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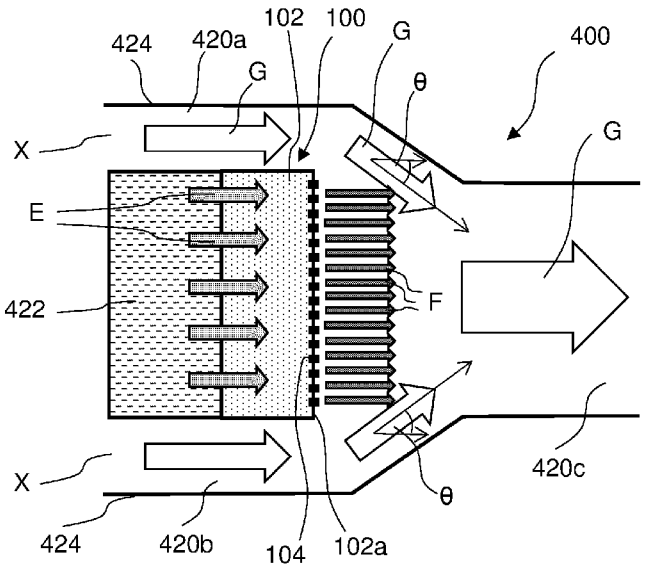


FIG. 6

(57) Abstract: An aerosol-generating system (400) comprising: a heater assembly (100) comprising: a heating element (104) and a porous body (102), the porous body having a liquid absorption surface (102b) and a heating surface (102a), the heating element being located on the heating surface of the porous body; wherein the heating element is fluid permeable such that, in use, vapour is emitted from the heater assembly in an average vapour emission direction; wherein the aerosol-generating system further comprises an air inlet and an aerosol outlet to define an airflow pathway through the aerosol-generating system; wherein the heater assembly is arranged in fluid communication with the airflow pathway such that air flows past the heater assembly in an average airflow direction, wherein the heater assembly and airflow pathway are arranged such that an angle between the average vapour emission direction and the average airflow direction is less than 90 degrees.

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AEROSOL-GENERATING DEVICE HAVING IMPROVED AEROSOL EXTRACTION

The present disclosure relates to an aerosol-generating system. In particular, but not exclusively, the present disclosure relates to a handheld electrically operated aerosol-generating system for heating an aerosol-forming substrate to generate an aerosol and for delivering the aerosol into the mouth of a user.

Aerosol-generating systems that heat a liquid aerosol-forming substrate in order to generate an aerosol for delivery to a user are generally known in the prior art. These aerosol-generating systems typically include a portion for holding a liquid aerosol-forming substrate and a heater assembly for heating the liquid aerosol-forming substrate. In one known type of aerosol-generating system, the heater assembly comprises a resistive heating element wound around a wick that supplies liquid aerosol-forming substrate to the heating element. In another known type of aerosol-generating system, the heater assembly comprises a solid porous body having a heating element arranged on one of its surfaces. The porous body conveys liquid aerosol-forming substrate to the heating element. When a user takes a puff on the aerosol-generating system, air is drawn through the aerosol-generating system and an electric current is passed through the heating element causing it to be heated by resistive or Joule heating. The heating element heats the liquid aerosol-forming substrate supplied by the wick or porous body causing volatile compounds to be released from the liquid aerosol-forming substrate, which cool to form an aerosol. The aerosol is then drawn into a user's mouth via a mouthpiece of the aerosol-generating system.

A problem encountered with known aerosol-generating systems is that the aerosol generated by the heater is not properly entrained in the airflow through the aerosol-generating system. Consequently, aerosol may condense on the internal surfaces of the aerosol-generating system. If sufficient aerosol condenses on the internal surfaces of the aerosol-generating system, large droplets of liquid aerosol-forming substrate may form and flow to the user's mouth. This can result in an unpleasant and undesirable user experience. Furthermore, condensation within the aerosol-generating system may damage the system, for example, by corroding surfaces or damaging circuitry.

The inventors have found that condensation within an aerosol-generating system can arise due to a number of factors. One factor is the arrangement of the heater assembly relative to the airflow pathway. Figure 1 shows a schematic cross-sectional view of a known type of heater assembly 1 arranged in an airflow pathway. The heater assembly 1 comprises a solid porous body 2 and a heating element 4. The heating element 4 is formed as a continuous track on a lower surface of the solid porous body 2 and a number of track sections 4a of the

heating element 4 are visible in cross-section in Figure 1. The heater assembly 1 is designed to be arranged in an opening at the base of a reservoir or liquid storage portion (not shown) for holding a liquid aerosol-forming substrate. An upper surface of the heater assembly 1 receives liquid aerosol-forming substrate from the liquid storage portion and the liquid aerosol-forming substrate is conveyed through the solid porous body 2 to the heating element 4, as denoted by arrows A in Figure 1.

The liquid aerosol-forming substrate is vaporised by the heat from the heating element 4 and vapour is emitted from the lower surface of the solid porous body 2 between the heating element track sections 4a, as denoted by arrows B in Figure 1. The heater assembly 1 is arranged such that its lower surface faces into the oncoming airflow path, denoted by arrows C in Figure 1. The airflow path C flows from an air inlet (not shown) towards the lower surface of the heater assembly 1 such that the airflow direction opposes the vapour emission direction B from the lower surface of the heater assembly 1. The vapour emitted from the heater assembly is entrained in the airflow path C and cools to form an aerosol. Aerosol-laden air then follows the airflow path C around and past the heater assembly 1 and continues to an aerosol outlet (not shown) where the aerosol is delivered into the mouth of a user.

To entrain the vapour in the airflow, the direction of the vapour needs to be changed from its vapour emission direction B to that of the airflow path C. The change in the vapour direction is denoted by arrows D in Figure 1. As can be seen in Figure 1, entraining the vapour in the airflow path C requires the airflow to almost completely reverse the vapour emission direction such that the vapour is made to flow in the opposite direction together with the airflow. The opposing directions of the vapour and airflow result in a significant loss of momentum for the vapour and airflow and can result in recirculation or turbulence in the airflow path C such that the aerosol is not properly entrained in the airflow and extracted from the device. Furthermore, the loss of momentum and turbulence of the aerosol and airflow can result in the vapour impinging on the internal surfaces (not shown) defining the airflow path C to form a condensate, which can accumulate to form droplets of liquid aerosol-forming substrate. This problem can be overcome to some extent by increasing the speed of the airflow. However, an increased airflow speed can adversely affect the heater assembly by cooling the heating element such that it takes longer to reach the boiling point of the liquid aerosol-forming substrate and aerosolization performance is reduced.

Another factor which causes condensation within an aerosol-generating system is vapour jet speed. Vapour jets are created in the heater assembly 1 of Figure 1 when the liquid aerosol-forming substrate is vaporised in the solid porous body 2 when thermal energy is provided by the heating element 4. The thermal energy or heat increases the temperature of

the heating track 4a, the solid porous body 2 and the liquid aerosol-forming substrate contained within the porous body 2. Once the boiling temperature of the liquid aerosol-forming substrate is reached, the liquid vaporises. The heating element track 4a of known heater assemblies is typically formed from a resistive metallic element which is not fluid permeable. Therefore, the vapour cannot escape from the solid porous body 2 in the regions underlying the heating element track 4a and vapour pressure builds up in these regions of the porous body 2. The vapour cannot pass through the heating track 4a and has to bypass it. Therefore, the vapour jets out on either side of the heating track as illustrated in Figure 1 by arrows B. The inventors have found that the vapour jets produced by known heater assembly can have a relatively high speed when a standard amount of operational power is supplied to the heater assembly. For example, a vapour emission speed of 0.5 metres per second was measured when 6.3 watts of power was provided to the heater assembly. Such a speed was found to be sufficient for the vapour to impinge on the internal walls of the airflow path C within the aerosol-generating system and form condensation.

It would be desirable to provide an aerosol-generating system that reduces aerosol condensation within the system. It would also be desirable to provide an aerosol-generating system that increases the entrainment of aerosol in the airflow through the system to improve aerosol extraction.

According to an example of the present disclosure, there is provided an aerosol-generating system. The aerosol-generating system may comprise a heater assembly. The heater assembly may comprise a heating element. The heating element may be configured to vaporise a liquid aerosol-forming substrate. The heater assembly may comprise a porous body. The porous body may be configured to convey the liquid aerosol-forming substrate to the heating element. The porous body may have a liquid absorption surface. The porous body may have a heating surface. The heating element may be located on the heating surface of the porous body. The heating element may be fluid permeable. In use, vapour may be emitted from the heater assembly in an average vapour emission direction. The aerosol-generating system may comprise an air inlet. The aerosol-generating system may comprise an aerosol outlet. The air inlet may be in fluid communication with the aerosol outlet. An airflow pathway may be defined through the aerosol-generating system. The heater assembly may be arranged in fluid communication with the airflow pathway. In use, air may flow past the heater assembly in an average airflow direction. The heater assembly and airflow pathway may be arranged such that an angle between the average vapour emission direction and the average airflow direction is less than 135 degrees.

According to an example of the present disclosure, there is provided an aerosol-

generating system comprising a heater assembly. The heater assembly comprises a heating element for vaporising a liquid aerosol-forming substrate and a porous body for conveying the liquid aerosol-forming substrate to the heating element. The porous body has a liquid absorption surface and a heating surface. The heating element is located on the heating surface of the porous body. The heating element is fluid permeable such that, in use, vapour is emitted from the heater assembly in an average vapour emission direction. The aerosol-generating system further comprises an air inlet and an aerosol outlet. The air inlet is in fluid communication with the aerosol outlet to define an airflow pathway through the aerosol-generating system. The heater assembly is arranged in fluid communication with the airflow pathway such that air flows past the heater assembly in an average airflow direction. The heater assembly and airflow pathway are arranged such that an angle between the average vapour emission direction and the average airflow direction is less than 135 degrees.

As used herein, the term "located on" encompasses an arrangement in which the heating element is located in direct contact with the heating surface of the porous body and an arrangement in which the heating element is located indirectly on the heating surface of the porous body, that is, another component or layer maybe arranged between the heating element and heating surface.

As used herein, the term "an angle between the average vapour emission direction and the average airflow direction" refers to an angle between the directions of travel of the vapour being emitted from the heater assembly and the airflow within the airflow pathway. For example, an angle of zero degrees would mean that the airflow and vapour emissions are travelling in the same direction, whereas an angle of 180 degrees would mean that the directions of travel of the airflow and vapour emission directly oppose one another.

Advantageously, by arranging the heater assembly and airflow pathway such that the angle between the average vapour emission direction and the average airflow direction is less than 135 degrees, the average airflow direction does not directly oppose the average vapour emission direction. Therefore, the momentum of the vapour and the airflow is not reduced to the same extent as when the average airflow direction does directly oppose the average vapour emission direction. This reduces the tendency for recirculation and turbulence to occur in the airflow path and the vapour is less likely to impinge on the internal surfaces of the aerosol-generating system. Accordingly, condensation of aerosol within the aerosol-generating system is less likely to occur.

The average vapour emission direction may be substantially perpendicular to the heating surface. As used herein, the term "substantially perpendicular" means 90 degrees plus or minus 10 degrees, preferably plus or minus 5 degrees.

An advantage of the average vapour emission direction being substantially perpendicular to the heating surface is that it makes orientating the average vapour emission direction relative to the average airflow direction straightforward because the vapour will be emitted substantially perpendicular to the heating surface of the porous body. Therefore, by angling the heater assembly appropriately relative to the airflow in the airflow pathway or *vice versa*, a desired angle between the average vapour emission direction and average airflow direction can be achieved.

The heater assembly may be located at a position along the airflow pathway. The heating surface of heater assembly may be in fluid communication with the airflow pathway. The heating surface may be arranged substantially parallel to the airflow pathway. The heating surface may be arranged substantially parallel to the average airflow direction. The heating surface may be arranged substantially perpendicular to the airflow pathway. The heating surface may be arranged substantially perpendicular to the average airflow direction. The heating surface may face in a downstream direction of the airflow pathway. The heater assembly may be arranged to one side of the airflow pathway. The heater assembly may be arranged within the airflow pathway. The airflow pathway may be spit such that air flows past more than one surface of the heater assembly. The airflow pathway may comprise a first airflow channel arranged substantially parallel to the heating surface. The airflow pathway may comprise a second airflow channel arranged substantially perpendicular to the heating surface. The second airflow channel may start at the heating surface.

The heater assembly and airflow pathway may be arranged such that an angle between the average vapour emission direction and the average airflow direction is less than 110 degrees, preferably less than 100 degrees.

