Sept. 29, 1970 E. HERBERG ET AL 3,531,221

VENTILATOR WITH AXIAL PROPELLER WHEEL

Filed Aug. 21, 1968 2 Sheets-Sheet 1

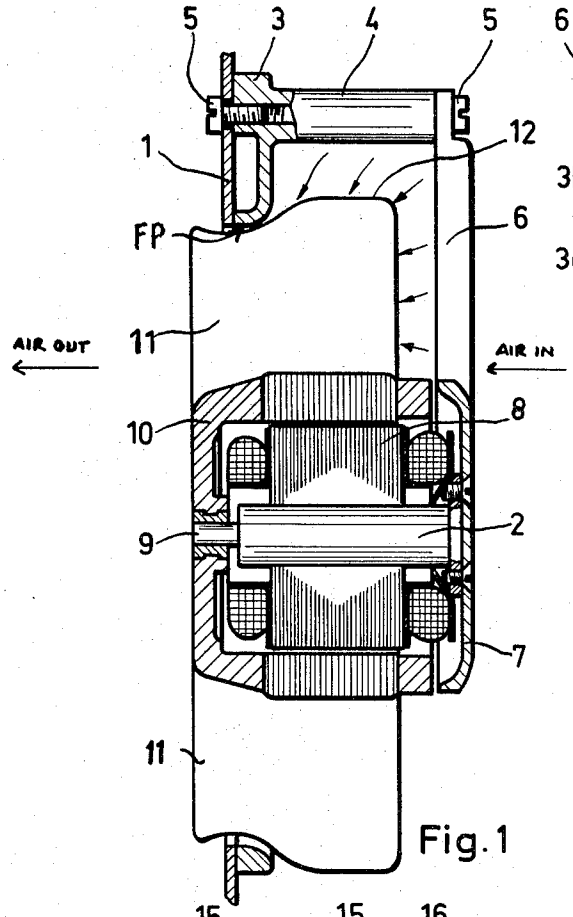

Fig. 1

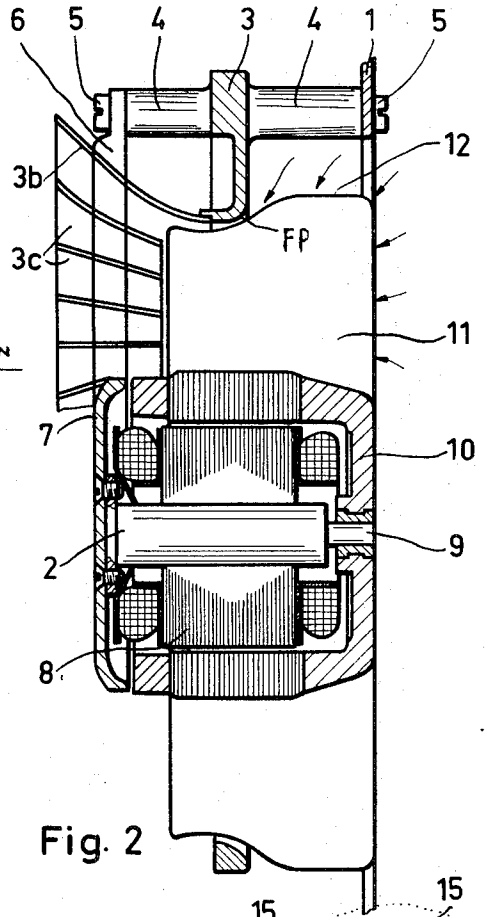

Fig. 2

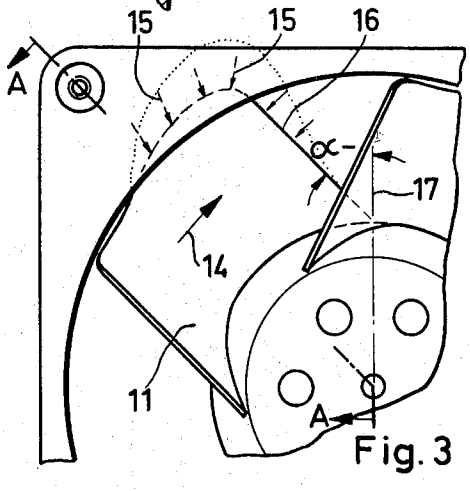

Fig. 3

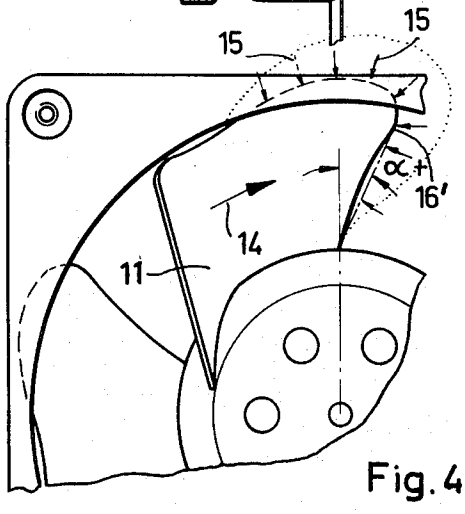

Fig. 4

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VENTILATOR WITH AXIAL PROPELLER WHEEL

