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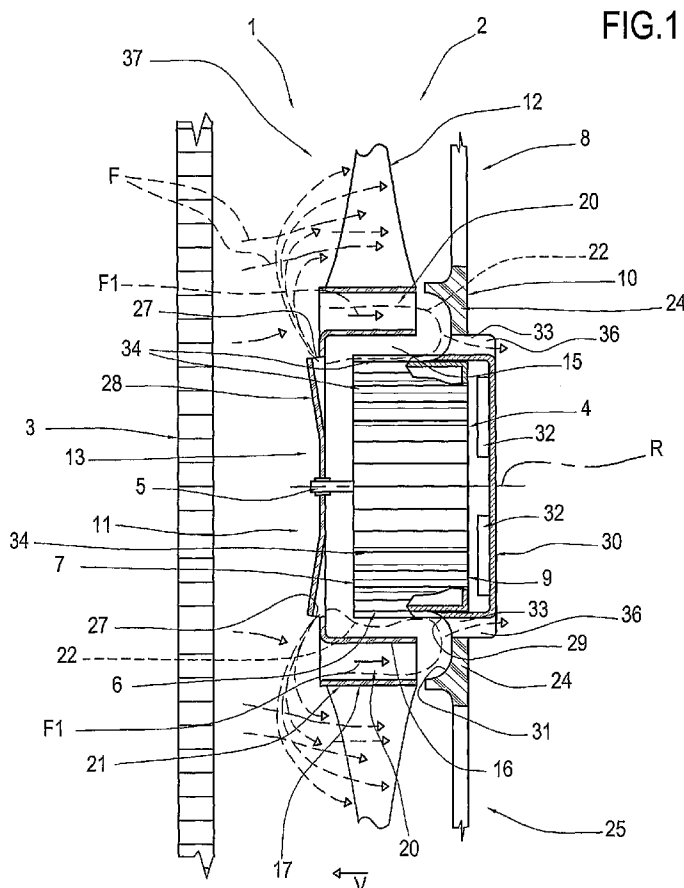
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(54) Title: VENTILATION UNIT



(57) Abstract: A ventilation unit (1) comprise : a rotary member (11) equipped with a hub (13) and a plurality of blades (12) connected to the hub (13), and a closed, or sealed, electric motor (4) housed at least partly in the hub (13) and designated to drive the rotary member (11); between the hub and the motor in the ventilation unit there is an air space forming part of fluid dynamic circuit for a flow (F1) for cooling the motor.

DescriptionVentilation unitTechnical Field

This invention relates to a ventilation unit for cooling systems.

Background Art

5 Prior art ventilators, such as motor ventilators for example, normally comprise a fan connected by its hub to an electric motor that drives the fan itself.

Usually, the motor is at least partly housed in the hub and is suitably positioned and supported by mounting means.

10 This specification relates in particular to ventilation units, such as electric fans, driven by a closed or sealed electric motor.

Sealed motors, by their very nature, do not offer the possibility of accessing with forced air circulation systems the sources of heat generated inside them by the magnetic circuit windings, by built-in electronic control components and any other sources of heat inherent in electric motors in general.

15 Thus, once assembled, a sealed motor affords no opening giving access to the inside of its casing so that all the electrical components housed in the casing are protected against dirt, dust and other airborne particles, making the motor especially suitable for use in very dusty or polluted environments.

One drawback of these motors is due precisely to their sealed structure which makes it difficult to extract the heat they produce during operation.

20 Consequently, sealed electric motors used to drive electric fans are relatively low-powered, in the order of a few hundred watts because of the difficulty of cooling them.

25 The difficulty of dissipating the heat is worsened by the fact that the motor is mounted in the hub, which hinders heat extraction.

These difficulties are made even worse in applications where the electric fan is required to operate in conditions of very high ambient temperature such as, for example, automotive applications for cooling radiators where operating temperatures exceed one hundred degrees Celsius.

Disclosure of the Invention

In this context, the main technical purpose of the present invention is to propose a ventilation unit comprising a sealed electric motor which is free of the above mentioned disadvantages.

5 It is an aim of this invention to provide a ventilation unit capable of dissipating the heat produced by the sealed electric motor that drives it.

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

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

Yet another aim of the invention to provide a ventilation unit capable of dissipating not only the heat produced by the motor but also the heat
15 produced by the electronic control components built in the motor.

The stated technical purpose and aims of the invention are substantially achieved by a ventilation unit as described in claim 1 and in one or more of the claims dependent thereon.

20 This invention also provides a rotary member having the characteristics of claim 21 and one or more of the claims dependent thereon.

Brief Description of the Drawings

Further features and advantages of the present invention are more apparent in the detailed description below, with reference to a preferred,
25 non-limiting, embodiment of a ventilation unit, as illustrated in the accompanying drawings, in which:

- Figure 1 illustrates a first preferred application 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;

30 - Figure 2 illustrates a second preferred application 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 first embodiment of a rotary member for the application illustrated in Figure 1;

35 - 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;

- Figure 6 is a schematic perspective view of a second embodiment of a rotary member for the application illustrated in Figure 2;

- Figure 7 is a schematic perspective view of a detail of the rotary member of Figure 6;

- Figure 8 illustrates the detail of Figure 7 in a schematic perspective view different from that of Figure 6.

Detailed Description of the Preferred Embodiments of the Invention

With reference to the accompanying drawings and in particular with reference to Figures 1 and 2, the numeral 1 denotes 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 of the closed or sealed type, having a casing 6.

