An impeller reduces peak noise in the frequency range of 8-10 kHz and is constructed, in disclosed embodiments, with a lower plate in the shape of a disk, an upper plate spaced apart from the lower plate by a predetermined distance and having a diameter corresponding with a diameter of the lower plate and a central air inlet, and a plurality of air guide members disposed radially between the lower plate and the upper plate having their outside corners chamfered.
FIG. 1
(PRIOR ART)
FIG. 11

23' a

23'

FIG. 12

![Sound Level Graph](image)

- Frequency (Hz)
- Sound Level (dBA)

- Peaks at 75.3, 82.6 dBa
VACUUM CLEANER IMPELLER AND MOTOR ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS


BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates generally to the field of vacuum cleaners. Some of the embodiments disclosed are directed more particularly to an impeller for a vacuum cleaner motor assembly.

[0004] 2. Description of the Related Art

[0005] Generally, a vacuum cleaner generates a partial vacuum and collects dust and impurities by the partial vacuum. Therefore, the vacuum cleaner has a motor assembly for generating the partial vacuum. The partial vacuum is generated by an impeller that draws in air as it is rotated by a motor.

[0006] Referring to FIGS. 1 and 2, a conventional motor assembly 1 includes a motor 10, an impeller 20 rotated by the motor 10 and a diffuser 30 guiding air drawn in by the impeller 20 toward the motor 10.

[0007] The impeller 20 has a lower plate 21, an upper plate 22 and a plurality of air guide members 23. The lower plate 21 is formed in the shape of a disk and disposed at a motor shaft 11 of the motor 10. The upper plate 22 is formed in the shape of a disk to correspond with the lower plate 21 and has a substantially same diameter as the lower plate 21. The upper plate 22 has an air inlet 25 drawing in air at its center. A plurality of air guide members 23 are disposed radially between the lower plate 21 and the upper plate 22 at regular intervals. Each of the air guide members 23 is formed in the shape of a bent band having a predetermined curvature. In an embodiment, one end 23a of the air guide members 23 is formed with right angles at peripheries of the lower plate 21 and the upper plate 22. Also, the air guide member 23 has a length such that its outside end 23a is within the periphery of the lower plate 21 and upper plate 22, and its inside end is outside of the air inlet 25 of the upper plate 22.

[0008] The diffuser 30 is disposed at an upper end of the motor 10 in concentric circles outside the impeller 20. There is a gap between the diffuser 30 and the impeller 20 to rotate the impeller 20. The diffuser 30 has a plurality of guide members for guiding the air when the air is drawn in and discharged by the impeller 20 toward the motor 10.

[0009] The operation of the conventional motor assembly 1 comprising the same structure as that described above will be explained hereinafter referring to FIGS. 1 and 2.

[0010] When the motor 10 of the motor assembly 1 rotates, the impeller 20 is rotated by the lower plate 21 disposed at the motor shaft 11 of the motor 10. When the impeller 20 rotates, the dust-laden air, which may contain dust and impurities, is drawn in through a dust inlet of a suction brush (not shown) fluidly connected with the air inlet 25 of the upper plate 22 of the impeller 20. Dust and impurities in the air are removed while passing through a dust-collecting unit (not shown), and accordingly, substantially clean air enters the air inlet 25 of the impeller 20. The air entered into the air inlet 25 flows along the plurality of air guide members 23 and discharges toward the diffuser 30. The air discharged from the diffuser 30 cools the motor 10 and is discharged outside the vacuum cleaner through an outlet of a main body thereof (not shown).

[0011] However, since the motor 10 rotates at high speed, the vacuum cleaner, which collects the dust and impurities by the suction force of the motor assembly 1, generates considerable noise. Accordingly, efforts have been made to reduce the noise. One approach is to change the flow passage of air discharged through the motor assembly. Another is to provide sound-absorbing materials. However, these methods do not efficiently reduce noise. The inventors have found that it is desirable to reduce a noise peak at a frequency of 8–10 kHz, in particular, among the noises that are generated by rotating of the impeller of the motor assembly, to make operation more pleasant for the user.

SUMMARY OF THE INVENTION

[0012] In some embodiments, an impeller for a vacuum cleaner is provided that reduces peak noise generated during rotation of the impeller, particularly (for example) in the frequency range of 8–10 kHz.

[0013] In further embodiments, a motor assembly is provided with a noise-reducing impeller.

