ABSTRACT

An agitator assembly having a spindle having a first end, a second end, and a longitudinal axis. One or more primary agitators are attached to the spindle between the first end and the second end, and edge agitators are attached in a generally circumferential pattern around the spindle’s first end. In one aspect, the edge agitators may be arranged at different inclination angles. In another aspect, the edge agitators may be attached on offset circumferential lines. In another aspect, at least one of the edge agitators is more flexible than a primary agitator. In another aspect, the first end has an edge cleaning assembly that is attached to the spindle and rotationally fixed relative thereto by one or more rotationally interlocking structures formed integrally with the edge cleaning assembly. Also provided is a cleaner having a housing and a spindle, with a window through the housing to view the first end of the spindle and substantially no other parts of the spindle. Also provided is an agitator assembly with a spindle, an edge cleaning assembly attached to the spindle, and edge agitators mounted to the edge cleaning assembly. The spindle, edge cleaning assembly and edge agitators have contrasting colors.

VACUUM BRUSHROLL EDGE CLEANER

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Appl. No.: 11/146,138
Filed: Jun. 7, 2005

Publication Classification

Int. Cl. A47L 5/30 (2006.01)
U.S. Cl. 15/383
VACUUM BRUSHROLL EDGE CLEANER

FIELD OF THE INVENTION

[0001] The present invention relates generally to vacuum cleaners and vacuum cleaner brushrolls.

BACKGROUND OF THE INVENTION

[0002] Electric vacuum cleaners are in almost universal use in homes, offices and other places where quick and efficient floor cleaning is desired. Typical vacuum cleaners include a rotating brushroll having one or more bristles, bumps, flaps or other agitating structures that are intended to strike or pass through carpets or fabrics to help release dirt and other debris. Examples of such brushrolls are shown in U.S. Pat. Nos. 4,209,873; 5,435,038; 5,495,634; and 6,760,952, which are incorporated herein by reference. The brushroll is often located in a brushroll chamber that has a downwardly facing inlet opening. The vacuum cleaner draws dirt-laden air in through the inlet opening, through at least a portion of the brushroll chamber, and into a dirt receptacle on the vacuum. Such dirt receptacles can comprise bag filters, HEPA grade filters, cyclone chambers, or any other type of dirt separation or retention device.

[0003] Vacuum cleaners are often relied upon to clean in and along corners and edges of walls. To this end one or both ends of the brushroll may be provided with bristles that are located as close as possible to the side edge of the vacuum, and which may extend at an angle from the ends of the brushroll to reach into corners. Examples of attempts to provide edge cleaning bristles are shown in U.S. Pat. Nos. 6,591,440 and 6,591,441, which are incorporated herein by reference. It is also known to provide auxiliary brushes located outboard of the device itself, as shown in U.S. Pat. Nos. 436,689; 2,348,861; 4,355,436; and 4,854,006, which are incorporated herein by reference.

[0004] Despite the foregoing and other attempts at improving edge cleaning performance of vacuum cleaners, there still exists a need to provide vacuum cleaners having enhanced edge cleaning while still being durable and economical to produce.

SUMMARY OF THE INVENTION

[0005] In a first aspect, the present invention provides an agitator assembly having a spindle having a first end, a second end, and a longitudinal axis. One or more agitators are attached to the spindle between the first end and the second end. The spindle also has one or more first bristle tufts inclined at a first inclination angle, one or more second bristle tufts inclined at a second inclination angle, and one or more third bristle tufts inclined at a third inclination angle. The spindle has an edge cleaning assembly that is attached to the remainder of the spindle, and the first, second, and third bristle tufts are attached to the edge cleaning assembly.

[0006] In variations of this first aspect of the invention, the one or more agitators may comprise one or more rows of primary cleaning bristle tufts. Also, the one or more first, second, and third bristle tufts may comprise two, three, or more of each bristle tuft. The first, second, and third bristle tufts may also be evenly spaced around the circumference of the spindle. Also, the one or more agitators, and the first, second, and third bristle tufts may be attached to the spindle. However, in another variation, the first end of the spindle has an edge cleaning assembly that is attached to the remainder of the spindle, and the first, second, and third bristle tufts are attached to the edge cleaning assembly.

[0007] In another variation of the first aspect of the invention, the second inclination angle is the same as the third inclination angle. In another variation, the first inclination angle is about +5 to about +30 degrees, the second inclination angle is about +5 to about -5 degrees, and the third inclination angle is about -5 to about -30 degrees. In still another variation, the first inclination angle is about +15 degrees, the second inclination angle is about zero degrees, and the third inclination angle is about -15 degrees.

[0008] The agitator assembly may also include one or more fourth bristle tufts inclined at a fourth inclination angle, one or more fifth bristle tufts inclined at a fifth inclination angle, and one or more sixth bristle tufts inclined at a sixth inclination angle. The fourth, fifth, and sixth bristle tufts are attached to the spindle in a generally circumferential pattern around the second end of the spindle, and the fourth inclination angle is different from the fifth inclination angle and the sixth inclination angle.

[0009] In a second aspect, the present invention provides an agitator assembly having a spindle having a first end, a second end, and a longitudinal axis. One or more agitators are attached to the spindle between the first and second ends. Two or more first bristle tufts are attached to the first end of the spindle along a first circumferential line, and two or more second bristle tufts are attached to the second end of the spindle along a second circumferential line. The two or more first bristle tufts and the two or more second bristle tufts are distributed in a generally circumferential pattern around the first end of the spindle, and the first circumferential line is axially offset relative to the second circumferential line.

[0010] In a variation of the second aspect of the invention, the agitator assembly also includes two or more third bristle tufts attached to the first end of the spindle along a third circumferential line. The first, second, and third bristle tufts are distributed in a generally circumferential pattern around the first end of the spindle, and the third circumferential line is axially offset relative to the first circumferential line and the second circumferential line.

[0011] In a third aspect, the present invention provides an agitator assembly having a spindle having a first end, a second end, and a longitudinal axis, and at least one primary agitator attached to the spindle between the first and second ends. Three or more edge agitators are attached to the spindle in a generally circumferential pattern around the first end of the spindle, and at least one of the edge agitators is more flexible than the at least one primary agitator.

