



159159

DUST REMOVING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 The present invention relates to a dust removing apparatus for injecting pure cleaning gas such as air and noble gas, gas including ultrasound which is vibrated by ultrasonic frequency, gas including positive and negative ions, or gas including ultrasound and ion (hereinafter, collectively "cleaning gas") to a dust removing object, thereby removing dust.

10

2. Description of the Related Art

 A dust removing apparatus removes dust from a dust removing object (object from which dust is to be removed) such as a glass substrate used for a TFT (thin film transistor) liquid crystal panel, a PDP (plasma display panel), and
15 an LCD (liquid crystal display), a solar battery panel, a sheet such as a long paper sheet, and a film.

 As a conventional technique related to such a dust removing apparatus, an invention described in Japanese Patent Application Laid-open No. 2004-41851 has been known. This conventional technique relates to a dust
20 removing head having a central injection chamber and suction chambers provided on both sides of the injection chamber.

 According to normal dust removing apparatuses, dust removing heads are located at upper and lower portions in many cases. In such a dust removing apparatus, when dust is removed continuously from a plurality of
25 glass substrates that are conveyed on a conveyor, even if cleaning gas is



G00002

injected to a gap between adjacent dust removing objects such as glass substrates, the cleaning gas is injected toward the upper and lower dust removing heads, the cleaning gas is injected to a location other than the dust removing heads, and a risk that dust is caught up by the cleaning gas is
5 considerably small.

However, as shown in Fig. 5B of Japanese Patent Application Laid-open No. 2004-41851, there is no lower dust removing head in some cases. In such a dust removing apparatus, when cleaning gas is injected to a gap between adjacent dust removing objects such as glass substrates, the
10 cleaning gas reaches to a lower portion (in an extreme case, to a floor on which the apparatus is installed). Although the dust removing apparatus is installed in a clean room, slight dust is caught up by gas, and there is a risk that the dust removing environment is deteriorated.

Further, it is conceived that injection of cleaning gas is stopped while an
15 injection hole and a gap between the adjacent dust removing objects such as the glass substrates are opposed to each other, however, in this case, it becomes necessary to provide a switching valve in a flow path of the cleaning gas. When switching of the switching valve, minute foreign matters separated from a sealing packing may be mixed in the cleaning gas in some cases, and
20 there is a risk that the dust removing ability is deteriorated.

SUMMARY OF THE INVENTION

The present invention has been achieved to solve the above problems, and an object of the invention is to provide a dust removing apparatus for
25 removing dust from only one side of a dust removing object, in which a

receiving unit having a simple configuration opposed to a dust removing head is added, after a flowing direction of cleaning gas from an injection chamber that passes through a gap between adjacent dust removing objects is changed, dust is sucked by a suction chamber, thereby suppressing unnecessary
5 scattering of dust.

A first aspect of the present invention provides a dust removing apparatus comprising: a dust removing head having at least one suction chamber including a suction opening and at least one injection chamber including an injection opening; a conveying unit that sequentially conveys a
10 plurality of dust removing objects into the dust removing head; and a receiving unit that is located to be opposed to the dust removing head, and that changes a receiving direction of cleaning gas injected from the injection opening of the injection chamber, wherein when the cleaning gas is injected toward the dust removing object from the injection opening of the injection chamber, the suction
15 chamber sucks, from the suction opening, the cleaning gas bounced off the dust removing object, and when the cleaning gas is injected toward a gap between adjacent two dust removing objects from the injection opening of the injection chamber, the suction chamber sucks, from its suction opening, the cleaning gas whose direction was changed by the receiving unit.

20 A second aspect of the present invention provides the dust removing apparatus according to the first aspect, wherein the receiving unit includes a passing hole through which cleaning gas passes, and the receiving unit also includes a receiving space that is partitioned by a flat surface and a curved surface, the receiving space is in communication with the passing hole, the
25 receiving space is a space having an arc cross section, the curved surface is

opposed to a suction opening and an injection opening, the flat surface is located substantially in parallel to a conveying direction of a dust removing object, and the cleaning gas that is injected from the injection opening of the injection chamber and passes through the passing hole, and the cleaning gas
5 is received by the curved surface of the receiving space, a direction of the cleaning gas is then changed by the flat surface of the receiving space, and the cleaning gas is sucked from the suction opening of the suction chamber.

A third aspect of the present invention provides the dust removing apparatus according to the first aspect, further comprising: an opposed plate
10 having a surface that is substantially in parallel to a conveying direction of the dust removing object; a passing hole that is formed in the opposed plate and that faces the injection opening and the suction opening; a semi-cylindrical body fixed to the opposed plate; and a receiving space that is partitioned by a flat surface of the opposed plate and a curved surface of the semi-cylindrical
15 body, the receiving space being a space having an arc cross section in which the curved surface of the semi-cylindrical body is opposed to the suction opening and the injection opening, and the flat surface of the opposed plate is located substantially in parallel to the conveying direction of the dust removing object, wherein the cleaning gas that is injected from the injection opening of
20 the injection chamber and passes through the passing hole, and the cleaning gas is received by the curved surface of the receiving space, a direction of the cleaning gas is changed by the flat surface of the receiving space, and the cleaning gas is sucked from the suction opening of the suction chamber.

A fourth aspect of the present invention provides the dust removing
25 apparatus according to the first aspect, wherein the receiving unit includes an

arc body having a curved receiving surface to which the injection opening and the suction opening are faced, the cleaning gas whose direction is changed by the receiving surface of the arc body is sucked from the suction opening of the suction chamber.

5 A fifth aspect of the present invention provides the dust removing apparatus according to the first aspect, wherein the receiving unit includes a box body having a flat receiving surface to which the injection opening and the suction opening are faced, the cleaning gas whose direction is changed by the receiving surface of the box body is sucked from the suction opening of the
10 suction chamber.

 A sixth aspect of the present invention provides the dust removing apparatus according to any one of the first to fifth aspects, wherein the dust removing head is located such that the injection chamber and upstream and downstream suction chambers that sandwich the injection chamber are
15 arranged along the conveying direction of the dust removing object.

