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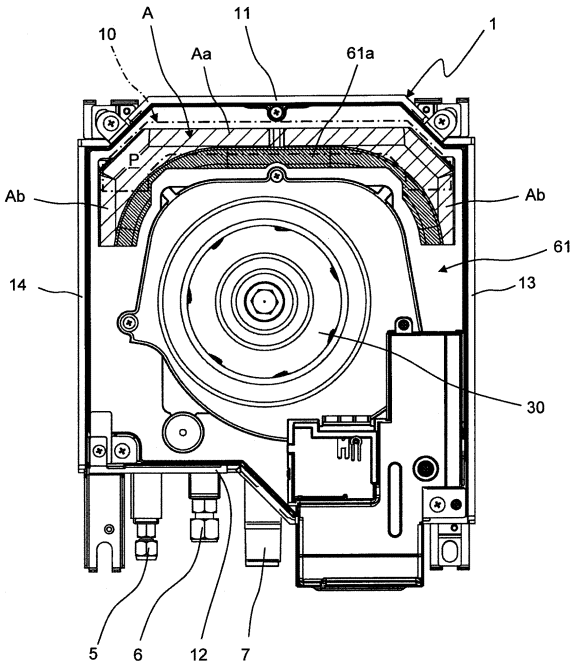
(54) INDOOR UNIT FOR AIR CONDITIONER

(57) An indoor unit for an air conditioner includes: a casing main body (1); a turbo fan (30) disposed in the casing main body (1); a heat exchanger (40) disposed in the casing main body (1) such that the turbo fan (30) is surrounded by the heat exchanger (40) on three sides; a partition plate (50) connected to two ends of the heat exchanger (40) to surround the turbo fan (30) in conjunction with the heat exchanger (40); and a blow-out port (10) through which air is blown out downward, the blow-out port (10) being located opposite the partition plate (50) with respect to the heat exchanger (40). An air flow path (P) from the heat exchanger (40) to the blow-out port (10) in the casing main body (1) has, at its downstream side, a sectional shape including a first air flow path region (Aa) extending along an edge of the casing main body (1) and second air flow path regions (Ab) respectively elongated from two ends of the first air flow path region (Aa) toward a second wall (12). The indoor unit for an air conditioner thus enables reduction in pressure loss at the air flow path, which leads to improvement in performance.

Fig.8



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Description

TECHNICAL FIELD

[0001] The present invention relates to an indoor unit for an air conditioner.

BACKGROUND ART

[0002] A conventional indoor unit for an air conditioner includes a heat exchanger having a U shape and a turbo fan configured to suck in and blow out air in three directions via the heat exchanger (see, for example, JP 2002-349890 A (Patent Literature 1)).

CITATION LIST

PATENT LITERATURE

[0003] Patent Literature 1: JP 2002-349890 A

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] In the conventional indoor unit for an air conditioner, desirably, opposite heat exchange parts of the heat exchanger having the U shape extend in parallel.

[0005] However, if an indoor unit for an air conditioner is configured to blow out air in one direction, the use of the heat exchanger having the U shape and including the opposite heat exchange parts extending in parallel imposes limitations on a space for an air flow path and hinders satisfactory increase in sectional area of the air flow path, which leads to degradation in performance.

[0006] Hence, the present invention sets out to provide an indoor unit for an air conditioner, the indoor unit being capable of increasing a sectional area of an air flow path and reducing a pressure loss at the air flow path with a simple configuration to thereby improve performance.

SOLUTIONS TO PROBLEM

[0007] An aspect of the present invention provides an indoor unit for an air conditioner,
the indoor unit including:

a casing;
a centrifugal fan disposed in the casing;
a heat exchanger disposed in the casing such that the centrifugal fan is surrounded by the heat exchanger on three sides;
a partition connected to two ends of the heat exchanger to surround the centrifugal fan in conjunction with the heat exchanger; and
a blow-out port through which air is blown out downward, the blow-out port being formed in the casing at a position opposite to the partition with respect to the heat exchanger,
wherein
an air flow path from the heat exchanger to the blow-out port in the casing at least partially has, at its downstream side, a sectional shape including a first air flow path region extending along an edge of the casing and second air flow path regions respectively elongated from two ends of the first air flow path region toward the partition.

[0008] According to the configuration described above, the heat exchanger is disposed in the casing such that the centrifugal fan is surrounded by the heat exchanger on three sides. In addition, the air flow path from the heat exchanger to the blow-out port at least partially has, at its downstream side, the sectional shape including the first air flow path region extending along the edge of the casing and the second air flow path regions respectively elongated from the two ends of the first air flow path region toward the partition. The indoor unit thus enables increase in sectional area of the air flow path and reduction in pressure loss at the air flow path with a simple configuration, which leads to improvement in performance.

[0009] The indoor unit for an air conditioner according to an embodiment further includes a drain pan disposed below the heat exchanger in the casing, and the air flow path at least partially has, at its side downstream of an upper end of the drain pan, the sectional shape including the first air flow path region and the second air flow path regions.

[0010] According to the embodiment described above, the air flow path at least partially has, at its side downstream of the upper end of the drain pan, the sectional shape including the first air flow path region and the second air flow path regions. This configuration therefore enables effective reduction in pressure loss by virtue of widening of a portion, where the sectional area is otherwise small, of the air flow path.

[0011] In the indoor unit for an air conditioner according to an embodiment,

the blow-out port includes:
a first blow-out port part extending along an edge of the casing, and
second blow-out port parts respectively elongated from two ends of the first blow-out port part toward the partition.

[0012] According to the embodiment described above, the blow-out port includes the first blow-out port part extending along the edge of the casing, and the second blow-out port parts respectively elongated from the two ends of the first blow-out port part toward the partition. This configuration therefore enables increase in sectional area of the air flow path and reduction in pressure loss at and around the blow-out port, which leads to further improvement in performance.

[0013] In the indoor unit for an air conditioner according to an embodiment,

the heat exchanger includes:

a first heat exchange part opposite to the blow-out port,
a second heat exchange part elongated from a first end of the first heat exchange part, and
a third heat exchange part elongated from a second end of the first heat exchange part, a clearance between the second heat exchange part and an opposite edge, or side, of the casing to the second heat exchange part is tapered from the first heat exchange part toward a distal end, or tip, of the second heat exchange part, and

a clearance between the third heat exchange part and an opposite edge, or side, of the casing to the third heat exchange part is tapered from the first heat exchange part toward a distal end, or tip, of the third heat exchange part.

[0014] According to the embodiment described above, the clearance between the second heat exchange part elongated from one of the ends of the first heat exchange part opposite to the blow-out port and the opposite edge, or side, of the casing to the second heat exchange part is tapered from the first heat exchange part toward the distal end, or tip, of the second heat exchange part. In addition, the clearance between the third heat exchange part elongated from the other end of the first heat exchange part opposite to the blow-out port and the opposite edge, or side, of the casing to the third heat exchange part is tapered from the first heat exchange part toward the distal end, or tip, of the third heat exchange part. An opening defined between the two ends of the heat exchanger having a U shape is thus increased. In addition, a joint between the first heat exchange part and the second heat exchange part and a joint between the first heat exchange part and the third heat exchange part are located inward away from an inner face of the casing. Spaces thus defined are utilized for the second blow-out port parts. This configuration therefore enables increase in area of the blow-out port.

[0015] In the indoor unit for an air conditioner according to an embodiment,

the heat exchanger includes:

a first heat exchange part opposite to the blow-out port,
a second heat exchange part elongated from a first end of the first heat exchange part, and
a third heat exchange part elongated from a second end of the first heat exchange part,

the second heat exchange part extends in parallel with an opposite edge, or side, of the casing to the second heat exchange part, and
the third heat exchange part extends in parallel with an opposite edge, or side, of the casing to the third heat exchange part.

[0016] According to the embodiment described above, the second and third heat exchange parts respectively elongated from the two ends of the first heat exchange part opposite to the blow-out port extend in parallel with the opposite sides of the casing to the second and third heat exchange parts, respectively. The joint between the first heat exchange part and the second heat exchange part and the joint between the first heat exchange part and the third heat exchange part may be curved or bent so as to be located inward away from the inner face of the casing. Spaces thus defined are utilized for the second blow-out port parts. This configuration therefore enables increase in area of the blow-out port.

[0017] The indoor unit for an air conditioner according to an embodiment further includes a flap configured to control a direction of air to be blown out through the blow-out port, the flap including
a flap main body extending along an edge of the casing, and
auxiliary flaps respectively elongated from two ends of the flap main body in a direction away from the edge of the casing.

[0018] According to the embodiment described above, the flap main body 20a extending along the edge of the casing controls a direction of air to be blown out through the first blow-out port part 10a. In addition, the auxiliary flaps 20b respectively elongated from the two ends of the flap main body 20a in the direction away from the edge of the casing respectively control directions of air to be blown out through the second blow-out port parts 10b.

[0019] In the indoor unit for an air conditioner according to an embodiment,
a distance between the second blow-out port parts of the blow-out port gradually increases from the first blow-out port part toward distal ends of the second blow-out port parts.

[0020] According to the embodiment described above, the blow-out port has such a shape that the distance between the second blow-out port parts gradually increases from the first blow-out port part toward the distal ends of the second blow-out port parts. In the casing, therefore, spaces defined by the curved portions or bent portions of the heat exchanger having the U shape are effectively utilized for the second blow-out port parts.

[0021] In the indoor unit for an air conditioner according to an embodiment,
a joint between the first heat exchange part and the second heat exchange part is curved,
a joint between the first heat exchange part and the third heat exchange part is curved,
a region defined by a first plane including a line that is in

contact with the first heat exchange part and in parallel with a longitudinal direction of the first blow-out port part, a second plane that is in contact with an outer face of the second heat exchange part excluding the joint between the first heat exchange part and the second heat exchange part, and an outer face of the heat exchanger overlaps a part of the blow-out port in plan view, and
a region defined by the first plane including the line that is in contact with the first heat exchange part and in parallel with the longitudinal direction of the first blow-out port part, a third plane that is in contact with an outer face of the third heat exchange part excluding the joint between the first heat exchange part and the third heat exchange part, and the outer face of the heat exchanger overlaps a part of the blow-out port in plan view.

[0022] According to the embodiment described above, the region defined by the first plane including the line that is in contact with the first heat exchange part and in parallel with the longitudinal direction of the first blow-out port part, the second plane that is in contact with the outer face of the second heat exchange part excluding the joint between the first heat exchange part and the second heat exchange part, and the outer face of the heat exchanger overlaps a part of the blow-out port in plan view. In addition, the region defined by the first plane including the line that is in contact with the first heat exchange part and in parallel with the longitudinal direction of the first blow-out port part, the third plane that is in contact with the outer face of the third heat exchange part excluding the joint between the first heat exchange part and the third heat exchange part, and the outer face of the heat exchanger overlaps a part of the blow-out port in plan view. This configuration ensures open spaces to be utilized for the blow-out port at a position outside the joint between the first heat exchange part and the second heat exchange part and at a position outside the joint between the first heat exchange part and the third heat exchange part.

[0023] In the indoor unit for an air conditioner according to an embodiment,
the second and third heat exchange parts at least partially overlap the second blow-out port parts of the blow-out port, respectively, as seen sideways from a direction opposite to the blow-out port with respect to the centrifugal fan.

[0024] According to the embodiment described above, the second and third heat exchange parts at least partially overlap the second blow-out port parts of the blow-out port, respectively, as seen sideways from the direction opposite to the blow-out port with respect to the centrifugal fan. Spaces in the casing are thus effectively utilized.

[0025] In the indoor unit for an air conditioner according to an embodiment,
the heat exchanger partially overlaps the second blow-out port parts of the blow-out port as seen sideways from a direction in which the first blow-out port part of the blow-out port extends.

[0026] According to the embodiment described above, the heat exchanger partially overlaps the second blow-out port parts of the blow-out port as seen sideways from the direction in which the first blow-out port part of the blow-out port extends. Spaces in the casing are thus effectively utilized.

[0027] In the indoor unit for an air conditioner according to an embodiment,
a width of the blow-out port is wider than a width of the heat exchanger as seen sideways from a direction opposite to the blow-out port with respect to the centrifugal fan.

[0028] According to the embodiment described above, the width of the blow-out port is wider than the width of the heat exchanger as seen sideways from the direction opposite to the blow-out port with respect to the centrifugal fan. The area of the blow-out port is thus further increased.

