



(51) International Patent Classification:
A47L 9/04 (2006.01)

(21) International Application Number:
PCT/GB2019/052780

(22) International Filing Date:
02 October 2019 (02.10.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1816396.4 08 October 2018 (08.10.2018) GB

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(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,

(54) Title: A CLEANER HEAD

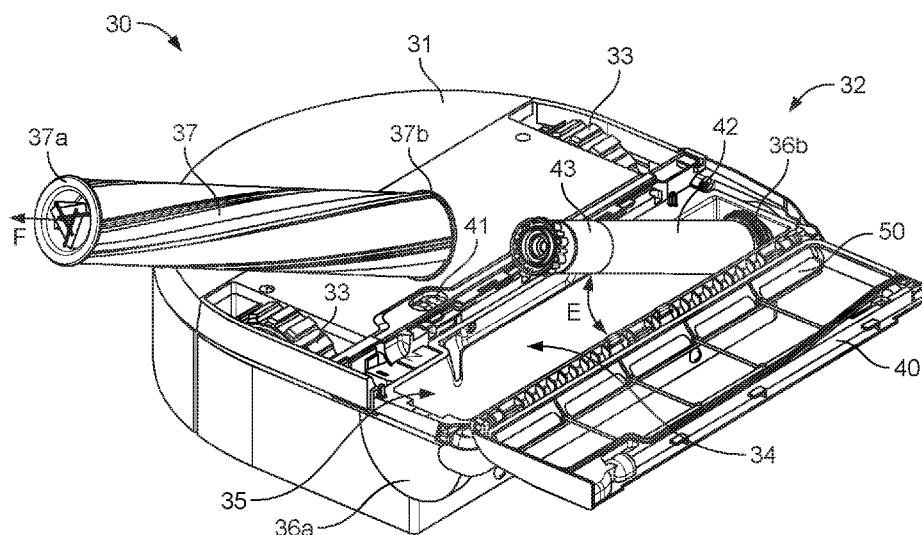


FIG. 4C

(57) Abstract: A cleaner head comprising: a suction chamber having a suction opening; an agitator comprising a hollow body and supported in the suction chamber by a support member, the support member having a first end that is fixed to a side wall of the suction chamber, and a second end that is free and over which the hollow body of the agitator can be slideably received; and a drive assembly forming part of the support member, and arranged to rotate the agitator about an axis. The fixed end of the support member is pivotally fixed to the side wall of the suction chamber such that the free end of the support member, together with the agitator supported thereon, can be pivoted to protrude out from the suction opening, to allow the agitator to be removed and replaced.



MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

A Cleaner Head

The present invention relates to a cleaner head for a vacuum cleaner, and in particular to a cleaner head having a motor-driven brushbar where the motor is located inside the brushbar.

Cleaner heads for vacuum cleaners are often provided with brushbars, often referred to as agitators. Brushbars typically comprise bristles that are used to agitate dust from the floor surface, and are particularly important in improving the level of dust pickup from carpeted floors. Brushbars can be motor driven, and are often driven by a motor via a belt. However, the drive and belt assembly can take up valuable space in the cleaner head, and often they prevent the cleaner head from being able to have a brushbar that extends the full width of the cleaner head.

More recently, advances have put the brushbar motor inside the brushbar itself. Such a scheme is described in GB2498351. In GB2498351, the brushbar is formed of a hollow body, and can be inserted through one side of the cleaner head and slideably mounted over the drive assembly which is cantilevered at the other end of the cleaner head.

Another example is shown herein in Figure 1. Figure 1 shows a cleaner head 1 having a suction chamber 2. A brushbar 3 can be inserted into the suction chamber 2 through an opening 4 in a side wall of the cleaner head 1. Upon inserting the brushbar 3 into the suction opening as represented by arrow A, the brushbar is slideably received onto the support body 5. The support body 5 is fixed to the opposing side wall to the opening at point 6 and extends through the centre of the suction chamber 2. The side wall at point 6 provides cantilever support to the support body. The motor for driving the brushbar is located within the support body 5. Once the brushbar is inserted into the suction chamber 2, the brushbar end cap 7 is then secured against the housing via a bayonet fitting to hold the brushbar in place.

Whilst there are many benefits associated with placing the motor inside the brushbar, removal of the brushbar through the side of the cleaner head can give rise to some design constraints. In addition, without proper sealing, it may be possible for air to leak through the side of the cleaner head where the brushbar is removed, and this may impact

head pressure inside the suction chamber, which may negatively impact pickup performance of the cleaner head.

A first aspect of the invention provides a cleaner head comprising: a suction chamber
5 having a suction opening; an agitator comprising a hollow body and supported in the suction chamber by a support member, the support member having a first end that is fixed to a side wall of the suction chamber, and a second end that is free and over which the hollow body of the agitator can be slideably received; and a drive assembly forming part of the support member, and arranged to rotate the agitator about an axis. The fixed
10 end of the support member is pivotably fixed to the side wall of the suction chamber such that the free end of the support member, together with the agitator supported thereon, can be pivoted to protrude out from the suction opening, to allow the agitator to be removed and replaced.

15 As a result, a cleaner head in which the brushbar motor is located inside the brushbar can still be achieved without requiring the brushbar to be removed through a side of the cleaner head. In turn, this may reduce the risk of air leaking through a side of the cleaner head and therefore can help maintain better head pressure within the suction chamber, leading to improved pickup performance.

20 The suction opening may be downward facing. In this way, the suction opening allows dirt to be drawn in from the floor surface on which the cleaner head is used, and also allows access to the brushbar for it to be removed and replaced.