 A seventh aspect of the present invention provides the dust removing apparatus according to any one of the first to fifth aspects, wherein the dust removing head is located such that the suction chamber and upstream and downstream injection chambers that sandwich the suction chamber are
20 arranged along the conveying direction of the dust removing object.

 An eighth aspect of the present invention provides the dust removing apparatus according to any one of the first to fifth aspects, wherein the dust removing head is located such that an upstream injection chamber and a downstream suction chamber are arranged along the conveying direction of
25 the dust removing object.

A ninth aspect of the present invention provides the dust removing apparatus according to any one of the first to fifth aspects, wherein the dust removing head is located such that an upstream suction chamber and a downstream injection chamber are arranged along the conveying direction of the dust removing object.

A tenth aspect of the present invention provides the dust removing apparatus according to any one of the first to fifth aspects, further comprising an ionizer that is located in the injection chamber and that produces ion near an emitter to which high voltage is applied, wherein cleaning gas including ion is injected from the injection opening of the injection chamber.

An eleventh aspect of the present invention provides the dust removing apparatus according to any one of the first to fifth aspects, further comprising a moving unit that moves the receiving unit toward or away from the dust removing head.

A twelfth aspect of the present invention provides the dust removing apparatus according to the eleventh aspect, wherein the receiving unit and the moving unit are set to be a pair, and a plurality of injecting units and same number of pairs of the receiving unit and the moving unit are provided.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side view of a dust removing apparatus according to a first embodiment of the present invention;

Fig. 2 is a sectional view of the dust removing apparatus according to the first embodiment;

Fig. 3 is a perspective view of an external appearance of the dust

removing apparatus according to the first embodiment;

Fig. 4A is a perspective view taken along a direction A in Fig. 3;

Fig. 4B is a sectional view taken along a line B-B in Fig. 3;

Fig. 4C is a sectional view taken along a line C-C in Fig. 3;

5 Fig. 5 is a perspective view taken along a line C-C in Fig. 3;

Fig. 6A is a sectional view taken along a line D-D in Fig. 5;

Fig. 6B is a sectional view taken along a line E-E in Fig. 5;

Fig. 7 shows a configuration of a receiving unit;

Fig. 8 is an explanatory diagram of a dust removing operation performed
10 by the dust removing apparatus;

Fig. 9 is an explanatory diagram of a dust removing operation performed
by the dust removing apparatus at the time of injection between dust removing
objects;

Fig. 10 is a side view of a dust removing apparatus according to a
15 second embodiment of the present invention;

Fig. 11 is a sectional view of the dust removing apparatus according to
the second embodiment;

Fig. 12 is an explanatory diagram of production of an arc body;

Fig. 13 is an explanatory diagram of an operation of the dust removing
20 apparatus according to the second embodiment;

Fig. 14 is a side view of a dust removing apparatus according to a third
embodiment of the present invention;

Fig. 15 is an explanatory diagram of an operation of the dust removing
apparatus according to the third embodiment;

25 Fig. 16 is an explanatory diagram of a dust removing operation

performed by a dust removing apparatus according to a fourth embodiment of the present invention;

Fig. 17 is an explanatory diagram of an injecting operation between dust removing objects performed by the dust removing apparatus according to the
5 fourth embodiment;

Fig. 18 is an explanatory diagram of a dust removing operation performed by a dust removing apparatus according to a fifth embodiment of the present invention;

Fig. 19 is an explanatory diagram of an injecting operation between dust
10 removing objects performed by the dust removing apparatus according to the fifth embodiment;

Fig. 20 is an explanatory diagram of a dust removing operation performed by a dust removing apparatus according to a sixth embodiment of the present invention;

15 Fig. 21 is an explanatory diagram of an injecting operation between dust removing objects performed by the dust removing apparatus according to the sixth embodiment;

Fig. 22 is an explanatory diagram of a dust removing apparatus according to a modification; and

20 Fig. 23 is an explanatory diagram of a dust removing apparatus according to another modification.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention are explained below with
25 reference to the accompanying drawings. Fig. 1 is a side view of a dust

removing apparatus according to a first embodiment of the present invention,
Fig. 2 is a sectional view of the dust removing apparatus, and Fig. 3 is a
perspective view of an external appearance of the dust removing apparatus.

In Fig. 3, the dust removing apparatus is shown while illustrations of sidewalls
thereof are omitted. The dust removing apparatus 1 includes a dust removing
5 head 100, a receiving unit 200, a conveying unit 300, and a moving unit 400.
The dust removing apparatus 1 removes dust from the dust removing head
100.

As shown in Figs. 2 and 3 in detail, the dust removing head 100 includes
10 an ionizer 120 located in a dust removing head body 110. Sidewalls 130
shown in Fig. 1 are fixed to both side surfaces of the dust removing head body
110.

The dust removing head 100 is explained with reference to the drawings.
Figs. 4A to 4C show internal and external configurations of the dust removing
head, where Fig. 4A is a perspective view taken along an arrow A in Fig. 3, Fig.
15 4B is a sectional view taken along a line B-B in Fig. 3, Fig. 4C is a sectional
view taken along a line C-C in Fig. 3. Fig. 5 is a perspective view taken along
the line C-C. Figs. 6A and 6B show an internal configuration of the dust
removing head, where Fig. 6A is a sectional view taken along a line D-D in Fig.
20 5, and Fig. 6B is a sectional view taken along a line E-E in Fig. 5. Fig. 7
shows a configuration of a receiving unit.

As shown in Fig. 4A, the dust removing head body 110 includes an
injection chamber 111, an upper suction chamber 112, a lower suction chamber
113, a top panel 114, sidewalls 115a and 115b, inner walls 116a and 116b, an
25 injection chamber bottom 111c, and suction chamber bottoms 112c and 113c

As shown in Figs. 2 to 6, the injection chamber 111 is a space partitioned by the top panel 114, the inner walls 116a and 116b and the injection chamber bottom 111c. A division wall 116c is provided between the inner walls 116a and 116b to reinforce mechanically. As shown in Fig. 4C, an internal space and an external space of the injection chamber 111 are in communication with each other through an inflow opening 111b, a passing hole 116e, and an injection opening 111a. A passing hole 124 shown in Fig. 6A is formed between a projection 121 of the ionizer 120 and a groove 116d, and a space is brought into communication through the passing hole 124 when the ionizer 120 is assembled.

