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(54) NOISE REDUCTION IN A VACUUM CLEANER UNIT

(57) In the field of handheld vacuum cleaners, a vacuum cleaner unit (4) is provided that comprises a motor-fan aggregate (10) and a main body housing (30) accommodating the motor-fan aggregate (10), wherein a sleeve-shaped wall (31) of the main body housing (30) is arranged to surround at a distance an aggregate housing (20), at an exterior of the vacuum cleaner unit (4). The aggregate housing (20) has at least one aggregate air outlet opening (25), and the sleeve-shaped wall (31) has at least one main air outlet opening (36). An air channel (40) from the at least one aggregate air outlet opening (25) to the at least one main air outlet opening (36) comprises space that is present between an exterior surface (27) of the aggregate housing (20) and an interior surface (37) of the sleeve-shaped wall (31), which contributes to reduction of noise in the vacuum cleaner unit (4).

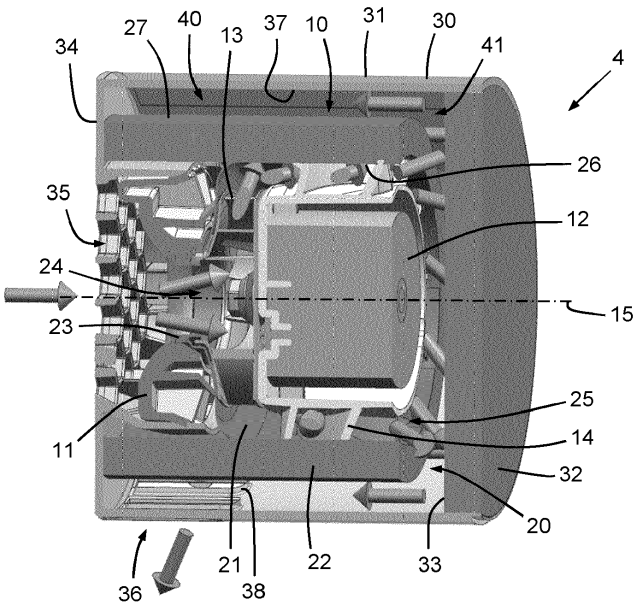

Fig. 3

EP 4 233 660 A1

Description

FIELD OF THE INVENTION

[0001] The invention relates to a vacuum cleaner unit configured to be applied as part of a handheld vacuum cleaner, the vacuum cleaner unit comprising: a motor-fan aggregate including a motor and a fan arranged in an aggregate housing, the fan being rotatable about a longitudinal axis of the motor-fan aggregate, and a main body housing accommodating the motor-fan aggregate and having a wall structure that comprises a sleeve-shaped wall arranged to surround at a distance the aggregate housing in a direction about the longitudinal axis of the motor-fan aggregate, at an exterior of the vacuum cleaner unit, wherein: the aggregate housing has at least one aggregate air outlet opening for letting out exhaust air from the motor-fan aggregate, and the sleeve-shaped wall has at least one main air outlet opening for letting out exhaust air from the vacuum cleaner unit.

[0002] Further, the invention relates to a handheld vacuum cleaner comprising a vacuum cleaner unit as mentioned.

BACKGROUND OF THE INVENTION

[0003] Handheld vacuum cleaners are commonly battery-operated, so that this type of vacuum cleaner is commonly cordless and is very easy to use. Therefore, handheld vacuum cleaners are becoming more and more popular. Some of the present developments in the field of handheld vacuum cleaners are aimed at increasing power levels. In view of the fact that, generally speaking, an increase of power level involves an increase of noise generated during operation, finding ways of damping/reducing noise becomes more relevant in the field of handheld vacuum cleaners. Noise reduction methods are often chosen on the basis of solutions which are available for conventional canister-type vacuum cleaners. However, as such solutions have not been designed against the background of the specific requirements associated with handheld vacuum cleaners, such solutions often involve a significant increase of size and weight, and also a significant increase of costs.

[0004] EP 3 184 011 A1 relates to a battery-operated handheld vacuum cleaner and discloses that in a handheld vacuum cleaner in which a flow of discharge air from the motor is allowed to take the shortest route to outside of the vacuum cleaner, a lot of noise is generated. As a noise reducing measure, EP 3 184 011 A1 proposes to design a discharge duct of the air in such a way that the duct is folded at an angle in a range of 120° and 200°, preferably 180°, wherein the airflow needs to follow a longer path before reaching the position of the exterior outlet. The main body housing is provided with a part that has an inclined orientation from the sleeve-shaped wall towards the center of the main body housing, and with a part that is generally shaped like a cup of which a bottom portion is elevated so as to form an interior cone in the cup. The first part and the second part are positioned relative to each other in such a way that the first part extends in a space between the interior cone and the outside wall of the cup of the second part, so that the folded duct is formed, and so that a flow of air discharged from the motor is made to follow a path including a backward curve, in a direction from the center of the main body housing to outside of the main body housing through the exterior outlet.

[0005] In the handheld vacuum cleaner known from EP 3 184 011 A1, the first part and the second part constitute additional components of the vacuum cleaner. Thus, the known noise reducing measure involves an increase of both weight and costs of the vacuum cleaner, and also a more bulky design of the vacuum cleaner because more volume is needed. Also, flow resistance in the vacuum cleaner is significantly increased.

SUMMARY OF THE INVENTION

[0006] It is an object of the invention to provide a vacuum cleaner unit configured to be applied as part of a handheld vacuum cleaner, which vacuum cleaner unit is designed to achieve significantly lower levels of noise generated by the unit during operation, as compared to a unit of conventional design, in a way that is efficient/minimalistic as far as the need for additional weight, space and costs is concerned, and without seriously affecting flow performance.

[0007] In view of the foregoing, the invention provides a vacuum cleaner unit configured to be applied as part of a handheld vacuum cleaner, the vacuum cleaner unit comprising: a motor-fan aggregate including a motor and a fan arranged in an aggregate housing, the fan being rotatable about a longitudinal axis of the motor-fan aggregate, and a main body housing accommodating the motor-fan aggregate and having a wall structure that comprises a sleeve-shaped wall arranged to surround at a distance the aggregate housing in a direction about the longitudinal axis of the motor-fan aggregate, at an exterior of the vacuum cleaner unit, wherein: the aggregate housing has at least one aggregate air outlet opening for letting out exhaust air from the motor-fan aggregate, the sleeve-shaped wall has at least one main air outlet opening for letting out exhaust air from the vacuum cleaner unit, and an air channel from the at least one aggregate air outlet opening to the at least one main air outlet opening comprises space that is present between an exterior surface of the aggregate housing and an interior surface of the sleeve-shaped wall.

