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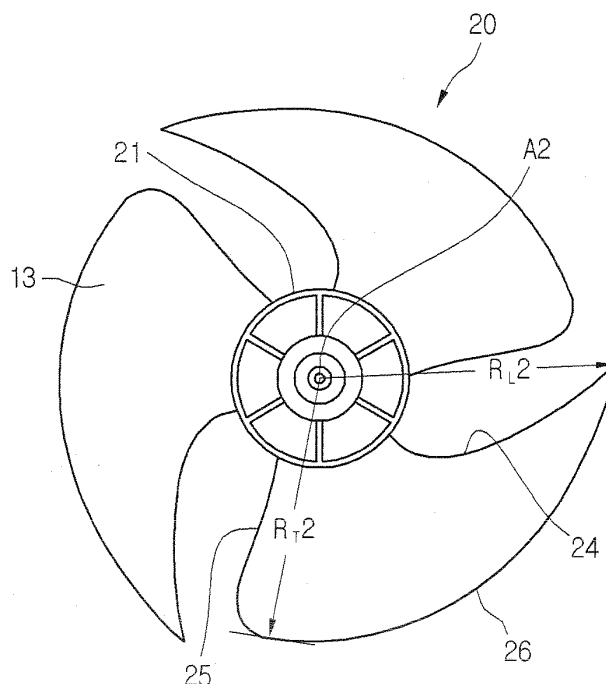
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(54) **Axial flow fan and outdoor unit for air conditioner**

(57) Provided are an axial flow fan (20) and an air conditioner outdoor unit (100) including the axial flow fan (20). The axial flow fan (20) includes a hub (21) and blades (23) disposed on an outer surface of the hub (21). Each of the blades (23) satisfies that a shortest distance (R_{L2}) measured from an imaginary line (L2) passing through a center of the hub to a front end of an outer edge of the blade (23) is greater than a shortest distance

(R_{T2}) measured from the imaginary line (L2) to a rear end of the outer edge of the blade (23). The front end of the outer edge of the blade (23) is a leading end (24) in a rotation direction of the blade (23), and the rear end of the outer edge of the blade is a trailing end (25) in the rotation direction of the blade. Owing to the shape of the blade (23), noise can be reduced while increasing the flowrate of air.

Fig. 3



Description

[0001] The present disclosure relates to an axial flow fan and an air conditioner outdoor unit including the axial flow fan.

[0002] Air conditioners are home appliances for cooling and/or heating indoor areas by using refrigerant circulating in heat-exchange cycles. A split type air conditioner includes an indoor unit and an outdoor unit. Components for heat-exchange cycle such as an outdoor heat exchanger and a compressor are disposed in the outdoor unit.

[0003] In addition, a fan is disposed in the outdoor unit to blow air for facilitating heat exchange between the outdoor heat exchanger and outdoor air. Generally, an axial flow fan is used as the fan. Air flows in the direction of a rotation shaft of an axial flow fan.

[0004] Hereinafter, an axial flow fan of the related art will be described in detail with reference to the accompanying drawings.

[0005] Fig. 1 is a plan view illustrating an axial flow fan 10 of the related art, and Fig. 2 is a schematic side view of the axial flow fan 10 of the related art.

[0006] Referring to Figs. 1 and 2, the axial flow fan 10 includes a hub 11 and a plurality of blades 13. A rotation shaft (not shown) of the axial flow fan 10 is coupled to the hub 11. As the blades 13 are rotated, air is forced to flow.

[0007] In detail, based on the rotation direction of the blades 13, the blades 13 include: leading edges 14; trailing edges 15; and tips 16. The tips 16 are outer edges of the blades 13. A shortest distance RL1 measured from an imaginary line L1 passing through the center A1 of the hub 11 to an end (front end) of the tip 16 close to the leading edge 14 is equal to a shortest distance RT1 measured from the imaginary line L1 to the other end (rear end) of the tip 16 close to the trailing edge 15.

[0008] However, the axial flow fan 10 of the related art has the following limitations.

[0009] First, the axial flow fan 10 generates noise during operation. Due to such noise, users complain about products using axial flow fans such as the axial flow fan 10.

[0010] Thus, various design changes have been attempted to reduce noise of the axial flow fan 10. In spite of such attempts, noise of the axial flow fan 10 is not sufficiently reduced, or the flowrate of air by the axial flow fan 10 is reduced if the noise of the axial flow fan 10 is reduced.

