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(54) **AEROSOL GENERATION APPARATUS AND OPERATION METHOD THEREFOR**

(57) This application provides an aerosol generating device and an operation method, including: a battery core; a resonant circuit, including an inductor and a capacitor; a switch circuit, including a first switch transistor and a second switch transistor; a controller, configured to output a first pulse signal and a second pulse signal, the first pulse signal and the second pulse signal being complementary and having a dead time; a driver, configured to drive the first switch transistor based on the first pulse signal and drive the second switch transistor

based on the second pulse signal; and a susceptor, configured to be penetrated by the changing magnetic field, to generate heat to heat an aerosol-forming substrate. According to the foregoing aerosol generating device, on the one hand, the dead time can be flexibly set and a direct connection of the switch transistors can be effectively prevented; and on the other hand, the dead time can be reduced, to reduce the loss of the switch transistors and effectively improve the efficiency of the whole machine.

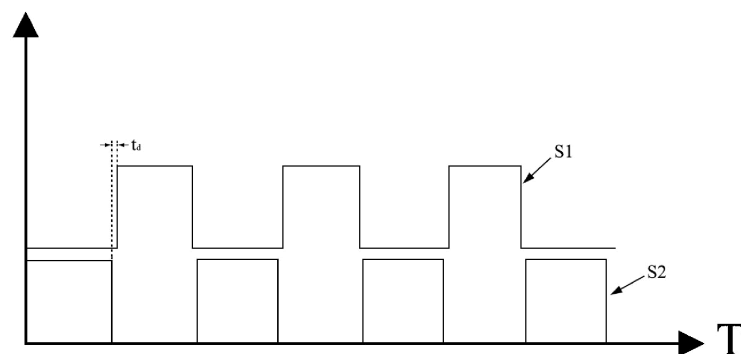


FIG. 6

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Chinese Patent Application No. 202410040020.5, filed with the China National Intellectual Property Administration on January 10, 2024 and entitled "AEROSOL GENERATION APPARATUS AND OPERATION METHOD THEREFOR", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] This application relates to the field of electronic atomization technologies, and in particular, to an aerosol generating device and an operation method.

BACKGROUND

[0003] An existing aerosol generating device usually adopts an LCC symmetric half-bridge or an LC asymmetric half-bridge, to cause an inductor to generate a changing magnetic field, and further cause a susceptor to heat an aerosol-forming substrate.

[0004] The LCC symmetric half-bridge or the LC asymmetric half-bridge is equipped with a corresponding switch circuit, and the switch circuit includes two switch transistors connected in series. A separate driver is typically adopted to drive the switch transistors, for the switch transistors to be alternately turned on and off. Generally, the driver has a dead time function, which can effectively prevent a direct connection of the switch transistors. However, the dead time corresponding to the driver is excessively long, which leads to a large loss of the switch transistors and reduces the efficiency of the whole machine.

SUMMARY

[0005] This application provides an aerosol generating device and an operation method, so as to solve the problem that the dead time of an existing prior aerosol generating device is excessively long, which leads to a large loss of the switch transistors and reduces the efficiency of the whole machine.

[0006] An aspect of this application provides an aerosol generating device, including: a battery core, configured to provide electric power; a resonant circuit, including an inductor and a capacitor forming a series resonance; a switch circuit, electrically connected to the resonant circuit; the switch circuit including a first switch transistor and a second switch transistor connected in series; a controller, configured to output a first pulse signal and a second pulse signal, the first pulse signal and the second pulse signal being complementary and having a dead time; a driver, configured to drive the first switch transistor based on the first pulse signal and drive

the second switch transistor based on the second pulse signal, to drive the first switch transistor and the second switch transistor to be alternately turned on and off, for an alternating current to flow through an inductor in the resonant circuit and generate a changing magnetic field; where the dead time is greater than a sum of a rising edge time and a falling edge time of the driver; and a susceptor, configured to be penetrated by the changing magnetic field, to generate heat to heat an aerosol-forming substrate to generate an aerosol.

[0007] Another aspect of this application provides a method for operating an aerosol generating device, the aerosol generating device including: a battery core, configured to provide electric power; a resonant circuit, including an inductor and a capacitor forming a series resonance; a switch circuit, electrically connected to the resonant circuit; the switch circuit including a first switch transistor and a second switch transistor; and a susceptor, configured to be penetrated by a changing magnetic field, to generate heat to heat an aerosol-forming substrate to generate an aerosol; the method includes: outputting a first pulse signal and a second pulse signal, the first pulse signal and the second pulse signal being complementary and having a dead time; driving the first switch transistor based on the first pulse signal and drive the second switch transistor based on the second pulse signal, to drive the first switch transistor and the second switch transistor to be alternately turned on and off, for an alternating current to flow through an inductor in the resonant circuit and generate the changing magnetic field; where the dead time is greater than a sum of a rising edge time and a falling edge time.

[0008] According to the foregoing aerosol generating device and operation method, two pulse signals that are complementary and have a dead time are output by the controller, and the dead time greater than a sum of the rising edge time and the falling edge time of the driver is set; in this way, on the one hand, the dead time can be flexibly set, to effectively prevent a direct connection of the switch transistors; on the other hand, the dead time can be reduced, to reduce the loss of the switch transistors and effectively improve the efficiency of the whole machine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] One or more embodiments are exemplarily described with reference to the corresponding figures in the accompanying drawings, and the exemplary descriptions are not to be construed as limiting the embodiments. Elements in the accompanying drawings that have same reference numerals are represented as similar elements, and unless otherwise particularly stated, the figures in the accompanying drawings are not drawn to scale.