[0008] It follows from the foregoing definition of the vacuum cleaner unit according to the invention that for the purpose of creating a path through the unit to be followed by exhaust air from the motor-fan aggregate, use is made of space that is present between an exterior surface of the aggregate housing and an interior surface of the sleeve-shaped wall. An insight on which the invention is

based is that it is possible to choose the position of the at least one main air outlet opening so as to be as far away as possible from the position of the at least one aggregate air outlet opening in a direction of the longitudinal axis of the motor-fan aggregate, which direction will hereinafter be referred to as longitudinal direction, and also so as to not be in a line of acoustic sight from the position of the at least one aggregate air outlet opening, as ways of achieving noise reduction without needing to add specific air guiding parts to existing designs of the vacuum cleaner unit. The flow of exhaust air reaches the space between the exterior surface of the aggregate housing and the interior surface of the sleeve-shaped wall, which surfaces are present in the vacuum cleaner unit anyway, either directly from the at least one aggregate air outlet opening or through a path from the at least one aggregate air outlet opening leading up to the space, and the flow of exhaust air is guided between the respective surfaces until the flow reaches the at least one main air outlet opening, while noise is reduced along the way due to continuous collisions between noise waves in the airflow and the respective surfaces.

[0009] The invention is especially applicable in a context of vacuum cleaner units which are designed with a motor-fan aggregate and a main body housing accommodating the motor-fan aggregate and having a wall structure that comprises a sleeve-shaped wall arranged to surround at a distance the aggregate housing in a direction about the longitudinal axis of the motor-fan aggregate, which is a context of many known types of vacuum cleaner units configured to be applied as part of a handheld vacuum cleaner.

[0010] In view of the fact that a notable aspect of the invention is designing the path to be followed by exhaust air through the vacuum cleaner unit in such a way that noise waves in the air are continuously made to collide with surfaces delimiting the path, it is advantageous if a dimension of the air channel between the exterior surface of the aggregate housing and the interior surface of the sleeve-shaped wall in the longitudinal direction is at least two times as large as a dimension of the air channel between the exterior surface of the aggregate housing and the interior surface of the sleeve-shaped wall in a radial direction, preferably at least three times as large as said dimension, more preferably at least four times as large as said dimension. Another or an additional measure in this respect involves arranging the at least one main air outlet opening in a portion of the sleeve-shaped wall that is reached through a maximally long air path of exhaust air from the at least one aggregate air outlet opening. This may involve having a longitudinal distance between the at least one main air outlet opening and the at least one aggregate air outlet opening that is as large as possible in the context of the vacuum cleaner unit.

[0011] It is furthermore advantageous if an air path of exhaust air from the at least one aggregate air outlet opening to the at least one main air outlet opening includes at least one sharp bend. Having at least one sharp bend is a way to have compactness of design in the longitudinal direction. Also, having at least one sharp bend is a way to cause many collisions between noise waves in the airflow and the surfaces delimiting the sharp bend, whereby energy is dissipated from the sound waves in the airflow so that noise is reduced. To put it differently, it is advantageous if the at least one aggregate air outlet opening is at a forward position relative to the at least one main air outlet opening as seen in the longitudinal downstream direction of the motor-fan aggregate. This implies that it may be so that the portion of the air channel defined by the space that is present between the exterior surface of the aggregate housing and the interior surface of the sleeve-shaped wall generally extends in a direction opposite to the longitudinal downstream direction of the motor-fan aggregate.

[0012] In a practical embodiment of the vacuum cleaner unit according to the invention, the wall structure of the main body housing further comprises an air deflecting wall having an interior surface facing the motor-fan aggregate at close range at the position of the at least one aggregate air outlet opening, the air deflecting wall being orientated differently from the sleeve-shaped wall. If said air deflecting wall is included in the wall structure of the main body housing, indeed, this may provide a way of creating the air path of the exhaust air with the at least one sharp bend as mentioned in the foregoing. It may be so that the air path immediately leads up from the at least one aggregate air outlet opening to the air deflecting wall, then along the air deflecting wall towards the periphery of the air deflecting wall, and then from the air deflecting wall to the at least one main air outlet opening, passing between the exterior surface of the aggregate housing and the interior surface of the sleeve-shaped wall. In order to further enhance noise reduction at the position of the air deflecting wall, it is advantageous if the air deflecting wall comprises material having sound-absorbing properties, at least at the side of the interior surface thereof. Practical examples of the material having sound-absorbing properties are a foam material, a felt material or another textile material, and a rubber material. Likewise, it is possible if the aggregate housing comprises material having sound-absorbing properties, at least at the side of the exterior surface thereof and/or if the sleeve-shaped wall comprises material having sound-absorbing properties, at least at the side of the interior surface thereof. Generally speaking, one or more walls of the wall structure of the main body housing may be entirely made of material having sound-absorbing properties or may comprise a combination of a wall body covered with a layer comprising such material.

[0013] In a practical embodiment of the vacuum cleaner unit according to the invention, the motor-fan aggregate is of generally cylindrical shape, and the sleeve-shaped wall is generally shaped like a tube segment having a circular periphery. In such a case, assuming that the wall structure of the main body housing comprises the air deflecting wall mentioned in the foregoing, it may

be so that the air deflecting wall is generally disc-shaped and is positioned at an end of the sleeve-shaped wall. The invention covers a possibility of providing the sleeve-shaped wall and the air deflecting wall as a single integral piece, which piece may be generally cup-shaped in that case.

[0014] As a further measure aimed at reducing noise from the flow of exhaust air, it may be beneficial if the interior surface of the sleeve-shaped wall comprises a structure including at least one ridge arranged to at least partially surround the at least one main air outlet opening. By applying this measure, it is achieved that energy from noise waves in the flow of exhaust air is dissipated right before the airflow flows through the at least one main air outlet opening and the noise from the airflow can be heard at the outside of the vacuum cleaner unit. Apart from that, it may be so that the interior surface of the sleeve-shaped wall has a generally smooth appearance.

[0015] In a practical embodiment of the vacuum cleaner unit according to the invention, the wall structure of the main body housing further comprises an air inlet side wall that is provided with at least one main air inlet opening for letting in air to the vacuum cleaner unit. It may be so that the at least one main air inlet opening and the at least one aggregate air outlet opening are present at opposite sides of the vacuum cleaner unit in the longitudinal direction, in which case having a long air path through the unit may involve having the at least one main air outlet opening at a similar longitudinal position as the at least one main air inlet opening.

[0016] The invention further relates to a handheld vacuum cleaner, comprising a vacuum cleaner unit as defined and described in the foregoing. The handheld vacuum cleaner may be of the type that is referred to as battery-operated handheld vacuum cleaner or cordless handheld vacuum cleaner. In the handheld vacuum cleaner, it may be so that the sleeve-shaped wall of the main body housing of the vacuum cleaner unit is at the exterior of the vacuum cleaner. Further, it may be so that the handheld vacuum cleaner comprises a handle configured to be taken hold of by a user, and that the vacuum cleaner unit is arranged close to the handle.

