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Neidhardt et al.

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[54] **RING-TYPE FAN**

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[51] **Int. Cl.** **F04b 35/00**

[58] **Field of Search** .... 415/79, 53 T, 199 T, 415/213 T; 417/371

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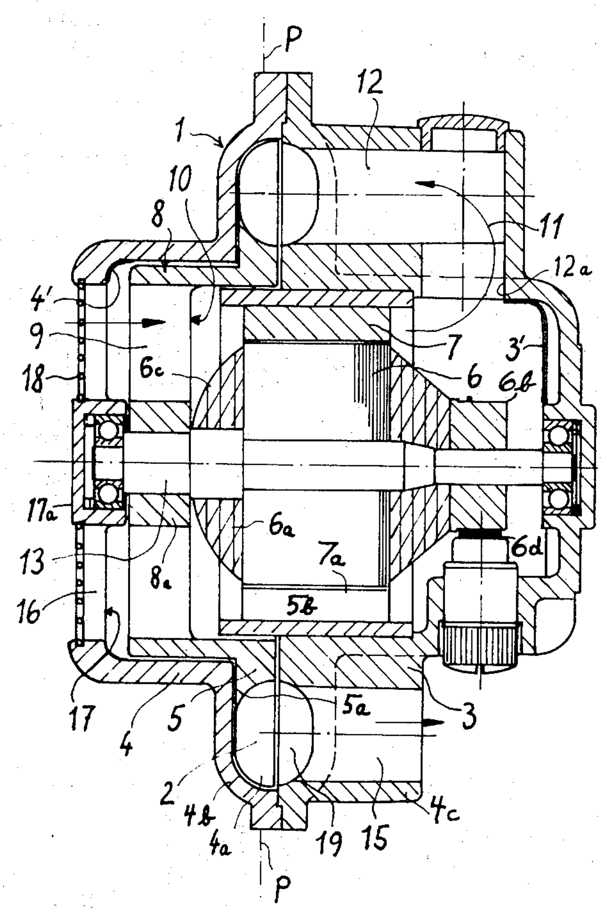
[57] **ABSTRACT**

A ring-type fan or compressor comprises an impeller ring having a propeller-forming hub and surrounds an electric motor to which the fan impeller is coupled. The motor extends axially to both sides of the plane of the impeller ring which surrounds the fan and is rotatable in a housing in which the intake passage communicates with the motor chamber on the opposite side of the motor structure so that the displaced gases are initially drawn through the motor chamber to cool the motor. An axial blower may be located within the housing and is driven by the motor within the annular impeller.

