SEPARATOR FOR VACUUM CLEANER

Field of the invention

The present invention relates to a separator for vacuum cleaners operating on the basis of a liquid bath, the liquid bath serving as pre-separation and as a dumping area for the aspirated particles. The vacuum cleaners are so-called “dust vacuum cleaners” and are intended for cleaning.

Background

Vacuum cleaners of various designs are known for use on residential and business premises. A common feature shared by all vacuum cleaners is that they create an air negative pressure and thus an airflow that aspirates unwanted particles and, in some embodiments, liquids into the vacuum cleaner. Within the vacuum cleaner, it is then necessary to separate the aspirated air from the aspirated particles and possibly the aspirated liquids. The air, after having been separated from the particles and possible liquids, is returned to the room, while the particles and any possible liquid must remain in the vacuum cleaner. The separation of particles from the air can be done with a mechanical filter, while the separation of particles and possibly aspirated liquids from the air can be done with a liquid bath (filter) and a special separator. An advantage of separating and disposing of particles and possibly aspirated liquids from the air by means of a liquid bath is that the liquid, which is usually water, is always available, unlike a mechanical filter, so in addition to solids also liquids can be aspirated, and thus e.g. also cleaning agents and that this type of vacuum cleaner, when used, slightly moistens the air in the room where it is used. A common problem of all liquid bath vacuum cleaners is that in addition to the particles also the fluid that joins the air stream must be removed from the air. Most liquid bath vacuum cleaners separate air from particles and the associated liquid by centrifugation, since air has a significantly lower specific mass than particles or liquid.

Liquid bath vacuum cleaners are disclosed for instance in patents U.S. Pat. No. 4,640,697 or DE 36 32 992, U.S. Pat. No. 5,030,257 and U.S. Pat. No. 5,125,129. The main disadvantage of solutions to air and particle separation according to these patents

is that the structure of the separators is technically demanding and not sufficiently efficient.

According to patent EP 0 496 837 B1, the separation of the air from the particles is carried out in three stages. As the air flows through the deposition liquid, large particles in this liquid get wetted and remain in it. Small particles flow with the air flow towards the separator and bind on its surface to fine droplets of liquid and, due to the high speed of rotation of the separator (from 20,000 to 25,000 rpm), are forced back to the liquid container. The smallest particles, along with micro droplets of liquid, are trapped inside the separator where, due to the huge centrifugal acceleration of up to 12,000 g, they stick to the inner wall of the separator. This third and final phase of separation of air from particles and liquid means that particles are accumulated inside the separator, said particles reducing the separator slots, thereby reducing the efficiency of both the separator and the entire vacuum cleaner and imbalance the separator, thereby causing vibrations. Due to the above-mentioned accumulation of particles inside the separator, the separator needs to be periodically cleaned, which is an inconvenience for the user and, above all, a potential danger since the separator must be dismounted. While performing this operation, the vacuum cleaner motor should not be driven as this would cause damage to the user due to rotation. Such a solution to separating air from particles and liquids, especially from the point of view of user's safety but also due to it being impractical, is a problem that needs to be solved.

Separation according to U.S. Pat. No. 5,902,386 is solved in a similar way as in EP 0 496 837 B1. An improvement is reflected in the separator's slot depth to width ratio and in the labyrinth added above the separator, which produces a counter airflow for preventing droplets and dust particles from entering the intake turbine wheel.

The main and common disadvantage of the solutions to the separator according to EP 0 496 837 B1 and U.S. Pat. No. 5,902,386 is the separator configured as a conical basket with vertical slots formed in a side wall of the separator. A side wall is formed as an array of ribs with slots formed between the ribs. Due to the high speed of rotation of the separator and, consequently, high centrifugal forces, the ribs and as a result the side

wall get deformed, i.e. bulge outwards. The separator is deformed, the slots become larger and the separator becomes inefficient. The separator is no longer balanced and vibrations are generated. In this structure, reinforcing the ribs of the side wall is the only way to avoid the deformation of the separator. This makes the side wall firmer, the slots smaller, thereby reducing the efficiency of the separator. In addition, wider ribs mean an increased area, on which dust particles and other impurities accumulate. The separator of this type is therefore less efficient due to its structure, due to the accumulation of dust particles and other impurities it becomes even less efficient and needs to be periodically cleaned as previously described.

