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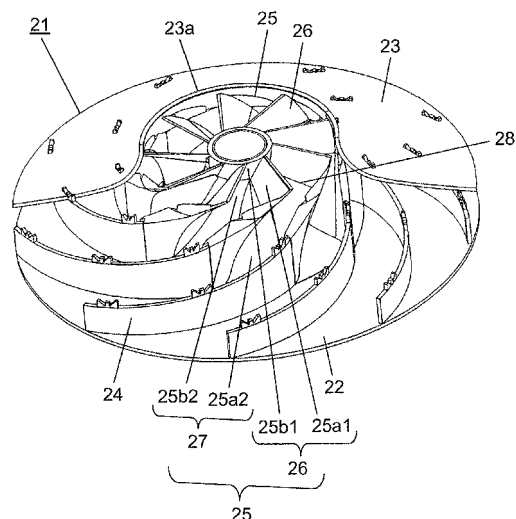
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(54) **IMPELLER, ELECTRIC AIR BLOWER USING SAME, AND ELECTRIC CLEANER USING ELECTRIC AIR BLOWER**

(57) An impeller of the present invention includes a front surface shroud including an air intake port; a back surface shroud provided facing the front surface shroud; a first inducer provided between the front surface shroud and the back surface shroud and including a plurality of first blade sections provided around a first hub portion; a second inducer including a plurality of second blade sections connected to the first blade section of the first inducer and provided around a second hub portion; and a plurality of blades connected to the second blade section of the second inducer. A multi-blade structure of the inducer thus can be realized, and an impeller of high performance and low noise can be provided.

FIG. 1



Description

TECHNICAL FIELD

[0001] The present invention relates to an impeller, an electric air blower using the same, and an electric cleaner using the electric air blower.

BACKGROUND ART

[0002] An electric air blower equipped with an impeller to enhance the suction power is known in a conventional electric cleaner (see e.g., Patent Literature 1).

[0003] The impeller provided in the electric air blower described in Patent Literature 1 will be hereinafter described with reference to FIGS. 17 to 20.

[0004] FIG. 17 is a cross-sectional view of a main part of a conventional electric air blower described in Patent Literature 1. As shown in FIG. 17, the conventional electric air blower includes electric motor 7 and impeller 121 provided on a rotation shaft of electric motor 7 to generate airflow, where impeller 121 is configured by inducer 125 including blade section 125a and substantially conical hub 125b. Impeller 121 is rotationally driven by electric motor 7, and the airflow discharged from impeller 121 is rectified by air guide 8. Impeller 121 and air guide 8 are enclosed by fan case 9.

[0005] The structure of impeller 21 will be hereinafter described with reference to FIG. 18.

[0006] FIG. 18 is a cutaway view of the impeller of the electric air blower. As shown in FIG. 18, impeller 121 is configured by back surface shroud 122 of a flat plate shape, front surface shroud 123 of a substantially umbrella shape, a plurality of blades 124, and inducer 125 made of resin provided in correspondence with air intake port 123a provided on a middle of front surface shroud 123. Blade 124 is attached to back surface shroud 122 and front surface shroud 123 that are made from sheet metal through caulking processing.

[0007] Additionally, inducer 125 is configured by substantially conical hub 125b, and a plurality of blade sections 125a formed on hub 125b. The airflow flowing from air intake port 123a of front surface shroud 123 towards blade 124 through blade section 125a of inducer 125 is rectified by substantially conical hub 125b.

[0008] A die structure for creating inducer 125 will be described below with reference to FIGS. 19 and 20.

[0009] FIG. 19 is a plan view describing a manufacturing method of an inducer of an impeller of the conventional electric air blower. FIG. 20 is a cross-sectional view describing a manufacturing method of the inducer of the conventional electric air blower.

[0010] As shown in FIGS. 19 and 20, in accordance with the shape of plurality of blade sections 125a, inducer 125 is produced by performing the resin molding processing using slide die 131, which slides substantially radially in an outer periphery direction and using a die including core 132 and cavity 133 that move in an up and down

direction.

[0011] However, when creating inducer 125 with such a die, the number of blade section 125a is limited since blade section 125a of inducer 125 of the conventional electric air blower has a complex three-dimensional shape. Thus, in the current situation, the production of blade section 125a is limited to six. Furthermore, if the number of blade sections 125a is six, a high frequency of about 3.0 KHz is generated when blade section 125a of inducer 125 is rotated at the number of rotations of about 30000 r/min. The frequency of about 3.0 KHz is a high frequency contained in a region of 1 KHz to 3 KHz, which is particularly easy to hear in the audibility zone of the human ear. Thus, when the cleaner is used at such a high frequency sound, it gives an unpleasant feeling to the user of the cleaner as a very cacophonous high frequency sound of high squealing.

[0012] Consideration is made in increasing the number of blade sections 125a to shift the frequency region of the high frequency sound to the region insensitive to the human ear. However, since blade section 125a of inducer 125 has a complex three-dimensional shape, it is difficult to produce blade section 125a using the die when increasing the number of blade sections 125a. Consideration is also made in adopting the method of producing blade section 125a with the mold technique such as casting, but the mold technique is not realistic because mass production is difficult and cost is very high.

Citation List

Patent Literature

[0013]

PTL 1: Unexamined Japanese Patent Publication No. 2000-45993

SUMMARY OF THE INVENTION

[0014] An impeller of the present invention includes a front surface shroud including an air intake port; a back surface shroud provided facing the front surface shroud; a first inducer provided between the front surface shroud and the back surface shroud and including a plurality of first blade sections provided around a first hub portion; a second inducer including a plurality of second blade sections connected to the first blade section of the first inducer and provided around a second hub portion; and a plurality of blades connected to the second blade section of the second inducer. A multi-blade structure of the inducer thus can be realized, and an impeller of high performance and low noise can be provided.

[0015] Moreover, an electric air blower of low noise that excels in the suction performance can be provided by using the impeller of the present invention.

[0016] Further, an electric cleaner of the present invention uses the electric air blower, whereby an electric

cleaner of high suction performance and low noise can be realized.

BRIEF DESCRIPTION OF DRAWINGS

[0017]

FIG. 1 is a cutaway perspective view describing a configuration of an impeller according to a first exemplary embodiment of the present invention.

FIG. 2 is a perspective view of an inducer of the impeller according to the first exemplary embodiment of the present invention.

FIG. 3 is a view taken along line 3-3 of FIG. 2, showing the inducer configuring the impeller according to the first exemplary embodiment of the present invention.

FIG. 4 is a plan view of a first inducer of the impeller according to the first exemplary embodiment of the present invention.

FIG. 5 is a perspective view showing a second inducer of the impeller according to the first exemplary embodiment of the present invention.

FIG. 6 is a cross-sectional view describing a manufacturing method of the first inducer of the impeller according to the first exemplary embodiment of the present invention.

FIG. 7 is a plan view describing a manufacturing method of the second inducer of the impeller according to the first exemplary embodiment of the present invention.

FIG. 8 is a cross-sectional view describing a manufacturing method of the second inducer of the impeller according to the first exemplary embodiment of the present invention.

FIG. 9 is a view taken along line 3-3 of FIG. 2, showing an inducer configuring an impeller according to a second exemplary embodiment of the present invention.

FIG. 10 is a view taken along line 3-3 of FIG. 2, showing an inducer configuring an impeller according to a third exemplary embodiment of the present invention.

FIG. 11 is a perspective view of an inducer configuring an impeller according to a fourth exemplary embodiment of the present invention.

FIG. 12 is a perspective view of a first inducer according to the fourth exemplary embodiment of the present invention.

FIG. 13 is a partial cross-sectional view describing an electric air blower using an impeller of another example according to the fourth exemplary embodiment of the present invention.

FIG. 14A is a side view describing a shape of an unchanged first inducer configuring an impeller according to a fifth exemplary embodiment of the present invention.

FIG. 14B is a side view describing a shape of a

changed first inducer configuring the impeller according to the fifth exemplary embodiment of the present invention.

FIG. 15A is a side view describing a shape of an unchanged first inducer configuring an impeller according to a sixth exemplary embodiment of the present invention.

FIG. 15B is a side view describing a shape of a changed first inducer configuring the impeller according to the sixth exemplary embodiment of the present invention.

FIG. 16 is a view showing an overall configuration of an electric cleaner according to a seventh exemplary embodiment of the present invention.

FIG. 17 is a cross-sectional view of a main part of a conventional electric air blower.

FIG. 18 is a cutaway view of an impeller of the conventional electric air blower.

FIG. 19 is a plan view describing a manufacturing method of an inducer of an impeller of the conventional electric air blower.

FIG. 20 is a cross-sectional view describing a manufacturing method of an inducer of the conventional electric air blower.

DESCRIPTION OF EMBODIMENTS

[0018] Exemplary embodiments of the present invention will be hereinafter described with reference to the drawings. It should be noted that the present invention is not limited by the exemplary embodiments.

FIRST EXEMPLARY EMBODIMENT

[0019] FIG. 1 is a cutaway perspective view describing a configuration of an impeller according to a first exemplary embodiment of the present invention. FIG. 2 is a perspective view of an inducer of the impeller according to the first exemplary embodiment of the present invention. FIG. 3 is a view taken along line 3-3 of FIG. 2, showing the inducer of the impeller according to the first exemplary embodiment of the present invention. FIG. 4 is a plan view of a first inducer of the impeller according to the first exemplary embodiment of the present invention. FIG. 5 is a perspective view showing a second inducer of the impeller according to the first exemplary embodiment of the present invention. The configuration of an electric air blower in which the impeller is attached to an electric motor is basically similar to the configuration of the conventional electric air blower, and hence a description thereof will be made with reference to FIG. 17.

[0020] The impeller to be attached to the electric motor of the electric air blower will be described in detail below.

[0021] As shown in FIG. 1, impeller 21 rotationally driven by electric motor 7 (see FIG. 17) is configured by front surface shroud 23, back surface shroud 22, inducer 25 including first inducer 26 and second inducer 27, and blade 24 connected to second inducer 27. As shown in

FIG. 4, first inducer 26 includes first hub 25b1 and first blade section 25a1 formed on an outer peripheral surface of first hub 25b1. Similarly, as shown in FIG. 5, second inducer 27 includes second hub 25b2 and second blade section 25a2 formed on an outer peripheral surface of second hub 25b2.