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

FIG. 2 is a wireframe diagram of an aerosol generating device according to an embodiment of this application;

FIG. 3 is a schematic diagram of a switch circuit and a resonant circuit according to an embodiment of this application;

FIG. 4 is a schematic diagram of a drive circuit according to an embodiment of this application;

FIG. 5 is a block diagram of a controller according to an embodiment of this application;

FIG. 6 is a schematic diagram of a pulse signal according to an embodiment of this application;

FIG. 7 is a schematic diagram of a waveform of a switch transistor according to an embodiment of this application;

FIG. 8 is schematic diagram of another waveform of a switch transistor according to an embodiment of this application; and

FIG. 9 is a schematic diagram of a method for operating an aerosol generating device according to an embodiment of this application.

DETAILED DESCRIPTION

[0010] For ease of understanding 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 described to be "connected to" another element, the element may be directly connected to the another element, or there may be one or more intermediate elements therebetween. Terms "upper", "lower", "left", "right", "inner", "outer", and similar expressions used in this specification are merely used for illustration.

[0011] Unless otherwise defined, meanings of all technical and scientific terms used in this specification are the same as that usually understood by a person skilled in the art of this application. In this specification, terms used in this specification of this application are merely intended to describe the specific implementations, and are not intended to limit this application. The term "and/or" used in this specification includes any or all combinations of one or more related listed items

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

[0012] As shown in FIG. 1, the aerosol generating device includes an atomizer 10 and a power supply assembly 20.

[0013] 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.

[0014] The atomizer 10 includes a carrier or container carrying a liquid aerosol-forming substrate, and a susceptor 11 can be incorporated in the carrier or container. For example, the container carrying the liquid aerosol-forming substrate has a liquid storage chamber, and the susceptor 11 is mounted inside the container; the position of the susceptor 11 inside the container is fixed, to facilitate more efficient coupling with the inductor 21 when the atomizer 10 is mated with the power supply assembly 20.

[0015] The susceptor 11 is configured to be coupled to the inductor 21, generate heat when penetrated by a changing magnetic field, and further heat the liquid aerosol-forming substrate, for at least one component of the liquid aerosol-forming substrate to volatilize, to form an aerosol for vaping.

[0016] The susceptor 11 may be in direct contact with the liquid aerosol-forming substrate inside the liquid storage chamber, or the susceptor 11 may be in indirect contact with the liquid aerosol-forming substrate. For example, a wicking material is arranged between the susceptor 11 and the liquid storage chamber, and the wicking material is configured to transfer the liquid aerosol-forming substrate to the susceptor 11. Optional wicking materials include porous materials or fibrous materials.

[0017] 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.

[0018] The power supply assembly 20 includes an inductor 21, a circuit 22, and a battery core 23.

[0019] The inductor 21 generates a changing magnetic field under an alternating current. The inductor 21 includes, but is not limited to, an induction coil.

[0020] The circuit 22 may control overall operations on the aerosol generating device. The circuit 22 not only controls operations on the battery core 23 and the inductor 21, but also controls operations on other elements in the aerosol generating device.

[0021] The battery core 23 supplies power for operating the aerosol generating device. The battery core 23 may be a rechargeable battery core or a disposable battery core.

[0022] FIG. 2 is a schematic diagram of an aerosol generating device according to another embodiment of this application.

[0023] As shown in FIG. 2, the aerosol generating device includes:

a chamber, a solid aerosol-forming substrate being removably received in the chamber; where the solid aerosol-forming substrate may be an aerosol-generating article A, for example, part of a cigarette.

[0024] A susceptor 110, at least partially extending inside the chamber, is configured to be coupled to an inductor 210, generate heat when penetrated by a changing magnetic field, and further heat the solid aerosol-

forming substrate, for at least one component of the solid aerosol-forming substrate to volatilize, to form an aerosol for vaping.

[0025] In one example, the susceptor 110 is generally in the shape of a pin or blade, which in turn is advantageous for insertion into the solid aerosol-forming substrate; meanwhile, the susceptor 110 may have a length of about 12 mm, a width of about 4 mm, and a thickness of about 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 about 12 mm, a width of about 5 mm, and a thickness of about 0.5 mm, and may be made of grade 430 stainless steel (SS430).

[0026] In another example, the susceptor 110 may further be configured in a cylindrical shape or a tubular shape; during use, an inner space thereof forms a chamber for receiving the solid aerosol-forming substrate, and by means of heating an outer periphery of the solid aerosol-forming substrate, generating an aerosol for vaping. These susceptors may also be made of stainless steel of level 420 (SS420) and alloy materials containing iron and nickel (such as permalloy).

[0027] The inductor 210 is configured to generate a changing magnetic field under an alternating current; according to settings of a product during use, the inductor 210 may include a cylindrical inductor coil wound in a spiral shape.

[0028] A circuit 220 is electrically connected to a battery core 230 and is configured to convert a direct current output from the battery core 230 into an alternating current having an appropriate frequency and resupply same to the inductor 210.

[0029] The battery core 230 supplies power for operating the aerosol generating device. The battery core 23 may be a rechargeable battery core or a disposable battery core.

[0030] Based on the foregoing aerosol generating device, FIG. 3 to FIG. 5 show schematic diagrams of basic assemblies of an embodiment of a circuit; the circuit includes:

a switch circuit 221, including a switch transistor Q1 and a switch transistor Q2 connected in series. The switch circuit 221 is configured to form an alternating current flowing through an inductor L when the switch transistor Q1 and the switch transistor Q2 are alternately turned on and off.

[0031] A resonant circuit 222 is an LCC symmetric half-bridge circuit formed of the inductor L, a capacitor C1, and a capacitor C2; in other examples, it is also feasible that an LC asymmetric half-bridge circuit is formed only of the inductor L and a capacitor C1 (or a capacitor C2). The resonant circuit 222 is configured to cause the inductor L to generate an alternating magnetic field to induce the susceptor to generate heat during resonance.

