(12) STANDARD PATENT (11) Application No. AU 2010324131 B2
(19) AUSTRALIAN PATENT OFFICE

(54) Title
An electrically heated smoking system with internal or external heater

(51) International Patent Classification(s)
A24F 47/00 (2006.01)

(21) Application No: **2010324131** (22) Date of Filing: **2010.11.26**

(87) WIPO No: **WO11/063970**

(30) Priority Data

(31) Number	(32) Date	(33) Country
09252687.0	**2009.11.27**	**EP**

(43) Publication Date: **2011.06.03**
(44) Accepted Journal Date: **2016.05.12**

(71) Applicant(s)
PHILIP MORRIS PRODUCTS S.A.

(72) Inventor(s)
Greim, Olivier;Plojoux, Julien;Ruscio, Dani;Zuber, Gerard

(74) Agent / Attorney
Fisher Adams Kelly Callinans, L 6 175 Eagle St, BRISBANE, QLD, 4000

(56) Related Art
US 5915387

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 June 2011 (03.06.2011)

PCT

(10) International Publication Number
WO 2011/063970 A1

(51) International Patent Classification: *A24F 47/00* (2006.01)

(21) International Application Number: PCT/EP2010/007178

(22) International Filing Date: 26 November 2010 (26.11.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data: 09252687.0 27 November 2009 (27.11.2009) EP

(71) Applicant *(for all designated States except US)*: **PHILIP MORRIS PRODUCTS S.A.** [CH/CH]; Quai Jeanrenaud 3, CH-2000 Neuchatel (CH).

(72) Inventors: **GREIM, Olivier**; Chemin des Sources, CH-1423 Villars-Burquin (CH). **PLOJOUX, Julien**; Rue Micheli-du-Crest, CH-1205 Geneva (CH). **RUSCIO, Dani**; Route de Troub 29, CH-2088 Cressier (CH). **ZUBER, Gerard**; Rue du Centre 12, CH-1752 Villars-sur-Glane (CH).

(74) Agent: **BRADFORD, Victoria, Sophie**; Reddie & Grose, 16 Theobalds Road, London WC1X 8PL (GB).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

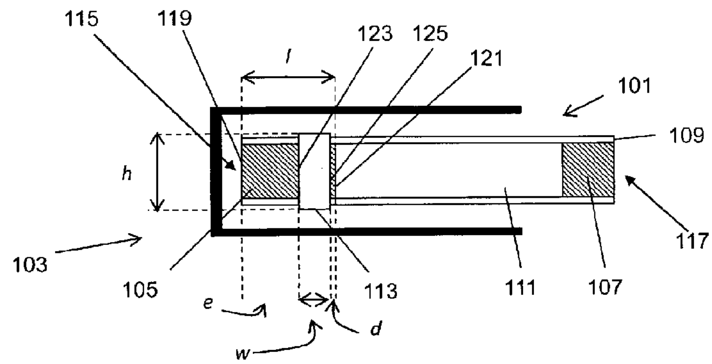
(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: AN ELECTRICALLY HEATED SMOKING SYSTEM WITH INTERNAL OR EXTERNAL HEATER

Figure 1



(57) Abstract: There is provided an electrically heated smoking system (103, 203) for receiving an aerosol-forming substrate (105, 205). The system comprises a heater for heating the substrate to form the aerosol, and the heater comprises a heating element (113, 213, 214). The electrically heated smoking system (103, 203) and the heating element (113, 213, 214) are arranged such that, when the aerosol-forming substrate (105, 205) is received in the electrically heated smoking system, the heating element (113, 213, 214) extends a distance only partially along the length of the aerosol forming-substrate, and the heating element is positioned towards the downstream end of the aerosol-forming substrate.

WO 2011/063970 A1

AN ELECTRICALLY HEATED SMOKING SYSTEM WITH INTERNAL OR EXTERNAL HEATER

The present invention relates to an electrically heated smoking system including a heater for heating an aerosol-forming substrate.

EP-A-0 358 002 discloses a smoking system comprising a cigarette with a resistance heating element for heating tobacco material in the cigarette. The cigarette has an electrical connection plug for connection to a reusable, hand held controller. The hand held controller includes a battery and a current control circuit which controls the supply of power to the resistance heating element in the cigarette.

One problem of such a proposed smoking system is that tobacco smoke tends to condense on the internal walls of the system. This is undesirable because condensation build up on the internal walls of the system can lead to reduced performance.

Accordingly, it is advantageous to provide an electrically heated smoking system which, in use, minimises the risk of smoke or aerosol condensation on its internal walls.

According to the invention, there is provided an electrically heated smoking system for receiving an aerosol-forming substrate, the system comprising a heater for heating the substrate to form the aerosol, the heater comprising a heating element, wherein the electrically heated smoking system and the heating element are arranged such that, when the aerosol-forming substrate is received in the electrically heated smoking system, the heating element extends a distance only partially along the length of the aerosol forming-substrate, and the heating element is positioned towards the downstream end of the aerosol-forming substrate.

According to another aspect of the invention, there is provided an electrically heated smoking system for receiving an aerosol-forming substrate, the system comprising a heater for heating the substrate to form the aerosol, the heater comprising a heating element, wherein the electrically heated smoking system and the heating element are arranged such that, when the aerosol-forming substrate is received in the electrically heated smoking system, the heating element extends a distance only partially along the length of the aerosol forming-substrate.

According to a further aspect of the invention, there is provided an electrically heated smoking system for receiving an aerosol-forming substrate, the system comprising a heater for heating the substrate to form the aerosol, the heater comprising a heating element, wherein the electrically heated smoking system and the heating element are arranged such that, when the aerosol-forming substrate is received in the electrically heated smoking system, the heating element is positioned towards the downstream end of the aerosol-forming substrate.

Positioning the heating element such that it extends only partially along the aerosol-forming substrate's length reduces the power required to heat the substrate and produce the aerosol.

Furthermore, positioning the heating element towards the downstream end of the aerosol-forming substrate also minimises the risk of condensation of the aerosol on the internal walls of the smoking system. This is because the non-heated portion of the aerosol-forming substrate (for example, a tobacco rod) located away from the heating element acts as a filtration zone, thereby minimising the risk of aerosol leaving the upstream end of the aerosol forming substrate.

In addition, positioning the heating element towards the downstream end of the aerosol-forming substrate shortens the zone contained between the downstream end of the heating element and the downstream end of the aerosol-forming substrate. This leads to a significant reduction in the energy required to generate an aerosol for the user. This also leads to a reduction in the time to first puff, that is to say, the time between energizing the heating element and providing the aerosol to a user.

The heating element may be an external heating element. Preferably, the heating element extends fully or partially around the circumference of the aerosol forming substrate. In one embodiment, the heating element extends substantially fully around the circumference of the aerosol forming substrate.

Alternatively, the heating element may be an internal heating element. In one embodiment, the heating element is arranged to be inserted into the aerosol forming substrate. The internal heating element may be positioned at least partially within or inside the aerosol forming substrate.

