



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
18.04.2012 Bulletin 2012/16

(51) Int Cl.:
F04D 29/28 (2006.01) F04D 17/10 (2006.01)

(21) Application number: **11791190.9**

(86) International application number:
PCT/JP2011/002643

(22) Date of filing: **12.05.2011**

(87) International publication number:
WO 2012/001861 (05.01.2012 Gazette 2012/01)

(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

(30) Priority: **29.06.2010 JP 2010147074**

(71) Applicant: **Panasonic Corporation**
Kadoma-shi
Osaka 571-8501 (JP)

(72) Inventors:
• **HIDEKUMA, Teppei**
Chuo-ku, Osaka-shi
Osaka 540-6207 (JP)

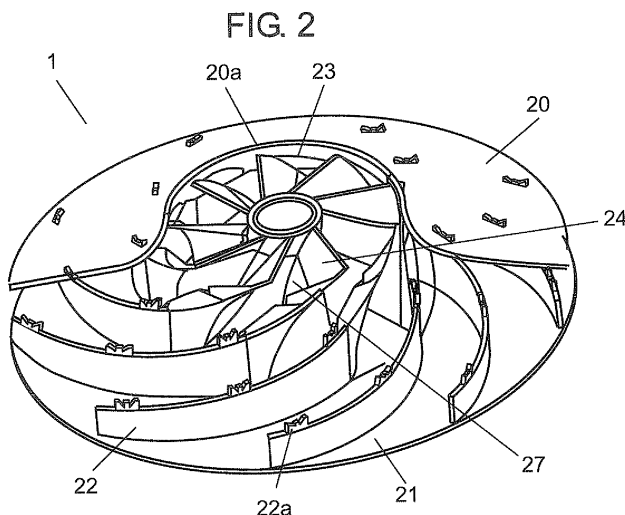
- **NISHIMURA, Tsuyoshi**
Chuo-ku, Osaka-shi
Osaka 540-6207 (JP)
- **MORISHITA, Kazuhisa**
Chuo-ku, Osaka-shi
Osaka 540-6207 (JP)
- **KAYAMA, Hiroyuki**
Chuo-ku, Osaka-shi
Osaka 540-6207 (JP)
- **NAKAMURA, Kazushige**
Chuo-ku, Osaka-shi
Osaka 540-6207 (JP)

(74) Representative: **Schwabe - Sandmair - Marx**
Patentanwälte
Stuntzstraße 16
81677 München (DE)

(54) **IMPELLER, AND ELECTRIC BLOWER AND ELECTRIC CLEANER PROVIDED WITH IMPELLER**

(57) An impeller (1) includes a front shroud (20) having a first opening (20a) at its center, a rear shroud (21) placed separately from the front shroud (20) with a space therebetween, multiple blades (22) held by and between the front shroud (20) and the rear shroud (21) and ex-

tending from a center toward an outer circumference of the rear shroud (21), and an inducer (23) placed at the center of the rear shroud (21). The inducer (23) includes an upper inducer (24) placed at the front shroud (20) side and a lower inducer (27) placed at the rear shroud (21) side.



Description

Technical Field

[0001] The present invention relates to an impeller and an electric blower, an electric vacuum cleaner equipped with the same impeller.

Background Art

[0002] Blowing performance (suction performance) of an electric blower used in an electric vacuum cleaner has been tried to improve specifically with respect to the impeller of the blower. For instance, a structure formed of a front shroud, a rear shroud, multiple blades, and an inducer having multiple vane sections has been proposed (e.g. refer to Patent Literature 1).

[0003] Fig. 11 is a partially cut-away perspective view for illustrating a structure of the conventional impeller discussed above. As shown in Fig. 11, impeller 321 includes rear shroud 322, front shroud 323, sheet metal blades 324, and resinous inducer 325. Rear shroud 322 is made of sheet metal. Front shroud 323 is disposed separately from rear shroud 322 with a space therebetween and having suction port 323a at its center. Multiple sheet metal blades 324 are held by and between rear shroud 322 and front shroud 323. Inducer 325 made of resin is disposed correspondingly to suction port 323a.

[0004] Resinous inducer 325 includes conical hub 325b and vane sections 325a formed on hub 325b. Vane sections 325a have a three-dimensional curve for rectifying the air flowing from suction port 323a to sheet metal blades 324.

[0005] Fig. 12A is a plan view illustrating the movement of a mold during the molding of resinous inducer 325 of the conventional impeller 321. Fig. 12B is a lateral view illustrating this movements.

[0006] As shown in Figs. 12A and 12B, resinous inducer 325 is formed through a resin molding process using laterally-sliding mold 331 that slides radially toward the outer circumference of vane section 325a. The mold includes laterally-sliding mold 331, upward-sliding mold 332, and downward-sliding mold 333. Molds 331 in equal numbers to that of vanes of vane sections 325a are prepared. Upward-sliding mold 332 in equal numbers to that of vanes of vane sections 325a are prepared. Downward-sliding mold 333 in equal numbers to that of vanes of vane sections 325a are prepared.

[0007] It has been believed that vane sections 325a of resinous inducer 325 in numbers of six and metal sheet blades 324 in numbers of also six are ideal quantities for improving the blowing (sucking) efficiency of impeller 321 of the conventional electric blower. However, a numbers over the six for vane sections 325a as well as for metal sheet blades 324 can sometimes gain the better blowing efficiency depending on an air volume and an rpm.

[0008] On top of that, it is generally known that a high frequency tone, which is a kind of noises generated by

the electric blower, is generated conspicuously at the frequency of a product of multiplying the number of vanes (numbers of vane sections 325a and the number of metal sheet blades 324) of impeller 321 by the rpm. In the case of small number of vanes, the frequency of the high frequency tone generated by the electric blower is audible frequency band to users, so that the tone sounds harshly and sometimes makes the users unpleasant.

[0009] To reduce this high frequency tone, an increment in the numbers of vanes of impeller 321 has been studied. This method moves the frequency of the high frequency tone away from the frequency band audible to the users, thereby reducing the harsh and unpleasant noises.

[0010] However, the method of molding resinous inducer 325 of impeller 321 of the conventional electric blower finds it difficult to mold inducer 325 having 6 or more than 6 vanes, and in a case where an end face of front shroud 323 side of a vane section 325a overlaps, viewed from the top or the side, with an end face of metal sheet blade 324 of the adjacent vane section 325a, the molding becomes also difficult.

Related Art Literature

[0011] Patent Literature 1: Unexamined Japanese Patent Application Publication No. 2000 - 45993

Disclosure of Invention

[0012] The present invention aims to provide an impeller for an electric blower, where vanes of an inducer of this impeller can be multiplied with ease and improving the blowing efficiency as well as lowering the noise, and the present invention also aims to provide the electric blower and an electric vacuum cleaner both equipped with this impeller.

[0013] The impeller of the present invention includes a front shroud having a first opening at its center section, a rear shroud disposed separately from the front shroud with a space therebetween, multiple blades held by and between the front and rear shrouds and extending from a center section toward an outer circumference of the rear shroud, and an inducer disposed at the center section of the rear shroud. The inducer includes an upper inducer disposed at the front shroud side and a lower inducer disposed at the rear shroud side.