[0032] In connection, a first end of the capacitor C1 is connected to a power supply Vbat, and a second end thereof is connected to a first end of the capacitor C2; a second end of the capacitor C2 is connected to ground

through a resistor R1; a first end of the switch transistor Q1 is connected to Vbat, a second end thereof is connected to a first end of the switch transistor Q2, and a second end of the switch transistor Q2 is grounded through the resistor R1; certainly, control ends of the switch transistor Q1 and the switch transistor Q2 are both connected to a driver U1, and are turned on and off under the drive of the driver U1; the switch transistor Q1 and the switch transistor Q2 include, but are not limited to, transistors such as IGBT and MOS, and in a preferred embodiment, both the switch transistor Q1 and the switch transistor Q2 are NMOS transistors. A first end of the inductor L is connected to the second end of the switch transistor Q1, and a second end of the inductor L is connected to the second end of the first capacitor C1.

[0033] For the resonant circuit 222 in the foregoing structure, in a switching state of the switch transistor Q1 and the switch transistor Q2, a connection status among the first capacitor C1, the second capacitor C2, and the inductor L is varying. When the switch transistor Q1 is turned on and the switch transistor Q2 is turned off, the capacitor C1 and the inductor L together form a closed LC series loop, and the capacitor C2 and the inductor L form an LC series loop with two ends connected to Vbat and ground, respectively (the loop starts from Vbat, passes through the inductor L and the capacitor C2 sequentially, and ends at a ground end); when the switch transistor Q1 is turned off and the switch transistor Q2 is turned on, the configured loop is opposite to the above state, the capacitor C1 and the inductor L form an LC series loop with two ends connected to Vbat and ground, respectively, and the capacitor C2 and the inductor L together form a closed LC series loop. In different states, both the first capacitor C1 and the second capacitor C2 can form respective LC series loops with the inductor L.

[0034] A controller 223 is configured to output two pulse signals that are complementary and have a dead time, that is, output a first pulse signal and a second pulse signal, the first pulse signal and the second pulse signal being complementary and having a dead time. As shown in FIG. 6, a first pulse signal S1 and a second pulse signal S2 are two pulse signals that are complementary and have a dead time. The first pulse signal S1 and the second pulse signal S2 have a same amplitude and opposite phases, and in the figure, t_d is the dead time of the first pulse signal S1 and the second pulse signal S2.

[0035] As shown in FIG. 5, in one example, the controller 223 includes a reference signal generating module 224, a dead time generator 225, and an output control module 226;

the reference signal generating module 224 is configured to output a reference signal based on a natural frequency of the resonant circuit 222; in a specific example, the reference signal generating module 224 includes a frequency multiplier 2241 and a pre-divider 2242; the frequency multiplier 2241

is configured to multiply the reference frequency signal, to generate a frequency multiplied signal; the pre-divider 2242 is configured to divide the frequency multiplied signal to obtain a divided signal approaching the natural frequency of the resonant circuit.

[0036] In a specific example, a register in the reference signal generating module 224 may be configured, for the reference signal generating module 224 to output a reference signal based on the divided signal.

[0037] For example, values of an automatic loading register TIMx_ARR, a capture/comparison register TIMx_CCRx, and a counter register TIMx_CNT are configured to generate a PWM pulse signal having a particular frequency and duty cycle, that is, a reference signal.

[0038] The dead time generator 225 is configured to generate two pulse signals that are complementary and have a dead time based on the reference signal and a preset dead time, that is, generate the first pulse signal and the second pulse signal;

in a specific example, the dead time generator 225 includes a dead time register 2251, configured to generate the dead time. For example, by configuring a brake of a timer and a DTG[7:0] portion in a dead-time register TMIX_BDTR, a corresponding dead time can be generated.

[0039] The output control module 226 is configured to output the first pulse signal and the second pulse signal generated by the dead time generator 225 through corresponding pins of the controller.

[0040] In a specific example, a signal output by the dead time generator 225 is divided into two signals, one is a raw signal and one is a reversed signal, specifically controlled by bits CCxP and CCxNP of a register CCER. Whether to output a polarity-selected signal from an OCx pin to an external pin CHx/CHxN (that is, whether to enable) is configured by a bit CxE/CxNE of the register CCER.

[0041] The driver U1 is configured to convert two pulse signals that are complementary and have a dead time output from the controller 223 into two drive signals, that is, to drive the first switch transistor based on the first pulse signal and to drive the second switch transistor based on the second pulse signal to drive the switch transistor Q1 and the switch transistor Q2 to be alternately turned on and off, for an alternating current to flow through an inductor L in the resonant circuit 222 and generate a changing magnetic field.

[0042] In one example, the driver U1 adopts a model UCC27212 switch transistor driver. A bootstrap diode is integrated inside the driver U1, and an external discrete diode is not needed.

[0043] A first input pin (as shown by a seventh pin in the figure) and a second input pin (as shown by an eighth pin in the figure) of the driver U1 are electrically connected to the controller 223, respectively, the first input pin receives a first pulse signal (as shown by LC_PWM_HI in the

figure) output from the controller 223, and the second input pin receives a second pulse signal (as shown by LC_PWM_LI in the figure) output from the controller 223.

[0044] The first output pin (as shown by a third pin in the figure) of the driver U1 is electrically connected to a control end of the switch transistor Q1 (as shown by LC_HO in the figure), and a second output pin (as shown by a tenth pin in the figure) of the driver U1 is electrically connected to a control end of the switch transistor Q2 (as shown by LC_LO in the figure).

[0045] A bootstrap capacitor C3 is connected between the first power supply pin (as shown by a second pin in the figure) and the second power supply pin (as shown by a fourth pin in the figure) of the driver U1, that is, one end of the bootstrap capacitor C3 is electrically connected to the first power supply pin, the other end of the bootstrap capacitor C3 is electrically connected to the second power supply pin, and the second power supply pin of the driver U1 is electrically connected between the switch transistor Q1 and the switch transistor Q2 (as shown by BOOST_HS in the figure).

