

DESCRIPTION

Title of Invention

DUST-COLLECTING APPARATUS, DUST-COLLECTING METHOD, AND DUST-COLLECTING SYSTEM

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Technical Field

[0001]

The present invention relates to a dust-collecting apparatus, a dust-collecting method, and a dust-collecting system, for collecting dust.

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Background Art

[0002]

There have been known various treatment apparatus configured to perform operations against the air that has been taken in, such as heating, cooling, humidification, dehumidification, sterilization, and air sending. An air-conditioning apparatus, which is one example of the treatment apparatus, is configured to take in air by using an air-sending device, subject the air, which has been taken in, to air conditioning, and discharge the air subjected to the air conditioning. When the air to be taken in contains dust, there is a risk in that operation efficiency of components in the treatment apparatus may be degraded due to intrusion of the dust. Therefore, there has been known a treatment apparatus equipped with a dust-collecting apparatus configured to collect the dust, for example, an air-conditioning apparatus equipped with a dust-collecting device.

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[0003]

In general, the dust-collecting apparatus includes a dust-collecting filter configured to perform dust collection. There has hitherto been known an electrostatic force imparting technology of imparting an electrostatic force to the dust-collecting filter in order to improve a dust-collecting force (for example, Patent Literature 1). Specifically, an attempt has been made to improve a dust-collecting force by using an electrostatic force by subjecting a surface of the dust-collecting filter

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to friction to accelerate charging and recharging.

Citation List

Patent Literature

5 [0004]

Patent Literature 1: Japanese Unexamined Patent Application Publication No.
2012-47353

Summary of Invention

10 Technical Problem

[0005]

In the related-art electrostatic force imparting technology, an electrostatic force is imparted to the surface of the dust-collecting filter through surface friction of the dust-collecting filter. However, in the related-art electrostatic force imparting technology, it is difficult to further increase an electric charge amount to be given to the dust-collecting filter. This is because there is a limit to the electric charge amount which the surface of the dust-collecting filter can hold.

[0006]

The present invention has been made in view of the above-mentioned circumstances, and an object of the present invention is to provide a dust-collecting apparatus, a dust-collecting method, and a dust-collecting system, which can increase an electric charge amount to be given to a dust-collecting filter.

Solution to Problem

25 [0007]

According to one embodiment of the present invention, there is provided a dust-collecting apparatus for collecting dust contained in air flowing in an air flow direction by using a dust-collecting filter, including: a pressurizing unit configured to pressurize the dust-collecting filter in the air flow direction; a support unit configured to be movable, and to support the pressurizing unit against the dust-collecting filter; and a drive unit configured to be driven to move the support unit along a crossing direction crossing the air flow direction when the pressurizing unit pressurizes the dust-collecting filter. The dust-collecting filter includes fiber materials that cause an electrostatic force by friction with the pressurizing unit, the pressurizing unit is connected to the support unit, and is moved by the drive unit through the support unit, the dust-collecting filter contains an electret material that causes polarization, the

electret material includes a first fiber material having a first triboelectric series, and a second fiber material having a second triboelectric series different from the first triboelectric series, and the pressurizing unit is configured to travel along the dust-collecting filter through drive of the drive unit, and to roll along a direction perpendicular to a pressurizing direction in which the pressurizing unit pressurizes the dust-collecting filter.

[0008]

According to one embodiment of the present invention, provided is a dust-collecting method of collecting dust contained in air flowing in an air flow direction by using a dust-collecting filter, the method including: a preparation step of preparing a pressurizing unit configured to pressurize the dust-collecting filter in the air flow direction, a dust-collecting filter including fiber materials that cause an electrostatic force by friction with the pressurizing unit, and containing an electret material that causes polarization and that includes a first fiber material having a first triboelectric series and a second fiber material having a second triboelectric series different from the first triboelectric series, and a support unit connected to the pressurizing unit and configured to support the pressurizing unit against the dust-collecting filter; a first step of moving the support unit along a crossing direction crossing the air flow direction when the pressurizing unit pressurizes the dust-collecting filter; and a second step of moving the pressurizing unit in which the pressurizing unit travels along the dust-collecting filter through movement of the support unit in the first step, and rolls along a direction perpendicular to a pressurizing direction in which the pressurizing unit pressurizes the dust-collecting filter.

[0009]

According to one embodiment of the present invention, there is provided a dust-collecting system for collecting dust contained in air flowing through an air passage in an air flow direction, including: a dust-collecting filter configured to collect the dust by causing the air to pass through the dust-collecting filter; a treatment apparatus configured to treat the air after passing through the dust-collecting filter; a pressurizing unit configured to pressurize the dust-collecting filter in the air flow direction; a support unit configured to be movable, and to support the pressurizing unit against the dust-collecting filter; and a drive unit configured to move the support unit when the pressurizing unit pressurizes the dust-collecting filter, to thereby move the pressurizing unit along a crossing direction crossing the air flow direction. The dust-collecting filter includes fiber materials that cause an electrostatic force by friction with the pressurizing unit, the pressurizing unit is connected to the support unit, and is moved by the drive unit through the support unit, the dust-collecting filter contains an electret material that causes polarization, the electret material includes a first fiber material having a first triboelectric series, and a second fiber material having a second triboelectric series different from the first triboelectric series, and the pressurizing unit is configured to travel along the dust-collecting filter through drive of the drive unit, and roll along a direction perpendicular to a pressurizing direction in which the pressurizing unit pressurizes the dust-collecting filter.

Advantageous Effects of Invention

[0010]

In the dust-collecting apparatus according to one embodiment of the present invention, the support unit is moved under a state in which the pressurizing unit pressurizes the dust-collecting filter. The pressurizing unit pressurizing the dust-collecting filter can be moved on the dust-collecting filter while keeping a pressurizing

state through movement of the support unit. That is, the dust-collecting filter is partially deformed by pressurization, and the deformation can be traveled on the dust-collecting filter. Therefore, the dust-collecting film can be subjected to internal friction as well as to surface friction, and an electrostatic force can be imparted to an inside of the dust-collecting filter as well as to a surface of the dust-collecting filter. Thus, an electric charge amount to be given to the dust-collecting filter can be increased. As a result, the dust-collecting performance of the dust-collecting filter can be improved. In this case, unlike the surface friction that means a phenomenon in which a member different from the dust-collecting filter rubs against the surface of the dust-collecting filter, the internal friction means a phenomenon in which materials for filter elements forming the dust-collecting filter rub against each other.

[0011]

In the dust-collecting method according to one embodiment of the present invention, the support unit is moved under a state in which the pressurizing unit pressurizes the dust-collecting filter. The pressurizing unit pressurizing the dust-collecting filter can be moved on the dust-collecting filter while keeping a pressurizing state through movement of the support unit. Therefore, the dust-collecting film can be subjected to internal friction as well as to surface friction, and the electrostatic force can be imparted to the inside of the dust-collecting filter as well as to the surface of the dust-collecting filter. Thus, the electric charge amount to be given to the dust-collecting filter can be increased. As a result, the dust-collecting performance of the dust-collecting filter can be improved.

[0012]

In the dust-collecting system according to one embodiment of the present invention, the support unit is moved under a state in which the pressurizing unit pressurizes the dust-collecting filter. The pressurizing unit pressurizing the dust-collecting filter can be moved on the dust-collecting filter while keeping the pressurizing state through the movement of the support unit. Therefore, the dust-collecting film can be subjected to the internal friction as well as to the surface friction, and the electrostatic force can be imparted to the inside of the dust-collecting filter as

well as to the surface of the dust-collecting filter. Thus, the electric charge amount to be given to the dust-collecting filter can be increased. As a result, the dust-collecting performance of the dust-collecting filter can be improved.

5 Brief Description of Drawings

[0013]

[Fig. 1] Fig. 1 is an explanatory view for illustrating a dust-collecting system according to Embodiment 1 of the present invention.

10 [Fig. 2] Fig. 2 is a sectional view when viewed from a front surface, for schematically illustrating a dust-collecting apparatus according to Embodiment 1.

[Fig. 3] Fig. 3 is a sectional view when viewed from a side surface, for schematically illustrating the dust-collecting apparatus according to Embodiment 1.

[Fig. 4] Fig. 4 is a partial sectional view for schematically illustrating a dust-collecting filter in Embodiment 1.

15 [Fig. 5] Fig. 5 is an explanatory view for illustrating a state in which a pressurizing unit pressurizes the dust-collecting filter in Embodiment 1.

[Fig. 6] Fig. 6 is a flowchart for illustrating an operation procedure of the dust-collecting system according to Embodiment 1.

