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(54) **Vacuum cleaner separator for high speed vacuum cleaner motor**

(57) A vacuum cleaner separator **(1)** for vacuum cleaner high-speed motor, preferably for a household vacuum cleaner consists of a central revolved surface portion **(2)** comprising a basic cylindrical segment **(3)** extending on the side of a turbine wheel **(4),** wherein said revolved surface portion **(2)** is provided with blades **(9).** The vacuum cleaner separator **(1)** is characterised by the fact that said revolved surface portion **(2)** is extended in axial direction with a segment **(5)** formed as a lateral surface area with said segment **(3)** of the coaxially running truncated cone, which is in contact with said segment **(3)** with the side having a smaller diameter and that said blades **(9)** extend to said segment **(5).** External edges **(10)** of said blades **(9)** are arranged on an apparent lateral surface area of the truncated cone, whose larger diameter lies adjacent to said turbine wheel **(4).** Said blades **(9)** are linked with each other on the side of said turbine wheel **(4)** by a sealing ring **(11)** lying within an opening **(12)** of a casing **(13)** of said turbine wheel **(4).**

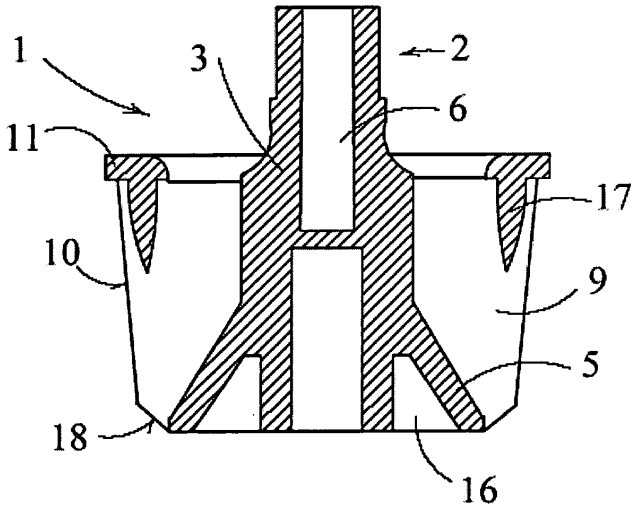

Fig. 2

EP 2 196 125 A2

Description

Subject of Invention

[0001] The subject of the present invention is a vacuum cleaner separator for high-speed vacuum cleaner motor, preferably a household vacuum cleaner.

Technical Problem

[0002] A technical problem solved by the present invention is how to construct such vacuum cleaner separator for high-speed vacuum cleaner motor that will reach the anticipated exclusion of dust particles under planned operating vacuum and would have decreased dimensions and an increased number of revolutions (30,000 to 45,000 rev/min) of the entire vacuum unit including the separator. Price efficient materials and manufacturing procedures should be used, wherein the new constructions should provide for the balancing of rotating parts due to anticipated high revolutions in a simple and quality way. The vacuuming arrangement should be simple and proper sealing should be ensured between the rotating separator and the standing housing. The product should be of high quality and have a long life span as well as having a market acceptable price. Further, the design of the separator should allow it to be independently placed on a shaft or be manufactured integrally with a turbine wheel.

Prior Art

[0003] Several inventions of this type are known and they are disclosed in different patent specifications.

[0004] EP 1 261 269 (Hyla Proizvodnja, razvoj in trgovina d.o.o.) discloses an invention of a separator consisting of several axially composed segments, in which blades are arranged on the circumference in the shape of an airplane wing. All blades are positioned equally with respect to the housing. The construction is mechanically relatively stiff and adequate also for high rotation frequencies, because the blades constituted of segments are relatively short. This embodiment allows for balancing of the separator on the shaft, wherein the fan cover is installed subsequently. A drawback of the described embodiment is a complicated construction of as many as six constituent parts, which results in high production costs. Sealing between the separator and the housing is effected through air counter-flow created by a turbine wheel in co-operation with air ducts on the internal side of the fan cover. A drawback of sealing is huge aerodynamic losses, which are a result of the fact that part of energy on the turbine wheel is used for the return flow of a part of air jet back to a fluid bath.