[0022] Front surface shroud 23 and back surface shroud 22 are made from sheet metal, or the like and are provided facing each other with a predetermined spacing. First inducer 26 and second inducer 27 are provided, and a plurality of blades 24 provided in correspondence to second blade section 25a2 of second inducer 27 are also provided between front surface shroud 23 and back surface shroud 22. Blade 24 is attached to back surface shroud 22 and front surface shroud 23 by caulk processing, for example.

[0023] In this case, first inducer 26 is provided on a middle in correspondence with air intake port 23a of front surface shroud 23, and is configured by first hub 25b1 having a substantially conical shape (include conical shape) and nine first blade sections 25a1, for example, provided evenly along the outer peripheral surface of first hub 25b1. Similarly, second inducer 27 is provided on a middle in correspondence with air intake port 23a of front surface shroud 23, and is configured by second hub 25b2 having a substantially conical shape (include conical shape) and nine second blade sections 25a2, for example, provided evenly along the outer peripheral surface of second hub 25b2. First inducer 26 and second inducer 27 are connected to each other through a joining surface of first blade section 25a1 and second blade section 25a2, and a joining surface of first hub 25b1 and second hub 25b2, to configure inducer 25. In this case, as shown in FIGS. 2 and 3, inducer 25 configured by first inducer 26 and second inducer 27 is connected to a plane perpendicular to a shaft of electric motor 7 of FIG. 17, that is, a plane substantially parallel (include parallel) to back surface shroud 22. First inducer 26 is provided on air intake port 23a side of front surface shroud 23, and second inducer 27 (see FIG. 5) is provided on back surface shroud 22 side. In this case, joining portion 28, which is the joining surface of first inducer 26 and second inducer 27 is air-tightly joined by an adhesive, for example. The leakage of airflow from a gap between first inducer 26 and second inducer 27 thus can be prevented, and the air blowing performance of the electric air blower can be enhanced.

[0024] First blade section 25a1 and second blade section 25a2 are preferably formed to a three-dimensional curved surface shape to rectify the airflow flowing from air intake port 23a of front surface shroud 23 towards blade 24.

[0025] The connected first blade section 25a1 of first inducer 26 and second blade section 25a2 of second inducer 27, and adjacent first blade section 25a1 of first inducer 26 and second blade section 25a2 of second inducer 27 are normally formed overlapping each other. Thus, the distance between first blade section 25a1 and

second blade section 25a2 adjacent to each other becomes close, whereby the pressure distribution of the airflow in the space can be evened and the occurrence of turbulent flow and the stripping of the airflow from the wall surface can be prevented. As a result, the loss of fluid energy of the airflow and the like can be reduced, and the impeller with enhanced air blowing efficiency can be realized.

[0026] In the present exemplary embodiment, an example in which the number of first blade section 25a1 and second blade section 25a2 is nine has been described, but is not limited thereto. For instance, the number merely needs to be seven or more.

[0027] The reasons therefor will be described below. Specifically, if the number of first blade section 25a1 and second blade section 25a2 is nine, the frequency of the high frequency sound that generates becomes high or about 4.5 KHz if the number of rotations of electric motor 7 is about 30000 rpm, for example. If the number is seven, the frequency of the high frequency sound that generates becomes about 3.5 KHz. Such frequencies of the high frequency sound are in the region where the sensitivity of the human ear is low, and hence are sounds that are less likely to be heard. Therefore, the electric air blower with lowered noise can be realized.

[0028] On the other hand, if the number of first blade section 25a1 and second blade section 25a2 is less than seven such as six, for example, the frequency of the high frequency sound that generates becomes about 3.0 KHz if the number of rotations is about 30000 r/min. Such frequency of the high frequency sound is in the region where the sensitivity is particularly high in the audibility zone of the human ear, and thus becomes the sound that is easily heard. Therefore, it becomes a high frequency sound that is high and very cacophonous, as expressed as "squealing sound", and gives an unpleasant feeling to the user.

[0029] If the number of first blade section 25a1 and second blade section 25a2 is greater than nine, the distance between adjacent first blade section 25a1 and second blade section 25a2 becomes too close, and hence the occurrence of turbulent flow and the stripping of the airflow from the wall surface easily occur. As a result, the loss of the fluid energy of the airflow and the like increases and the air blowing efficiency lowers.

[0030] A manufacturing method of manufacturing first inducer 26 and second inducer 27 using a die will be described below with reference to FIGS. 6 to 8.

[0031] FIG. 6 is a cross-sectional view describing a manufacturing method of the first inducer of the impeller according to the first exemplary embodiment of the present invention. FIG. 7 is a plan view describing a manufacturing method of the second inducer of the impeller according to the first exemplary embodiment of the present invention. FIG. 8 is a cross-sectional view describing a manufacturing method of the second inducer of the impeller according to the first exemplary embodiment of the present invention.

[0032] As shown in FIG. 6, the die for producing first inducer 26 shown in FIG. 4 is configured by two plates of core 32a and cavity 33a. The resin such as polyethylene terephthalate or polybutylene terephthalate, for example, is placed between core 32a and cavity 33a, and the resin is pressurized in a direction shown with an arrow in FIG. 6 to produce first inducer 26. First inducer 26 is thus easily molding processed with only the two-plate die including cavity 33a and core 32a.

[0033] Then, as shown in FIGS. 7 and 8, the die of second inducer 27 shown in FIG. 5 is configured by nine-directional slide die 31 configured in a divided manner at an angular interval of 40 degrees, core 32b, and cavity 33b when the number of second blade section 25a2 of second inducer 27 is nine, for example. The resin such as polyethylene terephthalate or polybutylene terephthalate, for example, is placed between core 32b and cavity 33b, and the resin is pressurized in a direction shown with an arrow in FIG. 8, and slide die 31 is also slid towards the center in a direction shown with an arrow in FIG. 7 to process the resin, and thus second inducer 27 is produced. Thereafter, slide die 31, core 32b, and cavity 33b are moved in the opening direction to produce second inducer 27. Second inducer 27 with second blade section 25a2 having a complex shape is thus easily molding processed with slide die 31 divided into plurals and adapted to slide substantially radially in the outer periphery direction.

[0034] In the conventional inducer, when realizing multi-blades and integrally forming nine blades, molding processing becomes very difficult and the cost becomes high.

[0035] However, as described above, according to the present exemplary embodiment, inducer 25 is configured in a divided manner by first inducer 26 and second inducer 27, and first inducer 26 and second inducer 27 can be respectively molded with the die. Thereafter, first inducer 26 and second inducer 27, which are molded and produced separately, are combined to produce inducer 25 when assembling impeller 21. Inducer 25 in which adjacent first blade section 25a1 and second blade section 25a2 overlap thus can be easily produced. Inducer 25 having a multi-blade shape such as in which the number of first blade section 25a1 and second blade section 25a2 is nine can be produced at low cost and high productivity.

[0036] In the present exemplary embodiment, an example in which first inducer 26 and second inducer 27 are produced by processing a resin material with the die molding has been described, but is not limited thereto. First inducer 26 and second inducer 27 may be produced from a metal material using techniques such as die-casting, sintering, or the like, for example. The inducer excelling in heat resistance and processing accuracy thus can be produced.

[0037] According to the present exemplary embodiment, an impeller including inducer 25 with a great number of blades sections having a complex shape can

be easily realized. Therefore, the efficiency of the electric air blower including the impeller in which the flow of the airflow between the blade sections is improved, and the electric cleaner using the electric air blower can be enhanced. Furthermore, the frequency of the high frequency sound generated at the blade section can be moved from the cacophonous frequency region to the high frequency region (frequency region where the sensitivity of human ear is low) by increasing the number of blade sections, which was difficult to realize in the prior art. Lower noise of the electric air blower including the impeller and the electric cleaner using the electric air blower thus can be realized.

[0038] The operation of impeller 21 configured as above will be described below.

[0039] First, when the electric motor is driven, impeller 21 coupled to the electric motor is rotated at high speed, and the airflow is suctioned from air intake port 23a of front surface shroud 23 of impeller 21. The suctioned airflow is passed through an internal passage surrounded by front surface shroud 23, inducer 25, and back surface shroud 22, and pushed out towards blade 24. Thereafter, the airflow that is pushed out is passed through an internal passage surrounded by front surface shroud 23, back surface shroud 22, and blade 24, and discharged from an outer peripheral part of impeller 21. In this case, the airflow smoothly flows from a longitudinal direction of impeller 21 towards a side direction along a curved surface of a three-dimensional shape formed by first blade section 25a1 and second blade section 25a2, and first hub 25b1 and second hub 25b2. The pressure loss thus can be sufficiently suppressed from occurring in impeller 21.

[0040] The electric air blower using impeller 21 will be described below. The electric air blower of the present exemplary embodiment differs from the conventional electric air blower only in the configuration of impeller 21, and hence the electric air blower of the present exemplary embodiment will be described with reference to FIG. 17.

[0041] The electric air blower of the present exemplary embodiment is configured at least by impeller 21 shown in FIG. 1 rotationally driven by electric motor 7, air guide 8 for rectifying the airflow discharged from impeller 21, and fan case 9 for enclosing impeller 21 and air guide 8. Impeller 21 includes front surface shroud 23, back surface shroud 22, inducer 25 including first inducer 26 and second inducer 27, and blade 24 connected to second inducer 27. In this case, as shown in FIG. 4, first inducer 26 includes first hub 25b1 having a substantially conical shape, and first blade section 25a1 with seven or more blades, for example, formed on the outer peripheral surface of first hub 25b1. Similarly, as shown in FIG. 5, second inducer 27 includes second hub 25b2 having a substantially conical shape, and second blade section 25a2 with seven or more blades, for example, formed on the outer peripheral surface of second hub 25b2.

[0042] In other words, the noise of the cacophonous high frequency sound region can be reduced, turbulent flow and the stripping of the airflow from the wall surface

that easily occur inside impeller 21 can be prevented, and the electric air blower excelling in the air blowing efficiency can be realized by using impeller 21 of the present exemplary embodiment.

[0043] Furthermore, the electric cleaner having low driving sound and high suction performance can be realized by using the electric air blower.

SECOND EXEMPLARY EMBODIMENT

[0044] FIG. 9 is a view taken along line 3-3 of FIG. 2, showing an inducer configuring an impeller according to a second exemplary embodiment of the present invention.

