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"Fan diffuser having a circular inlet and a
5 rotationally asymmetrical outlet"

The invention relates to a diffuser for a fan of axial,
radial or diagonal type of construction. The invention
also relates to an outer diffuser part or an inner
10 diffuser part for a diffuser and to a fan arrangement
which comprises a fan and a diffuser of said type.

The principle of a diffuser and also the use thereof
downstream of a turbomachine have been known for
15 decades. Diffusers are utilized in technical terms to
convert kinetic energy into pressure energy. For this
purpose, the flow must be decelerated. This is
generally achieved by means of a continuous or
discontinuous increase in size of the flow cross
20 section, which may be realized geometrically in a
variety of ways. In fan engineering, diffusers may be
used to slow gas flows and increase the gas pressure.
Here, in principle, a diffuser constitutes the inverse
of a nozzle in that, by contrast to the nozzle, the
25 cross section of the outlet opening is larger than the
cross section of the inlet opening, and the cross

section of the diffuser interior increases from the cross section of the inlet opening to the cross section of the outlet opening. This applies to gas flows at ultrasonic speeds.

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The advantageousness of the use of a diffuser downstream of an axial, diagonal or radial fan is based on the fact that, in general, in all fan construction types, the losses that arise as a result of dissipation of the emerging volume flow are dominant in relation to other loss sources. A part of the flow energy of the emerging jet can, by means of the diffuser, be converted back into static pressure, wherein the increase of the static pressure effects an increase in efficiency. Furthermore, the rotational speed can be reduced for the same air throughput, which entails a reduction in noise.

A diffuser of the type mentioned in the introduction is known for example from EP 0 581 978 A1. Said document relates to a multi-zone diffuser for an axial-throughflow turbomachine, in which bend angles of the diffuser inlet - both at a hub and also at a cylinder of the turbomachine - are defined, exclusively for the purpose of homogenization of a total pressure profile, by means of the duct height at the outlet of the final blade row. Here, within a deceleration zone of the diffuser, means for eliminating the swirl of the swirling flow are provided in the form of flow ribs, and flow-guiding guide rings divide the diffuser into multiple ducts. In order, with a predefined diffuser area ratio, which is to be understood to mean the ratio of the flow cross sections at the outlet relative to the inlet of the diffuser, and with as small a diameter of the first diffusion zone as possible and with as great a pressure recovery as physically possible and with a swirl-free outflow, to keep the overall length of the diffuser at a minimum, different special

embodiments of the first and second diffusion zones are provided for the diffuser, but these require a relatively high outlay in terms of manufacture.

- 5 In the case of the embodiment described in EP 0 581 978 A1 as being preferable, the known diffuser is situated in an exhaust-gas housing of a gas turbine, which exhaust-gas housing is designed such that it does not come into contact with the exhaust-gas flow. The actual
10 flow guidance is performed by the diffuser which, in its first zone, is designed as an insert part for the exhaust-gas housing. For this purpose, an outer delimiting wall and an inner delimiting wall of the diffuser are held by means of flow ribs. The outer
15 delimiting wall, which delimits the cross section of the diffuser interior to the outside, forms an outer housing of the diffuser, and the inner delimiting wall, which delimits the cross section of the diffuser interior to the inside, forms an inner housing. The
20 diffuser can thus be considered as being composed of an outer diffuser part, which delimits the flow space to the outside, and an inner diffuser part, which delimits the flow space to the inside.
- 25 It is desirable, therefore, to provide a diffuser, an outer diffuser part and/or an inner diffuser part for a diffuser and a fan arrangement of known type such that improvements in the operating behavior of an axial, diagonal or radial fan with regard to efficiency and
30 noise can be attained with little outlay in terms of construction.

Such an advantage may be able to be achieved, according to embodiments of the invention described herein, in
35 that, along the main flow direction, the cross section of the outer diffuser part changes from a circular cross section at the inlet opening to a non-circular cross section at the outlet opening. Alternatively, in the case of a generic diffuser in which, in addition,

an inner diffuser part is arranged concentrically with respect to the outer diffuser part in a known way, and which has a housing which, as an inner housing, delimits the diffuser interior to the inside, such an advantage may be able to be achieved by providing an inner diffuser part having, in at least one section perpendicular to the main flow direction, a non-circular cross section about the axis of rotation of the fan.

