(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 610 068 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
28.12.2005 Bulletin 2005/52

(21) Application number: **04724144.3**

(22) Date of filing: **29.03.2004**

(51) Int Cl.[7]: **F24F 5/00**

(86) International application number:
PCT/JP2004/004426

(87) International publication number:
WO 2004/088210 (14.10.2004 Gazette 2004/42)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **31.03.2003 JP 2003096748**

(71) Applicant: **Toshiba Carrier Corporation**
Tokyo 105-0023 (JP)

(72) Inventors:
- **ISHIJIMA, Mitsuyoshi Fuji ,Thoshiba Carr.Corp**
Shizuoka-Ken (JP)
- **TAKEUCHI, Akihiro Fuji ,Thoshiba Carr.Corp**
Shizuoka-Ken (JP)

(74) Representative: **Kramer - Barske - Schmidtchen**
Radeckestrasse 43
81245 München (DE)

(54) OUTDOOR UNIT FOR AIR CONDITIONER

(57) In an outdoor unit of an air conditioner, provided with an axial fan provided with a plurality of vanes arranged with a predetermined interval along an outer peripheral surface of a hub, each of the vanes having a vane rear edge portion having a profile line in a rotational direction so as to provide concave shape in a vane front edge direction, and a bell mouth arranged in an air blowing side by the axial fan, the outdoor unit is provided with an axial blower in which the bell mouth and the axial fan are arranged so as to satisfy a ratio (X/L) to be in a range between 0.2 and 0.8 in which X is a distance between a most fallen portion to an inner side in the rotational direction of the profile line of the vane rear edge and an air outflow surface of the bell mouth, and L is a length in an axial direction of the bell mouth.

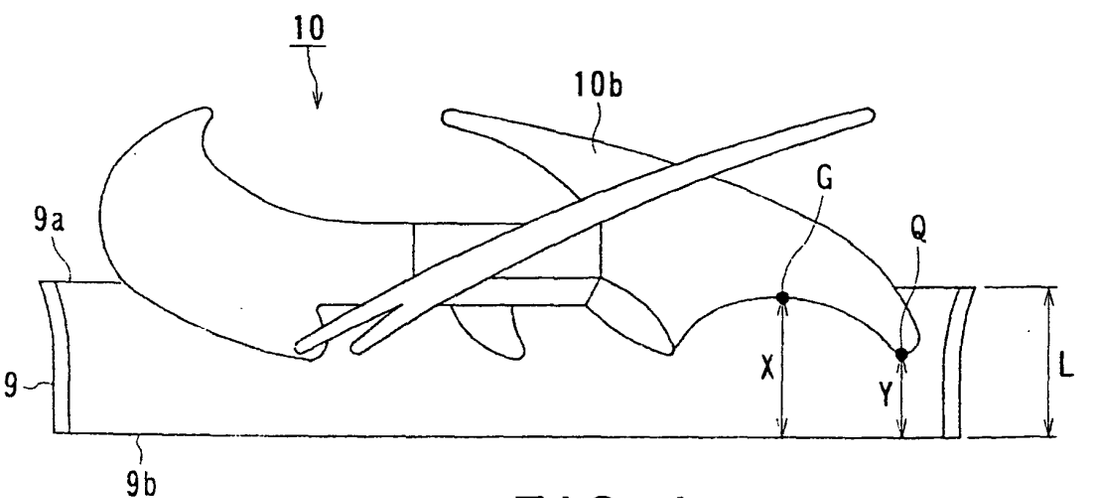

FIG. 4

EP 1 610 068 A1

Description

Technical Field

[0001] The present invention relates to an outdoor unit of an air conditioner, and more particularly to an outdoor unit provided with an axial blower which can suppress blower noise.

Background Art

[0002] Conventionally, the outdoor unit of the air conditioner is structured such that a bell mouth is attached to a discharge opening, and an axial blower having an axial fan provided with a plurality of vanes, which are arranged with a predetermined interval along an outer peripheral surface of a rotary hub, is arranged in an air inflow direction to the bell mouth.

[0003] In the axial fan of the outdoor unit as mentioned above, when air is blown in an axial direction in accordance with a rotation of the axial fan, a front edge portion of the vane accords with an air introducing direction, and a rear edge portion of the vane accords with an air outflow direction.

[0004] In recent years, in order to fulfil a demand of increasing a blowing amount and a demand of reducing a load of an electric motor, there has been provided an axial fan in which a corner portion, at which a front edge portion of the vane and an outer peripheral portion of the vane intersect, protrudes largely to a rotation direction side, and a profile line of the rear edge portion is formed in a concave shape in the air inflow direction (for example, Japanese Patent Application Laid-Open No. 2002-257088).

[0005] In the axial fan mentioned above, it is possible to reduce a vortex generated in wake of the vane rear edge portion and, hence, to attain an effect of reducing the blower noise and reducing the electric motor load in comparison with a case that the rear edge portion of the vane is formed in an approximately linear shape,.

