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Description

[0001] The invention relates to a fan wheel formed as a radial fan wheel or diagonal fan wheel as well as a fan, in which a corresponding fan wheel is installed.

[0002] Generic radial fan wheels are known from the prior art, for example from DE 10 2010 009 566 A1 and EP 2 829 732 A1.

[0003] Such radial fan wheels are preferably used in volume-flow-conducting elements (e.g. air handling units) in the area of ventilating and climate-control systems. According to standard, the characteristic curves of the radial fan wheels are measured in chamber test beds, in which the supplied air can flow off radially outward unimpeded. With such an installation situation, the air flow is then discharged along the chamber wall in the extension of the radial direction of the fan wheel.

[0004] In the application case, however, at least one other outflow situation occurs, in which the flow is diverted from the radial into the axial direction and subsequently discharges along the axis-parallel and not along the radial housing wall of the volume-flow-conducting element. Typically, this flow situation has a negative effect on the efficiency of the fan wheel.

[0005] The object of the invention is therefore to provide a fan wheel as well as a fan which have improved efficiency in the real installation situation.

[0006] These objects are achieved by means of a combination of features according to claims 1 and 11.

[0007] According to the invention, a fan wheel is provided, which is designed as a radial fan wheel or diagonal fan wheel and has a base plate, on which a plurality of fan blades is disposed distributed around an axial axis of rotation, the axial height extension of which fan blades extends between the intake side and the base plate. The base plate has a circumferential radial outer edge portion, which is curved, at least in sections, as seen in cross-section and forms, in this case, a circumferential elliptical transition of the base plate from a radial extension to an axial extension. The axial extension extends parallel to the axis of rotation of the fan wheel on a side of the base plate that is opposite the fan blades.

[0008] The elliptical bow shape of the radial outer edge portion effects a reduction to an elimination of the losses caused by the installation in a volume-flow-conducting element. The efficiency is improved by at least 0.1 as compared with the radial fan wheels known from the prior art. This was confirmed in multiple measurements, as described in more detail in the following.

[0009] The elliptical transition, viewed in cross-section, of the circumferential radial outer edge portion is determined by a longer and a shorter half-axis length. In one design variant of the invention, which is advantageous with respect to efficiency and the

reduction of loss, it is provided that the half-axis length ratio a/b is in a range from 1 - 10, preferably from 2 - 5, wherein “a” corresponds to a half-axis length in the radial direction and “b” corresponds to a half-axis length in the axial direction of the fan wheel.

[0010] The fan blades arranged or formed on the base plate each have a radial outer edge, which forms a transition point on a side having the base plate. An imaginary ring connecting the transition points in the circumferential direction forms a boundary line, to which the elliptical transition of the base plate adjoins directly or at a distance in the radial direction, i.e. the base plate extends beyond the fan blades in the radial direction and, in doing so, forms the elliptical transition. The current can thus flow unimpeded from the fan blades along the base plate in order to then be guided with respect to the further flow direction, in the radial outer region from the elliptical transition.

[0011] In addition to the elliptical transition, the base plate is formed, in one exemplary embodiment, with an axial extension, which subsequently extends in one piece at the elliptical transition in the axial direction and provides more extensive guidance for the air flow.

[0012] According to the invention, it is further provided that the base plate has an axial circumferential step in the central region extending radially outside the axis of rotation. This step is formed as a type of folded edge of the base plate and displaces the parts of the base plate lying in the central region to a parallel axial plane. The step and/or folded edge increases the stiffness of the base plate and of the fan wheel as well. The effect is more pronounced in combination with the elliptical transition. Furthermore, due to the step and/or folded edge in an axial direction away from the fan blades, it is additionally achieved that the rotor of an electric motor to be established in the central region of the base plate does not protrude as far in the direction of the fan blades. In a further development of the invention, a hub is formed on the base plate for this, which hub adjoins the step at the center in the direction of the axis of rotation.