Also as is apparent from Fig. 5, the injection opening 111a is a long slit. Because a dust removing object 10 enters from a direction substantially perpendicular to the longitudinal direction of the injection opening 111a shown in Fig. 5, cleaning gas can be injected to the entire region of the dust removing object 10.

As shown in Fig. 4C, the division wall 116c is provided between the injection opening 111a and the inflow opening 111b, and is preferably located close to the injection opening 111a. This is because, as the division wall 116c is closer to the injection opening 111a, cleaning gas passes through the injection opening 111a, and the injection opening 111a becomes less likely to be widened.

As shown in Fig. 4C and 6B, a plurality of passing holes 116e are provided in the division wall 116c, and this allows cleaning gas flowing from the inflow opening 111b to flow into the injection opening 111a.

As shown in Fig. 4A, which is an enlarged view of a portion a, the

groove 116d is formed in the injection chamber 111, the projection 121 of the ionizer 120 is slidably inserted into the groove 116d, and is mounted in the injection chamber 111.

5 The passing hole 124 is formed at the same time when the ionizer 120 is located. As shown in Fig. 6A, the projection 121 of the ionizer 120 is formed with a notch 123. As shown in Fig. 4A which is an enlarged view of a portion a, when the projection 121 is slid into the groove 116d and the ionizer 120 is inserted and mounted in the injection chamber 111, the notch 123 is covered with the groove 116d and becomes the passing hole 124 as shown in Fig. 6A.

10 The inflow opening 111b is provided on the top panel 114 on the upper surface of the dust removing head 100 as shown in Figs. 3, 4C, and 5.

As shown in Figs. 4B and 4C, the ionizer 120 is located in the injection chamber 111 and upstream from the division wall 116c. The ionizer 120 has a function of discharging positive and negative ions.

15 An emitter 122 is mounted on the ionizer 120, CD or AC is applied to the emitter 122 and discharges positive and negative ions by corona discharge.

As shown in Figs. 3 to 6, an upper suction chamber 112 is a space partitioned by the top panel 114, the sidewall 115a, the inner wall 116a, and the suction chamber bottom 112c. A space in the upper suction chamber 112 is in
20 communication through the air outlet 112b and the suction opening 112a as shown in Fig. 4C.

As shown in Figs. 5 and 6, the suction opening 112a is a long slit, and the suction opening 112a sucks, together with peripheral air, dust scattered by the cleaning gas injected from the injection opening 111a.

25 As shown in Figs. 3, 4C, and 5, the air outlet 112b is an opening through

which gas sucked from the suction opening 112a is discharged.

As shown in Figs. 3 to 6, the downstream suction chamber 113 is a space partitioned by the top panel 114, the sidewall 115b, the inner wall 116b and the suction chamber bottom 113c. As shown in Fig. 4C, a space in the downstream suction chamber 113 is in communication by the air outlet 113b and the suction opening 113a.

As shown in Figs. 5 and 6, the suction opening 113a is a long slit, and the suction opening 113a sucks, together with peripheral air, dust scattered by the cleaning gas injected from the injection opening 111a.

As shown in Figs. 3, 4C, and 5, the air outlet 113b is an opening through which gas sucked from the suction opening 113a is discharged.

The configuration of the dust removing head 100 is as described above.

A producing method of the dust removing head body 110 is explained next.

The dust removing head body 110 is produced by extrusion. For example, a metal material such as aluminum is pushed into a die, thereby forming the dust removing head body 110 in which the injection chamber 111, the upstream suction chamber 112, the downstream suction chamber 113, the sidewall 115a and 115b, the inner wall 116a and 116b, the division wall 116c, the injection chamber bottom 111c, the suction chamber bottom 112c and 113c, and the top panel 114 are integrally formed, and terminal processing such as ends is performed and the dust removing head body 110 is completed.

Immediately after the extrusion is completed, the inflow opening 111b and the air outlet 112b (see Figs. 3, 4C, and 5), the passing hole 116e of the division wall 116c (see Figs. 4C and 6B), and the injection opening 111a and the

suction openings 112a and 113a are not yet formed.

A drill is allowed to enter the extruded dust removing head 100 from a direction of an arrow F (see Fig. 3), and the inflow opening 111b and the passing hole 116e are formed at the same time. The inflow opening 111b and the passing hole 116e have the same diameters. Such a hole forming operation is performed many times at different locations, and a large number of inflow openings 111b and the passing holes 116e are formed as shown in Figs. 3 and 6B.

Similarly, a drill is allowed to enter the dust removing head 100 from the direction of the arrow F, and the air outlets 112b and 113b are formed. Such a hole forming operation is performed many times at different locations, and a large number of air outlets 112b and 113b are formed as shown in Fig. 3.

The injection opening 111a, and the suction openings 112a and 113a that are long slits are cut by a milling machine to complete the dust removing head body 110 shown in Figs. 3 to 6, the ionizer 120 is inserted from an opening of a side of the injection chamber 111, both sides are closed with sidewalls 130 and the dust removing head 100 is completed. In the injection chamber 111, the upper suction chamber 112 and the downstream suction chamber 113 are formed as an integral configuration in the dust removing head 100.

As shown in Fig. 8, the dust removing head 100 is constituted such that the upstream suction chamber 112 (V1), the injection chamber 111 (P) and the downstream suction chamber 113 (V2) are arranged in this order in a conveying direction of the dust removing object (in the first embodiment, in the direction of the arrow from left to right in Fig. 8), and the dust removing head

100 is located on the upper side of the conveying unit 300. The injection chamber 111 (P) is connected to an air blowing pump (not shown), and the upstream suction chamber 112 (V1) and the downstream suction chamber 113 (V2) are connected to a suction pump (not shown). Cleaning gas injected from the injection opening 111a of the injection chamber 111 and dust are sucked into the upper suction chamber 112 and the downstream suction chamber 113 through the suction openings 112a and 113a together with peripheral air. Air including the dust is discharged outside through the air outlets 112b and 113b (see Fig. 3) of the dust removing head 100, a discharge flow path and a discharge pipe. The dust removing head 100 has such a configuration.

