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Lee et al.

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(54) **AEROSOL GENERATING APPARATUS USING INDUCTION HEATING METHOD AND AEROSOL GENERATING METHOD USING INDUCTION HEATING METHOD**

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(30) **Foreign Application Priority Data**

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A24F 40/60	(2020.01)
H05B 6/10	(2006.01)

(52) **U.S. Cl.**
CPC ***A24F 40/465*** (2020.01); ***A24F 40/60*** (2020.01); ***H05B 6/108*** (2013.01)

(58) **Field of Classification Search**
CPC A24F 40/465; A24F 40/60; A24F 40/50; A24F 40/20; H05B 6/108; H05B 6/06;
(Continued)

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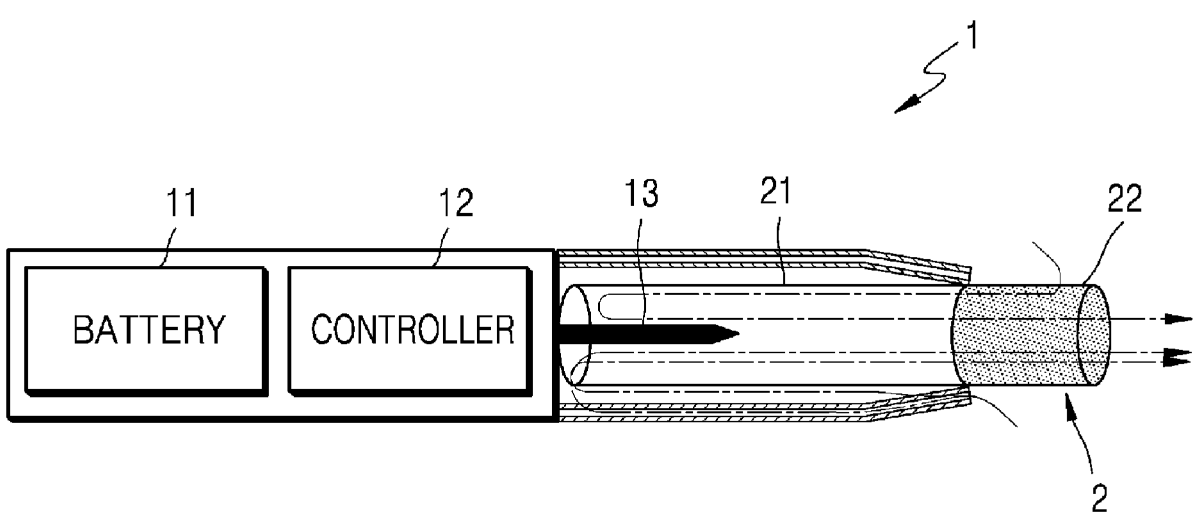
(57) **ABSTRACT**

An embodiment of the present invention includes a plurality of coils which have different numbers of windings and generate an alternating magnetic field when alternating current is applied; a susceptor for generating an aerosol by heating adjacent aerosol-generating substrates using heat generated through the alternating magnetic fields generated from the plurality of coils; and a controller for controlling a predetermined alternating current to be supplied to each of the plurality of coils, wherein the controller controls a first portion and a second portion of the susceptor to be heated differentially by alternating current supplied to the plurality of coils.

8 Claims, 12 Drawing Sheets



(58) **Field of Classification Search**
CPC . H05B 6/40; H05B 6/105; H05B 6/36; A61M 11/042; A61M 2205/0211; A61M 15/06; A61M 2205/3368; A61M 2205/7545; A61M 2205/36; A61M 2205/8206; H03K 17/223
See application file for complete search history.

