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(54) **FRAME FOR AN AXIAL FAN, AN AXIAL FAN, AND A METHOD FOR PRODUCING SUCH A FRAME**

(57) The present invention relates to a frame (3) for an axial fan (5), wherein the frame (3) comprises a plastic base part (2) and a metal ring part (1), wherein the plastic base part (2) is provided with an air inlet side (23) and an air outlet side (24), the plastic base part (2) further comprising a wall (21) enclosing a cylindrical space (22), the air inlet side (23) and the air outlet side (24) communicating via the cylindrical space (22), and the cylindrical space (22) being configured to accommodate an impeller (4), wherein the metal ring part (1) is connected to the wall (21) of the plastic base part (2), a height (hi) of the metal ring part (1) is less than 8% of a height (h2) of the wall (21) of the plastic base part (2), preferably less than 7%, more preferably less than 6%, especially preferably less than 5%.

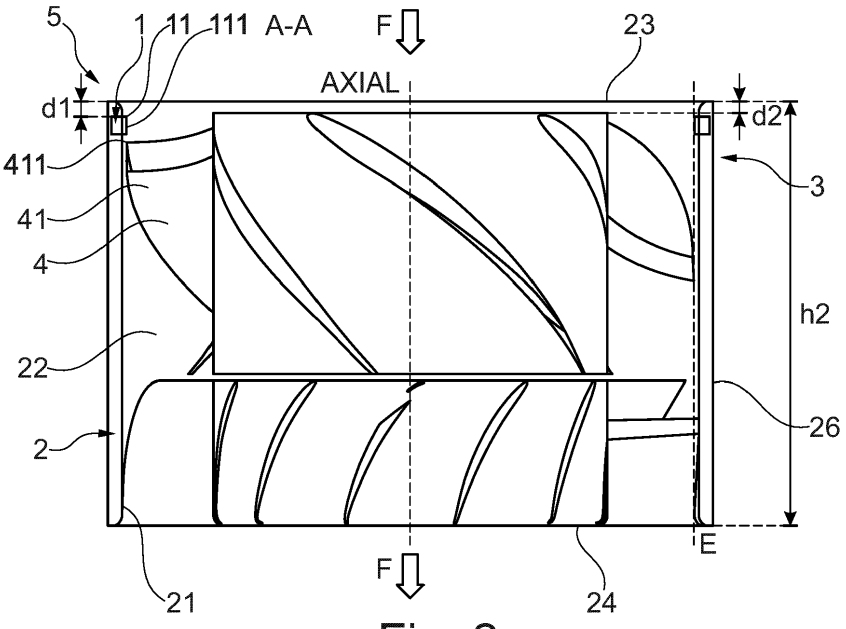

Fig. 2

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Description

Field of the invention

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

State of the art

[0002] Axial fans are widely used for general purpose applications, such as ventilation, to supply fresh air into a room, a vehicle, etc., heat dissipation, or to cool down computers, car engines, workplaces, etc.

[0003] Usually, an axial fan comprises an impeller with at least one blade, and a frame for containing the impeller. When the impeller rotates around an axial axis of the fan, air is drawn in and blown out in the axial direction of the fan, namely, the axial direction being in parallel to the air flow direction. For the impeller to rotate without interference, a clearance should be arranged between the at least one blade and the frame. However, the larger the clearance is, the more turbulence is generated within the clearance area, leading to more noise, and the smaller the effective size of the impeller will be (when the overall size of the fan is determined), degrading the efficiency of the axial fan.

[0004] A frame for an axial fan is conventionally made of plastic material by, for example, injection moulding. For such plastic frames, a large clearance between the frame and the at least one blade of the impeller is inevitably due to the usually large inaccuracies of production. It is therefore proposed in the state of the art, such as in EP3617521A1, to adopt a frame that is at least partially made of metal materials, wherein the part made of metal material(s) is arranged to face the impeller. In this case, the clearance can be considerably reduced thanks to the smaller inaccuracies of production for metal materials. But at the same time the manufacturing costs, especially the cost for metal materials and/or the cost for processing metal materials, are greatly increased.

Summary of the invention

[0005] It is an objective of the present invention to provide axial fans with good performance characteristics while at the same time reduce the manufacturing costs.

[0006] For achieving this objective, the present invention provides a frame for an axial fan. The frame comprises a plastic base part and a metal ring part, wherein the plastic base part is provided with an air inlet side and an air outlet side, the plastic base part further comprising a wall enclosing a cylindrical space, the air inlet side and the air outlet side of the plastic base part communicate via the cylindrical space, and the cylindrical space being configured to accommodate an impeller. The metal ring part is connected to the wall of the plastic base part, wherein a height of the metal ring part is less than 8% of a height of the wall, preferably less than 7%, more preferably less than 6%, especially preferably less than 5%.

[0007] It can be understood that the above-mentioned frame comprises two essential components, the plastic base part and the metal ring part. The wall of the plastic base part encloses the cylindrical space, which is in particular suitable to accommodate an impeller. The air inlet side and the air outlet side of the plastic base part communicate via the cylindrical space. When an impeller is disposed in the frame and starts to rotate, the air flows into the frame from the air inlet side and flows out from the air outlet side, thereby defining an air flow direction, which is essentially parallel to an axial direction of the axial fan. The air inlet side in particular refers to the surface where the plastic base part starts when viewed in the air flow direction, and the air outlet side in particular refers to the surface where the plastic base part ends when viewed in the air flow direction.

[0008] It can be understood that the metal ring part of the above-mentioned frame is connected to the wall of the plastic base part, and the metal ring part and the wall of the plastic base part are preferably coaxial with regard to each other. In an embodiment of the invention, the metal ring part is entirely covered by the wall of the plastic base part. In another embodiment of the invention, the metal ring part is at least partially covered by the wall of the plastic base part.

[0009] It can also be understood that the height of the metal ring part is less than 8% of the height of the wall of the plastic base part, wherein the height is measured in the air flow direction and is to be understood to be the largest extension of the metal ring part or the wall of the plastic base part in the air flow direction. Preferably, the height of the metal ring part is less than 7% of the height of the wall of the plastic base part; more preferably, less than 6% ; and especially preferably, less than 5%. It can be understood that by configuring the height of the metal ring part much shorter than the height of the wall of the plastic base part, the material cost for the metal ring part can be greatly reduced, and at the same time, it is surprisingly found out that the stability of the frame is still very high even if the metal ring part has only a small height, i.e. is very narrow in the air flow direction.

[0010] In an embodiment of the invention, the metal ring part has an inner section inwardly protruding from the wall of the plastic base part towards the cylindrical space, wherein the inner section in particular refers to surfaces of the metal ring part not covered by the plastic base part. It can be understood that when an impeller is disposed in the frame, the impeller is closest to the inner section of the metal ring part as compared to any other parts of the frame when viewed in a radial direction of the impeller, wherein the radial direction of the impeller is perpendicular to the air flow direction.

