DESCRIPTION

Title of Invention

DUST COLLECTING DEVICE AND AIR CONDITIONING APPARATUS

Technical Field

[0001]

The present invention relates to a dust collecting device that produces static electricity by friction to collect dust, and an air conditioning apparatus provided with the dust collecting device.

Background Art

[0002]

An electrostatic precipitator is provided as a given type of dust collecting device that collects dust in the air. The electrostatic precipitator includes a charging unit that produces a corona discharge by applying a high voltage from a high-voltage power supply to a wire electrode and charges dust in the air with produced ions, and a dust-collecting unit that produces an electrostatic field by applying a high voltage from the high-voltage power supply between plate-like electrodes, and electrostatically collects the charged dust on the plate. Using such an electrostatic collection mechanism, the electrostatic precipitator collects dust with a low pressure loss. However, in general, electrostatic precipitators use discharge and a high voltage, and may be therefore hard to handle.

[0003]

In contrast, a frictional charging type dust collecting device is known as a dust collecting device that collects dust in the air without applying a high voltage (see, for example, Patent Literature 1 and 2). In this type of dust collecting device, when friction acts on an insulator, the insulator is charged to become a charged body, a Coulomb force is produced between the charged body and dust in the air, and the dust is collected on the charged body by the Coulomb force. The frictional charging type dust collecting devices disclosed in Patent Literature 1 and 2 do not use discharge or a high voltage, and can thus be easily handled, as compared with the electrostatic precipitator.

Citation List

Patent Literature

[0004]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2002-336733

Patent Literature 2: Japanese Unexamined Patent Application Publication No. 2002-186879

Summary of Invention

Technical Problem

[0005]

However, in the friction charging type dust collecting device, the collection rate of particles to be collected in the air needs to be further improved.

[0006]

The present invention has been made to solve the above problem, and an object of the invention is to provide a friction charging type dust collecting device that achieves a higher particle collection rate.

Solution to Problem

[0007]

A dust collecting device according to an embodiment of the present invention includes a plurality of dust collection bodies that are arranged apart from each other such that an air passage is provided between the dust collection bodies to allow air to pass through the air passage, the duct collection bodies being charged when friction acts on the dust collection bodies, and one or more friction bodies that are rubbed against the dust collection bodies to cause the dust collection bodies to be discharged.

At least one of two of the dust collection bodies that are located opposite to each other with respect to the air passage includes one or more projections that project toward the air passage.

Advantageous Effects of Invention

[0008]

In the dust collecting device according to the embodiment of the present invention, because of provision of the one or more projections on the dust collection

bodies, a non-uniform electric field is produced around the dust collection bodies and a gradient force is induced, thereby improving the particle collection rate in the friction charging dust collecting device.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a schematic diagram illustrating a dust collecting device according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a side view illustrating a main portion of the dust collecting device according to Embodiment 1 of the present invention.

[Fig. 3] Fig. 3 is a perspective view illustrating an example of the shape of each of dust collection bodies in Embodiment 1 of the present invention.

[Fig. 4] Fig. 4 is a perspective view illustrating another example of the shape of each of the dust collection bodies in Embodiment 1 of the present invention.

[Fig. 5] Fig. 5 is a perspective view illustrating still another example of the shape of each of the dust collection bodies in Embodiment 1 of the present invention.

[Fig. 6] Fig. 6 is a side view illustrating motions of a friction body and projections in Embodiment 1 of the present invention.

[Fig. 7] Fig. 7 is a side view illustrating a main portion of a dust collecting device according to Embodiment 2 of the present invention.

[Fig. 8] Fig. 8 is a side view illustrating a main portion of a dust collecting device according to Embodiment 3 of the present invention.

[Fig. 9] Fig. 9 is a perspective view illustrating a main portion of a dust collecting device according to Embodiment 4 of the present invention.

[Fig. 10] Fig. 10 is a side view illustrating the main portion of the dust collecting device according to Embodiment 4 of the present invention.

[Fig. 11] Fig. 11 is another side view illustrating the main portion of the dust collecting device according to f Embodiment 4 of the present invention.

Description of Embodiments

[0010]

Dust collecting devices according to preferred embodiments of the present invention will be described with reference to the drawings. Also, in descriptions regarding each of the figures, components which are the same as or equivalent to those in a previous figure are denoted by the same reference signs.

