(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 617 521 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.03.2020 Bulletin 2020/10

(51) Int Cl.:
F04D 19/00 *(2006.01)* ***F04D 29/02*** *(2006.01)*
F04D 29/52 *(2006.01)*

(21) Application number: **18190993.8**

(22) Date of filing: **27.08.2018**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **Elektrosil GmbH**
22761 Hamburg (DE)

(72) Inventor: **NIEMANN, Hendrik**
22761 Hamburg (DE)

(74) Representative: **RGTH**
Patentanwälte PartGmbB
Neuer Wall 10
20354 Hamburg (DE)

(54) HOUSING FOR AN AXIAL FAN, AXIAL FAN, AND METHOD FOR PRODUCING A HOUSING FOR AN AXIAL FAN

(57) The invention concerns a housing (100) for an axial fan, wherein the housing comprises a circumferential wall (20), wherein the housing comprises a housing base body (10) made, in particular entirely, of a plastic material, and wherein the housing comprises a metallic ring portion (30) made, in particular entirely, of a metallic material, said metallic ring portion being in the shape of a ring or in the shape of at least one ring segment (33, 34, 35, 36), said metallic ring portion (30) forming at least part of the circumferential wall (20) of the housing, and said metallic ring portion (30) being firmly connected with the housing base body (10).

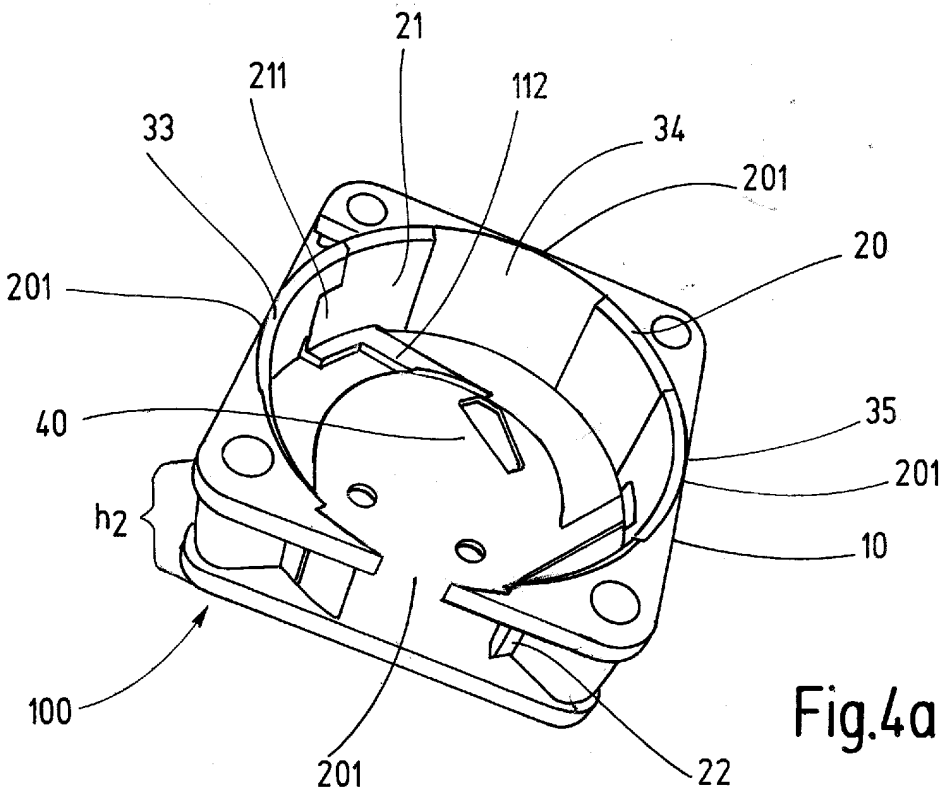

Fig.4a

EP 3 617 521 A1

(Cont. next page)

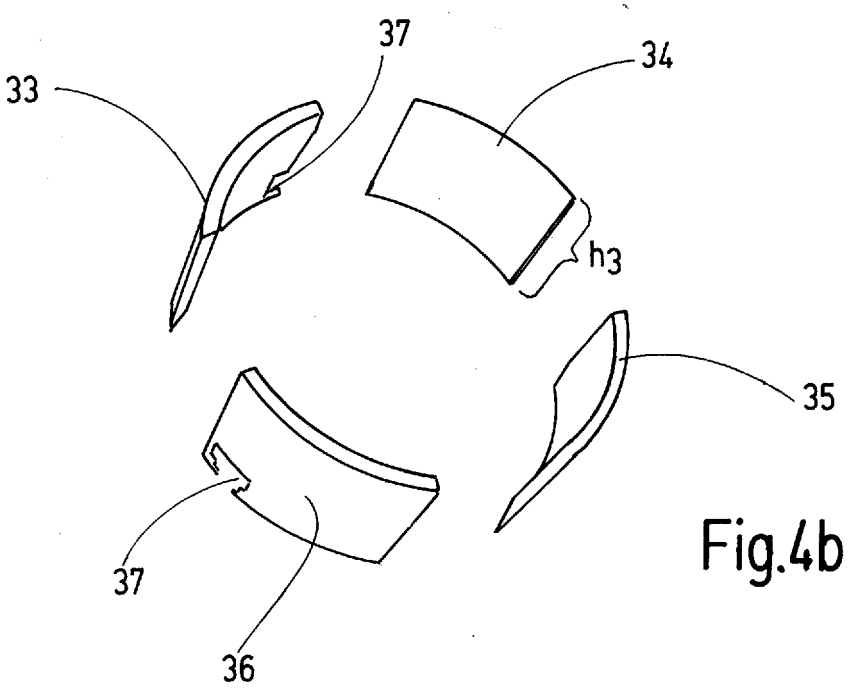

Fig.4b

Description

Field of the invention

[0001] The invention relates to a housing for an axial fan, an axial fan, and a method for producing a housing for an axial fan.

Description of related art

[0002] Fans for dissipating heat from electronic components are generally known in the art. Fans generally comprise a housing and an impeller arranged in said housing. Axial fans are a type of fan which are adapted to force air to move substantially parallel to the shaft about which the impeller rotates. In other words, the air flow of the axial fan is axially in and axially out. Generally, the housing of axial fans is made entirely of plastic material, for example by means of injection molding.

[0003] The impeller is arranged in an inner area of the housing which typically has a circular shape. The inner area is dimensioned such that there is a gap between the tips of the blades of the impeller and the housing wall enclosing the inner area. This gap is necessary to ensure that the blades of the propeller may freely rotate without touching the wall of the housing which would lead to damages of the fan and would produce unwanted noise. On the other hand, the gap reduces the performance of the fan because it reduces the maximum size of the impeller. Further, when the impeller is rotating with high speeds turbulences may incur at the ends of the blades of the propeller in the area of the gaps which may further reduce the performance of the fan.

Summary of the invention

[0004] It is an objective of the present invention to improve the performance of an axial fan while at the same time ensuring that the impeller may freely rotate without obstruction.

[0005] The above objective is achieved by providing a housing for an axial fan, wherein the housing comprises a circumferential wall. The housing further comprises a housing base body made, in particular entirely, of a plastic material. The housing further comprises a metallic ring portion made, in particular entirely, of a metallic material, said metallic ring portion being in the shape of a ring or in the shape of at least one ring segment, said metallic ring portion forming at least part of the circumferential wall of the housing, and said metallic ring portion being firmly connected with the housing base body.