[0011] In an embodiment of the invention, a shortest distance between the air inlet side and the metal ring part is less than 5% of the height of the wall of the plastic base part, wherein the shortest distance between the air inlet

side and the metal ring part is in particular the distance, measured in the air flow direction, from the air inlet side to the surface where the metal ring part starts when viewed in the air flow direction. Preferably, the shortest distance is less than 3% of the height of the wall of the plastic base part; and more preferably, less than 2%a. It can be understood that the metal ring part is in particular placed close to the air inlet side, such that when an impeller is disposed in the frame and starts to rotate, the metal ring part can facilitate the pressure to be built up inside the frame and can ensure a high-quality performance of the axial fan.

[0012] In an embodiment of the invention, the metal ring part consists of one metal ring. It can be understood that the material cost for the metal ring part can thus be greatly reduced and the manufacturing process is simple.

[0013] In an alternative embodiment of the invention, the metal ring part comprises a plurality of metal rings, and the plurality of metal rings are arranged along the air flow direction in succession. In particular, the plurality of metal rings have the same outer diameters. Preferably, the plurality of metal rings have the same outer diameters and the same inner diameters. More preferably, the plurality of metal rings are identical in size, namely the same outer diameters, inner diameters and heights measured in the air flow direction, so as to simplify the manufacturing process and reduce the manufacturing cost of the metal ring part. The plurality of metal rings are arranged at an interval along the air flow direction in succession, wherein the intervals between any two adjacent metal rings can be altering or constant. Preferably, the intervals between any two adjacent metal rings are constant. More preferably, the plurality of metal rings are stacked along the air flow direction in succession without spacing between any two adjacent metal rings.

[0014] In another alternative embodiment of the invention, the metal ring part comprises a plurality of metal ring sections, wherein the plurality of metal ring sections are arranged in a way that the metal ring part as an integral has no gap along a circumferential direction of the plastic base part, so that when an impeller is disposed in the frame and starts to rotate, the metal ring part as an integral can prevent pressure leakage, facilitate the pressure to be built up inside the frame, and ensure a high-quality performance of the axial fan. In particular, the plurality of the metal ring sections have the same outer diameters. Preferably, the plurality of metal ring sections have the same outer diameters and the same inner diameters. More preferably, the plurality of metal ring sections have the same outer diameters, inner diameters and heights measured in the air flow direction. Especially preferably, the plurality of metal ring sections are identical in size, including the same outer diameters, inner diameters, heights measured in the air flow direction and arc lengths, in order to simplify the manufacturing process and reduce the manufacturing cost of the metal ring part. It can be understood that when the metal ring part comprising the plurality of metal ring sections is connected to the wall of the plastic base part, each of the plurality of metal ring sections can have a same or a different shortest distance, measured in the air flow direction, to the air inlet side. For example, the plurality of metal ring sections can be divided into two or more groups (e.g. Group A and Group B) according to their shortest distance to the air inlet side; metal ring sections in the same group all have the same shortest distance to the air inlet side, while metal ring sections in Group A have a smaller shortest distance to the air inlet side than those in Group B; metal ring sections in Group A are spaced from each other in the circumferential direction of the plastic base part, thereby creating a gap between each two adjacent metal ring sections in Group A, and the metal ring sections in Group B having a larger shortest distance to the air inlet side, are arranged to block the gaps between each two adjacent metal ring sections in Group A, such that the metal ring formed by metal ring sections in Group A and B as an integral have no gap along the circumferential direction of the plastic base part. Other arrangements of the plurality of metal ring sections to form the metal ring part as an integral with no gap along the circumferential direction of the plastic base part are also possible.

[0015] In an embodiment of the invention, the frame consists of the metal ring part and the plastic base part.

[0016] In an embodiment of the invention, the metal ring part is insert-moulded with the plastic base part. It can be understood that the frame is formed as an integral when the metal ring part is insert-moulded with the plastic base part.

[0017] In an alternative embodiment of the invention, the metal ring part is interference fitted with the wall of the plastic base part. In particular, the outer diameter of the metal ring part is slightly larger than the inner diameter of the wall of the plastic base part, wherein the outer diameter of the metal ring part refers to its largest diameter, while the inner diameter of the wall of the plastic base part refers to its smallest diameter. Preferably, the metal ring part is provided with a certain degree of elasticity, such that during assembly, the metal ring part can be compressed and contract inwards, allowing the metal ring part to enter the cylindrical space enclosed by the wall of the plastic base part; and by stopping compressing the metal ring part, the metal ring part restores and interference fits with the wall of the plastic base part.

[0018] In another alternative embodiment of the invention, a groove for the metal ring part to fit in is provided on the wall of the plastic base part. In particular, the groove has a height measured along the air flow direction not smaller than the height of the metal ring part. Preferably, when the metal ring part comprises a plurality of metal rings, the groove comprises a plurality of sub-grooves arranged at an interval along the air flow direction in succession, wherein each of the plurality of sub-grooves has a height, measured along the air flow direction, not smaller than a height, measured along the air flow direction, of at least one of the plurality of metal rings, and wherein the interval between any two adjacent sub-

grooves is not larger than an interval between any two adjacent metal rings. Other arrangements to provide the groove suitable for the metal ring part to fit in are also possible, for example, when the metal ring part comprises a plurality of metal ring sections, the groove comprising a plurality of sub-groove sections.

[0019] In an embodiment of the invention, in which a groove for the metal ring part to fit in is provided on the wall of the plastic base part, the metal ring part is disposed in the groove. In particular, the outer diameter of the metal ring part is slightly larger than the inner diameter of the wall of the plastic base part, wherein the outer diameter of the metal ring part refers to its largest diameter, while the inner diameter of the wall of the plastic base part refers to its smallest diameter. Preferably, the metal ring part is provided with a certain degree of elasticity, such that during assembly, the metal ring part can be compressed and contract inwards, allowing the metal ring part to enter the cylindrical space enclosed by the wall of the plastic base part; and by stopping compressing the metal ring part, the metal ring part restores and snaps in the groove provided on the wall of the plastic base part.

[0020] In yet another alternative embodiment of the invention, the metal ring part is glued on the wall of the plastic base part. In particular, the outer diameter of the metal ring part equals to or is slightly smaller than the inner diameter of the wall of the plastic base part, wherein the outer diameter of the metal ring part refers to its largest diameter, while the inner diameter of the wall of the plastic base part refers to its smallest diameter; and a layer of adhesive is provided between the metal ring part and the wall of the plastic base part.

[0021] In an embodiment of the invention, the metal ring part is entirely made of a metallic material.

[0022] In an embodiment of the invention, the metal ring part is a stamped part. In an alternative embodiment of the invention, the metal ring part comprises a plurality of stamped parts. The metal ring part is made of SECC (Galvanized steel) and/or SPCD (Steel Plate Cold Deep Drawn steel). Preferably, the metal ring part is entirely made of SECC, or the metal ring part is entirely made of SPCD. It can be understood that the present invention particularly designs to allow the metal ring part to be a stamped part or to comprise a plurality of stamped parts, making the metal ring part suitable to be produced in mass production, and allowing the use of less expensive metallic materials such as SECC and SPCD, thereby reducing the manufacturing cost of the axial fan.