19 Claims, 11 Drawing Figures



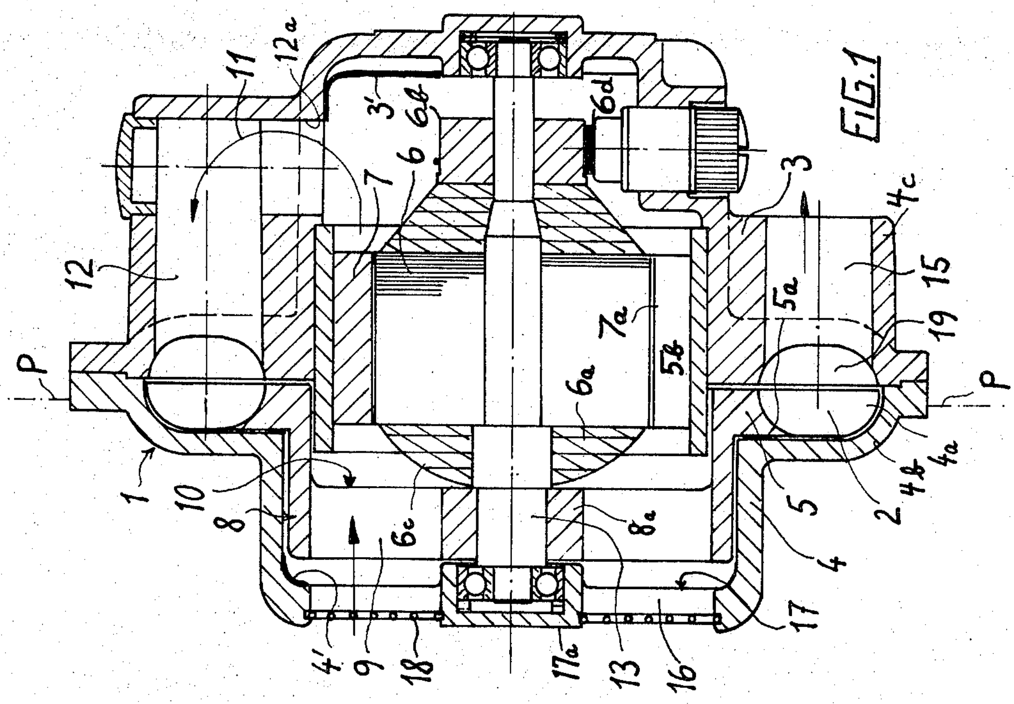


FIG.1

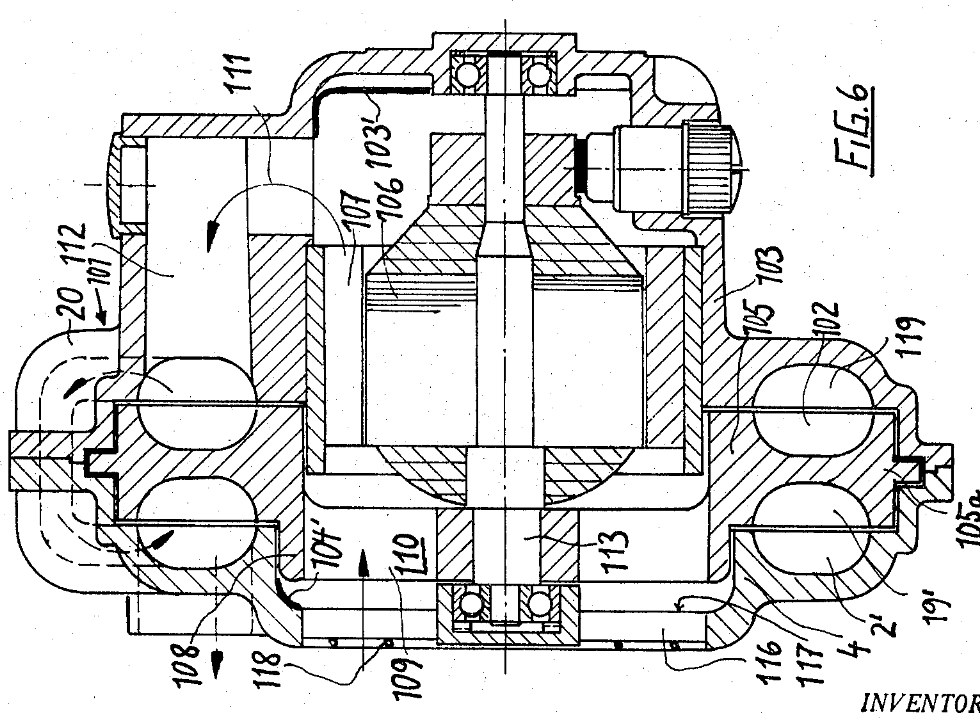


FIG.6

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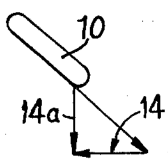


FIG.2A

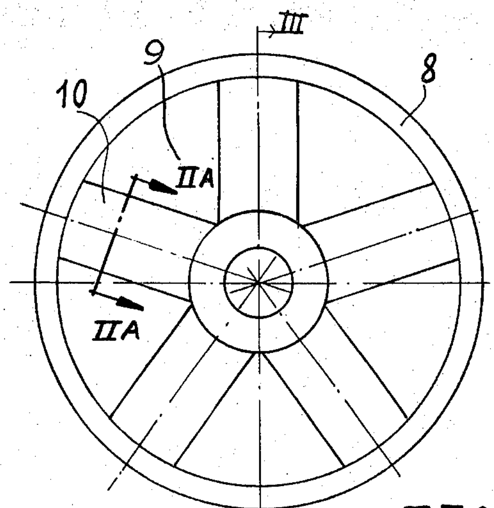


FIG.2

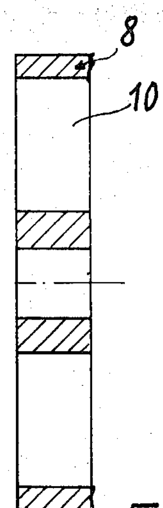
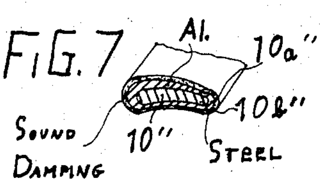


