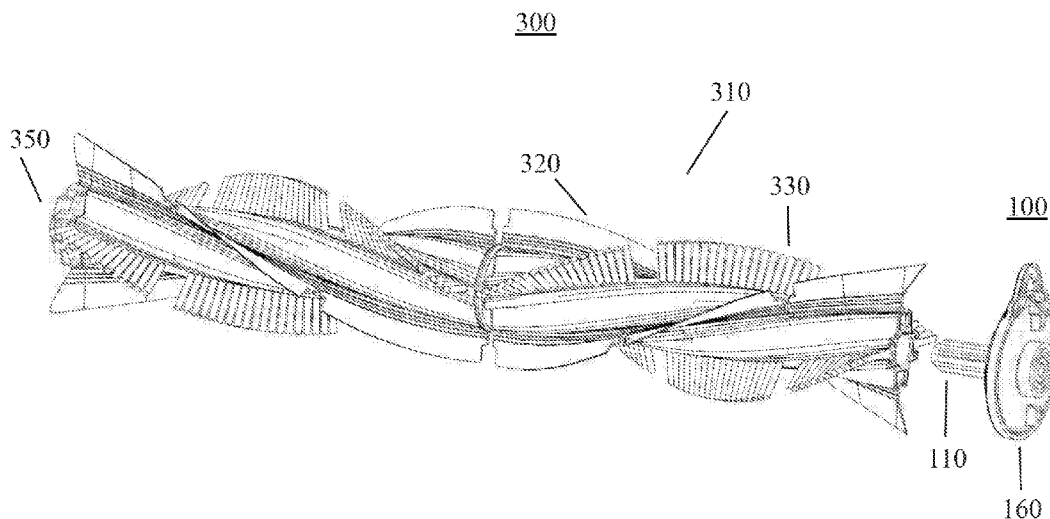




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(19) **United States**(12) **Patent Application Publication**  
**HERRON et al.**(10) **Pub. No.: US 2016/0345792 A1**(43) **Pub. Date: Dec. 1, 2016**(54) **BRUSH ENTANGLEMENT PREVENTION  
APPARATUS IN AUTONOMOUS ROBOTIC  
VACUUMS****Publication Classification**(51) **Int. Cl.***A47L 11/40* (2006.01)*A47L 11/24* (2006.01)(52) **U.S. Cl.**CPC ..... *A47L 11/4041* (2013.01); *A47L 11/24*  
(2013.01); *A47L 2201/06* (2013.01)(71) Applicant: **Neato Robotics, Inc.**, Newark, CA  
(US)(72) Inventors: **Matthew Allison HERRON**, Belmont,  
CA (US); **Ho Chong CHEUNG**,  
Sunnyvale, CA (US); **Charles Albert  
PITZER**, Newark, CA (US)(21) Appl. No.: **15/165,027**(22) Filed: **May 26, 2016****Related U.S. Application Data**(60) Provisional application No. 62/167,818, filed on May  
28, 2015.(57) **ABSTRACT**

An apparatus draws or leads hair and other potential entanglement debris away from the hub of a brush assembly in a vacuum as the brush rotates during vacuuming, thus avoiding or reducing entanglement and attendant problems, and obviating or reducing the need for manual removal of the entanglement. The apparatus has a profile which draws hair and other entanglement debris away from a hub of the brush assembly, or prevents it from reaching the hub, thus enabling the brush/brush assembly to continue to rotate freely. In one implementation, the apparatus attaches to a vacuum brush in an autonomous robotic vacuum.