[0006] However, in the conventional axial fan, since the profile line of the vane rear edge portion is positioned in an air introducing direction from a side peripheral end of the air inflow surface of the bell mouth, the air flowing out from the vane rear edge portion comes into collision with a peripheral end portion of the air inflow surface of the bell mouth, generating the vortex and, thereby, causing an increase of the blower noise.

Disclosure of The Invention

[0007] The present invention was conceived by taking the above circumstances into consideration, and an object of the present invention is to provide an outdoor unit of an air conditioner provided with an axial blower which intends to rectify a vane rear edge portion by optimizing a positional relation in an axial direction between the vane rear edge portion and a bell mouth, thereby reducing the blower noise.

[0008] In order to achieve the above object, according to the present invention, there is provided an outdoor unit of an air conditioner, comprising: an axial fan provided with a plurality of vanes with a predetermined interval along an outer peripheral surface of a hub, each of the vanes having a vane rear edge portion having a profile line in a rotational direction to provide a concave shape in a vane front edge direction; and a bell mouth arranged on an air blowing side from the axial fan, wherein the bell mouth and the axial fan are arranged so as to satisfy a ratio (X/L) to be in a range between 0.2 and 0.8 in which X is a distance between a most recessed portion to an inner side in the rotational direction of the profile line of the vane rear edge and an air outflow surface of the bell mouth and L is a length in an axial direction of the bell mouth.

[0009] The above object can be also achieved by providing an outdoor unit of an air conditioner, comprising: an axial fan provided with a plurality of vanes with a predetermined interval along an outer peripheral surface of a hub, each of the vanes having a vane rear edge portion having a profile line in a rotational direction to provide a concave shape in a vane front edge direction; and a bell mouth arranged on an air blowing side from the axial fan, wherein the bell mouth and the axial fan are arranged so as to satisfy a ratio (Y/L) to be in a range between 0.3 and 0.9 in which Y is a distance between a point where a profile line in a circumferential direction of the vane and a profile line of the vane rear edge portion intersect and an air outflow surface of the bell mouth and L is a length in an axial direction of the bell mouth.

[0010] In the above embodiments, it is desired that the concave shape of the profile line of the vane rear edge portion is a circular arc shape.

[0011] The concave shape of the profile line of the vane rear edge portion may be a V-shape or a trapezoidal shape.

[0012] More preferably, the above object of the present invention is achieved by providing an outdoor unit of an air conditioner, comprising: an axial fan provided with a plurality of vanes with a predetermined interval along an outer peripheral surface of a hub, each of the vanes having a vane rear edge portion having a profile line in a rotational direction to provide a concave shape in a vane front edge direction; and a bell mouth arranged on an air blowing side from the axial fan, wherein the bell mouth and the axial fan are arranged so as to satisfy a ratio (X/L) to be in a range between 0.2 and 0.8 in which X is a distance between a most recessed portion to an inner side in the rotational direction of the profile line of the vane rear edge and an air outflow surface of the bell mouth and L is a length in an axial direction of the bell mouth, and wherein the bell mouth and the axial fan are arranged so as to satisfy a ratio (Y/L) to be in a range between 0.3 and 0.9 in which Y is a distance between a point where a profile line in a circumferential direction of the vane and a profile line of

the vane rear edge portion intersect and an air outflow surface of the bell mouth and L is a length in an axial direction of the bell mouth.

[0013] As described above, according to the present invention, it is possible to provide the outdoor unit of the air conditioner provided with the axial blower capable of satisfying both demands of a blowing rate and of reduction of the electric motor load, inhibiting a vortex generated in the vane rear edge portion of the axial fan and reducing a blower noise, by setting a positional relation between the vane of the axial fan and the bell mouth to an optimum value, in the outdoor unit of the air conditioner.

Brief Description of The Drawings

[0014]

Fig. 1 is a schematic sectional view of an outdoor unit of an air conditioner according to the present invention.

Fig. 2 is a plan view showing an entire structure of an axial fan of the present invention as seen from a positive pressure surface side of a vane.

Fig. 3 is an enlarged view showing one vane of the axial fan according to a first embodiment of the present invention shown in Fig. 2.

Fig. 4 is a view showing a positional relation between the axial fan and a bell mouth in the first embodiment.

Fig. 5 is a graph showing a relation between a ratio (X/L) and a blower noise in the first embodiment (in which X: distance between a most recessed point of a profile line of a vane rear edge of the axial fan and an air outflow surface of the bell mouth; and L: length in an axial direction of the bell mouth).

Fig. 6 is an enlarged view showing one vane of an axial fan according to a first modified embodiment of the first embodiment.

Fig. 7 is an enlarged view showing one vane of an axial fan according to another modified embodiment of the first embodiment.

Fig. 8 is a graph showing a relation between a ratio (Y/L) and a blower noise according to a second embodiment of the present invention (in which Y: distance between a point where a profile line in a circumferential direction of a vane of the axial fan and a profile line of a vane rear edge portion intersect and an air outflow surface of the bell mouth is set to Y, and L: length in an axial direction of the bell mouth).