The heater assembly and airflow pathway may be arranged such that an angle between the average vapour emission direction and the average airflow direction is approximately 90 degrees. This arrangement results in the vapour being emitted at an angle substantially perpendicular to the average airflow direction. The average vapour emission direction has no speed or direction component that opposes the airflow direction and therefore any loss of momentum of the airflow is reduced. This reduces the tendency for recirculation and turbulence to occur in the airflow path and the vapour is less likely to impinge on the internal surfaces of the aerosol-generating system. Furthermore, entrainment of the vapour in the airflow is improved. Accordingly, condensation of aerosol within the aerosol-generating system is less likely to occur.

The heater assembly and airflow pathway may be arranged such that an angle between the average vapour emission direction and the average airflow direction is less than

90 degrees. In this arrangement, the average vapour emission direction has no speed or direction component that opposes the airflow direction and actually has a speed and direction component in the same direction as the average airflow direction. Therefore, any loss of momentum of the airflow is further reduced. This reduces the tendency for recirculation and turbulence to occur in the airflow path and the vapour is less likely to impinge on the internal surfaces of the aerosol-generating system. Furthermore, entrainment of the vapour in the airflow is improved. Accordingly, condensation of aerosol within the aerosol-generating system is less likely to occur.

The heater assembly and airflow pathway may be arranged such that an angle between the average vapour emission direction and the average airflow direction is approximately 45 degrees. The heater assembly and airflow pathway may be arranged such that an angle between the average vapour emission direction and the average airflow direction is less than 45 degrees.

The heater assembly and airflow pathway may be arranged such that the average vapour emission direction and the average airflow direction are substantially the same. In this arrangement, there is virtually no loss of momentum of the airflow as the average vapour emission direction and average airflow direction are the same. This reduces the tendency for recirculation and turbulence to occur in the airflow path and the vapour is less likely to impinge on the internal surfaces of the aerosol-generating system. Furthermore, entrainment of the vapour in the airflow is improved. Accordingly, condensation of aerosol within the aerosol-generating system is less likely to occur.

The porous body may comprise at least one airflow guide to guide the airflow towards the heating surface. Advantageously, this helps to direct the airflow to where the vapour is being emitted to improve the entrainment of aerosol in the airflow.

The air inlet may be distal to the heater assembly. The air inlet may be in the region of the heater assembly, for example, the air inlet may be located at a position along the length of the aerosol-generating system substantially corresponding to the position of the heater assembly.

The terms "'distal", "proximal", "upstream" and "downstream" are used herein to describe the relative positions of components, or portions of components, of an aerosol-generating system. Aerosol generating systems according to the present disclosure have a proximal end through which, in use, an aerosol exits the article or device for delivery to a user, and have an opposing distal end. The proximal end of the aerosol generating system may also be referred to as the mouth end. In use, a user draws on the proximal end of the aerosol generating system in order to inhale an aerosol generated by the aerosol generating system.

The terms upstream and downstream are relative to the direction of airflow or aerosol movement through the aerosol generating system when a user draws on the proximal end of the aerosol-generating system. The proximal end of the aerosol-generating system is downstream of the distal end of the aerosol-generating system.

A cross-sectional area of the airflow pathway in the region of the heater assembly may be configured such that, in use, the airflow speed in the region of the heater assembly is between 0.1 and 2 metres per second, preferably between 0.5 and 1.5 metres per second and more preferably approximately 1 metre per second. A cross-sectional area of the airflow pathway in the region of the heater assembly may be between 9.15 millimetres squared and 183 millimetres squared. This range of cross-sectional areas will provide an airflow speed in the region of the heater assembly in the range between 0.1 and 2 metres per second with a 55 millilitre (55 cubic centimetres) puff of 3 seconds duration based on a standard Coresta puffing profile. Such a puff is equivalent to a volumetric flow rate of 18.3 cubic centimetres per second through the airflow pathway. This range of airflow speeds has been found to effectively entrain the vapour emitted from different designs of heating element without excessively cooling the heating element.

The porous body may comprise a plurality of interconnected open cell pores. The porous material may have a porosity between 20% and 80%.

The porous body may have any suitable geometrical shape. For example, the porous body may be in the shape of a cube or a cuboid, or it may have a shape of a disc or a cylinder, or a combination the aforementioned shapes. The heating surface of the porous body may be flat or curved. The liquid absorption surface of the porous body may be flat or curved. The liquid absorption surface of the porous body may have a depression or well through which at least a portion of the liquid aerosol-forming substrate is absorbed.

The porous body may be substantially incompressible. The porous body may be incompressible.

The porous body may be made of any suitable material. The porous body may be made of a material having a thermal conductivity of less than 150 W/mK, preferably less than 100 W/mK and more preferably less than 60 W/mK. The porous body may be made of non-electrically conductive material.

The porous body may comprise a porous ceramic body. The porous body may comprise a ceramic. The porous body may comprise any suitable inert ceramic or bio-compatible ceramic. Examples of suitable ceramics include, but are not limited to, Al_2O_3, ZrO_2, Si_3N_4, SiC, Ti_3AlC_2, BN, AlN, SiO_2, MgO, mica, diatomite, silicates, silicides, borides, glass, or a combination thereof. An advantage of using ceramic materials is that they are thermal stable

at the temperature at which the heater assembly typically operates and generally have a thermal decomposition temperature that is significantly higher than that of a conventional wick. This may help to reduce the risk of unwanted by-products being produced during heating.

The porous body may comprise a porous glass body.

The porous body may comprise a capillary material that conveys a liquid through the material by capillary action. The porous body may have a fibrous or porous structure. The porous body may comprise a bundle of capillaries. For example, the porous body may comprise a plurality of fibres or threads or other fine bore tubes. The porous body may comprise fibres or threads of cotton or treated cotton, for example, acetylated cotton. Other suitable materials could also be used, for example, ceramic- or graphite based fibrous materials or materials made from spun, drawn or extruded fibres, such as fiberglass, cellulose acetate or any suitable heat resistant polymer.

The porous body may be composed of a monolithic material or of a hybrid material.

The thickness of the porous body may be configured such that heat losses through conduction to the liquid held the liquid reservoir or liquid storage portion are negligible. The thickness of the porous body may vary dependent on the thermal properties of the material it is made from and the liquid it coveys. The porous body may have a thickness between 1 mm and 10 mm, preferably between 2 mm and 8 mm and more preferably between 3 mm and 6 mm.

The heating element may be configured to have a vapour emission speed in the range 0.1 to 1 metres per second. Keeping factors such as the power supplied to the heating element constant, the vapour emission speed can be adjusted by adjusting the form of the heating element, as discussed further below.

The heating element may comprise a non-porous heating element or track. As discussed above, a non-porous heating element causes vapour pressure to build under the heating element and high vapour emission speeds result.

The heating element may be porous. The heating element may have a porosity between 20% and 80%.

The heating element may comprise an electrically resistive heating element. The heating element may be made from any suitable electrically conductive material. Suitable 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, constantan, nickel-, cobalt-, chromium-, aluminum-, titanium-, zirconium-, hafnium-, niobium-, molybdenum-, tantalum-, tungsten-, tin-, gallium-, manganese- and iron-containing alloys, and super-alloys based on nickel, iron, cobalt, stainless steel, Timetal®, iron-aluminum based alloys and iron-manganese-aluminum based alloys. Timetal® is a registered trade mark of Titanium Metals Corporation.

In one example, the heating element may be made from a metal alloy selected from one or more of Ni-Cr alloy, NiCrAlY alloy, FeCrAl alloys (e.g., Kanthal), FeCrAlY alloys, Fe_3Al alloy, Ni_3Al alloy, NiAl alloy, CuNi alloys.

In another example, the heating element may be made from stainless steel, such as a 300 series stainless steel such as AISI 304, 316, 304L, 316L.

In another example, the heating element may be made of an electro-ceramic, including but not limited to $MoSi_2$, doped SiC, Indium Tin Oxide (ITO), lanthanum-doped strontium titanate (SLT), yttrium-doped strontium titanate or a combination thereof.

The heating element may comprise a doped portion of the porous body. The porous body may be doped such that the portion of the porous body which acts as the heating element is electrically conductive. Doping the porous body may be advantageous in that it avoids altering the porosity of the porous body. This may be preferable to other known techniques of forming a heating element, which involve depositing the heating element by thin film or thick film techniques, which can reduce the properties of the porous body, in particular the porosity. The doped portion may be between 5 micrometres and 100 micrometres in thickness. The thickness of the doped portion may be increased where the cross sectional area of the heating element is smaller or where the heating resistance required is higher. The dopant used to dope the porous body may be an n-type dopant or a p-type dopant. The dopant may be any one of, but not limited to, nitrogen, phosphorous, aluminium or boron. The interface between the heating element and the porous body may comprise a portion of partially doped porous material.

The heating element may comprise a porous layer of electrically conductive material. Advantageously, a heating element comprising a porous layer of electrically conductive material allows an electrical current to flow through the heating element such that the heating element can be resistively heated and also allows vapours to travel through the heating element via the pores in its porous structure. Thus vapour emission occurs through the porous heating element. This avoids the build-up of vapour pressure underneath the heating element and high speed vapour emission at the sides of the heating element. The inventors have found that this arrangement produces a consistent vapour across the heating element and a

lower vapour emission speed of approximately 0.1 metres per second. Such a low vapour emission speed means that the vapour is easily carried away by the airflow reducing the impingement of vapour on the internal walls of the aerosol-generating system.

The heating element may comprise a porous metallic film. The porous metallic film may comprise a thick film, that is, the porous metallic film may have a thickness between 5 µm and 50 µm, preferably between 10 µm and 30 µm, more preferably between 15 µm and 25 µm. The porous metallic film may comprise a thin film, that is, the porous metallic film may have a thickness thinner than 5 µm, preferably thinner than 3 µm, more preferably thinner than 2 µm.

The heating element may comprise a metallic foam. The metallic foam may have a thickness of less than 100 µm, preferably less than 50 µm, more preferably less than 30 µm.

The heating element may define a heated area. The heated area may cover at least a part of the heating surface. The heated area may cover substantially the whole of the heating surface. The heated area may be of any suitable shape. The heated area may be square or rectangle, the heated area may be circular or ellipsoid. The heated area may be less than 30 mm^2, preferably less than 20 mm^2, more preferably less than 15 mm^2, even more preferably less than 10 mm^2.

The heating element may be configured to provide a power density of between 0.3 W/mm^2 and 2 W/mm^2, and preferably between 0.5 W/mm^2 and 1.5 W/mm^2. The heating element may be configured to provide a power density of at least 0.5 W/mm^2, and preferably of at least 1 W/mm^2.

The inventors have advantageously found that the power density applied to the heating element is a more important factor in determining the amount of aerosol generated than the power *per se* applied to the heating element. As used herein, the term "power density" refers to the amount of electrical power applied to the heating element per unit of heated area.

A first dimension of the heated area of the heating element may be in the range from 2 mm to 10 mm. A second dimension of the heated area of the heating element may be in the range of from 2 mm to 10 mm. The dimensions of the heated area of the heating element or heating surface may be 5 mm by 6 mm, or 5 mm by 4 mm, or 5 mm by 3 mm or 5 mm by 2 mm.

The heating element may have an electrical resistance at room temperature of between 0.5 Ω and 1.5 Ω, between 0.7 Ω and 1.3 Ω, or preferably about 1 Ω.

The electrical heating element may comprise a discrete, solid, pre-formed component. The electrical heating element may have any suitable shape or form. Examples of suitable shapes and forms include but are not limited to a band, a strip, a filament, a wire, a mesh, a

flat spiral coil, fibres or a fabric.

The electrical heating element may be formed from an electrically conductive material deposited on to the heating surface. As used herein, the term "electrically conductive material" denotes a material having a resistivity of $1x10^{-2}$ Ωm, or less. As used herein, the term "deposited" means applied as a layer or coating by a physical or chemical process, for example in the form of a liquid, plasma or vapour which subsequently condenses or aggregates to form the electrical heating element, rather than simply being laid on or fixed to the porous body as a solid, pre-formed component. The heating element may be deposited or patterned by thick film techniques such as screen-printing, inkjet-printing, aerosol jet printing, LDS (Laser Direct Structuring). A template may be added in the heating element material that will be removed upon sintering to form a porous structure and enhance liquid vaporization and reduce vapour emission speed. The heating element may be deposited or patterned by thin film techniques such as PVD (Physical Vapor Deposition), for example, evaporation or sputtering or CVD (Chemical Vapor Deposition), or similar.

The heater assembly may further comprise first and second electrical contacts connected to the heating element. Each electrical contact may be disposed at opposite sides of the heating surface. The electrical heating element may extend between the electrical contacts. The electrical heating element may form an electrical connection therebetween.

