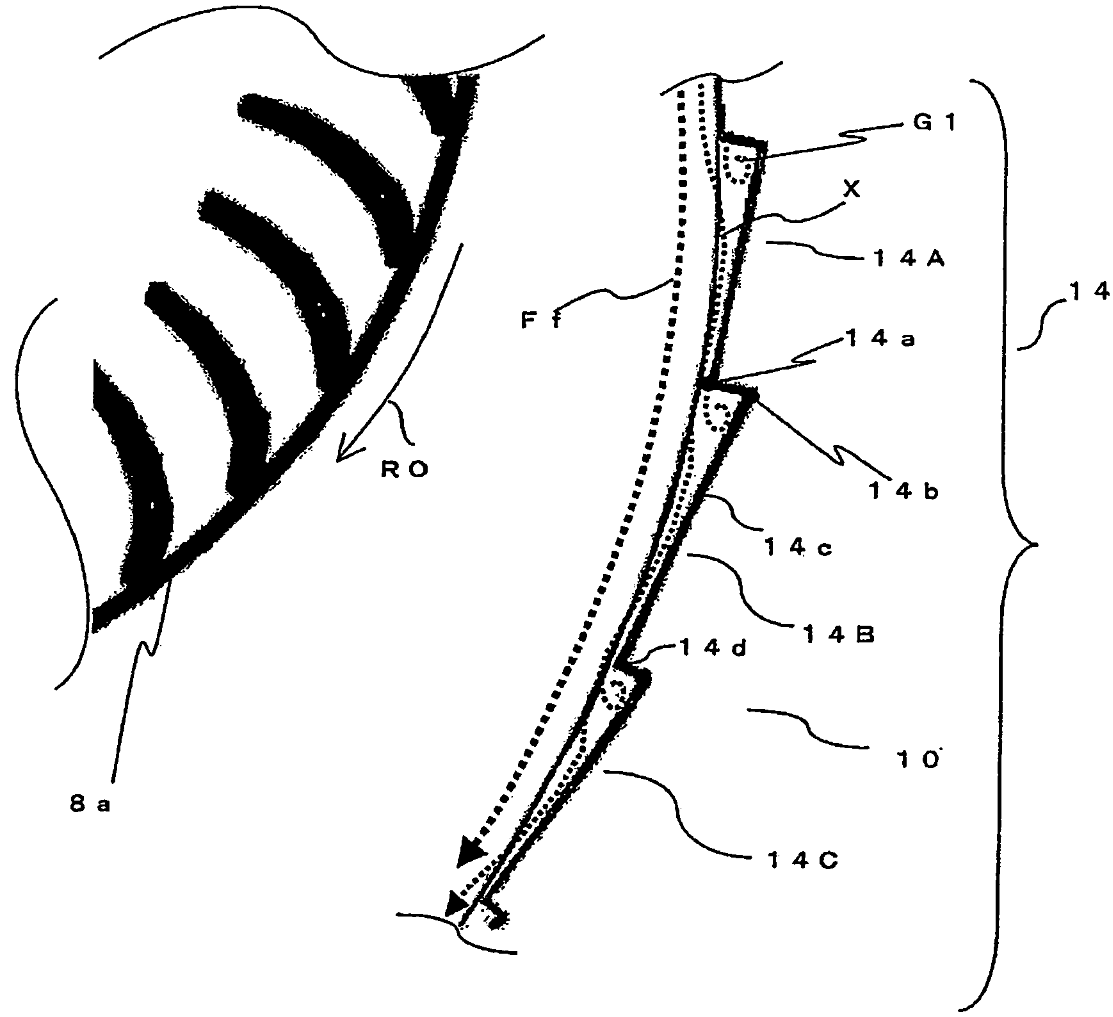


FIG. 9

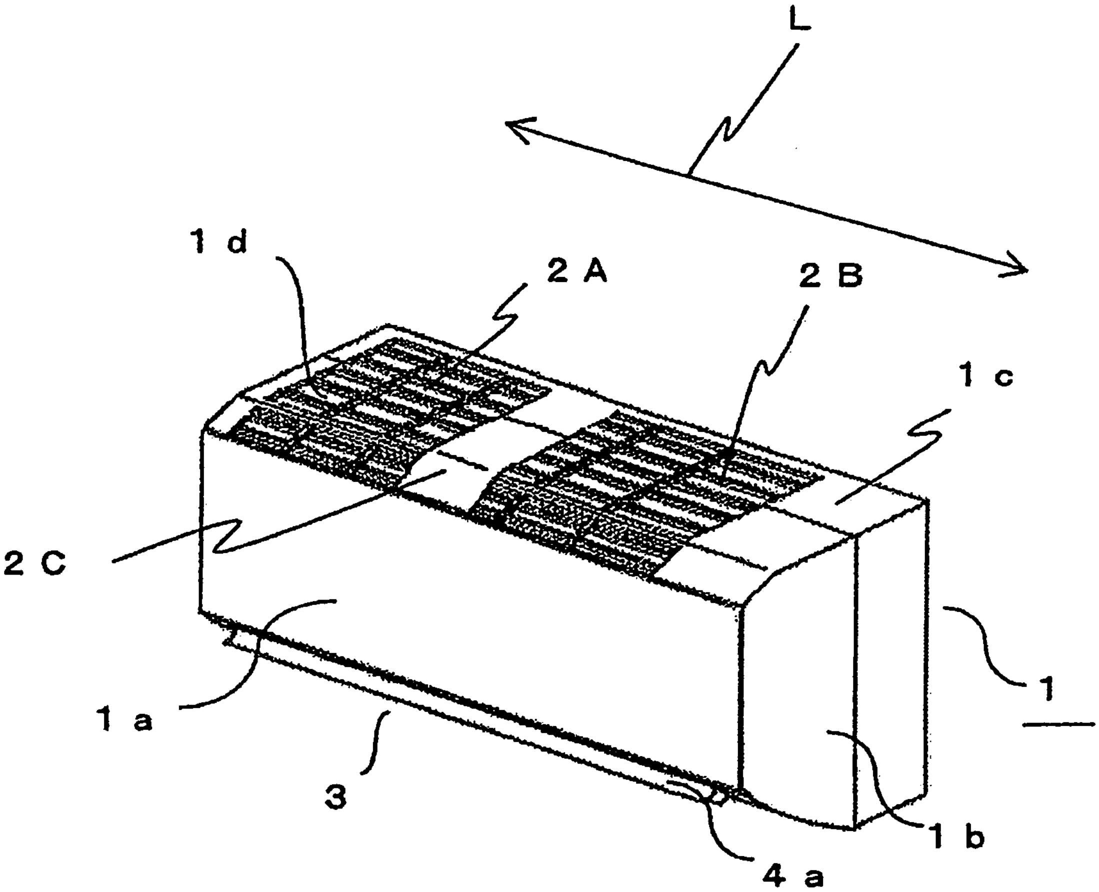
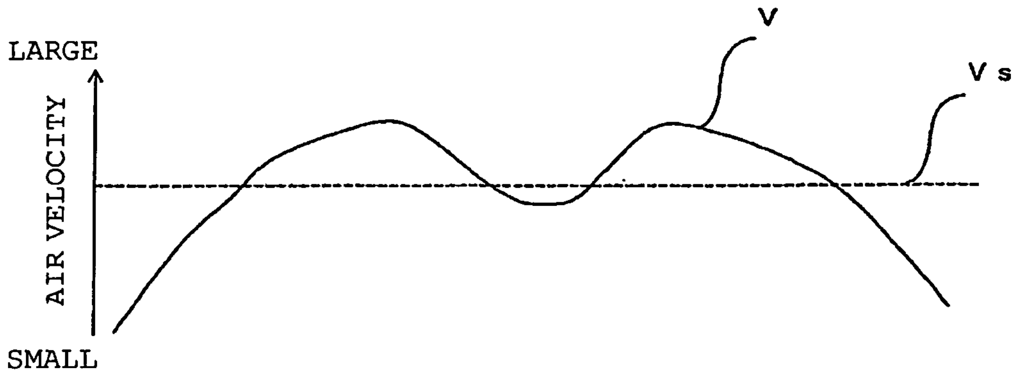


FIG. 10

(a)



(b)