[0011] If the axial flow fan 10 is used in an outdoor unit of an air conditioner, the size of the axial flow fan 10 is limited to prevent interference with other components disposed in the outdoor unit such as an orifice disposed in the outdoor unit for guiding air blown by the axial flow fan 10. Therefore, it is necessary to modify components disposed in the outdoor unit to increase the output power of the axial flow fan 10. That is, modification of components is necessary to increase the flowrate of air blown

by the axial flow fan 10.

[0012] Embodiments provide an axial flow fan generating less noise and an air conditioner outdoor unit including the axial flow fan.

5 **[0013]** Embodiments also provide an axial flow fan configured to reduce noise without affecting the flow rate of air and an air conditioner outdoor unit including the axial flow fan.

10 **[0014]** Embodiments also provide an axial flow fan configured to increase the flow rate of air more easily and an air conditioner outdoor unit including the axial flow fan.

[0015] In one embodiment, an axial flow fan includes: a hub; and a plurality of blades disposed on an outer surface of the hub, wherein each of the blades satisfies that a shortest distance measured from an imaginary line (L2) passing through a center of the hub to a front end of an outer edge of the blade is different from a shortest distance measured from the imaginary line (L2) to a rear end of the outer edge of the blade, wherein the front end of the outer edge of the blade is a leading end in a rotation direction of the blade, and the rear end of the outer edge of the blade is a trailing end in the rotation direction of the blade.

20 **[0016]** In another embodiment, an axial flow fan includes: a hub; and a plurality of blades disposed on an outer surface of the hub, wherein each of the blades satisfies that when the blade is rotated, a trajectory formed by a front end of an outer edge of the blade is greater than a trajectory formed by a rear end of the outer edge of the blade.

30 **[0017]** In another embodiment, there is provided an outer unit of an air conditioner, the outer unit including: a casing including a suction hole and a discharge hole for inflows and outflows of air; an outdoor heat exchanger disposed in the casing to allow a flow of refrigerant therein; an axial flow fan configured to blow outdoor air for heat exchange between the outdoor air and the refrigerant flowing in the outdoor heat exchanger; a motor configured to rotate the axial flow fan; and an orifice configured to guide outdoor air blown by the axial flow fan to an outside area of the casing through the discharge hole, wherein the axial flow fan includes a blade, and the blade satisfies that a shortest distance measured from an imaginary line (L2) passing through a center of a hub of the blade to a front end of an outer edge of the blade is different from a shortest distance measured from the imaginary line (L2) to a rear end of the outer edge of the blade, wherein the front end of the outer edge of the blade is a leading end in a rotation direction of the blade, and the rear end of the outer edge of the blade is a trailing end in the rotation direction of the blade.

45 **[0018]** The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

55 **[0019]** Fig. 1 is a plan view illustrating an axial flow fan of the related art.

[0020] Fig. 2 is a schematic side view illustrating the

axial flow fan of the related art.

[0021] Fig. 3 is a plan view illustrating an axial flow fan according to an embodiment.

[0022] Fig. 4 is a schematic side view illustrating the axial flow fan according to the embodiment.

[0023] Fig. 5 is a view illustrating results of simulations for comparing the velocity of air flows by the axial flow fan of the embodiment with the velocity of air flows by an axial flow fan of the related art.

[0024] Fig. 6 is a view illustrating results of simulations for comparing the velocity of turbulent flows of air by the axial flow fan of the embodiment with the velocity of turbulent flows of air by an axial flow fan of the related art.

[0025] Fig. 7 is a sectional view illustrating main parts of an air conditioner outdoor unit to which the axial flow fan of the embodiment is applied.

[0026] Hereinafter, an axial flow fan will be described in detail according to an embodiment with reference to the accompanying drawings.

[0027] Fig. 3 is a plan view illustrating an axial flow fan 20 according to an embodiment, and Fig. 4 is a schematic side view illustrating the axial flow fan 20 according to the embodiment.

[0028] Referring to Figs. 3 and 4, the axial flow fan 20 includes a hub 21 and a plurality of blades 23. The hub 21 has an approximately cylindrical shape. A rotation shaft (not shown) is coupled to the hub 21 to rotate the axial flow fan 20. Substantially, the rotation shaft is coupled to a center A2 of the hub 21. The blades 23 are disposed on the outer surface of the hub 21. Based on the rotation direction of the blades 23, the blades 23 include: leading edges 24; trailing edges 25; and tips 26 forming outer edges of the blades 23. If the blades 23 are rotated, air flows in the direction of the rotation shaft.

