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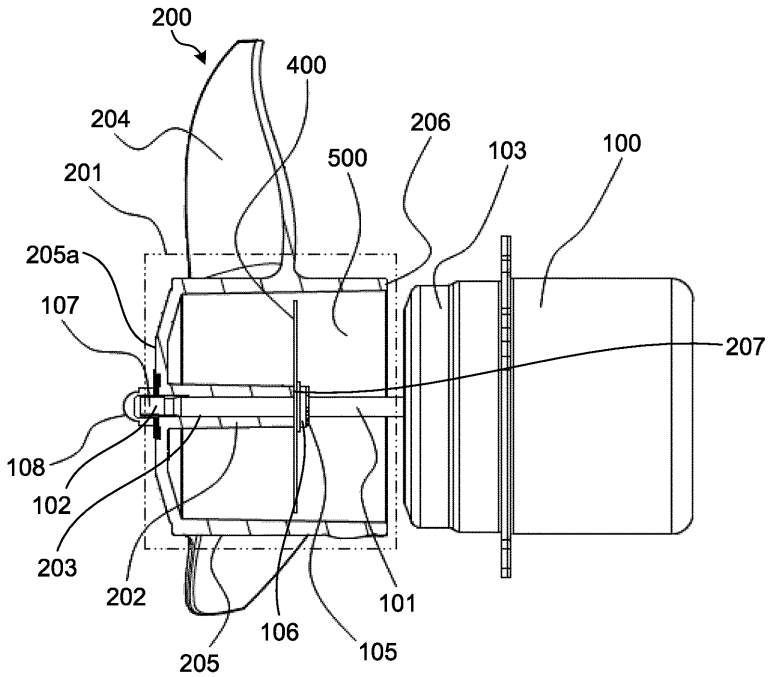
(54) **AXIAL FLOW BLADE, AND BLOWER**

(57) An axial flow blade (200) includes a boss (202) through which a shaft (101) of an electric motor (100) extends, the electric motor (100) rotating the shaft (101) about a rotational axis, a hub (205) having a cylindrical shape opened on a side closer to the electric motor (100), the hub (205) being coaxial with the boss (202) and surrounding a periphery of the boss (202), and a partition plate (400) installed in the hub (205) to partition a space in the hub (205) into two or more spaces.

FIG.3



EP 3 779 207 A1

Description

Field

[0001] The present invention relates to an axial flow blade and a blower that includes the axial flow blade.

Background

[0002] There is a blower that is installed in a location such as an office or a living room and that rotates a blade by an electric motor to blow air. As disclosed in Patent Literature 1, the blower has a structure in which the central portion of the blade, connecting the electric motor and the blade with each other, is constituted by a boss through which a shaft of the electric motor extends, and a hub having a cylindrical shape with its one end open and having vanes located on the hub. In this structure, a space is formed by being surrounded by the hub and a face of the electric motor located closer to the blade.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Patent Application Laid-open No. H5-018398

Summary

Technical Problem

[0004] In the blower having the above structure, a resonance phenomenon such as air column resonance or Helmholtz resonance occurs in the space surrounded by the electric motor and the hub of the blade at a frequency determined by the dimensions of the space. When the resonance frequency matches the frequency of bearing sound or the like of the electric motor, the sound is amplified to become operating noise. In order to reduce the amplification of the sound by shifting the resonance frequency from the frequency of bearing sound or the like of the electric motor, it is necessary to change the dimensions of the space in the hub of the blade. However, the dimensions of the space may not be simply changed in view of the possible influence on the required performance.

[0005] As described above, in the blower having the structure in which a space is formed by being surrounded by the hub and the face of the electric motor located closer to the blade, it is difficult to prevent an increase in the level of operating noise caused by resonance.

[0006] The present invention has been made in view of the above problems, and an object of the present invention is to provide a blower that can easily prevent an increase in the level of operating noise even when the blower has a structure in which a space is formed by being surrounded by a hub and a face of an electric motor located closer to a blade.

Solution to Problem

[0007] In order to solve the above problems and achieve the object, the present invention includes a boss through which a shaft of an electric motor extends, the electric motor rotating the shaft about a rotational axis. The present invention includes a hub having a cylindrical shape opened on a side closer to the electric motor, the hub being coaxial with the boss and surrounding a periphery of the boss. The present invention includes a partition plate installed in the hub to partition a space in the hub into two or more spaces.

Advantageous Effects of Invention

[0008] The blower according to the present invention has an effect where it is possible to easily prevent an increase in the level of operating noise even when the blower has a structure in which a space is formed by being surrounded by a hub and a face of an electric motor located closer to a blade.