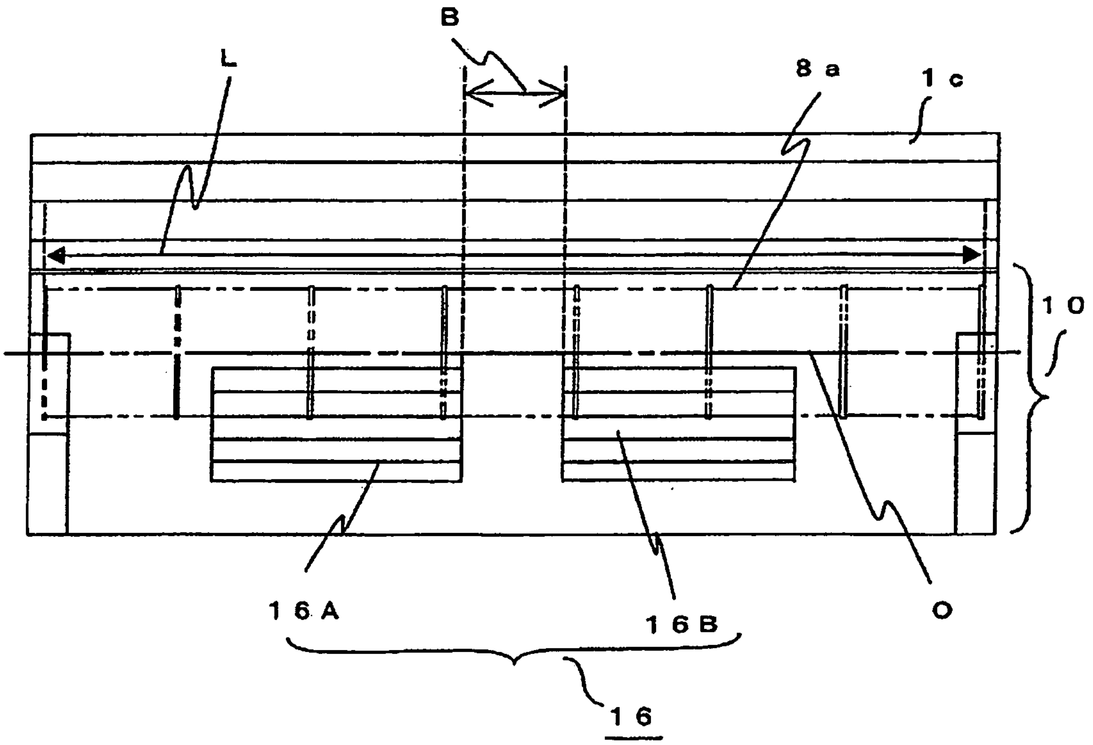


FIG. 11

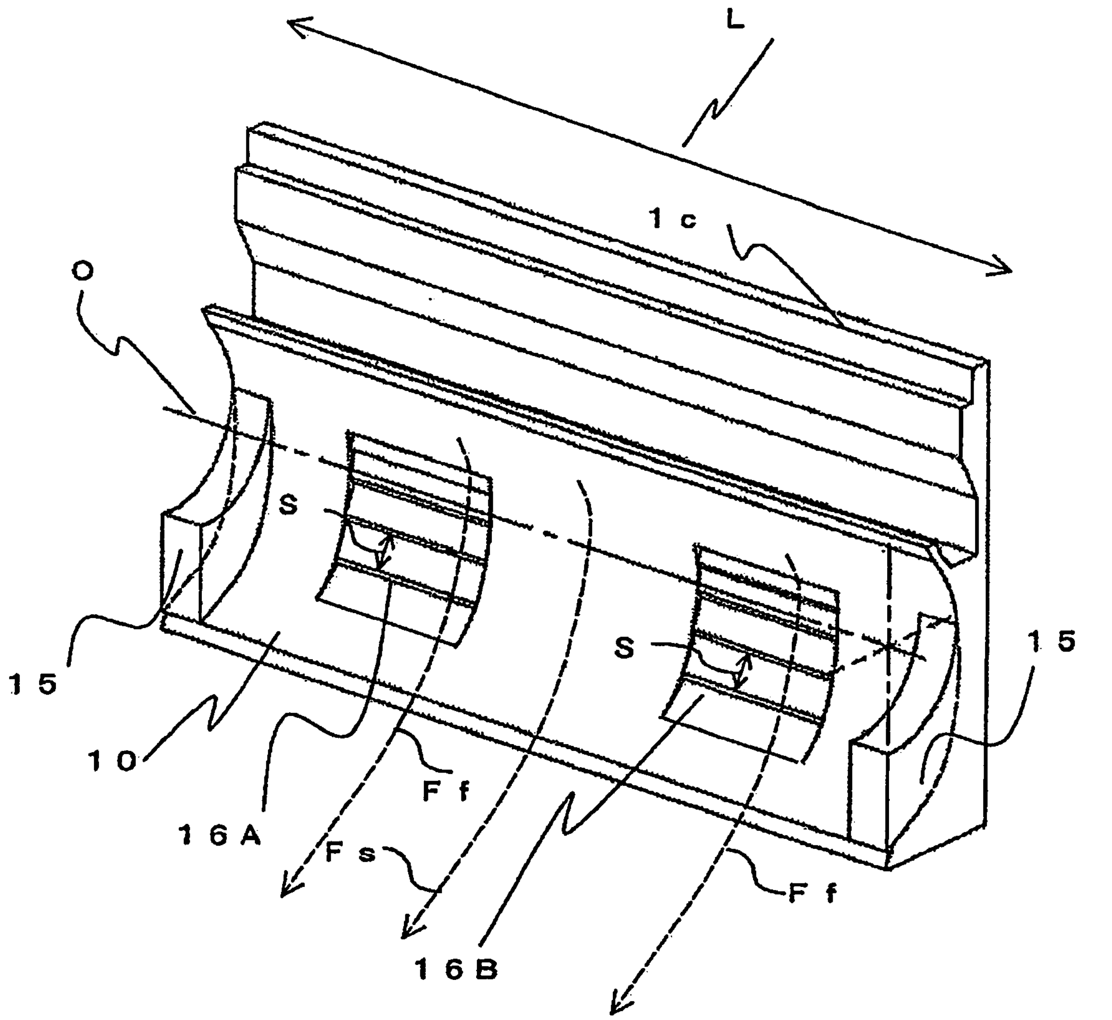