Best Mode for Carrying Out The Invention

[0015] Hereunder, embodiments according to the present invention will be described with reference to Figs. 1 to 8.

[0016] Fig. 1 is a sectional view of an outdoor unit 1 of an air conditioner.

[0017] The outdoor unit 1 is used in a state of being connected to an indoor unit, not shown, and is constituted by a bottom plate 2 arranged in a floor surface outside the room, structural members or parts, which will be mentioned hereinlater, arranged on the bottom plate 2, a discharge opening 4 and a main body cover 3 having a fan guard 5 which covers the discharge opening 4 and covering the structural members and the bottom plate 2.

[0018] The outdoor unit 1 is provided with a compressor 6 circulating a refrigerant in a refrigeration cycle, a refrigeration cycle member including an outdoor heat exchanger 7 in which plate-like heat radiation fins are laminated with a predetermined interval in a heat exchanger tube through which the refrigerant flows, a blower 8 for supplying an outdoor air to the outdoor heat exchanger 7, and a bell mouth 9 formed to the discharge opening 4, as the structural members, in an inner portion thereof.

[0019] The blower 8 is constituted by an axial fan 10 and a fan motor 11 and is arranged between the outdoor heat exchanger 7 and the bell mouth 9 in an axial direction thereof.

[0020] The fan motor 11 is mounted to a motor fixing plate 11a mounted to the bottom plate 2 by a fixture such as screw or the like.

[0021] In this case, the structural members or parts are arranged side by side in an axial direction of the motor in the order of the outdoor heat exchanger 7, the fan motor 11, the axial fan 10 and the bell mouth 9, from an upstream side of an air generated by the axial fan 10.

[0022] Fig. 2 is a plan view showing an entire structure of the axial fan 10 according to the present invention viewed from a positive pressure surface side of vanes 10b, and Fig. 3 is an enlarged view showing one vane 10b in Fig. 2.

[0023] In the axial fan 10 of the first embodiment of the present invention shown in Figs. 2 and 3, a plurality of vanes 10b are integrated with or integrally attached to a side surface of an outer peripheral surface of a cylindrical hub 10a at uniformly divided positions in a circumferential direction thereof and is integrally formed, for example, by resin molding or the like.

[0024] A rotating shaft of the fan motor 11 is inserted into and then fixed to a central portion of the hub 10a, and the axial fan 10 is rotated in a direction of an arrow M by the fan motor 11.

[0025] The vane 10b has a portion integrally connected to the hub 10a as a root portion 20. Further, a front side in a rotational direction (M) of the vane 10b is formed as a vane front edge portion 21, a rear side in the rotational direction is formed as a vane rear edge portion 22, and an end portion connecting an outer peripheral end portion of the vane front edge portion 21 and an outer peripheral end portion of the vane rear edge 22 is formed as a vane outer peripheral portion 23.

[0026] Further, with reference to the airflow on the

vane 10b in accordance with the rotation of the axial fan 10, the vane front edge portion 21 corresponds to an air introducing direction, and the vane rear edge portion 22 corresponds to an air outflow direction (Fig. 3).

[0027] The vane front edge portion 21 largely protrudes in the rotating or rotational direction toward the vane outer peripheral portion 23 from the root portion 20, and a profile line of the vane rear edge portion 22 is formed as a circular arc shaped concave portion recessed in the introducing direction opposite to the air outflow direction.

[0028] Further, a corner portion corresponding to a connection portion (an intersection portion) between the vane rear edge portion 22 and the vane outer peripheral portion 23 is formed as a convex bulge portion 24 bulging in the air outflow direction.

[0029] The air is sucked into an inner portion of the outdoor unit by the rotation of the axial fan 10 and passes through the outdoor heat exchanger 7, the axial fan 10 and the bell mouth 9, and the air is then discharged to the outside of the outdoor unit 1 from the fan guard 5.

[0030] Fig. 4 is a view showing a positional relation between the axial fan 10 and the bell mouth 9 in the first embodiment. The bell mouth 9 is provided around the discharge opening 4 of the main body cover 3 and is opposed to the vane rear edge portion 22 in the axial direction of the axial fan 10.

[0031] In this case, the vane rear edge portion 22 of the vane 10b is arranged such that points G and Q thereof completely lap over the bell mouth 9 in an axial direction so as to enter into the bell mouth.

[0032] Fig. 5 is a graph showing a relation between a ratio (X/L) and a blower noise in which a distance between a point G most recessed into an inner side in the rotational direction of the vane rear edge portion 22 of the vane 10b and the air outflow surface 9b of the bell mouth 9 in Fig. 4 is set to X, and a length in the axial direction of the bell mouth 9 is set to L.