ADVANTAGEOUS EFFECT OF INVENTION

[0029] As is clear from the foregoing description, according to the present invention, a blow-out port includes: a first blow-out port part extending along an edge of a casing, the first blow-out port part being located opposite a partition with respect to a heat exchanger disposed in the casing such that a centrifugal fan is surrounded by the heat exchanger on three sides; and second blow-out port parts elongated from two ends of the first blow-out port part toward the partition. An area of the blow-out port is thus increased with a simple configuration, which leads to improvement in performance.

BRIEF DESCRIPTION OF DRAWINGS

[0030]

FIG. 1 is a perspective view of an indoor unit for an air conditioner according to a first embodiment of the present invention, the indoor unit being seen obliquely from below.
FIG. 2 is a perspective view of the indoor unit seen obliquely from above.
FIG. 3 is a bottom view of the indoor unit.
FIG. 4 is a sectional view taken along line IV-IV in FIG. 3.
FIG. 5 is a bottom view of the indoor unit from which a panel, a drain pan, and the like are detached.
FIG. 6 illustrates a center of a turbo fan in the indoor unit.
FIG. 7 illustrates the center of the turbo fan in the indoor unit.
FIG. 8 is a bottom view of the indoor unit from which the panel is detached.
FIG. 9 is a bottom view of the indoor unit which is illustrated in FIG. 5 and to which a flap is attached.
FIG. 10 is a bottom view of the indoor unit from which the flap is detached.
FIG. 11 illustrates a relationship between regions

outside curved portions of a heat exchanger and a blow-out port in the indoor unit.

FIG. 12 illustrates a relationship between the heat exchanger and the blow-out port in the indoor unit seen sideways (X direction).

FIG. 13 illustrates a relationship between the heat exchanger and the blow-out port in the indoor unit seen sideways (Y direction).

FIG. 14 illustrates a width of the heat exchanger and a width of the blow-out port in the indoor unit seen sideways (X direction).

FIG. 15 is a bottom view of an indoor unit for an air conditioner according to a second embodiment of the present invention in a state in which a panel, a drain pan, and the like are detached from the indoor unit.

DESCRIPTION OF EMBODIMENTS

[0031] A specific description will be given of indoor units for an air conditioner according to the present invention, based on embodiments illustrated in the drawings.

[First Embodiment]

[0032] FIG. 1 is a perspective view of an indoor unit for an air conditioner according to a first embodiment of the present invention, the indoor unit being seen obliquely from below. This indoor unit is designed to be embedded in a ceiling.

[0033] As illustrated in FIG. 1, the indoor unit for an air conditioner according to the first embodiment includes a casing main body 1, a panel 2 having a rectangular shape, the panel 2 being mounted to a lower side of the casing main body 1, and a grille 3 detachably mounted to the panel 2. The casing main body 1, the panel 2, and the grille 3 constitute a casing.

[0034] The panel 2 has, in its longitudinal end and its lower face, a blow-out port 10 which extends along a shorter edge of the panel 2 and through which air is blown out downward. The panel 2 also has a flap 20 pivotably mounted thereto. In FIG. 1, the flap 20 closes the blow-out port 10.

[0035] The indoor unit also includes a drain socket 7 protruding from a sidewall of the casing main body 1. The drain socket 7 is connected to an external drain hose (not illustrated). The indoor unit also includes pipe connection parts 5 and 6 each protruding from a second wall 12 (see FIG. 5) of the casing main body 1. Each of the pipe connection parts 5 and 6 is connected to an external refrigerant pipe (not illustrated).

[0036] As illustrated in FIG. 1, the indoor unit also includes an electrical component unit 8 and hanger fittings 101 to 103 each protruding sideward from the casing main body 1.

[0037] FIG. 2 is a perspective view of the indoor unit seen obliquely from above. In FIG. 2, the same constituent elements as those illustrated in FIG. 1 are denoted with the same reference signs.

[0038] FIG. 3 is a bottom view of the indoor unit. In FIG. 3, the same constituent elements as those illustrated in FIG. 1 are denoted with the same reference signs.

[0039] As illustrated in FIG. 3, the casing main body 1 has in its center a suction port 1a. A filter 4 (see FIG. 4) is attached between the suction port 1a and the grille 3.

[0040] FIG. 4 is a sectional view taken along line IV-IV in FIG. 3. In FIG. 4, the same constituent elements as those illustrated in FIGS. 1 to 3 are denoted with the same reference signs.

[0041] As illustrated in FIG. 4, the casing main body 1 houses therein a turbo fan 30 to be driven by a motor 31. The casing main body 1 also houses therein a bell mouth 32 at a position between the suction port 1a and the turbo fan 30. The casing main body 1 also houses therein a heat exchanger 40 and a partition plate 50 at a position around the turbo fan 30. The casing main body 1 also houses therein a drain pan 60 at a position below the heat exchanger 40 and the partition plate 50. The casing main body 1 also houses therein a heat insulator 61 with which side faces and a bottom face of the drain pan 60 are covered. The heat insulator 61 has a portion 61a fronting on an air flow path P and protruding toward the air flow path P1 (see FIG. 8).

[0042] The turbo fan 30 is an example of a centrifugal fan. The partition plate 50 is an example of a partition. The partition may be integrated with the casing.

[0043] The casing main body 1 has the air flow path P for guiding air from the turbo fan 30 to the blow-out port 10 in the panel 2.

[0044] FIG. 5 is a bottom view of the indoor unit from which the panel 2, the drain pan 60, and the like are detached.

[0045] As illustrated in FIG. 5, the casing main body 1 includes a first wall 11 located near the blow-out port 10 (see FIG. 10), a second wall 12 opposite to the first wall 11, a third wall 13 connecting the first wall 11 and the second wall 12, and a fourth wall 14 connecting the first wall 11 and the second wall 12 and opposite to the third wall 13. In FIG. 5, reference numeral 10a denotes a first blow-out port part and 10b denotes second blow-out port parts 10b.

[0046] The heat exchanger 40 includes a first heat exchange part 41, a second heat exchange part 42 located at an upstream side of the first heat exchange part 41 with respect to a rotation direction (arrow R1) of the turbo fan 30 in plan view, and a third heat exchange part 43 located at a downstream side of the first heat exchange part 41 with respect to the rotation direction (arrow R1) of the turbo fan 30 in plan view.

[0047] The heat exchanger 40 has two ends connected to the partition plate 50 having an arcuate shape, so that the turbo fan 30 is surrounded with the heat exchanger 40 and the partition plate 50. The partition plate 50 is bowed outward.

[0048] The pipe connection parts 5 and 6 are connect-

ed to an end of the third heat exchange part 43 of the heat exchanger 40. The casing main body 1 also houses therein a drain pump 70 at a position between the partition plate 50 and the second wall 12 and near the third wall 13.

[0049] The third heat exchange part 43 elongated from the first heat exchange part 41 of the heat exchanger 40 at the downstream side in the rotation direction (arrow R1) of the turbo fan 30 is shorter in length than the second heat exchange part 42 elongated from the first heat exchange part 41 at the upstream side in the rotation direction (arrow R1) of the turbo fan 30. Therefore, the pipe connection parts 5 and 6 are connected to the end of the third heat exchange part 43. In other words, a space for connecting pipes is ensured in the casing main body 1. As compared with a case where the third heat exchange part 43 is equal in length to the second heat exchange part 42, a clearance between an outer periphery of the turbo fan 30 and a downstream-side end of the partition plate 50 is made larger than a clearance between the outer periphery of the turbo fan 30 and an upstream-side end of the partition plate 50.

[0050] In addition, the panel 2 has the blow-out port 10 at the position opposite to the partition plate 50 with respect to the heat exchanger 40. Therefore, air from the turbo fan 30 is smoothly blown out through the blow-out port 10 via the heat exchanger 40.

[0051] FIG. 6 illustrates a center O1 of the turbo fan 30 in the indoor unit. The center O1 of the turbo fan 30 is located upstream of a current of air (indicated by an arrow R2) between the turbo fan 30 and the partition plate 50, with respect to a perpendicular bisector L2 of a line L1 connecting the two ends of the partition plate 50. In other words, the center O1 of the turbo fan 30 is located on the left side of the perpendicular bisector L2 in FIG. 6.

[0052] With this configuration, the clearance between the outer periphery of the turbo fan 30 and the downstream-side end of the partition plate 50 with which an opening of the heat exchanger 40 is covered is larger than the clearance between the outer periphery of the turbo fan 30 and the upstream-side end of the partition plate 50. This configuration therefore enables reduction in pressure near the downstream-side end of the partition plate 50 that makes loud unusual noise. This configuration thus enables reduction in pressure at a high-pressure spot that may occur at the end of the partition plate 50 with which the opening of the heat exchanger 40 is covered, to thereby reduce unusual noise.

[0053] The inventors of the present invention performed a simulation on the condition that the center O1 of the turbo fan 30 is located upstream of the current of air (R2) between the turbo fan 30 and the partition plate 50, with respect to the perpendicular bisector L2 of the line L1 connecting the two ends of the partition plate 50. It was confirmed by this simulation that the indoor unit having the configuration described above reduces a pressure near the downstream-side end of the partition plate 50, and therefore reduces a pressure at a high-pressure spot that occurs at the end of the partition plate 50 with which the opening of the heat exchanger 40 is covered, to thereby reduce unusual noise.

[0054] As illustrated in FIG. 6, the partition plate 50 is bowed outward beyond the line L1 connecting the two ends of the partition plate 50 (partition) in plan view. In addition, the turbo fan 30 partially overlaps the region surrounded with the partition plate 50 and the line L1 connecting the two ends of the partition plate 50 (partition). Therefore, the turbo fan 30 rotates along the partition plate 50 bowed outward, and the partition plate 50 smoothly guides air from the turbo fan 30, which contributes to reduction in space for housing the components in the casing main body 1.

[0055] The position of the center O1 of the turbo fan 30 is set as illustrated in FIG. 7. The heat exchanger 40 includes a heat exchange part 40a (a hatched region in FIG. 7) having a line symmetrical shape in plan view. The turbo fan 30 is disposed such that the center O1 of the turbo fan 30 is located upstream of the current of air (indicated by the arrow R2) between the turbo fan 30 and the partition plate 50, with respect to a symmetry axis L3 of the heat exchange part 40a having the line symmetrical shape. In other words, the turbo fan 30 is disposed such that the center O1 of the turbo fan 30 is located on the left side of the symmetry axis L3 in FIG. 7.

[0056] As to a positional relationship between the heat exchanger 40 and the casing main body 1, desirably, the heat exchanger 40 is disposed in the casing main body 1 such that the symmetry axis L3 of the heat exchange part 40a having the line symmetrical shape in the heat exchanger 40 is aligned with a longitudinal center line of the casing main body 1.

[0057] FIG. 8 is a bottom view of the indoor unit from which the panel 2 is detached. In FIG. 8, the same constituent elements as those illustrated in FIGS. 1 to 5 are denoted with the same reference signs. The heat insulator 61 is disposed to cover the side face and bottom face of the drain pan 60 (see FIG. 4). In addition, the portion 61a of the heat insulator 61 protrudes toward the air flow path P1.

[0058] As illustrated in FIG. 8, the air flow path P from the heat exchanger 40 to the blow-out port 10 in the casing main body 1 has, at its side downstream of an upper end of the drain pan 60, a sectional shape (indicated by a hatched region A in FIG. 8) including a first air flow path region Aa extending along an edge of the casing main body 1 and second air flow path regions Ab respectively elongated from two ends of the first air flow path region Aa toward the second wall 12. The sectional shape of the air flow path P including the first air flow path region Aa and second air flow path regions Ab is a shape of a horizontal section taken along a plane perpendicular to an axis of rotation of the turbo fan 30.

[0059] FIG. 9 is a bottom view of the indoor unit which is illustrated in FIG. 5 and to which the flap 20 (diagonally shaded) is attached. FIG. 10 is a bottom view of the indoor unit from which the flap 20 is detached. In FIGS. 9 and 10, the same constituent elements as those illustrated in

FIGS. 1 to 7 are denoted with the same reference signs.

[0060] As illustrated in FIGS. 9 and 10, the heat exchanger 40 having a U shape in plan view includes the first heat exchange part 41 extending in parallel with the first wall 11 of the casing main body 1, the second heat exchange part 42 elongated from a first end of the first heat exchange part 41, and the third heat exchange part 43 elongated from a second end of the first heat exchange part 41.