[0017] The above-described and other aspects of the invention will be apparent from and elucidated with reference to the following detailed description of a practical embodiment of a handheld vacuum cleaner and a vacuum cleaner unit as can be applied in the handheld vacuum cleaner.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The invention will now be explained in greater detail with reference to the figures, in which equal or similar parts are indicated by the same reference signs, and in which:

Figure 1 diagrammatically shows a side view of a handheld vacuum cleaner according to an embodiment of the invention,

Figure 2 diagrammatically shows an exploded view of a vacuum cleaner unit according to an embodiment the invention,

Figures 3 and 4 diagrammatically show sectional views of the vacuum cleaner unit, in which a flow of exhaust air from a motor-fan aggregate of the unit is indicated by means of arrows,

Figure 5 diagrammatically shows a sectional view of the vacuum cleaner unit with a part of a main body housing of the vacuum cleaner unit being removed, in which a flow of exhaust air from a motor-fan aggregate of the unit is indicated by means of arrows,

Figures 6 and 7 diagrammatically show back views of the vacuum cleaner unit with a part of a main body housing of the vacuum cleaner unit being removed, in which the flow of exhaust air from a motor-fan aggregate of the unit is indicated by means of arrows, and

Figure 8 illustrates options in respect of positions where a foam material may be present in the vacuum cleaner unit.

DETAILED DESCRIPTION OF EMBODIMENTS

[0019] Figure 1 shows an embodiment of a handheld vacuum cleaner 1 according to the invention. It is to be noted that this embodiment is a practical one out of various possibilities covered by the invention, and that aspects of the embodiment as will be discussed in the following are in no way to be understood so as to represent limitations to the invention as defined in the attached claims.

[0020] The handheld vacuum cleaner 1 as shown is suitable to be used as a separate vacuum cleaner, or as functional part of a stick vacuum cleaner. The handheld vacuum cleaner 1 comprises a dust-receiving tube 2 of which a free end is suitable to be positioned at or close to a surface from which dust and dirt is to be removed, and also to be coupled to an assembly of an elongated tube and a suction nozzle of a stick vacuum cleaner. The handheld vacuum cleaner 1 further comprises a handle 3 configured to be taken hold of by a user, and a vacuum cleaner unit 4. During operation of the handheld vacuum cleaner 1, the vacuum cleaner unit 4 functions to create underpressure/suction in the dust-receiving tube 2, so that an inward airflow is obtained which is capable of carrying dust and dirt into the dust-receiving tube 2. The vacuum cleaner unit 4 is arranged downstream of a container unit 5 including both a separator such as a cyclone separator for separating dust and dirt from the incoming air, and space for storing the dust and dirt. With reference to figures 2-7, particulars of an embodiment of a vacuum cleaner unit 4 according to the invention are now explained.

[0021] Basically, the vacuum cleaner unit 4 comprises a motor-fan aggregate 10 and a main body housing 30 accommodating the motor-fan aggregate 10. The motor-

fan aggregate 10 comprises an air inflow nozzle 11, an assembly of a motor 12 and a fan 13, at a position downstream of the air inflow nozzle 11, and a stationary diffuser 14 at a position around the motor 12. The air inflow nozzle 11 comprises a flexible material such as a rubber material, and has a supporting functionality in the motor-fan aggregate 10. The fan 13 is arranged so as to be rotatable about a longitudinal axis 15 of the motor-fan aggregate 10, wherein the motor 12 serves to drive the fan 13 to perform an actual rotary movement during operation of the vacuum cleaner unit 4. The motor-fan aggregate 10 further comprises an aggregate housing 20, which in the present example comprises a first housing part 21 that is arranged to accommodate the motor 12, the fan 13 and the diffuser 14, and a second housing part 22 that covers both the first housing part 21 and the air inflow nozzle 11. The first housing part 21 is generally shaped like a tube segment that is partially closed at one side, namely the upstream side, and that has an annular rim 23 surrounding the opening 24 as present at the upstream side, wherein the annular rim 23 is snugly surrounded by a portion of the air inflow nozzle 11. The second housing part 22 is generally shaped like a tube segment, and is advantageously made of a material having sound-absorbing properties such as a foam material. In the present configuration, the downstream side of the aggregate housing 20 is an open side, which implies that the aggregate housing 20 has one aggregate air outlet opening 25 for letting out exhaust air from the motor-fan aggregate 10. The aggregate air outlet opening 25 is partially occupied by the diffuser 14, wherein an annular space surrounding the diffuser 14 remains for actually allowing passage of the exhaust air.

[0022] The main body housing 30 has a wall structure that comprises a sleeve-shaped wall 31 arranged to surround at a distance the aggregate housing 20 in a direction about the longitudinal axis 15 of the motor-fan aggregate 10, at an exterior of the vacuum cleaner unit 4, a generally disc-shaped air deflecting wall 32 having an interior surface 33 facing the motor-fan aggregate 10 at close range at the position of the aggregate air outlet opening 25, positioned at one end of the sleeve-shaped wall 31, and an air inlet side wall 34, positioned at another end of the sleeve-shaped wall 31. For the purpose of letting in air to the vacuum cleaner unit 4 during operation, the air inlet side wall 34 is provided with a plurality of main air inlet openings 35 for letting in air to the vacuum cleaner unit 4, while for the purpose of letting out exhaust air from the vacuum cleaner unit 4 during operation, the sleeve-shaped wall 31 is provided with a plurality of main air outlet openings 36.

[0023] The fact is that during operation of the vacuum cleaner unit 4, the fan 13 of the motor-fan aggregate 10 is rotated, as a result of which air is sucked in the vacuum cleaner unit 4 through the main air inlet openings 35. The air passes through the air inflow nozzle 11, reaches the fan 13 and is forced towards a space as present between the guide vanes of the diffuser 14 and an interior surface 26 of the aggregate housing 20 at the position of the first housing part 21. At the downstream end of the diffuser 14, the air, which is also referred to as exhaust air at that point, exits the motor-fan aggregate 10 through the aggregate air outlet opening 25, particularly through the annular space surrounding the diffuser 14 at the position of the aggregate air outlet opening 25. The diffuser 14 is shaped such that the exhaust air is let out from the aggregate housing 20 in a swirling movement. Being in the swirling condition, the exhaust air abuts against the interior surface 33 of the air deflecting wall 32, and subsequently also abuts against an interior surface 37 of the sleeve-shaped wall 31, and makes its way further down towards the main air outlet openings 36, passing between an exterior surface 27 of the aggregate housing 20 and the interior surface 37 of the sleeve-shaped wall 31 in the process. At the position of the main air outlet openings 36, the exhaust air exits the vacuum cleaner unit 4. The path followed by the air through the vacuum cleaner unit 4 is indicated by means of arrows in figures 3-7. As follows from the foregoing, among other things, this path follows an air channel 40 from the aggregate air outlet opening 25 to the main air outlet openings 36, the air channel 40 comprising space that is present between the exterior surface 27 of the aggregate housing 20 and the interior surface 37 of the sleeve-shaped wall 31.