The closed or sealed electric motor 4 is of substantially known type and therefore not described in detail.

The motor 4 comprises a drive shaft 5 that rotates about a respective axis of rotation R and projects outwards from a front portion 7 of the motor 4.

The unit 1 comprises means 8 for mounting the unit 1 and associated with the motor 4.

The mounting means 8 are preferably associated with the motor 4 substantially at a rear portion 9 of the casing 6.

In particular, the mounting means 8 comprise an annular member 10 for supporting the motor 4. The annular member 10 surrounds the rear portion 9 of the casing 6 and is fixed to the latter; the member 10 is commonly known as "motor mounting ring".

Looking in more detail, the means 8 for mounting the unit 1 are structured in such a way as to connect the ventilation unit 1 to external mounting structures outside the scope of this invention.

A rotary member 11, illustrated in particular in Figures 3 and 6, is connected to the shaft 5 and is driven by the motor 4.

The rotary member 11 comprises a plurality of blades 12 and a hub 13 for connecting the blades 12 to the drive shaft 5. The blades 12 driven by the motor 4 generate a main air flow F for dissipating heat from the radiator 3.

The blades 12 and the hub 13 define a main fan 37 for dissipating heat from the radiator 3.

The motor 4 is almost entirely housed inside the hub 13, except for the rear portion 9 associated with the mounting means 8.

Between the motor 4 casing 6 and the hub 13 and between the hub 13 and the motor mounting ring 10 there is an air space 15 necessary to allow the rotary member 11 to turn freely.

In Figures 1 and 2 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 element 16 and a second substantially tubular element 17 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 enables the hub 13 to be connected to the drive shaft 5.

The hub 13 comprises a plurality of blades 19, not illustrated in Figures 1 and 2, located between the first tubular element 16 and the second tubular element 17 to produce a flow F1, usually of air, 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.

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.

The blades 19 extend preferably radially between the first tubular element 16 and the second tubular element 17 inside the annular duct 20.

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.

5 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 blades 19 themselves.

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

10 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.

15 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.

20 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.

25 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 other words, the blade sections 23 do not have axially overlapping areas.

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.

30 In practice, the deflector 24 contributes to the formation of the fluid dynamic circuit 22.

In particular, with reference to Figure 1, where the application illustrated comprises, from left to right, the radiator 3, the rotary member 11, the motor 4 and a flow F conveyor 25, the deflector 24 is suitably positioned to channel the flow F1 produced by the blades 19 from the annular duct 20 into the air space 15.

The conveyor 25 is of substantially known type and is described below only insofar as is relevant to this invention.

It should be noticed that, if V is the direction of vehicle travel, the flow F produced by the blades 12 and the flow F1 produced by the blades 19, flow out of the fan 21 in the same direction, which is opposite to the direction V.

With reference to Figure 2, where the application illustrated comprises, from left to right, the radiator 3, the motor 4 and the related conveyor 25 and the rotary member 11, the flow deflector 24 is suitably positioned to channel the flow F1 from the annular duct 20 into the air space 15.

In the preferred embodiments illustrated, the annular duct 20, the air space 15 and the deflector 24 are suitably positioned so that the flow F1 in the circuit 22 is deflected substantially by the whole of the deflector 24.

As shown in Figures 5 and 7, a plurality of openings 26 is provided on the front wall 18 of the hub 13.

The openings 26 are in practice part of the 22 fluid dynamic circuit for the cooling flow.

The openings 26 are preferably made substantially at the air space 15.

With reference to Figure 1, the openings 26 enable the flow F1 to escape from the air space 15.

As shown in Figures 1, 4 and 5, the openings 26 preferably extend radially from the hub 13. In particular, at the openings 26, the front wall 18 is shaped in such a way as to form a substantially radial passage 27 for the openings 26.

For defining the passage 27, the hub 13 comprises a baffle 28 positioned at each of the openings 26 made in the wall 18.

In the operating configuration illustrated in Figure 1, the air flow F1 out of the fan 21 is channelled by the substantially semicircular flow deflector 24 formed in the structures both of the motor 4 and of the conveyor 25.

The deflector 24 turns the flow F1 by approximately 180° (sexagesimal) causing it to enter the air space 15 between the casing 6 and the hub 13.

This operating condition causes the pressure in the air space 15, in particular between the hub 13 and the motor mounting ring 10, to rise compared to the pressure upstream of the main fan 37 relative to the flow F.

The air flow, reversed with respect to the flow produced by the fan 21 and restrained by the cylindrical and preferably smooth inside surface of the hub 13,

moves in helical fashion around the casing 6 and escapes through the front openings 26.

The flow F1 or air escaping through the openings 26 mixes with the larger air flow F that has crossed the radiator 3 and moves towards the blades 12.

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

As shown in particular in Figures 2 and 6, the openings 26 are made in the front wall 18 and are substantially co-planar with the latter.

10 The openings 26 in Figure 2 allow the flow F1 to enter the air space 15.

It should be noticed that in the configuration illustrated in Figure 2, the fan 21, by keeping the flow F1 aligned with and moving in the same direction as the flow F of the main fan 37, causes the air in the air space 15 to circulate in the direction opposite to that shown in Figure 1, that is to say, from the hub 13 towards the rear portion 9 of the motor 4.

