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(54) **CROSS-FLOW FAN**

(57) To reinforce the strength of a cross-flow fan while controlling an increase in flow path loss caused by a reinforcement member of the cross-flow fan such as a support plate. Plural blades (40) extend in a lengthwise direction from a support plate (50). An auxiliary ring (60) is positioned on a lengthwise direction intermediate section of the plural blades (40) and is combined with outer ends (40a) of the plural blades (40). The auxiliary ring (60) is located in a position away from blade base portions (40c) on the support plate side of the blades (40) by a distance equal to or greater than 55% of the long dimension from the blade base portions (40c) to blade distal end portions (40d).

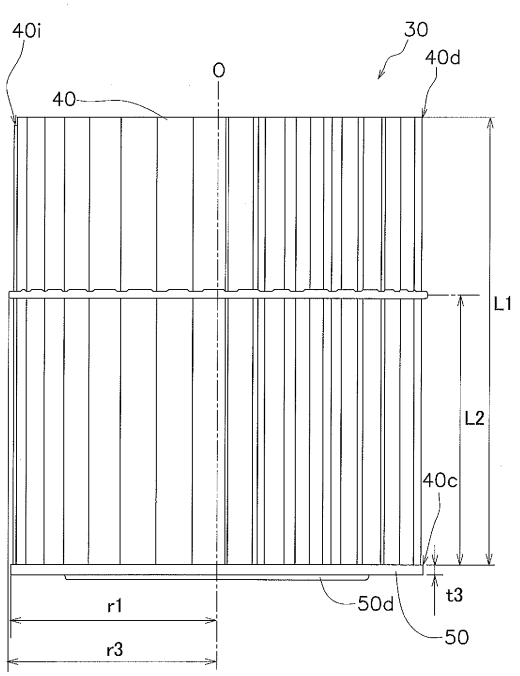

FIG. 6

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Description

TECHNICAL FIELD

[0001] The present invention relates to a cross-flow fan and particularly a cross-flow fan equipped with blades made of resin.

BACKGROUND ART

[0002] Cross-flow fans used, for example, in indoor units of air conditioners have two disc-shaped or circular annular support plates that are disposed on both lengthwise direction ends and plural blades that extend in the lengthwise direction and are disposed between the two support plates. Additionally, there are cases where, as described in patent document 1 (Japanese Patent Unexamined Publication No. H05-87086), for example, a disc-shaped or circular annular intermediate plate is disposed between both support plates in order to reinforce the strength of the plural blades.

SUMMARY OF THE INVENTION

<Technical Problem>

[0003] In this connection, it is described in patent document 1 that, when many support plates are disposed, flow path loss increases because air friction loss ends up occurring due to the plural support plates. However, if the number of support plates is reduced in order to reduce flow path loss caused by the support plates, the strength of the cross-flow fan ends up being reduced.

[0004] It is an object of the present invention to reinforce the strength of a cross-flow fan while controlling an increase in flow path loss caused by a reinforcement member of the cross-flow fan such as a support plate.

<Solution to Problem>

[0005] A cross-flow fan pertaining to a first aspect of the present invention comprises: a disc-shaped or circular annular support plate; plural blades extending in a lengthwise direction from the support plate; and an auxiliary ring that is positioned on a lengthwise direction intermediate section of the plural blades and is combined with outer ends of the plural blades, wherein the auxiliary ring is located in a position away from a blade base portion on the support plate side of the blades by a distance equal to or greater than 55% of the long dimension from the blade base portions to a blade distal end portion.

[0006] According to the cross-flow fan pertaining to the first aspect, the auxiliary ring is away from the blade base portions by a distance equal to or greater than 55% of the long dimension from the blade base portion to the blade distal end portion, so the strength of the cross-flow fan is improved; in addition, the auxiliary ring is combined with the outer ends of the plural blades, so flow path loss can be suppressed compared to a conventional support plate that supports the blades from their outer ends to their inner ends.

[0007] A cross-flow fan pertaining to a second aspect of the present invention is the cross-flow fan pertaining to the first aspect, wherein the auxiliary ring is molded integrally with the plural blades.

[0008] According to the cross-flow fan pertaining to the second aspect, by molding the auxiliary ring integrally with the plural blades, assembly of the auxiliary ring and the plural blades becomes unnecessary, so that, for example, work for coupling the auxiliary ring to the outer ends of the plural blades can be saved.

[0009] A cross-flow fan pertaining to a third aspect of the present invention is the cross-flow fan of the second aspect, wherein the support plate includes plural support plates, the auxiliary ring includes plural auxiliary rings, a fan block formed by integrally molding one of the support plates, one of the auxiliary rings, and the plural blades is plurally formed, and the support plate of at least one of the fan blocks fixedly is attached to the plural blades of another of the fan blocks.

[0010] According to the cross-flow fan pertaining to the third aspect, the plural blades are combined by the auxiliary ring that is away from the blade base portions by a distance equal to or greater than 55% of the long dimension from the blade base portion to the blade distal end portion, so it becomes easier to fixedly attach the support plate of one fan block to the plural blades of another fan block. Furthermore, because the fixed attachment of the blades becomes easier because of the auxiliary ring, the blades of each fan block can be lengthened.

[0011] A cross-flow fan pertaining to a fourth aspect of the present invention is the cross-flow fan of any of the first aspect to the third aspect, wherein the thickness of the auxiliary ring becomes thinner heading from the inner peripheral side toward the outer peripheral side.

[0012] According to the cross-flow fan pertaining to the fourth aspect, the thickness becomes thinner heading toward the outer peripheral side, so loss caused by air flow at the auxiliary ring can be reduced.

[0013] A cross-flow fan pertaining to a fifth aspect of the present invention is the cross-flow fan of the fourth aspect, wherein the inclination of the auxiliary ring heading from the outer peripheral side toward the inner peripheral side is greater on a first surface on the side of the blade distal end portion than on a second surface on the side of the support plate.

[0014] According to the cross-flow fan pertaining to the fifth aspect, the inclination heading from the outer peripheral side toward the inner peripheral side is greater on the first surface on the side of the blade distal end portion than on the second surface on the side of the support plate, so integral molding becomes easy.

[0015] A cross-flow fan pertaining to a sixth aspect of the present invention is the cross-flow fan of any of the first aspect to the fifth aspect, wherein the plural blades are disposed in such a way that their outer ends are po-

sitioned concentrically, and the auxiliary ring has a circular annular shape where its outer periphery runs along the outside of the outer ends of the plural blades.

[0016] According to the cross-flow fan pertaining to the sixth aspect, the outer periphery of the auxiliary ring runs along the outside of the outer ends of the blades, so the outer periphery of the auxiliary ring is continuous without being interrupted by the outer ends of the blades, and thus the strength of the auxiliary ring can be increased.

[0017] A cross-flow fan pertaining to a seventh aspect of the present invention is the cross-flow fan of any of the first aspect to the sixth aspect, wherein the auxiliary ring has a circular annular shape and has an outer radius equal to an outer radius of the support plate or larger than the outer radius of the support plate.

[0018] According to the cross-flow fan pertaining to the seventh aspect, the outer radius of the auxiliary ring is equal to or larger than the outer radius of the support plate, so the interval between the outer periphery of the auxiliary ring and the outer ends of the blades can be increased so that the strength of the auxiliary ring can be increased.

[0019] A cross-flow fan pertaining to an eighth aspect of the present invention is the cross-flow fan of any of the first aspect to the seventh aspect, wherein the auxiliary ring has a main body portion having a circular annular shape and a balancer portion that is molded integrally with the main body portion and partially increases the weight of the auxiliary ring in order to balance rotation.

[0020] According to the cross-flow fan pertaining to the eighth aspect, the balancer portion of the cross-flow fan is molded integrally with the main body portion of the auxiliary ring, so assembly man-hours pertaining to the balancer portion can be saved.

[0021] A cross-flow fan pertaining to a ninth aspect of the present invention is the cross-flow fan of the eighth aspect, wherein the balancer portion of the auxiliary ring is a raised portion disposed on the inner peripheral side of the main body portion.

[0022] According to the cross-flow fan pertaining to the ninth aspect, the balancer portion of the cross-flow fan is disposed on the inner peripheral side of the main body portion, so a drop in performance pertaining to the blowing of the cross-flow fan caused by disposing the balancer portion can be suppressed.

[0023] A cross-flow fan pertaining to a tenth aspect of the present invention is the cross-flow fan of the eighth aspect, wherein the balancer portion of the auxiliary ring is a raised portion disposed in the thickness direction of the main body portion.

[0024] According to the cross-flow fan pertaining to the tenth aspect, the balancer portion of the cross-flow fan is disposed in the thickness direction of the main body portion, so the balancer portion can be disposed in such a way that air resistance does not increase, and a drop in performance pertaining to the blowing of the cross-flow fan caused by disposing the balancer portion can be suppressed.

<Advantageous Effects of Invention>

[0025] In the cross-flow fan pertaining to the first aspect of the present invention, because of the auxiliary ring, the strength of the cross-flow fan can be reinforced while suppressing an increase in flow path loss.

[0026] In the cross-flow fan pertaining to the second aspect of the present invention, assembly of the auxiliary ring and the plural blades becomes unnecessary and costs can be reduced.

[0027] In the cross-flow fan pertaining to the third aspect of the present invention, the number of fan blocks can be reduced so that manufacturing costs can be reduced.

[0028] In the cross-flow fan pertaining to the fourth aspect of the present invention, loss caused by air flow can be reduced so that blowing characteristics can be improved.

[0029] In the cross-flow fan pertaining to the fifth aspect of the present invention, yield is improved because integral molding becomes easy, and the cross-flow fan can be inexpensively provided.