[0014] The impeller of the present invention allows the inducer to be equipped with multiple vane sections with ease and improving the blowing efficiency and lowering the noises.

Brief Description of Drawings

[0015]

Fig. 1 is a sectional view partially illustrating a structure of an electric blower equipped with an impeller

in accordance with a first embodiment of the present invention.

Fig. 2 is a partially cut-away perspective view illustrating a structure of the impeller in accordance with the first embodiment of the present invention.

Fig. 3 is an exploded perspective view illustrating a structure of the impeller in accordance with the first embodiment of the present invention.

Fig. 4 is a sectional view illustrating a structure of the impeller in accordance with the first embodiment of the present invention.

Fig. 5A is a plan view illustrating a structure of a mold for a lower inducer of the impeller in accordance with the first embodiment of the present invention.

Fig. 5B is a lateral view illustrating a structure of the mold for the lower inducer of the impeller in accordance with the first embodiment of the present invention.

Fig. 6A is a plan view illustrating a structure of a mold for an upper inducer of the impeller in accordance with the first embodiment of the present invention.

Fig. 6B is a lateral view illustrating a structure of the mold for the upper inducer of the impeller in accordance with the first embodiment of the present invention.

Fig. 7 is a sectional view illustrating a structure of an impeller in accordance with a second embodiment of the present invention.

Fig. 8 is a sectional view illustrating a structure of an impeller in accordance with a third embodiment of the present invention.

Fig. 9 is a sectional view illustrating a structure of an impeller in accordance with a fourth embodiment of the present invention.

Fig. 10 schematically illustrates an electric vacuum cleaner in accordance with a fifth embodiment of the present invention.

Fig. 11 is a partially cut-away perspective view illustrating a structure of a conventional impeller.

Fig. 12A is a plan view illustrating movements of a mold used in molding a resinous inducer of a conventional impeller.

Fig. 12B is a lateral view illustrating the movements of the mold used in molding a resinous inducer of a conventional impeller.

Embodiments for Carrying Out the Invention

[0016] Exemplary embodiments of the present invention are demonstrated hereinafter with reference to the accompanying drawings.

Embodiment 1

[0017] The following description refers to impeller 1 in accordance with the first embodiment of the present invention and also electric blower 100 equipped with impeller 1.

[0018] Fig. 1 is a sectional view partially illustrating a structure of electric blower 100 equipped with impeller 1 in accordance with the first embodiment of the present invention. Fig. 2 is a partially cut-away perspective view illustrating a structure of impeller 1 in accordance with the first embodiment of the present invention. Fig. 3 is an exploded perspective view illustrating a structure of impeller 1 in accordance with the first embodiment of the present invention. Fig. 4 is a sectional view illustrating a structure of impeller 1 in accordance with the first embodiment of the present invention.

[0019] As shown in Fig. 1, electric blower 100 includes impeller 1, air guide 2, fan case 3, motor 4, and bracket 6 disposed on a counter-load side.

[0020] Impeller 1 generates an air current (suction air). Air guide 2 is disposed confronting an outer rim of impeller 1 for rectifying the air current supplied from impeller 1. Fan case 3 accommodates impeller 1 and air guide 2 therein. Motor 4 drives impeller 1. Bracket 6 disposed at counter-load side is placed on the outer wall of motor 4, and fan case 3 is mounted to bracket 6 hermetically.

[0021] Impeller 1 is supported by shaft 5 of motor 4. Counter-load side bracket 6 includes exhausting opening 7 for exhausting the air sucked by impeller 1.

[0022] As shown in Fig. 2 - Fig. 4, impeller 1 includes front shroud 20, rear shroud 21, multiple blades 22, and inducer 23.

[0023] Front shroud 20 includes a first opening, i.e. suction port 20a, at its center section. Rear shroud 21 is disposed separately from front shroud 20 with a space therebetween. Multiple blades 22 are held by and between front shroud 20 and rear shroud 21, and extend from the center section toward the outer circumference (rim) of rear shroud 21. Inducer 23 is disposed at the center section of rear shroud 21, and is held by and between front shroud 20 and rear shroud 21.

[0024] Each one of blades 22 has multiple mating protrusions 22a and 22b respectively on its faces to be brought into contact with front shroud 20 and rear shroud 21. Front shroud 20 and rear shroud 21 have multiple mating slits 20b and 21a for receiving mating protrusions 22a and 22b respectively. Mating protrusions 22a and 22b are inserted into slits 20b and 21a respectively, and they are crimped together, whereby each blade 22 can be mounted to front shroud 20 and rear shroud 21.

[0025] Inducer 23 is split into upper inducer 24 and lower inducer 27 with a plane in parallel to rear shroud 21, namely, the plane vertical relative to shaft 5 of motor 4. Upper inducer 24 stays on front shroud 20 side, and lower inducer 27 stays on rear shroud 21 side. This structure allows applying the force vectors uniformly to the split faces of upper inducer 24 and lower inducer 27 when inducer 23 is held by and between front shroud 20 and rear shroud 21, whereby inducer 23 can be more firmly sandwiched between shrouds 20 and 21.

[0026] Inducer 23 is formed this way: end face P1 on front shroud 20 side of a vane section of inducer 23 overlaps with end face P2 on blade 22 side of a vane section

of the adjacent inducer 23, and this overlap is viewed from a top or a lateral view. In other words, this form is difficult for a conventional molding method to mold.

[0027] As shown in Fig. 3 and Fig. 4, upper inducer 24 includes ring section 25 having second opening 25a at the center and multiple first vane sections 26 extending from ring section 25 toward the outer circumference (rim) of inducer 23. Lower inducer 27 includes base section 28, multiple second vane sections 29, and shaft section 30. Base section 28 is mounted to rear shroud 21 and forms a conical shape. Second vane sections 29 extend from the center section of base section 28 toward the outer rim thereof. Shaft section 30 extends from the center section of base section 28 toward upper inducer 24, and fits into ring section 25.

[0028] As shown in Fig. 4, lower inducer 27 and rear shroud 21 have third opening 27a and fourth opening 21b at their centers for receiving shaft 5 of motor 4 respectively. Shaft 5 of motor 4 is fit into and supported by third opening 27a and fourth opening 21b, whereby impeller 1 can be driven by motor 4.

[0029] As shown in Fig. 3, projection 30a is formed on shaft section 30 of lower inducer 27 at base section 28 side. Recess 25b is formed on ring section 25 of upper inducer 24 at lower inducer 27 side, and recess 25b mates with projection 30a. Upper inducer 24 is thus positioned relative to and mounted to lower inducer 27 by using projection 30a and recess 25b.

[0030] Upper inducer 24 and lower inducer 27 form inducer 23. and ring section 25 of upper inducer 24 fits into shaft section 30 of lower inducer 27, whereby upper inducer 24 is positioned relative to and mounted to lower inducer 27. This simple structure allows holding upper inducer 24 and lower inducer 27 together more firmly.

[0031] First vane sections 26 of upper inducer 24 and second vane sections 29 of lower inducer 27 form the vane sections of inducer 23.

