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(54) Fan

(57) A fan (1) comprising an impeller (2), a casing (4) that is disposed so as to enclose the impeller (2), and a motor (3) for rotating the impeller (2) relatively to the casing (4), the fan having a rotational axis, wherein the impeller (2) includes a disk portion (22) and a plurality of blades (21) that is arranged on the disk portion, optionally the impeller also includes a disk like shroud (123), the casing (4) includes a side wall (40a) that is opposed to outer peripheral end portions (212) of the blades (21) with a gap and that is having an outlet (43), a first end plate (40b) that constitutes an upper wall of the casing, and a second end plate (40c) that constitutes a lower wall of the casing (4), both of the first and second end plates being provided with an aperture (41,42) including areas around the rotational axis.

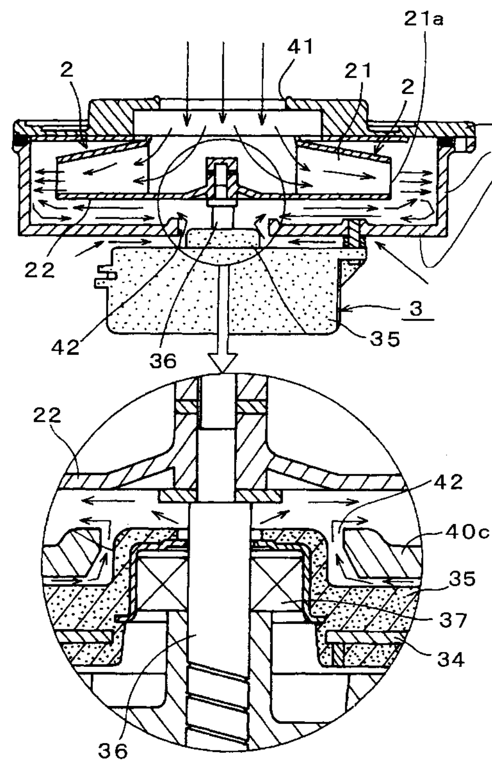

Fig.1

EP 1 479 917 A1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a fan for supplying fuel gas to a combustion apparatus such as a boiler. More specifically, the present invention relates to an improvement of a casing, an impeller and a motor of a fan for cost reduction, safety and low-noise operation.

2. Description of the Prior Art

[0002] A fan is used for supplying fuel gas to a combustion apparatus such as a boiler. There is one type of the fan that is described in Japanese unexamined patent publication No. H07-224796. This publication discloses a centrifugal fan that has an impeller having a plurality of blades and a gas inlet in upper part of the impeller as shown in the Figures of this publication, a motor for rotating the impeller to generate a gas flow from the gas inlet to the outer circumference of the impeller and a casing that encloses the periphery of the impeller.

[0003] It is not easy to construct the casing and the motor with no gaps between them in such a centrifugal blower fan. In this case, it may be difficult to prevent the gas to be supplied from leaking out of the fan through the gaps between the casing and the motor. If a sealing part, such as O-ring, is used, the number of the parts for constructing the fan will be increasing.

[0004] In addition, an opening that is provided to the upper part of the casing of the centrifugal fan as an inlet of the gas is just a hole having a substantially circular shape. Therefore, the centrifugal fan has an advantage of a static pressure higher than other type fans such as an axial fan or a laminar flow fan, but has a disadvantage of making noise due to a turbulent flow or a vortex generated in the casing.

[0005] In addition, when using the centrifugal fan for supplying fuel gas to a combustion apparatus such as a boiler, there is a risk of fire due to a spark generated by the motor. A DC motor having a mechanical commutator is called as DS brush motor. And because of the mechanical commutation, the DS brush motor usually generates sparks during its rotating. So when using a DC brush motor for supplying fuel gas to a combustion apparatus as a gas flow generating fan , many efforts and much cost may be required in order to avoid the burning risk. On the other hand a DC motor having a electrical commutation control is called as DC brushless motor. Because of electrical commutation, the DC brushless motor may not generates a spark at its commutation. However if the DS brushless motor is used for supplying fuel gas, it is necessary to insure that no spark is generated when the motor is rotating.

SUMMARY OF THE INVENTION

[0006] A first object of the present invention is to provide a fan that can prevent a gas to be supplied from leaking out of the fan from other than the outlet of the fan.

[0007] A second object of the present invention is to provide a fan that can suppress a noise caused by the fan rotation with maintaining better static pressure and better flow quantity than before.

[0008] A third object of the present invention is to provide a fan that can supply fuel gas to a combustion apparatus such as a boiler more safely than before. These objects are solved by means of a fan having the characteristics as cited in the independent claims; preferred embodiments are defined by dependent subclaims.

[0009] According to the present invention, inlet openings are formed on both ends of a casing in the axial direction of a fan, so that an air pressure inside the casing is always lower than that of the outside. By this structure, a supplied gas inside the casing does not leak into the outside of the fan.

[0010] In addition, the motor part of the fan may be molded by a resin or the like so that the gas does not leak externally through the inside of the motor.

[0011] Thus, the process for attaching a seal member that was necessary conventionally can be eliminated, so that workability can be improved. Furthermore, it is possible to provide the product at a low cost because the seal member is not necessary to be attached.

[0012] Also in the present invention, a flow duct cylinder can be provided to the inlet opening of the casing and is extended to an opening of a shroud of the impeller. This flow duct cylinder suppresses generation of a circulation and a turbulent flow of the gas inside the casing so that a noise caused by the circulation and the flow can be reduced. In addition, by suppressing generation of a turbulent flow, the static pressure and the flow quantity characteristics are also improved.

[0013] In addition, according to the present invention, the motor can be a DC brushless motor so that the brush and the commutator can be eliminated. Thus, a spark that might be generated between them at commutation does not appear, so there is little risk that the fuel gas catches fire by motor rotation. Accordingly, the fuel gas can be supplied safely.

[0014] Furthermore, in a preferred embodiment the motor part of the fan is molded by a resin or the like, so as to prevent adhesion of dust or water to a part inside the motor such as an electric contact that may cause a short circuit or a spark other than sparks caused by the commutation. Therefore, the risk that the fuel gas catches fire from the short circuit portion or others can be reduced substantially.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a cross section of a fan and an enlarged view of a main portion according to a first embodiment of the present invention.