[0023] In an embodiment of the invention, the plastic base part is entirely made of a plastic material.

[0024] In conclusion, the frame for an axial fan according to the present invention, when an impeller is disposed in the frame, allows a small clearance to be provided between the impeller and the frame, because a metal ring part is provided between the impeller and the plastic base part of the frame. At the same time, the manufacturing process and the manufacturing costs of the metal ring part, and therefore the frame for the axial fan, are simplified and reduced, by providing the metal ring part with a much smaller height in the air flow direction comparing to the plastic base part. In particular, this allows the metal ring part to be a stamped part or comprise a plurality of stamped parts suitable for mass production, and consequently allows the use of cheaper metallic materials such as SECC and SPCD. Last but not least, the metal ring part can facilitate the pressure to be built up inside the frame, when an impeller is disposed in the frame and the impeller starts to rotate, and can ensure a high-quality performance of the axial fan, while surprisingly is still able to retain a reasonably high stability of the frame.

[0025] For achieving the technical objective, the present invention further provides an axial fan. Preferably, the axial fan comprises a frame as described above.

[0026] In an embodiment of the invention, the axial fan further comprises an impeller and the impeller is disposed in the cylindrical space, wherein the inner section of the metal ring part has an inner surface extending along the air flow direction of the axial fan and facing the cylindrical space. It can be understood that the inner section inwardly protrudes from the wall of the plastic base part towards the cylindrical space where the impeller is disposed, while the metal ring part has its smallest diameter at the inner surface, and consequently the impeller is closest to the inner surface of the inner section of the metal ring part comparing to any other parts of the frame.

[0027] In an embodiment of the invention, the axial fan is provided with an axial axis, and the impeller is provided with at least one blade, which is configured to rotate together with the impeller when the impeller starts to rotate around the axial axis. It can be understood that, each of the at least one blade of the impeller has a tip, wherein the tip is the end point of the at least one blade, namely the tip being the farthest point of the at least one blade measured from the axial axis in the radial direction of the impeller. When the at least one blade is provided to be more than one, all the at least one blade have the same distance measured from the axial axis to the tip of the at least one blade in the radial direction of the impeller. According to the present embodiment, when the tip of the at least one blade is directly facing the inner surface, a clearance between the tip of the at least one blade and the inner surface is between a range of 0,02 mm to 0,07 mm. It can be understood that the clearance between the tip of the at least one blade and the inner surface represents the smallest distance between the impeller and the frame. Preferably, the clearance is between 0,02 mm to 0,06 mm; and more preferably, between 0,02 mm to 0,05 mm. According to the present embodiment, when the tip of the at least one blade is not directly facing the inner surface, an (imaginary) extension of the inner surface along the air flow direction is defined, and a clearance between the tip of the at least one blade and the extension of the inner surface along the air flow direction is between a range of 0,02 mm to 0,07 mm. It can be understood that the clearance between the tip of the at

least one blade and the extension of the inner surface along the air flow direction represents the smallest distance between the impeller and the frame. Preferably, the clearance is between 0,02 mm to 0,06 mm; and more preferably, between 0,02 mm to 0,05 mm.

[0028] In an embodiment of the invention, the shortest distance from the air inlet side to the metal ring part and a shortest distance from the air inlet side to the impeller have an absolute difference of less than 5% of the height of the wall of the plastic base part, wherein an absolute difference refers to the absolute value of the difference between the two shortest distances. Preferably, the absolute difference is less than 3% of the height of the wall of the plastic base part; more preferably, less than 1%; and especially preferably, the absolute difference is essentially 0, which means the metal ring part and the impeller are especially preferred to start at the same point in the air flow direction, so that when the impeller starts to rotate, the metal ring part can facilitate the pressure to be built up inside the frame and can ensure a high-quality performance of the axial fan.

[0029] In conclusion, the axial fan according to the present invention therefore achieves a small clearance between the impeller and the frame by providing a metal ring part between them. At the same time, the manufacturing process and the manufacturing costs of the metal ring part, and therefore the frame for the axial fan, are simplified and reduced, by providing the metal ring part with a much smaller height in the air flow direction comparing to the plastic base part. In particular, this allows the metal ring part to be a stamped part or comprise a plurality of stamped parts suitable for mass production, and consequently allows the use of cheaper metallic materials such as SECC and SPCD. Last but not least, when the impeller of the axial fan according to the present invention starts to rotate, the metal ring part can facilitate the pressure to be built up inside the frame and can ensure a high-quality performance of the axial fan, while surprisingly is still able to retain a reasonably high stability of the frame.

[0030] For achieving the technical objective, the present invention further provides a method for producing an axial fan. In an embodiment of the invention, the method is adopted for producing an axial fan comprising a frame as described above. In a preferred embodiment of the invention, the method is adapted for producing an axial fan as described above.

[0031] In an embodiment of the invention, the method comprises the following steps:

step S1: forming a metal ring part, and
step S2: forming a plastic base part and forming a frame by connecting the metal ring part to the plastic base part.

[0032] In an embodiment of the invention, step S1 comprises the following sub-step:
step S111: stamping a metal ring as the metal ring part.

[0033] Preferably, the metal ring is made of SECC (Galvanized steel) or SPCD (Steel Plate Cold Deep Drawn steel). More preferably, the metal ring part is entirely made of SECC, or the metal ring part is entirely made of SPCD. It can be understood that the metal ring part provided by step S111 may consist of one metal ring.

[0034] In an alternative embodiment of the invention, step S1 comprises the following sub-step:
step S121: stamping a plurality of metal rings as the metal ring part.

[0035] Preferably, the metal ring is made of SECC (Galvanized steel) and/or SPCD (Steel Plate Cold Deep Drawn steel). More preferably, the metal ring part is entirely made of SECC, or the metal ring part is entirely made of SPCD. It can be understood that the metal ring part provided by step S121 may comprise a plurality of metal rings.

[0036] In another alternative embodiment of the invention, step S1 comprises the following sub-step:
Step S121': stamping a plurality of metal ring sections as the metal ring part.

[0037] Preferably, the metal ring section is made of SECC (Galvanized steel) and/or SPCD (Steel Plate Cold Deep Drawn steel). More preferably, the metal ring part is entirely made of SECC, or the metal ring part is entirely made of SPCD. It can be understood that the metal ring part provided by the sub-step S121' may comprise a plurality of metal ring sections.

[0038] In an embodiment of the invention, step S2 comprises the following sub-steps:

step S211: placing the metal ring part into a mould, and
step S212: insert-injecting a plastic material in the mould, forming the plastic base part and the frame at the same time.

[0039] Preferably, when the metal ring part comprises a plurality of metal rings, in step S211, the plurality of metal rings are arranged along an axial direction of the mould in succession; or when the metal ring part comprises a plurality of metal ring sections, in step S211, the plurality of metal ring sections are arranged in a way that the metal ring part as an integral has no gap along a circumferential direction of the mould.