[0032] As shown in Fig. 4, ring section 25 of upper inducer 24 and shaft section 30 of lower inducer 27 are formed such that plane P3 on outer wall of ring 25 forming the same plane of plane P4 of base section 28 of lower inducer 27 at front shroud 20 side when upper inducer 24 is mounted to lower inducer 27.

[0033] In this embodiment, the number of first vane sections 26 of upper inducer 24, the number of second vane sections 29 of lower inducer 27, and the number of blades 22 are determined nine (9) respectively considering the air volume of electric blower 100 and the rpm of impeller 1.

[0034] Front shroud 20, rear shroud 21 and blades 22 are made of metal, and inducer 23 is made of resin.

[0035] A method for molding the foregoing inducer 23 is demonstrated hereinafter.

[0036] Fig. 5A is a plan view illustrating a structure of a mold for lower inducer 27 of impeller 1 in accordance with the first embodiment of the present invention. Fig. 5B is a lateral view of this mold structure. Fig. 6A is a plan view illustrating a structure of a mold for upper in-

ducer 24 of impeller 1 in accordance with the first embodiment of the present invention. Fig. 6B is a lateral view of this mold structure.

[0037] As shown in Fig. 5A and Fig. 5B, the mold of lower inducer 27 has angular intervals of 40 degrees, and includes sliding molds 31 disposed in nine directions, core 32 for molding lower inducer 27 from the top, and cavity 33 for molding lower inducer 27 from the bottom.

[0038] Inducer 23 has this structure therein: end face P1 on a vane section of inducer 23 at front shroud 20 side overlaps with end face P2 on a vane section of the adjacent inducer 23 at blade 22 side, and this overlap is viewed from the top face or the lateral face. However, since inducer 23 is split into upper inducer 24 and lower inducer 27, the mold structure discussed above allows molding this inducer 23.

[0039] As shown in Fig. 6A and Fig. 6B, the mold for upper inducer 24 includes core 42 for molding upper inducer 24 from the top and cavity 43 for molding upper inducer 24 from the bottom.

[0040] As discussed previously, it is difficult for inducer 23 with a conventional structure and a conventional molding method to have multiple vane sections. However, the split of inducer 23 into two parts, i.e. upper inducer 24 and lower inducer 27 as discussed in this embodiment, allows the two parts to be molded independently. During the assembly of impeller 1, these two parts are assembled together, so that the inducer having multiple vane sections can be obtained. Multiple vane sections can be thus achieved with ease in inducer 23, so that the blowing efficiency of electric blower 100 can be improved, and the lower noises also can be achieved.

[0041] Since inducer 23 is held by and between front shroud 20 and rear shroud 21, inducer 23 can be held firmly with this simple structure. Inducer 23 can have multiple vane sections with ease as discussed above. Use of impeller 1 in accordance with this first embodiment allows electric blower 100 to improve the blowing efficiency and lower the noises.

Embodiment 2

[0042] Impeller 51 in accordance with the second embodiment of the present invention is demonstrated hereinafter.

[0043] Fig. 7 is a sectional view illustrating a structure of impeller 51.

[0044] Similar elements to those of impeller 1 in accordance with the foregoing first embodiment have the same reference marks, and the descriptions thereof are omitted.

[0045] As shown in Fig. 7, groove section 34 is provided on a perimeter of front shroud 20 at a position where first vane section 26 is brought into contact with second vane section 29. Groove section 34 has a shape similar to an end face of the first vane section 26 and the second vane section 29 which are brought into contact with each other at groove section 34 of front shroud 20, and groove

section 34 has a width almost equal to that of this end face.

[0046] This structure, i.e. groove section 34, allows front shroud 20 to hold inducer 23 more firmly. Groove section 34 also allows correcting warp or deformation produced during the molding of inducer 23 by internal stress.

[0047] Use of impeller 51 in accordance with the second embodiment allows inducer 23 to have multiple vane sections with ease. Electric blower 100 can thus improve the blowing efficiency and lower the noises.

Embodiment 3

[0048] Impeller 52 in accordance with the third embodiment of the present invention is demonstrated hereinafter. Impeller 52 in accordance with the third embodiment of the present invention is demonstrated hereinafter with reference to Fig. 8 which is a sectional view illustrating a structure of impeller 52. Similar elements to those of impeller 1 and impeller 51 discussed in embodiments 1 and 2 have the same reference marks, and the descriptions thereof are omitted here.

[0049] As shown in Fig. 8, second vane section 29 includes projection 29a extending from an end face, contacting with front shroud 20, toward front shroud 20. Front shroud 20 includes hole 20c at a place corresponding to projection 29a for receiving projection 29a. Inducer 23 is rigidly mounted to front shroud 20 by inserting projection 29a of second vane section 29 into hole 20c of front shroud 20 and welding them together.

[0050] This simple structure allows front shroud 20 to hold inducer 23 more firmly, so that inducer 23 can be equipped with multiple vane sections with ease. As a result, use of impeller 52 in accordance with this third embodiment allows electric blower 100 to improve the blowing efficiency and lower the noises.

[0051] In this third embodiment, the structure of projection 29a is formed on second vane section 29; however, the present invention is not limited to this structure. For instance, projection 29a can be formed on first vane section 26, or it can be formed on both first vane section 26 and second vane section 29. These simple structure also allow front shroud to hold impeller 23 more firmly, and impeller 23 can be thus equipped with multiple vane sections with ease. As a result, electric blower 100 can improve the blowing efficiency and lower the noises.

Embodiment 4

[0052] Impeller 53 in accordance with the fourth embodiment of the present invention is demonstrated hereinafter. Impeller 53 in accordance with the fourth embodiment of the present invention is demonstrated hereinafter with reference to Fig. 9 which is a sectional view illustrating a structure around the center of impeller 53.

[0053] Similar elements to those of impellers 1, 51, and 52 demonstrated in embodiments 1 - 3 have the same

reference marks, and the descriptions thereof are omitted here.

[0054] As shown in Fig. 9, tab 30b is formed around the end face of shaft section 30 of lower inducer 27 at front shroud 20 side, and tab 30b is received like a stopper on ring section 25 of upper inducer 24 at front shroud 20 side.

[0055] This structure allows upper inducer 24 to hold lower inducer 24 more firmly along the shaft direction, so that inducer 23 can be equipped with multiple vane sections with ease. As a result, use of impeller 53 in accordance with the fourth embodiment allows electric blower 100 to improve the blowing efficiency and lower the noises.

Embodiment 5

[0056] Electric vacuum cleaner 200 in accordance with the fifth embodiment of the present invention is demonstrated hereinafter. Electric vacuum cleaner 200 in accordance with the fifth embodiment of the present invention is demonstrated hereinafter with reference to Fig. 10 which schematically shows vacuum cleaner 200. Similar elements to those used in embodiments 1 - 4 have the same reference marks, and the descriptions thereof are omitted here.

[0057] As shown in Fig. 10, cleaner 200 includes main body 201, intake tool 202 for sucking dust from a target surface for cleaning, hose 203 of which first end is hooked up to main body 201, extension tube 204 of which first end is connected to hose 203 and the other end is connected to intake tool 202. Manual operation section 205 is provided to an end section on hose 203 at extension tube 204 side.