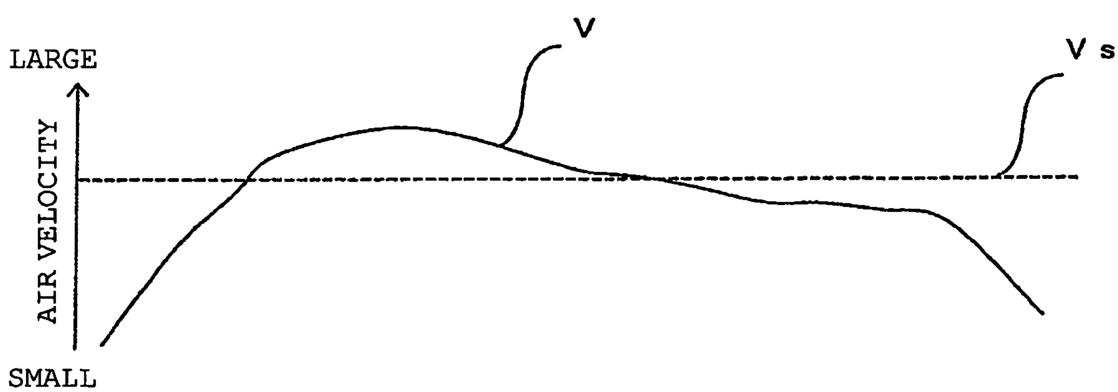
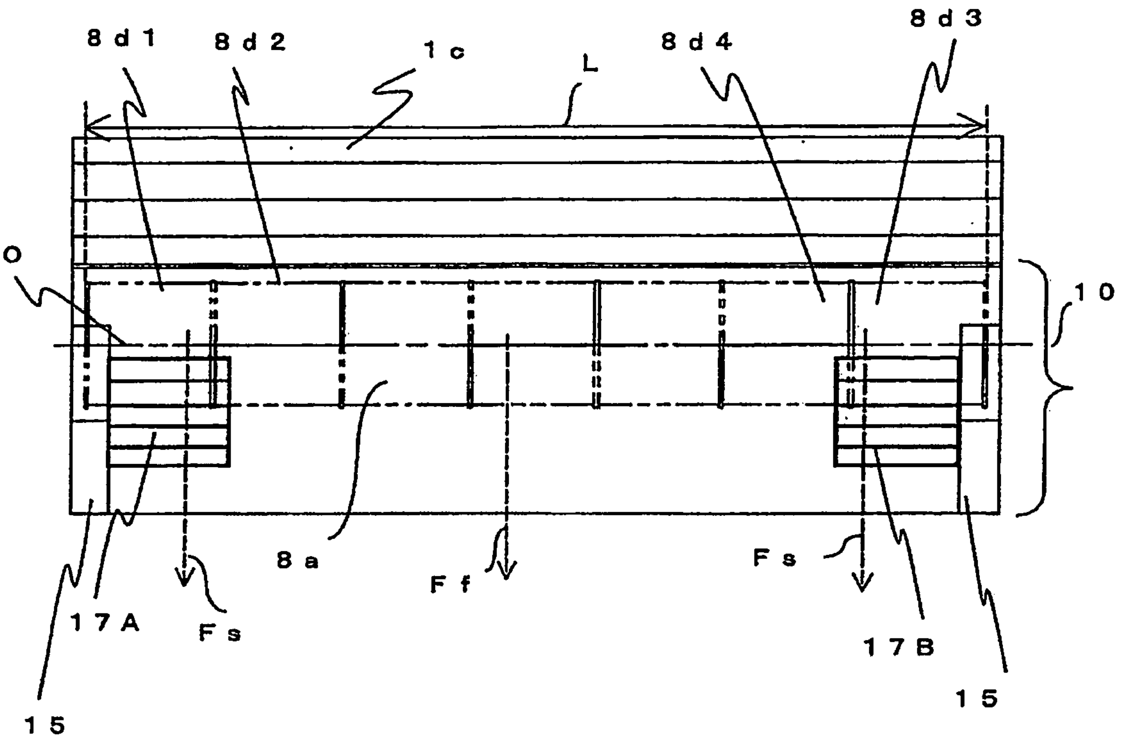