[0012] In variations of the third aspect of the invention, the primary agitator may comprise two helical rows of primary cleaning bristle tufts. In still another variation, the edge agitators are approximately evenly spaced around the circumference of the spindle. The three or more edge agitators may also have one or more first bristle tufts inclined at a first inclination angle, one or more second bristle tufts inclined at a second inclination angle, and one or more third bristle tufts inclined at a third inclination angle. In this latter variation,
the first, second, and third bristle tufts are distributed in a generally circumferential pattern around the first end of the spindle, and the first inclination angle is different from the second and third inclination angles. In another variation, the first end of the spindle has an edge cleaning assembly that is attached to the remainder of the spindle, and the edge agitators are mounted to the edge cleaning assembly.

[0013] In another variation of the third aspect, the primary agitator comprises a plurality of primary cleaning bristle tufts and the edge agitators comprises edge cleaning bristle tufts. In this variation, there may be nine edge cleaning bristle tufts. Also in this variation, each primary cleaning bristle tuft may have a diameter of about 0.091 inches to about 0.191 inches, and each edge cleaning bristle tuft may have a diameter of about 0.040 inches to about 0.140 inches. Furthermore, each primary cleaning bristle tuft may have a diameter of about 0.141 inches, and each edge cleaning bristle tuft may have a diameter of about 0.090 inches.

[0014] In a fourth aspect, the present invention provides an agitator assembly with a spindle having a first end, a second end, and a longitudinal axis. The first end includes an edge cleaning assembly that is attached to the remainder of the spindle and is rotationally fixed relative thereto by one or more rotationally interlocking structures formed integrally with the edge cleaning assembly. At least one primary agitator is attached to the spindle between the first end and the second end, and three or more edge agitators are mounted to the edge cleaning assembly and arranged in a generally circumferential pattern around the spindle.

[0015] In this aspect, the one or more rotationally interlocking structures may comprise one or more protrusions extending from the edge cleaning assembly to fit into one or more corresponding voids in the remainder of the spindle. Also in this aspect, the primary agitator may comprise two helical rows of primary cleaning bristle tufts, the edge agitators may comprise edge cleaning bristle tufts, and the edge agitators may comprise nine edge cleaning bristle tufts. In another variation, the edge agitators are approximately evenly spaced around the circumference of the spindle. The edge agitators may also comprise one or more first bristle tufts inclined at a first inclination angle, one or more second bristle tufts inclined at a second inclination angle, and one or more third bristle tufts inclined at a third inclination angle. In this variation, the first, second, and third bristle tufts are distributed in a generally circumferential pattern around the edge cleaning assembly, and the first inclination angle is different from the second and third inclination angles. In still another variation, at least one of the three or more edge agitators is not in the spindle assembly.

[0016] In a fifth aspect, the present invention provides a cleaner having a housing and a spindle. The housing has a downwardly facing opening, a chamber located adjacent the opening, and a window located to view into the chamber. The spindle is rotatably mounted in the chamber, and has a first end, a second end, a longitudinal axis, and at least one primary agitator attached to the spindle between the first end and the second end. The window is adapted to view the first and the second end of the spindle and substantially no other parts of the spindle.

[0017] In one variation of this aspect, the chamber has a vacuum outlet, and the window is further adapted to view the vacuum outlet. In another variation, the housing comprises a generally opaque structure, and the window is integrally molded with the generally opaque structure by a two-shot molding process. This aspect may also include a light that is adapted to illuminate the first end of the spindle.

[0018] In another variation, the spindle also has three or more edge agitators attached to the spindle in a generally circumferential pattern around the first end of the spindle. The edge agitators may include one or more first bristle tufts inclined at a first inclination angle, one or more second bristle tufts inclined at a second inclination angle, and one or more third bristle tufts inclined at a third inclination angle. In this variation, the first, second, and third bristle tufts are distributed in a generally circumferential pattern around the first end of the spindle, and the first inclination angle is different from the second and third inclination angles.

[0019] In still another variation, the spindle also includes an edge cleaning assembly that is attached to the remainder of the spindle, and edge agitators that are attached to the edge cleaning assembly. In this variation, the edge cleaning assembly may comprise one or more protrusions extending from the edge cleaning assembly to fit into one or more corresponding voids in the remainder of the spindle to thereby rotationally fix the edge cleaning assembly relative to the remainder of the spindle. Also in this variation, the spindle may have a first color, the edge cleaning assembly may have a second color, and the first color and the second color are contrasting colors. Alternatively, the edge cleaning assembly may have a first color, one or more edge agitators may have a second color, and the first color and the second color are contrasting colors. Further, the spindle may have a first color, the edge cleaning assembly may have a second color, and the first color and the second color are contrasting colors.

[0020] In a sixth aspect, the present invention provides an agitator assembly having a spindle having a first end, a second end, and a longitudinal axis. The first end includes an edge cleaning assembly that is attached to the remainder of the spindle. Three or more edge agitators are mounted to the edge cleaning assembly and arranged in a generally circumferential pattern around the spindle. The spindle has a first color, the edge cleaning assembly has a second color, and the one or more edge agitators have a third color. The first color and the second color are contrasting colors, and the second color and the third color are contrasting colors.

[0021] Other embodiments, features and variations are also included within the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The following Figures are provided to assist the reader with understanding the present invention, but are not intended to limit the scope of the invention in any way. Like reference numerals are used to designate like parts in the Figures.

[0023] FIG. 1 is an isometric view of a preferred embodiment of the present invention.

[0024] FIG. 2 is an exploded isometric view of the embodiment of FIG. 1.
FIG. 3 is another exploded isometric view of the embodiment of FIG. 1.

FIG. 4 is a cutaway fragmented side view of the embodiment of FIG. 1.

FIG. 5 is an exploded isometric view of the embodiment of FIG. 1, shown in conjunction with a vacuum cleaner base assembly of the present invention.

FIG. 6A is a cylindrical projection view of one embodiment of the edge cleaning assembly of FIG. 1.