Next, as shown in Figs. 2 and 7, the receiving unit 200 includes a semi-cylindrical body 210, opposed plates 220, a receiving space 230, a passing hole 240, a support unit 250, and sidewalls 260. The receiving unit 200 is located as shown in Figs. 1 to 3.

As shown in Fig. 7, the semi-cylindrical body 210 has such a shape that a cylindrical body whose both sides are closed with the sidewalls 260 is cut in half in its axial direction. Its inner side has a semi-circular curved surface.

The opposed plate 220 is a normal plate, and is formed at its central portion with the passing hole 240. The opposed plate 220 has a front and back flat surfaces that are substantially in parallel to the conveying direction of the dust removing object 10.

The receiving space 230 is partitioned by the back surface of the opposed plate 220 and the curved surface of the semi-cylindrical body 210, and the curved surface of the semi-cylindrical body 210 is opposed to the

injection opening 111a and the suction openings 112a and 113a through the passing hole 240. The receiving space 230 is has an arc cross section. Both the front and back surfaces of the opposed plate 220 are located substantially in parallel to the conveying direction of the dust removing object 10.

The passing hole 240 is provided in a central portion of the opposed plate 220, and vertical and horizontal lengths of the passing hole 240 are greater than the injection opening 111a of the dust removing head 100 and the suction openings 112a and 113a. With this structure, all of the cleaning gas injected from the injection opening 111a is not sprayed to the opposed plate 220, and passes through the passing hole 240.

The support unit 250 is fixed to a lower side of the semi-cylindrical body 210.

The sidewalls 260 are fixed to both side surfaces of the semi-cylindrical body 210.

The conveying unit 300 is a long rod roller that supports and conveys the dust removing object 10. The conveying unit 300 gives a driving force for conveying the dust removing object 10, or is turnable to follow the dust removing object 10 that is conveyed by another drive source.

The moving unit 400 moves the receiving unit 200 toward or away from the dust removing head 100 in the direction of the arrow a (vertical direction), and the moving unit 400 is a vertically moving stage for example. A vertical position is previously adjusted by the moving unit 400, and the receiving unit 200 is moved and fixed to a position where shock of cleaning gas is reliably absorbed.

The dust removing object 10 of the dust removing apparatus 1 is a glass substrate used for a TFT (thin film transistor) liquid crystal panel, a PDP (plasma display panel), and an LCD (liquid crystal display), a solar battery panel, a sheet such as a long paper sheet, and a film.

5 The dust removing operation performed by the dust removing apparatus 1 is explained next with reference to the drawings. Fig. 8 is an explanatory diagram of the dust removing operation performed by the dust removing apparatus, and Fig. 9 is an explanatory diagram of an operation at the time of injection between dust removing objects performed by the dust removing
10 apparatus.

Cleaning gas flowing from the inflow opening 111b flows through the passing hole 124 of the ionizer 120. Positive and negative ions discharged from the ionizer 120 are mixed into the cleaning gas. The cleaning gas passes through the passing hole 116e of the division wall 116c, reaches the
15 injection opening 111a and is injected from the injection opening 111a. In this case, the pressure in the injection chamber 111 becomes high, however, because the division wall 116c is integrally extended in the injection chamber 111 and the injection chamber 111 is reinforced as shown in Fig. 4C, it is possible to prevent the injection opening 111a from widening. Because the
20 division wall 116c is located close to the injection opening 111a, this further prevents the injection opening 111a from widening.

A plurality of dust removing objects 10 are sequentially conveyed on the conveying unit 300 at distances from one another, and the dust removing operation is sequentially performed. In this case, the dust removing object
25 100 always inject cleaning gas by the injection chamber 111 (P), and sucks

dust by the upper suction chamber 112 and the downstream suction chamber 113.

As shown in Fig. 8, the dust removing objects 10 from which dust is removed are conveyed in a conveying direction directly below the dust removing head 100. In this case, the upper surface of the dust removing object 10 is a dust removing object surface. In the dust removing head 100, cleaning gas is injected to the dust removing object surface of the dust removing object 10 from the injection chamber 111 (P), scattered dust is sucked by the upstream suction chamber 112 (V1) and the downstream suction chamber 113 (V2), and dust is removed from the dust removing object surface of the dust removing object 10.

As shown in Fig. 9, when the conveying operation is continued as it is and a gap between the adjacent two dust removing objects 10 reaches a location directly below the dust removing head 100, cleaning gas from the injection chamber 111 (P) of the dust removing head 100 passes through the passing hole 240, and the cleaning gas is received by a curved surface (an inner semi-circular curved surface of the semi-cylindrical body 210) of the receiving space 230 of the receiving unit 200. The cleaning gas moves along the curved surface, reaches the back surface of the opposed plate 220, the flowing direction is changed and the cleaning gas moves toward the passing hole 240. Because the cleaning gas moving along the back surface of the opposed plate 220 is in parallel to the conveying direction, the cleaning gas moves in the receiving space 230, and the cleaning gas is less prone to reach the upper side beyond the passing hole 240. As a result, the cleaning gas is sucked to the upper side by the upstream suction chamber 112 (V1) and the

downstream suction chamber 113 (V2). By increasing the suction amount more than the injection amount, the risk that the cleaning gas leaks toward the dust removing object can be reduced. With this structure, cleaning gas that passed through a gap between the adjacent two dust removing objects 10 does not uselessly scatter the dust, and the dust removing environment is excellently maintained. The dust removing operation can be continuously performed in a state where the cleaning gas is injected, the installation can be simplified, and the risk that unnecessary foreign matters are mixed can be reduced.

10 A second embodiment of the present invention is explained next. Fig. 10 is a side view of a dust removing apparatus according to the second embodiment, Fig. 11 is a sectional view of the dust removing apparatus, Fig. 12 is an explanatory diagram of a producing operation of an arc body, and Fig. 13 is an explanatory diagram of an operation performed by the dust removing apparatus. In Fig. 10, illustrations of the sidewalls are omitted. The dust removing apparatus 2 includes the dust removing head 100, a receiving unit 500, the conveying unit 300, and the moving unit 400. The dust removing apparatus 2 removes dust from the dust removing objects 10. If the dust removing apparatus 2 is compared with the dust removing apparatus 1 previously explained by Figs. 1 to 9, the dust removing apparatus 2 has the same configurations as those of the dust removing apparatus 1 except the configuration of the receiving unit 500. Like configurations are designated with like reference numerals, redundant explanations thereof will be omitted, and only the receiving unit 500 is explained.

