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Masai et al.

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[45] Nov. 19, 1974

[54] VORTEX BLOWER

[75] Inventors: **Tadahisa Masai**, Hitachi; **Takeshi Atago**, Katsuta, both of Japan

[73] Assignee: **Hitachi, Ltd.**, Tokyo, Japan

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[52] **U.S. Cl.** **415/213,** 415/53
[51] **Int. Cl.** **F04d 5/00,** F04d 11/00
[58] **Field of Search** .... 415/53 T, 213 T, 55, 56, 415/57

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Primary Examiner—William L. Freeh
Assistant Examiner—Louis J. Casaregola
Attorney, Agent, or Firm—Craig & Antonelli

[57] **ABSTRACT**

A vortex blower comprising a rotor unit provided with vanes disposed in an annular groove and a stator unit provided with an annular groove corresponding to that in said rotor unit, said both units being arranged in opposition to each other, said groove in said stator unit being provided with an inlet opening and an outlet opening, wherein the fluid is moved with rotation of said rotor unit such that said fluid will swirl in the annular grooves in said rotor and stator units and be discharged out from said outlet opening, and further characterized in that partitioning vanes adapted to prevent reverse flow of the fluid are provided in the annular groove in said stator unit.

10 Claims, 7 Drawing Figures

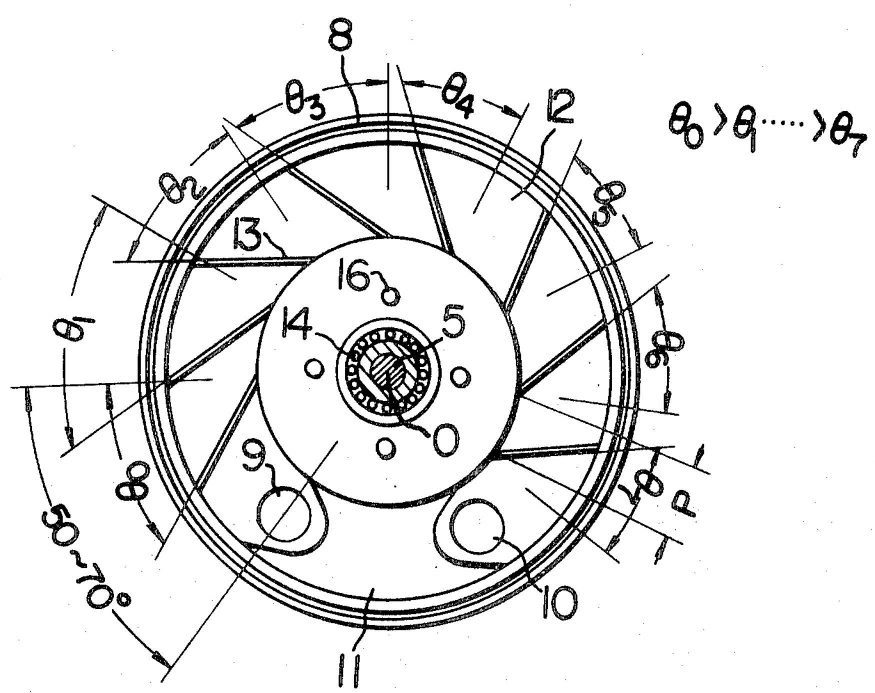


FIG. 1

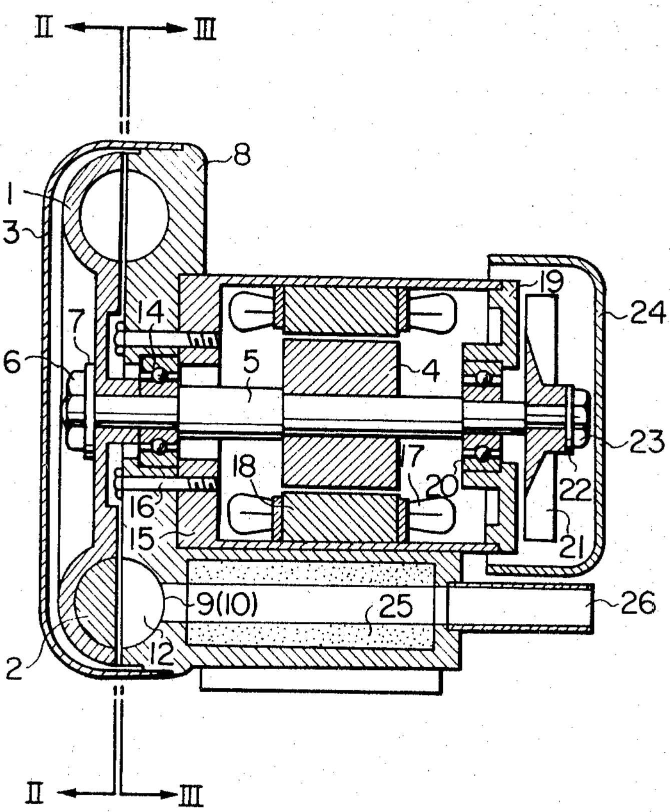


FIG. 2

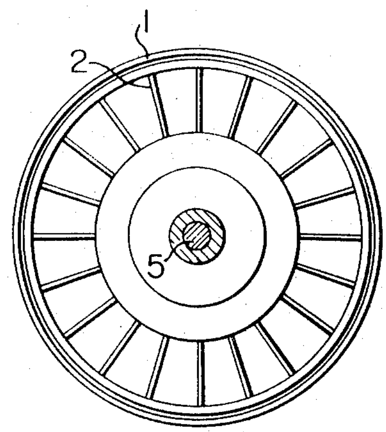

1
2
5

FIG. 3

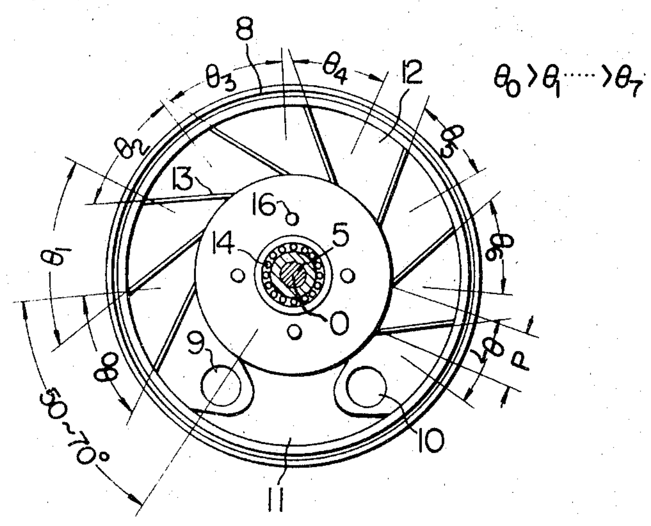

8
θ_3
θ_4
12
$\theta_0 > \theta_1 \cdots > \theta_7$
θ_2
θ_5
13
16
14
5
θ_1
θ_6
0
9
θ_0
θ_7
P
50~70°
10
11