[0058] Main body 201 includes one of impellers 1, 51, 52, 53 demonstrated in embodiments 1 - 4, electric blower 100 for generating suction air, and dust collector 206 placed on upstream side of blower 100 for collecting dust.

[0059] Operation and advantages of electric vacuum cleaner 200 discussed above are demonstrated hereinafter.

[0060] A user holds manual operation section 205 and starts the operation of cleaner 200, and then electric blower generates suction air for producing suction force. The user moves intake tool 202 on the target face, then dust together with the air can be sucked from the target face through intake tool 202.

[0061] The dust and air sucked flow into dust collector 206 through extension tube 204 and hose 203, and dust collector 206 separates the dust from the air, and only the dust is collected in dust collector 206. The air separated from dust is sucked by electric blower 100 and passes through blower 100 and main body 201 before it is discharged outside main body 201.

[0062] Since electric vacuum cleaner 200 in accordance with the fifth embodiment includes electric blower 100 equipped with one of impeller 1, 51, 52, or 53 demonstrated in embodiments 1 - 4, cleaner 200 achieves

high suction performance and low noises. Use of electric vacuum cleaner 200 in accordance with the fifth embodiment allows the users to carry out a clean-up efficiently.

[0063] The impeller of the present invention is not limited to the structure of impeller 1, 51, 52, or 53 demonstrated in the previous embodiments.

[0064] For instance, the number of first vane sections 26, the number of second vane sections 29, the number of blades 22 are set 9 (nine) respectively in embodiments 1 - 4. However, the impeller of the present invention is not limited to this structure. Those numbers can be set appropriately for the air volume of the electric blower and the rpm of the impeller.

Industrial Applicability

[0065] The impeller of the present invention allows the inducer to be equipped with multiple vane sections with ease. So that an electric blower or an electric vacuum cleaner equipped with this impeller can improve the suction performance and lower the noises.

[0066] On top of that, the impeller allows the electric vacuum cleaner to increase the sucking power and lower the noises. The present invention is thus useful for household electric appliances and industrial devices using an electric blower.

Description of Reference Signs

[0067]

1, 51, 52, 53	impeller
2	air guide
3	fan case
4	motor
5	shaft
6	counter-load side bracket
7	exhausting opening
20	front shroud
20a	suction port (first opening)
20b, 21a	mating slit
20c	hole
21	rear shroud
21b	fourth opening
22	blade
22a, 22b	mating protrusion
23	inducer
24	upper inducer
25	ring section
25a	second opening
25b	recess
26	first vane section
27	lower inducer
27a	third opening
28	base section
29	second vane section
29a	projection
30	shaft section

30a	projection
30b	tab
31	sliding mold
32, 42	core
5 33, 43	cavity
34	groove section
100	electric blower
200	electric vacuum cleaner
201	main body
10 202	intake tool
203	hose
204	extension tube
205	manual operation section
206	dust collector

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Claims

1. An impeller comprising:

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a front shroud having a first opening at a center section of the front shroud;
a rear shroud disposed separately from the front shroud with a space therebetween;
a plurality of blades held by and between the front shroud and the rear shroud, and extending from a center section of the rear shroud toward an outer circumference of the rear shroud; and
an inducer disposed at the center section of the rear shroud,

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wherein the inducer includes an upper inducer disposed at the front shroud side and a lower inducer disposed at the rear shroud side.

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2. The impeller of claim 1, wherein the inducer is held by and between the front shroud and the rear shroud.

3. The impeller of claim 1, wherein the inducer is split into the upper inducer and the lower inducer with a plane parallel to the rear shroud.

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4. The impeller of claim 1, wherein the upper inducer includes:

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a ring section having a second opening at a center section of the ring section; and
a plurality of first vane sections extending from the ring section toward an outer circumference of the inducer,
wherein the lower inducer includes:
a base section mounted to the rear shroud;
a plurality of second vane sections extending from a center section of the base section toward an outer circumference of the base section; and
a shaft section extending from the center section of the base section toward the upper inducer and fitting into the ring section.

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5. The impeller of claim 4, wherein the front shroud has a groove section on a whole perimeter of the front shroud at a place where the front shroud is brought into contact with the first vane sections and the second vane sections. 5
6. The impeller of claim 4, wherein a projection is provided to at least one of the first vane sections and the second vane sections, the projection extending from the first vane sections and the second vane section toward the front shroud, 10
wherein a hole is provided to the front shroud for receiving the projection, 15
wherein the inducer is rigidly mounted to the front shroud by inserting the projection into the hole and welding the projection. 15
7. The impeller of claim 4, wherein the shaft section of the lower inducer has a tab that is to be received by the ring section of the upper inducer for fitting. 20
8. An electric blower comprising the impeller as defined in any one of claim 1 through claim 7.
9. An electric vacuum cleaner comprising: 25
a main body including the electric blower of claim 8; and
an intake tool for sucking dust from a target face for cleaning. 30