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FIG. 1

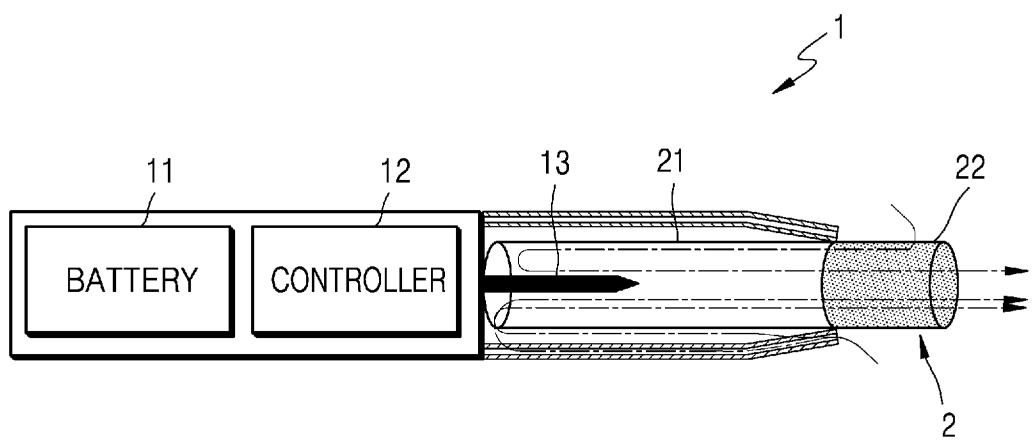


FIG. 2

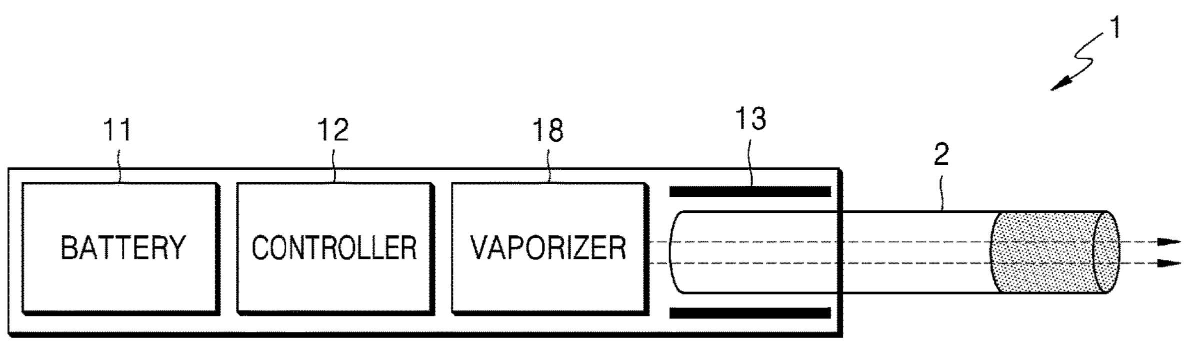


FIG. 3

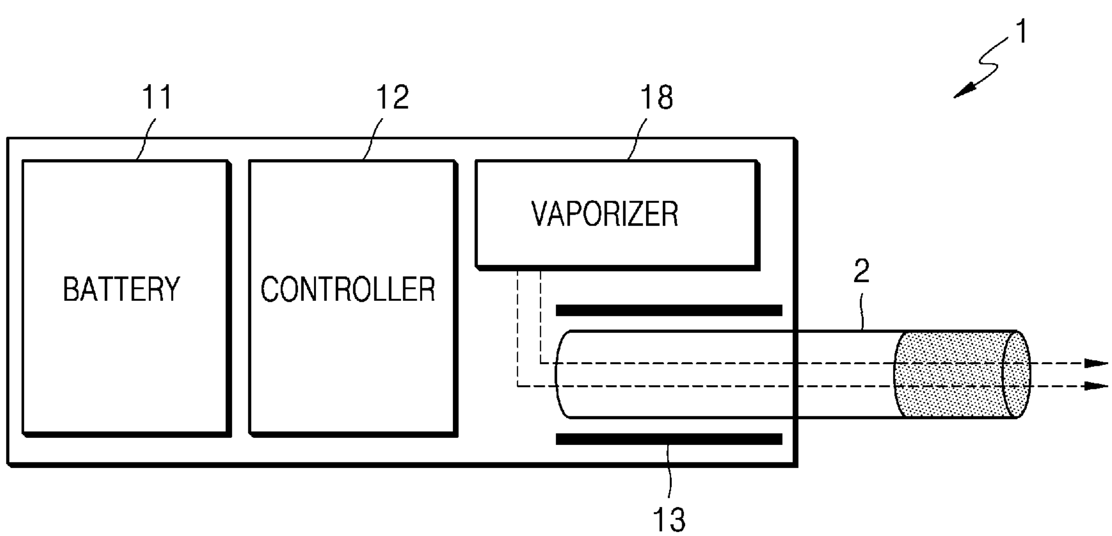


FIG. 4

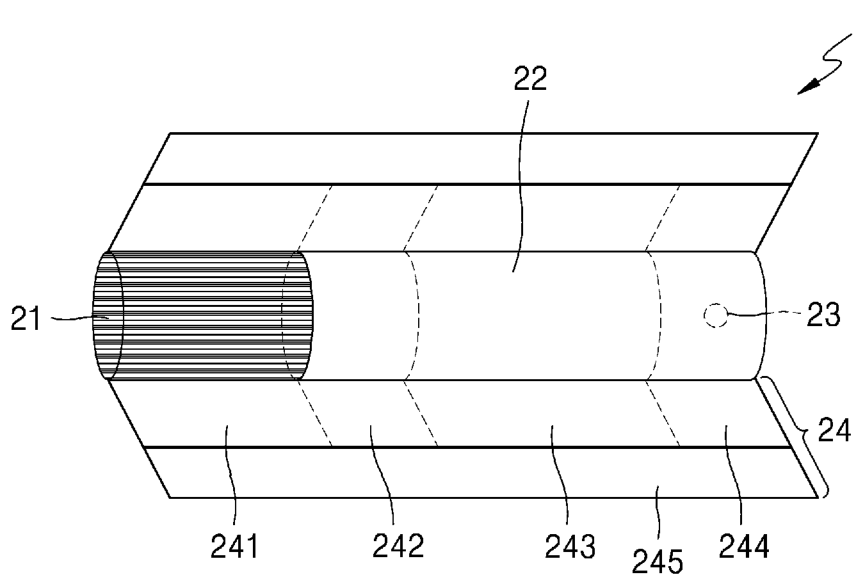


FIG. 5

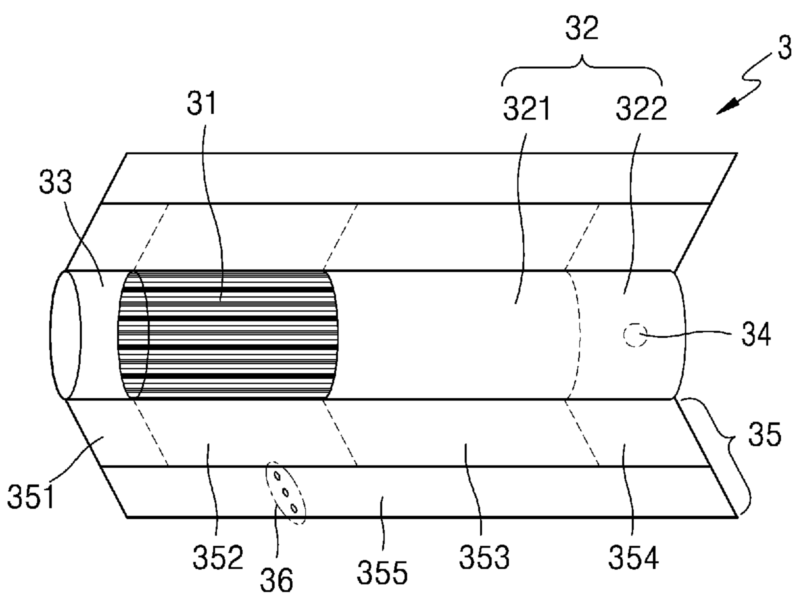


FIG. 6

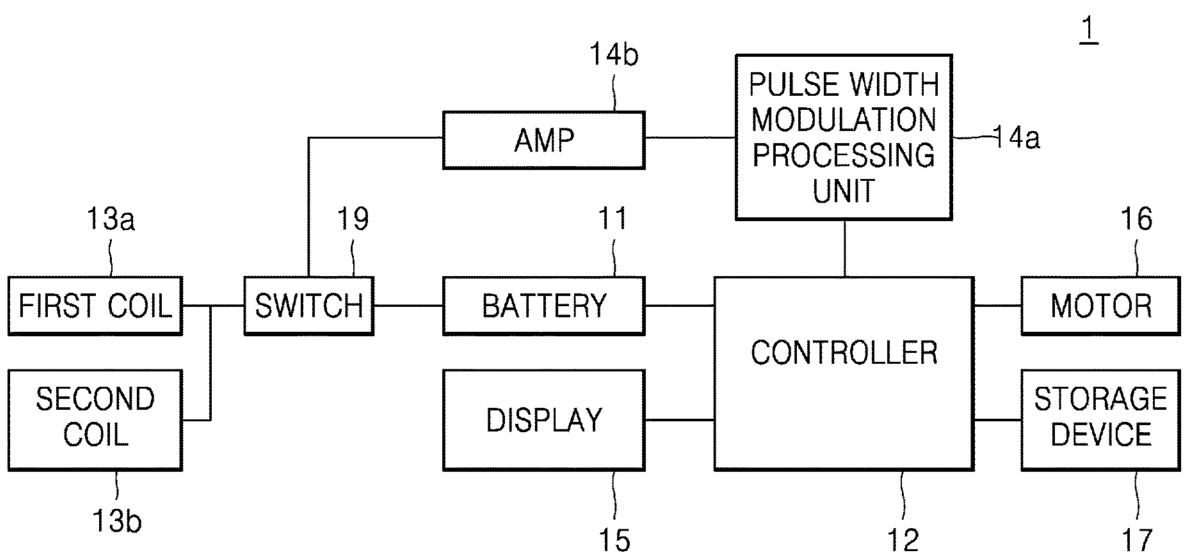

1
14b
AMP
PULSE WIDTH MODULATION PROCESSING UNIT
14a
13a
19
11
16
FIRST COIL
SWITCH
BATTERY
CONTROLLER
MOTOR
SECOND COIL
DISPLAY
STORAGE DEVICE
13b
15
12
17

FIG. 7

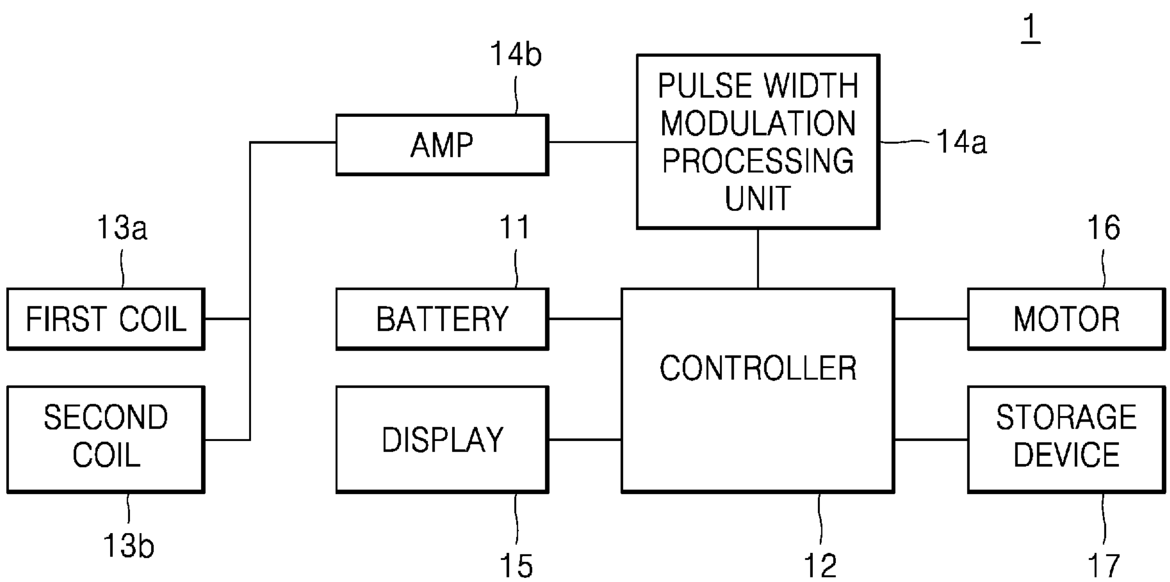

1
14b
AMP
PULSE WIDTH MODULATION PROCESSING UNIT
14a
13a
FIRST COIL
SECOND COIL
13b
11
BATTERY
DISPLAY
15
CONTROLLER
12
16
MOTOR
STORAGE DEVICE
17