Preferably, the aerosol-forming substrate is substantially cylindrical in shape. The aerosol-forming substrate may be substantially elongate. The aerosol-forming substrate may also have a length and a circumference substantially perpendicular to the length. Preferably, the electrically heated smoking system comprises an aerosol-forming substrate in which the length of the aerosol-forming substrate is substantially parallel to airflow direction in the electrically heated smoking system.

Preferably, the electrical energy is supplied to the heating element (or, in embodiments where further heating elements are included, to one or more of the heating elements) until the heating element or elements reach a temperature of between approximately 250 °C and 440 °C. Any suitable temperature sensor and control circuitry may be used in order to control heating of the heating element or elements to reach the temperature of between approximately 250 °C and 440 °C. This is in contrast to conventional cigarettes in which the combustion of tobacco and cigarette wrapper may reach 800 °C.

The upstream and downstream ends of the electrically heated smoking system are defined with respect to the airflow when the user takes a puff. Typically, incoming air enters the electrically heated smoking system at the upstream end, combines with the aerosol, and carries the aerosol in the airflow towards the user's mouth at the downstream end. As known to those skilled in the art, an aerosol is a suspension of solid particles or liquid droplets or both solid particles and liquid droplets in a gas, such as air.

Preferably, the substrate forms part of a separate smoking article and the user may puff directly on the smoking article. The smoking article may be substantially cylindrical in shape. The smoking article may be substantially elongate. The smoking article may have a length and a circumference substantially perpendicular to the length. The smoking article may have a total length between approximately 30 mm and approximately 100 mm. The smoking article may have an external diameter between approximately 5 mm and approximately 12 mm. The smoking article may comprise a filter plug. The filter plug may be located at the downstream end of the smoking article. The filter plug may be a cellulose acetate filter plug. The filter plug is preferably approximately 7 mm in length, but may have a length of between approximately 5 mm to approximately 10 mm.

Preferably, the smoking article is a cigarette. In a preferred embodiment, the smoking article has a total length of approximately 45 mm. It is also preferable for the smoking article to have an external diameter of approximately 7.2 mm. Preferably, the aerosol forming substrate comprises tobacco. Further, the aerosol forming substrate may have a length of approximately 10 mm. However it is most preferable for the aerosol-forming substrate to have a length of approximately 12 mm. Further, the diameter of the aerosol forming substrate may also be between approximately 5 mm and approximately 12 mm. The smoking article may comprise an outer paper wrapper. Further, the smoking article may comprise a separation between the aerosol-forming substrate and the filter plug. The separation may be approximately 18 mm, but may be in the range of approximately 5 mm to approximately 25 mm.

The heating element being positioned towards the downstream end of the aerosol-forming substrate may be defined as the separation between the downstream end of the heating element and the downstream end of the aerosol-forming substrate, being less than the separation between the upstream end of the heating element and the upstream end of the aerosol-forming substrate.

Preferably, the downstream end of the heating element is upstream of the downstream end of the aerosol-forming substrate by a distance d equal to, or greater than, approximately 1 mm. By having a distance d of greater than, or equal to approximately 1mm (rather than having $d = 0$), this avoids the heater being immediately adjacent the non-aerosol forming part of the smoking article, such as the non-tobacco part of the cigarette (with the exception of the cigarette paper) downstream to the tobacco plug. This reduces heat dissipation through non-tobacco materials. Furthermore, this gap allows a reduction of mainstream smoke temperature.

Preferably, the upstream end of the heating element is downstream of the upstream end of the aerosol-forming substrate by a distance *e* between approximately 2 mm and approximately 6 mm. Even more preferably, the upstream end of the heating element is downstream of the upstream end of the aerosol-forming substrate by a distance *e* of approximately 4 mm.

The non-heated portion of the aerosol-forming substrate located at the upstream end, that is, between the upstream end of the aerosol-forming substrate and the upstream end of the heating element, provides an efficient filtration zone. This minimises the risk of aerosol leaving the upstream end of the aerosol forming substrate in the electrically heated smoking system. This also minimises the risk of condensation of aerosol inside the electrically heated smoking system, which minimises the number of cleaning operations required throughout the smoking system's lifetime. In addition, the non-heated upstream portion of the aerosol-forming substrate acts as a slow-release aerosol reservoir which may be accessible by thermal conduction through the substrate throughout the smoking experience.

Preferably, the ratio of the distance *w*, that the heating element extends along the aerosol-forming substrate, to the length *l* of the aerosol-forming substrate, $\frac{w}{l}$ is between approximately 0.35 and approximately 0.6. Even more preferably, the ratio $\frac{w}{l}$ is approximately 0.5.

The ratio of $\frac{w}{l}$ of between approximately 0.35 and approximately 0.6 has the advantage that it maximises the volume of aerosol delivered to the user, whilst minimising the amount of aerosol leaving the upstream portion of the aerosol forming substrate. This minimises the risk of condensation of the aerosol in the smoking system. Further, this ratio also has the advantage that it minimises heat loss through non-tobacco materials. This means that the smoking system requires less energy.

Even more preferably, the ratio of the distance that the heating element extends along the aerosol-forming substrate to the length of the aerosol-forming substrate is approximately 0.5. A ratio of approximately 0.5 (for an aerosol forming substrate such as a tobacco plug of either 10 or 12 mm) offers the best balance in terms of aerosol deliveries, minimisation of the risk of aerosol leaving the upstream end of the aerosol forming substrate and aerosol temperature.

In one embodiment of the electrically heated smoking system, the heater further comprises a second heating element arranged, when the aerosol-forming substrate is received in the electrically heated smoking system: to extend a distance *y* only partially along the length *l* of the aerosol-forming substrate; and to be upstream of the first heating element. The first heating element, the second heating element or both heating elements may extend substantially partially or fully around the circumference of the aerosol forming substrate.

In another embodiment, the heater further comprises a second heating element arranged, when the aerosol-forming substrate is received in the electrically heated smoking system, to extend a distance *y* only partially along the length *l* of the aerosol-forming substrate.

Providing a second heating element upstream of the first heating element allows different parts of the aerosol-forming substrate to be heated at different times. This is also advantageous, since the aerosol-forming substrate does not need to be reheated for example if the user wishes to stop and resume the smoking experience. In addition, providing two separate heating elements provides for more straightforward control of the temperature gradient along the aerosol-forming substrate and hence control of the aerosol generation. Preferably, the heating elements are independently controllable.

Further heating elements may be provided between the first and second heating elements. For example, the heater may comprise three, four, five, six or more heating elements.

Preferably, the separation between the first heating element and the second heating element is equal to or greater than approximately 0.5 mm. That is to say preferably, the separation between the upstream end of the first heating element and the downstream end of the second heating element is equal to or greater than approximately 0.5 mm. However, any separation between the first and second heating elements may be used, provided the first and second heating elements are not in electrical contact with each other.

Preferably, the upstream end of the second heating element is downstream of the upstream end of the aerosol-forming substrate by a distance *g* between approximately 2 mm and approximately 4 mm. Even more preferably, the upstream end of the second heating element is downstream of the upstream end of the aerosol-forming substrate by a distance *g* of approximately 3 mm.