FIG. 12



F I G. 1 3



F I G. 1 4

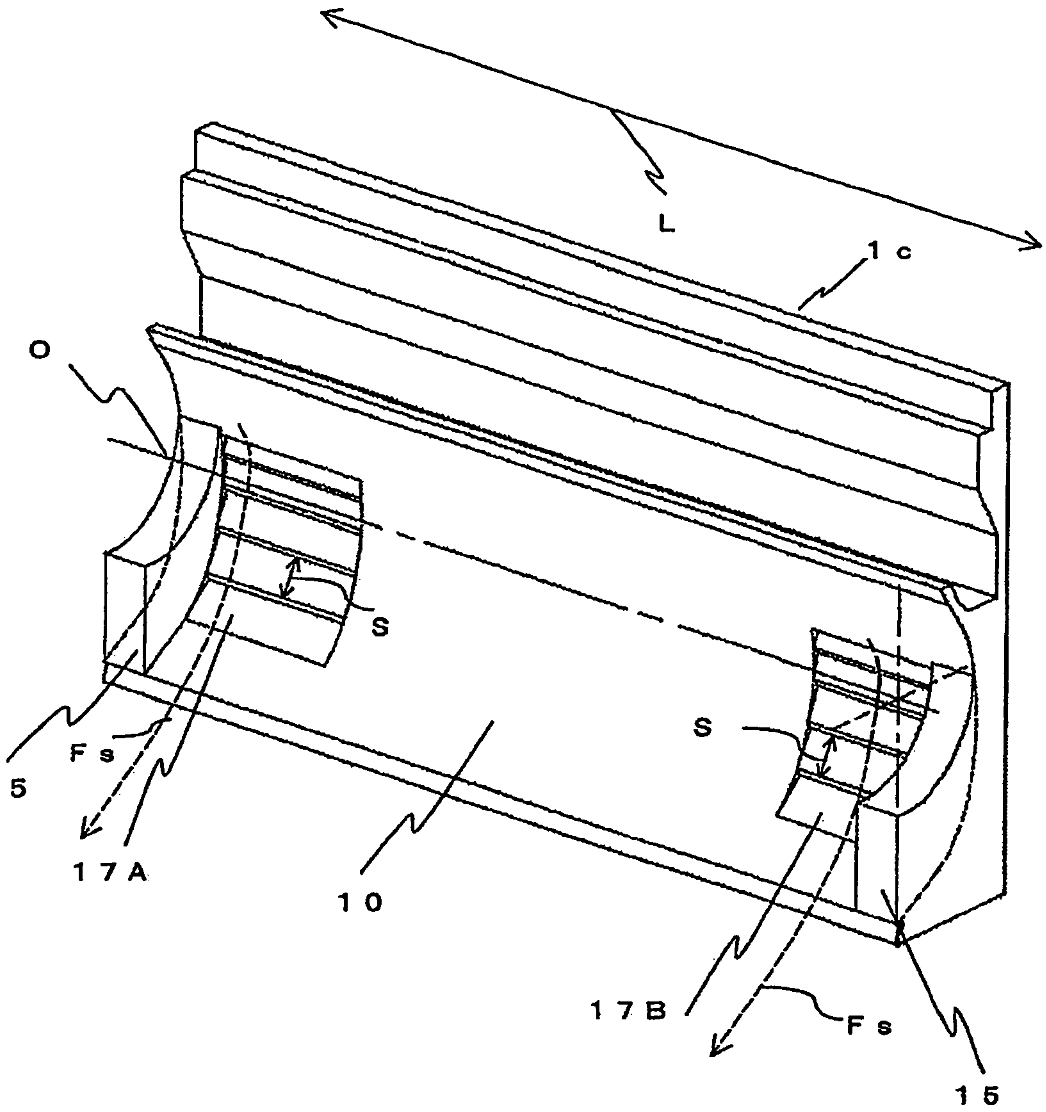