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In accordance with a first aspect of the invention, there is provided a fan arrangement comprising a diffuser and a fan of axial, radial or diagonal type of construction, wherein the diffuser is fastened to at least one static part of the fan by fastening means or by means of frictionally locking or positively locking connections, or the static part and the diffuser are formed as a single component, wherein the diffuser comprises an inlet opening and an outlet opening for a gaseous medium which flows through a diffuser interior, which is enclosed by an outer housing, in an axially oriented main flow direction from the inlet opening to the outlet opening, wherein the diffuser is located downstream the fan with regard to the main flow direction, wherein for conversion of dynamic pressure into static pressure the cross section of the outlet opening is larger than the cross section of the inlet opening, and the cross section of the diffuser interior increases from the cross section of the inlet opening to the cross section of the outlet opening, wherein the outer housing forms an outer diffuser part which delimits the diffuser interior to the outside, wherein along the main flow direction, the cross section of the outer diffuser part changes from a circular cross section at the inlet opening to a non-circular cross section at the outlet opening, characterized in that concentrically with respect to the outer diffuser part,

there is arranged an inner diffuser part which, with an inner housing, delimits the diffuser interior to the inside, wherein the inner diffuser part has, in at least one section perpendicular to the main flow direction, a non-circular cross section about the longitudinal axis of the inner diffuser part.

In accordance with a second aspect of the invention, there is provided a fan arrangement comprising a diffuser and a fan of axial, radial or diagonal type of construction, wherein the diffuser is fastened to at least one static part of the fan by fastening means or by means of frictionally locking or positively locking connections, or the static part and the diffuser are formed as a single component, wherein the diffuser comprises an inlet opening and an outlet opening for a gaseous medium which flows through a diffuser interior, which is enclosed by an outer housing, in an axially oriented main flow direction from the inlet opening to the outlet opening, wherein the diffuser is located downstream the fan with regard to the main flow direction, wherein for conversion of dynamic pressure into static pressure the cross section of the outlet opening is larger than the cross section of the inlet opening, and the cross section of the diffuser interior increases from the cross section of the inlet opening to the cross section of the outlet opening, wherein the outer housing forms an outer diffuser part which delimits the diffuser interior to the outside, characterized in that, concentrically with respect to the outer diffuser part, there is arranged an inner diffuser part which, with an inner housing, delimits the diffuser interior to the inside, wherein the outer diffuser part and/or the inner diffuser part are/is designed such that the cross section of the diffuser interior is non-rotationally symmetrical at at least one point.

Therefore, in accordance with present teachings there may on the one hand be provided an outer diffuser part for a fan of axial, radial or diagonal type of construction, which outer diffuser part changes, substantially along the main flow direction, from a circular to a non-circular cross section, wherein an inner diffuser part of arbitrary design is provided. On the other hand, there may also be provided in the diffuser an inner diffuser part which, in at least one section, has a non-circular cross section about the axis of rotation of the fan, wherein an outer diffuser part of arbitrary design is provided. The non-circular cross section may be in particular one which is of polygonal, in particular square, basic shape. Here, the invention encompasses the corresponding design of the outer diffuser part and/or of the inner diffuser part.

As in the case of known diffusers positioned downstream of a fan, a diffuser according to the invention effects a pressure conversion from dynamic pressure into static pressure. Here, the speed of the fluid is reduced and homogenized. Whereas a known diffuser designed so as to be fully rotationally symmetrical with respect to the axis of rotation of the fan converts the speed predominantly in an axial direction - that is to say the axial component of the speed vector - into static pressure, and with assumed swirl constancy reduces the

circumferential component of the speed only to the extent by which the diameter increases, a diffuser according to the invention additionally converts a part of the circumferential speed of the gas into static pressure, because the non-rotationally symmetrical geometry impedes a movement in a circumferential direction. As a result, the diffuser efficiency advantageously increases.

10 A diffuser having a not completely rotationally symmetrical flow cross section as a result of the design of its outer diffuser part and/or inner diffuser part, may also offer a further advantage. The maximum installation space available for a diffuser is, in
15 terminal equipment, normally prismatic, and a maximum width, a maximum height and a maximum length are defined by the product. Under these conditions, as a result of the corners present for example in the case of a polygonal, in particular square, cross section, it
20 is possible with a diffuser according to the invention to utilize a larger surface area normal to the axis of rotation of the fan, and thus permit a greater reconversion of the axial speed, by comparison with a completely rotationally symmetrical diffuser. This,
25 too, increases the diffuser efficiency.

Also, owing to the possible utilization of the corners, and without the defined installation space boundaries being crossed, the cross section of the outlet opening
30 has an equivalent radius greater than that of a completely rotationally symmetrical diffuser and can thus achieve an increased pressure reconversion from the circumferential speed. Here, an equivalent radius is to be understood to mean the radius of a circle
35 which has the same surface area as the non-

circular diffuser surface. Twice the equivalent radius is also referred to as the hydraulic diameter.

5 A diffuser as described herein may advantageously be used together with an axial, radial or diagonal fan operated in particular by means of an electric external-rotor motor, without a follow-up guide wheel having to be provided here.

10 Here, the overall construction of a fan arrangement with a fan and with a diffuser as described herein may be of single-part or two-part form. A single-part construction is to be understood here to mean that a static component of the fan, in particular a wall ring,
15 and the entire diffuser - that is to say the inner and/or the outer diffuser part - are formed as a single component. In this way, the wall ring of the fan becomes a constituent part of the diffuser.