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FIG. 1

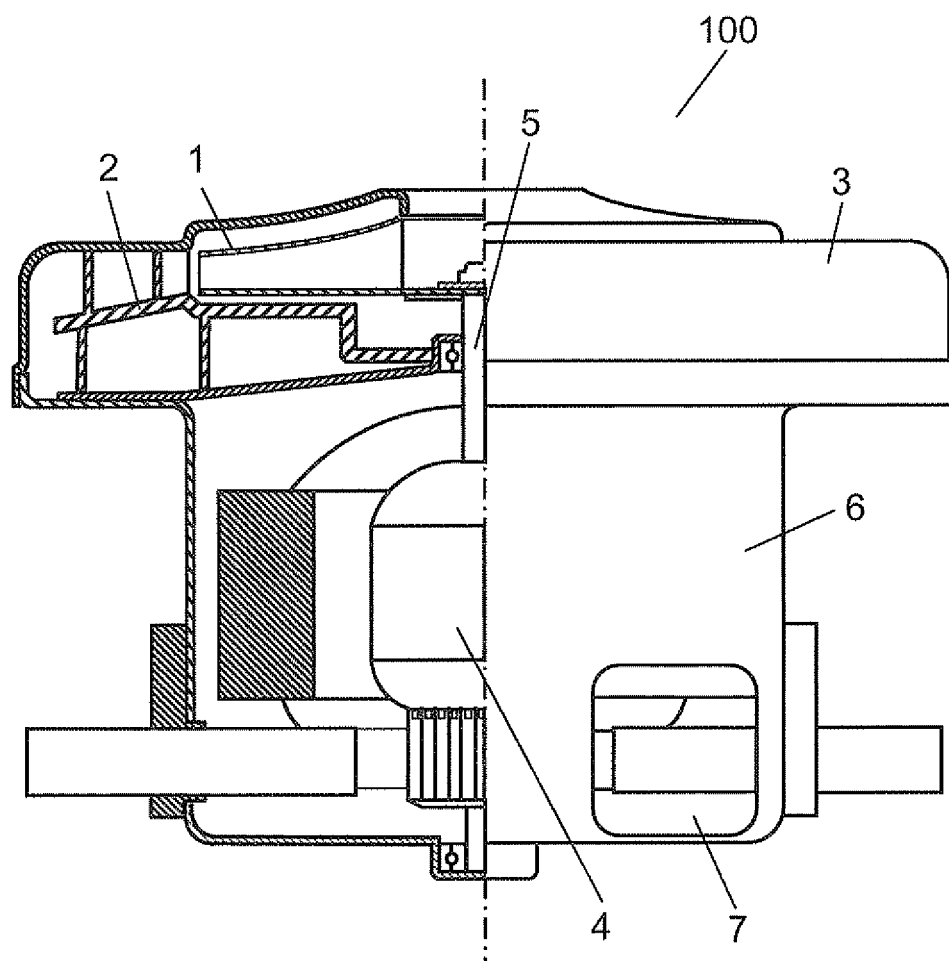


FIG. 2

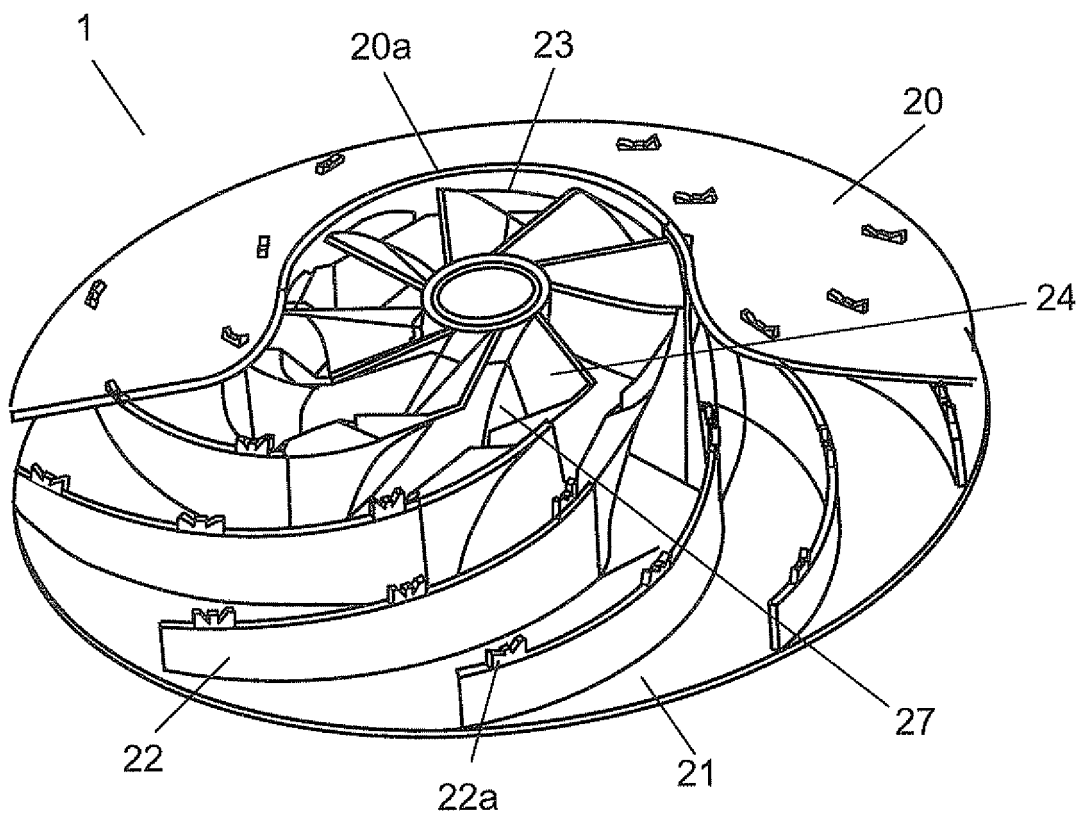


FIG. 3

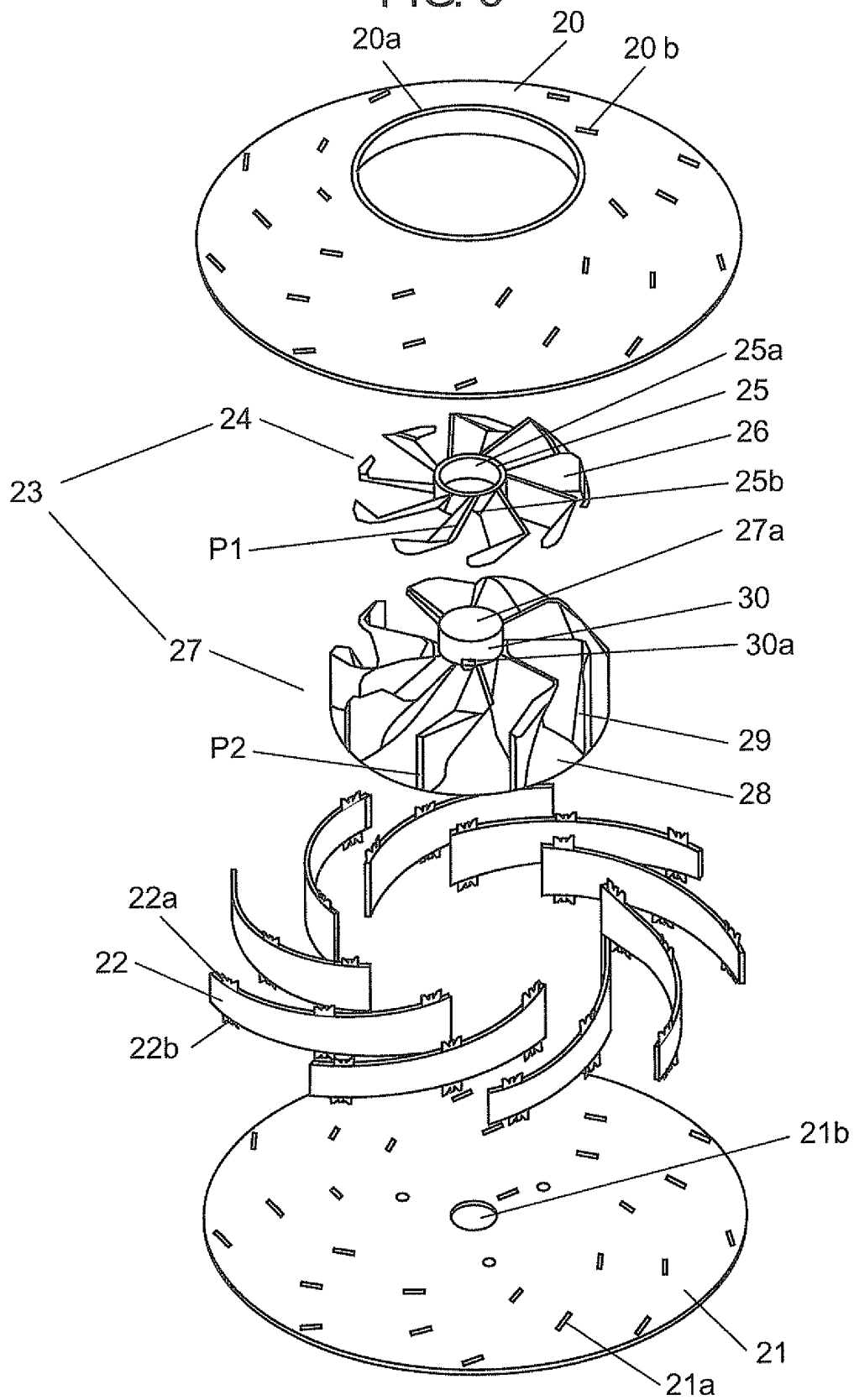


FIG. 4

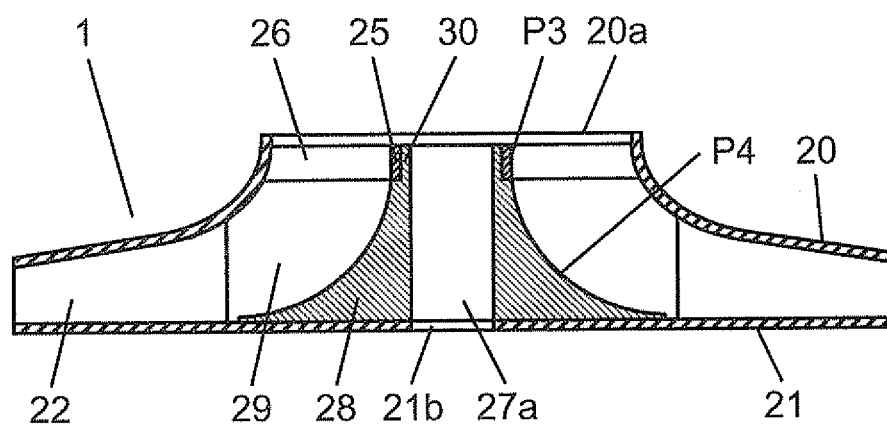


FIG. 5A

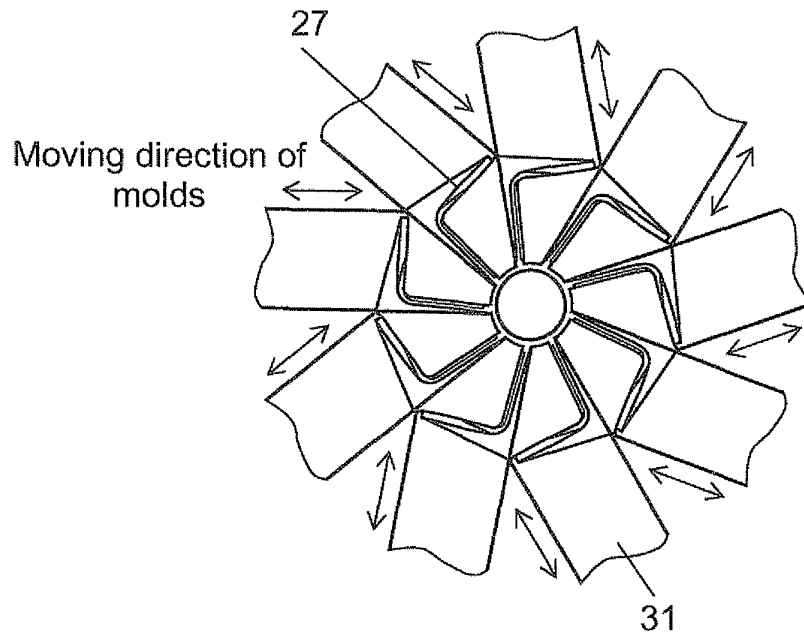


FIG. 5B

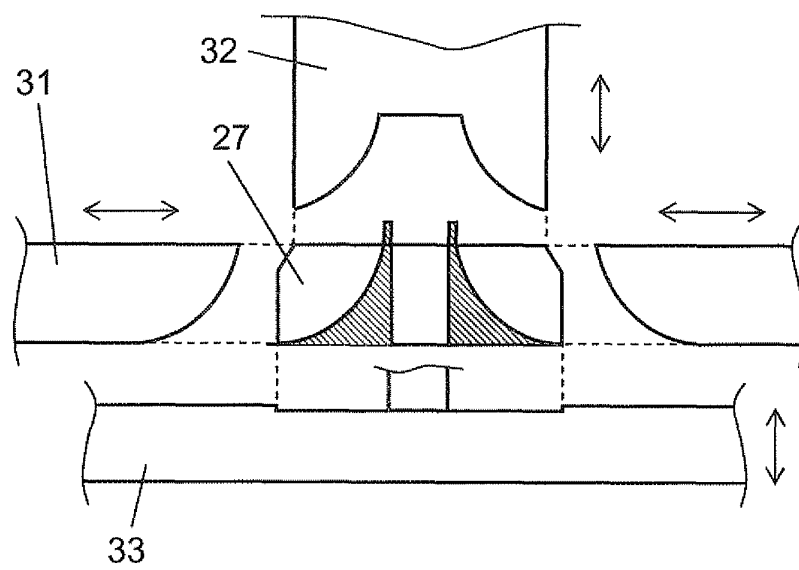


FIG. 6A

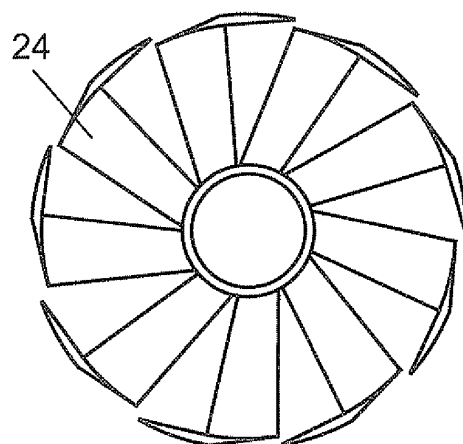


FIG. 6B

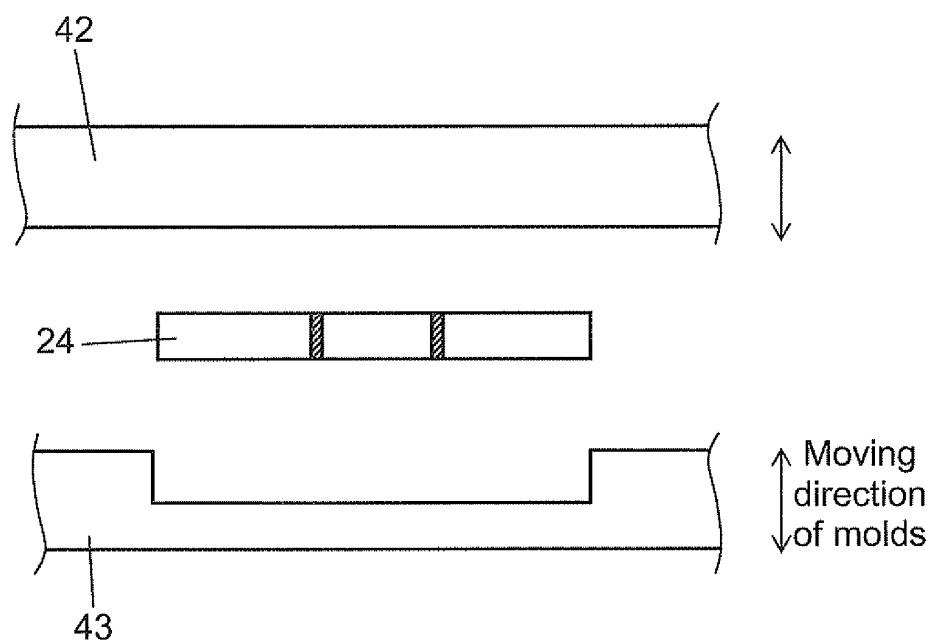


FIG. 7

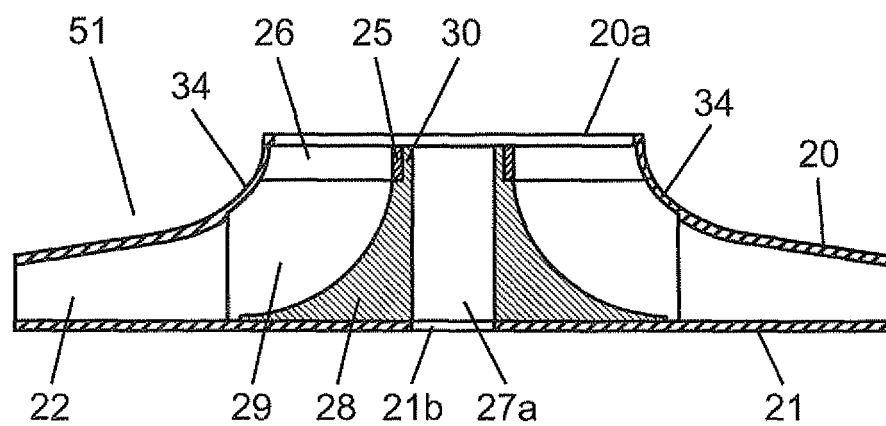


FIG. 8

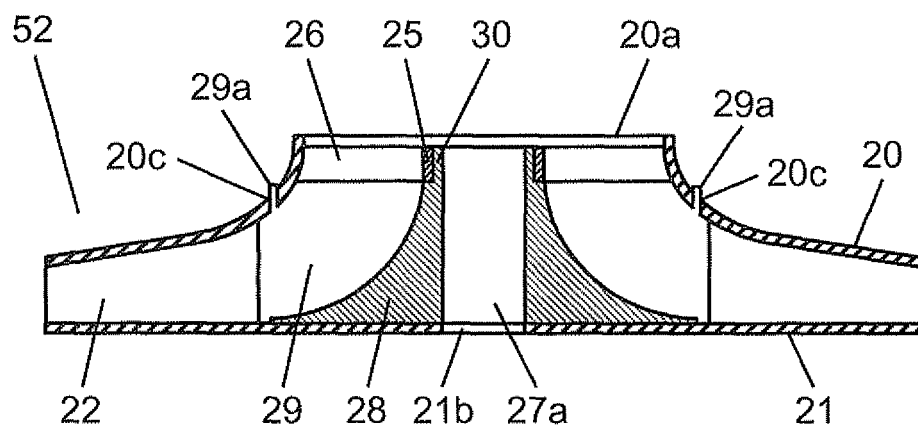


FIG. 9

