US012391582B2

(12) **United States Patent**
Li

(10) **Patent No.: US 12,391,582 B2**
(45) **Date of Patent: Aug. 19, 2025**

(54) **WATER NEGATIVE ION GENERATING DEVICE AND CONTROL CIRCUIT ARRANGEMENT THEREOF**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **18/726,824**

(22) PCT Filed: **Dec. 25, 2023**

(86) PCT No.: **PCT/CN2023/141562**
§ 371 (c)(1),
(2) Date: **Jul. 5, 2024**

(87) PCT Pub. No.: **WO2024/187896**
PCT Pub. Date: **Sep. 19, 2024**

(65) **Prior Publication Data**

US 2024/0417286 A1 Dec. 19, 2024

(30) **Foreign Application Priority Data**

Mar. 15, 2023 (CN) 202310244905.2

(51) **Int. Cl.**
C02F 1/46 (2023.01)
A61L 9/14 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***C02F 1/4608*** (2013.01); ***A61L 9/145*** (2013.01); ***B01D 47/066*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC C02F 1/4608; C02F 1/008; C02F 2201/46; F24F 8/30; F24F 8/194; F24F 6/12; F24F 8/192; F24F 8/80; F24F 2120/10; A61L 9/145; A61L 2209/132; A61L 2209/16; A61L 2209/213; A61L 9/14; A61L 9/12; A61L 9/03; A61L 2209/12; A61L 9/22; A61L 2209/135; A61L 2209/14; A61L 2209/134; A61L 2209/111; B01D 47/066; B01D 46/46; B01D 46/0032;
(Continued)

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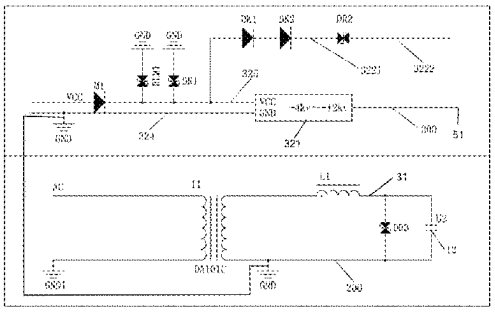
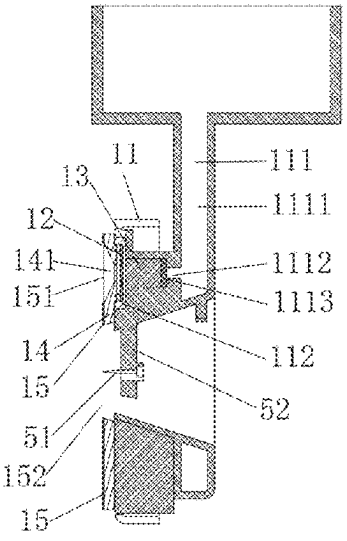
(57) **ABSTRACT**

A control circuit arrangement for a water negative ion generating device includes a water mist generating circuit for driving the generation of negative ion water mist, and a high voltage charging circuit for supplementing electrons to the negative ion water mist generated by the water mist generating circuit, wherein the water mist generating circuit and the high voltage charging circuit are grounded together, thereby ensuring that the two circuits work normally and produce negative ions.

2 Claims, 8 Drawing Sheets





(51) **Int. Cl.**

B01D 47/06	(2006.01)
B05B 17/06	(2006.01)
C02F 1/00	(2023.01)
F24F 8/30	(2021.01)

(52) **U.S. Cl.**

CPC ***B05B 17/0607*** (2013.01); ***C02F 1/008*** (2013.01); ***F24F 8/30*** (2021.01); *A61L 2209/132* (2013.01); *A61L 2209/16* (2013.01); *A61L 2209/213* (2013.01); *C02F 2201/46* (2013.01)

(58) **Field of Classification Search**

CPC B01D 46/442; B01D 46/4263; B01D 46/0028; B01D 46/0047; B01D 2273/30; B01D 2279/65; B05B 17/0607; B05B 3/0427; B05B 17/0692; B05B 7/0075; B05B 5/053; B05B 5/057; B05B 5/0533; B05B 5/0255; Y02A 50/20; F21V 33/0064; B03C 3/41; B03C 3/38; B03C 3/04; B03C 3/155; B03C 3/368; B03C 3/011; B03C 3/68; B03C 2201/06; B03C 2201/24; H01T 23/00; C01B 13/11; C01B 2201/22

See application file for complete search history.

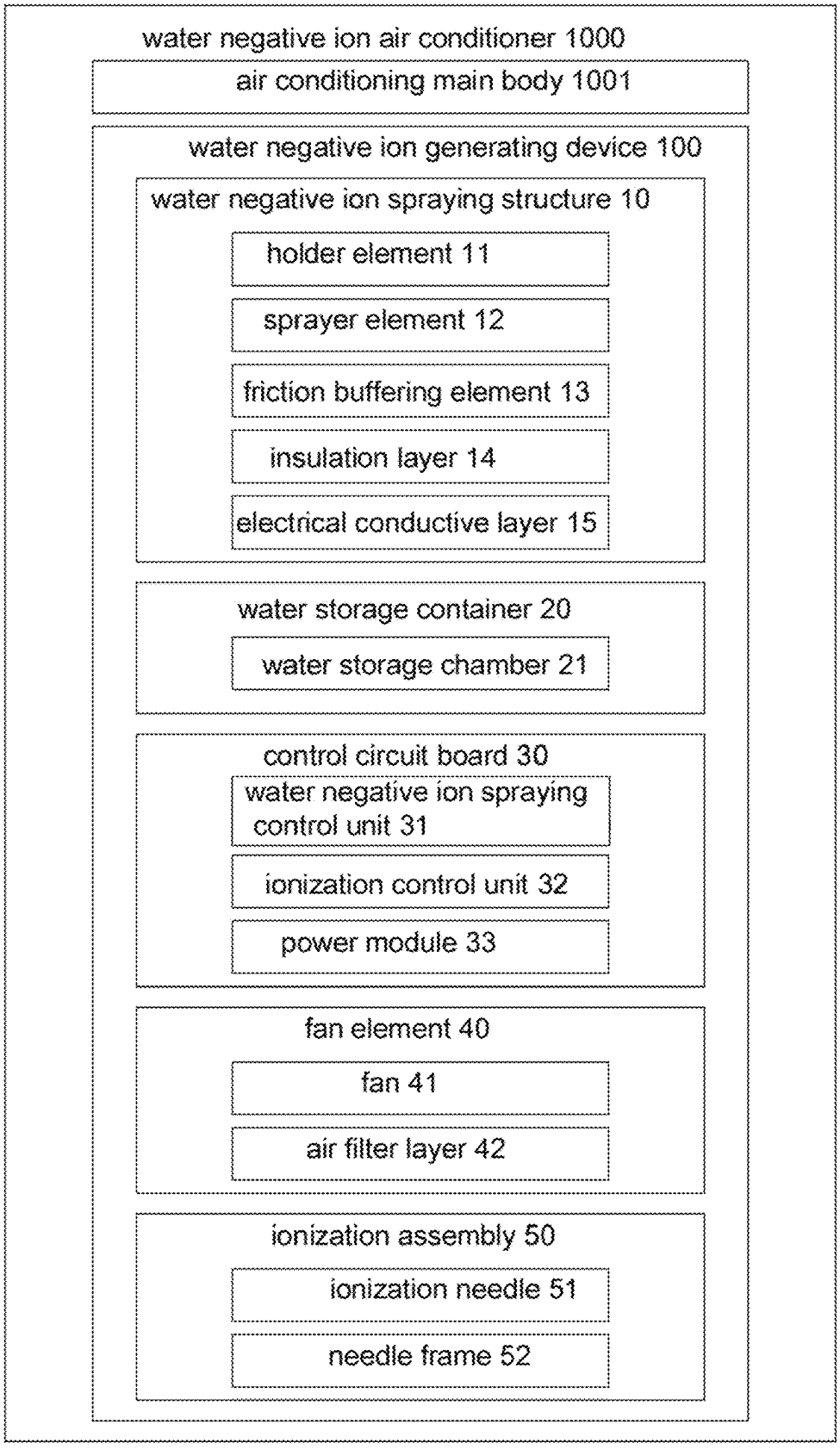

water negative ion air conditioner 1000
air conditioning main body 1001
water negative ion generating device 100
water negative ion spraying structure 10
holder element 11
sprayer element 12
friction buffering element 13
insulation layer 14
electrical conductive layer 15
water storage container 20
water storage chamber 21
control circuit board 30
water negative ion spraying control unit 31
ionization control unit 32
power module 33
fan element 40
fan 41
air filter layer 42
ionization assembly 50
ionization needle 51
needle frame 52

