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NAKAI et al.(10) **Pub. No.: US 2024/0188781 A1**(43) **Pub. Date: Jun. 13, 2024**(54) **CLEANING DEVICE**(52) **U.S. Cl.**(71) Applicant: **CANON KABUSHIKI KAISHA,**
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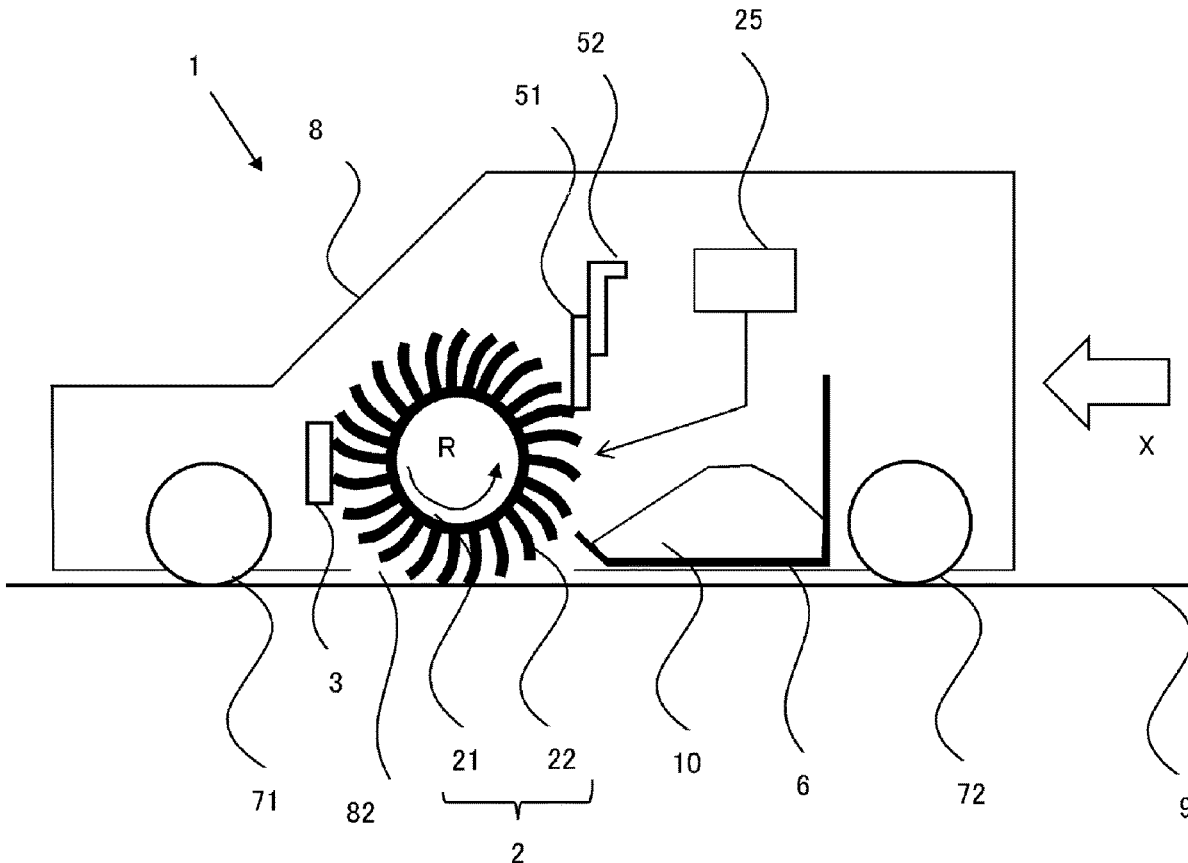
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ABSTRACT(21) Appl. No.: **18/519,873**(22) Filed: **Nov. 27, 2023**(30) **Foreign Application Priority Data**

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A cleaning device capturing dust on a cleaning target surface by static electricity includes: a frame body; a rotating brush rotatably supported on the frame body and provided with a brush part; a driver that rotates the rotating brush; an opening that exposes a portion of the brush part to outside of the frame body; and a rubbing member that gives a negative charge to the brush part by rubbing the brush part as the rotating brush rotates. A material that forms the rubbing member is on a further toward positive end of a triboelectric series than a material that forms the brush part.