Again, the non-heated portion of the aerosol-forming substrate located at the upstream end, that is, between the upstream end of the aerosol-forming substrate and the upstream end of the second heating element, provides an efficient filtration zone. This minimises the risk of aerosol escaping from the upstream end of the aerosol forming substrate in the electrically heated smoking system. This also minimises the risk of condensation of aerosol inside the electrically heated smoking system, which minimises the number of cleaning operations required throughout the electrically heated smoking system's lifetime. In addition, the non-heated upstream portion of the aerosol-forming substrate acts as a slow-release aerosol reservoir which may be accessible by thermal conduction through the substrate throughout the smoking experience.

For embodiments of the invention which have two heating elements, the lengths of both the heating elements may be slightly reduced (compared to the length of the heating element in embodiments of the invention which only have one heating element) in order to keep a zone upstream of the second heating element which is cooler than the heated portion of the aerosol forming substrate, and a zone downstream of the first heating element which is cooler than the heated portion of the aerosol forming substrate. That is to say, for embodiments of the invention which only have a single heating element, the heating element may have a length of approximately 4mm. Then, for embodiments of the invention which having two heating elements, the length of each heating element may be reduced to approximately 3mm, for example. A decrease in length may be compensated by a higher electrically power.

Alternatively, the first heating element (downstream) may have substantially the same dimension as the heating element in the smoking system which only has a single heating element, but the second heating element (upstream) may be shorter in length than the first heating element. That is to say, the first heating element has a length which is greater than the length of the second heating element. For example, the first heating element may have a length of approximately 4 mm, while the second heating element may have a length of approximately 3 mm.

This means that substantially equal aerosol yields and time to first puff are provided by the first and second heating elements.

Preferably, the ratio of the distance ($x + y$) that the first heating element and the second heating element together extend along the aerosol-forming substrate, to the length l of the aerosol-forming substrate $\frac{(x+y)}{l}$ is between approximately 0.5 and approximately 0.8.

The inventors have found that this range of the ratio $\frac{(x+y)}{l}$ maximises the advantages of the smoking experience. This ratio has the advantage that it maximises the aerosol delivery amount, whilst minimising the amount of aerosol escaping from the upstream portion of the aerosol forming substrate. This minimises the risk of condensation of the aerosol within the smoking system. Further, this ratio also has the advantage that it minimises heat loss through non-tobacco materials. This means that the smoking system requires less energy. A ratio of approximately 0.7 (for a tobacco plug of either 10 mm or 12 mm) offers the best balance in terms of aerosol deliveries, minimising the risk of aerosol leaving the upstream end of the aerosol forming substrate and aerosol temperature.

Each heating element may be in the form of a ring extending substantially partially or fully around the circumference of the aerosol-forming substrate. Preferably, the position of each heating element is fixed with respect to the electrically heated smoking system and hence the aerosol-forming substrate. Preferably, the heater does not include an end portion to heat the upstream end of the aerosol-forming substrate. This provides a non-heated portion of aerosol-forming substrate at the upstream end.

Each heating element preferably comprises an electrically resistive material. Each heating element may comprise a non-elastic material, for example a ceramic sintered material, such as alumina (Al_2O_3) and silicon nitride (Si_3N_4), or printed circuit board or silicon rubber. Alternatively, each heating element may comprise an elastic, metallic material, for example an iron alloy or a nickel-chromium alloy.

Other suitable electrically resistive materials include but are not limited to: semiconductors such as doped ceramics, electrically "conductive" ceramics (such as, for example, molybdenum disilicide), carbon, graphite, metals, metal alloys and composite materials made of a ceramic material and a metallic material. Such composite materials may comprise doped or undoped ceramics. Examples of suitable doped ceramics include doped silicon carbides. Examples of suitable metals include titanium, zirconium, tantalum and metals from the platinum group. Examples of suitable metal alloys include stainless steel, nickel-, cobalt-, chromium-, aluminium-titanium- zirconium-, hafnium-, niobium-, molybdenum-, tantalum-, tungsten-, tin-, gallium- and manganese- alloys, and super-alloys based on nickel, iron, cobalt, stainless steel, Timetal® and iron-manganese-aluminium based alloys. Timetal® is a registered trade mark of Titanium Metals Corporation, 1999 Broadway Suite 4300, Denver, Colorado. In composite materials, the electrically resistive material may optionally be embedded in, encapsulated or coated with an insulating material or vice-versa, depending on the kinetics of energy transfer and the external physicochemical properties required.

Alternatively, each heating element may comprise an infra-red heating element, a photonic source, or an inductive heating element.

Each heating element may comprise a heat sink, or heat reservoir comprising a material capable of absorbing and storing heat and subsequently releasing the heat over time to the aerosol-forming substrate. The heat sink may be formed of any suitable material, such as a suitable metal or ceramic material. Preferably, the material has a high heat capacity (sensible heat storage material), or is a material capable of absorbing and subsequently releasing heat via a reversible process, such as a high temperature phase change. Suitable sensible heat storage materials include silica gel, alumina, carbon, glass mat, glass fibre, minerals, a metal or alloy such as aluminium, silver or lead, and a cellulose material such as paper. Other suitable materials which release heat via a reversible phase change include paraffin, sodium acetate, naphthalene, wax, polyethylene oxide, a metal, metal salt, a mixture of eutectic salts or an alloy.

The aerosol-forming substrate preferably comprises a tobacco-containing material containing volatile tobacco flavour compounds which are released from the substrate upon heating. Alternatively, the aerosol-forming substrate may comprise a non-tobacco material.

Preferably, the aerosol-forming substrate further comprises an aerosol former. Examples of suitable aerosol formers are glycerine and propylene glycol.

In one embodiment, the aerosol-forming substrate is a solid or substantially solid substrate. The solid substrate may comprise, for example, one or more of: powder, granules, pellets, shreds, spaghettis, strips or sheets containing one or more of: herb leaf, tobacco leaf, fragments of tobacco ribs, reconstituted tobacco, homogenised tobacco, extruded tobacco and expanded tobacco. The solid substrate may be provided as a cylindrical plug of aerosol-forming substrate. Alternatively, the solid substrate may be provided in a suitable container or cartridge. Optionally, the solid substrate may contain additional tobacco or non-tobacco volatile flavour compounds, to be released upon heating of the substrate.

Optionally, the solid substrate may be provided on or embedded in a thermally stable carrier. The carrier may take the form of powder, granules, pellets, shreds, spaghettis, strips or sheets. Alternatively, the carrier may be a tubular carrier having a thin layer of the solid substrate deposited on its outer surface, or on both its inner and outer surfaces. Such a tubular carrier may be formed of, for example, a paper, or paper like material, a non-woven carbon fibre mat, a low mass open mesh metallic screen, or a perforated metallic foil or any other thermally stable polymer matrix. The solid substrate may be deposited on the surface of the carrier in the form of, for example, a sheet, foam, gel or slurry. The solid substrate may be deposited on the entire surface of the carrier, or alternatively, may be deposited in a pattern in order to provide a non-uniform flavour delivery during use.

