



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.07.2011 Bulletin 2011/29

(51) Int Cl.:
F04D 17/04 (2006.01) F04D 29/28 (2006.01)

(21) Application number: **11150299.3**

(22) Date of filing: **06.01.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(30) Priority: **13.01.2010 KR 20100003044**

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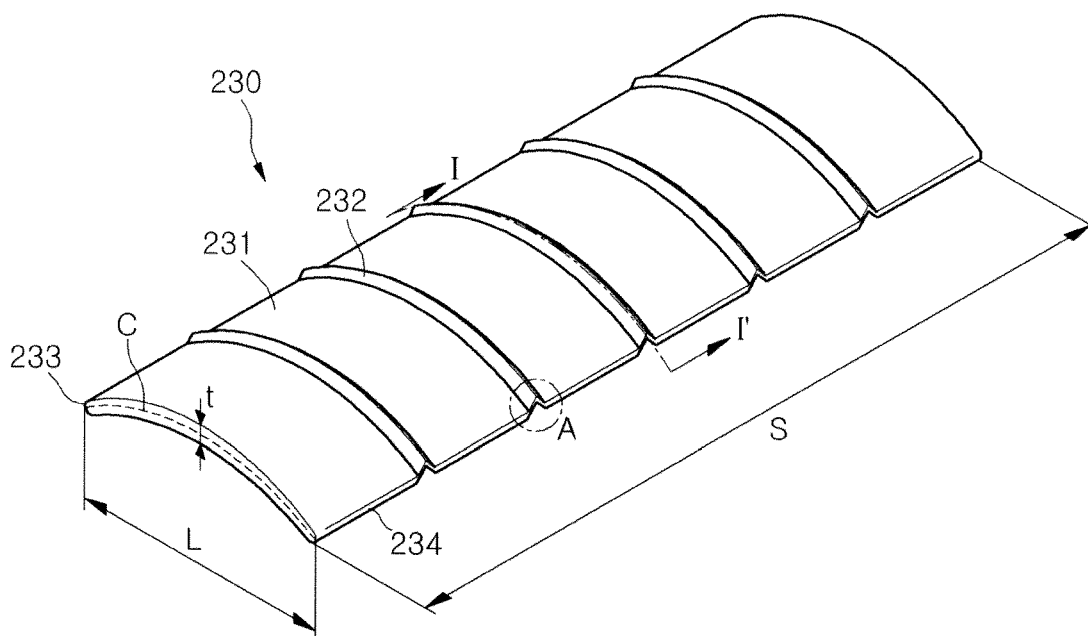
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(54) **Cross-flow fan and air conditioner equipped therewith**

(57) Provided are a cross-flow fan and an air conditioner including the same. A blade constituting the cross-

flow fan may be changed in shape to reduce a turbulence intensity of a discharge part of the fan and noises of the fan.

Fig. 3



Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefits of priority to Korean Patent Application No. 10-2010-0003044 (filed on January 13, 2010), which is herein incorporated by reference in its entirety.

BACKGROUND

[0002] The present disclosure relates to a cross-flow fan and an air conditioner including the same.

[0003] A cross-flow fan is referred to as a tangential fan. The cross-flow fan includes one or more fan blocks, which include a plurality of blades curved in a rotation direction. In the cross-flow fan, a suction flow does not occur in an axial direction, but occurs within a plane perpendicular to a shaft of the fan blocks.

[0004] The cross-flow fan may be widely applicable to a blower such as an air conditioner as well as may be applicable to a display device to cool a display module.

[0005] The cross-flow fan has a limitation in that a lot of noise occurs due to air current passing through the blades constituting the fan block.

SUMMARY

[0006] Embodiments provide a low-noise cross-flow fan having an improved structure of a blade constituting an impeller and an air conditioner including the low-noise cross-flow fan.

[0007] In one embodiment, a cross-flow fan including: a plurality of blades radially disposed relative to a rotation axis, the plurality of blades being spaced from each other along a circumference direction; and a supporting plate supporting the blades is characterized in that an uplift portion protrudes from the respective blades, and the uplift portion extends from an inner end of the blade to an outer end.

[0008] 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.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Fig. 1 is a side sectional view of an air conditioner including a cross-flow fan according to an embodiment.

[0010] Fig. 2 is a perspective view of a cross-flow fan according to an embodiment.

[0011] Fig. 3 is a perspective view of a blade constituting the cross-flow fan.

[0012] Fig. 4 is a side view of a cross-flow fan according to an embodiment.

[0013] Fig. 5 is an enlarged view illustrating a portion A of Fig. 3.