[0030] In the cross-flow fan pertaining to the sixth aspect of the present invention, the strength of the auxiliary ring can be increased so that the effect of reinforcing the strength of the cross-flow fan can be improved.

[0031] In the cross-flow fan pertaining to the seventh aspect of the present invention, the strength of the auxiliary ring can be increased so that the effect of reinforcing the strength of the cross-flow fan can be improved.

[0032] In the cross-flow fan pertaining to the eighth aspect of the present invention, the cross-flow fan in which rotational wobble is reduced by the balancer portion can be inexpensively provided.

[0033] In the cross-flow fan pertaining to the ninth aspect of the present invention, rotational wobble can be reduced while suppressing a drop in performance pertaining to blowing caused by disposing the balancer portion.

[0034] In the cross-flow fan pertaining to the tenth aspect of the present invention, rotational wobble can be reduced while suppressing a drop in performance pertaining to blowing caused by disposing the balancer portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035]

FIG. 1 is a cross-sectional view showing an overview of an indoor unit of an air conditioning apparatus;
FIG. 2 is a perspective view showing an overview of an impeller of a cross-flow fan pertaining to an embodiment;
FIG. 3 is a perspective view for describing a step in the assembly of the impeller of the cross-flow fan;
FIG. 4 is a plan view showing an example of the configuration of an end plate of the impeller;

FIG. 5 is a perspective view showing an example of the configuration of a fan block of the impeller;
FIG. 6 is a side view showing an example of the configuration of the fan block of the impeller;
FIG. 7 is a plan view showing an example of the configuration of a support plate of the fan block;
FIG. 8 is a cross-sectional view showing an example of the configuration of an auxiliary ring of the fan block;
FIG. 9 is a partially enlarged plan view for describing the configuration of the fan block shown in FIG. 5;
FIG. 10 is a partially enlarged side view for describing the configuration of the fan block shown in FIG. 6; and
FIG. 11 is a perspective view showing the configuration of another fan block contrasted with the fan block of FIG. 5.
FIG. 12 is a partially enlarged plan view for describing an example modification of the configuration of the fan block; and
FIG. 13 is a partially enlarged side view for describing an example modification of the configuration of the fan block.

DESCRIPTION OF EMBODIMENT

[0036] A cross-flow fan pertaining to an embodiment of the present invention will be described below taking as an example a cross-flow fan installed in an indoor unit of an air conditioning apparatus.

(1) Cross-flow Fan in Indoor Unit

[0037] FIG. 1 is a drawing showing an overview of a cross section of an indoor unit 1 of an air conditioning apparatus. The indoor unit 1 is equipped with a main body casing 2, an air filter 3, an indoor heat exchanger 4, a cross-flow fan 10, vertical flaps 5, and a horizontal flap 6. As shown in FIG. 1, the air filter 3 is disposed on the downstream of an air inlet 2a in the top surface of the main body casing 2 and opposes the air inlet 2a. The indoor heat exchanger 4 is disposed on the downstream of the air filter 3. Room air that passes through the air inlet 2a and reaches the indoor heat exchanger 4 all passes through the air filter 3 and has dirt and dust removed from it.

[0038] The indoor heat exchanger 4 is configured as a result of a front surface side heat exchanger 4a and a back surface side heat exchanger 4b being coupled to one another so as to form an inverted V shape as seen in a side view. In a plan view seen from the top surface of the main body casing 2, the front surface side heat exchanger 4a is disposed in a position opposing substantially the front surface side half of the air inlet 2a, and the back surface side heat exchanger 4b is disposed in a position opposing substantially the back surface side half. Both the front surface side heat exchanger 4a and the back surface side heat exchanger 4b are configured by arranging numerous plate fins parallel to one another in the width direction of the indoor unit 1 and attaching them to heat transfer tubes. When the room air that has been sucked in from the air inlet 2a and passed through the air filter 3 travels between the plate fins of the front surface side heat exchanger 4a and the back surface side heat exchanger 4b, heat exchange takes place and air conditioning is performed.

[0039] On the downstream of the indoor heat exchanger 4, the substantially cylindrically shaped cross-flow fan 10 extends long along the width direction of the main body casing 2 and is disposed parallel to the width direction of the main body casing 2 together with the indoor heat exchanger 4. The cross-flow fan 10 is equipped with an impeller 20, which is disposed in a space surrounded so as to be sandwiched by the inverted V-shaped indoor heat exchanger 4, and a fan motor (not shown in the drawings) for driving the impeller 20. The cross-flow fan 10 generates an air flow as a result of the impeller 20 being rotated in direction A1 (clockwise) indicated by the arrow in FIG. 1.

[0040] An outlet passage leading to an air outlet 2b downstream of the cross-flow fan 10 has a back surface side configured by a scroll member 2c. The scroll member 2c has substantially the same width as the open portion of the air outlet 2b in the main body casing 2 as seen in a front view. The upper end of the scroll member 2c is positioned higher than the upper end of the cross-flow fan 10 and, as seen in a side view, is positioned in a location offset toward the back surface side of the central axis of the cylindrical cross-flow fan 10. The lower end of the scroll member 2c is coupled to the open end of the air outlet 2b. A guide surface of the scroll member 2c has, in order to smoothly and quietly guide to the air outlet 2b the air blown out from the cross-flow fan 10, a smoothly curvilinear shape having a centre of curvature on the side of the cross-flow fan 10 as seen in a cross-sectional view.

(2) Schematic Structure of Impeller of Cross-flow Fan

[0041] FIG. 2 shows the schematic structure of the impeller 20 of the cross-flow fan 10. The impeller 20 is, for example, configured as a result of an end plate 21 and four fan blocks 30 being joined to one another. The end plate 21 is disposed on one end of the impeller 20 and one of the four fan blocks 30 is disposed on the other end. The end plate 21 has a rotary shaft 22 made of metal on an axial centre O. Additionally, ordinarily a boss portion (not shown in the drawings) that becomes connected to a fan motor shaft (not shown in the drawings) is disposed in the central portion of the fan block 30 disposed on the other end of the impeller 20. Alternatively, there are also cases where the fan block 30 disposed on the other end of the impeller 20 has another configuration, such as, for example, that fan block 30 being configured so as to have a member that combines with part of the fan motor and so as to have a metal shaft in its central portion. The rotary shaft 22 of the end plate 21 and the

boss portion (or metal shaft) of the fan block 30 on the other end of the impeller 20 are supported so that the impeller 20 rotates about the axial centre O. For the end plate 21, one that is the same as what has conventionally been used is used. However, in order to apply the present invention, it is not necessary for the structure of the end plate 21 to be one that is the same as what has conventionally been used, and the structure of the end plate 21 can be appropriately changed.

[0042] Each fan block 30 is equipped with plural blades 40, a circular annular support plate 50, and an auxiliary ring 60. In the assembly of the impeller 20, the plural blades 40 of one fan block 30 are fused to the support plate 50 of an adjacent fan block 30 or the end plate 21. FIG. 3 shows a step in which two mutually adjacent fan blocks 30 are fused to one another. The two fan blocks 30 are set on top of one another on a jig 103. The fan blocks 30 placed on top of one another are sandwiched by the jig 103 and a horn 102. Ultrasonic waves are supplied to the horn 102 from an oscillator 101, and the supplied ultrasonic waves travel through the horn 102 and are applied to the fan blocks 30. Because of that, the blades 40 of one fan block 30 and the support plate 50 of the other fan block 30 are fused to one another by the ultrasonic waves. In the same way, a fan block 30 and the end plate 21 are sandwiched between another jig and the horn 102 and ultrasonic waves are supplied by the oscillator 101 to the horn 102, so that the blades 40 of the fan block 30 and the end plate 21 are fused to one another. As shown in FIG. 4, a number of recessed portions 23 equal to the number of the blades 40 are formed in the end plate 21 in order to position the blades 40 on the end plate 21 during this fusing. The recessed portions 23 each have a planar shape slightly larger than the cross-sectional shape of the blades 40, so the blades 40 fit into and are fitted together with the recessed portions 23. Among the plural recessed portions 23, there is just one recessed portion 23 in which a step portion 23a is formed in order to position the end plate 21 and the fan block 30.

(3) Detailed Configuration of Fan Block

[0043] FIG. 5 to FIG. 10 show the detailed configuration of the fan blocks 30 pertaining to the present embodiment. FIG. 5 is a perspective view showing one of the plural fan blocks 30 configuring the impeller 20 shown in FIG. 2, and FIG. 6 is a side view of that fan block 30. The fan block 30 shown in FIG. 5 and FIG. 6 comprises plural blades 40, a support plate 50, and an auxiliary ring 60 that are integrally molded by injection molding, for example, using a thermoplastic resin as their main material. The rotational direction of the fan block 30 is direction A1 indicated by the arrow in FIG. 5.

(3-1) Blades

[0044] The plural blades 40 extend in the lengthwise direction (the direction along the axial centre O) from a first surface 50a of the circular annular support plate 50. The blades 40 are molded integrally with the support plate 50, and thus blade base portions 40c are fixed to the first surface 50a of the support plate 50 and the sides of the blades 40 opposite the blade base portions 40c in the lengthwise direction become blade distal end portions 40d. A length L1 of the blades 40 (the long dimension from the blade base portions 40c to the blade distal end portions 40d) is, for example, about 10 cm. The blades 40 have suction surfaces 40f and pressure surfaces 40e. When the fan block 30 rotates in direction A1 indicated by the arrow in FIG. 5, the pressure on the side of the pressure surfaces 40e of the blades 40 becomes higher and the pressure on the side of the suction surfaces 40f becomes lower.