Fig. 2 is a cross section of the fan according to the first embodiment of the present invention and an enlarged view of a main portion.

Fig. 3 is a plane view of the fan according to the first embodiment of the present invention.

Fig. 4 is a bottom view of the fan according to the first embodiment of the present invention.

Fig. 5 is a perspective view of an impeller that is cut out from the fan according to the first embodiment of the present invention.

Fig. 6 is a cross section of a motor of the fan according to the first embodiment of the present invention.

Fig. 7 is a cross section of a fan according to a second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] An embodiment of a fan according to the present invention will be described with reference to the attached drawings.

[0017] Note that all descriptions about direction in the explanation just indicate directions on the drawings and do not restrict directions in a real embodiment unless otherwise specified.

[0018] Fig. 1 is a cross section and an enlarged view of a main portion indicating a fan according to a first embodiment.

[0019] The fan 1 includes an impeller 2, a motor 3 and a casing 4. The impeller 2 is positioned in the casing 4, and the motor 3 rotates the impeller 2 relatively to the casing 4.

[0020] The impeller 2 includes a disk portion 22 and a plurality of blades 21 that are arranged along a circumference of a circle on the disk portion 22. The impeller 2 is attached to a rotation shaft 36 of the motor 3 at the rotation center of the impeller 2.

[0021] The casing 4 comprises a side wall 40a that faces an outer peripheral end portion 21a of the blade 21 without contact, a first end plate 40b as an upper wall that is positioned at the upper end of the casing 4 and a second end plate 40c as a lower wall that is positioned at the lower end of the casing 4. A circular first aperture 41 serving as an inlet is formed in the first end plate 40b at a center area including the rotational axis of the impeller 2. In addition the diameter of the first Aperture 41 is substantially the same as the one defined by the inner circumferential ends 21b of the blades 21. The second end plate 40c is provided with a second aperture (42), serving in the shown embodiment as an inlet at a periphery of the rotation center axis of the impeller 2.

[0022] Fig. 5 is a perspective view of the impeller 2 that is divided into two after removing the first end plate 40b. The disc portion 22 is provided with a plurality of small holes, defining passageways having definite section. Thus suction is provided in the vicinity of the second aperture. The passageways may be formed in various ways and are provided in the shown embodiment to be holes with diameters varying with the respective distance to the rotation center axis of the impeller 2.

[0023] The side wall 40a includes a circular peripheral wall and a linear wall portion that is continuous from the circular peripheral wall in the tangent direction thereof as shown in Figs. 3 and 4. An outlet 43 is provided to the extended end portion of the linear wall portion. Note that the peripheral wall 40a may have an equiangular spiral shape in which a radius of a part of the curved surface in the cylindrical shape of the side wall 40a increases gradually in the rotational direction of the impeller 2. In this case, it is preferable that the side wall 40a has the maximum radius portion of the side wall 40a and the minimum radius portion of the side wall 40a, and there is an opening to make the outlet 43 between the maximum radius portion of the side wall 40a and the minimum radius portion of the side wall 40a.

[0024] Fig. 6 is a cross section of the motor 3. The motor 3 includes a rotor magnet 31, a stator 33 having a plurality of coils 32, a circuit board 34 having a driving circuit for controlling supply of electricity to the coil 32, a motor housing 35, an output shaft 36 and a bearing 37. Note it is better for this bearing 37 to be enclosed by rubber or to be sealed the same. The rubber member 38 reduces communication between the inside of the motor 3 and the inside of the casing 4.

[0025] This motor 3 is a DC brushless motor, in which the driving circuit controls excitation of the coil 32 instead of a brush and a commutator. Therefore, a spark is not generated in the DC brushless motor though it can be generated between a brush and a commutator when exciting the coil. In addition, rotation efficiency of the brushless motor is high because there is little loss of rotation energy due to friction compared with the brush motor that includes a brush and a commutator that contact each other and slide during rotation. Furthermore, a life of the motor 3 can be elongated because there is no abrasion between a brush and a commutator. In addition, there is no sliding noise due to a brush and a commutator, so rotation noise can be reduced. Furthermore, excitation of the coil 32 is controlled by the electric signal in the DC brushless motor, so it is possible to perform a fine control in accordance with the change of torque and rotation speed.

[0026] An operation of the fan according to this embodiment is as follows. First, the motor 3 and the impeller 2 that is attached to the motor 3 start to rotate relatively to the casing 4. Then, gas at the inner circumferential portion of the impeller blade 21 is led in the outer circumferential direction of the impeller blade 21 by a centrifugal force. Thus, there is a negative pressure to a barometric pressure outside the casing 4 at the vicinity of the inner circumferential portion of the impeller 21 . On the other hand, the gas is compressed at the vicinity of the outer circumferential portion of the impeller 21, where higher pressure is generated than a barometric pressure outside the casing 4. Thus, gas outside the casing is led into the casing 4 through the first aperture 41 of the casing 4 that is open to the inner circumferential portion of the impeller blade 21. In addition, the gas is discharged externally through the outlet 43 of the casing 4 that is open to the outer circumferential portion of the impeller blade 21.

[0027] In addition, the second aperture 42 of the casing 4 is opposed to the surface of the disk portion 22 of the impeller 2 on which the blades are not arranged. Inside the casing 4, there is the highest pressure at the outer circumferential portion. The outlet 43 is open to the outer circumferential portion and is at a pressure substantially the same as the barometric pressure outside. Since a definite passageway is provided in the disc portion 22 gas can be sucked from the area surrounding the second aperture 42. As a result, the entire inside of the casing 4 is at a lower pressure than the outer circumferential portion, so the vicinity of the second aperture 42 is at a lower pressure than the barometric pressure outside. Therefore, the gas does not leak externally from the inside of the casing.

[0028] Note that auxiliary blades 24 can be arranged along a circumference of a circle on the surface of the disk portion 22 of the impeller 2 on which the blade are not arranged as shown in Fig. 2. By this structure, the pressure at the vicinity of the second aperture 42 in the casing 4 is further decreased, so that leakage of the gas externally can be prevented stably. Furthermore, this auxiliary blade 24 can work as a rib for reinforcing the impeller 2 because it is provided at the inner circumferential side with reference to the blade 21.