[0014] Fig. 6 is a sectional view taken along line I-I of Fig. 3 that illustrates a blade according to a first embodiment.

[0015] Fig. 7 is a schematic sectional view of a flow occurring on the blade according to the first embodiment.

[0016] Fig. 8 is a simulation comparing an airflow occurring in a cross-fan according to a related art to an airflow occurring in a cross-fan according to an embodiment.

10 [0017] Fig. 9 is a sectional view taken along line I-I of Fig. 3 that illustrates a blade according to a second embodiment.

15 [0018] Fig. 10 is a sectional view taken along line I-I of Fig. 3 that illustrates a blade according to a third embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0019] In the following detailed description of the preferred embodiments, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific preferred embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is understood that other embodiments may be utilized and that logical structural, mechanical, electrical, and chemical changes may be made without departing from the spirit or scope of the invention. To avoid detail not necessary to enable those skilled in the art to practice the invention, the description may omit certain information known to those skilled in the art. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined only by the appended claims.

[0020] Fig. 1 is a side sectional view of an air conditioner including a cross-flow fan according to an embodiment.

40 [0021] Referring to Fig. 1, an air conditioner 10 according to an embodiment includes a body 11 defining an outer appearance thereof, a heat exchanger 12 disposed inside the body 11, and a cross-flow fan 20 disposed under the heat exchanger 12 to discharge air passing through the heat exchanger 12 to the outside.

45 [0022] In detail, a suction grill 111 is disposed in a side of the body 11, i.e., a top surface of the body 11 to suck indoor air into the body 11. A separate suction hole may be defined in a front surface of the body 11 and selectively opened or closed by a suction panel 112. A filter 13 may be disposed at a rear side of the suction hole closed by the suction grill 111 and the suction panel 112 to filter foreign substances contained in sucked air.

50 [0023] Air suction and discharge of the cross-flow fan 20 are guided by a discharge guide 14. In detail, a discharge end of the discharge guide 14 communicates with the discharge hole 113 defined in a lower side of the body 11. Thus, air sucked by the cross-flow fan 20 is discharged into an indoor room through the discharge hole

113. A discharge louver 115 and a discharge vane 114 may be disposed in the discharge hole 113. The discharge louver 115 may guide a horizontal airflow of discharged air, and the discharge vane 114 may guide a vertical airflow of the discharged air. Furthermore, the discharge vane 114 may selectively close the discharge hole 113.

[0024] Also, the discharge guide 14 includes a stabilizer 142 disposed spaced from an edge of one side of the cross-flow fan 20 and a rear guide 141 disposed spaced from an edge of the other side of the cross-flow fan 20.

[0025] Fig. 2 is a perspective view of a cross-flow fan according to an embodiment, and Fig. 3 is a perspective view of a blade constituting the cross-flow fan.

[0026] Referring to Figs. 2 and 3, the cross-flow fan 20 according to an embodiment includes a plurality of fan blocks 210 coupled to each other. In detail, each of the fan blocks 210 includes a plurality of blades 230 radially arranged at a uniform pitch or a random pitch with respect to a rotation shaft and a supporting plate 220 having a circular plate and supporting an end of each of the blades 230. The rotation shaft of the cross-flow fan 20 passes through a center of the supporting plate 220.

[0027] Each of the plurality of blades 230 constituting the fan blocks 210 includes a blade body 231 and uplift portions 232 protruding with a distance therebetween in a length direction of the blade body 231.

[0028] Here, a length of each of the blades 230 is defined as a span S , a width of each of the blades 230 perpendicular to the length direction is defined as a chord L . Also, a side end adjacent to the rotation shaft of the cross-flow fan 20 is defined as an inner edge 233, and a side end opposite to the side end adjacent to the rotation shaft is defined as an outer edge 234. A diameter of a circle connecting the inner edges 233 of the blades 230 to each other is defined as a fan inner diameter $D1$, and a diameter of a circular connecting outer edges 234 of the blades 230 is defined as a fan outer diameter $D2$ (refer to Fig. 4).

[0029] Also, the blade 230 has a curved shape having a predetermined curvature in a width direction. In detail, a negative-pressure surface defining an outer surface of the cross-flow fan 20 has a curvature different from that of a positive-pressure surface receiving an air pressure on a surface opposite to the negative-pressure surface. A distance between the negative-pressure surface and the positive-pressure surface is defined as a thickness of the blade 230, and a volume between the negative-pressure surface and the positive-pressure surface is defined as a thickness t of the blade body 231. Also, the thickness of the blade body 231 is the thickest at a point at which the width of the blade 230 is bisected. A line bisecting the thickness of the blade 230 is defined as a camber line.