[0046] In one example, the dead time generated by the dead time register is greater than a sum of the rising edge time and the falling edge time of the driver U1, and in this way, a direct connection between the switch transistor Q1 and the switch transistor Q2 due to a transmission delay of the driver U1 can be prevented.

[0047] In one example, the dead time may be between 5 ns and 50 ns; or, the dead time is between 10 ns and 50 ns; or, the dead time is between 10 ns and 30 ns; or, the dead time is between 20 ns and 30 ns.

[0048] Again referring to FIG. 7 and FIG. 8, assuming that both the switch transistor Q1 and the switch transistor Q2 are NMOS transistors, AM4 in the figure is a current waveform at two ends, i.e., a drain and a source, of the switch transistor Q1, VF1 is an input voltage waveform of a gate of the switch transistor Q1, VF2 is an input voltage waveform of a gate of the switch transistor Q2, and VM1 is a voltage V_{DS} at two ends, i.e., a drain and a source, of the switch transistor Q1.

[0049] As shown in FIG. 7, in the prior art, since the driver has a dead time function, a corresponding dead time Δt_0 thereof is about 70 ns. As can be seen from the waveform corresponding to AM4 and VM1, in the dead time, a value of $VM1 \cdot AM4$ is relatively large, and therefore the power loss of the switch transistor is relatively high.

[0050] As shown in FIG. 8, two pulse signals that are complementary and have a dead time are output by means of the controller 223, and the dead time is set to be greater than a sum of the rising edge time and the falling edge time of the driver U1. The dead time Δt_1 is about 15 ns. As can be seen from the waveform corresponding to AM4 and VM1, in the dead time, a value of $VM1 \cdot AM4$ is relatively low, and therefore the power loss of the switch transistor is relatively low.

[0051] As shown in FIG. 9, another embodiment of this application further provides a method for operating an

aerosol generating device, and the aerosol generating device may refer to the foregoing content. The method includes the following steps:

S11: Output a first pulse signal and a second pulse signal, the first pulse signal and the second pulse signal being complementary and having a dead time.
S12: Drive the first switch transistor based on the first pulse signal and drive the second switch transistor based on the second pulse signal, to drive the first switch transistor and the second switch transistor to be alternately turned on and off, for an alternating current to flow through an inductor in the resonant circuit and generate a changing magnetic field; where the dead time is greater than a sum of a rising edge time and a falling edge time.

[0052] It should be noted that, the specification of this application and the accompanying drawings thereof illustrate preferred embodiments of this application. However, this application can be implemented in various different forms, and is not limited to the embodiments described in this specification. These embodiments are not intended to be an additional limitation on the content of this application, and are described for the purpose of providing a more thorough and comprehensive understanding of the disclosure of this application. It needs to be noted that the specification of this application and the 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, the foregoing technical features may further be combined to form various embodiments not listed above, and all such embodiments shall be construed as falling within the scope of the specification of this application. Further, a person of ordinary skill in the art may make improvements and variations based on the above descriptions, and such improvements and variations shall all fall within the protection scope of the appended claims of this application.

Claims

1. An aerosol generating device, comprising:

a battery core, configured to provide electric power;
a resonant circuit, comprising an inductor and a capacitor forming a series resonance;
a switch circuit, electrically connected to the resonant circuit; the switch circuit comprising a first switch transistor and a second switch

transistor;

a controller, configured to output a first pulse signal and a second pulse signal, the first pulse signal and the second pulse signal being complementary and having a dead time;

a driver, configured to drive the first switch transistor based on the first pulse signal and drive the second switch transistor based on the second pulse signal, to drive the first switch transistor and the second switch transistor to be alternately turned on and off, for an alternating current to flow through an inductor in the resonant circuit and generate a changing magnetic field; wherein the dead time is greater than a sum of a rising edge time and a falling edge time of the driver; and

a susceptor, configured to be penetrated by the changing magnetic field to generate heat, to heat an aerosol-forming substrate to generate an aerosol.

2. The aerosol generating device according to claim 1, wherein the dead time is between 5 ns and 50 ns; or, the dead time is between 10 ns and 50 ns; or, the dead time is between 10 ns and 30 ns; or, the dead time is between 20 ns and 30 ns.

3. The aerosol generating device according to claim 1, wherein the controller comprises a reference signal generating module, a dead time generator, and an output control module;

the reference signal generating module being configured to output a reference signal based on a natural frequency of the resonant circuit;
the dead time generator being configured to generate the first pulse signal and the second pulse signal based on the reference signal and a preset dead time; and
the output control module being configured to output the first pulse signal and the second pulse signal generated by the dead time generator through corresponding pins of the controller.

4. The aerosol generating device according to claim 3, wherein the reference signal generating module comprises a frequency multiplier and a pre-divider; the frequency multiplier is configured to multiply the reference frequency signal, to generate a frequency multiplied signal; and the pre-divider is configured to divide the frequency multiplied signal to obtain a divided signal approaching the natural frequency of the resonant circuit.

5. The aerosol generating device according to claim 3, wherein the dead time generator comprises a dead time register, configured to generate the dead time.