[0006] The housing thus comprises two components, the housing base body and the metallic ring portion. Preferably, the housing consists of the two aforementioned components. The circumferential wall of the housing extends along the circumference of the impeller which is to be arranged inside the housing. In other words, the circumferential wall encloses the impeller arranged in the housing or an inner area of the housing in which an impeller is to be arranged respectively. Between the blade tips of the impeller and the circumferential wall there has to be a gap to ensure that the blades of the impeller do not touch the circumferential wall. The width of the gap between the circumferential wall of the housing and a circular path formed by the rotating blade tips of the impeller is preferably constant. The metallic ring portion forms at least part of the circumferential wall, however, it is possible that the circumferential wall is entirely made up of the metallic ring portion. In embodiments in which the circumferential wall is only partly formed by the metallic ring portion, the other part of the circumferential wall may be formed by the housing base body.

[0007] The metallic ring portion preferably has the shape of a circular ring or the shape of at least one circular ring segment. The circular shape of the metallic ring portion corresponds to the shape of the impeller to be arranged inside the housing, which typically also has a circular shape and/or which has blades whose blade tips describe a circular path when the impeller rotates.

[0008] In cases in which the metallic ring portion is formed in the shape of a ring the metallic ring portion is closed in itself and forms a complete closed ring. In another embodiment, the metallic ring portion is made up of one or more ring segments, each segment forming part of a, preferably circular, ring. In this embodiment, the housing preferably has 2 to 8 ring segments, particular preferably 3 to 6 ring segments, especially preferably exactly 4 ring segments.

[0009] The metallic ring portion is firmly connected with the housing base body. This is to be understood such that the connection between the metallic ring portion and the housing base body may not be easily disengaged. Although it is possible that the connection between the metallic ring portion and the housing base body is of a detachable type, that is the metallic ring portion may be removable from the housing base body, it is preferred that the connection between the metallic ring portion and the housing base body is of a permanent type, so that the metallic ring portion may not be disengaged or removed from the housing base body. In particular, the metallic ring portion may be arranged integrated into the housing base body.

[0010] The outer dimensions of the housing of an axial fan are typically determined by the type of application for which the axial fan is to be used. Thus, the outer dimensions of the housing for a certain application may usually not be altered. The performance of the axial fan depends inter alia on the size of the impeller. Typically, it is desirable to design the impeller as large as possible. The maximum size of the impeller which may be arranged in a housing with predetermined dimensions depends on the minimum thickness of this circumferential wall and the minimum width of the gap between the blade tips of the impeller and the inner side of the circumferential wall.

[0011] By integrating a metallic ring portion into the housing base body with the metallic ring portion forming

at least part of the circumferential wall of the housing, wherein the housing base body is made of a plastic material, the strength of the circumferential wall is enhanced so that it is possible to reduce the minimum thickness of the wall as compared to housings which are made entirely of plastic material. In this manner, it is possible to install a larger sized impeller in the housing. In other words, the diameter of the circular path described by the blade tips of the impeller which may be installed in the housing according to the present invention is greater as compared to the circular path of an impeller arranged in a housing with the same dimensions made up entirely of a housing base body of a plastic material.

[0012] In known housings made entirely of a housing base body made of a plastic material, the inner side of the circumferential wall usually does not describe a true circular path because of production inaccuracies. These production inaccuracies are inherent to the production process of housings made, in particular, entirely of a plastic material (e.g. when using an injection molding method). Thus, with such known housings the gap between the circular path described by the blade tips of the impeller and the inside wall of the circumferential wall has to have for security reasons a quiet substantial width, typically more than 0,8 mm and in many cases more than 1,0 mm. By using metallic ring portions in the circumferential wall of a housing the negative effects of the production inaccuracies (e.g. projections from the inner side of the circumferential wall due to production inaccuracies) are reduced because it is easier to produce a smooth circular wall out of a metallic material as opposed to a plastic material. Therefore, the width of the gap between the blade tips of the impeller and the circumferential wall may be reduced so that the impeller may have a larger size and the performance of the fan is enhanced. In addition, by reducing the gap, turbulences are less likely to form and/or are less severe, which further increases the performance of the fan. The gap between the blade tips of the impeller and the circumferential wall may also be referred to as "tip clearance". Thus, by employing a housing according to the present invention, a fan may have a smaller tip clearance which leads to an improved performance.

[0013] By using the metallic ring portion together with a housing base body made of a plastic material for forming the housing of an axial fan it is possible to enhance the performance of the fan without having to manufacture the entire housing from a metallic material. Thus, it is possible to still use a housing base body made of a plastic material, which is cost efficient and easy to produce, and at the same time to enhance the performance of the fan.

[0014] Preferably, the housing has an inner area in which an axial fan may be disposed, wherein the circumferential wall of the housing encloses the inner area of the housing. Further, it is preferable that the metallic ring portion forms at least part of the inner side of the circumferential wall of the housing facing the inner area of the housing. In this way it is ensured that the inner side of the circumferential wall may be relatively smooth with less production inaccuracies so that the width of the gap between the blade tips and the inner side of the circumferential wall may be reduced (smaller tip clearance). The metallic ring portion may form the inner side and at the same time the outer side of the circumferential wall. This may in particular be the case with embodiments in which the entire circumferential wall is made up of the metallic ring portion. The metallic ring portion forming at least part of the inner side of the circumferential wall has the further advantage that the inner side may describe a relatively or substantially true circular path which is also advantageous for reducing the tip clearance.

[0015] Preferably, the metallic material of the metallic ring portion is selected from the group consisting of brass, aluminum, steel, or mixtures thereof.

[0016] Preferably, the metallic ring portion is in the shape of a ring and extends along the entire circumferential wall and/or forms the entire circumferential wall. In this embodiment, the metallic ring portion forms one cohesive ring to extend along and/or form the entire circumferential wall. Thus, the housing base body may not form any part of the circumferential wall in cases in which the metallic ring portion forms the entire circumferential wall. Alternatively, it may be preferred that the metallic ring portion is in a shape of at least one ring segment, said at least one ring segment forming part of the circumferential wall, wherein in said part of the circumferential the at least one ring segment forms the entire circumferential wall. In both aforementioned embodiments a circumferential wall or at least a part of the circumferential wall may be advantageously produced only by providing the metallic ring portion. This makes the circumferential wall easy to manufacture and also ensures that the circumferential wall has a high strength and an increased production accuracy which in term leads to an increased performance of the fan. In these embodiments, the circumferential wall or the part of the circumferential wall respectively preferably consists only of the metallic ring portion and does not have other components.

[0017] Preferably, the metallic ring portion has a thickness in the range of 0,1 mm to 0,8 mm, preferably in the range of 0,3 mm to 0,7 mm, particularly preferably in the range of 0,4 mm to 0,55 mm. Further preferably, the thickness of the metallic ring portion is 0,8 mm or less, particularly preferably 0,65 mm or less, especially preferably 0,55 mm or less. The thickness is typically the smallest dimension of the circumferential wall when compared to its height and circumference. Preferably, the circumferential wall will be arranged approximately orthogonal to a bottom of the housing. In that case, the thickness of the circumferential wall is disposed in a radial direction of the axial fan. Preferably, the thickness of the metallic ring portion is approximately constant along its circumference and preferably also in its height direction. If the thickness of the metallic ring portion is not constant along its circumference, the area of the metallic ring portion with the greatest thickness has to measured. With the

thickness of the metallic ring portion being within the aforementioned ranges the wall is relatively thin which allows for a relatively large sized impeller to be arranged in the housing. The relatively thin walls are made possible by use of the metallic ring portion. In this embodiment, it is particularly preferable the entire circumferential wall or at least an entire section of the circumferential wall is made up of the metallic ring portion and/or that the metallic ring portions forms an inner side and an outer side of the circumferential wall. In particular, the metallic ring portion may extend over the entire thickness of the circumferential wall. The aforementioned dimensions and measurement methods described for the metallic ring portion may also apply to the circumferential wall, in particular in cases in which the metallic ring portion forms the entire circumferential wall or at least an entire section of the circumferential wall and/or in which the metallic ring portions forms an inner side and an outer side of the circumferential wall.