Fig. 1

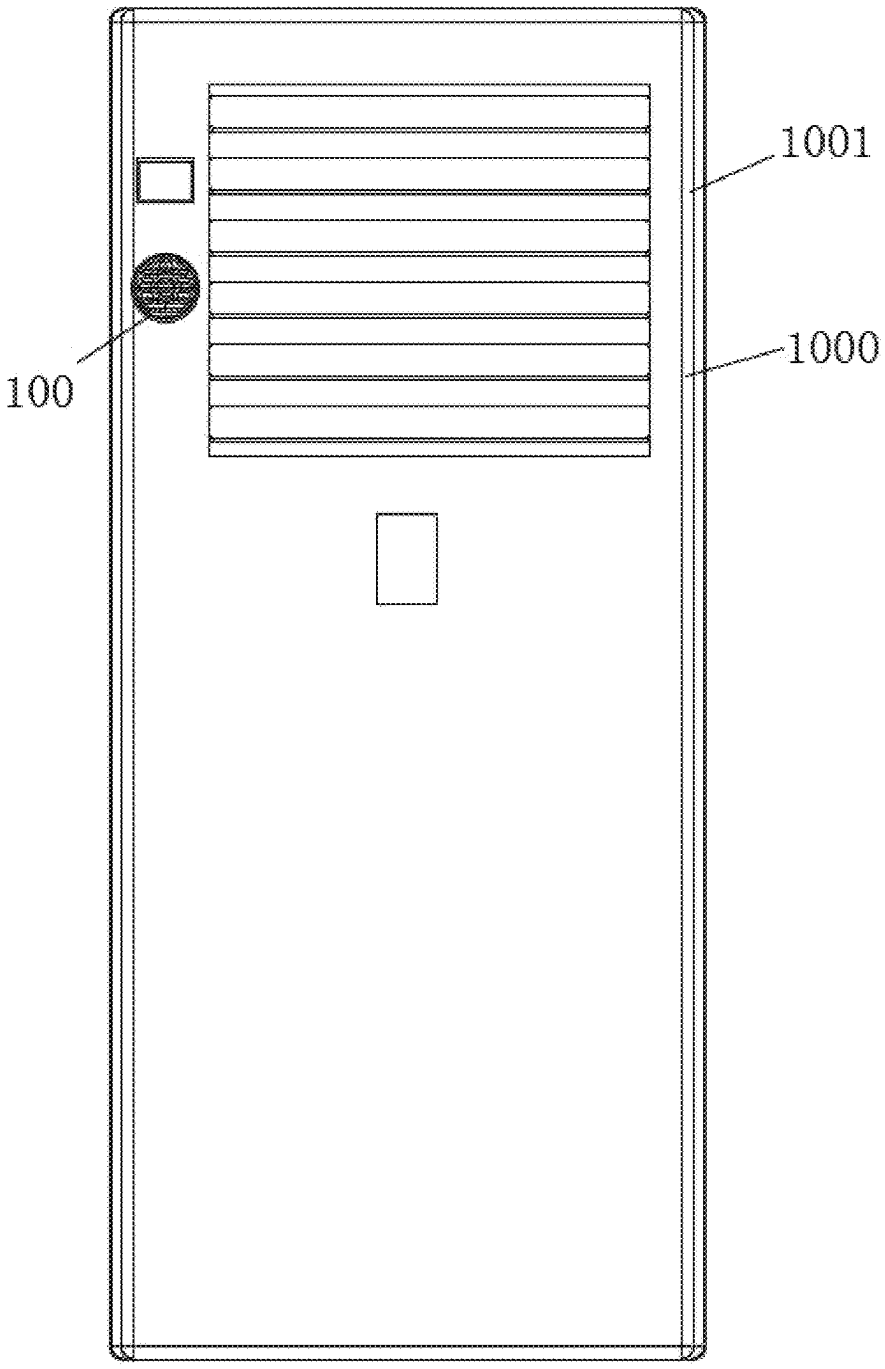


Fig.2

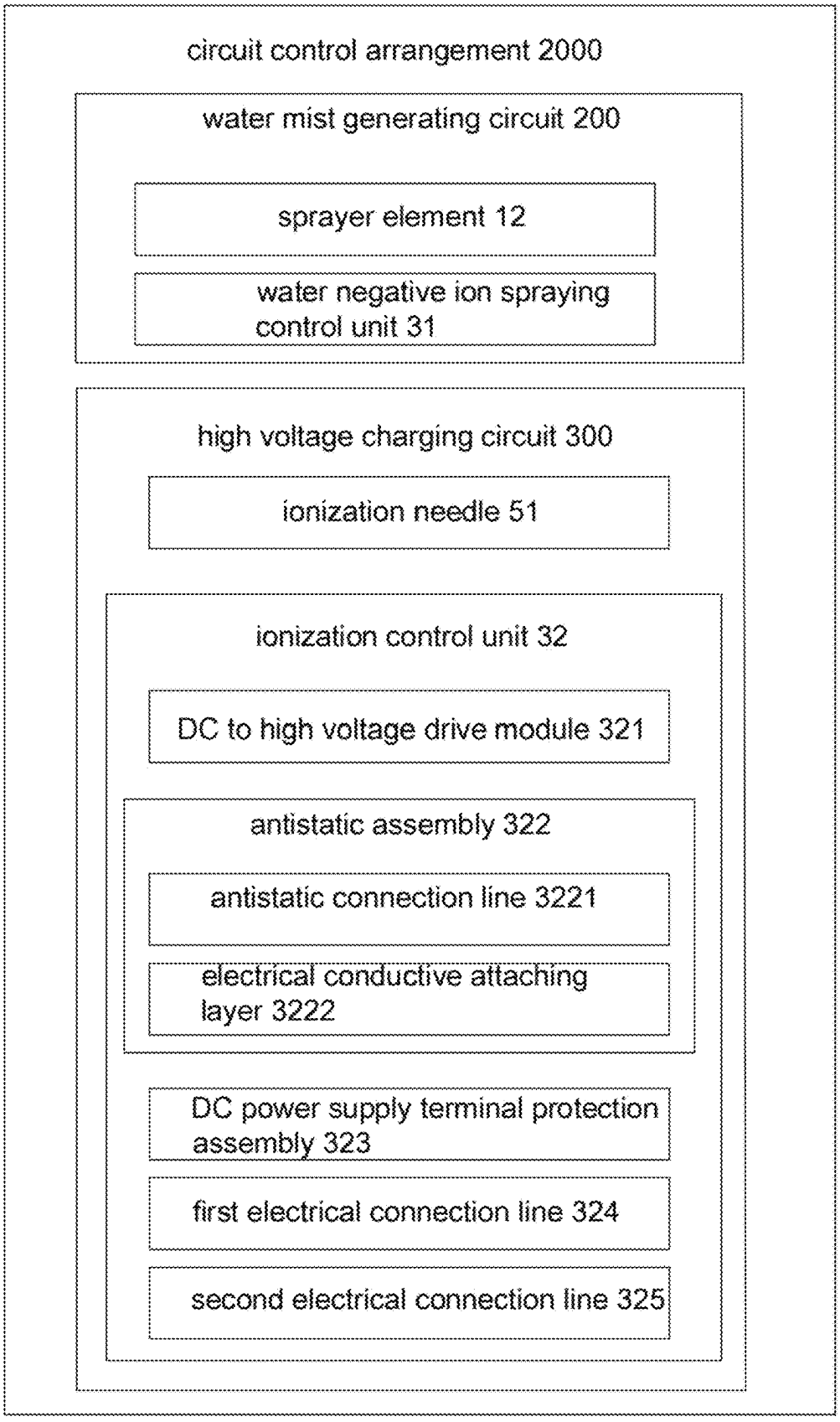

circuit control arrangement 2000
water mist generating circuit 200
sprayer element 12
water negative ion spraying control unit 31
high voltage charging circuit 300
ionization needle 51
ionization control unit 32
DC to high voltage drive module 321
antistatic assembly 322
antistatic connection line 3221
electrical conductive attaching layer 3222
DC power supply terminal protection assembly 323
first electrical connection line 324
second electrical connection line 325