15 In practice, the additional fan 21 creates a negative pressure in the air space 15 which produces a "suction effect" that attracts air from the openings 26.

Looking in more detail, it may be observed that the flow deflector 24 is associated with the motor 4 at the rear portion 9 of the casing 6.

Preferably, the deflector 24 is made at least partially in the mounting means 11 of the unit 1.

As illustrated in particular in Figures 1 and 2, the deflector 24 comprises an annular baffle 29 substantially curved in cross section, associated with the motor 4 and axially facing the air space 15.

25 More specifically, the baffle 29 is formed directly in the motor 4 and, in particular, on a rear shield 30 of the motor.

The flow deflector 24 comprises a second baffle 31 having a substantially curved cross section joined to the baffle 29 and substantially facing the annular duct 20, that is to say, the blades 19.

30 The baffle 31 is preferably formed on the annular mounting member 10 of the motor 4.

Preferably the baffle 29 turns the flow F1 by approximately 90° (sexagesimal) and the baffle 31 turns it by a further 90° (sexagesimal) since the annular duct 20 and the air space 15 extend substantially parallel to one another.

It should be noticed that, preferably, the mounting means 8 of the unit 1 comprise the conveyor 25 by which the motor mounting ring 10 is attached to the above mentioned external mounting structures.

5 In practice, with reference to Figure 1, during use, the configuration of the ventilation unit 1 and, in particular, of the rotary member 11 raises the pressure in the air space 15 at the baffles 29, 31 compared to the pressure upstream of the fan 37 relative to the flow F.

10 The flow F1, reversed and channelled by the tubular element 16, moves helically, thanks to its axial and tangential components, around the casing 6 until it reaches the front openings 26.

Preferably, the casing 6 has on its outside surface a plurality of ribs 34 that optimize the cooling effect.

The ribs 34 run preferably lengthways along the casing 6, increasing the heat exchange and improving the cooling effect on the motor 4.

15 In practice, in the ventilation unit 1, the fluid dynamic circuit 22 enables the motor 4 to be cooled by the air flow F1 moving along the surface of the casing 6.

20 The heat exchange by which the casing 6 is cooled is enhanced by the tangential component of the flow F1 which contributes to maximizing the speed of the flow F1 relative to the outside surface of the casing 6, thereby optimizing heat exchange by convection between the casing 6 and the air.

25 The axial component of the air flow F1 is substantially intended to extract from the air space 15 the mass of air channelled in. As the mass of air moves (in the above mentioned helical direction), its temperature increases compared to the temperature at which it entered on account of heat transfer from the casing 6 (thermal capacity effect of the circulating air mass).

The aim is to create a high-speed air flow in the air space 15: the higher the speed of the air, the more heat it dissipates.

30 Since there is a limit to the axial air speed, the tangential component is also used: the flow enters at an angle and moves around the fan 21 with a helical effect.

As is known, the output temperature T_{out} is related to the input temperature T_{in} by the equation:

35
$$T_{out} = T_{in} + P(W) / [1000 * Q (m^3/sec)]$$

where 1000 is the product of the air density by its thermal capacity (both measured at a temperature of approximately 100° Celsius considered as the mean operating temperature for automotive applications).

5 In the preferred embodiment illustrated, the unit 1 comprises electronic means 32 for controlling the motor 4 and preferably housed in the rear motor shield 30.

Advantageously, the baffle 29 has a plurality of openings 33 for the passage of a part of the cooling flow F1 so that the part passing through the
10 openings 33 extracts heat from the rear shield 30 and thus cools the electronic control means 32.

It should be noticed that the openings 33 define or delimit a plurality of fins 36 that optimize heat exchange with the part of the flow F1 that passes through the openings 33 themselves.

15 The fins 36 have a curved profile, in particular in the shape of a quarter circle to contribute to deflection of the air flow F1 from the fan 21.

It is important to note that the function of the blades 12 driven by the hub 13 is not substantially that of cooling the motor 4.

The invention as described brings important advantages.

20 The fluid dynamic circuit makes it possible to extract heat from the motor, thereby cooling it.

This extends the range of power ratings of sealed motors that can be used in applications of this type, in particular in the case of high ambient temperatures such as those reached in automotive engines.

25 The motor cooling flow, suitably channelled, also cools any electronic control components that may be present in the unit.

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.

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

Claims

1. A ventilation unit comprising:
a sealed motor (4) equipped with a drive shaft (5) that rotates 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, in particular, housed at least partially in the hub (13) and forming, together with the latter, an air space (15), the unit being characterized in that it comprises means (24, 26) for defining a fluid dynamic circuit (22) for a motor (4) cooling flow (F1), the circuit (22) comprising the air space (15), and the unit comprising means (21) for producing the cooling flow (F1).
2. The unit according to claim 1, characterized in that the means (24, 26) for defining a fluid dynamic circuit (22) comprise a plurality of openings (26) made in the hub (13), the openings (26) being comprised in the fluid dynamic circuit (22).
3. The unit according to claim 1 or 2, characterized in that the means (24, 26) for defining a fluid dynamic circuit (22) comprise at least one flow deflector (24) aligned at least with the air space (15).
4. The unit according to any of the claims from 1 to 3, characterized in that the means (21, 24, 26) for producing the cooling flow (F1) comprise a plurality of second blades (19) associated with the hub (13).
5. The unit according to claim 4, 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 in particular formed between the first tubular element (16) and the motor casing (6).
6. The unit according to claim 5, characterized in that the second blades (19) are located in the annular duct (20).