[0061] A clearance between the second heat exchange part 42 and the third wall 13 is tapered from the first heat exchange part 41 toward a distal end, or tip, of the second heat exchange part 42. A clearance between the third heat exchange part 43 and the fourth wall 14 is tapered from the first heat exchange part 41 toward a distal end, or tip, of the third heat exchange part 43. In other words, a distance between the second heat exchange part 42 and the third heat exchange part 43 gradually increases toward the two ends of the heat exchanger 40.

[0062] As illustrated in FIG. 9, the flap 20 configured to control a direction of air to be blown out through the blow-out port 10 includes a flap main body 20a extending along the first wall 11 of the casing main body 1, and auxiliary flaps 20b respectively elongated from two ends of the flap main body 20a toward the second wall 12 of the casing main body 1.

[0063] As illustrated in FIG. 10, the blow-out port 10 includes a first blow-out port part 10a having a rectangular shape and extending along the first wall 11 (shown in FIG. 9) of the casing main body 1, and second blow-out port parts 10b respectively elongated from two ends of the first blow-out port part 10a toward the second wall 12 (shown in FIG. 9) of the casing main body 1. The blow-out port 10 is indicated by a hatched region in FIG. 10, and is a region where the air flow path P is seen from a direction perpendicular to the panel 2.

[0064] The flap main body 20a extending along the edge of the casing main body 1 controls a direction of air to be blown out through the first blow-out port part 10a. In addition, the auxiliary flaps 20b respectively elongated from the two ends of the flap main body 20a in a direction away from the edge of the casing main body 1 respectively control directions of air to be blown out through the second blow-out port parts 10b.

[0065] FIG. 11 illustrates a relationship between regions S1 and S2 outside the curved portions of the heat exchanger 40 and the blow-out port 10 in the indoor unit.

[0066] As illustrated in FIG. 11, the region S1 is defined by a first plane including a contacting line F1 that is in contact with the first heat exchange part 41 and in parallel with the longitudinal direction of the first blow-out port part 10a, a second plane including a contacting line F2 that is in contact with an outer face of the second heat exchange part 42 excluding a joint between the first heat exchange part 41 and the second heat exchange part 42, and an outer face of the heat exchanger 40. The region S1 overlaps a part of one of the second blow-out port parts 10b of the blow-out port 10 in plan view. In addition, the region S2 is defined by the first plane including the contacting line F1 that is in contact with the first heat exchange part 41 and in parallel with the longitudinal direction of the first blow-out port part 10a, a third plane including a contacting line F3 that is in contact with an outer face of the third heat exchange part 43 excluding a joint between the first heat exchange part 41 and the third heat exchange part 43, and the outer face of the heat exchanger 40. The region S2 overlaps a part of the other second blow-out port part 10b of the blow-out port 10 in plan view.

[0067] This configuration ensures an open space to be utilized for one of the second blow-out port parts 10b at a position outside the joint between the first heat exchange part 41 and the second heat exchange part 42, and also ensures an open space to be utilized for the other second blow-out port part 10b at a position outside the joint between the first heat exchange part 41 and the third heat exchange part 43.

[0068] The blow-out port has such a shape that the distance between the second blow-out port parts 10b gradually increases from the first blow-out port part 10a toward the distal ends of the second blow-out port parts 10b. In the casing main body 1, therefore, the spaces defined by the curved portions of the heat exchanger 40 having the U shape are effectively utilized for the second blow-out port parts 10b.

[0069] The first embodiment employs the first plane including the contacting line F1 that is in parallel with the longitudinal direction of the first blow-out port part 10a and in contact with the first heat exchange part 41 of the heat exchanger 40 having the U shape. When the first blow-out port part is not formed in a rectangular shape, but is curved, a direction of a line that is in contact with a center of the first blow-out port part is defined as the longitudinal direction of the first blow-out port part.

[0070] FIG. 12 illustrates a relationship between the heat exchanger 40 and the blow-out port 10 in the indoor unit seen sideways (X direction). In FIG. 12, the same constituent elements as those illustrated in FIG. 5 are denoted with the same reference signs. An X direction is a direction in which the indoor unit is seen sideways from the second wall 12, and a Y direction is a direction in which the indoor unit is seen sideways from the third wall 13.

[0071] As illustrated in FIG. 12, the regions S3 and S4 of the second and third heat exchange parts 42 and 43 respectively overlap the second blow-out port parts 10b of the blow-out port 10 as seen sideways from the direction opposite to the blow-out port 10 with respect to the turbo fan 30 (i.e., the X direction). The spaces in the casing main body 1 are thus effectively utilized. The second and third heat exchange parts 42 and 43 may entirely overlap the second blow-out port parts 10b of the blow-out port 10.

[0072] FIG. 13 illustrates a relationship between the heat exchanger 40 and the blow-out port 10 in the indoor

unit seen sideways (Y direction). In FIG. 13, the same constituent elements as those illustrated in FIG. 5 are denoted with the same reference signs. An X direction is a direction in which the indoor unit is seen sideways from the second wall 12, and a Y direction is a direction in which the indoor unit is seen sideways from the third wall 13.

[0073] As illustrated in FIG. 13, the region S5 of the heat exchanger 40 overlaps the second blow-out port parts 10b of the blow-out port 10 as seen sideways from the direction in which the first blow-out port part 10a of the blow-out port 10 extends (i.e., the Y direction). The spaces in the casing main body 1 are thus effectively utilized.

[0074] FIG. 14 illustrates a width W2 of the heat exchanger 40 and a width W1 of the blow-out port 10 in the indoor unit seen sideways (X direction). In FIG. 14, the same constituent elements as those illustrated in FIG. 5 are denoted with the same reference signs. An X direction is a direction in which the indoor unit is seen sideways from the second wall 12, and a Y direction is a direction in which the indoor unit is seen sideways from the third wall 13.

[0075] As illustrated in FIG. 14, the width W1 of the blow-out port 10 is wider than the width W2 of the heat exchanger 40 as seen sideways from the direction opposite to the blow-out port 10 with respect to the turbo fan 30 (i.e., the X direction). The area of the blow-out port is thus further increased.

[0076] According to the indoor unit having the configuration described above, the heat exchanger 40 is disposed in the casing main body 1 such that the turbo fan 30 (centrifugal fan) is surrounded by the heat exchanger 40 on three sides. In addition, the air flow path P from the heat exchanger 40 to the blow-out port 10 has, at its downstream side, the sectional shape including the first air flow path region Aa extending along an edge of the casing main body 1 and the second air flow path regions Ab respectively elongated from the two ends of the first air flow path region Aa toward the partition 50. The indoor unit thus enables increase in sectional area of the air flow path P and reduction in pressure loss at the air flow path P with a simple configuration, which leads to improvement in performance.

[0077] The air flow path P has, at its side downstream of the upper end of the drain pan 60, the sectional shape including the first air flow path region Aa and the second air flow path regions Ab. This configuration therefore enables effective reduction in pressure loss by virtue of widening of a portion, where the sectional area is small, of the air flow path P.

[0078] In the first embodiment, the air flow path P has, at its side downstream of the upper end of the drain pan 60, the U-shaped section including the first air flow path region Aa and the second air flow path regions Ab. Alternatively, the section of at least a part of the downstream side of the air flow path from the heat exchanger to the blow-out port in the casing may have the U shape including the first air flow path region extending along the edge of the casing and the second air flow path regions respectively elongated from the two ends of the first air flow path region toward the partition.

[0079] The blow-out port 10 includes the first blow-out port part 10a extending along the edge of the casing main body 1, and the second blow-out port parts 10b respectively elongated from the two ends of the first blow-out port part 10a toward the partition plate 50. This configuration therefore enables increase in area of the blow-out port 10 and reduction in pressure loss at and around the blow-out port, which leads to further improvement in performance.

[0080] The clearance between the second heat exchange part 42 elongated from one of the ends of the first heat exchange part 41 opposite to the blow-out port 10 and the opposite edge, or side, of the casing main body 1 to the second heat exchange part 42 is tapered from the first heat exchange part 41 toward the distal end of the second heat exchange part 42. In addition, the clearance between the third heat exchange part 43 elongated from the other end of the first heat exchange part 41 opposite to the blow-out port 10 and the opposite edge, or side, of the casing main body 1 to the third heat exchange part 43 is tapered from the first heat exchange part 41 toward the distal end of the third heat exchange part 43. The opening defined between the two ends of the heat exchanger 40 having the U shape is thus increased. In addition, the joint between the first heat exchange part 41 and the second heat exchange part 42 and the joint between the first heat exchange part 41 and the third heat exchange part 43 are located inward away from an inner face of the casing main body 1. Spaces thus defined are utilized for the second blow-out port parts 10b. This configuration therefore enables increase in area of the blow-out port 10.

[0081] In the first embodiment, the turbo fan 30 is a centrifugal fan. Alternatively, the turbo fan 30 may by any centrifugal fan such as a sirocco fan.

[Second Embodiment]

[0082] FIG. 15 is a bottom view of an indoor unit for an air conditioner according to a second embodiment of the present invention in a state in which a panel, a drain pan, and the like are detached from the indoor unit. The indoor unit for an air conditioner according to the second embodiment is identical in configuration to the indoor unit for an air conditioner according to the first embodiment except for a heat exchanger 140 having a U shape, and is therefore described with also reference to FIGS. 1 to 3.

[0083] As illustrated in FIG. 15, the indoor unit for an air conditioner according to the second embodiment includes a heat exchanger 140 having a U shape in plan view. The heat exchanger 140 includes a first heat exchange part 141 extending in parallel with a first wall 11 of a casing main body 1, a second heat exchange part 142 elongated from a first end of the first heat exchange

part 141, and a third heat exchange part 143 elongated from a second end of the first heat exchange part 141. The second heat exchange part 142 extends in parallel with a second wall 12. The third heat exchange part 143 extends in parallel with a third wall 13.

[0084] According to the indoor unit having the configuration described above, the second and third heat exchange parts 142 and 143 respectively elongated from the two ends of the first heat exchange part 141 opposite to a blow-out port 10 extend in parallel with the opposite edges, or sides, of the casing main body 1 to the second and third heat exchange parts 142 and 143, respectively. A joint between the first heat exchange part 141 and the second heat exchange part 142 and a joint between the first heat exchange part 141 and the third heat exchange part 143 are curved so as to be located inward away from an inner face of the casing main body 1. Spaces thus defined are utilized for second blow-out port parts 10b. This configuration therefore enables increase in area of the blow-out port 10. An area of the blow-out port 10 increases as a curvature of each of the joint between the first heat exchange part 141 and the second heat exchange part 142 and the joint between the first heat exchange part 141 and the third heat exchange part 143 increases.

[0085] The indoor unit for an air conditioner according to the second embodiment produces effects similar to those of the indoor unit for an air conditioner according to the first embodiment.

[0086] Preferably, the second heat exchange part 142 and the third heat exchange part 143, which are respectively elongated from the two ends of the first heat exchange part 141, extend in parallel with each other irrespective of the shape of the casing main body.

[Third Embodiment]

[0087] An indoor unit for an air conditioner according to a third embodiment of the present invention is identical in configuration to the indoor unit for an air conditioner according to the first embodiment except for a heat exchanger, and is therefore described with also reference to FIGS. 1 to 5.

[0088] In the first embodiment, the heat exchanger 40 of the indoor unit includes the first heat exchange part 41, the second heat exchange part 42 seamlessly elongated from the first end of the first heat exchange part 41, and the third heat exchange part 43 seamlessly elongated from the second end of the first heat exchange part 41. The indoor unit for an air conditioner according the third embodiment includes a heat exchanger 40 divided into different pieces of a first heat exchange part, a second heat exchange part, and a third heat exchange part.

[0089] The indoor unit for an air conditioner according to the third embodiment produces effects similar to those of the indoor unit for an air conditioner according to the first embodiment.

[0090] In the first to third embodiments, the casing of the indoor unit is constituted of the casing main body 1, the panel 2, and the grille 3; however, the shape of the casing is not limited thereto.

[0091] Also in the first to third embodiments, the heat exchanger 40 of the indoor unit has the U shape; however, the shape of the heat exchanger is not limited thereto. Examples of the shape of the heat exchanger may include a circular arc shape, a V shape, and the like.

[0092] Also in the first to third embodiments, the indoor unit is designed to be embedded in a ceiling; however, the indoor unit is not limited thereto. Alternatively, the present invention is also applicable to, for example, an indoor unit designed to be suspended from a ceiling.