25 The fixed end of the support member may be pivotably fixed to the side wall of the suction chamber by a pivoting joint. As a result, the joint allows for the pivoting action in a controlled way, and ensures that the support member pivots only to a desired point, and is not over-pivoted which could result in damage to the cleaner head.

30 The first end of the support member may comprise a wiring loom provided through the pivoting joint to provide power to the drive assembly. As a result, the wiring loom can be protected by the pivot point and ensure it does not get damaged as the support member and brushbar pivot out from the suction opening.

A cooling airflow pathway may pass through the pivoting joint to provide cooling airflow to the drive assembly. As a result, the brushbar motor can be kept cool during operation, and the airflow pathway is not impeded by the pivoting joint.

- 5 The drive assembly may comprise a drive dog that is configured to engage with a complimentary drive dog receiving portion provided on the agitator. Alternatively, the drive assembly may be soft mounted to an inside surface of the agitator. Either allows effective transmission of the driving torque from the brushbar motor to the brushbar.
- 10 The cleaner head may further comprise a retaining frame to prevent pivoting of the support member and to retain the agitator in place in the cleaner head. As a result, the brushbar and support member will not inadvertently pivot out from the cleaner head during use, or if the cleaner head is lifted away from a floor surface.
- 15 The retaining frame may be pivotably mounted to an edge of the suction opening. As a result, the retaining frame can be moved to allow the brushbar to be removed, and then easily replaced. This may reduce the possibility of awkward alignment difficulties when replacing the retaining frame, and also reducing the possibility of the retaining frame being lost or damaged.
- 20 A catch may engage with a free end of the agitator to prevent the agitator from pivoting out from the suction opening, and to retain the agitator in the cleaner head. This provides an additional or alternative method of retaining the brushbar in place.
- 25 A second aspect of the invention provides a vacuum cleaner comprising the cleaner head of any one of the preceding statements. As a result, due to the benefits relating to the cleaner head described above, a vacuum cleaner can be achieved that may perform more efficiently, and may achieve improved pick up performance.
- 30 A third aspect of the invention provides a robotic vacuum cleaner comprising the cleaner head of any one of the previous statements relating to a cleaner head. As a result, due to the benefits relating to the cleaner head described above, a mobile robot vacuum cleaner can be achieved that may perform more efficiently, and may achieve improved pick up performance. In addition, the sides of the cleaner head are free of any brushbar

removal features, allowing them to be used for other purposes that are important to autonomous mobile robotic devices.

Outer faces of the sides of the cleaner head may form part of the outer surface of the robotic vacuum cleaner, and may be sensitive to physical contact with an obstacle. As a result, the robotic vacuum cleaner has improved sensitivity, and the sides of the cleaner head do not form a “blind spot” for the robot’s sensor system that is tasked with detecting obstacles in the environment in which the robotic vacuum cleaner is operating.

The robotic vacuum cleaner may comprise at least one microswitch that is triggered when a side of the cleaner head physically contacts an obstacle.

In order that the present invention may be more readily understood, embodiments of the invention will now be described, by way of example, with reference to the following accompanying drawings, in which:

Figure 1 is a prior art example of a cleaner head;

Figures 2A and 2B show a cleaner head according to the present invention during a brushbar removal operation;

Figure 3 is an underside view of a robotic vacuum cleaner; and

Figures 4A, 4B and 4C show the robotic vacuum cleaner of Figure 3 during a brushbar removal operation.

Figures 2A and 2B show a cleaner head 20. The cleaner head 20 has a body 21 and an attachment portion 22 for attaching the cleaner head to a vacuum cleaner, for example to a wand of a stick vacuum cleaner. The body 21 comprises a cover 23 and sides 24A and 24B which together form a suction chamber inside the body 22. On the underside of the body 22 is a suction opening 25. A brushbar 26 is typically housed inside the suction chamber. However, in Figure 2A which shows the cleaner head during a brushbar removal operation, the brushbar is shown as extending partially outside the suction chamber, protruding partially through the suction opening 25.

During use, the brushbar 26 acts to agitate dirt and dust on a floor surface that is being cleaned. The brushbar may be provided with strips of nylon bristles and rows of carbon fibre bristles to help improve the pickup performance of the cleaner head. From time to time, the brushbar 26 can become dirty, for example hair may become wrapped around the brushbar 26. When this happens, it is necessary to be able to remove the brushbar 26 from the cleaner head 20 in order to clean it, and then replace it back in place in the cleaner head 20 once cleaning has been completed.

As represented by double arrow B, the brushbar 26 is able to pivot in and out of the cleaner head 20 through the suction opening 25. The brushbar 26 pivots such that one end of the brushbar protrudes through the suction opening 25, providing a free end 26A which a user is able to grasp. The other end 26B remains mostly inside the suction chamber as it is close to the pivot point. A catch (not shown) may be provided to retain the end 26A of the brushbar inside the suction chamber. The catch could take the form of a brushbar end cap, for example, which engages with a complimentary engaging portion on the inside of the side wall 24A. The end cap could also incorporate a bearing support for the end 26A of the brushbar 26.

The brushbar 26 is supported within the suction chamber on a support member 27, and fits over it like a sleeve. The support member 27 is visible in Figure 2B which shows the cleaner head 20 after the brushbar 26 has been removed from the support member 27. The support member 27 is pivotally fixed to the inside of the side wall 24B of the cleaner head 20. Removal of the brushbar is carried out by pivoting the support member 27 and brushbar 26 out of the suction chamber such that the free end of the brushbar 26A protrudes through the suction opening 25 on the underneath of the cleaner head 20, and then sliding the brushbar 26 axially off the support member 27 as represented by arrow C. Replacement of the brushbar in the cleaner head 20 is carried out by carrying out the steps described above in reverse.