7. The unit according to claim 6, characterized in that the second blades (19) extend radially between the first tubular element (16) and the second tubular element (17), the first tubular element (16), the second tubular element (17) and the second blades (19) forming in particular an axial fan (21).

5

8. The unit according to any of the claims from 5 to 7, characterized in that the second blades (19) extend radially between the first and second tubular elements (16, 17) and their radial size is between about 20% and about 10% of the radial size of the first blades (12), said first blades (12) having in particular a radial size of between approximately 20mm and 200 mm.

10

9. The unit according to any of the claims from 4 to 8, characterized in that at least one of the second blades (19) is divided into at least two blade sections (23).

15

10. The unit according to claim 9, characterized in that the blade sections (23) are axially offset from each other.

11. The unit according to claim 2, characterized in that the hub (13) comprises a wall (18) transversal to the rotation axis (R), the openings (26) being made in the wall (18) transversal to the rotation axis (R).

20

12. The unit according to claim 11, characterized in that the openings (26) extend radially from the hub (13).

25

13. The unit according to claim 5, characterized in that the means (24, 26) for defining a fluid dynamic circuit (22) comprise at least one flow deflector (24) at least partially facing the annular duct (20) to join the annular duct (20) to the air space (15).

30

14. The unit according to claim 13, characterized in that the flow deflector (24) comprises at least one annular baffle (29) substantially curved in cross section, associated with the motor (4) and axially facing the air space (15).

35

15. The unit according to claim 13 or 14, characterized in that the flow deflector (24) comprises at least one second baffle (31) substantially curved in cross section

and substantially facing the annular duct (20).

16. The unit according to claims 14 and 15, characterized in that the second baffle (31) is joined to the first baffle (29).

5

17. The unit according to claim 14, characterized in that the first baffle (29) is formed in the motor (4), in particular on a rear shield (30) of the motor (4).

10

18. The unit according to claim 15 or 16, characterized in that it comprises means (8) for mounting the motor (4), the second baffle (31) being formed on the motor (4) mounting means (8).

15

19. The unit according to any of the claims from 1 to 18, characterized in that a rear portion (9) of the motor (4) has a plurality of openings (33) for the passage of the cooling flow (F1), said openings (33) forming part of the fluid dynamic circuit (22).

20

20. The unit according to claims 18 and 19, characterized in that the openings (33) for the passage of the cooling flow (F1) are made in the rear shield (30).

25

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

30

35

22. The rotary member according to claim 21, characterized in that the second blades (19) extend radially between the first and second tubular elements (16, 17) and their radial size is between about 20% and about 10% of the radial size of the first blades (12), said first blades (12) having in particular a radial size of between approximately 20 mm and 200 mm..

23. The rotary member according to claim 21 or 22, characterized in that at least one of the second blades (19) is divided into at least two blade sections (23).

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

25. The rotary member according to any of the claims from 21 to 24, characterized in that the hub (13) has a plurality of openings (26), the openings (26) being comprised in the fluid dynamic circuit (22).

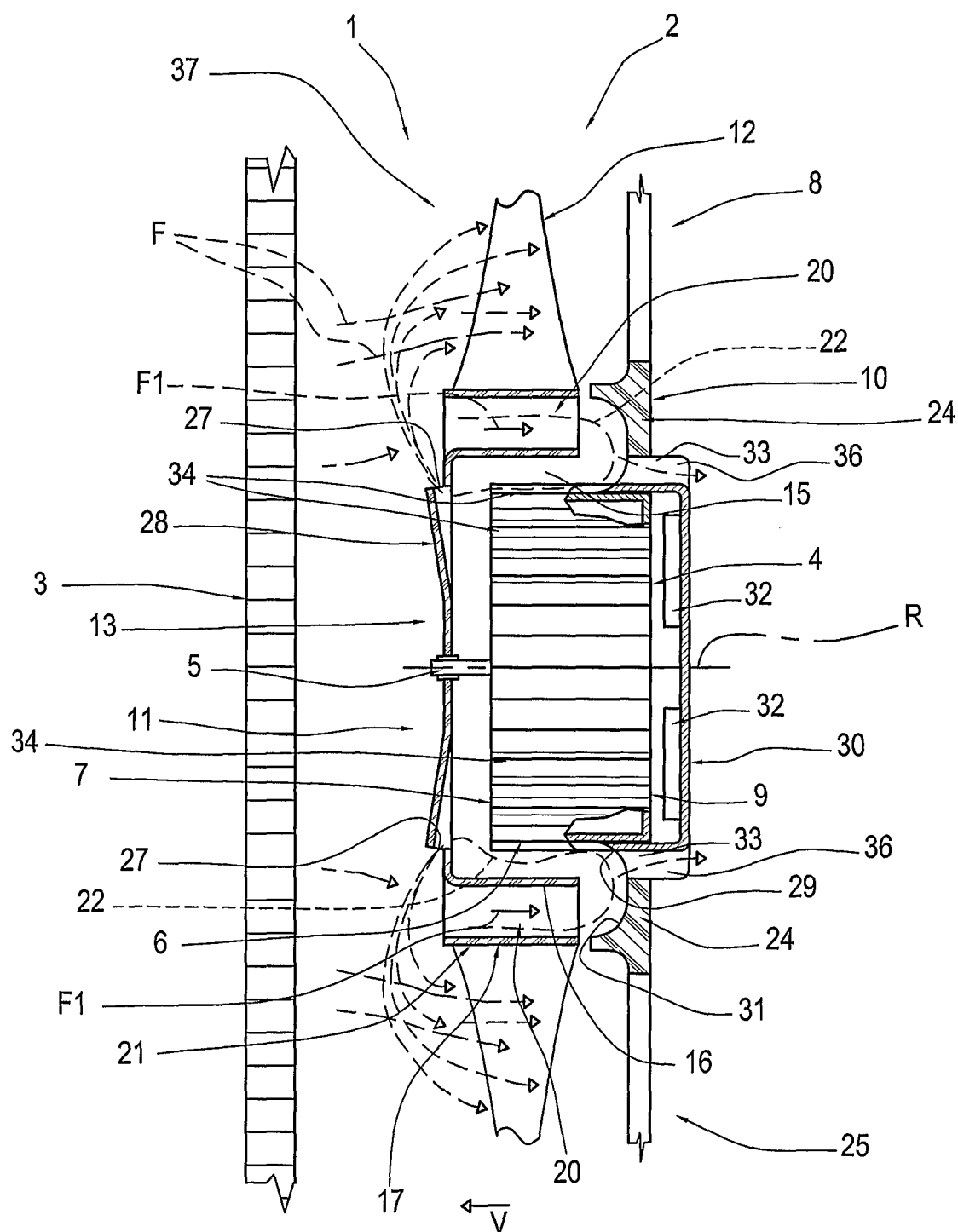
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26. The rotary member according to claim 25, characterized in that the hub (13) comprises a front wall (18), the openings (26) being made in said front wall (18).

