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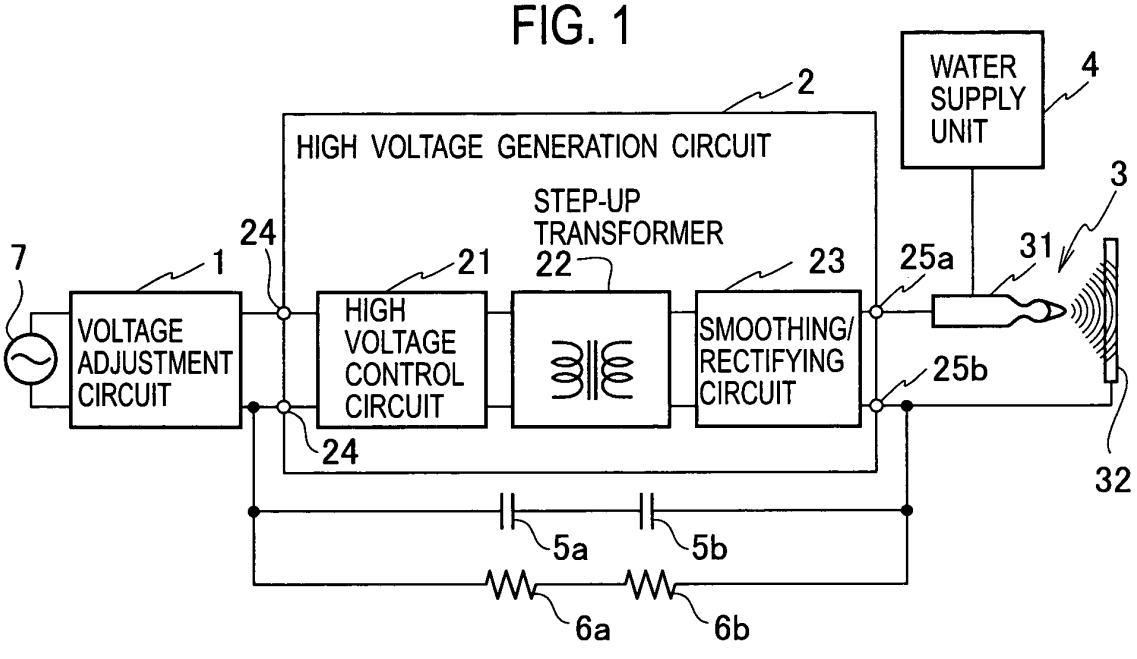
(54) Hot air blower

(57) There is provided a hair dryer that has an electrostatic atomizer, emits charge particulate water, and blows out warm air. The electrostatic atomizer generates the charged particulate water by electrostatically atomizing water, and includes: a discharge electrode (31); a counter electrode (32) opposed to the discharge electrode; a high voltage generation circuit (2) that applies a high voltage across the discharge electrode (31) and the counter electrode (32); and a water supply unit (4) that supplies the water to the discharge electrode (31), the water being electrostatically atomized when supplied to the discharge electrode (31). The high voltage generation circuit (2) is configured by connecting a high-frequency low-impedance element (5) between a primary input terminal (24) receiving an input voltage and a secondary low-voltage output terminal (25b) connected to the counter electrode (32) and paired with a secondary high-voltage output terminal (25a) that outputs the high voltage obtained by stepping up of the input voltage received by the primary input terminal (24) and then applied to the discharge electrode (31).

FIG. 1



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Description

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims the benefit of priority from a Japanese Patent Application No. TOKUGAN 2007-197644, filed on July 30, 2007; the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to a hot air blower, such as a hair dryer, having an electrostatic atomizer that generates charged particulate water.

2. Description of the Related Art

[0003] As conventional electrostatic atomizers, one disclosed in Japanese Patent Application Laid-Open No. 2006-239632 has been known. According to a technique described therein, high voltage is applied across a discharge electrode to which water is supplied and a counter electrode opposed to the discharge electrode, thereby to cause electric discharge therebetween. Water held by the discharge electrode is therefore pulled toward the counter electrode to form a shape called Taylor cone, and Rayleigh breakup occurring at the tip of the Taylor cone results in generation of nanometer-scale charged particulate water (nano-sized mist) and atomization thereof.