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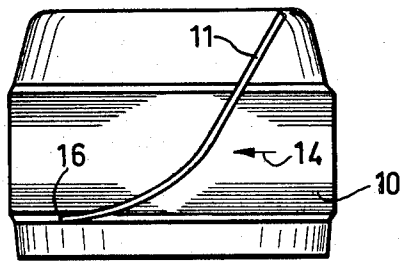

Fig. 5

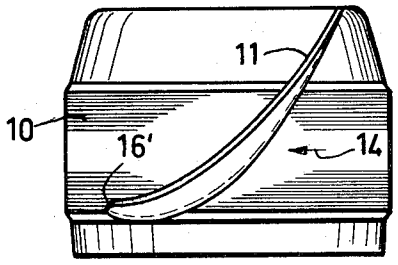

Fig. 6

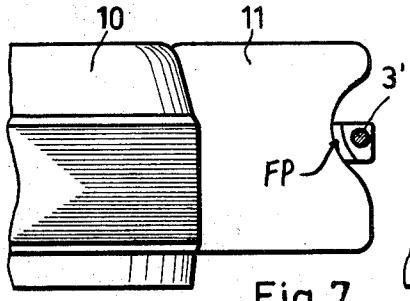

Fig. 7

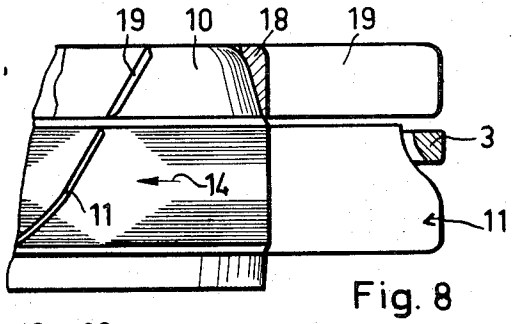

Fig. 8

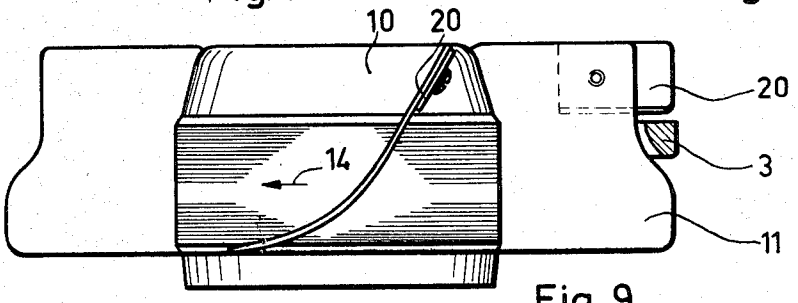

Fig. 9

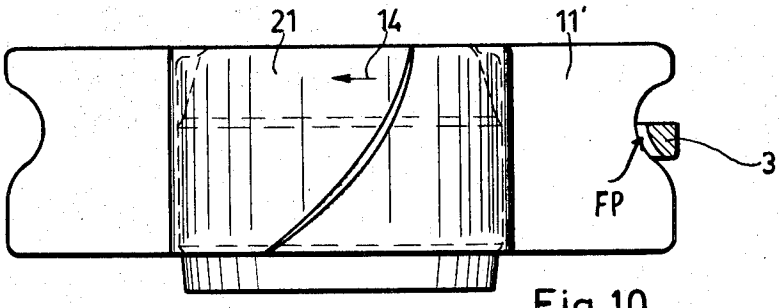

Fig. 10

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VENTILATOR WITH AXIAL PROPELLER WHEEL

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Claims priority, application Germany, Aug. 23, 1967, 1,628,353
Int. Cl. F04d 25/06, 19/00, 29/26
U.S. Cl. 230—117 14 Claims

ABSTRACT OF THE DISCLOSURE

A ventilator has a housing provided with a flow passage surrounded by a guiding wall having an open inlet end and an open outlet end. A fan assembly is mounted for rotation in this passage and includes a plurality of fan blades which project at least at the entrance side in axial direction beyond said guiding wall and outside said guiding wall in radial direction freely beyond the diameter of said passage.