[0093] The foregoing description concerns specific embodiments of the present invention; however, the present invention is not limited to the first to third embodiments, and various modifications and variations may be made within the scope of the present invention. For example, an appropriate combination of the configurations described in the first to third embodiments may be regarded as an embodiment of the present invention.

REFERENCE SIGNS LIST

[0094]

1	casing main body
1a	suction port
2	panel
3	grille
4	filter
5, 6	pipe connection part
7	drain socket
8	electrical component unit
10	blow-out port
11	first wall
12	second wall
13	third wall
14	fourth wall
20	flap
20a	flap main body
20b	auxiliary flap
30	turbo fan (centrifugal fan)
31	motor
32	bell mouth
40, 140	heat exchanger
41, 141	first heat exchange part
42, 142	second heat exchange part
43, 143	third heat exchange part
50	partition plate (partition)
60	drain pan
61	heat insulator
70	drain pump
P	air flow path

Claims

1. An indoor unit for an air conditioner, comprising:

   a casing (1, 2, 3);
   a centrifugal fan (30) disposed in the casing (1, 2, 3);
   a heat exchanger (40, 140) disposed in the casing (1, 2, 3) such that the centrifugal fan (30) is surrounded by the heat exchanger (40, 140) on three sides;
   a partition (50) connected to two ends of the heat exchanger (40, 140) to surround the centrifugal fan (30) in conjunction with the heat exchanger (40, 140); and
   a blow-out port (10) through which air is blown out downward, the blow-out port (10) being formed in the casing (1, 2, 3) at a position opposite to the partition (50) with respect to the heat exchanger (40, 140),
   wherein
   an air flow path (P) from the heat exchanger (40, 140) to the blow-out port (10) in the casing (1, 2, 3) at least partially has, at its downstream side, a sectional shape including a first air flow path region (Aa) extending along an edge of the casing (1, 2, 3) and second air flow path regions (Ab) respectively elongated from two ends of the first air flow path region (Aa) toward the partition (50).

2. The indoor unit for an air conditioner according to claim 1, further comprising:

   a drain pan (60) disposed below the heat exchanger (40, 140) in the casing (1, 2, 3),
   wherein
   the air flow path (P) at least partially has, at its side downstream of an upper end of the drain pan (60), the sectional shape including the first air flow path region (Aa) and the second air flow path regions (Ab).

3. The indoor unit for an air conditioner according to claim 1 or 2, wherein
   the blow-out port (10) includes:

   a first blow-out port part (10a) extending along an edge of the casing (1, 2, 3), and
   second blow-out port parts (10b) respectively elongated from two ends of the first blow-out port part (10a) toward the partition (50).

4. The indoor unit for an air conditioner according to claim 3, wherein
   the heat exchanger (40) includes

   a first heat exchange part (41) opposite to the blow-out port (10),
   a second heat exchange part (42) elongated from a first end of the first heat exchange part (41), and
   a third heat exchange part (43) elongated from a second end of the first heat exchange part (41),

   a clearance between the second heat exchange part (42) and an opposite edge, or side, of the casing (1, 2, 3) to the second heat exchange part (42) is tapered from the first heat exchange part (41) toward a distal end of the second heat exchange part (42), and
   a clearance between the third heat exchange part (43) and an opposite edge, side, of the casing (1, 2, 3) to the third heat exchange part (43) is tapered from the first heat exchange part (41) toward a distal end of the third heat exchange part (43).

5. The indoor unit for an air conditioner according to claim 3, wherein
   the heat exchanger (140) includes

   a first heat exchange part (141) opposite to the blow-out port (10),
   a second heat exchange part (142) elongated from a first end of the first heat exchange part (141), and
   a third heat exchange part (143) elongated from a second end of the first heat exchange part (141),

   the second heat exchange part (142) extends in parallel with an opposite edge, or side, of the casing (1, 2, 3) to the second heat exchange part (142), and
   the third heat exchange part (143) extends in parallel with an opposite edge, or side, of the casing (1, 2, 3) to the third heat exchange part (143).

6. The indoor unit for an air conditioner according to any one of claims 3 to 5, further comprising:

   a flap (20) configured to control a direction of air to be blown out through the blow-out port (10), the flap (20) including
   a flap main body (20a) extending along an edge of the casing (1, 2, 3), and
   auxiliary flaps (20b) respectively elongated from two ends of the flap main body (20a) in a direction away from the edge of the casing (1, 2, 3).

7. The indoor unit for an air conditioner according to claim 4 or 5, wherein
   a distance between the second blow-out port parts (10b) of the blow-out port (10) gradually increases from the first blow-out port part (10a) toward distal ends of the second blow-out port parts (10b).

8. The indoor unit for an air conditioner according to

claim 4 or 5, wherein
a joint between the first heat exchange part (41, 141) and the second heat exchange part (42, 142) is curved,
a joint between the first heat exchange part (41, 141) and the third heat exchange part (43, 143) is curved,
a region (S1) defined by a first plane including a line that is in contact with the first heat exchange part (41, 141) and in parallel with a longitudinal direction of the first blow-out port part (10a), a second plane that is in contact with an outer face of the second heat exchange part (42, 142) excluding the joint between the first heat exchange part (41, 141) and the second heat exchange part (42, 142), and an outer face of the heat exchanger (40) overlaps a part of the blow-out port (10) in plan view, and
a region (S2) defined by the first plane including the line that is in contact with the first heat exchange part (41, 141) and in parallel with the longitudinal direction of the first blow-out port part (10a), a third plane that is in contact with an outer face of the third heat exchange part (43, 143) excluding the joint between the first heat exchange part (41, 141) and the third heat exchange part (43, 143), and the outer face of the heat exchanger (40) overlaps a part of the blow-out port (10) in plan view.

9. The indoor unit for an air conditioner according to claim 4 or 5, wherein
the second and third heat exchange parts (42, 43) at least partially overlap the second blow-out port parts (10b) of the blow-out port (10), respectively, as seen sideways from a direction opposite to the blow-out port (10) with respect to the centrifugal fan (30).

10. The indoor unit for an air conditioner according to any one of claims 3 to 9, wherein
the heat exchanger (40) partially overlaps the second blow-out port parts (10b) of the blow-out port (10) as seen sideways from a direction in which the first blow-out port part (10a) of the blow-out port (10) extends.

11. The indoor unit for an air conditioner according to any one of claims 1 to 10, wherein
a width (W1) of the blow-out port (10) is wider than a width (W2) of the heat exchanger (40) as seen sideways from a direction opposite to the blow-out port (10) with respect to the centrifugal fan (30).

