

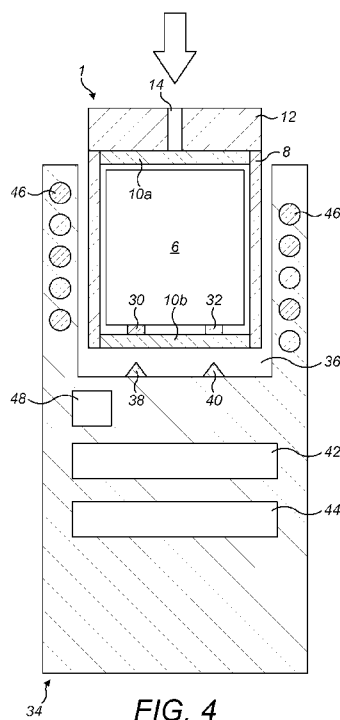
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(57) Abstract: An aerosol generating system is described. The system includes a capacitor (6) comprising an electrolyte which, when heated, generates an aerosol for inhalation by a user, and an induction heater comprising an induction coil (46) and a susceptor. The induction heater is configured to heat the capacitor (6).

- 1 -

AN AEROSOL GENERATING SYSTEM AND A METHOD OF CONTROLLING THE SAME

Technical Field

5 The present disclosure relates generally to an aerosol generating system, and in particular to an aerosol generating system that includes an aerosol generating article that is adapted to be received in an aerosol generating device for generating an aerosol for inhalation by a user. The present disclosure is particularly applicable to a portable (hand-held) aerosol generating device.

10

The present disclosure also relates to a method of controlling an aerosol generating system.

Technical Background

15 Devices which heat, rather than burn, an aerosol generating material to produce an aerosol for inhalation have become popular with consumers in recent years. A commonly available reduced-risk or modified-risk device is the heated material aerosol generating device, or so-called heat-not-burn device. Devices of this type generate an aerosol or vapour by heating an aerosol generating material to a temperature typically
20 in the range 150°C to 300°C. This temperature range is quite low compared to an ordinary cigarette. Heating the aerosol generating material to a temperature within this range, without burning or combusting the aerosol generating material, generates a vapour which typically cools and condenses to form an aerosol for inhalation by a user of the device.

25

Such devices may use one of a number of different approaches to provide heat to the aerosol generating material. All approaches for heating the aerosol generating material require some sort of power source such as a battery, which adds to the size and weight of the device. Embodiments of the present disclosure seek to provide a power source in
30 the aerosol generating article which may be used to supplement or partially replace the power source in the device. This may result in a smaller and lighter device, which is beneficial for the user. Embodiments of the present disclosure also seek to provide

- 2 -

controllable and consistent heating using an induction heater during a heating or vaping phase, for example.

Summary of the Disclosure

5 According to a first aspect of the present disclosure, there is provided an aerosol generating system comprising:

a capacitor comprising an electrolyte which, when heated, generates an aerosol for inhalation by a user; and

10 an induction heater comprising an induction coil and a susceptor, wherein the induction heater is configured to heat the capacitor.

The electrolyte may be heated in two ways: firstly by discharging the capacitor, by charging the capacitor, or by cycling the capacitor between being discharged and charged, and secondly by using the external induction heater that is positioned adjacent
15 the capacitor in use. For example, as described in more detail below, the induction heater may be positioned adjacent an aerosol generating space or heating chamber of an aerosol generating device that is designed to receive an aerosol generating article (or consumable). When the induction heater is used to heat the electrolyte, an alternating electromagnetic field is generated by the induction coil. The susceptor couples with the
20 electromagnetic field and generates heat due to eddy currents and/or magnetic hysteresis, which heat is then transferred to the electrolyte. To generate the alternating electromagnetic field necessary for induction heating, the aerosol generating system may further comprise an inverter circuit electrically connected to the induction coil.

25 The capacitor may have any suitable construction, but in a preferred embodiment it is an electric double-layer supercapacitor. The large capacitance of an electric double-layer supercapacitor may lead to an increase in the efficiency of aerosol generation during discharging and charging. The capacitor may further comprise a pair of electrodes and a porous separator between the electrodes. The first electrode may be a
30 positive electrode and the second electrode may be a negative electrode, or *vice versa*. The electrodes and the separator are immersed in the electrolyte.

- 3 -

Electrical charge is stored in the electrical field between the electrodes and the capacitance is a function of the surface area of the electrodes, the distance between them, and the dielectric constant of the separator material. The capacitor has a higher power density than a conventional power source such as a battery. When the capacitor
5 is charged by an external circuit connected to the pair of electrodes, cations in the electrolyte migrate toward the negative electrode and the anions migrate to the positive electrode, while the electrons travel through the external circuit from the negative to the positive electrode. Two layers of charge with opposite polarity (an electric double-layer) are therefore formed at the interfaces with the electrodes. When charging
10 finishes, positive electric charges on the positive electrode and anions in the electrolyte attract each other while negative electric charges on the negative electrode and cations in the electrolyte attract each other in order to stabilize the double layers on the electrodes. A stable voltage is generated. When the capacitor is discharged, the reverse processes happen.

15 Each electrode may comprise at least one electrode layer. Each electrode layer may be a carbon-based electrode layer, for example a layer of porous charcoal material or activated carbon which has a high specific surface area per volume and compatibility with the proposed electrolyte.

20 Each electrode may further comprise a current collector. Each current collector may comprise a metal foil layer, for example an aluminium foil layer. An electrode layer may be positioned adjacent one or both sides of a current collector. Each electrode layer may be formed as a coating. Such electrodes may be manufactured relatively easily and
25 cheaply using materials that are already known to be used in aerosol generating articles. Each current collector may encourage electron travelling via the external circuit.

The susceptor of the induction heater preferably comprises the current collectors. In other words, the current collectors are part of the capacitor electrodes but may also
30 function as the susceptor of the induction heater and transfer heat to the electrolyte when the induction heater is being operated, e.g., during a heating period of the induction heater. Because the current collectors have at least two functions, the size and

- 4 -

weight of the aerosol generating system may be reduced. In particular, it is not necessary for the aerosol generating article to include one or more separate susceptors for heating the electrolyte when the induction heater is operated.

5 The electrolyte also fulfils two functions. Firstly, it permits the cation and anion migration that occurs when the capacitor is charged or discharged, and secondly, when heated, it forms an aerosol that is safe to be inhaled by the user and has good characteristics. The electrolyte should therefore be selected accordingly. The electrolyte may comprise sodium chloride and glycerol, and optionally polyvinyl
10 alcohol as a gelling agent. Such an electrolyte has been found to permit cation and anion migration and is also safe for inhalation by the user.

When all of the electrolyte has been vapourised, the capacitor may not be further discharged or charged, and the article may need to be disposed of appropriately or re-
15 filled with electrolyte.

The separator must provide dielectric separation between the pair of oppositely charged electrodes. The separator also stores electrolyte in its pores and permits the passage of cations and anions during the charging and discharging processes. The separator may
20 comprise any suitable material. The separator may comprise a plant derived material and in particular may comprise a tobacco material, for example, a porous tobacco sheet, or it may comprise any suitable cellulose- or polypropylene-based material. When heated, the separator material may release one or more volatile compounds. The volatile compounds may include nicotine or flavour compounds such as tobacco or other
25 flavouring. To provide improved heating, the internal resistance of the capacitor may be increased by increasing the thickness of the separator between the oppositely charged electrodes. This may result in a capacitor having fewer turns or folds if the overall dimensions remain the same.

30 The aerosol generating article may further comprise any type of solid or semi-solid material downstream of the capacitor in an aerosol flow path. Example types of solid or semi-solid material include crumb, powder, granules, pellets, shreds, strands,

- 5 -

particles, gel, strips, loose leaves, cut filler, porous material, foam material or sheets. The material may comprise plant derived material and in particular, may comprise tobacco material. The aerosol generated by heating the electrolyte of the capacitor will flow through the solid or semi-solid material, which may be positioned between the
5 capacitor and a filter segment or mouthpiece through which the user inhales the aerosol, for example. The solid or semi-solid material may release one or more volatile compounds which may add flavour and nicotine to the aerosol, for example. Any heating provided by the capacitor or the induction heater also heats or warms the solid or semi-solid material which may promote the release of volatile compounds.

10

The aerosol that is inhaled by the user consists essentially of the vapourised or aerosolised electrolyte and optionally one or more volatile compounds that may be released by the separator material and/or the downstream solid or semi-solid material.

15 The capacitor may have any suitable construction such as a spiral wound (or “jelly roll”) construction that may be substantially cylindrical or flattened so that it has more of a cuboid shape that might be more suitable for a flat-format article, a prismatic construction, a folded or serpentine construction, or a stacked construction, for example.

20

In one embodiment a layered capacitor substrate may comprise a first electrode, a separator adjacent the first electrode, and a second electrode adjacent the separator, i.e., so that the separator is sandwiched between the first and second electrodes, and more particularly between a pair of carbon-based electrode layers. The first electrode may be
25 a positive electrode and the second electrode may be a negative electrode or *vice versa*. Such a substrate may be rolled or folded into a suitable shape while maintaining an air gap or other dielectric separation between facing electrodes or different parts of the same electrode. Dielectric separation in addition to that provided by the separator may be provided by one or more layers of dielectric material, for example. The dielectric
30 material may comprise any suitable material. The dielectric material may comprise a plant derived material and in particular may comprise a tobacco material, for example, a porous tobacco sheet, or it may comprise any suitable cellulose- or polypropylene-

- 6 -

based material. When heated, the dielectric material may release one or more volatile compounds. The volatile compounds may include nicotine or flavour compounds such as tobacco or other flavouring. The dielectric material and the separator material may be the same or different.