[0024] During operation of the vacuum cleaner unit 4, noise is generated. There is both direct noise coming from the motor-fan aggregate 10 and airborne noise at the position where the exhaust air exits the motor-fan aggregate 10. The configuration of the vacuum cleaner unit 4 is chosen such that effective noise reduction is obtained, and that this is achieved without a need for complex structural features such as added guiding elements of a specific shape aimed at creating guiding channels for the exhaust air. In the present embodiment, the exhaust air is guided by the interior surface 33 of the air deflecting wall 32 and subsequently between the exterior surface 27 of the aggregate housing 20 and the interior surface 37 of the sleeve-shaped wall 31. All of the surfaces as mentioned are already present in the general design of the vacuum cleaner unit 4, and there is no addition of any parts. An interesting advantage involved in this achievement of the invention is that the construction of the vacuum cleaner unit 4 is robust and very well capable of absorbing impact from vibrations occurring during operation, or even impact as a result of the handheld vacuum cleaner 1 including the vacuum cleaner unit 4 falling down to the ground for some reason, without structural damage. Also, the design of the vacuum cleaner unit 4 does not involve a need to produce components of the vacuum cleaner unit 4 with high tolerances.

[0025] One aspect of the noise reduction is preventing the noise waves in the exhaust air from being able to follow a direct, straight path from the aggregate air outlet opening 25 to the main air outlet openings 36. Another aspect of the noise reduction is having a path to be followed by the sound waves from the aggregate air outlet

opening 25 to the main air outlet openings 36 that is as long as possible in the context of the vacuum cleaner unit 4. For that reason, in the present embodiment, the position of the main air outlet openings 36 is chosen to be as close as possible to the air inlet side wall 34, as seen in the direction of the longitudinal axis 15 of the motor-fan aggregate 10. The fact is that the more opportunity for collisions between noise waves in the flow of the exhaust air and respective surfaces is created, the more noise is absorbed from the airflow as this is on its way to the main air outlet openings 36. In the present embodiment, among other things, the fact that a sharp bend 41 of about 90° needs to be taken by the exhaust air to enter the space between the exterior surface 27 of the aggregate housing 20 and the interior surface 37 of the sleeve-shaped wall 31 has a significant noise-reducing effect. Further, it is advantageous if the space between the exterior surface 27 of the aggregate housing 20 and the interior surface 37 of the sleeve-shaped wall 31 is relatively narrow as seen in a radial direction. In figure 4, both the radial dimension r and the longitudinal dimension 1 of said space are indicated, and it can be seen that the longitudinal dimension 1 is significantly larger than the radial dimension r. For example, the longitudinal dimension 1 can be about 35 mm, while the radial dimension r can be about 7 mm, which means that the longitudinal dimension 1 can be about five times as large as the radial dimension r. The invention is in no way restricted to this example, and other ratios of the longitudinal dimension 1 and the radial dimension r are feasible as well, wherein it is practical if the longitudinal dimension 1 is at least two times as large as the radial dimension r.

[0026] In the present embodiment, an additional measure that is taken to reduce noise is providing the interior surface 37 of the sleeve-shaped wall 31 with a structure configured to force the exhaust air to follow a kind of labyrinth-shaped path prior to passing through the main air outlet openings 36. The structure is chosen such that each of the main air outlet openings 36 is surrounded by a ridge 38. Also, the main air outlet openings 36 can be of generally elongated shape, with a relatively large dimension in the longitudinal direction and a relative small dimension in the direction about the longitudinal axis 15 of the motor-fan aggregate 10. A practical example of the first dimension is 25 mm, while a practical example of the second dimension is 2 mm. Speaking of examples of dimensions, it is to be noted that an outer diameter of the aggregate housing 20 may be about 70 mm, while an inner diameter of the main body housing 30 may be about 85 mm.

[0027] Figure 8 provides a schematic depiction of the vacuum cleaner unit 4, and serves to illustrate where a foam material 45 may be present in the vacuum cleaner unit 4. Also in this figure, the general direction of the flow of the exhaust air from the aggregate air outlet opening 25 to the main air outlet openings 36 is indicated by means of arrows. In general, using a foam material 45 inside the vacuum cleaner unit 4 is an effective way to reduce noise. As mentioned in the foregoing, it is advantageous if the second housing part 22 is made of a material having sound-absorbing properties such as a foam material 45. This option is illustrated in figure 8. In a more general sense, it is advantageous if the aggregate housing 20 comprises a foam material 45 at the side of the exterior surface 27 thereof. Having a foam material 45 around the motor 12 functions to reduce direct noise radiated by the motor-fan aggregate 10 during operation, and also to reduce the airborne noise coming from the motor-fan aggregate 10 at the position of the aggregate air outlet opening 25. Further, as illustrated in figure 8, it is advantageous if the sleeve-shaped wall 31 comprises a foam material 45 at the side of the interior surface 37 thereof, and also if the air deflecting wall 32 comprises a foam material 45, at least at the side of the interior surface 33 thereof.

[0028] It will be clear to a person skilled in the art that the scope of the invention is not limited to the examples discussed in the foregoing, but that several amendments and modifications thereof are possible without deviating from the scope of the invention as defined in the attached claims. It is intended that the invention be construed as including all such amendments and modifications insofar they come within the scope of the claims or the equivalents thereof. While the invention has been illustrated and described in detail in the figures and the description, such illustration and description are to be considered illustrative or exemplary only, and not restrictive. The invention is not limited to the disclosed embodiments. The drawings are schematic, wherein details which are not required for understanding the invention may have been omitted, and not necessarily to scale.

[0029] Variations to the disclosed embodiments can be understood and effected by a person skilled in the art in practicing the claimed invention, from a study of the figures, the description and the attached claims. In the claims, the word "comprising" does not exclude other steps or elements, and the indefinite article "a" or "an" does not exclude a plurality. Any reference signs in the claims should not be construed as limiting the scope of the invention.

[0030] Elements and aspects discussed for or in relation with a particular embodiment may be suitably combined with elements and aspects of other embodiments, unless explicitly stated otherwise. Thus, the mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

[0031] The terms "comprise" and "include" as used in the present text will be understood by a person skilled in the art as covering the term "consist of'. Hence, the term "comprise" or "include" may in respect of an embodiment mean "consist of', but may in another embodiment mean "contain/have/be equipped with at least the defined species and optionally one or more other species".

[0032] Notable aspects of the invention are summa-

rized as follows. In the field of vacuum cleaners, particularly handheld vacuum cleaners, a vacuum cleaner unit 4 is provided that comprises a motor-fan aggregate 10 and a main body housing 30 accommodating the motor-fan aggregate 10, wherein a sleeve-shaped wall 31 of the main body housing 30 is arranged to surround at a distance an aggregate housing 20, at an exterior of the vacuum cleaner unit 4. The aggregate housing 20 has at least one aggregate air outlet opening 25 for letting out exhaust air from the motor-fan aggregate 20, and the sleeve-shaped wall 31 has at least one main air outlet opening 36 for letting out exhaust air from the vacuum cleaner unit 4. An air channel 40 from the at least one aggregate air outlet opening 25 to the at least one main air outlet opening 36 comprises space that is present between an exterior surface 27 of the aggregate housing 20 and an interior surface 37 of the sleeve-shaped wall 31, which is a feature of the vacuum cleaner unit 4 that contributes to reduction of noise in the vacuum cleaner unit 4.