The electrical contacts may be formed from any suitable material. Examples of suitable materials for the electrical contacts include but are not limited to copper, zinc and gold.

In one example, the first and second electrical contacts may be formed from an electrically conductive material deposited directly onto the heating surface of the porous body.

The heating element and the porous body may be integrally formed. The provision of the heating element being integrally formed with the porous body may advantageously provide a more robust and reliable connection between the heating element and the porous body. This may advantageously help to improve the transfer of heat between the heating element and the porous body.

Forming the heating element integrally with the porous body may also advantageously provide a heating element which is easier to reliably manufacture, thus resulting in a more energy efficient heating element capable of generating a more consistent aerosol. This, in turn, may provide a user of the aerosol-generating system with an improved and more enjoyable experience. Such an arrangement may also help to reduce the likelihood of a user experiencing dry heating or a dry puff.

An advantage of forming the heating element integrally with the porous body is that it

helps to alleviate the problems of manufacturing tolerances encountered with wick and coil heaters and other arrangements in which a heating element is detached from a liquid transport element. The dimensions and arrangement of the heating element relative to the porous body are also fixed, which helps to produce a more consistent aerosol. This is because the heating element is fixed to the porous body, which helps to supply liquid aerosol-forming substrate to the heating element. This also helps to prevent unwanted loss of heat, which helps to improve energy efficiency.

By forming the heating element integrally with the porous body, the resulting aerosol-generating system may benefit from reduced material requirements. This is because the need for intermediate components which fix the heating element relative to the porous body can be reduced or eliminated entirely. The material savings can result in cost savings of the overall aerosol-generating system. An additional advantage of the reduced material requirements in the overall aerosol-generating system is the provision of a more sustainable and environmentally friendly solution.

Since the heating element is integrally formed with the porous body, the heating surface of the porous body may not be a clearly defined surface. The porous body and the heating element may be made from a single monolithic portion of porous material. Where this is the case, the heating element may be a portion of the porous material which has been configured to generate heat. As described in more detail below, this may be achieved by, for example, doping a portion of the porous material or diffusing electrically conductive material into the porous material. Accordingly, the heating surface of the porous body may represent the interface between the portion of the porous material which is configured to transport liquid aerosol-forming substrate, and a portion of the porous material which is configured to generate heat. Depending on how the heating element is formed, the heating surface of the porous body may be a gradual interface between the portion of the porous material which is configured to transport liquid aerosol-forming substrate, and a portion of the porous material which is configured to generate heat.

Alternatively, the porous body and heating element may be formed as two separate parts assembled together.

The heating element may be bonded to the heating surface of the porous body. An advantage of providing a heater assembly in which a heating element is bonded to a heating surface of a porous ceramic body is that a robust and reliable connection can be established between the heating element and the porous ceramic body. This may advantageously help to improve the transfer of heat between the heating element and the porous ceramic body.

The heating element may have a tapered cross-sectional shape. The heating element

may taper in a direction from the liquid absorption surface to the heating surface.

The liquid absorption surface of the porous body may have an area that is different to an area of the heating surface of the porous body.

A heater assembly having a heating surface with the same area as the liquid absorption surface may be inefficient due to heat generated by the heater not being used to vaporise an aerosol-forming substrate. An inefficient heater assembly provides a reduced throughput of aerosol.

Advantageously, providing a porous body in which the heating surface and the liquid absorption surface have different areas may improve the throughput of aerosol that can be generated by the heater assembly compared to a heater assembly in which the heating surface has the same area as the liquid absorption surface.

For example, in a heater assembly in which the area of the heating surface of the porous body is less than the area of the liquid absorption surface of the porous body, heat flow from the heating element towards the liquid absorption surface and then to the liquid storage portion by conduction may be reduced. The relatively smaller heating surface provides a small heat transfer area through which the transfer heat, by conduction, from the heating element to the porous body, and towards the liquid absorption surface.

Decreasing heat loss from the heating element to the bulk of the porous body may consequently increase heating efficiency because more of the heat energy provided by the heating element may be used to vaporise the aerosol-forming substrate. Consequently, the porous body having a shape such that the heating surface has a smaller area than the liquid absorption surface may increase the throughput of aerosol generated by the heater assembly.

For example, in a heater assembly in which the area of the liquid absorption surface of the porous body is less than the area of the heating surface of the porous body, the smaller area of the liquid absorption surface may cause a reduction in heat flow through the aerosol-forming substrate from the heating element to the liquid absorption surface via heat conduction.

Reducing heat flow from the heating surface to the liquid absorption surface may consequently increase heating efficiency because more of the heat energy provided by the heating element may be used to vaporise the liquid aerosol-forming substrate. Consequently, the porous body having a shape such that the liquid absorption surface has a smaller area than the heating surface may provide for increased heating efficiency, which may increase the throughput of aerosol generated by the heater assembly.

Increasing heating efficiency may reduce power consumption during use of the heater assembly.

The area of the heating surface of the porous body may be less than the area of the

liquid absorption surface of the porous body. The area of the liquid absorption surface of the porous body may be greater than the area of the heating surface of the porous body.

Advantageously, when the porous body has a shape such that the heating surface has a smaller area than the liquid absorption surface, heat flow from the heating element towards the liquid absorption surface and then to the liquid storage portion by conduction may be reduced. The relatively smaller heating surface provides a small heat transfer area through which the transfer heat, by conduction, from the heating element to the porous body, and towards the liquid absorption surface.

Decreasing heat loss from the heating element to the bulk of the porous body may consequently increase heating efficiency because more of the heat energy provided by the heating element may be used to vaporise the aerosol-forming substrate. Consequently, the porous body having a shape such that the heating surface has a smaller area than the liquid absorption surface may increase the throughput of aerosol generated by the heater assembly.

Advantageously, the porous body having a shape such that the heating surface has a smaller area than the liquid absorption surface may reduce the area of the heating surface that is not close enough to the heating element to allow aerosol-forming substrate being conveyed to the heating surface to be vaporised. In other words, the size and shape of the heating surface may more closely match with the size and shape of the heating element. Consequently, more of the liquid aerosol-forming substrate may be conveyed from the liquid absorption surface to an area of the heating surface that is near to the heating element, which may result in more of the liquid aerosol-forming substrate at the heating surface being vaporised. More liquid aerosol-forming substrate being vaporised may increase the throughput of aerosol generated by the heater assembly. Further, this arrangement may allow for the power density at the heating surface to be maximised, which also improves heating efficiency.

Advantageously, the liquid absorption surface having a larger area than the heating surface may allow the liquid absorption surface to receive a larger volume of liquid aerosol-substrate from a liquid storage portion. As a consequence of the relatively smaller area of the heating surface, as the liquid aerosol-forming substrate is conveyed through the porous body and towards the heating surface, the flow rate of the liquid aerosol-forming substrate to the heating element may be higher than with a typical heater assembly. A higher flow rate of liquid aerosol-forming substrate at the heating element may increase the throughput of aerosol generated by the heater assembly.

A ratio of the area of the heating surface of the porous body to the area of the liquid absorption surface of the porous body may be less than or equal to 0.9. A ratio of the area of the heating surface of the porous body to the area of the liquid absorption surface of the porous

body may be at least 0.1. A ratio of the area of the heating surface of the porous body to the area of the liquid absorption surface of the porous body may be between 0.1 and 0.9.

The area of the heating surface of the porous body may be greater than the area of the liquid absorption surface of the porous body. The area of the liquid absorption surface of the porous body may be less than the area of the heating surface of the porous body.

Advantageously, when the porous body has a shape such that the liquid absorption surface has a smaller area than the heating surface, the smaller area of the liquid absorption surface may cause a reduction in heat flow through the aerosol-forming substrate from the heating element to the liquid absorption surface via heat conduction. Reducing heat flow from the heating surface to the liquid absorption surface may consequently increase thermal efficiency because more of the heat energy provided by the heating element may be used to vaporise the liquid aerosol-forming substrate. Consequently, the porous body having a shape such that the liquid absorption surface has a smaller area than the heating surface may provide for increased heating efficiency, which may increase the throughput of aerosol generated by the heater assembly.

Advantageously, the porous body having a shape such that the liquid absorption surface has a smaller area than the heating surface may reduce the area of the heating surface that is not close enough to the heating element to allow aerosol-forming substrate being conveyed to the heating surface to be vaporised. In other words, the size and shape of the heating surface may more closely match with the size and shape of the heating element. Consequently, more of the liquid aerosol-forming substrate being may be conveyed from the liquid absorption surface and to an area of the heating surface that is near to the heating element, which may result in more of the liquid aerosol-forming substrate at the heating surface being vaporised. More liquid aerosol-forming substrate being vaporised may increase the throughput of aerosol generated by the heater assembly.

The heating surface of the porous body may be convex in one or both of a first transverse direction and a second transverse direction. The first transverse direction may be orthogonal to the second transverse direction.

Advantageously, by providing a porous body having a heating surface that is convex in one or both of a first transverse direction and a second transverse direction may enable the surface area of the heating surface to be increased without increasing a width of the heating surface. This may increase the efficiency of the aerosol-generating system at vaporising liquid aerosol-forming substrate, whilst helping to avoid the need to redesign other components of the aerosol-generating system to accommodate the porous ceramic body.

The provision of a heating surface that is convex along one or both of a first transverse

direction and a second transverse direction may help to avoid or minimise recirculation of airflow adjacent the heater assembly. In particular, a heating surface that is convex may help to avoid or minimise recirculation of airflow adjacent to a central region of the heater assembly. This may reduce a level of turbulence in the airflow adjacent to the heater assembly. As discussed above, reducing a level of turbulence in the airflow adjacent to the heater assembly may improve the entrainment of vapour of aerosol-forming substrate in the airflow. This may improve the quality of the aerosol generated by the aerosol-generating system.

Improving the entrainment of vapour in the airflow through the aerosol-generating system may avoid or reduce vapour condensing to form large droplets of liquid aerosol-forming substrate. This may help to avoid an unpleasant and undesirable user experience.

Improving the entrainment of vapour in the airflow through the aerosol-generating system may avoid or reduce vapour condensing on internal surfaces of the aerosol-generating system. This may help to avoid or minimise damage to the aerosol-generating system and may allow optimal function of the aerosol-generating system.

The heating surface of the porous body may be convex in a single transverse direction.

The heating surface of the porous body may be convex in both the first transverse direction and the second transverse direction.

The heating surface of the porous body may be convex in one or both of the first transverse direction and the second transverse direction based on the configuration of the heater assembly relative to one or more airflow pathways of the aerosol-generating system. The heater assembly may be configured to minimise a level of turbulence in the airflow adjacent to the heater assembly. For example, it may be advantageous for the heater assembly to be arranged in the aerosol-generating system such that air drawn into the aerosol-generating system follows a curved path along at least a portion of a curved surface of the heater assembly.

The heating element may be convex in one or both of the first transverse direction and the second transverse direction.

The curvature of the heating element in the first transverse direction may be substantially the same as the curvature of the heating surface of the porous body in the first transverse direction. The curvature of the heating element in the second transverse direction may be substantially the same as the curvature of the heating surface of the porous body in the second transverse direction. The curvature of the heating element in both the first transverse direction and the second transverse direction may be substantially the same as the curvature of the heating surface of the porous body in both the first transverse direction and the second transverse direction, respectively.

The heater assembly may comprise a thermally insulating layer. The thermally insulating layer may have a lower thermal conductivity than the porous body. The thermally insulating layer may be disposed between each of the porous body and the heating element. The thermally insulating layer may be in contact with each of the porous body and the heating element. The thermally insulating layer may be configured to reduce heat transfer from the heating element to the porous body.

Advantageously, by providing a thermally insulating layer disposed between each of the porous body and the heating element, heat losses from the heating element to the porous body, and to liquid within the porous body, are reduced. This provides a more efficient heater assembly in which the amount of use and number of uses of the device by a user can be increased, before the device power supply, such as a battery, is depleted. The inventors have estimated that in a known device, approximately one third of energy from the heating element is lost through conduction in the porous body and liquid in the porous body. The remaining two thirds are used to generate an aerosol by heating a liquid aerosol-forming substrate. In the arrangement described herein, these energy losses are reduced. Specifically, the thermally insulting layer reduces heat propagation or conduction from the heating element towards or through the porous body. This reduction in conduction can concentrate heat to a heating surface of the porous body, minimising heat dissipation and increasing heating efficiency of the heater assembly.

The thermally insulating layer may comprise a thermally insulating material. The thermally insulating material may have a lower thermal conductivity than the porous body. The thermally insulating material may have a higher porosity than the porous body. This has the advantage of providing a thermally insulating layer which is particularly effective at reducing energy losses, while being easy to manufacture.