FIG. 8

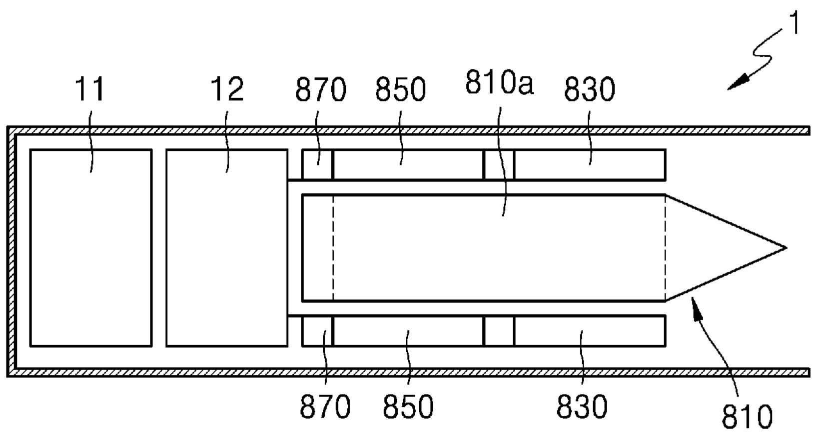


FIG. 9

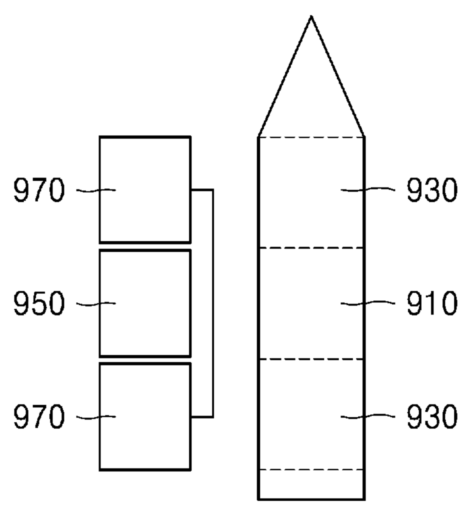


FIG. 10

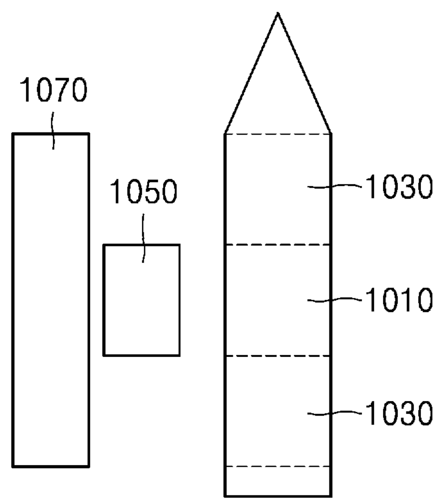


FIG. 11

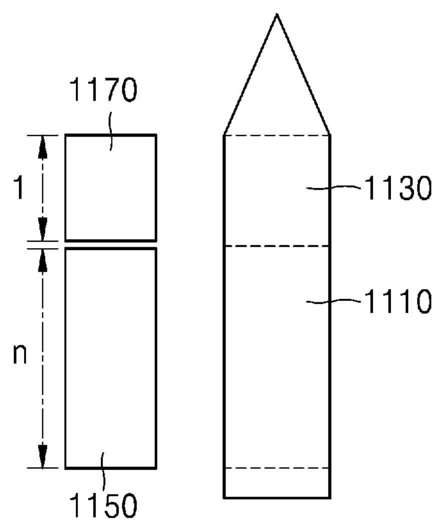
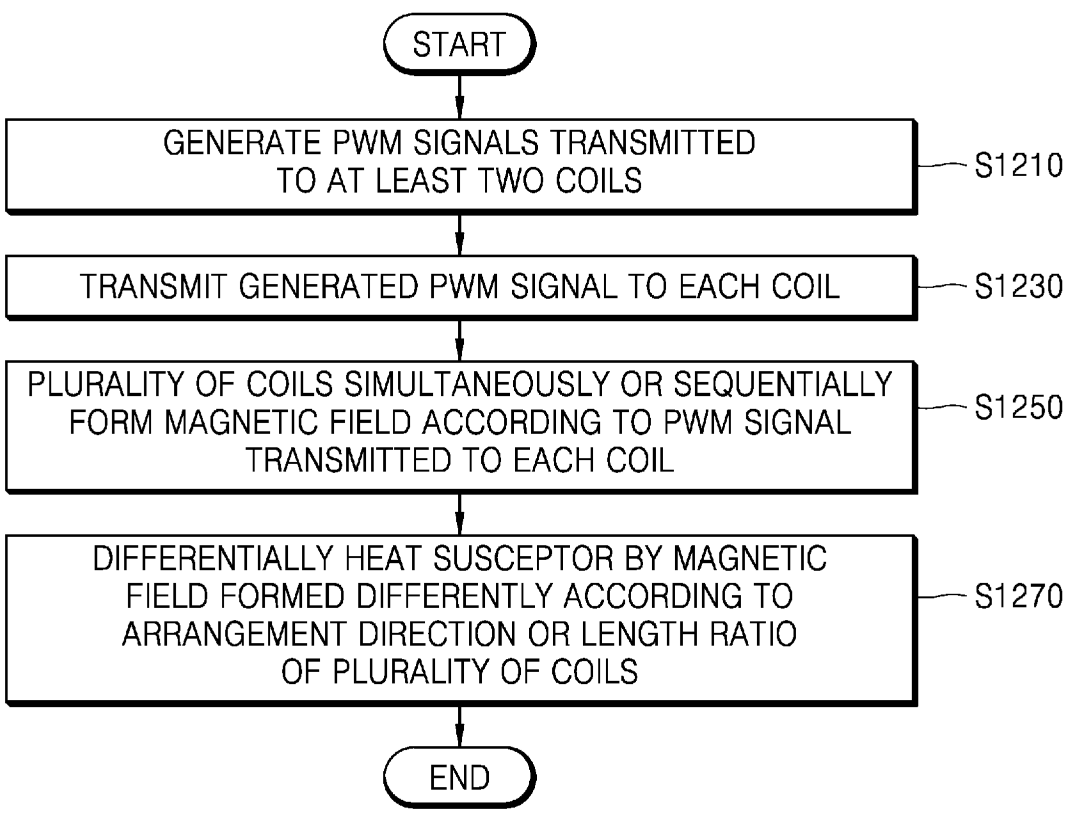


FIG. 12


START
GENERATE PWM SIGNALS TRANSMITTED TO AT LEAST TWO COILS
S1210
TRANSMIT GENERATED PWM SIGNAL TO EACH COIL
S1230
PLURALITY OF COILS SIMULTANEOUSLY OR SEQUENTIALLY FORM MAGNETIC FIELD ACCORDING TO PWM SIGNAL TRANSMITTED TO EACH COIL
S1250
DIFFERENTIALLY HEAT SUSCEPTOR BY MAGNETIC FIELD FORMED DIFFERENTLY ACCORDING TO ARRANGEMENT DIRECTION OR LENGTH RATIO OF PLURALITY OF COILS
S1270
END

AEROSOL GENERATING APPARATUS USING INDUCTION HEATING METHOD AND AEROSOL GENERATING METHOD USING INDUCTION HEATING METHOD

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 17/056,137 filed Nov. 17, 2020, which is a National Stage of International Application No. PCT/KR2019/015594 filed Nov. 15, 2019, claiming priority based on Korean Patent Application No. 10-2018-0156280 filed Dec. 6, 2018.

TECHNICAL FIELD

The present invention relates to an aerosol-generating device using induction heating and a method of generating an aerosol using induction heating, and more particularly, to an aerosol-generating device and a method of generating an aerosol by using a phenomenon in which material constituting a susceptor is heated by an alternating magnetic field generated by alternating current flowing through a coil such as an inductor.

BACKGROUND ART

Recently, the demand for alternative ways of overcoming the disadvantages of traditional cigarettes has increased. For example, there is growing demand for a method of generating aerosol by heating an aerosol generating material in cigarettes, rather than by combusting cigarettes. Accordingly, research into a heating-type cigarette and a heating-type aerosol generator has been actively conducted.

DESCRIPTION OF EMBODIMENTS

Technical Problem

The technical problem to be solved by the present invention is to provide an aerosol-generating device capable of uniformly heating a cigarette containing an aerosol-generating substrate through induction heating and a method of driving the aerosol-generating device.

Solution to Problem

A device according to an embodiment of the present invention for solving the above technical problem, may include a plurality of coils which have different numbers of windings and generate an alternating magnetic field when alternating current is applied; a susceptor for generating an aerosol by heating adjacent aerosol-generating substrates using heat generated through the alternating magnetic fields generated from the plurality of coils; and a controller for controlling a predetermined alternating current to be supplied to each of the plurality of coils, wherein the controller controls a first portion and a second portion of the susceptor to be heated differentially by alternating current supplied to the plurality of coils.

A method according to an embodiment of the present invention for solving the above technical problem, may include generating alternating magnetic fields by a controller controlling alternating current to be supplied to a plurality of coils having different winding numbers; and a susceptor being inductively heated by the alternating magnetic field

and heating an adjacent aerosol-generating substrate, wherein the heating of an adjacent aerosol-generating substrate may include differentially heating a first portion and a second portion of the susceptor by alternating current supplied to the plurality of coils.

Advantageous Effects of Disclosure

According to the present invention, when a user smokes using an aerosol-generating device operating according to an induction heating method, it is possible to provide a consistent feeling of smoking to the user.