FIG. 6B is a cylindrical projection view of another embodiment of the edge cleaning assembly of FIG. 1.

FIG. 6C is a cylindrical projection view of still another embodiment of the edge cleaning assembly of FIG. 1.

FIG. 6D is a cylindrical projection view of yet another embodiment of the edge cleaning assembly of FIG. 1.

FIG. 6E is a cylindrical projection view of still another embodiment of the edge cleaning assembly of FIG. 1.

FIG. 7 is fragmented isometric view of the embodiment of FIG. 5, shown assembled.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention provides a vacuum cleaner brushroll assembly that provides enhanced edge cleaning performance and various other advantages, as set forth in greater detail herein.

Referring to FIGS. 1-4, the present invention provides, in one aspect, a vacuum cleaner brushroll assembly 100 that is adapted to be rotatably mounted in a vacuum cleaner. The brushroll assembly 100 is built on a spindle 102, which is preferably made of wood, but may be manufactured from other substances, such as plastic or metal. The spindle 102 may have any cross-sectional shape, such as the cylindrical shape shown in accompanying drawings, or a helical shape, such as shown in U.S. Pat. No. 5,495,634, which is incorporated herein by reference. One or more agitators are located between the ends of the spindle 102. In a preferred embodiment, these agitators comprise two helical rows of primary cleaning bristle tufts 104 that extend from the spindle 102. The primary cleaning bristle tufts 104 may, in other embodiments, be replaced or supplemented by any other kind of agitating members, such as brushes, beater bars, wipers, or flaps, as are known in the art, and the helical arrangement may be modified or replaced with other agitator arrangements. A drive structure, such as a gear or the shown pulley 106, is integrally formed or mounted to the spindle 102, and adapted to be driven by an associated belt or gear. An additional set of bristles 105 are also provided on the end of the spindle 102 to further enhance its cleaning performance.

An edge cleaning assembly 108, which is discussed in greater detail below, is provided at one end of the spindle 102, and, when installed, forms the end of the spindle 102. For purposes of clarity in the following description, the end of the agitator assembly 100 and spindle 102 having the edge cleaning assembly 108 is referred to herein as the cleaning end, and the end of the agitator assembly 100 proximal the drive pulley 106 is referred to as the drive end. It will be appreciated, however, that a second edge cleaning assembly can be provided at the other end of the spindle, and that the drive pulley may instead be located at any other location along the length of the spindle 102, and may even be attached to or formed as part of the edge cleaning assembly 108.

The agitator assembly 100 is rotatably mounted in the vacuum cleaner by stub shafts 110, bearings 114 (or bushings, if desired), and first and second end caps 116, 118. The stub shafts 110 are pressed into corresponding stub shaft bores 112 at each end of the spindle 102. A portion of each stub shaft 110 extends out of each stub shaft bore 112, as best shown in FIG. 4. The stub shafts 110 are preferably steel, but may be made of other materials. A bearing 114 is pressed or slid onto the protruding end of each stub shaft 110, and may optionally be staked in place by deforming the distal end of the stub shaft 110. It is preferred, but not required, that the inner races of the bearings 114 fit snugly against the stub shaft 110 to prevent relative motion therebetween.

Each bearing 114 is mounted in a bore 130 within the agitator assembly 100. The bore 130 on the drive end is formed in the spindle 102, and the bore 130 on the cleaning end is formed in the edge cleaning assembly 108. The bearing 114 is located outboard of the edge cleaning assembly 108 (i.e., it is mounted further from the center of the agitator assembly 108, in relation to its length, than the point at which the edge cleaning assembly is mounted). This construction reduces the overall width and complexity of the agitator assembly 108, and allows each end of the agitator assembly 108 to be mounted in a cantilevered manner. An axially protruding surface 124 may be provided to contact the inner race of each bearing 114, which prevents the stationary outer races of the bearings 114 from rubbing against the moving portions of the agitator assembly 100. This surface 124 is formed as part of the spindle 102 at the drive end (on the left in FIG. 4), and as part of the edge cleaning assembly 108 at the cleaning end (on the right in FIG. 4).

The outer race of each bearing 114 is held by a respective end cap 116, 118. The first and second caps 116, 118 each include a bearing receptacle 120. The bearing receptacles 120 are shaped to extend into the respective bore 130 and fit around and hold the outer race of each bearing 114. As with the inner race, it is preferred, but not required, for the outer race of each bearing 114 to fit snugly within the respective receptacle 120 to prevent relative motion therewith. Each end cap 116, 118 also includes a mounting structure 122 that fits into corresponding first and second agitator mounting receptacles 136, 138 (FIG. 5) in the vacuum cleaner lower housing 502, thereby suspend the agitator assembly 100 in the vacuum cleaner.

As shown in FIG. 4, the first end cap 116 is located at the cleaning end of the agitator assembly 100, and the second end cap 118 is located at the drive end of the agitator assembly 100. The first and second end caps 116, 118 differ somewhat in this embodiment, but may be identical in other embodiments. As noted before, the first end cap 116 includes a cup-like bearing receptacle 120 and a mounting structure 122, which has a protruding square shape. The square mounting structure 122 is shaped and sized to fit into a
The second end cap 118 is similar to the first end cap 116, but also includes a radially-extending portion 126 that terminates in an octagonal skirt 128. The skirt 128 wraps around a stepped portion 132 of the spindle 102, and forms a labyrinth seal to protect the bearing 114. A felt seal 134 may also be provided in the cavity formed between the cup-like receptacle 120 and the skirt 128 (or elsewhere) to further protect the bearing 114. In this embodiment, the octagonal skirt 128 forms part of the end cap’s mounting structure 122, and is used to mount the end cap 116 to the vacuum cleaner housing. While the square protrusion portion of the mounting structure 122 is present in this embodiment, it may be omitted from other embodiments.