[0014] In some of the exemplary embodiments disclosed, various advantages are accomplished by providing an impeller for a vacuum cleaner comprising a lower plate in a shape of a disk; an upper plate separated from the lower plate at a predetermined distance, the upper plate having a diameter corresponding to the lower plate and a central air inlet; and a plurality of air guide members disposed radially between the lower plate and the upper plate, with the plurality of air guide members chamfered at both corners at their outside ends.

[0015] In an exemplary embodiment, the dimensions of the chamfered corner satisfy the following formula:

\[ 1.5 \text{ mm} \leq B \leq 2 \text{ mm} \]

[0016] where B is the dimension of the chamfered corner measured in the width direction of the air guide member and C is the width of the air guide member.

[0017] Also, the plurality of air guide members may be attached to the upper plate and the lower plate with coggings joints.

[0018] It is preferred that a dimension A of the chamfered corner measured along the length of the air guide member is shorter than a distance between an outside end of the air guide member and the outermost coggings joint. Also, it is preferred that this dimension A is between about 1.5 mm and about 3 mm.

[0019] In a further embodiment, an impeller for a vacuum cleaner comprises a lower plate in a shape of a disk; a plurality of air guide members disposed radially on the lower plate and having chamfered corners at their outer ends; and an upper plate disposed on the plurality of air
guide members, the upper plate having a central air inlet and a diameter corresponding to an inner beginning point of the upper chambers of the air guide members.

[0020] In further embodiments, a motor assembly for a vacuum cleaner comprises a motor and an impeller, the impeller comprising: a lower plate disposed at a motor shaft of the motor, the lower plate in a shape of a disk, an upper plate separated from the lower plate at a predetermined distance, the upper plate having a diameter corresponding to the lower plate and a central air inlet, and a plurality of air guide members disposed radially between the lower plate and the upper plate, with their corners chamfered at the outer ends thereof and a diffuser disposed at an upper portion of the motor, the diffuser guiding air drawn in from the impeller toward the motor.

[0021] In exemplary embodiments, dimensions of the chamfered corners are selected according to the following formula:

\[ B \leq \frac{C}{2} \]

[0022] Where \( B \) is the dimension of the chamfered corner measured in the width direction of the air guide member and \( C \) is the width of the air guide member.

[0023] Also, the plurality of air guide members may be attached to the upper plate and the lower plate with cogging joints.

[0024] It is preferred that a dimension \( A \) of the chamfered corner measured along the length of the air guide member is shorter than an outside diameter of the air guide member and the outermost cogging joint. Also, it is preferred that this dimension \( A \) is between about 1.5 mm and about 3 mm.

[0025] In another embodiment, a motor assembly for a vacuum cleaner comprises a motor and an impeller, the impeller comprising: a lower plate disposed at a motor shaft of the motor, the lower plate in a shape of a disk, a plurality of air guide members disposed radially on the lower plate, the plurality of air guide members chamfered at both outside corners thereof and an upper plate disposed on the plurality of air guide members, the upper plate having a diameter corresponding with a lengthwise beginning point of the chamfered corner of the air guide member and a central air inlet thereof and a diffuser disposed at an upper portion of the motor, the diffuser guiding air drawn in from the impeller toward the motor.

[0026] Further embodiments provide a vacuum cleaner comprising a suction brush, a dust collecting unit fluidly connected with the suction brush and collecting dust, and a motor assembly fluidly connected with the dust collecting unit and generating a suction force. The motor assembly includes a motor; an impeller comprising: a lower plate disposed at a motor shaft of the motor, the lower plate in a shape of a disk, an upper plate separated from the lower plate at a predetermined distance, the upper plate having a diameter corresponding to the lower plate and a central air inlet, and a plurality of air guide members disposed radially between the lower plate and the upper plate, with their corners chamfered at the outer ends thereof and a diffuser disposed at an upper portion of the motor, the diffuser guiding air drawn in from the impeller toward the motor.

[0027] Tested embodiments of the impeller reduce peak overall noise in the frequency range of 8–10 kHz as compared with conventional impellers.