BACKGROUND OF THE INVENTION

The present invention relates in general to ventilators and more particularly to ventilators acting as axial blowers. More specifically, the invention relates to ventilators having a flange-shaped frame to which spokes are mounted which carry the stator of the motor, whereas the propeller blades are attached to the rotor. Such ventilators are used for many purposes, especially they are often mounted to the casing of electronic apparatus to move a cooling air stream through the interior of such apparatus. As there is the general tendency to reduce the dimensions of electronic apparatus there is also the desire to keep the dimensions of these ventilators as small as possible. In these electronic apparatus the space available for the insertion of such ventilators is often rather limited especially as often several apparatus have to be assembled to a constructional unit.

It is a main object of this invention to improve the performance and to increase the efficiency of ventilation by a special design of the blades.

It is another object of this invention to make at an available space given such ventilators substantially more effective than it has hitherto been possible with small axial blowers.

SUMMARY OF THE INVENTION

In accordance with the present invention, these objects have been attained by providing in a ventilator, in combination, a fan assembly comprising a frame with a passage of circular cross-section, provided with at least one spoke supporting the motor, a guiding wall of said frame surrounding the passing air stream at its periphery, a propeller wheel having blades projecting at the entrance side of the air both in axial and radial direction beyond said guiding wall.

In this embodiment of an axial blower the portion of the propeller wheel which lies in front of the frame has an enlarged diameter so that the propeller wheel can no more be inserted through the aperture of the frame. This arrangement of an axial blower has the unexpected effect that the air drawn into the improved ventilator enters radially from outside along the periphery of the propeller wheel into the aperture of the frame serving for the passage of air. Thus a substantial increase of the intake of air, as well as the output, is obtained both as to quantity and pressure.

Furthermore, the inventive axial blower offers the great advantage that, compared with the hitherto used blowers, it eliminates almost completely the high noise level which has heretofore been found so objectionable in ventilators of this type.

It is useful if not only at the entrance side of the air but also at the exhaust side the blades of the propeller wheel project both in radial and in axial direction beyond the aperture of the frame serving for the passage of air.

In a preferred embodiment of the invention the clear width of the outer surrounding wall increases at the exhaust side continuously in the direction of the air stream and inserted annular shaped guiding walls subdivide the aperture angle of the exhaust aperture.

In some cases it is useful if the propeller wheel is a bipartite construction, each portion thereof projecting at the entrance side respectively the exhaust side both in radial and in axial direction beyond the aperture of the frame serving for the passage of air.

In special cases it may be favorable to provide the blades of the propeller wheel, either at the entrance side or exhaust side, with extensions projecting outwardly in radial direction beyond the aperture of the frame serving for the passage of air.

In another embodiment, in accordance with the present invention, the blades of the propeller wheel are made of elastic and resilient material, and the propeller wheel is inserted through said aperture of the frame by elastic deformation of the blades. In this case it has proved to be favorable to make the propeller wheel, being located at the exhaust side, as one integral unit and to mount it onto the rotor, whereas the blades, being located at the entrance side, are mounted separately onto the rotor.

Very good results have been obtained when at the entrance side the blades are inclined forwardly in the direction of the rotating wheel for scooping the air and when eventually, in addition, at least at the entrance side the blades are vaulted in the direction of the rotating wheel.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved ventilator itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a section through a ventilator according to the present invention, the section line being analogous to that identified by the line A—A of FIG. 3;

FIG. 2 is a section similar to FIG. 1 but through a further embodiment of the invention;

FIG. 3 is a fragmentary axial view of the embodiment shown in FIG. 2;

FIG. 4 is a view analogous to that of FIG. 3 but illustrating an additional embodiment of the invention;

FIG. 5 is a planview of a fan blade unit with only one fan blade being illustrated;

FIG. 6 is a view similar to FIG. 5 but illustrating a further embodiment of the invention;

FIG. 7 is a fragmentary view analogous to that of FIG. 5 illustrating yet another embodiment of the invention;

FIG. 8 is a view similar to FIG. 7 illustrating still a further embodiment of the invention;

FIG. 9 is a view similar to FIG. 5 and FIG. 7, illustrating still another embodiment of the invention; and

FIG. 10 is a view similar to FIG. 9 but illustrating yet a further embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the drawing identical reference numerals identify identical elements. It should be understood that components which are non-essential for the invention have been omitted. In all figures the direction of rotation of the rotatable components is indicated by arrows in heavy lines, and the flow is indicated, where necessary, by arrows in weak lines.