5

In another embodiment a layered capacitor substrate may comprise a first electrode, a first separator adjacent the first electrode, a second electrode adjacent the first separator, i.e., so that the first separator is sandwiched between the first and second electrodes and more particularly between a pair of carbon-based electrode layers, and a second
10 separator adjacent the second electrode. The second electrode is sandwiched between the first and second separators. The first electrode may be a positive electrode and the second electrode may be a negative electrode or *vice versa*. Such a substrate is particularly suitable for a spiral wound (or “jelly roll”) construction, which may be substantially cylindrical or may be flattened so that it has more of a cuboid shape.
15 Dielectric separation between the turns of the spiral wound capacitor is provided by the second separator, which in the wound substrate may be sandwiched between the first and second electrodes and more particularly between a pair of carbon-based electrode layers.

20 In yet another embodiment a layered capacitor substrate may comprise a plurality of first electrodes, a plurality of second electrodes, and a plurality of separators. The first electrodes may be positive electrodes and the second electrodes may be negative electrodes or *vice versa*. The first and second electrodes are stacked alternately such that the substrate comprises a first electrode, a second electrode, a first electrode, a
25 second electrode etc. in a stacking direction. A separator is sandwiched between each pair of electrodes and more particularly between a pair of carbon-based electrode layers to provide dielectric separation. Such a substrate may be useful for a flat-format article. The first electrodes may be electrically connected together and the second electrodes may be electrically connected together. The first electrodes may be electrically
30 connected to a first capacitor terminal and the second electrodes may be electrically connected to a second capacitor terminal.

- 7 -

5 The capacitor may be contained within a casing. More particularly, the casing may contain the capacitor substrate which includes the electrodes, separator etc., and the electrolyte. The electrolyte may be injected into the casing during manufacture or if the capacitor needs to be re-filled. The casing may electrically insulate the capacitor and may be formed of any suitable material or materials.

10 The casing may include a paper wrapper with a metal or polymer coating, for example. The casing may include a pair of end caps of any suitable material. The casing may comprise appropriate perforations or openings, or incorporate a suitable aerosol-permeable membrane material, so that the aerosol generated when the electrolyte is heated may be freely inhaled by the user, while also preventing leakage of the electrolyte when in a liquid or gel state. The aerosol generating article may include a filter segment, for example comprising cellulose acetate fibres, at a proximal end of the aerosol generating article. The filter segment may constitute a mouthpiece filter. One or more vapour collection regions, cooling regions, and other structures may also be included in some designs. The vapour cooling region may advantageously allow the vapour to cool and condense to form an aerosol with suitable characteristics for inhalation by a user, for example through the filter segment. In general terms, a vapour is a substance in the gas phase at a temperature lower than its critical temperature, which means that the vapour may be condensed to a liquid by increasing its pressure without reducing the temperature, whereas an aerosol is a suspension of fine solid particles or liquid droplets, in air or another gas. It should, however, be noted that the terms 'aerosol' and 'vapour' may be used interchangeably in this specification.

25 The capacitor will preferably be pre-charged in the packaged article, i.e., it will already be charged when it is purchased by the user and before it is removably inserted into an aerosol generating device. Pre-charging the capacitor reduces the amount of energy that is required from the power source of the device for heating. This may lead to a reduction in the size and weight of the device.

30

The capacitor and the susceptor may be part of an aerosol generating article and the induction coil may be part of an aerosol generating device adapted to receive, in use,

- 8 -

the aerosol generating article. The device may comprise an aerosol generating chamber or heating chamber that is adapted to receive the article so that it can be heated by the induction coil.

- 5 A switching circuit may be electrically connected between the pair of electrodes or capacitor terminals. The aerosol generating device may comprise the switching circuit, which is electrically connected to the pair of electrodes or capacitor terminals when the aerosol generating article is received in the device.
- 10 The switching circuit may be configured to control the discharging of the capacitor. The switching circuit may optionally also be configured to control the charging of the capacitor from a power source of the device such as a battery. The power source may optionally include a suitable power converter that provides a suitable output voltage. The inverter circuit and the switching circuit may be electrically connected in parallel
- 15 to the power source or in series. A parallel connection may enable independent control of the inverter circuit and the switching circuit. It also means that discharging and charging the capacitor by the switching circuit does not affect the induction heating of the capacitor by the inverter circuit and *vice versa*.
- 20 The heating of the electrolyte may be controlled by controlling the discharging and charging of the capacitor. In particular, the switching circuit may include a switching device which may be controlled by a controller to selectively provide a continuous or switched (i.e., a discontinuous or intermittent) short-circuit path between the pair of electrodes or capacitor terminals that allows the electrical charge stored in the capacitor
- 25 to be discharged through the switching circuit. The switching device may also be controlled by the controller to charge the capacitor from the power source. The switching device may include one or more switches. For example, the switching device may include a discharging switch that can be switched on to provide a short-circuit path between the pair of electrodes or capacitor terminals to discharge the capacitor, and a
- 30 charging switch that can be switched on to charge the capacitor. Each switch may be a controllable semiconductor switch such as a transistor (e.g., a metal oxide semiconductor field effect transistor (MOSFET), insulated-gate bipolar transistor

- 9 -

(IGBT) or bipolar transistor). The one or more switches may be opened or closed or switched on and off by the controller to provide the short-circuit path.

The switching circuit may include a first terminal that is electrically connected to the first electrode or terminal of the capacitor and a second terminal that is electrically connected to the second electrode or terminal of the capacitor when the aerosol generating article is received in the device. Prior to the article being inserted into the device, to prevent accidental or deliberate discharge of a pre-charged capacitor, it is preferred that at least one of the electrodes or terminals of the capacitor is inaccessible to the user. For example, one or both of the capacitor electrodes or terminals may be concealed within a casing of the article and are only made accessible for electrical connection with the terminals of the switching circuit after the aerosol generating article has been inserted into the device, or as it is in the process of being inserted. The electrical connection may require the casing to be ruptured at one or more locations and the device may include suitable means for rupturing, puncturing or tearing the casing. The first terminal of the switching circuit may be electrically connected directly to the first electrode at one or more locations, or may be electrically connected to a first capacitor terminal which is electrically connected in turn to the first electrode(s). Similarly, the second terminal of the switching circuit may be electrically connected directly to the second electrode at one or more locations, or may be electrically connected to a second capacitor terminal, which is electrically connected in turn to the second electrode(s). The capacitor terminals may be located anywhere on the article, e.g., near an end cap or a side of the article. The insertion orientation of the aerosol generating article into the device may be restricted to ensure correct alignment between the respective terminals so as to provide a reliable electrical connection between the capacitor and the external switching circuit.

The terminals of the switching circuit may be formed as rupturing devices that are designed to rupture, puncture or tear the casing and make an electrical connection with the electrodes or terminals of the capacitor. The rupturing devices may be fixed or stationary to the device and may be designed to rupture, puncture or tear the casing as the article is inserted into the device, e.g., into an aerosol generating space or heating

- 10 -

chamber. The rupturing device may also be movable. For example, in one arrangement the rupturing devices may be mounted on a panel or door of the device which is opened or removed to allow the article to be inserted and where the rupturing devices are designed to rupture, puncture or tear the casing when the panel or door is closed by the user. The panel or door may be hinged, for example. In another arrangement, the rupturing devices may be moved by a suitable actuator such as an electric motor or a piston, for example, that can force the rupturing devices through the casing and make an electrical connection. The rupturing devices may be moved through openings or slots in the part of the device that defines the aerosol generating space or heating chamber.

10 The rupturing devices may have any suitable shape and may, for example, be formed as a needle type or crown type with one or more pointed ends, a blade type with an edge, or a punch type with a non-pointed end. The rupturing devices may be designed to work with any of the capacitor constructions mentioned above. If one of the electrodes or terminals of the capacitor is accessible, only one rupturing device may be

15 needed.

The discharging and charging of the capacitor, and hence the heating of the electrolyte, may be controlled using the switching circuit, which may be part of an aerosol generating device. As noted above, the switching device of the switching circuit may

20 be controlled by a controller. The controller may transition the aerosol generating system between a first heating phase where the electrolyte is heated by discharging the capacitor or by cycling the capacitor between being discharged and charged, and a second heating phase where the electrolyte is heated using the external induction heater. The first heating phase may be a pre-heating phase and the second heating phase may

25 be a heating or vaping phase, for example.

In some cases, discharging the capacitor may provide sufficient heating without the need to charge the capacitor. For example, the capacitor may be continuously or intermittently discharged through the switching circuit to provide sufficient heating of

30 the electrolyte during an initial pre-heating phase. However, additional heating may be provided during the pre-heating phase by repeatedly cycling the capacitor between discharging and charging. The power for pre-heating may therefore be provided at least

- 11 -

in part by the capacitor and not by the power source of the device. This may result in a smaller power source, and hence in a smaller and lighter device. Heating may be provided by the induction heater during a subsequent heating or vaping phase when more controlled heating may be preferred.

5

The discharging and charging of the capacitor, and hence the heating of the electrolyte, may be controlled by varying the power at which the capacitor is discharged and charged through the switching circuit that is electrically connected between the pair of electrodes or terminals of the capacitor. For example, the discharging and charging
10 power may be varied by controlling the switching device of the switching circuit so that the capacitor is discharged or charged intermittently using an appropriate duty cycle, e.g., where the switching device is periodically enabled and disabled with a duty cycle that may be varied to control the rate at which the capacitor is discharged or charged. More particularly, the time for which the switching device is enabled (or “pulse width”)
15 may be varied based on the estimated or determined temperature of the capacitor. During the periods when the switching device is enabled the one or more switches (e.g., discharging switch or the charging switch) may be switched on and off as appropriate. The one or more switches may be switched off during the periods when the switching device is disabled. The discharging or charging power may be adjusted every time the
20 temperature of the capacitor is estimated or determined. The discharging power and the charging power may be controlled separately.