FIG. 15

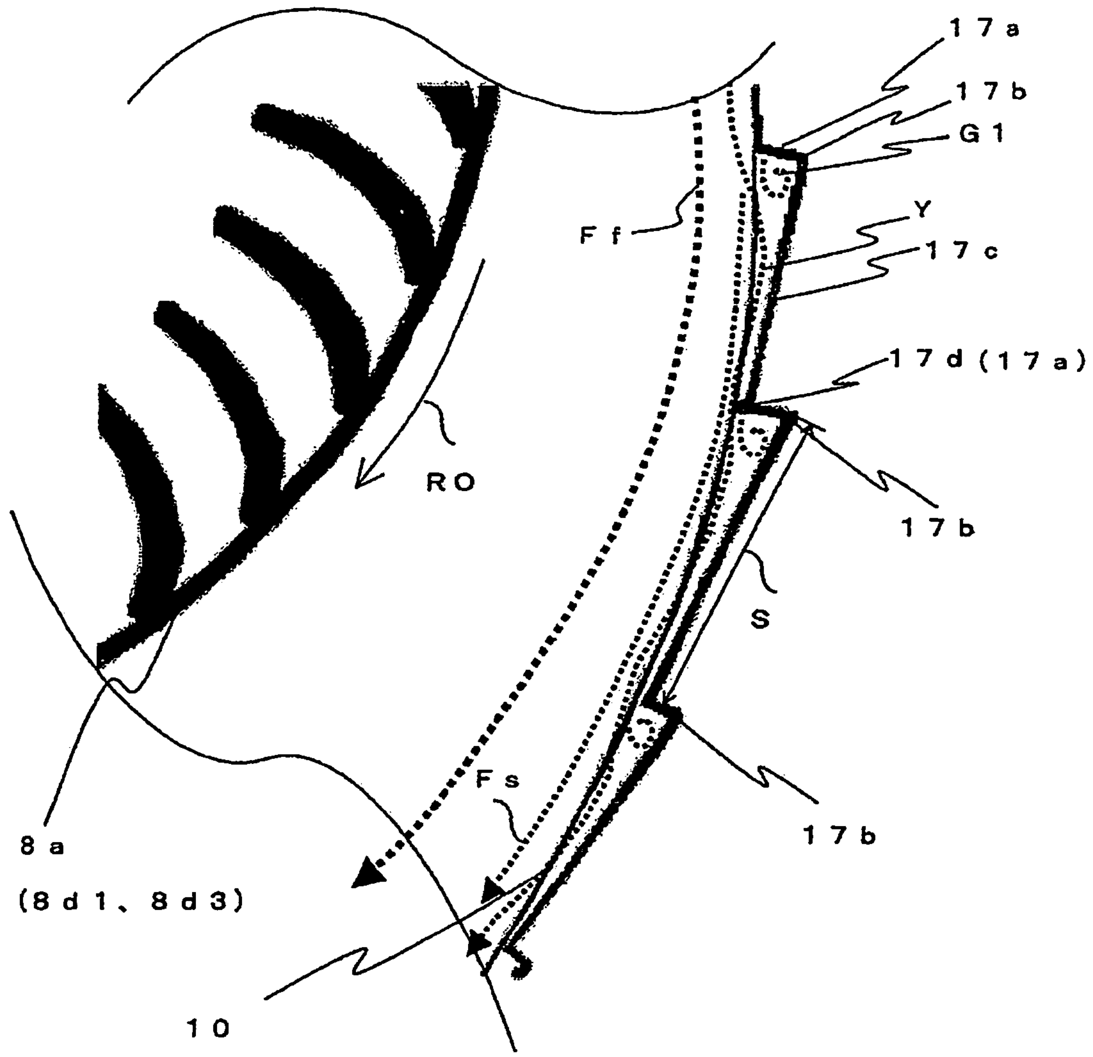


FIG. 16

