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(54) **AEROSOL GENERATING DEVICE AND CONTROL METHOD THEREFOR**

(57) This application provides an aerosol generating device and a control method therefor. The aerosol generating device includes: a power supply circuit; a direct current/alternating current (DC/AC) inverter, including a class-E power amplifier, the class-E power amplifier including a transistor switch and an LC load network consisting of a capacitor and an inductor; where the inductor is inductively coupled to a susceptor, to heat an aerosol-forming substrate to generate an aerosol; and a controller, configured to determine, during operation, an apparent ohmic resistance based on a DC supply voltage and a DC current output by the power supply circuit to the

DC/AC inverter; the controller being further configured to monitor a change in the apparent ohmic resistance, and when the apparent ohmic resistance changes, adjust a frequency and a duty cycle of a switch signal supplied to the transistor switch. According to the foregoing aerosol generating device and the control method therefor, a change in an apparent ohmic resistance is monitored, and when the apparent ohmic resistance changes, a frequency and a duty cycle of a switch signal supplied to the transistor switch are adjusted, so that the class-E power amplifier always operates in an optimal state.

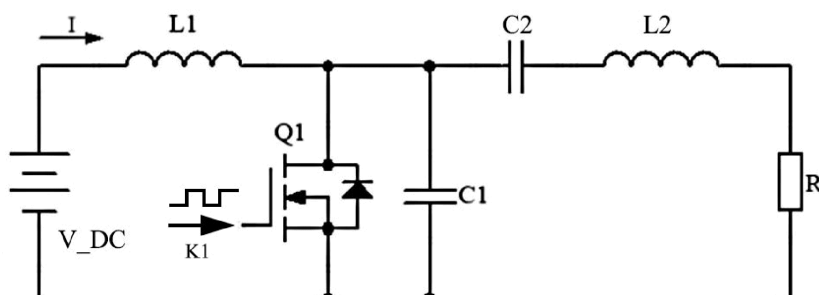


FIG. 3

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Chinese Patent Application No. 202410038019.9, filed with the China National Intellectual Property Administration on January 10, 2024 and entitled "AEROSOL GENERATING DEVICE AND CONTROL METHOD THEREFOR", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] Embodiments of this application relate to the field of electronic atomization technologies, and in particular, to an aerosol generating device and a control method therefor.

BACKGROUND

[0003] In an existing aerosol generating device, a class-E power amplifier is used, to cause an inductor to generate a variable magnetic field, and then cause a susceptor to heat an aerosol-forming substrate. The class-E power amplifier has features of high operating frequency and high efficiency, and uses a relatively small quantity of components, allowing for a reduced product volume. However, when a load of the class-E power amplifier fluctuates, an operating waveform of a transistor switch changes drastically, preventing the class-E power amplifier from operating in an ideal state in real time, resulting in a greatly reduced application range of the class-E power amplifier.

SUMMARY

[0004] This application provides an aerosol generating device and a control method therefor, to provide a real-time variable zero position for a class-E power amplifier under a variable load condition, enabling the class-E power amplifier to operate in an ideal state in real time.

[0005] In view of the foregoing technical problem, one aspect of this application provides an aerosol generating device, including:

- a power supply circuit, configured to provide a direct current (DC) supply voltage;
- a direct current/alternating current (DC/AC) inverter, connected to the power supply circuit; the DC/AC inverter including a class-E power amplifier, the class-E power amplifier including a transistor switch and an LC load network consisting of a capacitor and an inductor; where the inductor is inductively coupled to a susceptor, to heat an aerosol-forming substrate to generate an aerosol; and
- a controller, configured to determine, during operation, an apparent ohmic resistance based on the DC supply voltage and a DC current output by the power

supply circuit to the DC/AC inverter; the controller being further configured to monitor a change in the apparent ohmic resistance, and when the apparent ohmic resistance changes, adjust a frequency and a duty cycle of a switch signal supplied to the transistor switch.

[0006] In some embodiments, the controller is configured to: when detecting that the apparent ohmic resistance decreases, decrease the frequency of the switch signal for the transistor switch, and increase the duty cycle of the switch signal for the transistor switch; or when detecting that the apparent ohmic resistance increases, increase the frequency of the switch signal for the transistor switch, and decrease the duty cycle of the switch signal for the transistor switch.

[0007] In some embodiments, the power supply circuit is configured to provide a variable DC supply voltage, and the controller is further configured to control, when the apparent ohmic resistance changes, the power supply circuit to adjust the DC supply voltage.

[0008] In some embodiments, the controller is configured to control, when detecting that the apparent ohmic resistance decreases, the power supply circuit to decrease the DC supply voltage; or control, when detecting that the apparent ohmic resistance increases, the power supply circuit to increase the DC supply voltage.

[0009] In some embodiments, the power supply circuit includes a DC-DC conversion circuit and a regulating circuit;

the DC-DC conversion circuit includes an input terminal electrically connected to a battery cell, an output terminal outputting a DC supply voltage, and a feedback terminal; and

the regulating circuit is configured to receive control from the controller, to cause the feedback terminal of the DC-DC conversion circuit to generate a regulating signal, so that the DC-DC conversion circuit responds to the regulating signal and converts a voltage of the battery cell into a corresponding DC supply voltage.

[0010] In some embodiments, the aerosol generating device further includes a voltage detection circuit, configured to detect the DC supply voltage provided by the power supply circuit.

[0011] In some embodiments, the aerosol generating device further includes a current detection circuit, configured to detect the DC current drawn from the power supply circuit.

[0012] In some embodiments, the controller is further configured to determine a temperature of the susceptor based on the apparent ohmic resistance.

[0013] In some embodiments, the controller is further configured to determine whether the apparent ohmic resistance decreases or increases to a first preset resistance threshold, and adjust, based on a determining

result, the frequency and the duty cycle of the switch signal supplied to the transistor switch.

[0014] In some embodiments, the controller is further configured to output a switch signal having a first frequency and/or a first duty cycle in a first time period in a heating cycle, to maintain the apparent ohmic resistance close to a second preset resistance threshold; and output a switch signal having a second frequency and/or a second duty cycle in a second time period in the heating cycle, to maintain the apparent ohmic resistance close to a third preset resistance threshold.

[0015] Another aspect of this application provides a control method for an aerosol generating device. The foregoing aerosol generating device includes:

- a power supply circuit, configured to provide a DC supply voltage; and
- a DC/AC inverter, connected to the power supply circuit; the DC/AC inverter including a class-E power amplifier, the class-E power amplifier including a transistor switch and an LC load network consisting of a capacitor and an inductor; where the inductor is inductively coupled to a susceptor, to heat an aerosol-forming substrate to generate an aerosol.

[0016] The foregoing method includes:

- determining, during operation, an apparent ohmic resistance based on the DC supply voltage and a DC current output by the power supply circuit to the DC/AC inverter; and
- monitoring a change in the apparent ohmic resistance, and when the apparent ohmic resistance changes, adjusting a frequency and a duty cycle of a switch signal supplied to the transistor switch.

[0017] According to the foregoing aerosol generating device and the control method therefor, a change in an apparent ohmic resistance is monitored, and when the apparent ohmic resistance changes, a frequency and a duty cycle of a switch signal supplied to the transistor switch are adjusted, so that the class-E power amplifier always operates in an optimal state. That is, a drain voltage of the transistor switch satisfies a zero-voltage conduction condition and a zero-voltage-derivative conduction condition, thereby improving overall efficiency of the device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] One or more embodiments are exemplified by corresponding accompanying drawings, and these exemplified descriptions do not constitute a limitation on the embodiments. Components with the same reference numerals in the accompanying drawings are denoted as similar components, and the accompanying drawings are not limited by scale unless otherwise specified.

FIG. 1 is a schematic diagram of an aerosol generating device according to an implementation of this application;

FIG. 2 is a schematic diagram of another aerosol generating device according to an implementation of this application;

FIG. 3 is a schematic diagram of a circuit of a class-E power amplifier according to an implementation of this application;

FIG. 4 is a schematic diagram of a current detection circuit according to an implementation of this application;

FIG. 5 is a schematic diagram of a power supply circuit according to an implementation of this application;

FIG. 6 is a schematic waveform diagram of a gate voltage, a drain voltage, and a current of a transistor switch according to an implementation of this application;

FIG. 7 is a schematic waveform diagram of a gate voltage and a drain voltage of a transistor switch under an apparent ohmic resistance according to an implementation of this application;

FIG. 8 is a schematic waveform diagram of a gate voltage and a drain voltage of a transistor switch under another apparent ohmic resistance according to an implementation of this application;

FIG. 9 is another schematic waveform diagram of a gate voltage and a drain voltage of a transistor switch under another apparent ohmic resistance according to an implementation of this application;

FIG. 10 is a schematic waveform diagram of a gate voltage and a drain voltage of a transistor switch under a supply voltage according to an implementation of this application;

FIG. 11 is a schematic waveform diagram of a gate voltage and a drain voltage of a transistor switch under another supply voltage according to an implementation of this application;

FIG. 12 is a schematic diagram of a temperature-time curve of a susceptor according to an implementation of this application; and

FIG. 13 is a schematic flowchart of a control method for an aerosol generating device according to an implementation of this application.