Referring now to FIG. 5, the agitator assembly 100 is installed into the vacuum cleaner lower housing 502 by aligning the mounting structure 122 of the first end cap 116 with the first agitator mounting receptacle 136, then tilting the agitator assembly 100 downwards until the mounting structure of the second end cap 118 is fitted into the second agitator mounting receptacle 138. When installed, the first end cap 116 is prevented from rotating by engagement between the square mounting structure 122 and the square mounting receptacle 136, and the second end cap 118 is prevented from rotating by engagement between the octagonal skirt 128 and walls 139 formed in the second agitator mounting receptacle 138. During installation, a drive belt (not shown) is looped around the agitator’s drive pulley 106 and drawn to the appropriate tension when the agitator assembly 100 is pushed into place. The installation is completed when the upper housing 504 is attached to the lower housing 502, and surfaces (not visible) in the upper housing abut the second end cap 118 to prevent it from lifting out of the lower housing 502. This construction has been found to be desirable to reduce the profile of the end caps 116, 118 and their associated mounting structures 136, 138, and increase the width of the agitator assembly 100.

The agitator assembly 100 may also include various other features, or be constructed in other ways, as known in the art. For example, the agitator assembly 100 may include one or more magnetic components to operate in conjunction with electronics to detect whether or not it is rotating. The agitator assembly 100 may also include an internal motor, which eliminates the need to provide a pulley or other drive surface and maximizes its working length. The agitator assembly 100 may also be balanced to minimize vibrations by either removing or adding material at the appropriate locations. The agitator assembly 100 may also be used in conjunction with other agitator assemblies of similar or different construction that are arranged to provide multiple cleaning paths, or to operate on the same cleaning path. These and other variations involving the use of known technology are encompassed within the scope of the invention.

Referring back to FIGS. 1-4, the agitator assembly 100 also includes an edge cleaning assembly 108, which may be formed as part of the spindle 102 itself, or as a separate assembly that is attached to the spindle 102. Both variations are included within the scope of the present invention. In an embodiment in which the edge cleaning assembly 108 is separately formed, it preferably comprises a hub 144 having a plurality of bristle tufts 146 (or other agitators, such as beater bars, flaps and the like) extending generally radially therefrom. The hub 144 is preferably an injection-molded thermoplastic material, but other suitable plastics, metals, or other materials may be used. The hub 144 may be shaped with an outer surface 148 that generally matches the contour of the spindle 102, but this is not required. In a preferred embodiment, the outer surface 148 is generally cylindrical, and matches the cylindrical profile of the spindle 102, however, other shapes may be used, such as the helical shape shown in U.S. Pat. No. 5,405,634. The hub 144 has a central bore 130 into which the bearing 114 fits, and a passage 150 therethrough that serves as a continuation of the stub shaft bore 112. The hub may optionally include an axial protrusion 142 on the side facing away from the spindle 102 to serve as part of a labyrinth seal, as discussed above.

The hub 144 is held in place against the spindle 102 by the stub shaft 110 and/or bearing 114. In order to prevent the edge cleaning assembly 108 from rotating relative to the spindle 102, the edge cleaning assembly 108 and spindle 102 are provided with interlocking structures. In a preferred embodiment, these interlocking structures comprise one or more axial protrusions 152 that are formed integrally with and extend from the hub 144 in the direction of the spindle 102. These protrusions 152 fit into a corresponding axially extending void in the end of the spindle 102, which in this case comprises a slot 154 (or slots). The axial void in the spindle 102 (slot 154) and the axial protrusions 152 from the hub 144 are offset from the spindle’s axis of rotation, and thus mechanical (as opposed to frictional) engagement between them prevents relative rotation between the edge cleaning assembly 108 and the spindle 102. For ease of manufacture, the slot 154 of the shown embodiment is a continuous slot that is milled out of the end of the spindle 102. The two axial protrusions 152 are located at the outer perimeter of the hub 144, and a central cylindrical protrusion 156 extends from the hub 144 to abut the recessed wall 158 of the slot 154. The cylindrical protrusion 156 is provided to ensure that the hub 144 does not deform when it is installed and held in place by the bearing 114, and also adds to the stiffness of the hub 144. The remaining surfaces of the hub 144 generally fit flush against the face of the spindle 102. One or more pins, screws, clips, adhesives, or other attachment devices may also be used to help retain the hub 144 in place on the spindle 102.

While the foregoing arrangement of axially extending protrusions and voids is preferred to prevent relative rotation between the spindle 102 and the edge cleaning assembly 108, other rotationally interlocking structures may
be used. As used herein, the term rotationally interlocking structures includes any two or more mating structures that, when engaged, prevent relative rotation between the spindle 102 and the edge cleaning assembly 108, but do not necessarily prevent other relative movement, such as axial sliding. Other examples of rotationally interlocking structures that may be used with the present invention include spines, axial protrusions and voids that have non-axisymmetrical shapes, and so on. Any such variations may be used with the present invention.

Various other modifications to the hub 144 and slot 154 may be used with the present invention. For example, in embodiments in which there is little likelihood of the hub 144 deforming when it is installed or during use, the central protrusion 156 may be omitted. In still other embodiments, it may be desired to form the slot 154 as two separate voids that more closely follow the contours of the axial protrusions 152. This variation would be economical in embodiments in which the spindle 102 is made of a material that allows economical net shape molding of complex shapes. In such a case, the central protrusion 156 again may not be necessary. In another embodiment, the axial protrusions 152 may be formed as cylindrical pins, and the slot 154 may be replaced by two corresponding axially extending cylindrical voids in the end of the spindle 102, which can be easily formed by a drilling or molding operation. In addition, while the use of separate axial protrusions 154 in the shown embodiment reduces the weight of the hub 144, the axial protrusions 154 may alternatively be joined, along with the cylindrical protrusion 156, into a single protrusion. Other variations will be apparent to those of ordinary skill in the art in view of the present disclosure and with practice of the inventions described herein.

The edge cleaning bristle tufts 146 are attached to the hub 144 by bonding, staples, press fitting, pins, bar anchors, fusing or any other suitable attachment method, as are known in the art. They may also be molded in place, captured in place by molding the hub 144 around them, or formed integrally as part of the hub 144. These or any other methods may also be used to attach the primary cleaning bristle tufts 104 to the spindle 102. In a preferred embodiment, the edge cleaning assembly 108 has nine bristle tufts 146 that are evenly spaced around the circumference of the hub—that is, with about 40 degrees spacing, relative to the central axis of the spindle 102, between the centers of each adjacent pair of bristle tufts 146. In other embodiments, more or fewer bristle tufts may be used. For example, in other preferred embodiments, there are three or six edge cleaning bristle tufts 146. Furthermore, the bristle tufts 146 are not required to be evenly spaced around the edge cleaning assembly’s circumference, and may instead have an irregular or non-symmetrical spacing.