Brief Description of Drawings

[0009]

FIG. 1 is a perspective view of a circulator fan that is a blower using an axial flow blade according to a first embodiment of the present invention.
FIG. 2 is a side sectional view of the circulator fan according to the first embodiment.
FIG. 3 is an enlarged partial cross-sectional view illustrating the axial flow blade of the circulator fan according to the first embodiment.
FIG. 4 is an exploded perspective view illustrating an attachment structure of an electric motor and a blade of the circulator fan according to the first embodiment.
FIG. 5 is an enlarged side sectional view illustrating an interior of a hub of the circulator fan according to the first embodiment.
FIG. 6 is an enlarged side sectional view illustrating an interior of the hub of a circulator fan according to a second embodiment of the present invention.
FIG. 7 is an enlarged side sectional view illustrating an interior of a hub of a circulator fan according to a third embodiment of the present invention.
FIG. 8 is a perspective view of a partition plate that partitions the interior of the hub of the circulator fan according to the third embodiment.

Description of Embodiments

[0010] An axial flow blade and a blower according to embodiments of the present invention will be described in detail below with reference to the accompanying draw-

ings. The present invention is not limited to the embodiments.

First embodiment.

[0011] FIG. 1 is a perspective view of a circulator fan that is a blower using an axial flow blade according to a first embodiment of the present invention. FIG. 2 is a side sectional view of the circulator fan according to the first embodiment. As illustrated in FIGS. 1 and 2, a circulator fan 1 that is a blower includes: a stand 2 for floor installation; and a body frame 3 held by the stand 2 in such a manner that the body frame 3 is vertically pivotable. In the body frame 3, an electric motor 100 and an electric unit 4 are mounted. The electric unit 4 adjusts a voltage to be applied to the electric motor 100 and thereby changes the drive speed. An external power supply is provided to the electric unit 4 through a power cord 5. An axial flow blade 200 is attached to a shaft 101 of the electric motor 100. When the electric motor 100 is driven, the axial flow blade 200 rotates so that the circulator fan 1 blows air forward.

[0012] FIG. 3 is an enlarged partial cross-sectional view illustrating the axial flow blade of the circulator fan according to the first embodiment. FIG. 3 illustrates the side of the electric motor 100, while illustrating the cross-section of the axial flow blade 200. FIG. 4 is an exploded perspective view illustrating an attachment structure of the electric motor and the blade of the circulator fan according to the first embodiment. As illustrated in FIGS. 3 and 4, a central portion 201 of the axial flow blade 200 is constituted by a boss 202 and a hub 205. In the boss 202, a boss hole 203 is formed into which the shaft 101 of the electric motor 100 is fitted. A vane 204 is located on the hub 205. The hub 205 has a cylindrical shape with its one end open. The center axis of the hub 205 is coaxial with the center axis of the boss 202. In a state in which the axial flow blade 200 is attached to the shaft 101, an open end 206 of the hub 205 faces toward the electric motor 100. An end face 207 of the boss 202 is located in the hub 205 more inward from the open end 206.

[0013] Meanwhile, the shaft 101 of the electric motor 100 is provided with a groove 104 between a tip end portion 102 and an electric motor frame 103. A C-ring 105 is engaged with the groove 104. At the tip end portion 102, a D-cut shaped screw portion 107 is formed. The shaft 101 is inserted through the boss hole 203, and thereafter a cap nut 108 is tightened onto the screw portion 107, so that the axial flow blade 200 is fixed to the shaft 101. At this time, a drive transmission plate 300 is interposed between the axial flow blade 200 and the cap nut 108. A resin washer 106 serving as an abutting portion and a partition plate 400 are interposed between the boss 202 and the C-ring 105 and fixed between them.

[0014] The drive transmission plate 300 is formed with a hole 302 at the center of a plate surface 301. The hole 302 has a shape identical to the D-shape of the tip end portion 102 of the shaft 101. At edges 303 and 304 of the plate surface 301, clicks 305 and 306 are provided respectively and are positioned perpendicular to the plate surface 301. The hole 302 is engaged with the D-shaped screw portion 107, and the clicks 305 and 306 are engaged respectively with insertion holes 209 and 208 provided on a front surface 205a of the hub 205, so that rotation of the shaft 101 is transmitted to the axial flow blade 200.

[0015] The partition plate 400 is formed with a hole 402 at the center of a plate surface 401. The hole 402 has a diameter equal to the diameter of the shaft 101. The partition plate 400 has an outer diameter smaller than the inner diameter of the hub 205.