The support member 27 houses a brushbar motor inside which drives the drive dog 28. The drive dog 28 engages with a formation on the inside of the brushbar 26 when the brushbar is in position over the support member 27. In use, rotation of the brushbar motor

rotates the drive dog 28, and in turn the brushbar rotates inside the suction chamber of the cleaner head 20.

As the brushbar 26 is removed by first pivoting it out of the suction opening 25, it is not necessary to have an opening in the side wall 24A, such as shown in the prior art example of Figure 1. The side wall 24A can therefore be formed together with the cover 23, and the risk of any air leaking through the side wall 24 is reduced. This can help maintain head pressure within the cleaner head 20 during use, and this in turn can help improve the pickup performance of the cleaner head.

Whilst there are clearly advantages to pivoting the brushbar out of a cleaner head for a typical traditional style vacuum cleaner such as a stick vac, a cylinder and/or an upright vacuum cleaner as described above, there are even greater advantages for doing so on a robotic vacuum cleaner, which will now be described with reference to Figures 3, and 4A-C.

Figure 3 shows an underneath view of a robotic vacuum cleaner 30. The robotic vacuum cleaner comprises a main body 31 and a cleaner head 32. The main body 31 houses a drive system which includes wheels 33 that can be differentially driven in order for the robotic vacuum cleaner to autonomously navigate around an environment. Although not shown, the main body also comprises a suction motor to draw dirty air from the cleaner head, and a dirt separation system that separates dirt from the airflow generated by the suction motor. It will be understood that the robotic vacuum cleaner 30 will comprise a number of other components and systems that are typical for a robotic vacuum cleaner, however these are not the focus of this document, and will therefore not be described in any detail herein. For example the robotic vacuum cleaner 30 may further comprise a vision system, a sensor system, a navigation system, and a power supply such as a battery pack.

The cleaner head 32 of the robotic vacuum cleaner 30 shares many of the same features and components as the cleaner head 20 of Figures 2A and 2B. The cleaner head 32 comprises a cover and side edges 36A and 36B which together form a suction chamber 34 inside the cleaner head 32. The suction chamber 34 has a suction opening 35 which faces in a downward direction on the underneath of the cleaner head 32. As the robotic

vacuum cleaner 30 operates across a floor surface, dirty air will be drawn into the cleaner head 32 through the suction opening 35. Housed within the suction chamber 34 is a brushbar 37 which, when in use, is driven by a brushbar motor and rotates around an axis. Similarly to the brushbar 26 of cleaner head 20, the brushbar 37 of the cleaner head 32 of the robotic vacuum cleaner 30 acts to agitate dirt and dust on a floor surface that is being cleaned. The brushbar 37 is provided with strips of nylon bristles and rows of carbon fibre bristles (not shown) to help improve the pickup performance of the cleaner head. The brushbar 37 also comprises a tufted material (not shown), where the tufted material extends over substantially the entire circumferential and axial extent of the regions of the brushbar between the nylon and carbon fibre bristles.

From time to time, the brushbar 37 can become dirty, for example hair may become wrapped around the brushbar 37, or dirt may become lodged inside the cleaner head 32 which needs to be dislodged and removed. Although it is preferable on a robotic vacuum cleaner that the robot is able to autonomously handle all tasks such that user intervention is not required, it is inevitable that from time to time a user will be needed to carry out some maintenance tasks such as brushbar cleaning and clearing a blockage. When this happens, it is necessary for the user to be able to remove the brushbar 37 from the cleaner head 32, and replace it back in place in the cleaner head 32 once cleaning and/or clearing the blockage has been completed.

Figures 4A, 4B and 4C show the robotic vacuum cleaner 30 at different stages during a brushbar removal procedure. The cleaner head 32 of the robotic vacuum cleaner 30 comprises a retaining frame 40 which is pivotably fixed to the front edge of the suction opening 35. The retaining frame can be held in place by a spring-biased catch mechanism which is disengaged by actuating slider 41. Once the catch is disengaged, the retaining frame 40 can be pivoted away from the suction chamber 34 as indicated by arrow D in Figure 4A. Pivotaly moving the retaining frame in this way exposes the brushbar 37 such that it can be removed from the cleaner head 32. In addition to the retaining frame, a catch may be used to retain the brushbar 37 inside the cleaner head 32. As previously described in relation to cleaner head 20 of Figures 2A and 2B, the catch (not shown) may be provided to retain the end 37A of the brushbar inside the suction chamber, and could take the form of a brushbar end cap, for example, which

engages with a complimentary engaging portion on the inside of the side wall 36A. The end cap could also incorporate a bearing support for the end 37A of the brushbar 37.

In Figure 4B shows the brushbar 37 has been pivoted out from the suction chamber 34, as represented by arrow E, such that the free end 37A protrudes out from the suction opening 35. From this position, a user can grasp the free end 37A of the brushbar and slideably remove it from the support member 42, as indicated by arrow F in Figure 4C. The support member 42 supports the brushbar 37 during normal use, and is pivotably fixed at one end to the inside of the side wall 36B of the cleaner head 32 such that a free end of the support member 42 can pivot out from the suction chamber 34. A drive assembly in the form of a brushbar motor 43 is provided as part of the support member 42. The drive assembly shown in Figure 4C differs from that shown in the embodiment of Figures 2A and 2B as the brushbar motor 43 is not housed inside the support member 43, but rather forms part of the outside of the support member 42. In addition, instead of driving a drive dog, as was the case in the previous example, the brushbar motor 43 has an outer rotor configuration such that the outside of the brushbar motor 43 is soft mounted to an inside circumferential surface of the brushbar 37 and rotates relative to the remainder of the support member 42 so as to drive the rotation of the brushbar directly. The brushbar motors can be either brushed or brushless motors.