20 A two-part construction is to be understood to mean that the diffuser as described herein is formed as a component which is separate from the static components of the fan - that is to say as a separate component - wherein said diffuser however can be or is fastened to
25 the static parts of the fan, in particular to the wall ring or to a protective grille, by fastening means such as screws, rivets, clamps etc., or by means of non-positively locking, positively locking and/or cohesive connections, such as by means of a bayonet lock, by
30 means of a clip connection, by means of a welded connection or the like. Here, it is advantageously also possible for a diffuser according to the invention to be designed so as to be suitable for retroactive mounting on an already-installed fan.

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Furthermore, in the case of such a two-part construction of an arrangement, it is also possible for the fan itself to be of multi-part construction, which

is to be understood to mean that it may also be composed of multiple individual diffuser parts which can be or are connected to one another via fastening means or connections as mentioned above. Here, the
5 diffuser parts which can be assembled in this way at the location of use may be designed in a logistically advantageous manner, such that they can for example be stacked, thus reducing the transport volume. In this way, it is possible for the diffuser geometry, in
10 particular the diffuser length, to be varied according to the requirements through the omission or exchange of individual diffuser parts.

Further advantageous embodiments of the invention will
15 emerge from the subclaims and the following description. Embodiments of the invention will be explained in more detail on the basis of a plurality of exemplary embodiments illustrated in the appended figures of the drawing, in which:

20 figure 1 shows, in a longitudinal section, a diagrammatic illustration of a fan arrangement composed of a fan and a diffuser, in which fan arrangement a
25 diffuser according to an embodiment of the invention is or can be used,

figure 2 shows a perspective view of a gas outlet
30 side of a preferred embodiment of a diffuser according to an embodiment of the invention,

figure 3 shows a perspective view of a gas inlet
35 side of the preferred embodiment of a diffuser according to an embodiment of the invention illustrated in figure 2,

figure 4 shows a fan arrangement according to an
40 embodiment of the invention in a perspective sectional view,

- figure 5 shows a perspective view similar to figure 2,
- figure 6 shows a perspective view similar to figure 3,
- figure 7 shows a graphic illustration of a preferred dependency of a ratio of the cross-sectional area of the diffuser on the gas outlet side to the cross-sectional area of the diffuser on the gas inlet side on a ratio of the length of the diffuser to an outer diameter of the inlet opening of the diffuser,
- figure 8 shows a graphic illustration of a preferred dependency of a ratio of the hydraulic diameter to the length of the diffuser on a ratio of the length of the diffuser to an outer diameter of the inlet opening of the diffuser,
- figure 9 shows a perspective view of a preferred embodiment of an outer or inner diffuser part according to an embodiment of the invention,
- figure 10a / figure 10b and figure 11a / 11b show in each case an axial and a radial half-section of two preferred embodiments of an outer diffuser part according to an embodiment of the invention in a fan arrangement according to the invention,
- figure 12a / figure 12b to figure 15a / 15b show in each case an axial and a radial half-section of four preferred embodiments of an inner diffuser part according to an embodiment of the invention of the

invention in a fan arrangement according to the invention,

figure 16a / figure 16b and figure 17a / 17b

5 show in each case an axial and a radial half-section of two preferred embodiments of combinations of outer and inner diffuser parts according to the invention in a fan arrangement according to an
10 embodiment of the invention, wherein the outer diffuser part is in each case shortened,

figure 18a / figure 18b and figure 19a / 19b

15 show in each case an axial and a radial half-section of two preferred embodiments of combinations of outer and inner diffuser parts according to an embodiment of the invention in a fan arrangement
20 according to the invention,

figure 20a / figure 20b and figure 21a / 21b

show in each case an axial and a radial half-section of two preferred embodiments
25 of combinations of outer and inner diffuser parts according to the invention in a fan arrangement according to an embodiment of the invention, wherein the inner diffuser parts are shortened,

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figure 22a shows an axial half-section of a fan arrangement according to an embodiment of the invention with a centrifugal fan,

35 figure 22b shows an axial half-section of a fan arrangement according to an embodiment of the invention with a diagonal fan,

figure 23a / figure 23b

show in each case an axial and a radial half-section of a fan arrangement according to an embodiment of the invention as in figure 12a / 12b, having
5 an inner diffuser part, wherein the outlet surface is highlighted.

With regard to the following description, it is expressly stated that the invention is not restricted
10 to the exemplary embodiments, and is also not restricted to all or several features of described combinations of features; rather, each individual sub-feature of the exemplary embodiment may also have independent inventive significance separately from all
15 of the other sub-features described in connection therewith.

In the figures of the drawing, the same parts are also always denoted by the same reference signs, such that
20 said parts will generally also be described in each case only once.