[0028] A motor assembly incorporating the improved impeller disclosed in various embodiments reduces overall noise and particularly peak noise in the frequency range of 8–10 kHz relative to noise levels found in conventional devices.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0029] These and/or other aspects and advantages of the present invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawing figures of which:

[0030] FIG. 1 is a cross sectional view illustrating a conventional motor assembly;

[0031] FIG. 2 is a perspective view illustrating an impeller for a vacuum cleaner used in the motor assembly shown in FIG. 1;

[0032] FIG. 3 is a plain view illustrating an impeller rotating inside a diffuser;

[0033] FIG. 4 is a view illustrating noise sources of an impeller as determined by a computer simulation analysis of an air flow;

[0034] FIG. 5 is a perspective view illustrating an impeller for a vacuum cleaner according to a first exemplary embodiment of the present invention;

[0035] FIG. 6 is a front view illustrating the impeller for the vacuum cleaner shown in FIG. 5;

[0036] FIG. 7 is a view showing chamfering of an air guide member of the impeller for the vacuum cleaner shown in FIG. 5;

[0037] FIG. 8 is a view illustrating a motor assembly having an impeller according to the first embodiment of the present invention;

[0038] FIG. 9 is a view illustrating an air guide member of a first test impeller used for a noise comparative test;

[0039] FIG. 10 is a graphical illustration showing noise of the first test impeller having the air guide member shown in FIG. 9 and noise of an impeller according to the first embodiment of the present invention;

[0040] FIG. 11 is a view illustrating an air guide member of a second test impeller used for another noise comparative test;

[0041] FIG. 12 is a graphical illustration showing noise of the second test impeller having the air guide member shown in FIG. 11 and noise of an impeller according to the first embodiment of the present invention;

[0042] FIG. 13 is a perspective view illustrating an impeller for a vacuum cleaner according to a second embodiment of the present invention;

[0043] FIG. 14 is a partial front view illustrating the impeller for the vacuum cleaner shown in FIG. 13;

[0044] FIG. 15 is a view illustrating a motor assembly having an impeller according to the second embodiment of the present invention;
FIG. 16 is a graphical illustration showing noise of the conventional impeller and noise of an impeller according to the second embodiment of the present invention; and

FIG. 17 is a view illustrating a vacuum cleaner having a motor assembly according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

In the following description, similar drawing reference numerals may be used for the same elements even in different drawings. The embodiments described, and their detailed construction and elements, are merely provided to assist in a comprehensive understanding of the invention. Thus, it is apparent that the present invention can be carried out in a variety of ways, and does not require any of the specific features described herein. Also, well-known functions or constructions are not described in detail since they would obscure the invention with unnecessary detail.

A computer simulation analysis of noise sources was performed to analyze the noise generated by a rotating impeller, with the objective of reducing peak noise in the frequency range of 8–10 kHz. Results of this computer simulation analysis will be described with reference to FIGS. 3 and 4.

Airflow in the impeller 20 was analyzed by computer simulation of rotation of impeller 20 inside a diffuser 30 as shown in FIG. 3. The analysis result is shown in FIG. 4. Referring to FIG. 4, triangular tails 23a are respectively attached outside ends 23a of the plurality of air guide members 23. The triangular tails 23b represent forces applied in the outside ends 23a of the plurality of air guide members 23. This indicates that noise is generated from outside ends 23a of the plurality of air guide members 23 when the impeller 20 rotates. Accordingly, the inventors have determined that an interaction between outside ends 23a of the plurality of air guide members 23 of the impeller 20 and guide members 31 of the diffuser 30 may generate noise when the impeller 20 rotates inside the diffuser 30 as shown in FIG. 3. In other words, when the impeller 20 rotates, a major noise source may be outside ends 23a of the plurality of air guide members 23.

In an exemplary embodiment, the shape of outside end 23a of the air guide member 23 is changed, and the diameter of an upper plate of the impeller 20 may also be modified, to reduce noise arising from rotation of impeller 20, especially to reduce a noise peak in the frequency range of 8–10 kHz.

Hereinafter, certain embodiments of the present invention will be described in detail with reference to the accompanying drawing figures.

Referring to FIGS. 5 and 6, an impeller 110 for a vacuum cleaner according to a first embodiment of the present invention has a lower plate 111, an upper plate 112 and a plurality of air guide members 113.