The thermally insulating layer may comprise a material having a thermal conductivity of less than 40 Watts per metre-Kelvin. This has the advantage of providing a thermally insulating layer which is effective at reducing energy losses through the porous body. The thermally insulating layer may comprise a material having a thermal conductivity of less than 10 Watts per metre-Kelvin. This has the advantage of providing a thermally insulating layer which is particularly effective at reducing energy losses through the porous body.

The thermally insulating layer may extend entirely between the porous body and the heating element. This has the advantage of more effectively providing a barrier between the heating element and the porous body, and as such is particularly effective at reducing energy losses through the porous body.

The thermally insulating layer may comprise one or more of: alumina, zirconia, zirconia

with magnesium oxide, glass ceramic, quartz, a porous polymer. The porous polymer may be polyimide.

The thermally insulating layer may comprise alumina having a thermal conductivity of 20 – 40 Watts per metre-Kelvin. The thermally insulating layer may comprise a material having a thermal conductivity of less than 10 Watts per metre-Kelvin, such as zirconia with or without magnesium oxide, glass ceramics, quartz. Use of alumina, zirconia with or without magnesium oxide, glass ceramics, quartz, is advantageous, as these materials are compatible with a manufacturing process involving sintering, and as such a heater assembly having a thermally insulating layer of one of these materials is more easily manufactured.

The thermally insulating layer may have a thickness of between 0.1 mm and 2 mm. A thermally insulating layer with such a thickness is particularly suited to reducing energy losses from the heating element to the porous body. Preferably, the thermally insulating layer has a thickness of between 0.5 mm and 1.5 mm. A thermally insulating layer with such a thickness is further suited to reducing energy losses from the heating element to the porous body.

The average pore size of the porous body may vary between the liquid absorption surface and the heating surface.

The provision of a porous body which includes a variation of pore size between the liquid absorption surface and the heating surface may advantageously help to control the transport of liquid aerosol-forming substrate from a reservoir of liquid aerosol-forming substrate to the heating element. Specifically, the variation of pore size between the liquid absorption surface and the heating surface may allow the porous body to provide a consistent supply of aerosol-forming substrate to the heating surface. This may advantageously avoid undesirable “dry heating”. In addition, the porous body of the present invention may also advantageously prevent leakage of liquid aerosol-forming substrate from the heating surface of the porous body.

The average pore size of the porous body may vary in any way between the liquid absorption surface and the heating surface. The average pore size may vary from relatively larger pores at the liquid absorption surface to relatively smaller pores at the heating surface.

The provision of a porous body having a larger average pore size at the liquid absorption end, and a smaller average pore size at a heating end may particularly facilitate efficient transfer of liquid aerosol-forming substrate from the liquid absorption end of the porous body to the heating end of the porous body without allowing leakage. In particular, the inventors of the present invention have identified that liquid aerosol-forming substrate is transferred from the liquid absorption end of the porous body to the heating end of the porous body by capillary action. How rapidly the liquid aerosol-forming substrate moves through the

porous body depends on a number of factors including, but not limited to, the geometry of the pores, the surface tension between the liquid aerosol-forming substrate and the porous body, the viscosity of the liquid aerosol-forming substrate, the surface tension of the liquid aerosol-forming substrate. The inventors of the present invention have identified the need to balance these factors to provide efficient transfer of liquid aerosol-forming substrate to the heating surface of the porous body while preventing leakage of the liquid aerosol-forming substrate.

Firstly, in order to provide an efficient capillary flow of liquid through the porous body, the capillary pressure must overcome the viscous drag pressure. Secondly, to prevent leakage, inertial forces must not overcome the capillary pressure. These two requirements are realised by providing a porous body with larger pores at the liquid absorption end and smaller pores at the heating end.

In particular, the inventors of the present invention have realised that the viscosity of the liquid aerosol-forming substrate varies with temperature. In particular, the viscosity of the liquid aerosol-forming substrate decreases as its temperature increases. As a result, as the liquid aerosol-forming substrate moves through the porous body from the liquid absorption surface to the heating surface, the viscosity of the liquid aerosol-forming substrate decreases. Since the liquid aerosol-forming substrate is transported through the porous body by capillary forces, the capillary force needs to overcome the viscous drag of the liquid. The viscous drag decreases as viscosity decreases. As a result, the capillary force needed to move the liquid aerosol-forming substrate can decrease towards the heating surface of the porous body while still maintaining the same flow rate. Consequently, the average pore size of the porous body can decrease towards the heating surface without reducing the flow of liquid aerosol-forming substrate through the porous body.

The heating element may comprise a plurality of tracks or track portions arranged electrically in parallel. The heating element resistance at room temperature may be between 0.5 Ohms and 1.5 Ohms, preferably between 0.7 Ohms and 1.3 Ohms, and more preferably 1 Ohm. The resistance of the heating element may be matched to requirements of control electronics.

At least two of the electrically parallel heating tracks may have similar resistances to each other, or have the same resistance as each other. Preferably, all of the electrically parallel heating tracks are of similar or of the same resistance as each other. The heating tracks arranged electrically in parallel may have different resistances, which is particularly beneficial in a heater assembly where it is advantageous for zones of the heating element to generate different power levels. This could be the case, for example, to compensate for higher thermal losses in an outer part of the heating element. As such, heating tracks on an exterior

or outer part of the heating element may be designed to have a lower resistance (which can generate more heat) than heating tracks in the centre of the heating element.

The heating element may comprise a plurality of tracks or track portions. The plurality of tracks or track portions may be arranged electrically in parallel. By being arranged electrically in parallel, current flow is split into separate parallel flow paths, the separate parallel flow paths being subsequently re-combined.

The heating element may comprise a first connecting pad and a second connecting pad. The first or second connecting pads (or first and second connecting pads) may be configured to allow connection to an external circuit. An aperture or plurality of apertures in the heating element may separate each track or track portion. The heating element may comprise at least one diverging portion, in which current is split from the first connecting pad into track portions. The track portions define electrically parallel paths. The heating element may comprise a converging portion. In the converging portion, current is combined from track portions which define electrically parallel paths, into the second connecting pad.

Various different arrangements are possible of tracks or track portions arranged electrically in parallel. The heating element may comprise two, three, four or more track portions which define electrically parallel paths.

Advantageously, by providing tracks or track portions arranged electrically in parallel, if one track portion is defective, current can be redistributed and can still flow through the heating element, that is, the electrical connection between the first connecting pad and the second connecting pad is not broken. In contrast, in a simple serpentine heater defining a single electrical path between the first connecting pad and the second connecting pad, if a part of the serpentine heating element is broken or contains a defect, this can cause an increase in local resistance, causing increased power dissipation, which in turn increases the resistance until breakage.

The inventors have also identified that the electrically parallel tracks or track portions have a surprising additional advantage. In such an arrangement, in case of breakage of one track portion, the heating element will still operate and can, for an initial transitory period, operate in an advantageous way because the breakage of one track or track portion would result in a higher energy density on the remaining tracks or track portions. In such a case, the same power would still be provided but over a smaller area, so throughput of the aerosol-generating substrate is increased. Such a breakage causing an increase in current on unbroken tracks or track portions can eventually affect the user's experience. This can be mitigated for by a mechanism to alert the user about possible future below optimal performance of the heater assembly. Electrically parallel tracks have the advantage of

increasing the number of puffs before full failure of the heater, and potentially increasing the heater lifetime up to the lifetime of the device.

The heating element may comprise a plurality of tracks or track portions defining a path having at least one bend. The inner edge of the bend may be curved.

The inner edge of the bend being curved has the advantage of guiding current to flow in a more evenly distributed way around the at least one bend. This reduces a current concentration which in turn limits hot spot creation.

The heating element may comprise a plurality of tracks or track portions having a gradient of electrical resistivity perpendicular to current flow in a corner or corners, such that the electrical resistivity is higher at an inner part of the corner and lower at an outer part of the corner. Such a gradient is beneficial to counterbalance localized high current density and reduce hot spot creation.

The aerosol-generating system may comprise an aerosol-generating device and a cartridge. The cartridge may be removable couplable to the aerosol-generating device. The cartridge may comprise any of the above-described example heater assemblies. The cartridge may comprise a liquid storage portion or reservoir configured to hold a liquid aerosol-forming substrate. The liquid storage portion may be arranged at an opposite side of the heater assembly to the heating surface. Alternatively, the aerosol-generating device may comprise any of the above-described example heater assemblies.

As used herein, the term “aerosol-forming substrate” refers to a substrate capable of releasing volatile compounds that can form an aerosol. Volatile compounds may be released by heating the liquid aerosol-forming substrate.

The aerosol-forming substrate may be liquid at room temperature. The aerosol-forming substrate may comprise both liquid and solid components. The liquid aerosol-forming substrate may comprise nicotine. The nicotine containing liquid aerosol-forming substrate may be a nicotine salt matrix. The liquid aerosol-forming substrate may comprise plant-based material. The liquid aerosol-forming substrate may comprise tobacco. The liquid aerosol-forming substrate may comprise a tobacco-containing material containing volatile tobacco flavour compounds, which are released from the aerosol-forming substrate upon heating. The liquid aerosol-forming substrate may comprise homogenised tobacco material. The liquid aerosol-forming substrate may comprise a non-tobacco-containing material. The liquid aerosol-forming substrate may comprise homogenised plant-based material.

The liquid aerosol-forming substrate may comprise one or more aerosol-formers. An aerosol-former is any suitable known compound or mixture of compounds that, in use, facilitates formation of a dense and stable aerosol and that is substantially resistant to thermal

degradation at the temperature of operation of the system. Examples of suitable aerosol formers include glycerine and propylene glycol. Suitable aerosol-formers are well known in the art and include, but are not limited to: polyhydric alcohols, such as triethylene glycol, 1,3-butanediol and glycerine; esters of polyhydric alcohols, such as glycerol mono-, di- or triacetate; and aliphatic esters of mono-, di- or polycarboxylic acids, such as dimethyl dodecanedioate and dimethyl tetradecanedioate. The liquid aerosol-forming substrate may comprise water, solvents, ethanol, plant extracts and natural or artificial flavours.

The liquid aerosol-forming substrate may comprise nicotine and at least one aerosol-former. The aerosol-former may be glycerine or propylene glycol. The aerosol former may comprise both glycerine and propylene glycol. The liquid aerosol-forming substrate may have a nicotine concentration of between about 0.5% and about 10%, for example about 2%.

The airflow pathway may pass through the liquid storage portion. For example, the liquid storage portion may have an annular cross-section defining an internal passage or aerosol channel, and the airflow pathway may extend through the internal passage passage or aerosol channel of the liquid storage portion.

The cartridge may comprise a cartridge housing. The cartridge housing may be formed from a durable material. The cartridge housing may be formed from a liquid impermeable material. The cartridge housing may be formed form a mouldable plastics material, such as polypropylene (PP) or polyethylene terephthalate (PET) or a copolymer such as Tritan™, which is made from three monomers: dimethyl terephthalate (DMT), cyclohexanedimethanol (CHDM), and 2,2,4,4-tetramethyl-1,3-cyclobutanediol (CBDO). The cartridge housing of the cartridge may define a portion of the liquid storage portion or reservoir. The cartridge housing may define the liquid storage portion. The cartridge housing and the liquid storage portion may be integrally formed. Alternatively, the liquid storage portion may be formed separately from the outer housing and arranged in the outer housing.

The aerosol-generating device may comprise a power supply for supplying power to the heater assembly. The aerosol-generating device may comprise control circuitry for controlling the supply of power from the power supply to the heater assembly. The cartridge may be removably couplable to the aerosol-generating device.

The aerosol-generating device may comprise a housing. The housing may be elongate. The housing may comprise any suitable material or combination of materials. Examples of suitable materials include metals, alloys, plastics or composite materials containing one or more of those materials, or thermoplastics that are suitable for food or pharmaceutical applications, for example polypropylene, polyetheretherketone (PEEK) and polyethylene. The material is preferably light and non-brittle.

The aerosol-generating device housing may define a cavity for receiving a portion of a cartridge. The aerosol-generating device may have a connection end configured to connect the aerosol-generating device to a cartridge. The connection end may comprise the cavity for receiving the cartridge.