15 27. The rotary member according to claim 11, characterized in that the openings (26) extend radially from the hub (13).

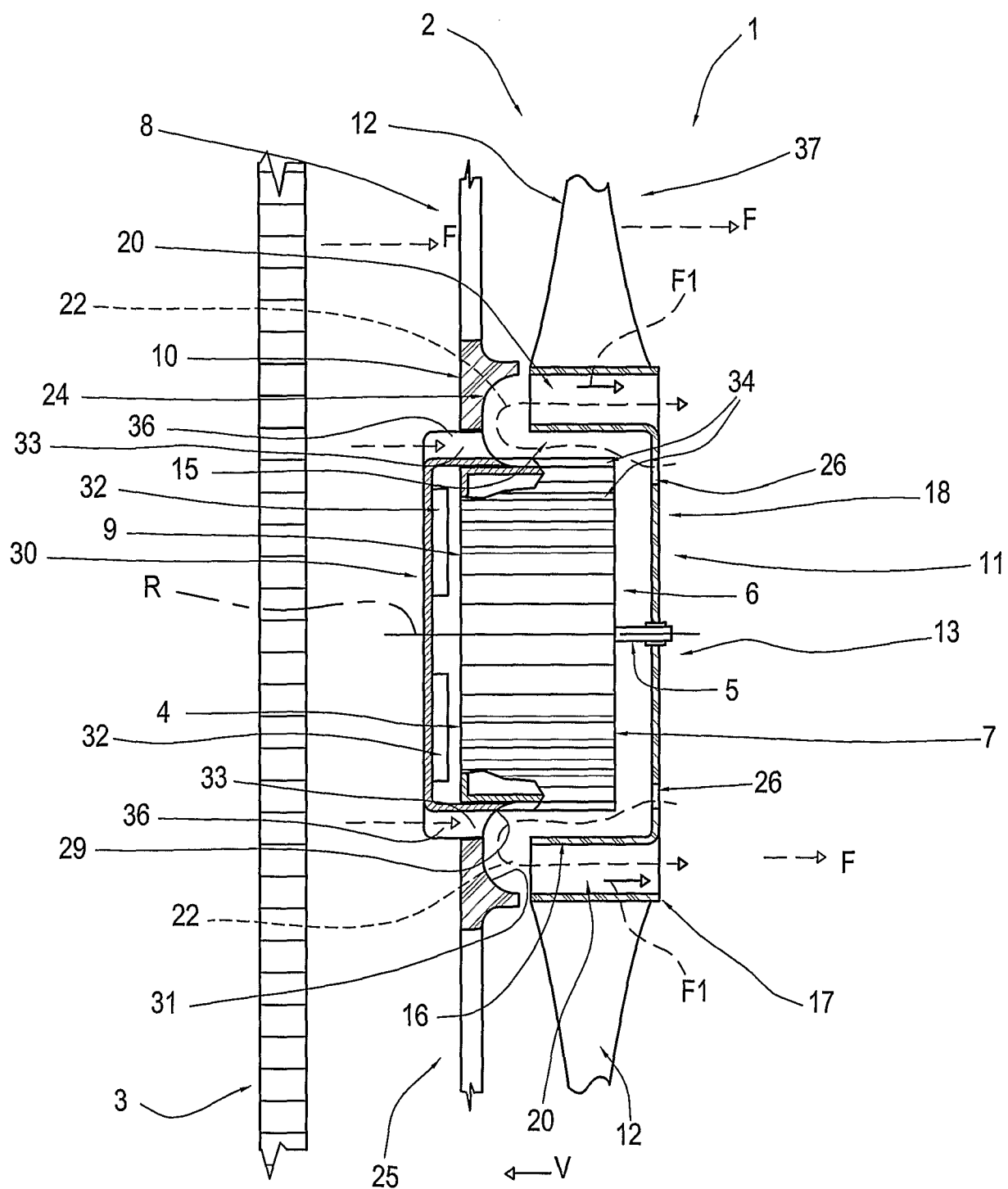
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FIG.1



