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(54) **METHOD FOR MEASURING NUMBER OF PUFFS AND AEROSOL GENERATING DEVICE**

(57) The present disclosure relates to the technical field of electronic atomization, and discloses a method for measuring a number of puffs and an aerosol generating device. In the method for measuring a number of puffs, based on a relationship between a coil voltage and a temperature at resonance, the coil voltage at each moment is collected in real time, a real-time temperature of an induction heater assembly is determined according to each coil voltage, and the number of puffs of the aerosol generating device is measured according to the real-time temperature. Then, the aerosol generating device is replenished with energy according to the number of puffs, an amount of aerosols can be guaranteed to be adjusted to maintain in a vapeable state, and tastes and puff experience can be improved. In addition, by determining the number of puffs of the aerosol generating device based on the coil voltage, dependence on a measuring chip is eliminated, and the problem of insufficient or excessive heat absorption of an aerosol generating substrate caused by a fault of the measuring chip is avoided. In addition, hardware cost can be further effectively reduced.

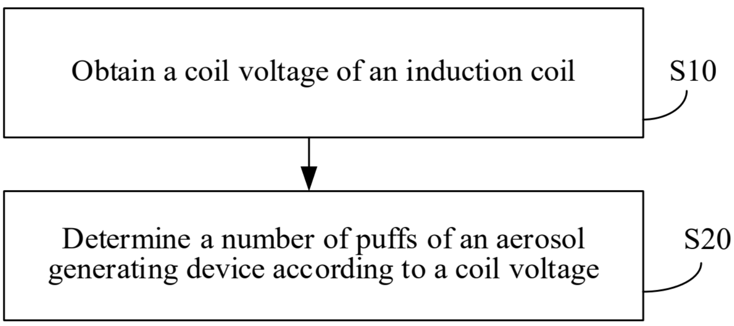

FIG. 6

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present disclosure claims the priority to Chinese Patent Application No. 202310947315.6 filed with the Chinese Patent Office on July 28, 2023 and entitled "Method for Measuring Number of Puffs and Aerosol Generating Device", which is incorporated herein in its entirety by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to the technical field of electronic atomization, and in particular, to a method for measuring a number of puffs and an aerosol generating device.

BACKGROUND

[0003] An aerosol generating device uses a heater to heat and bake an aerosol generating substrate, and generates aerosols for users.

[0004] The aerosol generating substrate can release a volatile compound that can generate aerosols. This volatile compound can be released by heating the aerosol generating substrate. The number of aerosol generating materials in the aerosol generating substrate is limited. With an increase in the number of puffs, fewer and fewer aerosols will be produced, resulting in a blander taste. As a result, by measuring the number of puffs of the aerosol generating substrate, energy can be quickly replenished, and sufficient aerosols and better tastes are guaranteed.

[0005] In some solutions known to the inventor of the present disclosure, the number of puffs is measured by a measuring chip. However, this method increases the hardware cost with a high failure rate.

SUMMARY

[0006] In view of this, some embodiments of the present disclosure provide a method for measuring a number of puffs and an aerosol generating device, which can accurately measure the number of puffs while saving cost.

[0007] In a first aspect, some embodiments of the present disclosure provide a method for measuring a number of puffs. The method is applied to an aerosol generating device, where the aerosol generating device includes an induction heater assembly and a power supply; the induction heater assembly includes an induction coil and a susceptor, the induction coil is configured to generate a changing magnetic field when a changing current flows therethrough, and the susceptor is configured to heat when penetrated by the changing magnetic field generated by the induction coil, to heat an aerosol generating substrate to generate an aerosol; and the power supply is used for providing energy for the induction heater assembly; and
the method includes:

obtaining coil voltages of the induction coil; and
determining the number of puffs of the aerosol generating device according to the coil voltages.

[0008] In some embodiments, the determining the number of puffs of the aerosol generating device according to the coil voltages includes:

determining, according to the coil voltages, a falling value interval of the coil voltages;
determining a slope of the falling value interval; and
determining the number of puffs according to the slope of the falling value interval.

[0009] In some embodiments, the determining, according to the coil voltages, a falling value interval of the coil voltages includes:

determining duration of the falling value interval; and
determining, according to the coil voltages and the duration of the falling value interval, the falling value interval of the coil voltages.

[0010] In some embodiments, the duration of the falling value interval of the coil voltages is 2s or within.

[0011] In some embodiments, the determining, according to the coil voltages, a falling value interval of the coil voltages includes:

determining that each coil voltage is in a falling process;
dividing the coil voltage in the falling process into a plurality of falling sub-intervals according to a preset time threshold;
determining slopes of the falling sub-intervals; and
determining to keep coil voltages of the falling sub-intervals according to the slopes of the falling sub-intervals, to form the falling value interval.

[0012] In some embodiments, the determining to keep coil voltages of the falling sub-intervals according to the slopes of the falling sub-intervals, to form the falling value interval includes:

determining whether the slope of each falling sub-interval satisfies a preset first slope threshold;
keeping the coil voltage of the falling sub-interval if the slope is greater than or equal to the preset first slope threshold, to form the falling value interval; and
discarding the coil voltage of the falling sub-interval if the slope is less than the preset first slope threshold.

[0013] In some embodiments, the determining the number of puffs according to the slope of the falling value interval includes:

determining whether the slope satisfies a preset second slope threshold; and

determining that a puff action exists in the falling value interval and increasing the number of puffs by one if the slope is greater than or equal to the preset second slope threshold.

[0014] In some embodiments, the method further includes: classifying the puff action by degree according to the slope of the falling value interval.

[0015] In some embodiments, the classifying the puff by degree according to the slope of the falling value interval includes:

determining that a degree of the puff action is deep when the slope is greater than or equal to a first preset puff threshold;

determining that a degree of the puff action is normal when the slope is greater than or equal to a second preset puff threshold and is less than the first preset puff threshold; and

determining that a degree of the puff action is light when the slope is less than the second preset puff threshold.

[0016] In some embodiments, the obtaining a coil voltage of the induction coil includes:

collecting coil voltages of the induction coil; and

performing filtering on the coil voltages by a moving average filtering method.