[0045] Among the plural blades 40, there is just one blade 40 having a cutaway portion 40i formed in the blade distal end portion 40d. The cutaway portion 40i is for positioning two fan blocks 30 or a fan block 30 and the end plate 21, and is a section that fits together with the step portion 23a of the recessed portion 23 of the end plate 21 described above or a step portion 51c of a recessed portion 51 of the fan block 30 described later. Because there is the cutaway portion 40i, the blades 40 and the recessed portions 23 of the end plate 21 or the recessed portions 51 of the fan block 30 can be made to have a one-to-one correspondence with one another in this way. When this positioning is done, the plural blades 40 can be made to correspond by group to plural split molds of a mold at the time of injection molding and the blades 40 can be disposed in such a way that they are easily removed from the split molds. Specifically, the plural blades 40 are disposed in a shape having asymmetry in which the inclination of the blades 40 is changed in the direction in which the blades 40 are removed from the split molds to make them easier to remove compared to a case where the plural blades 40 are disposed so as to have rotational symmetry relative to the axial centre O.

(3-2) Support Plate

[0046] FIG. 7 shows a state in which the circular annular support plate 50 is seen from its bottom surface, that is, a state in which the circular annular support plate 50 is seen from the side of a second surface 50b. Recessed portions 51 into which the blades 40 fit are formed in the second surface 50b, which is opposite the first surface 50a of the support plate 50. The recessed portions 51 each have a planar shape slightly larger than the cross-sectional shape of the blades 40, so when two fan blocks 30 are placed on top of one another, the blades 40 fit into and are fitted together with the recessed portions 51. A ring-shaped raised portion 52 higher than the second surface 50b is formed along the inner periphery of the support plate 50. The outer peripheral side of the raised portion 52 is slanted off of the horizontal plane, and the raised portion 52 fulfills the role of guiding the

blades 40 to the recessed portions 51 when two fan blocks 30 are placed on top of one another.

[0047] An outer periphery 51 a of the recessed portions 51 that outer ends 40a of the blades 40 touch is located on the inside of an outer periphery 50c of the support plate 50, and inner ends 51 b of the recessed portions 51 that inner ends 40b of the blades 40 touch are located on the outside of an inner periphery 50d of the support plate 50. In other words, a distance d1 from the centre (a point on the axial centre O) of the support plate 50 to the outer periphery 51 a of the recessed portions 51 (the distance to the outer ends 40a of the blades 40) is smaller than a radius r1 from the centre of the support plate 50 to the outer periphery 50c. Furthermore, a distance d2 from the centre (a point on the axial centre O) of the support plate 50 to the inner ends 51 b of the recessed portions 51 (the distance to the inner ends 40b of the blades 40) is larger than a radius r2 from the centre of the support plate 50 to the inner periphery 50d. In order to keep high the strength with which the support plate 50 supports the blades 40, a width W1 (radius r1 - radius r2) of the support plate 50 is set larger than the radial direction distance (distance d1 - distance d2) from the outer ends 40a of the blades 40 to the inner ends 40b.

(3-3) Auxiliary Ring

[0048] The auxiliary ring 60 is positioned on the lengthwise direction intermediate section of the blades 40 and is located in a position away from the blade base portions 40c by a distance of 60% of the long dimension from the blade base portions 40c to the blade distal end portions 40d (the length L1 of the blades 40). It is preferred that the position where the auxiliary ring 60 is disposed be away from the blade base portions 40c by a distance equal to or greater than 55% of the length L1 in order to improve the strength of the cross-flow fan 20 and facilitate the assembly step such as ultrasonic welding.

[0049] FIG. 8 shows the cross-sectional shape of the section where the auxiliary ring 60 and the blades 40 are joined to one another. The cross section shown in FIG. 8 is a cross section that appears when the auxiliary ring 60 and the blades 40 are cut by a plane perpendicular to the axial centre O. In FIG. 9, the auxiliary ring 60, the blades 40, and the support plate 50 when looking from the blade distal end portions 40d of the blades 40 toward the blade base portions 40c are shown partially enlarged. The auxiliary ring 60 mainly comprises a ring portion 61, connection portions 62, and auxiliary connection portions 63. A radius r3 of an outer periphery 61 a of the ring portion 61 is larger than the radius r1 of the outer periphery 51 a of the support plate 50. Furthermore, the radius r3 of the outer periphery 61 a of the ring portion 61 is larger than the distance d1 from the centre (a point on the axial centre O) of the auxiliary ring 60 to the outer ends 40a of the blades 40. That is, the outer periphery 61 a of the ring portion 61 runs along the outside of the outer ends 40a of all the blades 40. A radius r4 of an inner periphery 61 b of the ring portion 61 of the auxiliary ring 60 is larger than the radius r2 of the inner periphery 51 b of the support plate 50 and is slightly larger than the distance d1 to the outer ends 40a of the blades 40, and the inner periphery 61 b of the ring portion 61 runs along the neighborhood of the outside of the outer ends 40a of the blades 40.

[0050] The connection portions 62 are each formed in a triangular shape projecting inward from the ring portion 61 as seen in the direction of the axial centre O. The connection portions 62 having the triangular shape each have three vertex portions 62a, 62b, and 62c; the sides between the vertex portions 62a and 62b are connected to the ring portion 61, and the sides between the vertex portions 62a and 62c are connected to the suction surfaces 40f of the blades 40. The connection portions 62 are not connected to the pressure surfaces 40e of the blades 40. A length L4 of the sections where the connection portions 62 are connected to the suction surfaces 40f (the length from the vertex portions 62a to the vertex portions 62c) is shorter than 1/2 of a chord length L3. By setting the length L4 of the sections connected to the suction surfaces 40f shorter than 1/2 of the chord length L3, blowing characteristics are improved compared to a case where the length L4 is set longer than 1/2 of the chord length L3.

[0051] The auxiliary connection portions 63 are formed in the neighborhood of the outer ends 40a of the blades 40. The auxiliary connection portions 63 are sections filling in the spaces between the outer ends 40a of the blades 40, the connection portions 62, and the ring portion 61, and aid the connection of these three.

[0052] In FIG. 10, part of the auxiliary ring 60 as seen from the side is shown enlarged. The auxiliary ring 60 has a first surface 60a on the side of the blade distal end portions 40d, a second surface 60b on the side of the blade base portions 40c, an outer peripheral surface 60c, and an inner peripheral surface 60d. A curved surface 60e having a radius of curvature R1 is formed in the section interconnecting the first surface 60a and the outer peripheral surface 60c, and a curved surface 60f having a radius of curvature R2 is formed in the section interconnecting the second surface 60b and the outer peripheral surface 60c.

[0053] The thickness of the auxiliary ring 60 becomes thinner heading from the inner peripheral side toward the outer peripheral side. In other words, a thickness t2 of the auxiliary ring 60 at the outer peripheral surface 60c is smaller than a thickness t1 of the auxiliary ring 60 in the neighborhood of the blade base portions 40c. Seen in greater detail, an angle of inclination $\theta 1$ with which the first surface 60a of the auxiliary ring 60 intersects a plane perpendicular to the axial centre O is set so as to be larger than an angle of inclination $\theta 2$ with which the second surface 60b intersects this perpendicular plane. It will be noted that the thickness t1 of the auxiliary ring 60 is set smaller than a thickness t3 of the support plate 50.

(4) Example Modifications

(4-1)

[0054] In the above-described embodiment, the connection portions 62 of the auxiliary ring 60 each have a triangular shape as seen in a plan view, but the planar shape of the connection portions 62 is not limited to being triangular and may also be another shape, such as semicircular or trapezoidal, for example.

(4-2)

[0055] In the above-described embodiment, a case was described where the radius r3 of the outer periphery 61 a of the ring portion 61 is larger than the radius r1 of the outer periphery 51 a of the support plate 50, but the radius r3 of the outer periphery 61 a of the ring portion 61 may also be set the same as the radius r1 of the outer periphery 51 a of the support plate 50.

(4-3)

[0056] In the above-described embodiment, a case was described where, as shown in FIG. 8, the auxiliary ring 60 comprises the ring portion 61 having a circular annular shape, the connection portions 62, and the auxiliary connection portions 63. However, the auxiliary ring may also be equipped with a structure other than these. For example, a balancer portion may also be added to the auxiliary ring 60 (main body portion). The balancer portion is molded integrally with the auxiliary ring 60 (main body portion) and partially increases the weight of the auxiliary ring 60 in order to balance the rotation of the fan block 30. Whereas the ring portion 61, the plural connection portions 62, and the auxiliary connection portions 63 are disposed so as to have rotational symmetry about the axial centre O, the balancer portion 60 is disposed so as to have asymmetry.

[0057] When the balancer portion of the cross-flow fan 10 is molded integrally with the main body portion (the ring portion 61, the connection portions 62, and the auxiliary connection portions 63) of the auxiliary ring, assembly man-hours pertaining to the balancer portion can be saved. Because of that, the cross-flow fan 10 in which rotational wobble is suppressed by the balancer portion can be inexpensively provided.

[0058] When the balancer portion of the fan block 30 is molded integrally with the main body portion (the ring portion 61, the connection portions 62, and the auxiliary connection portions 63) of the auxiliary ring, assembly man-hours pertaining to the balancer portion can be saved. Furthermore, by disposing the balancer portion on the auxiliary ring 60 located on the outer radial portion, the balancer portion resin amount can be reduced and costs can be reduced. Conventionally, the balancer portion has been disposed on the circular annular support plate or the inner peripheral side thereof in order to correct an imbalance of the fan block caused by disposing the blades at an uneven pitch, but when the balancer portion is disposed on the auxiliary ring 60 located more on the outer radial side, the resin amount can be reduced and costs can be reduced. Furthermore, rather than using the support plate 50 on the blade base portions 40c to correct the balance of the blades 40 in an uneven pitch arrangement, it is more efficient to use the auxiliary ring 60 in the substantially central portion of the blades 40 to correct imbalance. Because of that, the cross-flow fan 10 in which rotational wobble is suppressed by the balancer portion can be inexpensively provided.