[0045] The impeller of the present exemplary embodiment differs from the first exemplary embodiment in that groove 29 is provided on one of the joining surfaces of joining portion 28 of at least first blade section 25a1 of first inducer 26 and second blade section 25a2 of second inducer 27. Other configurations are similar to the first exemplary embodiment.

[0046] As shown in FIG. 9, inducer 25 of impeller 21 according to the present exemplary embodiment includes groove 29 on a joining surface along joining portion 28 of first blade section 25a1 of first inducer 26 and second inducer 27. An adhesive is applied to groove 29 to adhere first blade section 25a1 of first inducer 26 and second inducer 27. In this case, the adhesive flows along groove 29, and hence the adhesive can be efficiently applied and the adhering workability can be enhanced. As the surface tension strongly acts on the adhesive applied on groove 29, the adhesive can be prevented from overflowing to the surface on which the airflow flows of first blade section 25a1 and second blade section 25a2. The lowering in the air blowing performance caused by the lowering in surface roughness (microscopic step caused by attachment of adhesive) of the surface on which the airflow flows of first blade section 25a1 and second blade section 25a2 can be prevented.

[0047] In the present exemplary embodiment, an example in which groove 29 is provided on one of the joining surfaces of either first blade section 25a1 side of first inducer 26 or second blade section 25a2 side of second inducer 27 has been described, but is not limited thereto and may be provided on both sides.

[0048] In the present exemplary embodiment, an example in which groove 29 is provided on one of the joining surfaces of either first blade section 25a1 side of first inducer 26 or second blade section 25a2 side of second inducer 27 has been described, but is not limited thereto. For instance, groove 29 may be provided on either first blade section 25a1 side of first inducer 26 or second blade section 25a2 side of second inducer 27, and a projection to be fitted to groove 29 may be provided on the other side to connect by fitting. Therefore, as consideration does not need to be made in the adhesive running out, the productivity can be enhanced.

[0049] Furthermore, in the present exemplary embod-

iment, an example in which groove 29 is provided on one of the joining surfaces of either first blade section 25a1 side of first inducer 26 or second blade section 25a2 side of second inducer 27 has been described, but is not limited thereto. For instance, as shown in FIG. 9, groove 29a may be further provided along joining portion 28 of first blade section 25a1 of first inducer 26 and second blade section 25a2 of second inducer 27 and on the surface side of first blade section 25a1 or second blade section 25a2 on which the airflow flows in a the opposite side of rotating direction (leftward direction in FIG. 9) of impeller 21. A surface (pressure surface) without a step is thus formed on first blade section 25a1 or second blade section 25a2 on the rotating direction (rightward direction in FIG. 9) side of impeller 21 that greatly influences the air blowing performance, in particular, thus preventing the lowering in the air blowing performance.

THIRD EXEMPLARY EMBODIMENT

[0050] FIG. 10 is a view taken along line 3-3 of FIG. 2 of an inducer configuring an impeller according to a third exemplary embodiment of the present invention.

[0051] The impeller of the present exemplary embodiment differs from the second exemplary embodiment in that groove 29b is provided on one of the joining surfaces of joining portion 28 of at least first hub 25b1 of first inducer 26 and second hub 25b2 of second inducer 27. Other configurations are similar to the second exemplary embodiment.

[0052] As shown in FIG. 10, inducer 25 of impeller 21 according to the present exemplary embodiment has groove 29b provided, discretely or over the entire periphery, on the joining surface along joining portion 28 of first hub 25b1 of first inducer 26 and second inducer 27.

[0053] The adhesive flowing out from the outer peripheral part of first blade section 25a1 and second blade section 25a2 to the inner peripheral part of first blade section 25a1 and second blade section 25a2 when first inducer 26 and second inducer 27 are adhered flows into groove 29b provided on joining portion 28 of first hub 25b1 or second hub 25b2 and accumulates thereat. The adhesive is thus prevented from flowing to root 30 of first hub 25b1 or second hub 25b2, and first blade section 25a1 or second blade section 25a2. As a result, the lowering in the air blowing performance caused by the lowering in surface roughness (microscopic step caused by attachment of adhesive) of the surface on which the airflow flows of first blade section 25a1 and second blade section 25a2 can be prevented.

FOURTH EXEMPLARY EMBODIMENT

[0054] FIG. 11 is a perspective view of an inducer configuring an impeller according to a fourth exemplary embodiment of the present invention. FIG. 12 is a perspective view of a first inducer according to the fourth exemplary embodiment of the present invention.

[0055] Impeller 21 of the present exemplary embodiment differs from the first exemplary embodiment in that ring portion 19 for connecting a plurality of first blade sections 25a1 of first inducer 26 is provided. Other configurations are similar to the first exemplary embodiment.

[0056] As shown in FIGS. 11 and 12, a plurality of (e.g., nine) first blade sections 25a1 of first inducer 26 of impeller 21 according to the present exemplary embodiment are connected with ring portion 19 made of metal, for example, to configure first inducer 26.

[0057] The mechanical strength of first inducer 26 thus can be raised. As a result, warp and deformation of first inducer 26 can be prevented, and first inducer 26 excelling in shape stability can be realized at high accuracy.

[0058] In the present exemplary embodiment, an example in which ring portion 19 is made from a metal material has been described, but is not limited thereto. For instance, ring portion 19 may be formed by integral molding with first blade section 25a1 and first hub 25b1 of first inducer 26 at an outer peripheral end of the upper part of first inducer 26. Accordingly, effects similar to those described above can be obtained, and productivity can be enhanced by integral molding.

[0059] Furthermore, in the present exemplary embodiment, an example in which ring portion 19 is formed simply to a ring shape has been described, but is not limited thereto. For instance, as shown in FIG. 13, projection 20 may be provided on an upper surface (side opposite to surface provided with first blade section 25a1) of ring portion 19. Projection 20 exhibits high effect when mounting impeller 21 to the electric air blower.

[0060] The electric air blower mounted with an impeller of another example configured by first inducer 26 including projection 20 will be described below with reference to FIG. 13.

[0061] FIG. 13 is a partial cross-sectional view describing an electric air blower using an impeller of another example according to the fourth exemplary embodiment of the present invention.

[0062] As shown in FIG. 13, projection 20 having an acute shape, for example, is formed on the upper surface of ring portion 19 of first inducer 26 of impeller 21. Seal portion 11 made of an elastic body, for example, enclosed in fan case 9 is deformed and bitten in through projection 20 to fix seal portion 11. In this case, projection 20 and seal portion 11 can be pressurized at an even load to connect with seal portion 11 since the mechanical strength is enhanced with ring portion 19 of first inducer 26. Accordingly, projection 20 and seal portion 11 can be connected at high air tightness. As a result, the electric air blower in which the leakage of airflow flowing into the impeller is prevented and in which the air blowing efficiency is not lowered, and the electric cleaner using the same can be realized.

FIFTH EXEMPLARY EMBODIMENT

[0063] An inducer configuring an impeller according to

a fifth exemplary embodiment of the present invention will be hereinafter described with reference to the drawings.

[0064] The inducer of the fifth exemplary embodiment has a configuration in which an inclination angle of the first blade section of the first inducer and an inclination angle of the second blade section of the second inducer are different.

[0065] In other words, if the amount of wind and the number of rotations demanded on the electric air blower are changed, this can be responded with a simple configuration of the inducer.

[0066] FIG. 14A is a side view describing a shape of an unchanged first inducer configuring the impeller according to the fifth exemplary embodiment of the present invention. FIG. 14B is a side view describing a shape of a changed first inducer configuring the impeller according to the fifth exemplary embodiment of the present invention.

[0067] First, as shown in FIG. 14A, when designing the performance of the electric air blower with amount of wind Q1 and number of rotations N1, an inclination angle of first blade section 25a1 of first inducer 26 that exhibits the best efficiency is assumed as θ_1 .

[0068] A case in which the performance of the electric air blower is changed to amount of wind Q2 and number of rotations N2 will be described below by way of example.

[0069] In this case, in the case of the impeller of the present exemplary embodiment, the inclination angle of first blade section 25a1 of first inducer 26 is changed to θ_2 and joined with second blade section 25a2 formed with inclination angle θ_1 of second inducer 27 to realize amount of wind Q2 and number of rotations N2, as shown in FIG. 14B. The gap formed between first blade section 25a1 and second blade section 25a2 is 40 degrees as described in the configuration of nine blade sections in the first exemplary embodiment and thus is not changed, whereby connection can be easily made to inclination angle θ_1 of second inducer 27 even if the inclination angle of first blade section 25a1 of first inducer 26 is changed to θ_2 . As a result, the performance of the changed electric air blower can be realized by simply changing the inclination angle of first blade section 25a1 of first inducer 26.

[0070] In the conventional impeller structure, on the other hand, inducer 25 needs to be newly developed and a new die is required therefor when changing the inclination angle θ_1 of the blade section of inducer 25 to θ_2 , and thus enhancement in productivity and lower cost are difficult.

[0071] According to the present exemplary embodiment, however, the predetermined performance can be achieved by simply changing the inclination angle of first blade section 25a1 of first inducer 26 that most influences the properties of inducer 25. Thus, it can be realized by simply producing newly only the die of first inducer 26, and hence high productivity and low cost can be easily realized.

[0072] Therefore, according to the present exemplary embodiment, the entire inducer does not need to be re-designed even if the design of the electric air blower is changed, and it can be responded by simply changing the die of the first inducer, for example. Accordingly, in the impeller, the electric air blower using the same, and the electric cleaner using the electric air blower, die cost, man hours for development, and schedule for development can be reduced.

[0073] In the present exemplary embodiment, the case of changing the die of the first inducer has been described by way of example, but the die of the second inducer may be changed and in this case similar effects can be obtained.

SIXTH EXEMPLARY EMBODIMENT

[0074] An inducer configuring an impeller according to a sixth exemplary embodiment of the present invention will be hereinafter described with reference to the drawings.

[0075] In the present exemplary embodiment, if the amount of wind and the number of rotations demanded on the electric air blower are changed, this can be responded with a simple configuration of the inducer.

[0076] FIG. 15A is a side view describing a shape of an unchanged first inducer configuring the impeller according to the sixth exemplary embodiment of the present invention. FIG. 15B is a side view describing a shape of a changed first inducer configuring the impeller according to the sixth exemplary embodiment of the present invention.