[0018] Preferably, the metallic ring portion is connected to the housing base body by means of molding, in particular injection molding, gluing and/or pressing. When the metallic ring portion is connected to the housing base body by the aforementioned methods, the metallic ring portion is firmly connected and in particular permanently connected to the housing base body. By means of any one of the aforementioned methods, a cohesive connection between the housing base body and the metallic ring portion may be achieved while employing relatively simple technical production processes. It is further preferable that the metallic ring portion is disposed on an inner side of the housing base body. In that way it may be ensured that the inner side of the circumferential wall is made up of the metallic ring portion or at least part of the circumferential wall. Also, a comparatively high stability of the housing may be achieved if the housing base body covers the metallic ring portion on its outer side. Preferably, the housing may be easier to produce when the metallic ring portion is disposed on an inner side of the housing base body. In particular, when the method of injection molding is used, the compound forming the housing base body may be injected on an outside of the metallic ring portion.

[0019] Preferably, the height of the metallic ring portion is less than the height of the housing, in particular less than 90 % of the height of the housing, particularly preferably less than 75 % of the height of the housing, especially preferably less than 60 % of the height of the housing. The height of the housing typically extends in the axial direction of an axial fan, i.e. in its flow direction. If the height of the housing is not substantially constant, the height of the housing is measured in the area of the housing that has the greatest height. In other words, the height is considered to be the largest extension of the housing in the height direction or axial direction respectively. Preferably, the housing has a substantially constant height, i.e. the height of the housing is the same in all areas of the housing. By providing a metallic ring portion with a height less than the height of the housing, the amount of metallic material to be used in the housing is reduced which makes the production of the housing more cost efficient. Therefore, it is preferable that the height of the metallic ring portion is smaller as compared to the height of the housing while at the same time it should be ensured that the metallic ring portion still provides the technical advantages for increasing the performance of the fan (i.e. decrease of the tip clearance and/or decrease of the width of the circumferential wall). Preferably, the minimum height of the metallic ring portion corresponds to the height or half of the height of an end area of the blades of an impeller to be placed into the housing. In this way it is ensured that the entire end portions of the blades of the impeller are adjacent to the metallic ring portion so that the gap to the circumferential wall can be relatively small. Preferably, the height direction of the metallic ring portion corresponds to an axial direction of the fan. The height of the metallic ring portion is to be understood to be the greatest extension of the metallic ring portion in its height direction. In other words, the height is to be measured in that area of the metallic ring portion in which the height is the greatest. Preferably, the metallic ring portion has a substantially constant height.

[0020] Preferably, the metallic ring portion comprises two side surfaces, in particular an inner side surface and an outer side surface. Further preferably, at least one of said side surfaces and especially preferably the outer side surface turned to the outside of the housing is formed structured. Further preferably, only the outer side surface is structured while the inner side surface is substantially smooth. The technical advantage of one side surface being structured is that a firm connection with the housing base body may be more easily achieved, in particular when the connection is achieved by molding, in particular injection molding, gluing and/or pressing. It is further possible that both side surfaces of the metallic ring portion are structured. The structured surface may be achieved by not polishing the metallic ring portion after it has been produced.

[0021] Preferably, the metallic ring portion comprises at least one, preferably exactly one, support portion projecting from the metallic ring portion for supporting the metallic ring portion on the housing base body. Particularly preferably, said support portion rests on a face surface of the housing base body. By means of this at least one support portion it can be further ensured that the metallic ring portion is firmly connected to the housing base body. The at least one support portion is preferably connected, in particular firmly connected, with the base house body and thus offers an additional connection surface for connecting the metallic ring portion with the housing base body. Preferably, the metallic ring portion and the at least one support portion are formed integrally as one piece. Further preferably, the support portion projects towards a side of the metallic ring portion. Particularly preferably, the support portion projects at approximately right angles from the metallic ring portion in

a cross-sectional view. Further, it may be preferable if the at least one support portion projects from an upper or a lower side of the metallic ring portion. It is further preferable that the support portion rests in a corner region of the housing on a face surface of the housing base body because in the corner regions the face surface of the housing usually has a greater area and so the support area is somewhat greater as compared to other regions of the housing. In this embodiment comprising the at least one support portion it is particularly preferable if the metallic ring portion is formed as a closed ring. In this case, it is further preferable if the support portion extends along the entire circumference of the ring portion. In this way, the support portion may form a rim of the metallic ring portion. In case that the metallic ring portion comprises several ring segments, it is preferable that each such ring segment comprises at least one, preferably exactly one, support portion.

[0022] Preferably, the housing base body has a substantially square basic shape and comprises four sides, wherein the housing has an inner area in which an impeller is disposable, said inner area being of circular shape, wherein a distance from the inner area to a middle portion of a side of the housing base body is less than a distance from the inner area to a corner portion of the base housing body, in which corner portion two sides of the housing base body abut. Further, the metallic ring portion is in the shape of at least one ring segment, said at least one ring segment being disposed in the middle portion or proximate to the middle portion of the side of the housing base body. Further preferably, the metallic ring portion comprises, in particular exactly, 4 ring segments, each ring segment being disposed in a middle portion of a side of the housing base body, wherein each of the 4 ring segments in disposed at a different side of the housing base body. The distance is measured from a center point of the middle portion or the corner portion respectively to the center point of the inner area of circular shape. It is advantageous to provide the at least one ring segment in a middle portion because the structure of the middle portion of the housing is typically weaker than the structure of the corner portion and thus the metallic ring portion may support the middle portion and strengthen its structure. This leads to a situation in which it is possible to have thinner circumferential walls in the middle portions as compared to housings without metallic ring portions. In order to further strengthen the structure of the housing it is preferable that each middle portion comprises one or more metallic ring segments. The corner portions may then in turn not comprise any metallic ring portions.

[0023] Another aspect of the invention relates to an axial fan, wherein said axial fan comprises a housing as described above.

[0024] Preferably, the axial fan comprises an impeller, said impeller comprising at least one blade, wherein a gap between a tip of the least one blade and the circumferential wall of the housing is less than 0,8 mm, preferably less than 0,66 mm, particularly preferably less than 0,5 mm, especially preferably less than 0,35 mm. Further, it may be preferable if the gap is between 0,1 mm and 0,4 mm and particularly preferable between 0,2 mm and 0,3 mm. The tip of the at least one blade is the outer most point of the blade in radial direction of the impeller and thus the point of the at least one blade closest to the circumferential wall. The gap is measured as the closest distance from this blade tip to the circumferential wall. In case that the circumferential wall is uneven so that measurements in different positions of the impeller may yield different results, an average distance is to be calculated. This arrangement ensures that the gap between the blade tip and the circumferential wall is small which leads to an enhanced performance of the axial fan.

[0025] Preferably, the axial fan comprises an impeller, said impeller comprising at least one blade, wherein the height of the metallic ring portion is more than 50 % of the height of the impeller, and/or wherein the height of the metallic ring portion is less than the height of the impeller, preferably less than 90 % of the height of the impeller, particularly preferable less than 80 % of the height of the impeller. Such a height of the metallic ring portion ensures that the metallic ring portion may be disposed in the area where it is most important in order to enhance the performance of the axial fan, namely in the area of the circumferential wall which is adjacent to the blade tip area of the blades of the impeller. If the metallic ring portion is arranged in this area, the gap may be relatively small and also the wall thickness of the circumferential wall in these areas may be small. Thus, if the height of the metallic ring portion is in one of the above-mentioned ranges, it is ensured that the height of the metallic ring portion is sufficient for the metallic ring portion to be placed in the important areas of the circumferential wall while at the same time it is ensured that the metallic ring portion is not larger than necessary. The height of the impeller is the largest extension of the impeller in its height direction which may preferably correspond to the axial direction of the axial fan.