25 As shown in Figs. 10 and 11, the receiving unit 500 includes an arc body

510 and a support unit 520.

The arc body 510 is an arc member, and has a curved receiving surface. Sidewalls can be mounted on both sides of the arc body 510 (a front surface and a back surface thereof in Fig. 10) so that cleaning gas does not flow
5 through both sides. The arc body 510 is long in the vertical direction in Fig. 10, and is longer than the injection opening 111a, and the suction openings 112a and 113a so that the cleaning gas can reliably be received. As shown in Fig. 12, the arc body 510 is formed by dividing a cylindrical body into three.

As shown in Fig. 10, the support unit 520 is fixed to a lower side of the
10 arc body 510, and moves the arc body 510 in the direction of the arrow a by the moving unit 400 (toward or away from the dust removing head body 110).

The dust removing operation performed by the dust removing apparatus 2 is explained next.

Cleaning gas including positive and negative ions discharged from the
15 ionizer 120 is injected from the dust removing head body 110 toward the dust removing objects 10. The dust removing operation performed by the dust removing objects 10 is as explained above with reference to Fig. 8, and redundant explanations thereof will be omitted.

As shown in Fig. 13, when a gap between adjacent two dust removing
20 objects 10 reaches a location directly below the dust removing head 100, cleaning gas from the injection chamber 111 (P) of the dust removing head 100 is received by a receiving surface (an inner arc curved surface of the arc body 510) of the arc body 510 of the receiving unit 500. The cleaning gas moves along the curved receiving surface, and the cleaning gas is sucked to the upper
25 side by the upstream suction chamber 112 (V1) and the downstream suction

chamber 113 (V2). By increasing the suction amount more than the injection amount, leakage of the cleaning gas toward the dust removing objects can be reduced. With this structure, cleaning gas that passed through a gap between the adjacent two dust removing objects 10 does not uselessly scatter the dust, and the dust removing environment is excellently maintained. The dust removing operation can be continuously performed in a state where the cleaning gas is injected, the installation can be simplified, and the risk that unnecessary foreign matters are mixed can be reduced.

A third embodiment of the present invention is explained next. Fig. 14 is a side view of a dust removing apparatus according to the third embodiment, Fig. 15 is an explanatory diagram of an operation of the dust removing apparatus. The dust removing apparatus 3 includes the dust removing head 100, a receiving unit 600, the conveying unit 300 and the moving unit 400. If the dust removing apparatus 3 is compared with the dust removing apparatus 1 previously explained by Figs. 1 to 9, the dust removing apparatus 3 has the same configurations as those of the dust removing apparatus 1 except the configuration of the receiving unit 600. Like configurations are designated with like reference numerals, redundant explanations thereof will be omitted, and only the receiving unit 600 is explained.

As shown in Figs. 14 and 15, the receiving unit 600 includes a box body 610 and a support unit 620.

The box body 610 is a box-like member and has a flat receiving surface. The box body 610 has sidewalls so that cleaning gas does not flow from the side. The box body 610 is long in the vertical direction in the drawings, and is especially longer than the injection opening 111a and the suction openings

112a and 113a so that the box body 610 reliably receives cleaning gas.

The support unit 620 is fixed to a lower side of the box body 610, and the moving unit 400 moves the box body 610 in the direction of the arrow a (toward or away from the dust removing head body 110).

5 The dust removing operation performed by the dust removing apparatus 3 is explained next.

Cleaning gas including positive and negative ions discharged from the ionizer 120 is injected from the dust removing head body 110 toward the dust removing objects 10. The dust removing operation performed by the dust removing objects 10 is as explained above with reference to Fig. 8, and
10 redundant explanations thereof will be omitted.

As shown in Fig. 15, when a gap between adjacent two dust removing objects 10 reaches a location directly below the dust removing head 100, cleaning gas from the injection chamber 111 (P) of the dust removing head 100
15 is received by a receiving surface of the box body 610 of the receiving unit 600. The cleaning gas moves along the receiving surface, and finally moves to the upper side along the sidewall, and the cleaning gas is sucked to the upper side at the upstream suction chamber 112 (V1) and the downstream suction chamber 113 (V2). By increasing the suction amount more than the injection
20 amount, leakage of the cleaning gas toward the dust removing objects can be reduced. With this structure, cleaning gas that passed through a gap between the adjacent two dust removing objects 10 does not uselessly scatter the dust, and the dust removing environment is excellently maintained. The dust removing operation can be continuously performed in a state where the
25 cleaning gas is injected, the installation can be simplified, and the risk that

unnecessary foreign matters are mixed can be reduced.

A fourth embodiment of the invention is explained next. Fig. 16 is an explanatory diagram of a dust removing operation performed by a dust removing apparatus according to the fourth embodiment, Fig. 17 is an
5 explanatory diagram of an injecting operation between dust removing objects performed by the dust removing apparatus. Figs. 16 and 17 are sectional views and illustrations of sidewalls are omitted. The dust removing apparatus 4 includes a dust removing head 140, the receiving unit 200, the conveying unit 300 and the moving unit 400. The dust removing apparatus 4 removes dust
10 from the dust removing object 10. If the dust removing apparatus 4 is compared with the dust removing apparatus 1 previously explained with reference to Figs. 1 to 9, the dust removing apparatus 4 has the same configurations as those of the dust removing apparatus 1 except the configuration of the dust removing head 140. Like configurations are
15 designated with like reference numerals, redundant explanations thereof will be omitted, and only the dust removing head 140 is explained.