FIG. 4

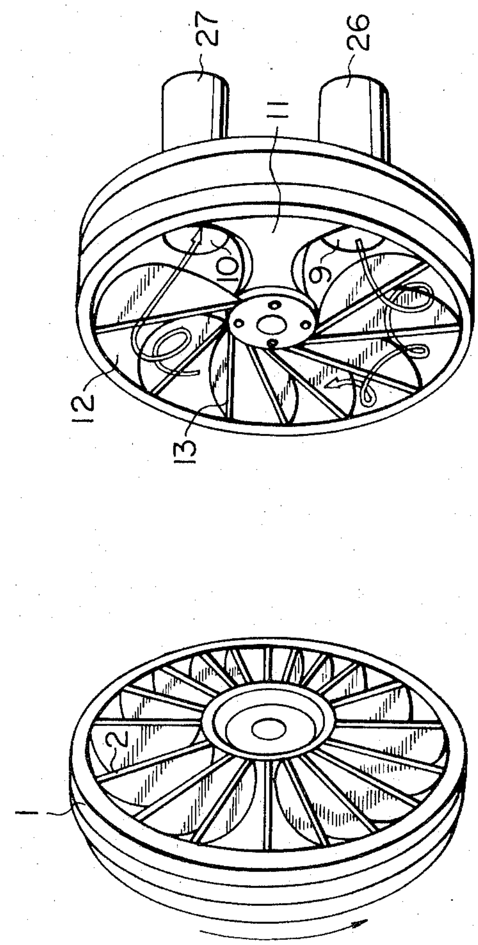


FIG. 5

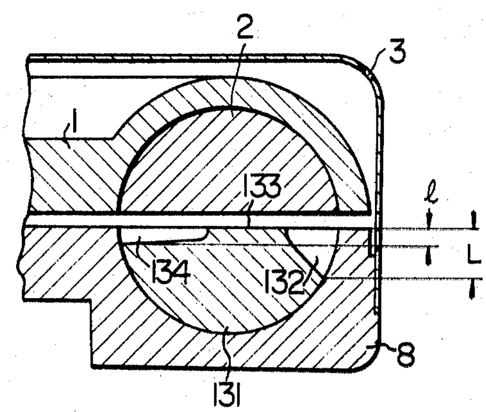


FIG. 6

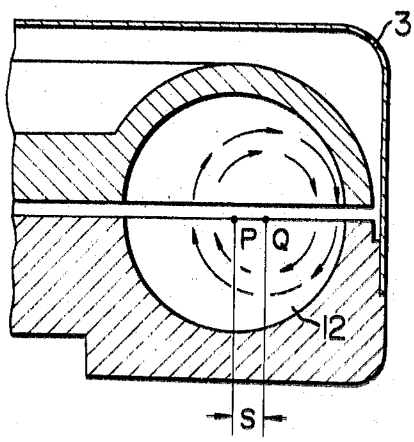
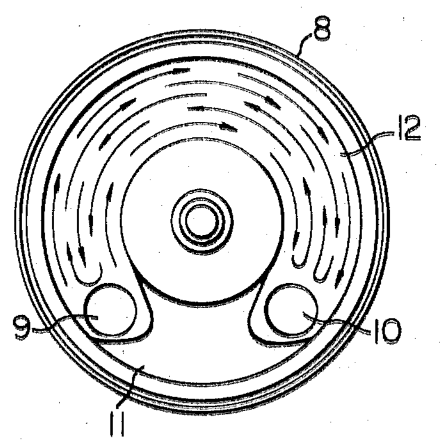


FIG. 7



VORTEX BLOWER

BACKGROUND OF THE INVENTION

This invention relates to a vortex blower and more particularly to the construction of the stator unit in such blower.

In general, a vortex blower has a stator unit and a rotor unit which are arranged such that their faces vertical to the axis of rotation of the rotor unit are opposed to and slightly spaced-apart from each other, and grooves, half-circular in sectional shape are provided in said both opposed faces such that said both grooves, when joined together, will form a passage substantially circular in sectional shape and annular about the axis of rotation of the rotor unit. Provided in the annular groove in said rotor unit are a plurality of vanes arranged to radially partition said annular groove. In the corresponding annular groove in the stator unit are formed the suitably spaced-apart inlet opening and outlet opening as well as a land plugging up the groove gap between said both openings. Thus, when the rotor unit is rotated, a swirl or vortex flow is produced in the substantially circularsectioned annular passage formed by said both rotor and stator units, while air is introduced from said inlet opening and discharged out from said outlet opening.