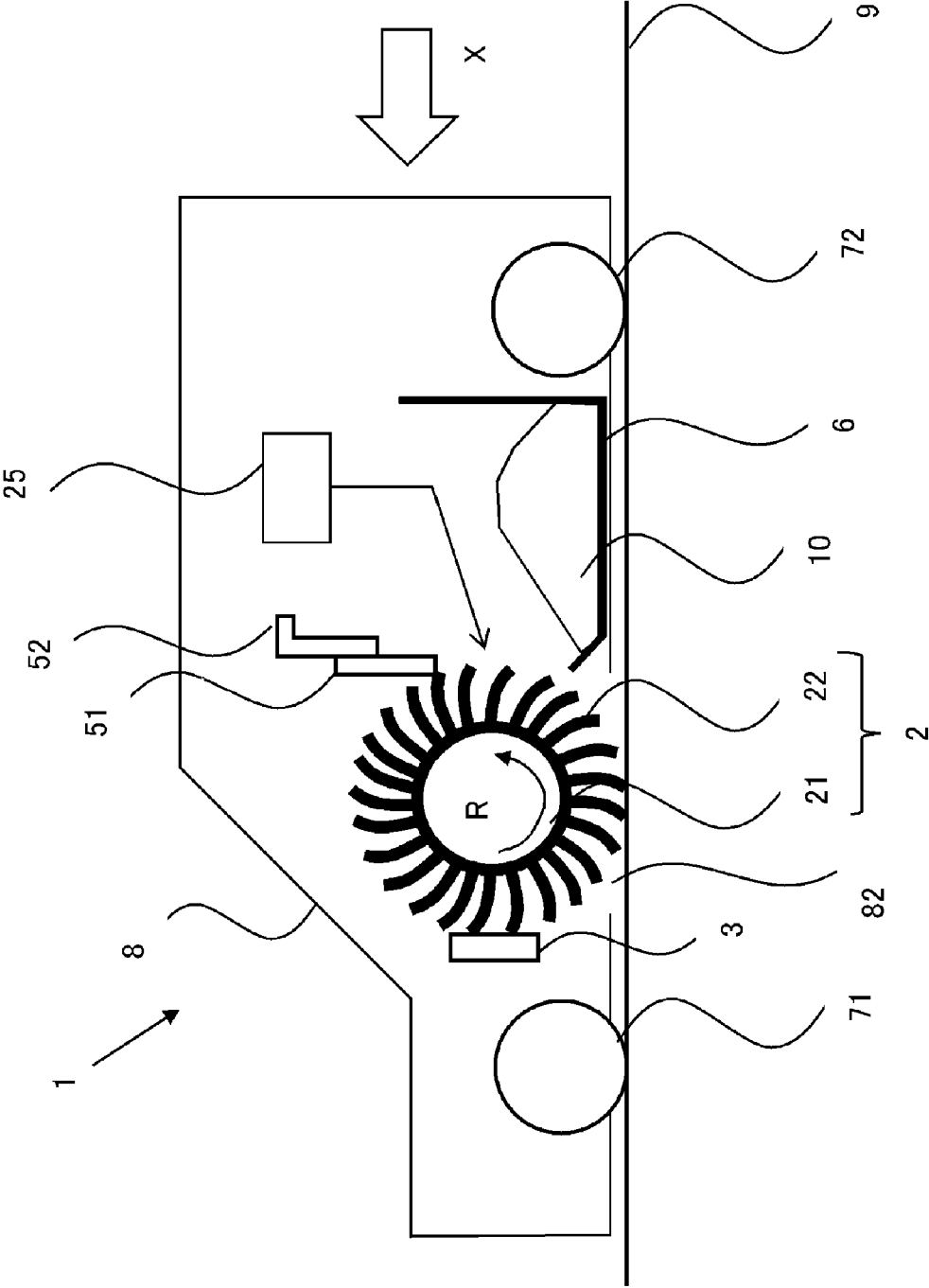


Fig.1

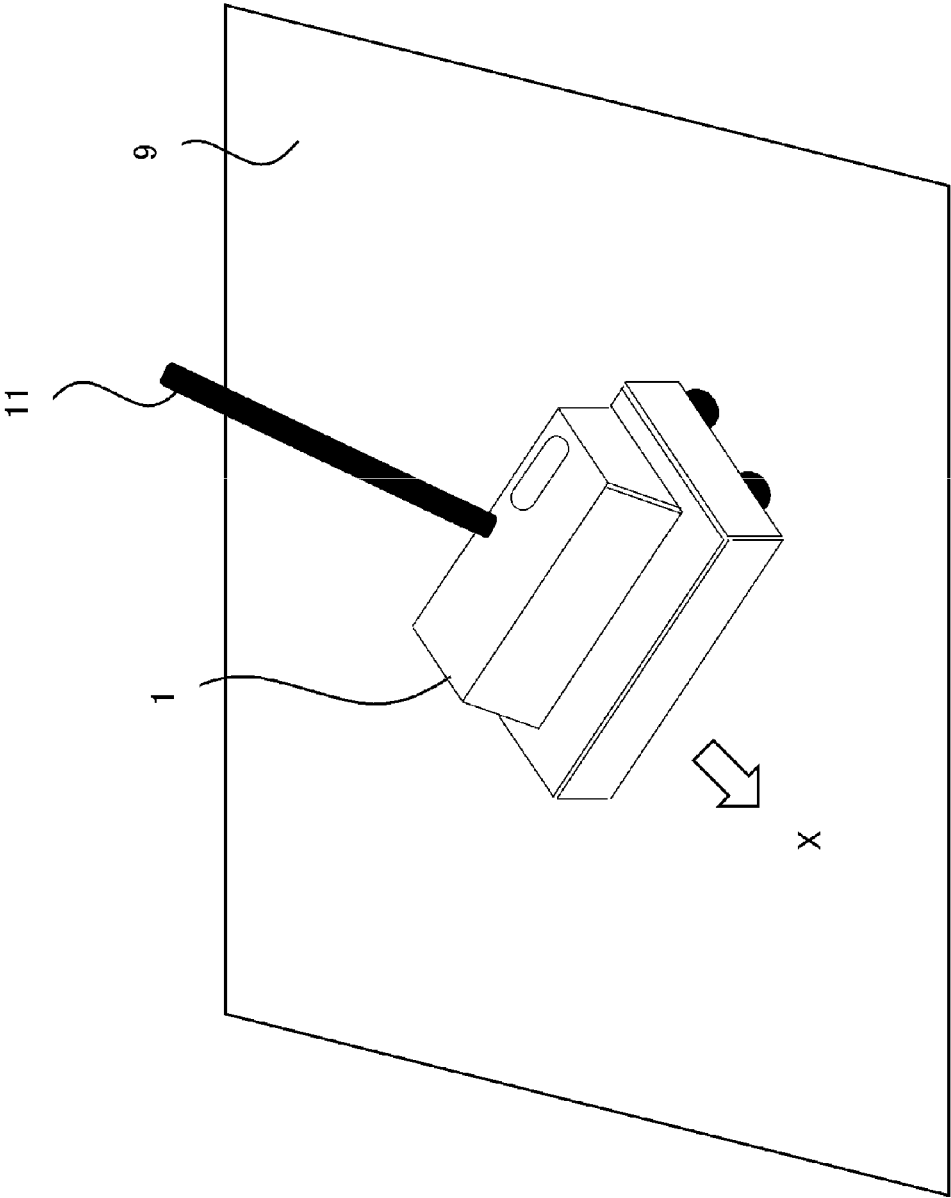


Fig. 2

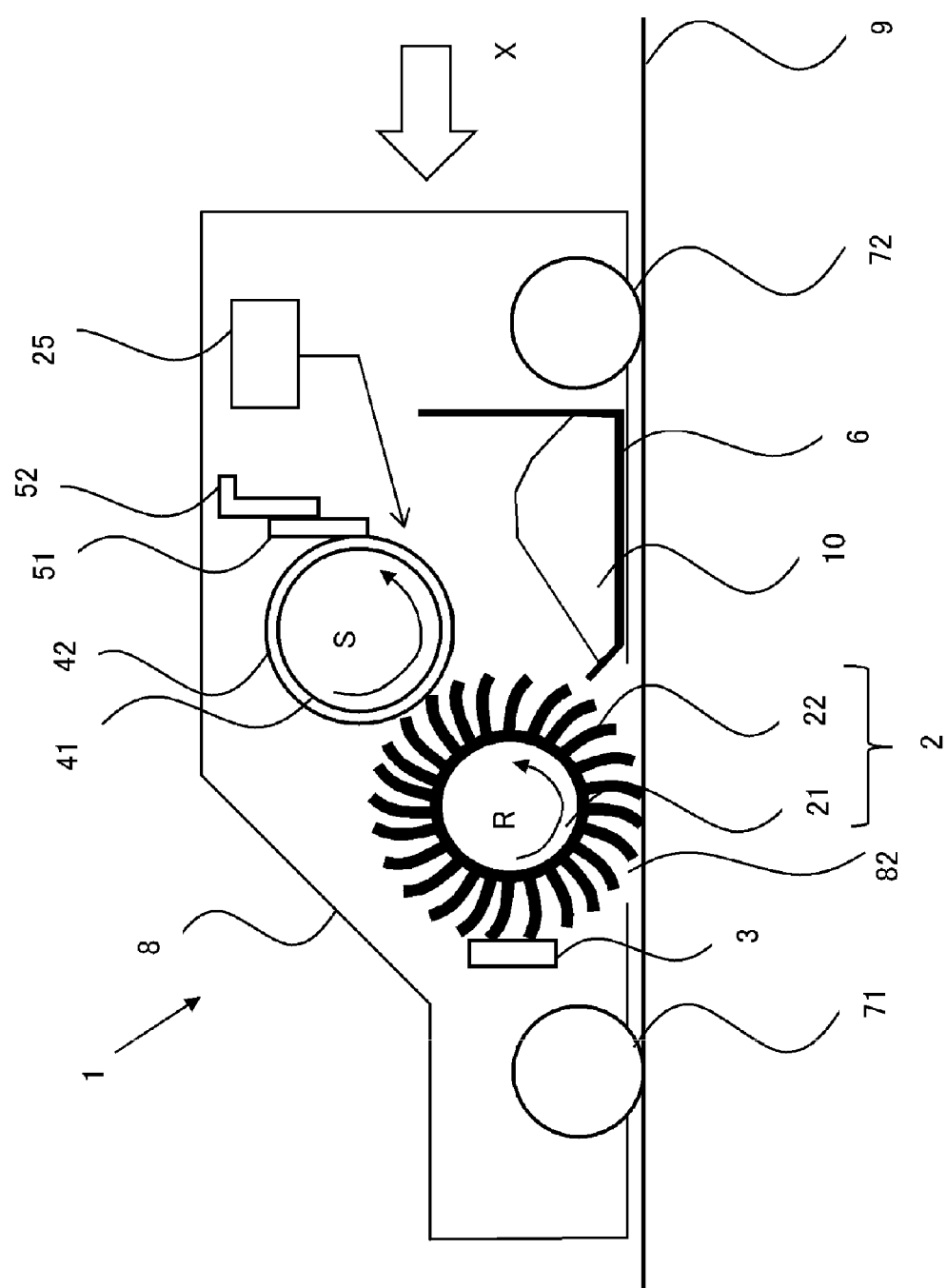


Fig.3

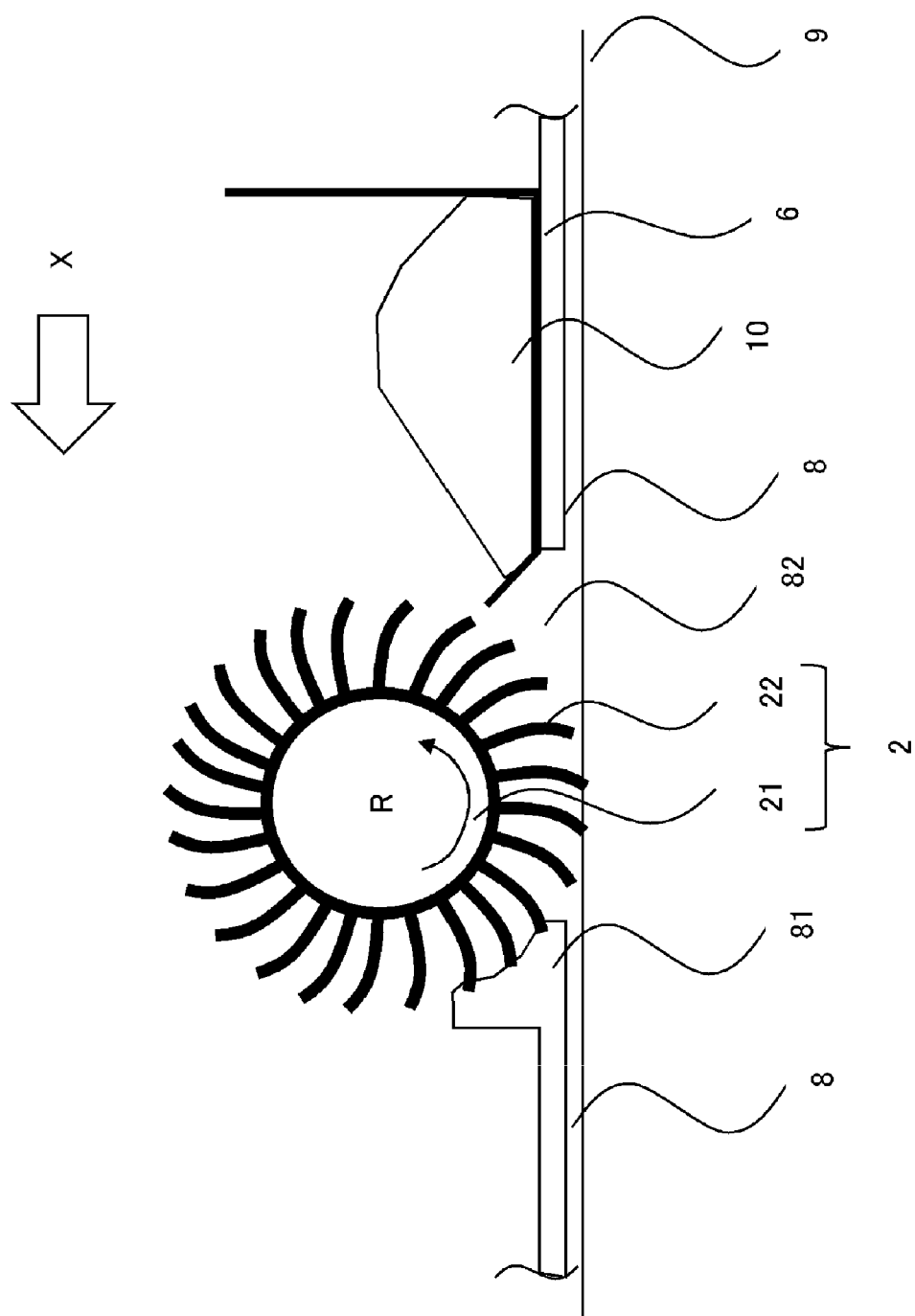


Fig.4

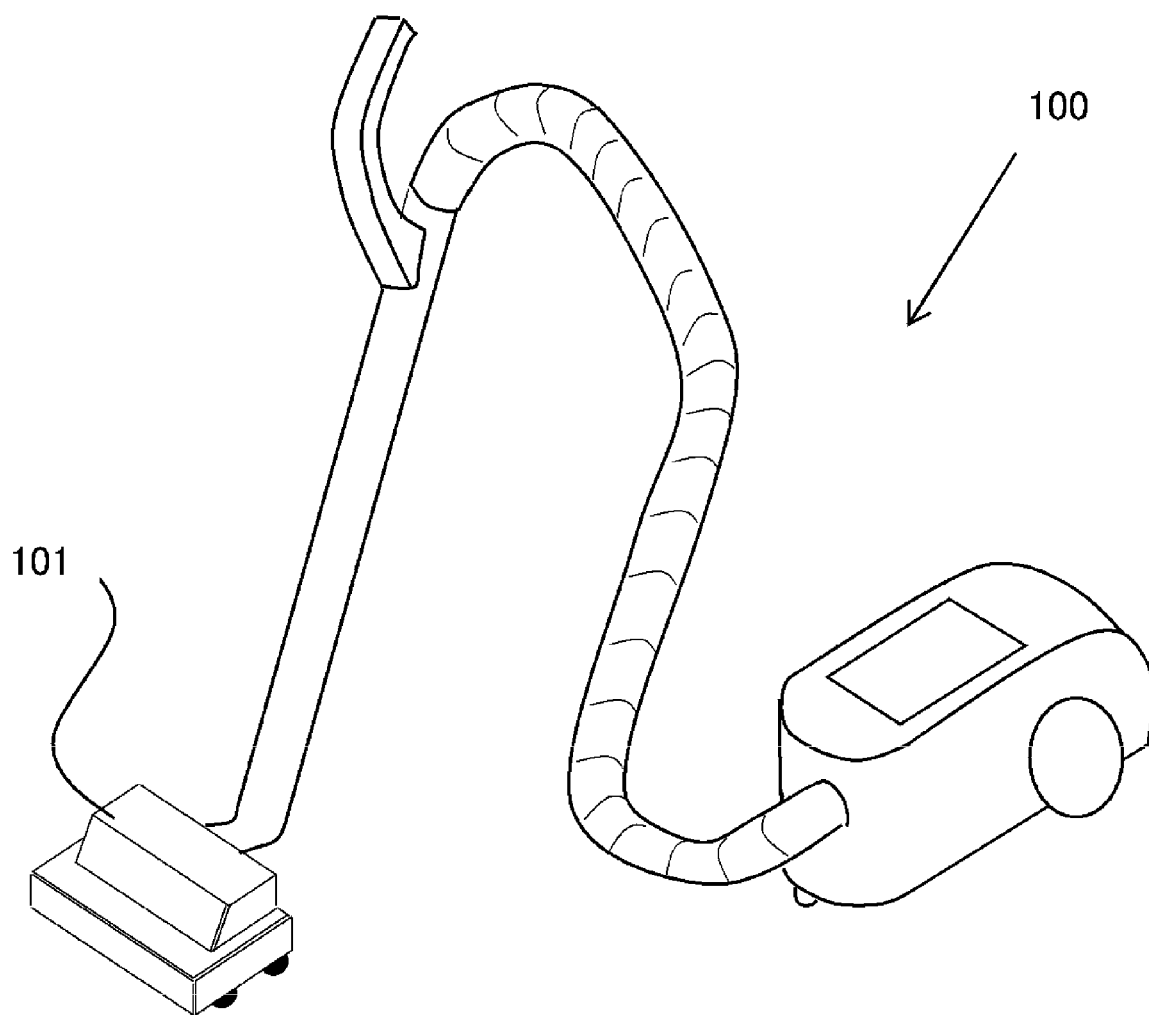


Fig.5

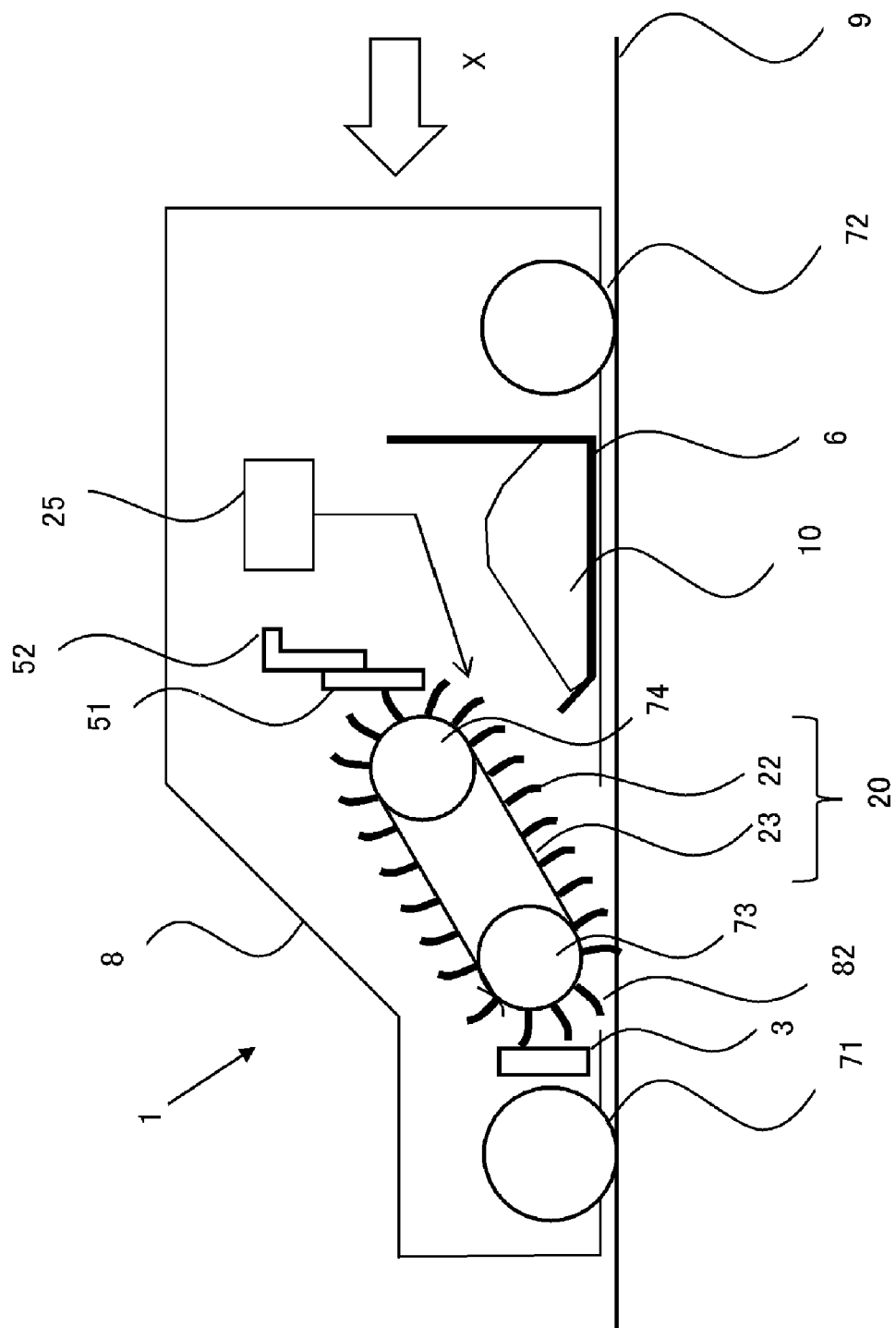


Fig. 6

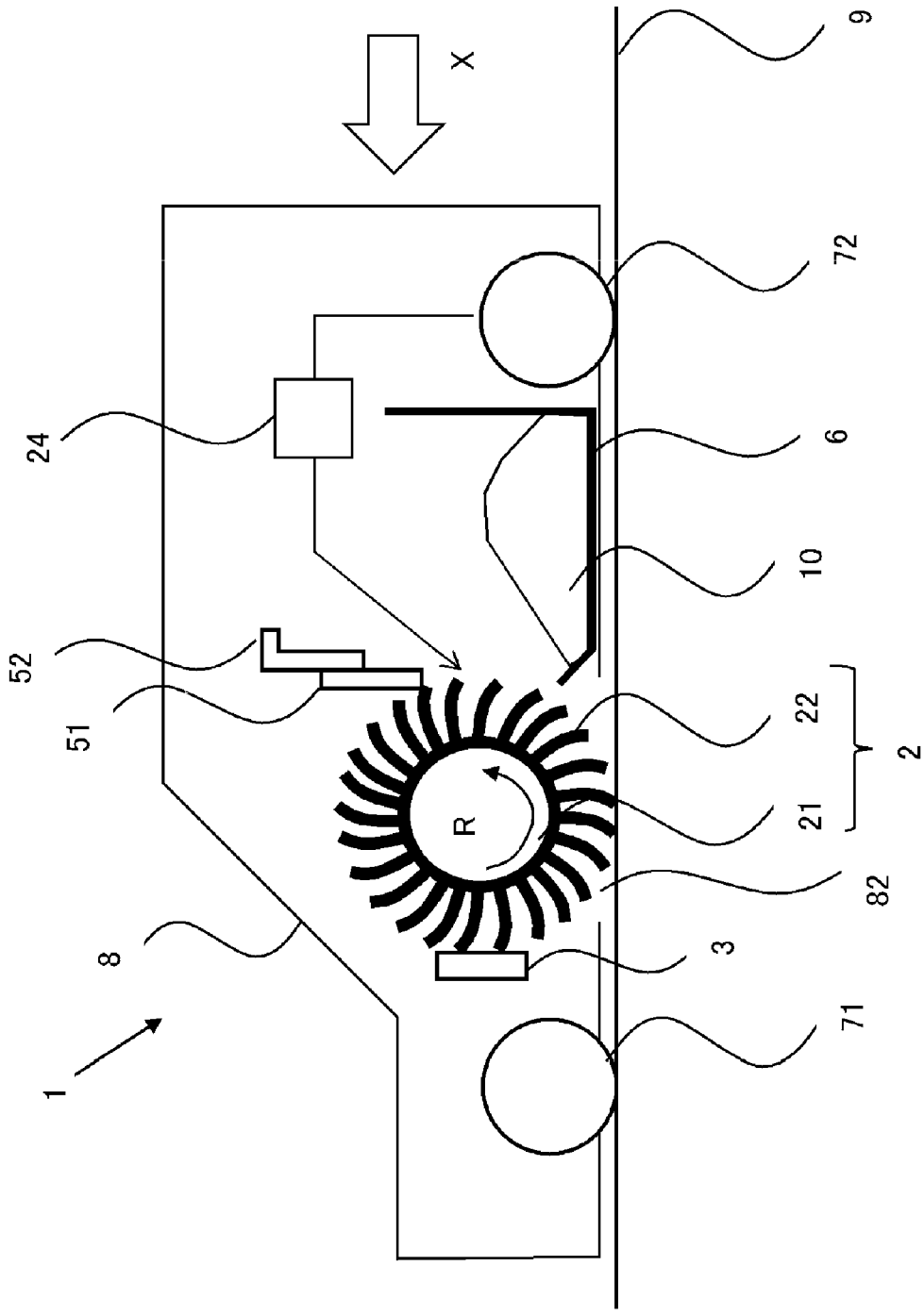


Fig.7

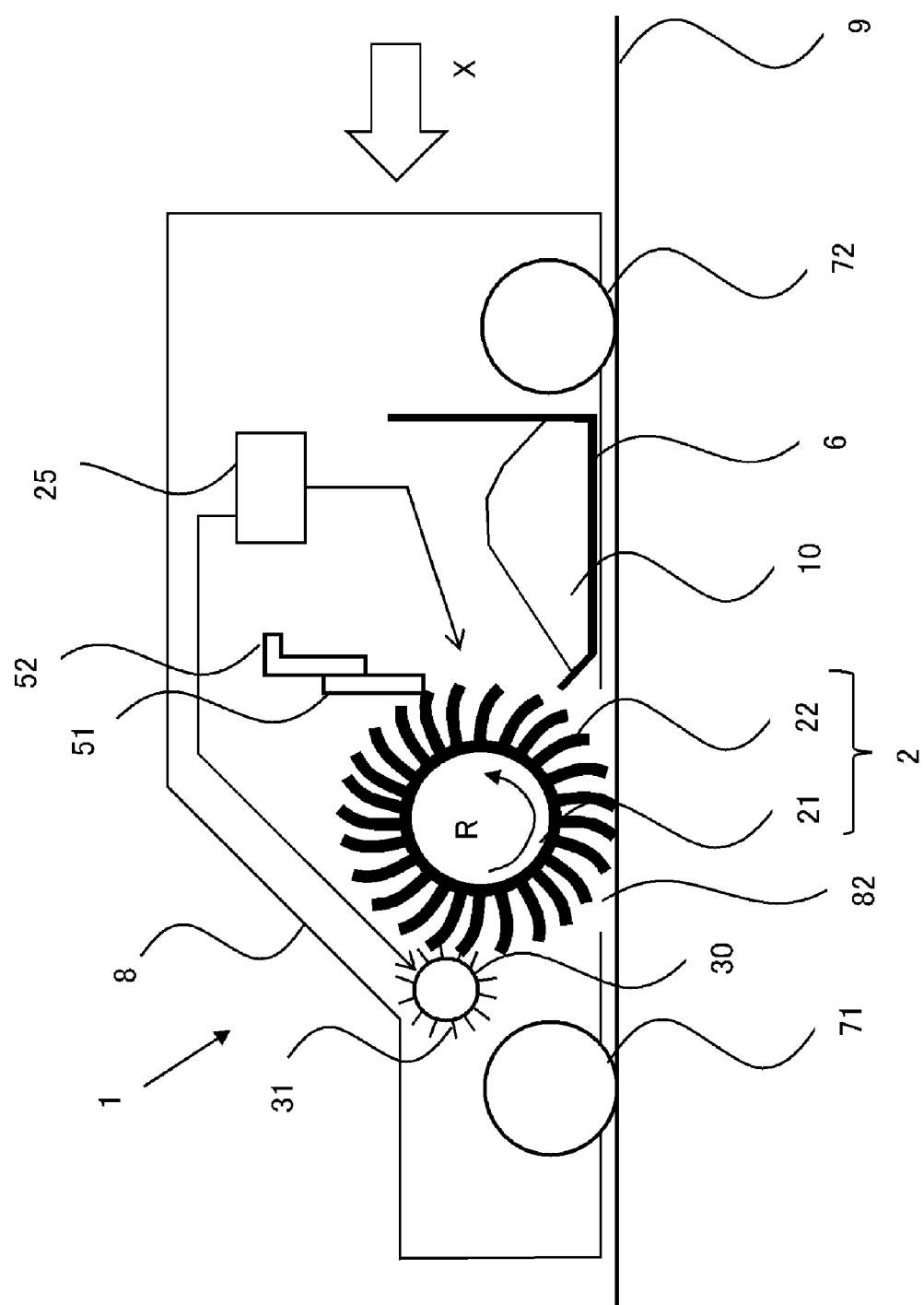


Fig. 8

CLEANING DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a cleaning device that captures dust.

Description of the Related Art

[0002] Electrostatic cleaning devices have been proposed that use static electricity as an approach of collecting dust on floor surfaces provide advantages of quietness and no exhaust air. The cleaning device according to Japanese Patent Application Publication No. 2015-84993, for example, has a first rotating member and a second rotating member rotatably disposed in a device main body. A brush is provided to an outer circumferential surface of the first rotating member to be charged by friction when making sliding contact with a floor surface. The second rotating member is charged by friction by a charging member inside the device. As the device main body is advanced on the floor surface, dust becomes positively charged by friction, so that the dust adheres to the brush on which a negative charge is accumulated by the triboelectric charging. The dust electrostatically adhered to the brush is ripped off by the second rotating member that is charged to a lower potential than the brush. The dust electrostatically adhered to the second rotating member is scraped off by a blade into a container part. The first rotating member and second rotating member are rotated by one driver. The first rotating member is driven to rotate in a direction in which the main body of the cleaning device is advanced on the floor surface.