DETAILED DESCRIPTION

[0019] To facilitate the understanding of this application, this application is described in more detail below with reference to the accompanying drawings and specific implementations. It should be noted that, when an element is expressed as "being fixed to" another element, the element may be directly on the another element, or one or more intermediate elements may exist between the element and the another element. When one element is expressed as "being connected to" another element, the element may be directly connected to the another

element, or one or more intermediate elements may exist between the element and the another element. The terms "upper", "lower", "left", "right", "inner", "outer", and similar expressions used in this specification are used for illustrative purposes only.

[0020] Unless otherwise defined, meanings of all technical and scientific terms used in this specification are the same as those usually understood by a person skilled in the technical field to which this application belongs. The terms in this specification of this application herein are used only for the purpose of describing the specific implementations, but are not intended to limit this application. A term "and/or" used in this specification includes any or all combinations of one or more related listed items.

[0021] FIG. 1 is a schematic diagram of an aerosol generating device according to an embodiment of this application.

[0022] As shown in FIG. 1, the aerosol generating device includes an atomizer 10 and a power supply assembly 20.

[0023] In an example, the atomizer 10 is removably connected to the power supply assembly 20, and the atomizer 10 may be in snap-fit connection, magnetic connection, or the like to the power supply assembly 20. In another example, it is also feasible that the atomizer 10 and the power supply assembly 20 are integrally formed.

[0024] The atomizer 10 includes a carrier or container carrying a liquid aerosol-forming substrate, and a susceptor 11 may be integrated into the carrier or container. For example, the container carrying the liquid aerosol-forming substrate has a liquid storage cavity, and the susceptor 11 is mounted in the container. A position of the susceptor 11 in the container is fixed, facilitating more efficient coupling to an inductor 21 when the atomizer 10 matches the power supply assembly 20.

[0025] The susceptor 11 is configured to be coupled to the inductor 21 to generate heat when being penetrated by a variable magnetic field, to heat the liquid aerosol-forming substrate, causing at least one component of the liquid aerosol-forming substrate to volatilize and form an aerosol for inhalation.

[0026] The susceptor 11 may be in direct contact with the liquid aerosol-forming substrate in the liquid storage cavity, or the susceptor 11 may be in indirect contact with the liquid aerosol-forming substrate. For example, a capillary material is disposed between the susceptor 11 and the liquid storage cavity. The capillary material is used for transferring the liquid aerosol-forming substrate to the susceptor 11. Optionally, the capillary material includes a porous material or a fibrous material.

[0027] The susceptor 11 may be made of at least one of the following materials: aluminum, iron, nickel, copper, bronze, cobalt, ordinary carbon steel, stainless steel, ferritic stainless steel, martensitic stainless steel, or austenitic stainless steel.

[0028] The power supply assembly 20 includes the

inductor 21, a circuit 22, and a battery cell 23.

[0029] The inductor 21 generates a variable magnetic field under an AC. The inductor 21 includes, but is not limited to, an induction coil.

[0030] The circuit 22 may control overall operations on the aerosol generating device. The circuit 22 not only controls operations on the battery cell 23 and the inductor 21, but also controls operations on other elements in the aerosol generating device.

[0031] The battery cell 23 supplies power for operating the aerosol generating device 100. The battery cell 23 may be a rechargeable battery cell or a disposable battery cell.

[0032] FIG. 2 is a schematic diagram of an aerosol generating device according to another embodiment of this application.

[0033] As shown in FIG. 2, the aerosol generating device includes:

20 a chamber, where a solid aerosol-forming substrate is removably received in the chamber; and the solid aerosol-forming substrate may be an aerosol-generating product A, such as a portion of a cigarette; a susceptor 110, at least partially extending in the chamber, and configured to be coupled to an inductor 210 to generate heat when being penetrated by a variable magnetic field, to heat the solid aerosol-forming substrate, causing at least one component of the solid aerosol-forming substrate to volatilize and form an aerosol for inhalation;

[0034] In one example, the susceptor 110 is generally in a shape of a pin or a blade, which is thus advantageous for insertion into the solid aerosol-forming substrate. Meanwhile, the susceptor 110 may have a length of approximately 12 mm, a width of approximately 4 mm, and a thickness of approximately 0.5 mm, and may be made of Grade 430 stainless steel (SS430). In an alternative embodiment, the susceptor 110 may have a length of approximately 12 mm, a width of approximately 5 mm, and a thickness of approximately 0.5 mm, and may be made of Grade 430 stainless steel (SS430).

[0035] In another example, the susceptor 110 may also be constructed in a cylindrical or tubular shape. During use, an inner space of the susceptor 110 forms a chamber for receiving the solid aerosol-forming substrate, and an aerosol for inhalation is generated by heating an outer periphery of the solid aerosol-forming substrate. Such susceptors may also be made of Grade 420 stainless steel (SS420) and an alloy material containing iron and nickel (such as Permalloy).

an inductor 210, configured to generate a variable magnetic field under an AC; where based on settings of the product in use, the inductor 210 may include a cylindrical inductor coil wound in a spiral shape; a circuit 220, electrically connected to a battery cell 230, and configured to convert a DC current output

from the battery cell 230 into an AC having a suitable frequency, and then supply the AC to the inverter 210; and

the battery cell 230, supplying power for operating the aerosol generating device. The battery cell 23 may be a rechargeable battery cell or a disposable battery cell.

[0036] Based on the foregoing aerosol generating device, FIG. 3 to FIG. 5 each show a schematic diagram of basic components of an embodiment of the circuit.

[0037] As shown in FIG. 3, the circuit includes a DC/AC inverter. The DC/AC inverter is connected to a power supply circuit, and the power supply circuit provides a DC supply voltage V_{DC} . In this embodiment, the DC/AC inverter includes a class-E power amplifier, specifically, a resonant switch power amplifier, including the following components: a transistor switch Q1, which includes a field effect transistor such as a metal-oxide-semiconductor field-effect transistor (MOSFET); a transistor switch driver circuit K1, which, under control of a controller, can supply a switch signal with a particular frequency and duty cycle to the transistor switch Q1; and an LC load network consisting of a capacitor C1, a capacitor C2, and an inductor L2. The inductor L2 may, for example, correspond to the inductor 21 shown in FIG. 1 or the inductor 210 shown in FIG. 2. In addition, a DC feeder choke L1 configured to supply the DC supply voltage V_{DC} from the power supply circuit is provided. The figure further shows an ohmic resistance R representing a total equivalent resistance or a total resistive load. During operation, the ohmic resistance R may include, for example, an ohmic resistance of the inductor L2 and an ohmic resistance of the susceptor 11 shown in FIG. 1, or include an ohmic resistance of the inductor L2 and an ohmic resistance of the susceptor 110 shown in FIG. 2.

[0038] The controller may be configured to determine, during operation, an apparent ohmic resistance (denoted by R_a below) by using the DC supply voltage of the power supply circuit and a DC current drawn from the power supply circuit, that is, determine, during operation, an apparent ohmic resistance based on the DC supply voltage and a DC current output by the power supply circuit to the DC/AC inverter.

[0039] A temperature of the susceptor may be determined by providing the apparent ohmic resistance R_a , that is, the apparent ohmic resistance R_a may indicate the temperature of the susceptor, and therefore, indicate a temperature of the aerosol-forming substrate. The apparent ohmic resistance R_a may increase with an increase in the temperature, or may decrease with an increase in the temperature; or may first increase and then decrease, or first decrease and then increase with an increase in the temperature. This is determined by a material property of the susceptor. For example, in a laminate consisting of two materials: Grade 430 stainless steel and Permalloy, when the temperature rises to 250°C, a value of the apparent ohmic resistance R_a

increases, and when heating continues, the value of the apparent ohmic resistance R_a starts to decrease. Contactless temperature control can be implemented by using Curie temperature characteristic of a metal magnetic material. That is, a current temperature of the susceptor can be determined based on the magnitude of a value of a current input to the inverter and/or a resonance voltage of the inverter, without needing to directly measuring the temperature of the susceptor.

[0040] In practice, both the DC supply voltage and the DC current drawn from the power supply circuit can be measured to determine the apparent ohmic resistance R_a . When the power supply circuit provides a fixed DC supply voltage, only the DC current drawn from the power supply circuit can be measured. FIG. 4 shows a current detection circuit, configured to detect the DC current drawn from the power supply circuit. The current detection circuit mainly includes:

a voltage detection chip U7 and a sampling resistor R33. One end of the sampling resistor R33 is electrically connected to the power supply circuit, and the other end of the sampling resistor R33 is electrically connected to the DC feeder choke L1 (shown by L1_OUT in the figure). Pin 4 of the current detection chip U7 is connected to one end of the sampling resistor R33. Pin 5 of the current detection chip U7 is electrically connected to the other end of the sampling resistor R33. Pin 6 of the voltage detection chip U7 outputs a sampled voltage at the two ends of the resistor R33 to the controller (shown by ADC_OUT in the figure). The controller can determine, based on the voltage at the two ends of the resistor R33 and a value of the resistor R33, a value of the DC current drawn from the power supply circuit. A resistor R12 and a capacitor C19 in the figure form a filter circuit to filter the sampled voltage at the two ends of the resistor R33.