[0059] The balancer portion can, for example, as shown in FIG. 12, be disposed as a raised portion 64 on the inner peripheral side of the main body portion, such as on the inner peripheral surface 60d of the auxiliary ring 60. It will be noted that, in FIG. 12, a substantially linear section 64a indicated by the long dashed double-short dashed line is the shape in a case where a balancer portion is not disposed. In this way, when the balancer portion is disposed on the inner peripheral side of the main body portion, rotational wobble can be reduced while suppressing a drop in performance pertaining to blowing caused by disposing the balancer portion.

[0060] The balancer portion can, for example, as shown in FIG. 12, be disposed as a raised portion 64 on the inner peripheral side of the main body portion, such as on the inner peripheral surface 60d of the auxiliary ring 60. It will be noted that, in FIG. 12, a substantially linear section 64a indicated by the long dashed double-short dashed line is the shape in a case where a balancer section is not disposed. In this way, when the balancer portion is disposed on the inner peripheral side of the main body portion, rotational wobble can be reduced while suppressing a drop in performance pertaining to blowing caused by disposing the balancer portion.

[0061] Furthermore, the balancer portion may also be a raised portion disposed in the thickness direction of the main body portion. For example, as shown in FIG. 13, a raised portion 65 of the auxiliary ring 60 formed by increasing the thickness of one of the plural connection portions 62 or the plural auxiliary connection portions 63 can also be disposed as the balancer portion. Alternatively, a raised portion 66 of the auxiliary ring 60 formed by increasing part of the thickness of the ring portion 61 can also be disposed as the balancer portion. Because the balancer portion of the cross-flow fan 10 is disposed in the thickness direction of the main body portion, the balancer portion can be disposed in such a way that air resistance does not increase, and rotational wobble can be reduced while suppressing a drop in performance pertaining to the blowing of the cross-flow fan caused by disposing the balancer portion.

(5) Characteristics

(5-1)

[0062] The ring portion 61 of the auxiliary ring 60 is positioned on the lengthwise direction intermediate section of the plural blades 40 and is combined with the outer ends 40a of the plural blades 40. Because the auxiliary ring 60 is combined with the outer ends 40a of the plural blades 40, flow path loss is suppressed compared to a case where a circular annular plate-like member supports the blades 40 from their outer ends to their inner ends. Furthermore, in the above-described embodiment, the auxiliary ring 60 is located in a position away from the blade base portions 40c on the support plate side of the blades 40 by a distance of 60% of the long dimension from the blade base portions 40c to the blade distal end portions 40d. Because the auxiliary ring 60 is away from the blade base portions 40c by a distance equal to or greater than 55% of the long dimension from the blade base portions 40c to the blade distal end portions 40d, the strength of the cross-flow fan 10 is improved, and this improvement in strength will be described.

[0063] Because the blades 40 each have a gently curved plate-like shape, they easily bend in the width direction of the blades 40. When the blades 40 bend, stress concentrates in the joint sections between the blade base portions 40c or the blade distal end portions 40d and the support plate 50 or the end plate 21 so that it becomes easier for breakage to occur, or this becomes a factor causing vibration. Furthermore, when the blades 40 bend, it becomes easier for joint defects to occur at the time when the blades 40 and the support plate 50 or the end plate 21 are joined to one another by ultrasonic fusing or the like. If the plural blades 40 are bundled together by the auxiliary ring 60, it becomes difficult for the blades 40 to bend, so problems such as breakage caused by stress concentration and joint defects caused by bending described above and the occurrence of noise can be eliminated. Furthermore, blade collapse after molding can be suppressed, insertion into fusion slots becomes easy, and blade stiffness on the distal end side from the auxiliary ring can be sufficiently ensured, so workability is further improved. In this way, in consideration of the blade distal end portions 40d being joined, the auxiliary ring 60 is disposed away by a distance equal to or greater than 55% of the long dimension from the blade base portions 40c to the blade distal end portions 40d, in a location offset toward the blade distal end portions 40d from the lengthwise direction exact middle of the blades 40. In the above-described embodiment, the auxiliary ring 60 is away by a distance of 60%, but as the blades 40 are bundled together at their lengthwise direction intermediate section, the auxiliary ring 60 is preferably located at a distance equal to or greater than 55% and equal to or less than 75% and even more preferably a distance equal to or greater than 60% and equal to or less than 65%.

[0064] A configuration will be considered where, for example, in order to obtain a block resembling the fan block 30 having the length L1, instead of the auxiliary ring 60, as shown in FIG. 11, two fan blocks 130 whose blades 140 are relatively short are joined to one another by a support plate 150. Here, the structure of the support plate 150 is the same as that of the support plate 50 described above. Comparing the two fan blocks 130 of FIG. 11 with the one fan block 30 of FIG. 5, their strength when configuring an impeller is substantially the same, but in the configuration of FIG. 11, not only does the flow path loss of the two fan blocks 130 increase compared to the case of the auxiliary ring 60 because the support plate 150 is positioned in the middle of the blocks, but the effective blade length becomes shorter. Moreover, in the configuration of FIG. 11, an increase in costs relating to assembly is also conceivable because there is an added step for joining the two fan blocks 130 to one another.

(5-2)

[0065] In the cross-flow fan 10 described above, the auxiliary ring 60 and the plural blades 40 are formed of resin, and the auxiliary ring 60 is molded integrally with the plural blades 40 by injection molding, for example. By molding the auxiliary ring 60 integrally with the plural blades, assembly of the auxiliary ring and the plural blades becomes unnecessary and costs can be reduced.

(5-3)

[0066] Furthermore, the support plate 50 is also formed of resin, and the fan block 30, in which one support plate 50, one auxiliary ring 60, and plural blades 40 are integrally molded by injection molding, for example, is plurally formed. Additionally, the plural blades 40 are combined by the auxiliary ring 60 that is away from the blade base portions 40c by a distance equal to or greater than 55% of the long dimension from the blade base portions 40c to the blade distal end portions 40d, so it becomes easier to fixedly attach the support plate 50 of one fan block 30 to the plural blades 40 of another fan block. As a result, the blades 40 of each fan block 30 can be lengthened and the number of fan blocks can be reduced so that manufacturing costs can be reduced.

(5-4)

[0067] The thickness of the ring portion 61 of the auxiliary ring 60 becomes thinner heading from the inner peripheral side toward the outer peripheral side. In other words, the thickness t1 on the inner peripheral side is larger than the thickness t2 on the outer peripheral side. For that reason, loss caused by air flow at the auxiliary ring 60 can be reduced and blowing characteristics can be improved. Furthermore, it is preferred that the thickness of the auxiliary ring 60 become thinner heading toward the outer peripheral side from the connection portions 62 to the ring portion 61. In this case also, blowing

characteristics can be further improved. Moreover, because the thickness of the auxiliary ring 60 is thinner on the inner peripheral side than it is on the outer peripheral side, it becomes easier to remove the fan block 30 of the cross-flow fan 10 from the mold during injection molding.

(5-5)

[0068] Furthermore, the inclination of the auxiliary ring 60 heading from the outer peripheral side toward the inner peripheral side is greater on the first surface 60a on the side of the blade distal end portions 40d than on the second surface 60b on the side of the support plate 50. Because the inclination heading from the outer peripheral side toward the inner peripheral side is greater on the first surface 60a than on the second surface 60b on the side of the support plate 50, removal of the molded product becomes easy when detaching the mold from the fan block 30 while rotating the mold about a place near the blade distal end portions 40d after injection molding, for example. A mold with this way of removal has parting faces plurally divided about the axial centre O, for example. In this way, yield is improved because integral molding becomes easy, and the manufacturing costs of the cross-flow fan 10 can be reduced.

(5-6)

[0069] The plural blades 40 are disposed in such a way that their outer ends 40a are positioned concentrically about the axial centre O. Furthermore, the auxiliary ring 60 has a circular annular shape where its outer peripheral surface 60c runs along the outside of the outer ends 40a of the plural blades 40. Because the outer peripheral surface 60c of the auxiliary ring 60 runs along the outside of the outer ends 40a of the blades 40, the outer peripheral surface 60c of the auxiliary ring 60 is continuous without being interrupted by the outer ends 40a. Because of that, the strength of the auxiliary ring 60 can be increased so that the effect of reinforcing the strength of the cross-flow fan 10 can be improved.

(5-7)

[0070] The auxiliary ring 60 has a circular annular shape and has the outer radius r3 larger than the outer radius r1 of the support plate 50. When the outer radius r3 of the auxiliary ring 60 is equal to or larger than the outer radius r1 of the support plate 50, the interval between the outer peripheral surface 60c of the auxiliary ring 60 and the outer ends 40a of the blades 40 can be increased so that the strength of the auxiliary ring 60 can be increased. By increasing the strength of the auxiliary ring 60 in this way, the effect of reinforcing the strength of the cross-flow fan 10 can be improved.

REFERENCE SIGNS LIST

[0071]

10	Cross-flow Fan
20	Impeller
30	Fan Block
40	Blades
50	Support Plate
60	Auxiliary Ring

CITATION LIST

<Patent Literature>

[0072] Patent Document 1: Japanese Patent Unexamined Publication No. H05-87086

Claims

1. A cross-flow fan comprising:

a disc-shaped or circular annular support plate (50);
plural blades (40) extending in a lengthwise direction from the support plate; and
an auxiliary ring (60) that is positioned on a lengthwise direction intermediate section of the plural blades and is combined with outer ends (40a) of the plural blades,
wherein the auxiliary ring is located in a position away from a blade base portion (40c) on the support plate side of the blades by a distance equal to or greater than 55% of the long dimension from the blade base portions to a blade distal end portion (40d).