[0004] In this conventional electrostatic atomizer, the counter electrode is grounded away at a predetermined distance from one end of the discharge electrode, and at the time of discharge, a negative high voltage, for example, approximately -4.6kV, is applied to the discharge electrode, thereby producing a high electric field between the discharge electrode and the counter electrode. In a process where the nano-sized mist generated in this high electric field is pulled and migrates from the discharge electrode toward the counter electrode, the generated nano-sized mist is easily attracted to the counter electrode because the counter electrode is grounded and an electrical potential thereof is stable. This disadvantageously decreases the amount of the nano-sized mist emitted outside the electrostatic atomizer. Therefore, enhancement of emission efficiency of the nano-sized mist emitted outside the electronic atomizer and further increase in the amount of emission have been desired.

[0005] The present invention has been made in consideration of the foregoing conventional circumstance, and an object thereof is to provide a hot air blow that offers a more increased amount of emission of nano-sized mist.

SUMMARY OF THE INVENTION

[0006] According to a first aspect of the present invention, there is provided a hot air blower having an electrostatic atomizer, emitting charged particulate water, and blowing out warm air. The electrostatic atomizer generates the charged particulate water by electrostatically atomizing water, and includes: a discharge electrode; a counter electrode opposed to the discharge electrode; a high voltage generation circuit that applies a high voltage across the discharge electrode and the counter electrode; and water supply means for supplying the water to the discharge electrode, the water being electrostatically atomized when supplied to the discharge electrode. The high voltage generation circuit is configured by connecting a high-frequency low-impedance element between a primary input terminal receiving an input voltage and a secondary low-voltage output terminal connected to the counter electrode and paired with a secondary high-voltage output terminal that outputs the high voltage obtained by stepping up of the input voltage received by the primary input terminal and then applied to the discharge electrode.

[0007] According to a second aspect of the present invention, there is provided a hot air blower having an electrostatic atomizer, emitting charged particulate water, and blowing out warm air. The electrostatic atomizer generates the charged particulate water by electrostatically atomizing water, and includes: a discharge electrode; a counter electrode opposed to the discharge electrode; a high voltage generation circuit that applies a high voltage across the discharge electrode and the counter electrode; and water supply means for supplying the water to the discharge electrode, the water being electrostatically atomized when supplied to the discharge electrode. The high voltage generation circuit is configured by connecting a high-frequency low-impedance element between a primary input terminal receiving an input voltage and a secondary high-voltage output terminal that outputs the high voltage obtained by stepping up of the input voltage received by the primary input terminal and then applied to the discharge electrode.

[0008] According to a third aspect of the present invention, in the hot air blower according to the first or the second aspect, the high-frequency low-impedance element is disposed within the hot air blower at a position hardly influenced by the discharge electrode being electrically charged.

[0009] According to the hot air blower in the first aspect of the present invention, the electrical potential of the secondary low-voltage output terminal is set to a stable potential slightly higher than a grounding potential, so that the charged particulate water can be generated stably and hence emitted in larger quantities than ever before.

[0010] According to the hot air blower in the second aspect of the present invention, the electrical potential of the secondary low-voltage output terminal is set to a sta-

ble potential slightly higher than the grounding potential, so that the charged particulate water can be generated stably and hence emitted in larger quantities than ever before.

[0011] According to the hot air blower in the third aspect of the present invention, the electrical potential of the secondary output terminal can be stabilized, so that stable discharge is ensured.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Exemplary embodiments of the invention will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only exemplary embodiments and are, therefore, not to be considered limiting of the invention's scope, the exemplary embodiments of the invention will be described with additional specificity and detail through use of the accompanying drawings in which:

Fig. 1 is a diagram showing a configuration of an electrostatic atomizer provided in a hot air blower according to a first embodiment of the present invention;

Fig. 2 is a diagram showing a structure of the hot air blower having therein the electrostatic atomizer according to the first embodiment of the present invention;

Fig. 3 is a diagram showing a structure of an insulation tube for a capacitor;

Fig. 4 is a diagram showing an electrical potential change of a secondary output in the case that the capacitor is not connected;

Fig. 5 is a diagram showing an electrical potential change of the secondary output in the case that the capacitor is connected; and

Fig. 6 is a diagram showing a configuration of an electrostatic atomizer provided in a hot air blower according to a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] Preferred embodiments of the present invention will be described below with reference to the drawings.

[0014] Fig. 1 is a diagram showing a configuration of an electrostatic atomizer provided in a hot air blower according to a first embodiment of the present invention, and Fig. 2 is a diagram showing a structure of a hair dryer, which is an example of the hot air blower having therein the electrostatic atomizer shown in Fig. 1.