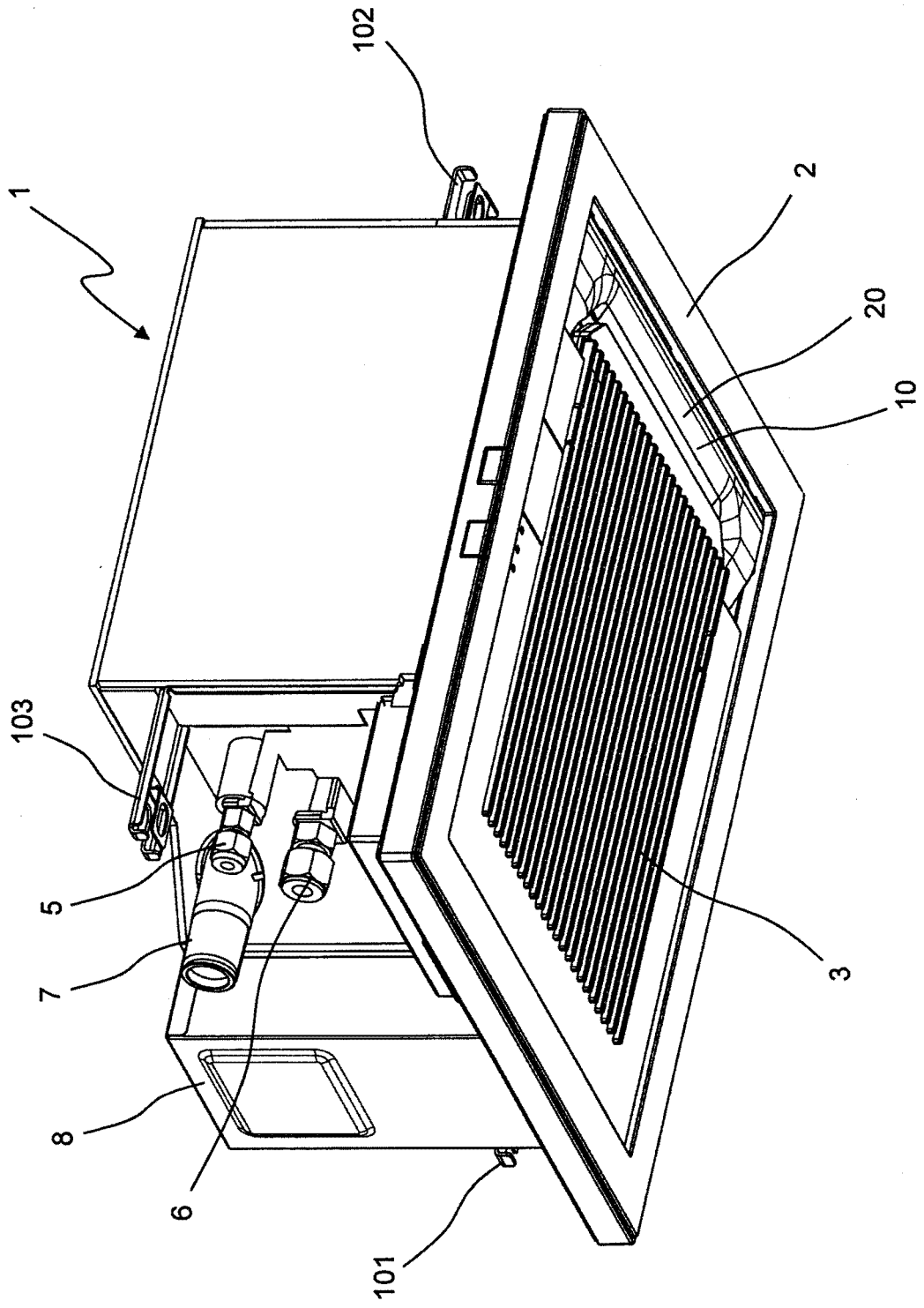


Fig.1

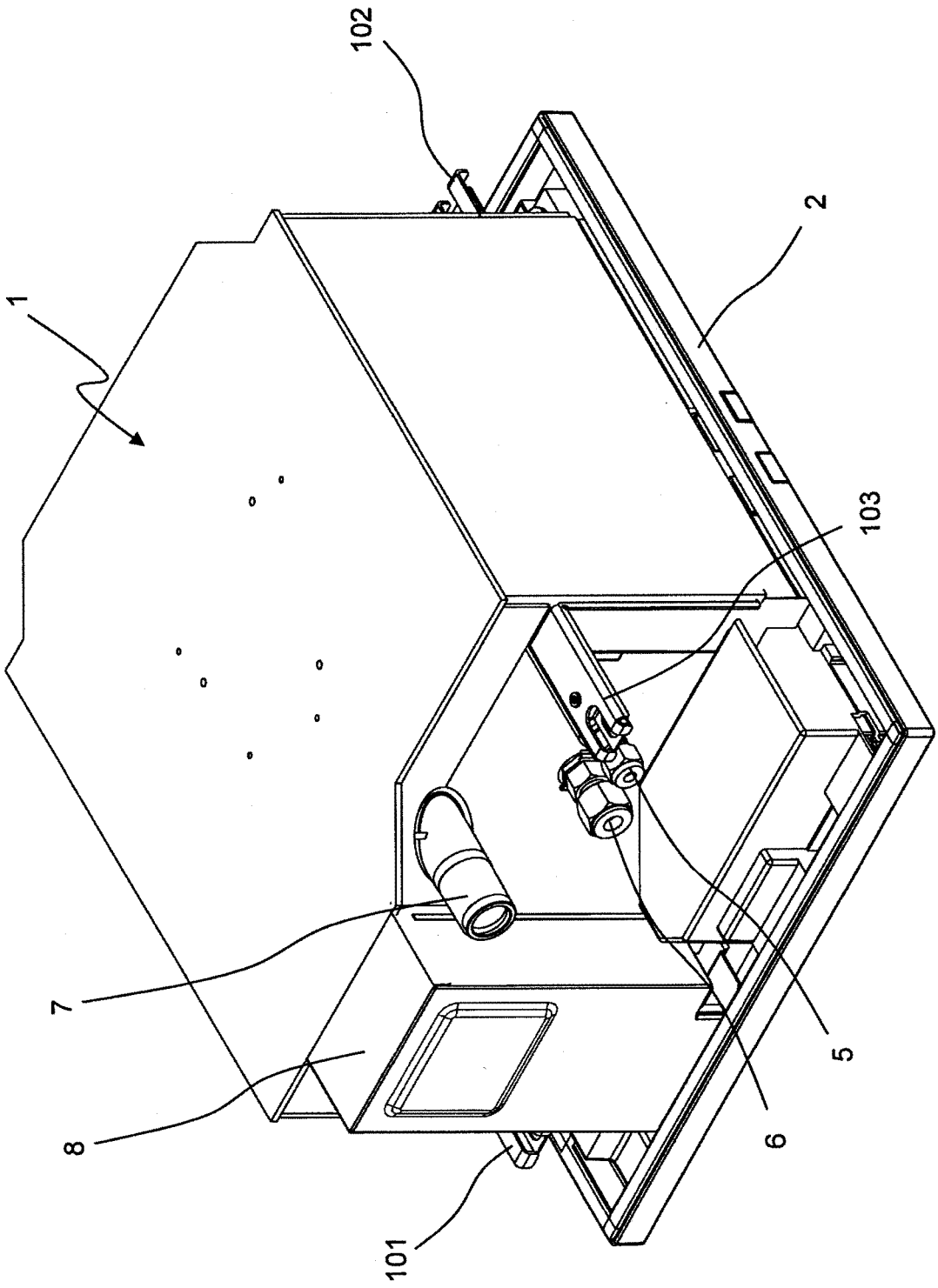
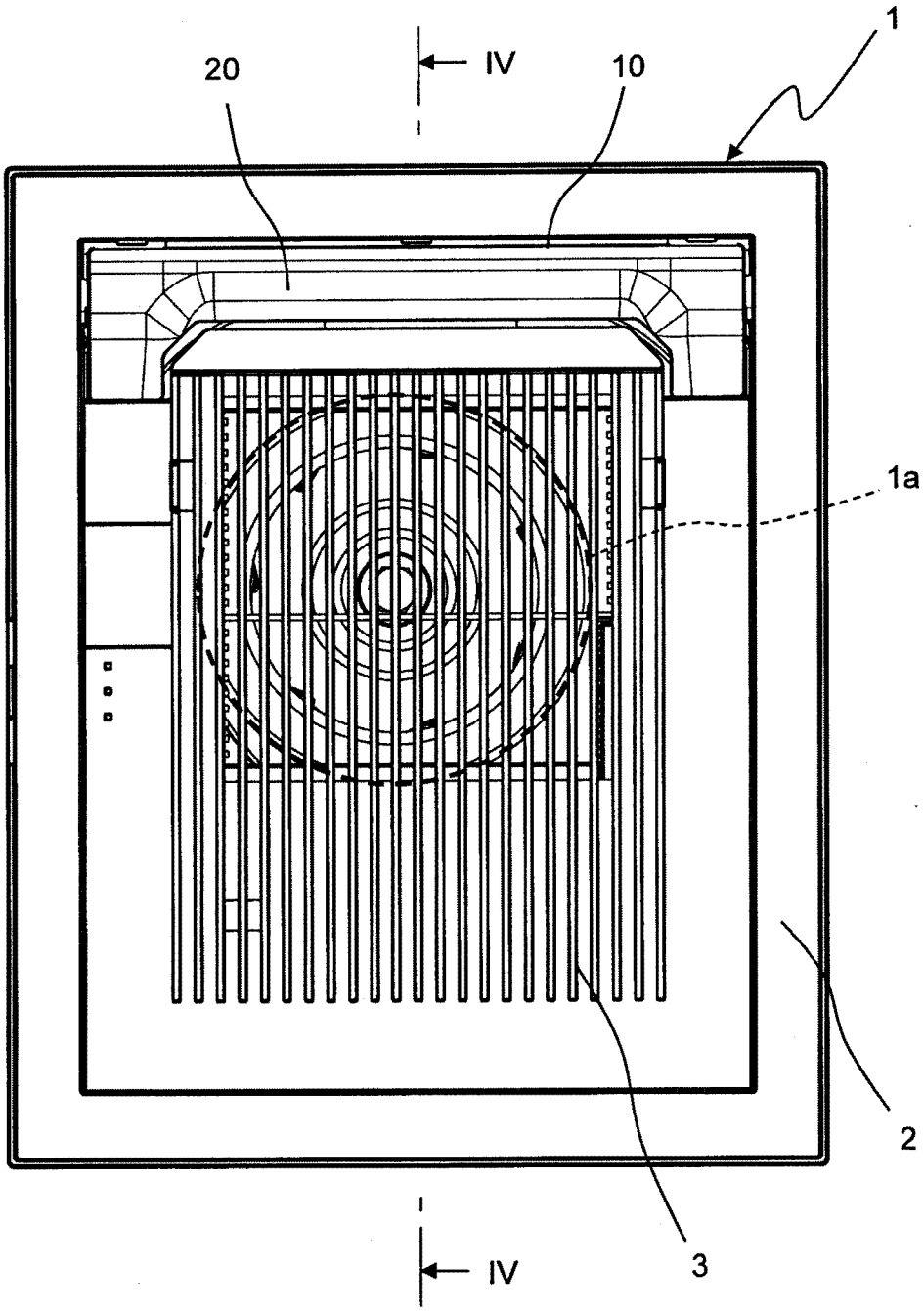