The lower plate 111 is formed in the shape of a disk and a center thereof is disposed at a motor shaft (not shown) of a motor. The upper plate 112 is formed in the shape of a disk to correspond with the lower plate 111 and has substantially the same diameter as the lower plate 111. The upper plate 112 has a central air inlet 115. Also, it is preferred that the air inlet 115 is formed to protrude from the upper plate 112 to a predetermined height. In the embodiment shown, a connecting part 114 connecting the air inlet 115 with the upper plate 112 is formed as a curved surface having a predetermined curvature to allow intake air to flow smoothly. The plurality of air guide members 113 are disposed radially between the lower plate 111 and the upper plate 112 at regular intervals. Each of the air guide members 113 is formed in the shape of a bent band having a predetermined curvature. Each of the air guide members can be attached to the upper plate 112 and the lower plate 111 by various joining methods. In the present embodiment, each of the air guide members is attached in the upper plate 112 and the lower plate 111 with clogging joints 116. At this time, one end 113a of the air guide member 113 toward the periphery of the lower plate 111 and of the upper plate 112 has both of its corners chamfered as shown at 113c. It is preferred that chamfered corners 113c satisfy the dimensional conditions described below.

FIG. 7 is a view showing details of chamfers on corners 113c of the air guide member 113.

Referring to FIG. 7, it is preferred that a dimension A of the chamfered corner, measured along the length of the air guide member, is shorter than a distance between an outside end of the air guide member and the outermost clogging joint. Dimension A will be referenced herein as the “lengthwise dimension” of chamfered corner 113. Also, it is preferred that this dimension A is between about 1.5 mm and about 3 mm. Preferably, a length B of the air guide member’s widthwise direction of the chamfered corner 113c, hereinafter referred to as a “widthwise dimension” of the chamfered corner 113c, is so determined to satisfy Formula 1:

$$1.5 \text{ mm} \leq B \leq 3 \text{ cm}$$

where, B is the widthwise dimension of the chamfered corner 113c, and C is the width of air guide member 113.

Also, the air guide member 113 has a length such that one end 113a thereof is inside the peripheries of the lower plate 111 and of the upper plate 112 and the other end thereof is outside of the air inlet 115 of the upper plate 112.

The operation of the impeller 110 for the vacuum cleaner comprising the same structure as that described above will now be described in more detail.

Referring to FIG. 8, a motor assembly 100 for the vacuum cleaner having an impeller according to a first embodiment of the present invention includes a motor 101, an impeller 110 rotated by the motor 101 and a diffuser 120 guiding air drawn in by the impeller 110 toward the motor 101.

Any of various types of motors operating at approximately 3,000 rpm to 3,600 rpm which are used generally in vacuum cleaners may be used as the motor 101. In the present embodiment, a universal motor operating at 3,000 rpm is used. However, this example is not intended to limit the scope of the present invention, as a wide variety of motors may be used for this purpose.

The impeller 110 has a lower plate 111, an upper plate 112 and a plurality of air guide members 113. Referring to FIGS. 5 and 8, the lower plate 111 is formed in the shape
of a disk and a center thereof is disposed at a motor shaft 102 of a motor 101. The upper plate 112 is formed in the shape of a disk to correspond with the lower plate 111 and has substantially the same diameter as the lower plate 111. The upper plate 112 has a centrally located air inlet 115 for drawing in air. Also, the air inlet 115 is formed to protrude from the upper plate 112 to a predetermined height. A connecting part 114 connecting the air inlet 115 with the upper plate 112 is formed as a curved surface having a predetermined curvature to allow intake air to flow smoothly. The plurality of air guide members 113 are disposed radially between the lower plate 111 and the upper plate 112 at regular intervals. Each of the air guide members 113 is formed in the shape of a bent band having a predetermined curvature. In the present embodiment, 9 air guide members 113 are attached to the upper plate 112 and the lower plate 111 with clogging joints 116. At this time, one end 113a of the air guide member 113 toward the periphery of the lower plate 111 and of the upper plate 112 has both of its corners 113c chamfered. It is preferred that the chamfered corners 113c satisfy the conditions described above. In the present embodiment, if a width of the air guide member 113 is C=7 mm, the widthwise dimension of the chamfered portion is B=C/2=3.5 mm and the lengthwise dimension A is 3 mm. In this embodiment, the outermost of the clogging joints 116a, 116b is separated by over 3 mm from the outside end 113b of the air guide member 113 (see FIG. 7).

[0061] The diffuser 120 is disposed at upper portion of the motor 101 in concentric circles outside the impeller 110. There is a gap between the diffuser 120 and the impeller 110 to rotate the impeller 110. The diffuser 20 has a plurality of guide members for guiding air when the air is drawn in and discharged by the impeller 110 toward the motor 101. The diffuser 120 shown in FIGS. 3 and 8 is an exemplary diffuser that can be used in the motor assembly 100 for the vacuum cleaner, and one will appreciate that various types of diffusers can be used.

