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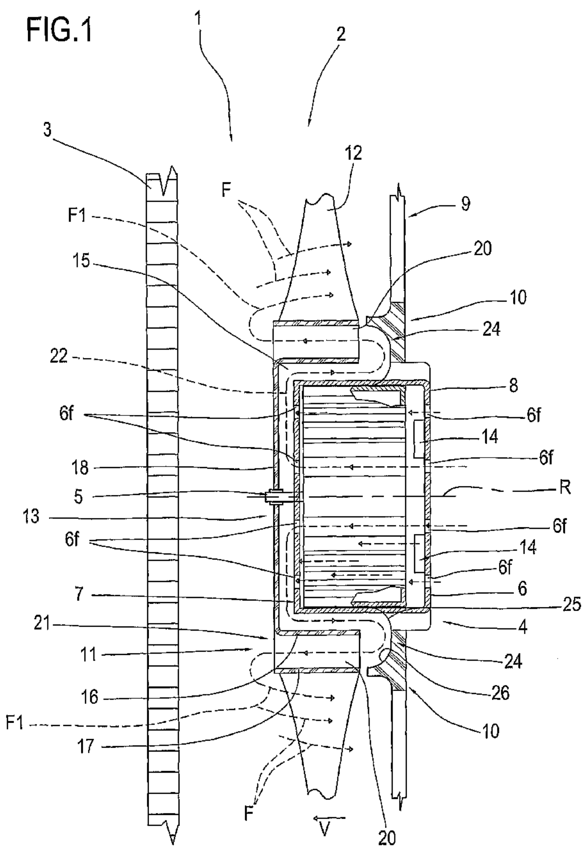
(54) Title: VENTILATION UNIT

(57) Abstract: Described is a ventilation unit (1) where an open motor (4) rotationally drives a hub (13) equipped round the outside of it with a plurality of first blades (12) forming an axial fan (27); the motor (4) is at least partially housed in the hub (13) and defines with the latter an air space (15) that forms part of a fluid dynamic circuit (22) for a flow (F1) that cools the motor (4); the cooling flow (F1) is produced by a secondary fan (21) that comprises a plurality of second blades (19), is built into the hub (13) inside the hub (13) itself and is coaxial with the fan (27) formed by the first blades (12).

FIG.1



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Description

Ventilation unit

Technical Field

This invention relates to a ventilation unit for cooling systems.

The invention relates in particular to a ventilation unit of the type comprising an axial fan connected by its hub to an electric motor that drives the fan itself.

This specification relates in particular to ventilation units driven by open electric motors, that is to say electric motors whose outside casing has a plurality of through holes for aeration.

Background Art

Usually, the motor is at least partly housed in the hub and is suitably positioned and supported by a mounting ring that peripherally surrounds the casing. Thus, the hub shields the motor and partly protects it from dirt. dust and other airborne particles, but at the same time reduces cooling efficiency.

In a prior art configuration, where the fan blades generate an air flow directed from the front to the back of the ventilation unit and where the motor casing has a front shield inside the hub and a rear shield outside the hub, both shields have respective pluralities of through holes for aeration, allowing air to flow through the motor from the back towards the front thereby cooling the windings, the magnetic circuit, the built-in electronic control components and any other sources of heat inherent in electric motors in general.

In prior art, forced air flows sucked into the motor from the outside atmosphere are produced in several different ways, all based on negative pressure generated inside the hub relative to the pressure of the outside atmosphere.

According to one technical solution, where the front wall of the hub is totally closed, the negative pressure is produced by the Venturi effect created in the air space between the fan hub and the motor mounting ring by the air flow generated by the fan blades.

The forced air circulation created by the Venturi effect is usually combined with a forced air circulation directed against the inside face of the hub by the radial stiffening spokes on the front wall of the hub.

According to another technical solution, where the front wall of the hub is provided with a plurality of through holes for aeration, the air circulation through the motor is generated by the pressure difference at the ends of the fan. Thus, in this case, the holes in the hub together with those in the front and rear shields provide a fluid dynamic return path for the air flow created by the fan blades.

Both of the above solutions are not very satisfactory to dissipate the heat produced by the electric motor and any electronic components built into it in applications where the ventilation unit is required to operate at high temperatures, such as for example, automotive applications where the ventilation unit is used to cool radiators.

Disclosure of the Invention

In this context, the main technical purpose of the present invention is to propose a ventilation unit capable of more effectively dissipating the heat produced by the electric motor that drives it and by any electronic components built into the motor.