Alternatively, the carrier may be a non-woven fabric or fibre bundle into which tobacco components have been incorporated. The non-woven fabric or fibre bundle may comprise, for example, carbon fibres, natural cellulose fibres, or cellulose derivative fibres.

The aerosol-forming substrate may alternatively be a liquid substrate. If a liquid substrate is provided, the electrically heated smoking system preferably comprises means for retaining the liquid. For example, the liquid substrate may be retained in a container. Alternatively or in addition, the liquid substrate may be absorbed into a porous carrier material. The porous carrier material may be made from any suitable absorbent plug or body, for example, a foamed metal or plastics material, polypropylene, terylene, nylon fibres or ceramic. The liquid substrate may be retained in the porous carrier material prior to use of the electrically heated smoking system or alternatively, the liquid substrate material may be released into the porous carrier material during, or immediately prior to use. For example, the liquid substrate may be provided in a capsule. The shell of the capsule preferably melts upon heating and releases the liquid substrate into the porous carrier material. The capsule may optionally contain a solid aerosol forming substrate in combination with the liquid.

Alternatively, or in addition, if the aerosol-forming substrate is a liquid substrate, the electrically heated smoking system may further comprise an atomiser in contact with the liquid substrate source and including the heating element or elements. The atomiser converts the liquid into an aerosol or fine mist of particles. The atomiser may comprise a liquid source connected to a tube. The tube may be heated by an electrical heater in close proximity to the tube, or in contact with the tube. The liquid is atomised when the tube is heated by the heater when electrical energy is passed through the heater.

In addition to the heating element or elements, the atomiser may include one or more electromechanical elements such as piezoelectric elements. Additionally or alternatively, the atomiser may also include elements that use electrostatic, electromagnetic or pneumatic effects. The electrically heated smoking system may still further comprise a condensation chamber.

The aerosol-forming substrate may alternatively be any other sort of substrate, for example, a gas substrate, or any combination of the various types of substrate. During operation, the substrate may be completely contained within the electrically heated smoking system. In that case, a user may puff on a mouthpiece of the electrically heated smoking system. Alternatively, during operation, the substrate may be partially contained within the electrically heated smoking system. In that case, the substrate may form part of a separate smoking article and the user may puff directly on the smoking article.

Preferably, the electrically heated smoking system further comprises a power supply for supplying power to the heating element or elements. The power supply may be any suitable power supply, for example a DC voltage source. In one embodiment, the power supply is a Lithium-ion battery. Alternatively, the power supply may be a Nickel-metal hydride battery or a Nickel cadmium battery.

Preferably, the electrically heated smoking system further comprises electronic circuitry arranged to be connected to the power supply and the heating element or elements. If more than one heating element is provided, preferably the electronic circuitry provides for the heating elements to be independently controllable. The electronic circuitry may be programmable.

In one embodiment, the system further comprises a sensor to detect air flow indicative of a user taking a puff. The sensor may be an electro-mechanical device. Alternatively, the sensor may be any of: a mechanical device, an optical device, an opto-mechanical device and a micro electro mechanical systems (MEMS) based sensor. In that embodiment, preferably, the sensor is connected to the power supply and the system is arranged to activate the heating element or elements when the sensor senses a user taking a puff. In an alternative embodiment, the system further comprises a manually operable switch, for a user to initiate a puff.

Preferably, the system further comprises a housing for receiving the aerosol-forming substrate and designed to be grasped by a user.

Features described in relation to one aspect of the invention may also be applicable to another aspect of the invention.

The invention will be further described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram showing a first embodiment of the electrically heated smoking system in use with a smoking article;

Figure 2 is a schematic diagram showing a second embodiment of the electrically heated smoking system in use with a smoking article;

Figure 3 is a detailed view of a cross-section of an external heating element according to one embodiment of the invention, which may be used in conjunction with Figure 1 or Figure 2;

Figure 4 is a detailed view of an external heating element laid out flat according to one embodiment of the invention, which may be used in conjunction with Figure 1 or Figure 2;

Figure 5 is a detailed view of an external heating element laid out flat according to another embodiment of the invention, which may be used in conjunction with Figure 1 or Figure 2; and

Figures 6 to 11 show a method for forming an internal heater according to one embodiment of the invention.

Figure 1 shows a smoking article 101 received in an electrically heated smoking system 103 according to a first embodiment of the invention. In this embodiment, the smoking article 101 has an elongate cylindrical shape and comprises an aerosol-forming substrate 105, and a filter plug 107, arranged sequentially and in coaxial alignment. The components 105 and 107 are overwrapped with an outer paper wrapper 109. In this embodiment, the aerosol-forming substrate 105 is in the form of a cylindrical plug of solid substrate. The length *l* of the plug is substantially parallel to the length of the smoking article and also substantially parallel to the direction of airflow (not shown) in the electrically heated smoking system when a user puffs on the smoking article. The circumference of the plug is substantially perpendicular to the length. The filter plug 107 is located at the downstream end of the smoking article 101 and, in this embodiment, is separated from the aerosol-forming substrate 105 by separation 111.

As already discussed, various types of smoking article may be used in the context of the present invention. The smoking article does not need to be of the form illustrated in Figure 1. In particular, the smoking article does not have to have a length of aerosol-forming substrate which is substantially perpendicular to its circumference.

In the first embodiment illustrated in Figure 1, the electrically heated smoking system 103 comprises a heater having a heating element 113. The heating element is resistive, and heats up as electrical current is passed through the heating element. In this embodiment, the heating element 113 is in the form of a ring, having a width *w* and a diameter *h*.

In Figure 1, the upstream end of the smoking article 101 is labelled 115, while the downstream end of the smoking article is labelled 117. Further, the upstream end of the aerosol-forming substrate is labelled 119, while the downstream end of the aerosol-forming substrate is labelled 121. Finally, the upstream end of the heating element is labelled 123, while the downstream end of the heating element is labelled 125.

In an alternative embodiment, the heater may be an internal heater. An internal heater is one which is placed within the aerosol forming substrate, for example as described in our co-pending European Patent Application No. 09252501.3, filed 29 October 2009, the contents of which are hereby incorporated in their entirety. The internal heater may be manufactured as described below with reference to Figures 6 to 11.

In an alternative embodiment the heater may comprise a temperature sensor used as an internal heater which is placed inside the aerosol-forming substrate. An example of a suitable internal heater is a PT resistive temperature sensor which may be used as an internal heater. The PT resistive temperature sensor may be made by Heraeus Sensor Technology, Reinhard-Heraeus-Ring, 23D-63801, Kleinostheim, Germany.

In the case of both internal and external heaters the heating element 113 extends only partially along the length *l* of the cylindrical plug of aerosol-forming substrate 105. That is to say, the width *w* of the heating element 113 is less than the length *l* of the plug of aerosol-forming substrate 105. The heating element 113 is positioned towards the downstream end 121 of the aerosol-forming substrate 105.