[0015] Referring to Fig. 1, the electrostatic atomizer includes a voltage adjustment circuit 1, a high voltage generation circuit 2, a discharge unit 3, a water supply unit 4, a capacitor 5 (5a, 5b), and a resistor 6 (6a, 6b).

[0016] The voltage adjustment circuit 1 receives 100V- or 200V-class electricity from an AC power supply 7, and when receiving a voltage over 100V, the voltage adjustment circuit 1 transforms it to 100V and feeds the voltage of 100V to a high voltage control circuit 21 of the high voltage generation circuit 2. Therefore, even when the AC power supply 7, whose power supply voltage is different depending on countries, is used to receive electricity therefrom, a uniform power supply voltage can be supplied to the high voltage control circuit 21 of the high voltage generation circuit 2.

[0017] The high voltage generation circuit 2 is composed of the high voltage control circuit 21, a step-up transformer 22, and a smoothing/rectifying circuit 23, and generates a high voltage by stepping up the voltage fed from the voltage adjustment circuit 1.

[0018] The high voltage control circuit 21 is connected to the voltage adjustment circuit 1 via a primary input terminal 24 of the high voltage generation circuit 2. The high voltage control circuit 21 receives via the primary input terminal 24 the electric power whose voltage has been adjusted by the voltage adjustment circuit 1, and controls power to be supplied to a primary coil of the step-up transformer 22.

[0019] The step-up transformer 22 has the primary coil connected to the high voltage control circuit 21, and a secondary coil connected to the smoothing/rectifying circuit 23. The step-up transformer 22 steps up the voltage fed from the high voltage control circuit 21, generates a positive or negative high voltage that is set in advance by the secondary coil, for example, approximately -4kV, and supplies the generated high voltage to the smoothing/rectifying circuit 23.

[0020] The smoothing/ rectifying circuit 23 is connected to the secondary coil of the step-up transformer 22. The smoothing/rectifying circuit 23 receives the AC high voltage obtained by the step-up transformer 22, smoothes and rectifies this AC high voltage, and outputs a DC high voltage obtained by smoothing and rectification via a secondary high-voltage output terminal 25a of the high voltage generation circuit 2.

[0021] The discharge unit 3 is composed of a discharge electrode 31 and a counter electrode 32. The discharge electrode 31 is connected to the secondary high-voltage output terminal 25a of the high voltage generation circuit 2, and is supplied with the high voltage obtained from the smoothing/rectifying circuit 23 via the secondary high-voltage output circuit 25a. The counter electrode 32 is opposed to the discharge electrode at a predetermined distance therefrom, and is connected to a secondary low-voltage output terminal 25b of the high voltage generation circuit 2.

[0022] The water supply unit 4 supplies to the discharge electrode 31, water used for electrostatic atomization performed by the discharge unit 3. The water supply unit 4 has, for example, a tank for storing water to supply it to the discharge electrode 31, or has, for example, a Peltier module, as cooling means for cooling the

discharge electrode 31 below the dew point to obtain condensed water of the discharge electrode 31.

[0023] The capacitor 5 is made up of two capacitors 5a and 5b that are connected in series between the primary input terminal 24 and the secondary low-voltage output terminal 25b. The capacitor 5 serves as a high-frequency low-impedance element to connect these terminals with each other, and sets the electrical potential of the secondary low-voltage output terminal 25b to a value roughly equivalent to that of the electrical potential of the primary input terminal 24.

[0024] The capacitor 5 can be made up of only one capacitor, but preferably made of two capacitors connected in series. When two capacitors are used and either is short-circuited, the connection between the primary input terminal 24 and the secondary low-voltage output terminal 25b via the low impedance element can be maintained, thereby avoiding impairing the function of maintaining a low impedance state by using the capacitor to connect both the terminals with each other.

[0025] Furthermore, as shown in Fig. 3, by covering the capacitor 5 with an insulator such as an insulating tube 33, the insulation of the capacitor 5 can be ensured, which prevents a short circuit caused by physical contact with other components.

[0026] Referring next to Fig. 2, a description will be given of a schematic structure of a hair dryer, which is an example of the hot air blower provided with the electrostatic atomizer shown in Fig. 1.

[0027] In Fig. 2, the hair dryer has a housing 81 that forms a main unit, and also has a handle 82 that is integral with the housing 81 and provided on a lower wall of the housing 81 so as to protrude downward. In the housing 81, provided are a fan 84 for intake of air from an air intake port 87 and a motor 83 for rotating the fan 84. At a downstream side of the motor 83, a heating unit 85 is provided on which a heater 86 is disposed to selectively heat the air sent by the fan 84 and generate warm air when the heater 86 is selectively electrically charged, where the generated warm air is sent through a blow-out port 88 to the outside.