Another aim of the invention is to propose a ventilation unit that enables the range of power ratings of the fan drive motors to be extended.

A further aim of the invention is to provide a ventilation unit that can be used at much higher temperatures than prior art ventilation units.

According to this invention, the above aims are achieved by a ventilation unit as described in the appended claims.

Brief Description of the Drawings

The invention will now be described with reference to the accompanying drawings which illustrate a preferred embodiment of it and in which:

- Figure 1 illustrates a first preferred embodiment of a ventilation unit according to the invention in a schematic side view not in proportion and partly in cross section, with some parts cut away for greater clarity;

- Figure 2 illustrates a second preferred embodiment of a ventilation unit according to the invention in a schematic side view not in proportion and partly in cross section, with some parts cut away for greater clarity;

- Figure 3 is a schematic perspective view of a rotary member forming part of the ventilation unit of Figure 1;

- Figure 4 is a schematic perspective view of a detail of the rotary member of Figure 3;

- Figure 5 illustrates the detail of Figure 4 in a schematic perspective view different from that of Figure 4.

Detailed Description of the Preferred Embodiments of the Invention

With reference to Figure 1, the numeral 1 denotes in its entirety a ventilation unit according to this invention.

As illustrated, the ventilation unit 1 can be advantageously applied to a cooling system 2, for example, for extracting heat from a radiator 3 of a vehicle (not illustrated).

The ventilation unit 1 comprises an electric motor 4 whose drive shaft 5 rotates about an axis of rotation R substantially at right angles to the large faces of the radiator 3.

The motor 4 is of the open type, that is to say, equipped with an outer casing 6 having a plurality of through holes 6f for aeration. More specifically, the casing 6 extends around the axis R according to a substantially cylindrical shape and is axially delimited by a front shield 7 and a rear shield 8, both at right angles to the axis R.

The shaft 5 extends towards the outside of the casing 6 on the side of the radiator 3, through the front shield 7.

The aeration through holes 6f are made both in the front shield 7 and in the rear shield 8 and, in both cases, are distributed uniformly around the axis R. Preferably, each hole 6f in the front shield 7 is axially aligned with a corresponding hole 6f in the rear shield 8.

In the preferred embodiment illustrated, the unit 1 comprises electronic means 14 for controlling the motor 4 and preferably housed in the casing 6, in the rear shield 8, in a position such as not to obstruct the holes 6f in the latter.

The electrical and magnetic characteristics of the motor 4 are of known type and are outside the scope of this invention.

The ventilation unit 1 comprises mounting means 9, associated with the motor 4 at the rear shield 8 of the casing 6 and structured in such a way as to connect the unit 1 to external mounting structures falling outside the scope of the invention.

In particular, the mounting means 9 comprise an annular member 10 for supporting the motor 4.

The annular member 10 surrounds and is fixed to the rear shield 8 of the casing 6.

A rotary member 11, better illustrated in Figure 3, is connected to the shaft 5 and is driven by the motor 4.

The rotary member 11 comprises a plurality of primary blades 12 mounted radially on a central, cup-shaped hub 13 fixed coaxially to the shaft 5 in such a way as to enclose the casing 6 except for the rear shield 8.

The blades 12 driven by the motor 4 generate a main air flow F for dissipating heat from the radiator 3. The flow F is directed from the radiator 3 towards the ventilation unit 1.

Between the motor 4 casing 6 and the hub 13 there is an air space 15 necessary to allow the rotary member 11 to turn freely.

In Figure 1 the air space 15 is not shown in proportion relative to the other components of the ventilation unit 1, so as to better illustrate the characteristics of the air space, as explained in more detail below.

As shown in particular in Figures 3, 4 and 5, the hub 13 comprises a first substantially tubular cylindrical element 16 and a second element 17, also substantially tubular and cylindrical, positioned outside the first tubular element 16.

The first and second tubular elements 16, 17 are coaxial with each other and rotatable about the axis R.

A wall 18 closes the first tubular element 16 at the front and makes the hub 13 integral with the drive shaft 5.

The hub 13 comprises a plurality of secondary blades 19, not illustrated in Figure 1 but only in Figures 3, 4 and 5, located between the first tubular element 16 and the second tubular element 17 to produce a flow F1 for cooling the motor 4.