The capacitor may be discharged and charged between predefined upper and lower limits. For example, if expressed in terms of state of charge (SOC), the upper limit may
25 be about 50-80% and the lower limit may be about 20-40%. SOC is here defined as the available capacity (in Ah) of the capacitor and is expressed as a percentage of its rated capacity. It will be understood that other predefined upper and lower limits may be selected and that they may be expressed in different terms such as voltage, for example. Since an output voltage of the capacitor linearly corresponds to the SOC of the
30 capacitor, if the output voltage of the capacitor is used instead of SOC, the calculation load can be reduced. For example, unlike the SOC of the capacitor that requires some calculation, the output voltage of the capacitor is easily and directly obtainable from a

- 12 -

- suitable voltage sensor or voltage sensing circuit. Using suitably-selected upper and lower limits may avoid problems such as non-linear effects or unacceptably large discharging or charging currents that may be encountered if the capacitor is substantially fully charged (e.g., above about 80%) or substantially fully discharged (e.g., below about 20%) when heating the electrolyte. Alternatively, the capacitor may be substantially fully charged (e.g., to about 100%) and/or substantially fully discharged (e.g., to about 0%) for increasing the efficiency of the aerosol generation during charging and discharging.
- 10 The controller may transition the aerosol generating system between the first and second heating phases when a threshold temperature is reached. For example, the capacitor may be discharged or may be cycled between being discharged and charged to heat the electrolyte until the threshold temperature is reached, after which the electrolyte is heated by the induction heater. When the threshold temperature is reached,
- 15 the controller may stop discharging and charging of the capacitor and start the operation of the induction heater, e.g., by controlling the inverter circuit so as to generate an alternating electromagnetic field in the induction coil. The threshold temperature may be a threshold temperature for the capacitor.
- 20 When the induction heater is used to heat the electrolyte it is important that the electrodes of the capacitor, and in particular the current collectors that are functioning as the susceptor of the induction heater, are electrically connected to facilitate eddy current flow. The current collectors may be electrically connected by providing a short-circuit path between the pair of electrodes or capacitor terminals. The aerosol
- 25 generating system may further comprise a thermal switching device (e.g., a self-closing bi-metallic switch) configured to provide a short-circuit path between the pair of electrodes when a temperature detected by the thermal switching device exceeds a threshold temperature (or switching temperature). The thermal switching device may be part of the aerosol generating device (e.g., part of the switching circuit) or part of
- 30 the aerosol generating article, in which case it will be electrically connected to the switching circuit when the article is received in the device. A bi-metallic switch comprises two metals with different coefficients of thermal expansion that are firmly

- 13 -

connected. As one metal expands more strongly than the other, the entire bi-metallic structure bends and may change shape abruptly – e.g., from a concave curvature to a convex curvature at a particular switching temperature. A self-closing bi-metallic switch is open in its normal state and only switches to a closed state when the switching
5 temperature is reached to establish an electrical connection between the switch terminals. It will be understood that other types of thermal switching device may also be used. The thermal switching device may be positioned adjacent the capacitor in use, e.g., in the aerosol generating chamber or heating chamber of the device or in the article itself. The thermal switching device will automatically provide the short-circuit path
10 and there is no need for the controller to detect or estimate a temperature of the capacitor.

In order to transition the aerosol generating system between the first heating phase and the second heating phase, the controller must know when the thermal switching device
15 has been activated – i.e., when the threshold temperature has been exceeded and the short-circuit path between the pair of electrodes or capacitor terminals has been provided by the thermal switching device. The aerosol generating device may further comprise a detection circuit configured to detect the short-circuiting of the capacitor by the thermal switching device. The detection circuit may be electrically connected to the
20 controller so that the controller may transition the aerosol generating system between the first and second heating phases when the thermal switching device is activated at the threshold temperature (or switching temperature). The detection circuit may comprise a current sensing circuit comprising a shunt resistor electrically connected in series with the thermal switching device and a current sensing amplifier electrically
25 connected with the shunt resistor. The detection circuit may comprise a voltage sensing circuit configured to detect the voltage across the capacitor. The voltage sensing circuit may comprise a voltage divider. Because the current sensing circuit consists essentially of the shunt resistor and the current sensing amplifier and the voltage sensing circuit consists essentially of a voltage divider, the detection circuit is implemented simply and
30 in a cost-effective way.

- 14 -

A short-circuit path between the pair of electrodes or capacitor terminals may alternatively be provided by switching on the discharging switch of the switching device described above. In particular, the controller may transition the aerosol generating system between the first and second heating phases when a threshold
5 temperature is reached. An estimated or determined temperature may be compared against the threshold temperature. When the threshold temperature is reached, the controller may stop the discharging and charging of the capacitor, switch on the discharging switch to provide the short-circuit path for eddy current flow, and start the operation of the induction heater, e.g., by switching on the inverter circuit to generate
10 an alternating electromagnetic field in the induction coil.

The temperature used by the controller to transition between the first and second heating phases may be an estimated or determined temperature of the capacitor, for example, and may be measured using a temperature sensor. For example, the aerosol generating
15 device may include a temperature sensor that is located close to the capacitor when the aerosol generating article is received in the device, or a temperature sensor may be configured to measure a temperature of a terminal of the external switching circuit which is in thermal as well as electrical contact with the respective electrode of the capacitor in use. The terminal may be the positive terminal of the switching circuit.

20 It will be understood that a thermal switching device is not essential and that the short-circuit path can be provided by the discharging switch of the switching circuit. However, using a separate thermal switching device may avoid the need for a temperature sensor and can simplify the control of the switching circuit. The thermal
25 switching device may also have an on-resistance value that is less than the on-resistance value of the discharging switch that is configured to provide a short-circuit path between the pair or electrodes or capacitor terminals.

The heating provided by the induction heater during the second heating phase may be
30 controlled based on a comparison between an estimated or determined temperature and a target temperature or temperature profile. The estimated or determined temperature may be a temperature of the capacitor, for example, and may be measured using a

- 15 -

temperature sensor. For example, the aerosol generating device may include a temperature sensor that is located close to the capacitor when the aerosol generating article is received in the device, or a temperature sensor may be configured to measure a temperature of a terminal of the external switching circuit which is in thermal as well
5 as electrical contact with the respective electrode of the capacitor. The terminal may be the positive terminal of the switching circuit. The temperature may also be estimated from an electrical parameter of the capacitor obtained during the second heating phase. In other words, the capacitor may be used as a temperature sensor. The electrical parameter will be known to vary with the temperature of the capacitor. One or more
10 values of the electrical parameter of the capacitor may be estimated or determined using at least one of current, voltage and time measurements taken when the capacitor is charged by applying one or more current pulses to the capacitor, for example. The electrical parameter may be the internal resistance or capacitance of the capacitor, for example. The electrical parameter may be used to estimate the temperature of the
15 capacitor using a suitable linear or non-linear function or look-up table, for example, that relates the value of the electrical parameter to temperature. The threshold temperature may be used as an initial temperature for the linear or non-linear function. Using one or more values of the electrical parameter of the capacitor to estimate the temperature of the capacitor is described below in the context of a temperature
20 estimation step.

According to a second aspect of the present disclosure, there is provided a method of controlling an aerosol generating system, the aerosol generating system comprising:

a capacitor comprising an electrolyte; and
25 induction heater comprising an induction coil and a susceptor;
wherein the capacitor is discharged or is cycled between being discharged and charged to heat the electrolyte until a threshold temperature is reached, after which the electrolyte is heated by the induction heater to generate an aerosol for inhalation by a user.

30 The method may further comprise a temperature estimation step where the capacitor is charged (e.g., by applying one or more current pulses to the capacitor) and a value of

- 16 -

an electrical parameter of the capacitor is estimated or determined. The value of the electrical parameter is used to estimate a temperature of the capacitor.

5 The capacitor may be short-circuited by a thermal switching device (e.g., a self-closing bi-metallic switch) when a temperature detected by the thermal switching device reaches or exceeds the threshold temperature (or switching temperature). Detection of the short-circuiting of the capacitor by the thermal switching device may be used to transition the aerosol generating system to heating the electrolyte using the induction heater.

10

Alternatively, the capacitor may be short-circuited by a switching device when an estimated or measured temperature (e.g., from a temperature sensor) reaches or exceeds the threshold temperature. The capacitor device may be short-circuited by a discharging switch of the switching device.

15

The induction heater may be alternated between a heating period and a non-heating period. The temperature estimation step may be carried out during a non-heating period. The capacitor may be short-circuited at least during each heating period, and optionally also during each non-heating mode if a temperature estimation step is not carried out.

20

The switching device may be used to short-circuit the capacitor for eddy current flow during the heating period but not during the non-heating period – during the non-heating period the switching device may instead be controlled to charge the capacitor as part of the temperature estimation step, e.g., controlling a charging switch of the switching device to apply one or more current pulses to the capacitor for estimating or determining one or more values of the electrical parameter.

25

30 The heating of the electrolyte may be controlled by a closed loop controller such as a PID controller with a proportional constant, an integral constant, and a derivative constant. To simplify and reduce processing time, one or both of the integral and derivative constants may be omitted. Other closed loop controllers may also be used.

- 17 -

Brief Description of the Drawings

Figure 1 is a diagrammatic view of an example of an aerosol generating article;

Figure 2 is a diagrammatic view of an example of a capacitor having a spiral wound construction;

5 Figure 3 is a cross section view along line A-A of Figure 2;

Figure 4 is a diagrammatic view of an aerosol generating device;

Figure 5 is a schematic representation of a first electrical circuit;

Figure 6 is a schematic representation of a second electrical circuit; and

10 Figure 7 is a representation of a temperature profile during a pre-heating and heating phase of a vaping session.

Detailed Description of Embodiments

Embodiments of the present disclosure will now be described by way of example only and with reference to the accompanying drawings.

15

Referring initially to Figure 1, there is shown diagrammatically an example of an aerosol generating article 1. The aerosol generating article 1 has a proximal end 2 and a distal end 4.

20 The aerosol generating article 1 includes a capacitor 6 that includes an electrolyte. The capacitor 6 is surrounded by a paper wrapper 8 with a metal or polymer coating. An end cap 10a, 10b is provided at each end of the capacitor 6. The paper wrapper 8 and the end caps 10a, 10b define an outer casing for the capacitor 6 that contains the electrolyte and provides electrical insulation.