[0029] A shortest distance measured from an imaginary line L2 passing through the center A2 of the hub 21 to a front end of the blade 23 is different from a shortest distance measured from the imaginary line L2 to a rear end of the blade 23. That is, a shortest distance RL2 measured from the line L2 to a front end of the tip 26 close to the leading edge 24 is different from a shortest distance RT2 measured from the line L2 to a rear end of the tip 26 close to the trailing edge 25.

[0030] In detail, the shortest distance RL2 measured from the line L2 to the front end of the tip 26 close to the leading edge 24 is greater than the shortest distance RT2 measured from the line L2 to a rear end of the tip 26 close to the trailing edge 25. In other words, the distance between the line L2 and the tip 26 is varied. That is, the distance between the line L2 and the tip 26 is gradually reduced from the front end to the rear end of the tip 26.

[0031] Owing to this structure of the blade 23, when the blade 23 is rotated, the trajectory of the front end of the tip 26 may be different from the trajectory of the rear end of the tip 26.

[0032] That is, according to the current embodiment, when the blade 23 is rotated, the diameter of a trajectory formed by a portion of the blade 23 close to the leading

edge 24 of the blade 23 may be different from the diameter of a trajectory formed by another portion of the blade 23 close to the trailing edge 25 of the blade 23.

[0033] That is, according to the current embodiment, when the blade 23 is rotated, the diameter of a trajectory formed by a portion of the blade 23 close to the leading edge 24 of the blade 23 may be greater than the diameter of a trajectory formed by another portion of the blade 23 close to the trailing edge 25 of the blade 23.

[0034] That is, according to the current embodiment, when the blade 23 is rotated, the diameter of the trajectory of the blade 23 may be gradually reduced in a direction from the front end of the tip 26 close to the leading edge 24 to the rear end of the tip close to the trailing edge 25. In addition, the trajectory of the blade 23 formed by rotation of the blade 23 may have a cylindrical shape the diameter of which reduces gradually in the direction of air blown by the axial flow fan 20.

[0035] Hereinafter, effects of the axial flow fan 20 of the embodiment will be described in detail with reference to the accompanying drawings.

[0036] Fig. 5 is a view illustrating results of simulations for comparing the velocity of air flows by the axial flow fan 20 of the embodiment with the velocity of air flows by an axial flow fan of the related art, and Fig. 6 is a view illustrating results of simulations for comparing the velocity of turbulent flows of air by the axial flow fan 20 of the embodiment with the velocity of turbulent flows of air by an axial flow fan of the related art.

[0037] Referring to Fig. 5, flows of air by an axial flow fan is indicated by brightness. The velocity of flows of air increases in the order of brightness. The velocity of air flows of a portion which has high brightness (upper left side and upper right side) is faster than that of a portion which has low brightness (the other side). That is, as shown in Fig. 5, the velocity of flows of air by the axial flow fan of the embodiment is significantly greater than the velocity of flows of air by an axial flow fan of the related. Numerically, the flow rate of air blown by the axial flow fan of the embodiment is greater than the flow rate of air blown by the axial flow fan of the related art by about 5%.

[0038] Fig. 6 illustrates turbulent flows of air by the axial flow fan of the embodiment and the axial flow fan of the related art. In Fig. 6, the velocity of the turbulent flows of air is denoted by the same way as those used in Fig. 5. As shown in Fig. 6, the axial flow fan of the embodiment causes less turbulent flows (a portion having high brightness near the trailing edge) as compared with the axial flow fan of the related art. Numerically, as compared with the axial flow fan of the related art, the axial flow fan of the embodiment reduces turbulent flows by about 3% and noise by about 2%.

[0039] Hereinafter, an explanation will be given on an exemplary case where the axial flow fan 20 is used in an outdoor unit of an air conditioner.

[0040] Fig. 7 is a sectional view illustrating main parts of an air conditioner outdoor unit 100 in which the axial

flow fan 20 of the embodiment is used.

[0041] Referring to Fig. 7, a casing 110 forms the exterior of the air conditioner outdoor unit 100. A suction hole 111 is formed in the rear side of the casing 110, and a discharge hole 113 is formed in the front side of the casing 110. Various components of a heat exchanger are disposed in the casing 110.