[0017] In a second aspect, the embodiments of the present disclosure provide an aerosol generating device. The aerosol generating device includes:

an induction heater assembly, where the induction heater assembly includes an induction coil and a susceptor, the induction coil is configured to generate a changing magnetic field when a changing current flows therethrough, and the susceptor is configured to heat when penetrated by the changing magnetic field generated by the induction coil, to heat an aerosol generating substrate to generate an aerosol;

a power supply used for providing energy for the induction heater assembly; and

a controller, where the controller is connected to the induction heater assembly and the power supply, and is used for performing the method for measuring a number of puffs described above.

[0018] In a third aspect, another embodiment of the present disclosure further provides a non-volatile computer-readable storage medium. The computer-readable storage medium stores a computer-executable instruction, where when executed by a controller, the computer-executable instruction causes the controller to perform the method described above.

[0019] In a fourth aspect, another embodiment of the present disclosure further provides a computer program product. The computer program product includes a computer program stored in a non-volatile computer-readable storage medium, where the computer program includes a program instruction, and when executed by a controller, the program instruction causes the controller to perform the method described above.

[0020] The present disclosure provides the method for measuring a number of puffs. The method is applied to the aerosol generating device. The aerosol generating device includes the induction heater assembly and the power supply; the induction heater assembly includes the induction coil and the susceptor, the induction coil is configured to generate the changing magnetic field when the changing current flows therethrough, and the susceptor is configured to heat when penetrated by the changing magnetic field generated by the induction coil, to heat the aerosol generating substrate to generate the aerosol; and the power supply is used for providing the energy for the induction heater assembly. The method includes: after obtaining the coil voltage of the induction coil, determining the number of puffs of the aerosol generating device according to the coil voltages.

[0021] In this embodiment, based on a relationship between a coil voltage and a temperature at resonance, the coil voltage at each moment is collected in real time, a real-time temperature of the induction heater assembly is determined according to each coil voltage, and the number of puffs of the aerosol generating device is measured according to the real-time temperature. Then, the aerosol generating device is replenished with energy according to the number of puffs, an amount of aerosols can be guaranteed to maintain in a vapeable state, and tastes and puff experience can be improved. In addition, by determining the number of puffs of the aerosol generating device based on the coil voltage, dependence on a measuring chip is eliminated, and the problem of insufficient or excessive heat absorption of an aerosol generating substrate caused by a fault of the measuring chip is avoided. In addition, hardware cost can be further effectively reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] One or more embodiments are illustratively described through drawings in corresponding accompanying drawings, and such illustrative description does not constitute limitation to the embodiments. Elements with the same reference numerals in the accompanying drawings are shown as similar elements, and the drawings in the accompanying drawings do not constitute scale limitation unless otherwise stated.

FIG. 1 is a schematic structural diagram of an aerosol generating device in some embodiments of the present disclosure;

FIG. 2 is a schematic structural diagram of an aerosol generating device in some embodiments of the present disclosure;

FIG. 3 is a schematic structural diagram of an aerosol generating device in some embodiments of the present disclosure;

FIG. 4 is a schematic structural diagram of an aerosol generating device in some embodiments of the present disclosure;

FIG. 5 is a schematic structural diagram of an aerosol generating product in some embodiments of the present disclosure;

FIG. 6 is a schematic flowchart of a method for measuring a number of puffs in some embodiments of the present disclosure; and

FIG. 7 is a waveform diagram of a coil voltage in some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0023] The present disclosure will be described in detail with reference to specific embodiments. The following embodiments will be conducive to further understanding of the present disclosure by those of ordinary skill in the art, but does not limit the present disclosure in any form. It should be noted that for those of ordinary skill in the art, they can make several transformations and improvements on the premise without deviating from a concept of the present disclosure. These transformations and improvements should fall within the protection scope of the present disclosure.

[0024] In order to make objectives, technical solutions, and advantages of the present disclosure clearer, the present disclosure will be further described below in detail with reference to accompanying drawings and embodiments. It should be understood that specific embodiments described herein are merely used to explain the present disclosure rather than limit the present disclosure.

[0025] It should be noted that, if there is no conflict, all features in the embodiments of the present disclosure can be combined with each other, which are within the protection scope of the present disclosure. In addition, although functional modules are divided in the schematic diagram of the device and logical order is shown in the flowchart, in some cases, the steps shown or described may be performed based on functional division different from that in the device or in an order different from that in the flowchart. In addition, the words such as "first", "second", and "third" used herein do not constitute limitation to the data or performing order, but merely distinguish the same or similar items with basically the same function and function.

[0026] Unless otherwise defined, all technical and scientific terms used by the present disclosure have the same meanings as those commonly understood by those of ordinary skill in the art of the present disclosure. The terms used in the description of the present disclosure are merely for the purpose of describing specific embodiments, and are not used to limit the present disclosure. As used in the description, the term "and/or" includes any and all combinations of one or more relevant listed items.

[0027] In addition, technical features involved in the implementations of the present disclosure described below can be combined with each other as long as there is no conflict.

[0028] FIG. 1 to FIG. 4 show an aerosol generating device 10 according to some embodiments of the present disclosure. The aerosol generating device includes a chamber 11, an induction heater assembly 12, a power supply 14, and a controller 15. The controller 15 is electrically connected to the power supply 14 and the induction heater assembly 12.

[0029] The chamber 11 is used to receive an aerosol generating product 20. The aerosol generating product 20 may be inserted or pulled out from the chamber 11 through an opening A in the aerosol generating device 10.

[0030] As shown in FIG. 5, in some embodiments, the aerosol generating product 20 includes a filter tip segment 21 and a substrate material segment 22. The substrate material segment 22 includes an aerosol generating substrate. The aerosol generating substrate may release a volatile compound that may generate aerosols. This volatile compound may be released by heating the aerosol generating substrate. The aerosol generating substrate may be a solid aerosol generating substrate. Alternatively, the aerosol generating substrate may include solid and liquid components.

[0031] In some embodiments, the aerosol generating substrate may include a tobacco-containing material that includes volatile tobacco flavor compounds that are released from the substrate when heated. Alternatively, the aerosol generating substrate may include a non-tobacco material. The aerosol generating substrate may further include an aerosol generating material. Examples of the aerosol generating material are glycerol and propylene glycol.

[0032] An aerosol generated by heating the substrate material segment 22 is transported to a user through the filter tip segment 21, and the filter tip segment 21 may be a cellulose acetate filter tip segment. The filter tip segment 21 may spray a flavoring liquid to provide an aroma, or separate fibers coated with the flavoring liquid may be inserted into the filter tip segment, to improve persistence of a taste transported to the user. The filter tip segment 21 may also have a spherical or cylindrical capsule, and the capsule may include flavoring substance-containing contents.