Fig.2

Fig.3



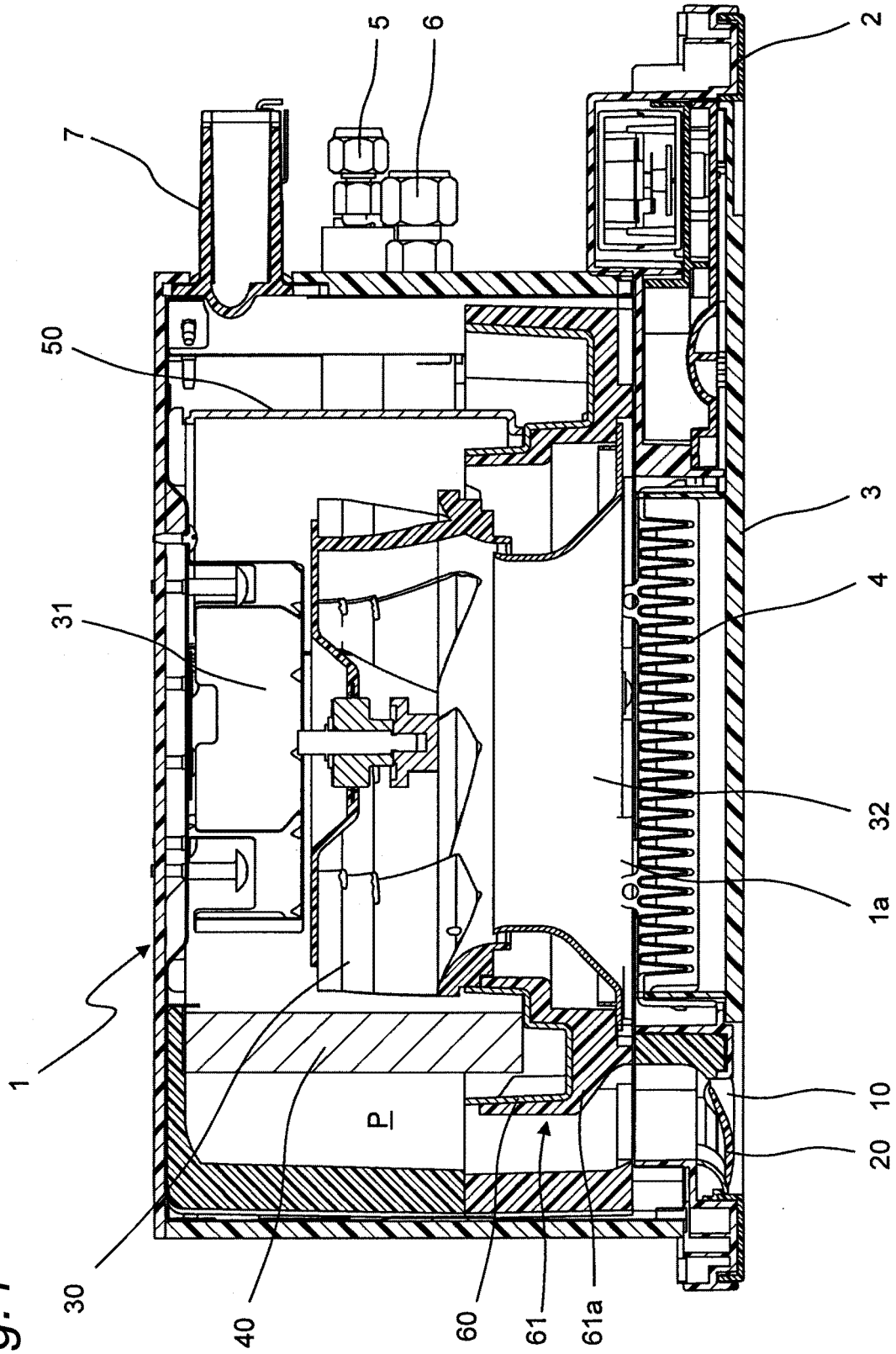


Fig.4

Fig.5

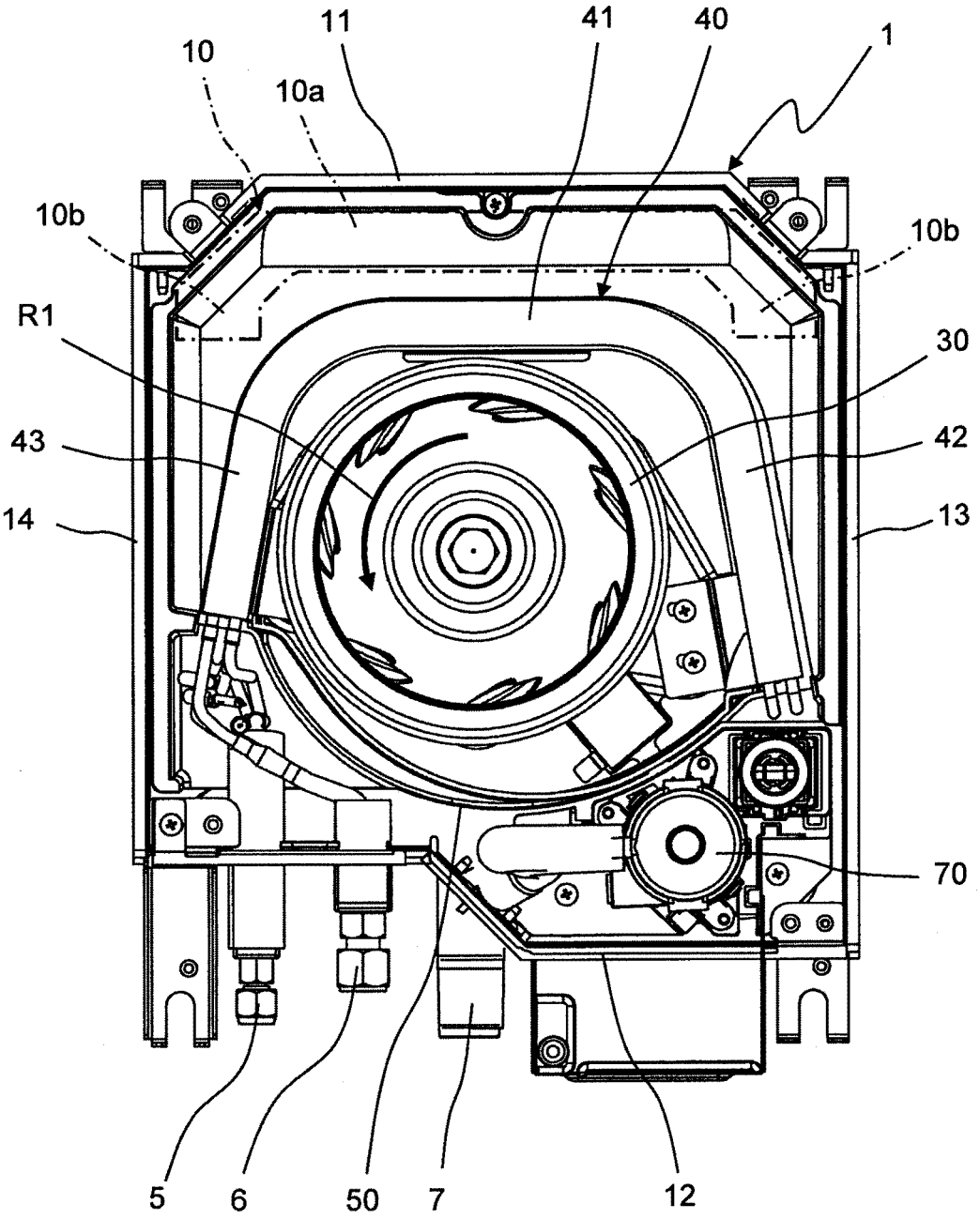


Fig.6

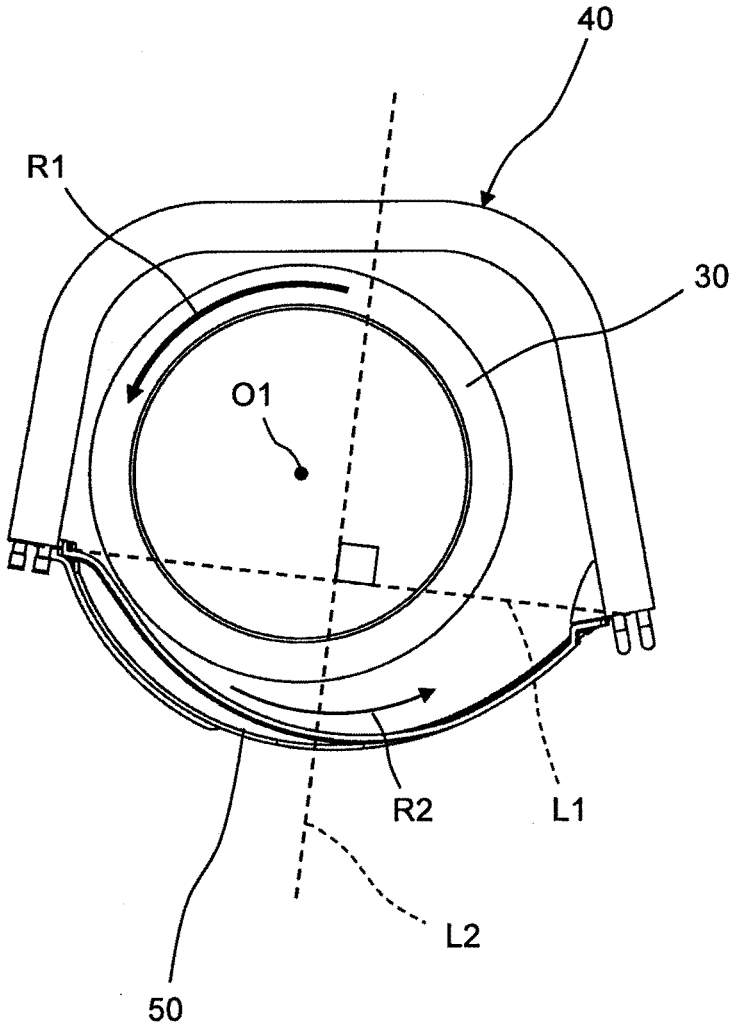


Fig.7

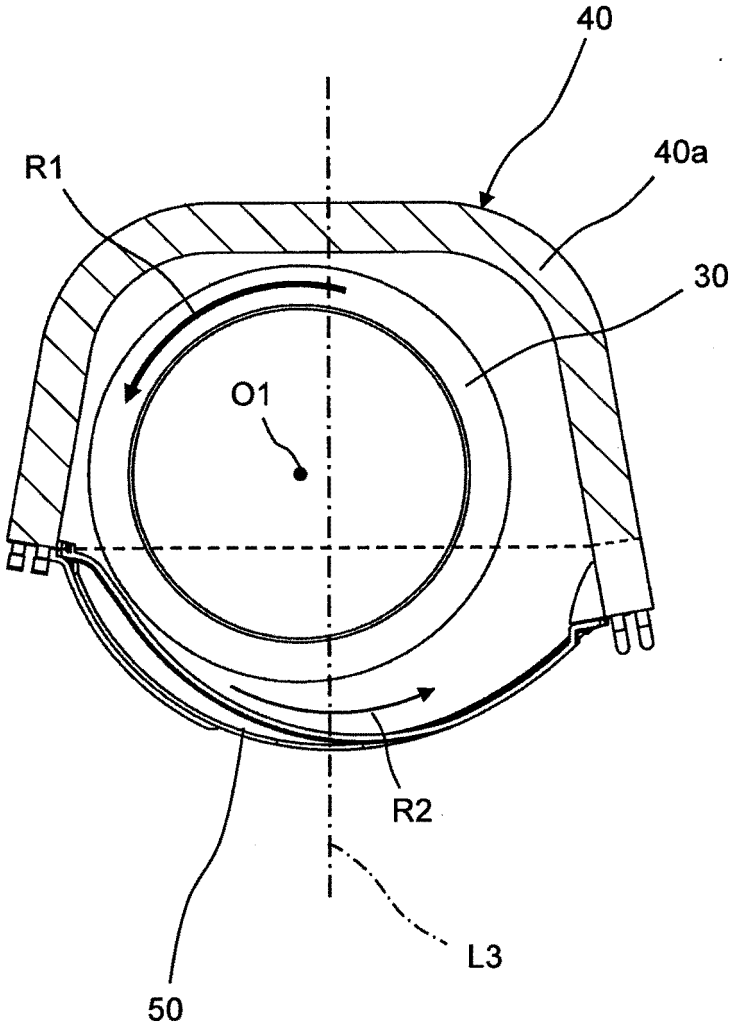


Fig.8

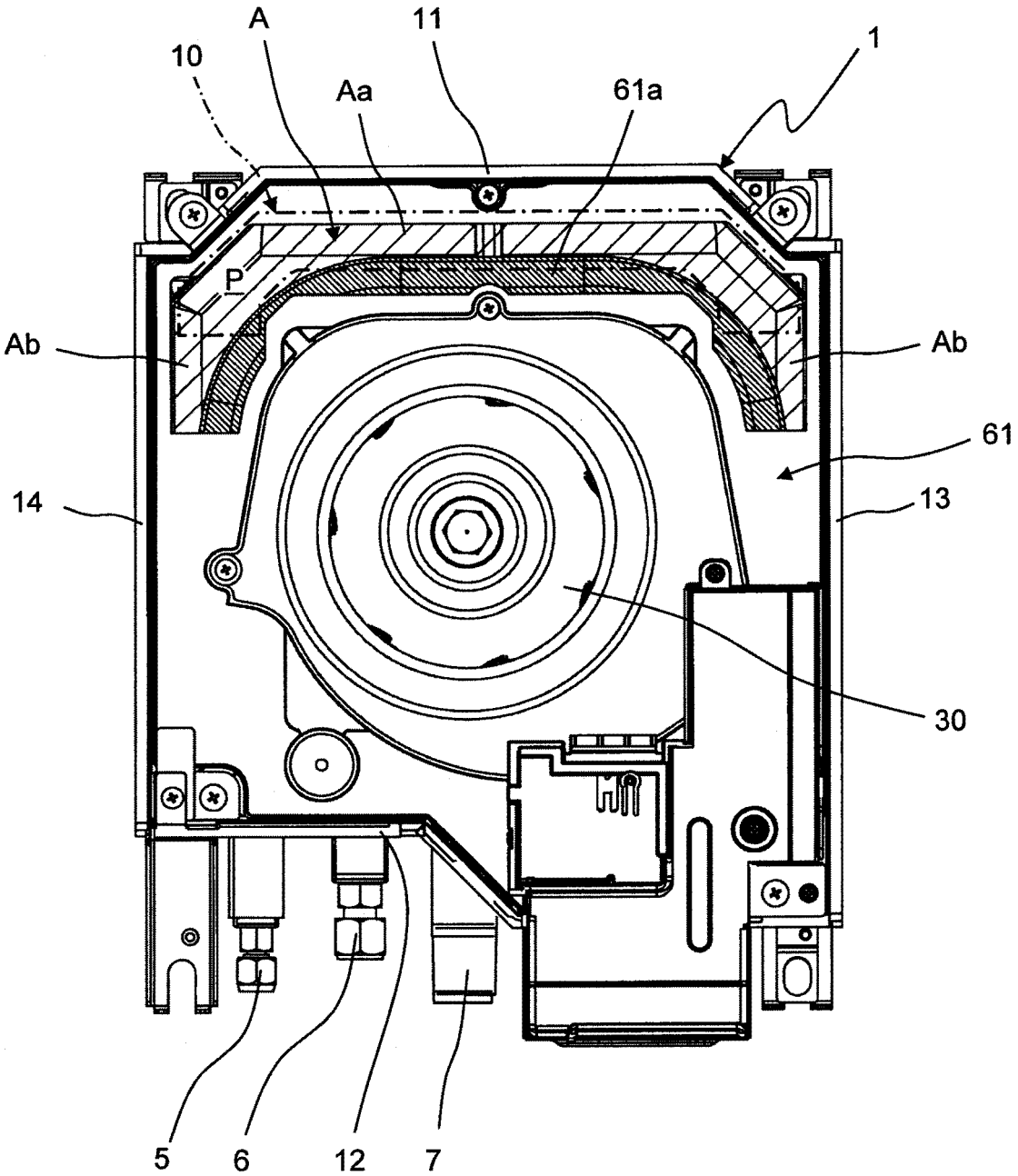


Fig.9

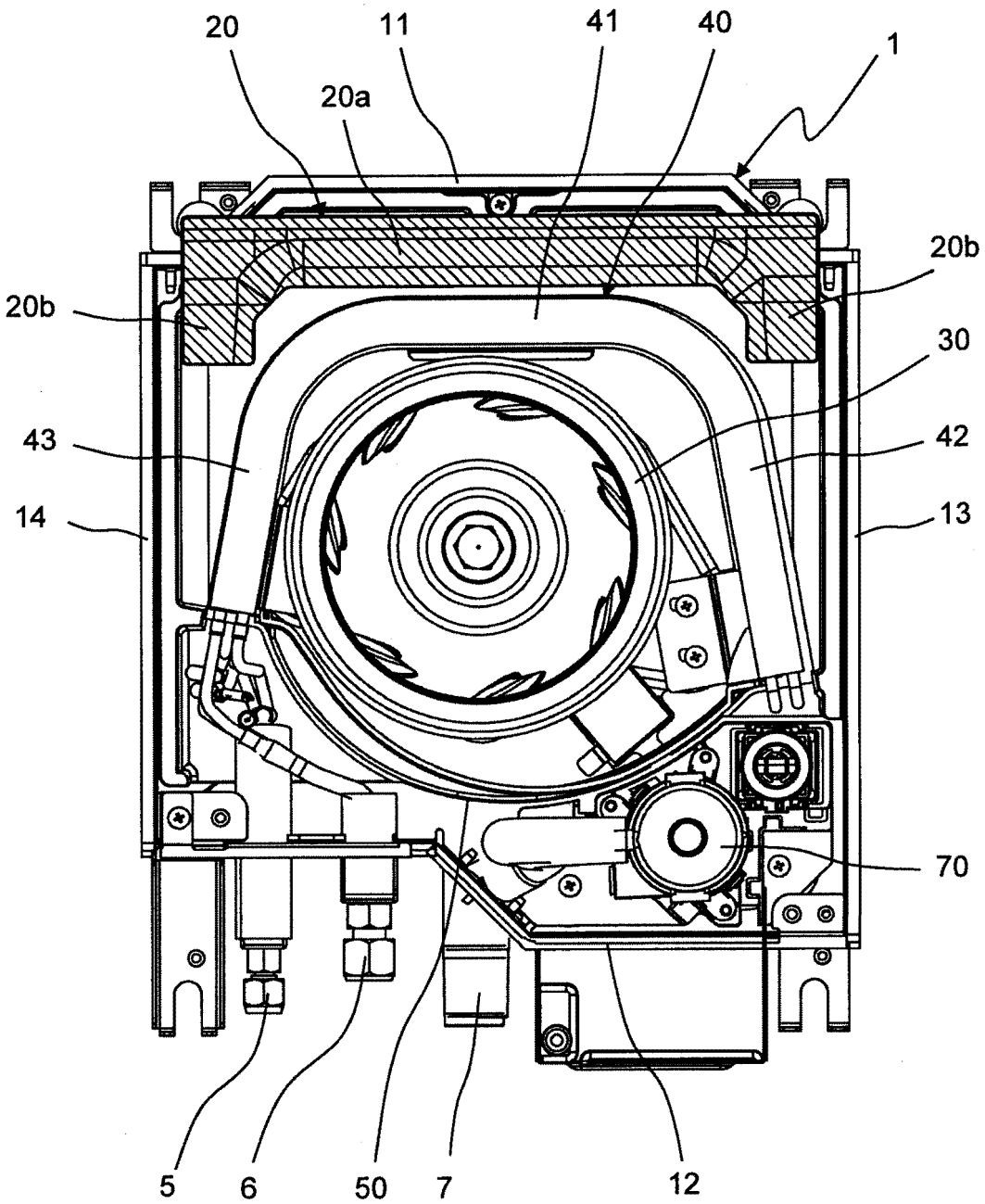


Fig.10

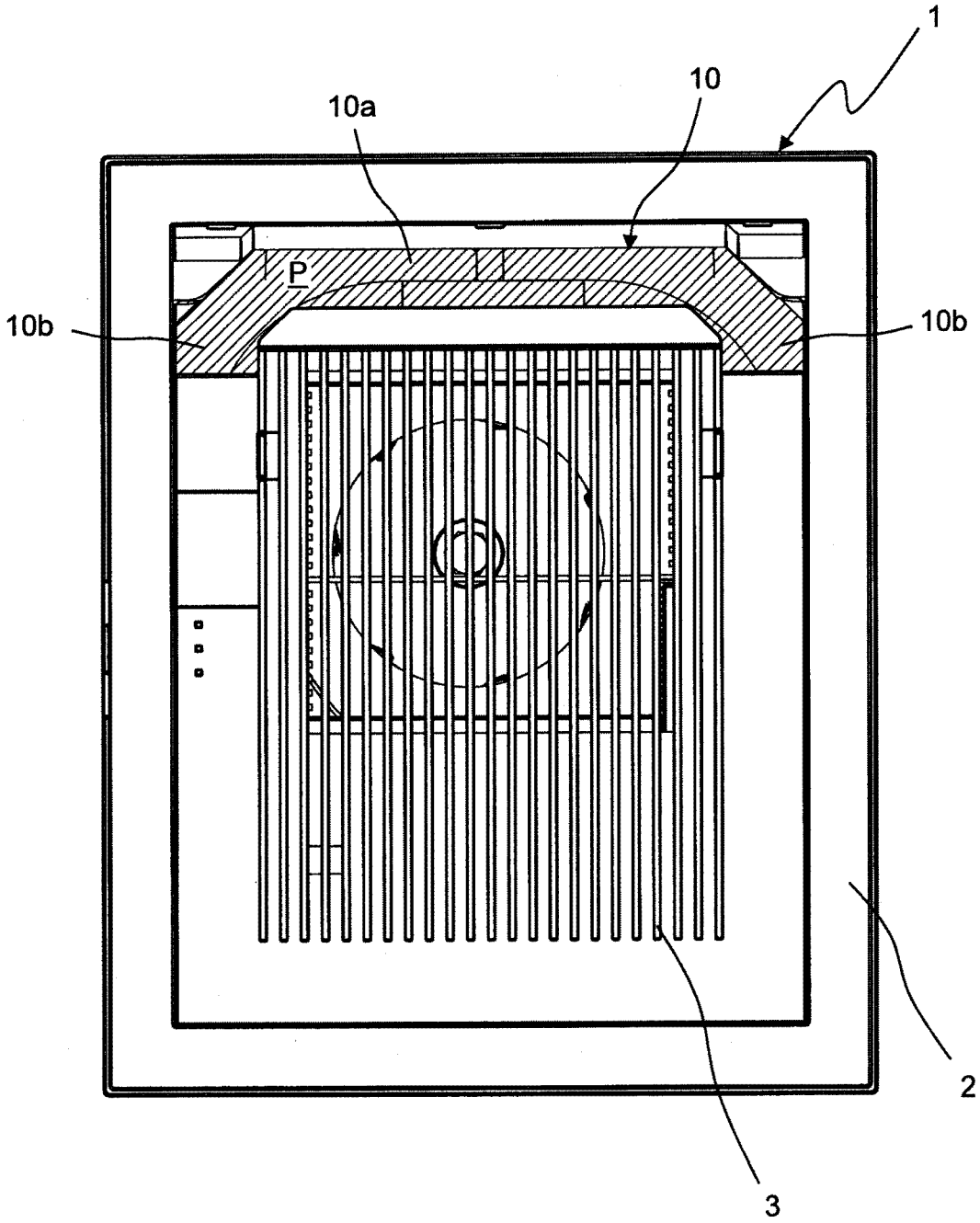


Fig.11

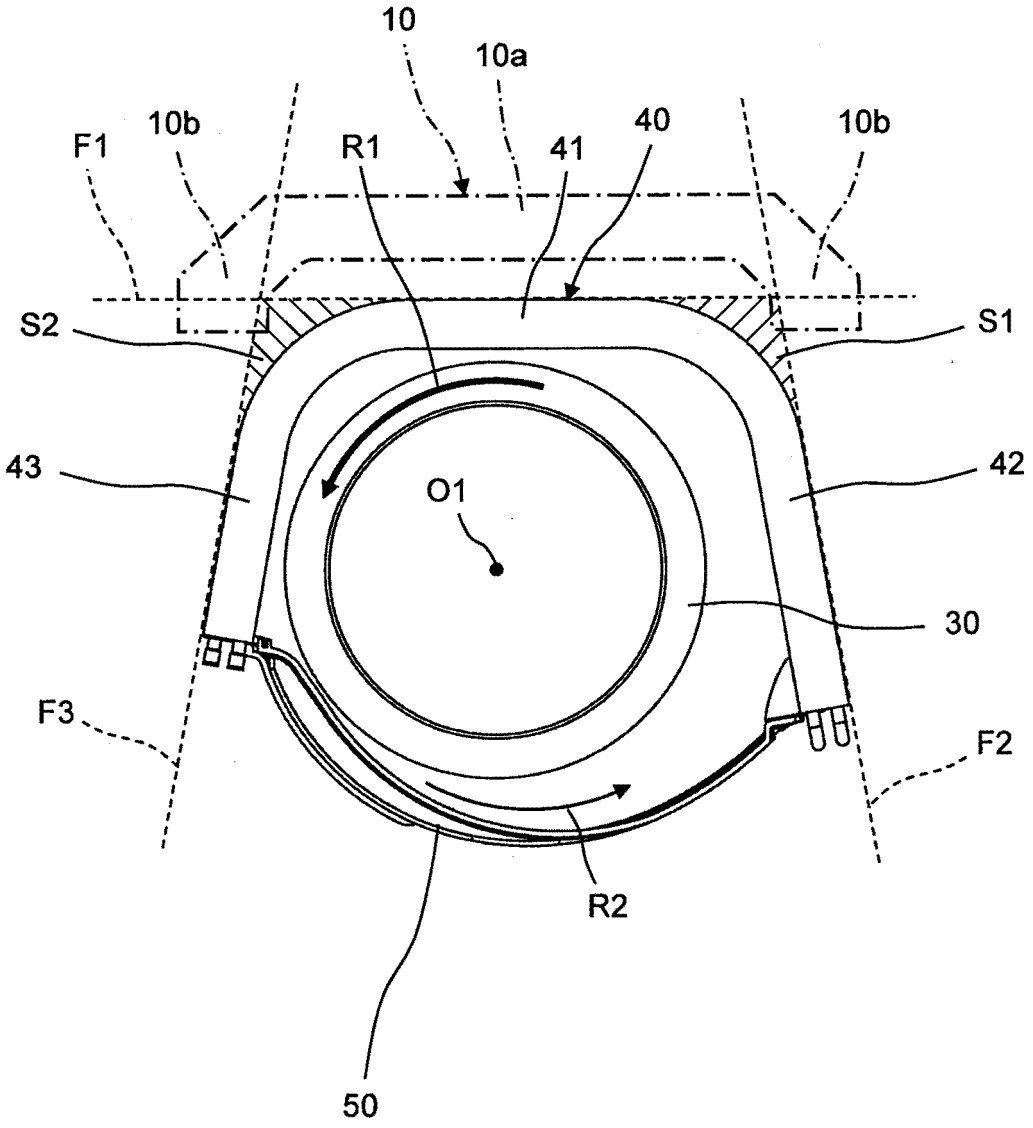


Fig.12

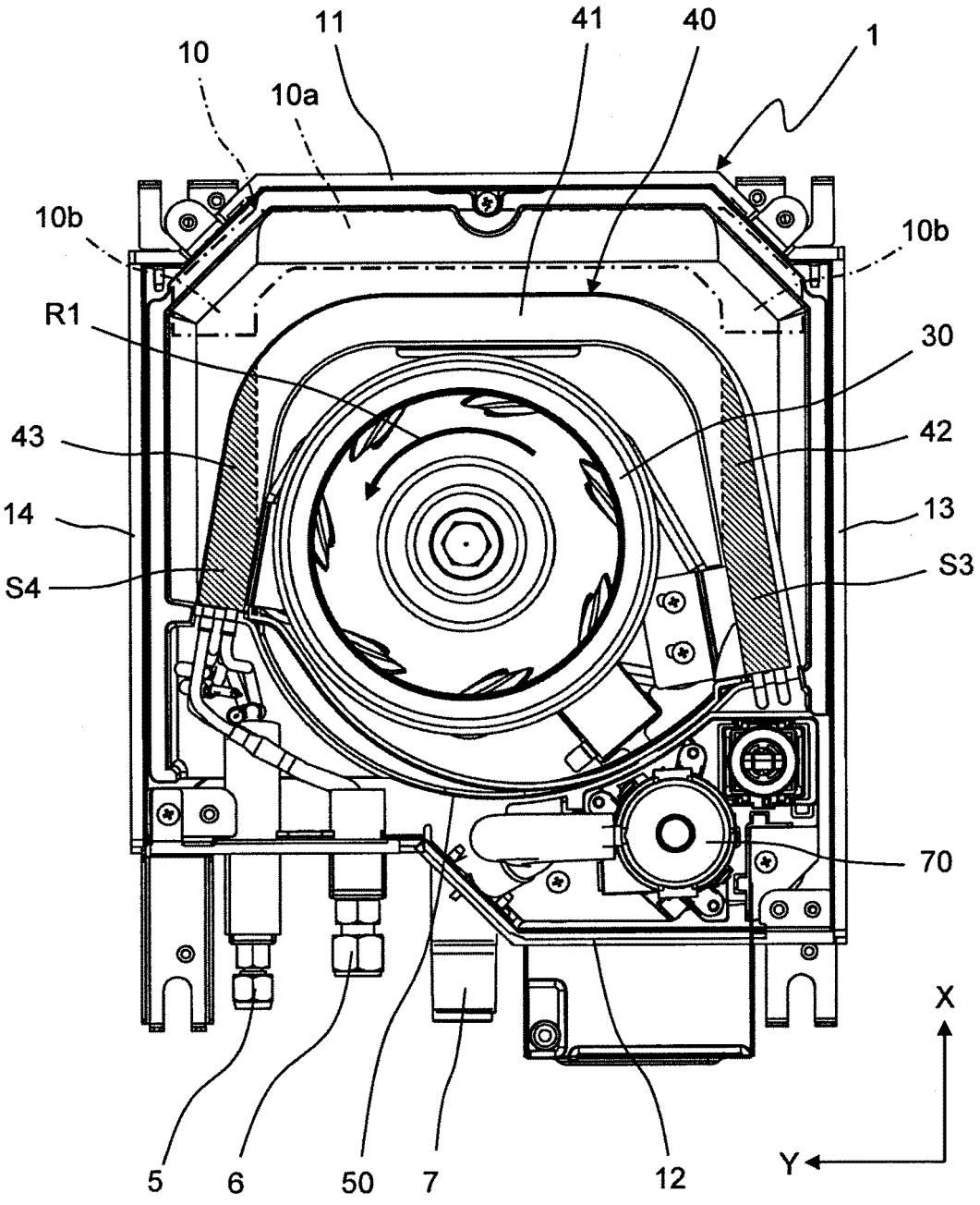


Fig.13

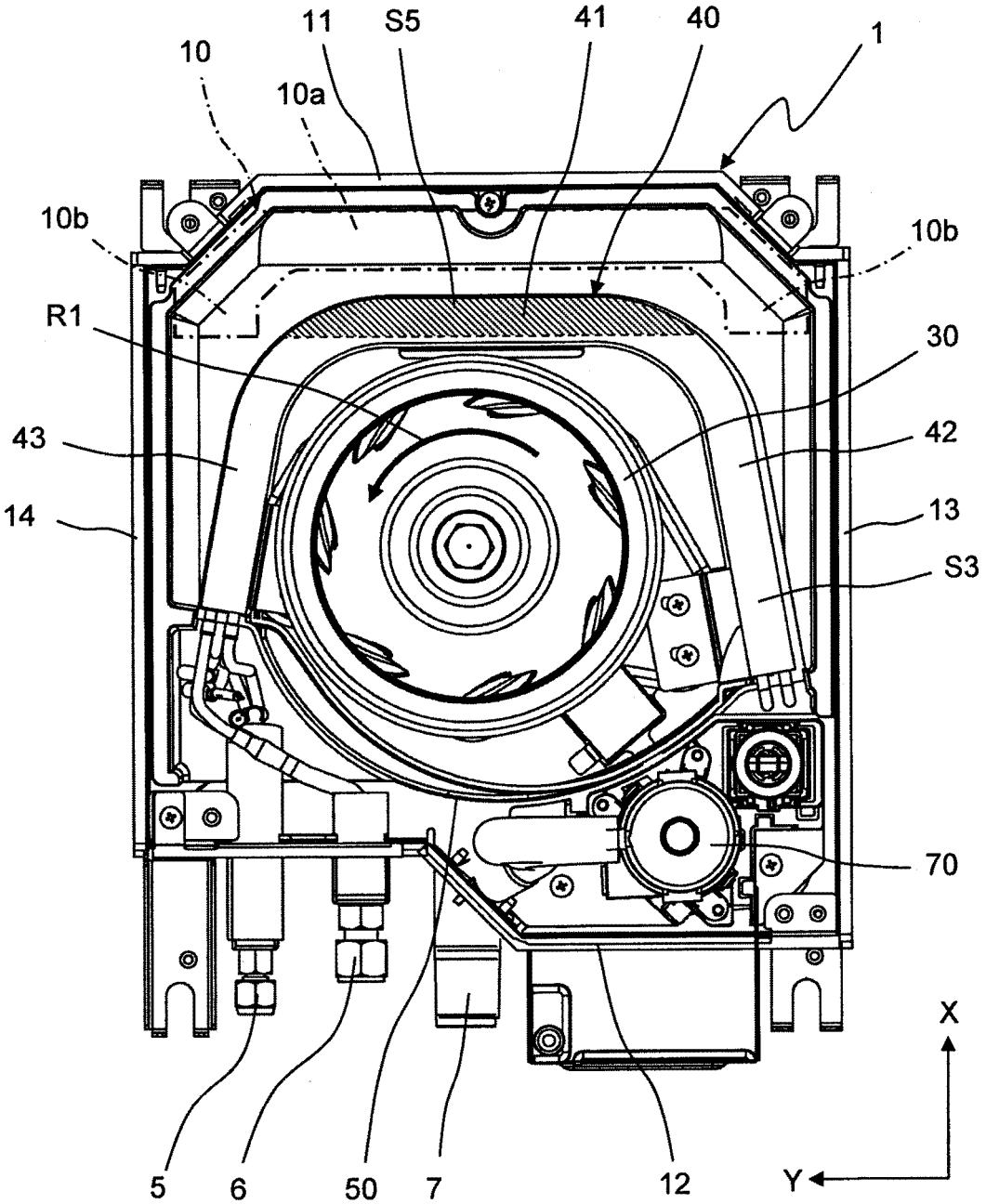


Fig.14

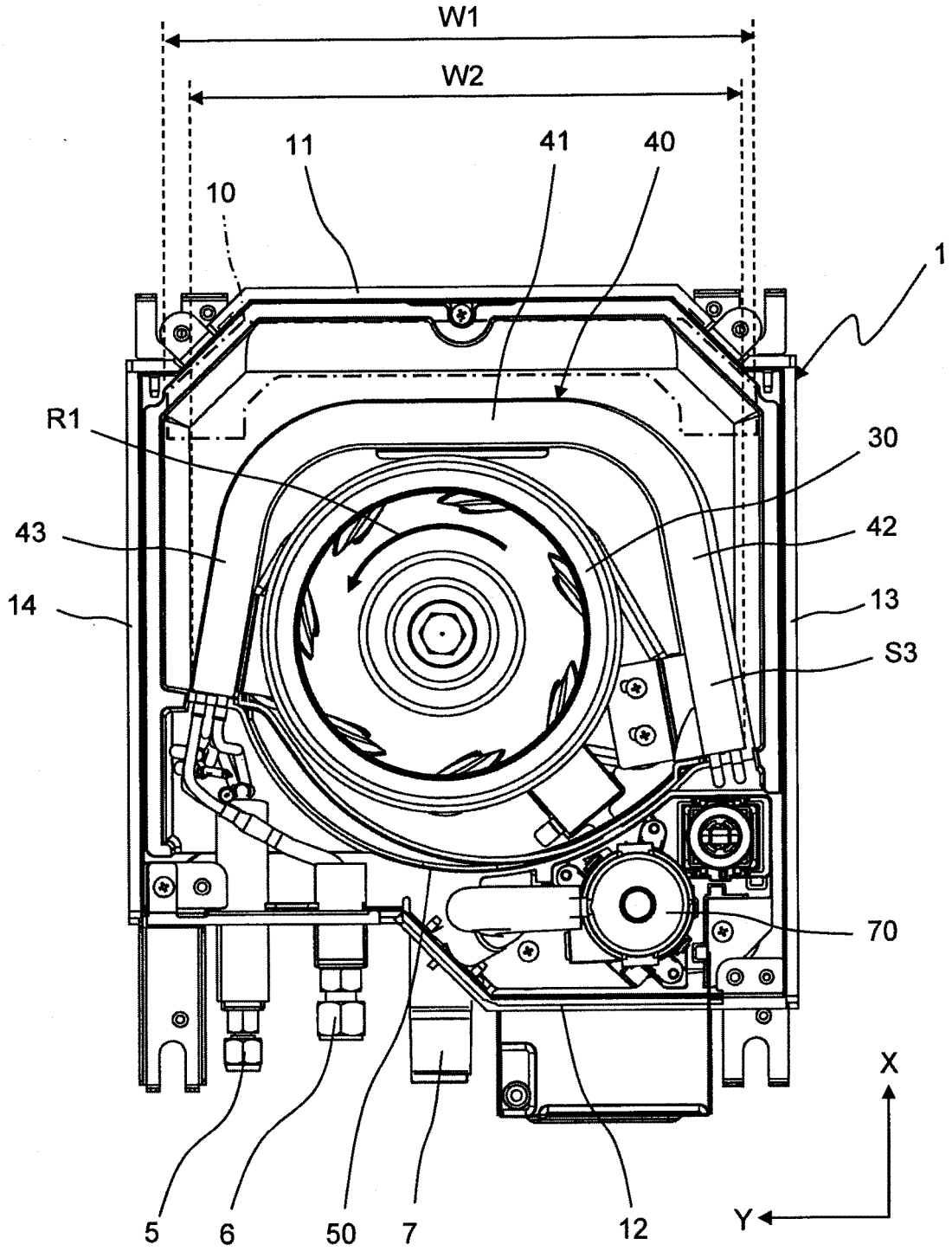