25

The aerosol generating article 1 may be generally cylindrical.

At the proximal end 2, the aerosol generating article 1 includes a mouthpiece 12 having an outlet 14 through which a user may inhale an aerosol that is generated by heating the electrolyte. Although not shown, the proximal end cap 10a may include appropriate
30 perforations or openings, or incorporate a suitable aerosol-permeable membrane material, so that the generated aerosol may pass through the end cap to the outlet 14.

- 18 -

Referring to Figure 2, the capacitor 6 is an electric double-layer capacitor and has a generally cylindrical, spiral wound (or “jelly roll”) construction. The capacitor 6 includes a positive electrode 16 and a negative electrode 18. The electrodes 16, 18 are separated by a pair of porous separators 20a, 20b. As shown more clearly in Figure 3, the positive electrode 16 includes a positive current collector 22. Each side of the positive current collector 22 is provided with a porous carbon-based electrode layer 24 such as a layer of porous charcoal material or activated carbon, for example. The negative electrode 18 includes a negative current collector 26. Each side of the negative current collector 24 is provided with a porous carbon-based electrode layer 28 such as a layer of porous charcoal material or activated carbon, for example. The positive and negative current collectors 22, 26 are aluminium foil layers, for example. The positive current collector 22 and the negative current collector 26 may enhance charging and discharging of the capacitor 6.

The separators 20a, 20b are formed from a tobacco material such as a porous tobacco sheet which releases volatile compounds when it is heated. In an alternative arrangement, which is not shown, the separators may be formed from a suitable cellulose- or polypropylene-based material and the electrolyte may flow through a tobacco material such as crumb tobacco that is downstream of the capacitor 6 in an aerosol flow path. The tobacco material may be positioned between the capacitor 6 (particularly the proximal end of the capacitor) and the mouthpiece 12. The tobacco material adds flavour and nicotine to the aerosol. The heating provided by the capacitor also heats or warms the tobacco material, which promotes the release of volatile compounds. Instead of the tobacco material, a flavour source without nicotine may be used. Additionally, or alternatively, the tobacco material may be embedded into the mouthpiece 12.

The electrodes 16, 18 and the separators 20a, 20b are immersed in an electrolyte which permits cation and anion migration when the capacitor 6 is charged or discharged, and generates an aerosol for inhalation by the user when it is heated. The electrolyte may comprise sodium chloride and glycerol, and optionally polyvinyl alcohol as a gelling

- 19 -

agent. The capacitor 6 is pre-charged during the manufacturing process and is packaged and sold to the user in a pre-charged state.

The aerosol generating article 1 includes a positive capacitor terminal 30 which is
5 electrically connected to the positive electrode 16, i.e., to the positive current collector 22 at one or more locations, and a negative capacitor terminal 32 which is electrically connected to the negative electrode 18, i.e., to the negative current collector 26, at one or more locations. The capacitor terminals 30, 32 may be located inside the outer casing of the aerosol generating article 1 so that they are not accessible to the user. This helps
10 to prevent the accidental or deliberate discharge of the capacitor 6 before the article is removably inserted into an aerosol generating device preparatory to starting a vaping session.

Figure 4 shows an aerosol generating device 34 adapted to receive the aerosol
15 generating article 1. The device 34 includes a cavity 36 into which the aerosol generating article 1 may be inserted.

The aerosol generating device 34 includes a pair of rupturing devices 38, 40 that are adapted to rupture the distal end cap 10b of the aerosol generating article 1 when it is
20 inserted into the cavity 36. The angular orientation of the aerosol generating article 1 relative to the aerosol generating device 34 may be restricted when it is inserted into the cavity 36 so that the rupturing device 38 makes an electrical connection with the positive capacitor terminal 30 and the rupturing device 40 makes an electrical connection with the negative capacitor terminal 32. Other ways of ensuring a reliable
25 electrical connection may be used. For example, the positive and negative terminals 30, 32 of the aerosol generating article 1 may have an annular construction and be located coaxial with each other so that appropriately positioned rupturing devices 38, 40 will make electrical contact with the terminals irrespective of the angular orientation of the aerosol generating article 1 relative to the aerosol generating device 34.

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The aerosol generating device 34 includes an electrical circuit 42 and a power source 44 such as a battery (e.g., lithium-ion secondary battery).

- 20 -

The aerosol generating device 34 includes an induction coil 46 that forms part of an induction heater. The current collectors 22, 26 of the capacitor 6 function as a susceptor of the induction heater. As described in more detail below, the induction heater is used
5 to heat the electrolyte in the capacitor 6 to generate an aerosol that may be inhaled by the user through the outlet 14 in the mouthpiece 12.

The aerosol generating device 34 includes a temperature sensor 48 for estimating or determining the temperature of the capacitor 6. The temperature sensor 48 may be
10 located in the cavity 36 of the aerosol generating device 34 or may be adapted to measure the temperature of the positive terminal of a switching circuit that is in thermal and electrical contact with the positive electrode 16 of the capacitor 6, and more particularly with the positive current collector 22. The temperature measurements provided by the temperature sensor 48 may be used to estimate the internal temperature
15 of the capacitor 6, for example by applying a suitable temperature offset.

A first example of an electrical circuit 42A is shown in Figure 5. The electrical circuit 42A includes a switching circuit 50, a low-dropout (LDO) regulator 52, an inverter 54, and microcontroller unit (MCU) 56.
20

The switching circuit 50 includes a DC/DC converter 58. The DC/DC converter 58 is electrically connected to the power source 44. It should be noted that the DC/DC converter 58 may be a buck (or step-down) converter, a boost (or step-up) converter, or a buck-boost converter and converts the DC input voltage from the power source 44
25 into a suitable DC output voltage. The DC/DC converter 58 may be omitted in some embodiments. The DC/DC converter 58 includes a voltage input terminal (labelled "VIN") and a voltage output terminal (labelled "VOUT"). A ground terminal (labelled "GND") is electrically connected to ground. The voltage input terminal is electrically connected to the power source 44. The DC/DC converter 58 includes a feedback
30 terminal (labelled "FB") which receives a DC output voltage feedback. The DC/DC converter 58 includes a serial data terminal (labelled "SDA") and a serial clock terminal (labelled "SCL") that are electrically connected to corresponding terminals of the MCU

- 21 -

56. The DC/DC converter 58 also includes an enable terminal (labelled "EN") that is electrically connected to a first input/output terminal (labelled "I/O1") of the MCU 56 and which allows the MCU to enable and disable operation of the DC/DC converter 58. In this embodiment, the enable terminal of the DC/DC converter 58 works according to positive logic – that is, the DC/DC converter 58 outputs a voltage from the voltage output terminal only when a high level signal is inputted to the enable terminal. It will be understood that the enable terminal may alternatively work according to negative logic.

The LDO regulator 52 is electrically connected to the power source 44. The LDO regulator 52 includes an input terminal (labelled "IN") that is electrically connected to the power source 44 and an output terminal (labelled "OUT") that provides a regulated voltage supply. A ground terminal (labelled "PGND") is electrically connected to ground. The LDO regulator 52 also includes an enable terminal (labelled "EN") that is electrically connected to the power source 44. In this embodiment, the enable terminal of the LDO regulator 52 works according to positive logic and the input and enable terminals of the LDO regulator 52 are electrically connected to the power source 44 in parallel. This means that the LDO regulator 52 continuously outputs a regulated voltage from the output terminal unless the power source 44 is unavailable.

The inverter 54 is electrically connected to the power source 44 in parallel with the DC/DC converter 58. The inverter 54 includes a positive input terminal (labelled "IN+") that is electrically connected to the power source 44 by means of a first semiconductor switch Q1 and a negative input terminal (labelled "IN-") that is electrically connected to ground. The inverter 54 includes a positive output terminal (labelled "OUT+") that is electrically connected to one end of the induction coil 46 by means of a second semiconductor switch Q2 and a negative output terminal (labelled "OUT-") that is electrically connected to the other end of the induction coil 46. The inverter 54 includes a serial data terminal (labelled "SDA") and a serial clock terminal (labelled "SCL") that are electrically connected to corresponding terminals of the MCU 56. The inverter 54 also includes an enable terminal (labelled "EN") that is electrically connected to a second input/output terminal (labelled "I/O") of the MCU 56 and which allows the MCU 56 to enable and disable operation of the inverter 54. The enable

- 22 -

terminal of the inverter 54 works according to either positive logic or negative logic. It should be noted that the inverter 54 is just an example for generating an AC current such that the induction coil 46 generates an alternating electromagnetic field for heating the capacitor 6. Other appropriate circuits can be used instead of the inverter 54 – e.g.,
5 an oscillating circuit comprising an oscillator, a switch and a capacitor. A pulsating current may be used instead of an AC current.

The switching circuit 50 includes a positive rail 60 that is electrically connected to the positive electrode 16 of the capacitor 6 and a ground rail 62 that is electrically connected
10 to the negative electrode 18 and to ground. Although not shown in Figure 5, it will be understood that the positive and ground rails 60, 62 may be electrically connected to the capacitor 6 by the pair of rupturing devices 38, 40 that make an electrical connection with the positive and negative capacitor terminals 30, 32. A third semiconductor switch Q3 is electrically connected between the positive and ground rails 60, 62 and provides
15 a short-circuit path between the positive and negative electrodes 16, 18 when it is switched on. This short-circuit path can be used to discharge the capacitor 6 and also to electrically connect the current collectors 22, 26 for eddy current flow when the induction heater is operated. The discharge/short-circuit current through the third semiconductor switch Q3 is shown by the bold arrow. The positive rail 60 is electrically
20 connected to the output voltage terminal of the DC/DC converter 58 by means of a fourth semiconductor switch Q4. When the DC/DC converter 58 is enabled, the fourth semiconductor switch Q4 can be switched on to charge the capacitor 6. The charging current is shown by the bold arrow. The third and fourth semiconductor switches Q3, Q4 may define a switching device of the switching circuit 50.