[0041] FIG. 5 shows a power supply circuit according to an embodiment of this application. The power supply circuit may provide a variable DC supply voltage to a class-E power amplifier. As shown in FIG. 5, the power supply circuit includes:

a DC-DC conversion circuit 301 consisting of a power supply chip U4 and peripheral circuits of the power supply chip U4. The power supply chip U4 mainly includes an input terminal (pin 8 in the figure) electrically connected to the battery cell, an output terminal (pin 16 in the figure) outputting the DC supply voltage V_{DC} , and a feedback terminal (pin 4 in the figure). The power supply chip U4 may be a boost chip or a buck chip, and in this example, a buck chip is used.

a regulating circuit 302 consisting of a potentiometer U12 and peripheral circuits of the potentiometer U12. The regulating circuit 302 is configured to receive control from the controller, to cause the feedback terminal of the DC-DC conversion circuit 301 to generate a regulating signal, so that the DC-DC conversion circuit 301 responds to the regulating

signal and converts a voltage BAT_IN of the battery cell into a corresponding DC supply voltage V_DC. Specifically, the potentiometer chip U12 is accessed and controlled by using an I2C protocol, allowing adjustment of a resistance value between pin 5 and pin 6, so that the feedback terminal of the DC-DC conversion circuit 301 generates a regulating signal. The magnitude of each level of adjustment is determined by a bit number of the chip, for example, 8 bits/10 bits/12 bits, that is, a maximum resistance value of the potentiometer is divided into 28/210/212.

[0042] Further, a voltage detection circuit 303 consisting of a resistor R28, a resistor R39, and a capacitor C45 is further included. The voltage detection circuit 303 is configured to detect a current DC supply voltage, to determine whether the current DC supply voltage is a required DC supply voltage. If the current DC supply voltage is not the required DC supply voltage, the potentiometer chip U12 is controlled until the current DC supply voltage is the required DC supply voltage. The resistor R28 and the resistor R39 form a voltage divider circuit, and the capacitor C45 is configured to filter a voltage divider signal.

[0043] Referring back to FIG. 3, output power P of the

$$0.5678 \times V_{DC}^2 / R$$

class-E power amplifier is

When the transistor switch Q1 (assumed to be an NMOS transistor) is turned on, if a drain voltage of the transistor switch Q1 exactly reaches a zero axis, the drain voltage of the transistor switch Q1 satisfies a zero-voltage conduction condition and a zero-voltage-derivative conduction condition. In this case, a voltage V_{ds} does not overlap a current I_{ds}, power consumed by the transistor switch Q1 is 0, and the efficiency of the class-E power amplifier is the highest. In practice, the efficiency of the class-E power amplifier can reach 95%. Specifically, as shown in FIG. 6:

(a) The drain voltage of the transistor switch Q1 satisfies the zero-voltage conduction condition and the zero-voltage-derivative conduction condition, and the class-E power amplifier operates in an optimal state. In this case, the ohmic resistance R is of an appropriate value. In the figure, U_g is a gate voltage, V_s is a drain voltage, and I_s is a drain current.

(b) When the value of the ohmic resistance R is relatively large, output power of the class-E power amplifier is relatively low, the class-E power amplifier operates in a quasi-optimal state, and a lowest point of the drain voltage of the transistor switch Q1 occurs below the zero axis (the horizontal axis in the figure).

(c) When the value of the ohmic resistance R is relatively small, the output power of the class-E power amplifier is relatively high, and the class-E power amplifier operates in a detuned state. In this

case, the drain voltage of the transistor switch Q1 is above the zero axis.

[0044] As can be seen from the above, a power loss of the class-E power amplifier is relatively small or approaches to zero only when matched to a load of an appropriate size. Actual efficiency of the class-E power amplifier is reduced when the load increases or decreases.

[0045] In an example, the controller is configured to monitor a change in the apparent ohmic resistance R_a, and when the apparent ohmic resistance R_a changes, adjust a frequency and a duty cycle of a switch signal supplied to the transistor switch Q1. In this way, the class-E power amplifier always operates in an optimal state. That is, the drain voltage of the transistor switch Q1 satisfies a zero-voltage conduction condition and a zero-voltage-derivative conduction condition, thereby improving overall efficiency of the device.

[0046] As shown in FIG. 7, when the apparent ohmic resistance R_a is 0.6 ohm, the frequency and the duty cycle of the switch signal (shown by VG2 in the figure) supplied to the transistor switch Q1 are respectively 6.82 MHZ and 50%. In this case, it can be observed that a waveform of the drain voltage of the transistor switch Q1 is relatively ideal, satisfying the zero-voltage conduction condition and the zero-voltage-derivative conduction condition.

[0047] As shown in FIG. 8, when heating causes the temperature to rise, the apparent ohmic resistance R_a decreases to 0.5 ohm. If the frequency and the duty cycle of the switch signal supplied to the transistor switch Q1 do not change, it can be observed from FIG. 8 that, a zero position of the drain voltage of the transistor switch Q1 is -0.9 V, and the transistor switch Q1 is not turned on at this moment. Therefore, a product of a voltage and a current across the drain and source terminals of the transistor switch Q1 is much greater than 0, resulting in a relatively large loss of the transistor switch Q1, severe heat generation of the transistor switch Q1, a relatively high operating temperature, and reduced efficiency.

[0048] As shown in FIG. 9, if the apparent ohmic resistance R_a decreases to 0.5 ohm, the frequency and the duty cycle of the switch signal supplied to the transistor switch Q1 are adjusted. For example, the frequency and the duty cycle of the switch signal supplied to the transistor switch Q1 are adjusted to 6.676 MHZ and 53%. It can be observed from FIG. 9 that, the waveform of the drain voltage of the transistor switch Q1 satisfies the zero-voltage conduction condition and the zero-voltage-derivative conduction condition.

[0049] In an example, the controller is configured to: when detecting that the apparent ohmic resistance R_a decreases, decrease the frequency of the switch signal of the transistor switch Q1, and increase the duty cycle of the switch signal of the transistor switch Q1; or when detecting that the apparent ohmic resistance R_a increases, increase the frequency of the switch signal of

the transistor switch Q1, and decrease the duty cycle of the switch signal of the transistor switch Q1.

[0050] In an example, the controller is further configured to control, when the apparent ohmic resistance R_a changes, the power supply circuit to adjust the DC supply voltage, thereby adjusting heating power and improving overall efficiency of the device.

[0051] In a specific example, the controller is configured to control, when detecting that the apparent ohmic resistance R_a decreases, the power supply circuit to decrease the DC supply voltage; or control, when detecting that the apparent ohmic resistance R_a increases, the power supply circuit to increase the DC supply voltage.

[0052] As shown in FIG. 10, when the apparent ohmic resistance R_a is 0.5 ohm, and the frequency and the duty cycle of the switch signal supplied to the transistor switch Q1 are 6.676 MHz and 53%, a power supply voltage is 3.3 V, and a power supply current is approximately 4.2 A. In this case, supply power is $3.3 \text{ V} * 4.2 \text{ A} = 13.9 \text{ W}$.

[0053] As shown in FIG. 11, if the apparent ohmic resistance R_a and the frequency and the duty cycle of the switch signal supplied to the transistor switch Q1 remain consistent with those in FIG. 10, the power supply voltage is adjusted to 2.5 V, and the power supply current is approximately 3.3 A. In this case, supply power is $2.5 \text{ V} * 3.3 \text{ A} = 8.25 \text{ W}$. That is, the heating power is reduced by reducing the power supply voltage, to maintain relatively low power to heat, thereby reducing heat generation of the transistor switch Q1, and further improving overall efficiency of the device.

[0054] In an example, the controller is further configured to adjust, if the apparent ohmic resistance R_a reaches a preset resistance threshold, the frequency and the duty cycle of the switch signal supplied to the transistor switch Q1. That is, whether the apparent ohmic resistance R_a decreases or increases to a first preset resistance threshold is determined, and the frequency and the duty cycle of the switch signal supplied to the transistor switch Q1 are adjusted based on a determining result.

[0055] In an example, the controller is further configured to output a switch signal having a first frequency and/or a first duty cycle in a first time period in a heating cycle, to maintain the apparent ohmic resistance R_a close to a second preset resistance threshold; and output a switch signal having a second frequency or/and a second duty cycle in a second time period in the heating cycle, to maintain the apparent ohmic resistance R_a close to a third preset resistance threshold. The second preset resistance threshold may be greater than or less than the third preset resistance threshold.

[0056] FIG. 12 is a schematic diagram of a temperature-time curve of a susceptor according to an implementation of this application. As shown in FIG. 12, a single inhalation duration for an aerosol generating device includes three time periods: a time period from t_0 to t_1 , a time period from t_1 to t_2 , and a time period from t_2 to t_3 .

[0057] In the time period from t_0 to t_1 , a temperature of

the susceptor rapidly rises from an initial temperature T_0 to a target temperature T_1 , for example, 250°C . Generally, the target temperature T_1 is a maximum temperature during a single inhalation for an electronic atomization device 100, and a duration of the time period from t_0 to t_1 is within 1s, for example, 0.2s, 0.4s, 0.6s, or 0.8s, to rapidly respond to inhalation by a user. At this stage, the susceptor needs to be capable of rapidly increasing the temperature to a desired temperature, to rapidly heat a liquid substrate as soon as possible to generate an aerosol.

[0058] In the time period from t_1 to t_2 , the temperature of the susceptor 11 decreases from the temperature T_1 to a temperature T_2 , and the temperature of the susceptor 11 is maintained at T_2 .