[0011]

Embodiment 1

Fig. 1 is a schematic view illustrating a dust collecting device according to Embodiment 1 of the present invention, and Fig. 2 illustrates a main portion of the dust collecting device.

[0012]

A dust collecting device 1 is provided with a plurality of dust collection bodies 2, a plurality of friction bodies 3 that are rubbed against the dust collection bodies 2 to cause the dust collection bodies 2 to be charged with static electricity, a housing including a shell 5 that covers the dust collection bodies 2 and the friction bodies 3, and a driving unit 4 that holds and frictionally moves the friction bodies 3 along outer surfaces of the dust collection bodies 2.

[0013]

The dust collection bodies 2 are arranged such that between any adjacent two of the dust collection bodies 2, an air passage 20 is provided. That is, the dust collection bodies 2 are disposed opposite to each other, with the air passages 20 interposed between the duct collection bodies 2. Also, the shell 5 is provided with an air inlet 51 that allows air to flow in, and an air outlet 52 that allows air having passed through the air passages 20 to flow out. Air containing particles to be collected flows into the shell 5 from the air inlet 51, passes through the air passages 20 formed between the adjacent dust collection bodies 2, and the particles of the air are collected so that the air is purified. Then, the purified air flows out from the air outlet 52.

[0014]

The dust collection bodies 2 are formed of material that produces static electricity and are charged when rubbed against the friction bodies 3. On a surface of each of the dust collection bodies 2, a projection 21 or projections 21 that project toward the air

passages 20 are provided. The number of the projections 21 is not limited, and it suffices that the number of the projections is one or more. Also, the projection or projections 21 may be provided on only one or both of dust collection bodies 2 that are located opposite to each other, with an associated air passage 20 interposed between the duct collection bodies 2.

[0015]

When the dust collection bodies 2 are charged by friction, an electric field is produced between adjacent ones of the dust collection bodies 2. In the electric field, a coulomb force acts on charged particles in the air, and because of the action of this force, the particles are attracted to adhere to surfaces of the dust collection bodies 2, whereby the particles are collected.

[0016]

At this time, because of provision of the projections 21 on the surfaces of the charged dust collection bodies 2, the distance between any two adjacent dust collection bodies 2 opposite to each other varies is short at distal end portions of associated projections 21, and the distance between any two adjacent dust collection bodies 2 is long at proximal end portions of the associated projections 21, that is, the distance is not uniform. Therefore, electric lines of force converge on the distal end portions of the projections 21. On the other hand, in the vicinity of the distal end portions of the projections 21, electric lines of force from one of the adjacent dust collection bodies 2 opposite to each other, at which the projections 21 are not located, do not converge. In the vicinity of the projections 21, a non-uniform electric field having an electric field gradient in directions along the electric lines of force is produced, and a gradient force is induced. The gradient force is a force that causes polarization in which particles are unbalanced and attracted toward a strong electric field because of the electric field gradient of the non-uniform electric field, and the gradient force acts even if the particles are not charged. Therefore, because the gradient force also acts on uncharged particles in the air and the particles are attracted to and collected at the dust collection bodies, a high collection rate is achieved, compared with the case where the projections 21 are not provided.

[0017]

The friction bodies 3 are formed of material that produces static electricity when rubbed against the dust collection bodies 2, and are disposed in contact with the surfaces of the dust collection bodies 2. In Embodiment 1, each of the friction bodies 3 is provided in an air passage 20 formed between associated dust collection bodies 2 opposite to each other, and is provided to rub against the surfaces of the associated dust collection bodies 2 at the same time. Also, the friction bodies 3 are arranged such that any adjacent two of the friction bodies 3 can rub against an associated single dust collection body 2, with the single dust collection body 2 sandwiched between the two friction bodies 3. It should be noted that the arrangement of the friction bodies 3 is not limited to the above. The friction bodies 3 may also be provided such that regarding any adjacent dust collection bodies 2 facing the same passage 20, an associated friction body 3 is rubbed against a surface of one of the adjacent dust collection bodies 2, and another associated friction body 3 is rubbed against a surface of the other dust collection body 2. Additionally, regarding the above rubbing operation, a friction body 3 may be rubbed against only one surface of a dust collection body 2, that is, the dust collection body 2 may be subjected to the rubbing operation without being sandwiched between two friction bodies 3.

[0018]

The friction bodies 3 extend along the flow direction of air in the air passages 20, and are provided in such a manner as to be moved in a direction crossing the flow of the air. Thereby, it is possible to reduce blockage of passage of air by the friction bodies 3.