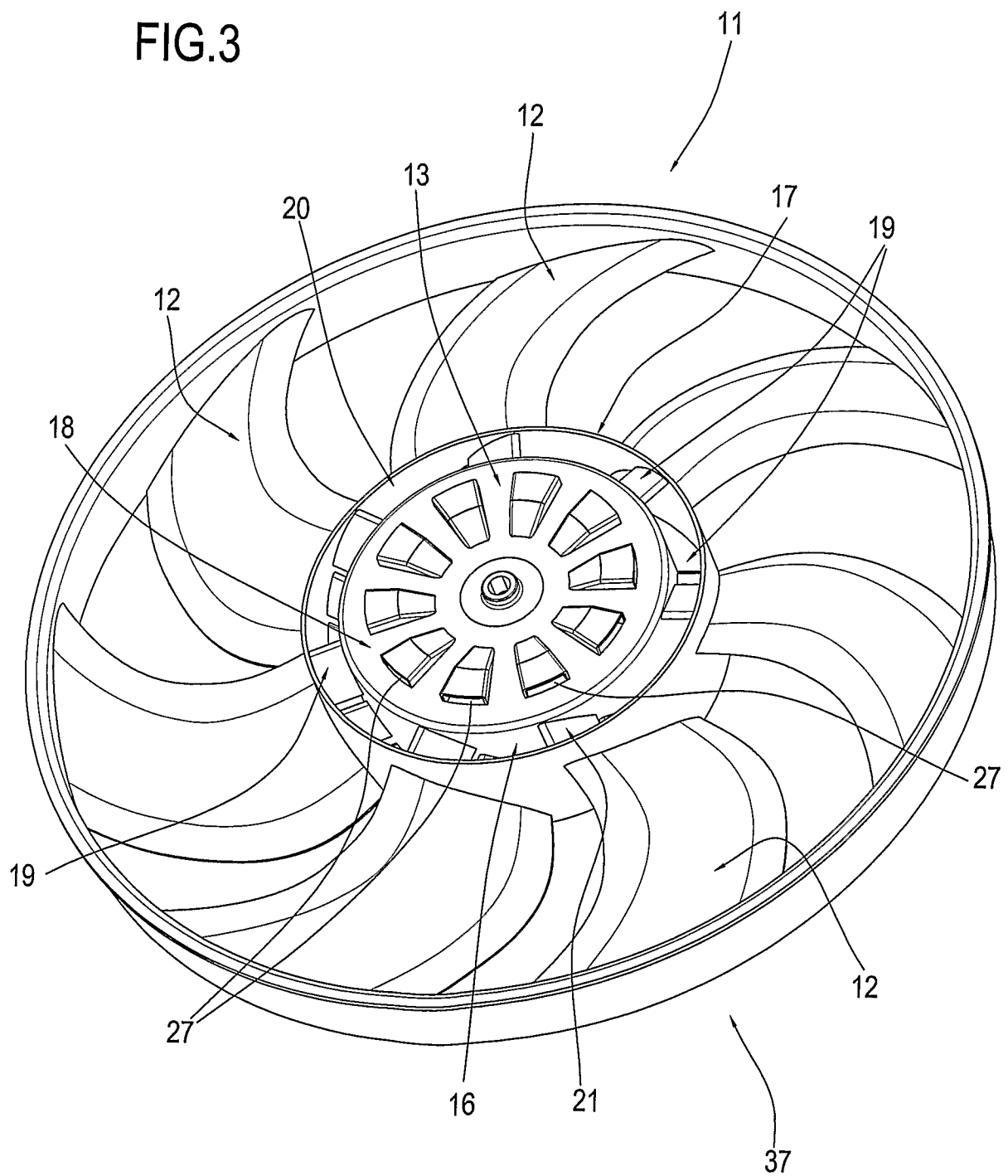
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FIG.2