As shown in Fig. 16, the dust removing head 140 is constituted such that an upstream injection chamber 142 (P1), a suction chamber 141 (V) and a downstream injection chamber 143 (P2) are arranged in this order in the
20 conveying direction of the dust removing objects (in the direction of the arrow from right to left in Fig. 16). The dust removing head 140 is located on the upper side of the conveying unit 300. The suction chamber 141 (V) is connected to a suction pump (not shown), and the upstream injection chamber 142 (P1) and the downstream injection chamber 143 (P2) are connected to an
25 air blowing pump (not shown). Cleaning gas injected from the injection

openings 142a and 143a of the upstream injection chamber 142 and the downstream injection chamber 143, and dust caught up by the cleaning gas are sucked into the suction chamber 141 through a suction opening 141a together with peripheral air. Air including the dust is discharged outside
5 through an air outlet of the dust removing head 140, a discharged air flow path and an air discharging pipe.

The dust removing operation performed by the dust removing apparatus 4 is explained next.

Cleaning gas is allowed to flow into the upstream injection chamber 142
10 from the inflow opening, positive and negative ions discharged from the ionizer 120 are added to the cleaning gas, and they are injected from the injection opening 142a. Similarly, cleaning gas is allowed to flow into the downstream injection chamber 143 from the inflow opening, positive and negative ions discharged from the ionizer 120 are added to the cleaning gas, and they are
15 injected from the injection opening 143a.

The plurality of dust removing objects 10 are sequentially conveyed on the conveying unit 300 at distances from one another, and the dust removing operation is sequentially performed. In this case, the dust removing head 140 always inject cleaning gas by the upstream injection chamber 142 (P1) and the
20 downstream injection chamber 143 (P2), and sucks dust by the suction chamber 141 (V).

As shown in Fig. 16, the dust removing objects 10 from which dust is removed are conveyed in the conveying direction directly below the dust removing head 140. In this case, the upper surface of the dust removing
25 object 10 is a dust removing object surface. In the dust removing head 140,

cleaning gas is injected to the dust removing object surface of the dust removing object 10 from the upstream injection chamber 142 (P1) and the downstream injection chamber 143 (P2), scattered dust is sucked by the suction chamber 141 (V), and dust is removed from the dust removing object surface of the dust removing object 10.

As shown in Fig. 17, when the conveying operation is continued as it is and a gap between the adjacent two dust removing objects 10 reaches a location directly below the dust removing head 140, cleaning gas from the upstream injection chamber 142 (P1) and the downstream injection chamber 143 (P2) of the dust removing head 140 passes through the passing hole 240, and the cleaning gas is received by a curved surface (the inner semi-circular curved surface of the semi-cylindrical body 210) of the receiving space 230 of the receiving unit 200. The cleaning gas moves along the curved surface or reaches the back surface of the opposed plate 220 and the direction is changed and moves to the passing hole 240. However, the flow path is once lowered due to the injection flow from the upstream injection chamber 142 (P1) and the downstream injection chamber 143 (P2) and then the flow path rises, and the cleaning gas is sucked to the upper side in the suction chamber 141 (V). By increasing the suction amount more than the injection amount, the risk that the cleaning gas leaks toward the dust removing object can be reduced. Further, a risk that injection flows on the both sides lead toward the dust removing object can be lowered. With this structure, cleaning gas that passed through a gap between the adjacent two dust removing objects 10 does not uselessly scatter the dust, and the dust removing environment is excellently maintained. The dust removing operation can be continuously

performed in a state where the cleaning gas is injected, the installation can be simplified, and the risk that unnecessary foreign matters are mixed can be reduced.

A fifth embodiment of the present invention is explained next. Fig. 18 is
5 an explanatory diagram of a dust removing operation performed by a dust removing apparatus according to the fifth embodiment, Fig. 19 is an explanatory diagram of an injecting operation between dust removing objects performed by the dust removing apparatus. Figs. 18 and 19 are sectional views and illustrations of the sidewalls are omitted. The dust removing
10 apparatus 5 includes a dust removing head 150, the receiving unit 200, the conveying unit 300, and the moving unit 400. The dust removing apparatus 5 removes dust from the dust removing object 10. If the dust removing apparatus 5 is compared with the dust removing apparatus 1 previously explained by Figs. 1 to 9, the dust removing apparatus 5 has the same
15 configurations as those of the dust removing apparatus 1 except the configuration of the dust removing head 150. Like configurations are designated with like reference numerals, redundant explanations thereof will be omitted, and only the dust removing head 150 is explained.

As shown in Fig. 18, the dust removing head 150 is constituted such
20 that an upstream injection chamber 151 (P) and a downstream suction chamber 152 (V) are arranged in this order in the conveying direction of the dust removing objects (in the direction of the arrow from right to left in Fig. 18), and the dust removing head 150 is located on the upper side of the conveying unit 300. The upstream injection chamber 151 (P) is connected to an air
25 blowing pump (not shown), and the downstream suction chamber 152 (V) is

connected to a suction pump (not shown). Cleaning gas injected from the injection opening 151a and dust caught up by the cleaning gas are sucked into the downstream suction chamber 152 through a suction opening 152a together with peripheral air. Air including the dust is discharged outside through an air outlet of the dust removing head 150, a discharged air flow path, and an air discharging pipe.

The dust removing operation performed by the dust removing apparatus 5 is explained next.

Cleaning gas is allowed to flow into the upstream injection chamber 152 from the inflow opening, positive and negative ions discharged from the ionizer 120 are added to the cleaning gas, and they are injected from the injection opening 151a.

The plurality of dust removing objects 10 are sequentially conveyed on the conveying unit 300 at distances from one another, and the dust removing operation is sequentially performed. In this case, it is assumed that the dust removing head 150 always inject cleaning gas by the upstream injection chamber 151 (P) and sucks dust by the downstream suction chamber 152 (V).

As shown in Fig. 18, the dust removing objects 10 from which dust is removed are conveyed in the conveying direction directly below the dust removing head 150. In this case, the upper surface of the dust removing object 10 is a dust removing object surface. In the dust removing head 150, cleaning gas is injected to the dust removing object surface of the dust removing object 10 from the upstream injection chamber 151 (P), scattered dust is sucked by the downstream suction chamber 152 (V), and dust is removed from the dust removing object surface of the dust removing object 10.