The power supply may be any suitable power supply. Preferably, the power supply is a DC power supply. The power supply may be a battery. The battery may be a Lithium based battery, for example a Lithium-Cobalt, a Lithium-Iron-Phosphate, a Lithium Titanate or a Lithium-Polymer battery. The battery may be a Nickel-metal hydride battery or a Nickel cadmium battery. The power supply may be another form of charge storage device such as a capacitor. The power supply may be rechargeable and be configured for many cycles of charge and discharge. The power supply may have a capacity that allows for the storage of enough energy for one or more user experiences of the aerosol-generating system; for example, the power supply may have sufficient capacity to allow for the continuous generation of aerosol for a period of around six minutes, corresponding to the typical time taken to smoke a conventional cigarette, or for a period that is a multiple of six minutes. In another example, the power supply may have sufficient capacity to allow for a predetermined number of puffs or discrete activations of the aerosol-generating system.

The control circuitry may comprise any suitable controller or electrical components. The controller may comprise a memory. Information for performing the above-described method may be stored in the memory. The control circuitry may comprise a microprocessor. The microprocessor may be a programmable microprocessor, a microcontroller, or an application specific integrated chip (ASIC) or other electronic circuitry capable of providing control. The control circuitry may be configured to supply power to the heating element continuously following activation of the device, or may be configured to supply power intermittently, such as on a puff-by-puff basis. The power may be supplied to the heating element in the form of pulses of electrical current, for example, by means of pulse width modulation (PWM).

Features described in relation to one of the above examples may equally be applied to other examples of the present disclosure.

The invention is defined in the claims. However, below there is provided a non-exhaustive list of non-limiting examples. Any one or more of the features of these examples may be combined with any one or more features of another example, embodiment, or aspect described herein.

Example Ex1: A heater assembly comprising a heating element for vaporising a liquid aerosol-forming substrate and a porous body for conveying the liquid aerosol-forming

substrate to the heating element.

Example Ex2: A heater assembly according to Example Ex1, wherein the porous body comprises a liquid absorption surface and a heating surface.

Example Ex3: A heater assembly according to Example Ex1 or Ex2, wherein the heating element is located on the heating surface of the porous body.

Example Ex4: A heater assembly according to any preceding example, wherein the heating element is fluid permeable.

Example Ex5: A heater assembly according to any preceding example, wherein the porous body comprises at least one airflow guide to guide an airflow towards the heating element.

Example Ex6: A heater assembly according to any preceding example, wherein the heating element is porous.

Example Ex7: A heater assembly according to Example Ex6, wherein the heating element has a porosity between 20% and 80%.

Example Ex8: A heater assembly according to Example Ex6 or Ex7, wherein the heating element comprises a porous layer of electrically conductive material.

Example Ex9: A heater assembly according to Example Ex8, wherein the heating element comprises a porous metallic film.

Example Ex10: A heater assembly according to Example Ex8, wherein the heating element comprises a metallic foam.

Example Ex11: A heater assembly according to any preceding example, wherein the heating element and the porous body are integrally formed.

Example Ex12: A heater assembly according to any preceding example, wherein the heating element comprises a doped portion of the porous body.

Example Ex13: A heater assembly according to any of Examples Ex1 to Ex10, wherein the porous body and heating element are formed as two separate parts assembled together.

Example Ex14: A heater assembly according to Example Ex13, wherein the heating element is bonded to the heating surface of the porous body.

Example Ex15: A heater assembly according to any preceding example, wherein the heating element has a tapered cross-sectional shape.

Example Ex16: A heater assembly according to Example Ex15, wherein the heating element tapers in a direction from the liquid absorption surface to the heating surface.

Example Ex17: A heater assembly according to Example Ex15 or Ex16, wherein the liquid absorption surface of the porous body has an area that is different to an area of the heating surface of the porous body.

Example Ex18: A heater assembly according to Example Ex17, wherein the area of the heating surface of the porous body is less than the area of the liquid absorption surface of the porous body.

Example Ex19: A heater assembly according to Example Ex17, wherein the area of the heating surface of the porous body is greater than the area of the liquid absorption surface of the porous body.

Example Ex20: A heater assembly according to any preceding example, wherein the heating surface of the porous body is convex in one or both of a first transverse direction and a second transverse direction, the first transverse direction being orthogonal to the second transverse direction.

Example Ex21: A heater assembly according to any preceding example, wherein the heater assembly further comprises a thermally insulating layer configured to reduce heat transfer from the heating element to the porous body.

Example Ex22: A heater assembly according to Example Ex21, wherein the thermally insulating layer has a lower thermal conductivity than the porous body.

Example Ex23: A heater assembly according to Example Ex21 or Ex22, wherein the thermally insulating layer is disposed between the porous body and the heating element.

Example Ex24: A heater assembly according to Example Ex21 or Ex22, wherein the thermally insulating layer is in contact with each of the porous body and the heating element.

Example Ex25: A heater assembly according to any preceding example, wherein the average pore size of the porous body varies between the liquid absorption surface and the heating surface.

Example Ex26: A heater assembly according to Example Ex25, wherein the average pore size varies from relatively larger pores at the liquid absorption surface to relatively smaller pores at the heating surface.

Example Ex27: A heater assembly according to any preceding example, wherein the heating element comprises a plurality of tracks or track portions arranged electrically in parallel.

Example Ex28: A heater assembly according to any preceding example, wherein the heating element comprises a plurality of tracks or track portions defining a path having at least one bend, the inner edge of the bend being curved.

Example Ex29: An aerosol-generating system comprising a heater assembly according to any preceding example.

Example Ex30: An aerosol-generating system according to Example Ex29, wherein, in use, vapour is emitted from the heater assembly in an average vapour emission direction.

Example Ex31: An aerosol-generating system according to Example Ex29 or Ex30, wherein the aerosol-generating system further comprises an air inlet and an aerosol outlet, the air inlet being in fluid communication with the aerosol outlet to define an airflow pathway through the aerosol-generating system.

Example Ex32: An aerosol-generating system according to Example Ex31, wherein the heater assembly is arranged in fluid communication with the airflow pathway such that air flows past the heater assembly in an average airflow direction.

Example Ex33: An aerosol-generating system according to Example Ex32, wherein the heater assembly and airflow pathway are arranged such that an angle between the average vapour emission direction and the average airflow direction is less than 135 degrees.

Example Ex34: An aerosol-generating system according to any of Examples Ex30 to Ex33, wherein the average vapour emission direction is substantially perpendicular to the heating surface.

Example Ex35: An aerosol-generating system according to Example Ex33 or Ex34, wherein the heater assembly and airflow pathway are arranged such that an angle between the average vapour emission direction and the average airflow direction is approximately 90 degrees.

Example Ex36: An aerosol-generating system according to Example Ex33 or Ex34, wherein the heater assembly and airflow pathway are arranged such that an angle between the average vapour emission direction and the average airflow direction is less than 90 degrees.

Example Ex37: An aerosol-generating system according to Example Ex36, wherein the heater assembly and airflow pathway are arranged such that the average vapour emission direction and the average airflow direction are substantially the same.

Example Ex38: An aerosol-generating system according to any of Examples Ex31 to Ex37, wherein the air inlet is distal to the heater assembly .

Example Ex39: An aerosol-generating system according to any of Examples Ex31 to Ex38, wherein a cross-sectional area of the airflow pathway in the region of the heater assembly is configured such that, in use, the airflow speed is between 0.1 and 2 metres per second.

Example Ex40: A method of manufacturing a heater assembly for an aerosol-generating system, the method comprising: forming a porous ceramic body for conveying a liquid aerosol-forming substrate, the porous ceramic body having a liquid absorption surface and a heating surface; and providing a heating element for vaporising a liquid aerosol-forming substrate, the heating element being located on the heating surface of the porous ceramic

body.

Example Ex41: A method according to Example Ex40, wherein the heating element is bonded to the heating surface of the porous body.

Example Ex42: A method according to Example Ex40, wherein the step of providing a heating element comprises depositing a porous layer of electrically conductive material on the heating surface of the porous ceramic body.

Example Ex43: A method according to Example Ex42, wherein the heating element is deposited or patterned by thick film techniques selected from one or more of screen-printing, inkjet-printing, aerosol jet printing and Laser Direct Structuring (LDS).

Example Ex44: A method according to Example Ex42, wherein the heating element is deposited or patterned by thin film techniques selected from one or more of Physical Vapor Deposition (PVD) techniques such as evaporation or sputtering and Chemical Vapor Deposition (CVD).

Example Ex45: A method according to Example Ex40, wherein the heating element and the porous body are integrally formed.

Example Ex46: A method according to Example Ex45, wherein the step of providing the heating element comprises doping a portion of the porous ceramic body to form a heating portion for vaporising the liquid aerosol-generating substrate.

Examples will now be further described with reference to the figures in which:

Figure 1 is a schematic cross-sectional view of a known type of heater assembly 1 arranged in an airflow pathway.

Figure 2 is a schematic plan view of a heater assembly according to an example of the present disclosure.

Figure 3 is a schematic cross-sectional view of the heater assembly of Figure 2.

Figure 4 is a schematic view of the interior of an aerosol-generating system according to an example of the present disclosure.

Figure 5 is a schematic cross-sectional view of part of an aerosol-generating system according to another example of the present disclosure showing an arrangement of a heater assembly relative to an airflow pathway within the aerosol-generating system.

Figure 6 is a schematic cross-sectional view of part of another aerosol-generating system according to another example of the present disclosure showing another arrangement of a heater assembly relative to an airflow pathway within the aerosol-generating system.

Figure 7 is a schematic perspective view of a heater assembly according to another example of the present disclosure;

Figure 8 is a schematic side view of the heater assembly of Figure 7;

Figure 9 is a schematic plan view of a heater assembly according to another example of the present disclosure;

Figure 10 is a schematic perspective view of a heater assembly according to another example of the present disclosure;

Figure 11 is a schematic cross-sectional view through a heater assembly according to another example of the present disclosure;

Figure 12 is a schematic cross-sectional view through a heater assembly according to another example of the present disclosure;

Figures 13a to 13c are schematic illustrations of three heating elements for an aerosol-generating system; and

Figures 14a and 14b are schematic illustrations depicting current flow around a corner of a heating element track.

It will be appreciated that at least some of the figures in the present application are schematic and have been simplified for the purposes of clarity. Consequently, some features may have been omitted and the features are not necessarily drawn to scale.

References to orientations such as vertical, horizontal, above, below, upper and lower, etc. when describing the features of the present disclosure are not intended to imply any limitation on the orientation of those features but are merely intended to show the relative spatial arrangement of features, particularly with reference to the figures or in normal use. It will be appreciated that the features of the present disclosure may have different orientations in use.

Referring to Figure 2, there is shown a heater assembly 100 comprising a heating element 104 for vaporising a liquid aerosol-forming substrate and a porous body 102 for supplying the liquid aerosol-forming substrate from a reservoir or liquid storage portion (not shown) to the heating element 104. The porous body 102 has a liquid absorption surface (not shown) and a heating surface 102a. The heating element 104 is arranged on the heating surface 102a of the porous body 102.

The heating element 104 is formed from a layer of electrically conductive material such that an electrical current can pass through the heating element 104 to heat the heating element 104 by resistive or Joule heating. The heating element 104 is also porous such that it is fluid permeable and vapours can pass through it from the heating surface 102a of the porous body 102. Therefore, in the heater assembly 100 of Figure 2, vapour emission occurs through the heating element 104. The heating element 104 may comprise a thin metallic layer or film having pores that pass through the thickness of the layer or film. Alternatively, the heating element may comprise a metallic foam having interconnected open pores that pass through

the thickness of the foam. In this example, the porous body 102 comprises a porous ceramic body formed from a suitable ceramic material such as Al_2O_3. Furthermore, the heating element 104 has been deposited on the porous ceramic body 102 using a suitable physical or chemical vapour deposition process.

The heater assembly 100 further comprises electrical contacts 106 that are electrically connected to the heating element 12. The electrical contacts 106 are arranged on the heating surface 102a and at or near opposite ends of the heating surface 102a. The heating element 104 extends between the electrical contacts 106. The electrical contacts 106 are arranged to be connected to control circuitry for controlling the supply of electrical power to the heating element. The electrical contacts 106 are formed from a more electrically conductive material than the heating elements such as copper, gold or zinc, although other suitable materials may be used. This avoids excess wasted heat being generated in the electrical contacts.

Figure 3 shows a schematic cross-sectional view of the heater assembly 100 of Figure 2. For clarity and simplicity, the electrical contacts 106 from Figure 1 have been omitted in Figure 2 and the features are not drawn to scale. The liquid absorption surface 102b is shown as the lower surface of the porous body 102 in Figure 3 and the heating surface 102a is shown as the lower surface of the porous body 102, although it will be appreciated that the orientation of these surfaces may differ in use or once the heater assembly 100 is installed in an aerosol-generating device. Liquid stored within a liquid reservoir or liquid storage portion (not shown) contacts the liquid absorption surface 102b and is conveyed through the porous body 102 to the heating surface 102a, as indicated by arrows E in Figure 3. The porous heating element 104 is arranged on the heating surface 102a of the porous body 102 and heats the liquid aerosol-forming substrate conveyed to it such that the liquid aerosol-forming substrate boils and generates a vapour. The porous heating element 104 has a plurality of pores 108 which pass through the thickness of the heating element from the heating surface 102a to an exterior of the heater assembly 100.