[0029] In addition, the fan can be used as a fan for supplying fuel gas to a combustion apparatus such as a boiler in this embodiment. The fuel gas can be fire by a spark. Therefore, it is necessary to prevent the fan from generating a spark or being a cause of fire, and to prevent the fuel gas from leaking externally.

[0030] First, by making the inside of the casing 4 always negative pressure with reference to the barometric pressure outside as described above, so as to prevent the gas from leaking externally.

[0031] In addition, by using a brushless motor, generation of a spark from a contact between a brush and a commutator can be suppressed. Furthermore, the stator 33 and the circuit board 34 of this motor are molded 38 by a resin having insulating properties. This mold resin 38 is preferably a synthetic resin, a natural resin, a rubber, a vinyl or a plastic. Since the motor 3 is molded, it will not happen that dust is deposited on the circuit board 34, and a short circuit is formed on the circuit board 34. In addition, it is also possible to prevent an electric connection portion such as a contact between the coil 32 and the circuit board 34 is broken by a vibration of the motor 3 or the device.

[0032] In addition, the impeller 2 is made of a resin that contains a conductive material as conductive filler. The conductive filler may be particles of a metal such as copper, a copper alloy, silver, nickel or a low melting point alloy, metal oxide particles such as zinc oxide, tin oxide or indium oxide, conductive polymer particles such as various types of carbon black, polypyrrole or polyaniline, a polymer particles coated with a metal, particles of copper or silver coated with a rare metal, metal fibers, or carbon fibers. Collision of gas molecules or particles that are contained in the gas always occurs on the surface of the impeller blade 21, so static electricity can be easily accumulated. Therefore, by containing the impeller blade 21 of a conductive material, electrification of the static electricity can be prevented.

[0033] Note that it is desirable in this embodiment that the casing 4 is made of aluminum by die casting. Aluminum has a good conductivity of electricity and is also improved in its mechanical strength by the die casting process. Therefore, the casing 4 is always conductive so that electrification of the static electricity can be prevented, sufficient strength is obtained by die casting, and fine machining of the casing 4 can be performed.

[0034] In addition, the casing 4 can be made of a resin by molding so as to produce it at a low cost. Furthermore, if it is formed integrally with the mold resin 38 of the motor 3, leakage of gas through the inside of the motor 3 externally can be prevented stably.

[0035] Fig. 7 is a cross section showing a fan according to the second embodiment.

[0036] The fan 101 includes an impeller 102, a motor 103 and a casing 104. The impeller 102 is positioned in the casing 104, and the motor 103 rotates the impeller 102 relatively to the casing 104.

[0037] The impeller 102 includes a disk portion 122 and a plurality of blades 121 arranged along a circumference of a circle on the surface of the disk portion 122. The impeller 102 is attached to a rotation shaft 136 of the motor 103 at the rotation center portion. In addition, a disk-like shroud 123 having a circular hole 123a at the center thereof is provided at the upper end portion of the blade 121. In addition, an outer rim end 123b of the shroud 123 is extended longer than the outer circumferential end 121b of the blade 121 to the outer circumference. Whereby a gas flow from the outer rim end 123b to the circular hole 123a may be decreased, because an opening between the outer rim end 123b and an inner side wall of the casing 104 is made be narrower. Therefore a noise due to a back flow, a turbulent flow or the vortex flow of the gas can be suppressed in the upper area of the shroud 123.

[0038] The casing 104 comprises a side wall 140a that is opposed to the outer peripheral end portion 121 a of the blade 121 without contact, a first end plate 140b as an upper wall that is positioned at the upper side of the casing 104, a second end plate 140c as an lower wall that is positioned at the lower side of the casing 104 and a cylinder-like wind tunnel 145. A circular first aperture 141 is formed in the first end plate 140b at a center area including the rotational axis of the impeller 2. In addition, a motor 103 is attached on the lower wall 140c of the casing. The side wall 140a has an equiangular spiral shape in which a radius of a part of the curved surface in the cylindrical shape of the side wall 140a increases gradually in the rotation direction of the impeller 102, having the same shape as the side wall 40a shown in Fig. 3. The side wall 140a has the maximum radius portion of the side wall 140a and the minimum radius portion of the side wall 140a, and there is an opening to make the outlet 143 between the maximum radius portion of the side wall 140a and the minimum radius portion of the side wall 140a. The wind tunnel 145 is provided so that the upper end thereof is attached closely on the lower side of the upper wall 140b at the position where the circular opening of the wind tunnel 145 is aligned with the first inlet hole 141, and the lower end of the wind tunnel 145 is extending to the same position or below the upper end of the center hole 123a of the shroud 123.

[0039] The motor 103 has the same structure as the motor 3 described in the first embodiment.

[0040] An operation of the fan in the second embodiment is as follows. First, the motor 103 and the impeller 102 that is attached to the motor 103 start to rotate relatively to the casing 104. Then, the gas at the inner circumferential portion of the impeller blade 121 is led in the outer circumferential direction of the impeller blade 121 by its rotation. And a negative pressure comparing with a barometric pressure outside the casing 104 is generated at the vicinity of the inner circumferential portion of the impeller 102. On the other hand, the gas is compressed at the vicinity of the outer circumferential portion of the impeller 121, where higher pressure is generated than a barometric pressure outside the casing 104. Thus, the gas outside the casing 104 is led into the casing 104 through the first aperture 141 of the casing 104 that is open to the inner circumferential portion of the impeller 102 through the wind tunnel 145. The wind tunnel 145 is open at the circular hole 123a of the shroud 123. As a result, a noise due to a back flow, a turbulent flow or a vortex flow of the gas can be suppressed. In addition, an external air can be led into the casing 104 efficiently and can be discharged smoothly from the portion. Preferably the lower end of the wind tunnel 145 is extending to below the top end of the center hole 123a of the shroud 123. In this case, a cylindrical gap between the outer circumferential surface of the wind tunnel 145 and the inner circumferential portion 123a of the shroud 123 is formed. The narrower the cylindrical gap is, the less a gas flow from the outer rim end 123b to the circular hole 123a may be, because of the labyrinth effect. Therefore a noise due to a back flow, a turbulent flow or the vortex flow of the gas can be more suppressed in the upper area of the shroud 123.