[0005] US 6,391,101 (Gustafson, Kassien) discloses an invention of this type, in which the shape (cross-section) of actually equal blades is improved. Additional circularly arranged low freely protruding blades arranged on the bottom of the separator are foreseen for the separation of particles having higher mass.

[0006] Such embodiment proved to be inadequate for high rotation frequencies due to the construction of separator blades. The balancing of a fan rotor and separator can also be implemented only consecutively by a technological procedure, in which a separator is disassembled prior to assembly, which considerably increases the time of assembly, the number of operations needed and eventually the price of the final product. Another option is balancing of the separator by removal of the material of the separator, which, however, decreases mechanical stability and has a negative impact on the appearance of the separator.

[0007] Problems similar to those described above are also present in the separator disclosed in patent specifications EP1219223 (Gisovatt s.p.a. industria elettrodomestici), EP0890335 (Vetrella s.p.a.) and in the patent application P 2007 0 0143 (Domel d.d.).

Solution to the Technical Problem

[0008] The described technical problem is solved by the separator of the invention, which is characterised by consisting of a revolved surface core having a coaxially running drilled hole to receive a shaft of the electric motor and which extends at a free end in a cone-like shape, wherein in the vicinity of the opposite part, i.e. adjacent to the turbine wheel, it is provided with a ring connecting the blades and acting as a dynamic sealing ring with respect to the housing. Blades are arranged along the entire height on the revolved surface core. The blades are characterised by their external free edge running on the surface plane of an apparent truncated cone, whose larger diameter lies near the turbine wheel and the smallest diameter is at the opposite end, wherein their internal edge lies on the described revolved surface core. Such design achieves air flow through the separator due to vacuum created by the turbine wheel, so that part of the air jet in the vicinity of the turbine wheel due to higher centrifugal force provided to it by a section of the separator directs radially outwards at the slot between the ring on the separator and the housing of the suction unit, so that a relatively small air flow is achieved with respect to the remaining changing conditions in direction towards the turbine wheel or in opposite direction. The air flowing through the slot is cleaned and does not diminish the quality of vacuuming. In the first embodiment the energy transfers to the air jet to make it pass through the separator; in the second embodiment it flows through the turbine wheel. The path of said air jet is considerably shorter and has less obstacles regardless of its direction. Energy consumption is therefore considerably lower in both cases in comparison with the solutions stated in the prior art. A final result is a greater yield of the apparatus as such.

[0009] Air flow is present within the separator and flows from the area of the separator with higher pressure through slots between blades to the interior of the sepa-

rator, where it flows parallel to the blades from the bottom of the separator towards the output from the separator in direction towards the turbine, which creates air vacuum. The pressure and the speed of air flow within the separator should therefore be arranged in a way that the vacuum of the suctioned air changes equally from the bottom of the separator to the output air opening so that no losses occur due to differences in vacuum due to a harmful mutual influence.

[0010] The described design of the separator provides for a dynamic balancing of the assembly, which consists of a pre-balanced rotor of the electric motor, a turbine wheel arranged on the same shaft and a separator, wherein such dynamic balancing is carried out, when the assembly is positioned in its operating position. After the final balancing, the last assembling intervention is needed, i.e. positioning of a cover of the turbine wheel. The number of assembling steps of a vacuuming unit is herewith considerably decreased.

[0011] The invention will now be explained in more detail by way of an embodiment and the drawings showing in

Fig. 1 perspective view of the separator of the invention,

Fig. 2 axial cross-section of the separator of the invention,

Fig. 3 axial view of the separator of the invention from the bottom side, and

Fig. 4 axial view of the separator of the invention from the side of connection to the turbine