25 The switching circuit 50 optionally includes a self-closing bi-metallic switch 64 that is electrically connected between the positive and ground rails 60, 62 and provides a short-circuit path between the positive and negative electrodes 16, 18 above a threshold temperature (or switching temperature). If the bi-metallic switch 64 is used to provide
30 a short-circuit path, the switching circuit 50 may also include a detection circuit so that the MCU 56 knows to transition heating to the induction heater. The detection circuit may include a current sensing circuit 66 configured to detect the current through the bi-

- 23 -

metallic switch 64. The current sensing circuit 66 includes a shunt resistor 68 electrically connected in series with the bi-metallic switch 64 and a current sensing amplifier 70 electrically connected with the shunt resistor 68. The output of the current sensing amplifier 70 is electrically connected to a third input/output terminal (labelled "I/O") of the MCU 56. The detection circuit may also include a voltage sensing circuit 72 configured to detect the voltage across the capacitor 6 and where the voltage sensing circuit is electrically connected to a fourth input/output terminal (labelled "I/O") of the MCU 56. The voltage sensing circuit 72 may include a voltage divider. The short-circuit path may be detected based on the short-circuit current flowing through the current sensing circuit 66 and/or a rapid drop in the output voltage of the capacitor 6 detected by the voltage sensing circuit 72. In some embodiments, one or both of the current sensing circuit 66 and the voltage sensing circuit 72 may be omitted from the detection circuit. A recovery voltage of the capacitor 6 may also be useful to detect when the short-circuit path is formed. After a short-circuit path has been formed and the capacitor 6 has been discharged, an output voltage of the capacitor 6 may spontaneously increase (or "recover"). The recovery voltage of the capacitor 6 may be explained by the slow polarisation of the dielectric material of the capacitor. To detect this recovery voltage, only the voltage sensing circuit 72 is needed.

The MCU 56 includes an input voltage terminal (labelled "VDD") electrically connected to the output voltage terminal of the LDO regulator 52 and receives a regulated voltage supply. As noted above, the MCU 56 includes a serial data terminal (labelled "SDA") and a serial clock terminal (labelled "SCL") that are electrically connected to corresponding terminals of the DC/DC converter 58 and the inverter 54. The MCU 56 includes a ground terminal (labelled "GND") that is electrically connected to ground. As noted above, the MCU 56 includes first, second, third and fourth input/output terminals that are respectively electrically connected to the enable terminals of the DC/DC converter 58 and the inverter 54, and which receive inputs from the detection circuit 66, 72. A further current sensing circuit 74 is configured to detect the current through the capacitor 6 and includes a shunt resistor 76 electrically connected in series with the positive rail 60 of the switching circuit 50 and a current sensing amplifier 78 electrically connected with the shunt resistor 76. The output of the

- 24 -

current sensing amplifier 78 is electrically connected to a fifth input/output terminal (labelled "I/O") of the MCU 56.

The MCU 56 also includes:

- 5 – A sixth input/output terminal (labelled "I/O") that is electrically connected to the first semiconductor switch Q1 for switching it on and off. When the first semiconductor switch Q1 is switched on, the inverter 54 is electrically connected to the power source 44, and when it is switched off, the inverter is electrically disconnected from the power source 44.
- 10 – A seventh input/output terminal (labelled "I/O") that is electrically connected to the second semiconductor switch Q2 for switching it on and off. When the second semiconductor switch Q2 is switched on, the positive output terminal of the inverter 54 is electrically connected to the induction coil 46 so that the induction coil 46 generates an alternating electromagnetic field, and when it is
15 switched off the positive output terminal is electrically disconnected from the induction coil 46.
- An eighth input/output terminal (labelled "I/O") that is electrically connected to the third semiconductor switch Q3 for switching it on and off. When the third semiconductor switch Q3 is switched on, a short-circuit path is provided
20 between the positive and ground rails 60, 62, and hence between the first and second electrodes 16, 18 of the capacitor 6. This short-circuit path may be used to discharge the capacitor 6 or to facilitate eddy current flow between the current collectors 22, 26 which function as the susceptor when the electrolyte is heated by the induction heater. When the third semiconductor switch Q3 is switched
25 off there is no short-circuit path through the third semiconductor switch Q3.
- A ninth input/output terminal (labelled "I/O") that is electrically connected to the fourth semiconductor switch Q4 for switching it on and off. When the fourth semiconductor switch Q4 is switched on, the positive rail 60 is electrically connected to the output voltage terminal of the DC/DC converter 58 so that DC
30 current is applied to the positive electrode 16 of the capacitor 6 to charge the capacitor. When the fourth semiconductor switch Q4 is switched off, the positive rail 60 is electrically disconnected from the output voltage terminal of

- 25 -

the DC/DC converter 58 and no DC current is applied to the positive electrode 16 of the capacitor 6.

A second example of an electrical circuit 42B is shown in Figure 6. The second example of the electrical circuit 42B is substantially similar to the first example. The difference is that the inverter 54 is connected in series with the DC/DC converter 58. In particular, the positive input terminal (labelled "IN+") of the inverter 54 is electrically connected to the output voltage terminal (labelled "VOUT") of the DC/DC converter 58 by means of the first semiconductor switch Q1.

In both of the first and second examples of the electrical circuit 42A, 42B, an I2C communication protocol may be used for serial data communication between the MCU 56 and the inverter 54 and the DC/DC converter 58. Other suitable communication protocols such as SPI or UART may be also used.

Figure 7 is representative of a vaping session that includes a pre-heating phase PHP and a heating or vaping phase VP.

Before the start of the pre-heating phase, for example, when the aerosol generating article 1 is inserted into the aerosol generating device 34, an identification step (indicated by "(0)") is carried out to determine an operating parameter and status of the capacitor, and check the authenticity of the aerosol generating article. During the identification step, the pre-charged capacitor 6 is discharged a plurality of times (e.g., five times). Each discharge is only for a very short period of time (e.g., about 10-100 ms). An average value of an electrical parameter of the capacitor 6 such as internal resistance, capacitance, discharging rate, or SOC of the capacitor 6 is determined using at least one of current, voltage and time measurements taken during each discharge. The average value of the electrical parameter may be used to detect if the aerosol generating article 1 is damaged or faulty. The average value of the electrical parameter of the capacitor 6 may also be used to adjust operating characteristics of the aerosol generating device 34. Authenticity of the aerosol generating article 1 may be established if, for example, the average value of the electrical parameter is within a predefined

- 26 -

range or is above or below a predefined threshold. If the aerosol generating article 1 is not authentic, further operation of the device 34 may be stopped. The identification step may determine whether the aerosol generating article 34 is new or pre-used, and/or may be used to obtain one or more useful parameters for the vaping session. The
5 identification step is optional and may be omitted.

During the pre-heating phase PHP, the capacitor 6 is repeatedly cycled between discharging and charging to continuously heat the capacitor 6 (indicated by "(1)"). The capacitor 6 is discharged and charged at a particular discharging and charging power as
10 shown that can provide rapid heating of the capacitor 6 towards a target temperature. In particular, to discharge the capacitor 6 the third semiconductor switch Q3 is switched on by the MCU 56. A continuous short-circuit path may be provided or the short-circuit path may be discontinuous or intermittent – i.e., by switching the third semiconductor switch Q3 on and off repeatedly. Discharging the capacitor 6 through the switching
15 circuit 50 dissipates heat in the electrodes 16, 18. This heats the electrolyte. Pre-charging the capacitor 6 reduces the amount of energy that is required from the power source 44 of the device for pre-heating. This may lead to a reduction in the size and weight of the aerosol generating device 34. In particular, the size and weight of the power source 44 may be reduced. This is significant because the power source is often
20 the largest and heaviest component of the aerosol generating device 34. The capacitor 6 may also be charged from the power source 44 by switching on the fourth semiconductor switch Q4. The capacitor 6 may be charged continuously or discontinuously – i.e., by switching the fourth semiconductor switch Q4 on and off repeatedly. Heat may be generated by repeatedly discharging the capacitor 6 through
25 the switching circuit 50 and subsequently charging the capacitor from the power source 44.

The capacitor 6 may be discharged and charged between predefined upper and lower limits. In Figure 7 the upper and lower limits are expressed in terms of SOC and the
30 upper limit is about 50-80% and the lower limit is about 20-40%. Alternatively, the capacitor 6 may be charged to about 100% and/or discharged to about 0% to increase the efficiency of aerosol generation.

- 27 -

Once the threshold temperature has been reached, the capacitor 6 is not discharged or charged and the capacitor is heated instead by the induction heater (indicated "(2)"). The threshold temperature may be about 180-230°C, for example. The heating provided
5 by the induction heater may heat the capacitor 6 to a target temperature of about 280°C.

The MCU 56 may transition to heating the capacitor 6 by the induction heater when the temperature measured by the temperature sensor 48 reaches the threshold temperature.

10 The first semiconductor switch Q1 is switched on to electrically connect the inverter 54 to the power source 44. Heating can then be controlled by switching the second semiconductor switch Q2 on and off. When the second semiconductor switch Q2 is switched on, the inverter output is applied to the induction coil 46 to generate an alternating electromagnetic field. The current collectors 22, 26 of the capacitor 6
15 function as the susceptor of the induction heater and couple with the electromagnetic field to generate heat due to eddy currents and/or magnetic hysteresis, which heat is then transferred to the electrolyte to generate an aerosol for inhalation by the user. To permit eddy current flows, the MCU 56 switches on the third semiconductor switch Q3 to create a short-circuit path between the first and second electrodes 16, 18, i.e., between
20 the current collectors 22, 26.