[0040] In an alternative embodiment of the invention, step S2 comprises the following sub-steps:

step S221: injecting a plastic material into a mould to form the plastic base part, and
step S222: inference fitting the metal ring part with the plastic base part.

[0041] Preferably, when the metal ring part comprises a plurality of metal rings, in step S222, the plurality of metal rings are arranged along an axial direction of the plastic base part in succession; or when the metal ring part comprises a plurality of metal ring sections, in step

S222, the plurality of metal ring sections are arranged in a way that the metal ring part as an integral has no gap along a circumferential direction of the plastic base part. The metal ring part is disposed into the plastic base part through the air inlet side and/or the air outlet side. Preferably, the metal ring part is disposed into the plastic base part through the air inlet side.

[0042] In another alternative embodiment of the invention, step S2 comprises the following sub-steps:

step S231: injecting a plastic material into a mould to form the plastic base part, wherein a groove is provided on the wall of the plastic base part, and
step S232: snapping the metal ring part in the groove of the plastic base part.

[0043] Preferably, when the metal ring part comprises a plurality of metal rings, in step S232, the plurality of metal rings are arranged along an axial direction of the plastic base part in succession; or when the metal ring part comprises a plurality of metal ring sections, in step S232, the plurality of metal ring sections are arranged in a way that the metal ring part as an integral has no gap along a circumferential direction of the plastic base part. The metal ring part is snapped into the plastic base part through the air inlet side and/or the air outlet side. Preferably, the metal ring part is snapped into the plastic base part through the air inlet side.

[0044] In an embodiment of the invention, in step S2 of the method for producing a frame for an axial fan, the metal ring part is connected to the plastic base part in a way, that a shortest distance between the air inlet side and the metal ring part is less than 5% of the height of the wall of the plastic base part, wherein the shortest distance between the air inlet side and the metal ring part is in particular the distance, measured in the axial direction of the plastic base part, air inlet side to the surface where the metal ring part starts when viewed in the axial direction of the plastic base part. Preferably, the shortest distance is less than 3% of the height of the wall of the plastic base part; more preferably, less than 2%. In can be understood that, the metal ring part is in particular placed closer to the air inlet side, such that when an impeller is disposed in the frame and starts to rotate, the metal ring part can facilitate the pressure to be built up inside the frame, and can ensure a high-quality performance of the axial fan.

[0045] In conclusion, the method for producing a frame for an axial fan according to the present invention therefore can produce a frame that achieves a small clearance between the impeller and the frame by providing a metal ring part between them. At the same time, the manufacturing process and the manufacturing costs of the metal ring part, and therefore the frame for the axial fan, are simplified and reduced, by providing the metal ring part with a much smaller height in the air flow direction comparing to the plastic base part. In particular, this allows the metal ring part to be a stamped part or comprise a plurality of stamped parts suitable for mass production, and consequently allows the use of cheaper metallic materials such as SECC and SPCD. Last but not least, when the impeller of the axial fan according to the present invention starts to rotate, the metal ring part can facilitate the pressure to be built up inside the frame and can ensure a high-quality performance of the axial fan, while surprisingly is still able to retain a reasonably high stability of the frame.

Brief description of the figures

[0046] The invention is explained below with preferred embodiments as shown by figures:

Fig. 1 a perspective view of an axial fan according to an embodiment of the present invention;
Fig. 2 a sectional view in A-A direction of Fig. 1;
Fig. 3 a perspective view of the axial fan in Fig. 1 wherein the plastic base part of the frame is transparentised;
Fig. 4 a top view of the axial fan in Fig. 1 wherein the plastic base part of the frame is transparentised;
Fig. 5 an enlarged partial view of section B in Fig. 4;
Fig. 6 a perspective view of the frame for the axial fan in Fig. 1;
Fig. 7 a sectional view in D-D direction of Fig. 6;
Fig. 8 a perspective view of an alternative frame for the axial fan in Fig. 1.

Preferred embodiments of the invention

[0047] Fig. 1 shows an embodiment of an axial fan 5 according to the present invention, and Fig. 2 provides the sectional view of the axial fan 5 in A-A direction of Fig. 1. The axial fan comprises a frame 3 and an impeller 4. When the impeller 4 starts to rotate, air flows into the frame 3 from an air inlet side 23 and flows out from an air outlet side 24, thereby defining an air flow direction F, which is parallel to an axial direction of the axial fan 5.

[0048] Fig. 6 and 7 depict an embodiment of the frame 3 for the axial fan 5 in more details. The frame 3 consists of a plastic base part 2 and a metal ring part 1, wherein the metal ring part 1 is connected to the plastic base part 2.

[0049] As shown in Fig. 6, the plastic base part 2 comprises a wall 21 enclosing a cylindrical space 22 in particular suitable to accommodate an impeller 4. The metal ring part 1 is connected to the wall 21 of the plastic base part 2, and the metal ring part 1 and the wall 21 are coaxial with regard to each other. The plastic base part 2 further comprises an outer wall 26 that depicts a substantially cuboid shape of the exterior of the plastic base part 2. At least one through hole 27 or threaded hole 27 is provided in at least one corner of the plastic base part 2 along the air flow direction F, such that the plastic base part 2, consequently the frame 3 as an integral, can be easily

connected to other devices such as a vehicle etc. Furthermore, the plastic base part 2 comprises a mounting seat 25 suitable for an impeller 4 to mount on, wherein the mounting seat 25 comprises a cylindrical part 251 supporting an impeller 4, and at least one supporting blade 252 provided around the cylindrical part 251 to connect the cylindrical part 251 to the wall 21 of the plastic base part 2. The mounting seat 25 is provided close to the air outlet side 24, and the at least one supporting blade 252 is in particular configured not to block or impede the air from flowing out of the frame 3 from the air outlet side 24.

[0050] Fig. 7 is a sectional view in the D-D direction of Fig. 6, which shows more clearly that the metal ring part 1 is entirely covered by the wall 21 of the plastic base part 2, and the air inlet side 23 and the air outlet side 24 of the frame 3 are provided on the plastic base part 2, wherein the air inlet side 23 refers to the surface where the plastic base part 2 starts when viewed in the air flow direction F, while the air outlet side 24 refers to the surface where the plastic base part 2 ends when viewed in the air flow direction F. The air inlet side 23 and the air outlet side 24 of the plastic base part 2 communicate via the cylindrical space 22. The metal ring part 1 is provided with an inner section 11 inwardly protruding from the wall 21 of the plastic base part 2 towards the cylindrical space 22, wherein the inner section 11 refers to surfaces of the metal ring part 1 not covered by the plastic base part 2. The inner section 11 is further provided with an inner surface 111 extending along the air flow direction F and facing the cylindrical space 22, wherein the metal ring part 1 has its smallest diameter at the inner surface 111.