[0013] According to the invention, the axial step and/or folded edge of the base plate, viewed in cross-section, is formed substantially Z-shaped with a web extending partially in the radial and axial direction, i.e. extending at an angle to the axis of rotation. The tilted circumferential web of the base plate, which connects the straight upper and lower legs of the “Z” in this case, extends at an angle α of 20 - 60 degrees to the radial direction of the fan wheel.

[0014] In an advantageous design variant, the step and/or folded edge has an axial height Z corresponding to ± 20% of the half-axis length b of the elliptical transition in the axial direction. The elliptical

[0015] transition, together with the step, hereby especially effectively works to enhance the stiffness of the base plate and of the fan wheel.

[0016] In one embodiment of the invention, it is further provided that the fan wheel has a cover plate, which is opposite the base plate and covers the fan blades on the intake

side, at least in sections, which cover plate forms an inlet opening extending around the axis of rotation in the center. The fan blades in this case are not completely covered by the cover plate along the upper edges thereof pointing toward the intake side; rather, they each have, in one exemplary embodiment, an edge section pointing to the intake side, which edge section extends separately from the cover plate in order to improve the guided current.

[0017] The cover plate and the base plate have essentially the same outer diameter. In this case, as a potential variant of the invention, it is provided that an imaginary envelope curve around the fan blades in the circumferential direction extends at an inclined angle (β) of 60 - 80 degrees with respect to a radial extension of the base plate, i.e. in a side section, the fan blades extend at an angle to an axial plane of the fan wheel and pointing in the direction of the axis of rotation of the base plate.

[0018] In addition, a size ratio of the base plate has been determined to be additionally effective in which the ratio d/h, i.e. of the outer diameter d of the base plate to the total axial height h thereof, is specified in a range of 20 - 25. Furthermore, in an advantageous embodiment, the ratio d/a between the outer diameter d of the base plate and the half-axis length a of the elliptical transition is specified in a range of 10 - 15, preferably 11 - 12, and the ratio d/b between the outer diameter d of the base plate and the half-axis length b of the elliptical transition is specified in a range of 28 - 38, preferably 30 - 34. In an advantageous embodiment, the inlet opening determined by the cover plate has a diameter sd, which has a value sd/b in a range from 15 - 25, particularly 18 - 21, in a ratio to the half-axis length b of the elliptical transition, and a value sd/a in a range from 5 - 8, particularly 6 - 7, in a ratio to the half-axis length a of the elliptical transition.

[0019] The invention further comprises a fan with a fan wheel, as described above, which is arranged in a volume-flow-conducting component having a preferably square flow cross-section with an edge length G. In order to obtain an especially advantageous flow situation with current diverted from the radial into the axial direction by the fan wheel, the ratio between the edge length G and an outer diameter D of the fan wheel is specified in a range from 1.1 - 3.0, preferably from 1.5 - 2.5.

[0020] All disclosed features of the fan wheel can be combined as desired, provided this is technically feasible.

[0021] Advantageous further embodiments of the invention are characterized in the dependent claims and/or are shown in more detail in the following by means of the figures, along with the description of the preferred embodiment of the invention. The following is shown:
Fig. 1 a side sectional view of a fan wheel;
Fig. 2 a schematic representation of a fan in a volume-flow-conducting element;
Fig. 3 a representation of the current in a volume-flow-conducting element;
Fig. 4 a representation of the current in a chamber test bed.

[0022] Figure 1 shows a side sectional view of a radial fan wheel 1 with a base plate 2 and a cover plate 13, provided on the intake side 4 and forming an air-inlet opening 14, between which a plurality of fan blades 3 arranged distributed around the axial axis of rotation are provided. The fan blades 3 extend on the base plate 2 from a central region 10' radially and partially diagonally outward and form a radial air-exit region on the radial outer edge 8 of the fan blades. In this case, the fan blades 3 are each shaped in a curve such that they extend in a bow shape, when viewed from above, and have an upper edge section 15 exposed by the cover plate 13 in a region pointing to the axial center. The radial outer edges 8 of the fan blades 3 each end at a transition point 9 on the base plate 2. In the embodiment shown, the axial-tilted extension of the outer edges 8 of the fan blades 3 occurs from the base plate 2 to the cover plate 13 at an angle β of about 70 degrees, wherein the fan blades 3 with the cover plate 13 form an essentially even radially external edge. When the transition points 9 are connected to a ring, an imaginary boundary line forms, to which the elliptical transition 6 of the base plate 2 adjoins directly or at a close distance in the radial direction, in the embodiment shown. The starting point of the elliptical transition 6 in the radial direction in this case is defined as the start of the curvature of the base plate 2 in the axial direction.