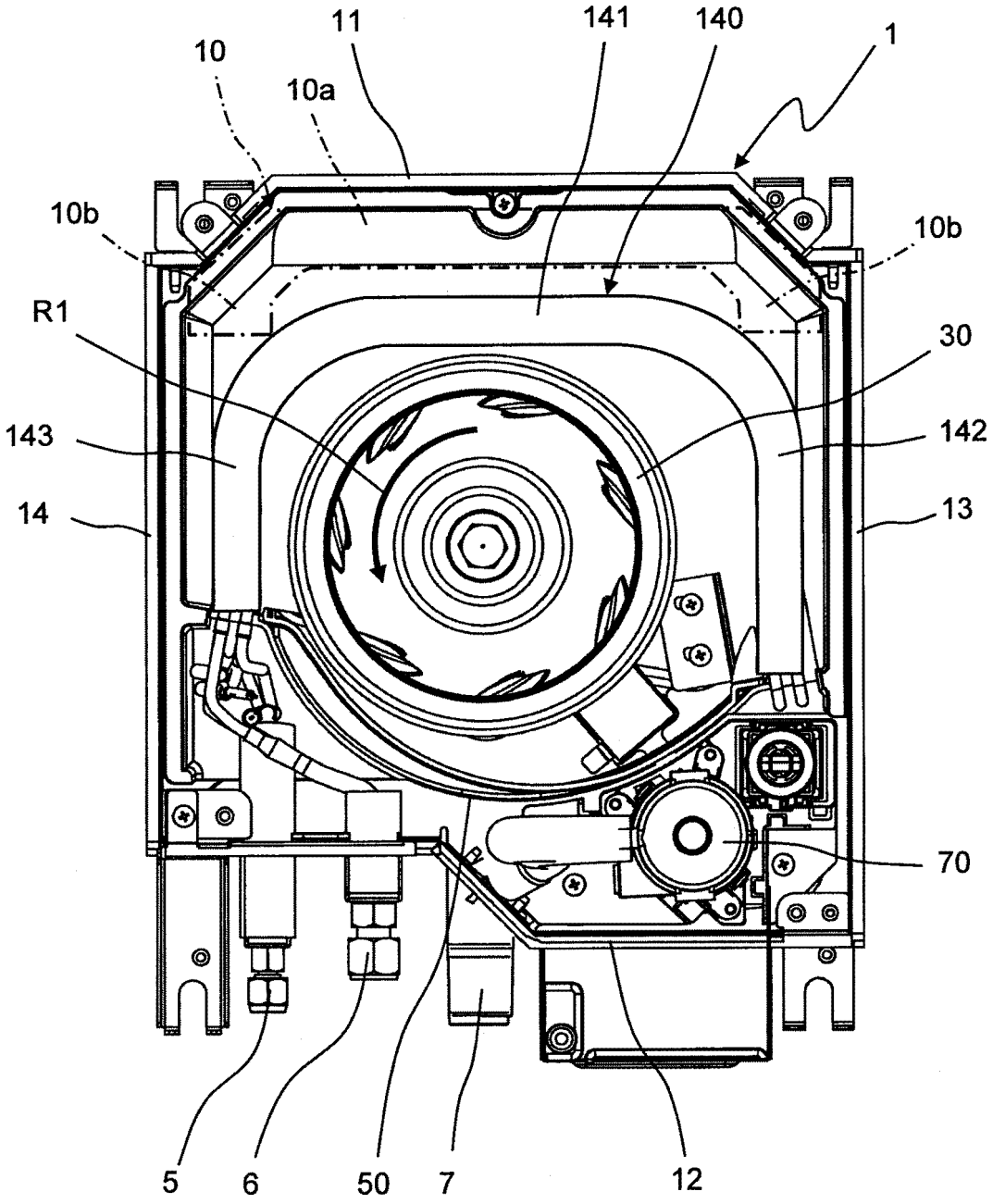


Fig.15



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/014254

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F24F1/00(2011.01)i, F24F13/22(2006.01)i, F24F13/30(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)
Int.Cl. F24F1/00, F24F13/22, F24F13/30

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 36456/1988 (Laid-open No. 140422/1989) (DAIKIN INDUSTRIES, LTD.) 26 September 1989, specification, page 5, line 16 to page 10, line 17, fig. 1-4 (Family: none)	1-2 3-7, 9-11 8
Y	JP 2011-99609 A (DAIKIN INDUSTRIES, LTD.) 19 May 2011, paragraphs [0024]-[0054], fig. 1-6 (Family: none)	3-7, 9-11

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

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25.06.2018	03.07.2018
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/014254

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2000-220859 A (HITACHI, LTD.) 08 August 2000, paragraphs [0026]-[0034], fig. 1-4 (Family: none)	4, 6-7, 9-11

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2002349890 A **[0002] [0003]**