BRIEF DESCRIPTION OF DRAWINGS

FIGS. **1** through **3** are diagrams showing examples in which a cigarette is inserted into an aerosol-generating device.

FIGS. **4** and **5** are diagrams showing examples of cigarettes.

FIG. **6** is a diagram schematically showing a block diagram of an example of an aerosol-generating device according to the present invention.

FIG. **7** is a block diagram of another example of an aerosol-generating device according to the present invention.

FIG. **8** is a diagram schematically showing a configuration of an aerosol-generating device according to an embodiment of the present invention.

FIG. **9** is a diagram schematically showing an example of a plurality of coils and a susceptor included in the induction-heating aerosol-generating device described in FIG. **8**.

FIG. **10** is a diagram schematically showing another example of a plurality of coils and a susceptor included in the induction-heating aerosol-generating device described in FIG. **8**.

FIG. **11** is a diagram schematically showing another example of a plurality of coils and a susceptor included in the induction-heating aerosol-generating device described in FIG. **8**.

FIG. **12** is a flowchart illustrating an example of a method of generating an aerosol using induction heating according to the present invention.

BEST MODE

A device according to an embodiment of the present invention for solving the above technical problem, may include a plurality of coils which have different numbers of windings and generate alternating magnetic fields when an alternating current is applied; a susceptor configured to generate an aerosol by heating adjacent aerosol-generating substrates using heat generated through the alternating magnetic fields generated from the plurality of coils; and a controller configured to control a predetermined alternating current to be supplied to the plurality of coils, such that a first portion and a second portion of the susceptor are heated differentially by the predetermined alternating current.

In the device, the susceptor may further include a third portion in addition to the first portion and the second portion, the first portion, the second portion, and the third portion are continuously connected, and the plurality of coils are arranged so that the first portion and the third portion are differentially heated from the second portion.

In the device, the first portion and the third portion are heated by an alternating magnetic field generated from a first coil having a predetermined interval with zero windings, and the second portion is heated by an alternating magnetic field generated from a second coil arranged in the interval.

In the device, the controller stops supplying the alternating current to the first coil when a predetermined time has elapsed after controlling so that the alternating current is supplied to the first coil and the second coil.

In the device, at least two of the plurality of coils are arranged to overlap in a specific direction from the first portion so that the first portion is heated according to alternating magnetic fields generated by the two coils.

In the device, the plurality of coils include a first coil and a second coil, and a ratio of a length of the second coil to a length of the first coil is equal to or less than a preset value.

In the device, the controller controls alternating current to be supplied to the plurality of coils at different time points through a field-effect transistor (FET).

A method according to an embodiment of the present invention for solving the above technical problem, may include generating alternating magnetic fields by a controller controlling an alternating current to be supplied to a plurality of coils having different winding numbers; and heating an adjacent aerosol-generating substrate by a susceptor that is inductively heated by the alternating magnetic fields, wherein the heating of the adjacent aerosol-generating substrate includes differentially heating a first portion and a second portion of the susceptor by the alternating current supplied to the plurality of coils.

In the method, the susceptor may further include a third portion in addition to the first portion and the second portion, the first portion, the second portion and the third portion are continuously connected, and the heating of an adjacent aerosol-generating substrate may include the plurality of coils heating the first portion and the third portion differentially from the second portion.

In the method, the heating of an adjacent aerosol-generating substrate may include heating the first portion and the third portion based on the alternating current being supplied to a first coil having a predetermined interval with zero windings; and heating the second portion based on the alternating current being supplied to a second coil arranged in the interval.

The method may further include stopping supply of alternating current to the first coil when a predetermined time has elapsed after the alternating current is supplied to the first coil and the second coil.

In the method, the heating of an adjacent aerosol-generating substrate may include heating the first portion according to alternating magnetic fields generated by the plurality of coils arranged to overlap in a specific direction from the first portion.

In the method, the plurality of coils may include a first coil and a second coil, and a ratio of a length of the second coil to a length of the first coil is equal to or less than a preset value.

In the method, the generating of alternating magnetic fields may include supplying alternating current to the plurality of coils at different time points through a field-effect transistor (FET).

MODE OF DISCLOSURE

With respect to the terms used to describe the various embodiments, general terms which are currently and widely used are selected in consideration of functions of structural elements in the various embodiments of the present disclosure. However, meanings of the terms can be changed according to intention, a judicial precedence, the appearance of new technology, and the like. Also, specified terms may be selected by the applicant, and in this case, the detailed meaning thereof will be described in the detailed description of the disclosure. Thus, the terms used in the present disclosure should be understood not as simple names but based on the meaning of the terms and the overall description of the present disclosure.

In addition, unless explicitly described to the contrary, the word "comprise" and variations such as "comprises" or "comprising" will be understood to imply the inclusion of stated elements but not the exclusion of any other elements. In addition, the terms "-er", "-or", and "module" described in the specification mean units for processing at least one function and/or operation and can be implemented by hardware components or software components and combinations thereof.

The attached drawings for illustrating one or more embodiments are referred to in order to gain a sufficient understanding, the merits thereof, and the objectives accomplished by the implementation. However, the embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein.

Hereinafter, embodiments of the present disclosure will be described in detail with reference to the drawings.

FIGS. **1** through **3** are diagrams showing examples in which a cigarette is inserted into an aerosol-generating device.

Referring to FIG. **1**, an aerosol generator **1** includes a battery **11**, a controller **12**, and a heater **13**. Referring to FIG. **2** and FIG. **3**, the aerosol generator **1** further includes a vaporizer **18**. Also, a cigarette **2** may be inserted into an inner space of the aerosol generator **1**.

The elements related to the embodiment are illustrated in the aerosol generator **1** of FIGS. **1** to **3**. Therefore, one of ordinary skill in the art would appreciate that other universal elements than the elements shown in FIGS. **1** to **3** may be further included in the aerosol generator **1**.

Also, FIGS. **2** and **3** show that the aerosol generator **1** includes the heater **13**, but if necessary, the heater **13** may be omitted.

In FIG. **1**, the battery **11**, the controller **12**, and the heater **13** are arranged in a row. Also, FIG. **2** shows that the battery **11**, the controller **12**, the vaporizer **18**, and the heater **13** are arranged in a row. Also, FIG. **3** shows that the vaporizer **18** and the heater **13** are arranged in parallel with each other. However, an internal structure of the aerosol generator **1** is not limited to the examples shown in FIGS. **1** to **3**. That is, according to a design of the aerosol generator **1**, arrangement of the battery **11**, the controller **12**, the heater **13**, and the vaporizer **18** may be changed.

When the cigarette **2** is inserted into the aerosol generator **1**, the aerosol generator **1** operates the heater **13** and/or the vaporizer **18** to generate aerosol from the cigarette **2** and/or the vaporizer **18**. The aerosol generated by the heater **13** and/or the vaporizer **18** may be transferred to a user via the cigarette **2**.

If necessary, even when the cigarette **2** is not inserted in the aerosol generator **1**, the aerosol generator **1** may heat the heater **13**.

The battery **11** supplies the electric power used to operate the aerosol generator **1**. For example, the battery **11** may supply power for heating the heater **13** or the vaporizer **18** and supply power for operating the controller **12**. In addition, the battery **11** may supply power for operating a display, a sensor, a motor, and the like installed in the aerosol generator **1**.

The controller **12** controls the overall operation of the aerosol generator **1**. In detail, the controller **12** may control operations of other elements included in the aerosol generator **1**, as well as the battery **11**, the heater **13**, and the vaporizer **18**. Also, the controller **12** may check the status of each component in the aerosol generator **1** to determine whether the aerosol generator **1** is in an operable state.

The controller **12** includes at least one processor. A processor can be implemented as an array of a plurality of logic gates or can be implemented as a combination of a general-purpose microprocessor and a memory in which a program executable in the microprocessor is stored. It will be understood by one of ordinary skill in the art that the present disclosure may be implemented in other forms of hardware.

The heater **13** may be heated by the electric power supplied from the battery **11**. For example, when the cigarette is inserted in the aerosol generator **1**, the heater **13** may be located outside the cigarette. Therefore, the heated heater **13** may raise the temperature of an aerosol generating material in the cigarette.

The heater **13** may be an electro-resistive heater. For example, the heater **13** includes an electrically conductive track, and the heater **13** may be heated as a current flows through the electrically conductive track. However, the heater **13** is not limited to the above example, and any type of heater may be used provided that the heater is heated to a desired temperature. Here, the desired temperature may be set in advance on the aerosol generator **1**, or may be set by a user.

In addition, in another example, the heater **13** may include an induction heating type heater. In detail, the heater **13** may include an electrically conductive coil for heating the cigarette in an induction heating method, and the cigarette may include a susceptor that may be heated by the induction heating type heater.