[0023] The base plate 2 has a circumferential radial outer edge portion 5, which extends in the shape of a bow viewed in the lateral cross-section shown and, in doing so, forms the elliptical transition 6 of the base plate 2 from its radial extension outward in an axial extension on a side opposite the fan blades 3. The elliptical transition 6 is determined by the half-axis lengths a and b, the ratio a/b of which assumes a value of about 3.0 in the embodiment shown. As soon as the extension of the base plate 2 is parallel to the axis of rotation, the elliptical transition 6 is considered to be complete. Following this, the axial extension 7 is formed as one piece in the axial direction.

[0024] Around the axis of rotation of the base plate 2, a central opening 19, at the radially external edge of which the hub 17 is formed, is provided in a center 10 around the axis of rotation. In a central region 10' extending around its center 10, the base plate 2 has an axial, substantially Z-shaped step 11, wherein the tilted circumferential web 12 of the "Z" extending partially in the radial and partially in the axial direction extends at an angle α of about 40 degrees to the radial direction of the fan wheel 1, i.e. in a plane parallel to the base plate 2. In the embodiment shown, the step 11 has an axial height Z, which is about 15% greater than the half-axis length b of the elliptical transition 6 in the axial direction. The ratio d/h between the outer diameter d of the base plate 2 and the total axial height h thereof is specified at a value of about 23 in the embodiment shown.

[0025] Figure 2 shows a schematic representation of a fan 20 with a fan wheel 1 in an installed state central to the axis of a volume-flow-conducting element 21. In the embodiment shown, the volume-flow-conducting element 21 has a square cross-section with an edge length G, which is greater than the outer diameter D of the fan wheel 1 by a factor of 1.3.

[0026] The configuration shown in Figure 2 corresponds to a real installation situation of the fan 20 as well as of the fan wheel 1. In this case, a current 16 is generated with a profile as is shown in Figure 3. After the intake through the intake opening 14, the air is initially blown out radially from the fan wheel 1. Subsequently, the substantial portion of the current 16 is discharged in the axial direction along the inner wall of the volume-flow-conducting element 21 and, in doing so, has executed a directional change from radial to axial. The current 26 achieved in the chamber test beds is discharged along a wall 31 continued in the radial direction of the fan wheel 1, as shown by example in Figure 4. There is no diversion in this case.

[0027] The invention is not limited in its design to the aforementioned preferred exemplary embodiments. Rather, a number of variants is conceivable, which would make use of the solution shown even with essentially different designs. For example, the axial extension 7 may also be formed tilted or curved. In addition, a change in the material thickness of the base plate may also be provided, for example with a tapering in the direction of the axial extension. The scope of the invention is defined solely by the claims.

Patentkrav

1. Ventilatorhjul, der er udført som et radialt ventilatorhjul eller et diagonalt ventilatorhjul, med en bundplade (2) og en flerhed af ventilatorvinger (3), der er placeret på bundpladen (2) og fordelt omkring en aksial rotationsakse, hvor den aksiale højdeudstrækning af ventilatorvingerne strækker sig mellem en indsugningsside (4) og bundpladen (2), hvor bundpladen (2) har et perifert radialt ydre kantparti (5), der er krummet i det mindste i snit som set i tværsnit og derved danner en elliptisk overgang (6) af bundpladen (2) fra en radial udstrækning til en aksial udstrækning, idet hver af ventilatorvingerne (3) har en radial ydre kant (8), som danner et overgangspunkt (9) på en side med bundpladen (2), og en tænkt ring, der forbinder overgangspunkterne (9) i omkredsretningen, danner en afgrænsningslinje, hvortil den elliptiske overgang (6) af bundpladen (2) støder op direkte eller i en afstand i radial retning, hvor bundpladen (2) i et centralt område (10') placeret radialt uden for rotationsaksen har et aksialt trin (11), der strækker sig i aksial retning væk fra ventilatorvingerne (3), som, set i tværsnit, i det væsentlige er udført i en Z-form med en bjælke (12), der strækker sig delvist i radial og aksial retning og strækker sig i en vinkel (α) på 20-60 grader i forhold til ventilatorhjulets radiale retning.