[0033] As shown in Fig. 5, the blower noise is reduced by arranging the axial fan 10 and the bell mouth 9 in a range in which the length X from the point G of the vane rear edge portion 22 to the air outflow surface 9b of the bell mouth is between about 20% of the length L in the axial direction of the bell mouth 9 and 80% (0.2L to 0.8L), and in particular, the blower noise becomes minimum when the length X is near 50% of the length L. Accordingly, it is experimentally known that it is effective to set the length X to the range mentioned above to reduce the blower noise. The experiment for this knowledge has been executed by installing the outdoor unit within an anechoic room and placing a microphone connected to a noise level meter at a position 1 m apart from a front surface of the outdoor unit, on the basis of JIS (Z 8731). The blower noise through the microphone is displayed on the noise level meter by a sound pressure level (dB).

[0034] Accordingly, it is possible to inhibit vortex generation by a collision of the air flowing out from the vane rear edge portion 22 with the peripheral end portion of the air inflow surface 9a of the bell mouth 9, and it is possible to reduce the blower noise generated by the vortex.

[0035] Hereunder, a modified embodiment of the outdoor unit of the air conditioner according to the above-mentioned first embodiment of the present invention will be described.

[0036] Although the first modified embodiment shown in Fig. 6 has a shape of the vane rear edge portion different from the shape of the vane rear edge portion 22 of the first embodiment in Fig. 3, the other same or identical portions are denoted by the same reference numerals, and detailed description thereof will be omitted.

[0037] In the modified embodiment, the axial fan has a profile line of the vane rear edge portion 22 used in the first embodiment, the axial fan being formed with an approximately V-shaped concave portion.

[0038] As shown in Fig. 6, the axial fan 10 is provided with the vane rear edge portion 22 having the profile line of approximately V-shaped concave portion recessed in an introducing direction opposite to the air outflow direction.

[0039] In this case, a peak Z of the V-shape corresponds to a point G of the circular arc shaped concave portion in the first embodiment, and a point Q1 where the rear edge portion 22 of the V-shape and the vane outer peripheral portion 23 intersect corresponds to the point Q in the first embodiment.

[0040] In the results obtained by executing the same experiment as that executed in the first embodiment with the use of the axial fan having the shape of the first modified embodiment mentioned above, the same effects as those of the first embodiment could be obtained.

[0041] A second modified embodiment of the outdoor unit of the air conditioner according to the first embodiment of the present invention will be further described with reference to Fig. 7.

[0042] Although the second modified embodiment shown in Fig. 7 has a shape of the vane rear edge portion different from the shape of the vane rear edge portion 22 of the first embodiment in Fig. 3, the other same or identical portions are denoted by the same reference numerals, and detailed description thereof will be omitted.

[0043] In this second modified embodiment, the axial fan has a profile line of the vane rear edge portion 22 used in the first embodiment, the axial fan being formed with a trapezoidal concave portion.

[0044] As shown in Fig. 7, the axial fan 10 is provided with the vane rear edge portion 22 having the profile line of approximately trapezoidal concave portion recessed in an introducing direction opposite to the air outflow direction.

[0045] In this case, a linear portion U of the trapezoidal shape corresponds to the point G in the first embodiment, and a point Q2 where the rear edge portion 22 of the trapezoidal shape and the vane outer peripheral portion 23 intersect corresponds to the point Q in the first

embodiment.

[0046] In the results obtained by executing the same experiment as that executed in the first embodiment with the use of the axial fan having the shape of the second modified embodiment mentioned above, the same effects as those of the first embodiment could be obtained.

[0047] Next, an outdoor unit of the air conditioner according to the second embodiment of the present invention will be further described.

[0048] In this second embodiment, the same portions as those of the first embodiment shown in Fig. 4 are denoted by the same reference numerals and a description thereof will be omitted.

[0049] In the second embodiment, the bulge portion 24 of the vane 10b is arranged so as not to protrude from the air outflow surface 9b of the bell mouth 9 in the axial direction, contrary to the structure shown in Fig. 4.

[0050] Fig. 8 relates to the second embodiment and is a graph showing a relation between a ratio (Y/L) and the blower noise in which a point where the vane outer peripheral portion 23 of the vane 10b and the vane rear edge portion 22 intersect is set to a point Q, a distance between the point Q and the air outflow surface 9b of the bell mouth 9 is set to Y, and the length in the axial direction of the bell mouth 9 is set to L.

[0051] As shown in Fig. 8, the blower noise is reduced by arranging the axial fan 10 and the bell mouth 9 in a range in which the length Y from the point Q of the vane rear edge portion 22 to the air outflow surface 9b of the bell mouth is between about 30% of the length L in the axial direction of the bell mouth 9 and 90% (0.3L to 0.9L), and in particular, the blower noise becomes minimum when the length Y is near 60% of the length L. Accordingly, it was found through an experiment that it is effective to set the length Y to the range mentioned above in order to reduce the blower noise. The experiment was executed under the same condition as that executed in connection with the first embodiment.