[0028] In the handle 82, a switch 89 is provided which switches on/off the motor 83, the heater 86, and the electrostatic atomizer, and also switches other functions of the hair dryer.

[0029] In a front part of an upper wall of the housing 81, the high voltage generation circuit 2, the discharge unit 3, and the water supply unit 4, which compose the electrostatic atomizer shown in Fig. 1 together with the voltage adjustment circuit 1 (not shown), are arranged. Nano-sized mist generated by the discharge unit 3 is emitted in the same direction as that of the air blown from the blow-out port 88, by an air flow generated by the fan 84 and then introduced into an introduction path 90.

[0030] On the upper wall within the housing 81 between the air intake port 87 and the fan 84, the capacitor 5 is arranged and connected to the high voltage generation circuit 2 via a wire (not shown).

[0031] With this structure, when electric power is supplied from the AC power supply 7 and a power supply voltage thereof is over 100V, this power supply voltage is adjusted by the voltage adjustment circuit 1 to 100V, and is then supplied to the high voltage generation circuit 2. The voltage supplied to the high voltage generation circuit 2 is stepped-up by the step-up transformer 22 to generate a high-voltage alternating current. The generated high-voltage alternating current is smoothed and rectified by the smoothing/ rectifying circuit 23 to generate a high-voltage direct current. The generated DC high voltage is applied to the discharge electrode 31 of the discharge unit 3 via the secondary high-voltage output terminal 25a, and consequently a high electric field is produced between the discharge electrode 31 and the counter electrode 32.

[0032] Meanwhile, the discharge electrode 31 is supplied with water from the water supply unit 4, and the water supplied to the discharge electrode 31 is electrostatically atomized by the high electric field produced between the discharge electrode 31 and the counter electrode 32, and the nano-sized mist is thereby generated, as described earlier. Since the generated nano-sized mist is electrically charged, it moves from the discharge electrode 31 to the counter electrode 32 because of the high electric field produced therebetween, and is then emitted outside by the air flow from the fan 84.

[0033] When the capacitor 5 is not inserted between the primary input terminal 24 and the secondary low-voltage output terminal 25b and therefore the secondary low-voltage output terminal 25b is in a high-impedance state, the electrical potentials of the secondary low-voltage output terminal 25b and the secondary high-voltage output terminal 25a change as shown in Figs. 4A and 4B, respectively, when the nano-sized mist is generated and emitted outside as described above.

[0034] For example, when the high voltage applied to the discharge electrode 31 is about -4kV, an amplitude V1 of the potential change ranges approximately between $\pm$1kV, and the potential change of the secondary low-output terminal 25b becomes considerably large with respect to the voltage applied to the discharge electrode 31. Thus, when the potential change of the secondary low-voltage output terminal 25b becomes large and unstable, the generated nano-sized mist is liable to adhere to the discharge electrode 31 or tends to be attracted to the counter electrode 32, and is not therefore easily emitted to the outside.

[0035] In contrast, when the capacitor 5 is inserted as in the first embodiment and therefore the secondary low-voltage output terminal 25b is in a low-impedance state, the electrical potentials of the secondary low-voltage output terminal 25b and the secondary high-voltage output terminal 25a change as shown in Figs. 5A and 5B, respectively.

[0036] Likewise, as in the foregoing example, when the high voltage applied to the discharge electrode 31 is about -4kV, an amplitude V2 of the potential change rang-

es approximately between ±100V, and the potential change of the secondary low-voltage output terminal 25b becomes considerably small with respect to the voltage applied to the discharge electrode 31. Thus, the potential change of the secondary low-voltage output terminal 25b is small as well as stable and the electrical potential thereof is stably set to a value higher than that of the grounding potential, so that situations such that the generated nano-sized mist is liable to adhere to the discharge electrode 31 or tends to be attracted to the counter electrode 32 are avoidable. Therefore, the generated nano-sized mist is easily emitted to the outside by the air flow sent by the fan 84, which leads to an increase of the amount of emission of the nano-sized mist, compared to the conventional configuration in which the electrical potential of the counter electrode 32 is set to the grounding potential.