[0041] An outer circumferential end 123b of the shroud 123 is extended longer than the outer circumferential end 121a of the blade 121 to the outer circumference. Therefore, the gas is prevented from flowing into the upper portion of the shroud 123 to form a circulating flow. Thus, the gas that is led into the outer circumferential portion of the impeller blade 121 is discharged to the outside of the casing 104 through the outlet 143 of the casing 104 that is open to the outer circumferential portion of the impeller blade 121.

[0042] Note that the first and the second embodiments described above are just examples of various embodiments of the present invention, and they can be modified or corrected in the scope of the present invention. For example, a space may be provided at the inner circumferential portion of the impeller for housing the motor so as to realize a compact size. A material of the impeller or the casing, a shape and a position of the first and/or second aperture or the outlet, a shape of the impeller blade, and others can be determined freely. In addition, it is determined freely whether or not there is the shroud or the wind tunnel that is continuous to the first aperture in the first embodiment, or a structure of the motor and whether or not there is the second aperture in the second embodiment.

Claims

1. A fan (1; 101) comprising an impeller (2; 102), a casing (4; 104) that is disposed so as to enclose the impeller (2; 102), and a motor (3; 103) for rotating the impeller (2; 102) relatively to the casing (4; 104), the fan having a rotational axis, wherein the impeller (2) includes a disk portion (22) and a plurality of blades (21) that is arranged on the disk portion (22), optionally the impeller also includes a disk like shroud (123),
   the casing (4) includes a side wall (40a) that is opposed to outer peripheral end portions (21a) of the blades (21) with a gap and that is having an outlet (43), a first end plate (40b) that constitutes an upper wall of the casing (4), and a second end plate (40c) that constitutes a lower wall of the casing (4),
   at least one, in particular both of the first and second end plates (40b) being provided with an aperture (41, 42) including areas around the rotational axis.

2. The fan according to claim 1, wherein means are provided, forming definite passageway in the disc portion (22).

3. The fan according to claim 1 or 2, wherein the disk portion (22) is positioned so as to be opposed to the second end plate (40c), and a plurality of auxiliary blades (24) is attached onto the lower surface of the disk portion (22) in a radial pattern centered at the

rotational axis, for generating gas flows to radial directions.

4. The fan according to claim 1, 2 or 3, wherein the second inlet hole (42) and/or said means forming definite passage way in the disc portion includes a plurality of small holes that is formed around the rotational axis.

5. A fan (101) comprising an impeller (102), a casing (104) that is disposed so as to enclose the impeller (102), and a motor (103) for rotating the impeller (102) relatively to the casing (104), the fan having a rotational axis, wherein the impeller (102) comprises a disk portion (122), a plurality of blades (121) that is arranged on the disk portion, and a disk-like shroud (123) having a center hole (123a) at the center thereof, the casing (104) comprises a side wall (140a) that is opposed to an outer peripheral end portion (121a) of the blades (121) with gaps, a first end plate (140b) that constitutes an upper of the casing (104) and have a wind tunnel (145) having a cylindrical shape, and a second end plate (140c) that constitutes a lower wall of the casing (104), the first end plate (140b) has a first inlet hole (141) including areas around the rotational axis, and the wind tunnel (145) is attached on the lower side of the first end plate (140b) at the position where the circular opening of the wind tunnel (145) is aligned with the first inlet hole (141), the side wall (140a) is provided with an outlet (143).

6. The fan according to claim 5, wherein a radius of an outer rim end (123b) of the shroud is larger than a distance between the blade outer circumferential end (121 a) and the rotation shaft.

7. The fan according to any one of claims 1 to 6, wherein the lower end of the wind tunnel (145) is extending to the same position or below the upper end of the center hole (123a) of the shroud (123).

8. The fan according to any one of claims 1 to 6, wherein the motor (3, 103) is a brushless motor that includes a stator (33) having one or more coils (32), a rotor magnet (31) that rotates with being opposed to the stator, and a circuit board (34) having a driving circuit for controlling excitation of the coil (32).

9. The fan according to any one of claims 1 to 8, wherein the motor (3, 103) is molded by a mold material (38) that has insulating properties.