[0059] In the time period from t_2 to t_3 , the temperature of the susceptor 11 decreases from the temperature T_2 to a temperature T_3 , and the temperature of the susceptor 11 is maintained at T_3 .

[0060] During actual operation, data such as preset resistance thresholds corresponding to the three time periods, and the frequency and the duty cycle of the switch signal of the transistor switch Q1 may be stored in the controller, so that the aerosol generating device operates based on a preset desired temperature curve. For example,

when heating is started, the DC supply voltage provided by the power supply circuit is controlled to be a first DC supply voltage, the frequency of the switch signal supplied to the transistor switch Q1 is controlled to be a first frequency, and the duty cycle of the switch signal supplied to the transistor switch Q1 is controlled to be a first duty cycle, so that the temperature of the susceptor rapidly rises from the initial temperature T_0 to the target temperature T_1 .

[0061] A change in an apparent ohmic resistance R_a is monitored. When the apparent ohmic resistance R_a reaches a preset resistance threshold corresponding to the target temperature T_1 , the DC supply voltage provided by the power supply circuit is controlled to be a second DC supply voltage less than the first DC supply voltage, that is, the heating power is reduced. The frequency of the switch signal supplied to the transistor switch Q1 is controlled to be a second frequency, and the duty cycle of the switch signal supplied to the transistor switch Q1 is controlled to be a second duty cycle, so that the temperature of the susceptor 11 decreases from the temperature T_1 to the temperature T_2 , and the temperature of the susceptor 11 is maintained at T_2 .

[0062] In the time period from t_2 to t_3 , the DC supply voltage provided by the power supply circuit is controlled to be a third DC supply voltage less than the second DC supply voltage, that is, the heating power is further reduced. The frequency of the switch signal supplied to the transistor switch Q1 is controlled to be a third frequency, and the duty cycle of the switch signal fed to the transistor switch Q1 is controlled to be a third duty cycle, so that the temperature of the susceptor 11 decreases from the

temperature T2 to the temperature T3, and the temperature of the susceptor 11 is maintained at T3.

[0063] FIG. 13 is a schematic flowchart of a control method for an aerosol generating device according to an embodiment of this application. The control method includes the following steps:

S11: Determine, during operation, an apparent ohmic resistance based on a DC supply voltage and a DC current output by a power supply circuit to a DC/AC inverter.

S12: Monitor a change in the apparent ohmic resistance, and when the apparent ohmic resistance changes, adjust a frequency and a duty cycle of a switch signal supplied to a transistor switch.

[0064] In an example, when it is detected that the apparent ohmic resistance decreases, the frequency of the switch signal for the transistor switch is decreased, and the duty cycle of the switch signal for the transistor switch is increased. Alternatively, when it is detected that the apparent ohmic resistance increases, the frequency of the switch signal for the transistor switch is increased, and the duty cycle of the switch signal for the transistor switch is decreased.

[0065] In an example, when the apparent ohmic resistance changes, the power supply circuit is controlled to adjust the DC supply voltage.

[0066] In an example, when it is detected that the apparent ohmic resistance decreases, the power supply circuit is controlled to decrease the DC supply voltage. Alternatively, when it is detected that the apparent ohmic resistance increases, the power supply circuit is controlled to increase the DC supply voltage.

[0067] In an example, a temperature of a susceptor is determined based on the apparent ohmic resistance.

[0068] In an example, whether the apparent ohmic resistance decreases or increases to a first preset resistance threshold is determined, and the frequency and the duty cycle of the switch signal supplied to the transistor switch are adjusted based on a determining result.

[0069] In an example, a switch signal having a first frequency and/or a first duty cycle is output in a first time period in a heating cycle, to maintain the apparent ohmic resistance close to a second preset resistance threshold; and a switch signal having a second frequency and/or a second duty cycle is output in a second time period in the heating cycle, to maintain the apparent ohmic resistance close to a third preset resistance threshold.

[0070] It should be noted that, the specification of this application and the accompanying drawings thereof provide preferred embodiments of this application. However, this application may be implemented in various different forms, and is not limited to the embodiments described in this specification. These embodiments are not used as an additional limitation on the content of this application, and are described for providing a more thorough and comprehensive understanding of the content disclosed

in this application. Moreover, various embodiments not listed above formed by further combining the foregoing technical features with each other are all construed as falling within the scope of this application. Further, for a person of ordinary skill in the art, improvements or modifications may be made according to the above descriptions, and all these improvements and modifications shall fall within the protection scope of the appended claims of this application.

Claims

1. An aerosol generating device, comprising:

a power supply circuit, configured to provide a direct current (DC) supply voltage;
a direct current/alternating current (DC/AC) inverter, connected to the power supply circuit; the DC/AC inverter comprising a class-E power amplifier, the class-E power amplifier comprising a transistor switch and an LC load network consisting of a capacitor and an inductor; wherein the inductor is inductively coupled to a susceptor, to heat an aerosol-forming substrate to generate an aerosol; and

a controller, configured to determine, during operation, an apparent ohmic resistance based on the DC supply voltage and a DC current output by the power supply circuit to the DC/AC inverter; the controller being further configured to monitor a change in the apparent ohmic resistance, and when the apparent ohmic resistance changes, adjust a frequency and a duty cycle of a switch signal supplied to the transistor switch.

2. The aerosol generating device according to claim 1, wherein the controller is configured to: when detecting that the apparent ohmic resistance decreases, decrease the frequency of the switch signal for the transistor switch, and increase the duty cycle of the switch signal for the transistor switch; or when detecting that the apparent ohmic resistance increases, increase the frequency of the switch signal for the transistor switch, and decrease the duty cycle of the switch signal for the transistor switch.

3. The aerosol generating device according to claim 1, wherein the power supply circuit is configured to provide a variable DC supply voltage, and the controller is further configured to control, when the apparent ohmic resistance changes, the power supply circuit to adjust the DC supply voltage.

4. The aerosol generating device according to claim 3, wherein the controller is configured to control, when detecting that the apparent ohmic resistance de-

creases, the power supply circuit to decrease the DC supply voltage; or control, when detecting that the apparent ohmic resistance increases, the power supply circuit to increase the DC supply voltage.

5. The aerosol generating device according to claim 3, wherein the power supply circuit comprises a DC-DC conversion circuit and a regulating circuit;

the DC-DC conversion circuit comprises an input terminal electrically connected to a battery cell, an output terminal outputting a DC supply voltage, and a feedback terminal; and the regulating circuit is configured to receive control from the controller, to cause the feedback terminal of the DC-DC conversion circuit to generate a regulating signal, so that the DC-DC conversion circuit responds to the regulating signal and converts a voltage of the battery cell into a corresponding DC supply voltage.
6. The aerosol generating device according to claim 3, further comprising a voltage detection circuit, configured to detect the DC supply voltage provided by the power supply circuit.
7. The aerosol generating device according to claim 1, wherein further comprising a current detection circuit, configured to detect the DC current drawn from the power supply circuit.
8. The aerosol generating device according to claim 1, wherein the controller is further configured to determine a temperature of the susceptor based on the apparent ohmic resistance.
9. The aerosol generating device according to claim 1, wherein the controller is further configured to determine whether the apparent ohmic resistance decreases or increases to a first preset resistance threshold, and adjust, based on a determining result, the frequency and the duty cycle of the switch signal supplied to the transistor switch.
10. The aerosol generating device according to claim 1, wherein the controller is further configured to output a switch signal having a first frequency and/or a first duty cycle in a first time period in a heating cycle, to maintain the apparent ohmic resistance close to a second preset resistance threshold; and output a switch signal having a second frequency and/or a second duty cycle in a second time period in the heating cycle, to maintain the apparent ohmic resistance close to a third preset resistance threshold.
11. A control method for an aerosol generation apparatus, wherein the aerosol generating device comprises:

a power supply circuit, configured to provide a direct current (DC) supply voltage; and a direct current/alternating current (DC/AC) inverter, connected to the power supply circuit; the DC/AC inverter comprising a class-E power amplifier, the class-E power amplifier comprising a transistor switch and an LC load network consisting of a capacitor and an inductor; wherein the inductor is inductively coupled to a susceptor, to heat an aerosol-forming substrate to generate an aerosol; and the method comprises:

determining, during operation, an apparent ohmic resistance based on the DC supply voltage and a DC current output by the power supply circuit to the DC/AC inverter; and monitoring a change in the apparent ohmic resistance, and when the apparent ohmic resistance changes, adjusting a frequency and a duty cycle of a switch signal supplied to the transistor switch.