20 [Fig. 7] Fig. 7 is a sectional view for schematically illustrating a dust-collecting filter using a plurality of fiber materials in Embodiment 2 of the present invention.

[Fig. 8] Fig. 8 is an explanatory view for illustrating a state in which the dust-collecting filter using the plurality of fiber materials is pressurized in Embodiment 2.

25 [Fig. 9] Fig. 9 is a sectional view for schematically illustrating a dust-collecting filter having a configuration in which sheets using fiber materials made of different materials overlap one another in Embodiment 3 of the present invention.

[Fig. 10] Fig. 10 is an explanatory view for illustrating a state in which the dust-collecting filter using the sheets formed of a plurality of fiber materials is pressurized in Embodiment 3.

30 [Fig. 11] Fig. 11 is a sectional view when viewed from a front surface, for schematically illustrating a dust-collecting apparatus according to Embodiment 4 of

the present invention.

[Fig. 12] Fig. 12 is a sectional view when viewed from a side surface, for schematically illustrating a dust-collecting apparatus according to Embodiment 5 of the present invention.

5 [Fig. 13] Fig. 13 is a sectional view when viewed from a front surface, for schematically illustrating a dust-collecting apparatus according to Embodiment 6 of the present invention.

[Fig. 14] Fig. 14 is a sectional view when viewed from a side surface, for schematically illustrating the dust-collecting apparatus according to Embodiment 6.

10 Description of Embodiments

[0014]

Now, embodiments of a dust-collecting apparatus, a dust-collecting method, and a dust-collecting system disclosed by the present application are described in detail with reference to the accompanying drawings. In the following description, as expressions representing a friction state, surface friction and internal friction are used. The surface friction means a phenomenon in which a member different from a dust-collecting filter rubs against a surface of the dust-collecting filter, and the internal friction means a phenomenon in which materials for filter elements forming the dust-collecting filter rub against each other. In a case in which the term "friction" is merely described, the surface friction and the internal friction are not distinguished from each other. Each of the embodiments described below is one example, and the present invention is not limited to those embodiments.

[0015]

25 First Embodiment

Fig. 1 is an explanatory view for illustrating a dust-collecting system according to Embodiment 1 of the present invention. The dust-collecting system 1 according to Embodiment 1 is a part of a commercial air-conditioning system to be installed in, for example, a building, and includes a dust-collecting apparatus 2, a fan 3, an air passage 4, and a sensing device 6.

[0016]

The dust-collecting apparatus 2 is a device configured to collect dust 5 contained in air taken in the air passage 4. The dust-collecting apparatus 2 is arranged in the air passage 4. The dust-collecting apparatus 2 includes a dust-collecting filter 21 as described later. The dust 5 contained in the air can be removed by the dust-collecting filter 21 of the dust-collecting apparatus 2.

[0017]

The fan 3 is an air-sending device configured to perform air-sending operation to the air in the air passage 4 in order to take the air in the air passage 4 from outside. That is, the fan 3 is one example of a treatment apparatus according to Embodiment 1. The fan 3 is a part of the commercial air-conditioning system. Therefore, the air taken in by the fan 3 can be subjected to also air-conditioning operation. Thus, an air-conditioning apparatus configured to perform such air-conditioning operation is also one example of the treatment apparatus according to Embodiment 1.

[0018]

The fan 3 is arranged in the air passage 4. The fan 3 is arranged on a downstream side of the dust-collecting apparatus 2 in an air flow direction in which the air is taken in. Therefore, the dust 5 can be removed by the dust-collecting apparatus 2 from the air taken in the fan 3.

[0019]

The air passage 4 is a pipe configured to guide the air taken in from outside into the air-conditioning apparatus through the fan 3. The dust-collecting apparatus 2 and the fan 3 are arranged in the air passage 4. In Fig. 1, the air flows from a right side to a left side of the fan 3 in the air passage 4. That is, in Fig. 1, the direction from the right side to the left side corresponds to the air flow direction.

[0020]

In the air passage 4, the air flowing in the air flow direction can be taken in the fan 3 after passing through the dust-collecting filter 21 to be subjected to removal of the dust 5. The air taken in the fan 3 can be thereafter guided to the air-conditioning apparatus to be subjected to the air-conditioning operation.

[0021]

The sensing device 6 is a device configured to detect the dust 5 in the air flowing in the air passage 4. The sensing device 6 can use a filter vibration method, a beta-ray absorption method, or other methods as a system for measuring the concentration of the dust or the number of dust particles in air. However, there is no particular limitation on the system to be used by the sensing device 6 installed in the dust-collecting system 1. For example, a light scattering method may be used.

[0022]

Fig. 2 is a sectional view when viewed from a front surface, for schematically illustrating the dust-collecting apparatus 2 according to Embodiment 1. Fig. 3 is a sectional view when viewed from a side surface, for schematically illustrating the dust-collecting apparatus 2 according to Embodiment 1. Fig. 4 is a partial sectional view for schematically illustrating the dust-collecting filter 21 according to Embodiment 1. Fig. 5 is an explanatory view for illustrating a state in which a pressurizing unit 22 pressurizes the dust-collecting filter 21 in Embodiment 1. The dust-collecting apparatus 2 includes the dust-collecting filter 21, the pressurizing unit 22, a drive unit 23, a screw shaft 24, a screw member 25, a guide shaft 26, a shaft slide member 27, a fixing frame 28, and an air-permeable member 29.

[0023]

The dust-collecting filter 21 is a rectangular sheet-like member which is formed of a plurality of fiber materials 211 and has longitudinal sides and lateral sides. The dust-collecting filter 21 is fixed to the fixing frame 28. The dust-collecting filter 21 is used for removing the dust 5 contained in the air flowing in the air flow direction. As the fiber materials 211, cupra, rayon, acetate, nylon, polyester, acrylic, aramid, vinylon, vinylidene, polyvinyl chloride, polyvinylidene chloride, polyethylene, polypropylene, polyurethane, cotton, hemp, silk, wool, glass fibers, pulp, or other materials can be used.

[0024]

At least one of the plurality of fiber materials 211 has electret characteristics. Examples of the fiber materials 2 having electret characteristics include polyethylene,

polypropylene, and acrylic. The effect of frictional electrification described later can be maintained for a long time period by using the fiber materials 211 having electret characteristics for the dust-collecting filter 21. By virtue of the effect of the frictional electrification, the dust 5 in the air can be attracted to the fiber materials 211 having the electret characteristics of the dust-collecting filter 21. Therefore, the dust-collecting performance of the dust-collecting apparatus 2 can be improved. The term "electret characteristics" as used herein refers to the characteristics of a material capable of permanently holding electric polarization and being charged even under a state in which there is no external electric field.

[0025]

There is no particular limitation on a manufacturing method for a sheet forming the dust-collecting filter 21. As the dust-collecting filter 21, a knitted fabric, a woven fabric, a nonwoven fabric, or other fabrics can be used.

[0026]

The pressurizing unit 22 is a pressurizing member configured to pressurize the dust-collecting filter 21. The pressurizing unit 22 is, for example, a cylindrical pressurizing member and is arranged so that an axial length direction thereof is positioned along the longitudinal side direction of the dust-collecting filter 21. The pressurizing unit 22 is supported against the dust-collecting filter 21 by the screw shaft 24, the screw member 25, the guide shaft 26, and the shaft slide member 27 described later in detail. Specifically, one end side of the pressurizing unit 22 in the axial length direction is supported by the screw shaft 24 and the screw member 25, and an other end side thereof in the axial length direction is supported by the guide shaft 26 and the shaft slide member 27.

[0027]

The pressurizing unit 22 has, as a sectional shape, a true circular shape, an elliptical shape, a polygonal shape, a gear wheel shape, a gear shape, or other shapes.

[0028]

The pressurizing unit 22 contains a polymer material having a high insulation

property. When the pressurizing unit 22 contains a polymer material having a high insulation property, the state in which a charge generated in the dust-collecting filter 21 moves to the pressurizing unit 22 can be suppressed. Examples of the polymer material having a high insulation property include polystyrene, an ABS resin, polypropylene, PC, PC/ABS, modified PPE, PBT, a phenol resin, a melamine resin, a natural rubber, a styrene-butadiene rubber, a butadiene rubber, a butyl rubber, an ethylenepropylene rubber, a chloroprene-acrylic rubber, a nitrile-butadiene rubber, a silicone rubber, a fluororubber, and a polysulfide rubber. The phrase "having a high insulation property" refers to that a material has a volume specific resistivity ($\Omega \cdot \text{cm}$) of 10^8 or more as a reference of an insulation property. When a material having a low insulation property is used for the pressurizing unit 22, the charge generated in the dust-collecting filter 21 moves from the dust-collecting filter 21, and an electrostatic force of the dust-collecting filter 21 decreases, with the result that the improvement of dust-collecting performance of the dust-collecting filter 21 may be inhibited.