2. The cross-flow fan according to claim 1, wherein the auxiliary ring is molded integrally with the plural blades.

3. The cross-flow fan according to claim 2, wherein
the support plate includes plural support plates,
the auxiliary ring includes plural auxiliary rings,
a fan block formed by integrally molding one of the support plates, one of the auxiliary rings, and the plural blades is plurally formed, and
the support plate of at least one of the fan blocks fixedly is attached to the plural blades of another of the fan blocks.

4. The cross-flow fan according to claim 1 or claim 2, wherein the thickness of the auxiliary ring becomes thinner heading from the inner peripheral side toward the outer peripheral side.

5. The cross-flow fan according to claim 4, wherein the

inclination of the auxiliary ring heading from the outer peripheral side toward the inner peripheral side is greater on a first surface (60a) on the side of the blade distal end portion than on a second surface (60b) on the side of the support plate.

6. The cross-flow fan according to any one of claims 1 to 5, wherein
the plural blades are disposed in such a way that their outer ends are positioned concentrically, and the auxiliary ring has a circular annular shape where its outer periphery (60c) runs along the outside of the outer ends of the plural blades.

7. The cross-flow fan according to any one of claims 1 to 6, wherein the auxiliary ring has a circular annular shape and has an outer radius (r3) equal to an outer radius (r1) of the support plate or larger than the outer radius of the support plate.

8. The cross-flow fan according to any one of claims 1 to 7, wherein the auxiliary ring has a main body portion having a circular annular shape and a balancer portion (64, 65) that is molded integrally with the main body portion and partially increases the weight of the auxiliary ring in order to balance rotation.

9. The cross-flow fan according to claim 8, wherein the balancer portion of the auxiliary ring is a raised portion (64) disposed on the inner peripheral side of the main body portion.

10. The cross-flow fan according to claim 8, wherein the balancer portion of the auxiliary ring is a raised portion (65) disposed in the thickness direction of the main body portion.