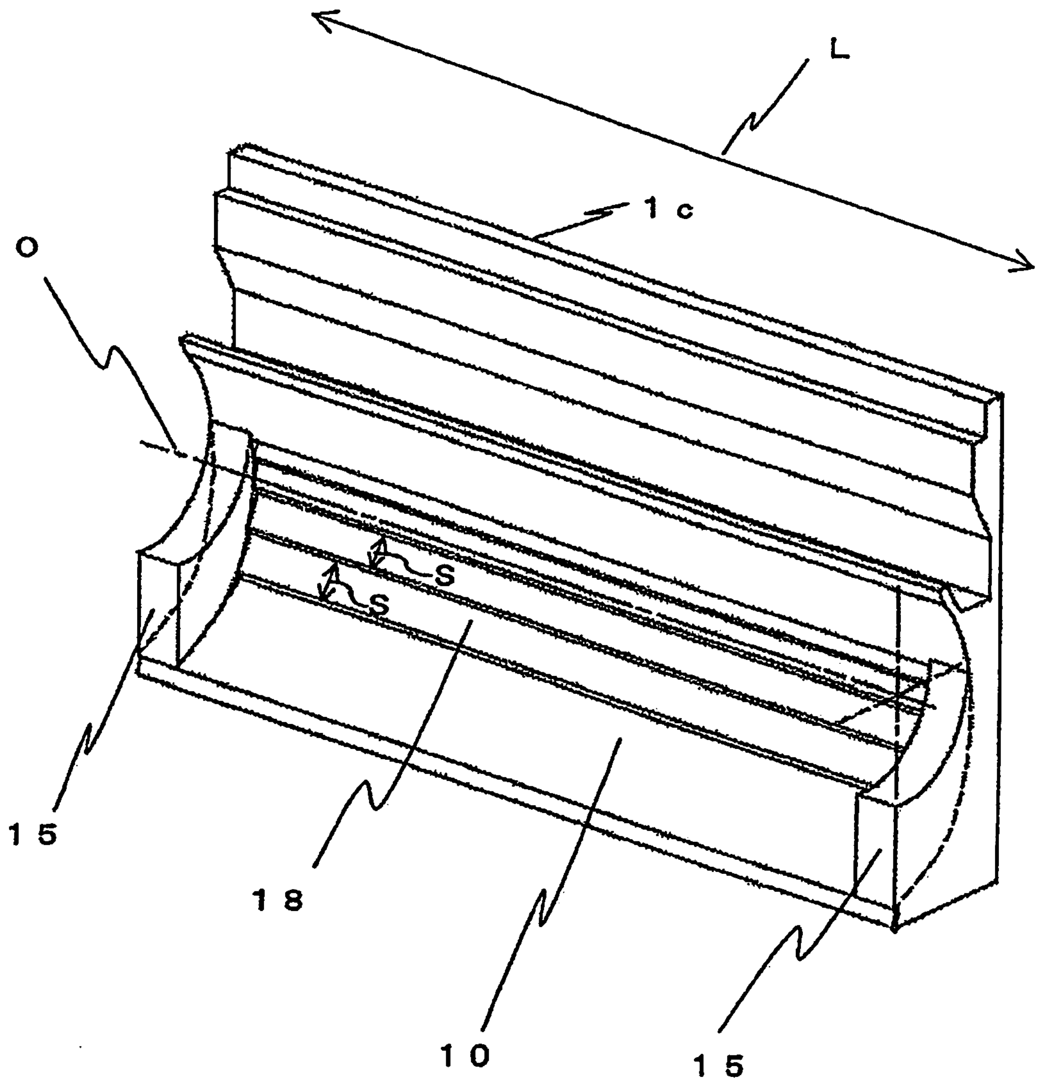


FIG. 17

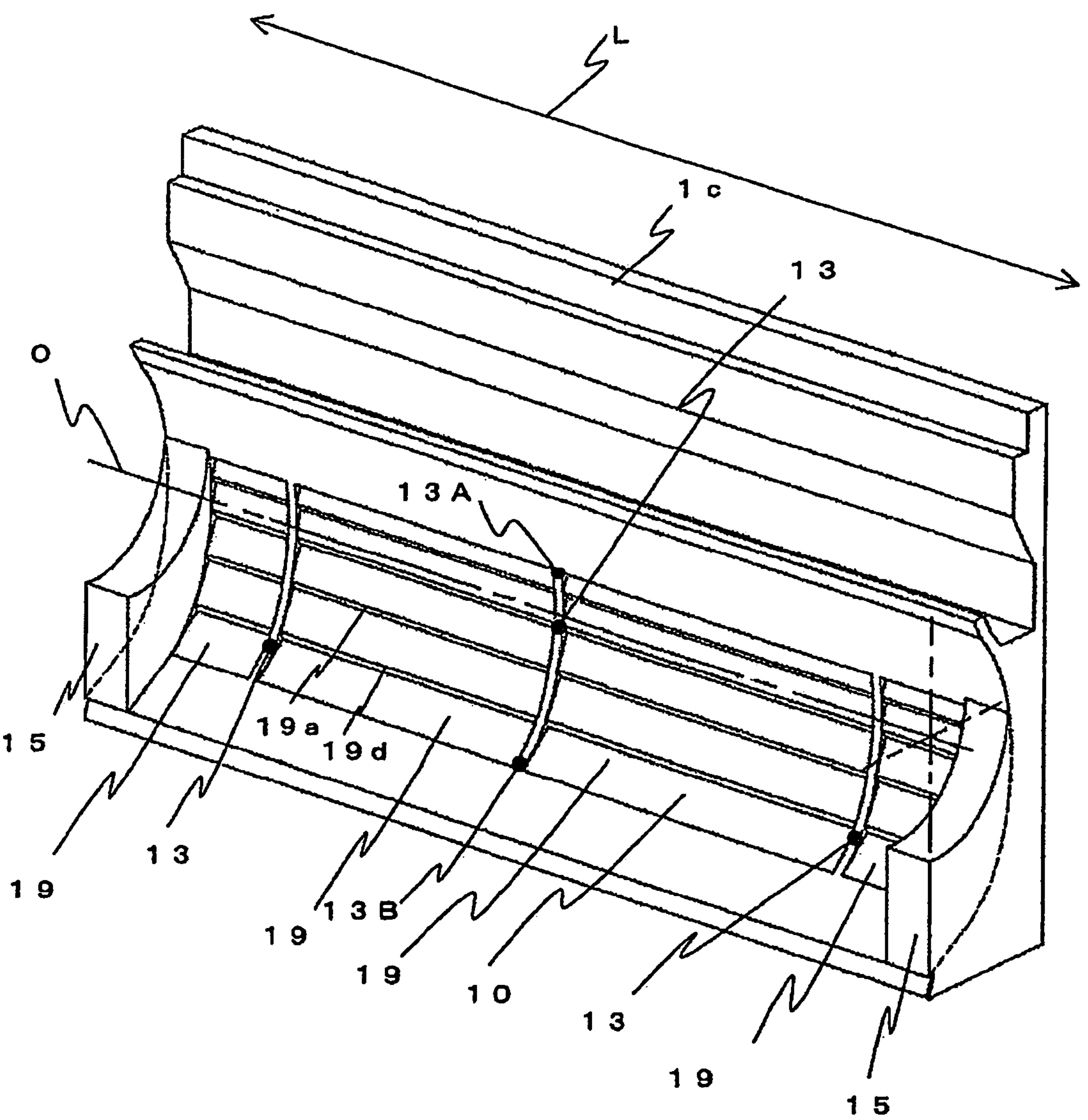