[0029]

The drive unit 23 is a drive member configured to be driven to move the pressurizing unit 22, and is connected to the pressurizing unit 22 through intermediation of the screw shaft 24 and the screw member 25. The drive unit 23 is configured to move the pressurizing unit 22 under a state of pressurizing the dust-collecting filter 21 on the dust-collecting filter 21 to subject the dust-collecting filter 21 to friction, to thereby impart an electrostatic force to the dust-collecting filter 21.

[0030]

A combination of the screw shaft 24 and the screw member 25 is a ball screw member configured to transmit a drive force of the drive unit 23 to the pressurizing unit 22. The screw shaft 24 is a bar-like member arranged so that the axial length direction thereof is positioned along the lateral side direction of the dust-collecting filter 21. The screw shaft 24 is fixed to the fixing frame 28. The ball screw member is connected to the dust-collecting filter 21 through intermediation of the fixing frame 28, and is connected also to the pressurizing unit 22 and the drive unit 23. The

screw member 25 serves also as a support member configured to support the pressurizing unit 22 against the dust-collecting filter 21.

[0031]

When the drive unit 23 rotates the screw shaft 24, the screw member 25 is moved on the screw shaft 24 in a positive or negative direction of the axial length in accordance with the rotation direction. In Fig. 2, the screw member 25 is moved rightward or leftward in accordance with the operation of the drive unit 23. The pressurizing unit 22 is designed so as to be moved along with the movement of the screw member 25.

[0032]

The shaft slide member 27 is moved in conformity to the movement of the screw member 25. The guide shaft 26 is a bar-like member arranged so that the axial length direction thereof is positioned along the lateral side direction of the dust-collecting filter 21. The guide shaft 26 is connected to the dust-collecting filter 21 through intermediation of the fixing frame 28 and is connected also to the pressurizing unit 22. The shaft slide member 27 is configured to support the pressurizing unit 22 against the dust-collecting filter 21. That is, the shaft slide member 27 serves also as a support member configured to move the pressurizing unit 22 in accordance with the drive of the drive unit 23.

[0033]

The screw shaft 24 and the guide shaft 26 are mounted at such positions as to enable the pressurizing unit 22 to be moved while pressurizing the dust-collecting filter 21. Further, the shaft screw 24 and the guide shaft 26 are arranged horizontally with respect to the surface of the dust-collecting filter 21. When the screw shaft 24 and the guide shaft 26 are not arranged horizontally with respect to the surface of the dust-collecting filter 21, there is a risk in that a part of the dust-collecting filter 21 cannot receive sufficient pressurization.

[0034]

The shaft slide member 27 is configured to move in conjunction with the movement of the screw member 25. Therefore, the friction resistance of the shaft

slide member 27 and the friction resistance of the guide shaft 26 are relatively small. It is not required to provide particular limitation on the friction resistance of the shaft slide member 27 and the friction resistance of the guide shaft 26, and it is only required that the screw member 25 and the shaft slide member 27 be interlocked with each other through the drive of the drive unit 23.

[0035]

The fixing frame 28 is a rectangular frame member configured to fix the dust-collecting filter 21. The screw shaft 24 and the guide shaft 26 are connected to the fixing frame 28. Further, the fixing frame 28 is manufactured by using a polymer material having an insulation property higher than that of the dust-collecting filter 21. In order to introduce a relatively high insulation property, the volume specific resistivity ($\Omega \cdot \text{cm}$) of the polymer material to be used for the fixing frame 28 is set to 10 raised to the 8th power or more. As the polymer material, for example, polystyrene, an ABS resin, polypropylene, PC, PC/ABS, modified PPE, PBT, a phenol resin, or a melamine resin can be used. Meanwhile, when a material having a relatively low insulation property is used for the fixing frame 28, the charge generated in the dust-collecting filter 21 may be dispersed through the fixing frame 28. Therefore, when the material having a relatively low insulation property is used, there is a risk in that the dust-collecting performance of the dust-collecting filter 21 may not be improved.

[0036]

The air-permeable member 29 is a member having air permeability and is arranged at a position of holding the dust-collecting filter 21 by using the pressurizing unit 22. The air from which dust is collected by the dust-collecting filter 21 passes through the air-permeable member 29 to flow to the fan 3.

[0037]

The air-permeable member 29 is manufactured by using a polymer material having an insulation property higher than that of the dust-collecting filter 21. The polymer material to be used for the air-permeable member 29 has a volume specific resistivity ($\Omega \cdot \text{cm}$) of 10 raised to the 8th power or more, and hence has a relatively high insulation property. As the polymer material, for example, polystyrene, an ABS

resin, polypropylene, PC, PC/ABS, modified PPE, PBT, a phenol resin, or a melamine resin can be used. Meanwhile, when a material having a relatively low insulation property is used for the air-permeable member 29, the charge generated in the dust-collecting filter 21 may be dispersed through the air-permeable member 29.

5 Therefore, when the material having a relatively low insulation property is used, there is a risk in that the dust-collecting performance of the dust-collecting filter 21 may not be improved.

[0038]

10 When the air-permeable member 29 ensures air permeability, there is no particular limitation on the structure thereof. For example, a net-like member or a perforated material may be used. Further, the air-permeable member 29 is connected to the dust-collecting filter 21 by using connecting means such as adhesion or melting.

[0039]

15 When the dust-collecting filter 21 is pressurized by the pressurizing unit 22, an external force directed from the pressurizing unit 22 to the air-permeable member 29 is applied to the dust-collecting filter 21. Through arrangement of the air-permeable member 29, the deformation of the dust-collecting filter 21 caused by the external force can be suppressed to enhance a pressurizing effect. When the pressurizing unit 22 under a pressurizing state with the enhanced pressurizing effect is moved, the friction effect can be enhanced. Specifically, a sufficient friction force can be generated in the dust-collecting filter 21 as well as on the surface of the dust-collecting filter 21. Due to the generated friction force, an electrostatic force is generated by the internal friction through the fiber materials 211 having electret characteristics of the dust-collecting filter 21 in the dust-collecting filter 21 as well as on the surface of the dust-collecting filter 21. Therefore, an increase in the electrostatic force imparted to the dust-collecting filter 21 can be expected. The dust-collecting filter 21, the pressurizing unit 22, the screw shaft 24, the guide shaft 26, the fixing frame 28, the air-permeable member 29, and the like are arranged so as to satisfy $\Delta L1 > \Delta L1'$, where $\Delta L1$ represents a surface deformation amount of the dust-

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collecting filter 21 directed from the dust-collecting filter 21 under a state of not being
pressurized to the dust-collecting filter 21 under a state of being pressurized, and
 $\Delta L_1'$ represents a deformation amount of the air-permeable member 29 directed from
the air-permeable member 29 under a state of not being pressurized to the air-
5 permeable member 29 under a state of being pressurized.

[0040]

The surface friction is different from the internal friction in electrostatic force to
be obtained. In the case of the surface friction, an electrostatic force is obtained
when fibers in a surface layer portion of the dust-collecting filter are charged.

10 Meanwhile, in the case of the internal friction, the fibers inside the dust-collecting filter
can also be charged. Therefore, a larger electrostatic force can be obtained from
the internal friction than that from the surface friction.

[0041]

Wind generated by the fan 3 flows from one surface side of the dust-collecting
15 filter 21 that is brought into contact with the pressurizing unit 22 to an other surface
side of the dust-collecting filter 21 that is not brought into contact with the pressurizing
unit 22. In Fig. 1, the wind flows from the right side to the left side. In Fig. 2, the
wind flows from a front side to a back side. This direction is defined as a first
direction.

20 [0042]

In the case of the above-mentioned configuration in which the air targeted for
dust collection flows toward the one surface side of the dust-collecting filter 21 that is
brought into contact with the pressurizing unit 22, the one surface side of the dust-
collecting filter 21 can be reliably subjected to friction. Therefore, charging of the
25 one surface side is sufficiently performed, and the dust-collecting effect can be
efficiently enhanced. However, the present invention is not limited to this
configuration. The present invention may have an opposite configuration in which
the air targeted for dust collection flows toward the other surface side of the dust-
collecting filter 21 that is not brought into contact with the pressurizing unit 22. In the
30 case of the opposite configuration, the pressurizing unit 22 is not present on the other

surface side against which the air targeted for dust collection blows, and hence the entire other surface side of the dust-collecting filter 21 can be used as a dust-collecting region. Therefore, when charging on the other surface side is sufficient, the dust-collecting effect can be efficiently enhanced.