[0062] The operation of the motor assembly 100 for the vacuum cleaner comprising the same structure as that described above is explained hereinafter.

[0063] When the motor shaft 102 of the motor assembly 100 rotates, the lower plate 111 of the impeller 110 disposed at the motor shaft 102 is rotated, thereby rotating the impeller 110. When the impeller 110 rotates, dust-laden air is drawn in through a dust inlet of a suction brush (not shown) that is fluidly connected with the air inlet 115 of the impeller upper plate 112. The dust and impurities in the dust-laden air are removed while passing through a dust-collecting unit (not shown), and accordingly, substantially clean air enters into the air inlet 115 of the impeller 110. The air entering air inlet 115 is scattered and enters inside ends of the plurality of air guide members 113. The air passing into the inside ends of the plurality of air guide members 113 is discharged toward the diffuser 120 through outside ends 113a thereof.

[0064] In this embodiment, impeller peak noise in the frequency range of 8–10 kHz is reduced compared to devices having a conventional impeller as shown in Table 1, FIGS. 10 and 12. In other words, the peak noise of the impeller 110 according to the first embodiment of the present invention is reduced by approximately 9 dB compared to a first test impeller having the air guide member 23 as shown FIG. 9, and by approximately 7.3 dB compared to a second test impeller having the air guide member 23' shown in FIG. 11. At FIGS. 10 and 12, thick curved lines 1 and 3 indicate respectively noise of the impeller according to the first embodiment of the present invention and thin curved lines 2 and 4 indicate respectively noise of the first test impeller and the second test impeller.

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impeller type</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>First embodiment</td>
</tr>
<tr>
<td>First test impeller</td>
</tr>
<tr>
<td>Second test impeller</td>
</tr>
</tbody>
</table>

[0065] Both corners 113c of outside end 113a of the air guide member 113 of the impeller 110 according to the first embodiment of the present invention are chamfered. An exemplary chamfering dimension of the chamfered corner 113c is A=3 mm, B=3.5 mm as described above (see FIG. 7). Both corners 23d of an outside end of the air guide member 23 of the first test impeller form right angles as shown in FIG. 9. An air guide member 23' of the second test impeller has a groove 23d' with a predetermined radius at an outside end thereof as shown in FIG. 11. The impeller 110 according to the first embodiment of the present invention, the fast and second test impellers have 8 or 9 air guide members. A universal motor operating at 3,000 rpm is used for the test. The graphical representation of generated noise in FIGS. 10 and 12 indicates a peak noise level in the frequency range of 8–10 kHz. The frequency range of 8–10 kHz generally includes a second BPF (Blade Passage Frequency) of the impeller. Here, the BPF represents the number of blades passing per second measured in cycles per second (Hz). For example, when the speed of rotation of the motor is 3,000 rpm and the impeller has 9 air guide members, the BPF is 4,500 Hz. This frequency is referred to as a first-degree BPF. The second-degree BPF is twice the first-degree BPF. In this example, the second-degree BPF is 9,000 rpm.

[0066] The air discharged from the diffuser 120 cools the motor 101 and is discharged outside the vacuum cleaner through an outlet in the main body (not shown).

[0067] Referring to FIGS. 13 and 14, an impeller 110' for a vacuum cleaner according to a second embodiment of the present invention has a lower plate 111, an upper plate 112' and a plurality of air guide members 113.

[0068] The lower plate 111 is formed in the shape of a disk and a center thereof is disposed at a motor shaft of a motor (not shown).

[0069] The upper plate 112' is formed in the shape of a disk to correspond with the lower plate 111 and has a shorter diameter than that of the lower plate 111. The diameter of the upper plate 112' is determined to correspond with a chamfering dimension of the air guide member 113. It is preferred that the upper plate 112' has a diameter such that an outside periphery 112d' of the upper plate 112' corresponds with a lengthwise beginning point 113s of chamfered corner 113c of the air guide member 113. The upper plate 112' has an air inlet 115 drawing in the air in a center thereof. Also, the air inlet 115 is formed to protrude from the upper plate 112' to
a predetermined height. And a connecting part 114' connecting the air inlet 115 with the upper plate 112' is formed as a curve surface having a predetermined curvature to allow the drawn in air to flow smoothly.