As shown in Fig. 19, when the conveying operation is continued as it is and a gap between the adjacent two dust removing objects 10 reaches a location directly below the dust removing head 150, cleaning gas from the up of the dust removing head 150 (P) passes through the passing hole 240, and the cleaning gas is received by a curved surface (the inner semi-circular curved surface of the semi-cylindrical body 210) of the receiving space 230 of the receiving unit 200. The cleaning gas moves along the curved surface or reaches the back surface of the opposed plate 220 and the direction is changed and moves to the passing hole 240, and the cleaning gas is sucked to the upper side at the downstream suction chamber 152 (V). By increasing the suction amount more than the injection amount, the risk that the cleaning gas leaks toward the dust removing object can be reduced. With this structure, cleaning gas that passed through a gap between the adjacent two dust removing objects 10 does not uselessly scatter the dust, and the dust removing environment is excellently maintained. The dust removing operation can be performed continuously in a state where the cleaning gas is injected, the installation can be simplified, and the risk that unnecessary foreign matters are mixed can be reduced.

A sixth embodiment of the present invention is explained next. Fig. 20 is an explanatory diagram of a dust removing operation performed by a dust removing apparatus according to the sixth embodiment, and Fig. 21 is an explanatory diagram of an injecting operation between dust removing objects performed by the dust removing apparatus. Figs. 20 and 21 are sectional views and illustrations of the sidewalls are omitted. The dust removing apparatus 6 includes a dust removing head 160, the receiving unit 200, the

conveying unit 300 and the moving unit 400. The dust removing apparatus 6 removes dust from the dust removing object 10. If the dust removing apparatus 6 is compared with the dust removing apparatus 1 previously explained by Figs. 1 to 9, the dust removing apparatus 6 has the same configurations as those of the dust removing apparatus 1 except the configuration of the dust removing head 160. Like configurations are designated with like reference numerals, redundant explanations thereof will be omitted, and only the dust removing head 160 is explained.

As shown in Fig. 20, the dust removing head 160 is constituted such that an upstream suction chamber 161 (V) and a downstream injection chamber 162 (P) are arranged in this order in the conveying direction of the dust removing objects (in the direction of the arrow from right to left in Fig. 20), and the dust removing head 160 is located on the upper side of the conveying unit 300. The upstream suction chamber 161 (V) is connected to a suction pump (not shown), and the downstream injection chamber 162 (P) is connected to an air blowing pump (not shown). Cleaning gas injected from the injection opening 162a and dust caught up by the cleaning gas are sucked into the upstream suction chamber 161 through a suction opening 161a together with peripheral air. Air including the dust is discharged outside through an air outlet of the dust removing head 160, a discharged air flow path and an air discharging pipe.

The dust removing operation performed by the dust removing apparatus 6 is explained next.

Cleaning gas is allowed to flow into the downstream injection chamber 162 from the inflow opening, positive and negative ions discharged from the

ionizer 120 are added to the cleaning gas, and they are injected from the injection opening 162a.

The plurality of dust removing objects 10 are sequentially conveyed on the conveying unit 300 at distances from one another, and the dust removing operation is sequentially performed. In this case, the dust removing head 160 always inject cleaning gas by the downstream injection chamber 162 (P), and sucks dust by the upstream suction chamber 161 (V).

As shown in Fig. 20, the dust removing objects 10 from which dust is removed are conveyed in the conveying direction directly below the dust removing head 160. In this case, the upper surface of the dust removing object 10 is a dust removing object surface. In the dust removing head 160, cleaning gas is injected to the dust removing object surface of the dust removing object 10 from the downstream injection chamber 162 (P), scattered dust is sucked by the upstream suction chamber 161 (V), and dust is removed from the dust removing object surface of the dust removing object 10.

As shown in Fig. 21, when the conveying operation is continued as it is and a gap between the adjacent two dust removing objects 10 reaches a location directly below the dust removing head 160, cleaning gas from the downstream injection chamber 162 (P) of the dust removing head 160 passes through the passing hole 240, and the cleaning gas is received by a curved surface (an inner semi-circular curved surface of the semi-cylindrical body 210) of the receiving space 230 of the receiving unit 200. The cleaning gas moves along the curved surface of the receiving space 230 or reaches the back surface of the opposed plate 220 and the direction is changed and moves to the passing hole 240, and the cleaning gas is sucked to the upper side at

upstream suction chamber 161 (V). By increasing the suction amount more than the injection amount, the risk that the cleaning gas leaks toward the dust removing object can be reduced. With this structure, cleaning gas that passed through a gap between the adjacent two dust removing objects 10
5 does not uselessly scatter the dust, and the dust removing environment is excellently maintained. The dust removing operation can be continuously performed in a state where the cleaning gas is injected, the installation can be simplified, and the risk that unnecessary foreign matters are mixed can be reduced.

10 Further modifications can be made, and for example it is possible to form a dust removing apparatus in which the receiving unit 500 explained by Figs. 10 and 11 is opposed to the dust removing head 140 explained by Figs. 16 and 17, the dust removing head 150 explained by Figs. 18 and 19, or the dust removing head 160 explained by Figs. 20 and 21. As one example, the
15 dust removing apparatus in which the receiving unit 500 explained by Figs. 10 and 11 is opposed to the dust removing head 140 explained by Figs. 16 and 17 will be explained with reference to Fig. 22. Fig. 22 is an explanatory diagram of a dust removing apparatus according to a modification. Even if cleaning gas is injected to the arc body 510 from the injection openings 142a and 143a,
20 the cleaning gas is received and it is sucked from the suction opening 141a, and this also functions as the dust removing apparatus 7 of the present invention.

A dust removing apparatus in which the receiving unit 500 explained by Figs. 10 and 11 is opposed to the dust removing head 150 explained by Figs.
25 18 and 19, and a dust removing apparatus in which the receiving unit 500

explained by Figs. 10 and 11 is opposed to the dust removing head 160 explained by Figs. 20 and 21 also function in the same manner.