For example, the heater **13** may include a tubular type heating element, a plate type heating element, a needle type heating element, or a rod type heating element, and may heat the inside or outside of the cigarette **2** according to the shape of the heating element.

Also, there may be a plurality of heaters **13** in the aerosol generator **1**. Here, the plurality of heaters **13** may be arranged to be inserted into the cigarette **2** or on the outside of the cigarette **2**. Also, some of the plurality of heaters **13** may be arranged to be inserted into the cigarette **2** and the other may be arranged on the outside of the cigarette **2**. In addition, the shape of the heater **13** is not limited to the example shown in FIGS. **1** to **3**, but may be manufactured in various shapes.

The vaporizer **18** may generate aerosol by heating a liquid composition and the generated aerosol may be delivered to the user after passing through the cigarette **2**. In other words, the aerosol generated by the vaporizer **18** may move along an air flow passage of the aerosol generator **1**, and the air flow passage may be configured for the aerosol generated by the vaporizer **18** to be delivered to the user through the cigarette.

For example, the vaporizer **18** may include a liquid storage unit, a liquid delivering unit, and a heating element, but is not limited thereto. For example, the liquid storage unit, the liquid delivering unit, and the heating element may be included in the aerosol generator **1** as independent modules.

The liquid storage may store a liquid composition. For example, the liquid composition may be a liquid including a tobacco containing material including a volatile tobacco flavor component, or a liquid including a non-tobacco material. The liquid storage unit may be detachable from the vaporizer **18** or may be integrally manufactured with the vaporizer **18**.

For example, the liquid composition may include water, solvents, ethanol, plant extracts, flavorings, flavoring agents, or vitamin mixtures. The flavoring may include, but is not limited to, menthol, peppermint, spearmint oil, various fruit flavoring ingredients, etc. The flavoring agent may include components that may provide the user with various flavors or tastes. Vitamin mixtures may be a mixture of at least one of vitamin A, vitamin B, vitamin C, and vitamin E, but are not limited thereto. Also, the liquid composition may include an aerosol former such as glycerin and propylene glycol.

The liquid delivery element may deliver the liquid composition of the liquid storage to the heating element. For example, the liquid delivery element may be a wick such as cotton fiber, ceramic fiber, glass fiber, or porous ceramic, but is not limited thereto.

The heating element is an element for heating the liquid composition delivered by the liquid delivering unit. For example, the heating element may be a metal heating wire, a metal hot plate, a ceramic heater, or the like, but is not limited thereto. In addition, the heating element may include a conductive filament such as nichrome wire and may be positioned as being wound around the liquid delivery element. The heating element may be heated by a current supply and may transfer heat to the liquid composition in contact with the heating element, thereby heating the liquid composition. As a result, aerosol may be generated.

For example, the vaporizer **18** may be referred to as a cartomizer or an atomizer, but is not limited thereto.

In addition, the aerosol generator **1** may further include universal elements, in addition to the battery **11**, the controller **12**, the heater **13**, and the vaporizer **18**. For example, the aerosol generator **1** may include a display capable of outputting visual information and/or a motor for outputting tactile information. In addition, the aerosol generator **1** may include at least one sensor (a puff sensor, a temperature sensor, a cigarette insertion sensor, etc.) Also, the aerosol generator **1** may be manufactured to have a structure, in which external air may be introduced or internal air may be discharged even in a state where the cigarette **2** is inserted.

Although not shown in FIGS. **1** to **3**, the aerosol generator **1** may configure a system with an additional cradle. For example, the cradle may be used to charge the battery **11** of the aerosol generator **1**. Alternatively, the heater **13** may be heated in a state in which the cradle and the aerosol generator **1** are coupled to each other.

The cigarette **2** may be similar to a typical burning cigarette. For example, the cigarette **2** may include a first portion containing an aerosol generating material and a second portion including a filter and the like. The second portion of the cigarette **2** may also include the aerosol generating material. For example, an aerosol generating material made in the form of granules or capsules may be inserted into the second portion.

The entire first portion may be inserted into the aerosol generator **1** and the second portion may be exposed to the outside. Alternatively, only a portion of the first portion may be inserted into the aerosol generator **1** or the entire first portion and a portion of the second portion may be inserted into the aerosol generator **1**. The user may puff aerosol while holding the second portion by the mouth of the user. At this time, the aerosol is generated by as the outside air passes through the first portion, and the generated aerosol passes through the second portion and is delivered to a user's mouth.

For example, the outside air may be introduced through at least one air passage formed in the aerosol generator **1**. For example, the opening and closing of the air passage formed in the aerosol generator **1** and/or the size of the air passage may be adjusted by a user. Accordingly, the amount and quality of the aerosol may be adjusted by the user. In another example, the outside air may be introduced into the cigarette **2** through at least one hole formed in a surface of the cigarette **2**.

Hereinafter, an example of the cigarette **2** will be described with reference to FIGS. **4** and **5**.

FIGS. **4** and **5** illustrate an example of a cigarette.

Referring to FIG. **4**, the cigarette **2** includes a tobacco rod **21** and a filter rod **22**. The first portion described above with reference to FIGS. **1** to **3** includes the tobacco rod **21** and the second portion includes the filter rod **22**.

In FIG. **4**, the filter rod **22** is shown as a single segment, but is not limited thereto. In other words, the filter rod **22** may include a plurality of segments. For example, the filter rod **22** may include a first segment for cooling down the aerosol and a second segment for filtering a predetermined component included in the aerosol. Also, if necessary, the filter rod **22** may further include at least one segment performing another function.

The cigarette **2** may be packaged by at least one wrapper **24**. The wrapper **24** may include at least one hole through which the outside air is introduced or inside air is discharged. For example, the cigarette **2** may be packaged by one wrapper **24**. In another example, the cigarette **2** may be packaged by two or more wrappers **24**. For example, the tobacco rod **21** may be packaged by a first wrapper **241**, and the filter rod **22** may be packaged by wrappers **242** to **244**. And the entire cigarette **2** may be packaged by another wrapper **245**. When the filter rod **22** includes a plurality of segments, each segment may be packaged by separate wrappers **242**, **243**, and **244**.

The tobacco rod **21** includes an aerosol generating material. For example, the aerosol generating material may include at least one of glycerin, propylene glycol, ethylene glycol, dipropylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, and oleyl alcohol, but it is not limited thereto. In addition, the tobacco rod **21** may include other additive materials like a flavoring agent, a wetting agent, and/or an organic acid. Also, a flavoring liquid such as menthol, humectant, etc. may be added to the tobacco rod **21** by being sprayed to the tobacco rod **21**.

The tobacco rod **21** may be manufactured variously. For example, the tobacco rod **21** may be fabricated as a sheet or a strand. Also, the tobacco rod **21** may be fabricated by tobacco leaves that are obtained by fine-cutting a tobacco sheet. Also, the tobacco rod **21** may be surrounded by a heat conducting material. For example, the heat-conducting material may be, but is not limited to, a metal foil such as aluminum foil. For example, the heat conducting material surrounding the tobacco rod **21** may improve a thermal conductivity applied to the tobacco rod by evenly dispersing the heat transferred to the tobacco rod **21**, and thereby improving tobacco taste. Also, the heat conducting material surrounding the tobacco rod **21** may function as a susceptor that is heated by an inducting heating type heater. Although not shown in the drawings, the tobacco rod **21** may further include a susceptor, in addition to the heat conducting material surrounding the outside thereof.

The filter rod **22** may be a cellulose acetate filter. In addition, the filter rod **22** is not limited to a particular shape. For example, the filter rod **22** may be a cylinder type rod or a tube type rod including a cavity therein. Also, the filter rod **22** may be a recess type rod. When the filter rod **22** includes a plurality of segments, at least one of the plurality of segments may have a different shape from the others.

Also, the filter rod **22** may include at least one capsule **23**. Here, the capsule **23** may generate flavor or may generate aerosol. For example, the capsule **23** may have a structure, in which a liquid containing a flavoring material is wrapped with a film. The capsule **23** may have a circular or cylindrical shape, but is not limited thereto.

Referring to FIG. **5**, the cigarette **3** may further include a front-end filter **33**. The front-end plug **33** may be located on a side of the tobacco rod **31** which is not facing the filter rod **32**. The front-end plug **33** may prevent the tobacco rod **31** from being detached and may prevent a liquefied aerosol from flowing from the tobacco rod **31** into an aerosol generating device (**1** of FIGS. **1** to **3**) during smoking.

The filter rod **32** may include a first segment **321** and a second segment **322**. Here, the first segment **321** may correspond to the first segment of the filter rod **22** of FIG. **4**, and the second segment **322** may correspond to the third segment of the filter rod **22** of FIG. **4**.