[0019]

As a combination of the materials of the dust collection bodies 2 and the friction bodies 3, for example, acrylic and nylon, polyester and nylon, PTFE and nylon, or polypropylene and nylon are used. If the materials are far from each other in triboelectric series, the charged power is great. This is preferable. In addition, the materials of the dust collection bodies 2 and the friction bodies 3 may also be reversed.

[0020]

The driving unit 4 includes a driving component 41 such as a motor, a drive shaft 42 having an outer surface having a spiral groove formed therein, and a holding body 43 that holds the friction bodies 3. The holding body 43 is engaged with the drive shaft 42, and the drive shaft 42 is connected to the driving component 41. When the driving component 41 is rotated, the drive shaft 42 is also rotated, as a result of which the engaged holding body 43 is moved, and the friction bodies 3 held by the holding body 43 are thus moved to rub against the surfaces of the dust collection bodies 2. The drive shaft 42 extends perpendicular to the flow direction of air that flows through the air passages 20 and a direction where the projections 21 are arranged.

[0021]

The driving component 41 and the drive shaft 42 that are included in the driving unit 4 are located outside the air passages 20 each provided between associated adjacent two of the dust collection bodies 2 that are opposite to each other. Thereby, the flow of air flowing through the air passages 20 is not blocked, and the rise in the pressure loss can be reduced.

[0022]

In the case of causing the dust collection bodies 2 to be charged by friction, the driving unit 4 is operated to cause the friction bodies 3 to move and rub against the dust collection bodies 2, thereby charging the dust collection bodies 2. When the rubbing operation is not performed, the friction bodies 3 are located at end portions of the air passages 20 in order to reduce blocking of the passage of air. In the case of re-charging the dust collection bodies 2, the friction bodies 3 are moved by the driving unit 4 to rub against the dust collection bodies 2 to charge the dust collection bodies 2 with static electricity. Furthermore, by charging the dust collection bodies 2 with the friction bodies 3, it is also possible to remove dust that adheres to the dust collection bodies 2 and loses charge, from the dust collection bodies 2.

[0023]

In the dust collecting device according to Embodiment 1 that has the above configuration, since the projections 21 are provided on surfaces of the dust collection

bodies 2, a gradient force is induced in addition to the Coulomb force, and the collection rate of particles in air can be raised.

[0024]

Next, the dust collection bodies 2 and the friction bodies 3 will be described in more detail.

[0025]

As illustrated in Fig. 1, the projections 21 provided on the dust collection bodies 2 are plate-like, and are provided to extend along the flow direction of air that flows from the air inlet 51 toward the air outlet 52 through the air passages 20. Thereby, it is possible to reduce blockage of passage of air flowing through the air passages 20 by the projections 21, reduce an increase in the pressure loss, and cause air to flow more efficiently.

[0026]

It should be noted that the shape of each of the projections 21 is not limited to the shape of a plate, that is, it may be the shape of a thorn, a fiber (napped pile) or a wave, and even if the projections 21 have any of the above shapes, they can be disposed along the flow direction of air that passes through the air passages 20. Figs. 3 to 5 illustrates examples of the shapes of the projections 21. In particular, it is preferable that each of the projections be formed in the shape of a thorn or a fiber as illustrated in Fig. 4, because the number of projections that serve as sources which produces a non-uniform electric field is large, as a result of which the inducement of the gradient force is promoted, and the particle collection rate is further raised.

[0027]

Furthermore, the projections 21 are flexible. Thereby, when the friction bodies 3 are moved to rub against the surfaces of the dust collection bodies 2, as illustrated in Fig. 6, the projections 21 are pushed down by the friction bodies 3 and the friction bodies 3 are moved over the projections 21, and therefore the movement of the friction bodies 3 is not hindered. As illustrated in Fig. 6, after the friction bodies 3 are moved over the projections 21 pushed down, the projections 21 return to the original state to extend toward the air passages 20. Thereby, it is possible to reduce interference

between the projections 21 and the friction bodies 3, and cause the friction bodies to rub against the surfaces of the dust collection bodies 2 and thus cause the friction bodies 3 to be charged efficiently.