5 [0043]

The pressurizing unit 22 travels along the axial length direction of the screw shaft 24 and the axial length direction of the guide shaft 26 in accordance with the drive of the drive unit 23. The direction of the travel of the pressurizing unit 22 depends on the rotation direction of the screw shaft 24 caused by the drive of the drive unit 23, and the pressurizing unit 22 can travel in any of the positive direction and the negative direction. In one example of Fig. 2, when the drive of the drive unit 23 occurs, the pressurizing unit 22 travels in a right direction or a left direction in Fig. 2. Specifically, the pressurizing unit 22 performs a traveling motion of traveling over the entire surface of the dust-collecting filter 21, a reciprocating motion of reciprocating within a relative wide range of the dust-collecting filter 21, or a vibrating motion of reciprocating within a relatively narrow range of the dust-collecting filter 21. With such operation, the pressurizing unit 22 subjects the dust-collecting filter 21 to friction. In this case, the axial length direction of the screw shaft 24 and the axial length direction of the guide shaft 26 are each defined as a second direction. The second direction is a direction crossing the first direction. In Embodiment 1, one example in which the first direction and the second direction are substantially perpendicular to each other is described. When the first direction and the second direction are substantially perpendicular to each other, the area of the dust-collecting filter 21 required with respect to the air passage 4 can be minimized, with the result that a cost reduction effect is obtained.

25 [0044]

When the pressurizing unit 22 under a state of pressurizing the dust-collecting filter 21 performs the traveling motion, the reciprocating motion, or the vibrating motion, as illustrated in Fig. 5, the pressurizing unit 22 is positively charged, and the dust-collecting filter 21 is negatively charged by the fiber materials 211 having electret

characteristics. By virtue of the pressurization of the dust-collecting filter 21 by the pressurizing unit 22 and the travel of the fiber materials 211 in the pressurized dust-collecting filter 21, the surface friction effect between the pressurizing unit 22 and the fiber materials 211, and the internal friction effect between the fiber materials 211 can be enhanced. When the dust-collecting filter 21 is pressurized, the dust-collecting filter 21 is deformed from the pressurizing unit 22 side to the air-permeable member 29 side, and hence a negative charge is generated also in the dust-collecting filter 21. Therefore, a sufficient electrostatic force can be generated in the dust-collecting filter 21 as well as on the surface of the dust-collecting filter 21.

[0045]

In the case of a ventilation state in which wind is generated by the fan 3, the pressurizing unit 22 stops at a position of an end portion of the dust-collecting filter 21 without performing the traveling motion, the reciprocating motion, or the vibrating motion. For example, in one example of Fig. 2, the pressurizing unit 22 stops at a right end portion or a left end portion of the dust-collecting filter 21 in Fig. 2. With this configuration, ventilation interruption caused by the pressurizing unit 22 can be prevented, and a decrease in air-conditioning efficiency of the commercial air-conditioning system can be suppressed. However, even in the case of a ventilation state, the pressurizing unit 22 may perform the traveling motion, the reciprocating motion, or the vibrating motion in accordance with the necessity of friction.

[0046]

When a raw material for the fiber materials 211 forming the dust-collecting filter 21 is a single material, the pressurizing unit 22 is manufactured by using a material having a triboelectric series different from that of the single material for the fiber materials 211 forming the dust-collecting filter 21. When the triboelectric series of the dust-collecting filter 21 is different from that of the pressurizing unit 22, as described above, the pressurizing unit 22 is positively charged by friction, and the fiber materials 211 are negatively charged by friction. The dust-collecting performance of the dust-collecting apparatus 2 is improved by virtue of charging of the dust-collecting filter 21.

[0047]

Fig. 6 is a flowchart for illustrating an operation procedure of the dust-collecting system 1 according to Embodiment 1. The dust-collecting system 1 that is a part of the commercial air-conditioning system determines whether or not the dust-collecting system 1 has received operation start manipulation (Step S1). When the dust-collecting system 1 determines that the dust-collecting system 1 has received the operation start manipulation (S1: YES), the dust-collecting system 1 operates the fan 3 to cause air to flow from the dust-collecting apparatus 2 to the fan 3 in the air passage 4 (Step S2). When the dust-collecting system 1 determines that the dust-collecting system 1 has not received the operation start manipulation (S1: NO), the dust-collecting system 1 repeatedly determines whether or not the dust-collecting system 1 has received the operation start manipulation. From the air flowing in the air passage 4, dust is collected by the dust-collecting filter 21 when the air passes through the dust-collecting filter 21 of the dust-collecting apparatus 2. The air, from which the dust is collected, reaches the air-conditioning apparatus through the fan 3 to be subjected to air conditioning.

[0048]

The dust-collecting system 1 determines whether or not drive conditions have been arranged after the operation of the fan 3 is started (Step S3). When the dust-collecting system 1 determines that the drive conditions have been arranged (S3: YES), the dust-collecting system 1 drives the drive unit 23 of the dust-collecting apparatus 2 (Step S4). Through the drive of the drive unit 23, the dust-collecting system 1 moves the pressurizing unit 22 on the dust-collecting filter 21 under a state in which the pressurizing unit 22 pressurizes the dust-collecting filter 21 (Step S5). Specifically, the dust-collecting system 1 causes the pressurizing unit 22 to perform the traveling motion, the reciprocating motion, or the vibrating motion. Through the travel of the pressurizing unit 22 under a pressurizing state, the internal friction occurs as well as the surface friction of the dust-collecting filter 21, and an electrostatic force can be supplied to the inside of the dust-collecting filter 21 as well as to the surface of the dust-collecting filter 21. Thus, as compared to a case in which an electrostatic

force is supplied to the surface of the dust-collecting filter 21, the electrostatic force can be accumulated also in the dust-collecting filter 21, and an electric charge amount to be given to the dust-collecting filter 21 can be increased. As a result, the dust-collecting performance of the dust-collecting apparatus 2 by the dust-collecting filter 21 can be improved. When the dust-collecting system 1 does not determine that the drive conditions have been arranged (S3: NO), the dust-collecting system 1 repeatedly determines whether or not the drive conditions have been arranged. The term "drive conditions" as used herein refer to conditions that can be set by a user. As examples of the drive conditions, there are given set time and date, an elapsed time from the operation start, the dust-collecting state of the dust-collecting filter 21, the number of movements of the pressurizing unit 22, and an instruction from the user.

[0049]

As determination criteria of the drive conditions, there are given the concentration and the number of particles of the dust 5 in the air measured by the sensing device 6 installed in the air passage 4. When the sensing device 6 measures the concentration and the number of particles of the dust exceeding reference values determined in advance, the dust-collecting system 1 is configured to determine that the drive conditions have been arranged in order to improve the dust-collecting performance of the dust-collecting filter 21 (Step S3: YES), and the dust-collecting system 1 drives the drive unit 23 of the dust-collecting apparatus 2 (Step S4).

[0050]

The pressurizing unit 22 performs the traveling motion, the reciprocating motion, or the vibrating motion. When the pressurizing unit 22 performs the traveling motion, the dust-collecting filter 21 is generally subjected to friction, and an electrostatic force can be supplied to the entire dust-collecting filter 21. When the pressurizing unit 22 performs the reciprocating motion, the traveling motion occurs a plurality of times, and hence an electrostatic force to be supplied to the entire dust-collecting filter 21 is increased. In the case of the vibrating motion, the dust-

collecting filter 21 is partially subjected to friction, and an electrostatic force can be supplied also to a part of the dust-collecting filter 21. Further, the travel distance of the pressurizing unit 22 is shortened as compared to that of the traveling motion and the reciprocating motion, and hence the operation can be finished within a short time period.

[0051]

The dust-collecting system 1 determines again whether or not the drive conditions have been arranged after the travel of the pressurizing unit 22 is finished (Step S6). When the dust-collecting system 1 determines that the drive conditions have been arranged (S6: YES), the dust-collecting system 1 returns the process to Step S4, drives the drive unit 23 of the dust-collecting apparatus 2 (Step 4), and continues the subsequent process. When the dust-collecting system 1 determines that the drive conditions have not been arranged (S6: NO), the dust-collecting system 1 determines whether or not the dust-collecting system 1 has received operation stop manipulation (Step S7).

[0052]

When the dust-collecting system 1 determines that the dust-collecting system 1 has received the operation stop manipulation (S7: YES), the dust-collecting system 1 stops the operation of the fan 3 to finish the process. When the dust-collecting system 1 determines that the dust-collecting system 1 has not received the operation stop manipulation (S7: NO), the dust-collecting system 1 returns the process to Step S6, determines again whether or not the drive conditions have been arranged (Step S6), and continues the subsequent process.