FIG.3

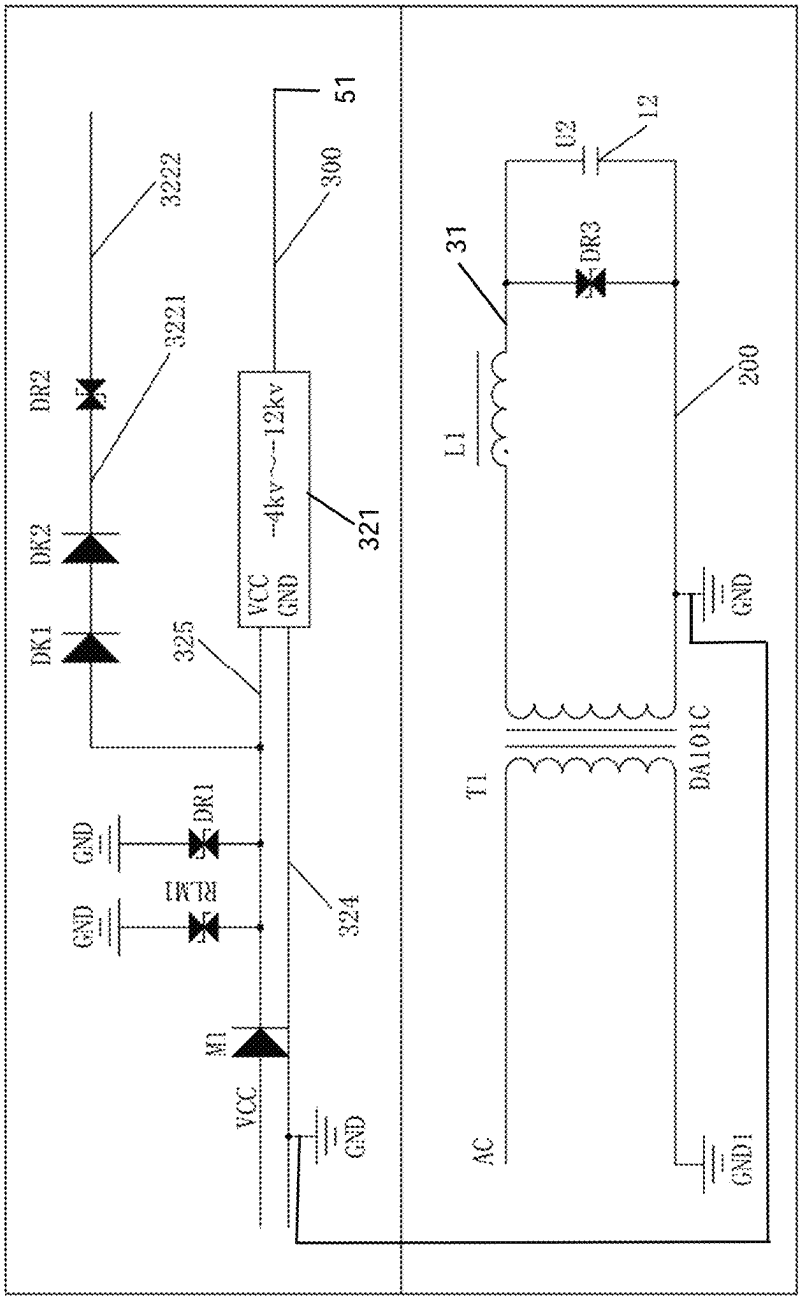

51
3222
300
U2
12
31
DR3
3221
DR2
200
L1
DR2
VCC
GND
4kv~12kv
321
DK1
325
GND
DR1
RLM1
GND
324
M1
T1
DA101C
VCC
GND
AC
GND1
GND