[0016] FIG. 5 is an enlarged side sectional view illustrating an interior of the hub of the circulator fan according to the first embodiment. When the partition plate 400 along with the axial flow blade 200 are assembled to the electric motor 100: the partition plate 400 is located in the hub 205 and partitions, a space 500 formed between the hub 205 and the electric motor 100 as illustrated in FIG. 3, into a space 501 and a space 502. The partition plate 400 partitions the space 500 into the space 501 and the space 502. This causes resonance in the space 502 located closer to the electric motor 100 relative to the partition plate 400. In a case where the partition plate 400 is installed, the dimension of the space where resonance occurs in the rotational-axis direction of the axial flow blade 200 is changed: from "A+B" that is the sum of a dimension A between the partition plate 400 and the front surface 205a of the hub 205 and a dimension B between the partition plate 400 and the electric motor frame 103; to the dimension B between the partition plate 400 and the electric motor frame 103. Also in the case where the partition plate 400 is installed, the volume of the space where resonance occurs is changed: from "V1+V2" that is the sum of a volume V1 of the space 501 between the partition plate 400 and the front surface 205a of the hub 205 and a volume V2 of the space 502 between the partition plate 400 and the electric motor frame 103; to the volume V2 of the space 502 between the partition plate 400 and the electric motor frame 103. In a case where there is not the partition plate 400, resonance occurs in the space 500 in its entirety with the volume "V1+V2". Accordingly, in the case where there is not the partition plate 400, the frequency of sound to be amplified in the space 500 is different from the frequency of sound to be amplified when resonance occurs in the space 502. Therefore, the frequency of air column resonance and Helmholtz resonance is changed by installing the partition plate 400. Because there is a gap between the inner diameter of the hub 205 and an outer circumference 403 of the partition plate 400, Helmholtz resonance also occurs in the space 501. An effect of muffling the resonance is thus obtained. It is allowable that in the space 501, the hub 205 is provided with a rib extending parallel to the rotational axis so as to form two or more spaces when the partition plate 400 is attached. That is, the partition plate 400 is installed to change the volume of the space

where resonance occurs between the partition plate 400 and the electric motor 100. Thus, the sound that might have been amplified when there is not the partition plate 400 can be prevented from being amplified after the installation of the partition plate 400.

[0017] The circulator fan 1 according to the first embodiment can prevent operating noise from being amplified without changing the shape of the axial flow blade 200. Therefore, the circulator fan 1, having a structure in which the space 500 is formed by being surrounded by the hub 205 and the face of the electric motor 100 located closer to the axial flow blade 200, can easily prevent an increase in the level of operating noise caused by resonance.

Second embodiment.

[0018] FIG. 6 is an enlarged side sectional view illustrating an interior of a hub of a circulator fan according to a second embodiment of the present invention. In FIG. 6, constituent elements identical to those according to the first embodiment are denoted by like reference signs, and detailed descriptions thereof are omitted. The hub 205 of the axial flow blade 200 in the circulator fan 1 according to the second embodiment is formed with engagement portions 210, 211, 212, and 213 protruding inward from the inner-diameter side. The partition plate 400 is fixed to the axial flow blade 200 by being fitted at the outer circumference 403 between the engagement portions 210 and 212 and between the engagement portions 211 and 213. While the partition plate 400 can be fitted in a state of being elastically deformed and warped between the engagement portions 211 and 213, it is also allowable to use another fitting method. The diameter of the hole 402 of the partition plate 400 is larger than an outer diameter of the boss 202, and thus a gap is provided between the boss 202 and the hole 402 of the partition plate 400. Other constituent elements are identical to those according to the first embodiment.

[0019] The partition plate 400 is installed in the hub 205 and partitions the space 500 formed between the hub 205 and the electric motor 100 into a space 503 and a space 504. As the partition plate 400 partitions the space 500 into the space 503 and the space 504, the resonance is generated in the space 504 located closer to the electric motor 100 relative to the partition plate 400. In a case where the partition plate 400 is installed, the dimension of the space where resonance occurs in the rotational-axis direction of the axial flow blade 200 is changed: from "C+D" that is the sum of a dimension C between the partition plate 400 and the front surface 205a of the hub 205 and a dimension D between the partition plate 400 and the electric motor frame 103; to the dimension D between the partition plate 400 and the electric motor frame 103. Also in the case where the partition plate 400 is installed, the volume of the space where resonance occurs is changed: from "V3+V4" that is the sum of a volume V3 of the space 503 between the partition plate 400 and the front surface 205a of the hub 205 and a volume V4 of the space 504 between the partition plate 400 and the electric motor frame 103; to the volume V4 of the space 504 between the partition plate 400 and the electric motor frame 103. Therefore, the frequency of air column resonance and Helmholtz resonance is changed by installing the partition plate 400. Because there is a gap between the outer diameter of the boss 202 and the hole 402 of the partition plate 400, Helmholtz resonance also occurs in the space 503. An effect of muffling the resonance is thus obtained.