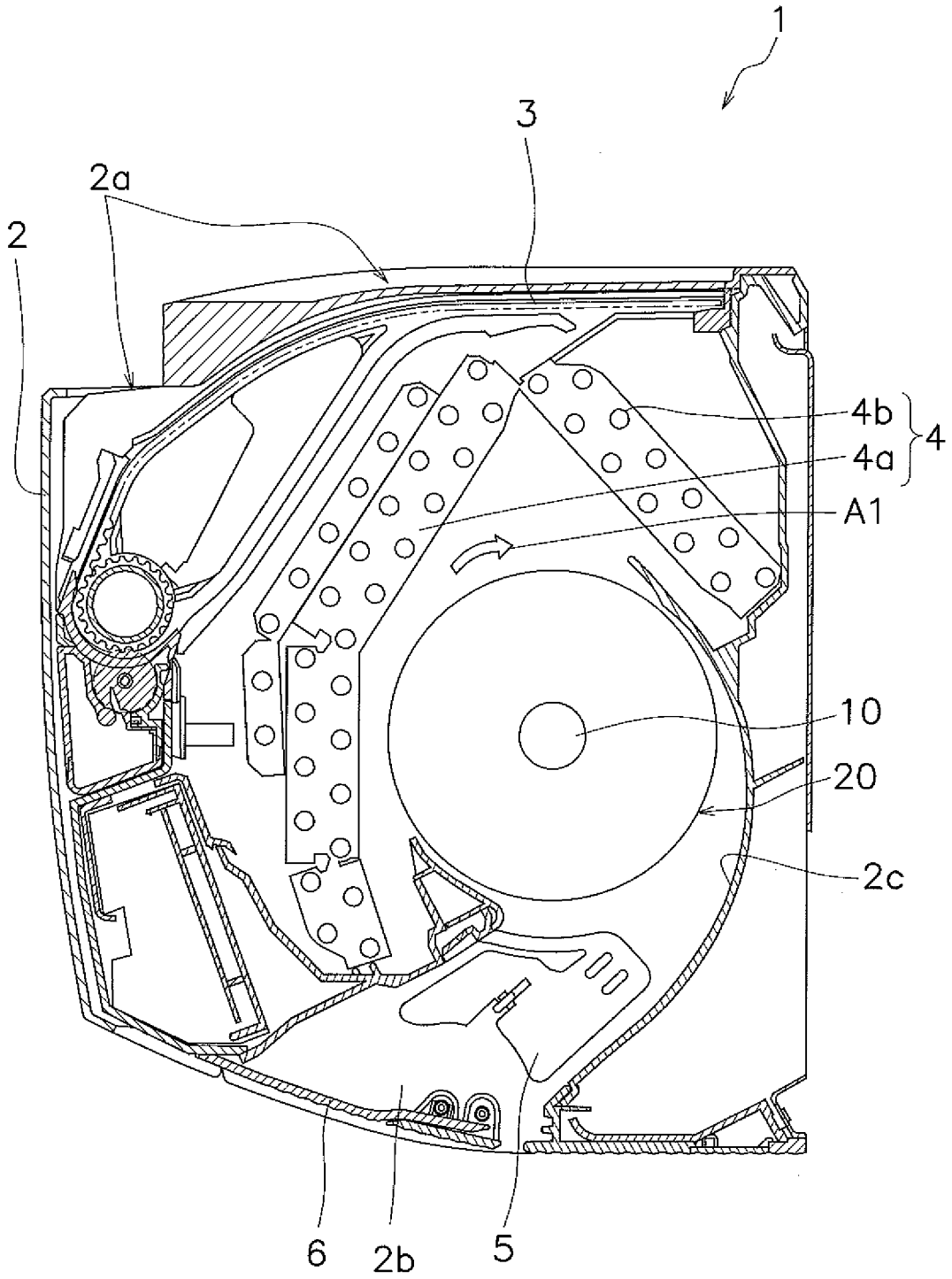


FIG. 1

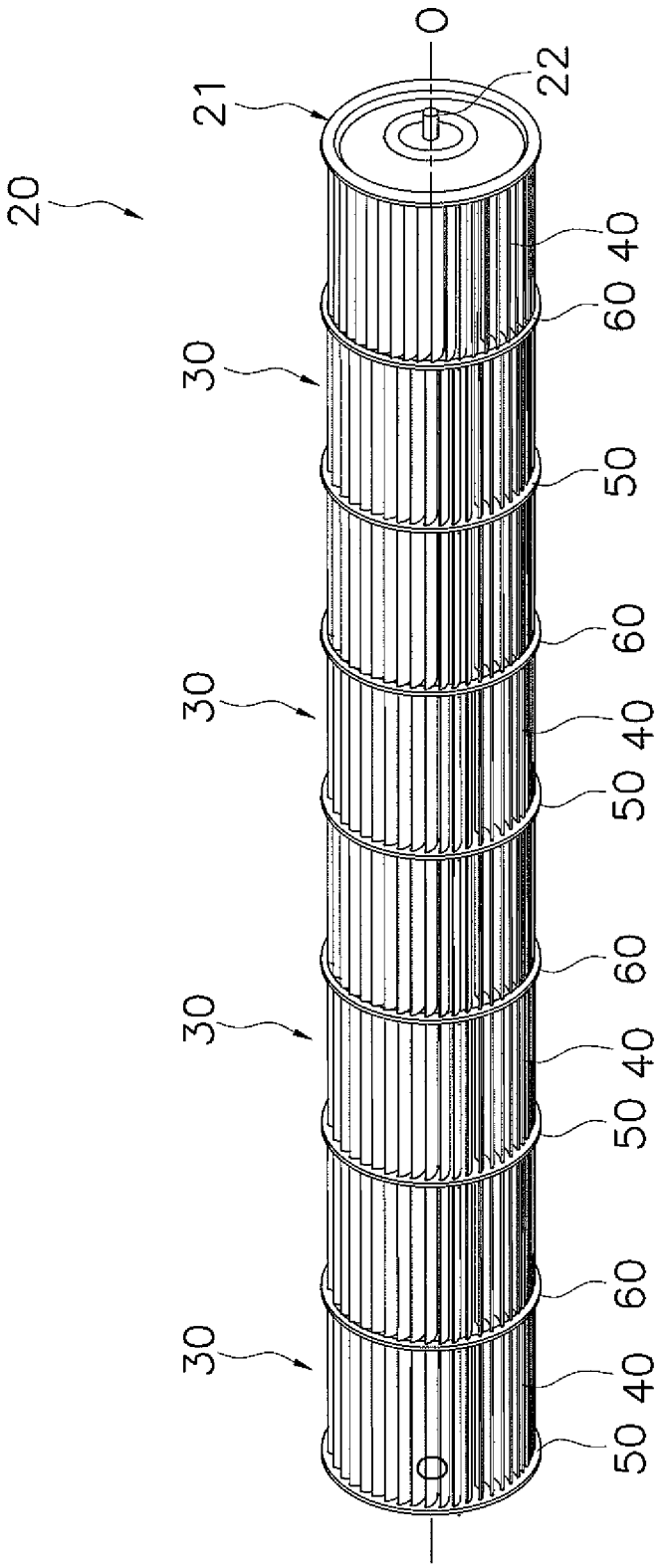


FIG. 2

FIG. 3

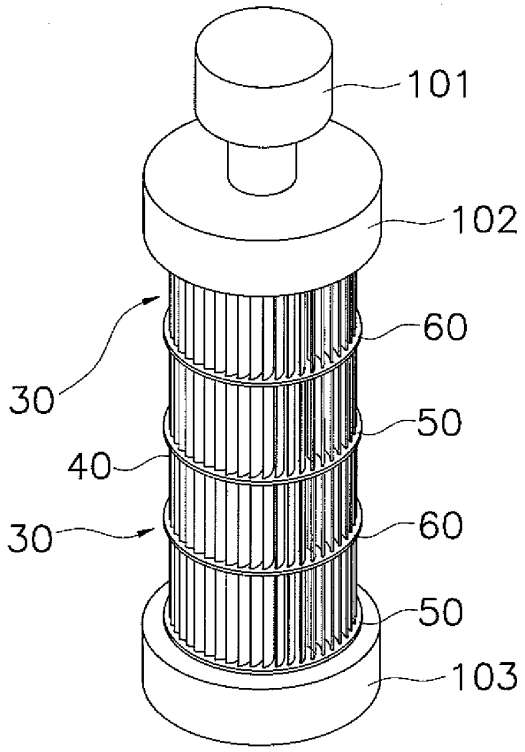
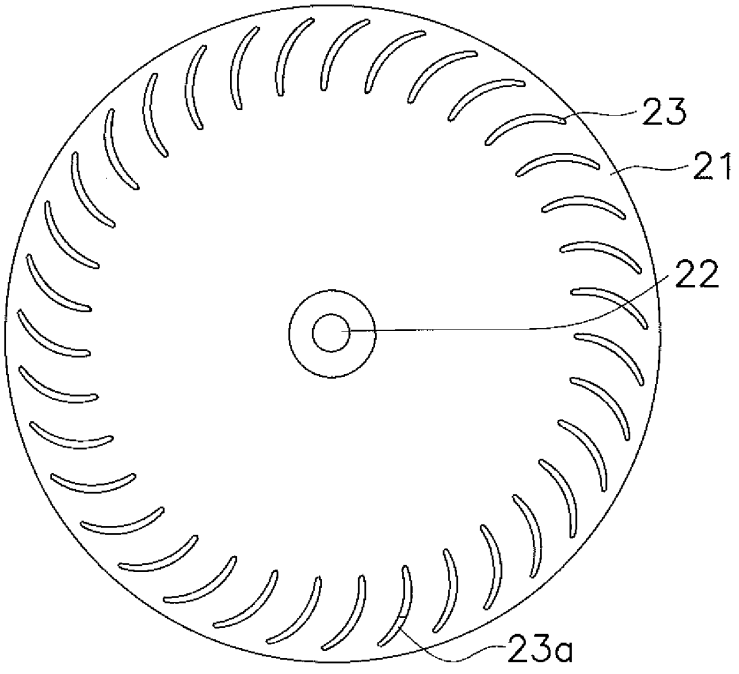