Discussing now the drawing in detail, and firstly the embodiment illustrated in FIG. 1, it will be seen that reference numeral **1** identifies a wall of a casing to which our novel ventilator is to be affixed and into the interior of which it is to direct a stream of cooling air. It is immaterial, of course, what such a casing contains, whether it be electronic components or anything else. Motor **2** is mounted on the wall of this casing by means of a frame or shroud **3**. This frame or shroud **3** is affixed to the wall **1** via screws **5** which later also serve to secure spacer sleeves or members **4**. The spacer sleeves **4** carry, spaced from the wall **1** and the frame **3**, supporting arms **7** which are arranged in a spoke-type configuration, and a flange **7**. The outer configuration of the frame **3** may be quadratic, if desired, and the motor **2**, carried by the aforementioned components, all of which together (with the exception of the casing **1**) may be thought of as a housing, is of the exterior-rotor type wherein the rotor **10** surrounds and is rotatable with reference to the stator **8**. The stator **8** is carried by the supporting arms **6** and the rotor **10** is mounted on the shaft **9**. It carries on its outer surface the fan blades **11**. The flow passage FP in the frame **3** is made as large as mechanical strength requirements for the frame **3** will permit.

The thin-line arrows indicate the direction of air aspiration, it being evident that air is aspirated both axially and radially inwardly past the supporting arms **6** and the spacer sleeves **4**. As shown, the fan blades **11** project in this embodiment in part (compare the edge **12**) radially as well as axially outwardly beyond the open inlet end of the flow passage, that is the end of the flow passage FP which in FIG. 1 is the right-hand end of the passage through the frame **3**.

Contrary to expectations it has been found that, quite surprisingly, the air in the region of the edges **12** will not be deflected outwardly away from the fan blades **11**, but rather will be aspirated radially inwardly over the entire circumference of the fan blade unit constituted by the rotor **10** and the plurality of fan blades **11** affixed thereto, as well as over the entire axial length of the edge **12**, that is over the entire length of that portion of each fan blade **11** which projects outwardly beyond the inlet end of the flow passage FP in upstream direction. This results in a significant improvement in the quantity of aspirated air, and we have found that if the largest diameter of the fan blade unit is approximately 7% larger than the diameter of the opening of the flow passage, the quantity of aspirated air is increased already by substantially 30%.

FIG. 2 illustrates a modification of the mounting of the motor to the casing of an apparatus. The stator **8** of the motor **2** is mounted at the exhaust side of frame **3** together with spokes **6** and flange **7** while the air enters freely without being hindered by the spokes. In this embodiment the frame respectively the ventilator casing together with the spokes can be made of one piece so that the propeller wheel together with the rotor and the shaft is one exchangeable constructional unit, whereas the flange with the stator, the bearing and the frame is another constructional unit. In the exhaust aperture there are inserted a funnel-shaped ring **3***b* and a small number of additional annular-shaped guiding walls **3***c* which subdivide the aperture angle of the exhaust aperture.

FIG. 3 is a front elevation of one part of the ventilator seen in the direction of the axis. Arrow **14** indicates the direction of the rotating blades **11**. Arrows **15** indicate the direction of the entering air when the propeller wheel rotates. The leading edges **16** of the blades are inclined by the angle α towards the radial plane **17** laid at the inner end of the blades through the axis. The lines marked with A show the direction of the section shown in FIG. 1.

FIG. 4 is a front elevation of one part of another embodiment of the blades. The leading edges **16'** of the blades are inclined forwardly to increase the sucking-in effect by an additional scooping effect of the blades, thus increasing the ease with which air is drawn into the improved ventilator. The impact energy losses of the air stream entering radially inwardly at the peripheral surface of the propeller wheel are thus essentially reduced so that the efficiency of ventilation is greater.

FIG. 5 is a side elevation of a propeller wheel according to the embodiment of FIG. 3, whereas FIG. 6 is a side elevation of a propeller wheel according to the embodiment of FIG. 4. In the FIGS. 5–8 only one blade is shown, the other blades being omitted to simplify the drawings. FIG. 6 illustrates clearly the concave vault of the blade in the region of the leading edge **16'**.

An increase of the intake of air, as well as the output, can be obtained when, as shown in FIG. 7, the outside diameter of the blades has a minimum in the region of the aperture of flange **7** and when said outside diameter increases from there to both sides. In this embodiment frame **3'** is a bipartite construction.

The frame can be made as a single unit if, according to FIG. 8, the propeller wheel is a bipartite construction, i.e. in addition to the blades **11** directly attached to the rotor, a small propeller wheel **18** with blades **19** is mounted with small clearance between the blades **11** and **19** when assembling the ventilator.