FIG.4

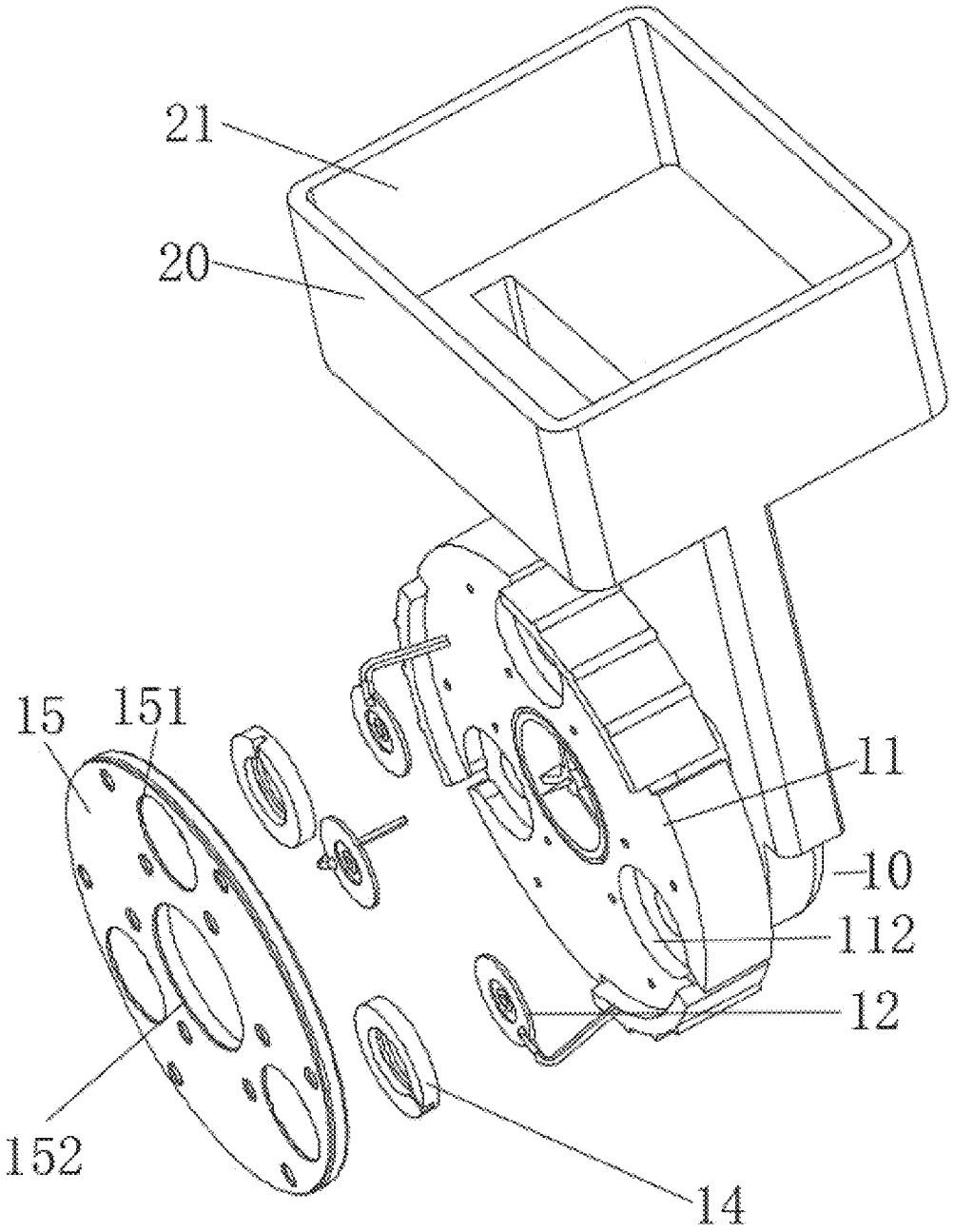


Fig.5

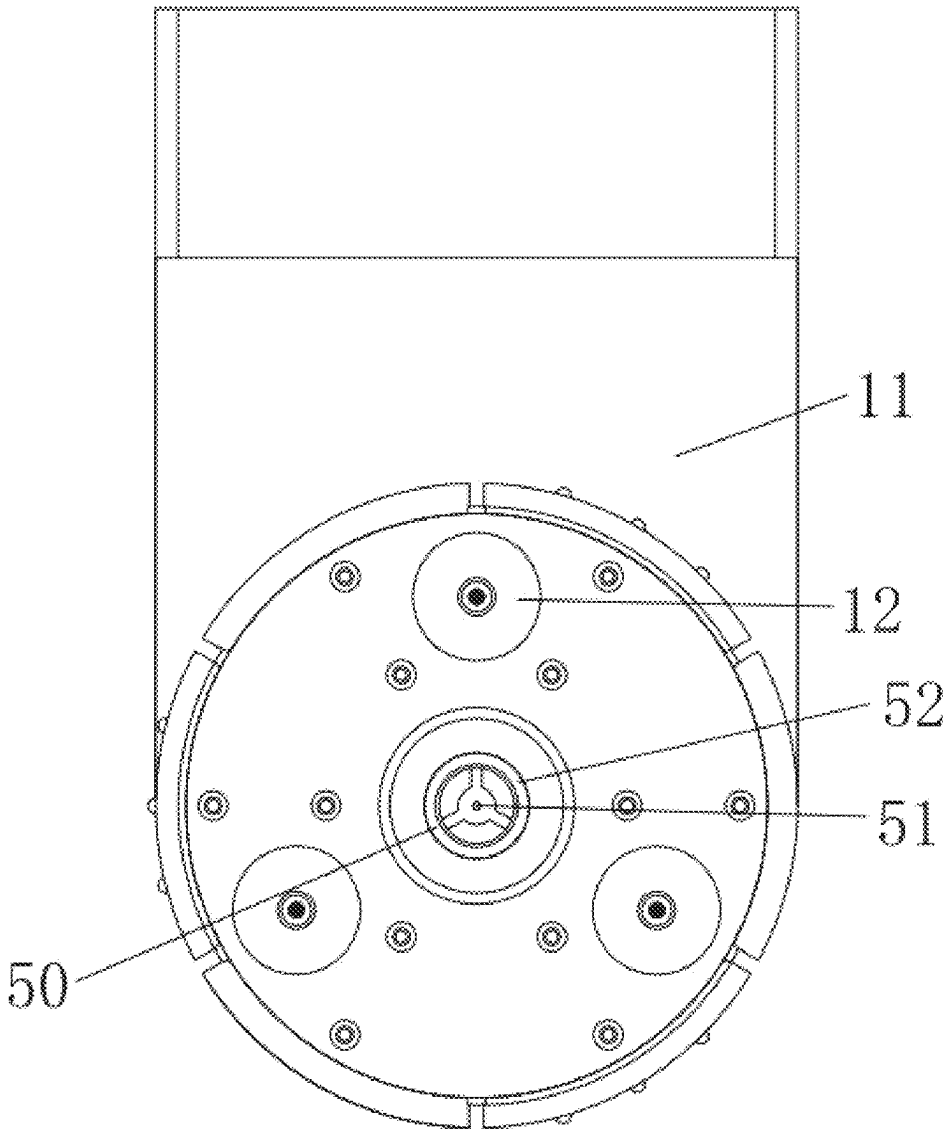


Fig.6

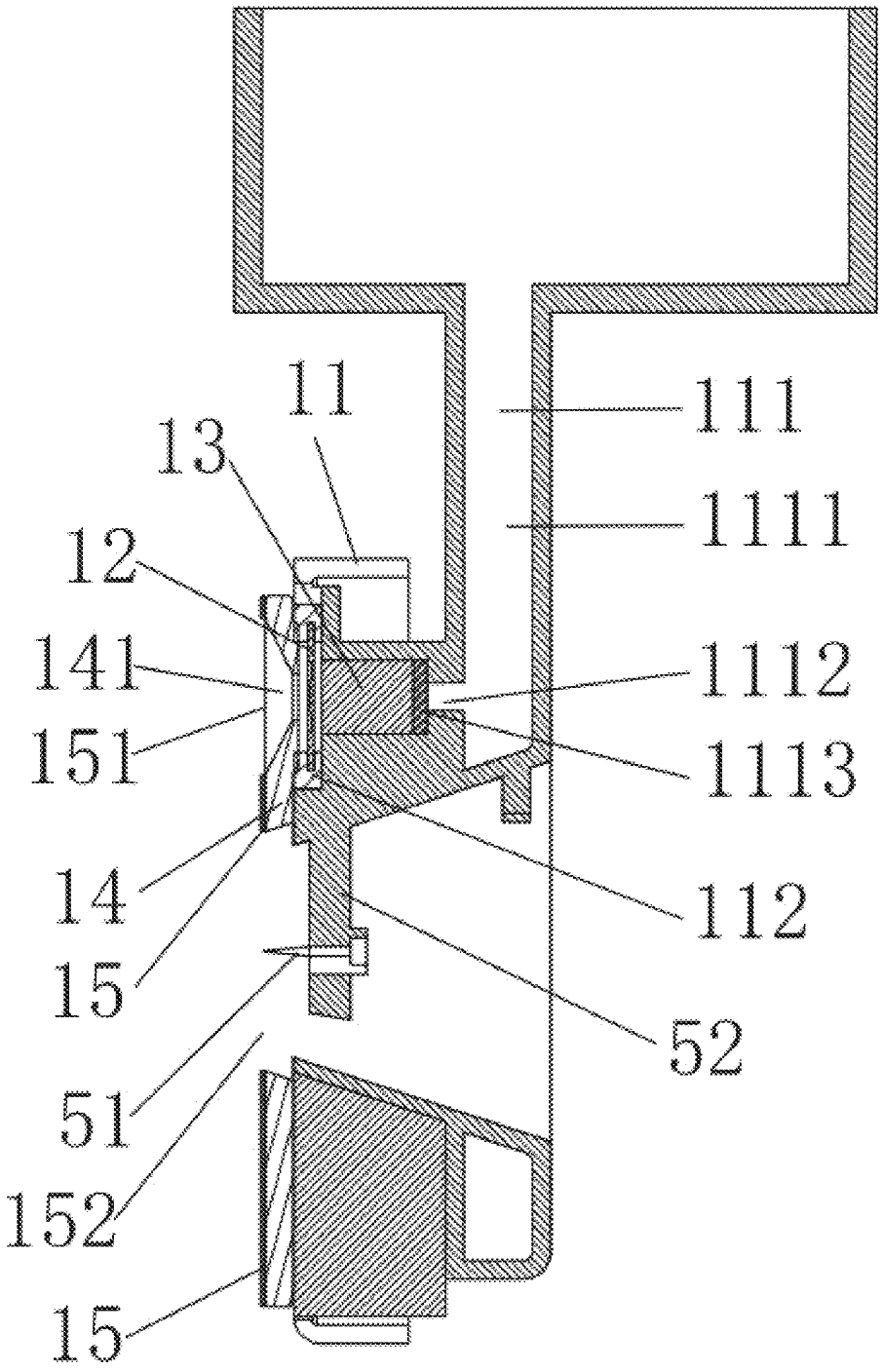


Fig.7

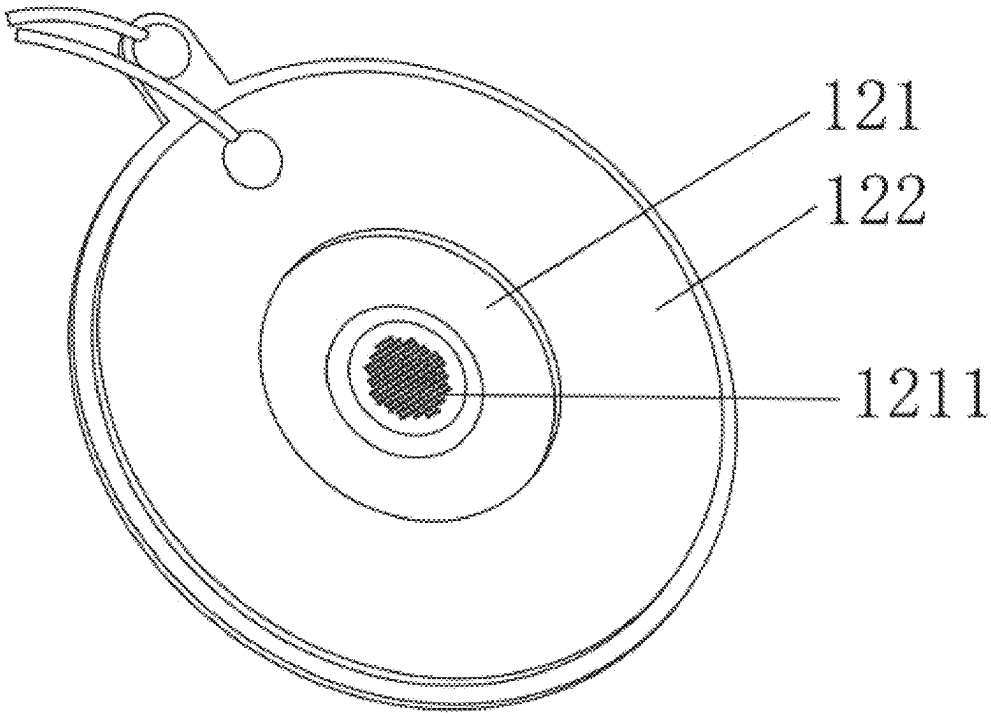


Fig.8

WATER NEGATIVE ION GENERATING DEVICE AND CONTROL CIRCUIT ARRANGEMENT THEREOF

CROSS REFERENCE OF RELATED APPLICATION

This is a U.S. National Stage under 35 U.S.C. 371 of the International Application Number PCT/CN2023/141562, filed Dec. 25, 2023, which claims priority under 35 U.S.C. 119(a-d) to Chinese application number 202310244905.2, filed Mar. 15, 2023, wherein the above patent applications are hereby incorporated by reference in their entities.

BACKGROUND OF THE PRESENT INVENTION

Field of Invention

The present invention relates to the field of negative ion technology, and particularly to a water negative ion generating device and control circuit arrangement thereof.