Since the heating element 104 is porous, vapour generated during heating of the heating element 104 can pass through the heating element 104 via the pores 108 and be emitted from the heating surface 102a, as indicated by arrows F in Figure 3. The heating element does not have any impermeable sections which prevent vapour release and cause a build up of vapour pressure underneath the heating element. This reduces the speed of vapour emission from the heating element 104 compared to conventional impermeable track heating elements. Table 1 below shows average vapour emission speeds of the vapours emitted from various different configurations of heating element. The heated area of all the heating elements in Table 1 was approximately 5 mm by 3 mm.

As can be seen from Table 1 below, all the heating elements achieved a relatively low vapour emission speed, that is, a vapour emission speed of less than 1 metre per second. Such low vapour emission speeds mean that the vapour can easily be carried away by the airflow in an airflow pathway without impinging on the internal walls of the airflow pathway and causing condensation. As indicated by arrows F, the average vapour emission direction is substantially perpendicular to the heating surface 102a of the porous body 102 and vapour is emitted consistently across the surface of the heating element.

Heating element material	Heating element thickness (μm)	Power applied to heating element (W)	Vapour emission speed (m/s)
Silicate	5	10	0.9
Alumina	15	15	0.6
SiC	15	15	0.45
SiC	50	15	0.6

Table 1

Figure 4 is a schematic illustration of the interior of an aerosol-generating system 200 according to an example of the present disclosure. The aerosol-generating system comprises two main components, a cartridge 202 and a main body part or aerosol-generating device 204. A connection end 202a of the cartridge 202 is removably connected to a corresponding connection end 204a of the aerosol-generating device 204. The connection end 202 of the cartridge 202 and connection end 204a of the aerosol-generating device 204 each have electrical contacts or connections (not shown) which are arranged to cooperate to provide an electrical connection between the cartridge 202 and the aerosol-generating device 204. The aerosol-generating device 204 comprises a device housing 209 that contains a power source in the form of a battery 206, which in this example is a rechargeable lithium ion battery, and control circuitry 208. The aerosol-generating system 200 is portable and has a size comparable to a conventional cigar or cigarette. A mouthpiece 210 is arranged at a mouth end 202b of the cartridge 202. The mouth end 202b is located opposite the connection end 202a of the cartridge 202.

The cartridge 202 comprises a cartridge housing 212 containing a heater assembly 100 and a liquid reservoir or liquid storage portion 218 for holding a liquid aerosol-forming substrate. The heater assembly 100 in Figure 4 has a similar construction to that of Figures 2 and 3 but is inverted compared to its orientation in Figures 2 and 3 such that the liquid

absorption surface 102b faces upwards and is in fluid communication with the liquid storage portion 218 and the heating surface 102a carrying the heating element (not shown) faces downwards. Liquid aerosol-forming substrate is conveyed downwards from the liquid absorption surface 102b through the porous body 102 to the heating element and vaporised aerosol-forming substrate is emitted from the heating surface 102a when electrical power is supplied to the heating element. As indicated by arrow F in Figure 1, the average vapour emission direction is substantially perpendicular to the heating surface 102a of the porous body 102.

The cartridge 202 comprises one or more air inlets 222 formed in the cartridge housing 212 at a location along the length of the cartridge 202 corresponding to the location of the heating surface 102a of the heater assembly 100. An aerosol outlet 226 is located in the mouthpiece 210 at the mouth end 202b of the cartridge 202. The one or more air inlets 222 are in fluid communication with the aerosol outlet 226 to define an airflow pathway 220 through the cartridge 202 of the aerosol-generating system 200. The airflow pathway 220 flows from the one or more air inlets 222 to the heater assembly 100 in an airflow channel 223. The heater assembly 100 is arranged in fluid communication with the airflow pathway 220 in the airflow channel 223. Air enters the one or more air inlets 222 and flows through the airflow channel 223 past the heater assembly 100 in an average airflow direction as indicated by arrows I in Figure 4. As can be seen in Figure 4, the heater assembly 100 and airflow pathway 220 in the airflow channel 223 are arranged such that an angle between the average vapour emission direction F and the average airflow direction I is approximately 90 degrees, that is, at an angle substantially perpendicular to the average airflow direction I. The average vapour emission direction F has no speed or direction component that opposes the average airflow direction I and therefore any loss of momentum of the vapour is reduced. This reduces the tendency for recirculation and turbulence of vapour to occur in the airflow path 220 and the vapour is less likely to impinge on the internal surfaces of the airflow channel 223.

In the example of Figure 4, the liquid storage portion 218 is annular in cross-section and is arranged around a central sealed aerosol channel 224. Once the airflow pathway 220 reaches the heater assembly 100, it is diverted upwards around the sides of the heater assembly 100 and flows through the aerosol channel 224 to the aerosol outlet 226. It will be appreciated that other arrangements of liquid storage portion and airflow pathway could be implemented, such as those discussed below in respect of Figures 5 and 6.

The aerosol-generating system 200 is configured so that a user can puff or draw on the mouthpiece 210 of the cartridge 202 to draw aerosol into their mouth through the aerosol outlet 226. In operation, when a user puffs on the mouthpiece 210, air is drawn in through the

one or more air inlets 222, along the airflow pathway 220 through the airflow channel 223, past and around the heater assembly 100 and along the airflow pathway 220 through the aerosol channel 224 to the aerosol outlet 226. The control circuitry 208 controls the supply of electrical power from the battery 206 to the cartridge 202 when the system is activated. This in turn controls the amount and properties of the vapour produced by the heater assembly 100. The control circuitry 208 may include an airflow sensor (not shown) and the control circuitry 208 may supply electrical power to the heater assembly 100 when user puffs are detected by the airflow sensor. This type of control arrangement is well established in aerosol-generating systems such as inhalers and e-cigarettes. When a user puffs on the mouthpiece 210 of the cartridge 202, the heater assembly 100 is activated and generates a vapour that is entrained in the airflow pathway 220. The vapour cools within the airflow pathway 220 to form an aerosol, which is then drawn into the user's mouth through the aerosol outlet 226.

Figure 5 is a schematic cross-sectional view of part of an aerosol-generating system 300 according to another example of the present disclosure showing an arrangement of a heater assembly relative 100 to an airflow pathway 320 within the aerosol-generating system 300. For simplicity, other components of the aerosol-generating system have been omitted from Figure 5. The heater assembly 100 of Figure 5 is identical to the heater assemblies 100 of Figures 2 and 3. The aerosol-generating system 300 comprises a liquid storage portion 322 that holds a liquid aerosol-forming substrate in contact with the liquid absorption surface 102b of the porous body 102. Liquid aerosol-forming substrate is conveyed from the liquid storage portion 322 through the porous body 102 to the heating surface 102a, as indicated by arrows E. Vaporised aerosol-forming substrate is emitted through the porous heating element 104 from the heating surface 102a. As indicated by arrows F, the average vapour emission direction is substantially perpendicular to the heating surface 102a of the porous body 102.

In the example of Figure 5, the heater assembly 100 is arranged below or to one side of the airflow channel or pathway 320, which airflow pathway 320 is defined by airflow channel walls 324. As viewed in Figure 5, a left-hand end of the visible portion of the airflow pathway 320 receives airflow from an air inlet (not shown) and the right-hand end of the visible portion of the airflow pathway delivers airflow to an aerosol outlet (not shown). The heating surface 102a of the porous body 102 is arranged parallel to the airflow pathway 320 and faces into the airflow pathway 320. The heater assembly 100 is in fluid communication with the airflow pathway such that the airflow in the airflow pathway flows past the heater assembly 100 in an average airflow direction, as indicated by arrows G. The heater assembly 100 and airflow pathway 320 are arranged such that an angle θ between the average vapour emission direction F and the average airflow direction G is approximately 90 degrees, that is, at an angle

θ substantially perpendicular to the average airflow direction G. The average vapour emission direction F has no speed or direction component that opposes the average airflow direction G and therefore any loss of momentum of the airflow is reduced. This reduces the tendency for recirculation and turbulence to occur in the airflow path 320 and the vapour is less likely to impinge on the internal surfaces of the airflow channel walls 324.

Figure 6 is a schematic cross-sectional view of part of an aerosol-generating system 400 according to another example of the present disclosure showing another arrangement of a heater assembly 100 relative to an airflow pathway 420 within the aerosol-generating system 400. For simplicity, other components of the aerosol-generating system have been omitted from Figure 6. The heater assembly 100 of Figure 6 is identical to the heater assemblies 100 of Figures 2 and 3. The aerosol-generating system 400 comprises a liquid storage portion 422 that holds a liquid aerosol-forming substrate in contact with the liquid absorption surface 102b of the porous body 102. Liquid aerosol-forming substrate is conveyed from the liquid storage portion 422 through the porous body 102 to the heating surface 102a, as indicated by arrows E. Vaporised aerosol-forming substrate is emitted through the porous heating element 104 from the heating surface 102a. As indicated by arrows F, the average vapour emission direction is substantially perpendicular to the heating surface 102a of the porous body 102.

In the example of Figure 6, the airflow channel or pathway 420 is split into first and second airflow pathway sections 420a and 420b which pass either side of the heater assembly 100. The first and second airflow pathway sections 420a and 420b combine downstream of the heater assembly 100 into a third airflow pathway section 420c. The first and second airflow pathway sections 420a and 420b receive airflow from one or more air inlets (not shown) and the third airflow pathway section 420c delivers airflow to an aerosol outlet (not shown). The airflow pathway 420 is defined by airflow channel walls 424.The heating surface 102a of the porous body 102 is arranged substantially perpendicular to the airflow pathway 420 and faces in a downstream direction of the airflow pathway 420. The heater assembly 100 is in fluid communication with the airflow pathway such that the airflow in the airflow pathway flows past the heater assembly 100 in an average airflow direction, as indicated by arrows G.

The heater assembly 100 and airflow pathway 120 are arranged such that an angle θ between the average vapour emission direction F and the average airflow direction G is less than 90 degrees. Upstream of the heating surface 102a of the porous body 102, the average airflow direction G past the heater assembly 100 is substantially the same as the vapour emission direction F. At the point along the airflow pathway 420 corresponding to the heating surface 102a the airflow pathway 420 starts to narrow or taper inwards, at which point the average airflow direction G past the heater assembly 100 changes to an angle θ relative to

the vapour emission direction F of approximately 45 degrees. Downstream of the heating surface 102a of the porous body 102 in the third airflow pathway section 420c, the average airflow direction G of the combined airflow is again substantially the same as the vapour emission direction F. It will be appreciated that the narrowing or tapering of the airflow pathway 420 could be omitted. In which case, the average airflow direction G past the heater assembly 100 would be substantially the same as the vapour emission direction F.

The cross-sectional area of the airflow pathways 220, 320 and 420 in the aerosol-generating devices of Figures 4, 5 and 6 respectively are designed such that sufficient vapours from the liquid aerosol-forming substrate are taken into the air flow once they are emitted from the heater assembly 100. The airflow speed is preferably higher than the vapour emissions speed of the vapour being emitted from the heater assembly to ensure proper entrainment of the vapours in the airflow pathways 320 and 420. For example, for a vapour emission speed of 0.1 to 0.7 metres per second, an airflow speed of approximately 1 metre per second is desirable. According to a standard Coresta puffing profile, a 55 millilitre (55 cm^3) puff of 3 seconds in duration amounts to a volumetric flow rate of 18.3 cm^3 per second. Since the airflow speed is the ratio of the volumetric flow rate to the cross-sectional area, an airflow speed of 1 metre per second is achieved with an airflow pathway having a cross-sectional area X of 18.3 mm^2. It will be appreciated that, in the aerosol-generating device of Figure 5 this, this cross-sectional area X is split across the cross-sectional areas of the two airflow pathway sections 420a and 420b.

A volumetric flow rate of 18.3 cm^3 per second has been found to be sufficient to provide a desired throughput of aerosol-forming substrate vapour or aerosol of 2.5 milligrams per second for a typical liquid aerosol-forming substrate comprising 44 percent glycerol, 44 percent propylene glycol, 10 percent water, and nicotine and flavourings. Furthermore, an airflow speed of 1 metre per second has been found to be sufficient to properly entrain the vapour in the airflow and reduce the likelihood of vapours impinging on the airflow channel wall 324 and 424 to form condensates. In addition, an airflow speed of 1 metre per second has been found to not result in significant cooling of the heating element 104 or a reduction in the amount or quality of aerosol produced.