FIG.3

FIG.7



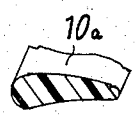


FIG.8

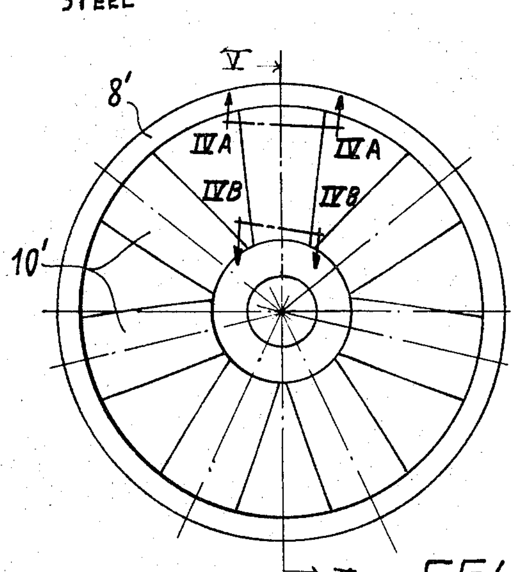


FIG.4

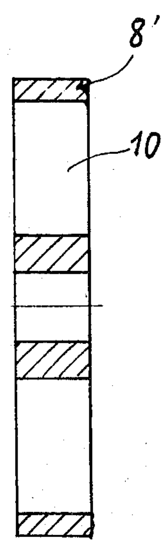


FIG.5

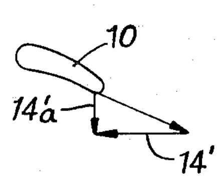


FIG.4A

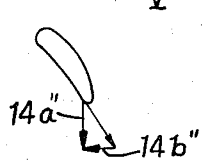


FIG.4B

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RING-TYPE FAN

FIELD OF THE INVENTION

Our present invention relates to a ring-type blower, fan or compressor and, more particularly, to a ring-type gas-displacement system provided with an electric motor.

BACKGROUND OF THE INVENTION

A ring-type fan, blower or compressor generally comprises a rotor or impeller which is rotated about its axis by an electric motor connected to a flange of the fan housing or shroud at one end of the motor, the impeller or motor having tthe configuration of a ring with vanes or the like spaced about its periphery for substantially axial inflow and radial or axial outflow of the gases. Such ring-type fans have been used in the past to compress relatively small quantities of gas to relatively high pressures, generally in the so-called "intermediate pressure range," e.g., for the paper-feed devices of a printing press, to supply air or suction to drive pneumatic conveyer systems, and for supplying air to catalytic afterburners or the like for the detoxification of waste gases of combustion.

A particularly advantageous use of such blowers is in the internal-combustion-engine art, e.g., for automotive vehicles, in which the blower supplies air for admixture with exhaust gases to be catalytically reformed or for afterburning in a pollution-reducing exhaust gas detoxification installation. With increasing concern as to atmospheric pollution by automotive vehicles, growing numbers of systems have been proposed for the afterburning or catalytic reformation of the exhaust gases of internal-combustion engines which require blowers of a small size and the ability to provide efficiently a supply of air under pressure to the afterburner or catalytic chamber. Blowers for this purpose have been described in the German printed application 1,428,246.

For many purposes, however, such arrangements still occupy excessive space and are inefficient. For example, a blower driven by an electric motor may have its output limited by the heat generated in the electric motor if the heat cannot be dissipated sufficiently quickly. Complicated arrangements have be proposed heretofore for dissipating the heat resulting from electric losses in motor-driven blowers and frequently these systems resulted in a prohibitive increase in the size of the unit to the point that they could not be installed in many locations.