[0026] In another aspect the invention relates to a method for producing a housing for an axial fan, preferably a housing as described above, said method comprising the steps of arranging a metallic ring portion, made, in particular entirely, of a metallic material, said metallic ring portion being in the shape of a ring or in the shape of at least one ring segment, in a mold, and injecting a plastic material in the mold for forming a housing for an axial fan. By means of this method the housing base body is formed around the metallic ring portion and once the housing base body has cured, the housing base body is firmly connected with the metallic ring portion. By using injection molding it may thus advantageously be achieved to manufacture a housing comprising a housing base body and a metallic ring portion in a comparatively simple and cost-efficient way, while ensuring a firm connection between the metallic ring portion and the housing base body.

Brief description of the figures

[0027] Preferred embodiments of the invention are described below with reference to the following figures which show in schematic representation:

Fig. 1a a perspective view of a housing base body of a housing for an axial fan;
Fig. 1b a perspective view of a circular ring as a metallic ring portion of a housing for an axial fan;
Fig. 2 a perspective view of a first embodiment of a housing for an axial fan comprising the housing base body of Fig. 1a and the circular ring of Fig. 1b;
Fig. 3 a perspective view of a second embodiment of a housing for an axial fan comprising a housing base body and four ring segments;
Fig. 4a a perspective view of a third embodiment of a housing for an axial fan comprising a housing base body and four ring segments;
Fig. 4b a perspective view of the four ring segments of Fig. 4a;
Fig. 5 a perspective view of a fourth embodiment of a housing for an axial fan comprising a housing base body and a circular ring;
Fig. 6 a perspective view of fifth embodiment of a housing for an axial fan;
Fig. 7 a schematic view of a section of a circumferential wall of a housing and blade of an impeller of a axial fan; and
Fig. 8 a schematic diagram of the performance of the impeller of an axial fan.

Preferred embodiments of the invention

[0028] Fig. 1a shows a housing base body (10) of a housing for an axial fan, said housing base body being made entirely of a plastic material. The housing base body (10) has a substantially square basic shape and comprises a bottom section (11), four side sections (12a to 12 d), and a top side (13). The bottom section comrises a round, plate-shaped center section (111) for mounting of an impeller which is connected via arms (112) to the rest of the housing base body (10)

[0029] Fig. 1b shows a metallic ring portion (30) for forming at least part of the circumferential wall of a housing for an axial fan. The metallic ring portion of Fig. 1b is configured in the shape of a continuous, circular ring, said ring comprising two side surfaces, in particular an inner side surface (31) turned to an inner area (40) of a housing and an outer side surface (32) turned to the outside of a housing when the ring is mounted in a housing. Preferably, at least one of said side surfaces and especially preferably the outer side surface (32) is formed structured. Further preferably, only the outer side surface (32) is structured while the inner side surface (31) is substantially smooth. The metallic ring portion has a height (h3). The height (h3) is constant along the entire circumference.

[0030] Fig. 2 shows a first embodiment of a housing (100), comprising the housing base body (10) shown in Fig. 1a and the metallic ring portion (30) shown in Fig. 1b. The housing (100) comprises a circumferential wall (20), which is made up by the metallic ring portion (30) and (sections of) the housing base body (10). In particular, the circumferential wall (20) is made up by the metallic ring portion (30) and the side sections (12a to 12d) of the housing base body (10). The circumferential wall (20) has a height (h1) extending from the top of the bottom section (11) of the housing base body (10) to the top side (13) of the housing base body (10). The housing (100) has a height (h2) extending from the bottom side of the bottom section (11) to the top side (13).

[0031] The metallic ring portion (30) forms one cohesive, closed ring extending along the entire circumferential wall (20). The circumferential wall (20) comprises an inner side (21) and an outer side (22). The height (h3) of the metallic ring portion (30) is less than the height (h1) of the circumferential wall (20). Thus, the upper part of the circumferential wall (20) is made up entirely of housing base body (10) while a lower part of the circumferential wall (20) is made up of the metallic ring portion (30). Further, the height (h3) of the metallic ring portion (30) is less than the height (h2) of the housing (100). The metallic ring portion (30) forms part of an inner side of the housing base body (10). Therefore, the surface of the inner side (21) of the circumferential wall (20) is partly formed by the metallic ring portion (30). In the embodiment shown in Fig. 2, the metallic portion (30) also forms part of the outer side (22) of the circumferential wall (20). However, in some embodiments, the housing base body entirely and exclusively forms the outer side of the circumferential wall (20), so that the metallic ring portion only forms part of the inner side or the entire inner side of the circumferential wall. As can be seen from Fig. 2, the metallic ring portion (30) and the housing base body (20) are arranged flush with respect to each other so as to form together one coherent and smooth inner side (21) of the circumferential wall (20).

[0032] The metallic ring portion (30) is connected with the housing base body (10). The connection between the metallic ring portion (30) and the housing base body (10) may not be easily disengaged. In the embodiments shown in the figures, the metallic ring portion (30) is connected to the housing base body (10) by means of injection molding.

[0033] The housing (100) further comprises an inner area (40) in which an impeller (not shown) may be disposed. The inner area (40) is enclosed by the circumferential wall (20). The inner area (40) has a circular shape, so that a distance from the center point of the inner area (40) to a middle portion (201) of a side of the housing base body (10) is less than a distance from the center point of the inner area (40) to a corner portion (202) of the base housing body (10). The corner portion (202) is where two sides of the housing base (10) body abut. The

inner area (40) is dimensioned such that there is a gap between the tips of the blades of an impeller to be mounted in the inner area (40). The inner side (21) of the circumferential wall (20) has a circular shape corresponding to the shape of an impeller to be arranged inside the housing (100), which typically also has a circular shape and/or which has blades whose tips describe a circular path when the impeller rotates. The inner side (21) of the circumferential wall (20) faces the inner area (40) of the housing (100) whereas the outer side (22) of the circumferential wall (20) faces the outside of the housing (100).

[0034] The metallic ring portion (30) forms at least part of the circumferential wall (20) of the housing (100). In this embodiment the metallic ring portion (30) is designed as a complete ring.

[0035] Fig. 3 shows a second embodiment of the housing (100), which is similar to the first embodiment shown in Fig. 2. In contrast to the first embodiment, the housing (100) of the second embodiment comprises a metallic ring portion (30) which is made up of four ring segments (33, 34, 35, 36), each segment forming part of a circular ring and being disposed in a middle portion (201) of a side of the housing base body (10). Furthermore, each of the four ring segments (33, 34, 35, 36) is disposed at a different side of the housing base body (10) and forms part of the circumferential wall (20). The ring segments (33, 34, 35, 36) are arranged in the housing (100) such that they are each spaced apart from each other. In other words, each ring segment is spaced apart from its two neighboring segments. The space between the ring segments is filled by the housing base body so as to form one coherent circumferential wall (20) which has a smooth and continuous surface at its inner side (21).

[0036] Fig. 4a shows a third embodiment of the housing (100), in which the metallic ring portion (30) is made up of four ring segments (33, 34, 35, 36) as shown in Fig. 4b) similar to the second embodiment shown in Fig. 3. Each segment (33, 34, 35, 36) forms part of a circular ring and is disposed in a middle portion (201) of a side of the housing base body (10) (in Fig. 4a only three of the four segments are shown in an installed state). Furthermore, each of the four ring segments (33, 34, 35, 36) is disposed at a different side of the housing base body (10) and forms part of the circumferential wall (20). In contrast to the first and second embodiment, the height (h3) of the ring sections (33, 34, 35, 36) is substantially equal to the height (h2) of the housing (100). In other words, the ring segments (33, 34, 35, 36) extend over the entire height (h2) of the housing (100). In further contrast to the first and second embodiment, the housing base body (10) does not extend around the entire circumference of the circumferential wall (20). Thus, in the area of the middle portions (201) of the sides of the housing (100), the circumferential wall is made up entirely of the ring segments (33, 34, 35, 36). Thus, in the middle portions (201) the thickness of the ring segments (33, 34, 35, 36) corresponds substantially to the thickness of the circumferential wall (20). In the corner portions (202) the circumferential wall (20) is made up of the housing base body (10). Two segments (33, 36) comprise cutouts (37) for mounting of arms (112)

[0037] Fig. 5 shows a fourth embodiment of the housing (100) which is similar to the third embodiment of Figs. 4a and 4b. In contrast, the fourth embodiment comprises a metallic ring portion (30), which is made up of one cohesive, closed ring. The metallic ring portion (30) forms the entire inner side (21) of the circumferential wall (20) and forms the entire circumferential wall in the middle portions (201). The housing base body (10) form part of the circumferential wall (20) only in the corner portions (202). In other words, in this embodiment in the middle portions (201) of the sides of the housing (100) the metallic ring portion (30) forms both of the inner side (21) and the outer side (22) of the circumferential wall (20).