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FIG.3



4/6

FIG.4

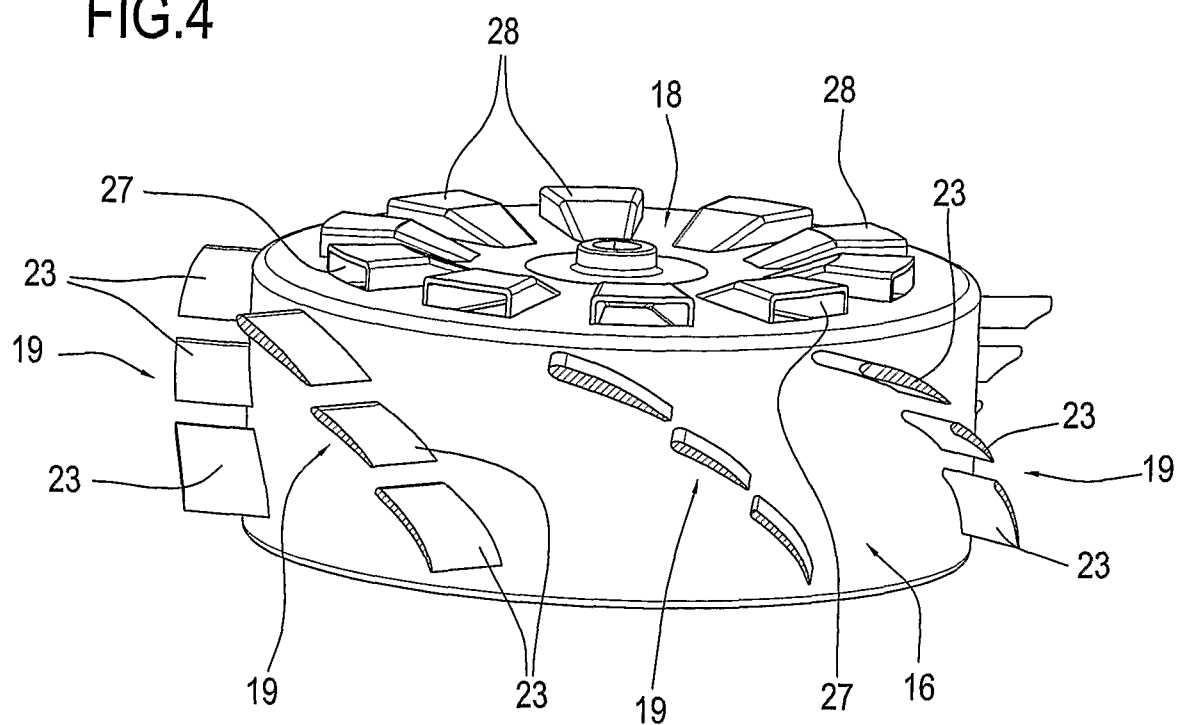
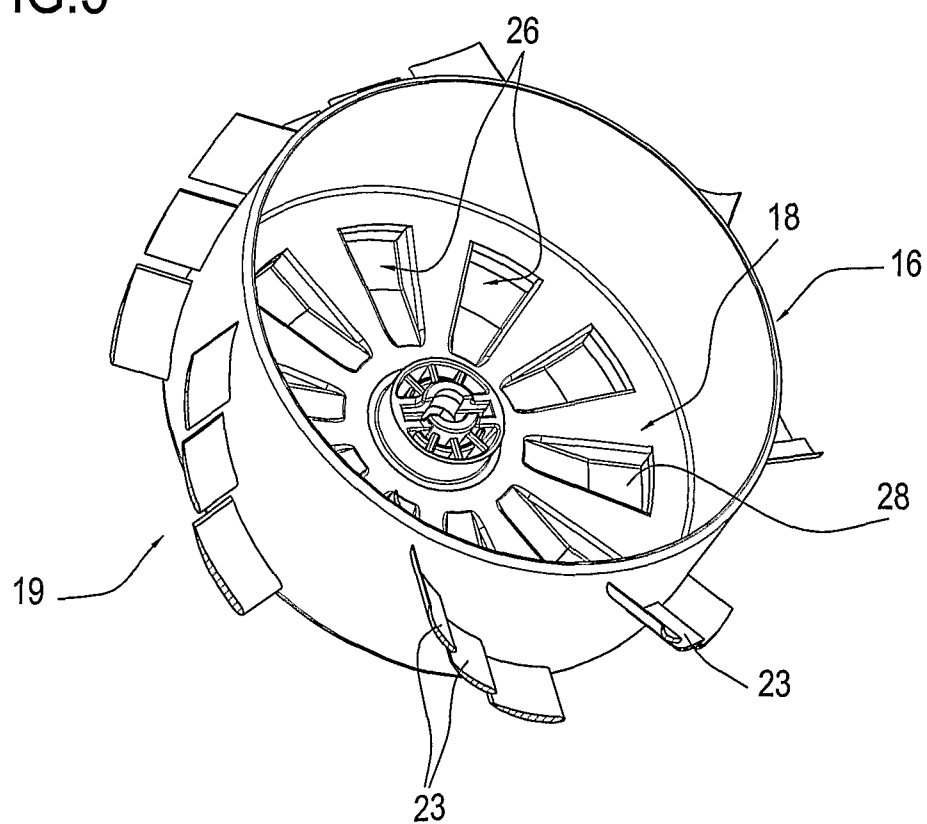
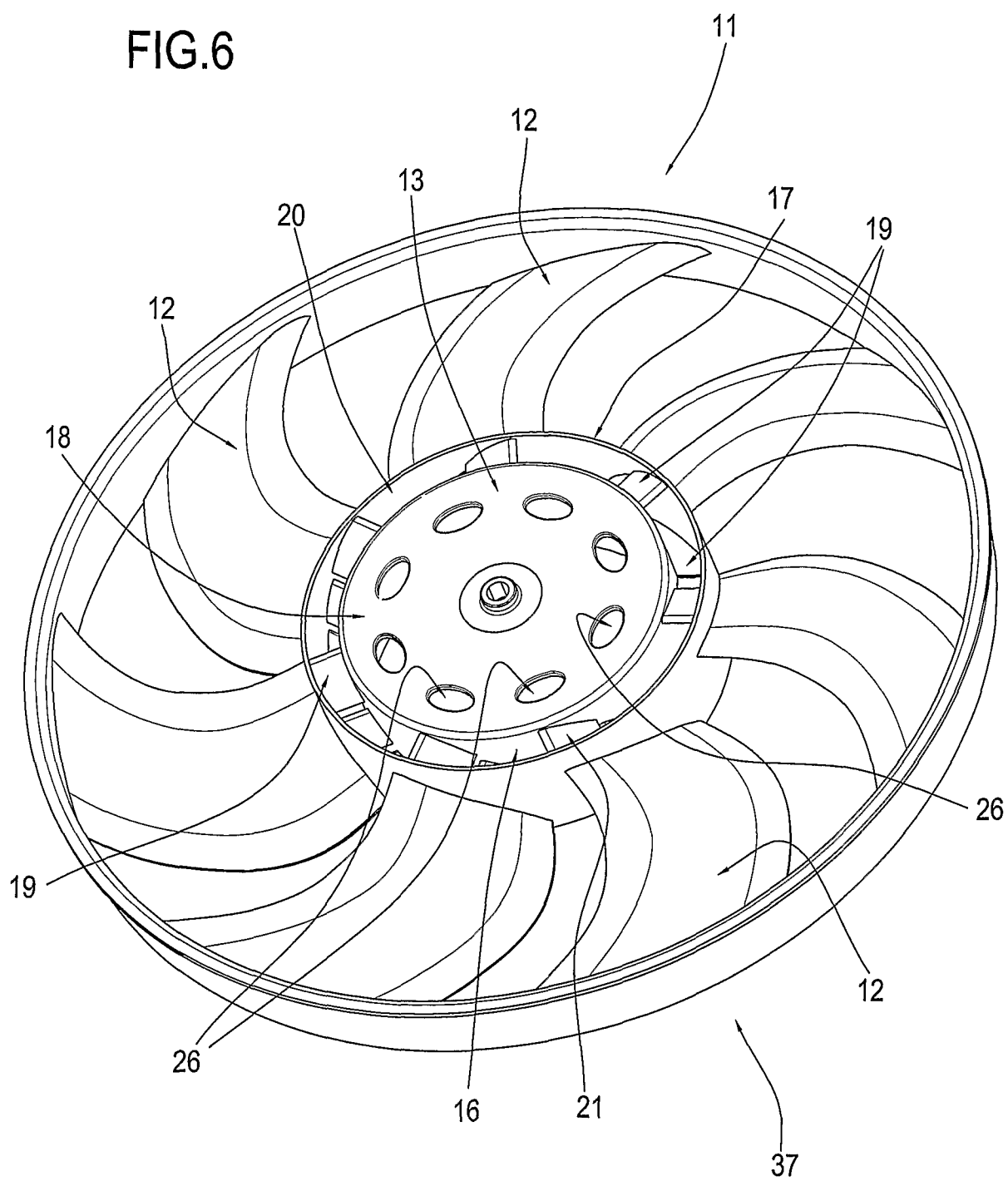