In the embodiment illustrated in Figure 1, the downstream end 125 of the heating element 113 is upstream of the downstream end 121 of the cylindrical plug of aerosol-forming substrate 105. In this embodiment, the separation between the downstream end 125 of the heating element 113 and the downstream end 121 of the cylindrical plug of aerosol-forming substrate 105 is *d*. Also in this embodiment, the upstream end 123 of the heating element 113 is downstream of the upstream end 119 of the cylindrical plug of aerosol-forming substrate 105. In this embodiment, the separation between the upstream end 123 of the heating element 113 and the upstream end 119 of the cylindrical plug of aerosol-forming substrate 105 is *e*.

The inventors of the present invention have found the various dimensions of the heating element 113 and the plug of aerosol-forming substrate 105, as well as the relative positions of the heating element 113 and the plug of aerosol-forming substrate 105, can be adjusted to substantially improve the smoking experience. In particular, the time to first puff can be reduced. That is to say, the time between the heating element being activated and the user being able to take a first puff on the smoking article can be reduced. In addition, the power required to generate the aerosol and sustain that aerosol generation can be reduced. In addition, this minimises the risk of aerosol leaving the upstream portion of the aerosol forming substrate. Furthermore, condensate and other residues forming on the inside of the electrically heated smoking system can be minimised, which minimises cleaning required.

As already mentioned, the heating element 113 is positioned towards the downstream end of the aerosol-forming substrate 105. That is to say, $d < e$. For an aerosol-forming substrate containing tobacco, positioning the heating element 113 towards the downstream end of the aerosol-forming substrate 105 shortens the tobacco filtration zone contained between the downstream end of the heating element 113 and the downstream end of the plug of aerosol-forming substrate 105 (that is to say, reduces *d*). This leads to a significant reduction of the energy required to generate a pleasant smoke and similarly leads to a reduction of the time to first puff. However, it is preferable for *d* not to be reduced to zero, as previously described. In fact, it has been found that, in order to maximise the advantages of the smoking experience, the separation between the downstream end of the heating element 113 and the downstream end of the cylindrical plug of aerosol-forming substrate 105, *d*, should be greater than or equal to 1 mm.

In addition, it has been found that, in order to maximise the advantages of the smoking experience, the separation between the upstream end 123 of the heating element 113 and the upstream end 119 of the (preferably) cylindrical plug of aerosol-forming substrate 105, *e*, should be between 2 mm and 6 mm and, more preferably, 4 mm. This non-heated portion of the cylindrical plug located at the upstream end provides an efficient filtration zone to minimise the risk of aerosol leaving the upstream end of the aerosol forming substrate of the smoking article. Consequently, this minimises the risk of condensation of aerosol, such as tobacco smoke, inside the internal walls of the electrically heated smoking system 103, which minimises the number of cleaning operations required throughout the lifetime of the electrically heated smoking system. Moreover, the non-heated zone acts as a slow-release smoking material reservoir which may be accessible by thermal conduction inside the plug during the smoking experience.

In addition, it has been found that, in order to maximise the advantages of the smoking experience, the width *w* of the heating element 113 in relation to the length *l* of the plug of aerosol-forming substrate 105, as well as the positioning of the heating element 113 in relation to the plug of aerosol-forming substrate 105 can be adjusted. In particular, it has been found that the ratio of the width of the heating element to the length of the plug of aerosol-forming substrate, $\frac{w}{l}$ should be between 0.35 and 0.6, more preferably, 0.5. The ratio $\frac{w}{l}$ as well as *w* itself, may be adjusted to appropriately deliver the aerosol up to a desired number of puffs.

Figure 2 shows a smoking article 201 received in an electrically heated smoking system 203 according to a second embodiment of the invention. In this embodiment, just like in Figure 1, the smoking article 201 has an elongate cylindrical shape and comprises an aerosol-forming substrate 205, and a filter plug 207, arranged sequentially and in coaxial alignment. The components 205 and 207 are overwrapped with an outer paper wrapper 209. In this embodiment, the aerosol-forming substrate 205 is in the form of a cylindrical plug of solid substrate. The length *l* of the plug may be substantially parallel to the length of the smoking article and also substantially parallel to the direction of airflow (not shown) in the electrically heated smoking system when a user puffs on the smoking article. The circumference of the plug may be substantially perpendicular to the length. The filter plug 207 is located at the downstream end of the smoking article 201 and, in this embodiment, is separated from the aerosol-forming substrate 205 by separation 211.

As already discussed, various types of smoking article may be used in the context of the present invention. The smoking article does not need to be of the form illustrated in Figure 2. For example, the smoking article doe not necessarily have to have a length of aerosol-forming substrate substantially perpendicular to its circumference.

In the second embodiment illustrated in Figure 2, the electrically heated smoking system 203 comprises a heater having a first heating element 213 and a second heating element 214 upstream of the first heating element. In this embodiment, the heating elements 213, 214 are both in the form of rings. That is to say that the heaters are external heating elements. The heating elements are resistive, and heat up as electrical current is passed through the heating element.

In Figure 2, the upstream end of the smoking article 201 is labelled 215, while the downstream end of the smoking article is labelled 217. Further, the upstream end of the aerosol-forming substrate is labelled 219, while the downstream end of the aerosol-forming substrate is labelled 221. Further, the upstream end of the first heating element 213 is labelled 223, while the downstream end of the first heating element 213 is labelled 225. Finally, the upstream end of the second heating element 214 is labelled 227, while the downstream end of the second heating element 214 is labelled 229.

In an alternative embodiment, one or more of the heaters may be an internal heater. An internal heater is one which is placed within the aerosol forming substrate, for example as described in our co-pending European Patent Application No. 09252501.3, filed 29 October 2009, the contents of which are hereby incorporated in their entirety. The internal heater may be manufactured as described below with reference to Figures 6 to 11.

In an alternative embodiment, the heater may comprise a temperature sensor used as an internal heater which is placed inside the aerosol-forming substrate. An example of a suitable internal heater is a PT resistive temperature sensor used as an internal heater. The PT resistive temperature sensor may be made by Heraeus Sensor Technology, Reinhard-Heraeus-Ring, 23D-

63801, Kleinostheim, Germany.

Two such heaters may be placed adjacent each other and clamped or held in position on a holder to form the first heating element 213 and the second heating element 214 upstream of the first heating element.

For both internal and external heaters, the width of the first heating element 213 is *x* and the width of the second heating element 214 is *y*. In this embodiment, both heating elements 213, 214 have the same diameter *h* although the diameters need not be equal. Both heating elements 213, 214 may extend substantially surround the circumference of the cylindrical plug of aerosol-forming substrate 205. Alternatively, one or more of the heating elements may be an internal heater inserted inside the aerosol forming substrate as previously described. However, each heating element extends only partially along the length *l* of the cylindrical plug of aerosol-forming substrate 205. That is to say, the width *x* of the first heating element 213 is less than the length *l* of the plug of aerosol-forming substrate 205 and the width *y* of the second heating element 214 is also less than the length *l* of the plug of aerosol-forming substrate 205. In addition, both heating elements together extend only partially along the length of the cylindrical plug of aerosol-forming substrate 205. That is to say, $(x + y)$ is less than the length *l* of the plug of aerosol-forming substrate 205. The first heating element 213 is positioned towards the downstream end 221 of the aerosol-forming substrate 205, and the second heating element 214 is positioned upstream of the first heating element 213 and separated from the first heating element by a distance *s*. In other words the upstream end 223 of the first heating element 213 is separated from the downstream end 229 of the second element 214 by a distance *s*.