Replacement of the brushbar 37 can be carried out by performing the steps described above and shown in Figures 4A-C in reverse.

A front edge of the robotic vacuum cleaner 30 is provided with a bumper 50. The bumper 50 is configured to detect any physical contact of the robotic vacuum cleaner 30 with any objects or obstacles located within the environment in which it is navigating. Detecting physical contact is crucial for a robotic vacuum cleaner to enable it to navigate autonomously within an environment without the risk of it becoming damaged or damaging anything else while it operates. Front bumpers, such as bumper 50 are extremely important as it is most likely that the robotic vacuum cleaner will come into contact with obstacles while it is driving in a forward direction. However, being able to detect physical contact from the sides is also a great benefit, as it allows the robot to be able to detect physical contact when travelling along a boundary such as a wall, and also to detect physical contact while cornering. Therefore, the outside faces of the side edges

36A and 36B of the cleaner head 32 are also sensitive to physical contact. This is made possible thanks to the side edges 36A and 36B being free from things like brushbar removal ports. By enabling the brushbar 37 to be removed by pivoting it out through the suction opening, this frees up the side edges 36A and 37B such that they can be made sensitive to physical contact, and therefore made into an extension of the overall bump sensor system of the robotic vacuum cleaner.

The outside of the side edges 36A and 36B of the cleaner head form part of the outer cover of the robotic vacuum cleaner 30. The outside of the side edges 36A and 36B are deformable, and microswitches are positioned behind the deformable outer cover such that when physical contact is made between the robotic vacuum cleaner 30 and an obstacle, the microswitch is triggered which sends a signal to the robotic vacuum cleaner's control system to inform it that contact has been made. The outside of the side edges 36A and 36B are made deformable by biasing the outer cover away from the microswitch using a spring. On contact with an obstacle, the biasing force of the spring is overcome, and the outer cover makes contact with the microswitch. In an alternative embodiment, the outer cover could be formed of a material that has an inherent biasing force, and the spring is not required. In addition, other alternative embodiments may use strain gauges to measure strain in the deformable material to detect physical contact instead of microswitches. Other alternatives of physical contact sensors will be well understood.

In both embodiments of the cleaner head, as described in relation to the cleaner head shown in Figures 2A and 2B and also of the robotic vacuum cleaner of Figures 3 and 4A-C, a pivoting joint connects the support member 27, 42 with the side wall. The pivoting joint allows the pivoting movement of the support member 27, 42 relative to the remainder of the cleaner head, while also providing a degree of cantilevered support to the brushbar 26, 37 while it is positioned inside the suction chamber. The pivoting joint in these embodiments also provides a protected passage through which a wiring loom can pass. The wiring loom provides power and control signals to the brushbar motor. By passing the wiring loom through the pivoting joint, the wiring is protected, and the risk of it becoming damaged due to the pivoting action of the support member 27, 42 is greatly reduced. The pivoting joint also provides a passage through which a cooling airflow can pass. The brushbar motor can become hot during use, and it is beneficial to cool the

motor using a cooling airflow. By passing the cooling airflow through ducting which passes through the pivoting joint, the risk is greatly reduced of the ducting becoming damaged and the cooling airflow being blocked due to the pivoting action of the of the support member 27, 42.

5

Whilst particular examples and embodiments have thus far been described, it will be understood that various modifications, some of which are already described above, may be made without departing from the scope of the invention as defined by the claims.

10

CLAIMS

1. A cleaner head comprising:

a suction chamber having a suction opening;

an agitator comprising a hollow body and supported in the suction chamber by a support member, the support member having a first end that is fixed to a side wall of the suction chamber, and a second end that is free and over which the hollow body of the agitator can be slideably received; and

a drive assembly forming part of the support member, and arranged to rotate the agitator about an axis;

wherein the fixed end of the support member is pivotably fixed to the side wall of the suction chamber such that the free end of the support member, together with the agitator supported thereon, can be pivoted to protrude out from the suction opening, to allow the agitator to be removed and replaced.

2. A cleaner head as claimed in claim 1, wherein the suction opening is downward facing.

3. A cleaner head as claimed in claim 1 or claim 2, wherein the fixed end of the support member is pivotably fixed to the side wall of the suction chamber by a pivoting joint.

4. A cleaner head as claimed in claim 3, wherein the first end of the support member comprises a wiring loom provided through the pivoting joint to provide power to the drive assembly.

5. A cleaner head as claimed in claim 3 or 4, wherein a cooling airflow pathway passes through the pivoting joint to provide cooling airflow to the drive assembly.

6. A cleaner head as claimed in any one of the preceding claims, wherein the drive assembly comprises a drive dog that is configured to engage with a complimentary drive dog receiving portion provided on the agitator.

7. A cleaner head as claimed in any one of claims 1 to 5, wherein the drive assembly is soft mounted to an inside surface of the agitator.

5 8. A cleaner head as claimed in any one of the preceding claims, wherein the cleaner head further comprises a retaining frame to prevent pivoting of the support member and to retain the agitator in place in the cleaner head.

9. A cleaner head as claimed in claim 8, wherein the retaining frame is pivotably mounted to an edge of the suction opening.