FIG.5



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FIG.6



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FIG.7

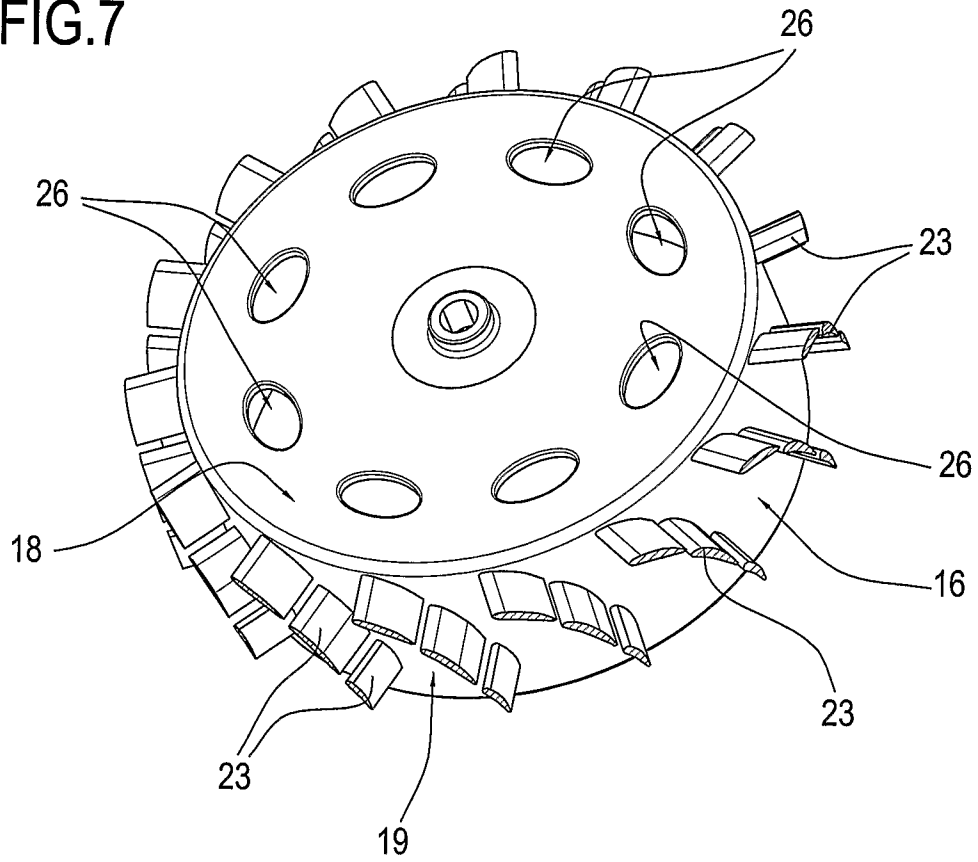


FIG.8