FIGS. 6A through 6F show five examples of embodiments of bristle tuft configurations that may be used with the present invention. These views show cylindrical projection views of the edge cleaning assembly 108 with the axial projections 152 omitted (that is, views as the edge cleaning assembly 108 would appear if it were “unrolled” and flattened out). In each of the five embodiments, the edge cleaning bristle tufts are arranged in a generally circumferential pattern around the end of the agitator assembly 108.

In the embodiment of FIG. 6A, the bristle tufts all extend at approximately 90 degrees relative to the hub surface 148, and are arranged on approximately the same circumferential line 602 around the hub 144. In the embodiment of FIG. 6B, the bristle tufts 146 are also arranged along a single circumferential line 602, but three of the tufts 606 are inclined towards a first edge 612 of the edge cleaning assembly 108, three of the tufts 608 are perpendicular, and three of the tufts 610 are inclined towards a second edge 614 of the edge cleaning assembly 108.

The embodiment of FIG. 6B is also shown in FIG. 4, in which the upper edge cleaning bristle tuft 146 is inclined at an angle θ, relative to a line 162 perpendicular to the rotating axis 160, towards one end of the agitator assembly’s rotating axis 160. For purposes of this disclosure, this angle θ is referred to as the bristle tuft’s inclination angle, and positive values thereof indicate an inclination towards one end of the rotating axis 160, while negative values indicate an inclination towards the other end of the rotating axis 160. The lower bristle tuft 146 in the embodiment of FIG. 4 is perpendicular to the assembly’s rotating axis, which corresponds to an inclination angle of zero. (The remaining bristle tufts are omitted for clarity).

The embodiment of FIG. 6C is similar to that of FIG. 6B, but in this embodiment the bristles 606 that are inclined towards the first edge 612 are also located on a circumferential line 616 that is axially offset towards the first edge 612. Similarly, the bristles 610 inclined towards the second edge 614 are mounted on a circumferential line 618 that is axially offset towards the second edge 614.

While the embodiment of FIG. 6A is expected to provide suitable results, the embodiments of FIGS. 6B and 6C are expected to provide various advantages over the configuration of FIG. 6A. For example, using a pattern of offset bristle angles and mounting points provides a wider cleaning path. In addition, it has been found that using an offset configuration, such as shown either of FIGS. 6B and 6C, reduces the likelihood that the bristle tufts 146 will generate enough heat to damage either the surface or the bristle tufts through repeated contact with the surface being cleaned.

In a preferred embodiment, the edge cleaning assembly 108 comprises an arrangement as shown in FIG. 6B or 6C having three or more bristle tufts 146, and most preferably nine bristle tufts 146, that are arranged in three sets. The first set of bristle tufts 146 have an inclination angle of about +5 to +30 degrees, and most preferably about +15 degrees. The second set of bristle tufts 146 have an inclination angle of about +5 to −5 degrees, and most preferably about zero degrees. The third set of bristle tufts 146 have an inclination angle of about −5 to −30 degrees, and most preferably about −15 degrees. The bristle tufts 146 of each set are interspersed among the tufts of the other sets, as shown in FIGS. 6B and 6C, to maximize the circumferential distance between the tufts of each set (if more than one tuft is provided in each set).

Although the foregoing embodiment is preferred, other embodiments are within the scope of the invention. For example, in the embodiment of FIG. 6B, the bristle tufts 146 comprise sets of tufts that are arranged around different circumferential lines, as in FIG. 6C. In this configuration a first set of bristle tufts 620 are arranged along a first circumferential line 622, and a second set of bristle tufts 624 are arranged along a second circumferential line 626.
bristle tufts 620, 624 have the same inclination angle, which is preferably about -30 to about +30 degrees. Like the embodiments of FIGS. 6B and 6C, this configuration is expected to provide improved cleaning while reducing the risk of damaging the surface being cleaned. This is particularly expected if the circumferential lines 622, 626 are spaced far enough to prevent significant overlap where the bristle tufts 620, 624 strike the surface being cleaned, such as by spacing them by a distance equal to or greater than the diameter of the bristle tufts 620, 624. However, this embodiment is also expected to require a wider edge cleaning assembly 108 on which to mount the bristle tufts 620, 624.

Still other variations of edge cleaning bristle tuft arrangements are anticipated for use with the present invention. For example, in a variation shown in FIG. 6E, there are two sets of bristle tufts 628, 630 (rather than three sets, as shown before) that are arranged at opposite inclination angles. The bristle tufts 628, 630 are arranged at opposite inclination angles (that is, opposite relative to a perpendicular line). It will be appreciated, however, that the bristle tufts 628, 630 of this or other embodiments may instead be at non-opposite angles. It is also not required for the bristle tufts 628, 630 to be inclined towards opposite ends of the agitator assembly, and they may instead all be inclined towards one end thereof. It will also be appreciated that more sets of bristle tufts may be added, to this or other embodiments, at any suitable or incompatible inclination angle, and that other patterns or random arrangements of bristle tufts inclination angles may be used with the present invention.

While the edge cleaning bristle tufts 146 and the primary cleaning bristle tufts 104 may be substantially identical in their construction, in a more preferred embodiment, they are constructed differently to obtain additional performance benefits. In this embodiment, the primary cleaning bristle tufts 104 are intended to be relatively rigid and few in number so that they aggressively sweep through the carpet being cleaned, which provides good cleaning performance while requiring a relatively low number of bristle tufts. Also in this preferred embodiment, the edge cleaning bristle tufts 146 are significantly less rigid than the primary cleaning bristle tufts 104 so that they do not burn or otherwise damage the surface being cleaned. The use of less rigid edge cleaning bristle tufts 146 may also be suitable in view of the fact that edges of carpets against walls and furniture often receive less foot traffic, and therefore the dirt along the edges is not as likely to be forced as deeply into the carpet as in more traveled areas of the carpet.