[0042] For example, an outdoor heat exchanger 120 and a compressor 130 are disposed in the casing 110. Refrigerant flowing in the outdoor heat exchanger 120 exchanges heat with outdoor air, and the compressor 130 is used to compress the refrigerant. In addition, the axial flow fan 20 and a motor 140 are disposed in the casing 110. The axial flow fan 20 is rotated by the motor 140 to blow outdoor air for facilitating heat exchange between the air and the refrigerant flowing in the outdoor heat exchanger 120. In detail, as the axial flow fan 20 is rotated, air is introduced into the casing 110 through the suction hole 111 and discharged from the casing 110 through the discharge hole 113 after the air exchanges heat with the outdoor heat exchanger 120.

[0043] As described above, in the axial flow fan 20, the shortest distance measured from the imaginary line L2 passing through the center A2 of the hub 21 to the front end of the blade 23 may be different from the shortest distance measured from the imaginary line L2 to the rear end of the blade 23. That is, when the axial flow fan 20 is rotated, the trajectory of the front end of the tip 26 may be different from the trajectory of the rear end of the tip 26.

[0044] An orifice 150 is provided in the casing 110. The orifice 150 has an approximately ring shape. The orifice 150 guides air blown by the axial flow fan 20 to the outside of the casing 110 through the discharge hole 113. For this, the orifice 150 is disposed at the downstream side of the axial flow fan 20 in a direction in which air flows by the axial flow fan 20. That is, the orifice 150 is closer to the trailing edges 25 of the blades 23 of the axial flow fan 20 than the leading edges 24 of the blades 23 of the axial flow fan 20. The orifice 150 is overlapped with portions of the blades 23. That is, the orifice 150 is overlapped with the trailing edges 25 of the blades 23.

[0045] The output power of the axial flow fan 20 (that is, the flow rate of air blown by the axial flow fan 20) may be proportional to the size of the blades 23. Since the orifice 150 are close to the trailing edges 25, if the size of the trailing edges 25 of the blades 23 is increased to increase the size of the blades 23, components including the orifice 150 have to be redesigned. In other words, if the shortest distance RT2 from the imaginary line L2 passing through the center of the axial flow fan 20 to the rear end of the tip 26 of the blade 23 close to the trailing edge 25 is increased, it may be necessary to redesign components of the outdoor unit 100.

[0046] However, according to the embodiment, the size of the blade 23 can be increased by increasing the leading edge 24 of the blade 23 that is distant from the orifice 150, and thus it may be unnecessary to redesign the orifice 150. That is, the output power of the axial flow

fan 20 can be increased by increasing the shortest distance RL2 from the imaginary line L2 to the front end of the tip 26 close to the leading edge 24 without having to redesign components of the outdoor unit 100.

[0047] According to the embodiments, the axial flow fan and the air conditioner outdoor unit including the axial flow fan provide the following effects.

[0048] Owing to the above-described shape of the blade, noise can be reduced while increasing the flow rate of air.

[0049] In addition, noise of the axial flow fan can be reduced and the flow rate of air blown by the axial flow fan can be increased without having to redesign other components of the outdoor unit.

Claims

1. An axial flow fan comprising:

a hub; and
a plurality of blades disposed on an outer surface of the hub,
wherein each of the blades satisfies that a shortest distance measured from an imaginary line (L2) passing through a center of the hub to a front end of an outer edge of the blade is greater than a shortest distance measured from the imaginary line (L2) to a rear end of the outer edge of the blade,
wherein the front end of the outer edge of the blade is a leading end in a rotation direction of the blade, and the rear end of the outer edge of the blade is a trailing end in the rotation direction of the blade.

2. The axial flow fan according to claim 1, wherein each of blades comprises a leading edge in the rotation direction thereof, a trailing edge in the rotation direction thereof, and a tip as the outer edge, wherein a shortest distance (RL2) measured from the imaginary line (L2) passing through the center of the hub to a front end of the tip close to the leading edge is greater than a shortest distance (RT2) measured from the imaginary line (L2) to a rear end of the tip close to the trailing edge.

3. The axial flow fan according to claim 2, wherein a shortest distance from the imaginary line (L2) to the tip is gradually decreased in a direction from the front end of the tip close to the leading edge to the rear end of the tip close to the trailing edge.

4. The axial flow fan according to any one of claims 1 to 3, wherein the hub has a cylindrical shape.

5. The axial flow fan according to any one of claims 1 to 4, further comprising a rotation shaft coupled to

the hub for rotating the axial flow fan.