Generally, a vortex blower has three to four times as high discharge pressure as other types of blowers and can be manufactured at a relatively low cost. It therefore is used generally for cooling of electronic computers, suction of yarns in spinning machines in fabric industries, and for other purposes. However, such vortex blower is very low in efficiency [its blower efficiency $M_B = g(Pd - Ps) \times Q/60\ Lin$, where g stands for gravitational acceleration (m/s^2), Pd for discharge pressure (mmAq), Ps for suction pressure (mmAq), Q for flow rate (m^3/min), and Lin for blower input (w)], with the maximum blower efficiency being approximately 30 to 40 percent. This peak blower efficiency point is in the low pressure high flow rate area, and also such blower efficiency declines almost rectilinearly with rise of discharge pressure. Actually, such vortex blower is used in an apparatus which is required to have the high pressure and low flow rate characteristics, and in practice, said vortex blower is usually used with blower efficiency on the level of ground 10 percent. Thus, the utility range of the vortex blower does not coincide with the maximum blower efficiency level. Decline of blower efficiency with rise of discharge pressure is attributable to the phenomenon that the fluid introduced from the inlet opening flows backwardly in the annular groove in the stator unit, that is, in the air chamber, while said fluid is discharged out from the outlet opening.

The fluid taken in from the inlet opening flows toward the outlet opening while swirling in the air chamber. In this case, the flowing velocity of the fluid towards the discharge opening is higher in the outer edge side of the air chamber than in the inner edge side, but the decline of its flow velocity is not effected rectilinearly from the outer edge side towards the inner edge side; the lowest flow velocity is found near the center of fluid swirl (near the middle point between the outer and inner edges of the air chamber). This is because pressure is low near the center of the fluid swirl and, in the air chamber, pressure is increased proportionally as the fluid approaches the outlet opening, with the result that the force directed towards the inlet opening from the discharge opening is applied to the fluid flow to force back the fluid near the center of swirl towards the inlet side, with the greatest influence thereof taking place near the center of fluid swirl. Thus, although the fluid flows in the direction of rotation of the rotor in the area close to both ends of fluid swirl in the air chamber, it flows reversely near the center of the swirl, so that actually the fluid merely circulates between the inlet and outlet openings. This is responsible for the shortcomings of this type of vortex blower that the maximum blower efficiency point can not be moved to a higher pressure side, that the optimum use range of the vortex blower does not coincide with the maximum blower efficiency point, and that the discharge pressure won't be raised satisfactorily.

SUMMARY OF THE INVENTION

Objects of the Invention

The object of the present invention is to provide an improved vortex blower whereby the maximum blower efficiency point can be moved towards the higher pressure region so that such maximum blower efficiency point will be within the optimum use range of the vortex blower.

Another object of the present invention is to provide a vortex blower of the recited type, further characterized by increased discharge pressure.

Features of the Invention

The salient feature of the present invention is to be seen in that partitioning vanes are arranged radially in an air chamber provided in the stator unit of the vortex blower in the form of a half circularsectioned annular groove and formed with an inlet opening and an outlet opening at both ends, whereby to prevent reverse flow of the fluid that would otherwise be caused in the direction of the inlet side from the outlet side.

BRIEF EXPLANATION OF THE DRAWINGS

FIG. **1** is a sectional view of a vortex blower according to an embodiment of the present invention;

FIG. **2** is a sectional view taken along the line II — II of FIG. **1**;

FIG. **3** is a sectional view taken along the line III — III of FIG. **1**;

FIG. **4** is perspective views of the rotor unit and the stator unit, respectively;

FIG. **5** is a fragmental sectional views showing the principal parts of the rotor unit and the stator unit, respectively, according to another embodiment of the present invention;

FIG. **6** is a sectional view of the joined assembly of the rotor and stator units in a prior art device; and

FIG. **7** is a front view of the stator unit in the prior art device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS:

Referring first to FIG. **1**, there is shown a vortex blower system according to a preferred embodiment of the present invention where the vortex blower and an electric motor are assembled together into an integral mechanism. In the figure, reference numeral **1** refers to the rotor unit which is formed with an annular groove, half circular-shaped in section, in which a plurality of rotor vanes **2** are provided. Said rotor vanes are arranged radially at fixed intervals as shown in FIG. **2**.