As can be seen initially from the illustration of figure 1, a fan arrangement 1 according to the
25 invention comprises a fan 2, for example of axial type of construction as illustrated, and a diffuser 3 which - though not readily apparent from the schematic illustration - is or at least may be designed according to the invention, as shown in an exemplary manner in
30 figures 2 and 3 for a diffuser 3 according to the invention and as shown in more detail in figure 4 for the arrangement 1 according to the invention. The fan 2, which may alternatively also be a fan of radial or diagonal type of construction, is operated by means of
35 a motor 4 and is fastened via a wall ring 5 to a support base 6, such as a wall.

Figures 2 and 3 and also figures 5 and 6 show that a diffuser 3 according to the invention has an inlet

opening 10 and an outlet opening 24 for a gaseous medium which flows through a diffuser interior I, which is enclosed by an outer housing 30, in an axially oriented main flow direction S - that is to say a main flow direction which runs substantially parallel to the longitudinal axis X-X of the diffuser 3 - from the inlet opening 10 to the outlet opening 20. The inlet opening 10 illustrated in figure 1 has a circular outer contour, wherein reference sign D1 denotes the diameter of the fan 2. The diffuser 3 has a length L.

The cross section 21 (hatched cross-sectional area A2 in figure 5) of the outlet opening 20 is larger than the cross section 11 (hatched cross-sectional area A1 in figure 6) of the inlet opening 10, and the cross section of the diffuser interior I increases, in particular continuously, from the cross section 11 of the inlet opening 10 to the cross section 21 of the outlet opening 20. The outer housing 30 forms an outer diffuser part AD which delimits the diffuser interior I to the outside.

It is provided according to the invention that, along the main flow direction S, the cross section of the outer diffuser part AD changes from a circular cross section 31 at the inlet opening 10 to a non-circular cross section 32 at the outlet opening 20. The latter is preferably substantially square, as illustrated in figure 2.

Concentrically with respect to the outer diffuser part AD, there is arranged an inner diffuser part ID which, by means of the inner housing 40 which forms it, delimits the diffuser interior I to the inside. It is provided here according to the invention that the inner diffuser part ID has, in at least one section perpendicular to the main flow direction S, a non-circular cross section 42 about the common longitudinal

axis X-X of the inner diffuser part ID and outer diffuser part AD. Here, such a cross section 42 which is non-circular aside from roundings in the corners to avoid stalling and which is substantially square, that is to say is square in terms of basic shape, is provided for example at the outlet opening 20. The cross section 41 of the inner diffuser part ID at the inlet opening 10 is, by contrast, of circular form.

10 In the case of a diffuser 3 with an inner diffuser part ID arranged concentrically with respect to the outer diffuser part AD, which inner and outer diffuser parts have approximately the same length L (less than 10 per cent difference in relation to the length of the larger part), a design of the surface profile according to formula (1) can be regarded as a particularly advantageous embodiment:

$$A2/A1 = -0.45 * (L/D1)^2 + L/D1 + 1 \quad (1),$$

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wherein the value $A2/A1$ may vary by ± 20 per cent. The formula (1) is illustrated by figure 7, wherein - as also already stated above - $A1$ is the area through which flow passes at the diffuser inlet 10, $A2$ is the area through which flow passes at the diffuser outlet 20, L is the diffuser length and $D1$ is the fan diameter.

It has been found that a hydraulic diameter d_{hydr} (double the value of the equivalent radius) related to length can - in particular independently of an inner diffuser part ID - be regarded as optimal if it is dimensioned in accordance with formula (2):

$$35 \quad d_{hydr}/L = 1.55 * (L/D1)^{-0.82} \quad (2),$$

as illustrated by figure 8. Here, too, the admissible range of variation is ± 20 per cent of the calculated value d_{hydr}/L .

5 Diffuser walls which form the inner housing 40, the outer housing 30 and/or - in the case of a multi-part construction - parts thereof may be composed of plastic and produced preferably by primary forming or shaping processes such as injection molding, extrusion, rotary
10 molding, foaming, vacuum deep-drawing, blow molding or the like.

Here, in a hybrid-type design, mechanically highly loaded regions of the diffuser 3 can be reinforced by
15 at least one metal part inlaid during the primary forming process or subsequently attached.

Also, in a frame-type design, a load-bearing structure of the diffuser 3 may be a framework spanned by a thin
20 material composed in particular of plastic or sheet metal.

In one advantageous embodiment of a multi-part diffuser 3, it is possible for thin (thickness of less than 1
25 mm, preferably less than 0.5 mm), originally planar plates, in particular punched metal sheets, to be bent and connected to one another during assembly. Additional add-on parts may be used for stiffening this construction.