[0020] The circulator fan 1 according to the second embodiment can prevent operating noise from being amplified without changing the shape of the axial flow blade 200. Therefore, the circulator fan 1, having a structure in which the space 500 is formed by being surrounded by the hub 205 and the face of the electric motor 100 located closer to the axial flow blade 200, can easily prevent an increase in the level of operating noise caused by resonance.

Third embodiment.

[0021] FIG. 7 is an enlarged side sectional view illustrating an interior of the hub of a circulator fan according to a third embodiment of the present invention. FIG. 8 is a perspective view of a partition plate that partitions the interior of the hub of the circulator fan according to the third embodiment. In FIGS. 7 and 8, constituent elements identical to those according to the first embodiment are denoted by like reference signs, and detailed descriptions thereof are omitted. The axial flow blade 200 of the circulator fan 1 according to the third embodiment includes engagement portions 214, 215, 216, and 217 on the outer side of the boss 202. The partition plate 400 is formed with the hole 402 on the plate surface 401. The hole 402 has a diameter equal to the diameter of the boss 202. The partition plate 400 has an outer diameter smaller than the inner diameter of the hub 205. The boss 202 extends through the hole 402. The partition plate 400 is interposed between the engagement portions 214 and 216 and between the engagement portions 215 and 217 and is thereby fixed to the axial flow blade 200. While the partition plate 400 can be fitted in a state of being elastically deformed and warped between the engagement portions 214 and 216 and between the engagement portions 215 and 217, it is also allowable to use another fitting method. At least one hole 404 is formed around the hole 402 through which the boss 202 extends. That is, at least one hole 404 is formed on the plate surface 401 in addition to the hole 402 through which the boss 202 extends. Other constituent elements are identical to those according to the first embodiment. While the shape and size of the hole 404 and the number of holes 404 are not particularly limited, because the partition plate 400 rotates along with the axial flow blade 200, it is preferable that the holes 404 are positioned in such a manner as to maintain the rotational balance.

[0022] The partition plate 400 installed in the hub 205 partitions the space 500 into the space 501 and the space 502, and thereby it is the space 502 where resonance occurs as illustrated in FIG. 7. In a case where the partition plate 400 is installed, the dimension of the space where resonance occurs in the rotational-axis direction of the axial flow blade 200 is changed: from "A+B" that is the sum of the dimension A between the partition plate 400 and the front surface 205a of the hub 205 and the dimension B between the partition plate 400 and the electric motor frame 103; to the dimension B between the partition plate 400 and the electric motor frame 103. Also in the case where the partition plate 400 is installed, the volume of the space where resonance occurs is changed: from "V1+V2" that is the sum of the volume V1 of the space 501 between the partition plate 400 and the front surface 205a of the hub 205 and the volume V2 of the space 502 between the partition plate 400 and the electric motor frame 103; to the volume V2 of the space 502 between the partition plate 400 and the electric motor frame 103. Therefore, the frequency of air column resonance and Helmholtz resonance is changed by installing the partition plate 400. There is a gap between the inner diameter of the hub 205 and the outer circumference 403 of the partition plate 400, and the partition plate 400 is formed with the holes 404 on the plate surface 401. Thus, Helmholtz resonance also occurs in the space 501. An effect of muffling the resonance is thus obtained in an extended area including the plate surface 401 on which there are the holes 404.

[0023] The circulator fan 1 according to the third embodiment can prevent operating noise from being amplified without changing the shape of the axial flow blade 200. Therefore, the circulator fan 1, having a structure in which the space 500 is formed by being surrounded by the hub 205 and the face of the electric motor 100 located closer to the axial flow blade 200, can easily prevent an increase in the level of operating noise caused by resonance.

[0024] The configurations described in the above embodiments are only examples of the content of the present invention. The configurations can be combined with other well-known techniques, and part of each of the configurations can be omitted or modified without departing from the scope of the present invention.

Reference Signs List

[0025] 1 circulator fan, 2 stand, 3 body frame, 4 electric unit, 5 power cord, 100 electric motor, 101 shaft, 102 tip end portion, 103 electric motor frame, 104 groove, 105 C-ring, 106 resin washer, 107 screw portion, 108 cap nut, 200 axial flow blade, 201 central portion, 202 boss, 203 boss hole, 204 vane, 205 hub, 205a front surface, 206 open end, 207 end face, 208, 209 insertion hole, 210, 211, 212, 213, 214, 215, 216, 217 engagement portion, 300 drive transmission plate, 301, 401 plate surface, 302, 402, 404 hole, 303, 304 edge, 305, 306 click, 400 partition plate, 403 outer circumference, 500, 501, 502, 503, 504 space.