[0053]

The dust-collecting system 1 drives the drive unit 23 when the drive conditions are arranged after the operation is started. For example, the dust-collecting system 1 according to Embodiment 1 is configured to determine a decrease in dust-collecting performance of the dust-collecting filter 21 so that the drive unit 23 is driven based on the determination result. With such configuration, the dust-collecting filter 21 can be recharged in an appropriate period. Further, the drive unit 23 is driven again when

the drive conditions are arranged after the drive of the drive unit 23 is finished. With such configuration, the pressurizing unit 22 travels again in an appropriate time period, and the dust-collecting filter 21 can be continuously recharged.

[0054]

5 In the foregoing, description is given of the dust-collecting system 1 as a part the commercial air-conditioning system. However, the dust-collecting system 1 may be incorporated into a household air-conditioning system.

[0055]

10 In the foregoing, description is given of the dust-collecting system 1 having a configuration in which the pressurizing unit 22 always pressurizes the dust-collecting filter 21. However, the dust-collecting system 1 may have a configuration in which the pressurizing unit 22 may travel so that the distance between the pressurizing unit 22 and the dust-collecting filter 21 can be changed. Specifically, the dust-collecting system 1 may have a configuration in which the pressurizing unit 22 travels in a
15 direction of approaching the dust-collecting filter 21 to pressurize the dust-collecting filter 21, and travels in a direction of being separated from the dust-collecting filter 21 to put the dust-collecting filter 21 in a non-pressurized state. With this configuration, the risk in that an electrostatic force accumulated in the dust-collecting filter 21 may be reduced through the pressurizing unit 22 can be suppressed.

20 [0056]

As described above, in the dust-collecting system 1 according to Embodiment 1, the screw member 25 and the shaft slide member 27 are configured to travel under a state in which the dust-collecting filter 21 is pressurized by the pressurizing unit 22. The pressurizing unit 22 pressurizing the dust-collecting filter 21 can travel on the
25 dust-collecting filter 21 while keeping a pressurizing state through the movement of the screw member 25 and the shaft slide member 27. Therefore, the pressurizing unit 22 can be suitably travel across the entire dust-collecting filter 21 while the pressurizing unit 22 is firmly supported. Further, the suitable movement of the pressurizing unit 22 across the entire dust-collecting filter 21 is realized. In addition,
30 the internal friction of the dust-collecting filter 21 as well as the surface friction of the

dust-collecting filter 21 are enabled, with the result that an electrostatic force can be imparted to the inside of the dust-collecting filter 21 as well as to the surface of the dust-collecting filter 21. Thus, an electric charge amount to be given to the dust-collecting filter 21 can be increased. As a result, the dust-collecting performance of the dust-collecting filter 21 can be improved.

[0057]

As described above, in the dust-collecting system 1 according to Embodiment 1, the dust-collecting filter 21 is subjected to friction to generate static electricity by using the pressurizing unit 22. The surface of the pressurizing unit 22 has a structure capable of suppressing fiber fray of the dust-collecting filter 21. Thus, in the dust-collecting system 1 according to Embodiment 1, damage to the dust-collecting filter 21 in association with recharging of static electricity can be suppressed, and the continuous operation performance is improved.

[0058]

Second Embodiment

Fig. 7 is a sectional view for schematically illustrating the dust-collecting filter 21 using a plurality of fiber materials 211a and 211b in Embodiment 2 of the present invention. Fig. 8 is an explanatory view for illustrating a state in which the dust-collecting filter 21 using the plurality of fiber materials 211a and 211b is pressurized in Embodiment 2. Regarding the dust-collecting system 1 according to Embodiment 2, description of the same configurations as those of the dust-collecting system 1 according to Embodiment 1 is omitted.

[0059]

In the dust-collecting system 1 according to Embodiment 1, as illustrated in Fig. 4 and Fig. 5, the dust-collecting filter 21 using the fiber materials 211 made of a single raw material is used. However, the present invention is not limited to such one example. In the dust-collecting system 1 according to Embodiment 2, as illustrated in Fig. 7, the dust-collecting filter 21 is formed so as to include the fiber materials 211a and the fiber materials 211b having different triboelectric series. Through use of the fiber materials 211a and the fiber materials 211b having different triboelectric

series, charging caused by the internal friction between the fiber materials 211a and the fiber materials 211b, as well as charging caused by the surface friction between the pressurizing unit 22 and the dust-collecting filter 21, is enabled. Therefore, a deep layer portion of the dust-collecting filter 21 can also be more efficiently charged.

5 There is no particular limitation on the arrangement of the fiber materials 211a and 211b in the dust-collecting filter 21.

[0060]

When the pressurizing unit 22 under a pressurizing state travels on the dust-collecting filter 21, as illustrated in Fig. 8, the internal friction occurs between the fiber materials 211a and 211b, and the dust-collecting filter 21 is charged. In charging caused by the internal friction between the fiber materials 211a and 211b in the dust-collecting filter 21, as compared to charging caused by the surface friction between the pressurizing unit 22 and the fiber materials on the surface of the dust-collecting filter 21, a region up to a deep inside portion of the dust-collecting filter 21 is charged, and the dust-collecting filter 21 obtains high dust-collecting performance.

[0061]

As described above, in the dust-collecting system 1 according to Embodiment 2, the screw member 25 and the shaft slide member 27 are configured to travel under a state in which the dust-collecting filter 21 is pressurized by the pressurizing unit 22.

20 The pressurizing unit 22 pressurizing the dust-collecting filter 21 can travel on the dust-collecting filter 21 while keeping a pressurizing state through the movement of the screw member 25 and the shaft slide member 27. Therefore, in addition to the surface friction of the dust-collecting filter 21, the internal friction of the dust-collecting filter 21 is enabled through the fiber materials 211a and 211b having different triboelectric series, with the result that an electrostatic force can be imparted to the inside of the dust-collecting filter 21 as well as to the surface of the dust-collecting filter 21. Thus, an electric charge amount to be given to the dust-collecting filter 21 can be increased. As a result, the dust-collecting performance of the dust-collecting filter 21 can be improved.

30 [0062]

Third Embodiment

Fig. 9 is a sectional view for schematically illustrating the dust-collecting filter 21 having a configuration in which sheets using the fiber materials 211a and 211b made of different materials overlap one another in Embodiment 3 of the present invention. Fig. 10 is an explanatory view for illustrating a state in which the dust-collecting filter 21 using the sheets formed of the plurality of fiber materials 211a and 211b is pressurized in Embodiment 3. Regarding the dust-collecting system 1 according to Embodiment 3, description of the same configurations as those of the dust-collecting system 1 according to Embodiment 1 is omitted.

[0063]

The dust-collecting filter 21 in Embodiment 3 has a configuration in which a first sheet using the fiber materials 211a and a second sheet using the fiber materials 211b made of a material different from that for the fiber materials 211a overlap one another. When the fiber materials 211a and 211b having different triboelectric series are made of different materials, the charging force with respect to friction of the first sheet is different from that of the second sheet, and collecting efficiency based on the charging force may be varied. Therefore, the effect of improving the initial filtration performance of the dust-collecting filter 21 is obtained. The term "initial filtration performance" as used herein means the filtration performance of the dust-collecting filter 21 under a state in which the performance has not been degraded at the beginning of use after manufacturing. When the first sheet using the fiber materials 211a and the second sheet using the fiber materials 211b made of a material different from that for the first materials 211a overlap one another, a combination of the surface filtration and the depth filtration is realized based on the magnitude of an opening caused by the difference in density, and the dust-collecting filter 21 having a low pressure loss and high collecting efficiency can be obtained.

[0064]

When the pressurizing unit 22 under a pressurizing state is moved on the dust-collecting filter 21, as illustrated in Fig. 10, frictional electrification occurs between the sheet of the fiber materials 211a and the sheet of the fiber materials 211b. Charging

occurs due to the friction in an inner side portion of the dust-collecting filter 21 in which the sheet of the fiber materials 211a and the sheet of the fiber materials 211b are brought into contact with each other. Therefore, as compared to charging caused by the friction between the pressurizing unit 22 and the sheet of the fiber materials 211a on the surface of the dust-collecting filter 21, a region up to a deep inside portion of the dust-collecting filter 21 is charged, and the dust-collecting filter 21 obtains high dust-collecting performance.