OBJECTS OF THE INVENTION

It is therefore the principal object of the present invention to provide an improved fan, blower or compressor for the purposes described and for like uses in which a high output and efficiency can be obtained with a unit of relatively small size.

Another object of the invention is to provide an electric-motor-driven fan or blower arrangement, especially for supplying relatively small quantities of a gas at an elevated pressure, which avoids the aforedescribed drawbacks.

It is another object of the invention to provide an improved, highly compact, electrically driven fan, blower or compressor which possesses increased efficiency by virtue of more effective cooling of the electric motor.

Still another object of the invention is the provision of a ring-type blower and electric-motor combination which, by comparison with prior-art systems, affords a more intensive dissipation of the heat generated by the electric motor and therefore possesses a greater output per unit volume of the system.

Still further, it is an object of our invention to provide a blower of the class and for the purposes described which, for given conditions, possesses a small overall volume that can be effective with conventional systems such as anti-pollution arrangements for automotive vehicles.

SUMMARY OF THE INVENTION

These objects and others which will become apparent hereinafter, can be attained, according to our present invention, with a blower which comprises an electric motor and a ring-type impeller or rotor driven thereby. According to the principles of this invention, the motor is concentrically surrounded by the vane-carrying annulus or ring of the impeller and extends to both sides in the axial direction of the radial plane of the blade crown or annulus. A housing is provided for the motor and the rotor which defines a central motor chamber, containing the field coils and armature windings, one of which is mounted on a rotatable member of the motor which is coupled with the impeller mentioned earlier.

The housing is provided with an axial intake at one end of the motor chamber through which the fluid medium is drawn into the system and conducted axially through the motor via passages provided in the field coil or stator assembly and/or through the armature or rotor assembly toward the other end of the motor. The housing also provides a fan chamber for the rotatable impeller and forms any necessary scroll or shroud therefore.

In accordance with the principles of the invention as applied to ring-type impellers or fans, the fan chamber is alongside and communicates with the motor chamber laterally or radially thereof so that the fluid medium which is conducted through the motor chamber, is diverted laterally into the fan chamber and preferably is drawn to the latter in the direction opposite that in which it traversed the motor chamber. This reversal of the flow direction of the fluid medium, to the intake of the fan chamber enables the intake and, if desired the discharge passages of the fan chamber to flank the motor chamber and ensures an especially space-saving arrangement of the motor and the fan. Furthermore, this arrangement provides a highly efficient cooling of the motor since substantially all of the medium displaced by the impeller passes through the motor chamber and the relatively rotating parts thereof for cooling purposes.

The motor chamber thus constitutes an intake passage for the impeller or blower chamber and is traversed by the fluid medium in one axial direction initially and then in the opposite axial direction. According to a feature of the invention, sound-damping layers are provided along the walls of this passage, especially in those walls of the passage forming the motor chamber, to reduce the noise generated by the unit and thereby increase the range of utility thereof. To reduce the flow losses (pressure drop) in the motor passages to a minimum and thereby increase the cooling efficiency and output of the unit, we also provide the through-flow passages in the motor chamber and elsewhere in the housing with aerodynamic or streamlined configurations. The rotor of the motor may similarly have a streamlined configuration.

According to still another feature of the invention, the impeller is provided with a hub which is connected to the rotatable part of the motor and spans the intake of the motor chamber while simultaneously forming an axial-flow fan, e.g., a propeller. The propeller of the impeller, having generally radially extending vanes along spokes of the hub, thus constitutes a first blower or compressor stage for which the blade crown of the impeller constitutes the second stage. The precompression or first stage thereby increases the output of the blower.

Still another increase in the output can be attained with only a minute increase in the size on the unit when the blade crown of the impeller is provided along opposite faces of its annulus with sets of vanes or blades, the respective shroud-enclosed chambers being connected in series by suitable conduit means. The result is a three-stage blower or fan when the system is further provided with a propeller-type precompressor arrangement according to the invention.