Claims

1. Vacuum cleaner unit (4) configured to be applied as part of a handheld vacuum cleaner (1), the vacuum cleaner unit (4) comprising:

a motor-fan aggregate (10) including a motor (12) and a fan (13) arranged in an aggregate housing (20), the fan (13) being rotatable about a longitudinal axis (15) of the motor-fan aggregate (10), and
a main body housing (30) accommodating the motor-fan aggregate (10) and having a wall structure that comprises a sleeve-shaped wall (31) arranged to surround at a distance the aggregate housing (20) in a direction about the longitudinal axis (15) of the motor-fan aggregate (10), at an exterior of the vacuum cleaner unit (4),
wherein:

the aggregate housing (20) has at least one aggregate air outlet opening (25) for letting out exhaust air from the motor-fan aggregate (10),
the sleeve-shaped wall (31) has at least one main air outlet opening (36) for letting out exhaust air from the vacuum cleaner unit (4), and
an air channel (40) from the at least one aggregate air outlet opening (25) to the at least one main air outlet opening (36) comprises space that is present between an exterior surface (27) of the aggregate housing (20) and an interior surface (37) of the sleeve-shaped wall (31).

2. Vacuum cleaner unit (4) as claimed in claim 1, wherein a dimension (1) of the air channel (40) between the exterior surface (27) of the aggregate housing (20) and the interior surface (37) of the sleeve-shaped wall (31) in a direction of the longitudinal axis (15) of the motor-fan aggregate (10) is at least two times as large as a dimension (r) of the air channel (40) between the exterior surface (27) of the aggregate housing (20) and the interior surface (37) of the sleeve-shaped wall (31) in a radial direction relative to the longitudinal axis (15) of the motor-fan aggregate (10).

3. Vacuum cleaner unit (4) as claimed in claim 1 or 2, wherein the at least one main air outlet opening (36) is arranged in a portion of the sleeve-shaped wall (31) that is reached through a maximally long air path of exhaust air from the at least one aggregate air outlet opening (25).

4. Vacuum cleaner unit (4) as claimed in any of claims 1-3, wherein an air path of exhaust air from the at least one aggregate air outlet opening (25) to the at least one main air outlet opening (36) includes at least one sharp bend (41).

5. Vacuum cleaner unit (4) as claimed in any of claims 1-4, wherein the wall structure of the main body housing (30) further comprises an air deflecting wall (32) having an interior surface (33) facing the motor-fan aggregate (10) at close range at the position of the at least one aggregate air outlet opening (25), the air deflecting wall (32) being orientated differently from the sleeve-shaped wall (31).

6. Vacuum cleaner unit (4) as claimed in claim 5, wherein the air deflecting wall (32) comprises material having sound-absorbing properties, at least at the side of the interior surface (33) thereof.

7. Vacuum cleaner unit (4) as claimed in any of claims 1-6, wherein the motor-fan aggregate (10) is of generally cylindrical shape, and wherein the sleeve-shaped wall (31) is generally shaped like a tube segment having a circular periphery.

8. Vacuum cleaner unit (4) as claimed in claim 7 insofar as dependent on any of claim 5 or 6, wherein the air deflecting wall (32) is generally disc-shaped and is positioned at an end of the sleeve-shaped wall (31).

9. Vacuum cleaner unit (4) as claimed in any of claims 1-8, wherein the interior surface (37) of the sleeve-shaped wall (31) comprises a structure including at least one ridge (38) arranged to at least partially surround the at least one main air outlet opening (36).

10. Vacuum cleaner unit (4) as claimed in any of claims

1-9, wherein the wall structure of the main body housing (30) further comprises an air inlet side wall (34) that is provided with at least one main air inlet opening (35) for letting in air to the vacuum cleaner unit (4).

11. Vacuum cleaner unit (4) as claimed in any of claims 1-10, wherein the aggregate housing (20) comprises material having sound-absorbing properties, at least at the side of the exterior surface (27) thereof and/or the sleeve-shaped wall (31) comprises material having sound-absorbing properties, at least at the side of the interior surface (37) thereof.

12. Vacuum cleaner unit (4) as claimed in claim 6 or 11, wherein the material having sound-absorbing properties is one of a foam material (45), a textile material and a rubber material.

13. Handheld vacuum cleaner (1), comprising a vacuum cleaner unit (4) as claimed in any of claims 1-12.

14. Handheld vacuum cleaner (1) as claimed in claim 13, being a battery-operated handheld vacuum cleaner (1).

15. Handheld vacuum cleaner (1) as claimed in claim 13 or 14, wherein the sleeve-shaped wall (31) of the main body housing (30) of the vacuum cleaner unit (4) is at the exterior of the handheld vacuum cleaner (1).

Amended claims in accordance with Rule 137(2) EPC.

1. Vacuum cleaner unit (4) configured to be applied as part of a handheld vacuum cleaner (1), the vacuum cleaner unit (4) comprising:

a motor-fan aggregate (10) including a motor (12) and a fan (13) arranged in an aggregate housing (20), the fan (13) being rotatable about a longitudinal axis (15) of the motor-fan aggregate (10), and
a main body housing (30) accommodating the motor-fan aggregate (10) and having a wall structure that comprises a sleeve-shaped wall (31) arranged to surround at a distance the aggregate housing (20) in a direction about the longitudinal axis (15) of the motor-fan aggregate (10), at an exterior of the vacuum cleaner unit (4),
wherein:

the aggregate housing (20) has at least one aggregate air outlet opening (25) for letting out exhaust air from the motor-fan aggregate (10),
the sleeve-shaped wall (31) has at least one main air outlet opening (36) for letting out exhaust air from the vacuum cleaner unit (4),
an air channel (40) enabling passage of exhaust air through the vacuum cleaner unit (4) from the at least one aggregate air outlet opening (25) to the at least one main air outlet opening (36) comprises space that is present between an exterior surface (27) of the aggregate housing (20) and an interior surface (37) of the sleeve-shaped wall (31), and
a dimension (l) of the air channel (40) between the exterior surface (27) of the aggregate housing (20) and the interior surface (37) of the sleeve-shaped wall (31) in a direction of the longitudinal axis (15) of the motor-fan aggregate (10) is at least two times as large as a dimension (r) of the air channel (40) between the exterior surface (27) of the aggregate housing (20) and the interior surface (37) of the sleeve-shaped wall (31) in a radial direction relative to the longitudinal axis (15) of the motor-fan aggregate (10).

2. Vacuum cleaner unit (4) as claimed in claim 1, wherein the at least one main air outlet opening (36) is arranged in a portion of the sleeve-shaped wall (31) that is reached through a maximally long air path of exhaust air from the at least one aggregate air outlet opening (25).