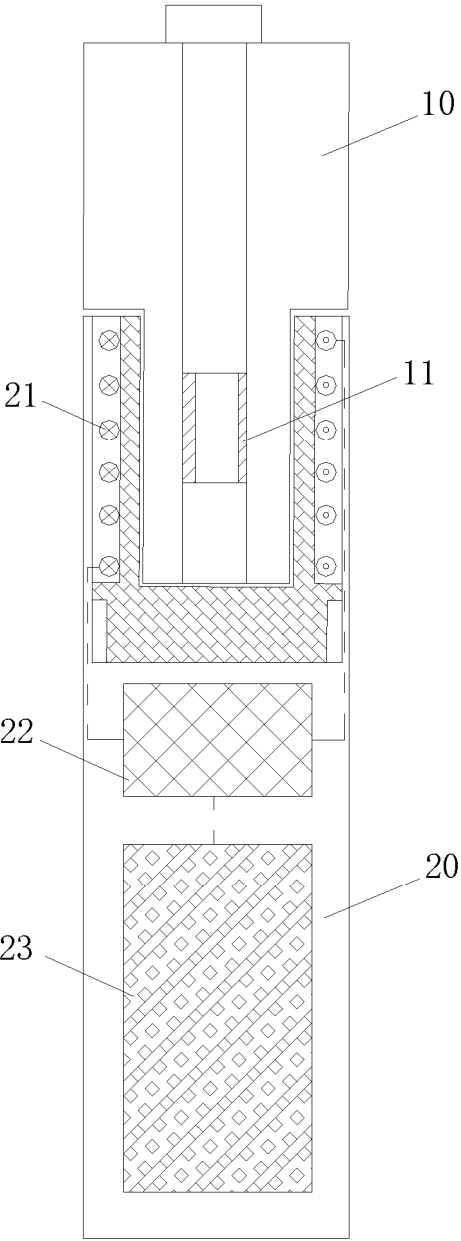


FIG. 1

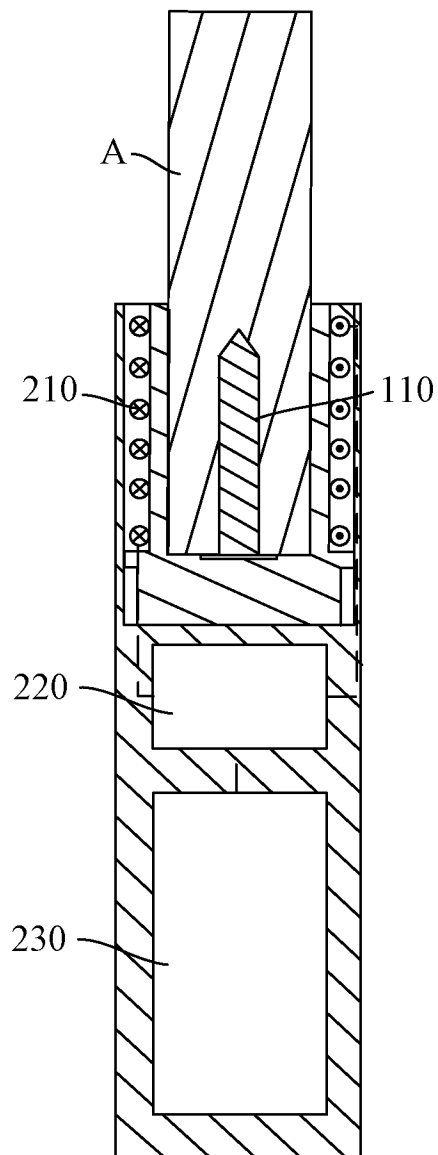


FIG. 2

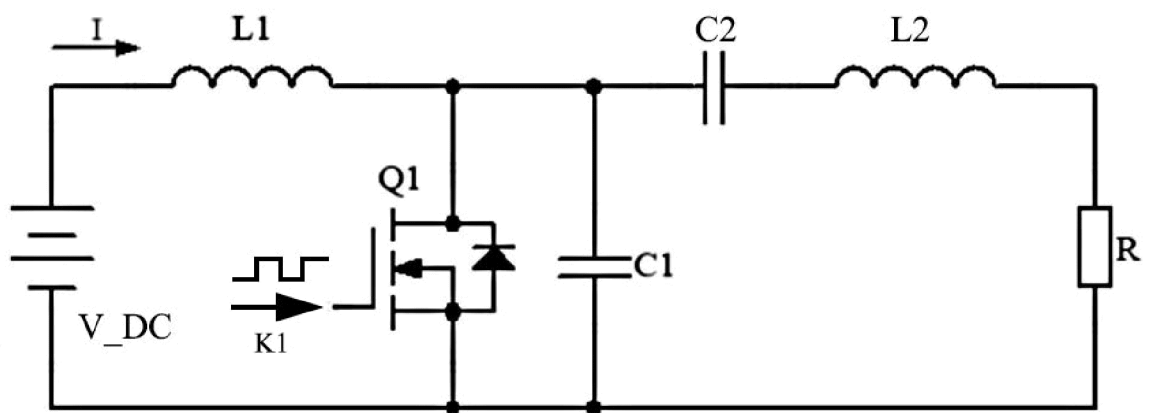


FIG. 3

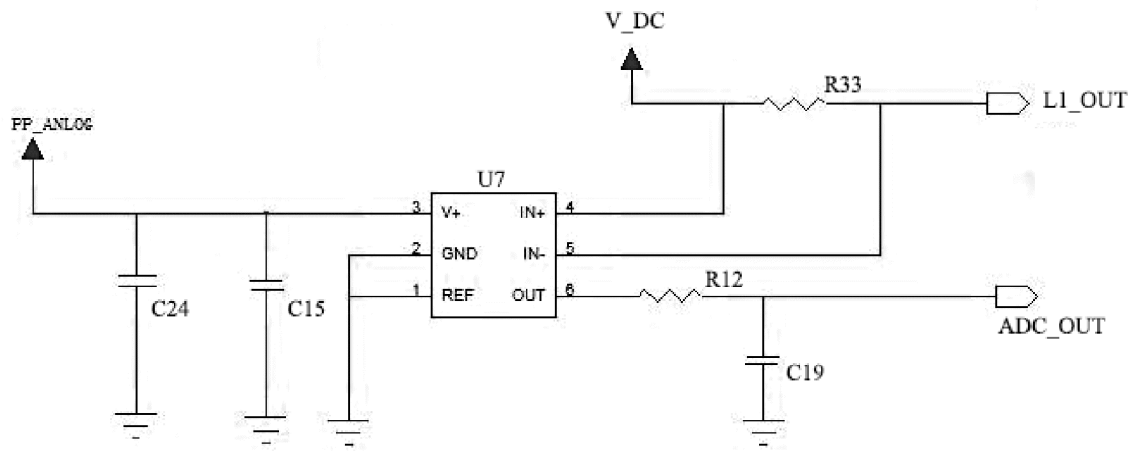


FIG. 4

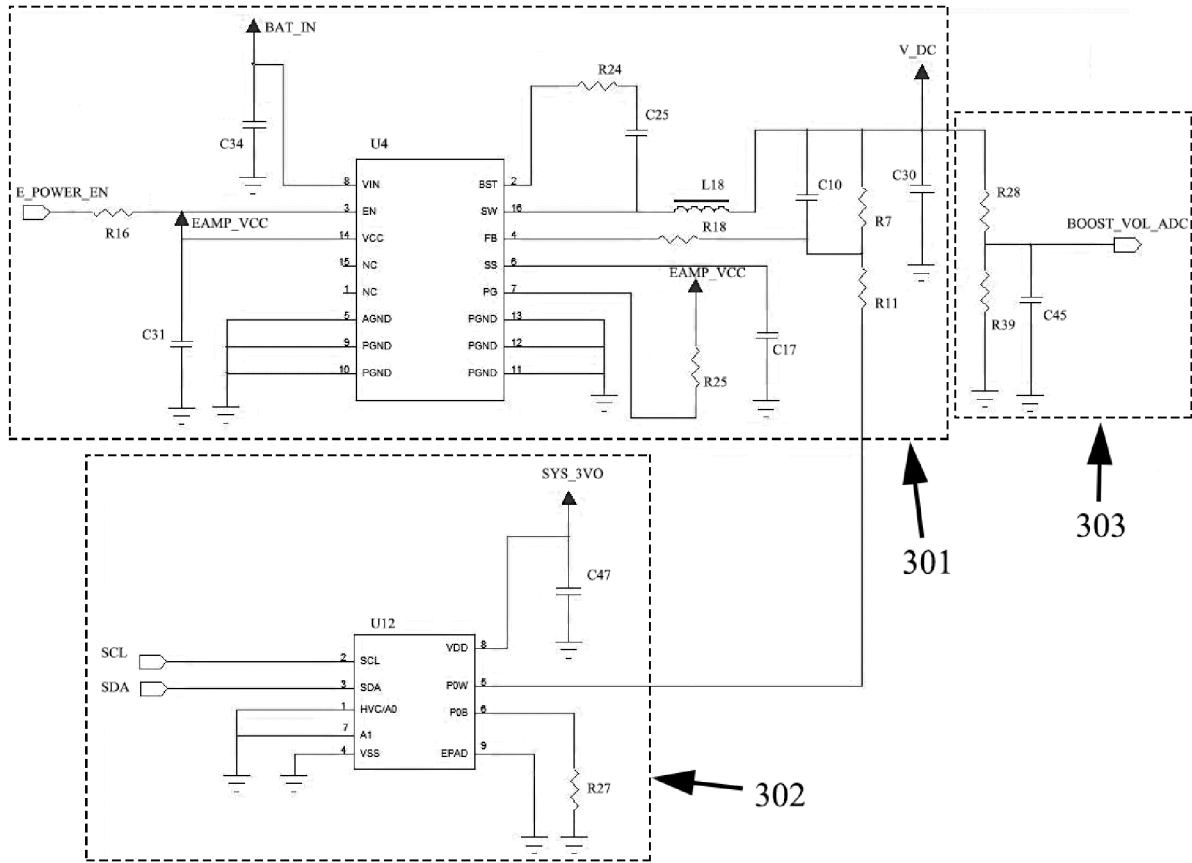


FIG. 5

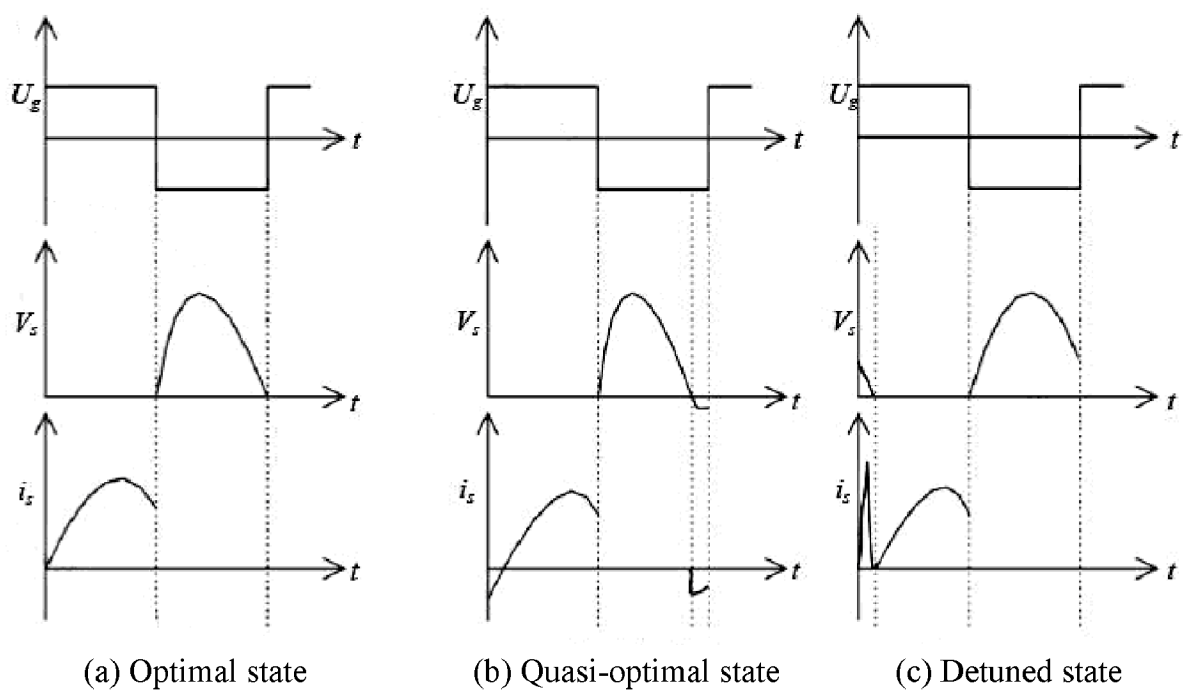


FIG. 6

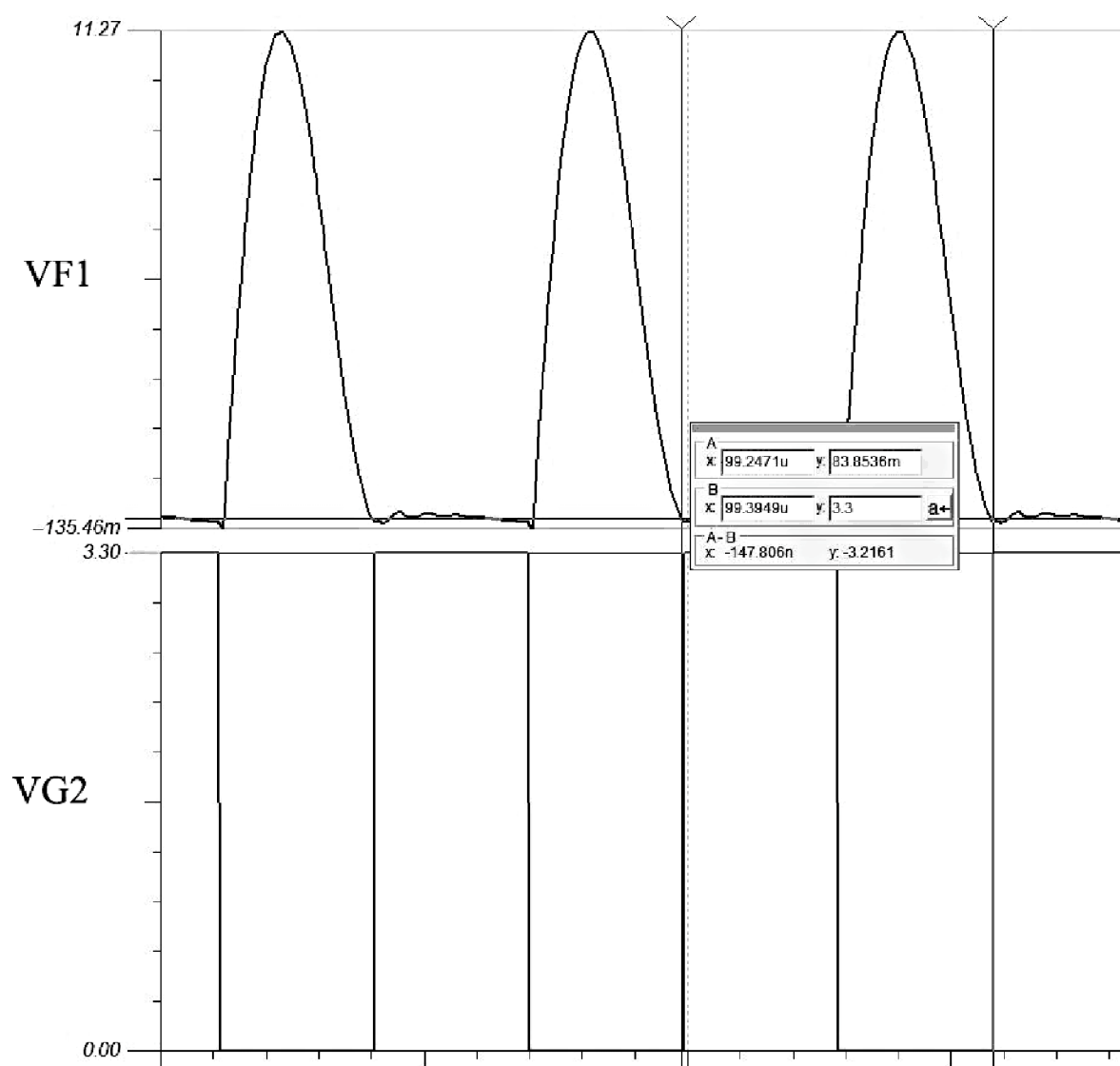


FIG. 7

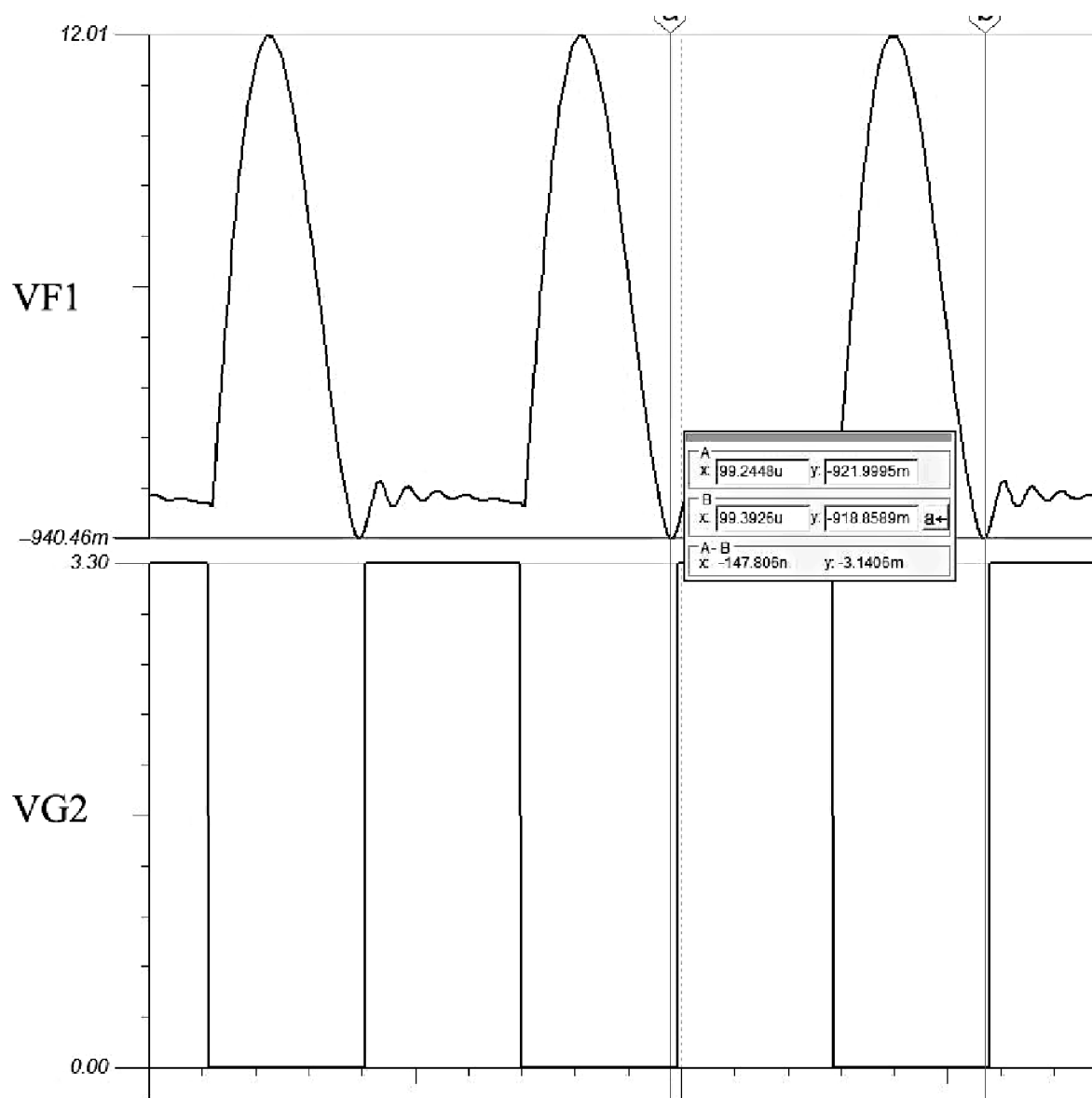


FIG. 8

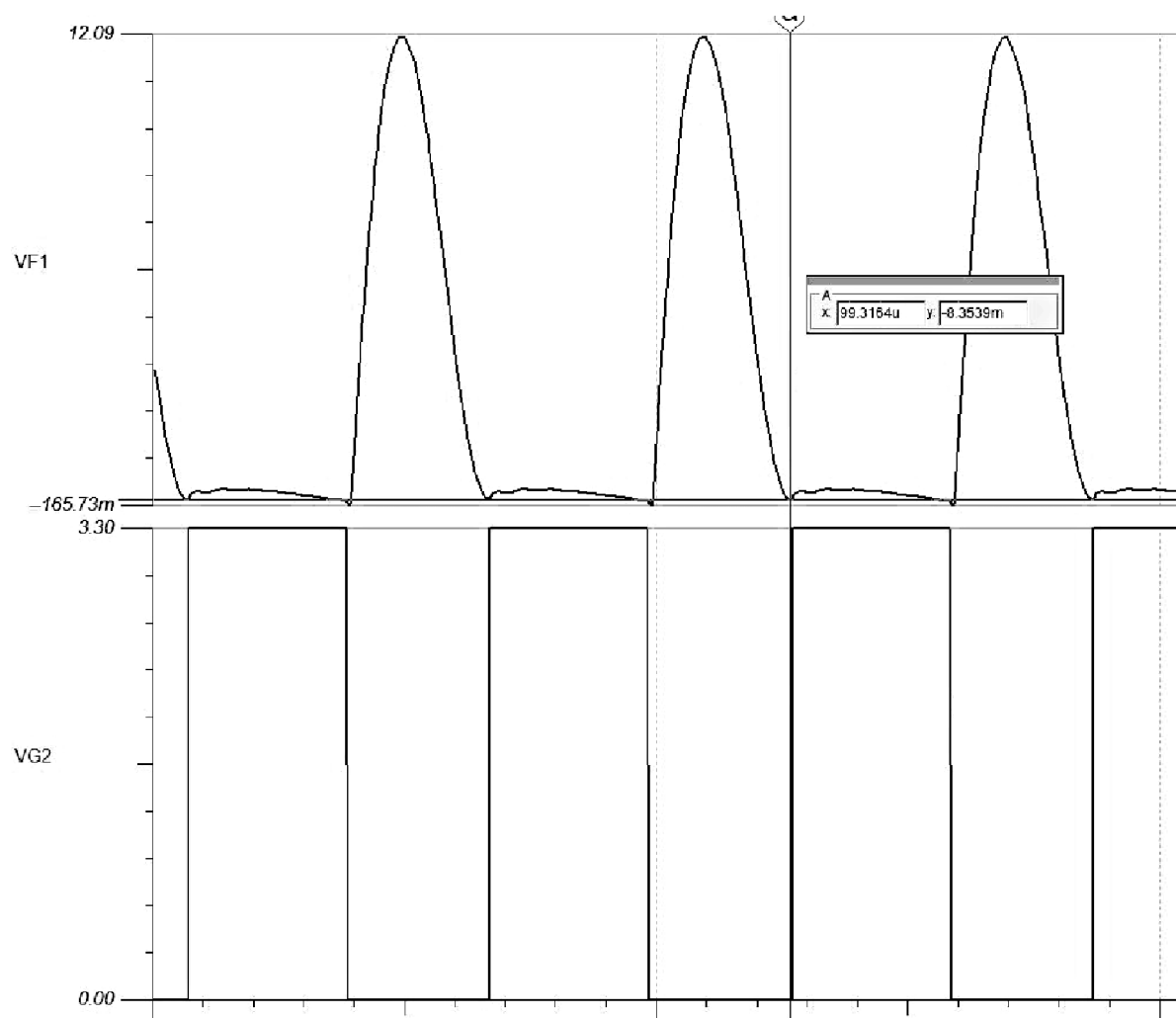


FIG. 9

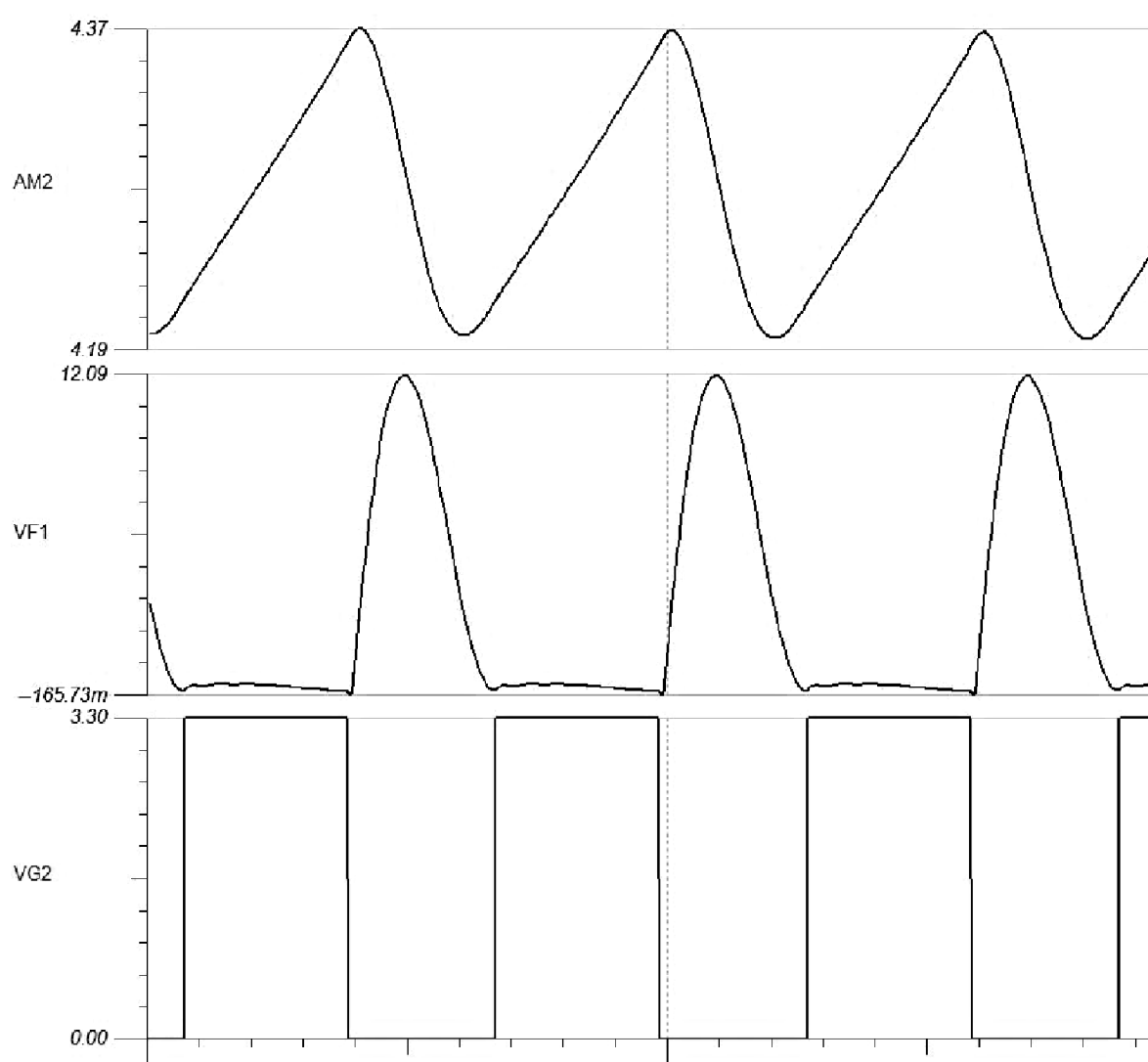


FIG. 10

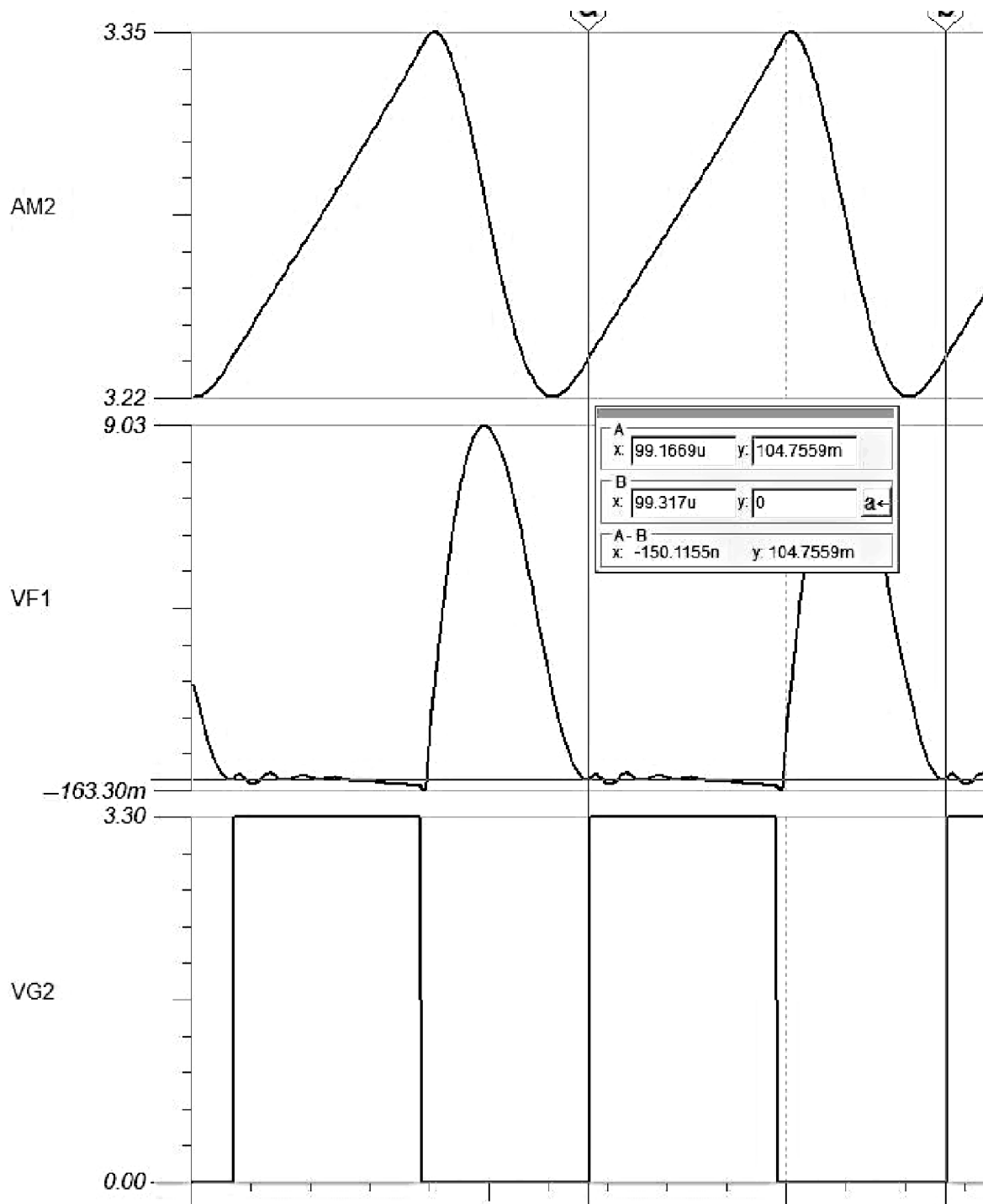


FIG. 11

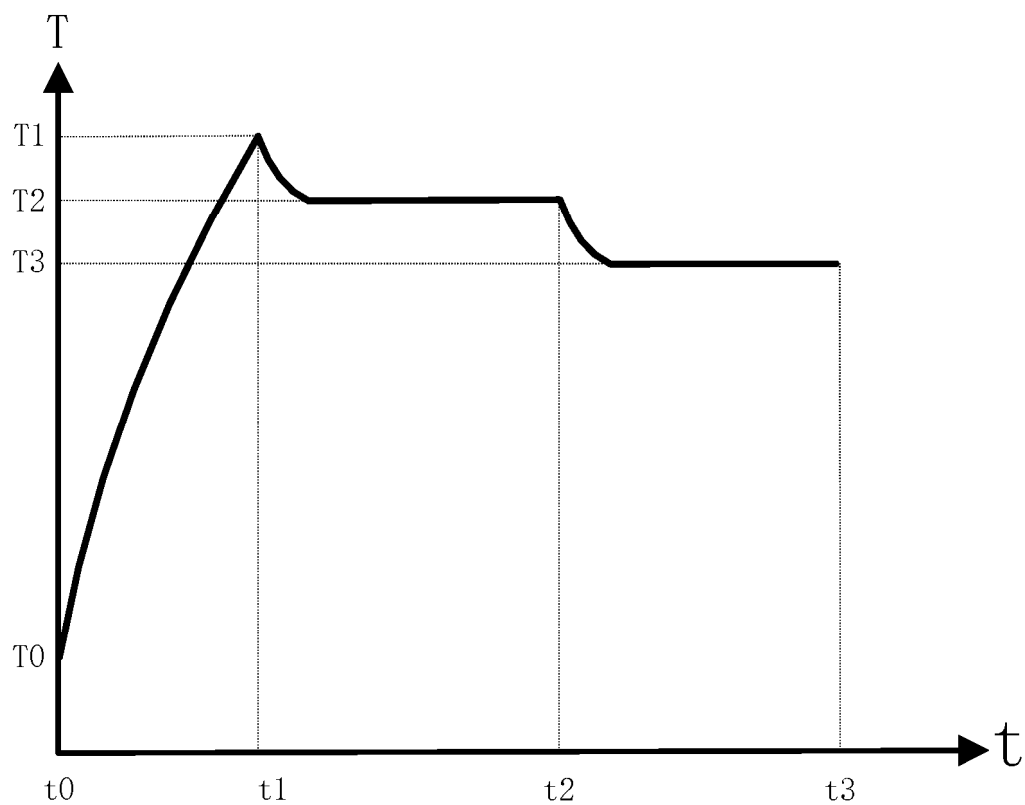


FIG. 12