Description of Related Arts

Negative ions have the function of air purification, such as dust removal, sterilization. A conventional negative ion generating machines generally use high-voltage ionization of the air to form negative ions. In order to obtain a higher concentration of negative ions, a relatively high voltage is required. However, extremely high voltage can generate static electricity and ozone. In addition, when the negative ion generating equipment generates negative ions, it is easy to cause charge accumulation, which may cause breakdown of the equipment and affect the safe use of the equipment.

By vibrating and impacting water, negative ions are generated and the negative ions are supplemented with electrons through an ionization assembly, so that a higher concentration of negative ions can be obtained. In this way, the ionization assembly does not require a particularly high voltage, and the generated negative ions tend to be saturated and have strong binding force. Even when the migration distance is long, the negative ions can still remain intact.

However, the negative ion generating equipment has different circuits. It is necessary to design the circuit and protect the components in the circuit in order to ensure the normal operation of the negative ion generating equipment to generate negative ions, and prevent short circuits in the circuit, so that it can be used safely.

SUMMARY OF THE PRESENT INVENTION

To solve the above technical problems, the present invention provides a control circuit arrangement for a water negative ion generating device, comprising:

- a water mist generating circuit for driving the generation of negative ion water mist; and
- a high voltage charging circuit for supplementing electrons to the negative ion water mist generated by the water mist generating circuit, wherein the water mist generating circuit and the high voltage charging circuit are grounded together.

Preferably, the water mist generating circuit comprises a sprayer element and a water negative ion spraying control unit electrically connected to the sprayer element, and the high voltage charging circuit comprises an ionization needle and an ionization control unit electrically connected to the ionization needle.

Preferably, the water negative ion spraying control unit of the water mist generating circuit comprises a boost transformer T**1**, a power inductor L**1**, and a protective component DR**3** which are electrically connected, wherein the protective component DR**3** is connected in parallel with the sprayer element.

Preferably, the protective component DR**3** is a bidirectional suppression transient diode with a reverse breakdown voltage not exceeding a maximum excitation voltage of the sprayer element.

Preferably, the sprayer element comprises an spraying piece with spraying holes and a piezoelectric ceramic piece.

Preferably, the ionization control unit comprises a DC to high voltage drive module which increases a voltage to −2 KV or above (such as −2 KV, −3 KV, −4 KV, −5 KV, etc.), wherein the ionization needle is electrically connected to the DC to high voltage drive module to generate negative ions, wherein the high voltage charging circuit further comprises an antistatic assembly which is used to eliminate static electrons generated by the ionization needle and attached to the water negative ion generating device, wherein the antistatic assembly comprises one or more DK**2**, and a sum of the DC reverse voltage withstand of the DK**2** is greater than a high voltage generated by the DC to high voltage drive module.

Preferably, the antistatic assembly also comprises one or more DR**2** connected in series with DK**2**, wherein DR**2** can be a transient diode, a varistor, an air discharge tube, a glass discharge tube, a semiconductor discharge tube, or a combination thereof.

Preferably, the antistatic assembly comprises an antistatic connection line, and one or more DKs which are connected in series in the antistatic connection line.

Preferably, at least a part of the antistatic connection line is attached to a housing of the water negative ion generating device.

Preferably, the antistatic assembly further comprises a DC power supply terminal protection assembly connected to the DC to high voltage drive module, wherein the DC power supply terminal protection assembly comprises a diode M**1** with a DC reverse voltage withstand of not less than 1 KV to prevent interference from the high voltage charging circuit affecting the system power supply VCC.

Preferably, the ionization control unit comprises a first electrical connection line electrically connected to GND and a second electrical connection line electrically connected to VCC. The DC power supply terminal protection assembly further comprises at least one DR**1**, wherein one end of DR**1** is electrically connected to the second electrical connection line, and the other end is electrically connected to GND, wherein DR**1** is a transient diode.

Preferably, the DC power supply terminal protection assembly further comprises at least one PLM**1**, wherein one end of PLM**1** is electrically connected to the second electrical connection line, and the other end is electrically connected to GND, wherein PLM**1** is one or more of a transient diode, a varistor, an air discharge tube, a glass discharge tube, and a semiconductor discharge tube.

Preferably, the DC to high voltage drive module increases the voltage to −4 KV~−12 KV.

The present invention also provides a water negative ion generating device, comprising:

a water storage container having a water storage chamber;

a water negative ion spraying structure for vibrating and rubbing the water from the water storage container; and

the above mentioned control circuit arrangement, wherein the water mist generating circuit is used to drive the water negative ion spraying structure to generate the negative ion water mist, and the high voltage charging circuit is used to supplement electrons to the negative ion water mist generated by driving the water mist generating circuit with the water negative ion spraying structure, wherein the water mist generating circuit and the high voltage charging circuit are grounded together.

Preferably, the water negative ion spraying structure comprises:

a holder element with a placement channel;

a friction buffer element which is arranged in the placement channel and has water absorption and elasticity;

a prayer element which is used to vibrate and rub the water in the friction buffer element;

an insulation layer having a through hole, wherein the prayer element is located between the insulation layer and the holder element; and

an electrical conductive layer arranged on an outer surface of the holder element and the insulation layer, wherein the electrical conductive layer has a discharge channel, the discharge channel of the electrical conductive layer corresponds to the position of the through hole of the insulation layer to allow the charged water droplets generated by the sprayer element to be released through the through hole of the insulation layer and the discharge channel of the electrical conductive layer to the outside of the water negative ion spraying structure.

Preferably, the sprayer element comprises an spraying piece and a ring-shaped piezoelectric ceramic piece stacked on the spraying piece. The spraying piece has spraying holes. When a predetermined frequency and peak voltage are applied to the spraying piece and the piezoelectric ceramic piece, the spraying piece will vibrate and strike the water droplets in the friction buffer element, thereby generating tiny water droplets through water resonance. At the same time, the tiny water droplets rub against the spraying piece for further acquiring negative electrons and forming negative ions which then diffuse into the environment through the spraying holes.

Preferably, the spraying piece is made of a material that is easier to lose electrons than water, or the surface of the spraying piece is coated with a coating, and the coating is polyimide, aluminum, or polyamide.

Preferably, an aperture size of the spraying holes of the spraying piece is less than 10 micrometers.

Preferably, the holder element has a connecting channel, and the connecting channel forms the placement channel and a guiding channel, and the guiding channel communicates with the water storage chamber of the water storage container, thereby guiding the water in the water storage chamber of the water storage container to the friction buffer element in the placement channel.

Preferably, the connecting channel of the holder element further has a buffering channel, the buffering channel is located between the guiding channel and the placement channel, and the buffering channel and the placement channel are arranged in the horizontal direction, and the guiding channel is arranged in the vertical direction, and the friction buffer element is only located in the placement channel and is prevented from entering the buffering channel.

The present invention also provides a water negative ion air conditioner which comprises an air conditioning main body and the above-mentioned water negative ion generating device. The advantageous effects of the present invention are:

(1) By grounding the water mist generating circuit and the high voltage charging circuit together, so that the two circuits form a closed loop of electron flow, thereby ensuring that the two circuits work normally and produce negative ions.

(2) The water negative ion spraying structure is used to vibrate the water at high frequency, thereby generating small water droplets. At the same time as the generation of small droplets, the spraying piece rubs against and has frictional contact with the small water droplets to simulate the way a waterfall hits the ground and naturally generates a high concentration of beneficial negative ions for human health.

(3) The high voltage charging circuit is used to supply the negative ions generated by the water negative ion spraying structure with additional charges, so that the two can work together to produce a high concentration of negative ions.

(4) High concentration negative ion water mist containing O_2-negative molecular group $O_2—(H_2O)_n$, H+ negative water molecular group $H_3O_2—(H_2O)_n$, HO-negative water molecular group $OH—(H_2O)n$, and negative water molecule $—(H_2O)n$ can be generated during the process of the high frequency vibration and rub of water.

(5) The DR**3** of the water mist generating circuit is a bidirectional suppression transient diode which can prevent the high voltage generated by the high voltage charging circuit from entering the sprayer element through the housing of the negative ion generating device, so as to control the voltage within a safe range and provide protection.

(6) The high voltage charging circuit provides antistatic function through the antistatic component and protects the power supply through the DC power supply terminal protection assembly, thus ensuring the safe and sustainable operation of the high voltage charging circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram of a water negative ion air conditioner according to a preferred embodiment of the present invention.

FIG. **2** is a schematic view of the water negative ion air conditioner according to the above mentioned preferred embodiment of the present invention.

FIG. **3** is a schematic diagram of a circuit control arrangement of a water negative ion generating device of the water negative ion air conditioner according to the above mentioned preferred embodiment of the present invention.