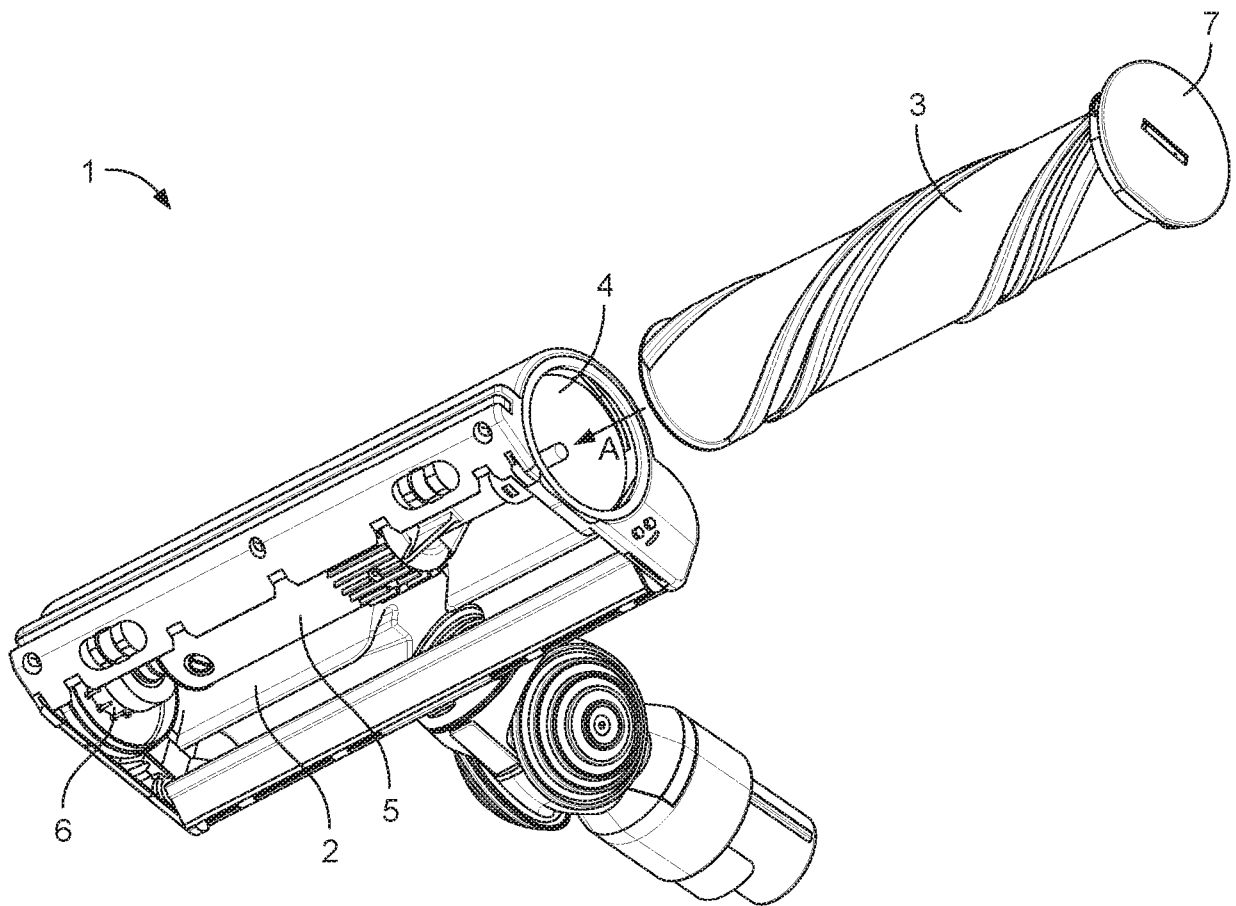
10 10. A cleaner head as claimed in any one of the preceding claims, wherein a catch engages with a free end of the agitator to prevent the agitator from pivoting out from the suction opening, and to retain the agitator in the cleaner head.

15 11. A vacuum cleaner comprising the cleaner head of any one of the preceding claims.

12. A robotic vacuum cleaner comprising the cleaner head of any one of claims 1 to 10.

20 13. The robotic vacuum cleaner as claimed in claim 12, wherein outer faces of the sides of the cleaner head form part of the outer surface of the robotic vacuum cleaner, and are sensitive to physical contact with an obstacle.

25 14. The robotic vacuum cleaner as claimed in claim 13, wherein the robotic vacuum cleaner comprises at least one microswitch that is triggered when a side of the cleaner head physically contacts an obstacle.