[0012] A vacuum cleaner separator **1** for vacuum cleaner high-speed motor, preferably for a household vacuum cleaner consists of a central revolved surface portion **2** comprising a cylindrical segment **3** extending on the side of a turbine wheel **4** on at least one half of the length of said separator **1** and a segment **5** formed as a lateral surface area with said segment **3** of the coaxially running truncated cone, which is in contact with said segment **3** with the side having a smaller diameter. Within said cylindrical segment 5 there is a coaxially running drilled hole **6** to receive an shaft **7** of an electric motor **8.** The lateral surface area of said revolved surface portion **2** is provided with blades extending radially and shaped in their cross-section in a known way in order to reach a good transfer of air jet between them, said air jet being created by said turbine wheel **4** by vacuum. A special feature is that external edges **10** of said blades **9** are arranged on an apparent lateral surface area of the truncated cone, whose larger diameter lies adjacent to said turbine wheel **4.** The width of said blades **9** varies as a function of the mentioned shape of said revolved surface portion **2** and the extension of said external edges **10.** Herewith the optimal laminar flow of the air jet between said blades is achieved, which contributes to a good yield of the apparatus as such.

[0013] Said blades **9** are linked with each other on the side of said turbine wheel **4** by a sealing ring **11,** which provides said blades **9** with sufficient stiffness needed for the expected high revolutions of said separator **1.** Further, said ring **11** should lie within an opening **12** of a casing **13** of said turbine wheel **4** in a way that it forms a gap **14** with its external surface and said opening **12.** Said gap **14** allows for a smooth positioning of said casing **15** only after all rotating parts have been balanced and assembled to an integral unit.

[0014] The geometry of said external edges **10** of said blades **9** is such that they lie on the lateral surface area of the apparent truncated cone, which provides such centrifugal force to a part of the air jet in the vicinity of said turbine wheel, that the force of vacuum is surpassed, which vacuum is created by said turbine wheel **4,** so that this part of the jet is directed radially outwards past said gap **14.** The pressure of the air jet near said gap **14** can vary due to a possible and expected variation in air resistance of the air jet at the output side of the air jet from the vacuum cleaner. The vacuuming unit with the separator of the invention is intended to be integrated into a vacuum cleaner with or without an air filter at the output side of the air jet. If an air filter is provided, it must not be forgotten that air resistance in the filter increases by its filthiness. In case of the air resistance being small (clean air filter) at the output side of the vacuuming unit, the vacuum in the area of said turbine wheel **4** is small and therefore the air jet in said gap **14** is oriented outwards towards said separator **1,** where it merges with the radially oriented part of the air jet.

[0015] If the vacuum in the vicinity of said turbine wheel **4** increases due an increased air resistance at the output side from the vacuuming unit, e.g. due to filthiness of the filter, the air jet through said gap **14** is oriented through said gap **14** towards said turbine wheel **4.** The air flowing through said gap **14** is part of the radially outwards oriented air jet directed by said separator **1.** This air is already cleaned and does not lower the quality of the basic operation of the vacuum cleaner.

[0016] In the internal area of the cone section **3,** i.e. on the free front side of said revolved surface section **2** further blades **15** may be provided, said blades **15** contributing to the formation of as homogeneous water mist as possible in the sense of equal size of individual water particles, which ensures an efficient reception of dust particles in an individual water particle. This is one of the basic conditions for efficient vacuuming. The number of blades **15** preferably equals the number of blades **9.** In order to reach the desired stiffness of the separator, the blades **9** and **15** are arranged in a way to merge in said section **3** at a smallest possible mutual distance, wherein such construction allows for a smaller thickness of the wall of said section **3** and thus meets a requirement for a desired low weight of the separator.

[0017] In large-scale separators such turbulent movement of the air jet can appear between said blades **9** that can decrease the yield of the vacuuming unit. In such case additional blades **16** are provided in the area be-

tween adjacent blades **9** in order to improve the laminarity of the air jet. These additional blades **16** can be shorter and have an optional cross-section and arranged on the spots, where laminarity destruction of the air jet is established by tests.

[0018] In order to reach the best laminar air flow as possible, the areas of said blades **9** can be machined at the free section of said separator **1,** i.e. opposite said turbine wheel **4.** Said blades **9** can be provided with a chamfer **17** in this section, which can be slanting or rounded.