The rotor unit **1** is preferably made by die casting. Provided covering the rotor unit **1** is a rotor cover **3** made by press work or other means. Numeral **4** indicates a motor rotor secured to a shaft **5**. At one end of said shaft **5** is secured the rotor unit **1** by means of a nut **6** through a washer **7**, and a stator unit **8** is provided in opposition to and suitably spaced-apart from said rotor unit **1**. The shaft **5** is rotatably supported by ball bearings **14** provided in the stator unit **8**. The stator unit **8** is also formed with a half circular-sectioned annular groove similar to that in the rotor **1**. In this groove are formed an inlet opening **9** and an outlet opening **10** which are spaced-apart from each other with a land **11** therebetween, and an air chamber **12** is formed between said inlet and outlet openings **9** and **10**. Provided in said air chamber **12** are a plurality of vanes **13** partitioning the interior of said chamber **12** as shown in FIG. **3**. These vanes are arranged substantially along the spiral flow which flows in the air chamber from the inlet opening **9** towards the outlet opening **10**. The stator unit **8** may also be made by die casting.

Also in the drawings, reference numeral **15** indicates a fixed base which is secured at its one end to the stator unit **8** by means of a bolt **16** and has provided at its other end an end bracket **19** adapted to rotatably support the shaft **5** through ball bearings **20**, **17** a field coil for generating a revolving magnetic field with the magnetic pole **18** of the motor, **21** a cooling fan secured to the shaft **5** by a nut **23** through a washer **22**, **24** a fan cover, and **25** a sound absorbing material adapted to adsorb noises produced by the pipe **26** through which fluid is introduced into the inlet opening **9**. A filter or like means (not shown) is provided at the inlet of said pipe **26**. Numeral **27** denotes a pipe for guiding out the fluid which has been discharged out from the outlet opening **10**, as shown in FIG. **4**.

The present device, which has the mechanism as substantially described above, is now discussed from its operational aspect.

When the rotary member **4** is rotated, the shaft **5** is also rotated to cause corresponding rotation of the rotor unit **1**, whereupon the fluid is introduced into the inlet opening **9** through the pipe **26**. The fluid thus introduced into the inlet opening **9** then flows into the air chamber **12** provided in the stator unit **8**, where said fluid flows swirling, or spirally, in the space defined by the half-circular annular groove in the rotor unit **1** and the corresponding half-circular annular groove in the air chamber **12** and then is discharged out from the outlet opening **10** into the pipe **27**, as shown in FIG. **4**. It is to be noted here that because pressure is low near the center of the fluid swirl (that is, near the middle point between the external side and the internal side of the air chamber) and also because pressure is gradually increased as the distance to the outlet opening **10** decreases, the fluid flowing towards the outlet opening **10** from the inlet opening **9** is given a tendency to flow reversely towards the inlet opening **9**. According to the present invention, however, as partitioning vanes **13** are provided in the air chamber **12** so as to check any reverse flow of fluid as shown in FIG. **3**, there takes place no reverse flow of fluid headed toward the inlet opening **9** from the discharge opening side.

If no vanes **13** are provided in the air chamber, there inevitably takes place a phenomenon of reverse flow near the center of the fluid swirl, that is, near the vortex center Q which is eccentric a distance S from the sectional center P of the air chamber **12**, when the fluid moves swirlingly from the inlet opening **9** towards the outlet opening **10** as shown in FIGS. **6** and **7**. This made it impossible to move the maximum blower efficiency point towards the higher pressure side. Whereas, according to the present invention, as there are provided vanes **13** arranged to check any tendency of fluid to flow reversely in the air chamber, no such reverse flow phenomenon takes place, thus making it possible to not only move the maximum blower efficiency point towards the higher pressure side but also elevate the discharge pressure.