[Second Embodiment]

[0037] Fig. 6 is a diagram showing a configuration of an electrostatic atomizer provided in a hot air blower according to a second embodiment of the present invention. The second embodiment is characterized, as shown in Fig. 2, in that one of two capacitors of the capacitor 5 is connected to the secondary high-voltage output terminal 25a instead of the secondary low-voltage output terminal 25b unlike the first embodiment shown in Fig. 1, in order to achieve the connection between the primary input terminal 24 and the secondary high-voltage output terminal 25a via the capacitor 5. Other portions are the same as in the first embodiment.

[0038] In this second embodiment, the capacitor 5 serves as a high-frequency low-impedance element to connect the primary input terminal 24 and the secondary high-voltage output terminal 25a with each other. Thus, the electrical potential of the secondary high-voltage output terminal 25a changes as shown in Fig. 5B referred earlier, and the electrical potential of the secondary low-voltage output terminal 25b, which changes in generally the same manner as the potential change of the secondary high-voltage output terminal 25a, almost changes as shown in Fig. 5A.

[0039] Accordingly, this second embodiment can provide the same advantageous effect as that obtained in the aforementioned first embodiment.

[Third Embodiment]

[0040] Next descriptions will be given of an electrostatic atomizer provided in a hot air blower according to a third embodiment of the present invention. The third embodiment is characterized in that the capacitor 5 is arranged as far as possible from the discharge electrode 31, and other portions are the same as in the first or the second embodiment.

[0041] The discharge electrode 31 is easily charged because the high voltage is applied thereto and the electrostatic atomization is performed. Therefore, when the capacitor 5 is arranged near the discharge electrode 31, the capacitor 5 is easily influenced by the electrically charged discharge electrode 31. Thus, changes in the electrical potentials of the secondary outputs of the high voltage generation circuit 2 are affected via the capacitor 5, and therefore the high voltage supplied to the discharge electrode 31 becomes unstable, which makes it difficult to perform stable discharge.

[0042] In the third embodiment, the capacitor 5 is arranged as far as possible, that is, at a position hardly influenced by the electrically charged discharge electrode 31, for example, on the upper wall within the housing 81 between the air intake port 87 and the fan 84 as shown in Fig. 2, and is connected to the high voltage generation circuit 2 via a wire (not shown), so that the inconvenience described above is avoided. Therefore, it is possible to achieve stable discharge and generation of the nano-sized mist.

[0043] Although the present invention made by the present inventors has been described in reference to its embodiment, the statement and drawings constituting part of the disclosure of the present invention should not be regarded as limiting the present invention. That is, various alternative embodiments, examples, and operation techniques made by those skilled in the art on the basis of the foregoing embodiment are, of course, within the scope of the present invention.

Claims

1. A hot air blower having an electrostatic atomizer, emitting charged particulate water, and blowing out warm air, the electrostatic atomizer generating the charged particulate water by electrostatically atomizing water,
the electrostatic atomizer comprising:

a discharge electrode (31);
a counter electrode (32) opposed to the discharge electrode (31);
a high voltage generation circuit (2) that applies a high voltage across the discharge electrode (31) and the counter electrode (32); and
water supply means (4) for supplying the water to the discharge electrode (31), the water being electrostatically atomized when supplied to the discharge electrode (31), wherein
the high voltage generation circuit (2) is configured by connecting a high-frequency low-impedance element between a primary input terminal (24) receiving an input voltage and a secondary low-voltage output terminal (25b) connected to the counter electrode (32) and paired with a secondary high-voltage output terminal (25a) that outputs the high voltage obtained by stepping up of the input voltage received by the primary input terminal (24) and then applied to the dis-

charge electrode (31).

2. A hot air blower having an electrostatic atomizer, emitting charged particulate water, and blowing out warm air, the electrostatic atomizer generating the charged particulate water by electrostatically atomizing water,
the electrostatic atomizer comprising:

a discharge electrode (31);
a counter electrode (32) opposed to the discharge electrode (31);
a high voltage generation circuit (2) that applies a high voltage across the discharge electrode (31) and the counter electrode (32); and
water supply means (4) for supplying the water to the discharge electrode (31), the water being electrostatically atomized when supplied to the discharge electrode (31), wherein,
the high voltage generation circuit (2) is configured by connecting a high-frequency low-impedance element between a primary input terminal receiving (24) an input voltage and a secondary high-voltage output terminal (25a) that outputs the high voltage obtained by stepping up of the input voltage received by the primary input terminal (24) and then applied to the discharge electrode (31).

3. The hot air blower according to claim 1 or 2, wherein the high-frequency low-impedance element is disposed within the hot air blower at a position hardly influenced by the discharge electrode (31) being electrically charged.