In view of the foregoing considerations, in a preferred embodiment, each primary cleaning bristle tuft 104 comprises nylon fibers, each having a diameter of about 0.004 to 0.014 inches, and most preferably about 0.009 inches. The fibers have a free length (length extending out of the spindle 102) of about 0.250 to 0.500 inches, and most preferably about 0.375 inches. There are about 80 to 120 fibers, and most preferably about 93 fibers, in each primary cleaning bristle tuft 104, and the bristles are arranged in an appropriately-sized hole to hold them in a tight bundle. If a preferred embodiment, the hole has a diameter of about 0.091 to 0.191 inches, and most preferably about 0.141 inches. Each edge cleaning bristle tuft 146 comprises nylon fibers, each having a diameter of about 0.004 to 0.011 inches, and most preferably about 0.006 inches, or less than 0.006 inches. The edge cleaning fibers have a length of about 0.250 to 0.500 inches, and most preferably about 0.375 inches. There are about 100 to 200 fibers, and most preferably about 124 to 130 fibers, in each edge cleaning bristle tuft 146, and the bristles are arranged in an appropriately-sized hole to hold them in a tight bundle. In a preferred embodiment, the hole for each edge cleaning bristle tuft 146 has a diameter of about 0.040 to 0.140 inches, and most preferably about 0.090 inches.

The foregoing configurations in which the primary agitators are more rigid than the edge cleaning agitators may also be implemented in embodiments in which one or both of the primary cleaning bristle tufts 104 and edge cleaning bristle tufts 146 are replaced by different agitator devices, such as beater bars, wipers, continuous brushes, or flaps.

The present invention also provides a unique housing arrangement for cleaning devices with edge cleaning features. An embodiment of a vacuum cleaner housing of the present invention is shown in FIGS. 5 and 7. In this embodiment, the vacuum cleaner housing comprises the base assembly of an upright vacuum, but it could also be modified to be a powerhead of a canister vacuum or an accessory cleaning tool. The present invention may also be used in conjunction with wet or dry extractors or any other type of suction cleaning device of any suitable configuration. The present invention also may be used with non-suction cleaning devices, such as electric sweepers, that rely upon movement of the agitator to capture dust and debris and deposit it into a dirt receptacle. Other uses will be apparent to those of ordinary skill in the art in view of the teachings herein.

The vacuum cleaner housing has a lower housing 502, an upper housing 504, a viewing window 506, and an optional furniture guard 508. The lower housing 502 comprises an agitator chamber 510 that opens towards the bottom (i.e., floor-engaging portion) of the device through a vacuum inlet nozzle (not visible), as known in the art. The agitator chamber 510 is sealed on the top by the upper housing 504, and has an air outlet 512 through which dirt-laden air is drawn into the rest of the vacuum cleaner. The lower housing also has wheel mounting bosses 514, and an opening 516 into which the upright portion of the vacuum fits. The furniture guard 508 fits around the front and sides of the housing, and preferably is manufactured from a relatively soft material that tends not to scratch or damage furniture and walls. As noted before, the agitator assembly 100 is installed in the lower housing 502 and retained in place by the upper housing 504.

A viewing window 506 is located at the end of the housing adjacent the edge cleaning assembly 108. The viewing window 506 permits the user to view the edge cleaning assembly 108 to see whether it is clogged and to determine whether it is rotating. To this end, the hub 144 and the bristle tufts 146 are preferably made with different and contrasting colors. Examples of contrasting colors include, but are not limited to: red and black, yellow and black, red and yellow, yellow and blue, black and white, red and white, blue and white, green and yellow and so on. The use of such colors provides a visual indication of movement, even when the user is standing several feet away from the viewing window 506. In addition (or alternatively), the axial protrusions 152 may be made with a different and contrasting color.
than the spindle 102, which is also expected to enhance the user’s ability to determine whether the agitator assembly 100 is rotating. In a preferred embodiment, the spindle 102 is black, the hub surface 148 and axial protrusions 152 are yellow, and the bristle tufts 146 are red.

[0063] It is preferred for the viewing window 506 to be located only over the edge cleaning assembly 108 or only over the edge cleaning assembly 108 and the immediately adjacent parts of the agitator assembly 100 and agitator chamber 510. However, in other embodiments, the viewing window 506 may be extended to provide a view of the air outlet 512 to assist the user in determining whether the air outlet 512 is obstructed. The viewing window 506 may also be extended to show other parts of the agitator assembly 102 or agitator chamber 510. While the use of the viewing window 506 is preferred, it may be removed entirely, or the entire upper housing 504 may be constructed from a transparent material.

[0064] A light 518 may also be provided to illuminate the edge cleaning assembly 108 and facilitate the user’s ability to determine whether the edge cleaning assembly 108 is rotating or clogged. Such a light may be a conventional bulb or diode light, or any other suitable type of illumination source, as are known in the art. The light and the edge cleaning assembly 108 may also comprise phosphorescent lights and materials, or similar devices, to further enhance the visibility of the parts and improve the user’s ability to see them.

[0065] The upper housing 504 may be formed of any suitable plastic material, and may be formed from metal or other materials, if desired. The viewing window 506 is preferably made of a transparent or semi-transparent plastic material. The upper housing 504 and viewing window 506 may be constructed in any suitable manner, but preferably are produced by a two-shot molding process. Using this process, the upper housing 504 is molded in a first step, but a void is left at the location where the viewing window 506 is desired to be placed. The upper housing 504 is then removed from the first mold and transferred to a second mold as an insert, and the viewing window 506 is molded directly into the upper housing 504. Alternatively, an insert that blocks the first mold to create the viewing window void may be removed, and the first mold may then be used to form the viewing window 506 as well. Of course, the opposite construction steps may be used instead, with the viewing window 506 being formed first, and the upper housing 504 being molded around it, and other two-shot molding processes may be used instead of the foregoing process. This construction process provides a durable construction in which the viewing window 506 is mechanically locked to the upper housing 504, and eliminates the need to attach the viewing window 506 by screws, adhesives, capturing it in place, or other means.