FIG. **4** is a schematic diagram of the circuit composition of the circuit control arrangement of the water negative ion generating device of the water negative ion air conditioner according to the above mentioned preferred embodiment of the present invention.

FIG. **5** is a perspective view of the water negative ion generating device of the water negative ion air conditioner according to the above mentioned preferred embodiment of the present invention.

FIG. **6** is a schematic view of a water negative ion spraying structure of the water negative ion generating

device according to the above mentioned preferred embodiment of the present invention.

FIG. **7** is a sectional view of the water negative ion spraying structure of the water negative ion generating device according to the above mentioned preferred embodiment of the present invention.

FIG. **8** is a schematic view of a sprayer element of the water negative ion spraying structure according to the above mentioned preferred embodiment of the present invention.

In the figures: **1000**—water negative ion air conditioner, **1001**—air conditioning main body, **100**—water negative ion generating device, **200**—water mist generating circuit, **300**—high voltage charging circuit;

10—water negative ion spraying structure, **11**—holder element, **111**—connecting channel, **112**—groove, **1111**—guiding channel, **1112**—buffering channel, **1113**—placement channel, **12**—sprayer element, **121**—spraying piece, **122**—piezoelectric ceramic piece, **1211**—spraying hole, **13**—friction buffering element, **14**—insulation layer, **141**—through hole, **15**—electrical conductive layer, **151**—discharge channel, **152**—opening, **20**—water storage container, **21**—water storage chamber;

30—control circuit board, **31**—water negative ion spraying control unit, **32**—ionization control unit, **321**—DC to high voltage drive module, **322**—antistatic assembly, **3221**—antistatic connection line, **3222**—electrical conductive attaching layer, **323**—DC power supply terminal protection assembly, **324**—first electrical connection line, **325**—second electrical connection line, **33**—power module;

40—fan element, **41**—fan, **42**—air filter layer;

50—ionization assembly, **51**—ionization needle, **52**—needle frame.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The terms and words used in the following specification are not limited to their literal meanings, but are only used by the present inventor to enable a clear and consistent understanding of the present application. Therefore, the following description of various embodiments of the present application is provided for the purpose of illustration, and not for the purpose of limiting the present application as defined by the appended claims and their equivalents, which are obvious to those skilled in the art.

Although ordinal numbers such as "first," "second," etc. will be used to describe various components, those components are not limited here. The term is only used to distinguish one component from another. For example, the first component can be referred to as the second component, and similarly, the second component can also be referred to as the first component, without departing from the teaching of the present invention. The term "and/or" as used herein includes any and all combinations of one or more of the listed items.

The terms used here are only for the purpose of describing various embodiments and are not intended to limit. As used herein, the singular form is also intended to include the plural form, unless the context clearly indicates otherwise. In addition, the terms "including" and/or "having" when used in this specification specify the presence of the stated features, numbers, steps, operations, components, elements, or combinations thereof, but do not exclude the presence or addition of one or more other features, numbers, steps, operations, components, elements, or combinations thereof.

FIGS. **1** to **8** show a water negative ion air conditioner **1000** according to a preferred embodiment of the present invention. The water negative ion air conditioner **1000** comprises a water negative ion generating device **100** and an air conditioning main body **1001**. The water negative ion generating device **100** comprises a water negative ion spraying structure **10**, a water storage container **20**, a control circuit board **30**, and a fan element **40**. The water storage container **20** is used to store liquid water, and the water is supplied to the water negative ion spraying structure **10** for the water negative ion spraying structure **10** to generate negative ions by vibrating and having frictional contact with the water. In addition, the water negative ion generating device **100** may also comprises an ionization assembly **50** which is used to supplement the negative ions generated by the water negative ion spraying structure **10** through discharge with negative electrons, so that the negative ions generated by the water negative ion spraying structure **10** tend to be electrically saturated, thereby producing a higher concentration of negative ions.

The water negative ion generating device **100** is installed on the air conditioning main body **1001** to provide the water negative ion air conditioner **1000** with the function of supplying negative ions. The air conditioning main body **1001** has a common air conditioning structure, which can comprise structures such as a housing, a refrigeration system and/or a warm air system, an air path system, a humidification system, an electrical system, etc., to ensure the normal operation of the air conditioning. It can be understood that the air conditioning main body **1001** can be a central air conditioning, an indoor wall-mounted air conditioning, a vertical air conditioning, a vehicle air conditioning, etc.

It can be understood that the water negative ion generating device **100** can also be used alone to generate water negative ions. Alternatively, it can be installed in other air conditioning devices such as car air conditioners, fresh air systems, etc.

The water negative ion spraying structure **10** comprises a holder element **11**, a sprayer element **12**, a friction buffer element **13**, an insulation layer **14**, and an electrical conductive layer **15**. The holder element **11** is a supporting carrier for the sprayer element **12**, the friction buffer element **13**, the insulation layer **14**, and the electrical conductive layer **15**. The holder element **11** is assembled with the water storage container **20** to guide the water in the water storage container **20** to the friction buffer element **13** and the sprayer element **12**, thereby generating negative ions under the action of the sprayer element **12**. The water used to generate negative ions can be various suitable types of water, such as drinking purified water, drinking conductive negative ion liquid, and drinking mineral water, etc.

The water storage container **20** has a water storage chamber **21**, and the holder element **11** has a connecting channel **111** which is communicated to the water storage chamber **21** of the water storage container **20**, so that the water in the water storage chamber **21** can reach the friction buffer element **13** and the sprayer element **12** through the connecting channel **111**.

More specifically, the connecting channel **111** comprises a guiding channel **1111**, a buffering channel **1112**, and a placement channel **1113**, wherein the guiding channel **1111**, the buffering channel **1112**, and the placement channel **1113** are connected in sequence. The guiding channel **1111** is communicated to the water storage chamber **21** of the water storage container **20**, and the placement channel **1113** is used to accommodate the friction buffering device **13**, and the

placement channel **1113** extends laterally from the guiding channel **1111**. For example, when the guiding channel **1111** extends in the vertical direction, the placement channel **1113** can extend in the horizontal direction.

Preferably, a buffering channel **1112** is formed between the guiding channel **1111** and the placement channel **1113**, and the size of the buffering channel **1112** is smaller than the size of the placement channel **1113**, for example, the inner diameter of the buffering channel **1112** is smaller than the inner diameter of the placement channel **1113**, so that the friction buffering device **13** can be kept in the placement channel **1113** without entering the buffering channel **1112**. The buffering channel **1112** also extends laterally from the guiding channel **1111**, for example, its extending direction is in the horizontal direction which is vertically to the guiding channel **1111**.

The friction buffer element **13** is made of water absorbent material, so that the friction buffer element **13** accommodated in the placement channel **1113** can absorb water and provide vibration impact water droplets for the sprayer element **12** to generate negative ions. And the friction buffer element **13** can play an elastic buffering role, so that the sprayer element **12**, during the process of vibration and friction water, hits on the friction buffer element **13** to obtain buffering and reduce noise. Preferably, the friction buffer element **13** is a cotton swab.

Referring to FIGS. **5** and **7**, the water in the water storage chamber **21** of the water storage container **20** flows downward along the vertical direction from the guiding channel **1111** to the buffering channel **1112** extending in the horizontal direction, and then the friction buffer element **13** sucks the water from the buffering channel **1112** into the storage channel **1113**, so that the friction buffer element **13** can be a water-absorbed cotton swab for the sprayer element **12** to impact and have frictional contact with the water to generate negative ions.

More specifically, as shown in FIG. **8**, the sprayer element **12** comprises a spraying piece **121** and a ring-shaped piezoelectric ceramic piece **122** stacked on the spraying piece **121**. The spraying piece **121** and the piezoelectric ceramic piece **122** are electrically connected to the control circuit board **30** and are started or stopped under the corresponding driving signal. The spraying piece **121** is made of electrical conductive material and is more prone to losing electrons comparing with water, and a central region thereof has multiple spraying holes **1211**. When a voltage with a predetermined frequency and peak value is applied to the spraying piece **121** and the piezoelectric ceramic piece **122**, the spraying piece **121** will generate high-frequency vibration to impact the water droplets in the friction buffer element **13**, thereby causing the water to resonate and produce tiny water droplets. At the same time, the tiny water droplets will frictionally rub against the spraying piece **121** at a high frequency, further acquiring a negative charge and forming negative ions which then diffuse into the environment through the spraying holes **1211**.

In the present invention, in order to generate negative ions, the water negative ion spraying structure **10** is used to perform two processes simultaneously, namely the process of generating small water droplets and the process of making the small water droplets carry negative ions. Specifically, when the spraying piece **121** of the water negative ion spraying structure **10** vibrates at a high frequency, water molecules are driven to resonate at the same frequency and vaporize, thereby generating small water droplets. At the same time, the generated small water droplets rub against and have frictional contact with the vibrating spraying piece **121** at a high frequency, causing the spraying piece **121** to lose its electrons and the small water droplets to acquire the electrons.