3. Vacuum cleaner unit (4) as claimed in claim 1 or 2, wherein the dimension (l) of the air channel (40) between the exterior surface (27) of the aggregate housing (20) and the interior surface (37) of the sleeve-shaped wall (31) in the direction of the longitudinal axis (15) of the motor-fan aggregate (10) is larger than half of a total dimension of the aggregate housing (20) in said direction.

4. Vacuum cleaner unit (4) as claimed in any of claims 1-3, wherein an air path of exhaust air from the at least one aggregate air outlet opening (25) to the at least one main air outlet opening (36) includes at least one sharp bend (41).

5. Vacuum cleaner unit (4) as claimed in any of claims 1-4, wherein the wall structure of the main body housing (30) further comprises an air deflecting wall (32) having an interior surface (33) facing the motor-fan aggregate (10) at close range at the position of the at least one aggregate air outlet opening (25), the air deflecting wall (32) being orientated differently from the sleeve-shaped wall (31).

6. Vacuum cleaner unit (4) as claimed in claim 5, wherein the air deflecting wall (32) comprises material having sound-absorbing properties, at least at the side of the interior surface (33) thereof.

7. Vacuum cleaner unit (4) as claimed in any of claims 1-6, wherein the motor-fan aggregate (10) is of generally cylindrical shape, and wherein the sleeve-shaped wall (31) is generally shaped like a tube segment having a circular periphery.

8. Vacuum cleaner unit (4) as claimed in claim 7 insofar as dependent on any of claim 5 or 6, wherein the air deflecting wall (32) is generally disc-shaped and is positioned at an end of the sleeve-shaped wall (31).

9. Vacuum cleaner unit (4) as claimed in any of claims 1-8, wherein the interior surface (37) of the sleeve-shaped wall (31) comprises a structure including at least one ridge (38) arranged to at least partially surround the at least one main air outlet opening (36).

10. Vacuum cleaner unit (4) as claimed in any of claims 1-9, wherein the wall structure of the main body housing (30) further comprises an air inlet side wall (34) that is provided with at least one main air inlet opening (35) for letting in air to the vacuum cleaner unit (4).

11. Vacuum cleaner unit (4) as claimed in any of claims 1-10, wherein the aggregate housing (20) comprises material having sound-absorbing properties, at least at the side of the exterior surface (27) thereof and/or the sleeve-shaped wall (31) comprises material having sound-absorbing properties, at least at the side of the interior surface (37) thereof.

12. Vacuum cleaner unit (4) as claimed in claim 6 or 11, wherein the material having sound-absorbing properties is one of a foam material (45), a textile material and a rubber material.

13. Handheld vacuum cleaner (1), comprising a vacuum cleaner unit (4) as claimed in any of claims 1-12.

14. Handheld vacuum cleaner (1) as claimed in claim 13, being a battery-operated handheld vacuum cleaner (1).

15. Handheld vacuum cleaner (1) as claimed in claim 13 or 14, wherein the sleeve-shaped wall (31) of the main body housing (30) of the vacuum cleaner unit (4) is at the exterior of the handheld vacuum cleaner (1).