[0065]

As described above, in the dust-collecting system 1 according to Embodiment 3, the screw member 25 and the shaft slide member 27 are configured to travel under a state in which the dust-collecting filter 21 is pressurized by the pressurizing unit 22. The pressurizing unit 22 pressurizing the dust-collecting filter 21 can travel on the dust-collecting filter 21 while keeping a pressurizing state through the movement of the screw member 25 and the shaft slide member 27. Therefore, in addition to the surface friction of the dust-collecting filter 21, the internal friction of the dust-collecting filter 21 is enabled through the sheet of the fiber materials 211a and the sheet of the fiber materials 211b having different triboelectric series, with the result that an electrostatic force can be imparted to the inside of the dust-collecting filter 21 as well as to the surface of the dust-collecting filter 21. Thus, an electric charge amount to be given to the dust-collecting filter 21 can be increased. As a result, the dust-collecting performance of the dust-collecting filter 21 can be improved.

[0066]

Fourth Embodiment

Fig. 11 is a sectional view when viewed from a front surface, for schematically illustrating the dust-collecting apparatus 2 according to Embodiment 4 of the present invention. Regarding the dust-collecting system 1 including the dust-collecting apparatus 2 according to Embodiment 4, description of the same configurations as those of the dust-collecting system 1 according to Embodiment 1 is omitted.

[0067]

Unlike the pressurizing unit 22 in Embodiment 1, the pressurizing unit 22 of the

dust-collecting apparatus 2 according to Embodiment 4 has an air-permeable structure. Specifically, the pressurizing unit 22 is a mesh-like plate member in which a plurality of ventilation ports for passing the air are opened in a surface thereof.

Further, the pressurizing unit 22 of the dust-collecting apparatus 2 according to
5 Embodiment 4 is formed so that an area for covering the surface of the dust-collecting filter 21 is larger than that of the pressurizing unit 22 in Embodiment 1. Specifically, the pressurizing unit 22 in Embodiment 4 has a rectangular shape slightly smaller than the dust-collecting filter 21. In order to enable the pressurization by the pressurizing unit 22 having a larger area, the dust-collecting apparatus 2 according to
10 Embodiment 4 includes two screw members 25 provided on the screw shaft 24 and configured to support the pressurizing unit 22, and two shaft slide members 27 provided on the guide shaft 26 and configured to support the pressurizing unit 22. That is, in the same manner as in the cylindrical pressurizing unit 22 in Embodiment 1, the mesh plate-like pressurizing unit 22 in Embodiment 4 performs a motion of
15 reciprocating along the screw shaft 24 and the guide shaft 26 to subject the dust-collecting filter 21 to friction. The mesh plate-like pressurizing unit 22 in Embodiment 4 performs a vibrating motion of reciprocating within a relatively narrow range of the dust-collecting filter 21.

[0068]

20 The dust-collecting system 1 according to Embodiment 4 includes the pressurizing unit 22 which has air permeability and is relatively large. Therefore, a time period during which the pressurizing unit 22 travels on the surface of the dust-collecting filter 21 can be further shortened. Therefore, efficiency of frictional electrification by the pressuring unit 22 and the dust-collecting filter 21 can be
25 enhanced.

[0069]

As described above, in the dust-collecting system 1 according to Embodiment 4, the screw members 25 and the shaft slide members 27 are configured to travel under a state in which the dust-collecting filter 21 is pressurized by the pressurizing
30 unit 22. The pressurizing unit 22 pressurizing the dust-collecting filter 21 can travel

on the dust-collecting filter 21 while keeping a pressurizing state through the movement of the screw members 25 and the shaft slide members 27. Therefore, in addition to the surface friction of the dust-collecting filter 21, the internal friction of the dust-collecting filter 21 is enabled, with the result that an electrostatic force can be imparted to the inside of the dust-collecting filter 21 as well as to the surface of the dust-collecting filter 21. Thus, an electric charge amount to be given to the dust-collecting filter 21 can be increased. As a result, the dust-collecting performance of the dust-collecting filter 21 can be improved. Further, through an increase in size of the pressurizing unit 22, the traveling time period of the pressurizing unit 22 required for friction is shortened, and the efficiency of frictional electrification can be enhanced.

[0070]

Fifth Embodiment

Fig. 12 is a sectional view when viewed from a side surface, for schematically illustrating the dust-collecting apparatus 2 according to Embodiment 5 of the present invention. Regarding the dust-collecting system 1 including the dust-collecting apparatus 2 according to Embodiment 5, description of the same configurations as those of the dust-collecting system 1 according to Embodiment 1 is omitted.

[0071]

The dust-collecting apparatus 2 according to Embodiment 5 includes a pressurizing unit 22a serving as a first pressurizing part and a pressurizing unit 22b serving as a second pressurizing part. The pressurizing unit 22a and the pressurizing unit 22b each have the same configuration as that of the pressurizing unit 22 in Embodiment 1. However, in Embodiment 5, the pressurizing unit 22a and the pressurizing unit 22b are arranged so as to sandwich the dust-collecting filter 21 therebetween. Therefore, the pressurizing unit 22a is configured to pressurize the dust-collecting filter 21 toward one side in the first direction, and the pressurizing unit 22b is configured to pressurize the dust-collecting filter 21 toward an other side in the first direction.

[0072]

The dust-collecting apparatus 2 according to Embodiment 5 includes a drive

unit 23a, a screw shaft 24a, a screw member 25a, and a fixing frame 28a provided for the pressurizing unit 22a, and includes a drive unit 23b, a screw shaft 24b, a screw member 25b, and a fixing frame 28b provided for the pressurizing unit 22b. Therefore, the dust-collecting filter 21 is fixed by the fixing frames 28a and 28b.

5 [0073]

The pressurizing unit 22a is fixed by a shaft slide member 27a and the screw member 25a and can be moved in conjunction with the movement of the screw member 25a. Similarly, the pressurizing unit 22b is fixed by a shaft slide member 27b and the screw member 25b and can be moved in conjunction with the movement of the screw member 25b.

10 [0074]

A polymer material having a high insulation property is used for the pressurizing units 22a and 22b. The material has the volume specific resistivity ($\Omega \cdot \text{cm}$) of 10 raised to the 8th power or more as a reference of an insulation property, and polystyrene, an ABS resin, polypropylene, PC, PC/ABS, modified PPE, PBT, a phenol resin, a melamine resin, a natural rubber, a styrene-butadiene rubber, a butadiene rubber, a butyl rubber, an ethylenepropylene rubber, a chloroprene-acrylic rubber, a nitrile-butadiene rubber, a silicone rubber, a fluororubber, a polysulfide rubber, or other materials can be used. When a material having a low insulation property is used for the pressurizing units 22a and 22b, there is a risk in that the charge generated in the dust-collecting filter 21 moves to degrade the dust-collecting performance of the dust-collecting filter 21.

15 [0075]

When the pressurizing unit 22a and the pressurizing unit 22b are provided, the deformation amount of the surface of the dust-collecting filter 21 satisfies $\Delta L2a + \Delta L2b$, where $\Delta L2a$ represents the deformation amount of the surface of the dust-collecting filter 21 at a time of pressurization by the pressurizing unit 22a, and $\Delta L2b$ represents the deformation amount of the surface of the dust-collecting filter 21 at a time of pressurization by the pressurizing unit 22b. Therefore, the change amount of the surface of the dust-collecting filter 21 is increased with the configuration including the

plurality of pressurizing units 22a and 22b, and the movement amount of the fiber materials 211 is increased, with the result that the pressure in association with friction is increased. Thus, the effect of frictional electrification is enhanced, thereby also improving the dust-collecting performance of the dust-collecting filter 21.

5 [0076]

As described above, in the dust-collecting system 1 according to Embodiment 5, the screw members 25a and 25b and the shaft slide members 27a and 27b are configured to move under a state in which the dust-collecting filter 21 is pressurized by the pressurizing units 22a and 22b. The pressurizing units 22a and 22b
10 pressurizing the dust-collecting filter 21 can travel on the dust-collecting filter 21 while keeping a pressurizing state. Therefore, in addition to the surface friction of the dust-collecting filter 21, the internal friction of the dust-collecting filter 21 is enabled, with the result that an electrostatic force can be imparted to the inside of the dust-collecting filter 21 as well as to the surface of the dust-collecting filter 21. Further,
15 with the configuration including the plurality of pressurizing units 22a and 22b, the pressure in association with friction to be given is increased. Thus, the electric charge amount to be given to the dust-collecting filter 21 can be increased. As a result, the dust-collecting performance of the dust-collecting filter 21 can be improved.

[0077]

20 Sixth Embodiment

Fig. 13 is a sectional view when viewed from a front surface, for schematically illustrating the dust-collecting apparatus 2 according to Embodiment 6 of the present invention. Fig. 14 is a sectional view when viewed from a side surface, for schematically illustrating the dust-collecting apparatus 2 according to Embodiment 6.
25 Regarding the dust-collecting system 1 including the dust-collecting apparatus 2 according to Embodiment 6, description of the same configurations as those of the dust-collecting system 1 according to Embodiment 1 is omitted.