[0019] It is understood that a man skilled in the art can conceive other embodiments based on being acquainted with the description of the above invention and the embodiment especially in the sense of a different industrial design or optional dimensioning of lamellas and gaps between them, without circumventing the essence of the invention defined in the appended claims.

Claims

1. A vacuum cleaner separator **(1)** for vacuum cleaner high-speed motor, preferably for a household vacuum cleaner consisting of a central revolved surface portion **(2)** comprising a cylindrical segment **(3)** extending on the side of a turbine wheel **(4)** and comprising a coaxially running drilled hole **(6),** wherein said revolved surface portion **(2)** is provided with blades **(9), characterised in that** said revolved surface portion **(2)** is extended in axial direction with a segment **(5)** formed as a lateral surface area with said segment **(3)** of the coaxially running truncated cone, which is in contact with said segment **(3)** with the side having a smaller diameter and that said blades **(9)** extend to said segment **(5),** wherein external edges **(10)** of said blades **(9)** are arranged on an apparent lateral surface area of the truncated cone, whose larger diameter lies adjacent to said turbine wheel **(4)** and that said blades **(9)** are linked with each other on the side of said turbine wheel **(4)** by a sealing ring **(11)** lying within an opening **(12)** of a casing **(13)** of said turbine wheel **(4).**

2. A vacuum cleaner separator as claimed in Claim 1, **characterised in that** further blades (15) may be provided in the internal area of said cone section **(3),** i.e. on the free front side of said revolved surface section **(2).**

3. A vacuum cleaner separator as claimed in Claim 1 and 2, **characterised in that** the number of blades **(15)** preferably equals the number of blades **(9)** and that said blades **(9)** and **(15)** are arranged in a way to merge in said section **(3)** at a smallest possible mutual distance.

4. A vacuum cleaner separator as claimed in Claims 1 to 3, **characterised in that** additional blades **(16)** are provided in the area between two adjacent blades **(9),** wherein said blades **(16)** are shorter and have an optional cross-section.

5. A vacuum cleaner separator as claimed in Claims 1 to 4, **characterised in that** the area of blades **(9)** can be provided with a chamfer (17) at the free section of said separator **(1),** i.e. opposite said turbine wheel **(4),** wherein said chamfer (17) can be slanting or rounded.