10. The fan according to any one of claims 1 to 9, wherein the impeller (2, 102) has conductivity.

11. The fan according to any one of claims 1 to 10, wherein the casing (4, 104) is made of aluminum by die casting.

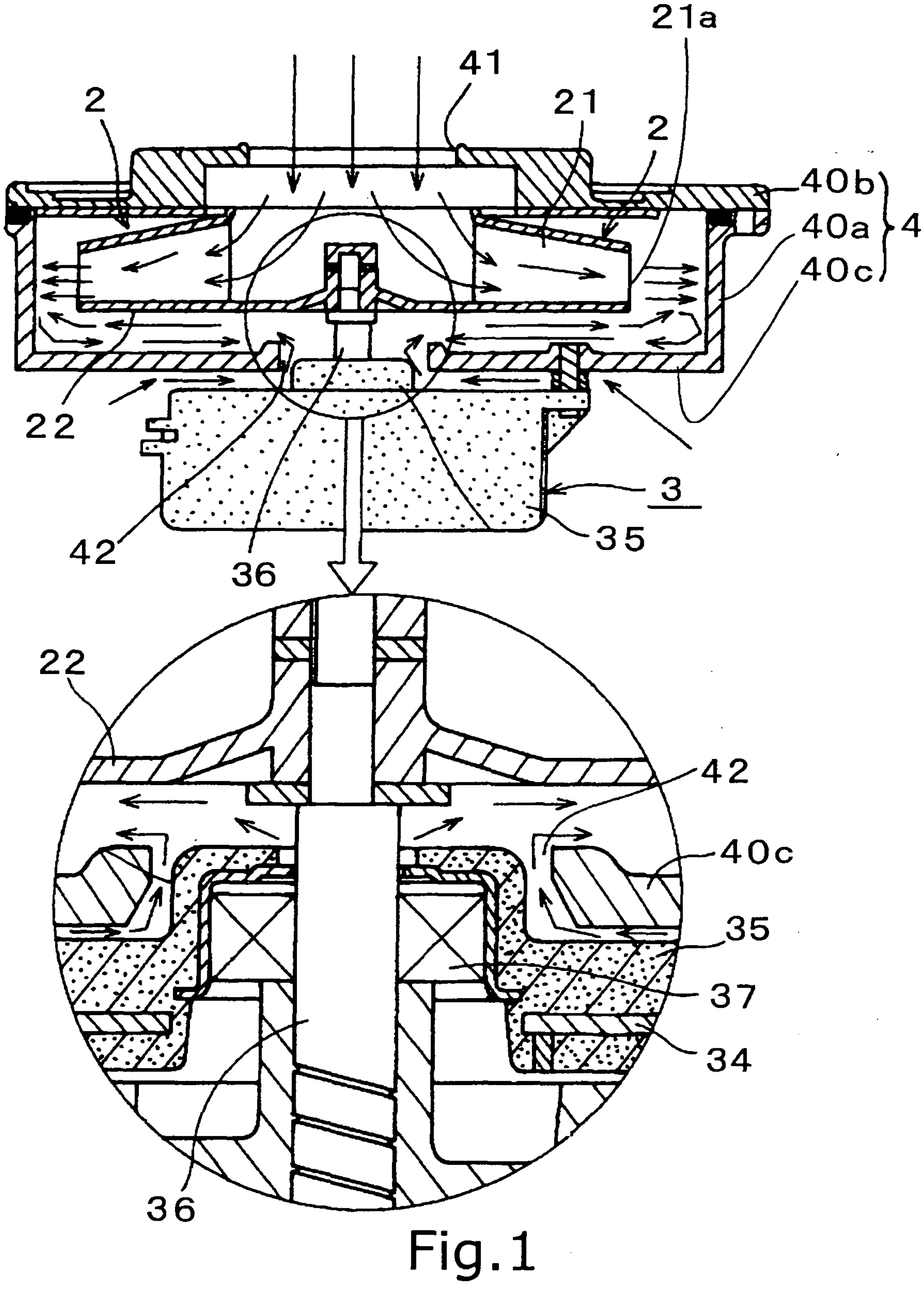

Fig.1

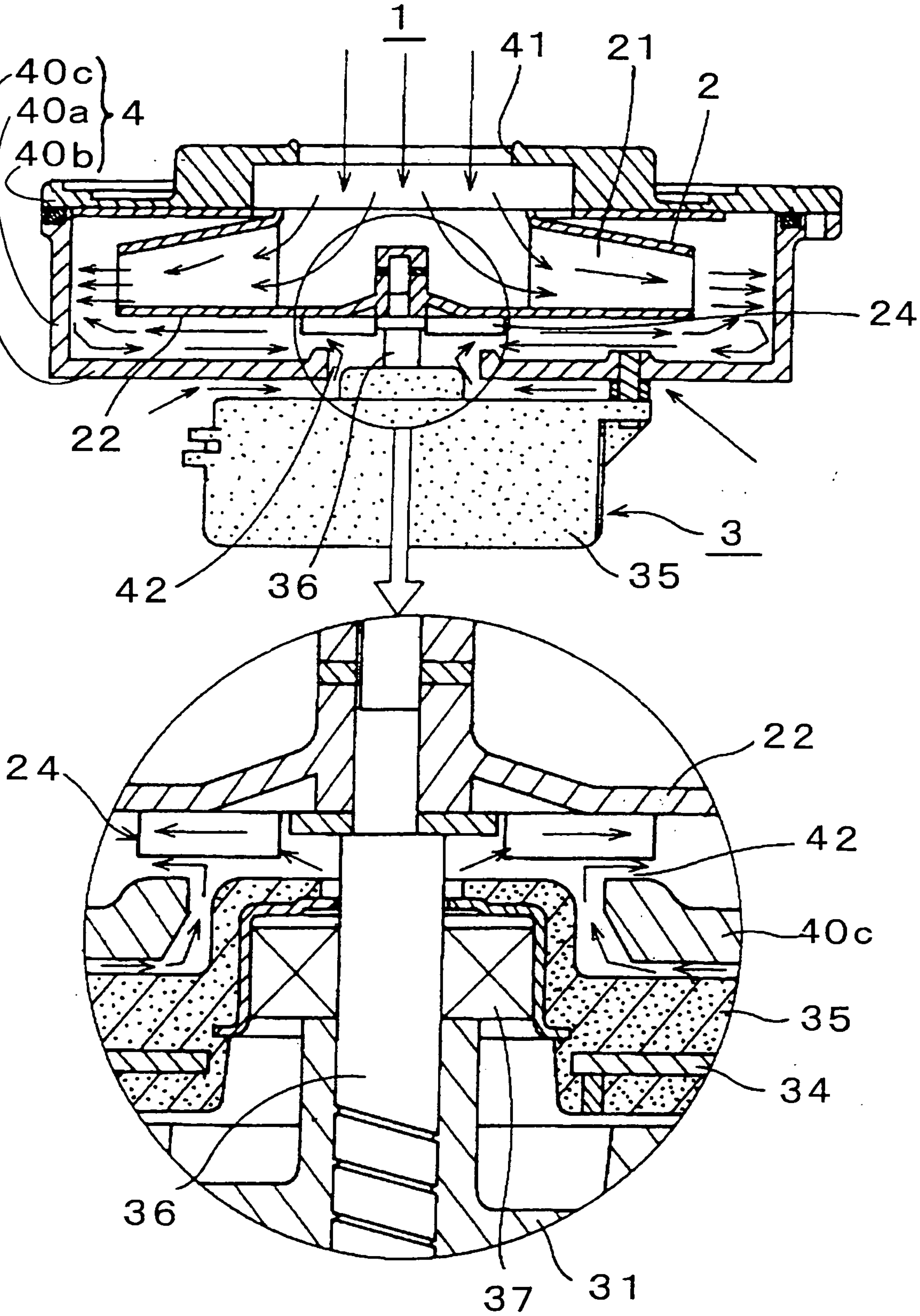

Fig.2

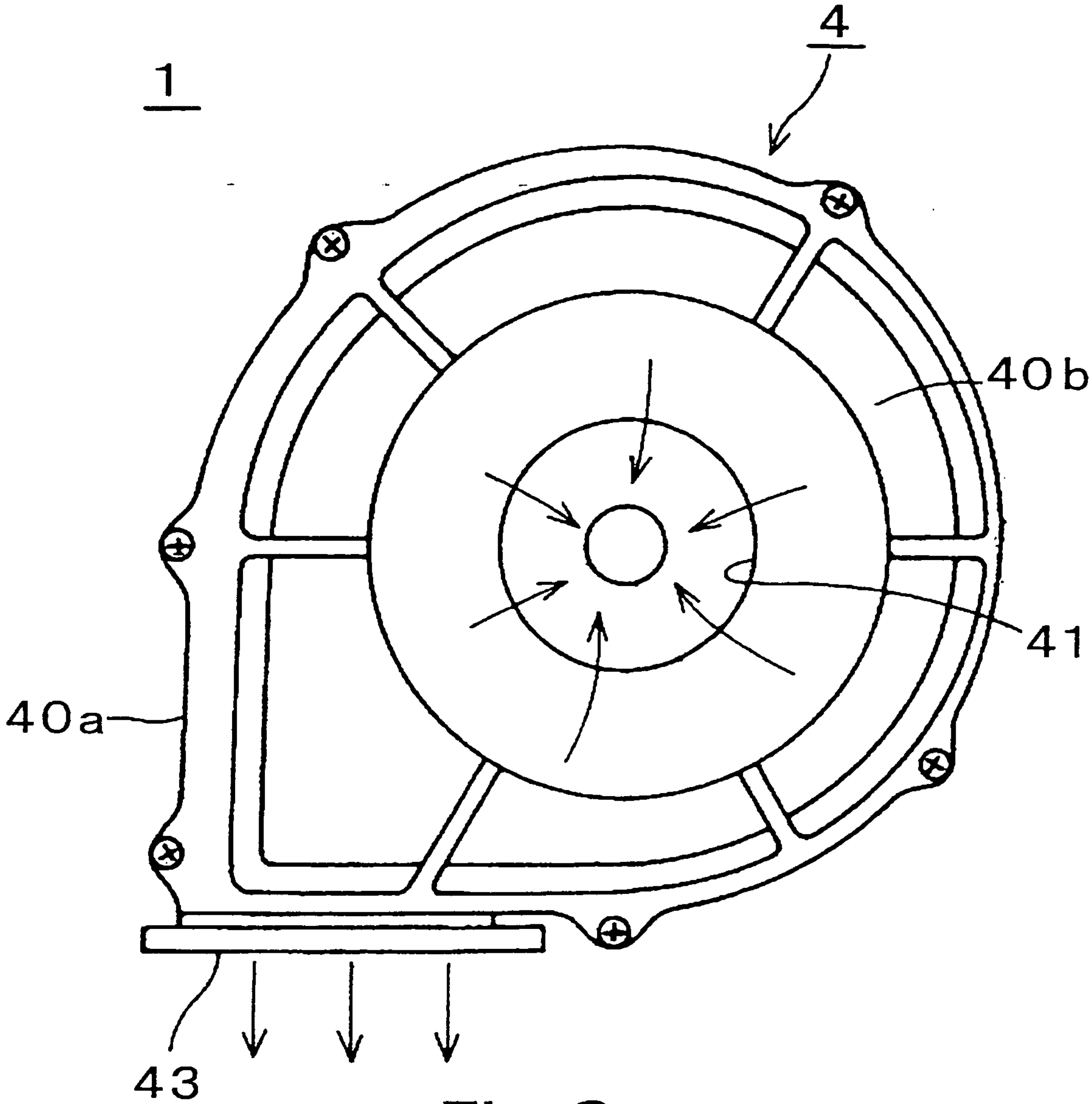

Fig.3

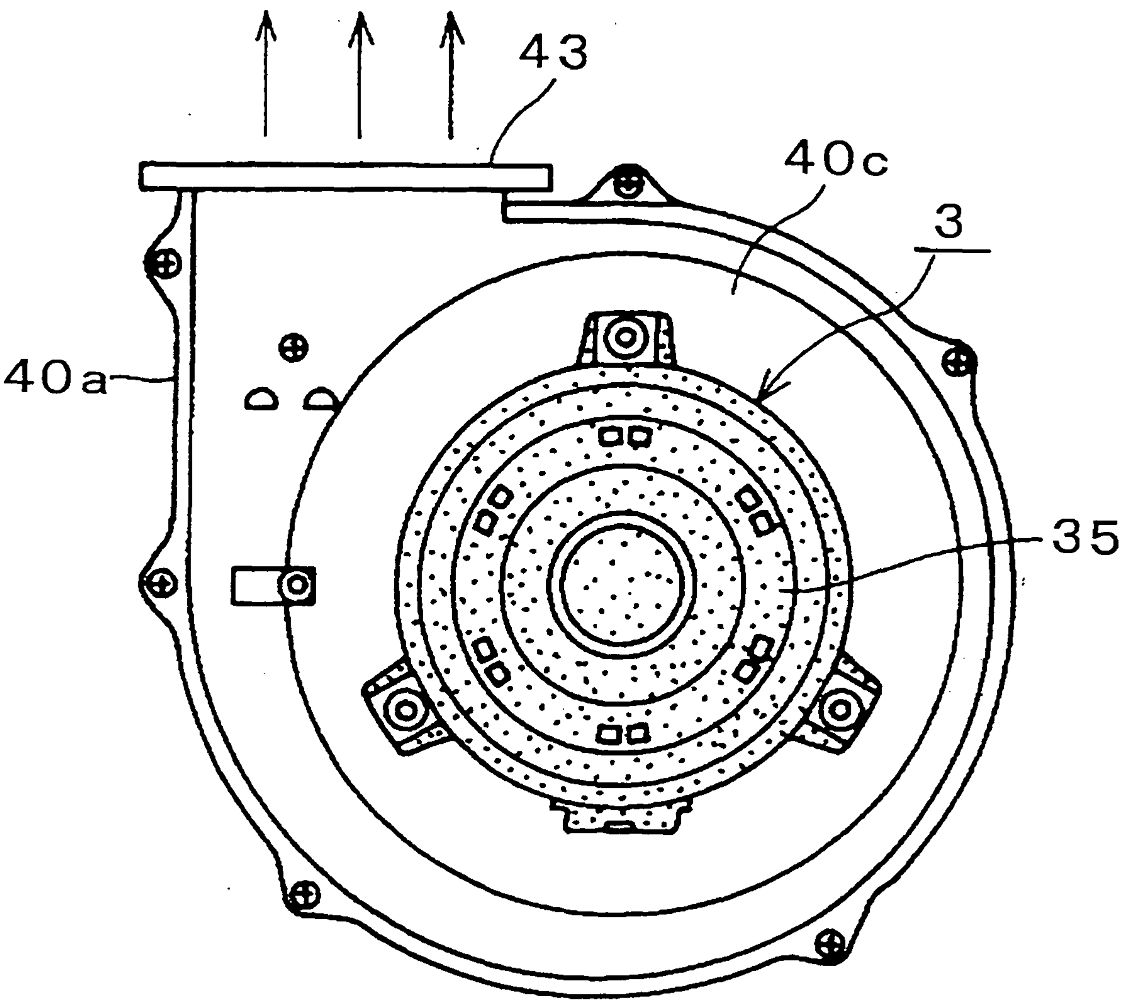

Fig.4

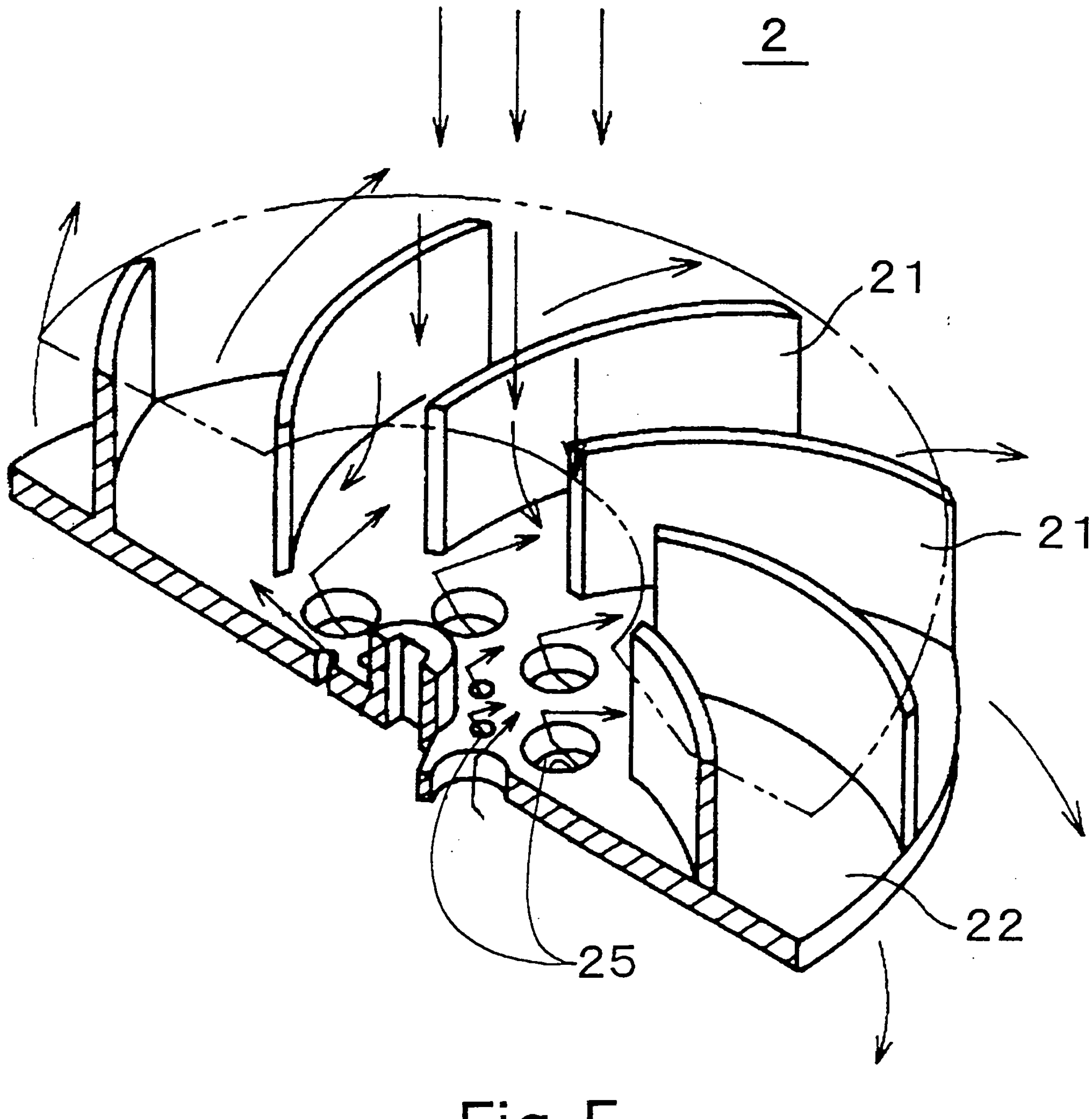