2. Ventilatorhjul ifølge krav 1, **kendetegnet ved**, at den elliptiske overgang (6) i det perifere radiale ydre kantparti (5) af bundpladen (2) har et halvakselængdeforhold (a)/(b) inden for et område fra 1-10, især fra 2-5, hvor (a) svarer til en halvakselængde i den radiale retning og (b) svarer til en halvakselængde i den aksiale retning af ventilatorhjulet (1).

3. Ventilatorhjul ifølge krav 1 eller 2, **kendetegnet ved**, at en aksial udstrækning (7) er udført i ét stykke ved den elliptiske overgang (6) i aksial retning.

4. Ventilatorhjul ifølge krav 1, **kendetegnet ved**, at et nav (17) er udført på bundpladen (2), hvilket nav støder op til trinnet (11) i radial retning.

5. Ventilatorhjul ifølge krav 1 eller 4, **kendetegnet ved**, at trinnet (11) har en aksial højde (Z) svarende til ±20 % af halvakselængden (b) af den elliptiske overgang (6) i aksial retning.

6. Ventilatorhjul ifølge mindst ét af de foregående krav, **kendetegnet ved**, at det har en dækplade (13), der er modsat bundpladen (2) og dækker ventilatorvingerne (3) på indsugningssiden (4) i det mindste i snit og danner en indløbsåbning (14), der strækker sig omkring rotationsaksen.

7. Ventilatorhjul ifølge det foregående krav, **kendetegnet ved**, at hver af ventilatorvingerne (3) har et kantparti (15), der peger mod indsugningssiden (4) og kører særskilt fra dækpladen (13).

8. Ventilatorhjul ifølge mindst ét af de foregående krav, **kendetegnet ved**, at en tænkt indhyllingskurve omkring ventilatorvingerne (3) i perifer retning strækker sig med en skrå vinkel (ß) på 60-80 grader i forhold til en radial forlængelse af bundpladen (2).

9. Ventilatorhjul ifølge mindst ét af de foregående krav, **kendetegnet ved**, at et forhold (d)/(h) mellem en ydre diameter (d) af bundpladen (2) og en aksial samlet højde (h) af bundpladen (2) er fastsat i et område på 20-25.

10. Ventilatorhjul ifølge mindst ét af de foregående krav, **kendetegnet ved**, at et forhold (d)/(a) mellem den ydre diameter (d) af bundpladen (2) og halvakselængden (a) af den elliptiske overgang (6) er fastsat i et område på 10-15, især 11-12.

11. Ventilator med et ventilatorhjul ifølge mindst ét af de foregående krav, hvor ventilatoren (20) er placeret i en volumenstrømningsledende komponent (21) med et firkantet strømningstværsnit med en kantlængde (G), og et forhold mellem kantlængden (G) og en udvendig diameter (D) af ventilatorhjulet er fastsat i et område på 1,1-3,0, især 1,5-2,5.