[0070] The plurality of air guide members 113 are disposed radially between the lower plate 111 and the upper plate 112' at regular intervals. Each of the air guide members 113 is formed in the shape of a bent band having a predetermined curvature. Each of the air guide member 113 can be attached to upper plate 112' and lower plate 111 with various types of jointing methods. In an exemplary embodiment, each of the air guide members 113 is attached to the upper plate 112' and the lower plate 111 with clogging joints 116. In an embodiment, one end 113a of the air guide member 113 is at the periphery of the lower plate 111 and of the upper plate 112' has chamfers at both corners 113c. The chamfering process will not be explained herein after since it is similar to that of the air guide member 113 of the impeller 110 according to a first embodiment of the present invention as described above.

[0071] Referring to FIG. 14, a lengthwise dimension A of the chamfered corner 113c is shorter than a distance between one end 113a of the air guide member 113 and the outermost joint 116a, 116b among clogging joints 116 which attach the air guide member 113 to the lower plate 111 and the upper plate 112'. Also, it is preferred that the lengthwise dimension A of the chamfered corner 113c of the air guide member 113 is between approximately 1.5 mm and 3 mm from an original corner 113d thereof.

[0072] Also, the air guide member 113 preferably has a length such that one end 113a thereof is inside the periphery of the lower plate 111 and the other end thereof is outside of the air inlet 115 of the upper plate 112'.

[0073] The operation of the impeller 110' for the vacuum cleaner comprising the same structure as that described above will not be explained since it is similar to the operation of the impeller 110 of the first embodiment described above.

[0074] FIG. 15 is a sectional view illustrating a motor assembly for the vacuum cleaner having an impeller 110' according to the second embodiment of the present invention.

[0075] Referring to FIG. 15, a motor assembly 100' for the vacuum cleaner having the impeller 110' according to the second embodiment of the present invention includes a motor 101, an impeller 110' rotated by the motor 101 and a diffuser 120 guiding intake air drawn by the impeller 110' toward the motor 101.

[0076] Any of various types of motors having approximately between 3,000 rpm and 3,600 rpm which are used generally in vacuum cleaners may be selected as the motor 101. In the present embodiment, a universal motor having 3,000 rpm is used. However, the scope of the invention is not limited to any particular motor 101.

[0077] The impeller 110' has a lower plate 111, an upper plate 112' and a plurality of air guide members 113. Referring to FIGS. 13 and 14, the lower plate 111 is formed in the shape of a disk and a center thereof is disposed at a motor shaft 102 of the motor 101. The upper plate 112' is formed in the shape of a disk to correspond with the lower plate 111 and has a diameter to correspond with beginning points 113s of the chamfered corner 113c of a plurality of air guide members 113. The upper plate 112' has a central air inlet 115 for drawing intake air. Also, the air inlet 115 is formed to protrude from the upper plate 112' to a predetermined height. A connecting part 114' connecting the air inlet 115 with the upper plate 112' is formed as a curved surface having a predetermined curvature to allow the intake air to flow smoothly. A plurality of air guide members 113 are disposed radially between the lower plate 111 and upper plate 112' at regular intervals. Each of the air guide members 113 is formed in the shape of a bent band having a predetermined curvature. In the present embodiment, 9 air guide members are attached to the upper plate 112' and the lower plate 111 with clogging joints 116. At an end 113a of the air guide member 113 nearest the periphery of lower plate 111 and upper plate 112', both corners 113c are chamfered. It is preferred that the chamfered corners 113c are formed to satisfy the conditions described above. In the present embodiment, if a width C of the air guide member 113 is approximately 7 mm, the widthwise dimension B of the chamfering corner 113c is B=C/2=3.5 mm and the lengthwise dimension A thereof is approximately 3 mm. In an embodiment, the outmost clogging joint 116a, 116b is spaced apart by 3 mm or more from the outside end 113a of the air guide member 113 (see FIG. 14).

[0078] The diffuser 120 is disposed at an upper portion of the motor 101 in concentric circles outside the impeller 110'. There is a gap between the diffuser 120 and the impeller 110' to rotate the impeller 110'. The diffuser 120 has a plurality of guide members for guiding air, when the air is drawn in and discharged by the impeller 110' toward the motor 101. The diffuser 120 shown in FIG. 15 is an example of a diffuser that can be used in the motor assembly 100' for the vacuum cleaner according to the present invention. Various types of diffusers can also be used in the motor assembly 100'.