[0028]

In particular, in the case where the projections 21 are provided along the flow direction of air so as not to block the flow of air passing through the air passages 20, and the friction bodies 3 located to extend along the flow direction of air are moved in the direction crossing the flow of air, the projections 21 and the friction bodies 3 easily interfere with each other. In view of this point, the projections 21 are made to have flexibility. It is therefore possible to cause the friction bodies 3to efficiently rub against the duct collection bodies 2 and efficiently charge the duct collection bodies, without hindering the flow of air, by reducing interference between the projections 21 and the friction bodies 3.

[0029]

The friction bodies 3 each include a core 31 serving as a base and a friction material 32 provided on the core 31. The friction material 32 is formed of material that produces static electricity and charges the dust collection bodies 2 when rubbing against the dust collection bodies 2. For example, as the friction material 32, material formed in the shape of, for example, a brush, a sponge, a plate, a cylinder, a film or nonwoven fabric can be used. Also, the external form of the friction material 32 may be a form that follows the surface shapes of dust collection bodies 2. For example, in the case where the dust collection bodies 2 are curved, the external form of the friction material 32 may be adjusted in accordance with the curve. Since the external form of the friction material 32 follows the surface shapes of the dust collection bodies 2, the friction material 32 can reliably rub against the surfaces of the dust collection bodies 2. Furthermore, the shape of the core 31 is not limited to the shape of a plate. For example, the core 31 may be formed in the shape of a plate having a projection or substantially in the shape of a wave that follows surfaces of dust collection bodies 2.

[0030]

In addition, it is preferable that the core 31 be formed of material having high stiffness, whereby the core 31 is not warped when the friction body 3 is moved, and it is possible to prevent an increase in the resistance to the movement of the friction body 3. By contrast, it is preferable that the friction material 32 be formed of material having flexibility, whereby the friction material 32 can be deformed in accordance with the surface shape of the dust collection body 2, and can efficiently rub against the dust collection body 2.

[0031]

Also, the friction bodies 3 are grounded. To be more specific, the core 31 included in the friction body 3 is formed of material having a high conductivity such as metal, and is electrically connected to a grounding electrode located outside the apparatus, by, for example, copper wire. Preferably, the friction material 32 should have a high conductivity, and may be formed of material having conductivity, such as material containing carbon or metal.

[0032]

Since the friction bodies 3 are grounded, electric charge that moves from the dust collection bodies 2 to the friction bodies 3 when the friction bodies 2 rub against the dust collection bodies 2 can be caused to escape from the friction bodies 3 to the grounding electrode. It is therefore possible to prevent saturation of the friction bodies 3, and efficiently charge the dust collection bodies 2.

[0033]

Furthermore, in Embodiment 1, with each dust collection body 2 sandwiched between associated friction bodies 3 grounded, the friction bodies 3 are rubbed against the duct collection body 2. In the case where with each dust collection bodies 2 sandwiched between associated friction bodies 3, the friction bodies 3 are rubbed against the dust collection bodies 2, when viewed microscopically, gaps are sometimes momentarily provided between the friction bodies 3 and the dust collection bodies 2 because of the movement of the friction bodies 3. It is assumed that a gap is provided between one of two friction bodies 3 between which an associated duct collection body 2 is sandwiched and the duct collection body 2, and the other friction body 3 and the

dust collection body 2 are in contact with each other. In this case, the above one of the two friction bodies 2 is electrically connected to the grounding electrode. At this time, because the above one of the friction bodies 3 is electrically connected to the grounding electrode as described above, it can be regarded as a grounding conductor, and because a capacitor is provided in the gap between the grounding conductor and the dust collection body 2, the capacitance of the dust collection body 2 increases momentarily and partially.

[0034]

It should be noted that if it is assumed that an ideal capacitor is provided in the air passage interposed between the grounding conductor and the dust collection body 2, the relationship between the surface potential V [V] of the dust collection body, the quantity of charge Q [C] of the dust collection body, and the capacitance C [F] of the dust collection body can be expressed by the following formula.

[0035] [Formula 1]

$$V = \frac{Q}{C} \quad \cdots \quad (1)$$

[0036]

As expressed in above formula (1), as the capacitance C increases, the quantity of charge Q that can be stored by the dust collection body increases. When the above other friction body 3 rubs against the dust collection body 2, with such a partial capacitor as described above formed and the capacitance C increased, the dust collection body 2 can obtain a larger quantity of charge.