Thus, the present invention provides a two-stage blower using a single impeller, the inner portion of which is provided with openings separated by webs, ribs or spokes which may have a pitch annulus similar to that of a propeller and constituting the first stage of a two-stage blower. The propeller forms an axial-intake, axial-outflow first-stage blower driving the fluid medium through the motor and providing a precompression in the motor chamber. The motor chamber is connected by the flow-reversal passage to the second-stage portion of the impeller which forms the ring-type blower. While the preferred condition is to provide all of the electrical portions of the motor within this chamber, we conceive that it is possible to drive a two-stage blower (in which the first stage is formed by a propeller portion of the impeller disk while the second stage is formed by the blade crown) by a motor whose electrical components, e.g., coils and magnets, are located outside of the blower housing. This arrangement loses the fortuitous cooling of the motor as previously described but provides a convenient two-stage blower construction.

The propeller spokes of the impeller can be formed in numerous ways according to the invention, for example, by stamping the impeller to punch out the aforementioned openings and in part the desired profile and pitch to the spokes or blades of the propeller. Of course, when the impeller is not stamped or punched from sheet metal, it may be injection-molded from synthetic resin around a metal skeleton and/or provided with a facing layer or coating of sound-damping material. As especially convenient construction provides the axial blower or propeller as a die-cast body with the desired configuration and pitch of the spokes. Advantageously, the spoke orientation is such that the axial throughflow velocity is the same at all radially spaced points along the propeller. The system also admits of a construction in which the propeller portion the impeller is injection-molded from synthetic resin while the outer periphery of the impeller forming the blade crown, is die-cast from a light metal such as aluminum and is pressed onto the spokes of the propeller member. The propeller member may also be constructed in the form of a steel sheet metal star-shaped skeleton about which aluminum is die-cast and may have aerodynamically or scooped-shaped spokes.

DESCRIPTION OF THE DRAWING

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is an axial cross-sectional view, in somewhat diagrammatic form, of a ring-type arrangement according to the invention;

FIG. 2 is an elevational view of the propeller portion of an impeller disk according to the invention;

FIG. 2A is a section taken along line IIA — IIA of FIG. 2;

FIG. 3 is a cross-section taken along the line III — III of FIG. 2;

FIG. 4 is a view similar to FIG. 2 of another impeller disk portion, according to the invention;

FIGS. 4A and 4B are respective sections taken along lines IVA — IVA and IVB — IVB of FIG. 4;

FIG. 5 is a cross-section taken along the line V — V of FIG. 4;

FIG. 6 is a view similar to FIG. 1, but illustrating another embodiment of the invention;

FIG. 7 is a perspective detailed view of a portion of an impeller arrangement according to another feature of the invention; and

FIG. 8 is a view similar to FIG. 7 but also showing a modification of the impeller disk.

SPECIFIC DESCRIPTION

From FIG. 1 of the drawing, it will be apparent that the blower arrangement **1** comprises a housing **4** defining a ring-type fan chamber **4*a*** with its shroud **4*b*** and a confronting housing portion **4*c*** forming the passage **19** which communicates with the ring-fan chamber. The impeller **5**, which is rotatably received in the housing **4**, comprises a disk portion **5*a*** lying generally in a radial plane P and formed along its outer periphery with a crown **2** of vanes or blades constituting the ring blower. The housing **3**, **4*c*** in which the stator of the electric motor is anchored, is juxtaposed with the disk portion **5*a***. A cylindrical boss **5*b*** of the impeller terminates in a propel'er-type axial-intake, axial outflow initial or precompression stage **9**, **10** to be described in greater detail hereinafter.

The motor comprises an armature or rotor **6** mounted on shaft **13** and surrounded by a stator **7** provided with the usual field coils not further illustrated. The magnetic portion **6*a*** of the armature, which is connected in the usual manner to the commutator **6*b***, has a streamlined configuration as shown at **6*c*** to deflect the air stream through axial passages **7*a*** of the stator. The housing **3**, moreover, is provided with brushes **6*d*** co-operating with the armature in the usual manner. As can be seen from FIG. 1 also, the motor **6**, **7** extends axially to the right and to the left beyond the radial plane P of the blade crown **2** which is so arranged as to be concentrically surrounding the motor **6**, **7**. The housing **3**, **4**, moreover, extends in the axial direction to both sides past the radial plane P and forms a passage **16**, **9**, **7*a*** through this motor chamber. The central portion of the impeller **5**, represented generally at **8**, includes a hub **8*a***, keyed to the shaft **18**, and a propeller **9**, **10**. This portion **8** of the impeller extends axially out of the radial plane of the blade crown **2**.