30 Figure 9 shows an embodiment of a diffuser 3 according to the invention which may also be used as an outer diffuser part AD or as an inner diffuser part ID or as an outer housing 30 or as an inner housing 40. Said
35 design is suitable in particular as a construction solution for wall rings 5 with a diameter D_1 of greater than 500 mm. The wall of this design is manufactured from a foil or flexible cover P composed preferably of

plastic, which foil or flexible cover can advantageously be folded for transport. The logistical outlay can thus be reduced. To produce the diffuser 3 or diffuser part AD, ID, it is for example possible for

5 a pre-cut flexible cover part to be welded together and connected to load-bearing and shaped rings 9a which surround the inlet opening 10 and the outlet opening 20. Here, the load-bearing and shaped rings 9a may be connected to one another via supporting struts 9b,

10 wherein said load-bearing and shaped rings together with said supporting struts form in particular, in a frame-type design, a framework as stated above. In the illustrated case, the load-bearing and shaped ring 9a at the inlet opening 10 is circular, and the load-

15 bearing and shaped ring 9a at the outlet opening 20 is approximately square but with rounded corners. Here, not only can the flexible cover P be supported by the load-bearing and shaped rings 9a, but rather the rings 9a may advantageously also serve for receiving a

20 protective grille, in particular at the outlet opening 20, in order to screw a wall ring 5 to the inlet opening 10. By means of the supporting struts 9b, which - like the load-bearing and shaped rings 9a - may be produced from steel or plastic depending on the

25 required strength, it is possible, if appropriate using an additional tensing device, for the flexible cover P to be tensed. Since the flexible cover P is a flexible component, it is possible for the length L of the diffuser 3 to be changed with little outlay by means of

30 a changed pre-cut form of the flexible cover P (and a modification of the supporting struts 9b). It is also possible in a simple manner for the flexible cover P to be provided with a surface geometry (so-called riblets) which yields a reduction in friction resistant on

35 surfaces over which turbulent flow passes. For this purpose, microscopically small channels with a spacing to one another of less than 100 μm may be formed into the flexible cover, which channels prevent transverse

movements of the flow and thereby reduce the wall friction by up to approximately 8 per cent.

The diffuser 3 according to the invention may also be
5 formed with a touch guard which is formed either in one piece with the inner housing 40 and/or the outer housing 30 or is formed as a separate component. If the diffuser 3 is formed with a touch guard, it is possible for a fan touch guard grille such as is conventionally
10 used with fans to be omitted or made structurally significantly simpler. Since, according to the invention, the touch guard is generally at a greater distance from the rotor - the illustration in figure 4 shows a fan blade 7 (with hub 8) - than a
15 conventionally used touch guard grille, the strut spacing can be designed to be larger, which may be advantageous in terms of flow and in terms of acoustics. Here, the touch guard may be of structurally very simple design, for example in the form of
20 rectangular struts.

Even though a preferred use according to the invention consists in the use of a diffuser 3 designed according to the invention for a low-pressure axial fan or low-
25 pressure diagonal fan, operated in particular with an electric external-rotor motor, without follow-up guide wheel, a diffuser 3 according to the invention may nevertheless be formed with a follow-up guide wheel. Such a follow-up guide wheel is composed of static
30 guide elements and diverts circumferential and/or radial components of the flow speed in the diffuser 3 in the axial direction X-X. In this way, the follow-up guide wheel increases the static pressure reconversion of the diffuser 3. Similarly to the situation described
35 for a touch guard, the follow-up guide wheel may be formed in one piece - follow-up guide wheel and diffuser form a structural unit - or may be formed as a separate component.

The diffuser 3 may also be designed such that, in addition to its inherent function, it simultaneously realizes both the follow-up guide wheel function and also the touch guard function. Here, too, a design in one piece with the outer/inner diffuser part 30/40 or a design as a separate part that can be mounted on the diffuser 3 is possible.

- 10 The diffuser 3 may be equipped with a sound-deadening means, in particular by means of sound-deadening materials. For this purpose, it is for example possible for a deadening material to be applied to the inner side, which faces toward the main flow S, of the diffuser 3 in the diffuser interior I in such a way that the free surface of the sound-deadening material forms the diffuser wall, which is active in terms of flow, of the inner housing 40 and/or of the outer housing 30. However, the sound-deadening material may be additionally or exclusively applied to the diffuser outer surface which faces away from the main flow S - that is to say on the outside of the outer diffuser part 30. To reduce mid- to low-frequency sound radiation, the diffuser may be equipped with a system for active noise reduction - "active noise control".

Figure 10a / figure 10b to figure 23a / 23b illustrate, in axial and radial half-sections in each case, preferred embodiments of outer diffuser parts AD according to the invention and/or inner diffuser parts ID according to the invention and combinations thereof in fan arrangements 1 according to the invention. Here, apart from in figures 22a and 22b, the contours of the diffuser parts AD, ID in the radial half-section are illustrated in each case for three selected positions (0 per cent of the length L, 50 per cent of the length L and 100 per cent of the length L).