During the vaping phase VP, the induction heater is alternated between a heating period and a non-heating period. For example, the induction heater may be operated intermittently using an appropriate duty cycle, e.g., where the second semiconductor
25 switch Q2 is periodically enabled and disabled with a duty cycle that may be varied to control the heating. The time for which the second semiconductor switch Q2 is switched on (or "pulse width") may be varied based on the estimated or determined temperature of the capacitor 6. A temperature estimation step may be carried out during a non-heating period – i.e., when the second semiconductor switch Q2 is switched off. During
30 each temperature estimation step, a series of current pulses are applied to the capacitor 6 by switching the fourth semiconductor switch Q4 on and off. The third semiconductor switch Q3 is switched off during the non-heating period when the current pulses are

- 28 -

applied to the capacitor 6 so that there is no short-circuit path between the first and second electrodes 16, 18. One or more values of an electrical parameter of the capacitor 6 may be estimated or determined using at least one of current, voltage and time measurements taken when the capacitor 6 is charged by applying the one or more
5 current pulses to the capacitor 6. Current and voltage measurements may be provided by the current and voltage sensing circuits 72, 74, for example. The electrical parameter may be the internal resistance or capacitance of the capacitor 6, for example. The electrical parameter may be used to estimate the temperature of the capacitor 6 using a suitable linear or non-linear function or look-up table, for example, that relates the value
10 of the electrical parameter to temperature.

If a bi-metallic switch 64 is provided, it will automatically switch to a closed state when the threshold temperature is reached. A short-circuit path between the pair of electrodes 16, 18 to facilitate eddy current flow can therefore be provided without having to
15 estimate or determine the temperature of the capacitor 6 and without having to then switch on the third semiconductor switch Q3. The on-resistance value of the bi-metallic switch 64 is also typically less than the on-resistance value of the third semiconductor switch Q3 to minimise on-state losses. The switching of the bi-metallic switch 64 is detected by the current and/or voltage sensing circuits 66, 72 and the MCU 56 will
20 transition to heating using the induction heater in the same way as described above – i.e., by enabling the inverter 54. The short-circuit path provided by the bi-metallic switch 64 will remain for as long as the temperature is above the threshold temperature and so it is not possible to carry out a temperature estimation step when the induction heater is in a non-heating period.

25 Although exemplary embodiments have been described in the preceding paragraphs, it should be understood that various modifications may be made to those embodiments without departing from the scope of the appended claims. Thus, the breadth and scope of the claims should not be limited to the above-described exemplary embodiments.

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- 29 -

Any combination of the above-described features in all possible variations thereof is encompassed by the present disclosure unless otherwise indicated herein or otherwise clearly contradicted by context.

- 5 Unless the context clearly requires otherwise, throughout the description and the claims, the words “comprise”, “comprising”, and the like, are to be construed in an inclusive as opposed to an exclusive or exhaustive sense; that is to say, in the sense of “including, but not limited to”.

- 30 -

Claims

1. An aerosol generating system comprising:
a capacitor (6) comprising an electrolyte which, when heated, generates an aerosol for inhalation by a user; and
5 an induction heater comprising an induction coil (46) and a susceptor (22, 26), wherein the induction heater is configured to heat the capacitor (6).
2. An aerosol generating system according to claim 1, wherein the capacitor (6) and the susceptor (22, 26) are part of an aerosol generating article (1) and the induction
10 coil (46) is part of an aerosol generating device (34) adapted to receive, in use, the aerosol generating article (1).
3. An aerosol generating system according to claim 1 or claim 2, wherein the capacitor (6) further comprises a pair of electrodes (16, 18) and a porous separator (20b)
15 between the electrodes (16, 18), each electrode (16, 18) comprising at least one electrode layer (24, 28) and a current collector (22, 26).
4. An aerosol generating system according to claim 3, wherein the susceptor
20 comprises the current collectors (22, 26).
5. An aerosol generating system according to claim 3 or claim 4, further comprising a switching circuit (50) electrically connected to the pair of electrodes (16, 18), wherein the switching circuit (50) comprises a switching device (Q3) configured to be controlled to provide a short-circuit path between the pair of electrodes (16, 18)
25 to discharge the capacitor (6).
6. An aerosol generating system according to claim 5, further comprising a thermal switching device (64) configured to provide a short-circuit path between the pair of electrodes (16, 18) when a temperature detected by the thermal switching device (64)
30 reaches or exceeds a threshold temperature.

- 31 -

7. An aerosol generating system according to claim 6, further comprising a detection circuit configured to detect the short-circuiting of the capacitor (6) by the thermal switching device (64), wherein the detection circuit comprises a current sensing circuit (66) comprising a shunt resistor (68) electrically connected in series with the thermal switching device (64) and a current sensing amplifier (70) electrically connected with the shunt resistor (68).

8. An aerosol generating system according to claim 6, further comprising a detection circuit configured to detect the short-circuiting of the capacitor by the thermal switching device, wherein the detection circuit comprises a voltage sensing circuit configured to detect the voltage across the capacitor.

9. An aerosol generating system according to any of claims 6 to 8, wherein the switching device comprises at least one switch (Q3) configured to provide a short-circuit path between the pair of electrodes (16, 18), wherein the at least one switch (Q3) has an on-resistance value, and wherein the thermal switching device (64) has an on-resistance value that is less than the on-resistance value of the at least one switch (Q3).

10. An aerosol generating system according to any of claims 5 to 9, further comprising a power source (44) and wherein the switching circuit (50) is further configured to control the charging of the capacitor (6) from the power source (44).

11. An aerosol generating system to claim 10, further comprising an inverter circuit (54) electrically connected to the induction coil (46), wherein the inverter circuit (54) and the switching circuit (50) are electrically connected in parallel to the power source (44).

12. A method of controlling an aerosol generating system, the aerosol generating system comprising:

a capacitor (6) comprising an electrolyte; and
induction heater comprising an induction coil (46) and a susceptor (22, 24);

- 32 -

wherein the capacitor (6) is discharged or is cycled between being discharged and charged to heat the electrolyte until a threshold temperature is reached, after which the electrolyte is heated by the induction heater to generate an aerosol for inhalation by a user.

5

13. A method according to claim 12, further comprising a temperature estimation step where the capacitor (6) is charged and a value of an electrical parameter of the capacitor (6) is estimated or determined, wherein the value of the electrical parameter is used to estimate a temperature of the capacitor (6).

10

14. A method according to claim 13, wherein the induction heater is alternated between a heating period and a non-heating period and wherein the temperature estimation step is carried out during a non-heating period.

15

15. A method according to claim 13 or claim 14, wherein the capacitor (6) is short-circuited at least during each heating period, wherein the capacitor (6) is optionally short-circuited by: (a) a thermal switching device (64) when a temperature detected by the thermal switching device (64) reaches or exceeds the threshold temperature and the short-circuiting is used to transition to heating the electrolyte by the induction heater, or (b) a switching device (Q3) when an estimated or measured temperature reaches or exceeds the threshold temperature.