More specifically, the first tubular element 16 and the second tubular element 17 form an annular duct 20 in which the blades 19 are mounted. The blades 19 extend preferably radially between the first tubular element 16 and the second tubular element 17 inside the annular duct 20.

In other words, the first tubular element 16, the second tubular element 17 and the blades 19 form an axial fan 21 that is thus contained between two cylindrical surfaces.

The annular duct 20 and the air space 15 at least partially form a fluid dynamic circuit 22 for the motor 4 cooling flow F1.

In the preferred embodiment illustrated, the blades 19 extend radially to an extent that is a function of the total diameter of the rotary member 11, or of the radial size of the blades 12.

More specifically, in a rotary member 11 having blades 12 whose radial size is between about 20 mm and about 200 mm, the blades 19 extend radially for between approximately 20% and 10%, respectively, of the radial size of the blades 12.

In practice, the smaller the radial size of the blades 12, the larger the blades 19 are percentage-wise.

The larger the radial size of the blades 12, the smaller the blades 19 are percentage-wise.

Preferably, the blades 19 are of the type known as "slotted split blades" to operate at high head.

The blades 19 are shaped to generate high head by minimizing the separation of the fluid vein from the blade and the consequent generation of vortices.

Usually, the fan 21 is dimensioned to generate a tangential output component of the flow F1 of the same order of magnitude as its axial component.

As shown in particular in Figures 4 and 5, each blade 19 is composed of a plurality of blade sections 23, three in the embodiment illustrated.

The blade sections 23 have different inclination angles that increase according to the axial distance from the front wall 18.

Advantageously, the blade sections 23 are completely axially offset from each other so as to avoid undercuts and thus enabling the rotary member 11 to be made by die casting.

In order to optimize the cooling of the motor 4, that is to say, for channelling the cooling flow F1 into the circuit 22, the ventilation unit 1 comprises a flow deflector 24. In practice, the deflector 24 contributes to closing the fluid dynamic circuit 22 and is positioned relative to the fan 21 in such a way that the cooling flow F1 is deflected by the whole of the deflector 24.

In particular, with reference to Figure 1, where the application illustrated comprises, from left to right, the radiator 3, the rotary member 11 and the motor 4, the deflector 24 is suitably positioned to channel into the annular duct 20 the flow F1 that the blades 19 force out of the air space 15.

The flow deflector 24 is made at least partially in the rear shield 8 of the casing 6 and at least partially in the mounting means 9 of the unit 1.

As illustrated in Figure 1, the deflector 24 comprises an annular baffle 25 substantially curved in cross section, made in the rear shield 8 and axially facing the air space 15.

The flow deflector 24 also comprises a second annular baffle 26 having a substantially curved cross section joined to the baffle 25 and substantially facing the annular duct 20, that is to say, the blades 19.

The baffle 26 is formed on the annular mounting member 10 of the motor 4.

The baffle 25 turns the flow F1 by approximately 90 degrees and the baffle 26 turns it by a further 90 degrees since the annular duct 20 and the air space 15 extend substantially parallel to one another.

Preferably, the casing 6 has on its outside surface a plurality of ribs (not illustrated) that optimize the cooling effect. The ribs run preferably lengthways along the casing 6 creating discontinuity that breaks the laminar motion of the cooling flow around the motor 4, thereby increasing heat exchange.

In use, with reference to Figure 1, the rotation of the member 11 generates in the air space 15 and at the baffles 25 and 26 a negative pressure that attracts air into the motor 4 through the holes 6f in the rear shield 8.

The flow F1 passing through casing 6 and into the air space 15 extracts heat from the motor 4, thus significantly contributing to cooling the motor.

It should be noticed that, if V is the direction of travel of the vehicle (not illustrated), the direction of the flow F is opposite to the direction V, while the direction of the flow F1 is the same as the direction V in the annular duct 20 and opposite to the direction V in the air space 15. In particular, in the duct 20, the flow F1 comes from the flow deflector 24 and flows out through the hub 13.

In other words, the outside air flows through the motor 4, flowing into the casing 6 through the holes 6f in the rear shield 8 and flowing out of the casing 6 through the holes 6f in the front shield 7, under the action of the fan 21 through the air space 15 and the flow deflector 24. The fluid dynamic circuit 22 for the flow F1 is closed outside the hub 13 between the front outlet of the annular duct 20 and the holes 6f in the rear shield 8. Outside the hub 13, the flow F1 mixes with the larger air flow F that has crossed the radiator 3 and moves towards the blades 12.