[0051] A height h1 of the metal ring part 1 measured in the air flow direction F is the largest extension of the metal ring part 1 in the air flow direction F, while a height h2 of the wall 21 of the plastic base part 2 measured in the air flow direction F is the largest extension of the wall 21 of the plastic base part 2 in the air flow direction F, wherein the height h1 of the metal ring part 1 is less than 5% of the height h2 of the wall 21 of the plastic base part 2.

[0052] Referring back to the axial fan 5 as shown from Fig. 1 to 5. The impeller 4 is disposed in the frame 3, in particular, in the cylindrical space 22 suitable to accommodate an impeller 4.

[0053] As shown in Fig. 2, an absolute difference of a shortest distance d1 between the air inlet side 23 and the metal ring part 1 and a shortest distance d2 between the air inlet side 23 and the impeller 4 is less than 1% of h2, wherein the shortest distance d1 between the air inlet side 23 and the metal ring part 1 is the distance, measured in the air flow direction F, from the air inlet side 23 to the surface where the metal ring part 1 starts when viewed in the air flow direction F, while the shortest distance d2 between the air inlet side 23 and the impeller 4 is the distance, measured in the air flow direction F, from the air inlet side 23 to the surface where the impeller 4 starts when viewed in the air flow direction F.

[0054] In order to better illustrate the relative position of the metal ring part 1 of the frame 3 and the impeller 4, the plastic base part 2 of the frame 3 is transparentised in Fig. 3 to 5.

[0055] As in Fig. 3, the impeller 4 is provided with at least one blade 41, which is configured to rotate together with the impeller 4, when the impeller 4 starts to rotate around an axial axis AXIAL. Each of the at least one blade 41 of the impeller 4 has a tip 411, wherein the tip 411 is the end point of the at least one blade 41, namely the tip 411 being the farthest point of the at least one blade 411 measured from the axial axis AXIAL in the radial direction of the impeller 4.In the present embodiment, the at least one blade 41 is provided to be more than one, and all the at least one blade 41 have the same distance measured from the axial axis AXIAL to the tip 411 of the at least one blade 41 in the radial direction of the impeller 4.

[0056] Fig. 4 shows a top view of the axial fan in Fig. 1 wherein the plastic base part of the frame is transparentised. For a better illustration, the section B in Fig. 4 is enlarged in Fig. 5.

[0057] Before going to more details in Fig. 5, returning back to Fig. 2 which depicts the tip 411 of the at least one blade 41 not being directly facing the inner surface 111, an extension E of the inner surface 111 is defined along the air flow direction F. Now referring to Fig. 5, a clearance C between the tip 411 of the at least one blade 411 and the extension E of the inner surface 111 along the air flow direction F is between a range of 0,02 mm to 0,05 mm.

[0058] Fig. 8 is a perspective view of the frame 3 for the axial fan 5 in Fig. 1, wherein a groove 211 for the metal ring part 1 to fit in is provided on the wall 21 of the plastic base part 2. The frame 3 is formed when the metal ring part 1 is disposed in the groove 211 provided on the wall 21 of the plastic base part 2.

List of Reference

[0059]

1	metal ring part
11	inner section
111	inner surface
2	plastic base part
21	wall
211	groove
22	cylindrical space
23	air inlet side
24	air outlet side
25	mounting seat
251	cylindrical part
252	supporting blade
26	outer wall
27	through hole / threaded hole
3	frame
4	impeller
41	at least one blade
411	tip of the at least one blade

5	axial fan
AXIAL	axial axis
h1	height of the metal ring part
h2	height of the wall of the plastic base part
d1	shortest distance between the air inlet side and the metal ring part
d2	shortest distance between the air inlet side and the impeller
F	air flow direction
E	(imaginary) extension of the inner surface along the air flow direction
C	clearance between the tip of the at least one blade and the inner surface, and/or clearance between the tip of the at least one blade and an extension of the inner surface along the air flow direction

Claims

1. A frame (3) for an axial fan (5),

wherein the frame (3) comprises a plastic base part (2) and a metal ring part (1),
wherein the plastic base part (2) is provided with an air inlet side (23) and an air outlet side (24), the plastic base part (2) further comprising a wall (21) enclosing a cylindrical space (22), the air inlet side (23) and the air outlet side (24) communicating via the cylindrical space (22), and the cylindrical space (22) being configured to accommodate an impeller (4),
wherein the metal ring part (1) is connected to the wall (21) of the plastic base part (2),
characterized in that
a height (h1) of the metal ring part (1) is less than 8% of a height (h2) of the wall (21) of the plastic base part (2), preferably less than 7%, more preferably less than 6%, especially preferably less than 5%.

2. The frame (3) according to claim 1,
wherein the metal ring part (1) has an inner section (11) inwardly protruding from the wall (21) of the plastic base part (2) towards the cylindrical space (22).

3. The frame (3) according to claim 1 or 2,
wherein a shortest distance (d1) between the air inlet side (23) and the metal ring part (1) is less than 5% of the height (h2) of the wall (21) of the plastic base part (2), preferably less than 3%, more preferably less than 2%.

4. The frame (3) according to any one of the preceding claims,

wherein the metal ring part (1) consists of one metal ring, and/or
wherein the metal ring part (1) comprises a plurality of metal rings, the plurality of metal rings being arranged along an air flow direction (F) in succession.

5. The frame (3) according to any one of the preceding claims,

wherein the metal ring part (1) is insert-moulded with the plastic base part (2); and/or
wherein the metal ring part (1) is interference fitted with the wall (21) of the plastic base part (2); and/or
wherein a groove (211) for the metal ring part (1) to fit in is provided on the wall (21) of the plastic base part (2).

6. The frame (3) according to claim 5,
wherein the metal ring part (1) is disposed in the groove (211) provided on the wall (21) of the plastic base part (2).

7. The frame (3) according to any one of the preceding claims,

wherein the metal ring part (1) is a stamped part, or the metal ring part (1) comprises a plurality of stamped parts,
wherein the metal ring part (1) is made of SECC (Galvanized steel) and/or SPCD (Steel Plate Cold Deep Drawn steel).

8. An axial fan (5),
wherein the axial fan (5) comprises a frame (3) according to any one of the preceding claims.

9. The axial fan (5) according to claim 8,

wherein the axial fan (5) further comprises an impeller (4) and the impeller (4) is disposed in the cylindrical space (22) provided in the frame (3),
wherein the inner section (11) of the metal ring part (1) has an inner surface (111) extending along the air flow direction (F) of the axial fan (5) and facing the cylindrical space (22).

10. The axial fan (5) according to claim 9,

wherein the impeller (4) is provided with at least one blade (41),
wherein a clearance (C) between a tip (411) of the at least one blade (41) and the inner surface (111), and/or the clearance (C) between the tip (411) of the at least one blade (41) and an extension of the inner surface (111) along the air flow direction (F) is between a range of 0,02 mm to 0,07 mm, preferably 0,02 mm to 0,06 mm,

more preferably 0,02 mm to 0,05 mm.