[0003] The cleaning device according to Japanese Patent Application Publication No. 2015-84993 uses triboelectricity between dust on the floor surface and the brush to cause the dust to be charged and electrostatically attracted to the brush. Namely, the dust collection efficiency is dependent on the charged state of the brush.

SUMMARY OF THE INVENTION

[0004] The present invention provides an electrostatic cleaning device capable of collecting dust more stably.

[0005] The present invention is a cleaning device capturing dust on a cleaning target surface by static electricity, the cleaning device comprising:

[0006] a frame body;

[0007] a rotating brush rotatably supported on the frame body and provided with a brush part;

[0008] a driver that rotates the rotating brush;

[0009] an opening that exposes a portion of the brush part to outside of the frame body; and

[0010] a rubbing member that gives a negative charge to the brush part by rubbing the brush part as the rotating brush rotates, wherein

[0011] a material that forms the rubbing member is on a further toward positive end of a triboelectric series than a material that forms the brush part.

[0012] The present invention is a cleaning device capturing dust on a cleaning target surface by static electricity, the cleaning device comprising:

[0013] a frame body;

[0014] a rotating brush rotatably supported on the frame body and provided with a brush part;

[0015] a driver that rotates the rotating brush;

[0016] an opening that exposes a portion of the brush part to outside of the frame body; and

[0017] a rubbing member that rubs the brush part as the rotating brush rotates, wherein