[0030] Each of the uplift portions 232 is disposed from the inner edge 233 from the blade body 231 to the outer edge 234. Also, the uplift portion 232 protrudes in a shape

having a width gradually decreasing upward or in a circularly rounded shape.

[0031] Fig. 4 is a side view of a cross-flow fan according to an embodiment.

[0032] Referring to Fig. 4, the cross-flow fan 20 according to an embodiment has a shape in which the plurality of blades 230 is radially arranged from a point spaced a predetermined distance from a rotation center. In detail, a mean camber line is defined by an inner blade tip angle $\beta 1$ and an outer blade tip angle $\beta 2$ of each of the blades 230. Here, the inner blade tip angle $\beta 1$ represents an angle between a tangent line $h1$ of a circle passing through the inner edge 233 of the blade 230 and a tangent line $h2$ passing through the mean camber line at the inner edge 233. Similarly, the outer blade tip angle $\beta 2$ represents an angle between a tangent line $h3$ of a circle passing through the outer edge 234 of the blade 230 and a tangent line $h4$ passing through the mean camber line at the outer edge 234.

[0033] Fig. 5 is an enlarged view illustrating a portion A of Fig. 3.

[0034] Referring to Fig. 5, the plurality of uplift portions 232 is disposed on the blade 230 according to an embodiment with a predetermined distance. The uplift portions 232 protrude from the negative-pressure surface of the blade 230. Also, each of the uplift portions 232 protrudes in a triangular shape having a width gradually decreasing upward.

[0035] In detail, an end of the outer edge 234 side of at least the blade 230 of both ends of each of the uplift portions 232 is curved with the same curvature as that of an outer peripheral arc k of the cross-flow fan 20. Hereinafter, the end of the outer edge 234 side of the blade 230 is referred to as an outer end, and an end of the inner edge 233 side of the blade 230 is referred to as an inner end.

[0036] As shown in Fig. 5, a cusp of the outer end of each of the uplift portions 232 is spaced a predetermined length p from the tangent line passing through the outer edge 234 of the blade 230. This occurs because the outer end of the uplift portion 232 is curved with the same curvature as that of the outer peripheral arc k of the cross-flow fan 20, and also may be clearly confirmed through Fig. 6. As described above, since the uplift portion 232 is disposed on the negative-pressure surface of the blade 230 and the outer end of at least the uplift portion 232 is curved with the same curvature as that of the outer peripheral arc k of the cross-flow fan 20, air passing through the cross-flow fan 20 may be reduced in turbulence intensity to significantly reduce noises.

[0037] Fig. 6 is a sectional view taken along line I-I of Fig. 3 that illustrates a blade according to a first embodiment.

[0038] Referring to Fig. 6, an uplift portion 232 of a blade 230 according to a first embodiment has a section similar to that of a blade body 231. Thus, it seems that the blade 230 has two sections different from each other. That is to say, the section of the blade body 231 overlaps

the section of the uplift portion 232. Also, the uplift portion 232 has an inner edge and an outer edge. In addition, the uplift portion 232 has a chamber line bisecting a thickness thereof and a chord defining a width thereof. The blade 230 may have a sectional shape varied according to sizes of inner and outer blade tip angles β_1 and β_2 and inner and outer blade tip angles of the uplift portion.

[0039] Referring to the sectional view according to the first embodiment, the blade body 231 has a chord length greater than that of the uplift portion 232. Also, the blade body 231 has the same inner and outer blade tip angles as those of the uplift portion 232.

[0040] Fig. 7 is a schematic sectional view of a flow occurring on the blade according to the first embodiment.

[0041] Referring to Fig. 7, air forcedly flowing by the cross-flow fan 20 flows along a positive-pressure surface of the blade 23. The air flowing along the positive-pressure surface of the blade 23 is divided by the outer end of the blade 23. Here, air discharged along a recessed surface of an inner side of the uplift portion 232 and a portion of air discharged along the positive-pressure surface of the blade body 231 are bent toward the negative-pressure surface of the blade 23. This is done because a pressure difference between the negative-pressure surface of the blade 23 and the positive-pressure surface of the blade body 231 occurs, and thus it has an influence on a flow of air flowing from a high pressure to a low pressure. Here, the air bent at the outer end of the blade body 231 is interrupted by the air discharged at the end of the uplift portion 232. Therefore, the air flowing along the positive-pressure surface of the blade body 231 may be smoothly discharged, and thus, an amount of air may be increased as well as the noises may be reduced.