FIG. 4



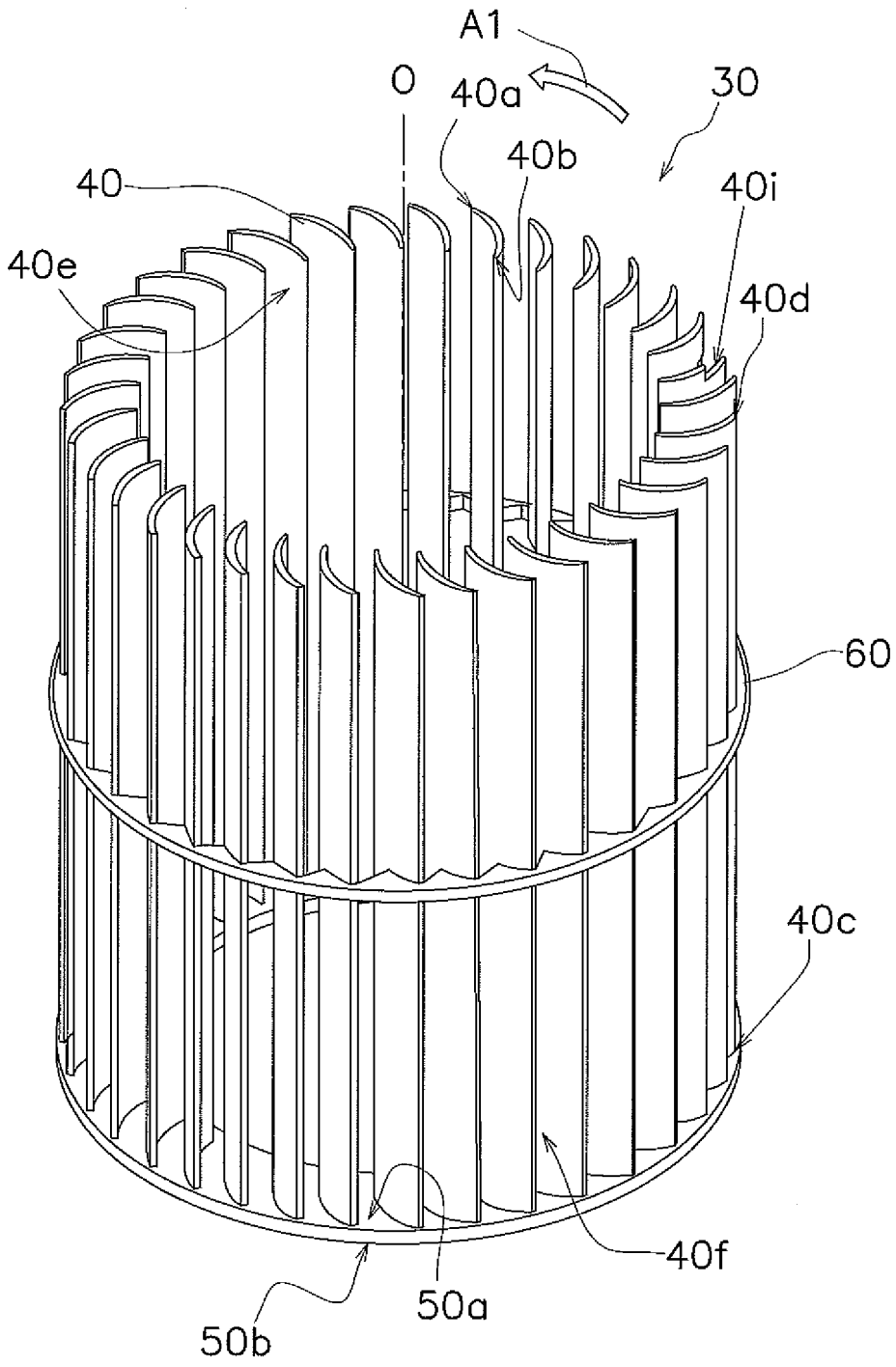


FIG. 5

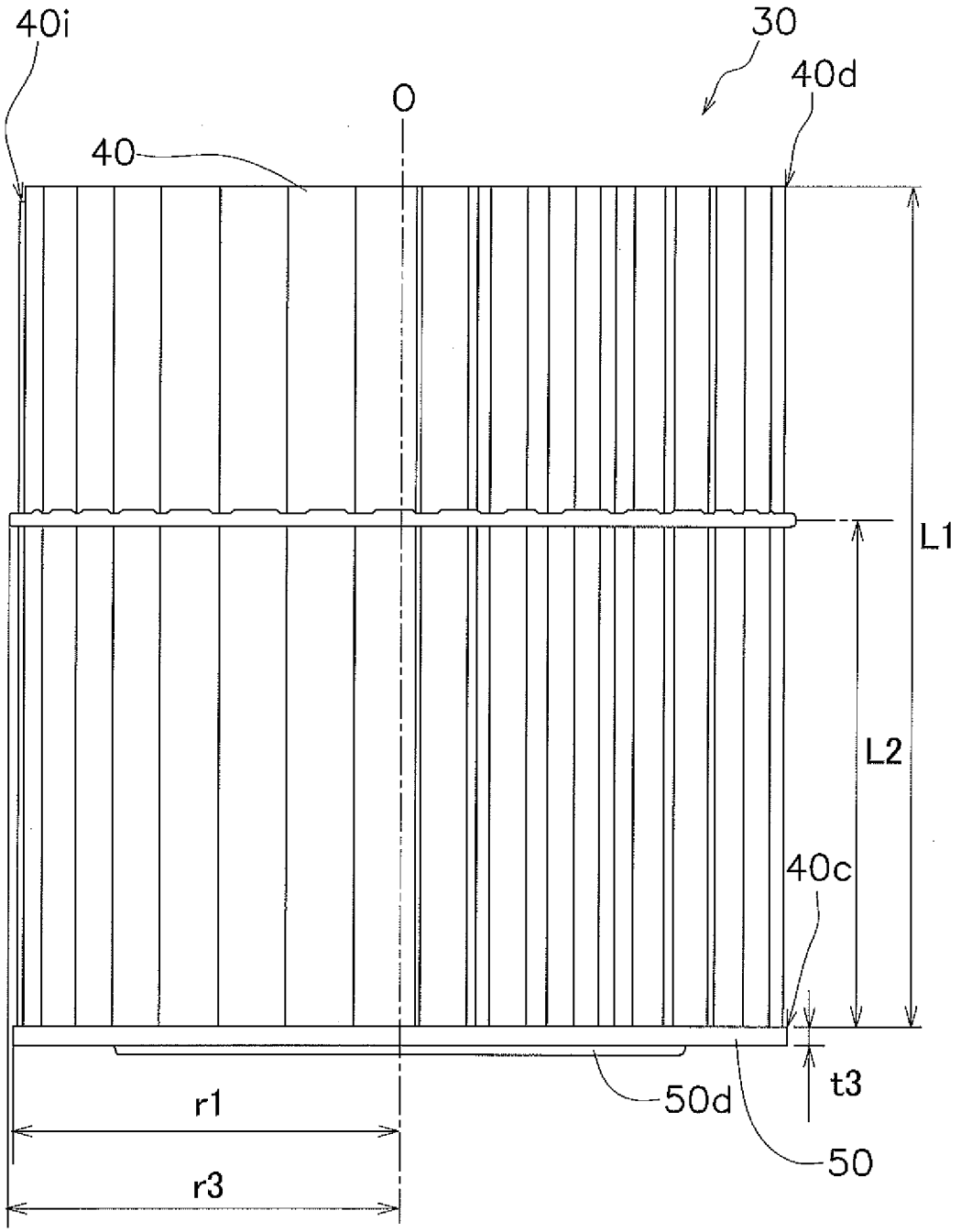


FIG. 6

FIG. 7

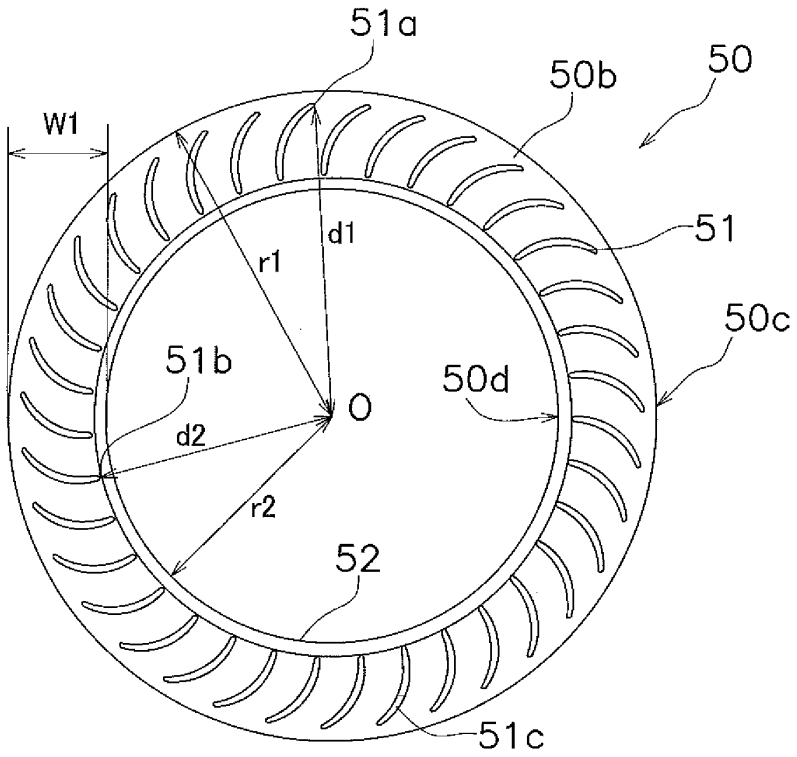

51a
50b
50
W1
51
d1
r1
50c
51b
50d
O
d2
r2
52
51c

FIG. 8

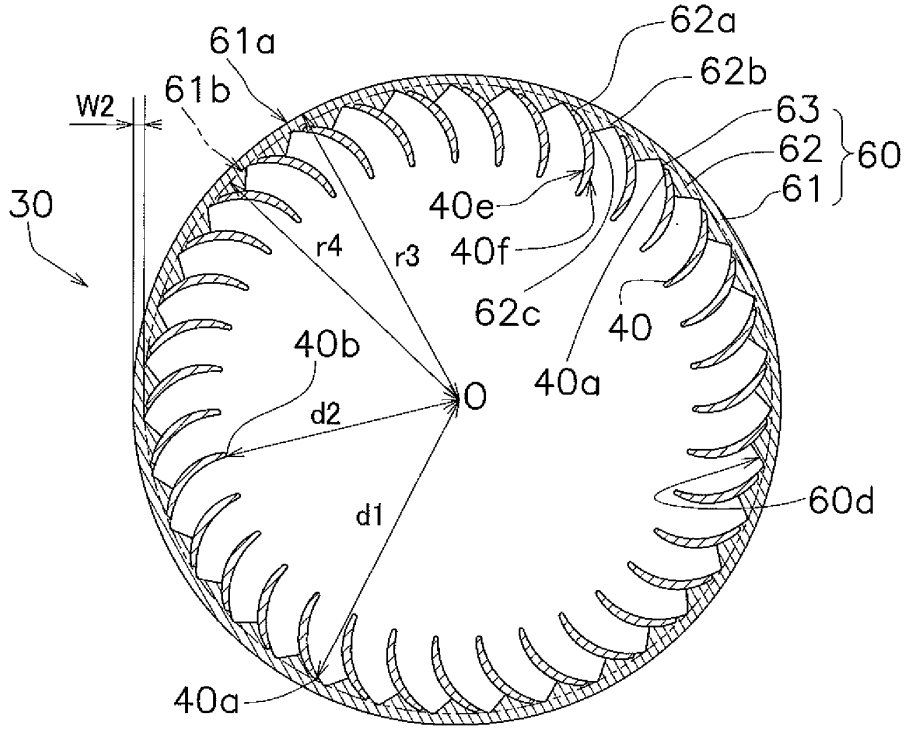

61a
62a
62b
61b
W2
63
62
60
61
30
40e
r4
r3
40f
62c
40
40b
40a
O
d2
60d
d1
40a

FIG. 9

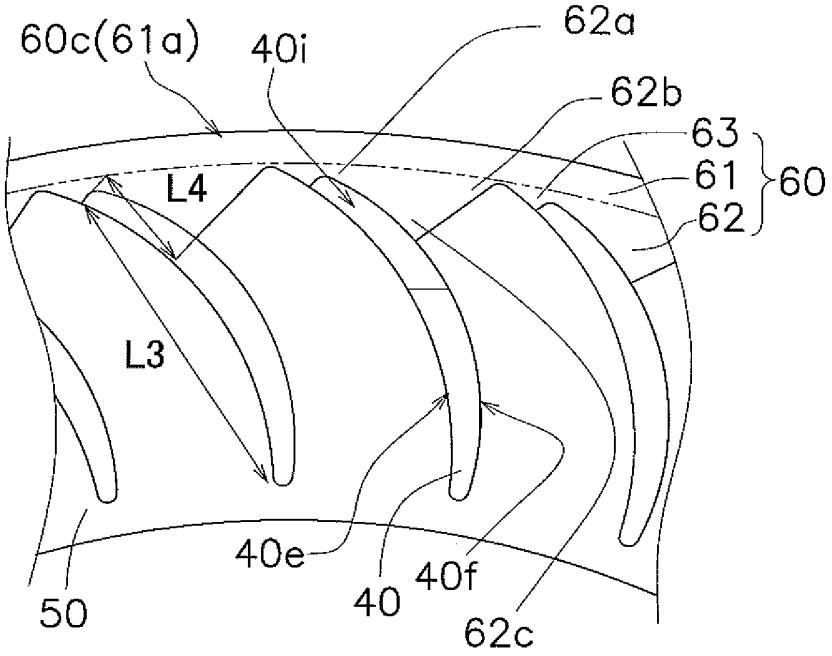
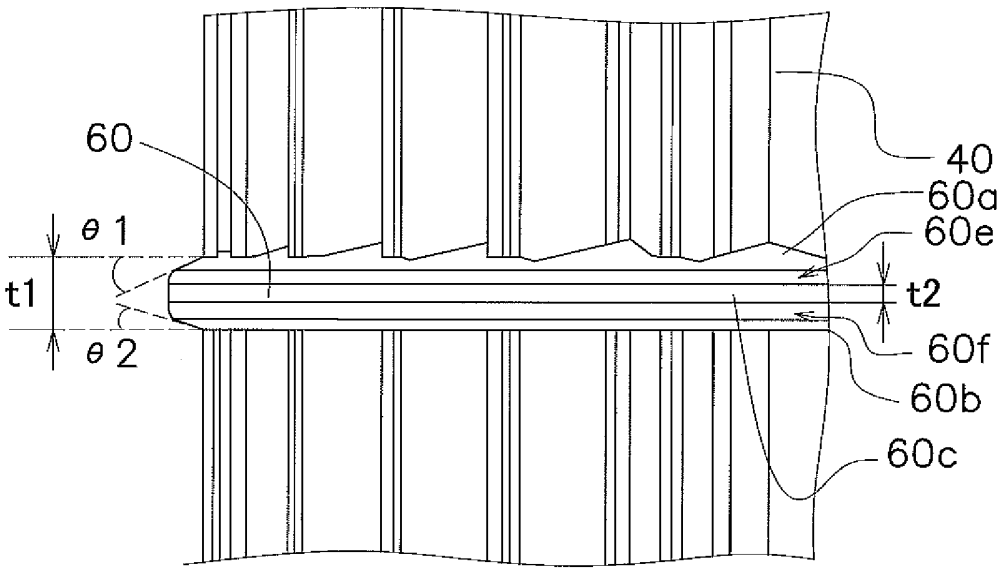