[0038] Fig. 6 shows a fifth embodiment of the housing (100), which is similar to the fourth embodiment shown in Fig. 5. In contrast to the fourth embodiment, the housing (100) of the fifth embodiment shown in Fig. 6 comprises a metallic ring portion (30) made up of one cohesive, closed ring, said ring comprises at least one support portion (37) projecting from the ring. The support portion (37) projects to the outside from an upper section of the ring and is in the shape of a tongue. The support portion (37) rests on a face surface (14) of a corner portion (202) of the housing base body (10). By means of this support portion (37) it can be further ensured that the metallic ring portion (30) is firmly connected to the housing base body (10). Although only one support portion (37) is shown in Fig. 6, it may be readily understood that the metallic ring portion (30) may comprise several support portions, in particular four support portions with each support portion being arranged in a different corner portion.

[0039] The metallic ring portion (30) and the support portion (37) are formed integrally as one piece. Furthermore, in a cross-sectional view (not shown), the support portion (37) projects at approximately right angles of the ring of the metallic ring portion (30) and at an upper side of the metallic ring portion (30).

[0040] In this embodiment where the metallic ring portion (30) is formed as a closed ring, it may also be preferable if the support portion (37) extends along the entire circumference of the ring portion (30). In this way, the support portion (37) may form a rim of the metallic ring portion (30). In case that the metallic ring portion (30) comprises several ring segments (33, 34, 35, 36), it may be preferable that each such ring segment (33, 34, 35, 36) comprises at least one, preferably exactly one, support portion (37).

[0041] Fig. 7 shows a schematic view of a section of a circumferential wall (20) of a housing and a blade (51) of an impeller of an axial fan. In the shown view, the section of the circumferential wall is made up entirely of the metallic ring portion (30). The tip clearance (60) is shown as a gap between the inner side (21) of the circumferential wall (20) and a tip (511) of the blade (51) of the impeller. The tip clearance (60) ensures that the blades of the im-

peller do not touch the circumferential wall (20).

[0042] Fig. 8 shows a schematic diagram of the performance of an axial fan. Two fan curves are illustrated: a first fan curve (61) of an axial fan placed in a housing in accordance with the present invention having a smaller tip clearance, and a fan curve (62) of the same axial fan placed in a different housing not in accordance with the present invention having a larger tip clearance (62). The intersecting points of a system impedance line (63) with the two aforementioned fan curves (61, 62) indicate the performance of each fan. It is clearly shown that a smaller tip clearance results in a better performance of the fan. By employing a housing according to the present invention, a fan may have a smaller tip clearance which leads to an improved performance.

Claims

1. Housing (100) for an axial fan,
wherein the housing comprises a circumferential wall (20),
wherein the housing comprises a housing base body (10) made, in particular entirely, of a plastic material, and
wherein the housing comprises a metallic ring portion (30) made, in particular entirely, of a metallic material, said metallic ring portion being in the shape of a ring or in the shape of at least one ring segment (33, 34, 35, 36), said metallic ring portion (30) forming at least part of the circumferential wall (20) of the housing, and said metallic ring portion (30) being firmly connected with the housing base body (10).

2. Housing according to claim 1,
wherein the housing (100) has an inner area (40) in which an axial fan is disposable,
wherein the circumferential wall (20) of the housing (100) encloses the inner area (40) of the housing, and
wherein the metallic ring portion (30) forms at least part of the inner side (21) of the circumferential wall (20) of the housing (100) facing the inner area (40) of the housing.

3. Housing (100) according to claim 1 or 2,
wherein the metallic material of the metallic ring portion (30) is selected from the group consisting of brass, aluminum, steel, or mixtures thereof.

4. Housing (100) according to any one of the preceding claims,
wherein the metallic ring portion (30) is in the shape of a ring and extends along the entire circumferential wall (20) and/or forms the entire circumferential wall (20), or
wherein the metallic ring portion (30) is in the shape of at least one ring segment, said at least one ring segment (33, 34, 35, 36) forming part of the circumferential wall (20), wherein in said part of the circumferential wall the at least one ring segment(33, 34, 35, 36) forms the entire circumferential wall (20).

5. Housing (100) according to any one of the preceding claims,
wherein the metallic ring portion (30) has a thickness (th) in the range of 0,1 mm to 0,8 mm, preferably in the range of 0,3 mm to 0,7 mm, particularly preferably in the range of 0,4 mm to 0,55 mm.

6. Housing (100) according to any one of the preceding claims,
wherein the metallic ring portion (30) is connected to the housing base body (10) by means of molding, in particular injection molding, gluing and/or pressing.

7. Housing (100) according to any one of the preceding claims,
wherein the height (h3) of the metallic ring portion (30) is less than the height (h2) of the housing (100), preferably less than 90% of the height (h2) of the housing (100), particularly preferably less than 75% of the height (h2) of the housing (100), especially preferably less than 60% of the height (h2) of the housing (100).

8. Housing (100) according to any one of the preceding claims,
wherein the metallic ring portion (30) comprises two side surfaces (31, 32), wherein at least one of said side surfaces, in particular the side surface (32) turned to the outside of the housing (100), being structured.

9. Housing (100) according to any one of the preceding claims,
wherein at least one support portion (37) for supporting the metallic ring portion (30) on the housing base body (10) projects from the metallic ring portion (30), said support portion (37) preferably resting on a face surface (14) of the base housing body (10).

10. Housing (100) according to any one of the preceding claims,
wherein the housing base body (10) has a substantially square basic shape and comprises four sides,
wherein the housing (100) has an inner area (40) in which an impeller is disposable, said inner area (40) being of circular shape, wherein a distance from the inner area (40) to a middle portion (201) of a side of the housing base body (10) is less than a distance from the inner area (40) to a corner portion (202) of the basic housing body (10), in which corner portion (202) two sides of the housing base body (10) abut,
wherein the metallic ring portion (30) is in the shape

of at least one ring segment (33, 34, 35, 36), said at least one ring segment (33, 34, 35, 36) being disposed in the middle portion (201) or proximate to the middle portion (201) of a side of the housing base body (10).

11. Axial fan,
the axial fan comprising a housing (100) according to any one of the preceding claims.

12. Axial fan according to claim 11,
wherein the axial fan comprises an impeller, said impeller comprising at least one blade (51), and
wherein a gap (60) between a tip (511) of the at least one blade (51) and the circumferential wall (20) of the housing (100) is less than 0,8 mm, preferably less than 0,65 mm, particularly preferably less than 0,5 mm, especially preferably less than 0,35 mm.

13. Axial fan according to claim 11 or 12,
wherein the axial fan comprises an impeller, said impeller comprising at least one blade (51), and
wherein the height of the metallic ring portion (30) is more than 50% of the height of the impeller, and/or
wherein the height of the metallic ring portion (30) is less than the height of the impeller, preferably less than 90% of the height of the impeller, particularly preferable less than 80% of the height of the impeller.