[0033] Components of the aerosol generating product 20 related to this embodiment are shown merely in FIG. 3. Accordingly, those of ordinary skill in the art related to this embodiment should understand that the aerosol generating product 20 may further include general components other than those shown in FIG. 3, for example, a cooling segment for cooling the aerosol generated by heating the substrate material section 22, to enable the user to puff the aerosol cooled to an appropriate temperature.

[0034] The power supply 14 provides electric power for operating of the aerosol generating device 10. For example, the power supply 14 may provide electric power for the induction heater assembly 12, and the induction heater assembly 12 heats and generates heating energy after receiving the electric power, electric power required by a display device, a sensor, and an electric motor. In addition, the power supply 14 may provide electric power required for operating of other elements provided in the aerosol generating device 10, such as electric power required by the display device, the sensor, and the electric motor. The power supply 14 may be a rechargeable battery or a disposable battery. The power source 14 may be, but is not limited to, a lithium iron phosphate ($LiFePO4$) battery. For example, the power supply 14 may be a lithium cobaltate ($LiCo02$) battery or a lithium titanate battery.

[0035] When the aerosol generating product 20 is inserted into the chamber 11, the induction heating assembly 12 may generate the heating energy through the electric power provided by the power supply 14. The heating energy is transferred to the aerosol generating product 20, and the aerosol generating substrate in the aerosol generating product is raised in temperature, to generate the aerosol. The generated aerosol is transferred, through the filter tip segment 21 of the aerosol generating product 20, to a user for being puffed.

[0036] The aerosol generating substrate in the aerosol generating product 20 is heated by the induction heater assembly 12, to generate a vapeable aerosol. The induction heater assembly 12 includes an induction coil 121 and a susceptor 122. When a changing current flows through the induction coil 121, the induction coil 121 generates a changing magnetic field. When the changing magnetic field penetrates the susceptor 122, the susceptor 122 heats, to directly or indirectly heat the aerosol generating substrate and generate the aerosol.

[0037] In some embodiments, the induction heater assembly 12 further includes a capacitor C1, a switch K1, and a switch K2. A first end of the switch K1 is connected to the power supply 14, the switch K1 is connected to the switch K2 in series, a second end of the switch K1 is connected to an input end of the capacitor C1, a second end of the switch K2 is connected to a ground terminal, and the capacitor C1 is connected to the induction coil 121 in series. Specifically, a heating principle of the induction heater assembly is that the capacitor C1 and the induction coil 121 form an LC oscillator. When the power supply 14 outputs a direct current voltage, the direct current voltage is provided for the LC oscillator through the switch K1. In this case, the capacitor C1 also starts to be charged based on the direct current voltage. When a voltage on the capacitor C1 reaches a value, the switch K1 is turned off since an on voltage is reduced to be lower than a threshold. When the switch K1 is turned off, the capacitor C1 starts to discharge through the switch K2. Based on this, the LC oscillator generates inverted oscillation through alternating energy storage and discharge of the capacitor C1, and forms an alternating current flowing through the induction coil 121, and then the induction coil 121 generates the alternating magnetic field. The susceptor 122 is induced to form eddy current heating in the alternating magnetic field.

[0038] With reference to FIG. 1 to FIG. 4, in some embodiments, the induction coil 121 is arranged on an outer surface of a tubular substrate. The tubular substrate is a tubular assembly in an axial direction of the chamber and surrounding the chamber. In some embodiments, the tubular substrate may be the tubular assembly made from a thermal insulation material.

[0039] It can be understood that the susceptor 122 is made of a metal material, for example, a permalloy or stainless iron. Then, the susceptor 122 may heat in the changing magnetic field generated by the induction coil 121, to convert electric energy into heat energy. A shape of the susceptor 122 may be set by those of ordinary skill in the art voluntarily. With reference to FIG. 1, in some embodiments, the susceptor 122 is a metal pipe, and may be used as an inner wall of the chamber 11. When the aerosol generating product 20 is inserted into the chamber 11, the susceptor 122 come into contact with the aerosol generating product 20. Then, when the susceptor 122 heats, the heating energy may be effectively transferred to the aerosol generating product 20 to bake the aerosol generating substrate.

[0040] With reference to FIG. 4, in some embodiments, the susceptor 122 is a metal plate and is arranged in the chamber. When the aerosol generating product is inserted into the chamber, the susceptor 122 penetrates the aerosol generating product 20 and comes into contact with the aerosol generating substrate. Then, when the susceptor 122 heats, the heating energy may be effectively transferred to the aerosol generating product 20, to bake the aerosol generating substrate.

[0041] With reference to FIG. 3, in some embodiments, a metal plate or a metal needle is embedded in the aerosol generating product 20. When the aerosol generating product 20 is inserted into the chamber 11, the embedded metal plate or metal needle is used as the susceptor 122, and heats under the action of the changing magnetic field generated by the induction coil 121, to bake the aerosol generating substrate.

[0042] With reference to FIG. 2, in some embodiments, when the susceptor 122 heats, the heating energy may be effectively transferred to airflow passing through the susceptor. Heated airflow enters the aerosol generating product 20 to bake the aerosol generating substrate.

[0043] The controller 15 may control overall operating of the aerosol generating device 10. Specifically, the controller 15 controls operating of the power supply 14 and the induction heater assembly 12, and may also control operating of another device. In some embodiments, the controller 15 includes a memory for storing a program instruction corresponding to the method for measuring a number of puffs in any of the following method embodiments, and further includes a monitoring circuit or a timer for monitoring power supply time, and a measuring circuit for collecting the coil voltage, etc. Then, when the method for measuring a number of puffs in any of the following method embodiments is implemented, the number of puffs is measured based on the coil voltage. In this way, energy is replenished quickly, an amount of aerosols can be guaranteed to maintain in a vapeable state, and tastes and puff experience can be improved. In addition, dependence on a measuring chip is eliminated, and the problem of insufficient or excessive heat absorption of an aerosol generating substrate caused by a fault of the measuring chip is avoided. In addition, hardware cost can be further effectively reduced.