As shown by the various embodiments, it is possible with regard to the lengths of the diffuser parts AD, ID to make a distinction between three different variants:

- 5 A) both parts AD, ID have the same length L (figure 18a, figure 19a, figure 22b) or there is only one part AD, ID with a certain length L (figure 10a to figure 15a, figure 23a);
- 10 B) the length (denoted in this case by the reference sign L_{ext}) of the outer diffuser part AD is smaller than the length (denoted in this case by the reference sign L_{int}) of the inner diffuser part ID (figure 16a, figure 17a);
- 15 C) the length (likewise denoted in this case by the reference sign L_{ext}) of the outer diffuser part AD is greater than the length (likewise denoted in this case by the reference sign L_{int}) of the inner diffuser part
- 20 ID (figure 20a, figure 21a, figure 22a).

As shown in figure 22a, variant B) can be used preferably in a centrifugal fan, and as shown in figure 22b, variant A) can preferably be used in a diagonal

25 fan.

Figure 10a / figure 10b illustrate an outer diffuser part AD with the following design of its contour: at 0 per cent of the length L - circular (rotationally

30 symmetrical); at 50 per cent of the length L - substantially square (that is to say with rounded corners, not rotationally symmetrical); at 100 per cent - likewise substantially square (that is to say with corners which are rounded but more pronounced than at

35 50 per cent, not rotationally symmetrical). Figure 12a / figure 12b illustrate a similarly designed inner diffuser part ID.

Figure 11a / figure 11b illustrate an outer diffuser part AD with the following design of its contour: at 0 per cent of the length L - circular (rotationally symmetrical); at 50 per cent of the length L - substantially square (that is to say with rounded corners, not rotationally symmetrical); at 100 per cent - circular (rotationally symmetrical). Figure 14a / figure 14b illustrate a similarly designed inner diffuser part ID.

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Figure 13a / figure 13b illustrate an inner diffuser part ID with the following design of its contour: at 0 per cent of the length L - square (not rotationally symmetrical); at 50 per cent of the length L - substantially square (that is to say with rounded corners, not rotationally symmetrical); at 100 per cent - circular (rotationally symmetrical).

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Figure 15a / figure 15b illustrate an inner diffuser part ID with the following design of its contour: at 0 per cent of the length L - square (not rotationally symmetrical); at 50 per cent of the length L - substantially square (that is to say with rounded corners, not rotationally symmetrical); at 100 per cent - square (not rotationally symmetrical).

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Figure 16a / 16b illustrate a fan arrangement 1 according to the invention in which is provided an outer diffuser part AD with a design according to figure 10a / figure 10b, but without rounded corners at 100 per cent of the length L_{ext} , which outer diffuser part is combined with an inner diffuser part ID with a design according to figure 15a / figure 15b. The length L_{ext} of the outer diffuser part AD is smaller than the length L_{int} of the inner diffuser part ID.

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Figure 17a / 17b illustrate a fan arrangement 1 according to the invention in which is provided an

outer diffuser part AD with a design according to figure 11a / figure 11b, which outer diffuser part is combined with an inner diffuser part ID with a design according to figure 14a / figure 14b, but with rounded
5 corners at 50 per cent of the length L_{int} . Here, too, the length L_{ext} of the outer diffuser part AD is smaller than the length L_{int} of the inner diffuser part ID.

Figure 18a / 18b illustrate a fan arrangement 1
10 according to the invention in which is provided an outer diffuser part AD with a design according to figure 10a / figure 10b, which outer diffuser part is combined with an inner diffuser part ID in which a circular cross section is provided over the entire
15 length L. The length L of the outer diffuser part AD is equal to the length L of the inner diffuser part ID.

Figures 19a / 19b show a fan arrangement 1 according to the invention as in figure 18a / figure 18b, with the
20 difference that the outer diffuser part AD has a design according to figure 11a / figure 11b.

Figure 20a / 20b illustrate a fan arrangement 1 according to the invention in which is provided an
25 inner diffuser part ID with a design according to figure 12a / figure 12b, but without rounded corners at 100 per cent of the length L_{int} , which inner diffuser part is combined with an outer diffuser part AD in which a circular cross section is provided over the
30 entire length L. The length L_{ext} of the outer diffuser part AD is greater than the length L_{int} of the inner diffuser part ID.

Figures 21a / 21b show a fan arrangement 1 according to
35 the invention as in figure 10a / figure 10b, with the difference that the inner diffuser part ID has a design according to figure 14a / figure 14b.

The various embodiments of the invention illustrated above each have specific advantages determined by the type of construction of the respective fan 2, in particular by the outflow field of the fan 2 and/or by the available installation space and by further boundary conditions. This is illustrated by way of example by figure 22a and figure 22b, which are already mentioned above.

From the illustration, shown in figure 23a / figure 23b, of the embodiment according to figure 12a / figure 12b, it is clear that not only an outer diffuser part AD alone (without inner diffuser part ID) but also an inner diffuser part ID alone (without outer diffuser part AD) may perform the function of a complete diffuser 3, as indicated in the drawing by the reference sign 3 placed in each case between parentheses. A space of the diffuser 3 which corresponds in the latter embodiments to the interior I of the other embodiments is therefore likewise denoted in said embodiments by the reference sign I. As shown in particular by figure 23a, said space is delimited at one side by the wall ring 5 and at the other side by the inner diffuser part ID, wherein the outlet opening 20 extends, or the outflow cross-sectional area A2 of the diffuser 3 is spanned, between said two parts 5, ID. It is thus not necessary for an outer housing 30 to be provided.