[0052] As mentioned above, it is therefore possible to inhibit a vortex flow generated by a collision of the air flowing out from the bulge portion 24 with the fan guard 5 in the wake side of the axial fan 10, and it is also possible to reduce the blower noise generated by the vortex.

[0053] Further, in a further preferred embodiment of the present invention, such as that designed so as to satisfy both of the relation (the ratio) between the values X and L in the first embodiment, as shown in Fig. 4, and the relation (the ratio) between the values Y and L in the second embodiment, it goes without saying that the noise reducing effect is increased.

Industrial Applicability

[0054] As mentioned above, in accordance with the present invention, there can be provided an outdoor unit of an air conditioner provided with an axial blower which can satisfy both the requirements of the blowing rate and of reducing the electric motor load, and in addition, the vortex generation in the vane rear edge portion of the axial fan can be inhibited and the blower noise can be effectively reduced.

Claims

1. An outdoor unit of an air conditioner, comprising:

an axial fan provided with a plurality of vanes with a predetermined interval along an outer peripheral surface of a hub, each of the vanes having a vane rear edge portion having a profile line in a rotational direction to provide a concave shape in a vane front edge direction; and a bell mouth arranged on an air blowing side from the axial fan,

wherein the bell mouth and the axial fan are arranged so as to satisfy a ratio (X/L) to be in a range between 0.2 and 0.8 in which X is a distance between a most recessed portion to an inner side in the rotational direction of the profile line of the vane rear edge and an air outflow surface of the bell mouth and L is a length in an axial direction of the bell mouth.

2. The outdoor unit of an air conditioner according to claim 1, wherein the concave shape of the profile line of the vane rear edge portion is a circular arc shape.

3. The outdoor unit of an air conditioner according to claim 1, wherein the concave shape of the profile line of the vane rear edge portion is a V-shape.

4. The outdoor unit of an air conditioner according to claim 1, wherein the concave shape of the profile line of the vane rear edge portion is a trapezoidal shape.

5. An outdoor unit of an air conditioner, comprising:

an axial fan provided with a plurality of vanes with a predetermined interval along an outer peripheral surface of a hub, each of the vanes having a vane rear edge portion having a profile line in a rotational direction to provide a concave shape in a vane front edge direction; and a bell mouth arranged on an air blowing side from the axial fan,

wherein the bell mouth and the axial fan are arranged so as to satisfy a ratio (Y/L) to be in a range between 0.3 and 0.9 in which Y is a distance between a point where a profile line in a circumferential direction of the vane and a profile line of the vane rear edge portion intersect and an air outflow

surface of the bell mouth and L is a length in an axial direction of the bell mouth.

6. The outdoor unit of an air conditioner according to claim 5, wherein the concave shape of the profile line of the vane rear edge portion is a circular arc shape.

7. The outdoor unit of an air conditioner according to claim 5, wherein the concave shape of the profile line of the vane rear edge portion is a V-shape.

8. The outdoor unit of an air conditioner according to claim 5, wherein the concave shape of the profile line of the vane rear edge portion is a trapezoidal shape.

9. An outdoor unit of an air conditioner, comprising:

an axial fan provided with a plurality of vanes with a predetermined interval along an outer peripheral surface of a hub, each of the vanes having a vane rear edge portion having a profile line in a rotational direction to provide a concave shape in a vane front edge direction; and a bell mouth arranged on an air blowing side from the axial fan,

wherein the bell mouth and the axial fan are arranged so as to satisfy a ratio (X/L) to be in a range between 0.2 and 0.8 in which X is a distance between a most recessed portion to an inner side in the rotational direction of the profile line of the vane rear edge and an air outflow surface of the bell mouth and L is a length in an axial direction of the bell mouth, and

wherein the bell mouth and the axial fan are arranged so as to satisfy a ratio (Y/L) to be in a range between 0.3 and 0.9 in which Y is a distance between a point where a profile line in a circumferential direction of the vane and a profile line of the vane rear edge portion intersect and an air outflow surface of the bell mouth and L is a length in an axial direction of the bell mouth.