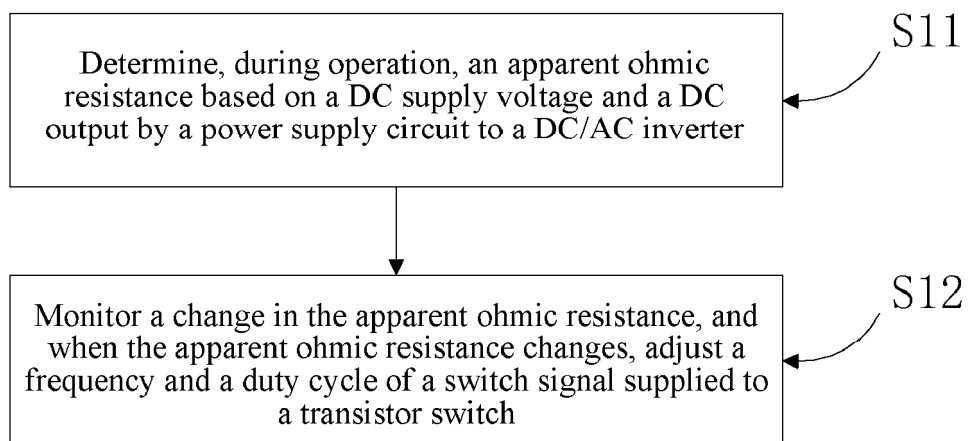


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2025/071317

A. CLASSIFICATION OF SUBJECT MATTER

A24F40/57(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

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)

CNXTX, ENTXTX, CNKI: 深圳市合元科技有限公司, 李新军, 徐中立, 李永海, 气溶胶, 电源, 电压, 电流, 转换器, 逆变器, E类功率放大器, 晶体管开关, 电容, 电感, LC负载网络, 感受器, 视在欧姆电阻, 温度, 频率, 占空比, 电阻, 电流, aerosol, power source, voltage, converter, Class-E power amplifier, transistor switch, capacitor, inductor, LC load network, susceptor, apparent ohmic resistance, temperature, resistance, current, frequency, duty ratio

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 106163306 A (PHILIP MORRIS PRODUCTS S.A.) 23 November 2016 (2016-11-23) description, paragraphs 5-70, and figure 4	1, 2, 8, 9, 11
Y	CN 106163306 A (PHILIP MORRIS PRODUCTS S.A.) 23 November 2016 (2016-11-23) description, paragraphs 5-70, and figure 4	3-7, 10
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X	CN 105307524 A (PHILIP MORRIS PRODUCTS S.A.) 03 February 2016 (2016-02-03) description, paragraphs 5-81, and figure 4	1, 2, 8, 9, 11
A	CN 116723779 A (PHILIP MORRIS PRODUCTS S.A.) 08 September 2023 (2023-09-08) entire document	1-11

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"D" document cited by the applicant in the international application	"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
"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 08 April 2025	Date of mailing of the international search report 14 April 2025
Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088	Authorized officer Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2025/071317

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Information on patent family members

International application No.

PCT/CN2025/071317

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