It is important to note that the function of the blades 12 driven by the hub 13, forming a fan 27 for extracting heat from the radiator 3, is not substantially that of cooling the motor 4 .

In the embodiment illustrated in Figure 2, the ventilation unit 1 is positioned differently relative to the radiator 3. In particular, looking at Figure 2, the radiator 3, the rotary member 11 and the motor 4 are positioned in that order from left to right. In fact, compared to the one illustrated in Figure 1, the ventilation unit 1 is mirrored about a plane at right angles to the axis R, but the rotary member 11 rotates in opposite direction to that described above so that the flow F that extracts heat from the radiator 3 is, in this case too, directed from the radiator 3 towards the ventilation unit 1. As a result, the flow direction F1 in the duct 20 is also reversed. In particular, in the duct 20, the flow F1 comes from the outside of the hub 13 and is directed towards the flow deflector 24.

In use, with reference to Figure 2, the rotation of the member 11 generates at the flow deflector 24 and in the air space 15 a positive pressure that pushes the flow F1 into the motor 4 through the holes 6f in the shield 7, the rear shield in this case.

It should be noticed that, if V is the direction of travel of the vehicle (not illustrated), the direction of the flow F is opposite to the direction V, while the direction of the flow F1 is the same as the direction V in the annular duct 20 and opposite to the direction V in the air space 15.

In other words, the outside air flows through the motor 4, flowing into the casing 6 through the holes 6f in the shield 7 and flowing out of the casing 6 through the holes 6f in the shield 8, under the action of the fan 21 through the flow deflector 24 and the air space 15. The fluid dynamic circuit 22 for the flow F1 is closed outside the hub 13 between the holes 6f in the shield 8 and the rear inlet of the annular duct 20. Outside the hub 13, the flow F1 mixes with the larger air flow F that has crossed the radiator 3 and moves towards the blades 12.

In both the embodiments described above, it is clear that the fan 21 can generate a cooling flow F1 of considerable volume and velocity capable of highly effectively dissipating the heat produced by the electric motor and its built-in electronic components.

This not only enables the range of power ratings of the fan drive motors to be extended but, compared to prior art ventilation units, also allows the ventilation unit according to the invention to operate under conditions of very high ambient temperature.

The invention described above may be modified and adapted in several ways without thereby departing from the scope of the inventive concept, as defined in the claims herein.

Moreover, all the details of the invention may be substituted by technically equivalent elements.

Claims

1. A ventilation unit comprising an open motor (4) equipped with a casing (6) and a drive shaft (5) rotatable about a respective axis of rotation (R), a rotary member (11) comprising a hub (13) for connection to the shaft (5), and a plurality of first blades (12) connected to the hub (13); the motor (4) being at least partially housed in the hub (13) and defining with the latter an air space (15), the unit (1) being characterized in that it comprises means (21, 24) for defining a fluid dynamic circuit (22) for a flow (F1) that cools the motor (4); the circuit (22) at least partly comprising the air gap (15).

2. The unit according to claim 1, characterized in that the means (21, 24) for defining the fluid dynamic circuit (22) comprise means (21) for generating the cooling flow (F1) and at least one flow deflector (24) for channelling the flow (F1) into the air space (15).

3. The unit according to claim 2, characterized in that the flow deflector (24) and the means (21) for generating the cooling flow (F1) are positioned relative to each other in such a way that the cooling flow (F1) is deflected by the whole of the deflector (24).

4. The unit according to claim 2 or 3, characterized in that the means (21) for producing the cooling flow (F1) comprise a plurality of second blades (19) associated with the hub (13).

5. The unit according to any of the claims from 1 to 3, characterized in that the means (21, 24) for defining the fluid dynamic circuit (22) comprise means (21) for generating the cooling flow (F1) embodied by a fan (21); said fan (21) for generating the cooling flow (F1) being built into the hub (13) inside the hub (13) itself and being coaxial with the fan (27) formed by the first blades (12).

6. The unit according to claim 5, characterized in that the fan (21) for producing the cooling flow (F1) is an axial fan (21) comprising a plurality of second blades (19) associated with the hub (13).

7. The unit according to any of the claims from 1 to 6, characterized in that the hub (13) comprises a first tubular element (16) and a second tubular element (17) positioned outside the first tubular element (16); the first and second tubular elements (16, 17) defining an annular duct (20) forming part of the fluid dynamic circuit (22), the air space (15) being formed between the first tubular element (16) and the motor casing (6).