The diameter and the total length of the cigarette **3** may correspond to the diameter and the total length of the cigarette **2** of FIG. **4**.

The cigarette **3** may be wrapped by at least one wrapper **35**. At least one hole through which outside air flows in or inside gas flows out may be formed in the wrapper **35**. For example, the front-end plug **33** may be wrapped by a first wrapper **351**, the tobacco rod **31** may be wrapped by a second wrapper **352**, the first segment **321** may be wrapped by a third wrapper **353**, and the second segment **322** may be wrapped by a fourth wrapper **354**. Also, the entire cigarette **3** may be re-wrapped by a fifth wrapper **355**.

Also, at least one perforation **36** may be formed in the fifth wrapper **355**. For example, the perforation **36** may be formed in a region surrounding the tobacco rod **31**, but is not limited thereto. The perforation **36** may serve to transfer heat generated by the heater **13** shown in FIGS. **2** and **3** into the tobacco rod **31**.

Also, the second segment **322** may include at least one capsule **34**. Here, the capsule **34** may serve to generate a flavor or an aerosol. For example, the capsule **34** may have a structure in which a liquid containing perfume is wrapped in a film. The capsule **34** may have a spherical or cylindrical shape, but is not limited thereto.

FIG. **6** is a diagram schematically showing a block diagram of an example of an aerosol-generating device according to the present invention.

Referring to FIG. **6**, the aerosol-generating device **1** according to the present invention includes a battery **11**, a controller **12**, a first coil **13**a, a second coil **13**b, a pulse width modulation processing unit **14**a, an AMP **14**b, a display **15**, a motor **16**, a storage device **17**, and a vaporizer **18**. Hereinafter, for convenience of description, the general function of each component included in the aerosol-generating device **1** will be first described, and then an operation of the controller **12** according to the embodiment will be described in detail.

The battery **11** supplies power to the first coil **13**a and the second coil **13**b, and an amount of power supplied to the first coil **13**a and the second coil **13**b may be adjusted by a control signal generated by the controller **12**. Depending on an embodiment, a regulator that maintains a constant voltage of the battery may be included between the battery **11** and the controller **12**.

The controller **12** controls overall operations of the battery **11**, the first coil **13***a*, the second coil **13***b*, the pulse width modulation processing unit **14***a*, the display **15**, the motor **16**, the storage device **17** and the vaporizer **18** which are included in the aerosol-generating device **1**. Although not shown in FIG. **6**, depending on an embodiment, the controller **12** may further include an input receiving unit (not shown) that receives a user's button input or touch input, and a communication unit (not shown) capable of communicating with an external communication device such as a user terminal. In addition, although not shown in FIG. **6**, the controller **12** may further include a module for performing proportional integral differential control (PID) on the first coil **13***a* and the second coil **13***b*.

When an AC current is supplied to the first coil **13***a* and the second coil **13***b*, an alternating magnetic field is generated. A direction and intensity of the alternating magnetic field generated by the first coil **13***a* and the second coil **13***b* may vary depending on a direction of the alternating current supplied to the first coil **13***a* and the second coil **13***b* and the number of windings of the first coil **13***a* and the second coil **13***b*. When alternating current is supplied to the first coil **13***a* and the second coil **13***b* to generate an alternating magnetic field, a susceptor material located around the first coil **13***a* and the second coil **13***b* is affected by the alternating magnetic field, and the susceptor is heated. This induction heating phenomenon is a well-known phenomenon and may be explained by Faraday's Law of induction and Ohm's Law. According to the induction heating phenomenon means a phenomenon, a changing electric field is generated in a conductor when a magnetic induction in the conductor changes.

As described above, in the present invention, the electric field is generated in the conductor, so that an eddy current flows in the conductor according to Ohm's law. The eddy current generates heat proportional to the current density and resistance of the conductor. The susceptor that generates heat by the alternating magnetic field may heat an aerosol-generating substrate to generate an aerosol when a cigarette containing the aerosol-generating substrate contacts the susceptor.

The pulse width modulation processing unit **14***a* allows the controller **12** to control the power supplied to the first coil **13***a* and the second coil **13***b* by transmitting PWM (Pulse Width Modulation) signals to the first coil **13***a* and the second coil **13***b*. Depending on an embodiment, the pulse width modulation processing unit **14***a* may be implemented to be included in the controller **12**, and the PWM signal output from the pulse width modulation processing unit **14***a* may be a digital PWM signal. In addition, the PWM control signal transmitted from the pulse width modulation processing unit **14***a* may be amplified according to a preset amplification factor by the AMP **14***b*.

The display **15** visually outputs various alarm messages generated by the aerosol-generating device **1** so that a user using the aerosol-generating device **1** may check the alarm messages. The user may check the battery power shortage message or the susceptor overheat warning message output to the display **15**, and then may stop the operation of the aerosol-generating device **1** or take appropriate measures before the aerosol-generating device **1** is broken.

The motor **16** is driven by the controller **12** so that the user may recognize that the aerosol-generating device **1** is ready for use through tactile sense.

The storage device **17** stores various pieces of information to provide a consistent flavor to the user who uses the aerosol-generating device **1** while appropriately controlling a power supplied to the first coil **13***a* and the second coil **13***b* by the controller **12**. The storage device **17** may not only be configured as a non-volatile memory, such as a flash memory, but also may be configured as a volatile memory that temporarily stores data only when power is supplied in order to secure a faster data input/output (I/O) speed.

The vaporizer **18** may generate an aerosol by heating a liquid composition, and the generated aerosol may be delivered to the user through a cigarette **2**. As described in FIGS. **2** and **3**, the vaporizer **18** may include a liquid storage, a liquid delivery element, and a heating element. In particular, the vaporizer **18** may include a heating element for heating the liquid composition stored in the liquid storage. And the liquid storage may be manufactured to be detachable from the vaporizer **18**, or may be manufactured integrally with the vaporizer **18** as a single body.

The switch **19** sequentially transmits an amplification control signal output from the AMP **14***b* to the first coil **13***a* and the second coil **13***b*. The controller **12** may control opening and closing of the switch **19** so that the PWM signal may be transmitted to one of the first coil **13***a* and the second coil **13***b*. The switch **19** may be opened or closed in accordance with the PWM signal, or may be periodically opened or closed with a built-in timer. The switch **19** may be replaced with a field-effect transistor (FET), depending on the embodiment.

FIG. **7** is a block diagram of another example of an aerosol-generating device according to the present invention.

In FIG. **7**, descriptions of components overlapping with FIG. **6** will be omitted.

The PWM control signal output from the pulse width modulation processing unit **14***a* is transmitted to the first coil **13***a* and the second coil **13***b* via the AMP **14***b*. Unlike the FIG. **6**, the aerosol-generating device shown in FIG. **7** is not provided with a switch **19** for selectively transmitting a PWM signal to the first coil **13***a* or the second coil **13***b*. The controller **12** generates a control signal for the first coil **13***a* and a control signal for the second coil **13***b* separately, so that the PWM signal may be transmitted to the first coil **13***a* or the second coil **13***b* through the pulse width modulation processing unit **14***a*. Although not shown in FIGS. **6** and **7**, a configuration for performing impedance matching may be added to the receiving terminals of the first coil **13***a* and the second coil **13***b* in order to maximize power supply.

The controller **12**, the pulse width modulation processing unit **14***a*, the display **15**, the storage device **17** and the vaporizer **18** in FIGS. **6** and **7** may correspond to at least one processor or may include at least one processor. Accordingly, the controller **12**, the pulse width modulation processing unit **14***a*, the display **15**, the storage device **17** and the vaporizer **18** may be driven in a form included in other hardware device such as a microprocessor or general purpose computer system.

In addition, the first coil **13***a* or the second coil **13***b* illustrated in FIGS. **6** and **7** is a simple representation of a plurality of coils. Depending on an embodiment, the number of coils included in the aerosol-generating device **1** may be more than two, and the plurality of coils may have different inductances or different number of windings per unit length.

FIG. **8** is a diagram schematically showing a configuration of an aerosol-generating device according to an embodiment of the present invention.

Referring to FIG. **8**, the aerosol-generating device **1** according to an embodiment of the present invention may include a battery **11**, a controller **12**, a susceptor **810**, a first coil **830**, a second coil **850**, and a bobbin **870**. It is assumed that components other than those described above are omitted for convenience of description. The battery **11** and the controller **12** perform the same functions as those described with reference to FIGS. **1** to **7**

The susceptor **810** is made of a material that is heated by the alternating magnetic field that is generated when the alternating current is applied to the first coil **830** and the second coil **850**. The susceptor **810** refers to a material capable of converting electromagnetic energy into heat, and an eddy current induced in the susceptor **810** by an alternating magnetic field heats the susceptor **810**. Here, the magnetic hysteresis loss inside the susceptor **810** additionally heats the susceptor **810**. Also, when the susceptor **810** in inserted in a cigarette including an aerosol-generating substrate, as the aerosol-generating substrate of the cigarette directly or indirectly contacts the heated susceptor **810**, the aerosol-generating substrate may be heated to generate an aerosol.