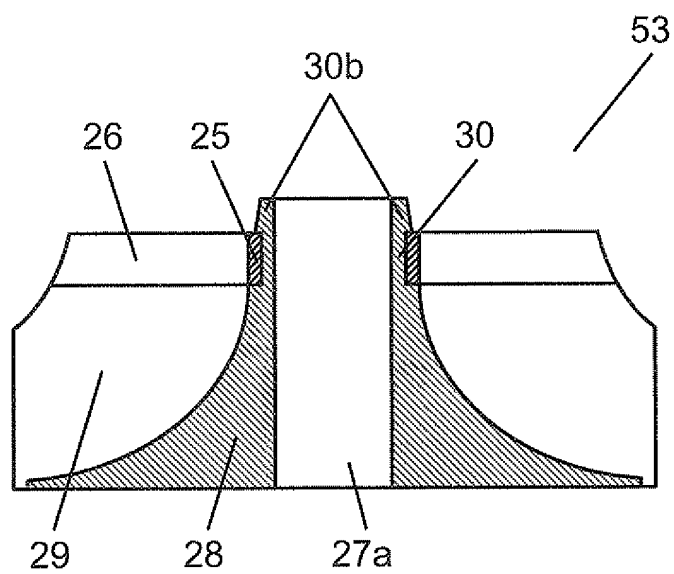


FIG. 10

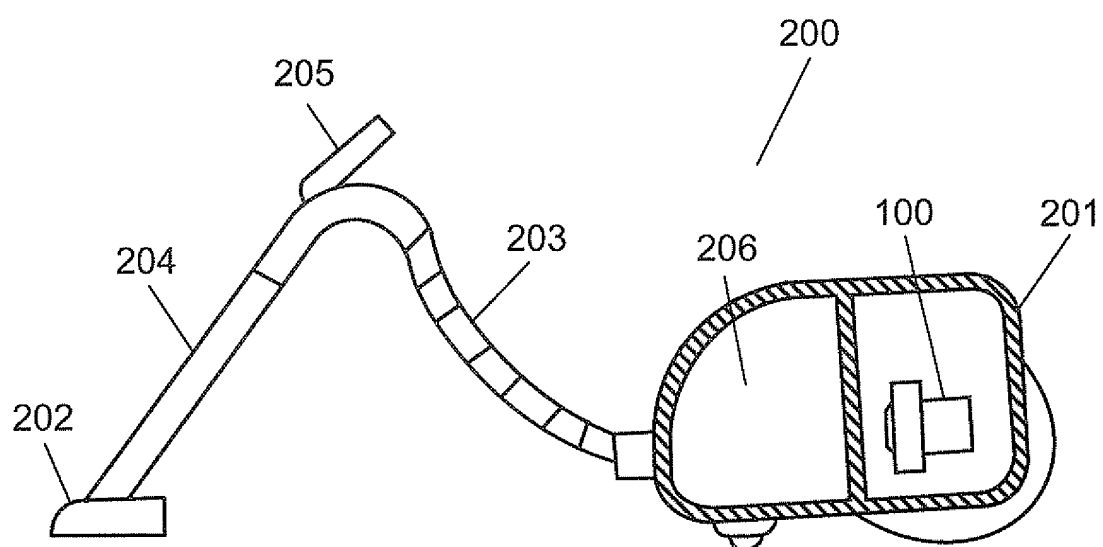


FIG. 11

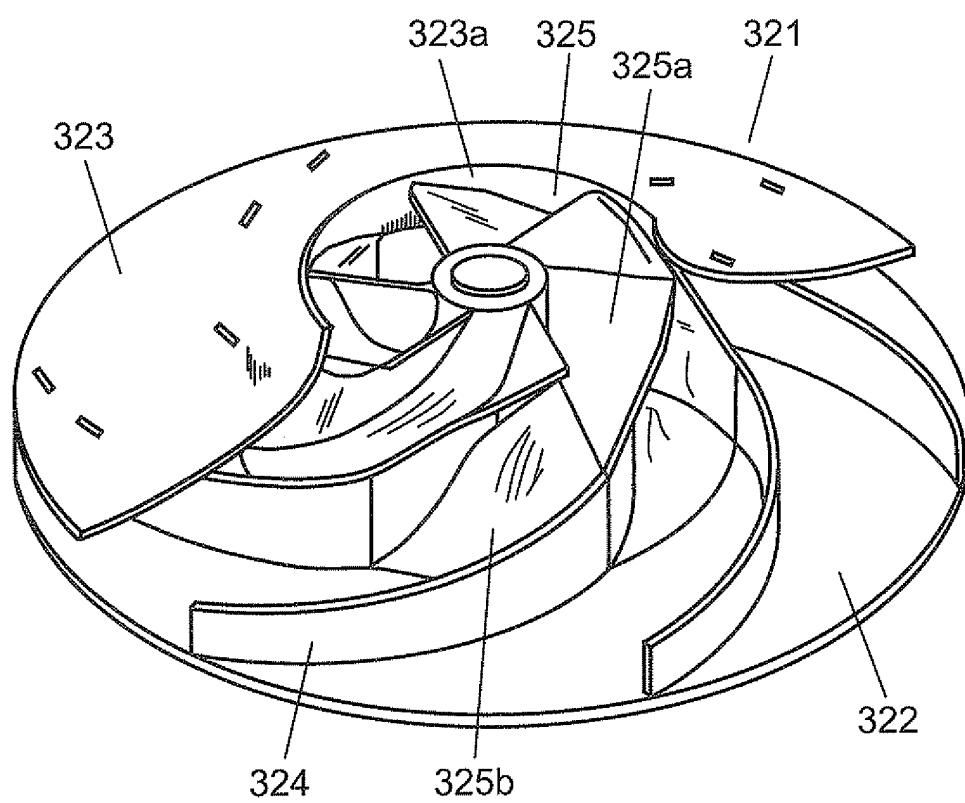


FIG. 12A

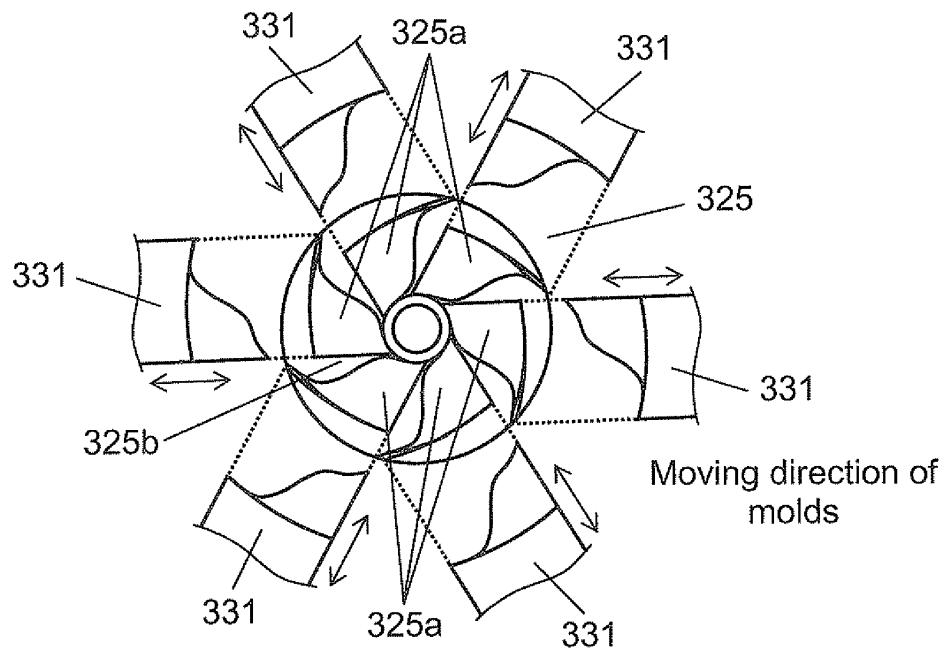
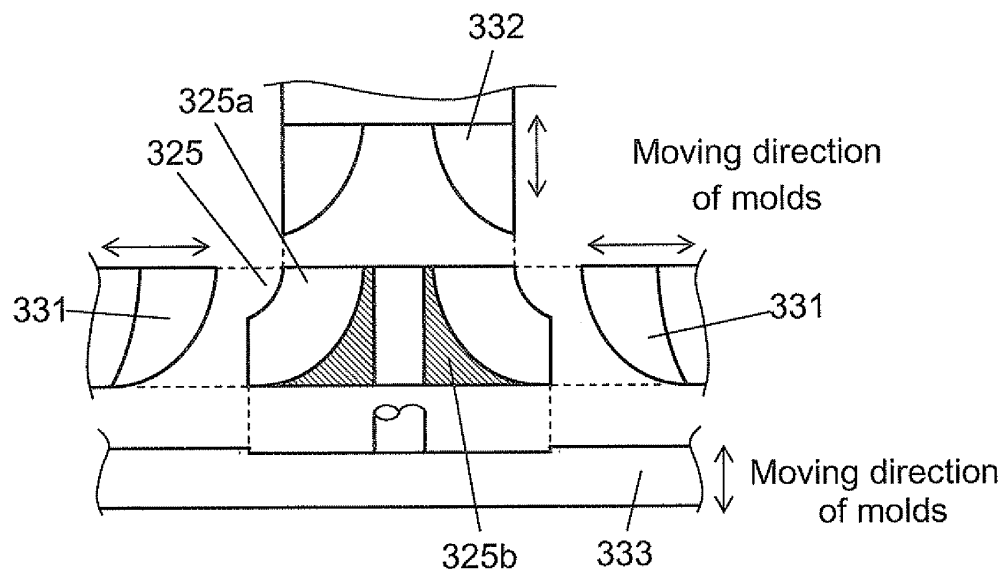


FIG. 12B



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/002643

A. CLASSIFICATION OF SUBJECT MATTER <i>F04D29/28</i> (2006.01) i, <i>F04D17/10</i> (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) <i>F04D29/28</i> , <i>F04D17/10</i> Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011 Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011 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 2004-308647 A (Hitachi Industries Co., Ltd.), 04 November 2004 (04.11.2004), all drawings (Family: none)	1-9
A	JP 2007-244563 A (Matsushita Electric Industrial Co., Ltd.), 27 September 2007 (27.09.2007), fig. 3 (Family: none)	1-9
A	JP 2000-34993 A (Matsushita Electric Industrial Co., Ltd.), 02 February 2000 (02.02.2000), fig. 7 (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 27 May, 2011 (27.05.11)		Date of mailing of the international search report 07 June, 2011 (07.06.11)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/002643

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2006-105121 A (Kenjun Denki Kogyo Kofun Yugen Koshi), 20 April 2006 (20.04.2006), fig. 10 & DE 102005007318 A1	4
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 172717/1987 (Laid-open No. 78287/1989) (Toyota Motor Corp.), 25 May 1989 (25.05.1989), fig. 1 (Family: none)	4, 7
A	JP 9-177694 A (Matsushita Electric Industrial Co., Ltd.), 11 July 1997 (11.07.1997), paragraph [0031]; fig. 10 to 11 (Family: none)	5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000045993 A [0011]