[0078]

The dust-collecting apparatus 2 according to the six embodiment includes a
30 rotating body 20a and a rotating body 20b arranged so as to sandwich the dust-

collecting filter 21 therebetween. The rotating body 20a includes the pressurizing unit 22a serving as the first pressurizing part configured to pressurize the dust-collecting filter 21 toward one side in the first direction, and the rotating body 20b includes the pressurizing unit 22b serving as the second pressurizing part configured to pressurize the dust-collecting filter 21 toward an other side in the first direction. The rotating body 20a is rotatably fixed by a rotation shaft 241 and a shaft stopper 251a, and the rotating body 20b is rotatably fixed by the rotation shaft 241 and a shaft stopper 251b.

[0079]

The rotating body 20a is connected to the drive unit 23 through intermediation of a drive belt 271a, and the rotating body 20b is connected to the drive unit 23 through intermediation of a drive belt 271b. The rotating body 20a and the rotating body 20b are arranged at positions of pressurizing the dust-collecting filter 21 and are rotated by the drive of the drive unit 23. That is, the rotating body 20a and the rotating body 20b are configured to subject the dust-collecting filter 21 to friction by rolling in a direction substantially perpendicular to a pressurizing direction under a state of pressurizing the dust-collecting filter 21.

[0080]

A polymer material having a high insulation property is used for the pressurizing units 22a and 22b. The material has the volume specific resistivity ($\Omega \cdot \text{cm}$) of 10^8 or more as a reference of an insulation property, and polystyrene, an ABS resin, polypropylene, PC, PC/ABS, modified PPE, PBT, a phenol resin, a melamine resin, a natural rubber, a styrene-butadiene rubber, a butadiene rubber, a butyl rubber, an ethylene propylene rubber, a chloroprene-acrylic rubber, a nitrile-butadiene rubber, a silicone rubber, a fluororubber, a polysulfide rubber, or other materials can be used. When a material having a low insulation property is used for the pressurizing units 22a and 22b, there is a risk in that the charge generated in the dust-collecting filter 21 moves to degrade the dust-collecting performance of the dust-collecting filter 21.

[0081]

The rotating body 20a is rotated in conjunction with the movement of the drive belt 271a responding to the drive of the drive unit 23. The motion speed of the drive belt 271a depends on a size of a shaft diameter and a rotation speed of the drive unit 23. The rotating body 20b is rotated in conjunction with the movement of the drive belt 271b responding to the drive of the drive unit 23. The motion speed of the drive belt 271b depends on the size of the shaft diameter and the rotation speed of the drive unit 23. That is, the rotational motion of the rotating body 20a and the rotating body 20b is controlled by the drive unit 23.

[0082]

The rotating body 20a and the rotating body 20b can be rotated and moved at different movement speeds by differentiating the shaft diameter of the drive unit 23 at a position where the drive belt 271a is mounted from the shaft diameter of the drive unit 23 at a position where the drive belt 271b is mounted. That is, through adjustment of the size of the shaft diameter of the drive unit 23, a first rotational movement speed at which the first pressurizing part is moved and a second rotational movement speed at which the second pressurizing part is moved can be controlled to be different from each other.

[0083]

When the drive unit 23 is driven, in a case in which the pressurizing unit 22a and the pressurizing unit 22b are positioned so as to be opposed to each other with respect to the dust-collecting filter 21, it is preferred that the first rotational movement speed and the second rotational movement speed be set to the same speed. When the first rotational movement speed and the second rotational movement speed are set to the same speed, the rotating body 20a and the rotating body 20b are rotated while the opposing state between the pressurizing unit 22a and the pressurizing unit 22b is maintained. This is because, when the pressurizing state maintained by the pressurizing unit 22a and the pressurizing unit 22b is rotated and moved with respect to the entire dust-collecting filter 21, the entire dust-collecting filter 21 is pressurized, thereby being capable of obtaining a large frictional electrification effect.

[0084]

When the drive unit 23 is driven, in a case in which the pressurizing unit 22a and the pressurizing unit 22b are not positioned so as to be opposed to each other with respect to the dust-collecting filter 21, it is preferred that the first rotational movement speed and the second rotational movement speed be set to different speeds. This is because, when the first rotational movement speed and the second rotational movement speed are set to different speeds, the pressurizing unit 22a and the pressurizing unit 22b are repeatedly switched between an opposing state and a non-opposing state at various portions on the dust-collecting filter 21, thereby being capable of pressurizing the entire dust-collecting filter 21.

[0085]

As a method of pressurizing the dust-collecting filter 21 with the pressurizing unit 22a and the pressurizing unit 22b, a configuration involving rotating the rotating body 20a and the rotating body 20b in the same direction may be employed, or a configuration involving rotating the rotating body 20a and the rotating body 20b in opposite directions may be employed. When the drive belt 271a and the drive belt 271b are configured to move in the same direction with respect to the drive of the drive unit 23 by using, for example, a gear, the rotating body 20a and the rotating body 20b can be rotated in the same direction. When the drive belt 271a and the drive belt 271b are configured to move in opposite directions with respect to the drive of the drive unit 23, the rotating body 20a and the rotating body 20b can be rotated in opposite directions. When the rotating body 20a and the rotating body 20b are rotated in the same direction, the pressurizing unit 22a that is a bar-like part provided in a radial direction of the rotating body 20a, and the pressurizing unit 22b that is a bar-like part provided in a radial direction of the rotating body 20b are rotated at a certain defined distance. Therefore, the entire dust-collecting filter 21 can be pressurized under a nearly equal pressure. When the rotating body 20a and the rotating body 20b are rotated in opposite directions, the distance between the pressurizing unit 22a of the rotating body 20a and the pressurizing unit 22b of the rotating body 20b is increased or decreased depending on the rotation, and the rotating body 22a and the rotating body 20b may overlap one another. Therefore, a

value of the pressure of pressurizing the dust-collecting filter 21 can be increased or decreased for each period.

[0086]

As described above, in the dust-collecting system 1 according to the six
5 embodiment, the rotating body 20a and the rotating body 20b are rotated under a
state in which the dust-collecting filter 21 is pressurized by the pressurizing units 22a
and 22b. The pressurizing units 22a and 22b pressurizing the dust-collecting filter
21 can be moved on the dust-collecting filter 21 while keeping a pressurizing state.
Therefore, the inside of the dust-collecting filter 21 as well as the surface of the dust-
10 collecting filter 21 can be subjected to friction, and an electrostatic force can be
imparted to the inside of the dust-collecting filter 21 as well as to the surface of the
dust-collecting filter 21. Further, due to the configuration involving friction caused by
a rotational motion, the moving spaces of the pressurizing units 22a and 22b can be
reduced, and in addition, the dust-collecting apparatus 2 can be downsized. Thus,
15 an electric charge amount to be given to the dust-collecting filter 21 can be increased
while the dust-collecting apparatus 2 is downsized.

[0087]

Regarding the dust-collecting system 1 according to Embodiment 6, description
is given of the configuration in which the dust-collecting system 1 includes the rotating
20 body 20a configured to subject a front surface of the dust-collecting filter 21 to friction
and the rotating body 20b configured to subject a rear surface of the dust-collecting
filter 21 to friction. However, the dust-collecting system 1 may include one rotating
body configured to subject any one of the front surface and the rear surface of the
dust-collecting filter 21 to friction. With this configuration, the number of the rotating
25 bodies to be required is reduced, and hence a reduction in manufacturing cost can be
expected.

[0088]

The present invention is not limited to the specific details as mentioned and
described above and the representative embodiments. Modified examples and
30 effects easily derived by a person skilled in the art are also included in the present

invention. Thus, various changes may be made without departing from the spirit or scope of the general concept of the present invention defined by the scope of claims and equivalents thereof.