(PRIOR ART)
FIG. 1

2 / 4

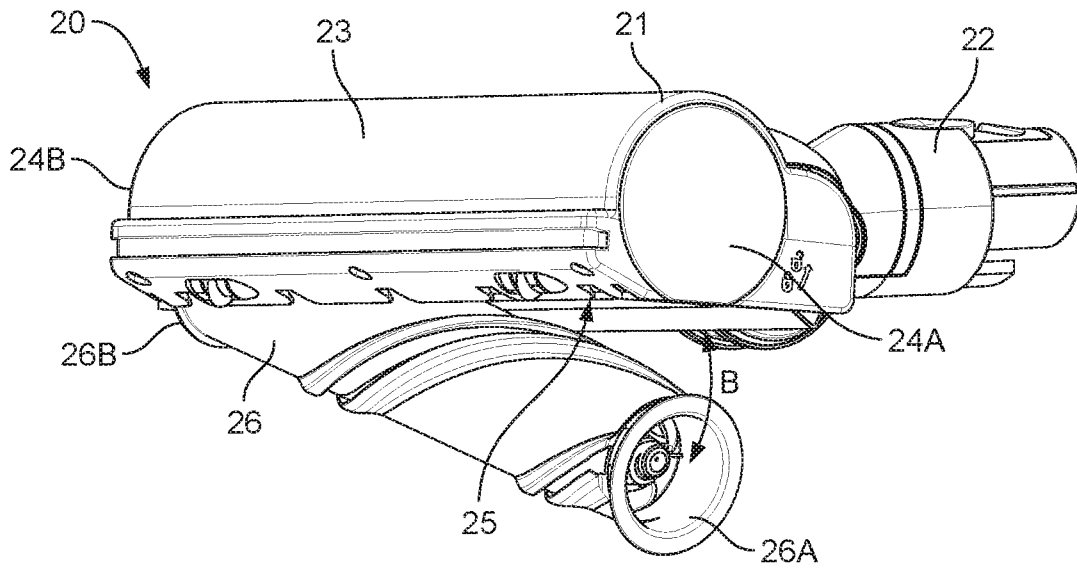


FIG. 2A

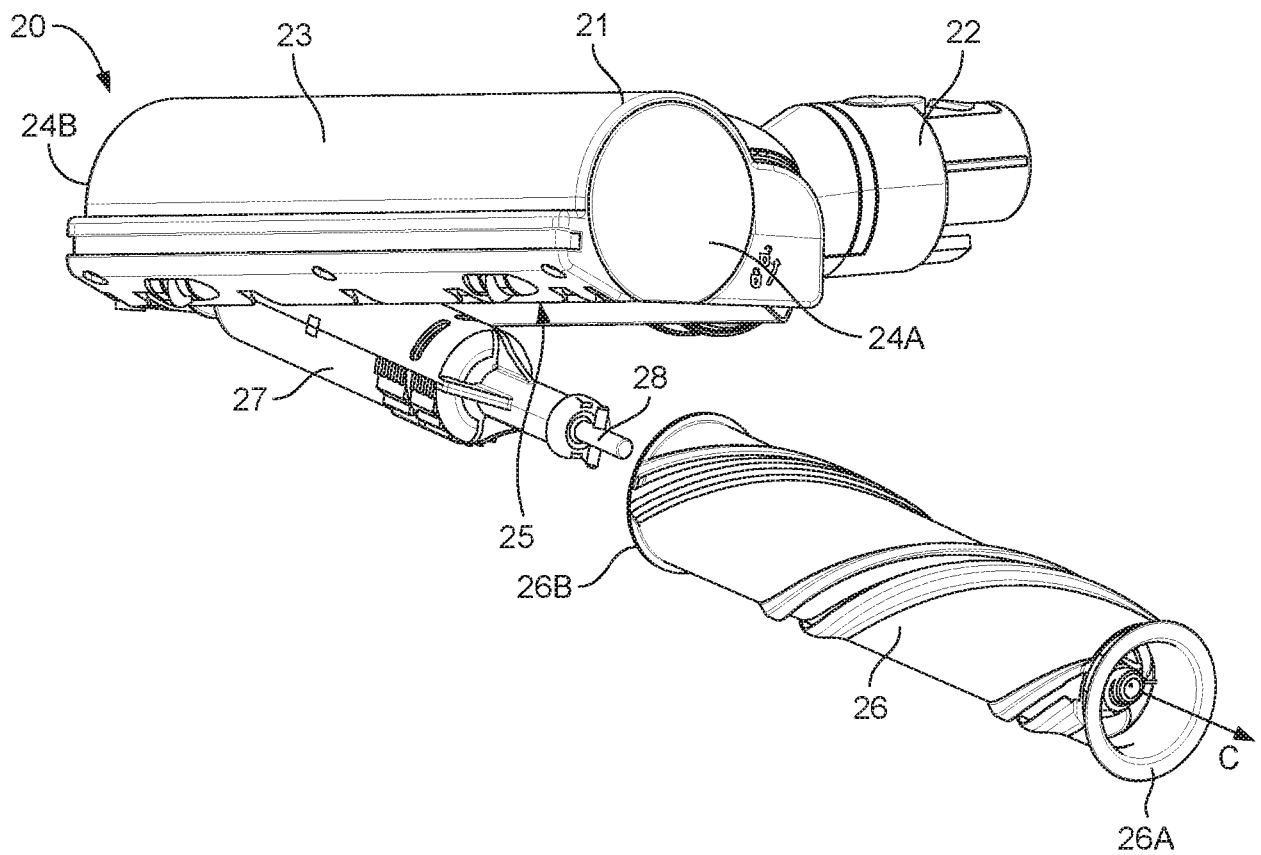


FIG. 2B

3 / 4

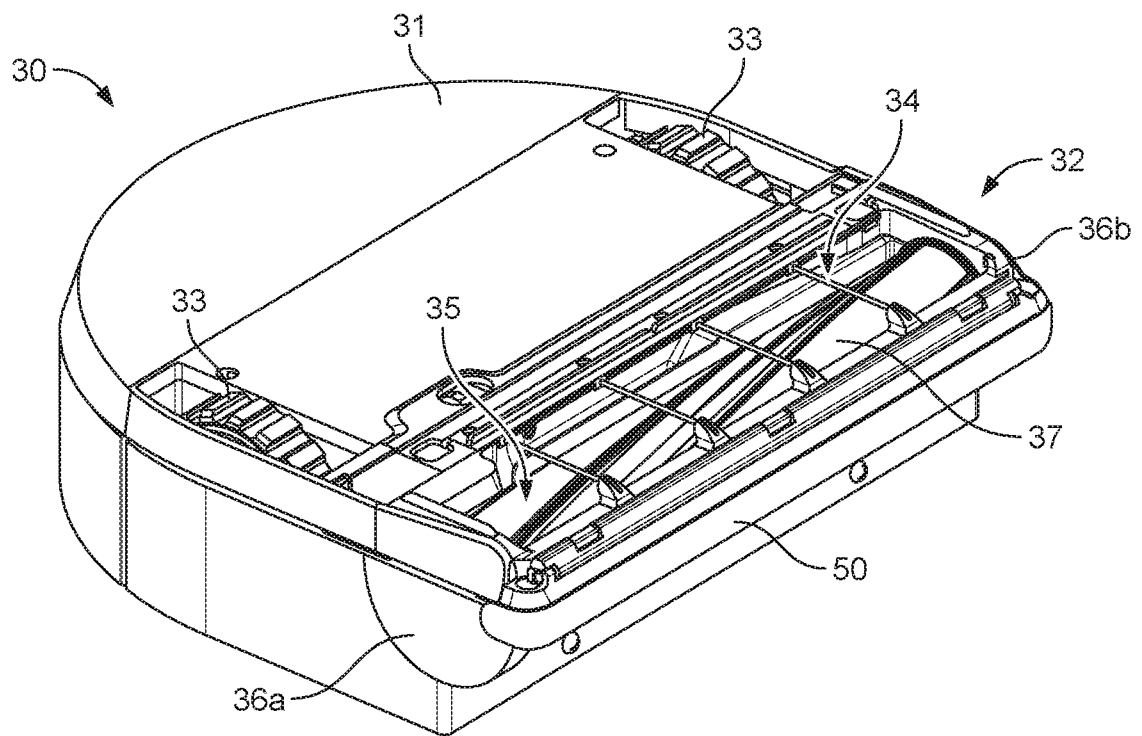


FIG. 3

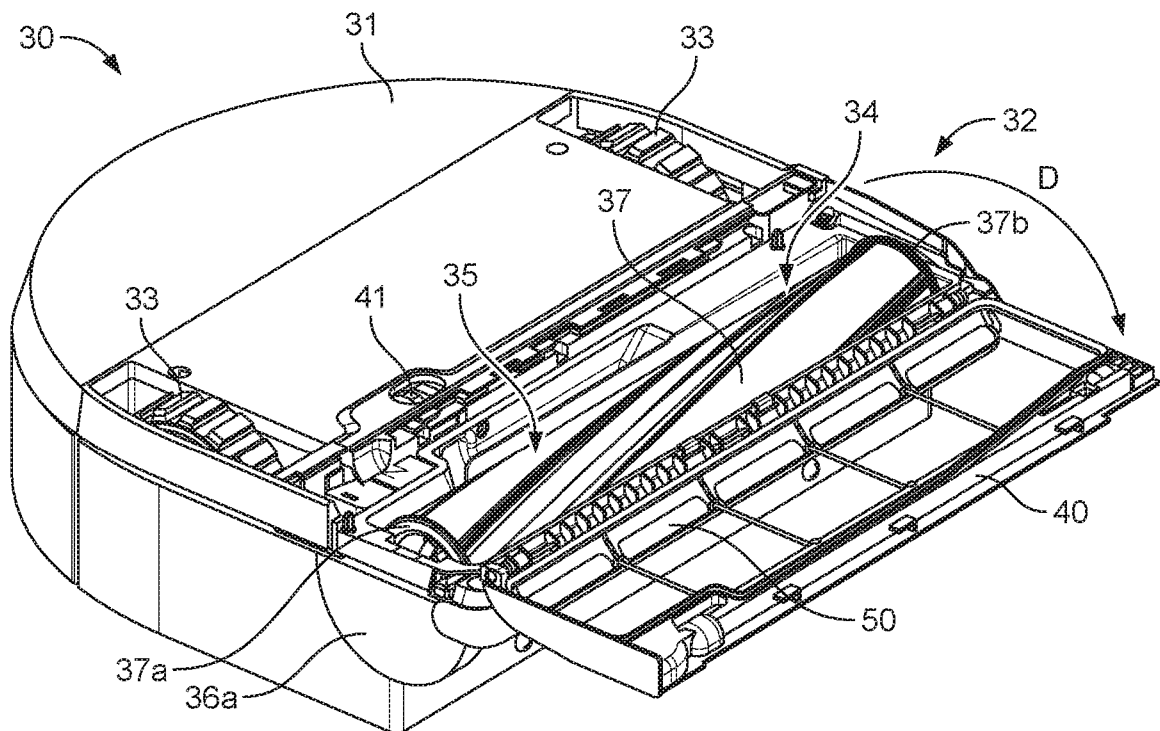


FIG. 4A

4 / 4

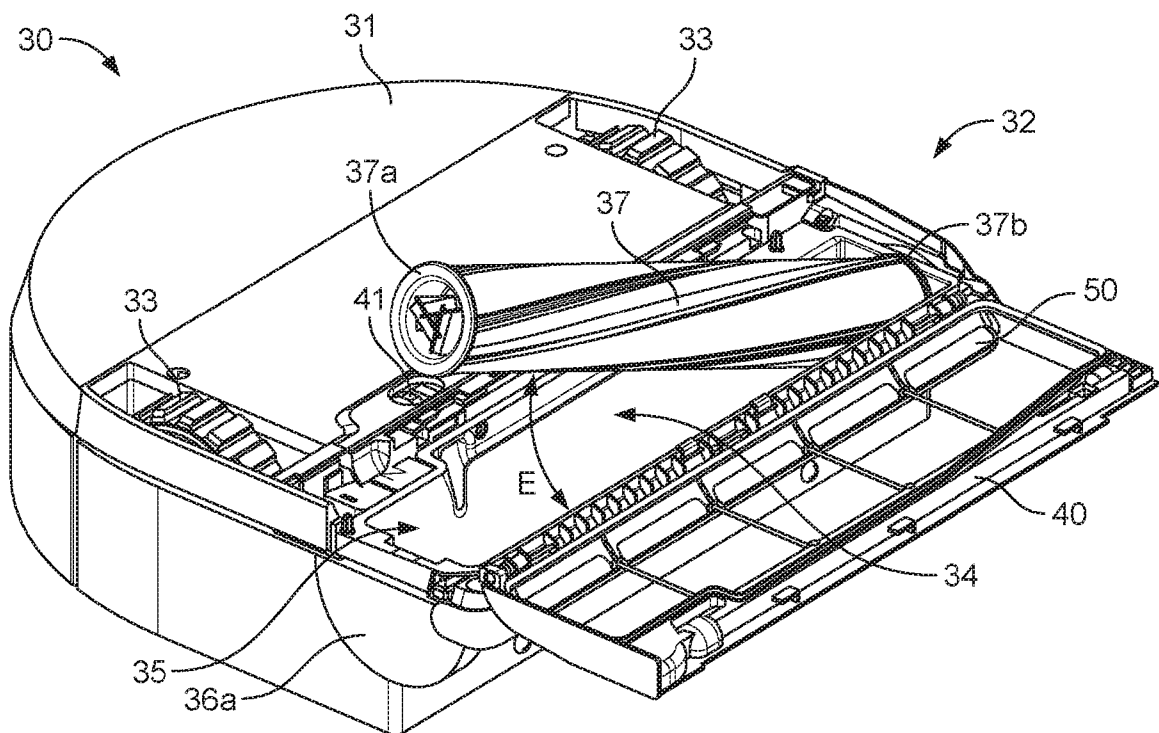


FIG. 4B

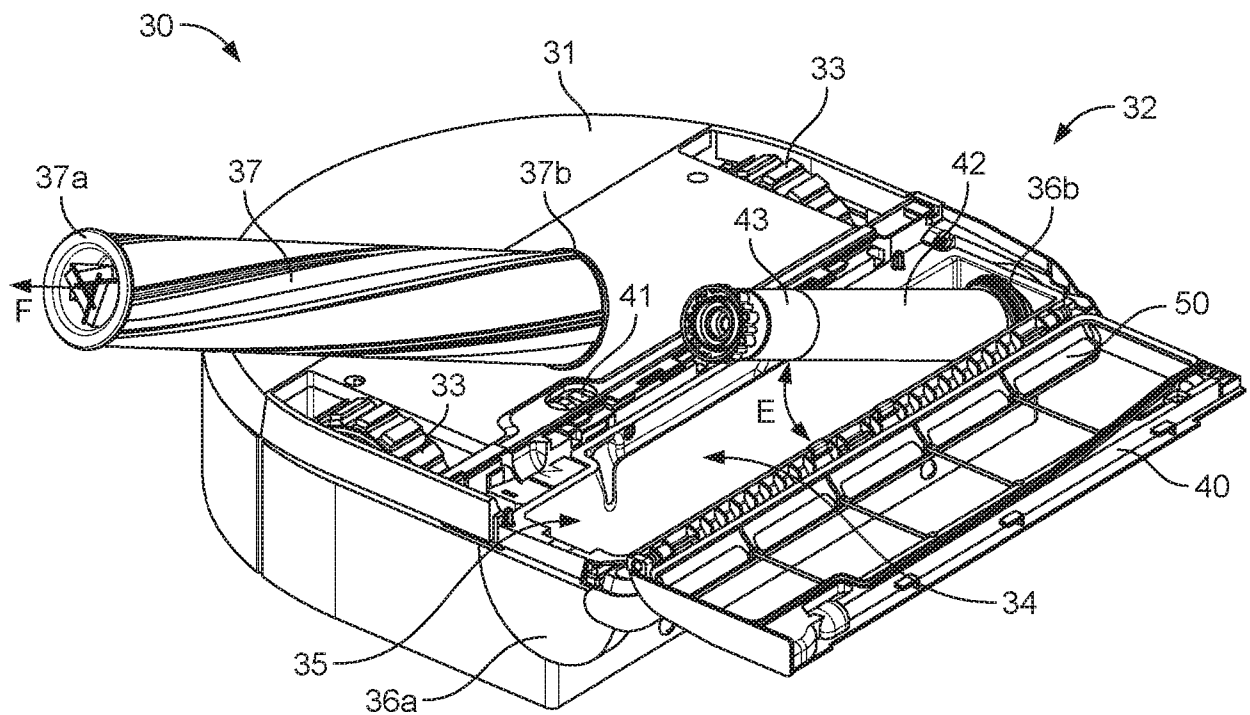


FIG. 4C

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2019/052780

A. CLASSIFICATION OF SUBJECT MATTER
INV. A47L9/04
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A47L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 134 745 A (WOERWAG PETER [CH]) 24 October 2000 (2000-10-24)	1-4,6,7, 10,11
Y	columns 3-5; claims; figures	5,8,9, 12-14
Y	----- GB 2 543 314 A (DYSON TECHNOLOGY LTD [GB]) 19 April 2017 (2017-04-19)	5
A	pages 8-11; claims; figures	6
Y	----- US 8 528 158 B2 (MAGUIRE SCOTT ANDREW [GB]; BOWER ANDREW JAMES [GB] ET AL.) 10 September 2013 (2013-09-10)	8,9
	columns 6-12; claims; figures 1-7	
Y	----- US 2017/332857 A1 (NAM BOHYUN [KR] ET AL) 23 November 2017 (2017-11-23)	12-14
	paragraphs [0334] - [0401]; figures 38-46	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

10 December 2019

Date of mailing of the international search report

17/12/2019

Name and mailing address of the ISA/

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Lopez Vega, Javier

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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