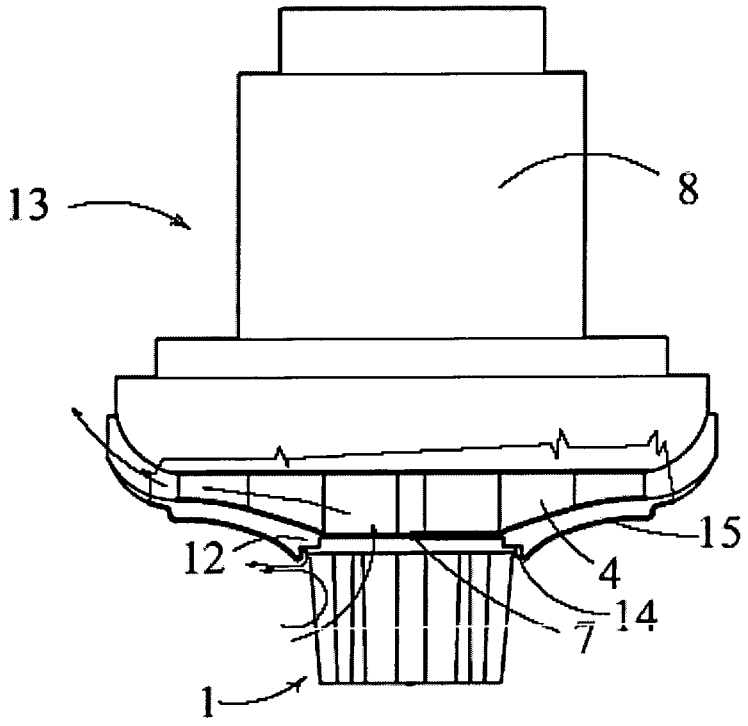

Fig. 1

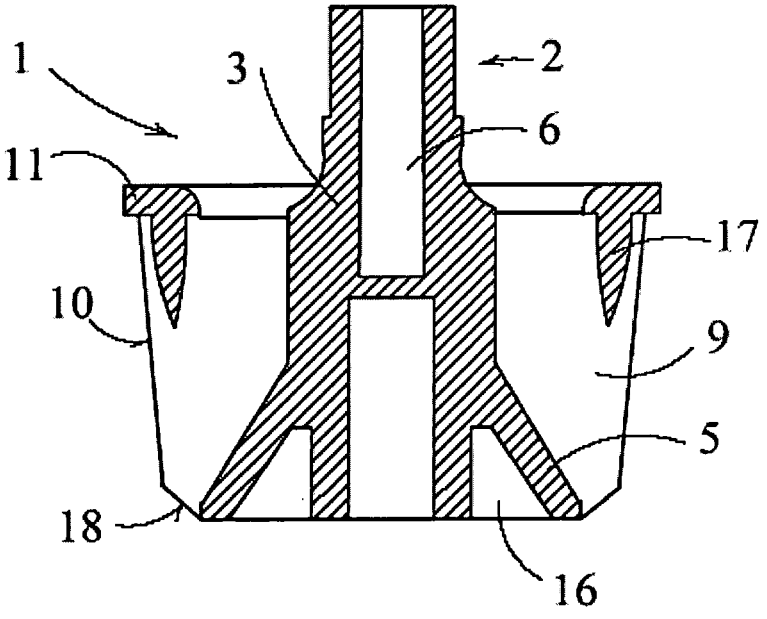

Fig. 2

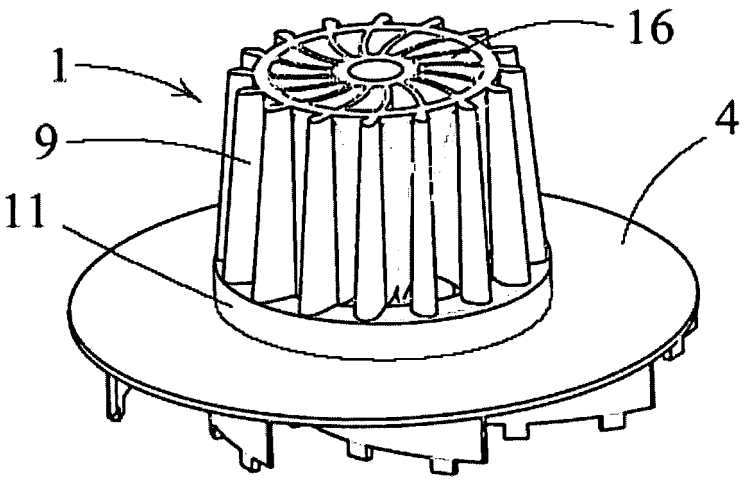

Fig. 3

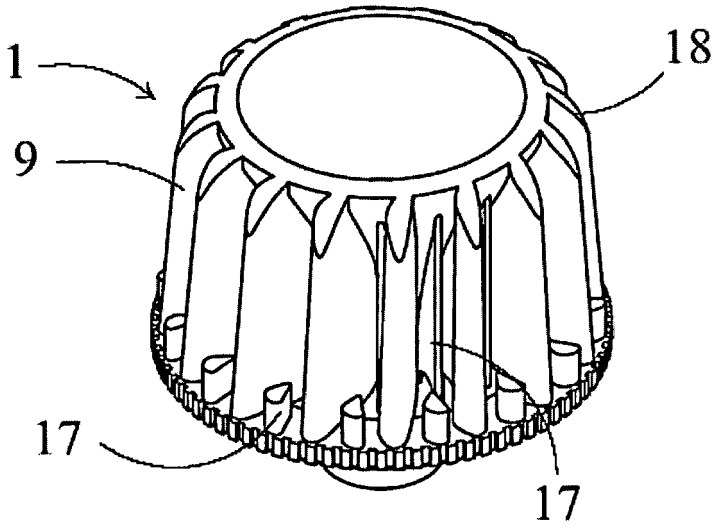

Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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- US 6391101 B **[0005]**
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