[0044] In combination with the illustrative application and implementation of the aerosol generating device according to the embodiment of the present disclosure, the method for measuring a number of puffs according to some embodiments of the present disclosure will be described below. With reference to FIG. 6, FIG. 6 is a schematic flowchart of the method for measuring a number of puffs according to some embodiments of the present disclosure. It can be understood that the performing subject of the control method may be one or more controllers. As shown in FIG. 6, the method includes:

S10: coil voltages of the induction coil are obtained.

[0045] Based on the heating principle of the induction heater assembly, it can be learned that when the power supply inputs electric energy into the induction heater assembly, the induction coil forms an alternating current based on the electric energy, and a driving circuit outputs the coil voltages of the induction coil based on the alternating current. In this case, the controller collects the coil voltages of the induction coil based on a sampling frequency, and store the coil voltages of the induction coil according to the sampling time. Optionally, the sampling frequency may be per microsecond or millisecond.

[0046] In some embodiments, with reference to FIG. 7, FIG. 7 is a waveform diagram of the coil voltage in some embodiments of the present disclosure. As shown in FIG. 7, a horizontal axis is operating time of the aerosol generating device, and a vertical axis is the coil voltage collected based on the sampling frequency during the operating time. A stage before a moment t2 is referred to as a preheating state. In this stage, the susceptor adopts two different sensing materials, one sensing material has a positive temperature coefficient feature, the other sensing material has a negative temperature coefficient feature, the two sensing materials have different Curie temperature points, and when the sensing material having the negative temperature coefficient feature reaches the Curie temperature point at a moment t1, the coil voltage reaches a lowest point. After the moment t2, the aerosol generating device may directly enter a puff stage, or enter the puff stage after a degree of heat preservation stage (a temperature fall interval adjacent to the moment t2). In this case, the aerosol generating substrate reaches an extent of sufficient aerosol generation. In the puff stage, the user puffs away the generated aerosols, and new cold airflow enters the aerosol generating product. Then, a temperature of the susceptor falls rapidly, and the coil voltage also falls accordingly. Once the temperature fall is recognized by the controller, higher give power is provided for the induction heater assembly to raise the temperature of the susceptor. Thus, when the puff action occurs, the coil voltage shows a change from rapid fall to rapid rise, for example, an interval t3 to t4 and an interval t5 to t6, representing occurrence of one puff action each. In some embodiments, since the induction coil is directly connected to a battery cell, the coil voltage is easily affected by attenuation of a capacity of a battery cell. For example, in a process after the moment t2, the coil voltage shows a very slow fall trend regardless of intentional temperature control. In some embodiments, the controller may alternatively control the temperature to make the coil voltage in the fall trend.

[0047] In some embodiments, when the coil voltage is collected, a directly collected coil voltage may jump. In order to prevent erroneous determination of the number of puffs caused by the jump of the coil voltage, the coil voltage may be subjected to filtering after the coil voltage is collected. For example, a moving average filtering method is used for filtering on the coil voltage. Specifically, a size of a time window is defined, that is, how many sampling points are averaged. Then, based on the time window, the coil voltages corresponding to a current time point and a plurality of previous sampling points are obtained and averaged, and an average calculation result is taken as a filtering result of the current time point. Then, the coil voltage corresponding to a next time point of the current time point is taken as a last sampling point of the time window, a first sampling point of the time window is discarded, and then the coil voltages in a new queue are averaged, to obtain the coil voltage of the next time point. Based on this, through filtering on the coil voltage corresponding to each sampling time point, accuracy of the coil voltage corresponding to each moment is improved.

[0048] S20: the number of puffs of the aerosol generating device is determined according to the coil voltages.

[0049] The aerosol generating device generates the aerosol by heating the aerosol generating product, and when the aerosol generating device is puffed, cold air generated by the puff enters the aerosol generating device, and reduces the temperature of the susceptor. Thus, during work of the aerosol generating device, the number of puffs of the aerosol generating device may be learned by measuring the temperature of the susceptor. It should be noted that in a resonant circuit, the coil voltage and a quality factor interact with each other, and the quality factor decreases with the increase of the temperature. Thus, when the aerosol generating device works, the number of puffs of the aerosol generating device may be determined according to the coil voltage of the induction coil.

[0050] In some embodiments, step S20 includes:

S21: according to the coil voltages, a falling value interval of the coil voltages is determined.

[0051] The controller performs sampling based on the sampling frequency, obtains and stores the coil voltages of the sampling points, and performs determination with details as below.

[0052] In some embodiments, the controller compares the coil voltage at the current sampling point with the coil voltage at the previous sampling point, determines whether the coil voltage at the current sampling point is in a falling process at first, and then determines the falling value interval of the coil voltage according to the coil voltage in the falling process.

[0053] For example, when the controller collects an n^{th} coil voltage U_n, the controller compares the n^{th} coil voltage U_n with the $(n-1)^{th}$ coil voltage U_{n-1}. If the n^{th} coil voltage U_n is greater than the $(n-1)^{th}$ coil voltage U_{n-1}, it is considered that the coil voltage U_n is a rising process.

[0054] In this case, the controller continues collecting $(n+1)^{th}$ and (n+2) coil voltages U_{n+1}, U_{n+2}, ... If the $(n+1)^{th}$ coil voltage U_{n+1} is less than the n^{th} coil voltage U_n, it is considered that the coil voltage U_{n+1} starts to fall, and the n^{th} coil voltage U_n may be regarded as a start point of this falling process.

[0055] If the $(n+2)^{th}$ coil voltage U_{n+2} is less than the $(n+1)^{th}$ coil voltage U_{n+1}, it is considered that the coil voltage U_{n+2} is still in the falling process.

[0056] If the $(n+3)^{th}$ coil voltage U_{n+3} is greater than the $(n+2)^{th}$ coil voltage U_{n+2}, it is considered that the coil voltage U_{n+3} starts to rise, and the $(n+2)^{th}$ coil voltage U_{n+2} may be regarded as an end point of this falling process. Thus, the n^{th}, the $(n+1)^{th}$, and the $(n+2)^{th}$ coil voltages U_n, U_{n+1}, U_{n+2} may form one falling value interval of the coil voltages, and the next step S22 may be performed.