8. The unit according to claim 7, where the means (21, 24) for defining the fluid dynamic circuit (22) comprise means (21) for generating the cooling flow (F1) and at least one flow deflector (24) for channelling the flow (F1) into the air gap (15), characterized in that the flow deflector (24) at least partially faces the annular duct (20) to join the annular duct (20) to the air space (15).

9. The unit according to claim 8, characterized in that the means (21) for producing the cooling flow (F1) are confined within the annular duct (20).

10. The unit according to claim 8 or 9, where the means (21) for producing the cooling flow (F1) comprise a plurality of second blades (19) associated with the hub (13), characterized in that the first tubular element (16), the second tubular element (17) and the second blades (19) form an axial fan (21).

11. The unit according to claim 10, characterized in that the second blades (19) extend radially between the first tubular element (16) and the second tubular element (17).

12. The unit according to any of the claims from 7 to 11, characterized in that the flow deflector (24) comprises a first annular baffle (25) with a substantially curved cross section, associated with the motor (4) and axially facing the air gap (15).

13. The unit according to claim 12, characterized in that the first baffle (25) is formed in the motor (4), in particular on a shield (8) of the motor casing (6).

14. The unit according to claim 13, characterized in that it comprises electronic means (14) for controlling the motor (4) and located in the shield (8).

15. The unit according to any of the claims from 12 to 14, characterized in that the flow deflector (24) comprises at least one second annular baffle (26) with a substantially curved cross section, joined to the first baffle (25) and substantially facing the annular duct (20).

16. The unit according to claim 15, characterized in that it comprises means (9) for mounting the motor (4), the second baffle (26) being formed on the motor (4) mounting means (9).

17. The unit according to claim 4 or 6, characterized in that the second blades (19) extend radially to an extent of between 10% and 20% of the radial size of the first blades (12).

18. The unit according to claim 4 or 6 or 17, characterized in that at least one of the second blades (19) is divided into at least two blade sections (23).

19. The unit according to claim 18, characterized in that the blade sections (23) are axially offset from each other.

20. A rotary member (11) that can be driven by a respective open motor (4) to produce a first air flow (F), said rotary member (11) comprising a hub (13) and a plurality of first blades (12) associated with the hub (13) to generate the first flow (F), the rotary member (11) being characterized in that the hub (13) comprises a first tubular element (16) and a second tubular element (17) positioned outside the first tubular element (16) and a plurality of second blades (19) located between the first tubular element (16) and the second tubular element (17), the first and second tubular elements (16, 17) defining an annular duct (20) forming part of a fluid dynamic circuit (22) for cooling the motor (4).

21. The rotary member according to claim 20, characterized in that the second blades (19) extend radially to an extent of between 10% and 20% of the radial size of the first blades (12) to generate a second motor cooling flow (F1) in the fluid dynamic circuit (22).

22. The rotary member according to claim 20 or 21, characterized in that at least

one of the second blades (19) is divided into at least two blade sections (23).

23. The rotary member according to claim 22, characterized in that the blade sections (23) are axially offset from each other.