The embodiment illustrated in FIG. 9 shows that, where desired or necessary, the blades **11** can be so constructed that the blade unit can be introduced into the flow passage from one open end, with provision being made for the blade to extend not only axially but also radially beyond the respective open ends of the flow passage at both sides. This is accomplished in FIG. 9 by securing discrete portions **20** to the axially projecting portions of the blades **11** at one open end of the flow passage. Evidently, if for any reason this should be desired, the portions **20** could be secured to the axially projecting portions of the blades **11** at both open ends of the flow passage. The portions **20** may, incidentally, serve for balancing the fan blade unit in one plane whereas for purposes of balancing in the second plane the rotor may be provided with suitable means for effecting balancing.

Coming, finally, to the embodiment of FIG. 10, it will be seen that here the frame **3** is of one-piece construction but that the blades **11'** extend not only axially but also radially beyond both open ends of the flow passage in the frame **3**. To make this possible without resorting to a two-piece frame **3**, as shown in FIG. 7, or resorting to the construction of FIG. 8, we make the blades **11'** in FIG. 10 of resiliently deflectable material, for instance synthetic plastic material which are advantageously provided on a supporting sleeve **21** secured onto the rotor. Installation in the flow passage FP is then accomplished simply by resiliently deflecting the blades **11'** until they can be pushed through the flow passage, whereupon they are released and returned to their normal position which is illustrated in FIG. 10.

Generally speaking we prefer to secure, for instance weld the blades **11** directly to the rotor, advantageously to the magnetically active material of the rotor. However, we wish it to be understood that any other type of arrangement is suitable, and that the blades may be secured to a solid ring or sleeve, to a cup or bell-shaped member, or the like which in turn will be affixed to the rotor. Uniting of the blades into such a configuration may be accomplished by resorting to soldering, welding, casting or similar techniques.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. In a ventilator, in combination, a housing provided with a guide wall defining a flow passage having an open inlet end and an open outlet end axially spaced from said inlet end, said housing defining upstream of said inlet end of said passage a radially at least substantially unobstructed air intake zone; and a fan assembly comprising a fan blade unit mounted for rotation in part within the confines of said passage and including a plurality of fan blades which project at the inlet end in axial direction beyond said guiding wall and outside said guiding wall in said air intake zone in radial direction freely beyond the diameter of said passage.

2. In a ventilator as defined in claim **1**, said fan blades also projecting both in radial and in axial direction beyond the open outlet of said guiding wall.

3. In a ventilator as defined in claim **1**, said fan assembly including stator means carried by said housing, and rotor means surrounding and rotatable relative to said stator means; and wherein said fan blades are carried by said rotor means.

4. In a ventilator as defined in claim **3**, said fan blades being directly affixed to said rotor means.

5. In a ventilator as defined in claim **1**, each of said fan blades consisting of a first and a second discrete portion and said fan blade unit including a hub consisting of two discrete sections one of which carries the first portions and the other of which carries the second portions of said fan blades; and wherein both of said sections are mounted for joint rotation with said first portions in part projecting radially and axially outwardly beyond one of said open ends and said second portions in part projecting radially and axially outwardly beyond the other of said open ends.

6. In a ventilator as defined in claim **5**, further comprising annular-shaped guiding walls inserted within the outlet end and subdividing the aperture angle thereof.

7. In a ventilator as defined in claim **1**, said fan blades each including a main body portion which projects axially beyond said open inlet end, and an auxiliary body portion fixed with said main body portion exteriorly of said open inlet end and projecting radially of the latter.

8. In a ventilator as defined in claim **1**, said fan blades consisting of an elastically deflectable material so as to be insertable into said flow passage through one of said open ends by elastic deflection of the respective blades.

9. In a ventilator as defined in claim **8**, said fan blades consisting of synthetic plastic material.

10. In a ventilator as defined in claim **1**, said fan blades consisting of synthetic plastic material.

11. In a ventilator as defined in claim **1**, said fan blades being inclined in direction of rotation of said fan blade unit at least at their respective leading edges.

12. In a ventilator as defined in claim **1**, said fan blades being at least in the region of their respective leading edges vaulted and provided with a concavity facing the direction of rotation of said fan blade unit so as to constitute a scoop for gaseous fluid.

13. In a ventilator as defined in claim **1**, wherein the largest diameter of said blades is substantially equal to the distance between respective opposed outer sides of said housing.

14. In a ventilator as defined in claim **1**, wherein at the outlet end the clear width of said guide wall surrounding the passing air stream at its periphery increases continuously in the direction of said air stream.

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U.S. Cl. X.R.

415—209; 416—240