Figures 7 and 8 show schematic illustrations of an example heater assembly 500 for an aerosol-generating system. The heater assembly 500 includes a heating element 510 and a porous body 520. The heating element 510 is configured to vaporise an aerosol-forming substrate, such as a liquid aerosol-forming substrate, to form an aerosol. The heating element 510 is configured to convert electrical energy into heat energy by material resistance of the heating element 510 to an electrical current.

The porous body 520 is configured to convey the liquid aerosol-forming substrate to the heating element 510. In other words, the porous body 520 supplies the liquid aerosol-forming substrate to the heating element 510. The porous body 520 has a first end face and an opposing second end face. The first end face is a liquid absorption surface 530 and the second end face is a heating surface 540. In this example, the liquid absorption surface 530 and the heating surface 540 are both substantially flat surfaces. The porous body 520 also has a plurality of lateral faces extending between the liquid absorption surface 530 and the heating surface 540. In this example, as will be discussed in more detail below, the porous body 520 has a first lateral face 550 opposing a second lateral face 560, and a third lateral face 570 opposing a fourth lateral face 580.

The porous body 520 comprises a plurality of pores. The plurality of pores are interconnected to provide a fluid pathway for liquid aerosol-forming substrate through the porous body 520, from the liquid absorption surface 530 to the heating surface 540. The porous body 520 is formed from a material that does not chemically interact with the liquid aerosol-forming substrate. In this example, the porous body 520 is a porous ceramic body and may be formed from, for example, Ca_2SiO_3 or SiO_2 (or Ca_2SiO_3 and SiO_2). In another example, the porous body 520 may be, for example, a porous glass body.

The heating element 510 is located on the heating surface 540 of the porous body 520. In the example of Figures 7 and 8, the heating element 510 is a porous film that extends across substantially all of the heating surface 540.

The liquid absorption surface 530 of the porous body 520 has an area that is different to an area of the heating surface 540 of the porous body 520. Specifically, in the example of Figures 7 and 8, the area of the heating surface 540 is less than the area of the liquid absorption surface 530.

In the example of Figures 7 and 8, the heating surface 540 has smaller area than the liquid absorption surface 530 because the length of the heating surface 540 is less than the length of the liquid absorption surface 530. In addition, or alternatively, in another example, the heating surface 540 may have a smaller area than the liquid absorption surface 530 because the width of the heating surface 540 is less than the width of the liquid absorption surface 530.

In the example of Figures 7 and 8, the porous body 520 is shaped as a trapezoid prism. With the porous body 520 having a trapezoid prism shape, the first lateral face 550 and the second lateral face 560 both have a trapezium shape, specifically an isosceles trapezoid, the third lateral face 570 and the fourth lateral face 580 both have a rectangle shape, and the liquid absorption surface 530 and the heating surface 540 both have a rectangle shape. In

another example, the liquid absorption surface 530 and the heating surface 540 may have a square shape.

The porous body 520 tapers from the liquid absorption surface 530 towards the heating surface 540. In other words, the cross-sectional area of the porous body 520 gradually becomes smaller from the liquid absorption surface 530 towards the heating surface 540. In the example of Figures 7 and 8, the length of the porous body 520 decreases from the liquid absorption surface 530 towards the heating surface 540 which causes the tapering.

In one example, the porous body 520 is formed from a sintered ceramic such as silicon carbide. The porous body 520 includes open pores. The open pores are longitudinal pores which generally extend from the liquid absorption surface 530 to the heating surface 540 of the porous body 520. The pore size of the pores in the porous body 520 vary between the liquid absorption surface 530 and the heating surface 540.

The porous body 520 includes a heating end and a liquid absorption end, the heating surface 540 being disposed at the heating end, and the liquid absorption surface 530 being disposed at the liquid absorption end. The porous body 520 includes a first average pore size at the liquid absorption end, and a second average pore size at the heating end. The first average pore size is greater than the second average pore size.

The first pore size at the liquid absorption end is about 150 micrometres. The second pore size at the heating end is about 20 micrometres. The pore size varies linearly between the first pore size and the second pore size to provide a pore size gradient between the liquid absorption end and the heating end of the porous body 520.

The pore structure and pore size gradient in the porous body 520 is achieved by etching the pores into a portion of silicon carbide.

Figure 9 shows a schematic plan view of an example heater assembly 600 for an aerosol-generating system. The heater assembly 600 includes a heating element 610 and a porous body 620. The porous body 620 can be made from any suitable ceramic material such as the materials discussed in any of the examples above. The heating element 610 is located on a heating surface 612 of the porous body 620. In the example of Figure 9, the heating element 610 is a serpentine in shape and is located on the heating surface 612. Similar to the example heater assembly 500 in Figures 7 and 8, the heater assembly 600 of Figure 9 has a tapered shape such that the area of the heating surface 612 is less than the area of the liquid absorption surface (not visible), which is located on the underside of the porous body 620 in the view shown in Figure 9. Both the liquid absorption surface and the heating surface 612 are square. In this way, the porous body 620 of the heater assembly 600 has the shape of a truncated square based pyramid. The four longitudinal surfaces 613 of the porous body 620

each have an equally sized trapezium shape.

The porous body 620 of the heater assembly 600 further comprises a plurality of airflow guides 614 for guiding the airflow towards the heating surface 612. Each of the four longitudinal surfaces 613 includes an airflow guide in the form of a longitudinal groove or slit provided in the surfaces 613. Each of the airflow guides 614 extends from the liquid absorption surface (not visible) to the heating surface 612. The airflow guides 614 help to improve the efficiency of the airflow in the region of the heater assembly 600. This arrangement is particularly beneficial when the airflow is substantially aligned with the vapour emission direction of the vaporised aerosol-forming substrate from the heating surface 612.

Figure 10 shows a heater assembly 700 for use in an aerosol-generating system. The heater assembly 700 comprises a heating element 710 for vaporising a liquid aerosol-forming substrate. The heater assembly 700 also comprises a porous body 720 for conveying the liquid aerosol-forming substrate to the heating element 710. The porous body 720 has a liquid absorption surface 721 and an opposed heating surface 722. The heating element 710 is located on the heating surface 722 of the porous body 720. The porous body 720 can be made from any suitable ceramic material such as the materials discussed in any of the examples above.

The heating surface 722 of the porous body 720 is curved. In particular, the heating surface 722 of the porous body 720 is convexly curved in a single transverse direction (the first transverse direction).

The porous body 720 is prismatic in shape. When viewing a longitudinal cross-section perpendicular to the direction of curvature of the porous body 720, the heating surface 722 of the porous body 720 is shown as an arc. The porous body 720 has two longitudinal planes of symmetry.

The heating surface 722 of the porous body 720 has a width 723 in the first transverse direction substantially the same as the width of the porous body 720 in the first transverse direction, and substantially the same as the width of the heater assembly 700 in the first transverse direction. The heating surface 720 of the porous body 720 has a width of about 5 millimetres in the first transverse direction.

The heating surface 722 of the porous body 720 has a length or thickness 724 of about 1 millimetre. The porous body 720 has a length or thickness 725 of about 3 millimetres.

The heating surface 722 of the porous body has a of curvature of about 3.6 millimetres. The heating surface 722 of the porous body has a surface area of about 28 square millimetres.

The porous body 720 comprises four longitudinal surfaces or side walls extending from the liquid absorption surface 721 to the heating surface 722. The four side walls are

substantially perpendicular to the liquid absorption surface 721, which is substantially flat. The liquid absorption surface 721 is square in shape.

The heating element 710 is a resistive heating element 710 and is curved. In particular, the curvature of the heating element 710 is substantially the same as the curvature of the heating surface 722 of the porous body 720. As such, the heating element 710 is also convexly curved in a single transverse direction.

The heating element 710 is located directly on the heating surface 722 of the porous body 720. The heating element 710 extends across a majority of the heating surface 722 of the porous body 720. Substantially the entirety of the heating element 710 is in contact with the heating surface 722 of the porous body 720.

Figure 11 shows a schematic cross-sectional view of a heater assembly 800 for an aerosol-generating system. The heater assembly 800 comprises: a heating element 810, a thermally insulating layer 820 and a porous body 830. The porous body 830 is configured to supply liquid aerosol-forming substrate to the heating element 810. Specifically, the porous body 830 is configured to transmit liquid aerosol-forming substrate from a liquid reservoir (not shown) to the heating element 810. The porous body 830 is configured to store some liquid aerosol-forming substrate before aerosolization by the heating element 810.

The porous body 830 is a rectangular block and has a first end face and an opposing second end face. The first end face is a liquid absorption surface 834 and the second end face is a heating surface 833. In this example, the liquid absorption surface 834 and the heating surface 833 are both substantially flat surfaces. The porous body 830 also has a plurality of lateral faces extending between the liquid absorption surface 834 and the heating surface 833. The porous body 830 has a first lateral face 831 opposing a second lateral face 832, and a third lateral face (not shown) opposing a fourth lateral face (not shown). The porous body 830 has a thickness defined between the liquid absorption surface 834 and the heating surface 833.

The porous body 830 comprises a plurality of open-cell pores. The plurality of open-cell pores are interconnected to provide a fluid pathway for aerosol-generating liquid through the porous ceramic body 830. The heater assembly 800 may be configured such that liquid can pass through the fluid pathway of the porous body 830 to the heating element 810, as depicted by arrows 870. The porous body 830 is configured for fluid 870 to pass from the liquid absorption side 834 to the heating surface 833. The porous body 830 comprises a material which does not chemically interact with the liquid aerosol-forming substrate. The porous body 830 comprises ceramic. The porous body 830 comprises porous ceramic, such as but not limited to one or more of: Al_2O_3, ZrO_2, Si_3N_4, SiC, Ti_3AlC_2, BN, AlN, SiO_2, MgO, mica, diatomite,

silicates, silicides, borides. Alternatively, the porous body 830 may comprise porous glass. It will be appreciated that the porous body 830 may have a different shape or comprise a different material.

The heating element 810 is configured to heat a liquid aerosol-forming substrate to form an aerosol. The heating element 810 is configured to convert electrical energy into heat energy by material resistance of the heating element 810 to an electrical current.

The heating element 810 comprises a track defining a path across a heating surface 823 of the thermally insulating layer 820. The heating element 810 defines a serpentine or an electrically parallel track shape across the heating surface 823 of the thermally insulating layer 820. Three cross-sections through portions of the track of the heating element 810 are shown in Figure 11. The plurality of track portions are arranged with distances between at least two of the plurality of track portions 818, 819 in the range 200 to 300 micrometres. The track portions are evenly spaced. It will be appreciated that distances between at least two of the plurality of track portions 818, 819 may not be equal.

The heating element 810 is elongate and comprises metal, such as but not limited to stainless steel, Ni-Cr alloy, NiCrAlY alloy, FeCrAl alloys (e.g., Kanthal), FeCrAlY alloys, Fe_3Al alloy, Ni_3Al alloy, NiAl alloy, and CuNi alloys. It will be appreciated that the heating element 810 may have a different shape or comprise a different material.

The heating element 810 is arranged along an outer surface of the thermally insulating layer 820. The heating element 810 is in direct contact with the thermally insulating layer 820. The thermally insulating layer 820 is arranged to enhance thermal insulation between the heating element 810 and the porous body 830. The thermally insulating layer 820 is arranged to extend across at least a portion of the heating element 810 to thermally insulate the heating element 810 from the porous body 830. The thermally insulating layer 820 is configured to reduce heat dissipation through the porous body 830, so as to enhance energy efficiency by reducing energy losses.

The thermally insulating layer 820 is planar and has a size and shape configured to extend across the electrical heating element 810. The thermally insulating layer 820 is configured to entirely extend across a surface of the heating element 810. The thermally insulating layer 820 is configured to substantially cover the porous body 830 below the thermally insulating layer 120.

The thermally insulating layer 820 has a first end face 824 and an opposing second end face 823. In this example, the first 824 and second 823 end faces are both substantially flat surfaces. The first end face 824 of the thermally insulating layer 820 is in direct contact with the porous ceramic body 830. The second end face 823 of the thermally insulating layer

820 is in direct contact with the heating element 810.

The thermally insulating layer 820 has a thickness defined between the first end face 824 and the second end face 823. The thickness of the thermally insulating layer 820 is less than the thickness of the porous body 830. The thermally insulating layer 820 may have a thickness between 0.1 mm and 2 mm, preferably between 0.5 mm and 1.5 mm.