[0018] a material that forms the rubbing member and the dust to be captured by the cleaning device are positioned on a same side in a triboelectric series relative to a material that forms the brush part.

[0019] The present invention can provide an electrostatic cleaning device capable of collecting dust more stably.

[0020] Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] FIG. 1 is a cross-sectional view illustrating a schematic configuration of a cleaning device according to Embodiment 1;

[0022] FIG. 2 is a perspective view illustrating a schematic configuration of a cleaning device according to Embodiment 1;

[0023] FIG. 3 is a cross-sectional view illustrating a schematic configuration of a cleaning device according to Embodiment 2;

[0024] FIG. 4 is a cross-sectional view illustrating a schematic configuration of a cleaning device according to a modification of the embodiment;

[0025] FIG. 5 is a perspective view illustrating a schematic configuration of a cleaning device according to a modification of the embodiment;

[0026] FIG. 6 is a cross-sectional view illustrating a schematic configuration of a cleaning device according to a modification of the embodiment;

[0027] FIG. 7 is a cross-sectional view illustrating a schematic configuration of a cleaning device according to a modification of the embodiment; and

[0028] FIG. 8 is a cross-sectional view illustrating a schematic configuration of a cleaning device according to a modification of the embodiment.

DESCRIPTION OF THE EMBODIMENTS