[0037]

Such a partial capacitor as described above is formed momentarily, and is lost when the friction body 3 is moved. However, even if a single capacitor is lost, a new capacitor is formed at another location in accordance with the movement of the friction body 3, and similarly, formation of a capacitor is repeated a number of times. Furthermore, even if a partial capacitor is lost, the charge on the surface of the dust collection body 2 that is given, with the capacitance increased, is not lost immediately, and the dust collection body 2 can thus hold a large quantity of charge. Thereby, an

electrostatic field having a high electric-field strength is produced in the vicinity of the surface of the dust collection body 2. Because the Coulomb force and the gradient force act more strongly as the electric-field strength increases, a larger number of particles in the air can be collected by increasing the quantity of charge as described above.

[0038]

It should be noted that regarding Embodiment 1, although it is described above by way of example that two friction bodies 3 between which an associated dust collection body 2 is sandwiched are both grounded, this is not limitative, and it suffices that at least one of the friction bodies 3 is grounded. If at least one of the friction bodies 3 is grounded, it is possible to increase the quantity of charge as described above. Furthermore, it is also possible to use a grounding conductor made of a metal block (for example, a stainless block) instead of one of the friction bodies 3, and with the dust collection body 2 sandwiched between this grounding conductor and the friction body 3, the conductor and the friction body can be rubbed against the dust collection body 2.

[0039]

Also, the dust collecting device 1 according to Embodiment 1 may be used solely, but it is also possible to incorporate the dust collecting device 1 in, for example, an air conditioning apparatus provided with a fan that produces a flow of air that passes through the air passages 20.

[0040]

Embodiment 2

A dust collecting device according to Embodiment 2 is the same as those according to Embodiment 1 except for the configuration of the dust collection bodies 2. Embodiment 2 will be described below by referring mainly to the differences between Embodiments 1 and 2.

[0041]

Fig. 7 illustrates a main portion of the dust collecting device according to Embodiment 2. In the dust collecting device of Embodiment 2, first dust collection

bodies 22 that are positively charged by friction with the friction bodies 3 and second dust collection bodies 23 that are negatively charged by friction with the friction bodies 3 are provided as the dust collection bodies 2. Of any adjacent two dust collection bodies 2 located opposite to each other, one is the first dust collection body 22 and the other is the second dust collection body 23. An example of each of the first dust collection bodies 22 that are positively charged is polyamide (PA6), which has a strong tendency to be positively charged by friction, and an example of each of the second dust collection bodies 23 that are negatively charged is polypropylene (PP), which has a strong tendency to be negatively charged. It should be noted that in the case where three or more dust collection bodies are provided, it is not particularly limited how the first dust collection bodies 22 and the second dust collection bodies 23 are arranged. The first dust collection bodies 22 and the second dust collection bodies 23 may be alternately arranged, or a plurality of first dust collection bodes 22 and a plurality of second dust collection bodies 23 may be interchanged with each other, or one of the number of first dust collection bodies and the number of second dust collection bodies may be larger than the other.

[0042]

When the friction bodies 3 are moved by the driving unit 4 to rub against the first dust collection bodies 22 and the second dust collection bodies 23, the first dust collection bodies 22 are positively charged and the second dust collection bodies 23 are negatively charged.

[0043]

In general, in the case where the dust collection bodies are positively charged, negatively charged ones of particles to be collected in the air are collected, and in the case where the dust collection bodies are negatively charged, positively charged ones of the particles to be collected in the air are collected. In the case where the dust collection bodies 2 are only dust collection bodies positively charged or only dust collection bodies negatively charged, only negatively charged particles or only positively charged particles are sufficiently collected, the other particles, that is, positively charged particles or negatively charged particles cannot be sufficiently collected.

[0044]

In contrast, the dust collecting device of Embodiment 2 is provided with different types of dust collection bodies, that is, dust collection bodies that are positively charged and dust collection bodies that are negatively charged. Thereby, negatively charged particles can be collected by the positively charged first dust collection bodies 22, and positively charged particles can be collected by the negatively charged second dust collection bodies 23. Thus, particles can be easily collected regardless of whether the particles to be collected are positively charged or negatively charged. It is therefore possible to collect particles at a high rate, as compared with the case where only dust collection bodes of the same type are used.

[0045]

Also, the average electric-field strength E [V/m] in an air passage 20 interposed between a first dust collection body 22 that is positively charged and a second dust collection body 23 that is negatively charged is expressed by the following formula (2).