The susceptor **810** of FIG. **8** may consist of a susceptor heating unit **810*a*** and the remaining portion. The susceptor heating unit **810*a*** refers to a portion heated by the magnetic fields of the first coil **830** and the second coil **850**, and may contain a susceptor material such as iron or aluminum. The remaining portion of the susceptor **810** other than the susceptor heating unit **810*a*** may contact certain portions of the cigarette which do not include a filter or an aerosol generating-substrate. If a portion other than the susceptor heating unit **810*a*** is heated, the filter of the cigarette may be melted or hot aerosol may be generated, thereby providing an unpleasant smoking sensation to the user. For this reasons, the remaining portion of the susceptor **810** other than the susceptor heating unit **810*a*** does not contain a susceptor material.

The first coil **830** and the second coil **850** are supplied with alternating current under control of the controller **12** to generate an alternating magnetic field, and the magnetic field generated around the first coil **830** and the second coil **850** causes the susceptor heating unit **810*a*** of the susceptor **810** to be heated. The principle of heating the susceptor heating unit **810*a*** has been described above and is therefore omitted here. In addition to different physical properties of the first coil **830** and the second coil **850**, the first coil **830** and the second coil **850** may be supplied with alternating currents of different magnitudes from the controller **12**. As such, according to the present invention, the heating state of the susceptor heating unit **810*a*** may be effectively controlled, and the taste of the cigarette provided to the user may be optimized. According to the present invention, by supplying a time-varying alternative current determined by experimentally or empirically accumulated data to the first coil **830** and the second coil **850**, the susceptor **810** may be heated by induction heating, thereby generating aerosols.

The bobbin **870** serves as a bobbin for winding the first coil **830** and the second coil **850** smoothly.

According to the prior art, a plurality of susceptors which are made of materials having different Curie temperatures are used. If a single susceptor is used, it is difficult to uniformly heat the aerosol-generating substrate by the single coil, and thus there is a problem in that the aerosol-generating substrate is burned or the temperature control of the susceptor is not easy. However, as described in FIG. **8**, according to the present invention, it is possible to uniformly heat the aerosol-generating substrate by heating a susceptor made of a single material with a plurality of coils according to induction heating, thereby providing a high quality of smoking experience to a user.

FIG. **9** is a diagram schematically showing an example of a plurality of coils and a susceptor included in the induction-heating aerosol-generating device described in FIG. **8**.

For convenience of description, FIG. **9** only shows a plurality of coils generating an alternating magnetic field and a susceptor heating unit **810*a*** heated by the plurality of coils, which are shown in FIG. **8**. It is assumed that other omitted components are the same as those shown in FIG. **8**. In addition, hereinafter, description will be made with reference to FIG. **8**. The first coil **950** and the second coil **970** receive alternating current from the controller **12** to form an alternating magnetic field.

First, the susceptor heating portion **810*a*** includes a first heating portion **910** heated by the first coil **950** and a second heating portion **930** heated by the second coil **970**. The first heating portion **910** is heated under the influence of the alternating magnetic field when an alternating magnetic field is formed by alternating current supplied to the first coil **950**. The first heating portion **910** may be mainly heated under influence of the alternating magnetic field formed by the first coil **950**, but may also be heated under some influence by the expansion of the alternating magnetic field formed by the second coil **970**.

The second heating portion **930** is heated under the influence of the alternating magnetic field when an alternating magnetic field is formed by alternating current supplied to the second coil **970**. The second heating portion **930** may be mainly heated under the influence of the alternating magnetic field formed by the second coil **970**, but may also be heated under some influence by the expansion of the alternating magnetic field formed by the first coil **950**. The second heating portion **930** is positioned on both sides of the first heating portion **910**, and the susceptor heating portion **810*a*** has a configuration in which the second heating portion **930**, the first heating portion **910**, and the second heating portion **930** are continuously connected. Here, the direction of the sides or the top and bottom with respect to the first heating portion **910** may vary depending on the orientation of the aerosol-generating device **1** including the susceptor **810**.

As the first heating portion **910** and the second heating portion **930** are affected by the alternating magnetic field formed by the first coil **950** and the second coil **970**, respectively, the temperature of the first heating portion **910** and the second heating portion **930** rises, and the first heating portion **910** and the second heating portion **930** are differentially heated. According to the present invention, by controlling the physical properties of the first coil **950** and the second coil **970** or the amount of alternating current flowing through the first coil **950** and the second coil **970**, the first heating portion **910** and the second heating portion **930** may be heated differentially. As the aerosol-generating substrate is heated by using the above characteristics, the aerosol-generating substrate contacting the first heating portion **910** and the second heating portion **930** may be uniformly heated to generate aerosols of a consistent quality.

The first coil **950** and the second coil **970** receive alternating current under control of the controller **12** to form an alternating magnetic field. As described above, the first coil **950** effectively raises the temperature of the first heating portion **930**, and the second coil **950** effectively raises the temperature of the second heating portion **930**.

The second coil **970** is a coil having a specific number of windings, and does not have the same number of windings over the entire length of the coil. The second coil **970** has a predetermined interval (length) in which the number of windings is zero. More specifically, a predetermined interval in which the number of windings is zero in the second coil **970** may be determined based on the width or thickness of the first heating portion **910**. Here, the number of windings of the coil is defined as the number of turns of the coil per unit length.

Further, the first coil **950** is arranged in at a predetermined interval in which the number of windings of the second coil **970** is zero. In the preheating step of heating the susceptor **810**, the controller **12** controls alternating current to be supplied to both the first coil **950** and the second coil **970**, such that both the first heating portion **910** and the second heating portion **930** of the susceptor heating portion **810***a* are heated to the preheating temperature. And then, when a predetermined time has elapsed after the first heating portion **910** and the second heating portion **930** reach the preheating temperature, the controller **12** determines that the susceptor **810** has entered a temperature maintenance section, and stops supplying the alternating current to the second coil **970**.

In the present invention, as the controller **12** supplies alternating current only to the first coil **950** in a temperature maintenance section, it is possible to prevent melting of a filter of a cigarette and generation of overheated aerosols, which may occur when the temperature of the second heating portion **930** of the susceptor is excessively high. In addition, for convenience of explanation, the number of coils in FIG. **9** is limited to two. However, in the present invention, the number of coils is not limited to a specific number, and the number of coils may be more than two depending on an embodiment.

FIG. **10** is a diagram schematically showing another example of a plurality of coils and a susceptor included in the induction-heating type aerosol-generating device described in FIG. **8**.

For convenience of explanation, FIG. **10** only shows a plurality of coils generating an alternating magnetic field and a susceptor heating portion **810***a* heated by the plurality of coils, which are shown in FIG. **8**. Other omitted components are assumed to be the same as those shown in FIG. **8**. In addition, hereinafter, it will be described with reference to FIG. **8**. When alternating current is applied to a first coil **1050** and a second coil **1070**, the first coil **1050** and the second coil **1070** may form an alternating magnetic field.

First, the susceptor heating portion **810***a* includes a first heating portion **1010** heated by the first coil **1050** and a second heating portion **1030** heated by the second coil **1070**. When alternating current is supplied to the first coil **1050** to form an alternating magnetic field, the first heating portion **1010** is heated under the influence of the alternating magnetic field. The first heating portion **1010** is heated under an influence of the alternating magnetic field formed by the first coil **1050**, but may also be heated under an influence of the expansion of the alternating magnetic field formed by the second coil **1070**.

In addition, when alternating current is supplied to the second coil **1070** to form an alternating magnetic field, the susceptor heating portion **810***a* including both the first heating portion **1010** and the second heating portion **1030** is heated under the influence of the alternating magnetic field. The controller **12** allows the alternating current to flow simultaneously through the first coil **1050** and the second coil **1070**, so that the susceptor heating portion **810***a* rapidly reaches the preheating temperature. And then, the controller **12** may induce that only the first heating portion **1010** is continuously heated by blocking the alternating current supplied to the second coil **1070**. Through this process, the first heating portion **1010** is affected by both the alternating magnetic field formed by the first coil **1050** and the alternating magnetic field formed by the second coil **1070**. In the present exemplary embodiment, the coil heating the first heating portion **1010** may be understood as an equivalent coil in which the numbers of windings of the first coil **1050** and the second coil **1070** are overlapped or summed. In addition, although the number of the plurality of coils is limited to two in FIG. **10**, depending on the embodiment, the number of coils may be more than two.