14. Method for producing a housing (100) for an axial fan, preferably a housing (100) according to any one of claims 1 to 10, comprising the steps:

arranging a metallic ring portion (30), made, in particular entirely, of a metallic material, said metallic ring portion (30) being in the shape of a ring or in the shape of at least one ring segment (33, 34, 35, 36), in a mold, and
injecting a plastic material in the mold for forming a housing (100) for an axial fan.

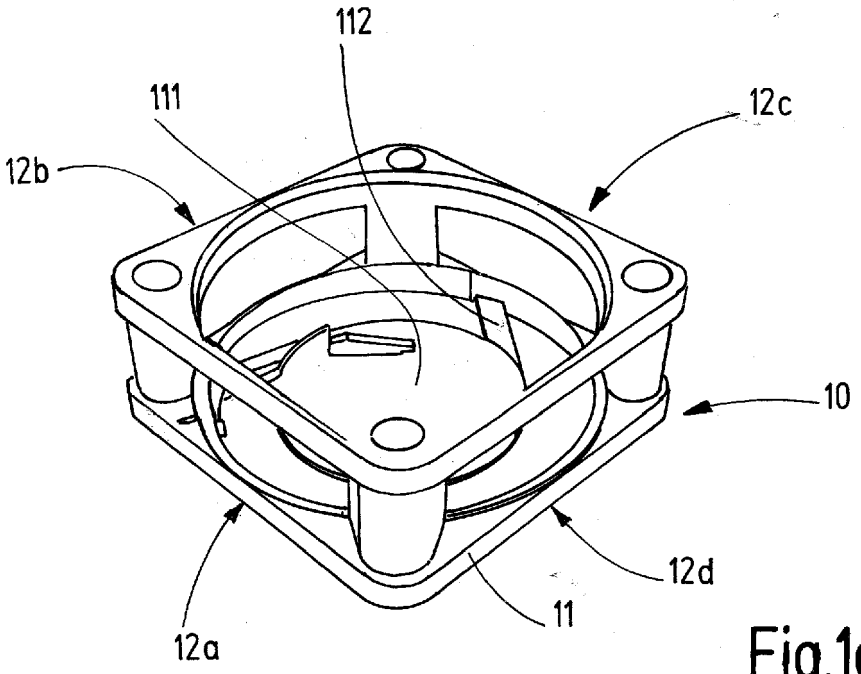

Fig.1a

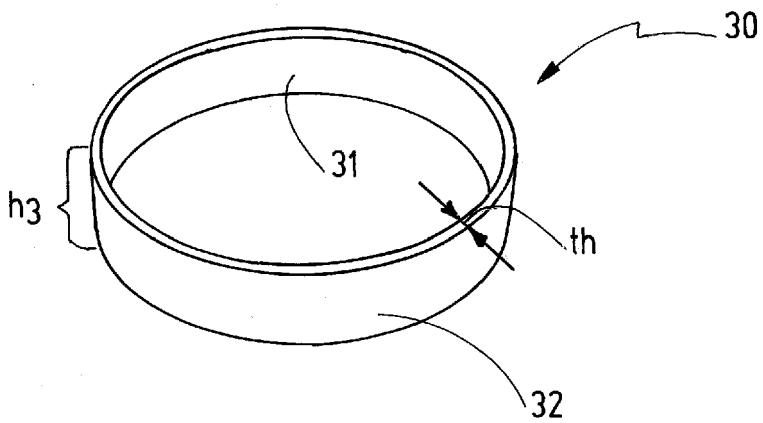

Fig.1b

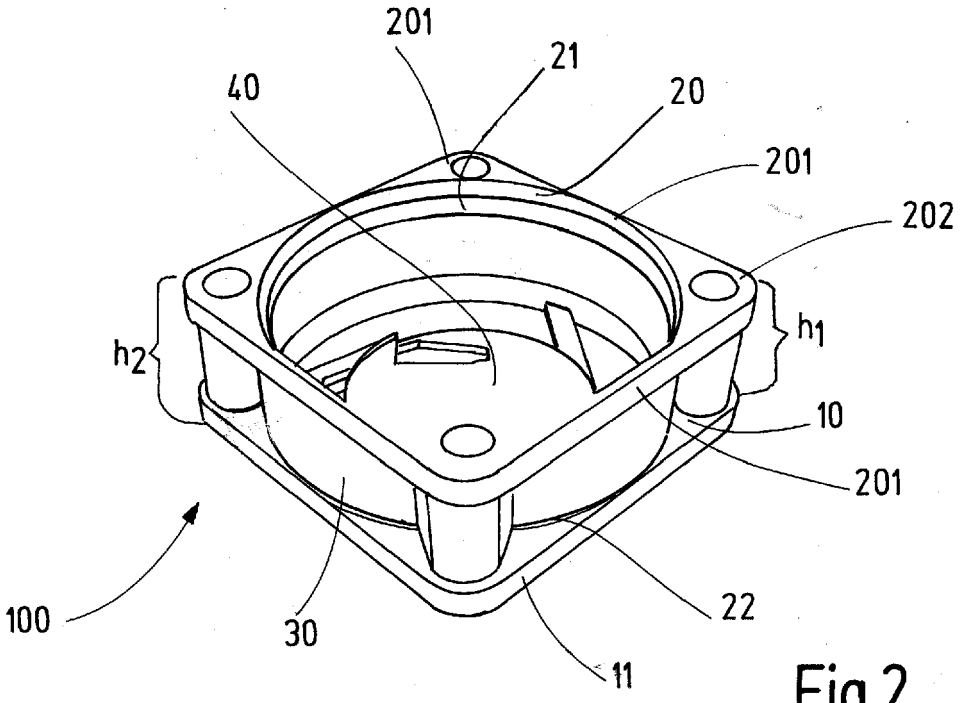
201
21
40
20
201
202
h2
h1
10
201
100
30
22
11

Fig.2

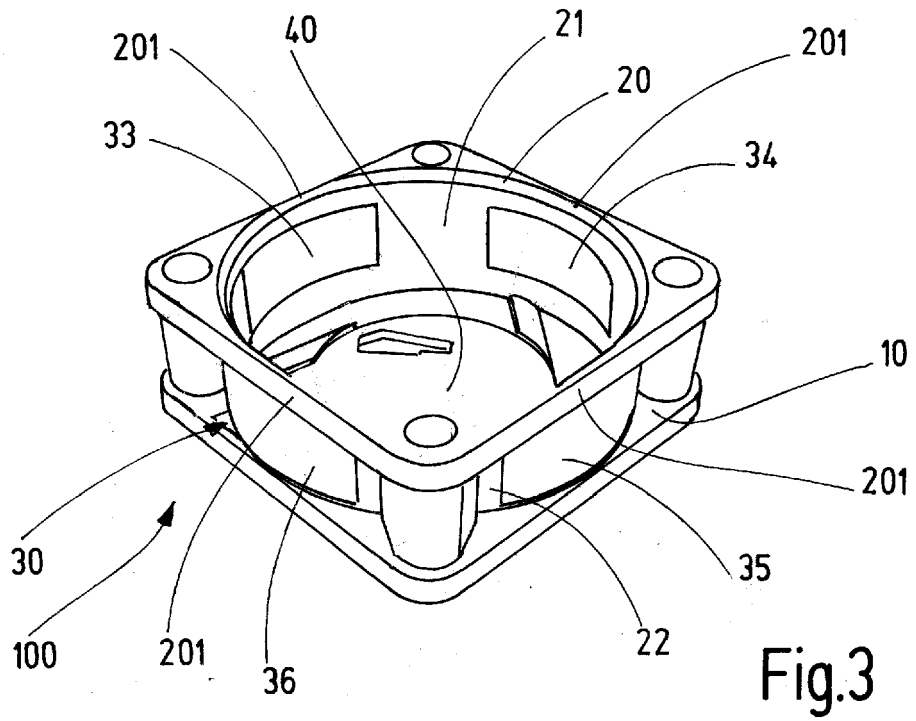
201
40
21
201
20
33
34
10
201
30
35
100
201
36
22