20

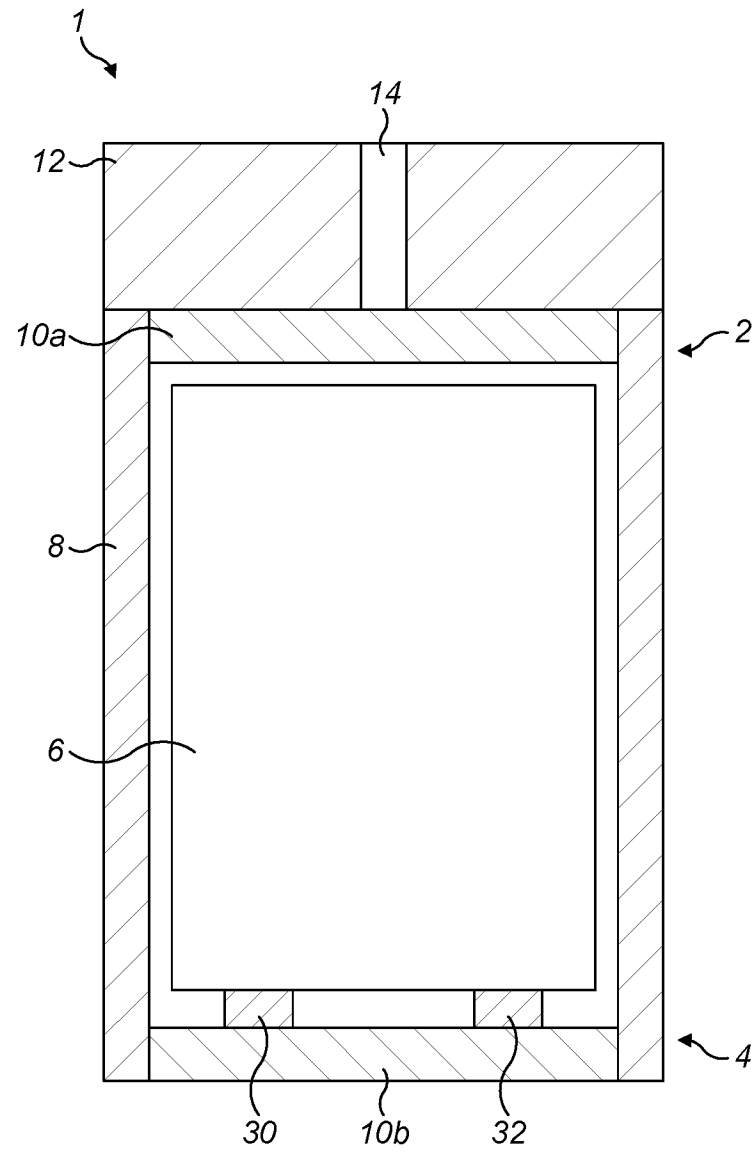


FIG. 1

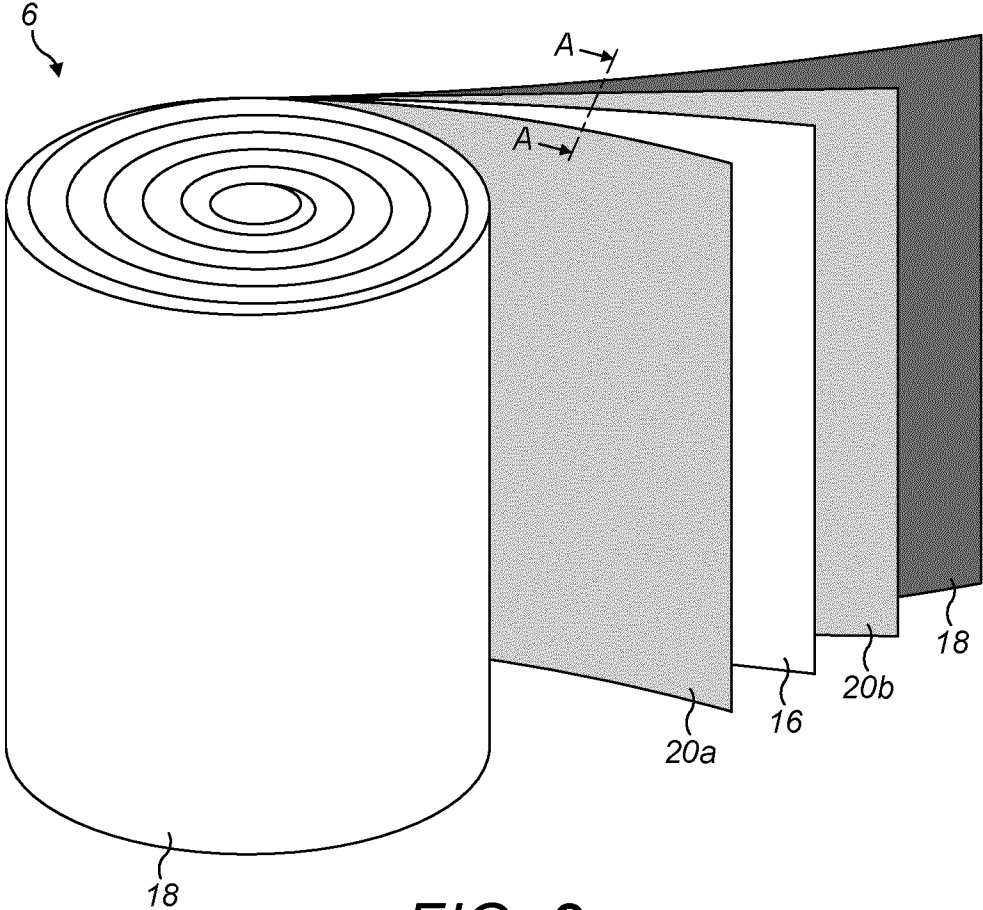


FIG. 2

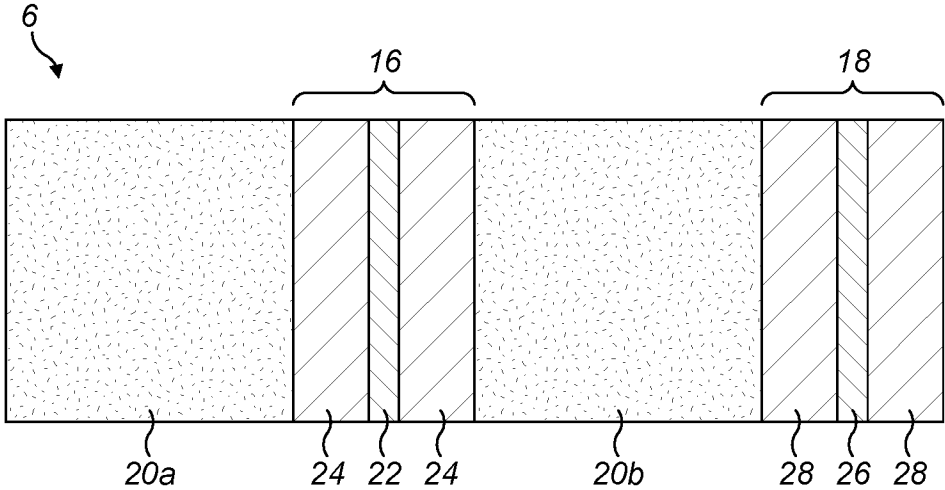
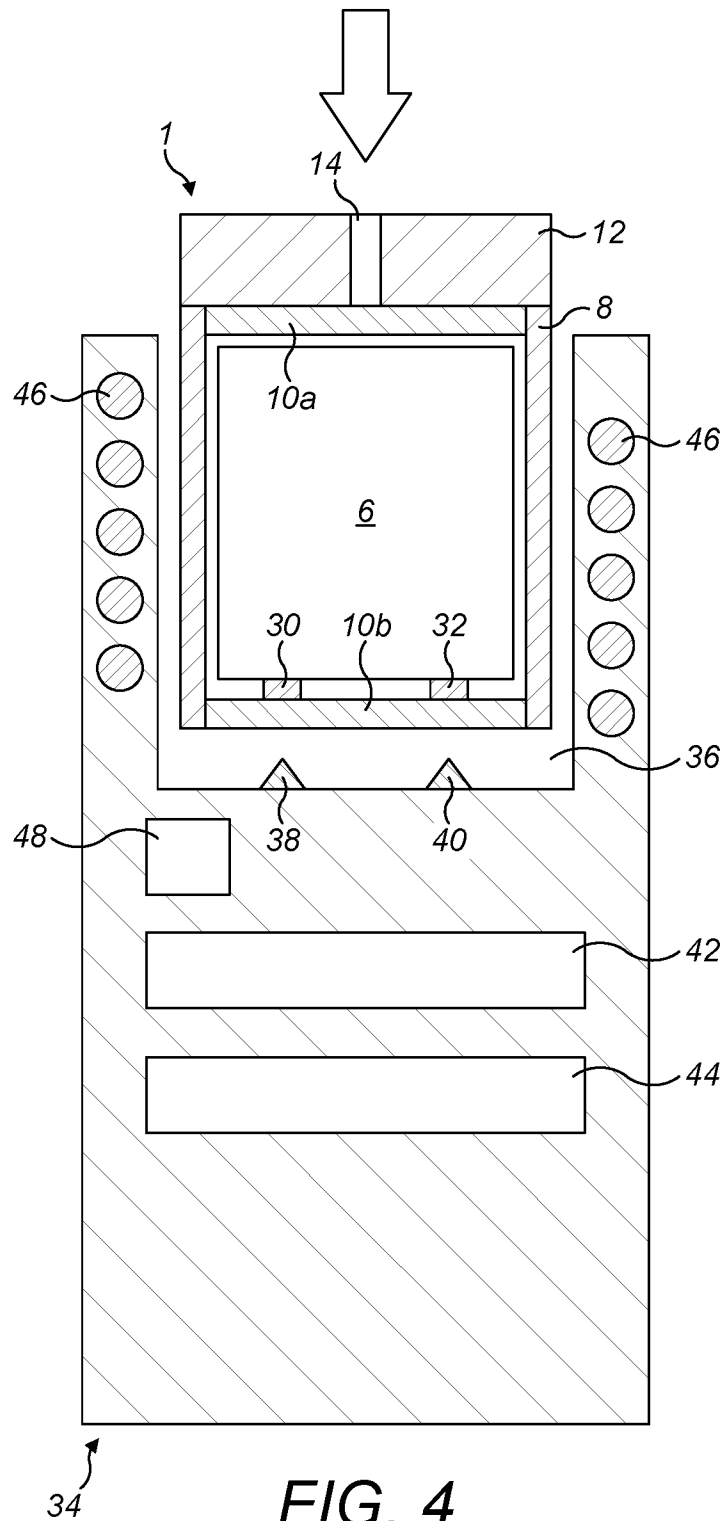