[0029] Preferred embodiments of the present invention will be illustratively described in detail below with reference to the drawings. It should be noted that the sizes, materials, shapes, and relative arrangements of the constituent components described in these embodiments are not intended to limit the scope of this invention to these specifics unless otherwise stated. The components once described below as being of a certain material and having a certain shape should be understood to be of the same material and have the same shape in later descriptions thereof unless otherwise specifically stated.

Embodiment 1

Overall Configuration

[0030] The overall configuration of the cleaning device according to Embodiment 1 will be described with reference to FIG. 1 and FIG. 2. FIG. 1 is a schematic diagram illustrating a cross section of an electrostatic cleaning device 1 according to Embodiment 1. FIG. 2 is a perspective view illustrating the outer appearance of the cleaning device 1.

[0031] The cleaning device 1 captures and collects dust on a cleaning target surface by static electricity, as a user grips the handle 11 of the cleaning device 1 and moves the cleaning device 1 on a floor surface 9 that is the cleaning target surface.

[0032] As illustrated in FIG. 1, the cleaning device 1 includes a frame body 8, a rotating brush 2, a motor 25, a rubbing member 3, a blade 51, a dust container 6, a wheel 71, and a wheel 72. The handle 11 is provided to the cleaning device 1. The handle 11 extends in a direction intersecting the vertical direction when the cleaning device 1 is placed on a horizontal plane, to allow the user to easily grip the handle 11 from behind the cleaning device 1. Below, the direction to which the handle 11 extends from the cleaning device 1 shall be referred to as the rear side, and the opposite direction as the front side. Arrow X in FIG. 1 and FIG. 2 indicates the direction from the rear side to the front side.