Claims

1. An axial flow blade comprising:

   a boss through which a shaft of an electric motor extends, the electric motor rotating the shaft about a rotational axis;
   a hub having a cylindrical shape opened on a side closer to the electric motor, the hub being coaxial with the boss and surrounding a periphery of the boss; and
   a partition plate installed in the hub to partition a space in the hub into two or more spaces.

2. The axial flow blade according to claim 1, wherein the partition plate is formed with a hole at a central portion thereof, the shaft extending through the hole, and
   the partition plate with the shaft extending through the hole is interposed between the boss and a boss abutting portion located on the shaft, and is fixed to the boss.

3. The axial flow blade according to claim 1, wherein the partition plate is formed with a hole at a central portion thereof, the shaft extending through the hole,
   the hub is formed with an engagement portion protruding inward from an inner surface of the hub, and
   the partition plate is fixed to the hub by engaging an outer circumferential portion of the partition plate with the engagement portion.

4. The axial flow blade according to claim 1, wherein the partition plate is formed with a hole at a center thereof, the boss extending through the hole,
   the boss is formed with an engagement portion protruding outward from an outer circumference of the boss, and
   the partition plate is fixed to the boss by engaging an edge of the hole of the partition plate with the engagement portion.

5. The axial flow blade according to any one of claims 1 to 4, wherein the partition plate is formed with at least one hole on a plate surface thereof in addition to the hole through which the boss extends.