FIG. 3

3 / 6



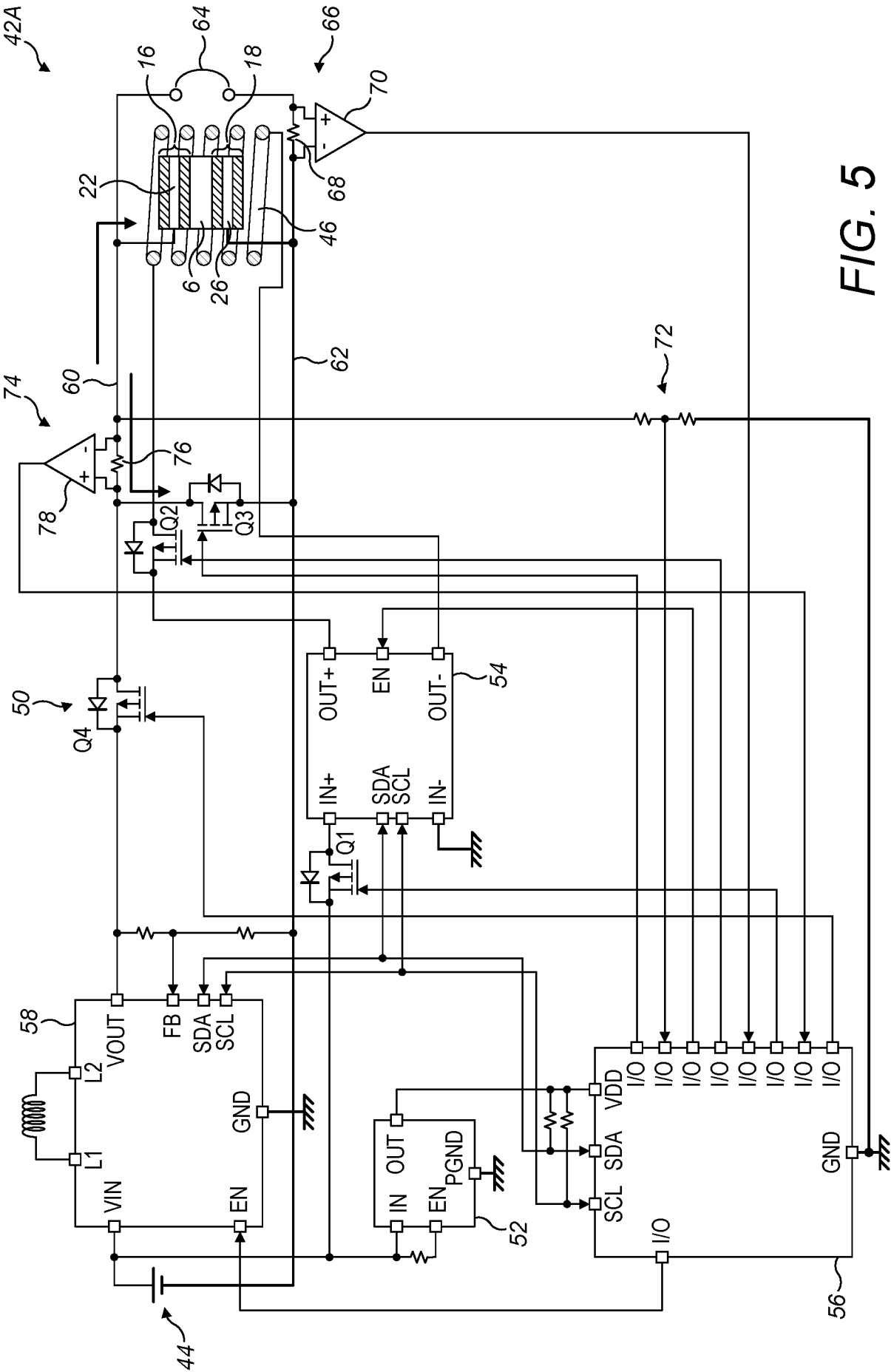


FIG. 5

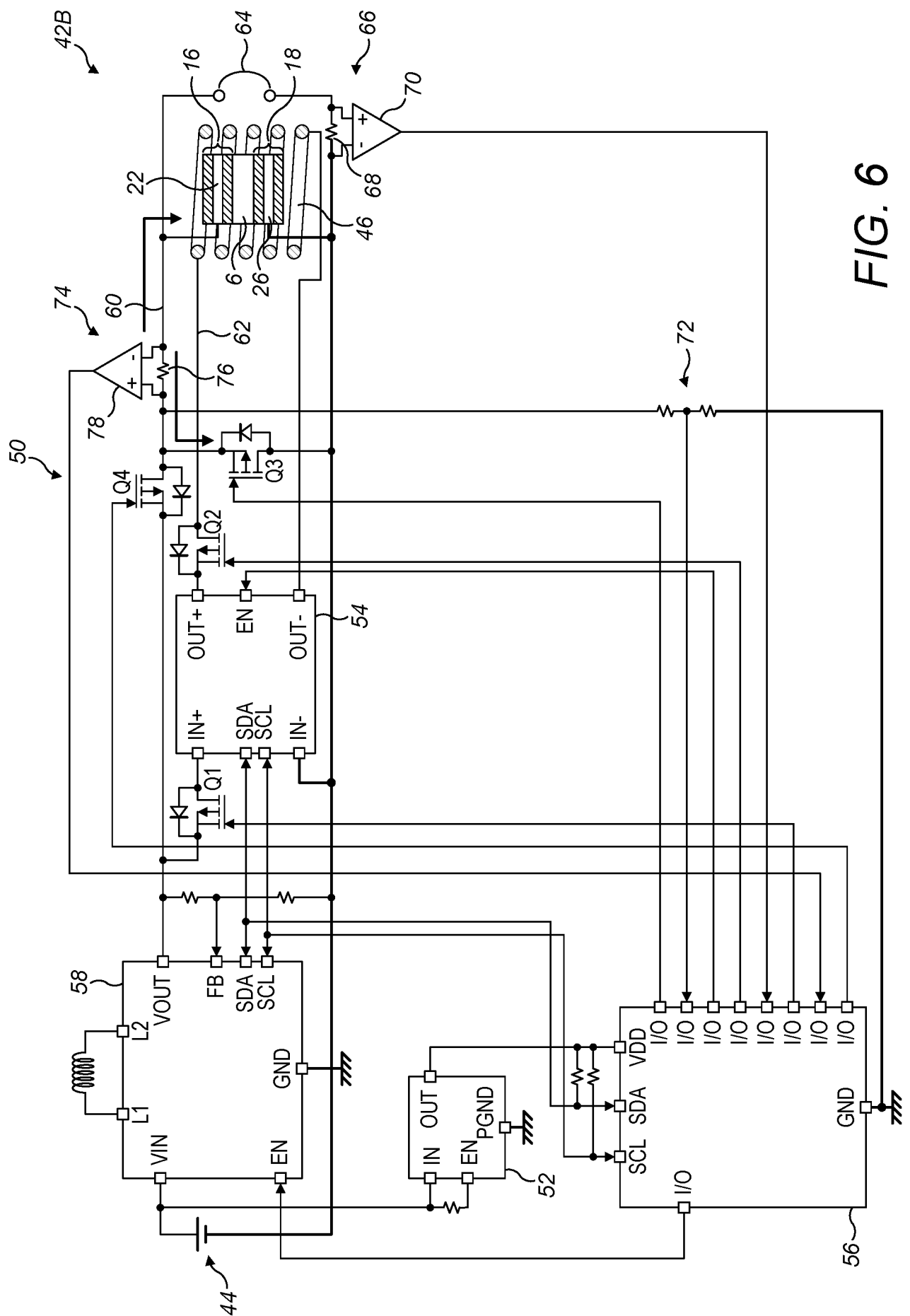


FIG. 6

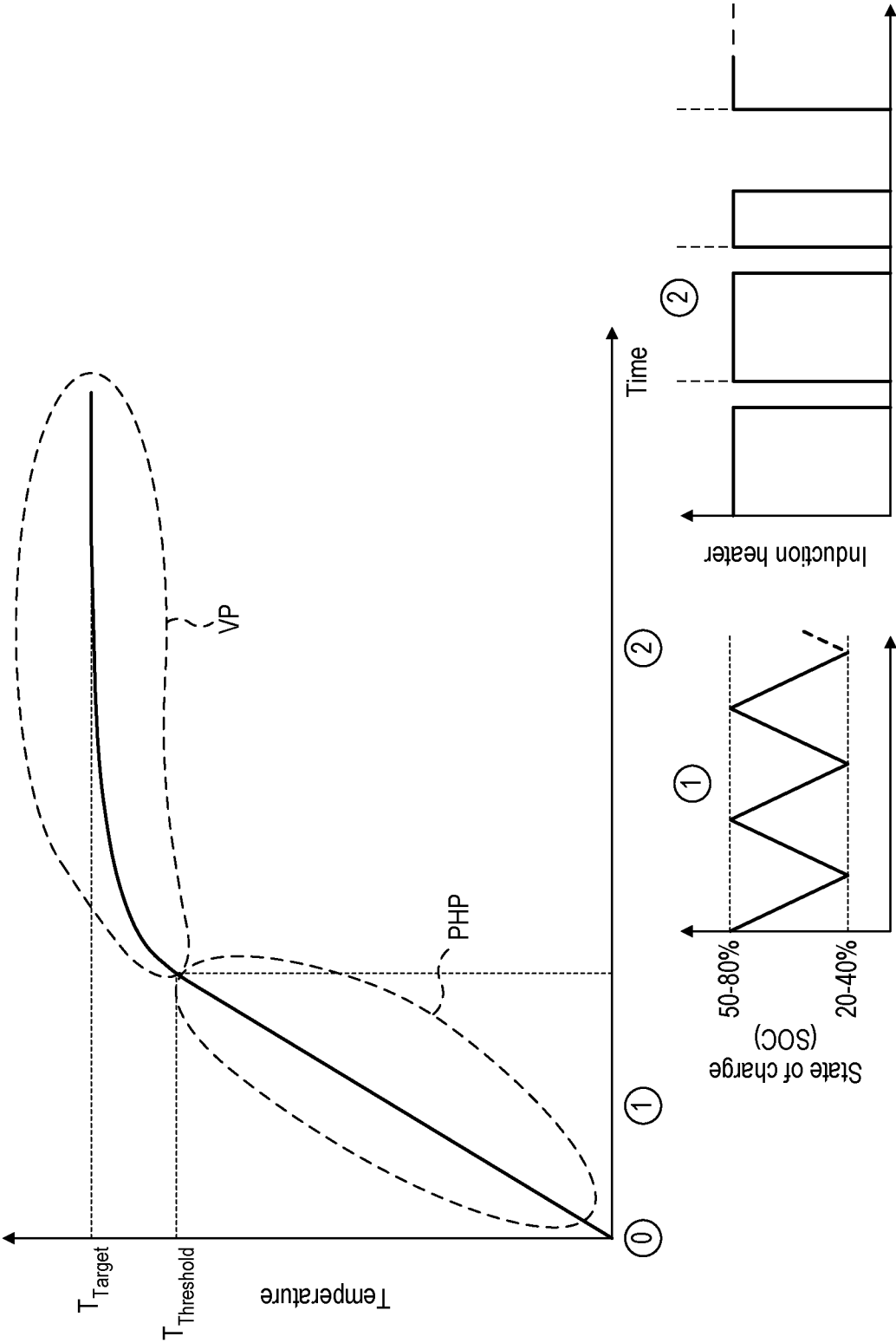


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/050104

A. CLASSIFICATION OF SUBJECT MATTER INV. A24F40/46 A24F40/20 A24F40/465 ADD.		
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) A24F A61M		
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) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2017/137505 A1 (PHILIP MORRIS PRODUCTS SA [CH]) 17 August 2017 (2017-08-17)	1-4,
A	page 1, lines 3-31	12-14
	page 15, line 18 - page 17, line 13;	5-11, 15
	figures 1-6, 9	

A	US 2022/183377 A1 (BLANDINO THOMAS PAUL [US] ET AL) 16 June 2022 (2022-06-16)	1-15
	paragraph [0002] - paragraph [0079]	

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search 25 March 2024		Date of mailing of the international search report 08/04/2024
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