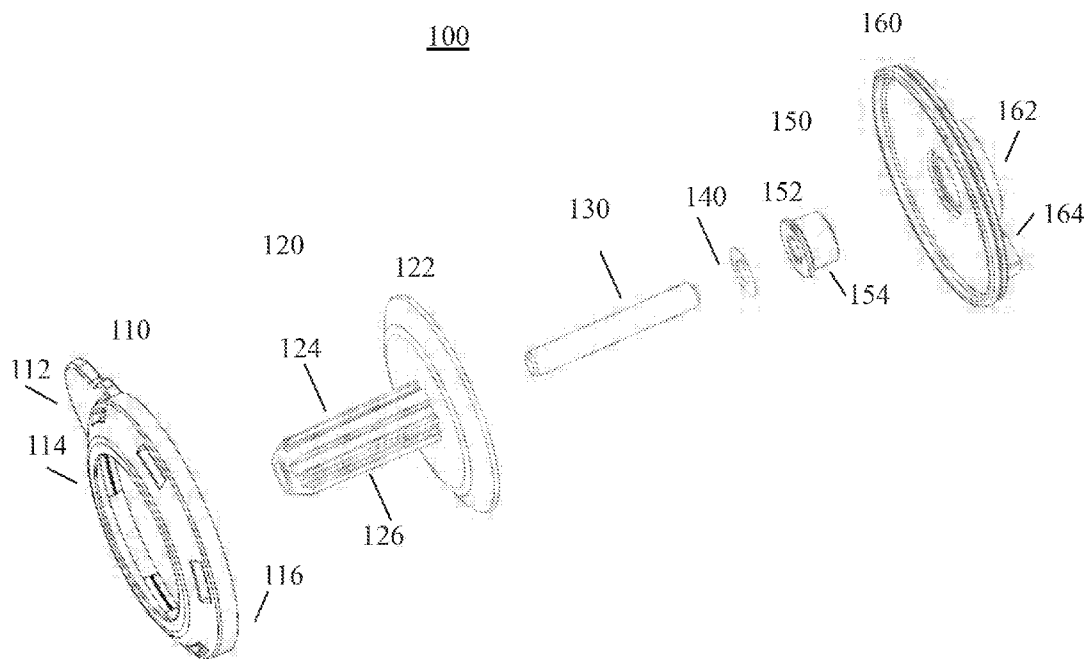


FIG. 1

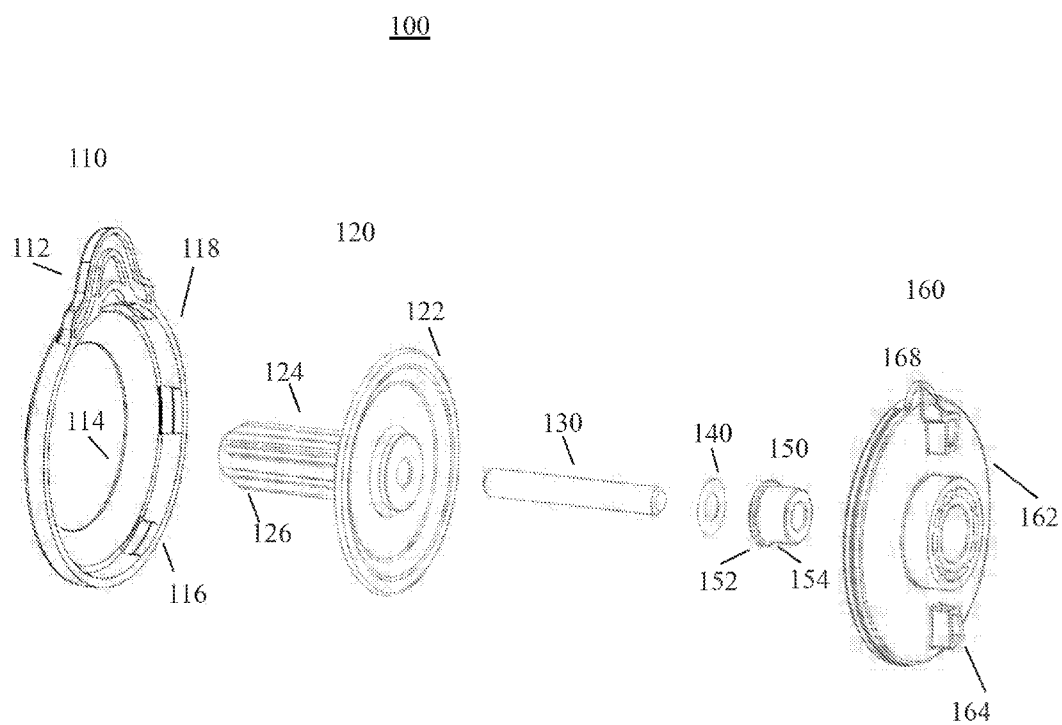


FIG. 2

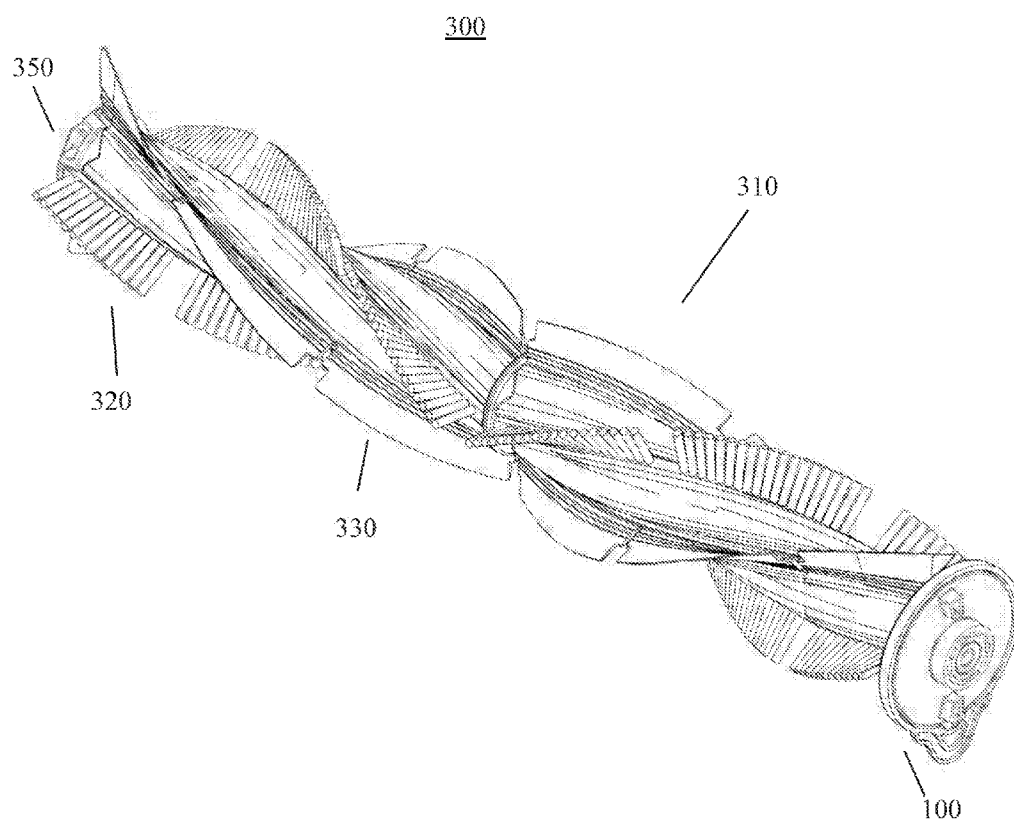


FIG. 3

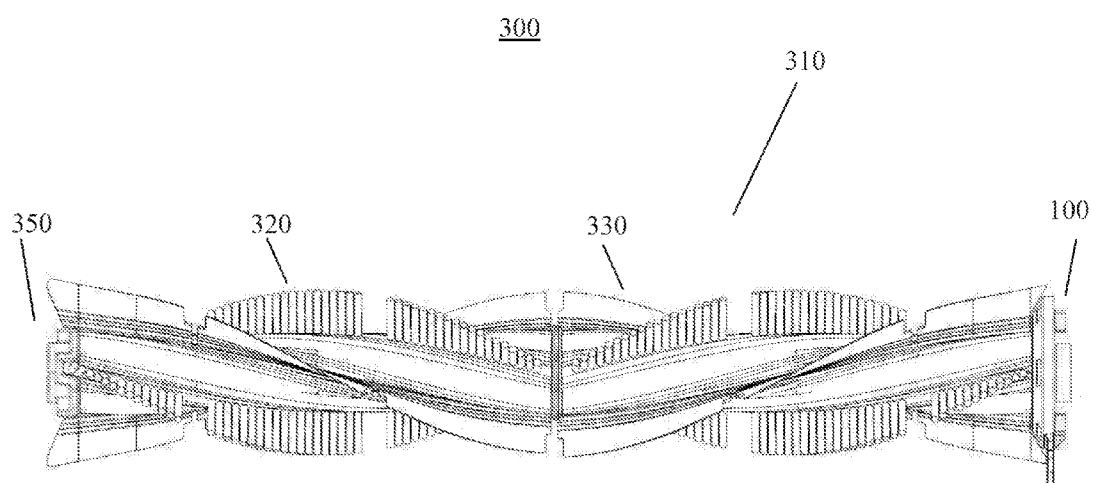


FIG. 4

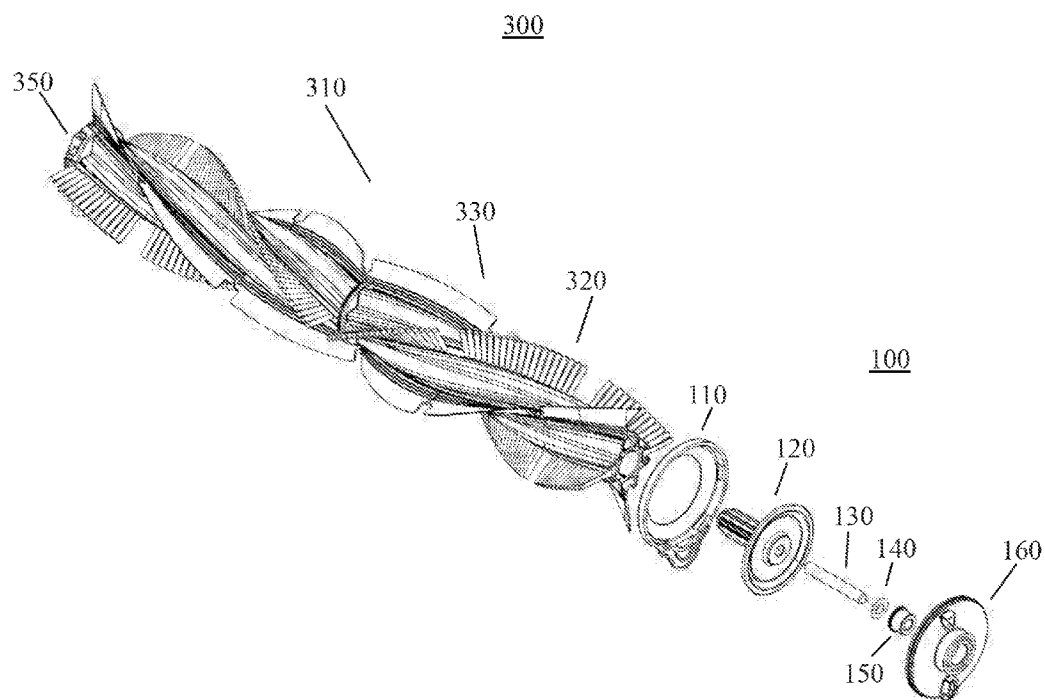