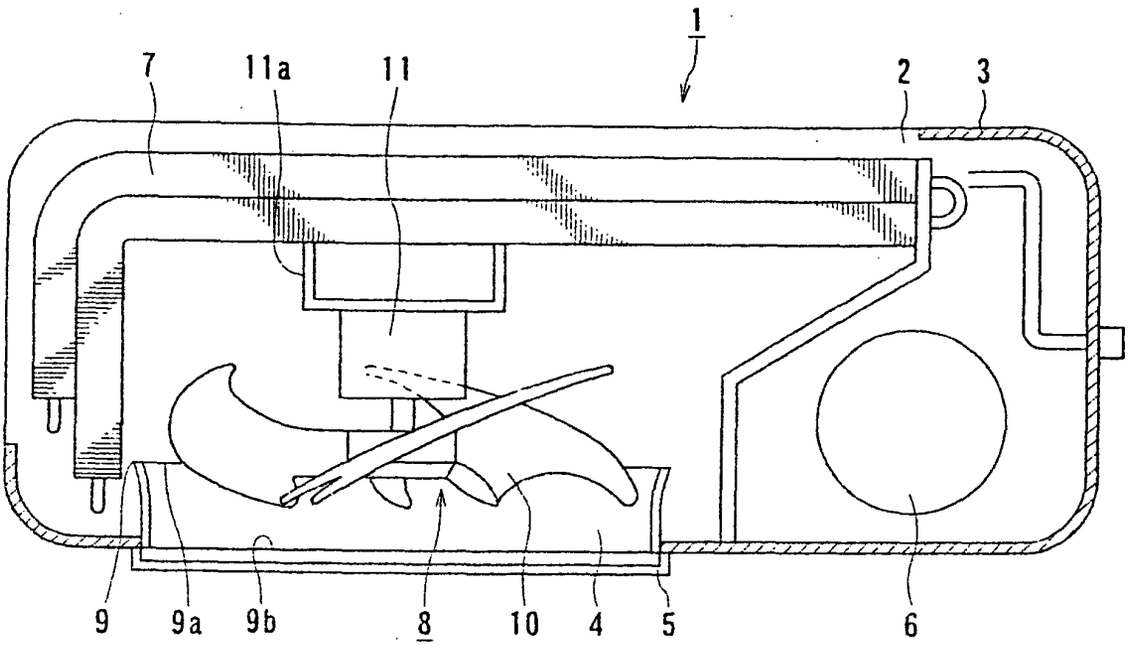

FIG. 1

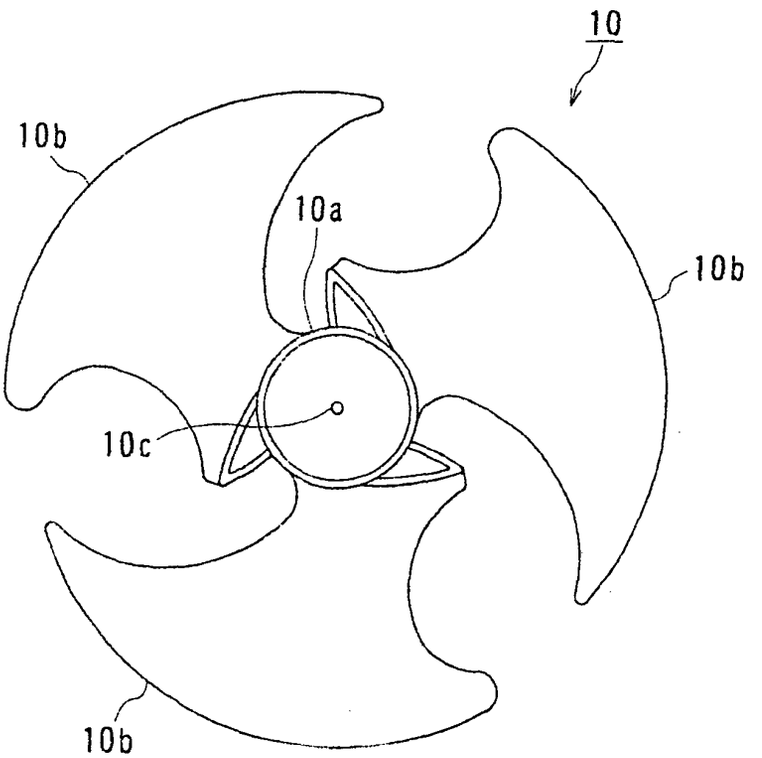

FIG. 2

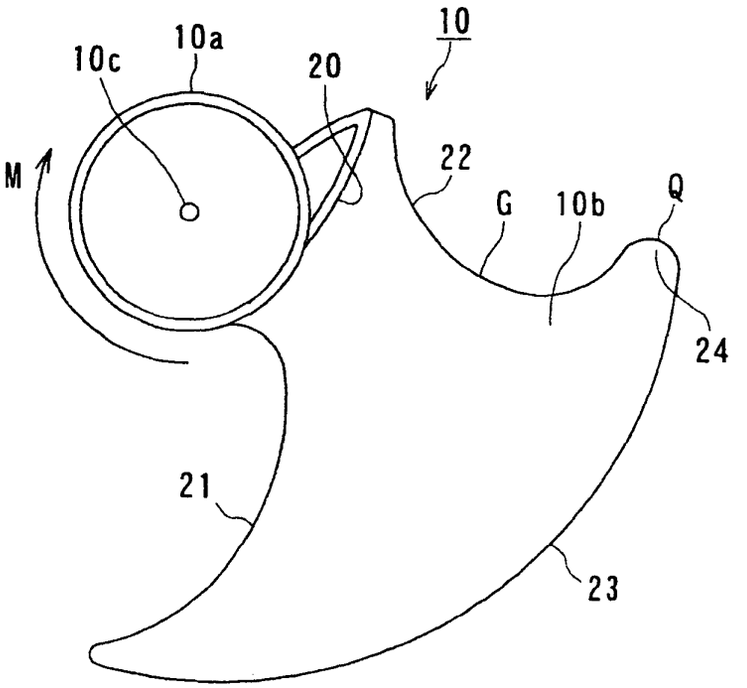

FIG. 3