[0077] First, as shown in FIG. 15A, when designing the performance of the electric air blower with amount of wind Q1 and number of rotations N1, a height of first blade section 25a1 of first inducer 26 that exhibits the best efficiency is assumed as H1.

[0078] A case in which the performance of the electric air blower is changed to amount of wind Q2 and number of rotations N2 will be described below by way of example.

[0079] In this case, in the case of the impeller of the present exemplary embodiment, the height of first blade section 25a1 of first inducer 26 is changed to H2, and joined with second blade section 25a2 of second inducer 27 to realize amount of wind Q2 and number of rotations N2, as shown in FIG. 15B. The performance of the changed electric air blower thus can be realized by simply changing the inclination angle of first blade section 25a1 of first inducer 26.

[0080] In the conventional impeller structure, on the other hand, inducer 25 needs to be newly developed and a new die is required therefor when changing the height H1 of the blade section of inducer 25 to H2, and thus enhancement in productivity and lower cost are difficult.

[0081] According to the present exemplary embodiment, however, the predetermined performance can be achieved by simply changing the height of first blade sec-

tion 25a of first inducer 26 that most influences the properties of inducer 25. Thus, it can be realized by simply producing newly only the die of first inducer 26, and hence high productivity and low cost can be easily realized.

[0082] Therefore, according to the present exemplary embodiment, the entire inducer does not need to be re-designed even if the design of the electric air blower is changed, and it can be responded by simply changing the die of the first inducer, for example. Accordingly, in the impeller, the electric air blower using the same, and the electric cleaner using the electric air blower, die cost, man hours for development, and schedule for development can be reduced.

[0083] In the present exemplary embodiment, the case of changing the die of the first inducer has been described by way of example, but the die of the second inducer may be changed and in this case similar effects can be obtained.

SEVEN EXEMPLARY EMBODIMENT

[0084] FIG. 16 is a view showing an overall configuration of an electric cleaner according to a seventh exemplary embodiment of the present invention.

[0085] In FIG. 16, the electric cleaner according to the present exemplary embodiment includes cleaner main body 34, hose 35 communicated to cleaner main body 34, extended tube 36 communicated to one end of hose 35, operation handle 37 provided on an end of hose 35, and floor vacuuming tool 38 communicated to one end of extended tube 36. Electric air blower 39 including the impeller for generating the suction power is incorporated in cleaner main body 34. Dust collecting chamber 40 for accumulating suctioned dust is provided on an upstream side of electric air blower 39.

[0086] In the present exemplary embodiment, the electric air blower including any impeller 21 described in the first to sixth exemplary embodiments is incorporated for electric air blower 39.

[0087] The operation of the electric cleaner configured as above will be described below.

[0088] First, the user holds operation handle 37 and starts the operation of the electric cleaner. The suction power is generated from electric air blower 39, and the dust is suctioned with air from floor vacuuming tool 38 moved on the floor surface. The suctioned dust is flowed to dust collecting chamber 40 through extended tube 36 and hose 35 with the air, and the dust and the air are separated in dust collecting chamber 40. The separated dust is accumulated in dust collecting chamber 40, and only the air is suctioned by electric air blower 39. The suctioned air is passed through the inside of electric air blower 39, and furthermore, passed through the inside of cleaner main body 34 to be discharged to the outside of cleaner main body 34.

[0089] According to the present exemplary embodiment, the electric cleaner that has high suction performance, that does not generate cacophonous noise, that is

comfortable, and that excels in operability can be realized by electric air blower 39 mounted with the impeller with enhanced air blowing efficiency of the present invention.

INDUSTRIAL APPLICABILITY

[0090] The present invention is useful in the electric cleaner, consumer electronics, industrial instruments and the like that use the electric air blower in which enhancement in the efficiency of the amount of wind and the number of rotations, and reduction in noise are desired.

REFERENCE MARKS IN THE DRAWINGS

[0091]

7: electric motor
8: air guide
9: fan case
11: seal portion
19: ring portion
20: projection
21, 121: impeller
22, 122: back surface shroud
23, 123: front surface shroud
23a, 123a: air intake port
24, 124: blade
25, 125: inducer
25a1: first blade section
25a2: second blade section
25b1: first hub
25b2: second hub
26: first inducer
27: second inducer
28: joining portion
29, 29a, 29b: groove
30: root
31, 131: slide die
32a, 32b, 132: core
33a, 33b, 133: cavity
34: cleaner main body
35: hose
36: extended tube
37: operation handle
38: floor vacuuming tool
39: electric air blower
40: dust collecting chamber
125a: blade section
125b: hub

Claims

1. An impeller comprising:

a front surface shroud including an air intake port;

a back surface shroud provided facing the front surface shroud;
a first inducer provided between the front surface shroud and the back surface shroud and including a plurality of first blade sections provided around a first hub portion;
a second inducer including a plurality of second blade sections connected to the first blade section of the first inducer and provided around a second hub portion; and
a plurality of blades connected to the second blade section of the second inducer.

2. The impeller according to claim 1, wherein the first blade section of the first inducer and the adjacent second blade section of the second inducer overlap each other.
3. The impeller according to claim 1, wherein the number of the first blade section of the first inducer and the second blade section of the second inducer is at least seven.
4. The impeller according to claim 1, wherein the first inducer and the second inducer are connected through a joining portion.
5. The impeller according to claim 4, wherein a groove is formed in the joining portion.
6. The impeller according to claim 5, wherein a groove is formed in a surface on the opposite side of rotating direction side of the first blade section or the second blade section.
7. The impeller according to claim 4, wherein the joining portion is a connecting surface of the first blade section of the first inducer and the second blade section of the second inducer.
8. The impeller according to claim 7, wherein the connecting surface further includes a connecting surface of the first hub portion and the second hub portion.
9. The impeller according to claim 1, wherein the plurality of first blade sections of the first inducer are connected to each other with a ring portion.
10. The impeller according to claim 9, wherein the first inducer and the ring portion are integrally molded.
11. The impeller according to claim 9, wherein a projection is provided on an outer periphery of the ring portion.
12. The impeller according to claim 1, wherein an inclination angle of the first blade section of the first in-

ducer and an inclination angle of the second blade section of the second inducer are different.

13. The impeller according to claim 1, wherein an axial height of the first blade section of the first inducer and an axial height of the second blade section of the second inducer are different. 5
14. An electric air blower comprising the impeller according to claim 1, and an electric motor. 10
15. An electric cleaner using the electric air blower according to claim 14. 15