6. A blower comprising the axial flow blade according to any one of claims 1 to 5 and the electric motor.

FIG.1

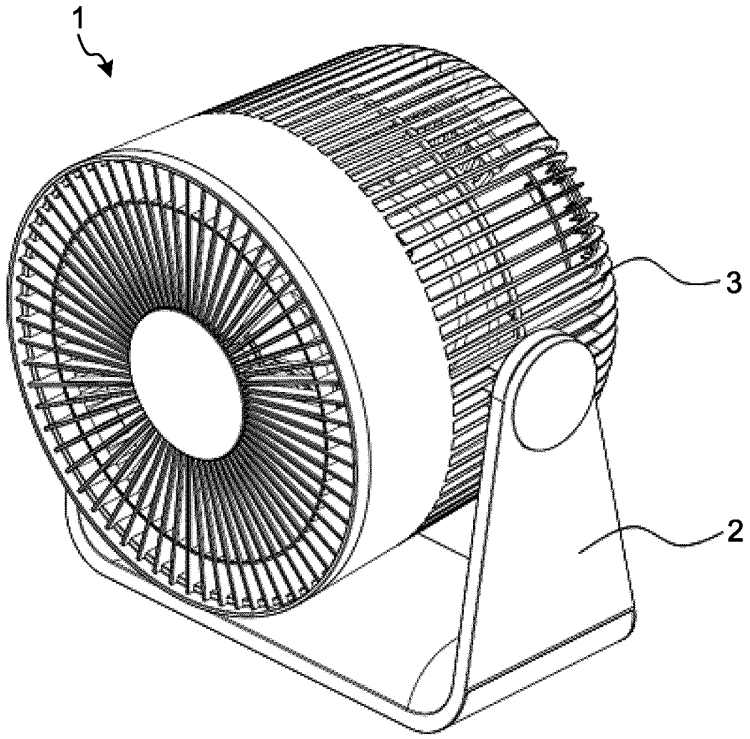


FIG.2

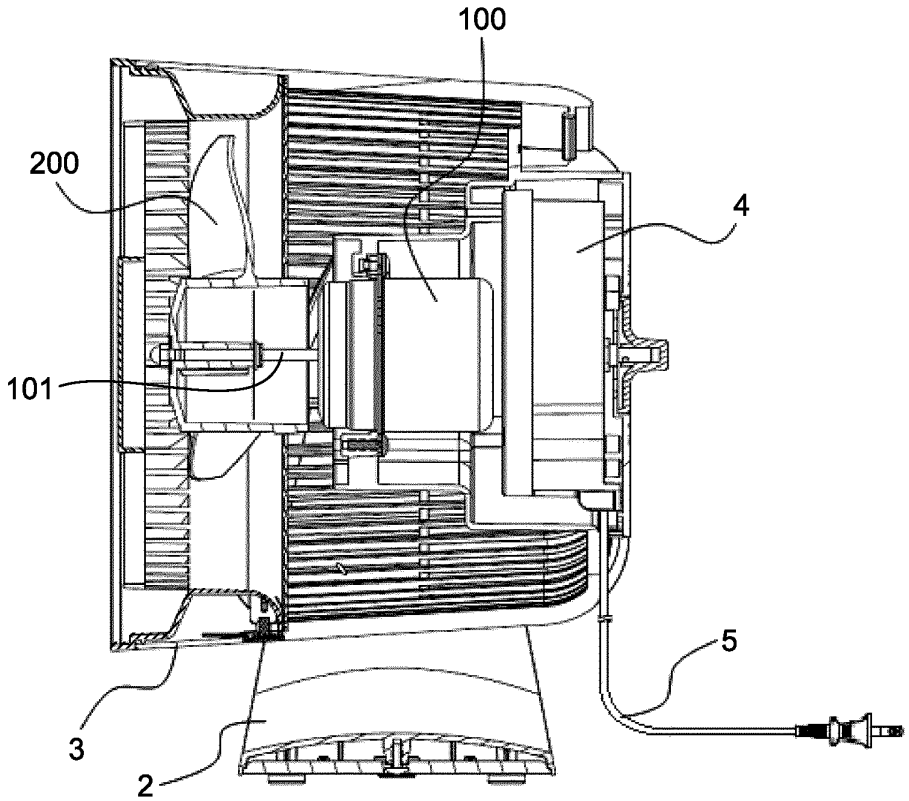
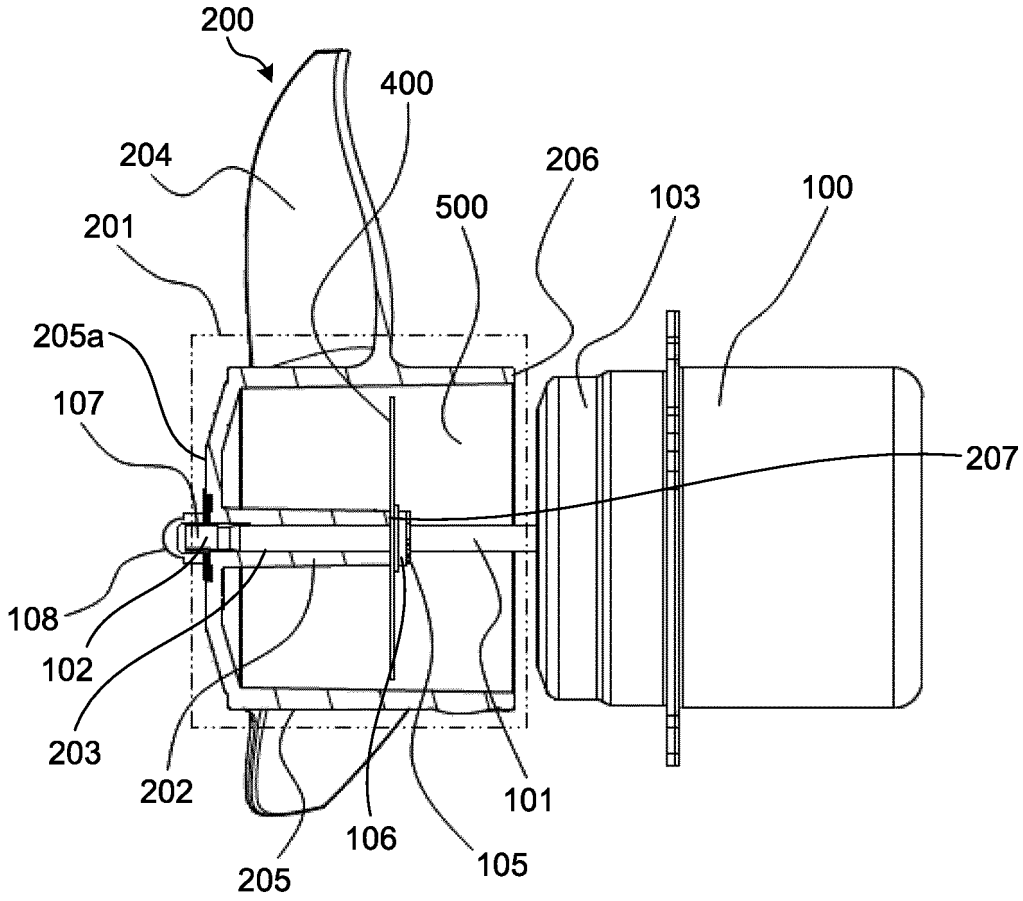