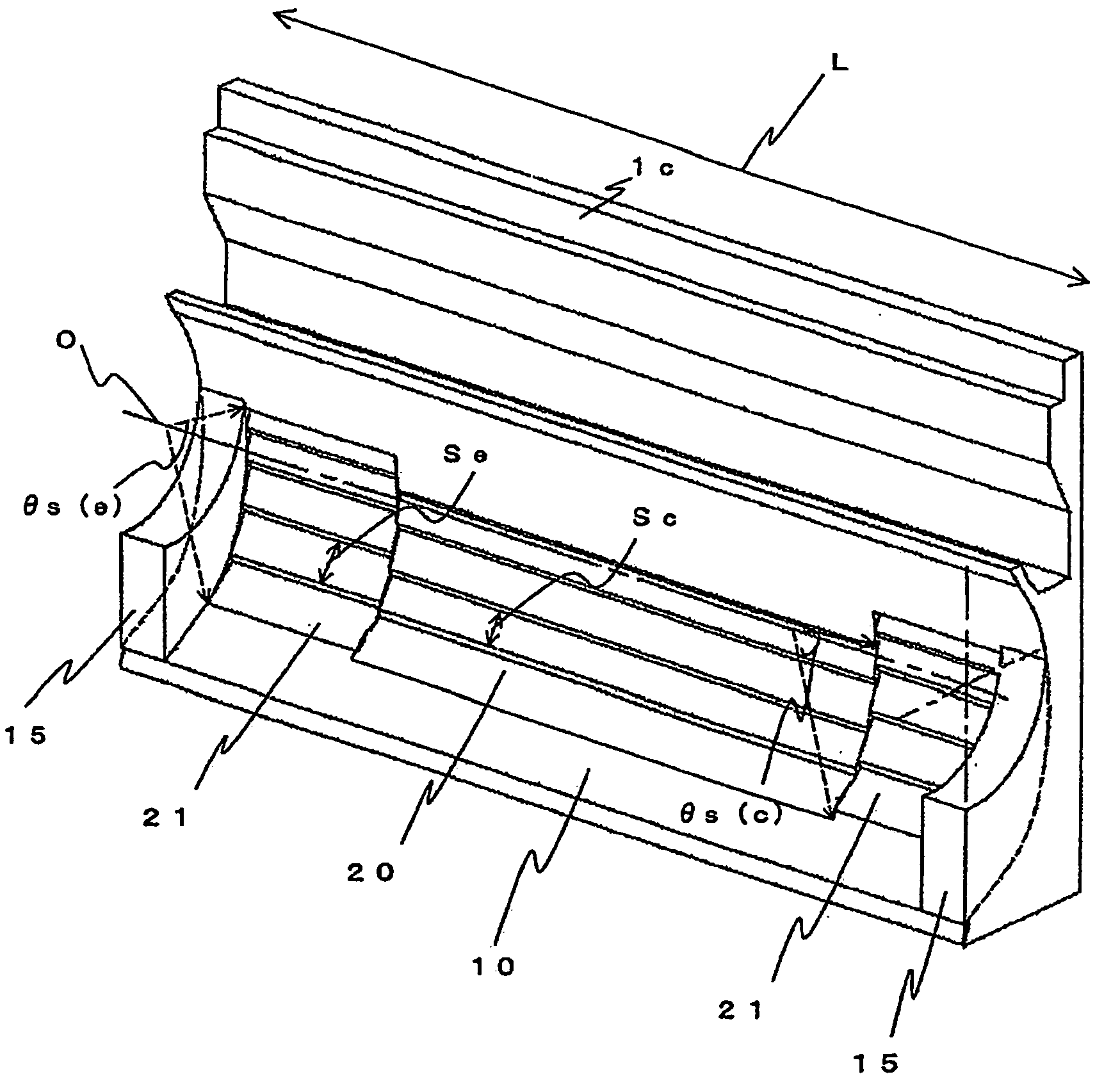
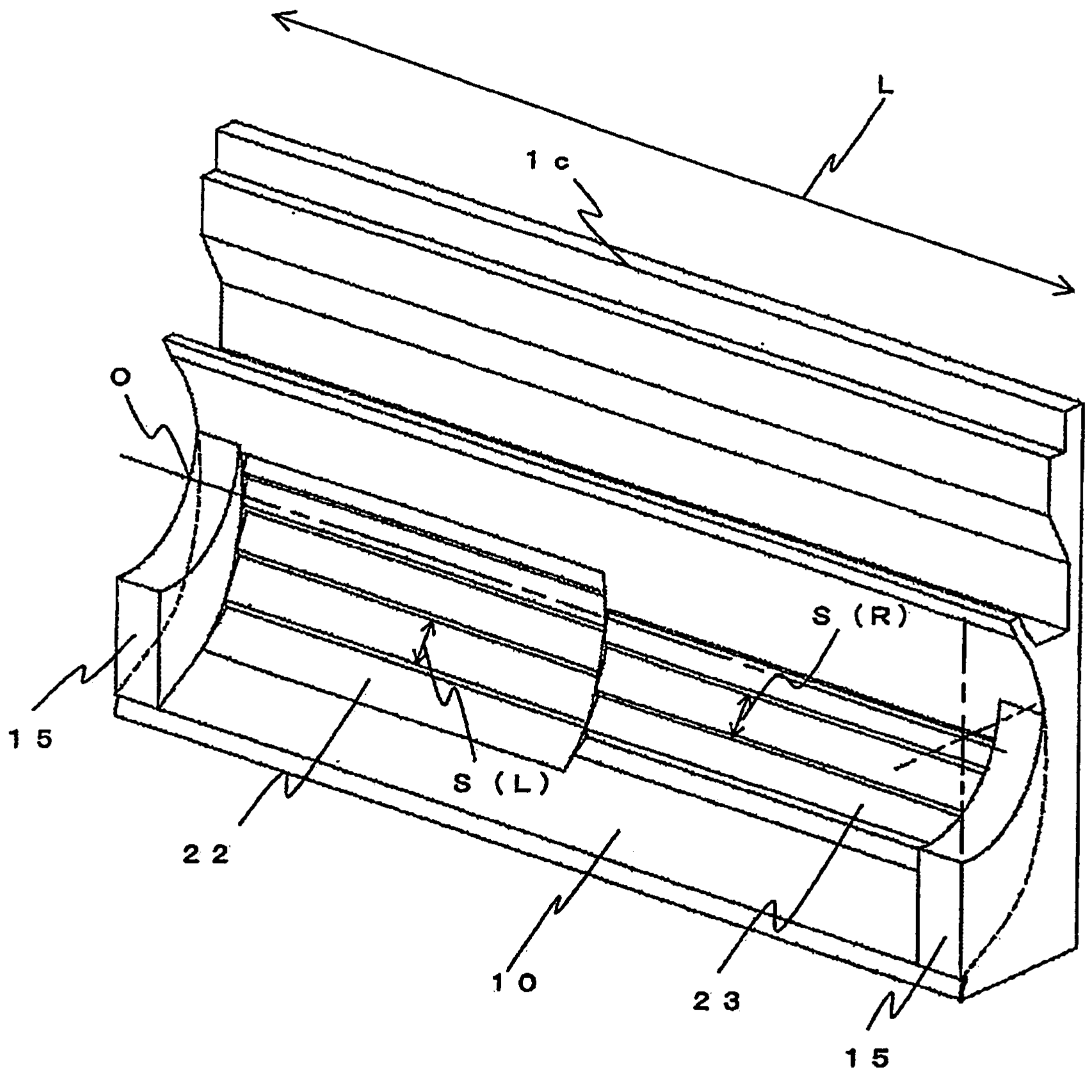