FIG. 5

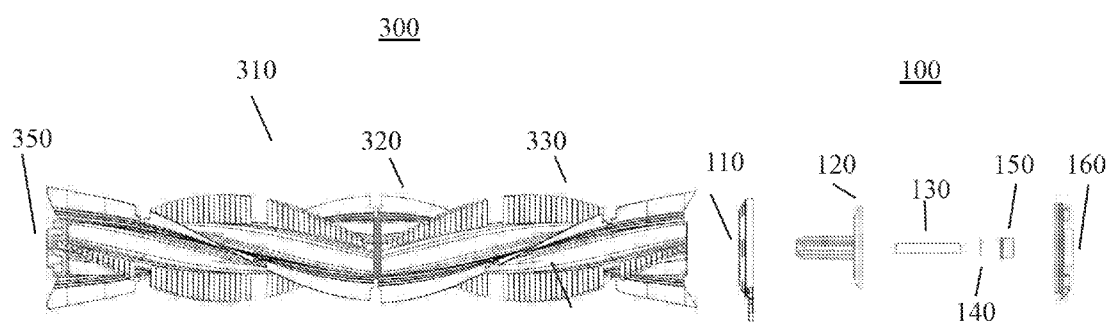


FIG. 6

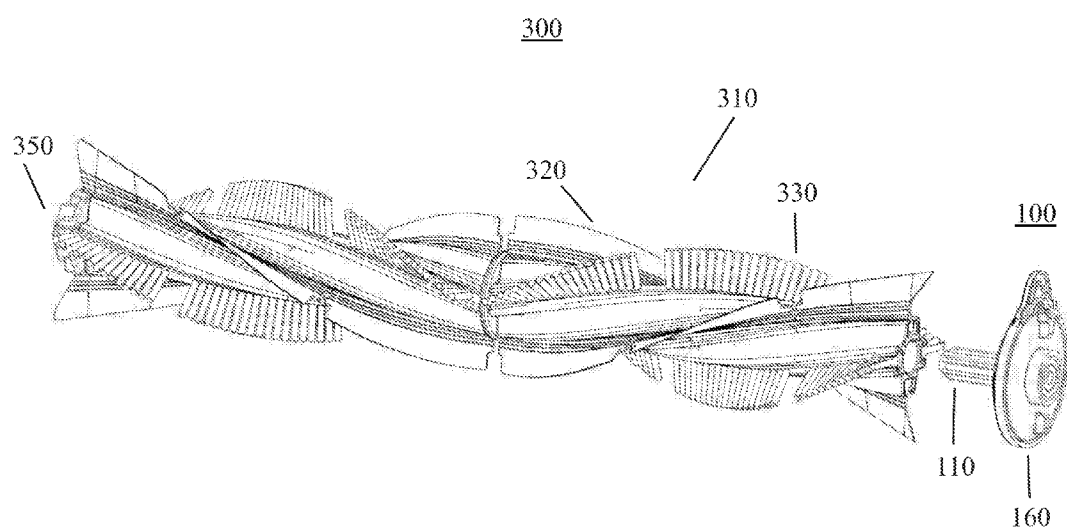


FIG. 7



## BRUSH ENTANGLEMENT PREVENTION APPARATUS IN AUTONOMOUS ROBOTIC VACUUMS

[0001] The present application claims the benefit of U.S. Provisional Patent Application No. 62/167,818, filed May 28, 2015, incorporated by reference in its entirety herein.

### BACKGROUND

[0002] Aspects of the present invention relate to entanglement prevention in brush assemblies in autonomous robotic vacuums.