11. The axial fan (5) according to any one of claims 8 to 10,
wherein an absolute difference of the shortest distance (d1) between the air inlet side and the metal ring part (1) and the shortest distance (d2) between the air inlet side and the impeller (4) is less than 5% of the height (h2) of the wall (21), preferably less than 3%, more preferably less than 1%, especially preferably the difference is essentially 0.

12. A method for producing a frame (3) for an axial fan (5), preferably for producing a frame (3) according to any one of claims 1 to 7,

wherein the frame (3) comprises a plastic base part (2) and a metal ring part (1), the plastic base part (2) further comprising a wall (21) enclosing a cylindrical space (22),
characterized in that
a height (h1) of the metal ring part (1) is less than 8% of a height (h2) of the wall (21), preferably less than 7%, more preferably less than 6%, especially preferably less than 5%;
wherein the method comprises the steps:

S1: forming the metal ring part (1), and
S2: forming the plastic base part (2) and forming the frame (3) by connecting the metal ring part (1) to the plastic base part (2).

13. The method according to claim 12,
wherein step S1 comprises the sub-step:

S111: stamping a metal ring as the metal ring part (1), wherein the metal ring is made of SECC (Galvanized steel) or SPCD (Steel Plate Cold Deep Drawn steel), or
S121: stamping a plurality of metal rings as the metal ring part (1), wherein the metal ring is made of SECC (Galvanized steel) and/or SPCD (Steel Plate Cold Deep Drawn steel).

14. The method according to claim 12 or 13,

wherein step S2 comprises the sub-steps:

S211: placing the metal ring part (1) into a mould, wherein when the metal ring part (1) comprises a plurality of metal rings, the plurality of metal rings are arranged along an axial direction of the mould in succession, and
S212: insert-injecting a plastic material in the mould, forming the plastic base part (2) and the frame (3) at the same time;
or
S221: injecting a plastic material into a mould to form the plastic base part (2), and
S222: inference fitting the metal ring part (1) with the plastic base part (2),

wherein when the metal ring part (1) comprises a plurality of metal rings, the plurality of metal rings are arranged along an axial direction of the mould in succession;
or
S231: injecting a plastic material into a mould to form the plastic base part (2),
wherein a groove (211) is provided on the wall (21), and
S232: snapping the metal ring part (1) in the groove (211) of the plastic base part (2), wherein when the metal ring part (1) comprises a plurality of metal rings, the plurality of metal rings are arranged along an axial direction of the mould in succession.

15. The method according to any one of claims 12 to 14, wherein in step S2, the metal ring part (1) is connected to the wall (21) of the plastic base part (2) such that a shortest distance (d1) between the air inlet side (23) and the metal ring part (1) is less than 5% of the height (h2) of the wall (21) of the plastic base part (2), preferably less than 3%, more preferably less than 2%.

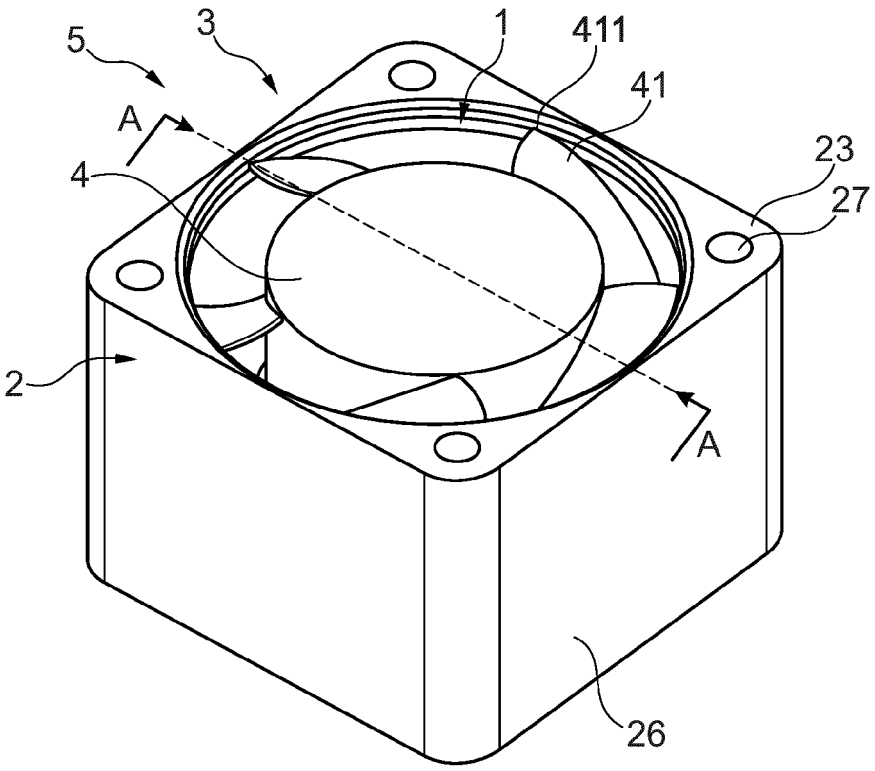
5
3
1
411
41
A
4
23
27
2
A
26

Fig. 1

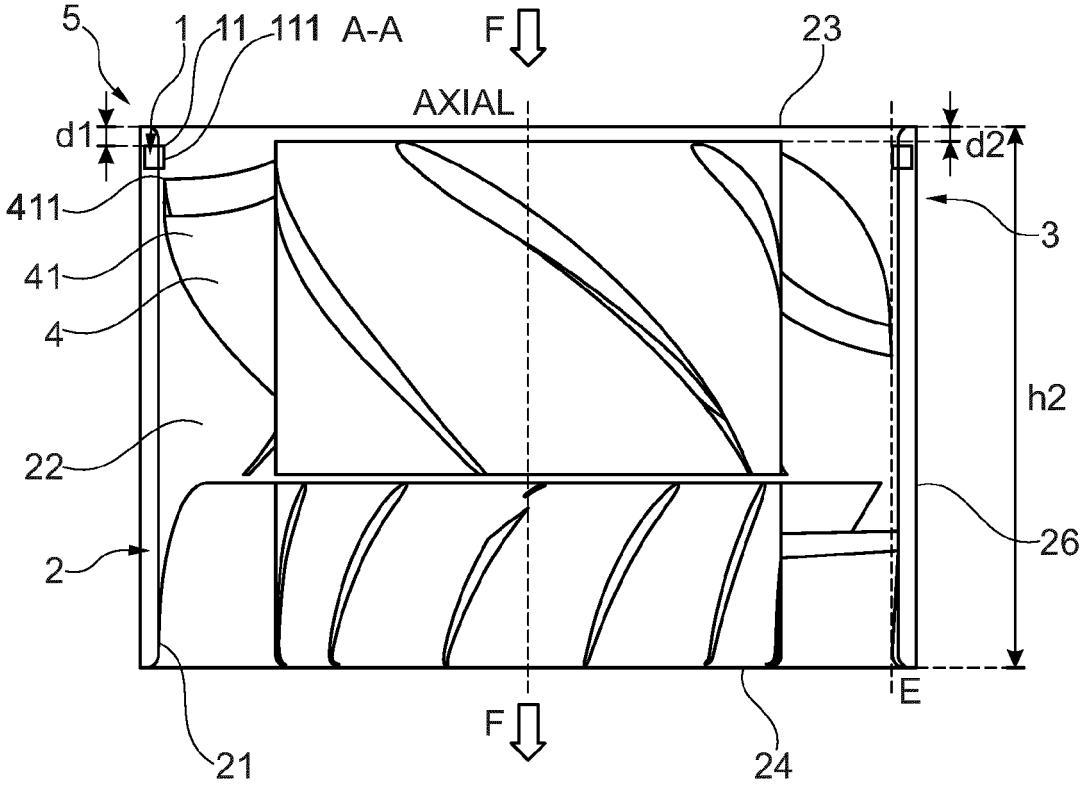
5
1
11
111
A-A
F
AXIAL
23
d1
d2
411
3
41
4
h2
22
26
2
E
F
21
24