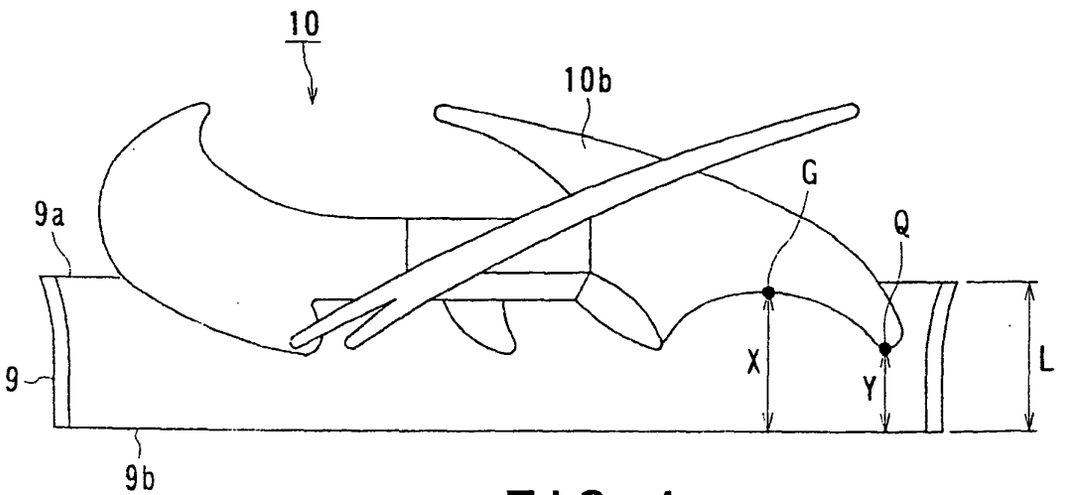

FIG. 4

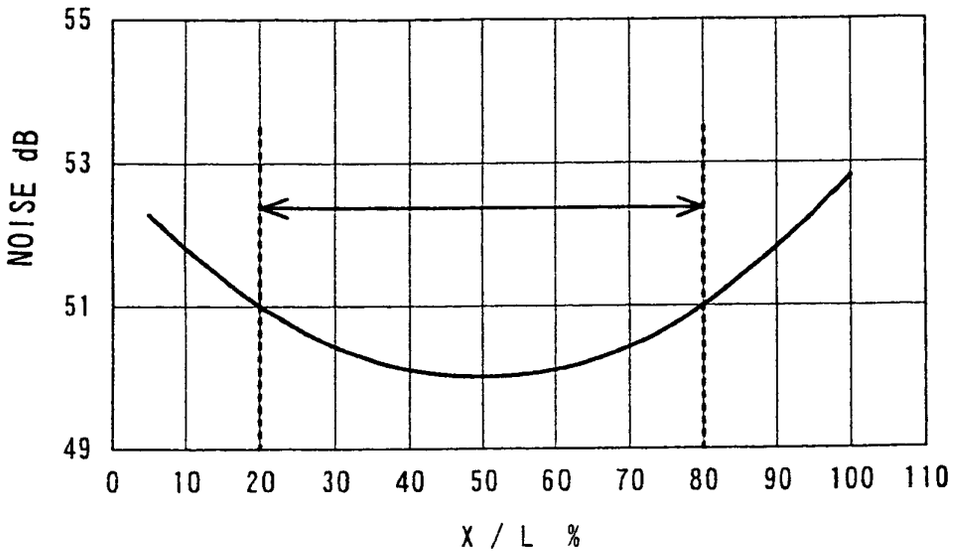
55
53
51
49
NOISE dB
0
10
20
30
40
50
60
70
80
90
100
110
X / L %