Still further modifications can be made, and for example, it is possible to form a dust removing apparatus in which a receiving unit formed by two arc
5 bodies is opposed to the dust removing head 140 having two injection openings 142a and 143a explained with reference to Figs. 16 and 17. Fig. 23 is an explanatory diagram of a dust removing apparatus according to another modification. A receiving unit includes a first support unit 530 and a first arc
10 body 540, and the receiving unit can move in the direction of an arrow b by a first moving unit 410. The first arc body 540 is located on the lower side of the injection opening 142a. A receiving unit includes a second support unit 550 and a second arc body 560, and the receiving unit can move in the direction of an arrow c by a second moving unit 420. The second arc body 560 is located on the lower side of the injection opening 143a. Even if cleaning gas is
15 injected from the injection openings 142a and 143a to the first arc body 540 and the second arc body 560, the cleaning gas is received and can be sucked from the suction opening 141a, and this configuration functions as the dust removing apparatus 8 according to the present invention.

The dust removing apparatuses 1 to 8 according to the above
20 embodiments can be further modified. For example, a suction hose is brought into communication with a lower side of any of the receiving unit 200, 500, or 600, cleaning gas flowing into the receiving space is discharged to another location using the air discharging pump through the suction hose, or the other end of the suction hose is located on a location that does not
25 influence the dust removing operation and the gas can be discharged.

The ionizer 120 of the dust removing head 110, 140, 150, or 160 can be removed, an ultrasound radiator can be mounted instead of the ionizer 120 of the dust removing head 110, 140, 150, or 160, or the ultrasound radiator can be added to the ionizer 120 of the dust removing head 110, 140, 150, or 160.

- 5 The present invention can be applied to such configurations.

The present invention provides a dust removing apparatus for removing dust from only one side of a dust removing object, in which a receiving unit having a simple configuration opposed to a dust removing head is added, after a flowing direction of cleaning gas from an injection chamber that passes
10 through a gap between adjacent dust removing objects is changed, dust is sucked by a suction chamber, thereby reducing unnecessary scattering of dust.

WHAT IS CLAIMED IS:

1. A dust removing apparatus comprising:
 - a dust removing head having at least one suction chamber including a suction opening and at least one injection chamber including an injection opening;
 - a conveying unit that sequentially conveys a plurality of dust removing objects into the dust removing head; and
 - a receiving unit that is located to be opposed to the dust removing head, and that changes a receiving direction of cleaning gas injected from the injection opening of the injection chamber, wherein
 - when the cleaning gas is injected toward the dust removing object from the injection opening of the injection chamber, the suction chamber sucks, from the suction opening, the cleaning gas bounced off the dust removing object, and
 - when the cleaning gas is injected toward a gap between adjacent two dust removing objects from the injection opening of the injection chamber, the suction chamber sucks, from its suction opening, the cleaning gas whose direction was changed by the receiving unit.
2. The dust removing apparatus according to claim 1, wherein
 - the receiving unit includes a passing hole through which cleaning gas passes, and the receiving unit also includes a receiving space that is partitioned by a flat surface and a curved surface, the receiving space is in communication with the passing hole, the receiving space is a space having an arc cross section, the curved surface is opposed to a suction opening and an

injection opening, the flat surface is located substantially in parallel to a conveying direction of a dust removing object, and

the cleaning gas that is injected from the injection opening of the injection chamber and passes through the passing hole, and the cleaning gas
5 is received by the curved surface of the receiving space, a direction of the cleaning gas is then changed by the flat surface of the receiving space, and the cleaning gas is sucked from the suction opening of the suction chamber.

3. The dust removing apparatus according to claim 1, further comprising:
10 an opposed plate having a surface that is substantially in parallel to a conveying direction of the dust removing object;

a passing hole that is formed in the opposed plate and that faces the injection opening and the suction opening;

a semi-cylindrical body fixed to the opposed plate; and

15 a receiving space that is partitioned by a flat surface of the opposed plate and a curved surface of the semi-cylindrical body, the receiving space being a space having an arc cross section in which the curved surface of the semi-cylindrical body is opposed to the suction opening and the injection opening, and the flat surface of the opposed plate is located substantially in
20 parallel to the conveying direction of the dust removing object, wherein

the cleaning gas that is injected from the injection opening of the injection chamber and passes through the passing hole, and the cleaning gas is received by the curved surface of the receiving space, a direction of the cleaning gas is changed by the flat surface of the receiving space, and the
25 cleaning gas is sucked from the suction opening of the suction chamber.

4. The dust removing apparatus according to claim 1, wherein the receiving unit includes an arc body having a curved receiving surface to which the injection opening and the suction opening are faced, the cleaning gas
5 whose direction is changed by the receiving surface of the arc body is sucked from the suction opening of the suction chamber.
5. The dust removing apparatus according to claim 1, wherein the receiving unit includes a box body having a flat receiving surface to which the
10 injection opening and the suction opening are faced, the cleaning gas whose direction is changed by the receiving surface of the box body is sucked from the suction opening of the suction chamber.
6. The dust removing apparatus according to any one of claims 1 to 5,
15 wherein the dust removing head is located such that the injection chamber and upstream and downstream suction chambers that sandwich the injection chamber are arranged along the conveying direction of the dust removing object.
- 20 7. The dust removing apparatus according to any one of claims 1 to 5, wherein the dust removing head is located such that the suction chamber and upstream and downstream injection chambers that sandwich the suction chamber are arranged along the conveying direction of the dust removing object.

25

8. The dust removing apparatus according to any one of claims 1 to 5, wherein the dust removing head is located such that an upstream injection chamber and a downstream suction chamber are arranged along the conveying direction of the dust removing object.

5

9. The dust removing apparatus according to any one of claims 1 to 5, wherein the dust removing head is located such that an upstream suction chamber and a downstream injection chamber are arranged along the conveying direction of the dust removing object.

10

10. The dust removing apparatus according to any one of claims 1 to 5, further comprising an ionizer that is located in the injection chamber and that produces ion near an emitter to which high voltage is applied, wherein cleaning gas including ion is injected from the injection opening of the

15 injection chamber.

11. The dust removing apparatus according to any one of claims 1 to 5, further comprising a moving unit that moves the receiving unit toward or away from the dust removing head.

20

12. The dust removing apparatus according to claim 11, wherein the receiving unit and the moving unit are set to be a pair, and a plurality of injecting units and same number of pairs of the receiving unit and the moving unit are provided.