[0042] Fig. 8 is a simulation comparing an airflow occurring in a cross-fan according to a related art to an airflow occurring in a cross-fan according to an embodiment.

[0043] Referring to Fig. 8, a left side of Fig. 8 illustrates an airflow occurring in a cross-flow fan region according to a related art, and a right side of Fig. 8 illustrates an airflow occurring in a cross-flow fan region according to an embodiment.

[0044] When comparing three regions D, E, and F of the cross-flow fan according to the related art to three regions d, e, and f of the cross-flow fan according to the embodiment, it may be seen that a turbulence intensity of the cross-flow fan according to the embodiment is reduced when compared to that of the cross-flow fan according to the related art. That is, it may be seen that the blade structure of the cross-flow fan according to the embodiment is applied to reduce the turbulence intensity at the discharge part of the fan and the noises of the fan. This may be obvious from the airflow described in Fig. 7.

[0045] Fig. 9 is a sectional view taken along line I-I of Fig. 3 that illustrates a blade according to a second embodiment.

[0046] Referring to a sectional view of a blade 230 according to a second embodiment, similar to that of the first

embodiment, a blade body 231 has a chord length greater than that of an uplift portion 232. Also, the blade body 231 has the same inner blade tip angle as that of the uplift portion 232. However, the blade body 232 has an outer blade tip angle greater than that of the uplift portion.

[0047] Fig. 10 is a sectional view taken along line I-I of Fig. 3 that illustrates a blade according to a third embodiment.

[0048] Referring to a sectional view of a blade according to a third embodiment, a blade body 231 has the same chord length as that of an uplift portion 232. Also, the blade body 231 has the same outer blade tip angle as that of the uplift portion 232. However, the blade body 231 has an inner blade tip angle less than that of the uplift portion 232.

[0049] According to the cross-flow fan including the above-described components and the air conditioner including the cross-flow fan, the noises due to the air passing through the blade may be reduced. That is, the turbulence intensity at the discharge part of the fan block may be reduced to reduce the noises.

[0050] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

Claims

1. A cross-flow fan comprising: a plurality of blades radially disposed relative to a rotation axis, the plurality of blades being spaced from each other along a circumference direction; and a supporting plate supporting the blades, **characterized in that** an uplift portion protrudes from the respective blades, and the uplift portion extends from an inner end of the blade to an outer end.
2. The cross-flow fan according to claim 1, wherein the outer end of the uplift portion is curved with the same curvature as that of an outer peripheral arc of the cross-flow fan.
3. The cross-flow fan according to claim 2, wherein the uplift portion has a shape having a width gradually decreasing upward.
4. The cross-flow fan according to claim 2, wherein a chamber line passing through the uplift portion is

rounded with a curvature different from that of a chamber line passing through a blade body.

5. The cross-flow fan according to claim 1, wherein the uplift portion is provided in plurality along a length direction of the blade, and the plurality of uplift portions is spaced from each other. 5
6. The cross-flow fan according to claim 1, wherein the blade comprises a blade body disposed on a surface on which a positive-pressure surface and a negative-pressure surface face each other, and the uplift portion protrudes from the positive-pressure surface of the blade toward the negative-pressure surface. 10
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7. The cross-flow fan according to claim 6, wherein the blade body has a width greater than that of the uplift portion, and the blade body has the same inner and outer blade tip angle as that of the uplift portion corresponding to the blade body. 20
8. The cross-flow fan according to claim 6, wherein the blade body has a width greater than that of the uplift portion, the blade body has the same inner blade tip angle as that of the uplift portion, and the blade body has an outer blade tip angle greater than that of the uplift portion. 25
30
9. The cross-flow fan according to claim 6, wherein the blade body has the same width as that of the uplift portion, the blade body has an inner blade tip angle less than that of the uplift portion, and the blade body has the same outer blade tip angle as that of the uplift portion. 35
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10. An air conditioner comprising the cross-flow fan according to any one of claim 1 to 9. 40
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Fig. 1