5 Reference Signs List

[0089]

1 dust-collecting system 2 dust-collecting apparatus 20a rotating body 20b rotating body 21 dust-collecting filter 211 fiber material 211a fiber material 221b fiber material 22 pressurizing unit 22a pressurizing unit 22b pressurizing unit 23 drive unit 24 screw shaft 241 rotation shaft 25 screw member 25a screw member 25b screw member 251a shaft stopper 251b shaft stopper 26 guide shaft 27 shaft slide member 27a shaft slide member 27b shaft slide member 271a drive belt 271b drive belt 28 fixing frame 29 air-permeable member 3 fan 4 air passage 5 dust 6 sensing device

CLAIMS

1. A dust-collecting apparatus for collecting dust contained in air flowing in an air flow direction by using a dust-collecting filter, the dust-collecting apparatus comprising:
 - a pressurizing unit configured to pressurize the dust-collecting filter in the air flow direction;
 - a support unit configured to be movable, and to support the pressurizing unit against the dust-collecting filter; and
 - a drive unit configured to, when the pressurizing unit pressurizes the dust-collecting filter, move the support unit along a crossing direction crossing the air flow direction, wherein
 - the dust-collecting filter includes fiber materials that cause an electrostatic force by friction with the pressurizing unit,
 - the pressurizing unit is connected to the support unit, and is moved by the drive unit through the support unit,
 - the dust-collecting filter contains an electret material that causes polarization, the electret material includes
 - a first fiber material having a first triboelectric series, and
 - a second fiber material having a second triboelectric series different from the first triboelectric series, and
 - the pressurizing unit is configured to
 - travel along the dust-collecting filter through drive of the drive unit, and
 - roll along a direction perpendicular to a pressurizing direction in which the pressurizing unit pressurizes the dust-collecting filter.
2. The dust-collecting apparatus of claim 1, wherein the pressurizing unit is configured to travel along a direction perpendicular to the pressurizing direction in which the pressurizing unit pressurizes the dust-collecting filter.
3. The dust-collecting apparatus of claim 1, wherein the pressurizing unit is configured to vibrate along a direction perpendicular to the pressurizing direction in which

the pressurizing unit pressurizes the dust-collecting filter.

4. The dust-collecting apparatus of any one of claims 1 to 3, wherein the pressurizing unit has a cylindrical shape.

5. A dust-collecting apparatus for collecting dust contained in air flowing in an air flow direction by using a dust-collecting filter, the dust-collecting apparatus comprising:

- a pressurizing unit configured to pressurize the dust-collecting filter in the air flow direction;

- a support unit configured to be movable, and to support the pressurizing unit against the dust-collecting filter; and

- a drive unit configured to, when the pressurizing unit pressurizes the dust-collecting filter, move the support unit along a crossing direction crossing the air flow direction, wherein

- the dust-collecting filter includes fiber materials that cause an electrostatic force by friction with the pressurizing unit,

- the pressurizing unit is connected to the support unit, and is moved by the drive unit through the support unit,

- the dust-collecting filter contains an electret material that causes polarization,

- the electret material includes

- a first fiber material having a first triboelectric series, and

- a second fiber material having a second triboelectric series different from the first triboelectric series,

- the pressurizing unit includes

- a first pressurizing part configured to pressurize the dust-collecting filter by being brought into contact with one surface of the dust-collecting filter, and

- a second pressurizing part configured to pressurize the dust-collecting filter by being brought into contact with an other surface of the dust-collecting filter,

- the support unit includes

- a first support part arranged on the one surface and configured to support the first pressurizing part, and

a second support part arranged on the other surface and configured to support the second pressurizing part, and

the drive unit is configured to move the first pressurizing part at a first movement speed and move the second pressurizing part at a second movement speed different from the first movement speed.

6. The dust-collecting apparatus of claim 5, wherein the pressurizing unit is configured to travel along the dust-collecting filter through drive of the drive unit.

7. A dust-collecting method of collecting dust contained in air flowing in an air flow direction by using a dust-collecting filter,

the method comprising:

a preparation step of preparing a pressurizing unit configured to pressurize the dust-collecting filter in the air flow direction, a dust-collecting filter including fiber materials that cause an electrostatic force by friction with the pressurizing unit, and containing an electret material that causes polarization and that includes a first fiber material having a first triboelectric series and a second fiber material having a second triboelectric series different from the first triboelectric series, and a support unit connected to the pressurizing unit and configured to be movable, and to support the pressurizing unit against the dust-collecting filter;

a first step of moving the support unit along a crossing direction crossing the air flow direction when the pressurizing unit pressurizes the dust-collecting filter; and

a second step of moving the pressurizing unit in which the pressurizing unit travels along the dust-collecting filter through movement of the support unit in the first step, and rolls along a direction perpendicular to a pressurizing direction in which the pressurizing unit pressurizes the dust-collecting filter.

8. A dust-collecting method of collecting dust contained in air flowing in an air flow direction by using a dust-collecting filter,

the method comprising:

a preparation step of preparing a pressurizing unit configured to pressurize the dust-collecting filter in the air flow direction, a dust-collecting filter including fiber materials that cause an electrostatic force by friction with the pressurizing unit, and containing an electret material that causes polarization and that includes a first fiber material having a first triboelectric series and a second fiber material having a second triboelectric series different from the first triboelectric series, and a support unit connected to the pressurizing unit and configured to be movable, and to support the pressurizing unit against the dust-collecting filter;

a first step of moving the support unit along a crossing direction crossing the air flow direction when the pressurizing unit pressurizes the dust-collecting filter; and

a second step of moving the pressurizing unit through movement of the support unit in the first step, wherein

the pressurizing unit includes

a first pressurizing part configured to pressurize the dust-collecting filter by being brought into contact with one surface of the dust-collecting filter, and

a second pressurizing part configured to pressurize the dust-collecting filter by being brought into contact with an other surface of the dust-collecting filter, and

the support unit includes

a first support part arranged on the one surface and configured to support the first pressurizing part, and

a second support part arranged on the other surface and configured to support the second pressurizing part, and

in the pressurizing part, the first pressurizing part is moved at a first movement speed and the second pressurizing part is moved at a second movement speed different from the first movement speed.

9. A dust-collecting system for collecting dust contained in air flowing through an air passage in an air flow direction, comprising:

a dust-collecting filter configured to collect the dust by causing the air to pass through the dust-collecting filter;

a treatment apparatus configured to treat the air after passing through the

dust-collecting filter;

a pressurizing unit configured to pressurize the dust-collecting filter in the air flow direction;

a support unit configured to be movable, and to support the pressurizing unit against the dust-collecting filter; and

a drive unit configured to move the support unit when the pressurizing unit pressurizes the dust-collecting filter, to thereby move the pressurizing unit along a crossing direction crossing the air flow direction, wherein

the dust-collecting filter includes fiber materials that cause an electrostatic force by friction with the pressurizing unit,

the pressurizing unit is connected to the support unit, and is moved by the drive unit through the support unit,

the dust-collecting filter contains an electret material that causes polarization,

the electret material includes

a first fiber material having a first triboelectric series, and

a second fiber material having a second triboelectric series different from the first triboelectric series, and

the pressurizing unit is configured to

travel along the dust-collecting filter through drive of the drive unit, and

roll along a direction perpendicular to a pressurizing direction in which the pressurizing unit pressurizes the dust-collecting filter.

10. A dust-collecting system for collecting dust contained in air flowing through an air passage in an air flow direction, comprising:

a dust-collecting filter configured to collect the dust by causing the air to pass through the dust-collecting filter;

a treatment apparatus configured to treat the air after passing through the dust-collecting filter;

a pressurizing unit configured to pressurize the dust-collecting filter in the air flow direction;

a support unit configured to be movable, and to support the pressurizing unit

against the dust-collecting filter; and

a drive unit configured to move the support unit when the pressurizing unit pressurizes the dust-collecting filter, to thereby move the pressurizing unit along a crossing direction crossing the air flow direction, wherein

the dust-collecting filter includes fiber materials that cause an electrostatic force by friction with the pressurizing unit,

the pressurizing unit is connected to the support unit, and is moved by the drive unit through the support unit,

the dust-collecting filter contains an electret material that causes polarization,

the electret material includes

a first fiber material having a first triboelectric series, and

a second fiber material having a second triboelectric series different from the first triboelectric series,

the pressurizing unit includes

a first pressurizing part configured to pressurize the dust-collecting filter by being brought into contact with one surface of the dust-collecting filter, and

a second pressurizing part configured to pressurize the dust-collecting filter by being brought into contact with an other surface of the dust-collecting filter,

the support unit includes

a first support part arranged on the one surface and configured to support the first pressurizing part, and

a second support part arranged on the other surface and configured to support the second pressurizing part, and

in the pressurizing part, the first pressurizing part is moved at a first movement speed and the second pressurizing part is moved at a second movement speed different from the first movement speed.

11. The dust-collecting system of claim 9, further comprising a sensing device configured to detect the dust contained in the air,

wherein the drive unit is configured to move the pressurizing unit when the sensing device detects the dust contained in the air.

12. The dust-collecting system of claim 10, further comprising a sensing device configured to detect the dust contained in the air,
- wherein the drive unit is configured to move the pressurizing unit when the sensing device detects the dust contained in the air.