As emerges already from the above embodiments, the present invention is not restricted to the illustrated exemplary embodiments but rather encompasses all means and measures which are equivalent within the meaning of the invention. It thus also falls within the scope of the invention for the inlet opening 10 to not have a circular annular cross section 11 owing to a corresponding design of the outer diffuser part AD and/or of the inner diffuser part ID, and/or for the

outlet opening 20 to not have an annular cross section 21 with a square outer and inner contour of the opening 20, which is however of annular basic shape in any case, owing to a corresponding design of the outer
5 diffuser part AD and/or of the inner diffuser part ID.

The rotational asymmetry according to the invention in at least one cross-sectional region of the diffuser interior I may be realized on the one hand by means of
10 a corresponding - in each case exclusive - design of the outer diffuser part AD or of the inner diffuser part ID or on the other hand by means of the design both of the outer housing 30 and also of the inner housing 40. Here, the cross section of the diffuser
15 interior space I may vary in a variety of ways along the main flow direction S.

Here, aside from the embodiments illustrated in the drawings, as further embodiments which are not
20 illustrated, the two following embodiments are for example preferably possible: an outer diffuser part AD with the following design: at 0 per cent of the length L - circular (rotationally symmetrical); at 30 per cent of the length L - square (not rotationally
25 symmetrical); at 60 per cent - circular (rotationally symmetrical); at 100 per cent - square (not rotationally symmetrical); or an inner diffuser part ID which, in any cross section, is polygonal with a number of corners other than four, in particular is
30 pentagonal.

By contrast to diffusers which are used downstream of gas turbines, the flow of which, under the action of the final guide wheel provided there, no longer
35 exhibits swirl, the invention extends to include in particular diffusers 3 which are used behind fans 2 without a guide wheel, wherein the fans 2 generate swirl in the gas flow.

Furthermore, the invention is not restricted to the combinations of features defined in independent claims 1 to 4, 6, 19 and 20 but rather may also be defined by
5 any other desired combination of certain features of all of the individual features disclosed. This means that basically practically any individual feature of the independent claims may be omitted or replaced by at
10 least one individual feature disclosed at some other point in the application. In this respect, the claims should be understood to be merely a first attempt at defining an invention.

Reference signs

	1	Fan arrangement
	2	Fan of 1
5	3	Diffuser of 1
	4	Motor of 2
	5	Wall ring of 1
	6	Support base for 1
	7	Blade of 2
10	8	Hub of 2
	9a	Load-bearing and shaped ring of 3 (figure 9)
	9b	Supporting strut of 3 (figure 9)
	10	Inlet opening in 3
	11	Cross section of 10
15	20	Outlet opening out of 3
	21	Cross section of 20
	30	Outer housing of 3
	31	Cross section of 30 at 10
	32	Cross section of 30 at 20
20	40	Inner housing of 3
	41	Cross section of 40 at 10
	42	Cross section of 40 at 20
	AD	Outer diffuser part
25	A1	Cross-sectional area of 10
	A2	Cross-sectional area of 20
	D1	Outer diameter of 10
	I	Diffuser interior
	ID	Inner diffuser part
30	L	Length of 3 or AD/ID
	L _{ext}	Length of AD
	L _{int}	Length of ID
	P	Flexible cover (figure 9)
	S	Main flow direction through 3
35	X-X	Longitudinal axis through 1, 2, 3

Claims

1. A fan arrangement comprising a diffuser and a fan of axial, radial or diagonal type of construction, wherein the diffuser is fastened to at least one static part of the fan by fastening means or by means of frictionally locking or positively locking connections, or the static part and the diffuser are formed as a single component, wherein the diffuser comprises an inlet opening and an outlet opening for a gaseous medium which flows through a diffuser interior, which is enclosed by an outer housing, in an axially oriented main flow direction from the inlet opening to the outlet opening, wherein the diffuser is located downstream the fan with regard to the main flow direction, wherein for conversion of dynamic pressure into static pressure the cross section of the outlet opening is larger than the cross section of the inlet opening, and the cross section of the diffuser interior increases from the cross section of the inlet opening to the cross section of the outlet opening, wherein the outer housing forms an outer diffuser part which delimits the diffuser interior to the outside, wherein
along the main flow direction, the cross section of the outer diffuser part changes from a circular cross section at the inlet opening to a non-circular cross section at the outlet opening, characterized in that
concentrically with respect to the outer diffuser part, there is arranged an inner diffuser part which, with an inner housing,

delimits the diffuser interior to the inside,
wherein

the inner diffuser part has, in at least one
section perpendicular to the main flow direction,
5 a non-circular cross section about the
longitudinal axis of the inner diffuser part.