6. The axial flow fan according to claim 5, wherein the rotation shaft is coupled to the center of the hub. 5
7. The axial flow fan according to claim 5, wherein if the blades are rotated, air is forced to flow along the rotation shaft.
8. The axial flow fan according to claim 1, wherein each of the blades satisfies that when the blade is rotated, a trajectory formed by the front end of the outer edge of the blade is greater than a trajectory formed by the rear end of the outer edge of the blade. 10 15
9. The axial flow fan according to claim 8, wherein each of blades comprises a leading edge in a rotation direction thereof, a trailing edge in the rotation direction thereof, and a tip as the outer edge, wherein when the blade is rotated, the diameter of a trajectory formed by a portion of the blade close to the leading edge is greater than the diameter of a trajectory formed by another portion of the blade close to the trailing edge. 20 25
10. The axial flow fan according to claim 9, wherein the diameter of a trajectory formed by rotation of the blade is gradually reduced in a direction from a front end of the tip close to the leading edge to a rear end of the tip close to the trailing edge. 30
11. The axial flow fan according to claim 8, wherein a trajectory formed by rotation of the blade has a cylindrical shape with a diameter gradually reducing in a direction of air blown by the axial flow fan. 35

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Fig. 1

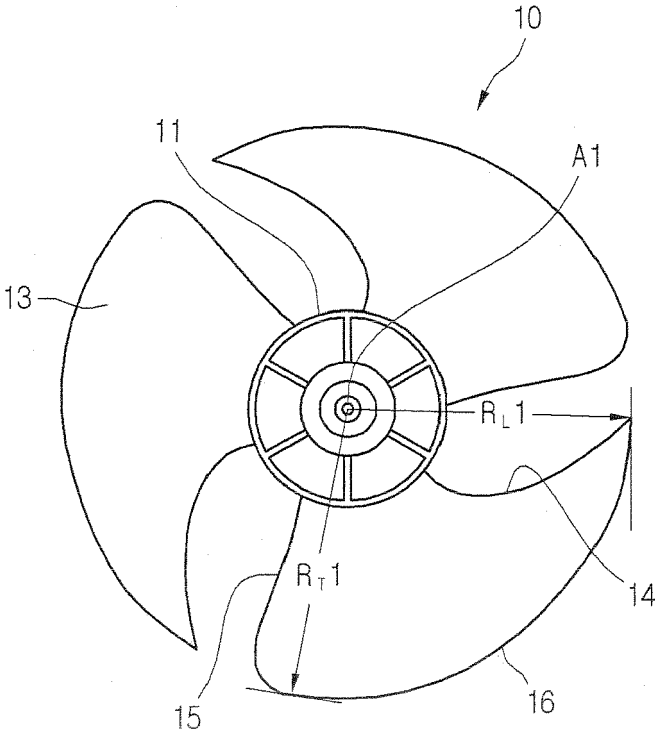


Fig. 2

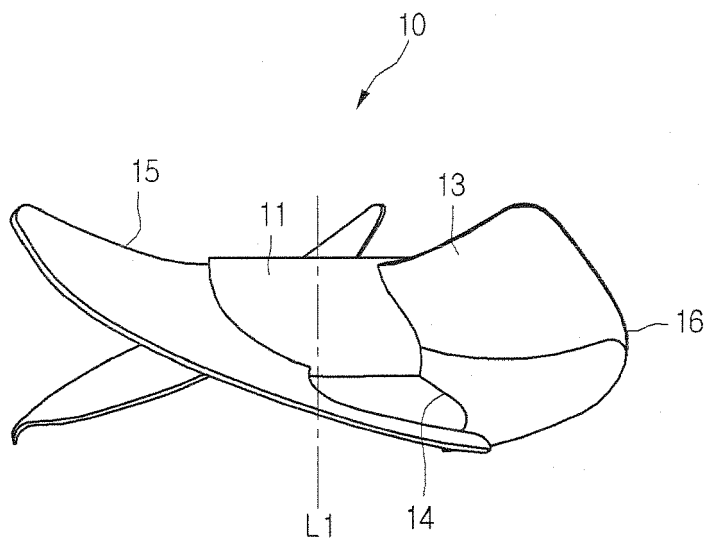


Fig. 3

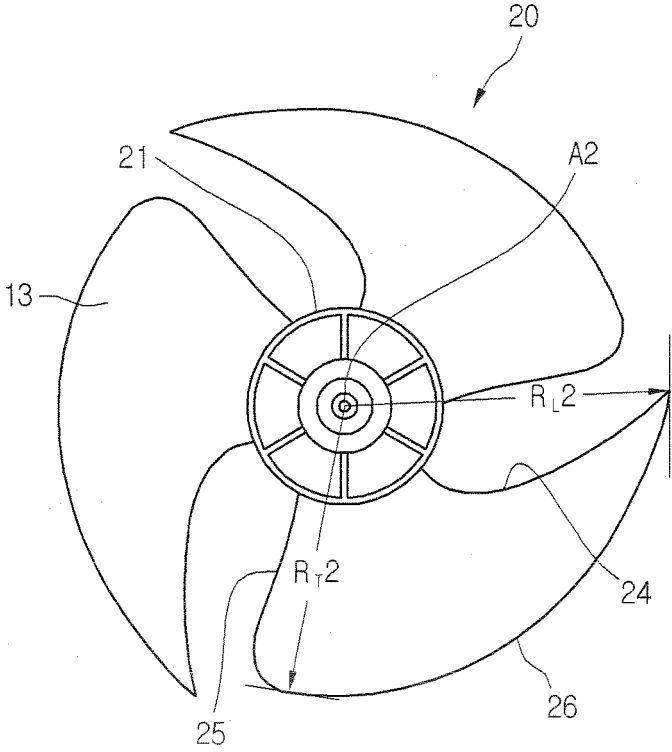


Fig. 4

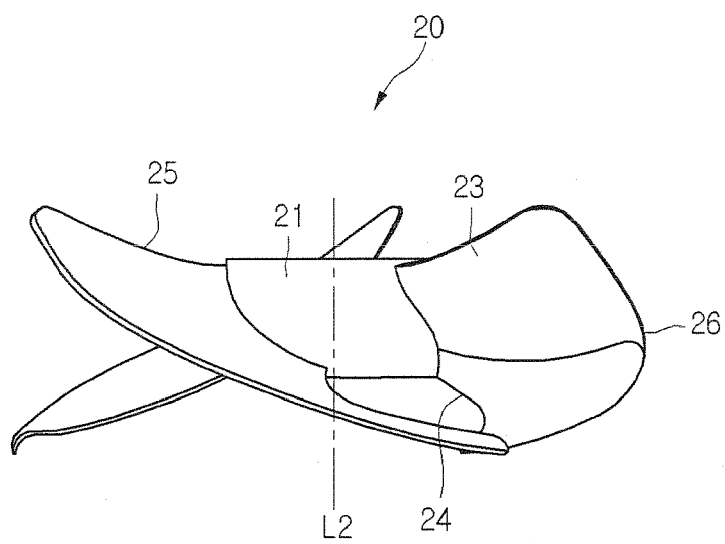
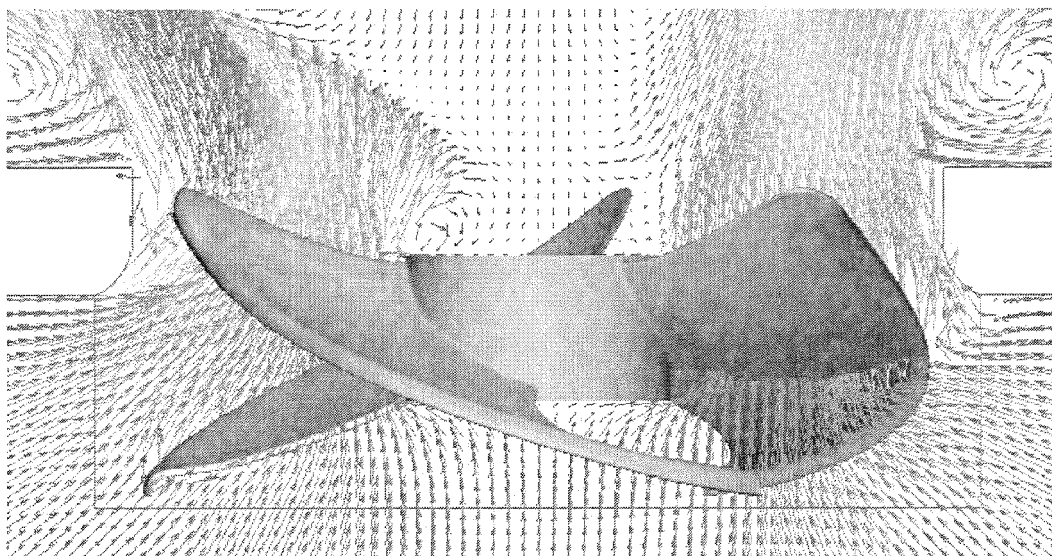
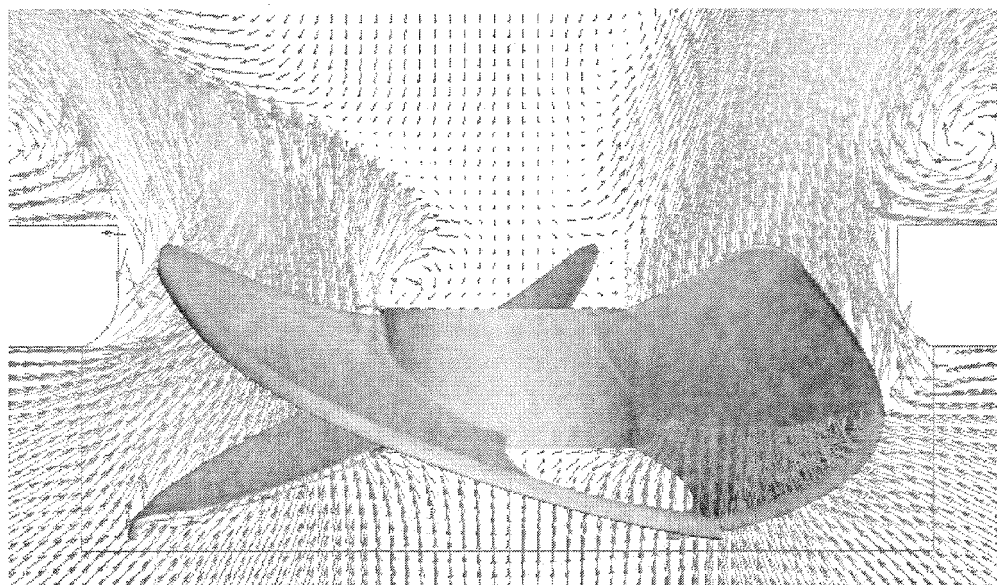