Pressure of the fluid flowing in the air chamber **12** is gradually raised as the distance from the inlet opening **9** increases, so that the pitch of the spiral flow in the air chamber **12** is also gradually reduced as the distance from the inlet opening **9** increases (that is, as the distance to the outlet opening **10** decreases), and hence if the air chamber **12** is seen sectionally along the line III — III, the angle between the flowing direction of the fluid and the radial direction from the center **0** of the annular air chamber is gradually reduced. In other words, the fluid flowing direction approaches the radial direction as the fluid comes closer to the outlet opening **10**. The direction of the spiral flow at this time is left-handed in FIG. **3**. Therefore, for obtaining the best blower efficiency in the present invention, the vanes provided in the air chamber **12** are preferably arranged such that their angle of arrangement will substantially conform to the direction of said left-hand spiral air flow, such as shown in FIG. **3**. That is, the setting angle of the vanes **13** is selected to coincide with the direction where end portions of the vanes **13** contacting with the internal side of the air chamber **12** is advanced in the direction of rotation (clockwise in the drawings) of the rotor unit. In still other words, the partitioning vanes **13** are arranged such that the intersection between the vanes **13** and the innermost edge of the air chamber will be positioned forwardly, in the direction of advancement of the fluid, of the straight line connecting the center **0** of the air chamber with the intersection of said vanes **13** with the outermost edge of the air chamber. Moreover, at the intersection between the vanes **13** and the innermost edge of the air chamber, the angle θ made by the arrangement of vanes and the straight radial line from the center **0** of the air chamber is gradually reduced as the distance from the inlet opening **9** increases and hence as the distance to the outlet opening **10** decreases. That is, if the angle θ of the respective vanes is expressed with suffix **0, 1, 2, 3, ... 7** according to the distance from the inlet opening **9**, there exists the following relation: $\theta_0 > \theta_1 > \theta_2 > \theta_3 > \ldots\ldots > \theta_7$. The pitch P between adjoining vanes is also reduced correspondingly to the reduction of pitch of the spiral flow as the distance from the inlet **9** increases (and hence as the distance to the outlet **10** decreases).

The fluid just taken in from the inlet port **9** is in the stage of "transition" where the swirling flow is not yet formed, so that it needs to enlarge to some extent the distance from the inlet port **9** to the first vane **13** (the vane closest to said inlet port). This is because of the fact that if any such vanes **13** is provided close to the inlet port **9**, desired spiral flow can not be formed due to resistance of such vane. The results of experiments shows that best spiral flow can be formed if arrangement is made such that the angle formed by the segment connecting the center of the inlet opening 9 with the center of the air chamber 12 and the segment connecting the intersection between the vanes 13 and air chamber 12 with the center of said chamber 12 will be about 50° to 70°.

As described above, according to the present invention, partitioning vanes are provided in the air chamber in the stator unit to thereby prevent reverse flow of the fluid towards the inlet side from the outlet side, so that it is possible to not only position the maximum efficiency point of the vortex blower in the optimum use range of the same but also appreciably increase the discharge pressure. In FIG. 5 is shown another embodiment of the present invention. It will be seen that partitioning vanes 131 are provided in an air chamber formed in the stator unit 8. Each of said vanes 131, on the outer edge side of the air chamber, is divided into an outer edge cut-out portion 132, an intermediate portion 133 and an inner edge cut-out portion 134. The fluid coming in from the outer edge portion of the rotor unit 1 flows into the outer edge portion of the air chamber and is there changed in its direction by the vanes 131 while at the same time the speed energy is converted into a pressure. The outer edge cut-out portion 132 of each vane is to allow the fluid to enter smoothly into the air chamber and the inner edge cut-out portion 134 is designed to allow smooth passage of fluid into the half-circular-sectioned annular groove formed in the rotor unit 1, while the intermediate portion 133 proves helpful to prevent reverse flow of the fluid. In order to permit even more smooth ingress and egress of fluid, the depth of the outer edge cut-out portion, as indicated by L, is made greater than the intermediate portion 133 as the fluid velocity in the outer edge portion of the air chamber is high, while the depth of the inner edge cut-out portion 134 is made smaller as indicated by *l*. Thus, provision of cut-out portions both in the outer edge side and in the inner edge side of each vane 13 enables smooth swirling of the fluid.