[0066] This two-shot molding process may also be used to make various other parts of vacuum cleaners. For example, it may be used to make windows to view various different parts of cleaners, such as to view the entire brushroll, to view the agitator of a wet extractor, to view the interior of a cyclone or bag chamber, and so on. This two-shot process may also be used to make parts that have multiple different colors, or that have different physical properties in different locations. Other uses will be apparent to those of ordinary skill in the art in view of the present disclosure.

[0067] While the embodiments described herein are preferred, these are not intended to limit the scope of the invention. Indeed, many additional variations on the embodiments herein will be apparent to those of ordinary skill in the art, and such variations are within the scope of the present invention. In addition, to the extent the present disclosure describes and claims features of the invention in terms of specific dimensions and materials, it will be understood that alternative dimensions and materials may be used without leaving the spirit and scope of the invention. Furthermore, to the extent any dimensions are specified in the invention as claimed, it will be understood that the scope of any claims reciting such dimensions will also include any manufacturing variances that may be experienced when producing the claimed invention.

1. An agitator assembly comprising:
   a spindle having a first end, a second end, and a longitudinal axis;
   one or more agitators attached to the spindle between the first end and the second end;
   one or more first bristle tufts inclined at a first inclination angle;
   one or more second bristle tufts inclined at a second inclination angle;
   one or more third bristle tufts inclined at a third inclination angle; and
   wherein the one or more first bristle tufts, the one or more second bristle tufts, and the one or more third bristle tufts are attached to the spindle in a generally circumferential pattern around the first end of the spindle, and the first inclination angle is different from the second and third inclination angles.

2. The agitator assembly of claim 1, wherein the one or more agitators comprise two helical rows of primary cleaning bristle tufts.

3. The agitator assembly of claim 1, wherein:
   the one or more first bristle tufts comprise two or more first bristle tufts;
   the one or more second bristle tufts comprise two or more second bristle tufts; and
   the one or more third bristle tufts comprise two or more third bristle tufts.

4. The agitator assembly of claim 3, wherein:
   the one or more first bristle tufts comprise three or more first bristle tufts;
   the one or more second bristle tufts comprise three or more second bristle tufts; and
   the one or more third bristle tufts comprise three or more third bristle tufts.

5. The agitator assembly of claim 1, wherein the second inclination angle is the same as the third inclination angle.

6. The agitator assembly of claim 1, wherein:
   the first inclination angle is about +5 to about +30 degrees;
   the second inclination angle is about ±5 to about ±5 degrees; and
the third inclination angle is about -5 to about -30 degrees.
7. The agitator assembly of claim 6, wherein:
   the first inclination angle is about +15 degrees;
   the second inclination angle is about zero degrees; and
   the third inclination angle is about -15 degrees.
8. The agitator assembly of claim 7, wherein:
   the one or more first bristle tufts comprise three first bristle tufts;
   the one or more second bristle tufts comprise three second bristle tufts; and
   the one or more third bristle tufts comprise three third bristle tufts.
9. The agitator assembly of claim 1, wherein the one or more first bristle tufts, the one or more second bristle tufts, and the one or more third bristle tufts are approximately evenly spaced around the circumference of the spindle.
10. The agitator assembly of claim 1, further comprising:
    one or more fourth bristle tufts inclined at a fourth inclination angle;
    one or more fifth bristle tufts inclined at a fifth inclination angle;
    one or more sixth bristle tufts inclined at a sixth inclination angle; and
    wherein the one or more fourth bristle tufts, the one or more fifth bristle tufts, and the one or more sixth bristle tufts are attached to the spindle in a generally circumferential pattern around the second end of the spindle, and the fourth inclination angle is different from the fifth and sixth inclination angles.
11. The agitator assembly of claim 1, wherein the one or more agitators, the one or more first bristle tufts, the one or more second bristle tufts, and the one or more third bristle tufts are attached to the spindle.
12. The agitator assembly of claim 1, wherein:
    the first end of the spindle comprises an edge cleaning assembly that is attached to the remainder of the spindle; and
    the one or more first bristle tufts, the one or more second bristle tufts, and the one or more third bristle tufts are attached to the edge cleaning assembly.
13. An agitator assembly comprising:
    a spindle having a first end, a second end, and a longitudinal axis;
    one or more agitators attached to the spindle between the first end and the second end;
    two or more first bristle tufts attached to the first end of the spindle along a first circumferential line;
    two or more second bristle tufts attached to the first end of the spindle along a second circumferential line; and
    wherein the two or more first bristle tufts and the two or more second bristle tufts are distributed in a generally circumferential pattern around the first end of the spindle, and the first circumferential line is axially offset relative to the second circumferential line.
14. The agitator assembly of claim 13, further comprising:
    two or more third bristle tufts attached to the first end of the spindle along a third circumferential line; and
    wherein the two or more first bristle tufts, the two or more second bristle tufts, and the two or more third bristle tufts are distributed in a generally circumferential pattern around the first end of the spindle, and the third circumferential line is axially offset relative to the first circumferential line and the second circumferential line.
15. An agitator assembly comprising:
    a spindle having a first end, a second end, and a longitudinal axis;
    at least one primary agitator attached to the spindle between the first end and the second end;
    three or more edge agitators attached to the spindle in a generally circumferential pattern around the first end of the spindle; and
    wherein at least one of the three or more edge agitators is more flexible than the at least one primary agitator.
16. The agitator assembly of claim 15, wherein the at least one primary agitator comprises one or more rows of primary cleaning bristle tufts.
17. The agitator assembly of claim 15, wherein the three or more edge agitators comprise edge cleaning bristle tufts.
18. The agitator assembly of claim 15, wherein the three or more edge agitators comprise nine edge cleaning bristle tufts.
19. The agitator assembly of claim 15, wherein the three or more edge agitators are approximately evenly spaced around the circumference of the spindle.
20. The agitator assembly of claim 15, wherein the three or more edge agitators comprise:
    one or more first bristle tufts inclined at a first inclination angle;
    one or more second bristle tufts inclined at a second inclination angle; and
    one or more third bristle tufts inclined at a third inclination angle; and
    wherein the one or more first bristle tufts, the one or more second bristle tufts, and the one or more third bristle tufts are distributed in a generally circumferential pattern around the first end of the spindle, and the first inclination angle is different from the second and third inclination angles.
21. The agitator assembly of claim 15, wherein the at least one primary agitator comprises a plurality of primary cleaning bristle tufts and the three or more edge agitators comprise edge cleaning bristle tufts.
22. The agitator assembly of claim 21, wherein each primary cleaning bristle tuft has a diameter of about 0.091 inches to about 0.191 inches, and each edge cleaning bristle tuft has a diameter of about 0.040 inches to about 0.140 inches.
23. The agitator assembly of claim 22, wherein each primary cleaning bristle tuft has a diameter of about 0.141 inches, and each edge cleaning bristle tuft has a diameter of about 0.090 inches.
24. The agitator assembly of claim 15, wherein:
the first end of the spindle comprises an edge cleaning assembly that is attached to the remainder of the spindle; and
three or more edge agitators are mounted to the edge cleaning assembly.