FIG.1

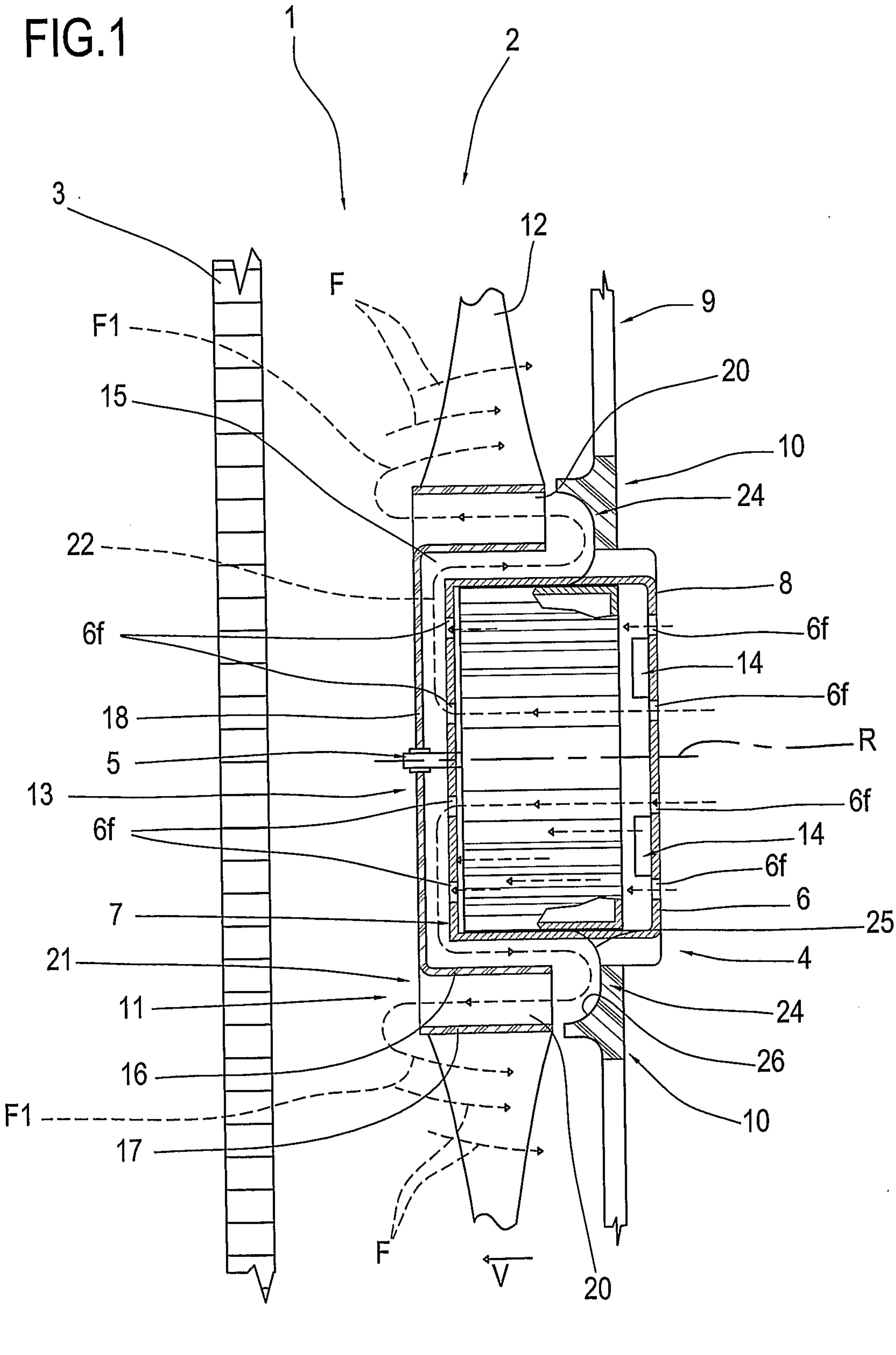
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FIG.2