[0046] [Formula 2]

$$E = \frac{\rho_+ + \rho_-}{\varepsilon_0} \quad \cdots (2)$$

[0047]

ρ_+ is a charge density [C/m^2] of the first dust collection body 22 that is positively charged, ρ_- is a charge density [C/m^2] of the second dust collection body 23 that is negatively charged, and ε_0 is the vacuum permittivity that is 8.85×10^{-12} [F/m].

[0048]

As indicated in above formula (2), the higher the charge density ρ_+ of the first dust collection body 22 that is positively charged and the charge density ρ_- of the second dust collection body 23 that is negatively charged, the higher the average electric-field strength E in the air passages 20, and a high electrostatic collection rate is obtained. It should be noted that according to formula (2), in the case in which dust collection bodies 2 made of the same material are disposed opposite to each other, in theory, the average electric-field strength is zero. However, in practice, the quantity of charge on the surface of each of the dust collection bodies varies in accordance with the position

on the surface. Thus, a produced electric field has a variable electric-field strength, and actually, the average electric-field strength is constant.

[0049]

As described above, in the dust collecting device of Embodiment 2, since the first dust collection bodies 22 that are positively charged and the second dust collection bodies 23 are negatively charged are disposed oppose to each other, particles are easily collected regardless of whether the particles to be collected are positively charged or negatively charged, and a higher collection rate can thus be obtained, as compared with the case where dust collection bodies of the same type are provided. Also, the average electric-field strength in the air passages 20 can be raised, and a higher collection rate can be obtained.

[0050]

Embodiment 3

The dust collecting device according to Embodiment 3 is the same as that according to Embodiment 1 except for the configuration of the friction bodies 3. Embodiment 3 will be described by referring mainly to the differences between Embodiments 1 and 3.

[0051]

Fig. 8 illustrates a main portion of the dust collecting device according to Embodiment 3. In the dust collecting device of Embodiment 3, the friction bodies 3 are each provided with a first friction material 33 that is negatively charged by friction with the dust collection bodies 2 and a second friction material 34 that is positively charged by friction with the dust collection bodies 2. The first friction material 33 and the second friction material 34 are disposed such that the first friction material 33 is rubbed against one of associated two dust collection bodies 2 located opposite to each other with respect to an air passage 20, and the second friction material 34 is rubbed against the other dust collection body 2. Also, in the case where a plurality of friction materials hold a single dust collection body 2 and are rubbed against the single dust collection body 2, the friction materials are of the same type. It should be noted that although Fig. 8 illustrates a configuration in which both the first friction material 33 and the

second friction material 34 are provided in a single friction body 3, this is not limitative, and friction bodies 3 each including a first friction material 33 only and friction bodies 3 each including a second friction material 34 only may also be disposed in appropriate combination.

[0052]

The dust collection body 2 against which the first friction material 33 is rubbed is positively charged, and the dust collection body 2 against which the second friction material 34 is rubbed is negatively charged. Thereby, since one of the two dust collection bodies 2 located opposite to each other is positively charged and the other is negatively charged. Therefore, particles to be collected are easily collected regardless of they are positively charged or negatively charged, and the average electric-field strength in the air passage 20 can be raised, and a higher collection rate can be achieved as in Embodiment 2.

[0053]

Furthermore, the first dust collection body 2 and the second dust collection body 23 may also be used as dust collection bodies 2 as in Embodiment 2. In this case, the negatively charged first friction material 33 is rubbed against the positively charged first dust collection body 22, and the positively charged second friction material 34 is rubbed against the negatively charged second dust collection body 23. Thereby, the dust collection bodies can be further efficiently charged.

[0054]

Also, it is preferable that as illustrated in Fig. 8, the first friction material 33 that is negatively charged and the second friction material 34 that is positively charged be combined into a single friction body 3. To be more specific, the first friction material 33 and the second friction material 34 are provided opposite to each other with respect to the core 31. When this friction body 3 including both the first friction material 33 and the second friction material 34 is moved, the dust collection body against which the first friction material 33 is rubbed is positively charged and the dust collection body against which the second friction material 34 is rubbed is negatively charged. Thereby, by simply using a single friction body 3, one of associated two dust collection bodies 2

located opposite to each other can be positively charged and the other can be negatively charged.