Fig. 2

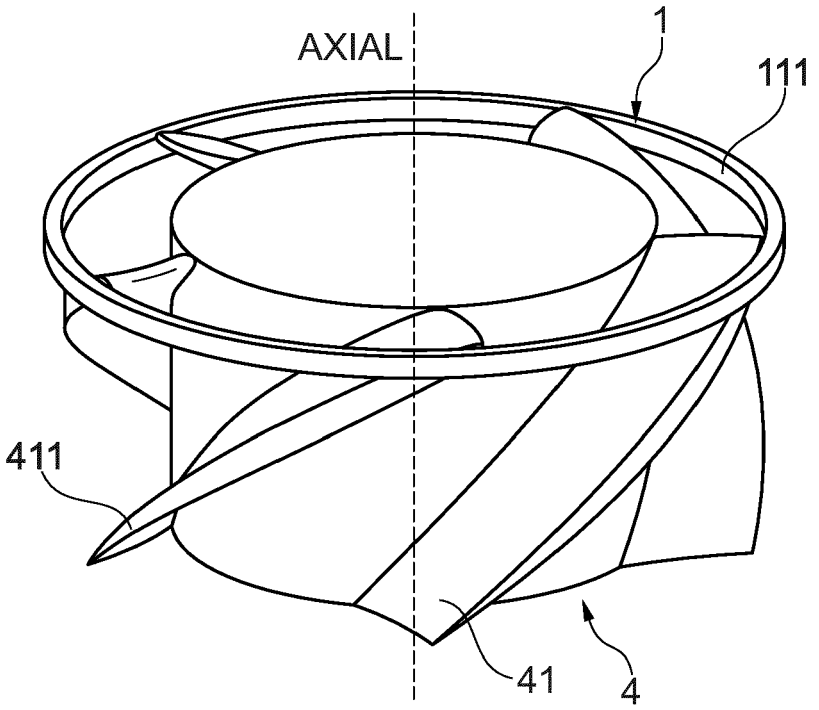

Fig. 3

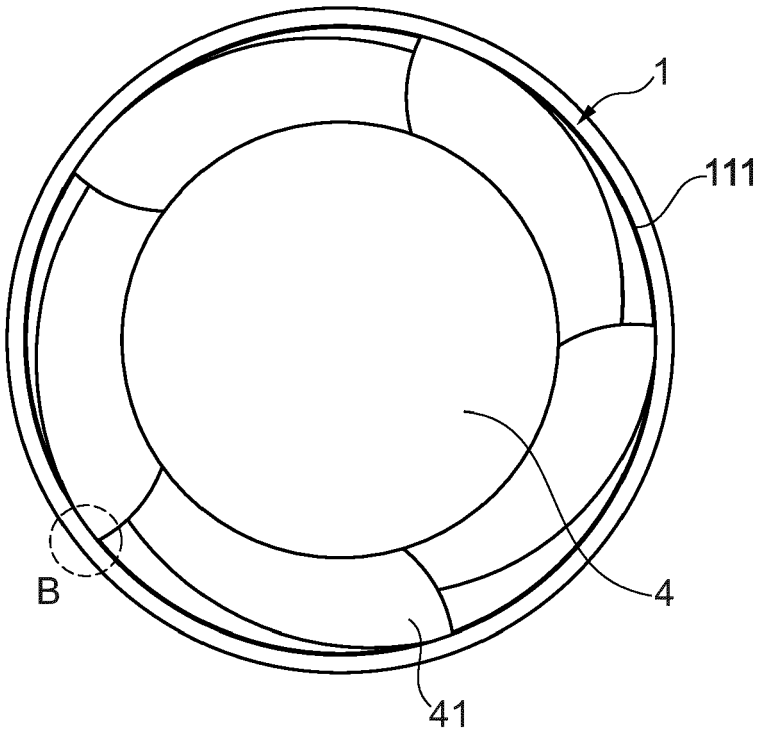

Fig. 4

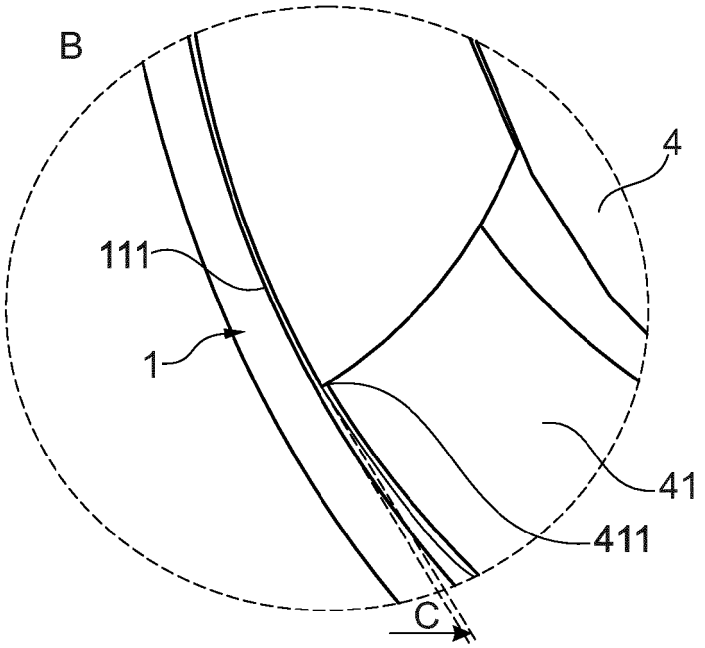

Fig. 5

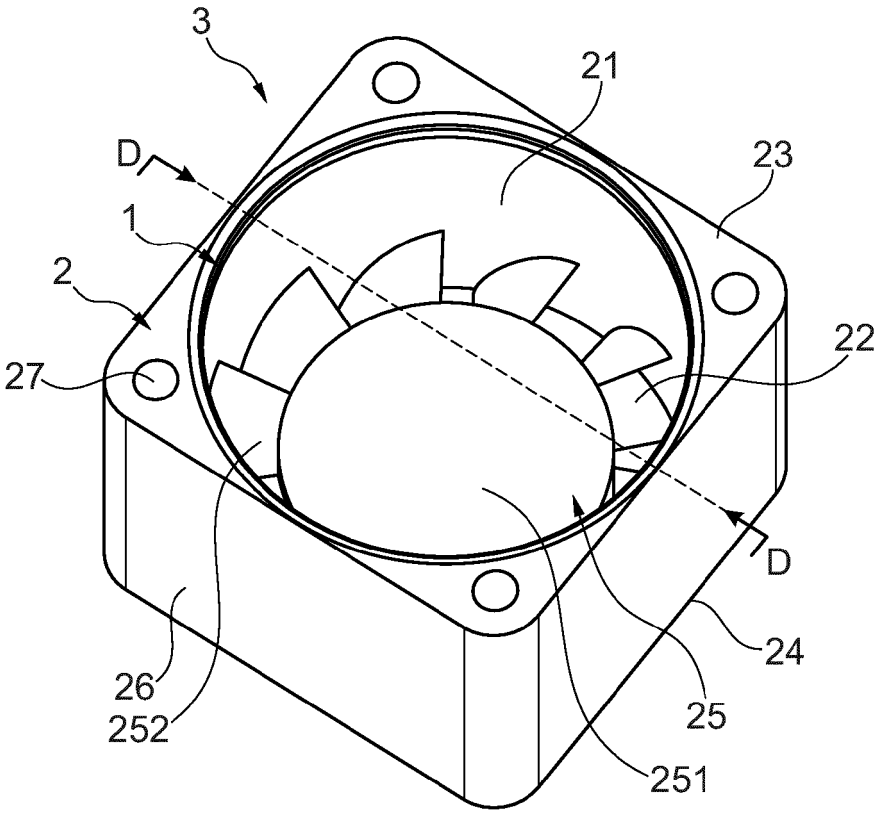

Fig. 6

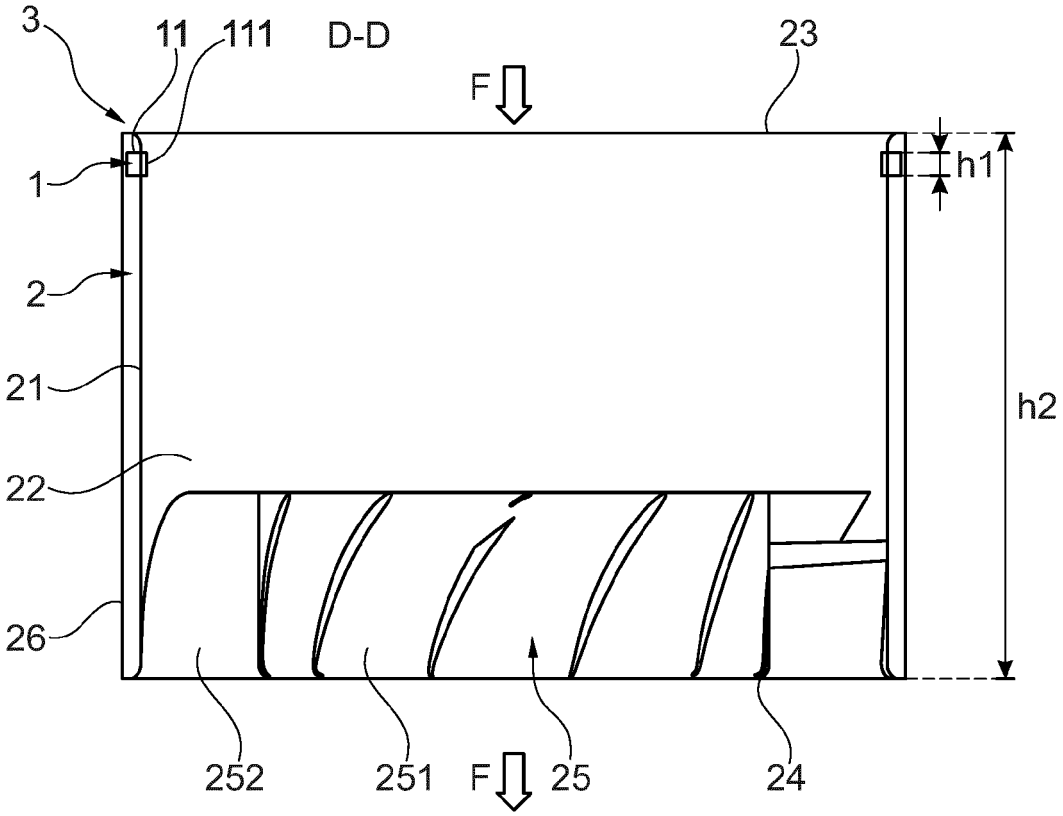

Fig. 7

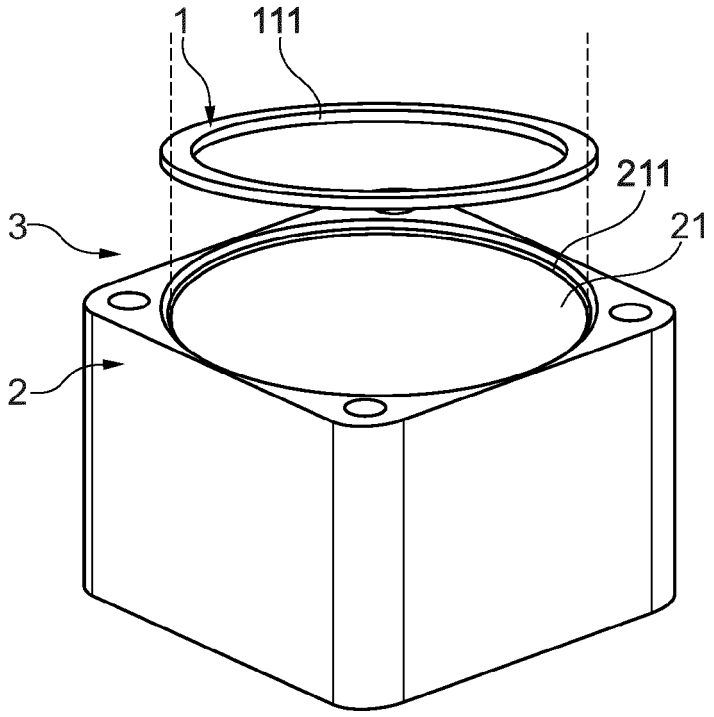

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 21 21 0635

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A,D	EP 3 617 521 A1 (ELEKTROSIL GMBH [DE]) 4 March 2020 (2020-03-04) * paragraph [0029] - paragraph [0031] * * figures 1a, 1b * * claims 7, 13 *	1-15	
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F04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	9 May 2022	Oliveira, Damien

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09-05-2022

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