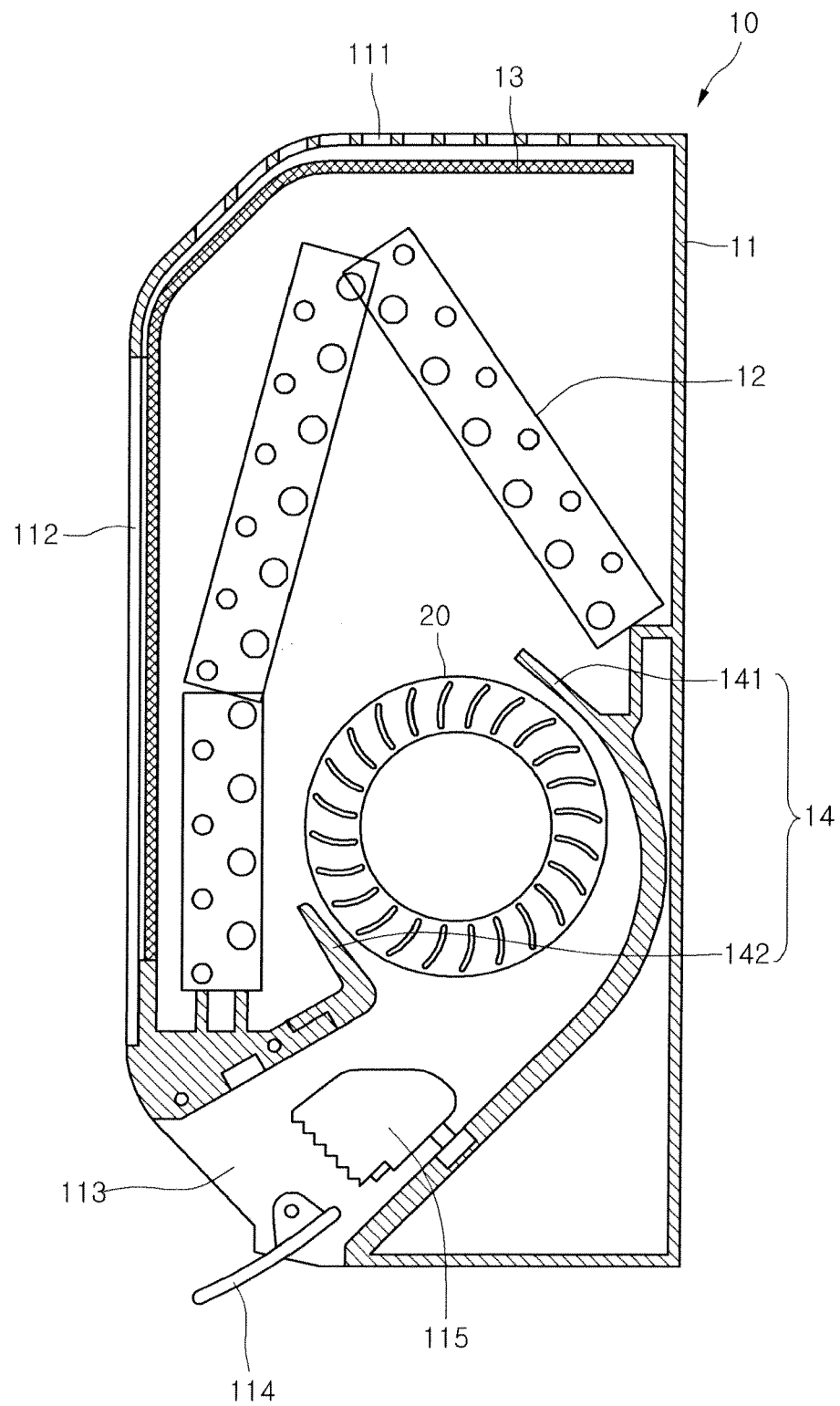


Fig. 2

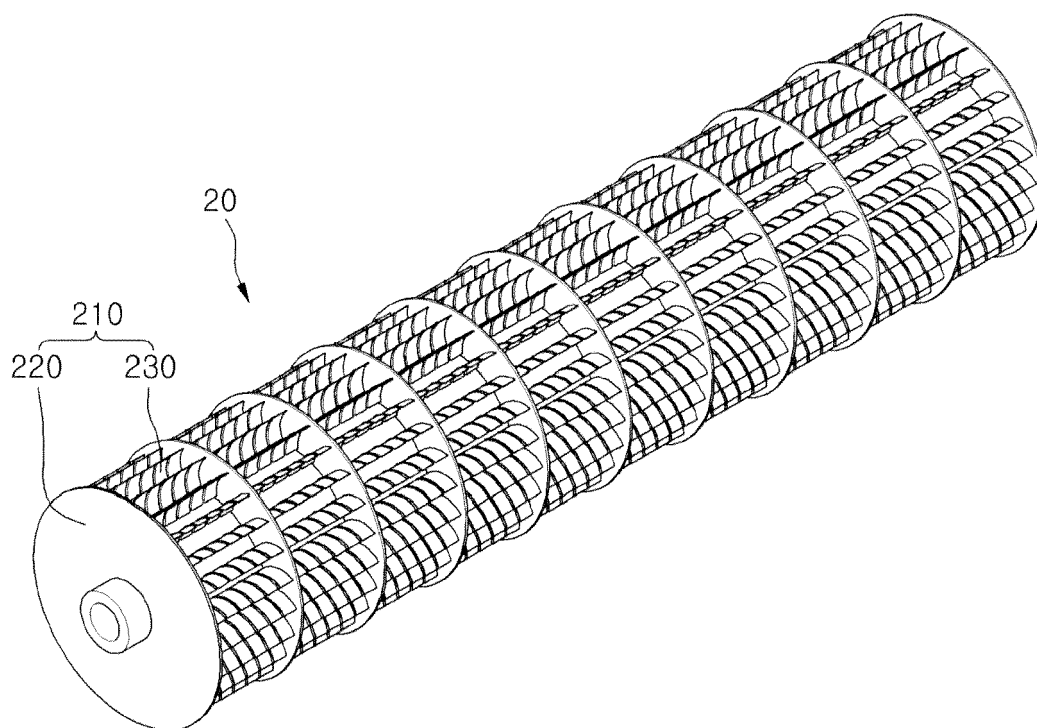


Fig. 3

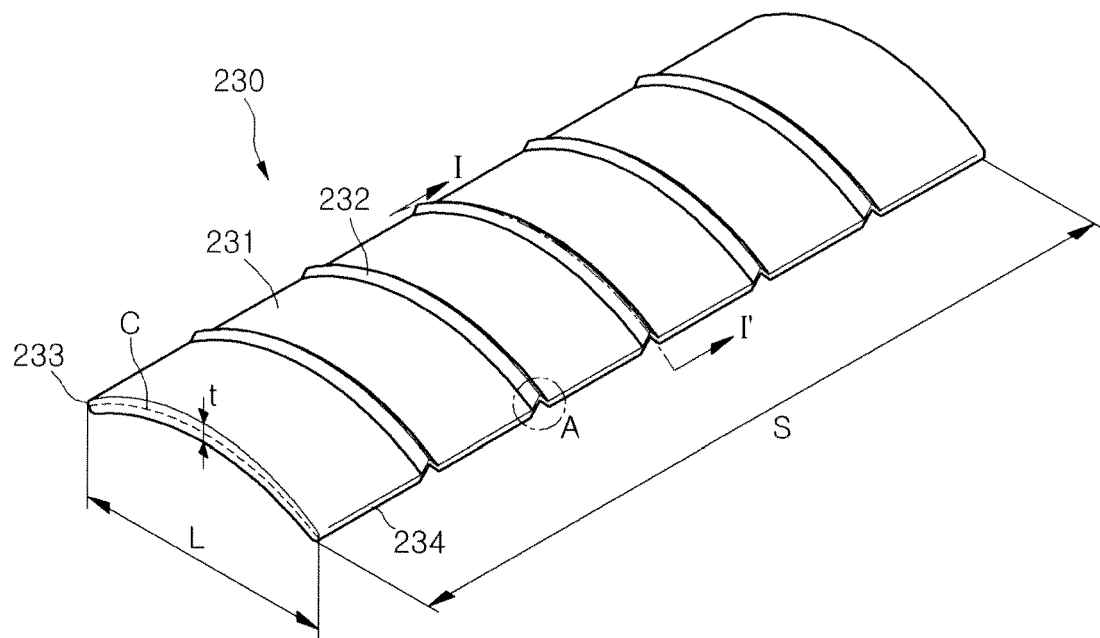


Fig. 4