FIG. 1

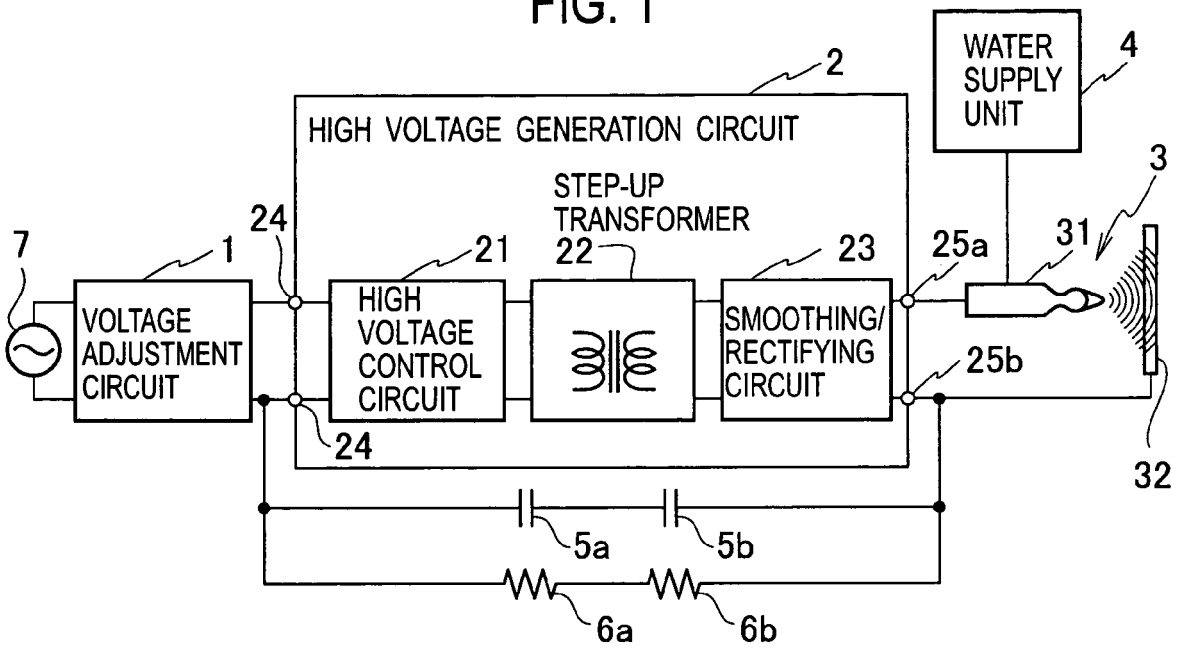

2
HIGH VOLTAGE GENERATION CIRCUIT
WATER SUPPLY UNIT
4
3
STEP-UP TRANSFORMER
7
1
24
21
22
23
25a
31
VOLTAGE ADJUSTMENT CIRCUIT
HIGH VOLTAGE CONTROL CIRCUIT
SMOOTHING/ RECTIFYING CIRCUIT
25b
24
32
5a
5b
6a
6b