What is claimed is:

1. A vortex blower comprising a rotor unit provided with a plurality of vanes arranged at fixed intervals in an annular groove, half circular in sectional shape, formed in said rotor unit, and a stator unit also formed with a similar annular groove half circular in sectional shape and designed to serve as an air chamber, the last-said groove being provided at suitable locations thereof with an inlet opening, an outlet opening and a land portion separating said both openings, said both units being arranged in opposed relation and suitably spaced-apart relative to each other, wherein by rotating said rotor a vortex flow is produced in the grooves in said rotor and stator units and is discharged out from said outlet opening, and further characterized in that a plurality of partitioning vanes are provided in the air chamber formed in said stator unit, wherein said partitioning vanes are arranged such that the intersection betwen said vanes and the inner edge of said air chamber will be located further forward in the direction of advancement of the fluid than the corresponding intersection of the straight line connecting the center of said air chamber with the intersection between said vanes and the outer edge of said air chamber.

2. A vortex blower as claimed in claim 1, wherein arrangement is made such that the angle made by said vanes and the straight radial line extending from the center (0) of the air chamber and passing the intersection between the inner edge of said air chamber and said vanes will become smaller gradually as the distance from the inlet opening increases (in other words, as the distance to the outlet opening decreases).

3. A vortex blower as claimed in claim 1, wherein said vanes are arranged such that the pitch between a vane and the succeeding one will become smaller as the distance from the inlet opening increases (and hence as the distance to the outlet opening decreases).

4. A vortex blower as claimed in claim 1, wherein each said vane is provided with cut-out portions at its ends on both outer edge side and inner edge side of the air chamber.

5. A vortex blower as claimed in claim 4, wherein the depth of the cut-out portion provided on the outer edge side of the air chamber is greater than the depth of the cut-out portion provided on the inner edge side of said chamber.

6. A vortex blower as claimed in claim 2, wherein vane arrangement is made such that the pitch between a vane and the succeeding one will become smaller as the distance from the inlet opening increases (and hence as the distance to the outlet opening decreases).

7. A vortex blower as claimed in claim 6, wherein each said vane is provided with cut-out portions at its ends on both inner edge side and outer edge side of the air chamber.

8. A vortex blower as claimed in claim 7, wherein the depth of the cut-out portion provided on the outer edge side of the air chamber is greater than the depth of the cut-out portion provided on the inner edge side.

9. A vortex blower as claimed in claim 6, wherein arrangement is made such that the angle made by the intersection between the inlet opening and the air chamber inner edge of the vane closest to said inlet opening relative to the center of the air chamber will be 50° to 70°.

10. A vortex blower comprising:

rotor means having an annular rotor groove therein,

a plurality of rotor vanes arranged in said annular groove,

stator means having an annular stator groove therein with radially inner and outer edges,

said stator means and said rotor means being arranged to define a fluid flow chamber between said rotor and said stator grooves,

fluid inlet and outlet means communicating directly with the fluid flow chamber,

a plurality of partitioning vanes arranged within said stator groove and extending between the radially inner and outer edges, each of said partitioning vanes intersecting the radially inner edge of said stator groove at a location closer to the fluid outlet means than the intersection of each said vane with the radially outer edge of said stator groove.

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