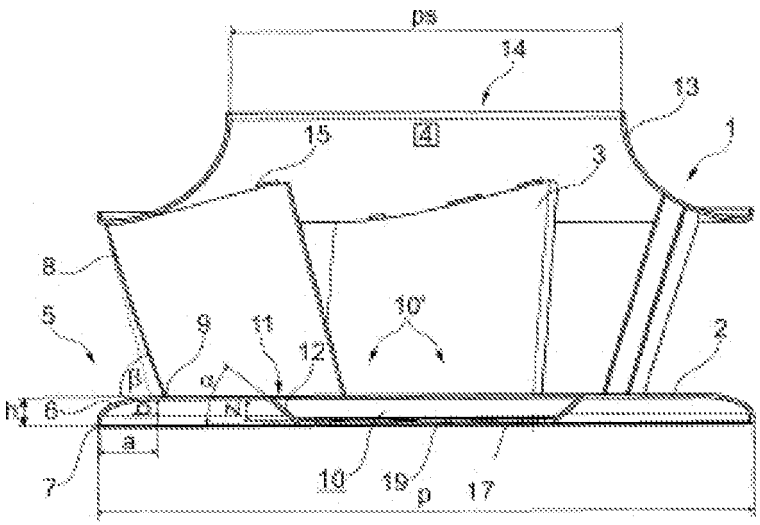

Fig. 1

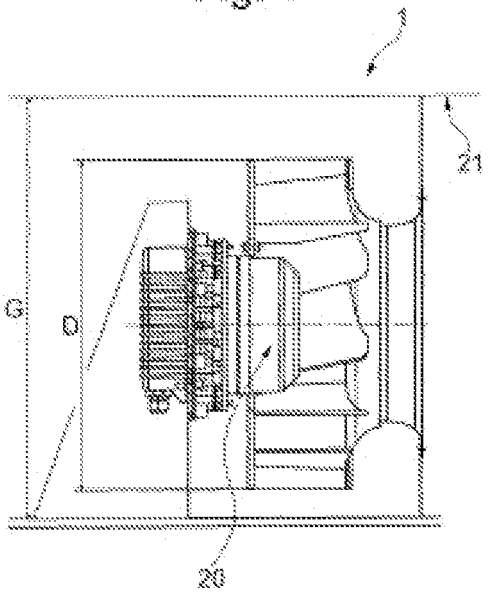

Fig. 2

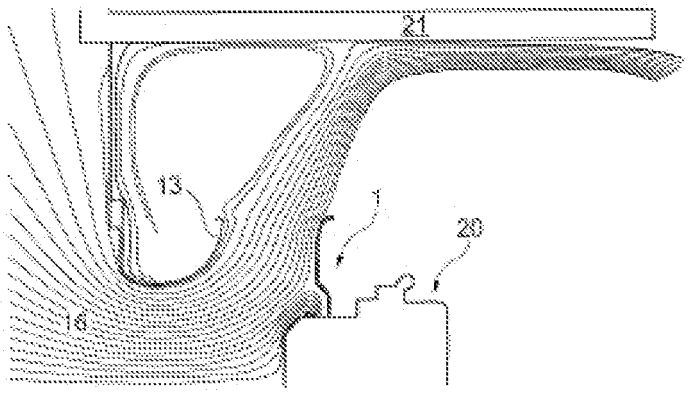

Fig. 3

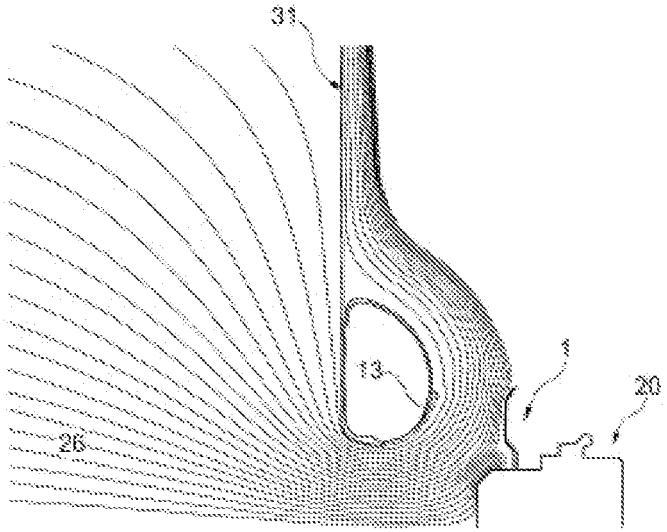

Fig. 4