[0033] The rotating brush 2 is rotatably supported on the frame body 8. The rotating brush 2 includes a shaft part 21 rotatably supported on the frame body 8, and a brush part 22 attached to the shaft part 21 to rotate integrally with the shaft part 21. The rotating brush 2 is rotated in the direction of arrow R by the motor 25 that is a driver. The rotation direction R of the rotating brush 2 is counterclockwise in a cross-section perpendicular to the shaft part 21 of the rotating brush 2 as shown in FIG. 1, the left side of the drawing being the front side.

[0034] The frame body 8 has an opening 82 in a bottom part that faces the floor surface 9 during the use of the cleaning device 1. A portion of the brush part 22 is exposed to the outside of the frame body 8 through the opening 82. The portion of the brush part 22 exposed through the opening 82 is configured to slide or rub against the floor surface 9 as the cleaning device 1 moves on the floor surface 9 during the use thereof.

[0035] Power supply to the motor 25 can be achieved by any known power supply means such as a battery or external power source and will not be described and illustrated here. The drive force of the motor 25 can be transmitted to the rotating brush 2 by any known drive transmission means such as gears and will not be described and illustrated here.

[0036] The rubbing member 3 rubs the brush part 22 when the rotating brush 2 rotates. The rubbing member 3 is disposed upstream of the opening 82 in the rotating direction of the rotating brush 2. In other words, the rubbing member 3 is disposed upstream of the position where the rotating brush 2 contacts and slides or rubs against the floor surface 9 in the rotating direction of the rotating brush 2.

[0037] The blade 51 is a removal member that scrapes off dust adhered to the brush part 22 by making contact with the brush part 22. The blade 51 is disposed downstream of the position where the rotating brush 2 contacts and slides or rubs against the floor surface 9 in the rotating direction of the rotating brush 2. In other words, the blade 51 is positioned downstream of the opening 82 and upstream of the rubbing member 3 in the rotating direction of the rotating brush 2.

[0038] The dust container 6 holds dust 10 scraped from the rotating brush 2 by the blade 51. The dust container 6 is attachable to and removable from the cleaning device 1. The user can remove the dust container 6 from the cleaning device 1 and dispose of the collected dust 10, and then attach the emptied dust container 6 to the cleaning device 1.

[0039] The wheels 71 and 72 attached to the frame body 8 support the cleaning device 1 such as to allow the cleaning

device 1 to move smoothly on the floor surface 9 and to maintain a constant amount of penetration of the rotating brush 2 to the floor surface 9.

Brush Configuration

[0040] For the brush part 22, a polyethylene terephthalate (hereinafter PET) material with a 10D pile fineness, 5 mm pile length, and 30 kF/inch² density was used. Why this material was selected will be described later. The outside diameter of the rotating brush 2 was 30 mm, and the shaft rotation speed was 50 rpm. The brush part 22 thus configured such that the rotating brush 2 is able to electrostatically attract the dust on the floor surface 9. Relatively large clumps on the floor surface 9 are physically swept up by the rotating force of the brush part 22 and can be collected in the dust container 6.

Blade Configuration

[0041] For the blade 51, an elastic polyurethane resin material was used. The blade 51 was fixed to a blade support plate 52 such as to make contact with the rotating brush 2 with a pressure that allows the blade to scrape off dust adhered to the surface of the rotating brush 2. The blade support plate 52 is fixed to the frame body or elsewhere of the main body of the cleaning device 1.

Configuration of Rubbing Member

[0042] For the rubbing member 3, a brush with a 10D pile fineness, 3 mm pile length, and 50 kF/inch² density was used. Such a brush increases the time and area of contact with the rotating brush 2 and can raise the amount of charge. The rubbing member 3 is not limited to a brush shape. Components in various shapes such as plates or rollers may be used as the rubbing member.

Materials for Various Components

[0043] In a triboelectric series, the material for the rubbing member 3 and the dust to be captured by the cleaning device 1 are positioned on the same side relative to the material that forms the brush part 22. In Embodiment 1, the material for the brush part 22 is closer to the negative end of the triboelectric series than the dust. Moreover, the work function of the material that forms the rubbing member 3 is smaller than the work function of the material that forms the brush part 22. To sum up, the relevant materials have the following relationships.

[0044] In the triboelectric series,

[0045] Brush part 22 < Dust < Rubbing member 3 (from negative to positive),

[0046] or

[0047] Brush part 22 < Rubbing member 3 < Dust (from negative to positive).

[0048] In the work function,

[0049] Rubbing member 3 < Brush part 22.

[0050] Let us now assume a case of cleaning a house of a common household using the cleaning device 1. Expected sources of dust generated in everyday life and accumulated on the floor surface 9 include fibers such as hemp, cotton, silk, rayon, nylon, and wool, and wood, human skin, human hair, and fur. Most of these materials originating from the natural world are positioned from near zero toward the positive end of the triboelectric series. Accordingly, the dust to be captured by the cleaning device 1 according to

Embodiment 1 is expected to be composed of materials positioned from near zero toward the positive end of the triboelectric series.

[0051] As mentioned above, the brush part 22 and rubbing member 3 are made of materials respectively closer to the negative end and the positive end of the triboelectric series. Therefore, the rubbing member 3 and the brush part 22 sliding or rubbing against each other produce a negative charge on the brush part 22. As the brush part 22 facing the floor surface 9 through the opening 82 is negatively charged, the brush part 22 attracts positively charged dust on the floor surface 9 even though there is no rubbing (friction contact) between the brush part 22 and the floor surface 9 or dust. Accordingly, dust that does not enough rubbed by the brush part 22 due to the shape or contour of the floor surface 9 can also be captured. In Embodiment 1, the brush part 22 is configured to protrude from the opening 82 to the extent that the brush part 22 slides or rubs against the floor surface 9 as the cleaning device 1 moves on the floor surface 9. Therefore, as the cleaning device 1 travels, the brush part 22 rubs the floor surface 9 or the dust on the floor surface. The brush part 22 sliding or rubbing against the dust on the floor surface 9 produces a positive charge on the dust. The brush part 22 is negatively charged by being rubbed by the rubbing member 3. Thus, the opposite polarity charges of the brush part 22 and dust enable efficient electrostatic attraction of the dust on the floor surface 9 to the brush part 22.

[0052] The material for the brush part 22 should preferably have durability and wear resistance in addition to the ability to electrostatically attract the dust on the floor surface 9. Preferable materials having such properties and satisfying the condition of the triboelectric series described above include polyester, acrylic, polypropylene, PET, and polyurethane. In Embodiment 1, PET was used as the material for the brush part 22.

[0053] The material for the rubbing member 3 should preferably be able to provide a negative charge on the brush part 22 by sliding or rubbing against the brush part 22. Preferable materials having such ability and satisfying the conditions of the triboelectric series and the work function described above include glass, wool, nylon, and rayon. In Embodiment 1, nylon was used as the material for the rubbing member 3.

[0054] Dust on the floor surface 9 is mostly closer to the positive end of the triboelectric series. Therefore, with the brush part 22 being negatively charged by the rubbing member 3, even when the brush part 22 does not fully come into contact with the dust due to asperities on the floor surface 9, the dust on the floor surface 9 can be efficiently collected by the electrostatic attractive force acting between the brush part 22 and the dust. The work function of the material that forms the rubbing member 3 being smaller than the work function of the material that forms the brush part 22 enables efficient negative charging of the brush part 22 by rubbing between the rubbing member 3 and the brush part 22.

How to Determine the Triboelectric Series

[0055] A measurement method to determine the triboelectric series will be described. Which of the given two members is relatively positive or negative in the triboelectric series can be determined by examining the charge polarity on the surface of each member when the two members are rubbed together.

[0056] One method of determining the relationship in the triboelectric series between PET and nylon, for example, which are the respective materials for the brush part 22 and the rubbing member 3, will be described. The PET brush part 22 and nylon rubbing member 3 are contacted with 200 gf and rubbed together 5 cm back and forth 10 times. Using an electrostatic voltmeter (Model 542A-1, TREK), the surface potential of each of the brush part 22 and rubbing member 3 is measured. The surface potential of the brush part 22 was -3200 V, and the surface potential of the rubbing member 3 was +2800 V. Therefore, the results indicate that the PET brush part 22 is relatively negative and the nylon rubbing member 3 is relatively positive in the triboelectric series.