[0003] Autonomous robotic vacuums often work in rooms on a schedule, when the user is not present. As such a vacuum traverses an environment, the vacuum picks up dirt, dust, lint, hair, and other debris and collects it in an onboard bin. In environments where substantial amounts of hair fall on the ground, brushes on board an autonomous robotic vacuum pick up the hair. Such pick up is known to cause clogging of the brush assembly, and in particular the hub on which the brush(es) is/are mounted, potentially preventing the brush(es) from rotating, and thus keeping the vacuum from operating properly. As such vacuums tend to be battery operated, the battery can run down before the vacuum finishes traversing the environment. Alternatively, if the vacuum keeps moving with the clogged brush assembly, proper cleaning cannot occur.

[0004] When the user returns, s/he may not know that there has been an entanglement. In that situation, the user may simply recharge the vacuum and set it again to operate when the user is away. However, the vacuum will not clean, because the entanglement still is there. As a result, the user will come home and find that the vacuum has not performed its intended tasks.

[0005] If the user examines the vacuum, s/he may see the entanglement. The user then has to remove the entanglement manually. However, in some circumstances the user may not see the entanglement, around the hub, very clearly. Also, even if the user does see the entanglement, it may not be easy to remove. Over time, the buildup of hair and debris could cause fatal damage to the robotic vacuum.

[0006] It would be desirable to provide an approach which avoids entanglement in the first instance.

### SUMMARY OF THE INVENTION

[0007] In view of the foregoing, it is an object of the present invention to provide an apparatus which draws or leads hair and other potential entanglement debris away from the hub of a brush assembly as the brush rotates during vacuuming, thus avoiding or reducing entanglement and attendant problems, and obviating or reducing the need for manual removal of the entanglement.

[0008] In one aspect, an effect of the entanglement prevention apparatus is to enable the brush to be closer to the hub, enabling the brush to clean more effectively.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is an exploded view of an entanglement prevention apparatus in accordance with one aspect of the invention.

[0010] FIG. 2 is another exploded view of an entanglement prevention apparatus in accordance with one aspect of the invention.

[0011] FIG. 3 is another view of an entanglement prevention apparatus, as related to a brush assembly, in accordance with one aspect of the invention.

[0012] FIG. 4 is yet another view of an entanglement prevention apparatus, as related to a brush assembly, in accordance with one aspect of the invention.

[0013] FIG. 5 is an exploded view of an entanglement prevention apparatus, as related to a brush assembly, in accordance with one aspect of the invention.

[0014] FIG. 6 is another exploded view of an entanglement prevention apparatus, as related to a brush assembly, in accordance with one aspect of the invention.

[0015] FIG. 7 is yet another exploded view of an entanglement prevention apparatus, as related to a brush assembly, in accordance with one aspect of the invention.

### DETAILED DESCRIPTION

[0016] As now will be described in detail with respect to one or more embodiments, in one aspect the invention provides an apparatus which attaches to a vacuum brush, enabling the brush to rotate freely. The apparatus has a profile which draws hair and other entanglement debris away from a hub of the brush assembly, or prevents it from reaching the hub, thus enabling the brush/brush assembly to continue to rotate freely.

[0017] In one aspect of the invention, any number of autonomous robotic vacuums which operate with a brush assembly may employ the entanglement prevention apparatus described herein. One example of a robotic device which has vacuuming as one of its functions is described in U.S. Pat. No. 7,555,363, commonly assigned with the present application. The contents of this patent are incorporated herein by reference.

[0018] Looking at FIG. 1, an entanglement prevention apparatus 100 is constituted by a first endpiece 110 and a second endpiece 160. In an embodiment, the endpieces 110 and 160 may be snapfit or otherwise attached to each other. Between the two endpieces 110, 160 sits an insert 120 which is shaped to fit closely with endpiece 110; a bar 130 providing support to insert 120; a washer 140; and a bushing 150. In an embodiment, bar 130 and washer 140 may be press fit or otherwise attached to insert 120. In an embodiment, bushing 150 may be press fit or otherwise attached to second endpiece 160. The overall assembly of apparatus 100 is such that, when attached to a brush assembly as will be discussed in more detail herein, the insert 120, with bar 130 and washer 140, spins freely within the apparatus.

[0019] Each of the components of apparatus 100 now will be discussed in more detail. In an embodiment, first endpiece 110 may be generally circular in cross section, except for a tongue-shaped extension 112 which in some circumstances can facilitate holding the structure fast to a brush housing assembly. In an embodiment, the endpiece 110 may be made of plastic. Other materials which facilitate snap fitting or other attachment to second endpiece 160 also are possible.

[0020] Endpiece 110 has a first side 114 and a second, opposite side 116. Sides 114 and 116 are sized to accommodate insert 120, as now will be discussed.

[0021] In an embodiment, insert 120 has a generally circular portion 122 and an extension 124 which is shaped to engage with the above-mentioned brush assembly. In an embodiment, extension 124 may have raised portions 126 which facilitate firmer engagement with the brush assembly.