An interesting solution is disclosed in U.S. patent No. 5,908,493, which is based on a completely different three-stage separation.

Also known is a solution from EP 1 261 269 B1, wherein the separator consists of segments and a segment of the separator is made as a wheel having a periphery on radial supports, the periphery being provided with uniformly distributed blades.

Blades designed according to patent EP 142 60 93 are also known. The blades are designed in a way to produce turbulence spaces behind the front of the blades.

Reference to any prior art in the specification is not an acknowledgement or suggestion that this prior art forms part of the common general knowledge in any jurisdiction or that this prior art could reasonably be expected to be combined with any other piece of prior art by a skilled person in the art.

Summary of the invention

It is desirable for the invention to provide a structure of an improved vacuum cleaner separator that will increase the efficiency of extraction of particles and associated liquid from the air stream and will prevent dust or other impurities from accumulating on the separator or the blades, thereby avoiding cleaning of the separator and preventing liquid droplets, dust particles and other impurities from entering the turbine wheel space.

Experience has shown that efficient separation requires air slots between the blades to

be as small as possible, wherein the total area of the slots should be as large as possible. The shape of the blades is also important. The blades basically have the shape of an aircraft wing, with the front side of the blades being sharply truncated and the thickness of the blades continuously decreases towards a tail, i. e. the end of the blades in the interior of the separator, so that the tails of the blades are formed as a sharp edge. A sharply truncated front side increases the efficiency of expulsion of solid particles, while the sharp edge of the tails of the blades reduces the accumulation of dirt on the separator blades.

A first aspect of the invention provides a separator for vacuum cleaners operating on the basis of a liquid bath, the liquid bath serving as pre-separation and as a dumping area for the aspirated particles and the air flow being generated by a turbine wheel in a housing, the separation being achieved by a centrifugal separator, the separator consisting of at least two segments, each of the segments being formed as a radially flat ring (that is centrally secured to a hub via radial supports and having blades equidistantly formed and substantially perpendicularly to the surface of the ring, said blades extending from the outer circumference of the ring towards the interior, and the blades being positioned in a way that an angle is present in the opposite direction of rotation between the radial direction and the direction of the blade, said angle being in the range 0 to 40 angular degrees, and each of the segments having an axially formed hub with an opening for attaching the separator to the shaft of the motor, wherein the blades are positioned on each individual segment in a way that a gap is formed between each two adjacent blades of each segment, wherein, when individual segments are stacked one over another, the blades of one segment extend into the gaps between the blades of the next segment, such that a newly formed gap is formed between the two adjacent blades of the assembled separator.

Brief description of the drawings

The invention will be described in more detail by way of an embodiment and the accompanying drawings representing in:

Figure 1 Embodiment of a separator and turbine assembly,
Figure 2 Disassembled separator in perspective view (“exploded view”),
Figure 3 Segment of the separator, top view,
Figure 4 Assembled separator.

Detailed description of the drawings

An assembly consisting of a separator 1 and a turbine wheel 2 with a motor 3 within a housing 4 is the basis of operation of a liquid-bath based vacuum cleaner. In principle, the vacuum cleaner operates in a way that the motor 3 on its shaft drives the turbine wheel 2 and the separator 1. The assembly and the operation are illustrated in Figure 1. The turbine wheel 2 generates negative pressure, as a result, a flow including a mixture of air, water droplets and other impurities is created which is directed towards the separator 1 in the direction of arrow 5. As the separator 1 rotates at high speed, droplets and other impurities having a high specific weight, due to centrifugal force, cannot enter the separator 1 or can do so only exceptionally. The air having a low specific weight, however, enters the separator 1 due to the pressure generated by the turbine wheel 2, the air is drawn in by the turbine wheel 2 and blown into the room. Droplets and other impurities that accidentally penetrate the separator 1 are rotated in the separator 1 by means of radial supports 12 and ejected from the separator 1 by centrifugal force as indicated by arrow 6.