[0057] In some embodiments, determining the puff action based on the temperature fall of the heating element is easily influenced by a temperature fall caused by the attenuation of the cell of the power supply or the temperature control. For example, as shown in FIG. 7, in the interval t2 to t3, the coil voltages collected by the controller keep in the falling process due to the influence of the attenuation of the capacity of the battery cell or intentional temperature control, but no puff actions exit within the falling value interval collected in this interval. In general, the temperature fall caused by the puff features short fall time and a large temperature fall magnitude the temperature fall of the heating element caused by the puff. The temperature fall caused by the attenuation of the cell of the power supply or the temperature control features long fall time and a small temperature change magnitude. In view of that, the controller may compare the coil voltage at the current sampling point with the coil voltage at the previous sampling point, determine whether the coil voltage at the current sampling point is in the falling process at first, and then determine the falling value interval of the coil voltage in combination with duration of the falling process.

[0058] For further description with the example described above, if the $(n+1)^{th}$ coil voltage U_{n+1} is less than the n^{th} coil voltage U_n, it is considered that the coil voltage U_{n+1} starts to fall, and the n^{th} coil voltage U_n may be regarded as a start point of this falling process, and U_n and U_{n+1} are put into the current falling value interval.

[0059] If the $(n+2)^{th}$ coil voltage U_{n+2} is less than the $(n+1)^{th}$ coil voltage U_{n+1}, it is considered that the coil voltage U_{n+2} is still in the falling process. Then, a time difference between sampling time of U_{n+2} and sampling time of the start point U_n is determined. If the time difference satisfies a preset time threshold, U_{n+2} is put into the current falling value interval.

[0060] If the $(n+3)^{th}$ coil voltage U_{n+3} is greater than the $(n+2)^{th}$ coil voltage U_{n+2}, it is considered that the coil voltage U_{n+3} starts to rise, and the $(n+2)^{th}$ coil voltage U_{n+2} may be regarded as an end point of this falling process. Thus, U_n, U_{n+1}, U_{n+2} may form one falling value interval of the coil voltages.

[0061] If the $(n+3)^{th}$ coil voltage U_{n+3} is less than the $(n+2)^{th}$ coil voltage U_{n+2}, it is considered that the coil voltage U_{n+3} is still in the falling process. Then, a time difference between sampling time of U_{n+3} and the sampling time of the start point U_n is determined. If the time difference does not satisfy a preset time threshold (or the time difference exceeds the preset time threshold), it can be understood that the falling process keeps going from the start point U_n to U_{n+3}, and the duration of the falling value interval exceeds the preset time threshold. It indicates that the falling value interval slowly falls. Then, the falling value interval may be discarded. In other words, U_n, U_{n+1}, U_{n+2} that are put into the falling value interval may be discarded, and the start point of the falling value interval may be re-determined. For example, U_{n+3} is put into the current falling value interval, and U_{n+3} is regarded as a new start point of the current falling value interval. For example, a coil voltage that is collected after U_{n+3} and is in the falling process is taken as a new start point.

[0062] In the embodiment, the time difference between each coil voltage collected and the start point is determined one by one. In some embodiments, by setting a function such as timing, the time difference can be merely determined for the coil voltage collected after a period of time from the start point. In this way, some operations can be reduced.

[0063] In some embodiments, the controller may compare the coil voltage at the current sampling point with the coil voltage at the previous sampling point. As long as the coil voltage is in the falling process, the coil voltage is put into the falling value interval, the overall falling value interval may be divided into a plurality of falling sub-intervals, and the falling sub-intervals may be divided in chronological order according to a preset time threshold. In this way, the coil voltage of the falling sub-interval having earlier sampling time may be discarded, and merely the coil voltage of a last falling sub-interval having later sampling time is kept in the falling value interval. In this way, operations are reduced, the process of determining the puff action is not easily affected by the temperature fall caused by the attenuation of the cell of the power supply or the temperature control, and accuracy of measuring of the number of puffs is increased.

[0064] In some embodiments, due to temperature control logic adopted by the aerosol generating device, when the temperature falls to an extent due to the puff, power may be provided for the heating element, and the temperature of the heating element rises. Thus, after the puff action occurs, an obvious temperature rise process may occur. In other words, the puff action is accompanied by the following temperature rise process when occurring. When such a case is reflected in a temperature curve, the temperature falls at first and then rises. It may alternatively be understood that the puff action occurs at a moment approaching the end point in the falling value interval. Thus, the controller may compare the coil voltage at the current sampling point with the coil voltage at the previous sampling point. As long as the coil voltage is in the falling process, the coil voltage is put into the falling value interval, and after the end point of the falling value interval appears, merely part of the coil voltage of the last falling sub-interval in the falling value interval is kept. In addition, the duration of the kept coil voltage satisfies the preset time threshold, the next step S22 is performed. In this way, the operations are reduced, a sufficient quantity of coil voltages are guaranteed for an operation of the slope, and the accuracy of measuring of the number of puffs is increased.

[0065] In the embodiment, the preset time threshold may control the duration of the falling value interval, such that the accuracy of measuring of the number of puffs is increased advantageously. In some embodiments, the preset time threshold is 0s to 2s. Accordingly, the duration of the falling value interval processed in the next step S22 is preferably controlled to 2s or within.

[0066] In some embodiments, after determining the falling value interval, the controller may alternatively divide the falling value interval into a plurality of falling sub-intervals, perform a slope operation on the start point and end point of each falling sub-interval separately, and determine the slope of each falling sub-interval. Whether the slopes satisfy a preset first slope threshold is determined. If the slope is less than the preset first slope threshold, it indicates that the temperature fall in the falling sub-interval is very gentle and no puff action exists, and the coil voltage corresponding to the falling sub-interval is discarded. If the slope is greater than or equal to the preset first slope threshold, it indicates that the temperature fall in the falling sub-interval is sharp, and the puff action probably exists, the coil voltage in the falling sub-interval is kept, and the next step S22 is performed. In some embodiments, the coil voltages of a plurality of falling sub-intervals that satisfy the preset first slope threshold are combined to form a new falling value interval, and the next step S22 is performed.

[0067] In some embodiments, the controller may alternatively divide the falling sub-intervals step by step in the process of determining the falling value interval, perform a slope operation on the start point and end point of each falling sub-interval, and determine the slope of each falling sub-interval. Whether the slope satisfies the preset first slope threshold is determined. If the slope is less than the preset first slope threshold, it indicates that the temperature fall in the falling sub-interval is very gentle and no puff action exists probably, and the coil voltage corresponding to the falling sub-interval is discarded. If the slope is greater than or equal to the preset first slope threshold, it indicates that the temperature fall in the falling sub-interval is sharp, and the puff action probably exists, the coil voltage in the falling sub-interval is kept, and the next step S22 is performed. In some embodiments, the coil voltages of the plurality of falling sub-intervals that satisfy the preset first slope threshold may alternatively be combined to form a new falling value interval, and the next step S22 is performed.