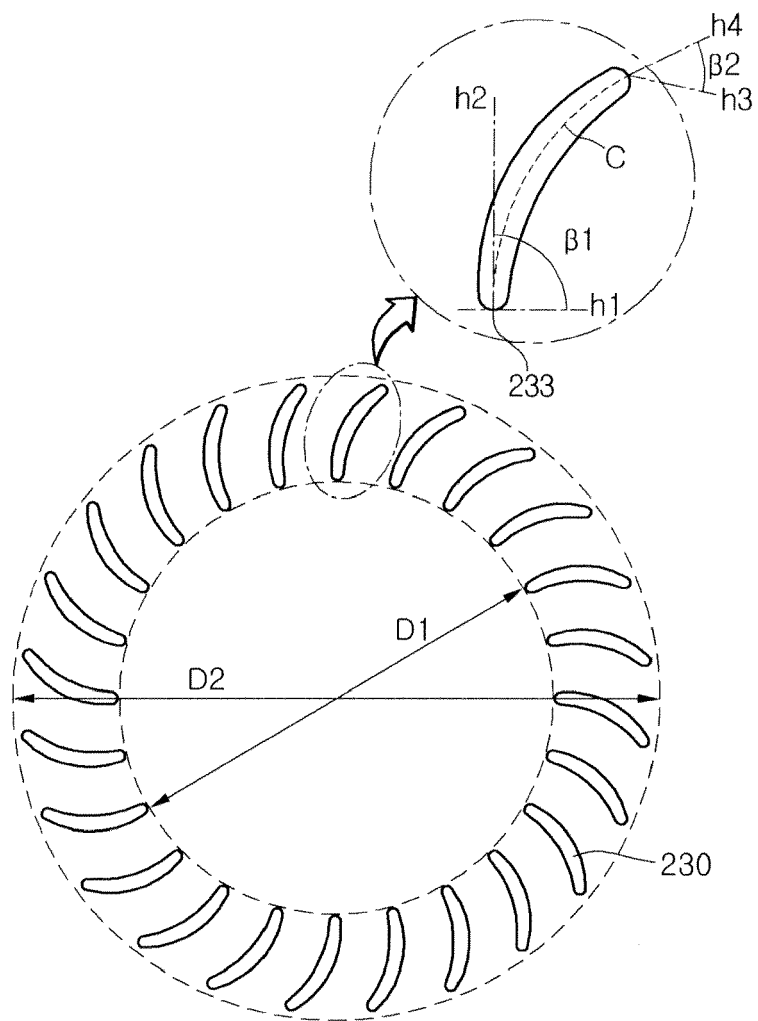


Fig. 5

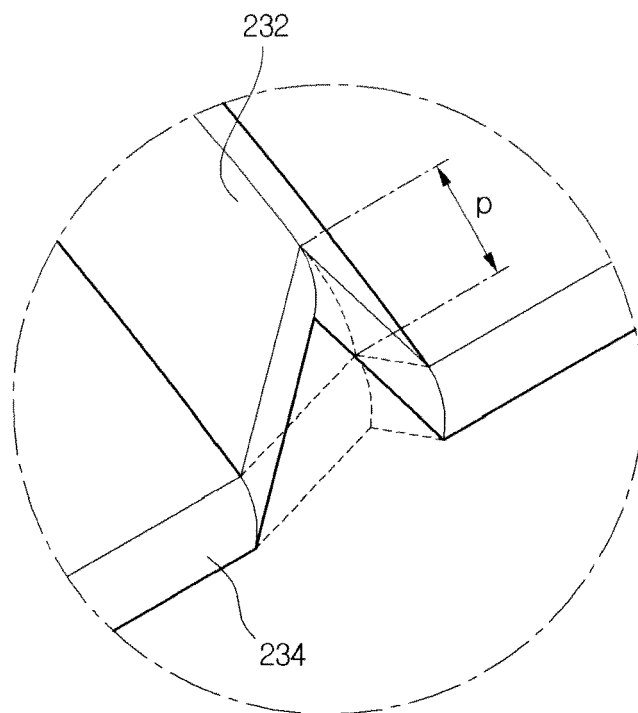


Fig. 6

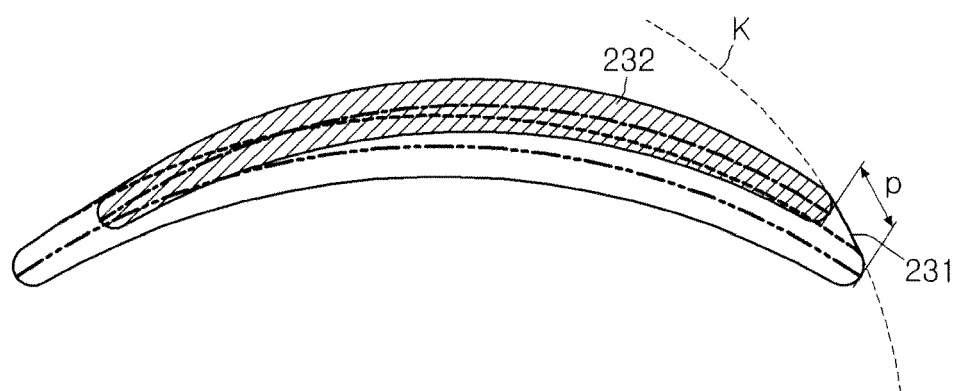


Fig. 7