[0079] The operation of the motor assembly 100' for the vacuum cleaner having the impeller 110' according to the second embodiment of the present invention comprising the same structure as that described above will not be explained in further detail, since it is similar to that of the motor assembly 100 having the impeller 110 according to the first embodiment of the present invention described above.

[0080] In the embodiment shown, peak impeller noise in the frequency range of approximately 8~10 kHz of the motor assembly 100' having an impeller 110' according to the second embodiment of the present invention is significantly reduced, compared to a motor assembly having a conventional impeller as shown in Table 2 and FIG. 16. Peak noise generated by the impeller 110' according to the second embodiment of the present invention is reduced by approximately 6.5 dB compared to the conventional impeller. At FIG. 16, a thick line 5 indicates noise of the impeller 110 according to the second embodiment of the present invention and a thin line 6 indicates noise of the conventional impeller. Also, overall noise that averages noise in frequency of total range is reduced by approximately 1.6 dBA.
Both corners 13c of outside end 113a of the air guide member 113 of the impeller 110 according to the second embodiment of the present invention are chamfered. Dimensions of chamfered corners 113c are A=3 mm and B=3.5 mm as described above. The upper plate 112 of the impeller 110 has a diameter corresponding to the beginning points 113a of the chamfered corners 113c of air guide members 113 (see FIG. 14). Impeller 20 according to the conventional art has a plurality of air guide members 23 having right angles at corners 23d of their outside ends as shown FIG. 9. The impeller 110 according to the second embodiment of the present invention and the conventional impeller 20 respectively have 8 or 9 air guide members. A universal motor operating at 3,000 rpm is used for the noise test. The term “overall noise” refers to average noise in the total frequency range. The “peak noise” in the range of approximately 8–10 kHz refers to a noise having a peak value in frequency of 8–10 kHz. The frequency range of 8–10 kHz generally includes a second BPF (Blade Passage Frequency) of the impeller. The BPF represents the number of blades passing per a second measured in cycles per second (Hz). For example, when the motor rotates at 3,000 rpm and the impeller has 9 air guide members, the BPF is 4,500 Hz. This is called as a first-degree BPF. The second-degree BPF is twice the first-degree BPF. In the present embodiment, the second-degree BPF is approximately 9,000 rpm.

FIG. 17 is a view illustrating a vacuum cleaner having the motor assembly 100 having an impeller 110 according to the first embodiment of the present invention.

Referring to FIG. 17, the vacuum cleaner 200 according to the present invention includes a suction brush 210 that draws in dust and impurities, an extension pipe 220 fluidly connecting between the suction brush 210 and a main body 230, and the main body 230 that is partitioned into a dust collecting portion (not shown) and a motor portion 231. The suction brush 210 has a dust inlet (not shown), which draws in dust and impurities at the bottom thereof. A dust-collecting unit (not shown), which separates and collects dust and impurities from the dust-laden air drawn in through the suction brush 210, is disposed at the dust collecting portion (not shown). For example, a dust bag or cyclone dust collecting unit may be used as the dust-collecting unit. A motor assembly 100, which generates a suction force drawing in dust and impurities through the suction brush 210, is disposed within the motor portion 231. The motor assembly 100 has a motor 101, an impeller 110 (see FIG. 8) rotated by the motor 101 and a diffuser 120 guiding air drawn in by the impeller 110 toward the motor 101. The impeller 110 has a plurality of air guide members 113. An outside end 113a of the air guide member 113 thereof has chamfered corners 113c. Since the motor assembly 100 is similar to that described above, a detailed explanation will be omitted.

When the vacuum cleaner 200 is turned on for cleaning operations according to the present invention, the motor 101 located in motor portion 231 starts rotating. When the motor 101 rotates, the impeller 110 disposed at an end of the motor shaft 102 rotates. When the impeller 110 rotates, dust-laden air is drawn in through the dust inlet of the suction brush 210. The dust and impurities contained in the dust-laden air are removed while passing through the dust-collecting unit located in the dust collecting portion, and as a result, the dust-laden air is cleaned. The cleaned air enters into the air inlet 115 of the impeller 110, passes outside ends 113a of a plurality of air guide members 113 and enters into the diffuser 120 (see FIGS. 7 and 8). At this time, since both corners 113c of the plurality of air guide members 113 are chamfered, peak noise in the frequency range of 8–10 kHz is reduced. The air entering the diffuser 120 passes through the motor 101 and is discharged outside the main body 230 of the vacuum cleaner 200 through an outlet 233.