[0068] The method on how to determine the falling value interval in the embodiments may be used separately or in combination without conflicting with each other.

[0069] S22: a slope of the falling value interval is determined.

[0070] In some embodiments, after the falling value interval is determined, the slope of the falling value interval is calculated based on the start point and the end point of the falling value interval. The slope of the falling value interval may be determined based on a linear function, the coil voltage, and the moment corresponding to the coil voltage. It should be noted that the linear function is a function of first degree. With an analytic expression of the function of first degree, the coil voltage and the moment corresponding to the coil voltage are substituted into the analytic expression of the function of first degree, and the slope of the falling value interval may be determined.

[0071] In some embodiments, after the falling value interval is determined, all the coil voltages may alternatively be divided into a plurality of segments, and the slope operation may be performed separately based on the start point and end point of each segment of coil voltage. Then, an average operation may be performed on the slopes of the plurality of segments of coil voltages, to obtain the slope of the falling value interval.

[0072] S23: the number of puffs is determined according to the slope of the falling value interval.

[0073] In some embodiments, after the slope of the falling value interval is obtained, whether the slope satisfies a preset second slope threshold is determined. It is considered that a puff action exists in the falling value interval and the number of puffs is increased by one through recognition of the puff action if the slope is greater than or equal to the preset second slope threshold. If the slope of the falling value interval is less than the preset second slope threshold, the falling value interval may be caused by the attenuation of the capacity of the battery cell or the intentional temperature control, no puff action exists, and the number of puffs is not increased.

[0074] In some embodiments, in the process of determining the number of puffs of the aerosol generating device, the puff action may be classified by degree according to the slope of the falling value interval. Specifically, the slope of the falling value interval is obtained at first, and then whether the slope satisfies a first puff threshold and/or a second puff threshold is determined. It is determined that a degree of the puff action is deep if the slope is greater than or equal to the first puff threshold. It is determined that a degree of the puff action is normal when the slope is less than the first puff threshold and greater than or equal to the second puff threshold. It is determined that a degree of the puff action is light when the slope is less than the second puff threshold. It can be understood that the deep puff, the normal puff, and the light puff are differentiated names based on the puff amount and/or puff duration of the user. The recognition of the degree of the puff action is conducive to the understanding and statistics of habits of the user and to personalized control over the habits of the user.

[0075] To sum up, in the method for measuring a number of puffs according to the embodiment of the present disclosure, based on a relationship between a coil voltage and a temperature at resonance, the coil voltage at each moment is collected in real time, a real-time temperature of the induction heater assembly is determined according to each coil voltage, and the number of puffs of the aerosol generating device is measured according to the real-time temperature. Then, the aerosol generating device is replenished with energy according to the number of puffs, an amount of aerosols can be guaranteed to be adjusted to maintain in a vapeable state, and tastes and puff experience can be improved. In addition, by determining the number of puffs of the aerosol generating device based on the coil voltage, dependence on a measuring chip is eliminated, and the problem of insufficient or excessive heat absorption of an aerosol generating substrate caused by a fault of the measuring chip is avoided. In addition, hardware cost can be further effectively reduced.

[0076] It should be noted that the embodiment of the device described above is merely illustrative, the units described as separated components can be physically separated or not, and the components displayed as the units can be physical units or not, that is, the components can be located in one place or distributed over a plurality of network units. Some or all modules can be selected according to actual needs to achieve the objectives of the solution of the embodiment.

[0077] The embodiments of the present disclosure provide a non-volatile computer-readable storage medium. The computer-readable storage medium stores a computer-executable instruction. When executed by the controller, for example, the controller 15 in FIG. 1, the computer-executable instruction causes the controller to perform the method for measuring a number of puffs in any of the method embodiments, for example, steps S10 to S20 of the method in FIG. 6 described above.

[0078] The embodiments of the present disclosure provide a computer program product. The computer program product includes a computer program stored in a non-volatile computer-readable storage medium. The computer program includes a program instruction, and when executed by a controller, the program instruction causes the controller to perform the method for measuring a number of puffs in any of the method embodiments, for example, steps S10 to S20 of the method in FIG. 6 described above.

[0079] It can be clearly understood by those of ordinary skill in the art from the description of the implementations that the implementations can be implemented by means of computer software and general hardware platforms, or can be implemented through the hardware certainly. For those of ordinary skill in the art, all or some processes in the method of the embodiments described above can be implemented by instructing related hardware by the computer program. The program may be stored in a computer-readable storage medium, and the program may include the processes of the method embodiments described above when executed. The storage medium may be a magnetic disk, an optical disk, a read-only memory (ROM), or a random access memory (RAM).

[0080] Finally, it should be noted that the embodiments described above are merely used for describing the technical solution of the present disclosure, rather than limiting the same. Under the idea of the present disclosure, the technical features in the embodiments or different embodiments described above can alternatively be combined, and steps can be implemented in any order, and have many other changes in different aspects of the present disclosure as mentioned above, which are not provided in details for brevity. Although the present disclosure has been described in detail with reference to the foregoing embodiments, those of ordinary skill in the art should understand that the technical solution described in the foregoing embodiments can still be modified, or some technical features in the technical solution can be equivalently replaced. However, these modifications or replacements do not make the essence of a corresponding technical solution depart from the scope of the technical solution of the embodiments of the present disclosure.

Claims

1. A method for measuring a number of puffs, applied to an aerosol generating device, wherein the aerosol generating device comprises an induction heater

assembly and a power supply; the induction heater assembly comprises an induction coil and a susceptor, the induction coil is configured to generate a changing magnetic field when a changing current flows therethrough, and the susceptor is configured to heat when penetrated by the changing magnetic field generated by the induction coil, to heat an aerosol generating substrate to generate an aerosol; and the power supply is used for providing energy for the induction heater assembly; and
the method comprises:

obtaining coil voltages of the induction coil; and
determining the number of puffs of the aerosol generating device according to the coil voltages.