6. The aerosol generating device according to claim 1, wherein the driver comprises a first input pin, a second input pin, a first output pin, and a second output pin;
- 5
- the first input pin is electrically connected to the controller, to receive the first pulse signal output by the controller; the second input pin is electrically connected to the controller, to receive the second pulse signal output by the controller; and the first output pin is electrically connected to a control end of the first switch transistor, and the second output pin is electrically connected to a control end of the second switch transistor.
- 10
- 15
7. The aerosol generating device according to claim 6, wherein the driver further comprises a first power supply pin, a second power supply pin, and a bootstrap capacitor; and one end of the bootstrap capacitor is electrically connected to the first power supply pin, the other end of the bootstrap capacitor is electrically connected to the second power supply pin, and the second power supply pin is electrically connected between the first switch transistor and the second switch transistor.
- 20
- 25
8. The aerosol generating device according to claim 7, wherein a bootstrap diode is integrated in the driver.
- 30
9. The aerosol generating device according to claim 1, wherein both the first switch transistor and the second switch transistor are NMOS transistors.
- 35
10. The aerosol generating device according to claim 1, wherein the resonant circuit comprises an LC asymmetric half-bridge resonant circuit or an LCC symmetric half-bridge resonant circuit.
- 40
11. A method for operating an aerosol generating device, wherein the aerosol generating device comprises:
- 45
- a battery core, configured to provide electric power;
- a resonant circuit, comprising an inductor and a capacitor forming a series resonance;
- a switch circuit, electrically connected to the resonant circuit; the switch circuit comprising a first switch transistor and a second switch transistor; and
- 50
- a susceptor, configured to be penetrated by a changing magnetic field, to generate heat to heat an aerosol-forming substrate to generate an aerosol;
- 55
- the method comprises:

outputting a first pulse signal and a second

pulse signal, the first pulse signal and the second pulse signal being complementary and having a dead time;

driving the first switch transistor based on the first pulse signal and driving the second switch transistor based on the second pulse signal, to drive the first switch transistor and the second switch transistor to be alternately turned on and off, for an alternating current to flow through an inductor in the resonant circuit and generate the changing magnetic field; wherein the dead time is greater than a sum of a rising edge time and a falling edge time.