In this embodiment, the downstream end 225 of the first heating element 213 is upstream of the downstream end 221 of the plug of aerosol-forming substrate 205. In this embodiment, the separation between the downstream end 225 of the first heating element 213 and the downstream end 221 of the cylindrical plug of aerosol-forming substrate 205 is *f*. Also in this embodiment, the upstream end 227 of the second heating element 214 is downstream of the upstream end 219 of the cylindrical plug of aerosol-forming substrate 205. In this embodiment, the separation between the upstream end 227 of the second heating element 214 and the upstream end 219 of the cylindrical plug of aerosol-forming substrate 205 is *g*. As already mentioned, the separation between the heating elements 213 and 214 is *s*.

The inventors of the present invention have found that the various dimensions of the heating elements 213, 214 and the plug of aerosol-forming substrate 205, as well as the relative positions of the heating elements 213, 214 and the plug of aerosol-forming substrate 205 can be adjusted to substantially improve the smoking experience. In particular, the time to first puff can be reduced. That is to say, the time between the heating element or elements being activated and the user being able to take a first puff on the smoking article can be reduced. In addition, the power required to generate the aerosol and sustain that aerosol generation can be reduced. In addition, this minimises the risk of aerosol escaping from the upstream portion of the aerosol forming substrate. Furthermore, the risk of condensate and other residues forming on the inside of the electrically heated smoking system can be minimised, which minimises cleaning required.

As already mentioned, the heating elements 213, 214 are positioned towards the downstream end of the aerosol-forming substrate 205. That is to say, $f < g$. For an aerosol-forming substrate containing tobacco, positioning the heating elements 213, 214 towards the downstream end of the aerosol-forming substrate 205 shortens the tobacco filtration zone contained between the downstream end of the first heating element 213 and the downstream end of the plug of aerosol-forming substrate 205 (that is to say, reduces *f*). This leads to a significant reduction of the energy required to generate a pleasant smoke and similarly leads to a reduction of the time to first puff. However, it is preferable for *f* not to be reduced to zero, as previously described. In fact, it has been found that, in order to maximise the advantages of the smoking experience, the separation between the downstream end of the first heating element 213 and the downstream end of the cylindrical plug of aerosol-forming substrate 205, *f*, should be greater than or equal to 1 mm.

In addition, it has been found that, in order to maximise the advantages of the smoking experience, the separation between the upstream end 227 of the second heating element 214 and the upstream end 219 of the (preferably) cylindrical plug of aerosol-forming substrate 205, *g*, should be between 2 mm and 4 mm and, more preferably, 3 mm. This non-heated portion of the cylindrical plug located at the upstream end 219 of the aerosol forming substrate provides an efficient filtration zone to minimise the risk of aerosol escaping from the upstream portion of the aerosol forming substrate. Consequently, this minimises the risk of condensation of aerosol, for example tobacco smoke, inside the internal walls of the electrically heated smoking system 203. This minimises the number of cleaning operations required throughout the lifetime of the electrically heated smoking system. Moreover, the non-heated zone acts as a slow-release smoking material reservoir which may be accessible during the smoking experience by thermal conduction inside the aerosol-forming substrate.

In order to maximise *g*, so as to provide an efficient filtration zone and, at the same time, minimise *f*, so as to reduce the power requirements, the separation *s* of the heating elements 213, 214 should be minimised. However, it has been found that *s* should not be reduced to zero, as previously described. In fact, it has been found that, in order to maximise the advantages of the smoking experience, the separation *s* between the upstream end 223 of the first heating element 213 and the downstream end 229 of the second heating element 214 should be greater than or equal to about 0.5 mm.

In addition, it has been found that, in order to maximise the advantages of the smoking experience, the combined width $(x + y)$ of the heating elements 213, 214 in relation to the length l of the plug of aerosol-forming substrate 205, as well as the positioning of the heating elements 213, 214 in relation to the plug of aerosol-forming substrate 205 can be adjusted. In particular, it has been found that the ratio of the combined width of the heating elements to the length of the plug of aerosol-forming substrate, $\frac{(x+y)}{l}$ should be between 0.5 and 0.8. The ratio $\frac{(x+y)}{l}$ as well as x and y, may be adjusted to appropriately deliver the aerosol up to a desired number of puffs.

Figure 3 is a detailed view of a cross-section of an external heating element according to one embodiment of the invention. Figure 4 is a detailed view of an external heating element laid out flat, according to one embodiment of the invention and Figure 5 is a detailed view of an external heating element laid out flat according to another embodiment of the invention. The external heating elements of Figures 3, 4 and 5 may be used in conjunction with the embodiments of both Figure 1 and Figure 2. Note that, for the sake of clarity, Figures 1, 2, 3, 4 and 5 are not to the same scale.

Figure 3 is a section through the external heating element 113, 213, 214. As shown in Figure 3, the heating element 113, 213, 214 may take the form of an incomplete ring, having a diameter h. An electrical connection to a voltage V+ is made at A, and an electrical connection to a voltage V- is made at B. The ring is incomplete because a gap or separation may be formed in the ring to provide the electrical connections A and B. In Figure 3, the gap between the two terminals A and B has been exaggerated for the sake of clarity. However, the gap or spacing between the two terminals is preferably as small as possible, whilst not permitting an electrical short circuit between the two terminals. The gap between the two terminals may be 0.5 mm or 1 mm.

In Figure 3, an aerosol forming substrate 105, 205 is located inside or within the external heating element. In Figure 3, the aerosol forming substrate 105, 205 is surrounded by a paper wrapper 109, 209. However this is, in fact, optional. In the case in which the aerosol forming substrate is surrounded by an outer paper wrapper, the heating element may be in physical contact with the outer paper wrapper to allow for efficient transfer of heat to the aerosol forming substrate via the paper wrapper. In the case in which there is no paper wrapper, the heating element 113, 213, 214 may be in physical contact with aerosol forming substrate to directly transfer heat to the aerosol forming substrate.

Figure 4 shows the heating element in which the ring is laid out flat to show the detailed structure of the heating element. The heating element may comprise one or more substantially u-shaped segments, each u-shaped segment having two substantially straight portions electrically connected to each other by a semi-circular portion. One or more of the u-shaped elements are joined together at the end of the one of the straight portions of the u-shaped elements to form the structure shown in Figure 4. The straight portions may be substantially parallel to one another. In use, the straight portions may be positioned so that they are substantially parallel to the longitudinal axis of the smoking article. The heating element may extend substantially fully around the circumference of the aerosol forming substrate. The heating element may be stamped out from suitable sheet material and then formed into the ring shape as shown in Figure 3.