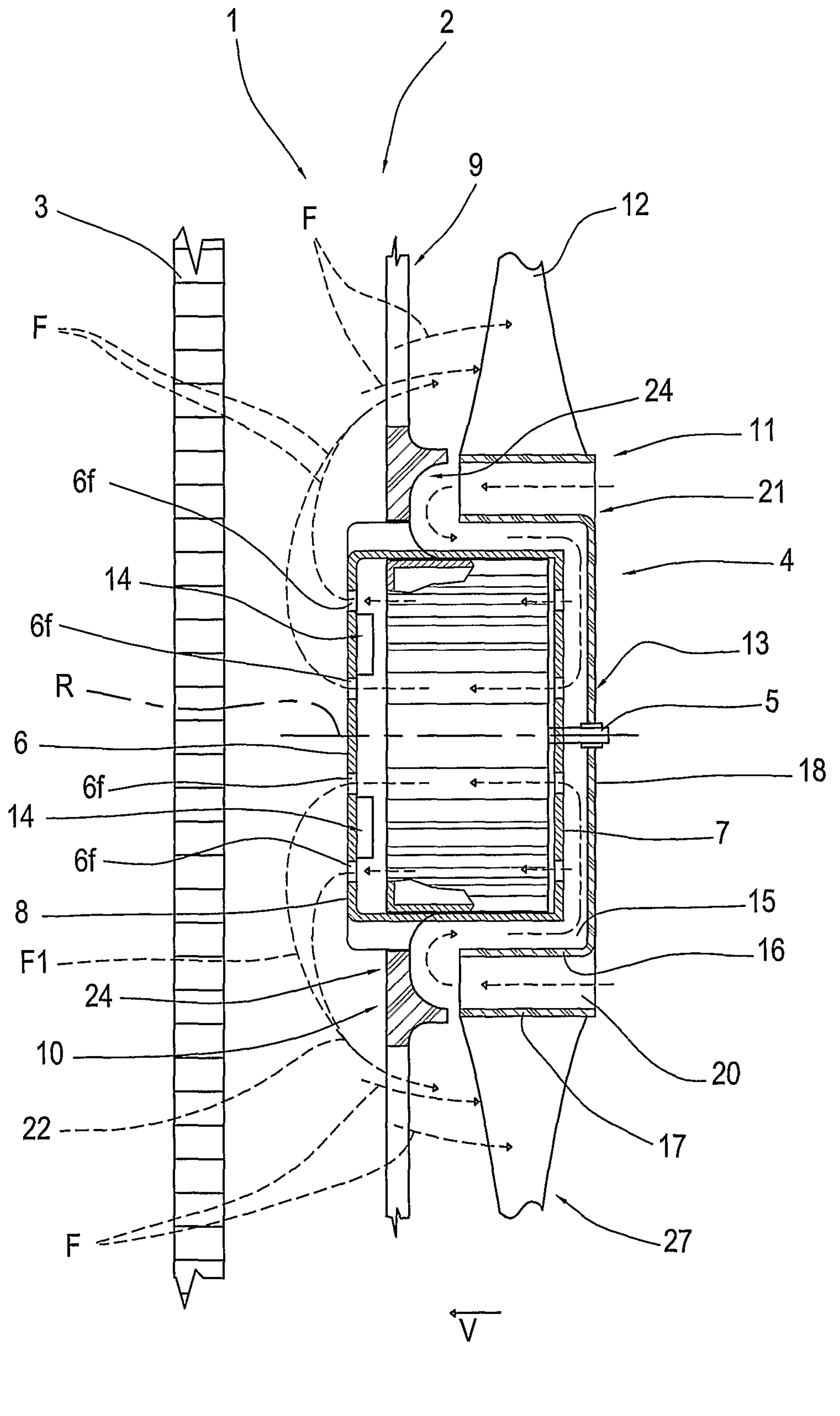
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FIG.3