FIG. 5

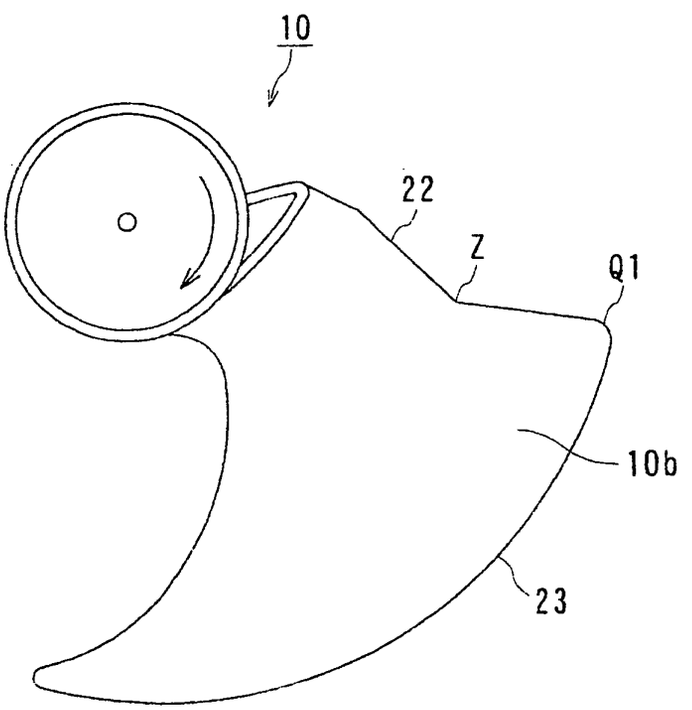
10
22
Z
Q1
10b
23

FIG. 6

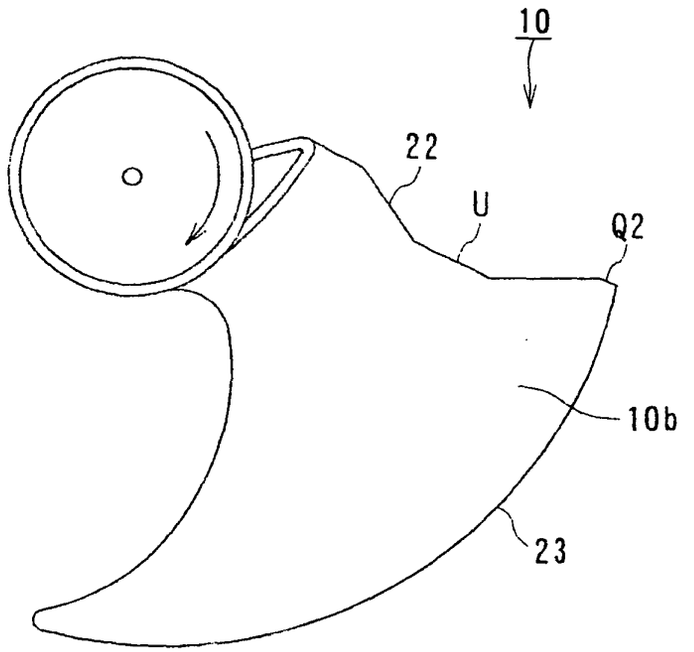
10
22
U
Q2
10b
23

FIG. 7

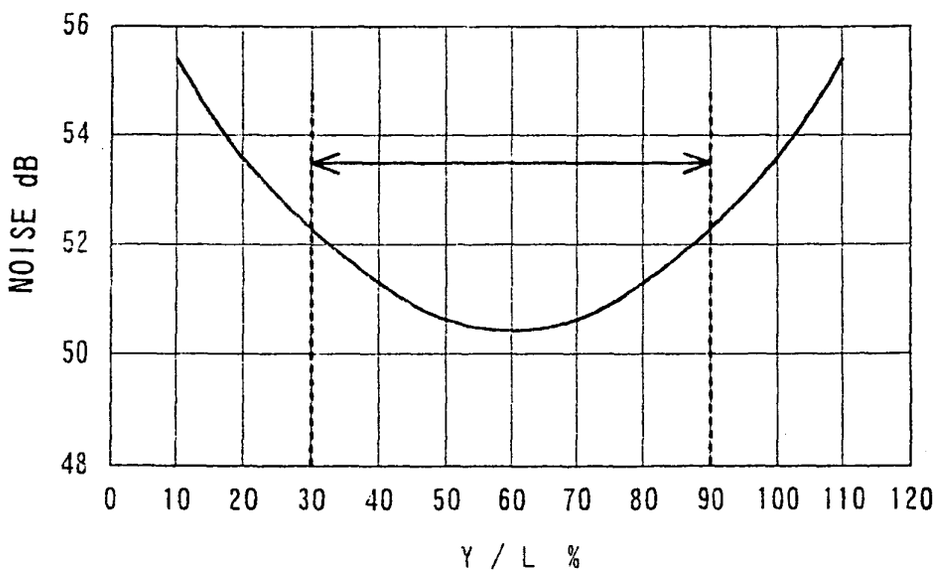
56
54
52
50
48
NOISE dB
0
10
20
30
40
50
60
70
80
90
100
110
120
Y / L %

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/004426

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F24F5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F24F5/00

Documentation searched other than minimum documentation to the exten t that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2004
Kokai Jitsuyo Shinan Koho 1971-2004 Toroku Jitsuyo Shinan Koho 1994-2004

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.
A	JP 5-231678 A (Daikin Industries, Ltd.), 07 September, 1993 (07.09.93), Full text; all drawings (Family: none)	1-9
A	JP 6-137608 A (Toshiba A.V.E. Kabushiki Kaisha), 20 May, 1994 (20.05.94), Full text; all drawings (Family: none)	1-9

☐ 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
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 July, 2004 (07.07.04)	27 July, 2004 (27.07.04)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)