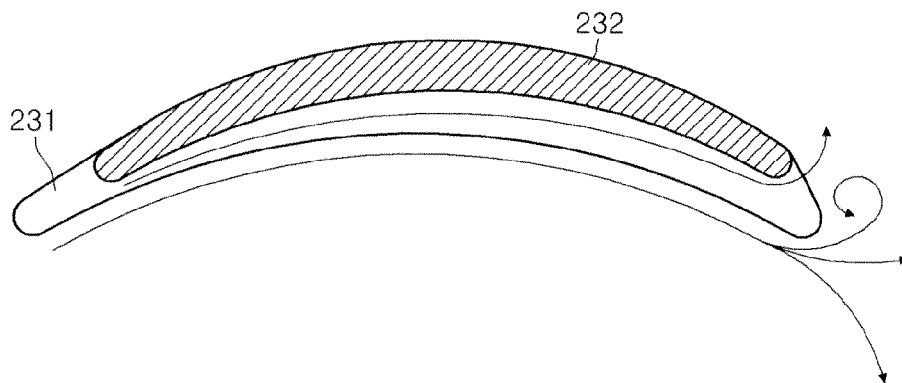


Fig. 8

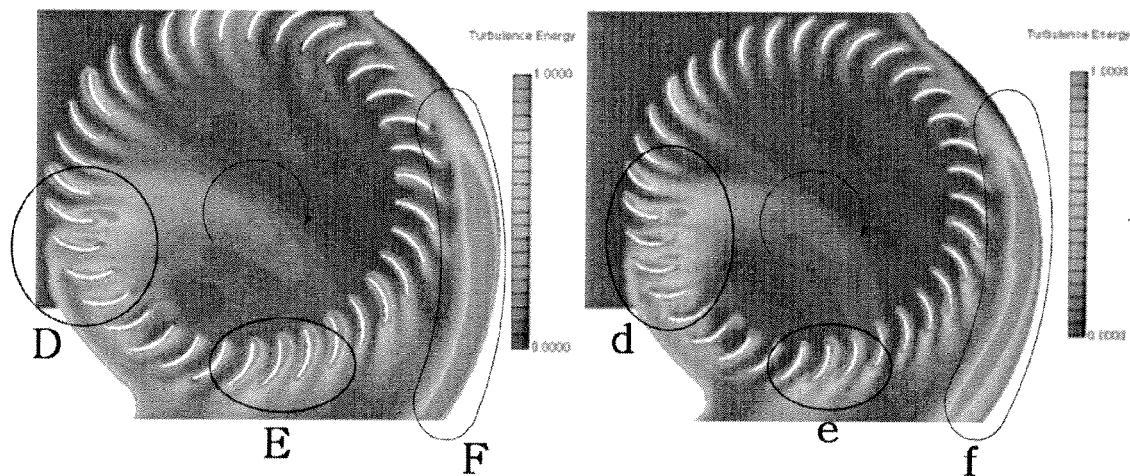


Fig. 9

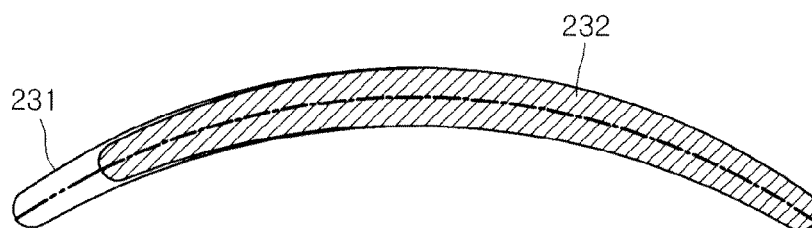
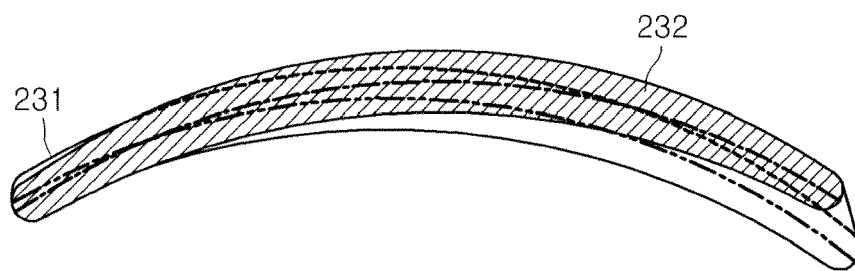


Fig. 10



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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