As is also seen in FIG. 1, but may be better visualized from FIGS. 2 – 4, the axially projecting central portion 8 of the impeller is provided in the axial direction with openings 9 defined between radial spokes 10 which are pitched (FIGS. 2 and 4) to constitute the scoopes or blades of an axial intake, axial outflow blower. This axial intake, axial outflow blower draws the fluid medium, generally air, into the motor chamber from left to right as visualized in FIG. 1 and precompresses the air which then flows through the motor chamber and within and between the rotor 6 and stator 7 thereof. At the far end of the motor housing, there is provided a radial passage 12*a* opening into an axially extending intake port 12 of the ring blower 1. The gas stream is thus reversed in direction as shown by the arrow 11 to flow into the ring blower. Numerals 3' and 4' represent sound-damping layers which are provided at several locations along the inner walls of housing 3, 4. It will be understood that all of the walls of this chamber can be provided with such a lining which can be constituted from fiber glass and attached by suitable adhesive to the wall.

The blades 10 of the axial intake, axial outflow blower can be simply an inclined spoke (FIGS. 2 and 3) stamped from sheet metal or die-cast from metal or molded from a synthetic resin as shown at 10*a* in FIG. 8. The vector 14 in FIG. 2, of course, represents the direction of rotation while vector 14*a* represents the velocity of gas flow in the axial direction. In FIGS. 4 and 5, the blades 10' of central portion 8' of the rotor are shown to be somewhat differently profiled. Here the blades are designed so as to be scoop-shaped and to have a steep pitch closer to the hub. The increasing pitch is designed such that the axial flow vector 14*a*' and 14*a*'' is approximately the same at all radial distances from the axis in spite of the different velocity vectors 14' and 14'' corresponding to the angular speeds of the several sections. In FIG. 1, we have shown the blower outlet 15 swung to the underside of the blower although in accordance with customary ring-type blower principles it is located in fact adjacent the intake portion 12.

Ahead of the central portion 8 of the impeller, which forms the axial intake first blower stage previously mentioned, there is provided an intake passage represented at 16 which is subdivided into a plurality of openings by stationary guide vanes 17 which may have a complementary pitch to those of blades 10 and cooperate with the latter to increase the axial flow of air into the system. The hub of radial vane 17 forms a bearing housing 17*a* in which the shaft 13 is journaled. The opening 16 is covered in part by a protective grid or screen 18.

In FIG. 6, we have shown another embodiment of the invention wherein parts identical to those of FIG. 1 in function have been designated with the same numerals preceded with a hundreds designation. In this embodiment, the blade crown 102 on one face of the impeller disk 105*a* is matched by an oppositely facing blade crown 2' communicating with the side passage 19' which is tied to the passage 119 via a duct 20. The cross-section of the passages 119, 19' is so selected as to decrease in accordance with the increasing air compression. The double-sided vane arrangement shown in FIG. 6 thus provides a second ring-blower stage and, without materially increasing the size of the assembly, increases the output.

It should be noted that the system described admits of various modifications. For example, a steel skeleton 10'' of the essential portion of the rotor may be stamped from sheet metal, encased in a die-cast aluminum sheath 10a'' and then covered with a layer 10b'' of sound-damping material. It may use motors of various types including asynchronous motors, commutator motors, central-stator and outer-rotor motors, motors with electronic speed control, etc. These and other modifications readily apparent to those skilled in the art are intended to be incorporated within the scope of the invention except as limited by the appended claims.

We claim:

1. A ring-type blower, comprising:
   an electric motor having a stator and a rotor rotatable relative to said stator about an axis;
   an impeller connected with said motor and having an annulus forming a blade crown concentrically surrounding said motor; and
   a housing surrounding said motor and said annulus and defining a motor chamber wholly receiving said stator and rotor of said motor and axially extending to opposite sides of the blade crown of said annulus, said stator and said rotor being so constructed and arranged as to be in direct contact with fluid traversing said motor chamber,
   an intake opening communicating with said motor chamber to one axial side of said motor,
   a ring-type blower chamber receiving said annulus around said motor chamber, and
   an axially extending passage communicating between said blower chamber and said motor chamber and opening into the latter at the opposite side of said motor whereby a fluid medium is drawn through said opening and said motor chamber between said stator and said rotor in one direction and is then fed through said passage to said blower chamber in the opposite axial direction, said housing having generally parallel inlet and outlet fittings communicating respectively with said opening and said blower chamber.