Validation of Effects

[0057] The dust collection performance in each of Embodiment 1 and Comparative Example 1 was evaluated next. Comparative Example 1 differs from Embodiment 1 in that the material for the rubbing member 3 was changed from nylon to perfluoroalkoxy alkane (PFA). Therefore, the rubbing member 3, brush part 22, and dust in Comparative Example 1 have the following relationships in the triboelectric series.

Triboelectric Series:

[0058] Rubbing member 3 < Brush part 22 < Dust (from negative to positive).

[0059] In the evaluation of the dust collection performance, we used flour (Nisshin Cake Flour) made by Nisshin Seifun Welna Inc. (former Nisshin Foods Inc.) as dust, and foam double-layer flooring vinyl sheet HS made by TOLI Corporation as the floor surface 9. Using a tea strainer, the flour was scattered on the floor surface 9 in a thin layer. The collection rate was calculated by measuring the weight of scattered flour (A), and the weight of remaining flour (B) on the floor surface 9 after running the cleaning device 1 on the floor surface 9 with the scattered flour. The collection rate was defined as follows:

$$\text{Collection rate (\%)} = 100 \times (1 - B/A)$$

[0060] Table 1 shows the results.

TABLE 1

	Rubbing member 3	Collection Rate (%)
Embodiment 1	Nylon	80
Comparative Example 1	PFA	67

[0061] The collection rate was lower in Comparative Example 1 than in Embodiment 1. This is assumed to be because of the following: In Comparative Example 1, the PFA rubbing member 3 is closer to the negative end of the triboelectric series than the PET brush part 22, so that the surface of the brush part 22 is positively charged when the brush part 22 slides or rubs against the rubbing member 3. Since the dust that is mainly flour on the floor surface 9 is positively charged, it is assumed that the dust electrostatically repelled the brush part 22 and hardly adhered to the brush part 22, resulting in the lower collection rate.

Embodiment 2

[0062] Embodiment 2 differs from Embodiment 1 in the configuration for removing the dust that has adhered to the

rotating brush 2. Other configurations are the same as those of Embodiment 1. In the following description, the components common to Embodiment 1 will be given the same reference numerals and will not be described again.

[0063] The overall configuration of the cleaning device 1 according to Embodiment 2 will be described with reference to FIG. 3. FIG. 3 is a schematic diagram illustrating a cross section of the cleaning device 1 according to Embodiment 2. A collection roller 41 is provided as a collection member for collecting the dust that has adhered to the brush part 22. The collection roller 41 is in contact with the brush part 22 downstream of the opening 82 and upstream of the rubbing member 3 in the rotating direction of the rotating brush 2. The collection roller 41 is a rotating member rotatably supported on the frame body 8. The collection roller 41 rotates in the direction of arrow S by the drive force of the motor 25. The rotation direction S of the collection roller 41 is counterclockwise in a cross-section perpendicular to the shaft part 21 of the rotating brush 2 as shown in FIG. 3, the left side of the drawing being the front side. The drive force of the motor 25 is transmitted also to the rotating brush 2 as in Embodiment 1. The blade 51 makes contact with the collection roller 41 and scrapes off the dust that has adhered to the surface of the collection roller 41. The dust scraped from the surface of the collection roller 41 by the blade 51 is held in the dust container 6. The dust on the floor surface 9, after being captured by the brush part 22, is collected by the collection roller 41 from the brush part 22 and scraped off by the blade 51. Eventually, the collected dust 10 accumulates in the dust container 6.

Configuration of Collection Roller

[0064] The collection roller 41 is composed of a metal core covered by a surface layer member 42. Iron, aluminum, or SUS may be used as the material for the metal core. A 300 μm thick coat of perfluoroalkoxy alkane (PFA) was used as the surface layer member 42 here. Why this material was selected will be described later. The outside diameter of the collection roller 41 was 24 mm, and the shaft rotation speed was 50 rpm.

[0065] In Embodiment 2, the material for the surface layer member 42 of the collection roller 41 and the dust have an opposite polarity charge relative to the brush part 22 in the triboelectric series. The material for the brush part 22 is closer to the negative end of the triboelectric series than the dust as in Embodiment 1. The material for the rubbing member 3 and the dust are positioned on the same side relative to the material for the brush part 22 in the triboelectric series. The work function of the material that forms the surface layer member 42 of the collection roller 41 is larger than the work function of the material that forms the brush part 22. To sum up, the relevant materials have the following relationships.

- [0066] In the triboelectric series,
- [0067] Surface layer member 42<Brush part 22<Dust<Rubbing member 3 (from negative to positive),
- [0068] or
- [0069] Surface layer member 42<Brush part 22<Rubbing member 3<Dust (from negative to positive).
- [0070] In the work function,
- [0071] Rubbing member 3<Brush part 22<Surface layer member 42.

Material for Surface Layer Member

[0072] The material used for the surface layer member 42 forms a negative charge on the brush part 22 by sliding or rubbing against the brush part 22. Namely, a material that is closer to the negative end of the triboelectric series than the material for the brush part 22 is used for the surface layer member 42. Considering that the blade 51 is contacted to the surface layer member 42, the material for the surface layer member 42 should preferably have wear resistance and good sliding properties. Preferable materials having such properties and satisfying the condition of the triboelectric series described above include polytetrafluoroethylene (PTFE), silicone, polychlorotrifluoroethylene (PCTFE, CTFE), polyvinylidene fluoride (PVDF), polyvinyl fluoride (PVF), PFA, tetrafluoroethylene-hexafluoropropylene copolymer (FEP), ethylene-tetrafluoroethylene copolymer (ETFE), ethylene-chlorotrifluoroethylene copolymer (ECTFE), and other fluoropolymers. In Embodiment 2, PFA was used as the material for the surface layer member 42.

[0073] Thus the positively charged dust adhered on the brush part 22 can be electrostatically attracted to the collection roller 41.

Blade Configuration

[0074] For the blade 51, an elastic polyurethane resin material was used. The blade 51 was secured using a blade support plate 52 to achieve a desired contact pressure. The blade can thus scrape off the dust adhered on the surface of the collection roller 41, while causing minimal wear or damage on the surface layer member 42 in making contact therewith.

Validation of Effects

[0075] The dust collection performance in each of Embodiment 2 and Comparative Examples 2 to 4 was evaluated next similarly to Embodiment 1.

[0076] For the evaluation, the material for the rubbing member 3 in Embodiment 2 was changed from nylon to PFA in Comparative Example 2. In Comparative Example 3, for the evaluation, the material for the rubbing member 3 in Embodiment 2 was changed from nylon to PFA, and the surface layer member 42 was removed so that the metal core made of SUS of the collection roller 41 makes contact with the brush part 22. In Comparative Example 4, for the evaluation, the surface layer member 42 was removed so that the metal core made of SUS of the collection roller 41 makes contact with the brush part 22.

[0077] Table 2 shows the results.

TABLE 2

	Rubbing member 3	Surface Layer Member 42	Collection Rate (%)
Embodiment 2	Nylon	PFA	86
Comparative Example 2	PFA	PFA	72
Comparative Example 3	PFA	SUS	62
Comparative Example 4	Nylon	SUS	73

[0078] The collection rate was lower in Comparative Examples 2 to 4 than in Embodiment 2. This is assumed to be because of the following: In Comparative Example 2, the

material that forms the rubbing member 3 was changed to PFA that is closer to the negative end of the triboelectric series than the material that forms the brush part 22. Therefore, the surface of the brush part 22 is positively charged when the brush part 22 slides or rubs against the rubbing member 3. Since the dust on the floor surface 9 is mostly positively charged, the dust that failed to come into friction contact with the brush part 22 and to be rubbed by the brush part 22 is not likely to be attracted electrostatically to the positively charged brush part 22. This is considered to be the reason why the collection rate was lower in Comparative Example 2 than in Embodiment 2.