2. A fan arrangement comprising a diffuser and a fan
of axial, radial or diagonal type of construction,
10 wherein the diffuser is fastened to at least one
static part of the fan by fastening means or by
means of frictionally locking or positively
locking connections, or the static part and the
diffuser are formed as a single component, wherein
15 the diffuser comprises an inlet opening and an
outlet opening for a gaseous medium which flows
through a diffuser interior, which is enclosed by
an outer housing, in an axially oriented main flow
direction from the inlet opening to the outlet
20 opening, wherein the diffuser is located
downstream the fan with regard to the main flow
direction, wherein for conversion of dynamic
pressure into static pressure the cross section of
the outlet opening is larger than the cross
25 section of the inlet opening, and the cross
section of the diffuser interior increases from
the cross section of the inlet opening to the
cross section of the outlet

opening, wherein the outer housing forms an outer
diffuser part which delimits the diffuser interior
to the outside,
characterized in that, concentrically with respect
5 to the outer diffuser part, there is arranged an
inner diffuser part which, with an inner housing,
delimits the diffuser interior to the inside,
wherein
the outer diffuser part and/or the inner diffuser
10 part are/is designed such that the cross section
of the diffuser interior is non-rotationally
symmetrical at at least one point.

3. The fan arrangement as claimed in claim 1 or 2,
characterized in that the non-circular cross
section of the outer diffuser part and/or of the
inner diffuser part is of polygonal, in particular
5 square, basic shape.
4. The fan arrangement as claimed in any one of the
preceding claims,
characterized by the diffuser composed of a
10 plurality of individual diffuser parts which are
connected to one another by fastening means such
as screws, rivets, clamps or the like, or by means
of frictionally locking, positively locking and/or
cohesive connections, such as by means of a
15 bayonet lock, by means of a clip connection, by
means of a welded connection or the like.
5. The fan arrangement as claimed in any one of the
preceding claims,

characterized in that the diffuser, or at least one diffuser part, is composed of originally planar plates which are bent and connected to one another, in particular of punched metal sheets, or
5 of a flexible cover, which is/are if appropriate tensed and/or stiffened with the aid of additional add-on parts such as supporting struts and/or bearing and shaped rings.

10 6. The fan arrangement as claimed in any one of the preceding claims,
characterized in that the inner housing, the outer housing and/or parts thereof are/is composed of plastic and are/is produced preferably by primary
15 forming or shaping processes such as injection molding, extrusion, rotary molding, foaming, vacuum deep-drawing, blow molding or the like.

7. The fan arrangement as claimed in claim 6,
20 characterized in that mechanically highly loaded regions of the inner housing, of the outer housing and/or of the parts thereof are reinforced by at least one metal part inlaid during the primary forming process or subsequently attached.

25 8. The fan arrangement as claimed in any one of the preceding claims,
characterized in that a load-bearing structure of the diffuser is a framework spanned by a thin
30 material composed in particular of plastic or sheet metal.

9. The fan arrangement as claimed in any one of the preceding claims,

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characterized in that a touch guard, for example in the form of rectangular struts, is arranged on the inner housing and/or on the outer housing, which touch guard is formed in one piece with the
5 respective housing or is formed as a separate part fastened to the inner housing and/or to the outer housing.

10. The fan arrangement as claimed in any one of the
10 preceding claims,
characterized in that a follow-up guide wheel is arranged on the inner housing and/or on the outer housing, which follow-up guide wheel is formed in one piece with the respective housing or as a
15 separate part fastened to the inner housing and/or outer housing and is composed of static guide elements which are designed so as to divert circumferential and/or radial components of the flow speed in the axial direction.

20 11. The fan arrangement as claimed in any one of the preceding claims
characterized by a sound-deadening means, wherein in particular the diffuser interior is lined with
25 a sound-deadening material, preferably in such a way that the free surface of the sound-deadening material on that side of the inner housing and/or of the outer housing which faces towards the main flow forms a diffuser wall which is active in
30 terms of flow.

12. The fan arrangement as claimed in claim 11,
characterized in that a sound-deadening material is applied to the diffuser outer surface, which
35 faces away from the main flow, of the outer housing.

13. The fan arrangement as claimed in claim 11,
characterized in that the outer diffuser part
and/or the inner diffuser part is/are composed
partially or in particular integrally of the
5 sound-deadening material.
14. The fan arrangement as claimed in any one of the
preceding claims,
characterized by a system for active noise
10 reduction ("active noise control") for reducing
mid- to low-frequency sound radiation.
15. The fan arrangement as claimed in any one of the
preceding claims,
15 characterized in that the diffuser is fastened to
the at least one static part of the fan, in
particular to a wall ring and/or to a protective
grille, by screws, rivets, clamps or the like, or
by means of a bayonet lock, by means of a clip
20 connection, or by means of a welded connection.