It can be understood that in order to make the small water droplets easier to carry the electrons and generate negative ions, the size of the spraying holes **1211** disposed in the spraying piece **121** is made as small as possible and the quantity is increased. In the present invention, the aperture size of the spraying holes **1211** is less than 10 micrometers, preferably with an opening size of less than 5 micrometers. The size of the spraying holes **1211** is correspondingly used to control the size of the small liquid droplets generated by the water negative ion spraying structure **10**.

The spraying piece **121** contacts with the water stored in the friction buffer element **13** and is used to excite the production of negative ions. Its material needs to have both conductive friction performance and corrosion resistance. For example, the spraying piece **121** can be a metal alloy such as stainless steel, for example, the spraying piece **121** is made of 316L stainless steel, which is more likely to lose electrons and become positively charged relative to water droplets. To enhance the electrical conductivity, the surface of the spraying piece **121** can also be coated with materials such as polyimide, aluminum, or polyamide such as polyamide (nylon)-11, so that the coating is more likely to lose electrons and carry a positive charge. In this way, when the spraying piece **121** of the water negative ion spraying structure **10** vibrates at a high frequency, the tiny water droplets interact with the coating and are more likely to carry a negative charge, thereby forming negative ions.

The holder element **11** forms a groove **112** at an end of the placement channel **1113** for installing the spraying piece **121** and the piezoelectric ceramic piece **122** of the sprayer element **12**. The insulation layer **14** is used to securely install the sprayer element **12** in the groove **112**, so that the sprayer element **12** is clamped between the insulation layer **14** and an inner surface of the groove **112**.

The insulation layer **14** has a through hole **141** in the middle, which corresponds to the central area of the spraying piece **121** of the sprayer element **12**, so that the tiny negative ion water droplets sprayed from the spraying holes **1211** of the spraying piece **121** are sprayed outward from the through hole **141**. Both the insulation layer **14** and the holder element **11** are made of insulating material, so that the electrical conductive structure of the sprayer element **12** is sandwiched between the insulation layer **14** and the holder element **11** to avoid short circuit.

The electrical conductive layer **15** is provided on an outer surface of the insulation layer **14** and the holder element **11**, and the electrical conductive layer **15** has a discharge channel **151**. The position of the discharge channel **151** is aligned with the through hole **141** of the insulation layer **14**, so that the tiny negative ion water droplets sprayed from the spraying holes **1211** of the spraying piece **121** can reach the discharge channel **151** of the electrical conductive layer **15** through the through hole **141** and be sprayed outwards from the discharge channel **151**. In the present invention, the electrical conductive layer **15** has electrical conductivity, which can prevent charge accumulation on the insulation layer **14**. The electrical conductive layer **15** can also be further electrically connected to the control circuit board **30** through a connecting wire for electrostatic discharge treatment, for example, by setting an electrostatic discharge component such as a diode component on the control circuit board **30**, the electrical conductive layer **15** can also guide the electrons to the ground through a wire for electrostatic discharge treatment, thereby preventing negative charge

accumulation in the water negative ion spraying structure **10**. The electrical conductive material of the electrical conductive layer **15** has moisture resistance and electrical corrosion resistance, such as metal or metal alloy, and 314 stainless steel material is preferred in this embodiment.

That is to say, when the sprayer element **12** is in operation, it will cause the accumulation of negative charges, especially if the negative electrons accumulate too much on the insulation layer **14** and the holder element **11** which are made of insulating materials, it is not easy to remove the negative electrons. When the negative charges reach a certain level, a high-voltage electric field is formed and will electrically charging the conductive material in the environment, which may cause the sprayer element **12** to be breakdown and damaged by the electrical charges. If the circuit board in the device is discharged, it will cause irreparable damage.

In addition, the water negative ion generating device **100** of the present invention also comprises an ionization assembly **50** which comprises an ionization needle **51** and a needle frame **52**, the ionization needle is installed on the needle frame **52** and electrically connected to the control circuit board **30**. The ionization needle **51** is located around the sprayer element **12**, and generates negative ions such as negative oxygen ions by ionizing the air. These negative ions are bond to the negative ions generated by the sprayer element **12**, so that the negative ions generated by the sprayer element **12** tend to be electrically charged saturated. In this way, the negative ion generating device **100** of the present invention can generate high concentration of negative ions, and the high concentration of negative ions containing elements such as O_2-negative molecular group O_2—(H_2O)n, H+ negative water molecular group H_3O_2—$(H_2O)_n$, HO— negative water molecular group OH—(H_2O)n, and negative water molecule —(H_2O)n.

In other words, the ionization needle **51** will also release negative charges to the surroundings during operation, causing the accumulation of negative electrons, the electrical conductive layer **15** of the present invention can timely export and dissipate the accumulated negative electrons generated during the operation of the sprayer element **12** and the ionization needle **51**, thereby preventing the occurrence of electrical discharge phenomena due to high static electricity concentration after a period of use. The electrical conductive layer **15** has an opening **152** in the middle corresponding to the ionization needle **51**.

The control circuit board **30** of the present invention comprises a water negative ion spraying control unit **31**, an ionization control unit **32**, and a power module **33**. The water negative ion spraying control unit **31** and the ionization control unit **32** are electrically connected to the power module **33** and can be integrated on one circuit board or separately on individual circuit boards. The water negative ion spraying control unit **31** is used to deliver voltage with a predetermined frequency and peak value to the sprayer element **12**, and the ionization control unit **32** is used to deliver voltage to the ionization needle **51**.

Referring to FIG. **5** to FIG. **7**, the water negative ion spraying structure **10** comprises a circular holder element **11**, a plurality of the spraying elements **12**, a plurality of friction buffer elements **13**, a plurality of insulation layers **14**, and an integral circular electrical conductive layer **15**. There are a plurality of sprayer elements **12** around the ionization needle **51**, so that each ionization needle **51** can provide charge replenishment to the negative ions generated by the plurality of sprayer elements **12** around it during operation.

The water negative ion generating device **100** of the present invention also comprises the fan element **40** which comprises a fan **41** and one or more air filter layers **42**. The negative ion generating device can comprises a housing, and the fan **41** and the air filter layers **42** are assembled on the housing. When the fan **41** operates, it sucks air into the housing and filters it through the air filter layers **42** before blowing it towards the water negative ion spraying structure **10** and the ionization assembly **50**. In this way, the negative ions generated by the water negative ion spraying structure **10** and the ionization assembly **50** are carried away from the water negative ion generating device **100** by the wind generated by the fan element **40**, thereby allowing the negative ions to migrate to a greater distance.

Referring to FIGS. **3** and **4**, the water negative ion generating device **100** of the present invention comprises a circuit control arrangement **2000** which comprises a water mist generating circuit **200** and a high voltage charging circuit **300**. The water mist generating circuit **200** comprises the sprayer element **12** and the water negative ion spraying control unit **31**, while the high voltage charging circuit **300** comprises the ionization needle **51** and the ionization control unit **32**.

The water negative ion spraying control unit **31** comprises a boost transformer T**1**, power inductor L**1**, protective component DR**3**. In the diagram, AC represents the pulse small signal, which is boosted by T**1** to the voltage that can drive the water mist generating circuit **200**. DR**3** is a transient diode (Transient Voltage Suppressor, TVS) which is bidirectional suppression. The main function of DR**3** is to prevent the high voltage generated by the high voltage charging circuit **300** from entering the sprayer element **12** through the housing of the water negative ion generating device **100**. Once DR**3** starts working, it controls the voltage within a safe range and plays a protective role. The reverse cutoff voltage (Vrwm) of DR**3** must not exceed a maximum excitation voltage of the sprayer element **12**.

The spraying piece **121** and the piezoelectric ceramic piece **122** of the sprayer element **12** are respectively electrically connected to the positive and negative poles of the boost transformer T**1**, and the protective component DR**3** is connected in parallel with the sprayer element **12**. After being boosted by the booster T**1**, the sprayer element **12** is loaded with a voltage of 3K-5 MHZ and a peak value of 60-90V.

The ionization control unit **32** of the high voltage charging circuit **300** comprises a DC to high voltage drive module **321**, an antistatic assembly **322**, and a DC power supply terminal protection assembly **323**. The high voltage charging circuit **300** generates negative electrons through high voltage discharge, and the negative electrons are captured by water molecules to generate negative ion molecules. The antistatic assembly **322** is used to eliminate the electrons attached to the housing of the water negative ion generating device **100** generated during the operation of the high voltage charging circuit **300**, and the DC power supply terminal protection assembly **323** is used to protect the power module **33**.