Circular portion **122** has a first surface, facing extension **124**, with a first radius, and a second surface, on an opposite of the first surface, having a second, larger radius. In an embodiment, the progression from the first radius to the second radius is smooth and generally continuous. As a result, the circular portion **122** has a profile which variously may be known to ordinarily skilled artisans as a bevel, a chamfer, a taper, a slanted or angled surface, or a truncated cone. Each of these terms can have meanings which are synonymous or which are slightly different from each other. In the description herein, for convenience, the shape will be referred to as a bevel. However, this term should be understood to be shorthand for any of the several terms just mentioned, with corresponding definitions being applicable. Thus, for example, in the context of the present disclosure, something that is referred to as a chamfer will be understood also to be a bevel, a taper, a slanted or angled surface, or a truncated cone. Calling a structure one of these names does not prevent it from being known under one of the other names.

**[0022]** The bevel profile of circular portion **122** fits in a complementary fashion with a corresponding concave profile of side **116** of endpiece **110**. The fitting is such that, when endpieces **110** and **160** are mated (snap fit) to each other, insert **120** rotates freely within the assembly comprising endpieces **110** and **160**. Also, the profile of side **114** complements the shape of circular portion **122**. Side **114**'s profile, the smaller part of the bevel profile, faces the brush assembly, as will be seen. Elements **130**, **140**, and **150**, which will be discussed in more detail below, facilitate the free rotation of insert **120**.

**[0023]** Bar **130**, which in an embodiment is metal, fits in an opening in insert **120**. Bar **130** may be force fit into insert **120**, or otherwise may be firmly attached or adhered to insert **120**. In an embodiment, washer **140** may have an opening corresponding to that of a diameter of bar **130**, and may facilitate rotation of bar **130** within insert **120**.

**[0024]** Bushing **150**, which in an embodiment also is metal, has a flanged portion **152** and a cylindrical portion **154**. Cylindrical portion **154** may fit into an opening in second endpiece **160**. This fit may be a force fit or a press fit, or other kind of attachment or adherence that puts bushing securely in the second endpiece **160**. An end of bar **130** may slide into an opening in bushing **150**. The metal to metal contact between bar **130** and bushing **150** reduces friction, and enables the bar **130** to rotate freely within the bushing **150**. Alternatively, for example, bushing **150** may be made of nylon, plastic, or other material which produces relatively little friction when in contact with bar **130**. As another alternative, bearings may replace bushing **150**. As yet another alternative, bar **130** may be made of a material other than metal. However, where torqueing of extension **124** in insert **120** potentially is an issue, having the bar **130** be made of more rigid material can be desirable.

**[0025]** Second endpiece **160** may be made of a material which facilitates a press fit or a snap fit with first endpiece **110**. On a side opposite the side of endpiece **160** into which bushing **150** fits, there may be extensions, **162**, **164** which facilitate attachment of apparatus **100** into a larger structure, such as an underside of a vacuum, which in an embodiment is an autonomous robotic vacuum.

**[0026]** FIG. 2 shows an exploded view of apparatus **100** in an opposite direction or orientation, so that certain portions of elements **110-160** are more visible. In particular, side **116**

of first endpiece **110** is more visible, as is the surface on that side which complements the upper surface of circular portion **122**. Cylindrical mating surface **118** also is visible. The lip on that mating surface surrounds circular portion **122** as that portion nests within first endpiece **110**.

**[0027]** FIG. 2 shows a hole in the middle of insert **120**, into which bar **130** fits. In an embodiment, washer **140** seats in the underside of insert **120**, and is attached so that bar **130** is secure within extension **124** of insert **120**. As with the previous embodiment, washer **140** may facilitate rotation of bar **130** within insert **120**. The other side of second endpiece **160** also is more visible in FIG. 2, with extensions **162**, **164** more visible.

**[0028]** FIG. 3 shows a brush assembly **300** which includes brush **310**, apparatus **100**, and end cap **350**. In an embodiment, brush **310** includes bristled portions **320** and non-bristled portions **330**, for cleaning of different types of surfaces, different types of debris, and the like. In an embodiment, bristled portions **320** and/or non-bristled portions **330** are attached in serpentine fashion in brush **310**. Such a configuration may facilitate collection of gathered debris for direction toward a dustbin within the robotic vacuum. FIG. 3 shows an embodiment in which these portions **320**, **330** are attached in a double serpentine configuration. Such a configuration also can facilitate guidance of debris toward a dustbin or other receptacle on board a robotic vacuum such as may be seen in U.S. Pat. No. 7,555,363.