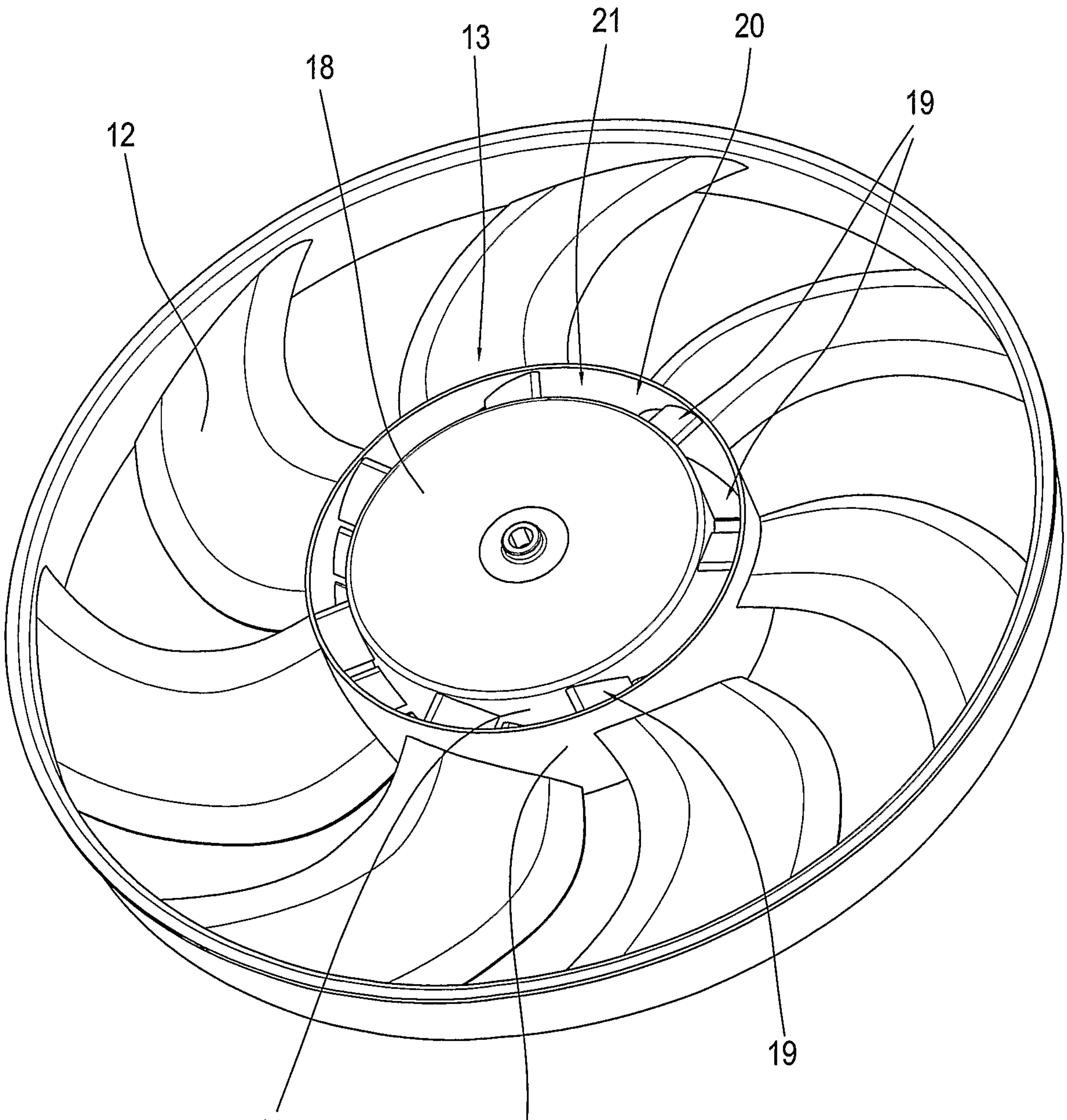

FIG.4

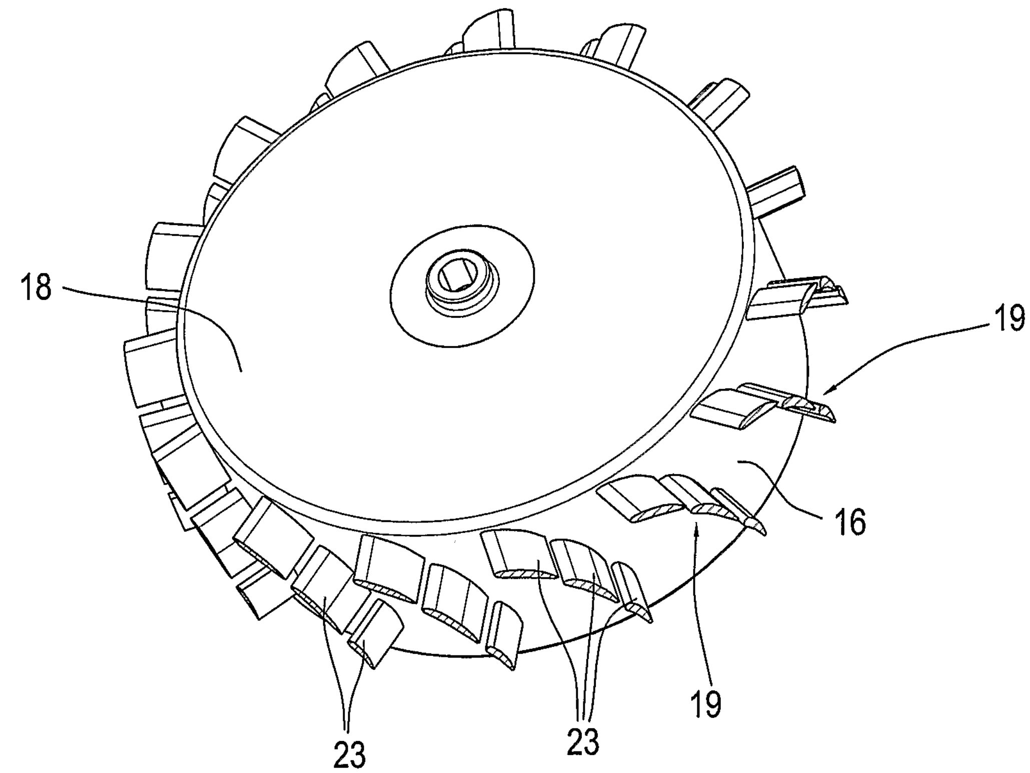

FIG.5