The ionization needle **51** is electrically connected to the DC to high voltage drive module **321**, and the DC to high voltage drive module **321** increases the voltage to −2 KV or above (such as −2 KV, −3 KV, −4 KV, −5 KV or higher), the preferred voltage is raised to −4 KV or above, generating a negative high voltage with respect to GND. Preferably, the DC to high voltage drive module **321** raises the voltage provided by the power module to −4 KV to −12 KV. The ionization needle **51** can charge the water mist generated by

the sprayer element **12**, that is, the electrons generated by the ionization needle **51** are promptly absorbed by the water mist generated by the sprayer element **12**, thereby generating negatively charged water mist rich in negative ions.

The ionization control unit **32** comprises a first electrical connection line **324** and a second electrical connection line **325**. The first electrical connection line **324** is electrically connected to GND (Ground) as a common ground line and serves as a negative pole of the circuit, and the internal ground line is non-isolated. The second electrical connection line **325** is electrically connected to VCC (Voltage Circuit, the power supply voltage), as a positive electrode of the circuit.

In this embodiment, as an example, VCC can be 12V, and the parameters of the DC to high voltage drive module **321** are 10.5±0.5V boost−10 KV±1 KV, with a power less than 3 W.

The antistatic assembly **322** comprises an antistatic connection line **3221** and at least a part of which can be adhered to the housing of the water negative ion generating device **100**. The fixing end of the antistatic assembly **322** can be an electrical conductive column such as a copper column which is fixed to the housing. The antistatic assembly **322** also comprises a DR**2** and at least one DK**2**, wherein the DR**2** and DK**2** are connected in series with the antistatic connection line **3221**. In this way, the electrons attached to the housing of the water negative ion generating device **100** are guided to the DR**2** and DK**2** through the antistatic connection line **3221** to achieve antistatic treatment.

For better static electricity conduction, the antistatic assembly **322** can comprise an electrical conductive attaching layer **3222**, such as double-sided conductive aluminum foil or copper foil which can be attached to an inner side of the housing of the water negative ion generating device **100**.

In this embodiment, the antistatic assembly **322** can comprise two DKs, such as a DK**1** and a DK**2** which are series-connected. DK**1** and DK**2** are both protective components which can be transient diodes, varistors, gas discharge tubes, glass discharge tubes, semiconductor discharge tubes, etc.

In this embodiment, as an example, two DK protection components are embodied as transient diodes each with a bidirectional polarity, the reverse breakdown voltage (Vrwm) is 5.8V, the breakdown voltage (minimum value) is 6.45V, the breakdown voltage (maximum value) is 7.14V, the reverse leakage current (Ir) is 500 uA, the peak pulse current (Ipp) is @10/1000 μs: 58.1 A, and the maximum clamping voltage is 10.5V DO-214AA 600 W VRWM=6.8V.

DK**2** selection mainly concerns the designing of the DC reverse withstand voltage (Vr), the DK**2** assembly can be achieved by connecting one or more diodes in series, so that the sum of the DC reverse withstand voltages of multiple DK**2***s* is greater than the high voltage generated by the DC to high voltage drive module **321**. In this embodiment, for example, three diodes can be connected in series, and 3 DK**2***s* can be selected to be connected in series together, with a DC reverse withstand voltage of 5 KV, and the sum of the DC reverse withstand voltage of the three connected in series is 15 KV, which is greater than the high voltage of 10 KV±1 KV generated by the DC to high voltage drive module **321**.

As an example, in this embodiment, the DC reverse withstand voltage of DK**2** is 5 KV, the average rectified current (Io) is 200 mA, the forward voltage drop (Vf) is 5V@200 mA, and the reverse current (Ir) is 5 uA@5 kV.

The DC power supply terminal protection assembly **323**, which is arranged on the second electrical connection line **325**, comprises one or more diodes M**1** and protection components PLM**1** and DR**1**. The diode M**1** is connected in series in the second electrical connection line **325**, and one end of each of the PLM**1** and DR**1** is respectively electrically connected to the second electrical connection line **325**, and the other end is electrically connected to GND.

M**1** can be a general-purpose diode. Its selection mainly depends on the DC reverse voltage (Vr), forward voltage drop (Vf), average rectified current (Io), wherein the main characteristic requirement is that the DC reverse voltage (Vr) is not less than 1 KV. The main function of M**1** is to prevent the high voltage charging circuit **300** from generating interference that affects the system power supply VCC.

In this embodiment, as an example, some parameters of M**1** model selection are as follows: the diode is configured as an independent type, with a DC reverse voltage (Vr) of 2 KV, an average rectification current (Io) of 1 A, a forward voltage drop (Vf) of 1.1V@1 A, and a reverse current (Ir) of 5 uA@2 kV.

PLM**1** is a protective component, such as a transient diode, a varistor, an air discharge tube, a glass discharge tube, a semiconductor discharge tube, etc. DR**1** is a transient diode (Transient Voltage Suppressor, TVS) which is bidirectional in polarity.

The protective component of the DC power supply terminal protection assembly **323** comprises at least a DR**1**. In this embodiment, as an example, the selected parameters of DR**1** are reverse breakdown voltage (Vrwm) of 13V, breakdown voltage (minimum value) of 14.4V, peak pulse current (Ipp) of @10/1000 μs: 28, and maximum clamping voltage of 21.5V.

In this embodiment, PLM**1** is embodied as the glass discharge tube, with the selection parameters being a DC breakdown voltage of 140V, an accuracy of ±30%, an insulation resistance of 100 MΩ, a static capacitance of 0.8 pF, and a current flow of 300 A for the high-efficiency discharge tube.

Referring to FIG. **4**, in order to charge the water droplets generated by the water mist generating circuit **200**, a ground GND of the DC to high voltage drive module **321** electrically connected to the ionization needle **51** of the high voltage charging circuit **300** and a ground GND of the water mist generating circuit **200** share a same grounding, that is, the ground GND of the high voltage charging circuit **300** and the ground GND of the water mist generating circuit **200** are directly connected by an electrical connection wire for forming a closed loop for the flow of electrons. Usually, for the high voltage module, from the perspective of electromagnetic compatibility, the power supply and ground inside the high voltage module are isolated from the input power supply and the ground to protect the input voltage and the ground.

It is found in the experiment that when the high voltage charging circuit **300** and the water mist generating circuit **200** are not grounded together, the negative ion generating device **100** with the isolated high voltage module has a significantly smaller amount of negative ions generated, and the presence of negative ions cannot be detected in the basic test at a distance of 6 meters from the water negative ion generating device **100**. However, when the high voltage charging circuit **300** and the water mist generating circuit **200** are grounded together, the concentration of negative ions can reach about 30,000/cm^3 at a distance of 6 meters from the water negative ion generating device **100**.

The above description combines specific embodiments to illustrate the basic principles of the present application. However, it should be noted that the advantages, benefits, and effects mentioned in this application are only examples and not limitations. It should not be assumed that these advantages, benefits, and effects are necessary for all embodiments of the present application. In addition, the specific details disclosed above are provided for illustrative and explanatory purposes only, and should not be considered as limitations. These details do not restrict the implementation of the present application to the specific details disclosed above

What is claimed is:

1. A water negative ion generating device comprising:

a water storage container having a water storage chamber;

a holder element having a placement channel communicated to the water storage chamber;

a friction buffer element made of cotton arranged in the placement channel;

a water mist generating circuit for driving the generation of negative ion water mist, wherein the water mist generating circuit comprises a sprayer element and a water negative ion spraying control unit electrically connected to the sprayer element, wherein the sprayer element comprises a spraying piece with spraying holes and a piezoelectric ceramic piece, so as to vibrate water to generate tiny water droplets through water resonance, at the same time, the tiny water droplets rub against the spraying piece for further acquiring negative electrons and forming negative ions which then diffuse into the environment through the spraying holes, wherein the sprayer element is used to vibrate and rub the water in the friction buffer element; and

a high voltage charging circuit, wherein the high voltage charging circuit comprises an ionization needle and an ionization control unit electrically connected to the ionization needle, wherein the water mist generating circuit and the high voltage charging circuit are grounded together, wherein the ionization control unit comprises a DC to high voltage drive module, wherein the ionization needle is electrically connected to the DC to high voltage drive module for generating electrons, wherein the DC to high voltage drive module increases a voltage of the ionization needle to −2 KV or above, wherein the ionization needle is arranged in a horizontal direction and the sprayer element is located adjacent to the ionization needle and arranged in a vertical direction.

2. The control circuit arrangement according to claim **1**, wherein the DC to high voltage drive module increases the voltage to −4 KV~−12 KV.

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