FIG.3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207
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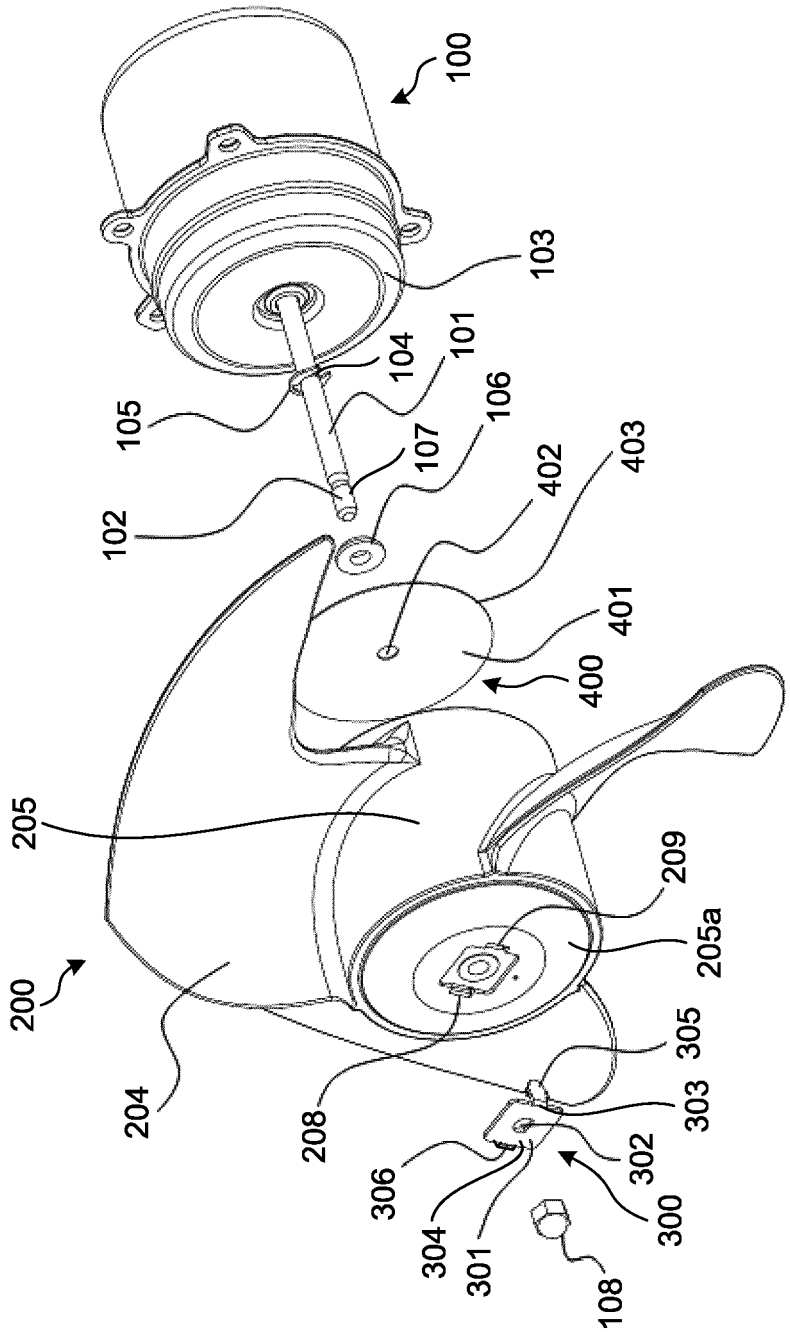
205

FIG.4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104
105
106
107
102
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205a
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302
304
301
300
108

FIG.5

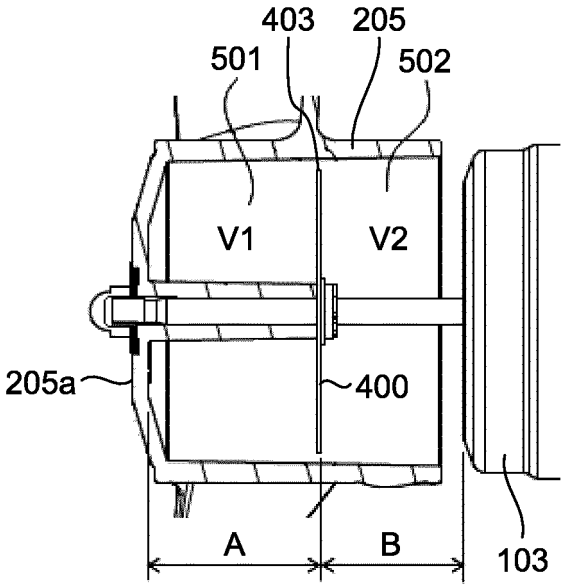
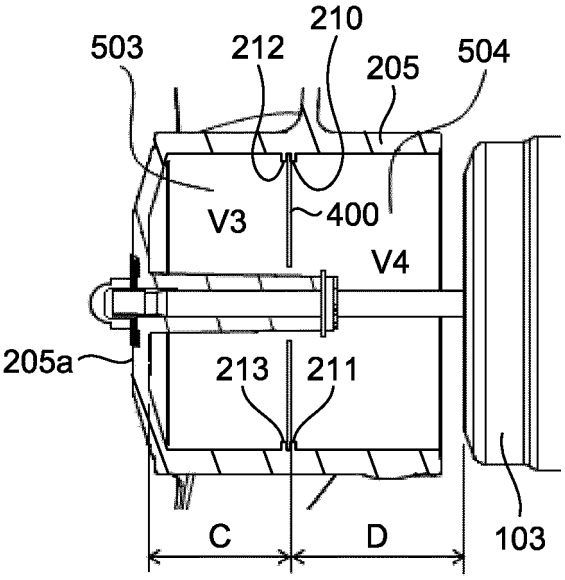