[0055]

Also, in this case, when the first friction materials 33 and 34 are rubbed against respective dust collection bodies 2, the first friction material 33 is negatively charged and the second friction material 34 is positively charged. However, the first friction material 33 and the second friction material 34 are located opposite to each other, with the core 31, which is a conductor, interposed between the first friction material 33 and the second friction material 34, and the positive charge of the first friction material 33 and the negative charge of the second friction material 34 cancel each other. It is therefore possible to reduce occurrence of a phenomenon in which the friction bodies 3 is saturated with charge, and cause the dust collection bodies 2 to be efficiently charged by friction.

[0056]

Embodiment 4

The dust collecting device according to Embodiment 4 is the same as that according to Embodiment 1 except that the dust collecting device of Embodiment 4 is provided with drying units 6 that dry the dust collection bodies 2.

Embodiment 4 will be described by referring mainly to the differences between Embodiments 1 and 4.

[0057]

Fig. 9 is a perspective view of a main portion of the dust collecting device according to Embodiment 4, and Figs. 10 and 11 are side views illustrating the main portion of the dust collecting device according to Embodiment 4. The dust collecting device of Embodiment 4 is provided with drying units 6 that dry the dust collection bodies 2 before the friction bodies 3 are rubbed against the dust collection bodies 2. The drying units 6, as well as the friction bodies 3, are held by the holding body 43. As each of the drying units 6, for example, a hot-wire heater formed in the shape of a metal plate is used.

[0058]

In the case of charging a dust collection body 2 by friction, the drive shaft 42 is rotated by the action of the driving component 41, an associated friction body 3 and an associated drying unit 6 are moved by the holding body 43 that is engaged with the drive shaft 42. At this time, before the friction body 3 is rubbed against the dust collection body 2, a metal plate which is the drying unit 6 is heated to, for example, 80 degrees C, and is moved while being contacting with the dust collection body 2, thereby causing moisture on the surface of the dust collection body 2 to evaporate, and drying the surface of the dust collection body 2. Because the surface of the dust collection body 2 is dried, the surface resistance of the dust collection body 2 is increased, the friction body 3 can be further effectively rubbed against the dust collection body 2, whereby the dust collection body 2 can be further efficiently charged. Also, thereby, a high friction charging effect can be stably obtained, regardless of the humidity of an atmosphere.

[0059]

It should be noted that that the temperature of the drying unit 6 is not limited to 80 degrees C, and may be any temperature as long as it is lower than the melting point of the dust collection body 2. However, under this condition, it is preferable that the temperature of the drying unit 6 be a higher temperature in order that the drying unit 6 efficiently could dry the dust collecting body 2.

[0060]

Furthermore, regarding Embodiment 4, although it is described by way of example that the friction bodies 3 and the drying units 6 are held side by side by a single holding body 43, a plurality of holding bodies 43 may be provided, and it may be set that the friction bodies 3 are held by one of the holding bodies, and the drying units 6 are held by another one of the holding bodies.

[0061]

Also, the drying units 6 are not limited to the hot-wire heaters formed in the shape of a metal plate. That is, as the drying units 6, another type of heating means or drying means not using heating means may be used. Furthermore, it is not indispensable that the drying units 6 are held by the holding body 43. For example, a drier may be

used to send hot air to the surfaces of the dust collection bodies 2, or a compressor-type or desiccant-type of dehumidifier device may be provided in space outside the air passages and caused to send air to the dust collection bodies 2, in order to dry the dust collection bodies 2. In the case where any of the above means is used as the drying units 6, it is configured to dry the dust collection bodies 2 before the friction bodies 3are rubbed against the dust collection bodies 2.

[0062]

As described above, according to Embodiment 4, the drying units 6 dry the dust collection bodies 2 before the friction bodies 3 are rubbed against the dust collection bodies 2. Thereby, the surface resistance of each of the dust collection bodies 2 is increased to improve the friction effect, and the dust collection bodies 2 can be further efficiently charged.

[0063]

The above embodiments of the present invention are described above, but their configurations are not limited to the configurations described above. The embodiments and modifications of the present invention can be freely combined or modified as appropriate or a portion or portions of each embodiment may also be omitted as appropriate, within the scope of the present invention.

Reference Signs List

[0064]

1 dust collecting device 2 dust collection body 20 air passage 21 projection 22 first dust collection body 23 second dust collection body 3 friction body 31 core 32 friction material 33 first friction material 34 second friction material 4 driving unit 41 driving component 42 drive shaft 43 holding body 5 shell 51 air inlet 52 air outlet 6 drying unit