Fig.5

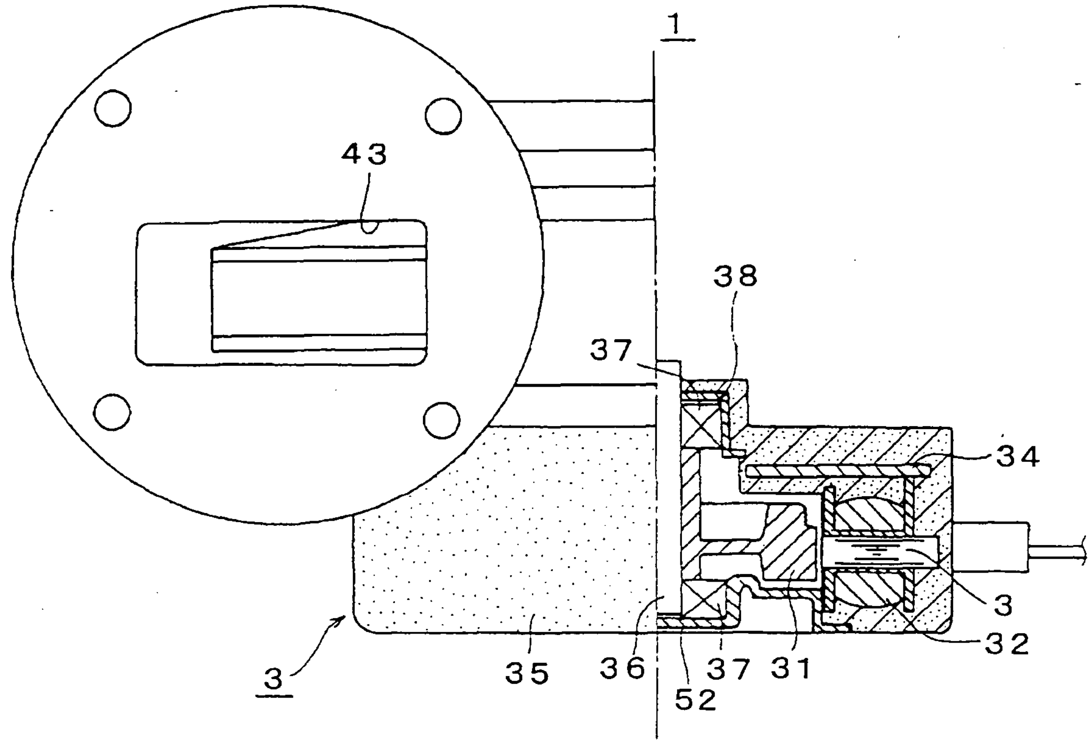

Fig.6

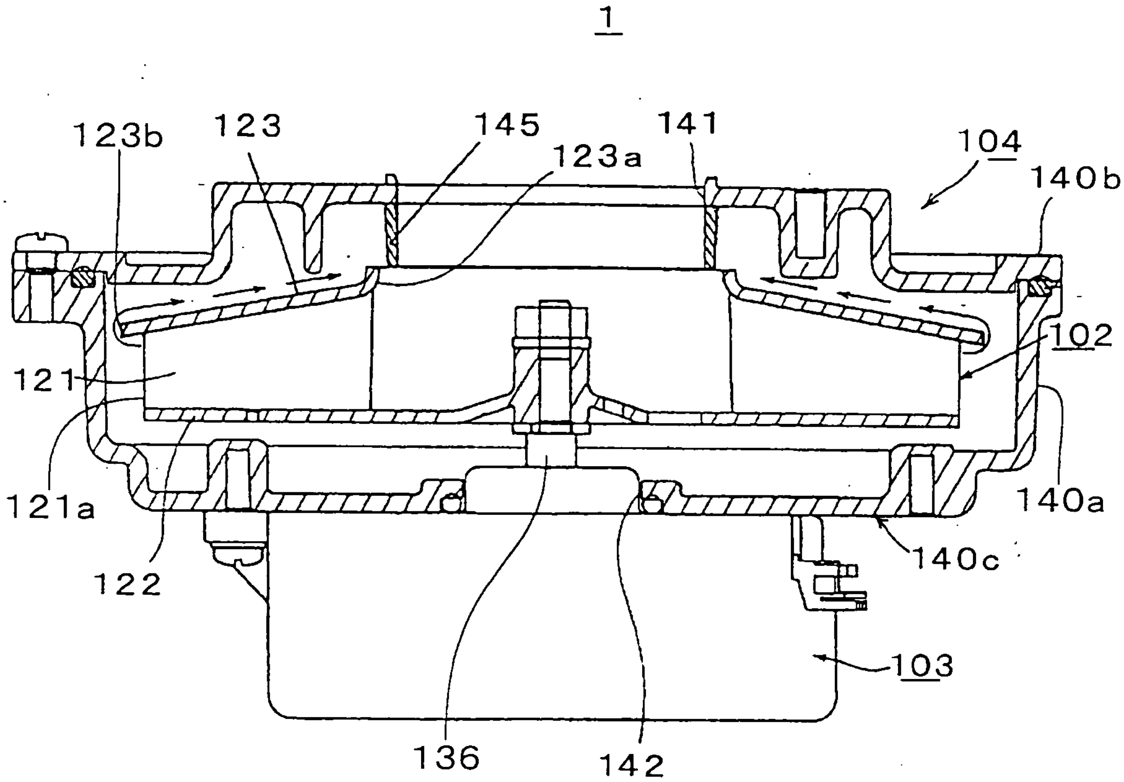
1
123b
123
145
141
104
123a
140b
102
121
121a
140a
140c
122
103
136
142

Fig.7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 01 2269

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	US 3 730 642 A (BARNSTEAD J ET AL) 1 May 1973 (1973-05-01) * column 2, line 1 - column 3, line 30 * * column 3, line 55 - column 4, line 7; figure 3 *	1-4,7 5,8	F04D29/42
Y	EP 1 122 444 A (EBM WERKE GMBH & CO KG) 8 August 2001 (2001-08-08) * paragraph [0010] - paragraph [0014]; figure 3 *	5	
X A	US 2002/057022 A1 (YAMAMOTO KATSUHIKO) 16 May 2002 (2002-05-16) * paragraph [0031] - paragraph [0041]; figure 2 *	1,2,7,11 5	
X A	US 2002/057965 A1 (CHANG BOR HAW ET AL) 16 May 2002 (2002-05-16) * paragraph [0023] - paragraph [0025]; figures 2,3B *	1-3,7 4-6	
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X A	US 2002/146318 A1 (HORNG ALEX) 10 October 2002 (2002-10-10) * paragraph [0019] - paragraph [0032]; figures 7,8 *	1,2,7 4,5	F04D
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	4 August 2004	Di Giorgio, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 01 2269

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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04-08-2004

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