2. The method according to claim 1, wherein the determining the number of puffs of the aerosol generating device according to the coil voltages comprises:

determining, according to the coil voltages, a falling value interval of the coil voltages;
determining a slope of the falling value interval; and
determining the number of puffs according to the slope of the falling value interval.

3. The method according to claim 2, wherein the determining, according to the coil voltages, a falling value interval of the coil voltages comprises:

determining duration of the falling value interval; and
determining, according to the coil voltages and the duration of the falling value interval, the falling value interval of the coil voltages.

4. The method according to claim 3, wherein the duration of the falling value interval of the coil voltages is 2s or within.

5. The method according to claim 2, wherein the determining, according to the coil voltages, a falling value interval of the coil voltages comprises:

determining that each coil voltage is in a falling process;
dividing the coil voltage in the falling process into a plurality of falling sub-intervals according to a preset time threshold;
determining slopes of the falling sub-intervals; and
determining to keep coil voltages of the falling sub-intervals according to the slopes of the falling sub-intervals, to form the falling value interval.

6. The method according to claim 5, wherein the determining to keep coil voltages of the falling sub-intervals according to the slopes of the falling sub-intervals, to form the falling value interval comprises:

determining whether the slope of each falling sub-interval satisfies a preset first slope threshold;
keeping the coil voltage of the falling sub-interval if the slope is greater than or equal to the preset first slope threshold, to form the falling value interval; and
discarding the coil voltage of the falling sub-interval if the slope is less than the preset first slope threshold.

7. The method according to any one of claims 2 to 6, wherein the determining the number of puffs according to the slope of the falling value interval comprises:

determining whether the slope satisfies a preset second slope threshold; and
determining that a puff action exists in the falling value interval and increasing the number of puffs by one if the slope is greater than or equal to the preset second slope threshold.

8. The method according to any one of claims 2 to 7, further comprising:
classifying the puff action by degree according to the slope of the falling value interval.

9. The method according to claim 8, wherein the classifying the puff by degree according to the slope of the falling value interval comprises:

determining that a degree of the puff action is deep when the slope is greater than or equal to a first preset puff threshold;
determining that a degree of the puff action is normal when the slope is greater than or equal to a second preset puff threshold and is less than the first preset puff threshold; and
determining that a degree of the puff action is light when the slope is less than the second preset puff threshold.

10. The method according to claim 1, wherein the obtaining coil voltages of the induction coil comprises:

collecting coil voltages of the induction coil; and
performing filtering on the coil voltages by a moving average filtering method.

11. An aerosol generating device, comprising:

an induction heater assembly, wherein the induction heater assembly comprises an induc-

tion coil and a susceptor, the induction coil is configured to generate a changing magnetic field when a changing current flows therethrough, and the susceptor is configured to heat when penetrated by the changing magnetic field generated by the induction coil, to heat an aerosol generating substrate to generate an aerosol;
a power supply used for providing energy for the induction heater assembly; and
a controller, wherein the controller is connected to the induction heater assembly and the power supply, and is used for performing the method for measuring a number of puffs according to any one of claims 1 to 10.