Figure 5 shows another embodiment of the heating element in which the ring is laid out flat to show the detailed structure of the heating element. The heating element shown in Figure 5 comprises a rectangle of sheet material. The heating element may be stamped out from suitable sheet material and then formed into the ring shape as shown in Figure 3, by shaping or bending.

Other shapes of the heating element are possible such as one or more semi-circular rings, each ring electrically joined to its neighbour such that when it is laid out flat, the semicircular rings form an elongated structure that extends in a particular direction. The rings are arranged so that they form troughs and peaks in a rippled or wavy structure. As before, the heating element may be flat stamped out of a piece of suitable material using a suitably shaped stamp. The heating element may then be bent into the appropriate shape, as shown in Figure 3. The heating element may also be mechanically attached to the rest of the smoking system, to prevent relative movement of the housing and the heater.

Preferably control circuitry is provided which controls when the voltages are applied to A and B. When a potential difference is applied between A and B, electrical current flows along the heating element from A to B or from B to A, and the heating element heats up as a result of the Joule heating effect which occurs in the heating element. In an alternative embodiment, the heating element does not have to comprise one or u-shaped elements, but may be substantially annular in shape with a portion of the annulus removed to allow electrical connection of a potential difference.

The provision of two heating elements in the embodiment of Figure 2 allows the user to stop and resume the smoking experience without needing to reheat any portion of the substrate. One possible method of usage is as follows. Firstly, the first (downstream) heating element 213 is activated at the start of the smoking experience. Then, the heating element 213 is deactivated at one of the following events: 1) the puff count of the first heating element 213 reaches a predetermined limit, 2) the user terminates the smoking experience, or 3) the smoking article 201 is removed from the electrically heated smoking system 203. Then, the second (upstream) heating element 214 may be activated at one of the following events: 1) the user wishes to resume the smoking experience after a short or extended break, or 2) the puff count of the first heating element 213 has reached a predetermined limit so the second heating element 214 needs to be activated in order to begin heating a new portion of the substrate.

This method allows a fresh portion of the substrate to be heated for each heating sequence. One or more further heating elements may be provided between the downstream heating element and the upstream heating element.

The heating elements shown in Figures 1, 2, 3, 4 and 5 may be made from any suitable material, for example an electrically resistive material. Preferred materials include a ceramic sintered material, such as alumina (Al_2O_3) and silicon nitride (Si_3N_4), printed circuit board, silicon rubber, an iron alloy or a nickel-chromium alloy.

The aerosol-forming substrates shown in Figures 1, 2, 3, 4 and 5 may be provided in any suitable form. In the illustrate embodiments, the substrate is a solid substrate in the shape of a cylindrical plug which forms part of a smoking article. The substrate may alternatively be a separate substrate which may be directly inserted into the electrically heated smoking system.

Figures 6 to 11 show a manufacturing process for the internal heater using a technique similar to that used in screen printing.

Referring to Figure 6, firstly an electrically insulating substrate 601 is provided. The electrically insulating substrate may comprise any suitable electrically insulating material, for example, but not limited to, a ceramic such as MICA, glass or paper. Alternatively, the electrically insulating substrate may comprise an electrical conductor that is insulated from the electrically conductive tracks (produced in Figure 7 and discussed below), for example, by oxidizing or anodizing its surface or both. One example is anodized aluminium. Alternatively, the electrically insulating substrate may comprise an electrical conductor to which is added an intermediate coating called a glaze. In that case, the glaze has two functions: to electrically insulate the substrate from the electrically conductive tracks, and to reduce bending of the substrate. Folds existing in the electrically insulating substrate can lead to cracks in the electrically conductive paste (applied in Figure 7 and discussed below) causing defective resistors.

Referring to Figure 7, the electrically insulating substrate is held securely, such as by a vacuum, while a metal paste 701 is coated onto the electrically insulating substrate using a cut out 703. Any suitable metal paste may be used but, in one example, the metal paste is silver paste. In one particularly advantageous example, the paste comprises 20% to 30% of binders and plasticizers and 70% to 80% of metal particles, typically silver particles. The cut out 703 provides a template for the desired electrically conductive tracks. After the metal paste 701 has been coated onto the electrically insulating substrate 601, the electrically insulating substrate and paste are fired, for example, in a sintering furnace. In a first firing phase at between 200 °C and 400 °C, the organic binders and solvents are burned out. In a second firing phase at between 350 °C and 500 °C the metal particles are sintered.

Referring to Figure 8, the result is an electrically insulating substrate 601 having an electrically conductive track or tracks 801 thereon. The electrically conductive track or tracks comprises heating resistors and the necessary connection pads. Finally, the electrically insulating substrate 601 and electrically conductive tracks 801 are formed into the appropriate form for use as a heater in an electrically heated smoking system.

Referring to Figure 9, the electrically insulating substrate 601 may be rolled into tubular form, such that the electrically conductive tracks lie on the inside of the electrically insulating substrate. In that case, the tube may function as an external heater for a solid plug of aerosol-forming material. The internal diameter of the tube may be the same as or slightly bigger than the diameter of the aerosol-forming plug.

Referring to Figure 10, alternatively, the electrically insulating substrate 601 may be rolled into tubular form, such that the electrically conductive tracks lie on the outside of the electrically insulating substrate. In that case, the tube may function as an internal heater and can be inserted directly into the aerosol-forming substrate. This may work well when the aerosol forming substrate takes the form of a tube of tobacco material, for example, such as tobacco mat. In that case, the external diameter of the tube may be the same as or slightly smaller than the internal diameter of the aerosol-forming substrate tube.

Referring to Figure 11, alternatively, if the electrically insulating substrate 601 is sufficiently rigid or is reinforced in some way, some or all of the electrically insulating substrate and electrically conductive tracks may be used directly as an internal heater simply by inserting the electrically insulating substrate and electrically conductive tracks directly into the aerosol-forming substrate.

2010324131 09 Feb 2015

CLAIMS

1. An electrically heated smoking system for receiving an aerosol-forming substrate the system including a heater for heating the substrate to form the aerosol, the heater including a heating element, wherein the electrically heated smoking system and the heating element are arranged such that, when the aerosol-forming substrate is received in the electrically heated smoking system, the heating element extends a distance only partially along the length of the aerosol forming-substrate, and the heating element is positioned towards the downstream end of the aerosol-forming substrate, wherein the ratio of the distance that the heating element extends along the aerosol-forming substrate, to the length of the aerosol-forming substrate, is between 0.35 and 0.6, and wherein the downstream end of the heating element is upstream of the downstream end of the aerosol-forming substrate by a distance equal to or greater than 1 mm.

2. An electrically heated smoking system according to claim 1 in which the heating element extends substantially fully around the circumference of the aerosol forming substrate.

3. An electrically heated smoking system according to any preceding claim in which the heating element is arranged to be inserted into the aerosol forming substrate.

4. An electrically heated smoking system according to any preceding claim, wherein the upstream end of the heating element is downstream of the upstream end of the aerosol-forming substrate by a distance between 2 mm and 6 mm.