[0079] In Comparative Example 3, the surface layer member 42 was removed from the configuration of Comparative Example 2 so that the metal core made of SUS of the collection roller 41 makes contact with the brush part 22. SUS is closer to the positive end of the triboelectric series than PET that is the material for the brush part 22, so that the brush part 22 is negatively charged when the brush part 22 slides or rubs against the collection roller 41. This allows the positively charged dust on the brush part 22 to stay more easily on the negatively charged brush part 22. Therefore, the dust on the brush part 22 is less likely to migrate onto the collection roller 41 when making contact with the collection roller 41. As the rotating brush 2 rotates, the dust on the floor surface 9 is collected by attraction on the brush part 22. However, when less dust migrates from the brush part to the collection roller 41, more dust builds up on the brush part 22. In such a condition, the dust that is already on the brush part 22 hinders collection of the dust on the floor surface 9 in the process of transferring the dust on the floor surface 9 onto the brush part 22, which results in a lowered collection performance. This is considered to be the reason why the collection rate was lower in Comparative Example 3 than in Embodiment 2 and Comparative Example 2.

[0080] In Comparative Example 4, the same material as in Embodiment 2 was used for the rubbing member 3, but the material for the surface layer member 42 was changed to SUS. Therefore, it is assumed that the dust on the brush part 22 could hardly migrate to the surface layer member 42, resulting in the collection rate lower than that of Embodiment 2.

Variation Examples

[0081] Various modifications are possible in the above-described embodiments. For example, a contacted part 81 may be provided to a part of the frame body 8 of the cleaning device 1 as illustrated in FIG. 4 for the brush part 22 to make contact with. The contacted part 81 may be made of one of the materials (such as nylon) mentioned as preferable for the rubbing member 3 in the embodiments described above. FIG. 4 shows a cross section similar to FIG. 1 of a cleaning device 1 that has the contacted part 81, in particular the vicinity of the rotating brush 2. In this case, a part of the frame body functions as the rubbing member in the embodiments described above. The contacted part 81 is provided upstream of the opening 82 where the rotating brush 2 is exposed to the floor surface 9 in the rotating direction of the rotating brush 2 (direction indicated by arrow R). The brush part 22 can be negatively charged by the contacted part 81 and the brush part 22 sliding or rubbing against each other.

[0082] The configuration of the cleaning device 1 in the embodiments described above may be used in a head part 101 of a known vacuum cleaner 100 as illustrated in FIG. 5.

FIG. 5 is a perspective view illustrating a schematic configuration of the vacuum cleaner 100. The vacuum cleaner 100 is able to remove dust on the floor surface by using a flow of air, as well as to remove dust adhered on the brush part 22. Thus, the cleaner can exhibit enhanced performance for removing dust on a floor.

[0083] FIG. 6 illustrates an alternative configuration that uses a brush belt 20 instead of the rotating brush 2. The brush belt 20 is composed of an endless belt 23 rotatably passed around tension rollers 73 and 74, and a brush part 22 on the surface of the belt 23. FIG. 6 shows a cross section similar to FIG. 1 of a cleaning device 1 that has the brush belt 20. In this configuration, the brush part 22 rotates integrally with the belt 23. The brush belt 20 may be rotated by the drive force of the motor 25 similarly to Embodiment 1.

[0084] The drive source for rotating the rotating brush 2, collection roller 41, and brush belt 20 is not limited to the motor 25. For example, the rotating brush 2 may be rotated using a transmission member 24 such as a gear, which may be used to transmit the rotary force of the wheel 71 or wheel 72 to the rotating brush 2 when the cleaning device 1 moves, as illustrated in FIG. 7. FIG. 7 shows a cross section similar to FIG. 1 of a cleaning device 1 that has such a transmission member 24. Likewise, the collection roller 41 and brush belt 20 may be rotated by transmitting the rotary force of the wheel 71 or wheel 72.

[0085] The rubbing member may be configured by a rotating member 30 rotatably supported on the frame body that forms the device main body of the cleaning device 1 as illustrated in FIG. 8. The rotating member 30 may have a surface layer made of a material that satisfies the conditions for the material that forms the rubbing member 3 described above. Alternatively, a second brush part 31 may be provided to an outer circumferential surface of the rotating member 30 to make contact with the brush part 22 (first brush part) of the rotating brush 2. The second brush part 31 may be made of a material that satisfies conditions similar to those for the material that forms the rubbing member 3 described above. Similarly, a brush may be provided to a surface of the rubbing member 3 of Embodiment 1 illustrated in FIG. 1 such as to be able to rub the brush part 22 of the rotating brush 2. This brush may be made of a material that satisfies conditions similar to those for the material that forms the rubbing member 3 described above.

[0086] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

[0087] This application claims the benefit of Japanese Patent Application No. 2022-198355, filed on Dec. 13, 2022, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. A cleaning device capturing dust on a cleaning target surface by static electricity, the cleaning device comprising:
 - a frame body;
 - a rotating brush rotatably supported on the frame body and provided with a brush part;
 - a driver that rotates the rotating brush;

an opening that exposes a portion of the brush part to outside of the frame body; and

a rubbing member that gives a negative charge to the brush part by rubbing the brush part as the rotating brush rotates, wherein

a material that forms the rubbing member is on a further toward positive end of a triboelectric series than a material that forms the brush part.

2. The cleaning device according to claim 1, wherein the material that forms the rubbing member has a smaller work function than the material that forms the brush part.

3. The cleaning device according to claim 1, wherein, in a rotating direction of the rotating brush, the rubbing member is positioned upstream of the opening and is positioned downstream of another member in contact with the rotating brush.

4. The cleaning device according to claim 1, wherein the portion of the brush part exposed through the opening is configured to rub the cleaning target surface as the cleaning device moves on the cleaning target surface.

5. The cleaning device according to claim 1, wherein the rotating brush includes a shaft part rotatably supported on the frame body, and

the brush part is attached to the shaft part and is configured to rotate integrally with the shaft part.

6. The cleaning device according to claim 1, wherein the rotating brush includes a rotatably stretched endless belt, and

the brush part is attached to the belt and is configured to rotate integrally with the belt.

7. The cleaning device according to claim 1, wherein the brush part of the rotating brush is a first brush part, and the rubbing member includes a second brush part making contact with the first brush part.

8. The cleaning device according to claim 1, wherein the rubbing member is a rotating member rotatably supported on the frame body.

9. The cleaning device according to claim 1, wherein the rubbing member is a part of the frame body.

10. The cleaning device according to claim 1, wherein the driver is a motor.

11. The cleaning device according to claim 1, further comprising

a wheel provided to the frame body, the wheel supporting the cleaning device so as to be movable on the cleaning target surface during use of the cleaning device, wherein

the driver includes a transmission member that transmits rotation of the wheel to the rotating brush, and the rotating brush is configured to rotate as the transmission member transmit rotation of the wheel to the rotating brush.

12. The cleaning device according to claim 1, further comprising:

a removal member that makes contact with the brush part downstream of the opening and upstream of the rubbing member in a rotating direction of the rotating brush and scrapes off dust adhered to the brush part; and

a container that holds dust scraped from the brush part by the removal member.

13. The cleaning device according to claim 1, further comprising

a collection member that collects dust adhered to the brush part, the collection member making contact with the brush part downstream of the opening and upstream of the rubbing member in a rotating direction of the rotating brush, wherein

a material that forms the collection member is on a further toward negative end of the triboelectric series than the material that forms the brush part.

14. The cleaning device according to claim 13, wherein the material that forms the collection member has a larger work function than the material that forms the brush part.

15. The cleaning device according to claim 13, wherein the collection member is a rotating member rotatably supported on the frame body, and

the cleaning device includes:

a removal member that makes contact with a surface of the collection member and scrapes off dust adhered to a surface of the collection member; and

a container that holds dust scraped from the collection member by the removal member.

16. The cleaning device according to claim 1, wherein the cleaning device is a head part of a vacuum cleaner.

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