Since structure and operation of a vacuum cleaner having a motor assembly 100 with an impeller 110 according to the second embodiment of the present invention are similar to those of a vacuum cleaner having an impeller 110 according to the first embodiment described above, a detailed explanation thereof will be omitted.

While the embodiments of the present invention have been described, additional variations and modifications of the embodiments may occur to those skilled in the art once they learn of the basic inventive concepts. Therefore, it is intended that the appended claims shall be construed to include both the above embodiments and all such variations and modifications that fall within the spirit and scope of the invention.

What is claimed is:

1. An impeller for a vacuum cleaner comprising:
   a lower plate in a shape of a disk;
   an upper plate spaced apart from the lower plate by a predetermined distance, the upper plate having a diameter corresponding with a diameter of the lower plate and an air inlet in the center thereof; and
   a plurality of air guide members disposed radially between the lower plate and the upper plate, the air guide members chamfered at both outside ends thereof.
2. The impeller for the vacuum cleaner of claim 1, wherein a dimension of the chamfered corner satisfies the formula 1.5 mm≤B≤C/2, where B is the widthwise dimension of the chamfered corner, and C is the width of the air guide member.
3. The impeller for the vacuum cleaner of claim 1, wherein a lengthwise dimension of the chamfered corner is between approximately 1.5 mm and 5 mm.
4. An impeller for a vacuum cleaner comprising:
   a lower plate in a shape of a disk;
   a plurality of air guide members disposed radially on the lower plate, the plurality of air guide members having chamfered corners at outside ends thereof; and
   an upper plate disposed on the plurality of air guide members, the upper plate having a central air inlet and a diameter corresponding to a lengthwise beginning point of the chamfered corner of the air guide member.
5. The impeller for the vacuum cleaner of claim 4, wherein a dimension of the chamfered corners satisfies the formula \(1.5 \text{ mm} \leq B \leq C/2\), where \(B\) is the widthwise dimension of the chamfered corner, and \(C\) is the width of the air guide member.

6. The impeller for the vacuum cleaner of claim 4, wherein a lengthwise dimension of the chamfered corners is between approximately 1.5 mm and 3 mm.

7. A motor assembly for a vacuum cleaner comprising:
   - a motor;
   - an impeller comprising,
     - a lower plate disposed at a motor shaft of the motor, the lower plate in a shape of a disk,
     - an upper plate spaced apart from the lower plate by a predetermined distance, the upper plate having a central air inlet and a diameter corresponding with a diameter of the lower plate, and
     - a plurality of air guide members disposed radially between the lower plate and the upper plate, the air guide members having both outside corners chamfered; and
     - a diffuser disposed at an upper portion of the motor, the diffuser guiding intake air from the impeller toward the motor.

8. The motor assembly for the vacuum cleaner of claim 7, wherein a dimension of the chamfered corners satisfies the formula \(1.5 \text{ mm} \leq B \leq C/2\) where, \(B\) is the widthwise dimension of the chamfered corner, and \(C\) is the width of air guide member.

9. The motor assembly for the vacuum cleaner of claim 7, wherein a lengthwise length of the chamfered corners is approximately between 1.5 mm and 3 mm.

10. A motor assembly for a vacuum cleaner comprising:
    - a motor;
    - an impeller comprising,
      - a lower plate in a shape of a disk,
      - a plurality of air guide members disposed radially on the lower plate, the plurality of air guide members chamfered at both outside corners thereof, and
      - an upper plate disposed on the plurality of air guide members, the upper plate having a diameter corresponding with a lengthwise beginning point of the chamfered corner of the air guide member and a central air inlet thereof; and
      - a diffuser disposed at an upper portion of the motor, the diffuser guiding intake air from the impeller toward the motor.

11. The motor assembly for the vacuum cleaner of claim 10, wherein a dimension of the chamfered corners satisfies the formula \(1.5 \text{ mm} \leq B \leq C/2\) where, \(B\) is the widthwise dimension of the chamfered corner, and \(C\) is the width of the air guide member.

12. The motor assembly for the vacuum cleaner of claim 10, wherein a lengthwise dimension of the chamfered corner is between approximately 1.5 mm and 3 mm.

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