5. An electrically heated smoking system according to any preceding claim, wherein the upstream end of the heating element is downstream of the upstream end of the aerosol-forming substrate by a distance of around 4 mm.

6. An electrically heated smoking system according to any preceding claim, wherein the ratio of the distance that the heating element extends along the aerosol-forming substrate to the length of the aerosol-forming substrate is around 0.5.

7. An electrically heated smoking system according to any one of claims 1 to 3, wherein the heater further includes a second heating element arranged, when the aerosol-forming substrate is received in the electrically heated smoking system: to extend a distance only partially along the length of the aerosol-forming substrate, and to be upstream of the first heating element.

8. An electrically heated smoking system according to claim 7, wherein the separation between the upstream end of the first heating element and the downstream end of the second heating element is equal to or greater than 0.5 mm.

9. An electrically heated smoking system according to claim 7 or claim 8, wherein the upstream end of the second heating element is downstream of the upstream end of the aerosol-forming substrate by a distance between 2 mm and 4 mm.

10. An electrically heated smoking system according to any one of claims 7 to 9, wherein the upstream end of the second heating element is downstream of the upstream end of the aerosol-forming substrate by a distance of around 3 mm.

11. An electrically heated smoking system according to any one of claims 7 to 10, wherein the ratio of the distance that the first heating element and the second heating element together extend along the aerosol-forming substrate, to the length of the aerosol-forming substrate is between 0.5 and 0.8.

12. An electrically heated smoking system according to any preceding claim, wherein the aerosol-forming substrate is a solid substrate.

13. An electrically heated smoking system according to any preceding claim, wherein the aerosol-forming substrate is a liquid substrate.

Figure 1

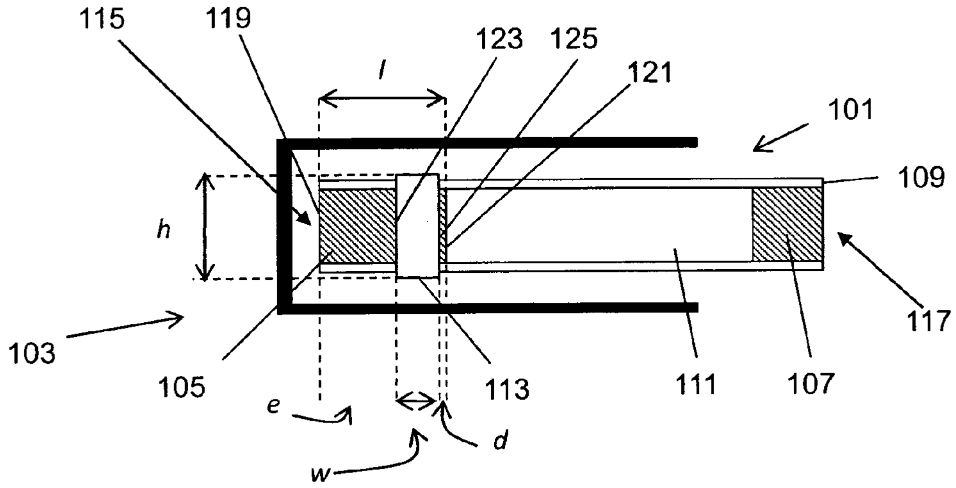


Figure 2

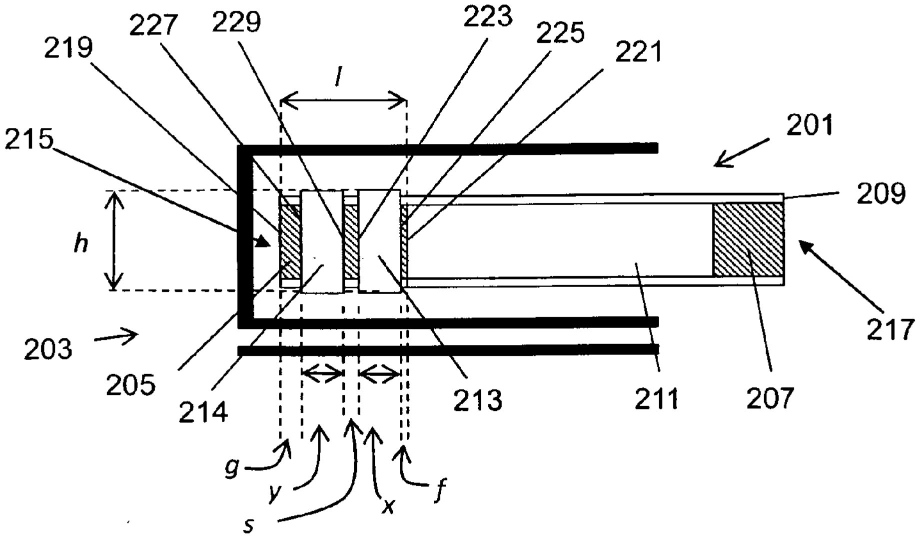


Figure 3

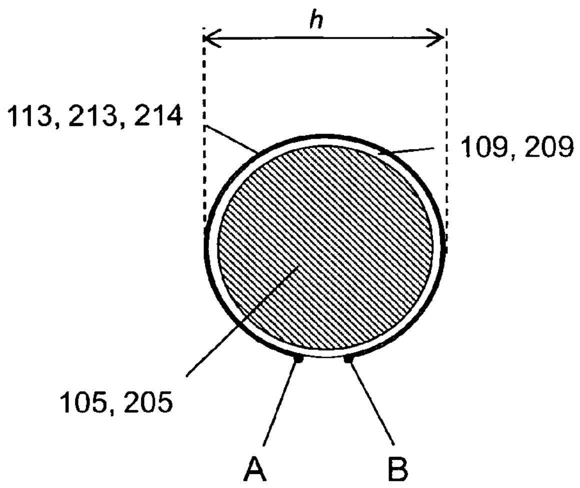


Figure 4

Figure 5

Figure 6

Figure 7

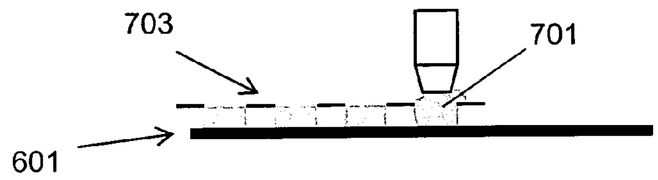


Figure 8

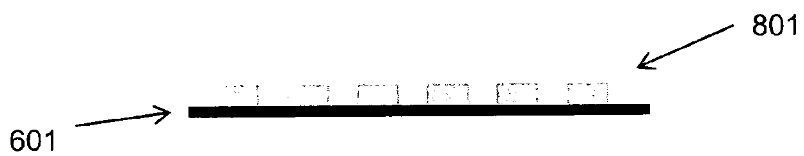


Figure 9

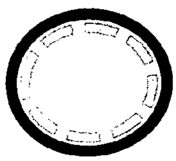


Figure 10

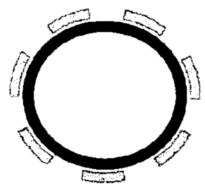


Figure 11