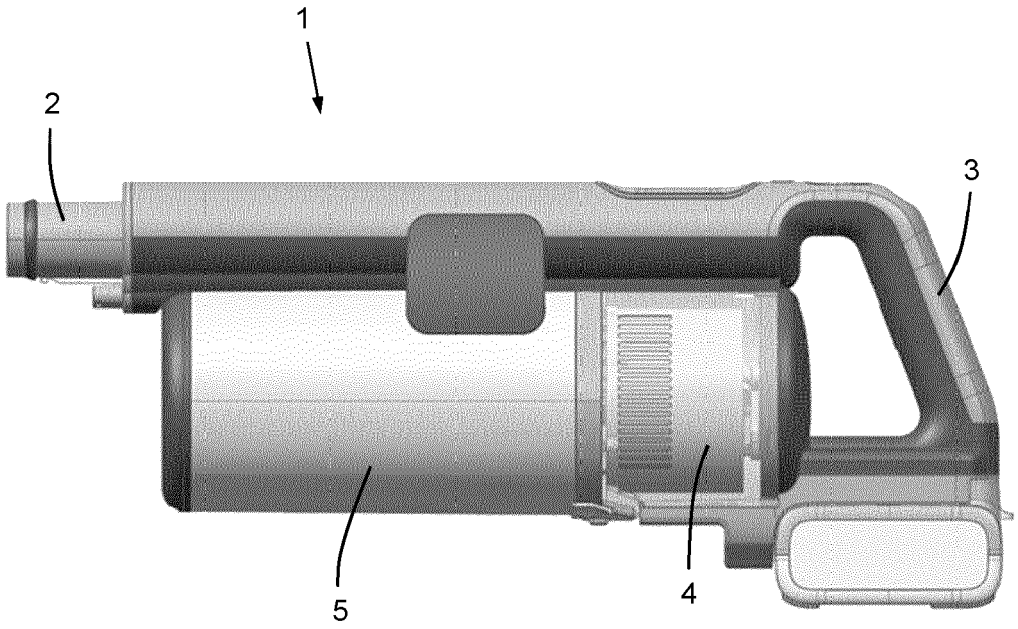

Fig. 1

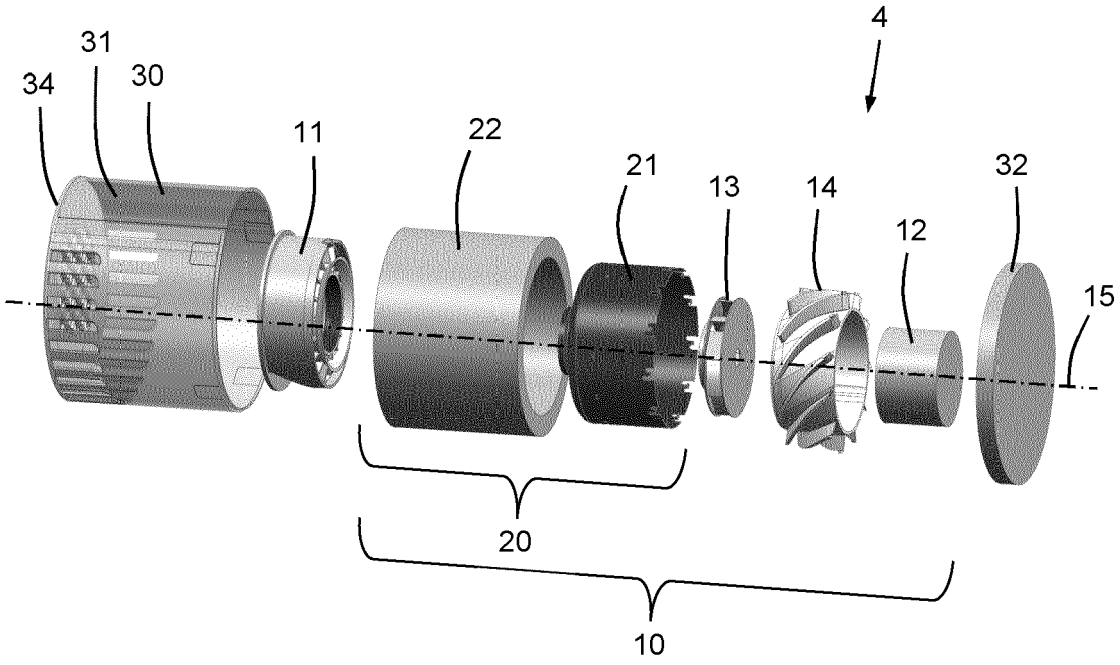

Fig. 2

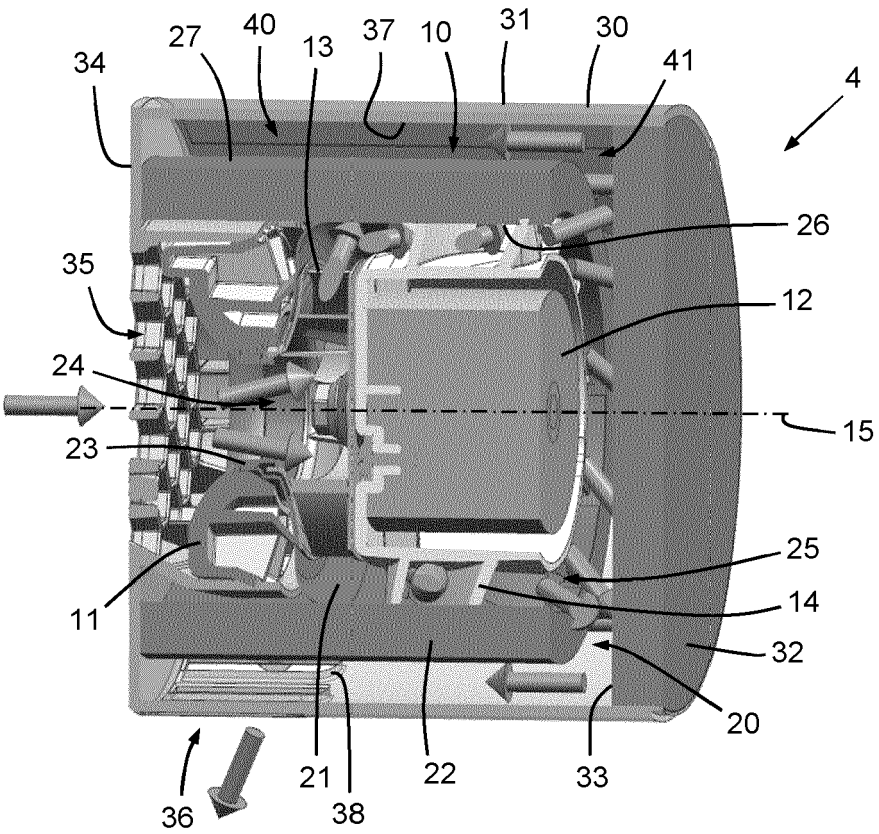
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Fig. 3

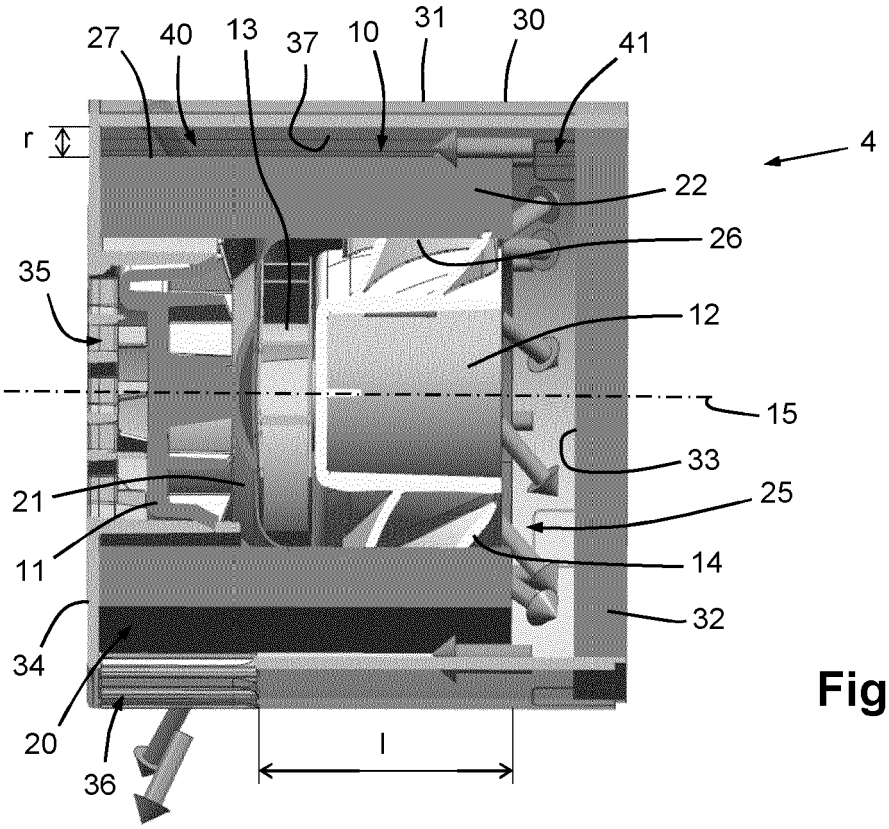
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Fig. 4

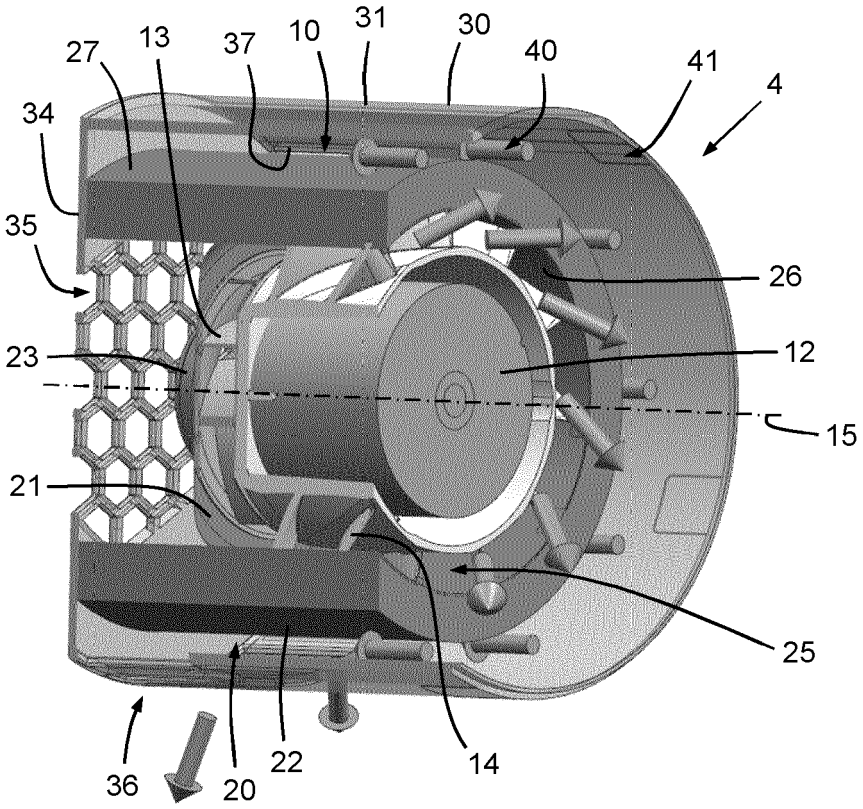
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Fig. 5