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FIG. 1

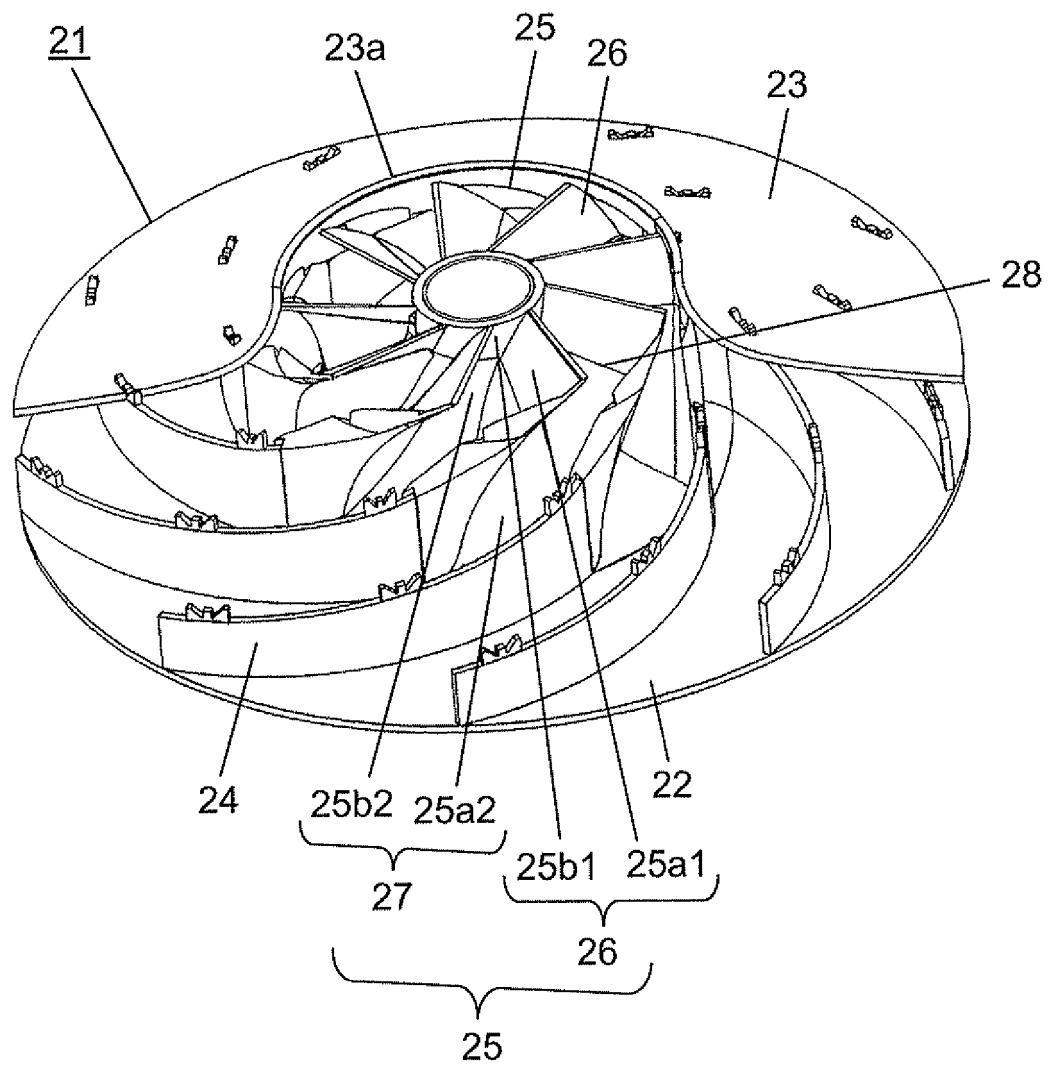


FIG. 2

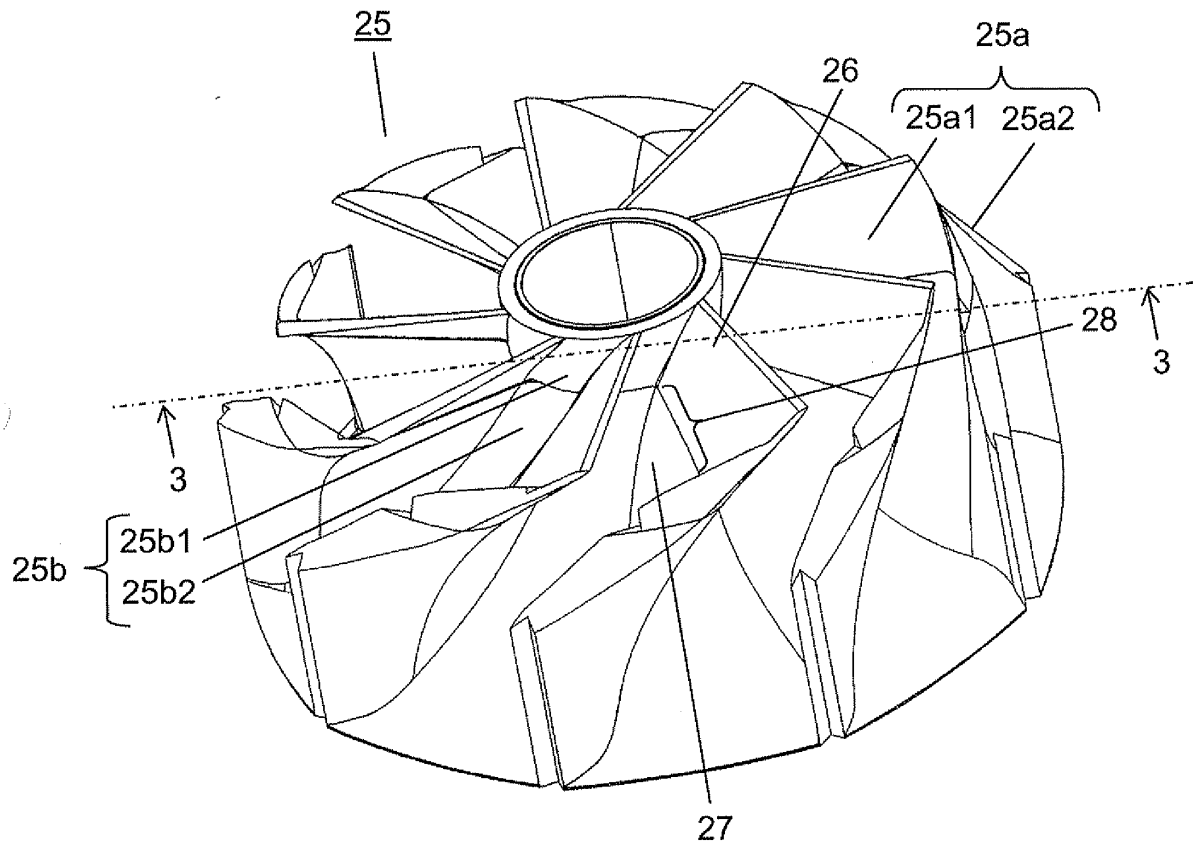


FIG. 3

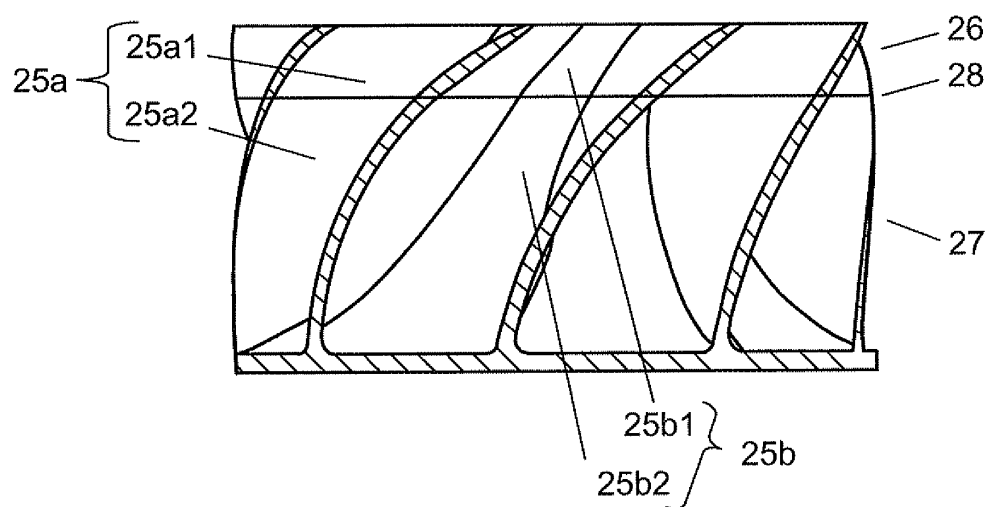


FIG. 4

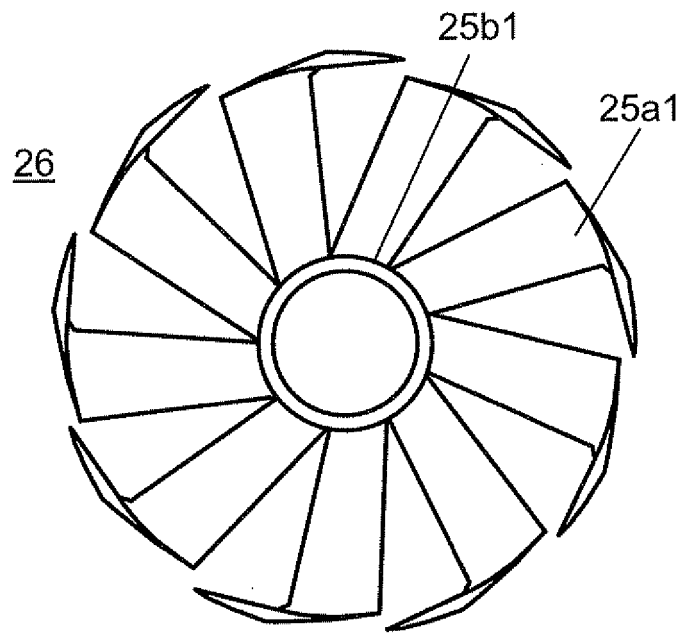


FIG. 5

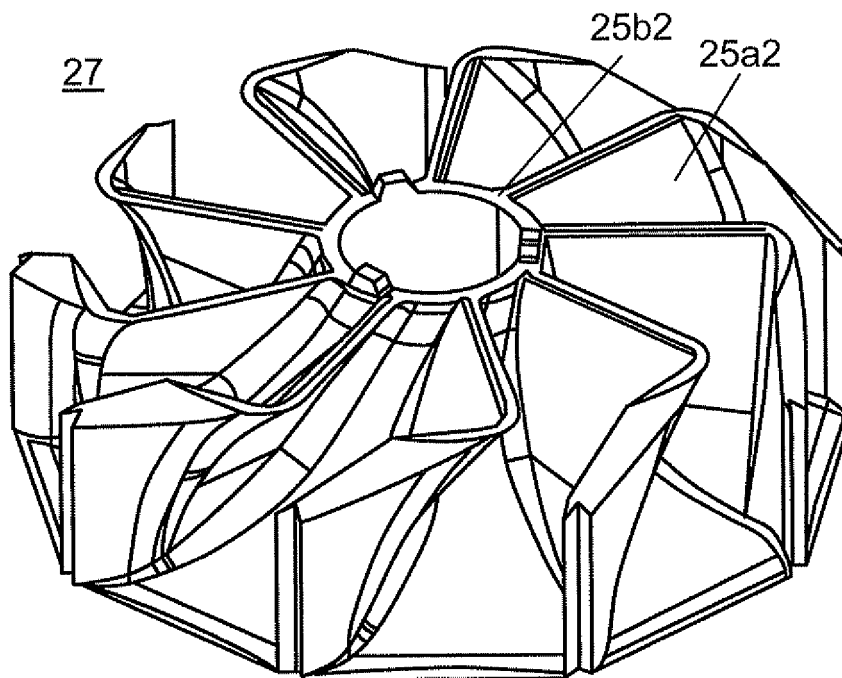


FIG. 6

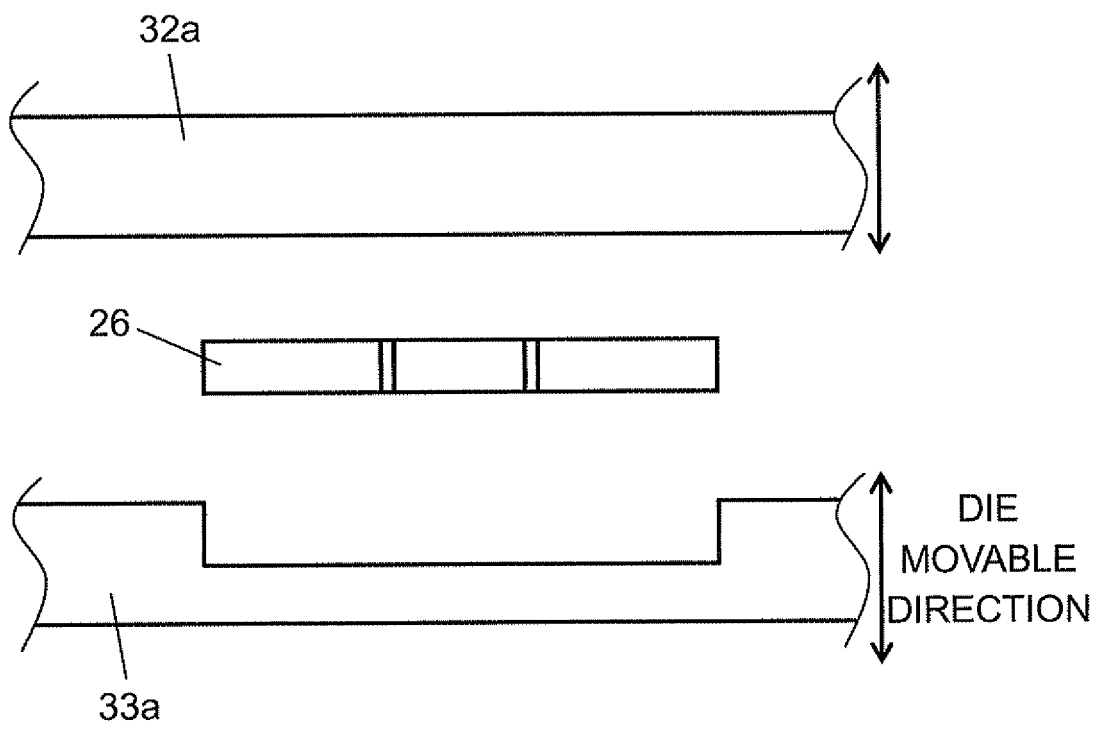


FIG. 7

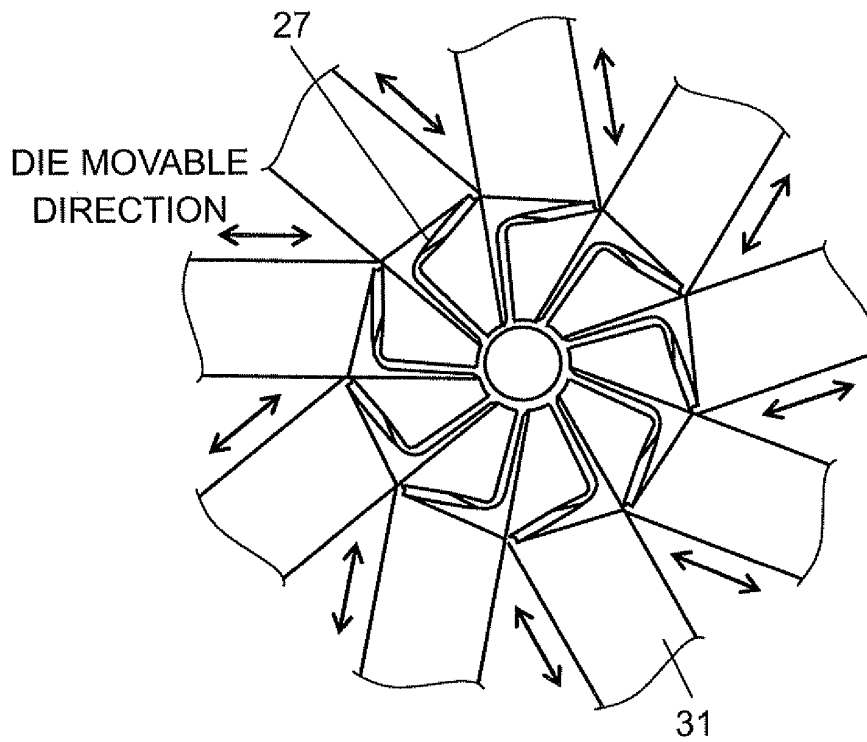


FIG. 8

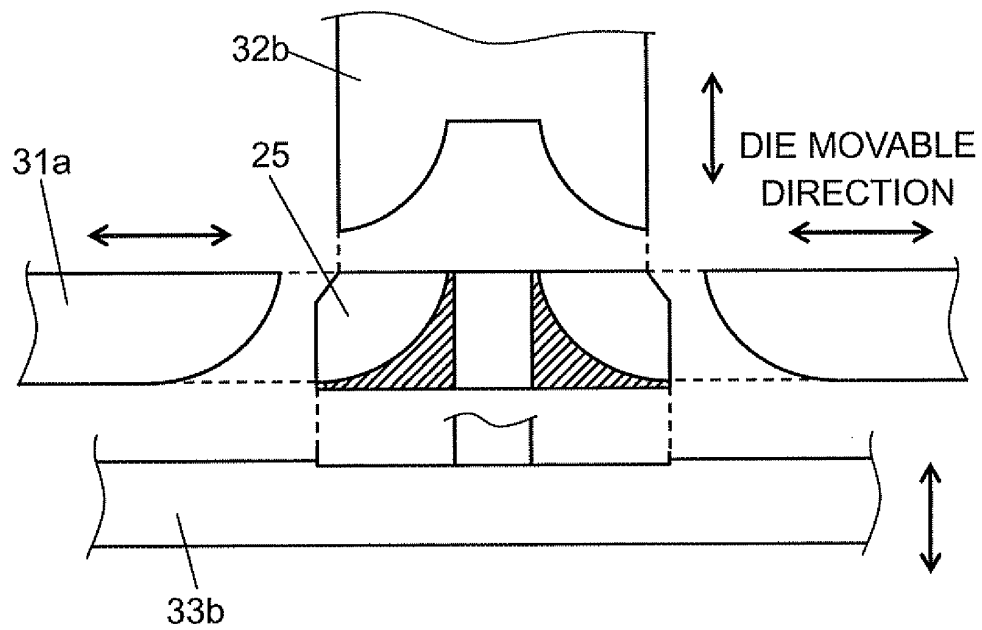


FIG. 9

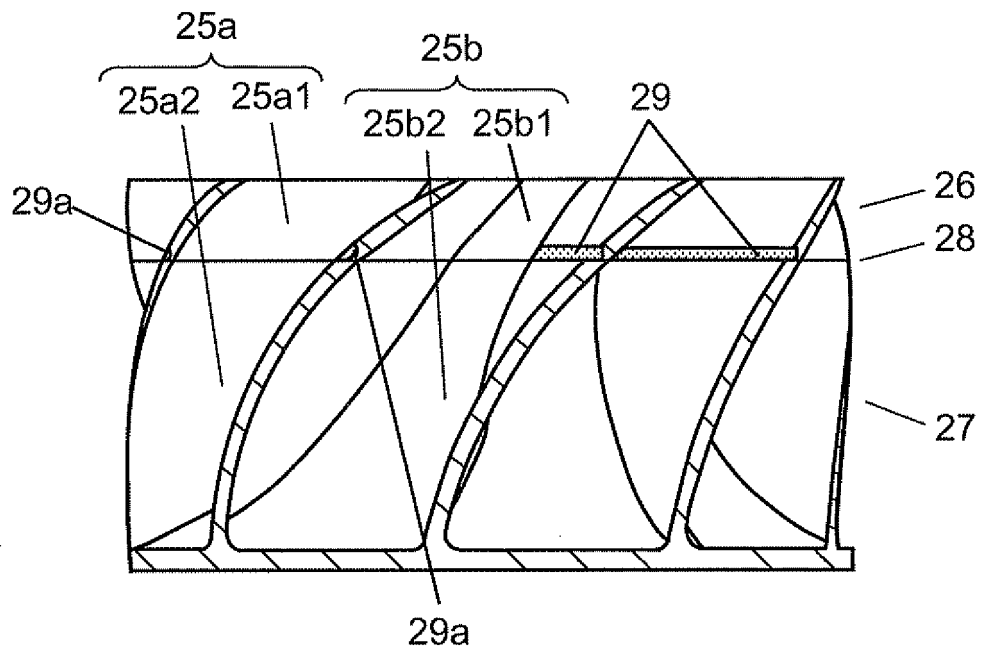


FIG. 10

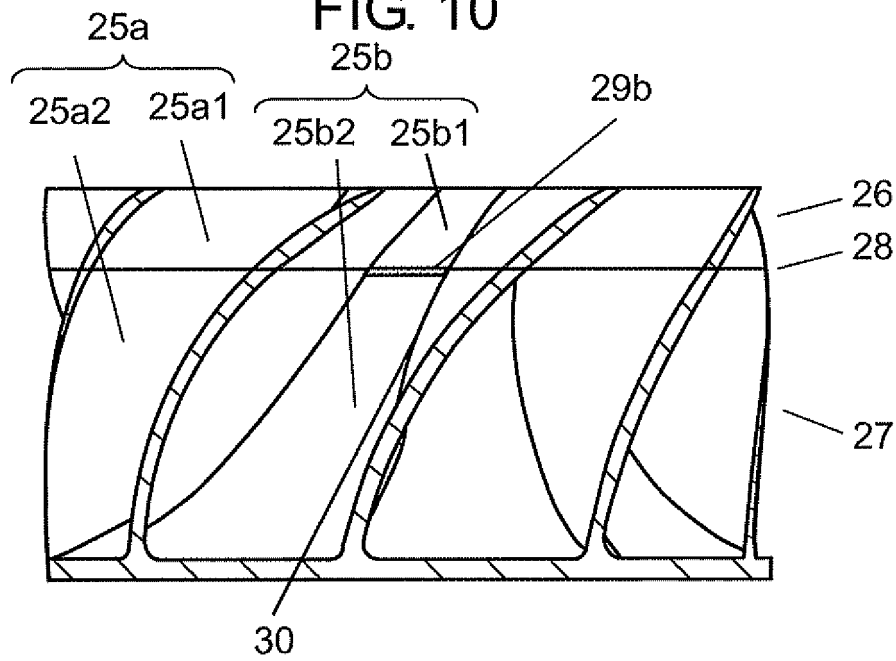


FIG. 11

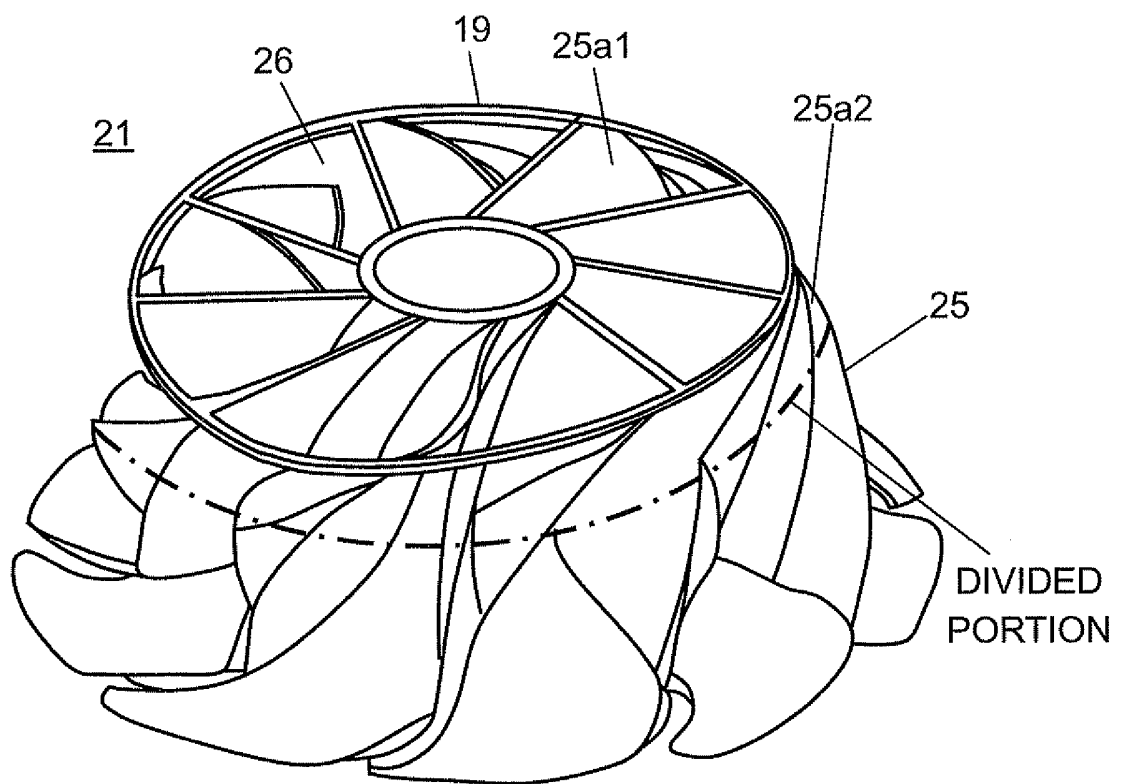