60c(61a)
40i
62a
62b
63
61
60
62
L4
L3
40e
40
40f
62c
50

FIG. 10


60
40
60a
θ 1
60e
t1
t2
θ 2
60f
60b
60c

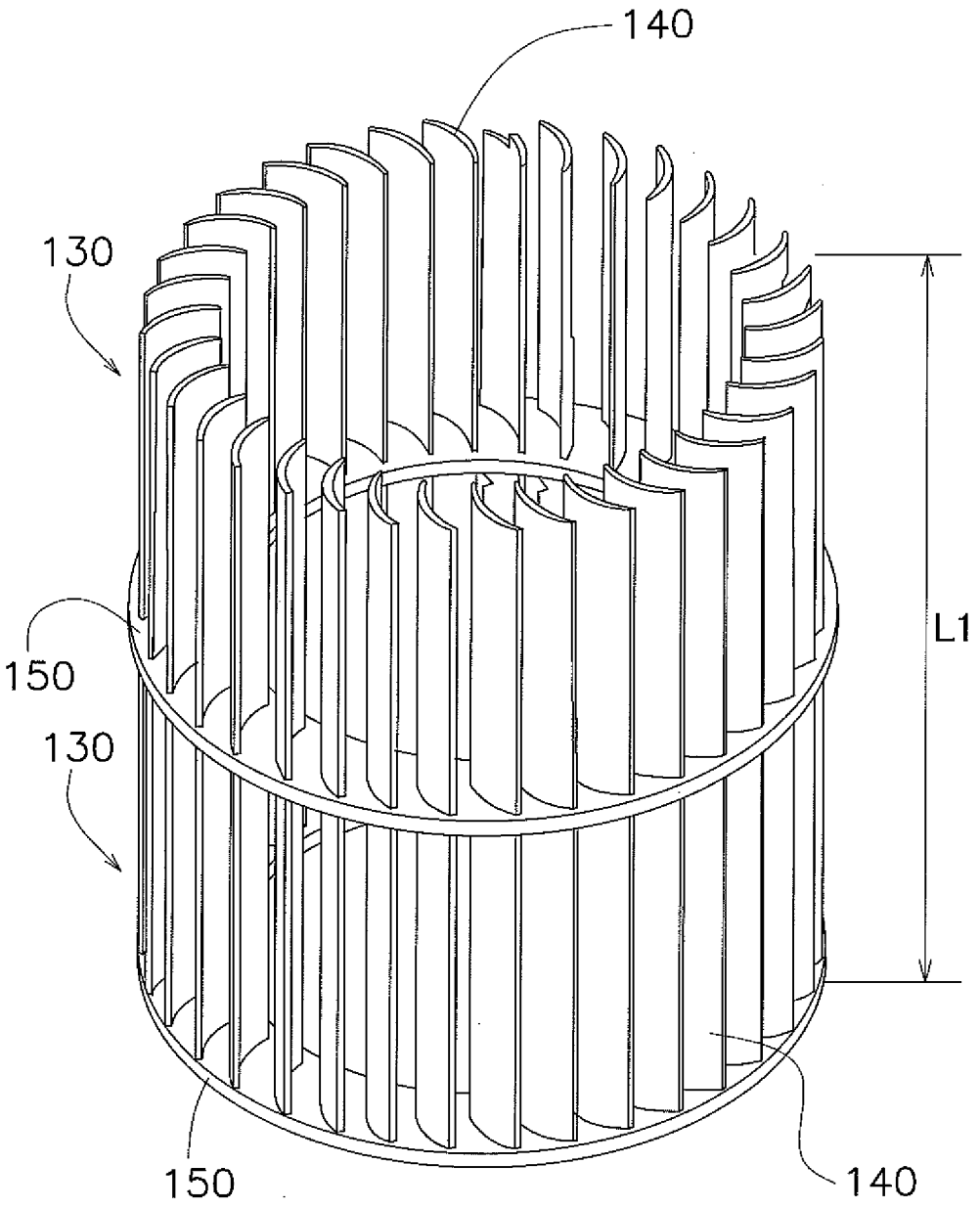


FIG. 11

FIG. 12

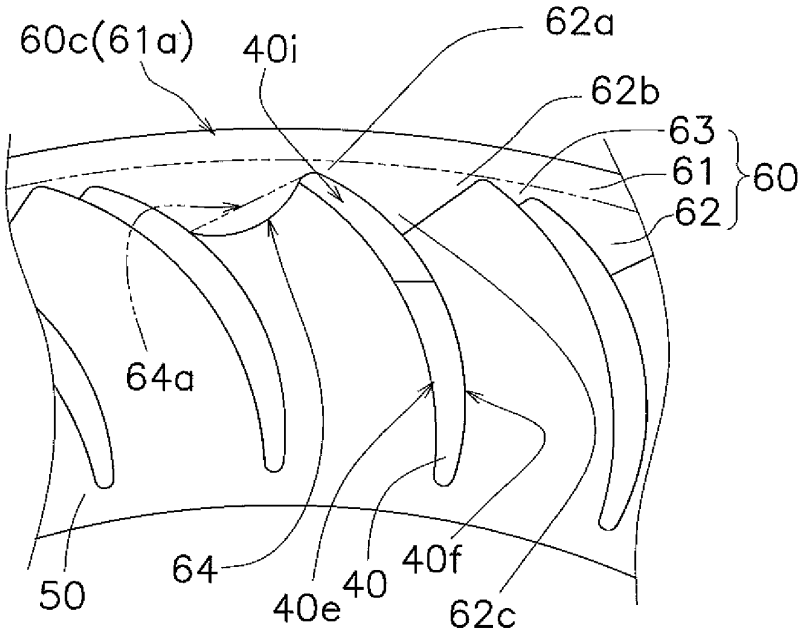
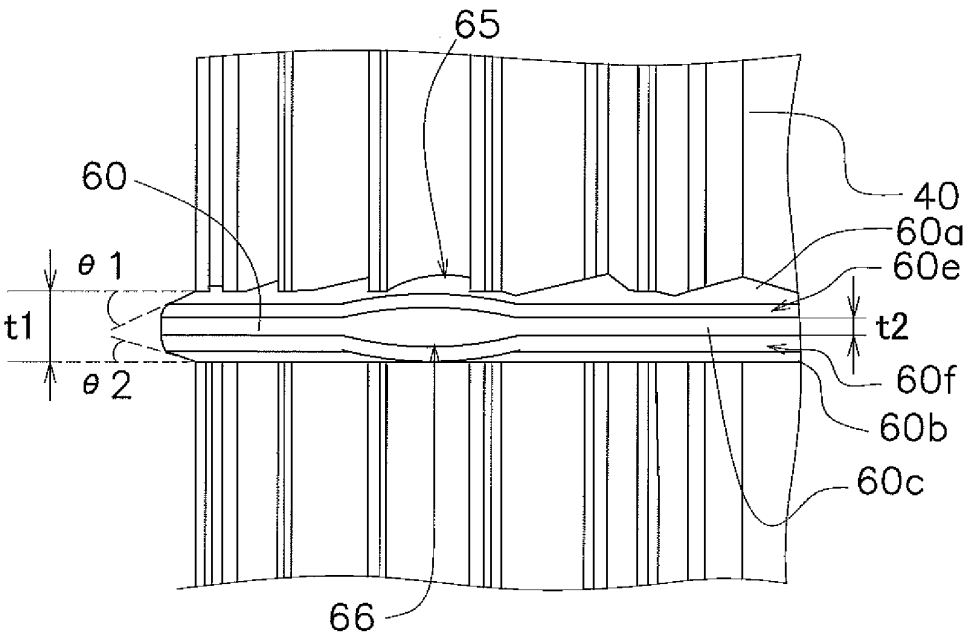

60c(61a)
40i
62a
62b
63
61
60
62
64a
50
64
40e
40
40f
62c

FIG. 13


65
60
40
60a
θ 1
60e
t1
t2
θ 2
60f
60b
60c
66

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/073142

A. CLASSIFICATION OF SUBJECT MATTER
F04D17/04(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)
F04D17/04

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 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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	JP 2000-120578 A (Sharp Corp.), 25 April 2000 (25.04.2000), paragraphs [0032], [0038], [0060]; fig. 17 (Family: none)	1 2-4,6-10 5
Y	JP 53-34108 A (Hitachi, Ltd.), 30 March 1978 (30.03.1978), page 2, upper right column, line 3 to lower left column, line 17; fig. 4 to 6 (Family: none)	2-4,6-10

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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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
18 November, 2013 (18.11.13)	03 December, 2013 (03.12.13)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/073142

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 33411/1980(Laid-open No. 136192/1981) (Tokyo Shibaura Electric Co., Ltd.), 15 October 1981 (15.10.1981), page 3, lines 14 to 18; fig. 6 (Family: none)	4,6-10
Y	JP 3-229991 A (Matsushita Electric Industrial Co., Ltd.), 11 October 1991 (11.10.1991), page 2, lower left column, line 11 to lower right column, line 17; fig. 1, 2 (Family: none)	4,6-10
Y	JP 2006-329098 A (Daikin Industries, Ltd.), 07 December 2006 (07.12.2006), paragraphs [0021], [0023]; fig. 5 (Family: none)	8-10
Y	JP 4-164195 A (Matsushita Electric Industrial Co., Ltd.), 09 June 1992 (09.06.1992), page 2, upper right column, line 8 to lower left column, line 6; fig. 2, 3 (Family: none)	8-10
A	JP 6-173885 A (Toshiba Corp.), 21 June 1994 (21.06.1994), entire text; all drawings (Family: none)	1-10
A	JP 39-5378 B1 (Nikorausu Raingu), 28 April 1964 (28.04.1964), entire text; all drawings (Family: none)	1-10
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 25395/1979(Laid-open No. 125996/1980) (Mikuni Plastics Co., Ltd.), 06 September 1980 (06.09.1980), entire text; all drawings (Family: none)	1-10

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/073142

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 18170/1983(Laid-open No. 123695/1984) (Hosiden Electronic Co., Ltd.), 20 August 1984 (20.08.1984), entire text; all drawings (Family: none)	1-10

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H0587086 B **[0002] [0072]**