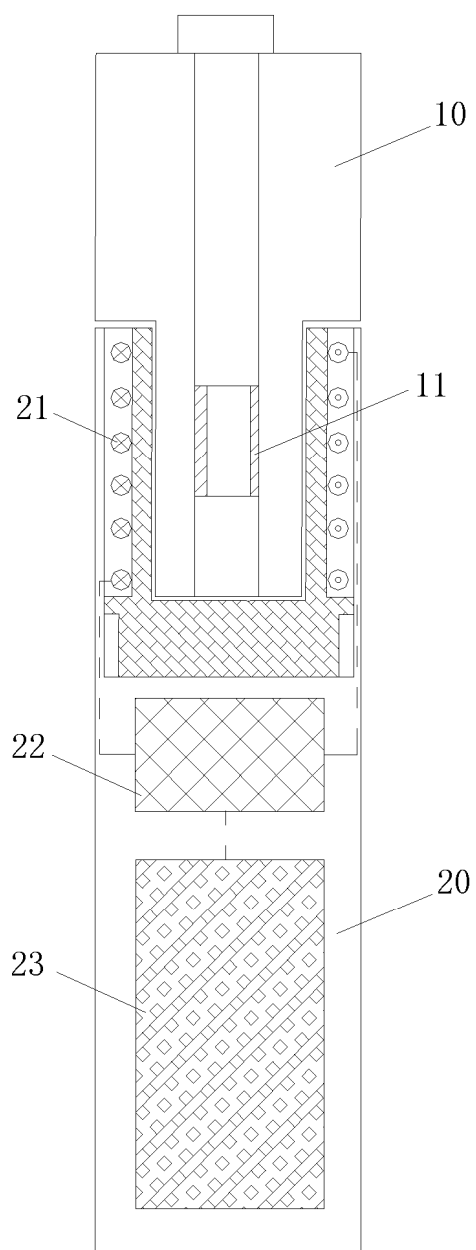


FIG. 1

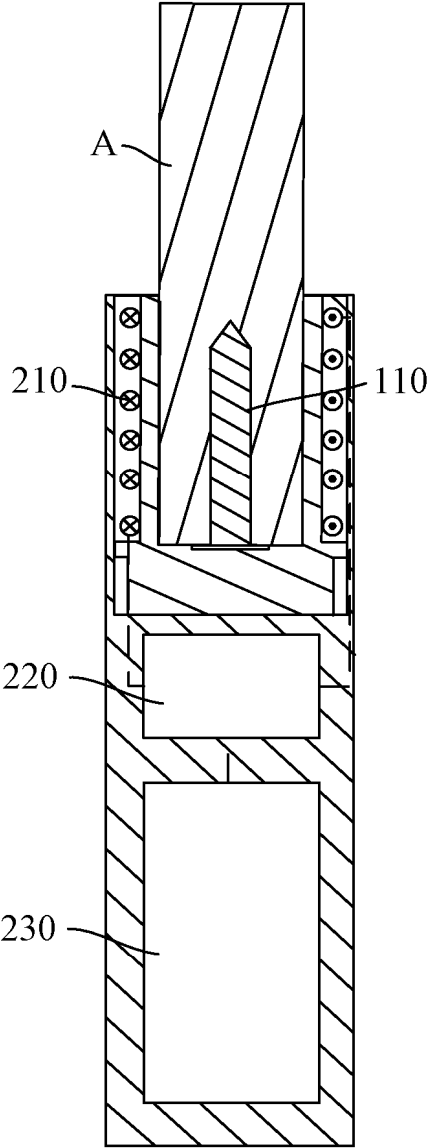


FIG. 2

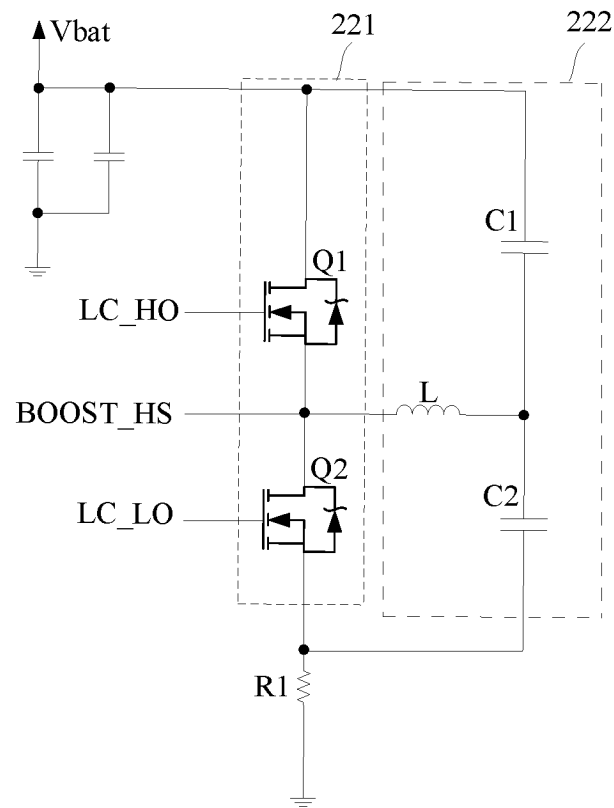


FIG. 3

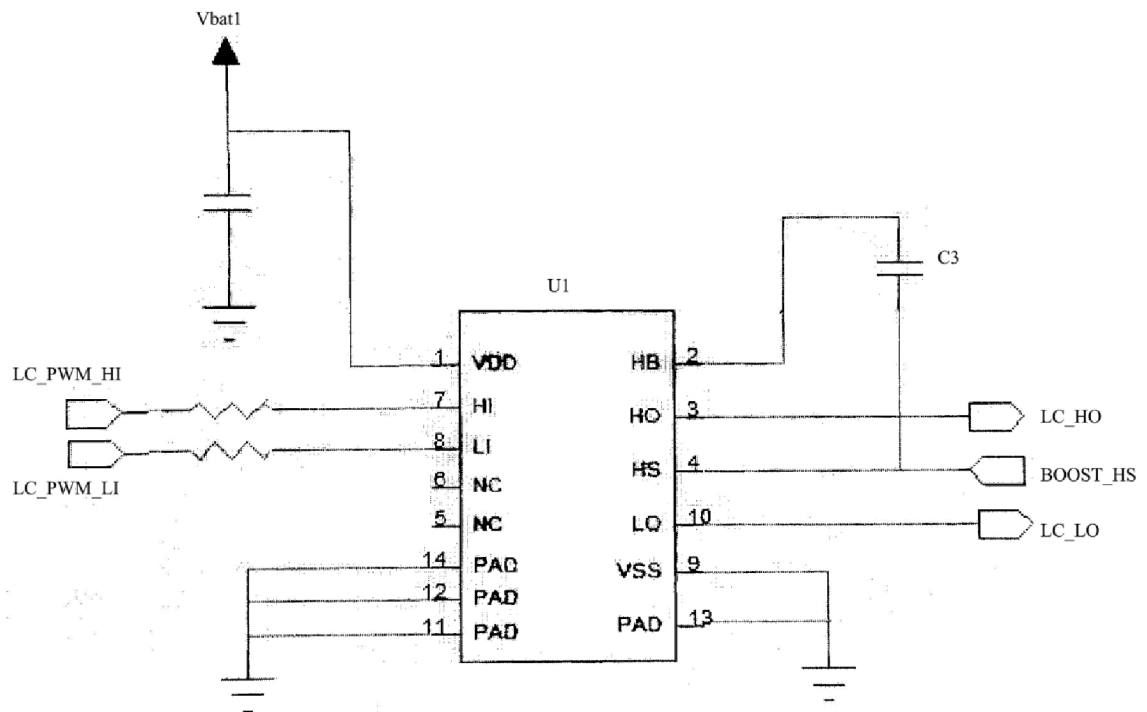


FIG. 4

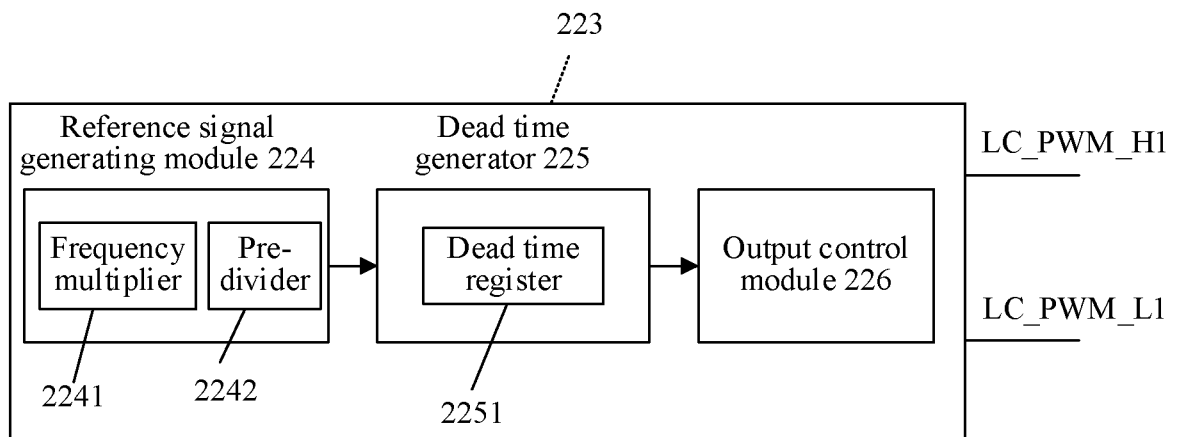


FIG. 5

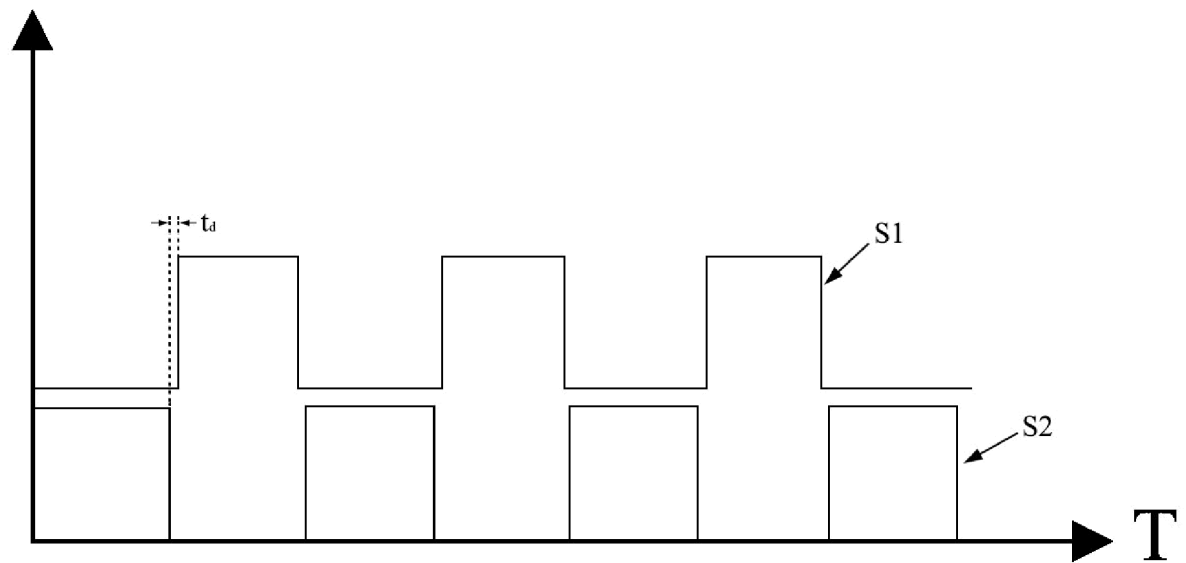


FIG. 6

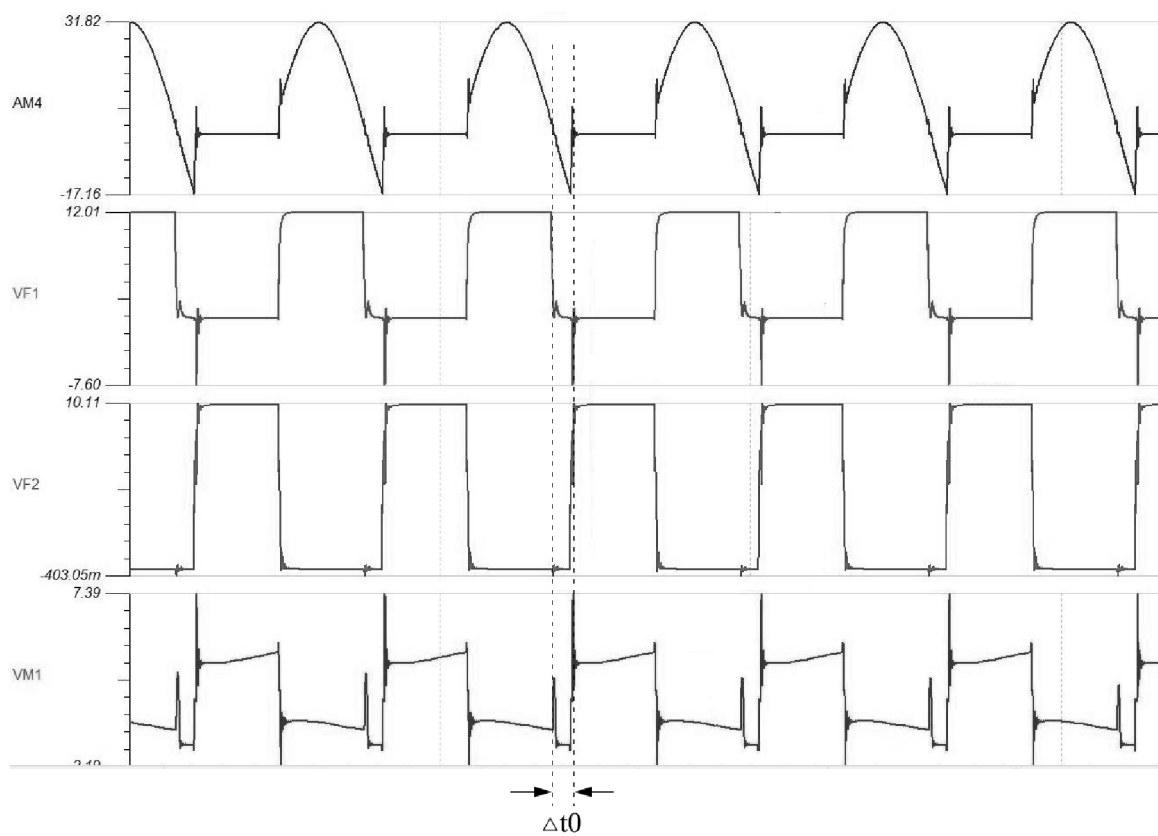


FIG. 7

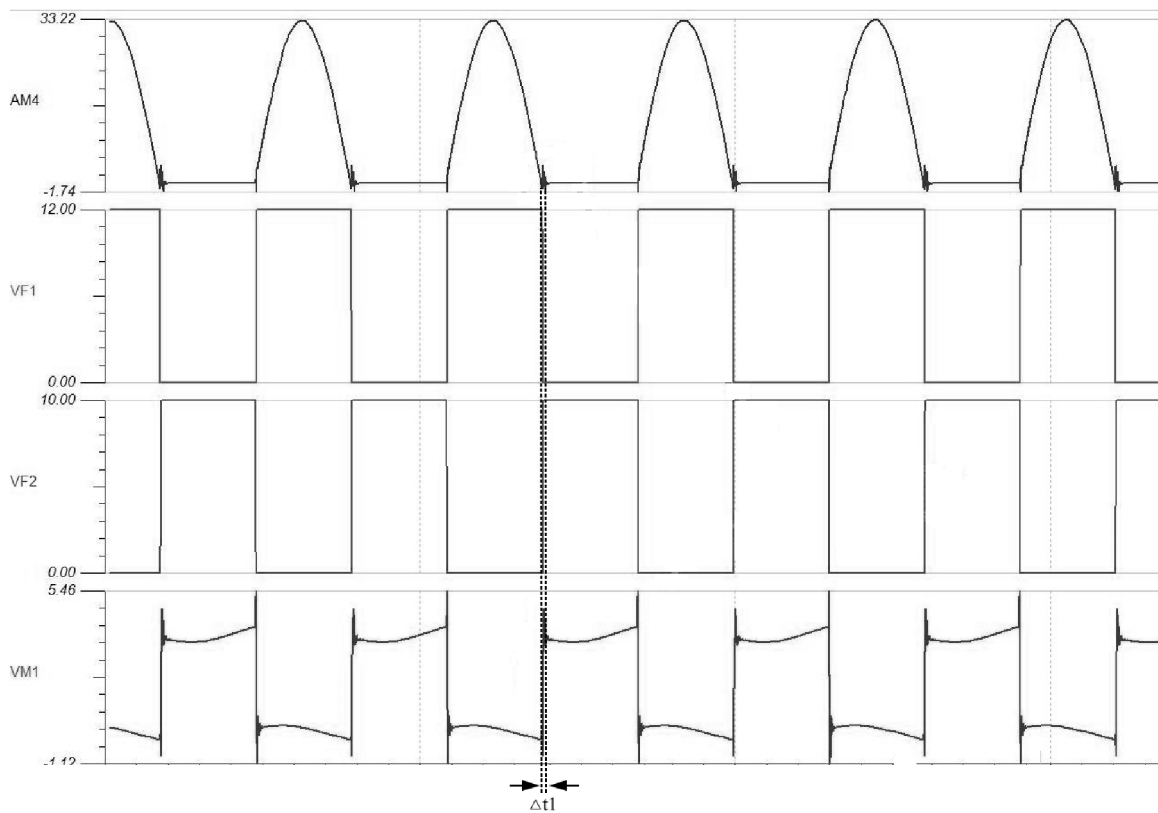


FIG. 8

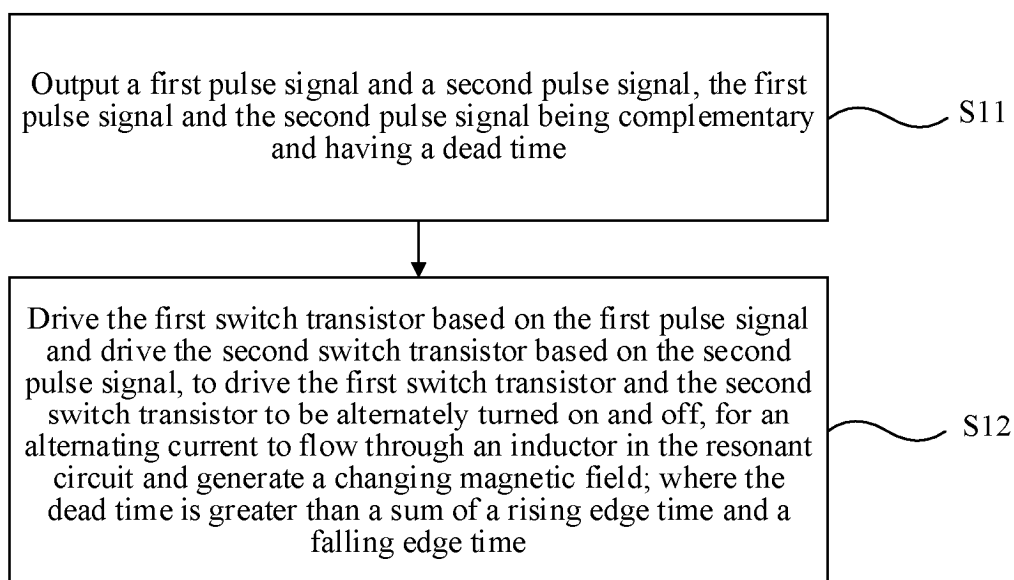


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2025/071509

A. CLASSIFICATION OF SUBJECT MATTER

A24F40/50(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: A24F40/-

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)

DWPI, CNKI, CNABS, WPABS, ENTXT: 电子烟, 气溶胶, 加热, 雾化, 控制, 电磁, 振荡, 谐振, 电路, 死区, 开关, aerosol, LC, oscillator, transistor, circuit, controller, dead w time, switch

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 214431831 U (SHENZHEN FIRST UNION TECHNOLOGY CO., LTD.) 22 October 2021 (2021-10-22) description, paragraphs 0043-0058	1-11
A	CN 114554890 A (PHILIP MORRIS PRODUCTS S.A.) 27 May 2022 (2022-05-27) entire document	1-11
A	CN 107670894 A (CHIPSEA TECHNOLOGIES (SHENZHEN) CORP., LTD.) 09 February 2018 (2018-02-09) entire document	1-11
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A	CN 214127018 U (SHENZHEN FIRST UNION TECHNOLOGY CO., LTD.) 07 September 2021 (2021-09-07) 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
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"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

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Name and mailing address of the ISA/CN

China National Intellectual Property Administration (ISA/
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2025/071509

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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
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