25. An agitator assembly comprising:
a spindle having a first end, a second end, and a longitudinal axis, the first end comprising an edge cleaning assembly that is attached to the remainder of the spindle and rotationally fixed relative thereto by one or more rotationally interlocking structures formed integrally with the edge cleaning assembly;
at least one primary agitator attached to the spindle between the first end and the second end;
three or more edge agitators mounted to the edge cleaning assembly and arranged in a generally circumferential pattern around the spindle.

26. The agitator assembly of claim 25, wherein the one or more rotationally interlocking structures comprise one or more protrusions extending from the edge cleaning assembly to fit into one or more corresponding voids in the remainder of the spindle.

27. The agitator assembly of claim 25, wherein the at least one primary agitator comprises two helical rows of primary cleaning bristle tufts.

28. The agitator assembly of claim 25, wherein the three or more edge agitators comprise edge cleaning bristle tufts.

29. The agitator assembly of claim 25, wherein the three or more edge agitators comprise nine edge cleaning bristle tufts.

30. The agitator assembly of claim 25, wherein the three or more edge agitators are approximately evenly spaced around the circumference of the spindle.

31. The agitator assembly of claim 25, wherein the three or more edge agitators comprise:
one or more first bristle tufts inclined at a first inclination angle;
one or more second bristle tufts inclined at a second inclination angle; and
one or more third bristle tufts inclined at a third inclination angle; and
wherein the one or more first bristle tufts, the one or more second bristle tufts, and the one or more third bristle tufts are distributed in a generally circumferential pattern around the edge cleaning assembly, and the first inclination angle is different from the second and third inclination angles.

32. The agitator assembly of claim 25, wherein at least one of the three or more edge agitators is more flexible than the at least one primary agitator.

33. A cleaner comprising:
a housing comprising:
a downwardly facing opening;
a chamber located adjacent the opening; and
a window located to view into the chamber;
a spindle rotatably mounted in the chamber, the spindle comprising:
a first end;
a second end;
a longitudinal axis; and
at least one primary agitator attached to the spindle between the first end and the second end; and
wherein the window is adapted to view the first end of the spindle and substantially no other parts of the spindle.

34. The cleaner of claim 33, wherein the chamber has a vacuum outlet, and the window is further adapted to view the vacuum outlet.

35. The cleaner of claim 33, wherein the housing comprises a generally opaque structure, and the window is integrally molded with the generally opaque structure by a two-shot molding process.

36. The cleaner of claim 33, further comprising a light adapted to illuminate the first end of the spindle.

37. The cleaner of claim 33, wherein the spindle further comprises three or more edge agitators attached to the spindle in a generally circumferential pattern around the first end of the spindle.

38. The cleaner of claim 37, wherein the three or more edge agitators comprise:
one or more first bristle tufts inclined at a first inclination angle;
one or more second bristle tufts inclined at a second inclination angle; and
one or more third bristle tufts inclined at a third inclination angle; and
wherein the one or more first bristle tufts, the one or more second bristle tufts, and the one or more third bristle tufts are distributed in a generally circumferential pattern around the first end of the spindle, and the first inclination angle is different from the second and third inclination angles.

39. The cleaner of claim 37 wherein at least one of the three or more edge agitators is more flexible than the at least one primary agitator.

40. The cleaner of claim 37 wherein:
the spindle further comprises an edge cleaning assembly that is attached to the remainder of the spindle; and
the three or more edge agitators are attached to the edge cleaning assembly.

41. The cleaner of claim 40, wherein the edge cleaning assembly comprises one or more protrusions extending from the edge cleaning assembly to fit into one or more corresponding voids in the remainder of the spindle and thereby rotationally fix the edge cleaning assembly relative to the remainder of the spindle.

42. The cleaner of claim 33, wherein the spindle further comprises:
an edge cleaning assembly that is attached to the remainder of the spindle; and
one or more edge agitators attached to the edge cleaning assembly.
43. The cleaner of claim 42, wherein:
the spindle has a first color;
the edge cleaning assembly has a second color; and
wherein the first color and the second color are contrasting colors.

44. The cleaner of claim 42, wherein:
the edge cleaning assembly has a first color;
the one or more edge agitators have a second color; and
wherein the first color and the second color are contrasting colors.

45. The cleaner of claim 42, wherein:
the spindle has a first color;
the edge cleaning assembly has a second color;
the one or more edge agitators have a third color; and
wherein the first color and the second color are contrasting colors, and the second color and the third color are contrasting colors.

46. An agitator assembly comprising:
a spindle having a first end, a second end, and a longitudinal axis, the first end comprising an edge cleaning assembly that is attached to the remainder of the spindle;
three or more edge agitators mounted to the edge cleaning assembly and arranged in a generally circumferential pattern around the spindle;
wherein the spindle has a first color, the edge cleaning assembly has a second color, and the one or more edge agitators have a third color; and
wherein the first color and the second color are contrasting colors, and the second color and the third color are contrasting colors.

*   *   *   *   *