Fig.3

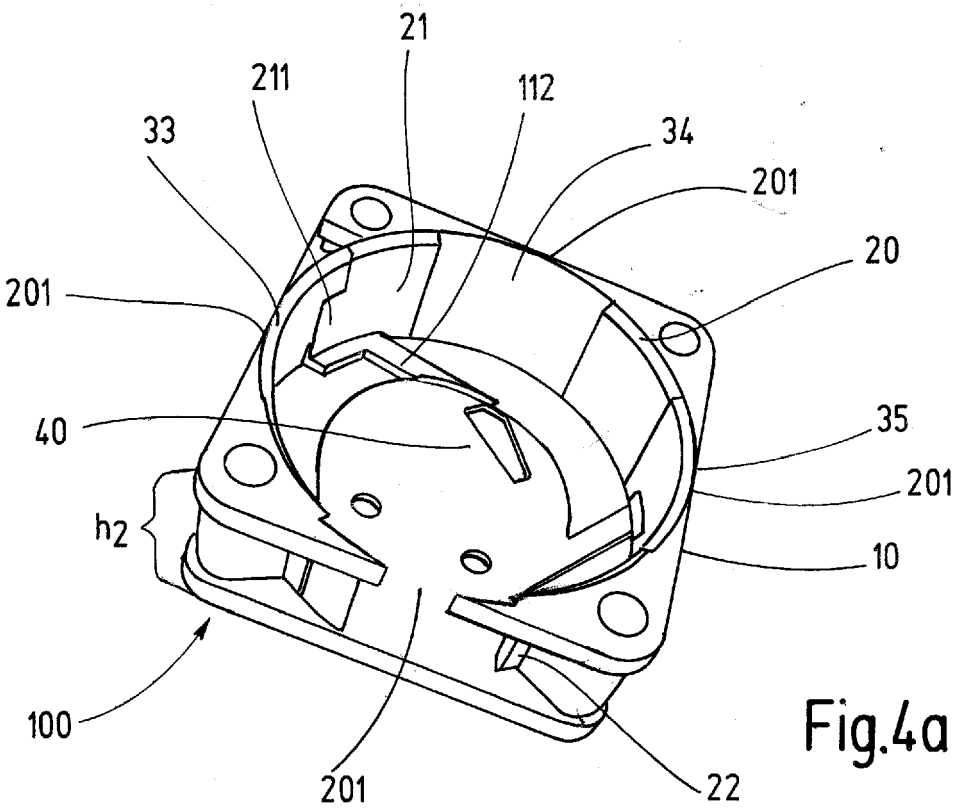
21
211
112
33
34
201
20
201
40
35
201
h2
10
100
201
22

Fig.4a

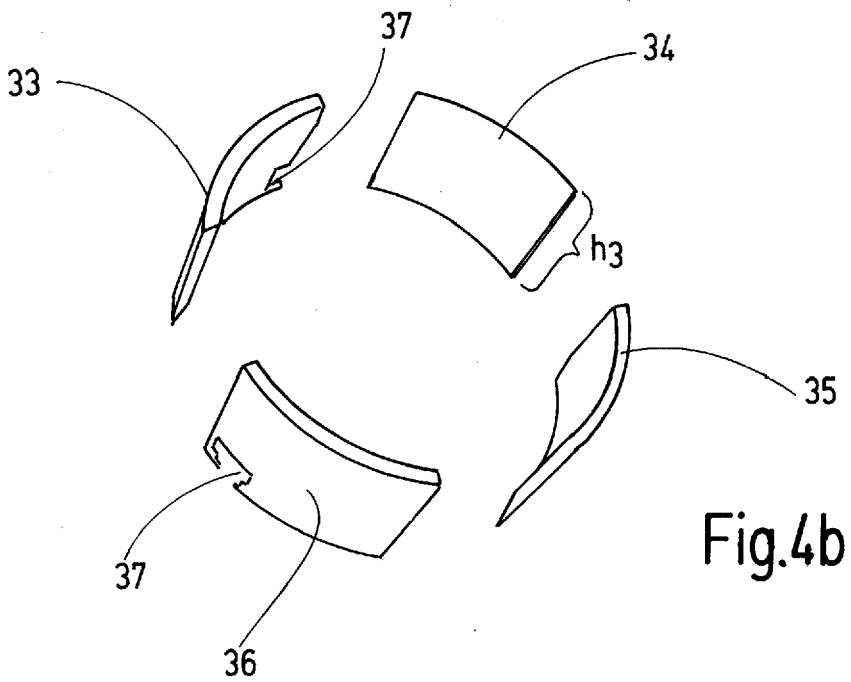
37
34
33
h3
35
37
36

Fig.4b

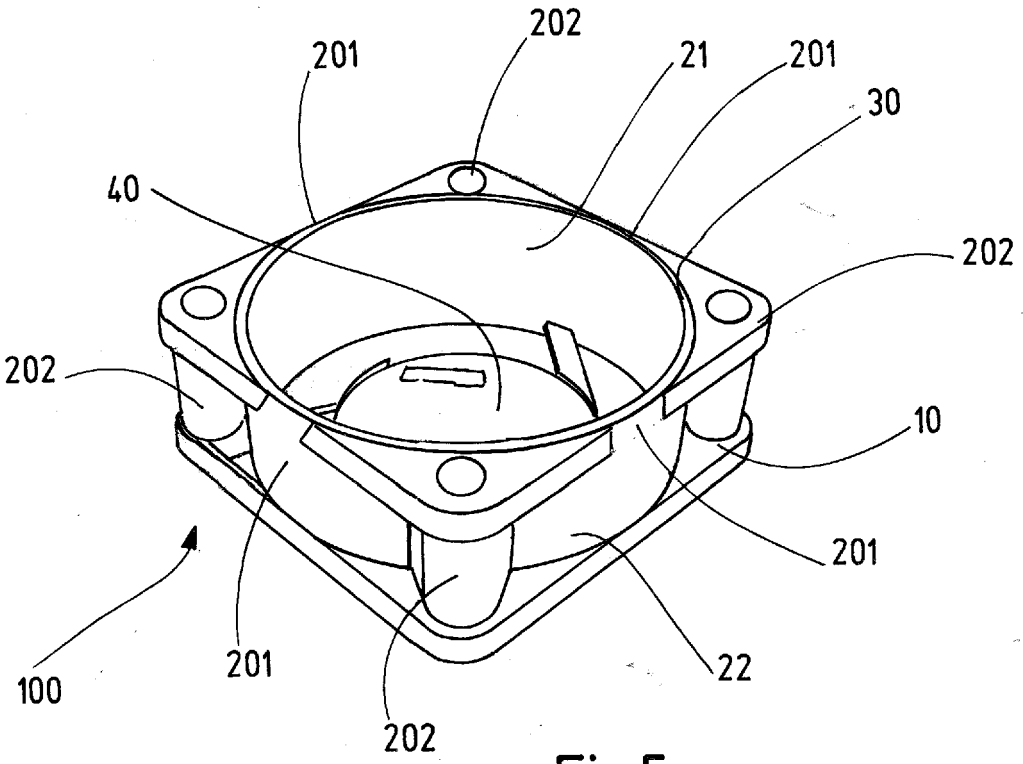
202
201
21
201
30
40
202
202
10
201
100
201
22
202