**[0029]** In FIG. 3, apparatus **100** is attached to brush **310** as part of the overall brush assembly **300**. In an embodiment, extension **124** of insert **120** of apparatus **100** fits into an opening (not seen in this figure, but visible in FIGS. 5 and 7, for example) at the center of the brush assembly **300**. In an embodiment, end cap **350** is attached to brush **310** on an opposite side from apparatus **100**. End cap **350** may be configured to attach to motive structure, for example, in an autonomous robotic vacuum or other cleaning apparatus, so as to facilitate rotation of the brush assembly **300** by motive force. Such attachment may require a different configuration for end cap **350** than for apparatus **100**. In an embodiment, end cap **350** may have the same structure, configuration, and operation as apparatus **100**. In an embodiment, rotation of the brush may come through attachment, either directly or via some kind of gearing arrangement, to motive wheels, again as may be seen in U.S. Pat. No. 7,555,363.

**[0030]** FIG. 4 shows a side view of brush assembly **300**, making it easier to see end cap **350** as juxtaposed with apparatus **100**. The double serpentine configuration of bristled and non-bristled portions **320**, **330** in an embodiment also is more apparent.

**[0031]** FIG. 5 shows an exploded view of apparatus **100** as it fits into brush assembly **300**. As alluded to earlier, extension **124** of insert **120** fits through first endpiece **110** into an opening (unnumbered) in brush **310** so as to attach firmly within the opening, through press fit, force fit, or other manner of adherence, while enabling the subassembly comprising insert **120**, bar **130**, and washer **140** to continue to rotate freely through bushing **150**, thus enabling free rotation of brush assembly **300** at that end. The extensions on the side of second endpiece **160** may facilitate attachment of that assembly within an autonomous robotic vacuum. Such attachment will not impede free rotation of the insert **120**

within apparatus **100**, however. The brush assembly opening into which extension **124** fits is central to the brush assembly.

[0032] FIG. 6 shows a different, side view of what FIG. 5 shows, including an exploded view of apparatus **100**, to show how parts **110-160** come together and go into brush assembly **300**.

[0033] FIG. 7 shows yet a different view of brush assembly **300**, with an assembled version of apparatus **100** and insert **120** juxtaposed with an opening in brush assembly **300**.

[0034] It has been discovered that the bevel shape of first endpiece **110**, into which insert **120** fits, tends to effectively guide hair and other potential entanglement debris away from the hub in which brush assembly **300** is mounted, or prevent such debris from reaching the hub in the first place. As a result, debris will not wrap around any portion of the bushing or bearing mechanism, potentially fouling it. Hair or fibers have difficulty going from a smaller diameter to a larger diameter along the bevel as the assembly rotates. The bevel creates a barrier to keep fiber or hair from impinging on the bushing or bearing, preventing clogging. The effect of this structure is to enable the brush **310** to be positioned more closely to the hub on which brush assembly **300** is mounted, enabling a longer brush which can clean more surface during a pass of the robotic device. As a result, the brush **310** can clean more effectively within the overall robotic vacuum structure (actually, closer to the outer edges of that structure), in part because of the brush proximity to the hub.

[0035] What has been described here is a brush assembly for use in an autonomous robotic device with various capabilities. The robotic device's autonomy is in contrast to a remote control operation of the device. Autonomy enables the robotic device to operate without supervision or external influence, for example, to clean the environment, or zones within the environment in which the robot is operating. The entanglement prevention feature described herein works well with an autonomous robotic device which may operate, for example, on a schedule when the owner/user/operator is unavailable (for example, in the case of a home robotic vacuum, away from home). Entanglement prevention means that, for example, while the owner/user/operator is unavailable, the autonomous robotic device may operate with lessened risk of non-functionality, or battery drain, or the like because of fouling or other impeding of rotation of the brush assembly.

[0036] The brush assembly, of which the entanglement prevention apparatus described herein is a part, may be part of a home robotic vacuum, but also may be configured as a cartridge which a user may select from among several types of cleaning cartridges or modules (e.g. waxers, dusters, buffers, mops, or other types of cleaners). That is, an autonomous robotic device employing a brush assembly with the entanglement prevention apparatus described herein may be configured to receive different kinds of cleaning cartridges or modules, so as to perform as a floor cleaning product which performs different types of cleaning, not just vacuuming. A non-limiting example of such a cartridge configuration again may be seen in U.S. Pat. No. 7,555,363.

[0037] Although the invention has been described in language specific to structural features and/or methodological steps, it is to be understood that the invention is not to be

limited to the specific features or steps disclosed. Rather, the specific features and steps are disclosed as preferred forms of implementing the invention, which is to be defined by the claims.

What is claimed is:

1. A brush entanglement prevention apparatus comprising:

a first endpiece having a first, beveled side;  
a second endpiece; and

an insert fitting between said first and second endpieces, said insert having a generally circular portion with a beveled insert side having a contour matching that of the first, beveled side of the first endpiece, the insert further having an extension that extends from the beveled insert side and extends through the first endpiece into an opening in an elongate brush assembly, such that the first beveled side of the first endpiece faces the elongate brush assembly;

the first endpiece having a second, complementary side facing the insert, the second, complementary side having a surface generally fitting around the beveled insert side;

the arrangement being such that the first, beveled side of the first endpiece prevents entanglement of hair that otherwise would prevent rotation of the brush assembly.