403
205
501
502
V1
V2
205a
400
A
B
103

FIG.6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205
504
V3
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V4
205a
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211
C
D
103

FIG.7

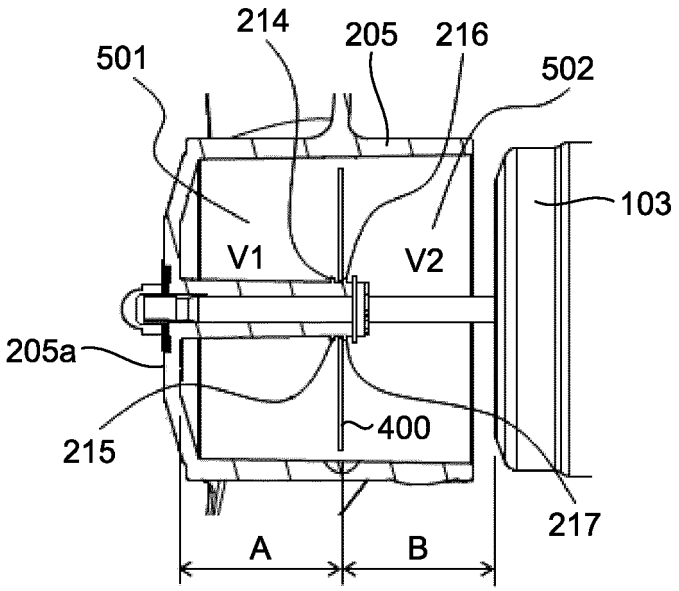
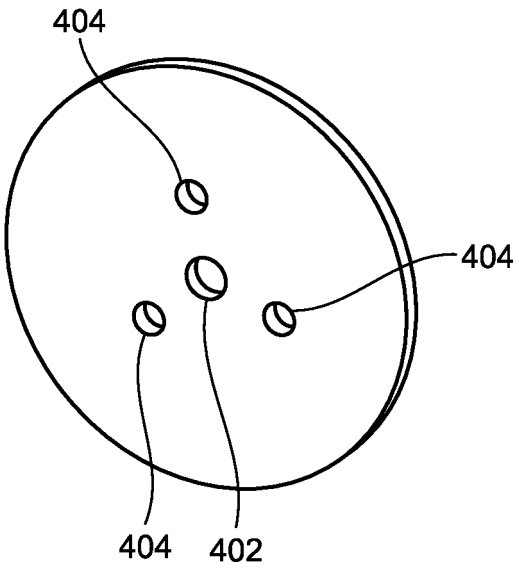


FIG.8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/013288

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F04D29/32(2006.01)i, F04D29/66(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F04D29/32, F04D29/66

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

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 115502/1981 (Laid-open No. 20395/1983) (MITSUBISHI ELECTRIC CORPORATION) 08 February 1983, specification, page 2, line 6 to page 4, line 4, fig. 1-3 (Family: none)	1-2, 6 4-5
X Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 114540/1978 (Laid-open No. 30963/1980) (AISIN SEIKI CO., LTD.) 28 February 1980, specification, page 2, line 12 to page 4, line 7, fig. 3 (Family: none)	1-2, 6 4

☒ 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
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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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"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
06.06.2018	19.06.2018
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/013288

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 4-259696 A (TOSHIBA CORPORATION) 16 September 1992, paragraphs [0010]-[0012], fig. 1, 2 (Family: none)	1, 3, 5-6
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 21902/1978 (Laid-open No. 126107/1979) (HITACHI HOME TEC LTD.) 03 September 1979, specification, page 1, line 18 to page 2, line 5, fig. 1, 2 (Family: none)	4
Y	JP 2006-307666 A (NISSAN MOTOR CO., LTD.) 09 November 2006, paragraphs [0007], [0011], [0014], fig. 3-5 (Family: none)	5

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H5018398 B **[0003]**