The structure and the operation of the separator will be explained by way of drawings.

The separator 1 of the invention illustrated in Figures 2 to 4 preferably has a cylindrical shape and consist of segments 7, each of the segments 7 being formed as a radially flat ring 13 that is centrally secured to a hub 11 via radial supports 12 and having separator

CLAIMS

1. A separator for vacuum cleaners operating on the basis of a liquid bath, the liquid bath serving as pre-separation and as a dumping area for the aspirated particles and the air flow being generated by a turbine wheel in a housing, the separation being achieved by a centrifugal separator, the separator consisting of at least two segments, each of the segments being formed as a radially flat ring that is centrally secured to a hub via radial supports and having blades equidistantly formed and substantially perpendicularly to the surface of the ring, said blades extending from the outer circumference of the ring towards the interior, and the blades being positioned in a way that an angle is present in the opposite direction of rotation between the radial direction and the direction of the blade, said angle being in the range 0 to 40 angular degrees, and each of the segments having an axially formed hub with an opening for attaching the separator to the shaft of the motor, wherein the blades are positioned on each individual segment in a way that a gap is formed between each two adjacent blades of each segment, wherein, when individual segments are stacked one over another, the blades of one segment extend into the gaps between the blades of the next segment, such that a newly formed gap is formed between the two adjacent blades of the assembled separator.

2. A separator according to claim 1, wherein the minimum width of the gaps is 1.2 to 3.5 of the maximum thickness of the blade and the minimum width of the newly formed gaps is 0.1 to 1.25 of the maximum thickness of the blade.

3. A separator according to any one of the preceding claims, wherein the blades have basically a profile of an aircraft wing, wherein a front side of the blade is cut at an angle of about 15 to 45 angular degrees with respect to the tangent of the circumference, and tails of the blades are formed as a sharp edge.

4. A separator according to any one of the preceding claims, wherein the blades are provided at their upper edge with projections, the radially flat rings are provided in the gaps with recesses, wherein, when the segments are assembled, the projections on the blades engage the recesses on the radially flat rings.

5. A separator according to any one of the preceding claims, wherein the height of the

hub is approximately identical to the height of the blades and positioning connectors are formed on the hub of each segment for engagement of the blades of one segment into the gaps between the blades of another segment, when the segments are being assembled.

6. A separator according to any one of the preceding claims, consisting of a first end segment, a second end segment, and at least one intermediate segment.

7. A separator according to claim 6, wherein the intermediate segment is provided with blades on both sides of the radially flat ring.

8. A separator according to claim 7, wherein the blades on either side of the radially flat ring are arranged so as to be offset on one side of the radially flat ring towards the blades on the other side of the radially flat ring by one half of the gap.

9. A separator according to claim 7, wherein the blades on both sides of the radially flat ring are aligned one above the other.

10. A separator according to claim 6, wherein the first end segment and the second end segment are provided with blades only on one side of the radially flat ring, wherein the first end segment is provided with blades on the side of the radially flat ring facing away from the turbine wheel and the second end segment is provided with blades on the side of the radially flat ring facing the turbine wheel.

11. A separator according to claim 6, wherein the first end segment and the second end segment are formed as stand-alone elements, a bottom and a sealing ring being formed as stand-alone elements.

12. A separator according to claim 6, wherein the first end segment preferably has the radially flat ring provided with an integrated sealing ring, and the second end segment has the radially flat ring provided with an integrated bottom.

13. A separator according to any one of claims 7 to 12, wherein the radial supports are shaped so as to cover 50 to 100% of the total height of the hub along the hub, while the

height of the radial supports decreases towards the ring.