2. A brush entanglement prevention apparatus according to claim 1, wherein the extension includes raised portions which facilitate attachment of the brush entanglement prevention apparatus with the brush assembly.

3. A brush entanglement prevention apparatus according to claim 1, wherein the first and second endpieces have attachment portions enabling the endpieces to be snapfit together, with the insert being enclosed therebetween.

4. A brush entanglement prevention apparatus according to claim 1, wherein the extension includes an opening therethrough, and the apparatus further comprises a bar passing through the opening and providing rigidity to the extension.

5. A brush entanglement prevention apparatus according to claim 1, wherein the second endpiece has an opening in a center portion thereof, and the apparatus further comprises a bushing extending through the opening and secured to the second endpiece through the opening.

6. A brush assembly comprising:

a central portion;

a brush mounted on the central portion; and

a brush entanglement prevention apparatus comprising:

a first endpiece having a first, beveled side;  
a second endpiece; and

an insert fitting between said first and second endpieces, said insert having a generally circular portion with a beveled insert side having a contour matching that of the first, beveled side of the first endpiece, the insert further having an extension that extends from the beveled insert side and extends through the first endpiece into an opening in the central portion, such that the first beveled side of the first endpiece faces the brush assembly;

the first endpiece having a second, complementary side facing the insert, the second, complementary side having a surface generally fitting around the beveled insert side;

the arrangement being such that the first, beveled side of the first endpiece prevents entanglement of hair that otherwise would prevent rotation of the brush assembly.

7. A brush assembly according to claim 6, wherein the brush includes bristled portions and non-bristled portions.

8. A brush assembly according to claim 7, wherein the bristled portions and non-bristled portions are arranged in double serpentine fashion around the central portion.

9. A brush assembly according to claim 6, wherein the central portion includes an opening at least one end thereof, and wherein the extension includes raised portions which facilitate attachment of the brush entanglement prevention apparatus with the central portion.

10. A brush assembly according to claim 6, wherein the first and second endpieces have attachment portions enabling the endpieces to be snapfit together, with the insert being enclosed therebetween.

11. A brush assembly according to claim 6, wherein the extension includes an opening therethrough, and the apparatus further comprises a bar passing through the opening and providing rigidity to the extension.

12. A brush assembly according to claim 6, wherein the second endpiece has an opening in a center portion thereof, and the apparatus further comprises a bushing extending through the opening and secured to the second endpiece through the opening.

13. An autonomous robotic cleaning device comprising:  
a body;

first motive apparatus to propel the body, the motive apparatus including a motor and wheels;

navigation structure to direct the body according to pre-determined paths or according to real-time directions; and

cleaning apparatus attachable to the body to clean a floor in an environment;

the cleaning apparatus including a brush assembly attachable to the body, the brush assembly comprising:

a central portion;

a brush mounted on the central portion; and

a brush entanglement prevention apparatus comprising:  
a first endpiece having a first, beveled side;

a second endpiece; and

an insert fitting between said first and second endpieces, said insert having a generally circular portion with a beveled insert side having a contour matching that of the first, beveled side of the first endpiece, the insert further having an extension that extends from the beveled insert side and extends through the first endpiece into an opening in the central portion, such that the first beveled side of the first endpiece faces the brush assembly; the first endpiece having a second, complementary side facing the insert, the second, complementary side having a surface generally fitting around the beveled insert side;

the arrangement being such that the first, beveled side of the first endpiece prevents entanglement of hair that otherwise would prevent rotation of the brush assembly;

the cleaning apparatus further including second motive apparatus to power the brush assembly.

14. An autonomous robotic device according to claim 13, wherein the brush includes bristled portions and non-bristled portions.

15. An autonomous robotic device according to claim 14, wherein the bristled portions and non-bristled portions are arranged in double serpentine fashion

16. An autonomous robotic device according to claim 13, wherein the extension includes raised portions which facilitate attachment of the brush entanglement prevention apparatus with the brush assembly.

17. An autonomous robotic device according to claim 13, wherein the first and second endpieces are snapfit together, with the insert being enclosed therebetween.

18. An autonomous robotic device according to claim 13, wherein the extension includes an opening therethrough, and the apparatus further comprises a bar passing through the opening and providing rigidity to the extension.

19. An autonomous robotic device according to claim 13, wherein the second endpiece has an opening in a center portion thereof, and the apparatus further comprises a bushing extending through the opening and secured to the second endpiece through the opening.

20. An autonomous robotic device according to claim 13, wherein the second motive apparatus includes gearing to engage with the first motive apparatus.

\* \* \* \* \*