Fig.5

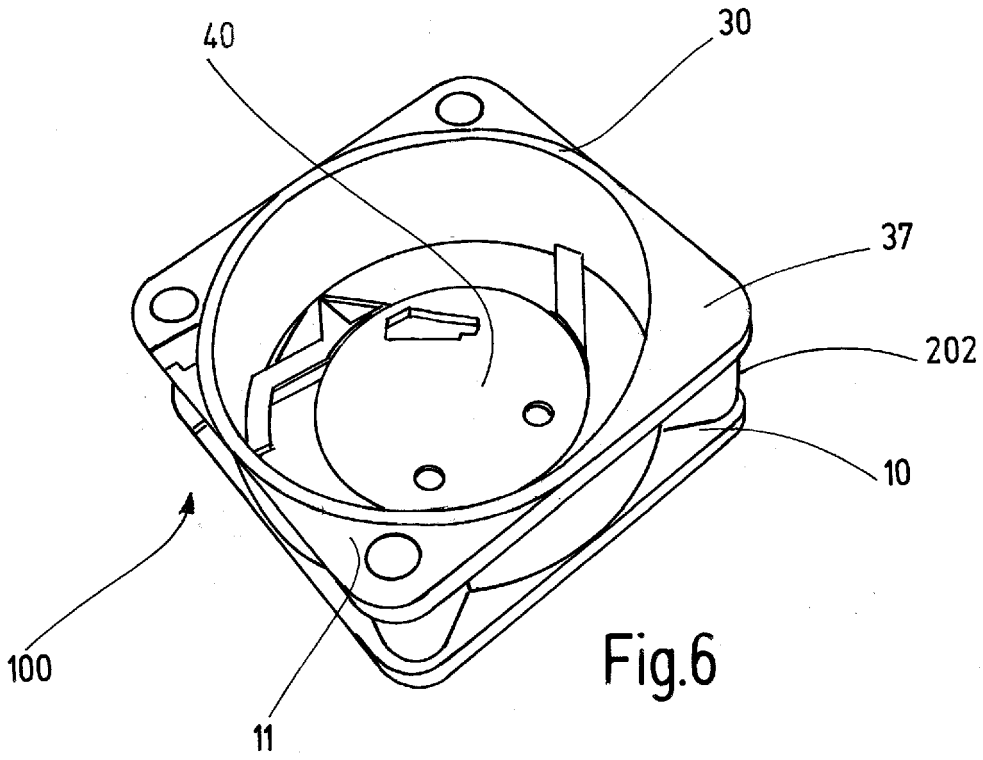
40
30
37
202
10
100
11

Fig.6

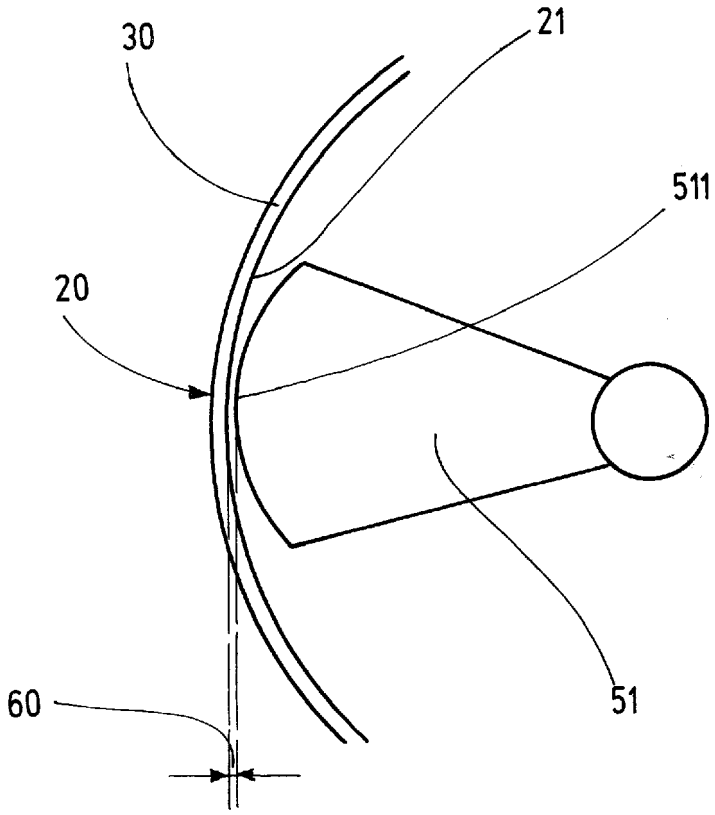

Fig.7

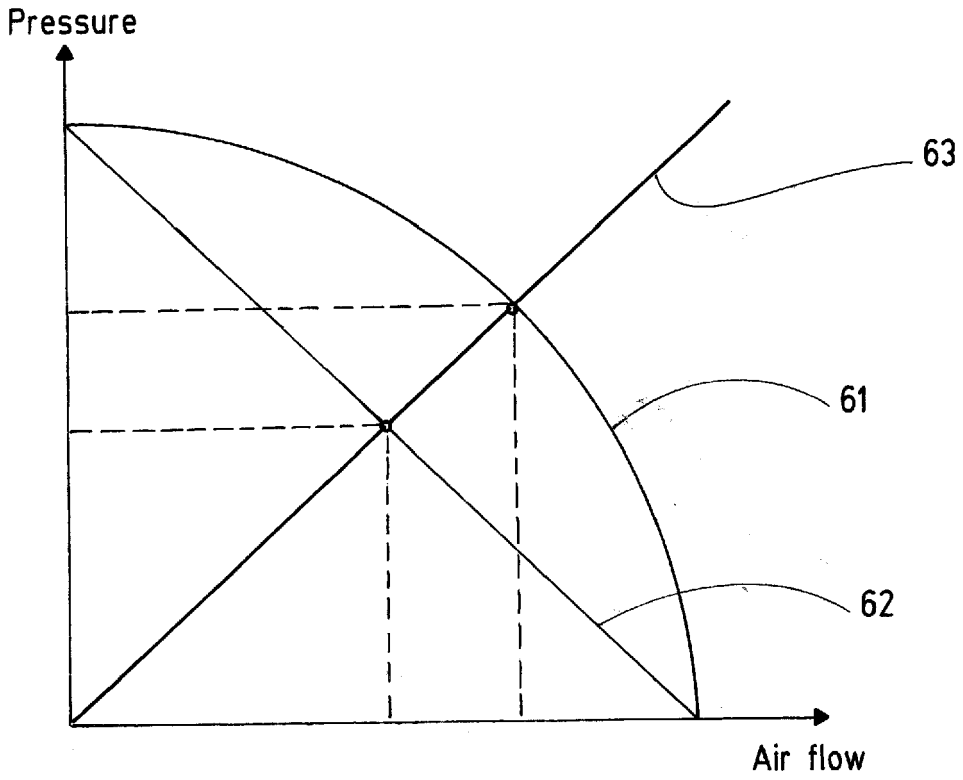

Fig.8

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 19 0993

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	JP H04 103297 U (SEIKO [JP]) 7 September 1992 (1992-09-07) * paragraphs [0001] - [0007] * * figure 1 *	1-7,9-14 8	INV. F04D19/00 F04D29/02 F04D29/52
X	DE 20 2016 100787 U1 (HEYLO GMBH [DE]) 7 April 2016 (2016-04-07) * paragraphs [0009], [0027], [0028], [0031] - [0033] * * figures 2-4 *	1-5,7,8, 11-13	
X	CH 600 165 A5 (MATEC HOLDING) 15 June 1978 (1978-06-15) * column 2, line 52 - column 3, line 19 * * figures 1,2 *	1-4,8, 11,13	
A	US 2009/169377 A1 (HORNG ALEX [TW]) 2 July 2009 (2009-07-02) * paragraphs [0036] - [0041] * * figures 2-6 *	1,6,14	
			TECHNICAL FIELDS SEARCHED (IPC) F04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	1 February 2019	Gombert, Ralf

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 19 0993

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

01-02-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP H04103297 U	07-09-1992	NONE	
DE 202016100787 U1	07-04-2016	NONE	
CH 600165 A5	15-06-1978	CH 600165 A5	15-06-1978
		FR 2330859 A1	03-06-1977
US 2009169377 A1	02-07-2009	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82