Fig. 5

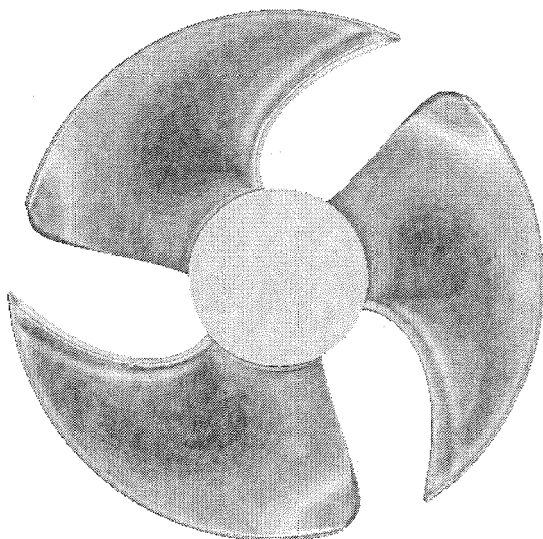


-Present invention-

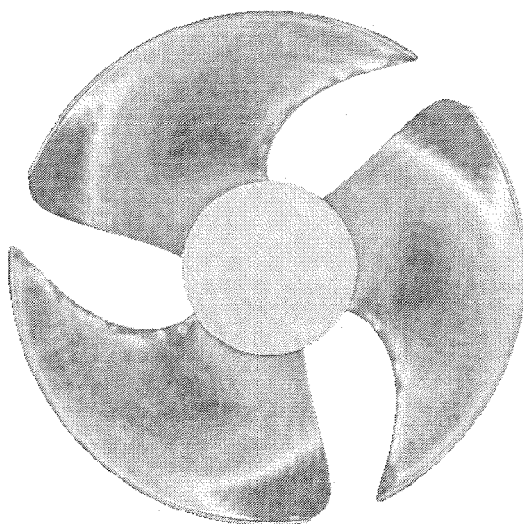


-Prior art-

Fig. 6



-Present invention-



-Prior art-

Fig. 7