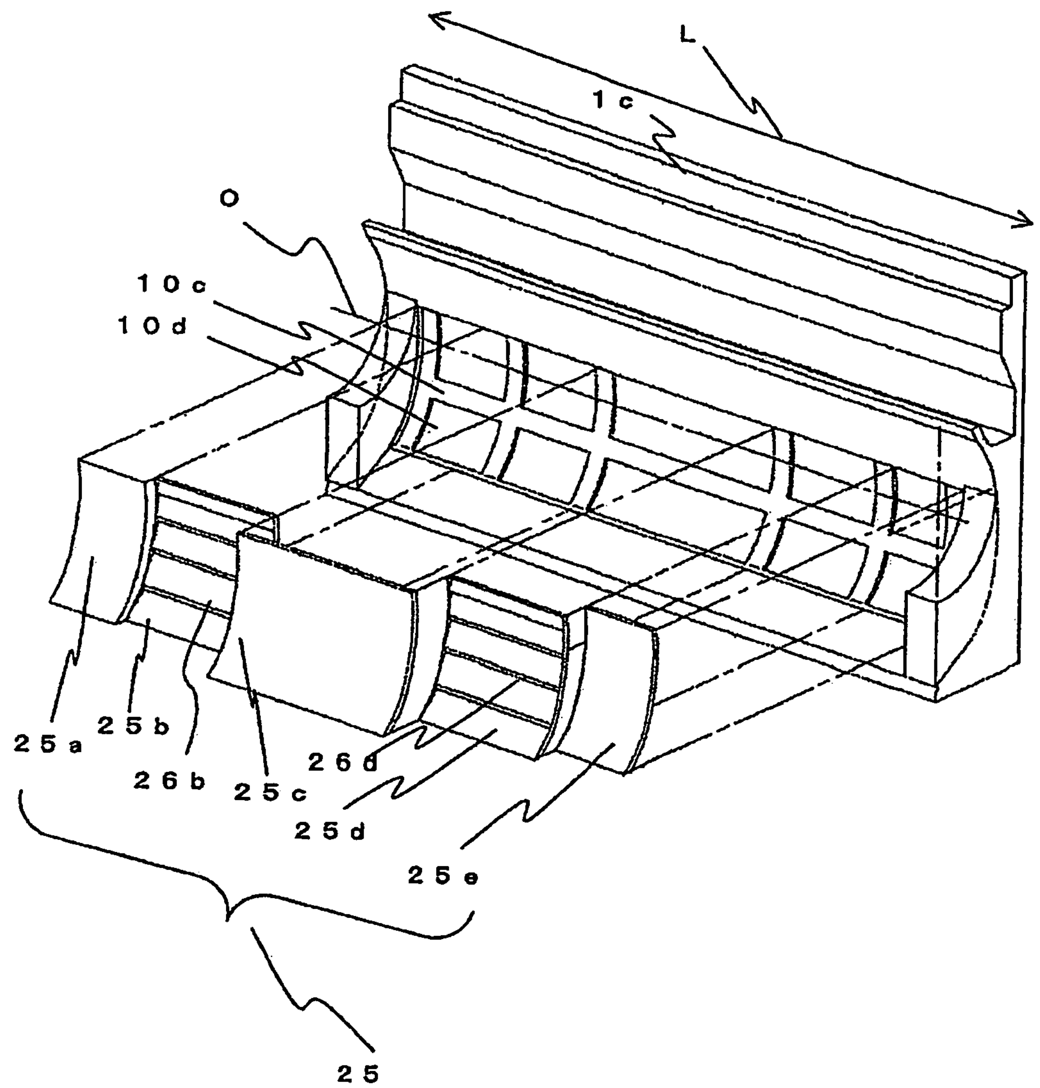
FIG. 18



F I G. 1 9



F I G. 2 0



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/001548

A. CLASSIFICATION OF SUBJECT MATTER
F24F1/00(2006.01)i, *F24F13/06*(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)
F24F1/00, F24F13/06

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	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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 08-121396 A (Matsushita Electric Industrial Co., Ltd.), 14 May 1996 (14.05.1996), paragraphs [0033] to [0034]; fig. 6 (Family: none)	1-11
Y	JP 2002-250534 A (Mitsubishi Heavy Industries, Ltd.), 06 September 2002 (06.09.2002), paragraphs [0016] to [0025]; fig. 2 (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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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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
27 May, 2010 (27.05.10)	08 June, 2010 (08.06.10)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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