FIG. 2

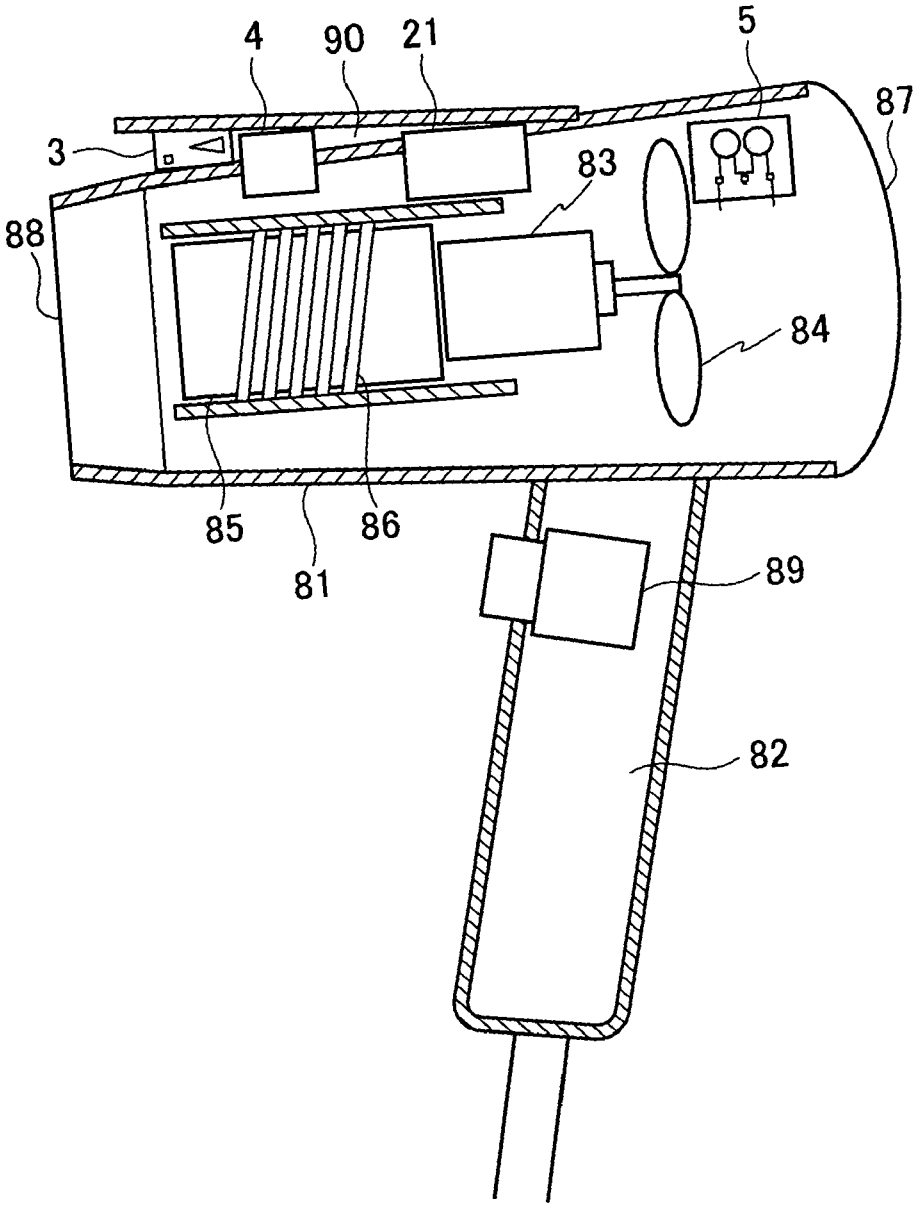


FIG. 3

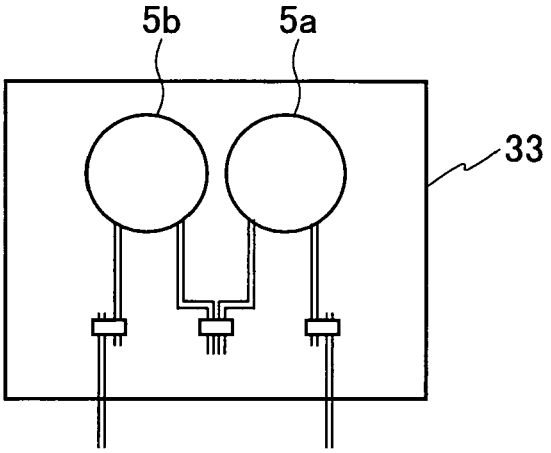


FIG. 4

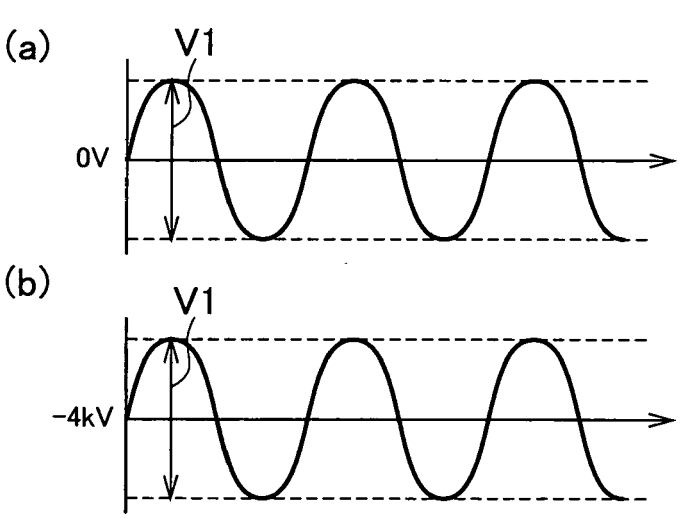


FIG. 5

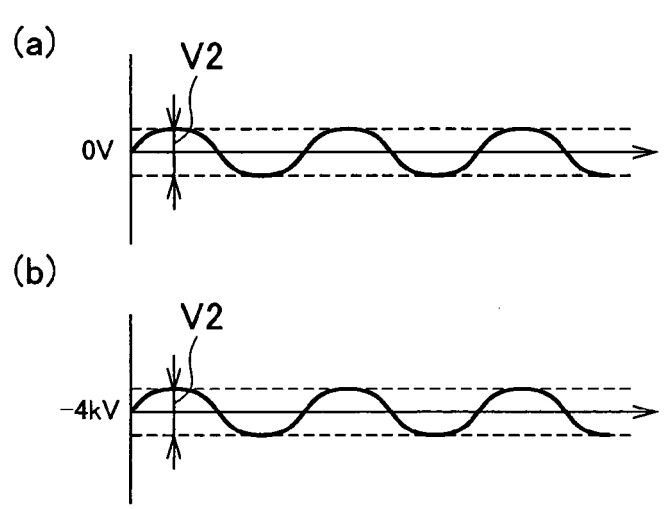
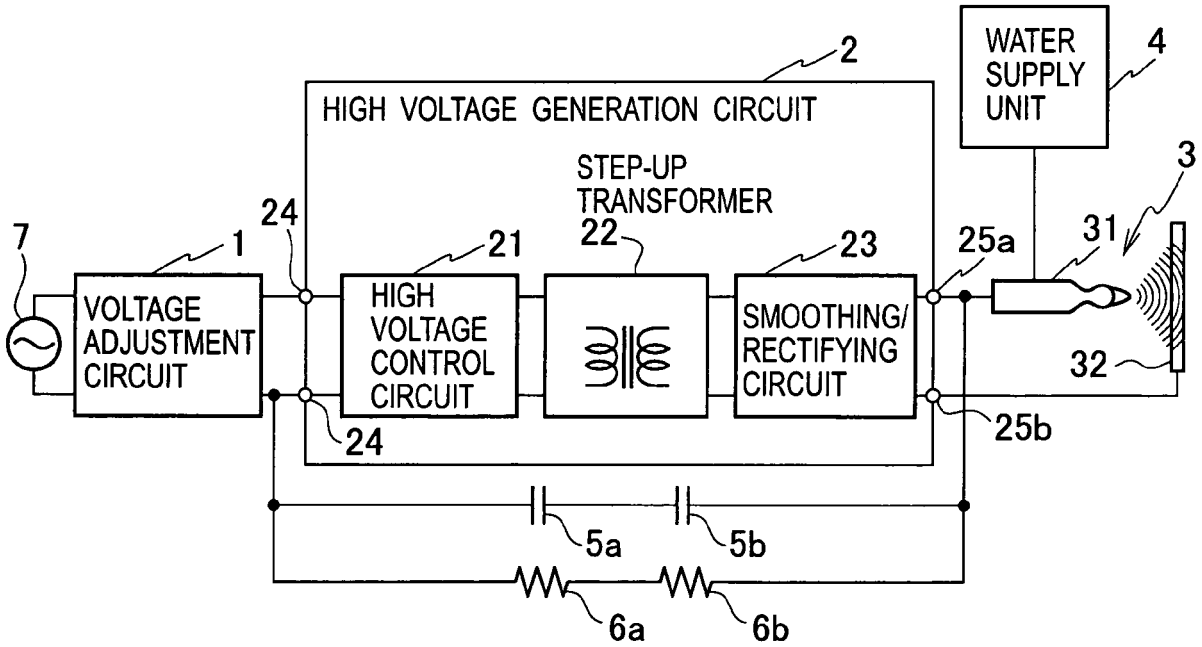

(a)
V2
0V
(b)
V2
-4kV

FIG. 6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25a
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VOLTAGE ADJUSTMENT CIRCUIT
HIGH VOLTAGE CONTROL CIRCUIT
SMOOTHING/ RECTIFYING CIRCUIT
32
24
25b
5a
5b
6a
6b

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EUROPEAN SEARCH REPORT

Application Number
EP 08 01 3444

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 810 592 A (MATSUSHITA) 25 July 2007 (2007-07-25) * the whole document * -----	1-3	INV. A45D20/12
A	WO 2006/093190 A (MATSUSHITA) 8 September 2006 (2006-09-08) * abstract * * figures 1,2 * -----	1-3	
			TECHNICAL FIELDS SEARCHED (IPC)
			A45D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	1 December 2008	Witkowska-Piela, A

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01-12-2008

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2006239632 A **[0003]**