2. The blower defined in claim 1 wherein said chamber and said passage define a channel for said fluid medium, further comprising a sound-damping layer lining at least one wall of said channel.

3. The blower defined in claim 2 wherein said layer is provided on a wall of said motor chamber.

4. A ring-type blower, comprising:
   an electric motor having a stator and a rotor rotatable relative to said stator about an axis;
   an impeller connected with said motor and having an annulus forming a blade crown concentrically surrounding said motor; and
   a housing surrounding said motor and said annulus and defining
   a motor chamber receiving said motor and axially extending to opposite sides of the blade of said annulus,
   an intake opening communicating with said motor chamber to one axial side of said motor,
   a ring-type blower chamber receiving said annulus around said motor chamber, and
   an axially extending passage communicating between said blower chamber and said motor chamber and opening into the latter at the opposite side of said motor whereby a fluid medium is drawn through said opening and said motor chamber in one direc-

tion and is then fed through said passage to said blower chamber in the opposite direction, said housing having generally parallel inlet and outlet fittings communicating respectively with said opening and said blower chamber, said impeller having a central portion extending axially out of said plane and formed with an axial-intake axial-out-flow fan between said opening and said motor.

5. The blower defined in claim **4** wherein said chamber and said passage define a channel for said fluid medium, further comprising a sound-damping layer lining at least one wall of said channel.

6. The blower defined in claim **5** wherein said layer is provided on a wall of said motor chamber.

7. The blower defined in claim **4** wherein said axial-intake fan comprises a plurality of angularly spaced radial spokes of a pitch adapted to axially induce the flow of gas into said motor chamber.

8. The blower defined in claim **7** wherein said spokes are composed at least in part of die-cast metal.

9. The blower defined in claim **8** wherein said spokes have steel skeletons and aluminum die-cast around the skeleton.

10. The blower defined in claim **4** wherein said fan consists at least in part of synthetic-resin radial spokes.

11. The blower defined in claim **4** wherein said spokes are provided with sound-damping layers.

12. A ring-type blower, comprising:

an electric motor having a stator and a rotor rotatable relative to said stator about an axis;

an impeller connected with said motor and having an annulus forming a blade crown concentrically surrounding said motor; and

a housing surrounding said motor and said annulus and defining

a motor chamber receiving said motor and axially extending to opposite sides of the blade of said annulus,

an intake opening communicating with said motor chamber to one axial side of said motor,

a ring-type blower chamber receiving said annulus around said motor chamber, and

an axially extending passage communicating between said blower chamber and said motor chamber and opening into the latter at the opposite side of said motor whereby a fluid medium is drawn through said opening and said motor chamber in one direction and is then fed through said passage to said blower chamber in the opposite direction, said housing having generally parallel inlet and outlet fittings communicating respectively with said opening and said blower chamber, said annulus being provided with blade crowns on opposite faces thereof, each received in a respective radial-type blower chamber formed in said housing, said blower further comprising a conduit connecting said blower chambers in series.

13. The blower defined in claim **12** wherein said chamber and said passage define a channel for said fluid medium, further comprising a sound-damping layer lining at least one wall of said channel.

14. The blower defined in claim **13** wherein said layer is provided on a wall of said motor chamber.

15. The blower defined in claim **12** wherein said impeller has an axial-intake fan comprising a plurality of angularly spaced radial spokes of a pitch adapted to axially induce the flow of gas into said motor chamber.

16. The blower defined in claim **15** wherein said spokes are composed at least in part of die-cast metal.

17. The blower defined in claim **16** wherein said spokes have steel skeletons and aluminum die-cast around the skeleton.

18. The blower defined in claim **15** wherein said fan consists at least in part of synthetic-resin radial spokes.

19. The blower defined in claim **15** wherein said spokes are provided with sound-damping layers.

* * * * *