FIG. 12

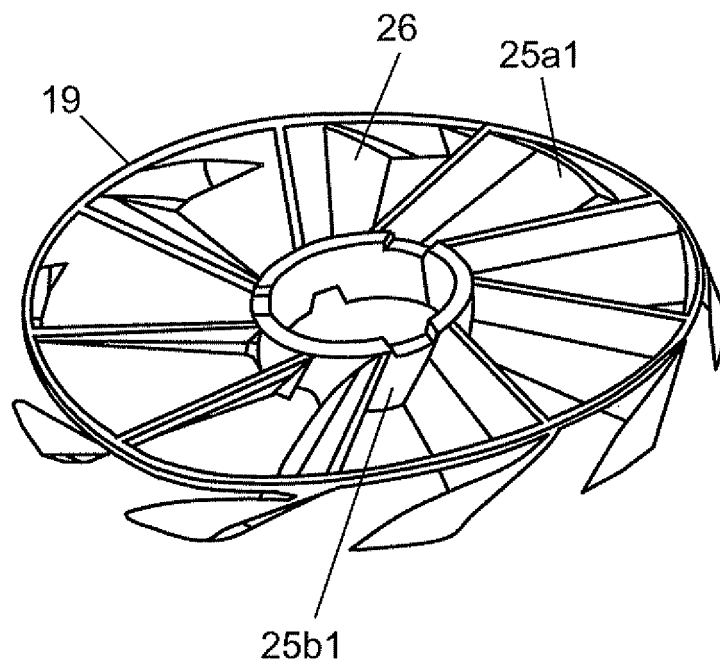


FIG. 13

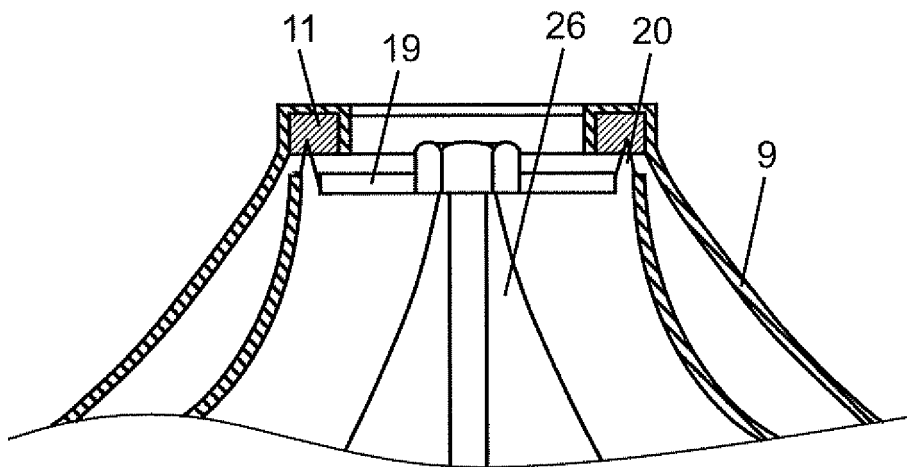


FIG. 14A

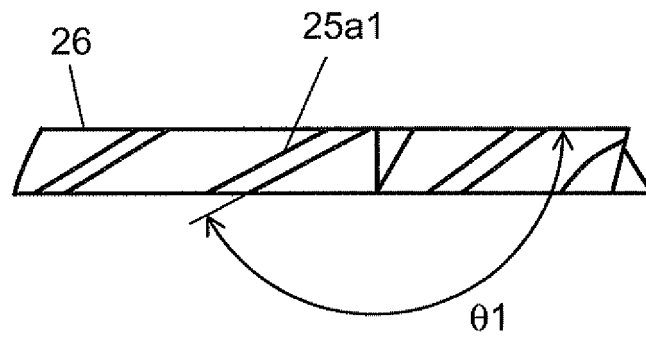


FIG. 14B

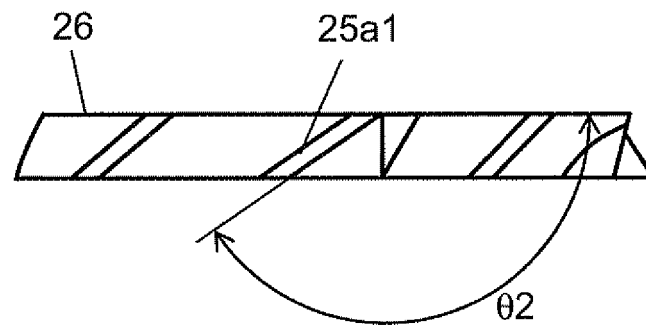


FIG. 15A

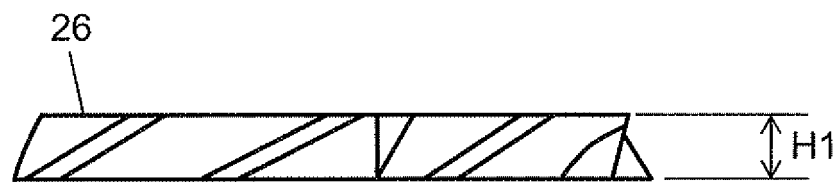


FIG. 15B



FIG. 16

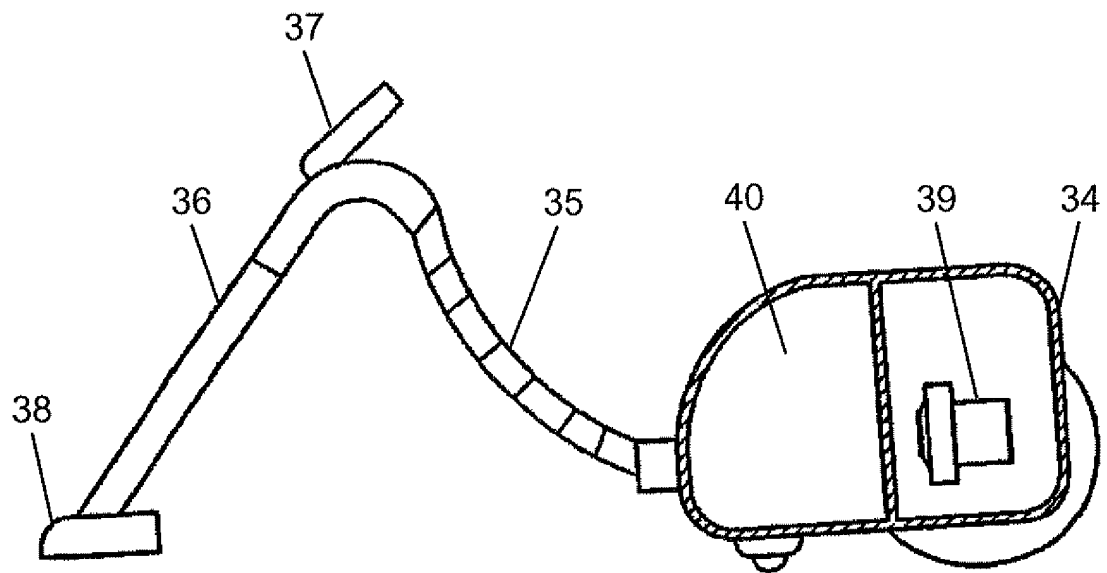


FIG. 17

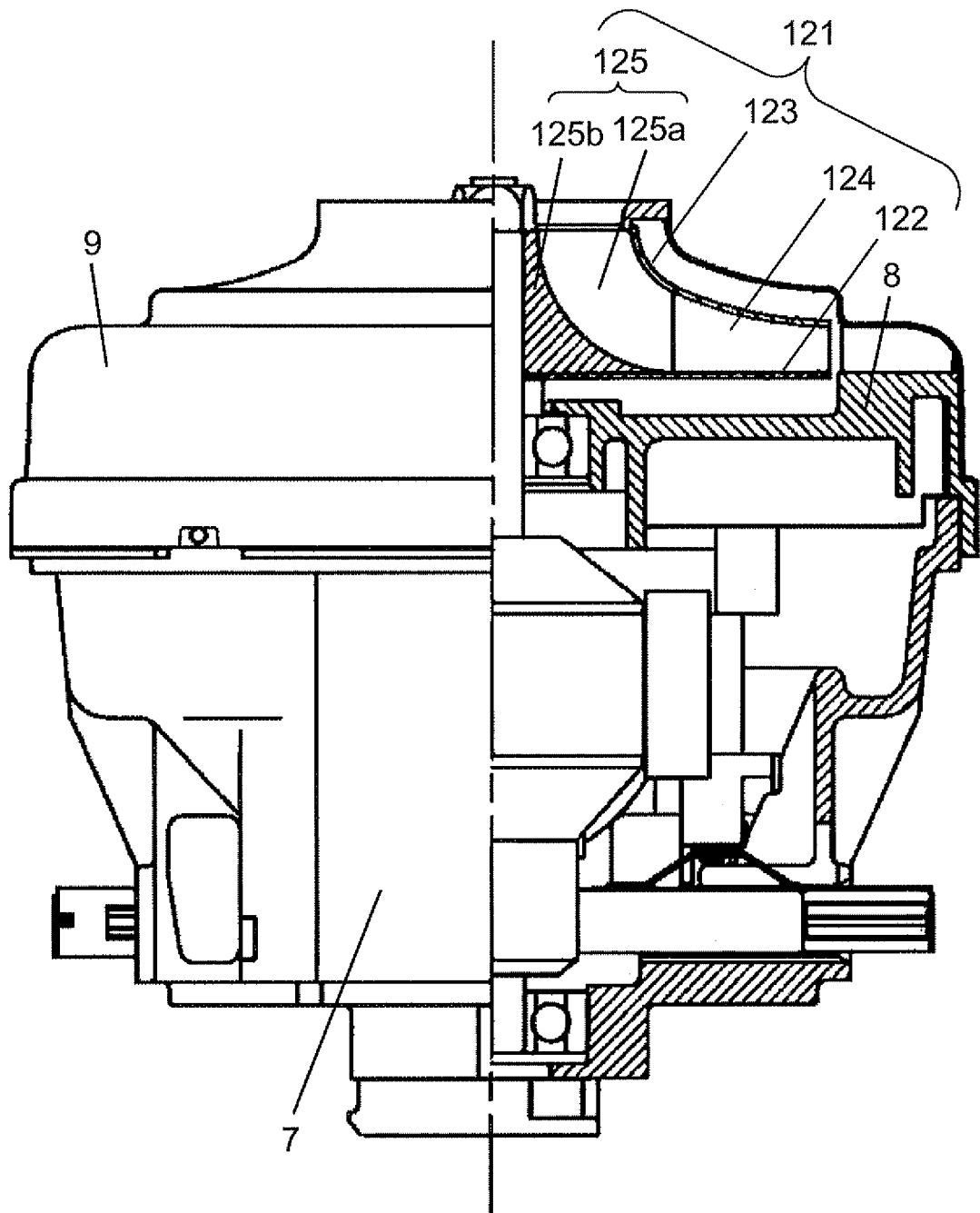


FIG. 18

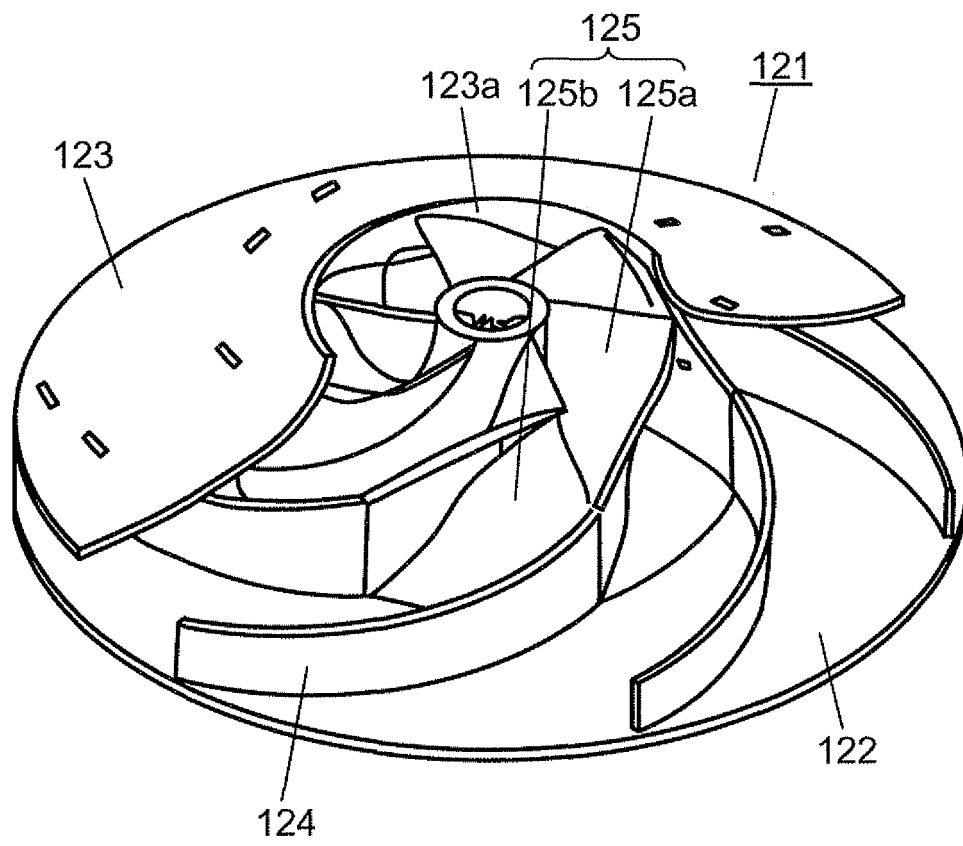


FIG. 19

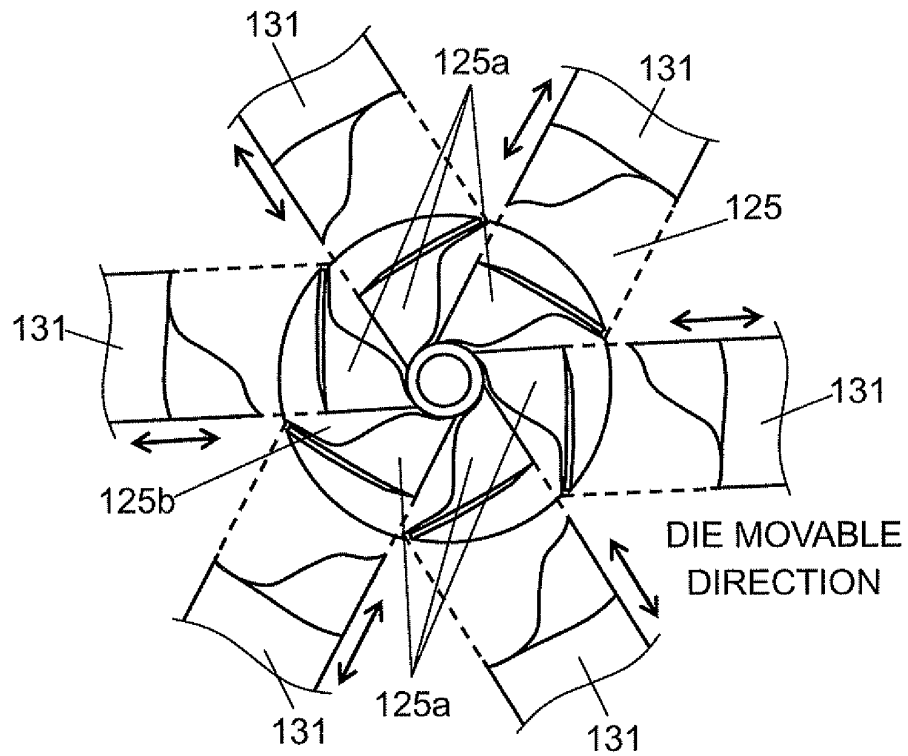
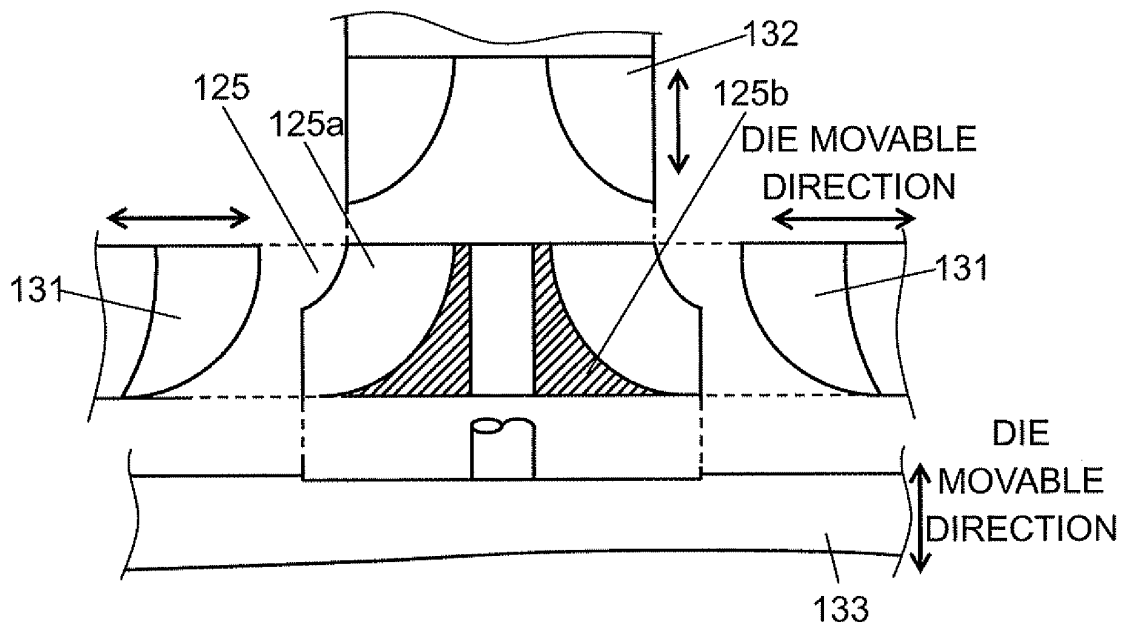


FIG. 20



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/000841

A. CLASSIFICATION OF SUBJECT MATTER

F04D29/28 (2006.01) i, A47L9/00 (2006.01) i, F04D17/10 (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)

F04D29/28, A47L9/00, F04D17/10

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 3724211 B2 (Matsushita Electric Industrial Co., Ltd.), 07 December 2005 (07.12.2005), entire text; all drawings (Family: none)	1-15
A	JP 59-103999 A (Matsushita Electric Industrial Co., Ltd.), 15 June 1984 (15.06.1984), entire text; all drawings (Family: none)	1-15
A	JP 2007-244563 A (Matsushita Electric Industrial Co., Ltd.), 27 September 2007 (27.09.2007), entire text; all drawings (Family: none)	1-15

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search
12 May, 2011 (12.05.11)Date of mailing of the international search report
24 May, 2011 (24.05.11)Name and mailing address of the ISA/
Japanese Patent Office

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/000841

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 4207249 B2 (Panasonic Corp.), 14 January 2009 (14.01.2009), entire text; all drawings & US 6592329 B1 & EP 1079114 A1 & WO 1999/058857 A1	1-15

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000045993 A [0013]