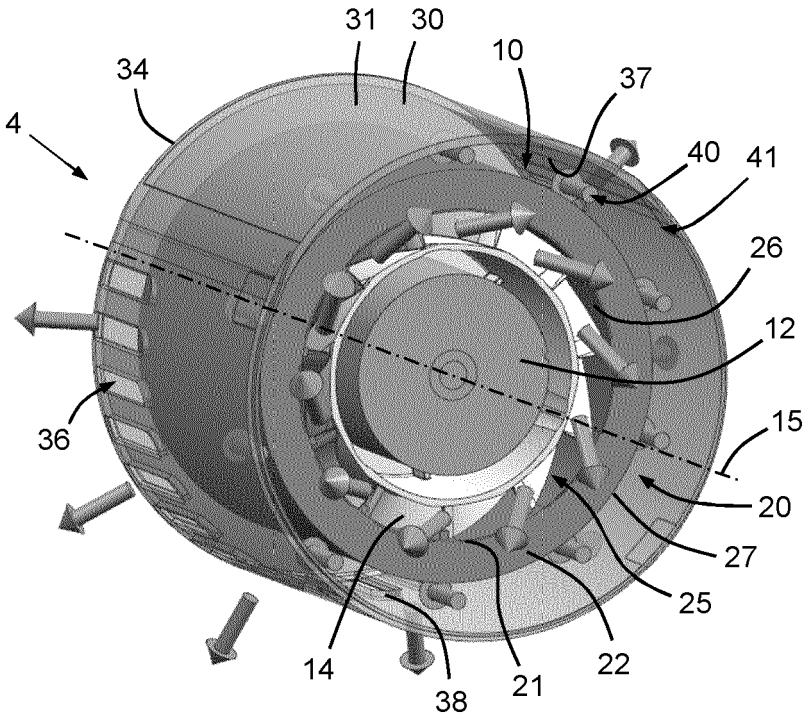
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Fig. 6

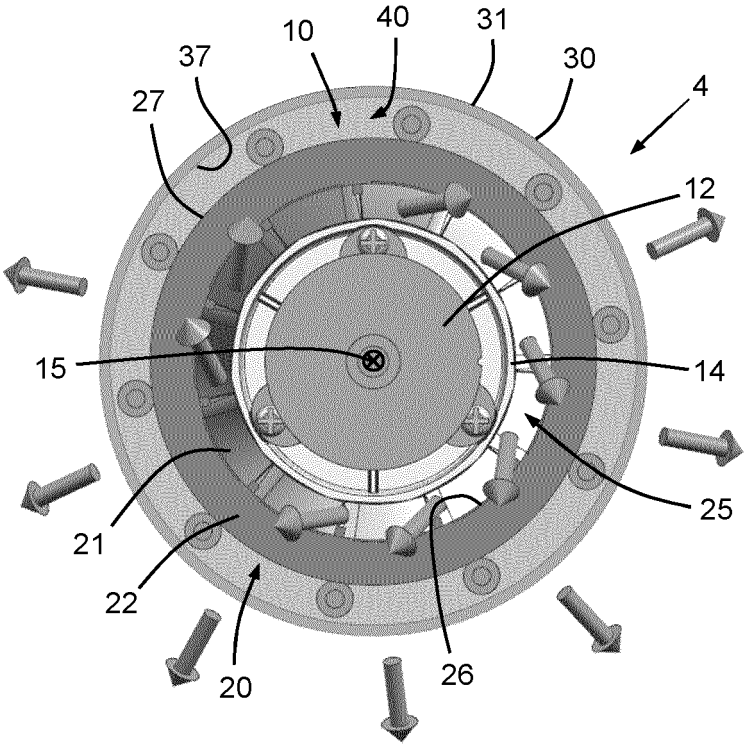
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Fig. 7

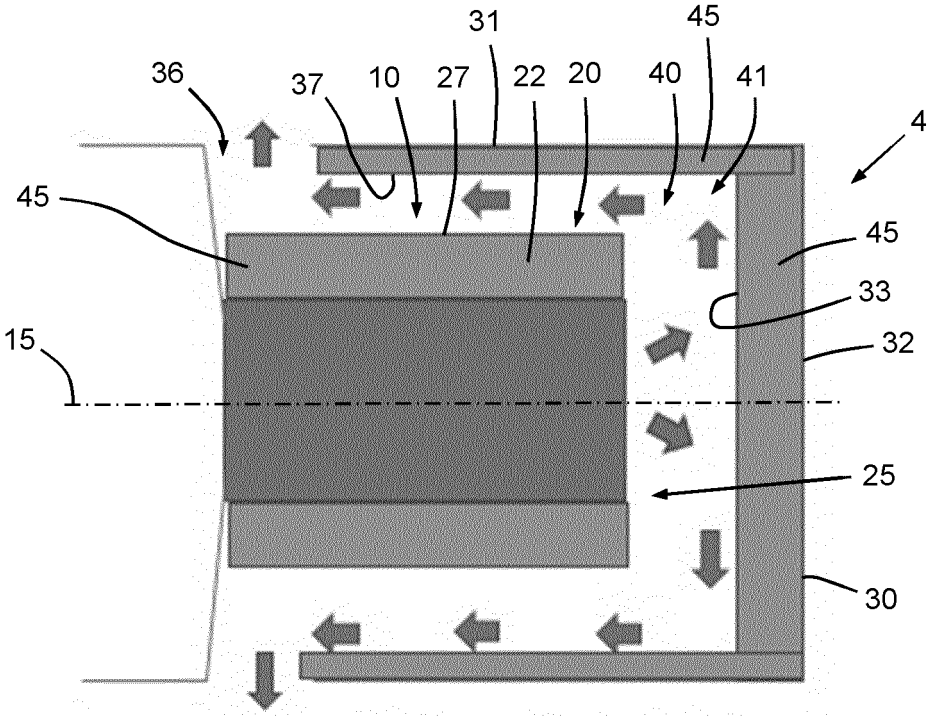
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Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 22 15 8129

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A47L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 July 2022	Jezierski, Krzysztof

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