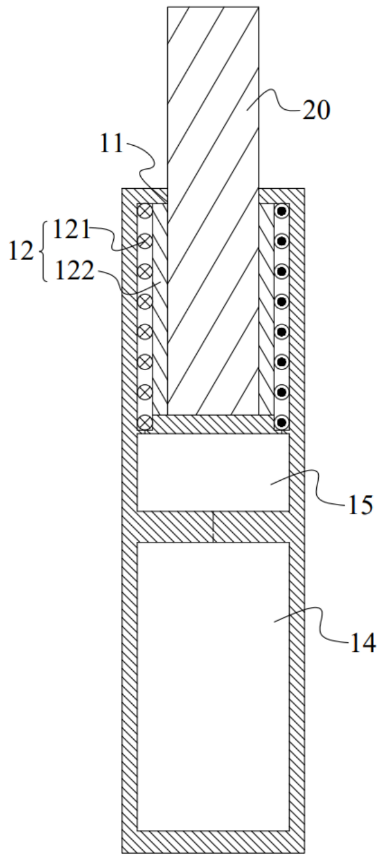

FIG. 1

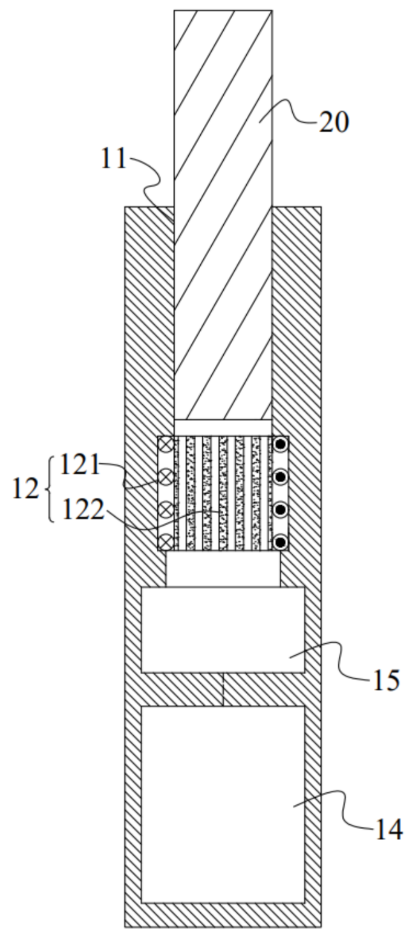

FIG. 2

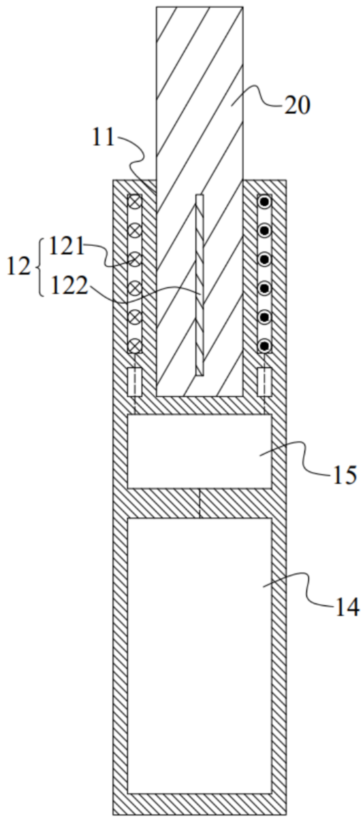

FIG. 3

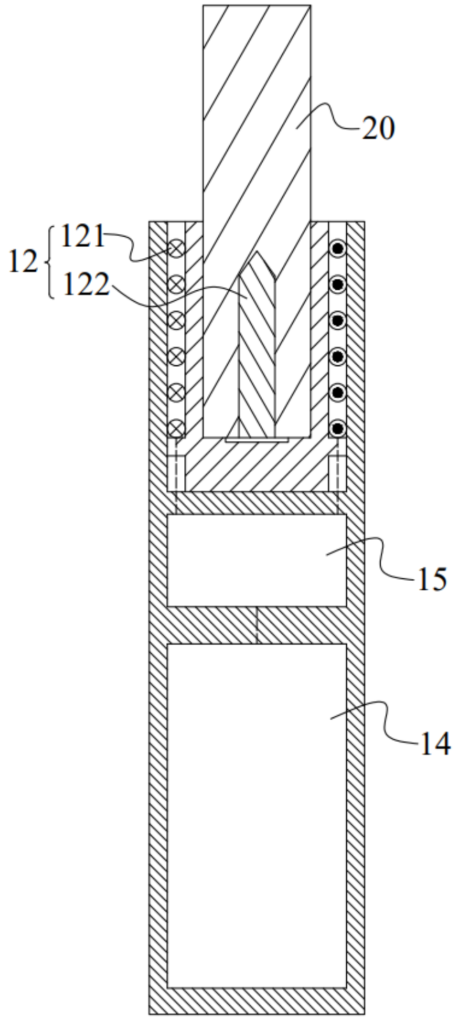

FIG. 4

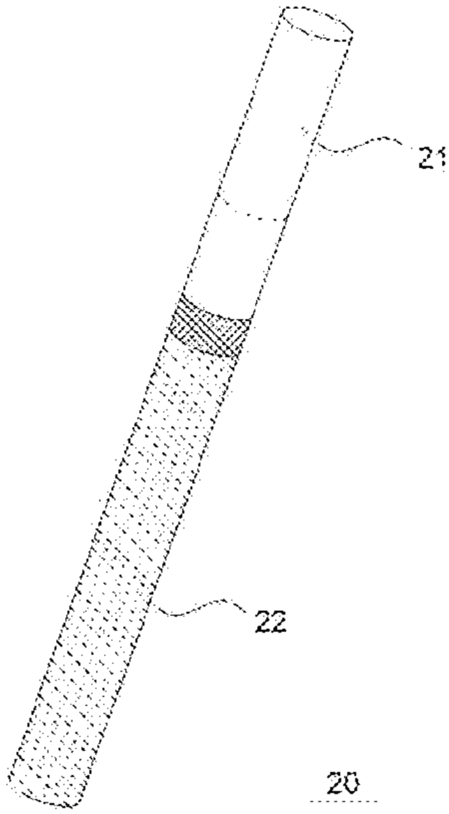

FIG. 5

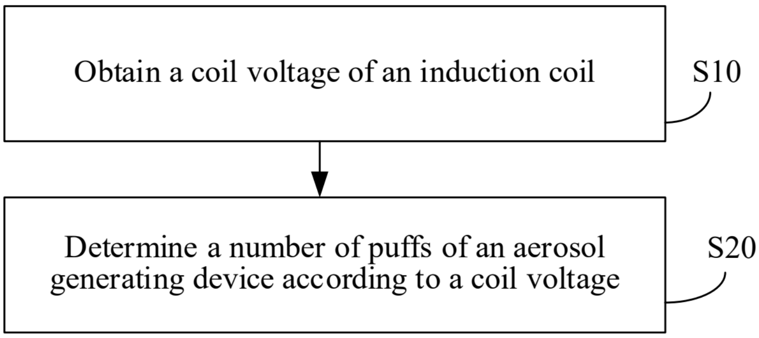

FIG. 6

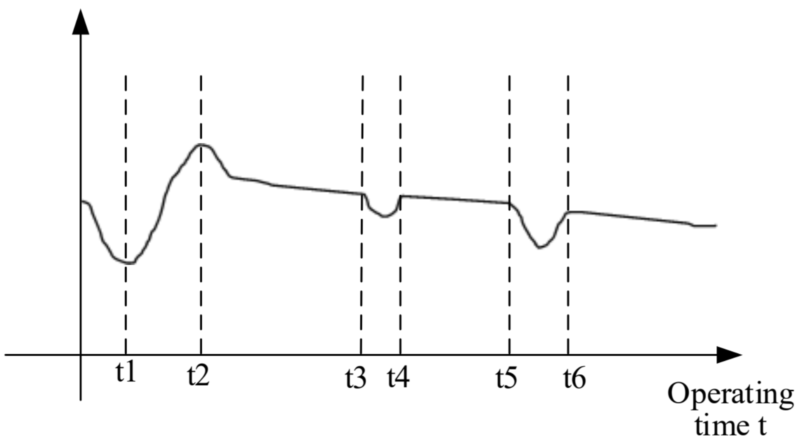

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No. **PCT/CN2024/103670**

A. CLASSIFICATION OF SUBJECT MATTER

A24F40/465(2020.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:A24F 40/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT, ENTXTC, DWPI, CNKI: 雾化, 抽吸, 计数, 次数, 口数, 感应, 线圈, 磁场, 电流, 电压, nebuli+, puff+, count+, number, mouth, induction, coil, magnetic, field, current, voltage

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	CN 116033840 A (KT&G CORP.) 28 April 2023 (2023-04-28) description, paragraphs [0040]-[0111], and figures 1-9	2-9
Y	CN 114376274 A (SHENZHEN MAISHI TECHNOLOGY CO., LTD.) 22 April 2022 (2022-04-22) description, paragraphs [0069] and [0076]	2-9
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A	CN 112118751 A (KT&G CORP.) 22 December 2020 (2020-12-22) entire document	1-11
A	CN 114601201 A (SHENZHEN FIRST UNION TECHNOLOGY CO., LTD.) 10 June 2022 (2022-06-10) entire document	1-11

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "D" document cited by the applicant in the international application
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- "O" document referring to an oral disclosure, use, exhibition or other means
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- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 August 2024	**09 September 2024**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088**	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2024/103670

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 2023285486 A1 (PHILIP MORRIS PRODUCTS S.A.) 19 January 2023 (2023-01-19) entire document	1-11

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2024/103670

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