FIG. **11** is a diagram schematically showing another example of a plurality of coils and a susceptor included in the induction-heating type aerosol-generating device described in FIG. **8**.

For convenience of description, FIG. **11** only shows a plurality of coils that generate an alternating magnetic field and a susceptor heating portion **810***a* heated by the plurality of coils as shown in FIG. **8**. Other omitted components are assumed to be the same as those shown in FIG. **8**. In addition, hereinafter, it will be described with reference to FIG. **8**, a first coil **1150** and a second coil **1170**, when alternating current is applied, may form an alternating magnetic field.

First, the susceptor heating portion **810***a* includes a first heating portion **1110** heated by the first coil **1150** and a second heating portion **1130** heated by the second coil **1170**. When alternating current is supplied to the first coil **1150** to form an alternating magnetic field, the first heating portion **1110** is heated under an influence of the alternating magnetic field. Here, the first heating portion **1110** may also be heated under an influence of the expansion of the alternating magnetic field formed by the second coil **1170**.

In addition, when alternating current is supplied to the second coil **1170** to form an alternating magnetic field, the second heating portion **1130** is heated under the influence of the alternating magnetic field. The length ratio of the first coil **1150** and the second coil **1170** is n:1, where n may be any real number determined mathematically or experimentally. Here, the length of the coil means the length of the coil itself in the coiled state, and does not mean the length of a metal wire state that is in an uncoiled state, which should not be called a coil.

According to a known formula for calculating the strength of the magnetic field of a solenoid coil, when the number of windings per portion length is changed, the strength of the magnetic field generated by alternating current flowing in the coil is also changed. By changing the number n appropriately, the heating speeds of the first heating portion **1110** and the second heating portion **1130** also changes according to the physical properties of the first coil **1150** and the second coil **1170**. As illustrated in FIGS. **9** and **10**, the controller **12** may simultaneously heat the first heating portion **1110** and the second heating portion **1130**, and then stop supplying the alternating current to the second coil **1170**. When the supply of the alternating current to the second coil **1170** is stopped, the second heating portion **1130** may be heated at a much slower speed than the speed at which the first heating portion **1110** is heated, by a conduction heat of the first heating portion **1110** or by the expansion of the alternating magnetic field formed by the first coil **1150**.

According to this exemplary embodiment, by adjusting the number n to adjust the heating speeds of the first heating portion **1110** and the second heating portion **1130** differently, the aerosol-generating substrate contacting the susceptor heating portion **810***a* may be heated according to desired characteristics. In this exemplary embodiment, the ratio of the length of the second coil **1170** to the length of the first coil **1150** may be equal to or less than a preset value. Here, the ratio of the length of the second coil **1170** to the length of the first coil **1150** is 1/n when shown with reference to FIG. **11**.

FIG. **12** is a flowchart illustrating an example of a method of generating an aerosol using an induction heating method according to the present invention.

The aerosol-generating method shown in FIG. **12** may be implemented by the aerosol-generating device according to FIGS. **1**, **2**, **3**, **6** and **7**. Hereinafter, the aerosol-generation method will be described with reference to FIGS. **1**, **2**, **3**, **6**, and **7**, and the description overlapping with the above description will be omitted.

In step S**1210**, the controller **12** controls to generate PWM signals transmitted to at least two coils. After generating the control signal, the controller **12** may generate PWM control signals by transmitting a control signal to the pulse width modulation processing unit **14** located inside or outside the controller **12**.

In step S**1230**, the PWM signals generated in step S**1210** are transmitted to a plurality of coils, respectively.

In step S**1250**, a plurality of coils receiving the PWM signals form alternating magnetic fields simultaneously or sequentially.

In step S**1270**, the susceptor **810** provided in the aerosol-generating device **1** is differentially heated by a magnetic field formed differently according to the arrangement direction or a length ratio of the plurality of coils. When the cigarette containing the aerosol-generating substrate contacts the susceptor heated differentially in step S**1270**, the aerosol-generating substrate is differentially heated, so that the properties of the generated aerosols may be variously adjusted. According to the present invention, the user may inhale aerosols that provide an optimized feeling of smoking.

Those of ordinary skill in the art related to this embodiment will understand that it may be implemented in a modified form without departing from the essential characteristics of the above-described substrate. The disclosed methods should be considered in a descriptive sense only and not for purposes of limitation. The scope of the present invention is shown in the claims rather than the foregoing description, and all differences within the equivalent scope should be interpreted as being included in the present invention.

INDUSTRIAL APPLICABILITY

The present invention may be utilized to manufacture next-generation electronic cigarettes that may provide convenience for users and provide a consistent smoking experience.

What is claimed is:

1. An aerosol generating device using an induction heating method, the aerosol generating device comprising:

a plurality of coils having different numbers of windings and configured to generate an alternating magnetic field when an alternating current is applied;

a susceptor configured to heat an aerosol generating article inserted therein by generating heat within the alternating magnetic field generated from the plurality of coils; and

a controller configured to control a preset alternating current to be supplied to each of the plurality of coils, wherein the susceptor includes a first portion and a second portion arranged to be parallel to the plurality of coils in a longitudinal direction of the susceptor, and the controller is further configured to: control the first portion and the second portion to be differentially heated by the alternating current supplied to the plurality of coils; and control the alternating current to be selectively supplied to the plurality of coils according to a preheating section for increasing a temperature of the susceptor to a preheating temperature and a temperature maintenance section for maintaining the temperature of the susceptor,

wherein the plurality of coils include a first coil corresponding to the first portion and a second coil corresponding to the second portion, and the first coil and the second coil have different inductances, and

wherein the controller is further configured to control the alternating current to be supplied to any one coil from among the first coil and the second coil in the temperature maintenance section.

2. The aerosol generating device of claim **1**, wherein the controller is further configured to control to stop the supply of the alternating current to any one coil from among the first coil and the second coil when a preset time elapses after reaching the preheating temperature.

3. The aerosol generating device of claim **1**, wherein the susceptor includes a single material.

4. The aerosol generating device of claim **1**, wherein the controller is further configured to generate a first pulse width modulation (PWM) control signal and a second PWM control signal for supplying the alternating current to the first coil and the second coil, respectively.

5. The aerosol generating device of claim **4**, wherein a reception side of each of the first coil and the second coil further includes an impedance matching circuit unit.

6. The aerosol generating device of claim **1**, wherein the susceptor includes a remaining portion other than the first portion and the second portion arranged to be parallel to the plurality of coils in the longitudinal direction of the susceptor, and the controller is further configured to control the first portion, the second portion, and the remaining portion to be differentially heated by the alternating current supplied to the plurality of coils.

7. An aerosol generating device using an induction heating method, the aerosol generating device comprising:

a plurality of coils having different numbers of windings and configured to generate an alternating magnetic field when an alternating current is applied;

a susceptor configured to heat an aerosol generating article inserted therein by generating heat within the alternating magnetic field generated from the plurality of coils; and

a controller configured to control a preset alternating current to be supplied to each of the plurality of coils, wherein the susceptor includes a first portion and a second portion arranged to be parallel to the plurality of coils in a longitudinal direction of the susceptor, and the controller is further configured to: control the first portion and the second portion to be differentially heated by the alternating current supplied to the plurality of coils;

wherein the controller is further configured to control the alternating current to be selectively supplied to the plurality of coils according to a preheating section for increasing a temperature of the susceptor to a preheating temperature and a temperature maintenance section for maintaining the temperature of the susceptor, wherein the plurality of coils include a first coil corresponding to the first portion and a second coil corresponding to the second portion, and the first coil and the second coil have different inductances, and

wherein the controller is further configured to control the alternating current to be supplied to any one coil from among the first coil and the second coil in the preheating section.

8. An aerosol generating device using an induction heating method, the aerosol generating device comprising:

a plurality of coils having different numbers of windings and configured to generate an alternating magnetic field when an alternating current is applied;

a susceptor configured to heat an aerosol generating article inserted therein by generating heat within the alternating magnetic field generated from the plurality of coils; and

a controller configured to control a preset alternating current to be supplied to each of the plurality of coils, wherein the susceptor includes a first portion and a second portion arranged to be parallel to the plurality of coils in a longitudinal direction of the susceptor, and the controller is further configured to: control the first portion and the second portion to be differentially heated by the alternating current supplied to the plurality of coils;

wherein the controller is further configured to control the alternating current to be selectively supplied to the plurality of coils according to a preheating section for increasing a temperature of the susceptor to a preheating temperature and a temperature maintenance section for maintaining the temperature of the susceptor,

wherein the plurality of coils include a first coil corresponding to the first portion and a second coil corresponding to the second portion, and the first coil and the second coil have different inductances, and

wherein the controller is further configured to control alternating currents having different magnitudes to be supplied to the first coil and the second coil.

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