The thermally insulating layer 820 comprises a material having a low thermal conductivity. The thermally insulating layer 820 comprises or consists of a material with a lower thermal conductivity than the porous ceramic body 830. The thermally insulating layer 820 may have a higher porosity than the porous ceramic body 830. The thermally insulating layer 820 may comprise a material such as one or more of: alumina, zirconia, zirconia with magnesium oxide, glass ceramic, quartz, a porous polymer. It will be appreciated that the thermally insulating layer 820 may have a different shape or comprise a different material.

Figure 12 shows a schematic cross-sectional view of another example heater assembly 801 for an aerosol-generating system. The heater assembly 801 of Figure 12 is the same as the heater assembly 800 of Figure 11, with the exception that the heating element 815 comprises a porous heating element. The porous ceramic body 830, and the thermally insulating layer 820 are as described in relation to the heater assembly 800 of Figure 11 and like reference numerals have been used to label like components.

The heating element 815 extends to cover an area of the second end face 823 of the thermally insulating layer 820. The heating element 815 has a liquid absorption surface 814 and a heating surface 813. In this example, the liquid absorption surface 814 of the heating element 815 and the heating surface 813 of the heating element 815 are both substantially flat surfaces. The liquid absorption surface 814 of the heating element 815 is in direct contact with the thermally insulating layer 120.

Figures 13a to 13c are shown schematic illustrations of different heating elements 910a to 910c for an aerosol-generating system. Each heating element 910a to 910c comprises a plurality of tracks or track portions 917 arranged electrically in parallel. By being arranged electrically in parallel, current flow is split into separate parallel flow paths. The flow paths are subsequently re-combined.

In the heating elements 910a to 910c of Figures 13a to 13c, each heating element 910a to 910c comprises a first connecting pad 913 and a second connecting pad 914. The first and second connecting pads 913, 914 are configured to allow connection to an external circuit. An aperture or plurality of apertures 915 in the heating elements 910a to 910c separate each track 917. Each heating element 910a to 910c comprises a diverging portion, in which current is split from the first connecting pad 913 into tracks 917 which define electrically

parallel paths. Each heating element 910a to 910c comprises a converging portion, in which current is combined from tracks 917 which define electrically parallel paths, into the second connecting pad 914.

Figures 13a to 13c show three different arrangements of tracks or track portions arranged electrically in parallel. In Figure 13a, four tracks 917 are separated by three apertures 915 to define four electrically parallel paths. In Figure 13b, six track portions 917 are separated by one aperture 915 to define two electrically parallel paths. In Figure 13b, each electrically parallel path defines a serpentine path between the first connecting pad 913 and the second connecting pad 914. In Figure 13c, eight track portions 917 are separated by four apertures 915 to define four pairs of electrically parallel paths. Each pair of electrically parallel path in Figure 13c is separated by an intermediate connection 916, of which three are shown in Figure 13c.

By having tracks or track portions arranged electrically in parallel, if one track portion is defective, current can be redistributed and can still flow through the heating elements 910a to 910c, that is, the electrical connection between the first connecting pad 913 and the second connecting pad 914 is not broken. This has the advantage of increasing the number of puffs before full failure of the heater, and potentially increasing the heater lifetime up to the lifetime of the device. In contrast, in a simple serpentine heater defining a single electrical path between a first connecting pad 913 and a second connecting pad 914, if a part of the serpentine heating element is broken, then the heating element will stop working due to an increase in local resistance at the breakage or defect point. A defect in a simple serpentine heater causes an increase in local resistance. An increase in local resistance causes increased power dissipation. Increased power dissipation in turn increases the resistance until breakage.

The inventors have also identified that the parallel tracks or track portions arranged electrically in parallel, explained with reference to Figures 13a to 13c, has a surprising additional advantage. In such an arrangement, in case of breakage of one track portion, the heating element will still operate and can, for an initial transitory period, operate in an advantageous way, because the breakage of one track or track portion would result in a higher energy density on the remaining tracks or track portions. In such a case, the same power would still be provided but on a smaller area, so the throughput would be increased. While such a breakage causing an increase in current on unbroken tracks or track portions can eventually degrade the user experience, the device or cartridge can include a mechanism to alert the user about possible future below optimal performance of the heater assembly.

Such a mechanism relies on the following principles. The total electrical resistance of

the heating element depends on the following factors:

1) the number of heating tracks in parallel (more parallel tracks decrease the total resistance);

2) the cross-sectional area (width or thickness (or width and thickness)) of the parallel heating tracks (a higher cross-sectional area leads to a lower resistance);

3) the length of the parallel heating tracks (longer tracks have a higher resistance);

4) if the heating element is porous, tuning the porosity of heating element (higher porosity increases resistance);

5) particular chemical or material composition (e.g. alloys by doping).

The overall total heating element resistance R_{tot} of an arrangement of a number of heating tracks or track portions (i) arranged in parallel such that electric current in at least two neighbouring tracks or track portions flows in the same direction, R_i is set out in equation 1:

$$\frac{1}{R_{tot}} = \sum_i^n \frac{1}{R_i} \qquad (1)$$

where n is the total number of heating tracks arranged electrically in parallel.

The behaviour of a parallel track heating element when one heating track fails can be considered with reference to a heating element with 4 parallel heating tracks, for example as shown in Figure 13a. The heating tracks each have a resistance of 3 Ohms. The total resistance of the heating element is 0.75 Ohms, calculated using equation 1.

When one heating track starts to fail, the resistance of the failing heating track increases. The total resistance of the heating element also starts to increase, following a linear relationship with the failing heating track resistance. However, as the heating track resistance continues to increase, the heating element resistance asymptotes to a constant resistance value. At this constant resistance value, the influence of the failing heating track on the heating element resistance is capped. In this example, where unbroken heating tracks each have a resistance of 3 Ohms, the total resistance of the heating element that asymptotes to 1 Ohm when the failed track can be considered as an open circuit (that is, no more current can flow through it). When one track breaks in this example, only three tracks remain for the purpose of calculating the total heating element resistance.

To consider the behaviour of such a heating element, a supply voltage of 3.5 Volts and target power of 5.5 Watts are considered. In this example, unbroken parallel heating tracks remain with their initial resistance of 3 Ohms. In the failing track, the total maximum current decreases with increasing resistance. In the failing track, current decreases to zero once

broken. The current through the unbroken parallel tracks remains substantially constant as the resistance of the failing track increases (if resistance change due to temperature increase is ignored).

A similar behaviour is observed for the maximum power generation . Less total power is generated once a heating track has failed. However, in this example, the maximum power remains higher than the target of 5.5 Watts despite failure of one of the heating tracks.

In contrast to a heating element comprising a film, the overall heating element resistance increase of the parallel track heating element can be monitored by control electronics. In a film heating element, a damaged area may widen with time until failure occurs, because the current density across the film heating element (perpendicular to the current flow) increases at the damaged area, generating more power, elevating the local temperature. This locally increases the resistance of the film heating element, further increasing the temperature until breakdown (that is, positive feedback). In the parallel track heating element, in contrast, the overall heating element resistance increase can be monitored by the control electronics. The aerosol-generating system may be configured such that when a predetermined threshold is reached, the device or system tells the user through a user interface that the heater assembly should be exchanged.

The aerosol-generating system may also be configured to extend the life of the parallel track heating element. The aerosol-generating system may comprise control circuitry configured to, after detecting the failure of a heating track for example by a feedback loop, adjust the power fed to the heater. The control circuitry may be configured to provide a pulse width modulation (“PWM”) signal to control the power fed to the heater. The control circuitry may adjust the power fed to the heater by adjusting the duty cycle of the pulse width modulation signal. In an example, control circuitry may be configured to have a duty cycle at 33.7 percent when the heating tracks are in a normal condition. The duty cycle may increase to 44.9 percent when one of the heating tracks has failed. When one of the heating tracks fails, the power density (heating power generated by surface area) increases, enhancing the thermal efficiency of the heater body. Therefore, the proper operation of the heater is not jeopardized with one failed heating track. A similar result occurs if a second heating track breaks. The control circuitry may be configured such that the duty cycle further increases (to 67.4 percent in the current example). Thus, a heating element with four parallel heating tracks can still operate with the nominal condition of 5.5 Watts, even if two of these heating tracks are broken, since the duty cycle remains below 100 percent.

The control circuitry may be configured such that, based on the change of nominal total resistance of the heating element once a parallel heating track has failed, it is possible

for the control circuitry to assess the state of the heating element (that is, number of heating tracks which have failed). The control circuitry may be configured such that, after a predefined number of heating track(s) have failed, the device can tell the user that the heater assembly should be changed.

Figures 14a and 14b are shown schematic illustrations of current flow 909 around a corner of a heating element track. Figure 14a is a schematic illustration of current flow 909a around a known heating element in which a track portion 917a defines a path having a bend, the inner edge of the bend having a sharp corner. In such a track portion 917a, current flow depicted by arrows 909a, which follows a path of least resistance, is concentrated (that is, there is an increase in current density). This concentration occurs at an inner edge of the corner. Current concentration can increases the local temperature, and can lead to the presence of hot spot at the corner. A hot spot is disadvantageous, as it can affect the efficiency and reliability of the heating element. A hot spot occurs despite the potential for local resistivity of the heater track material to increase due to a local increase in temperature (which would direct current flow away to a path of lower resistance).

Figure 14b is a schematic illustration of current flow 909b around a heating element in which a track portion 917b defines a path having a bend, the inner edge of the bend being curved. In such a track portion 917b, current flow 909b does not form a local hot spot.

In contrast to the track shape shown in Figure 14a, current flow 909b in the smoother curved track portion 917b, as shown in Figure 14b, remains more evenly distributed across the heating track 917b, as depicted by dashed arrows 909b. Current flow 909b is guided to flow more evenly, to avoid a concentration of current at any point. This in turn limits hot spot creation. The heater track 917b may have a gradient of electrical resistivity perpendicular to current flow in a corner or corners, such that the electrical resistivity is higher at an inner part of the corner and lower at an outer part of the corner. Such a gradient is beneficial to counterbalance localized high current density and reduce hot spot creation.

For the purpose of the present description and of the appended claims, except where otherwise indicated, all numbers expressing amounts, quantities, percentages, and so forth, are to be understood as being modified in all instances by the term "about". Also, all ranges include the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein. In this context, therefore, a number A is understood as A ± 5 percent (5%) of A. Within this context, a number A may be considered to include numerical values that are within general standard error for the measurement of the property that the number A modifies. The number A, in some instances as used in the appended claims, may deviate by the percentages enumerated above provided

that the amount by which A deviates does not materially affect the basic and novel characteristic(s) of the claimed invention. Also, all ranges include the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein.

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Claims

1. An aerosol-generating system comprising:

a heater assembly comprising:

a heating element for vaporising a liquid aerosol-forming substrate, and

a porous body for conveying the liquid aerosol-forming substrate to the heating element, the porous body having a liquid absorption surface and a heating surface, the heating element being located on the heating surface of the porous body;

wherein the heating element is fluid permeable such that, in use, vapour is emitted from the heater assembly in an average vapour emission direction;

wherein the aerosol-generating system further comprises an air inlet and an aerosol outlet, the air inlet being in fluid communication with the aerosol outlet to define an airflow pathway through the aerosol-generating system;

wherein the heater assembly is arranged in fluid communication with the airflow pathway such that air flows past the heater assembly in an average airflow direction, wherein the heater assembly and airflow pathway are arranged such that an angle between the average vapour emission direction and the average airflow direction is less than 90 degrees.

2. An aerosol-generating system according to claim 1, wherein the average vapour emission direction is substantially perpendicular to the heating surface.

3. An aerosol-generating system according to claim 1 or 2, wherein the heater assembly and airflow pathway are arranged such that the average vapour emission direction and the average airflow direction are substantially the same.

4. An aerosol-generating system according to any preceding claim, wherein the porous body comprises at least one airflow guide to guide the airflow towards the heating element.

5. An aerosol-generating system according to any preceding claim, wherein the air inlet is distal to the heater assembly.

6. An aerosol-generating system according to any preceding claim, wherein a cross-sectional area of the airflow pathway in the region of the heater assembly is between 9.15 millimetres squared and 183 millimetres squared.

7. An aerosol-generating system according to any preceding claim, wherein the heating element comprises a porous layer of electrically conductive material.

8. An aerosol-generating system according to any preceding claim, wherein the heating element and the porous body are integrally formed.

9. An aerosol-generating system according to any of claims 1 to 7, wherein the heating element is bonded to the heating surface of the porous body.

10. An aerosol-generating system according to any preceding claim, wherein the heating element has a tapered cross-sectional shape.

11. An aerosol-generating system according to any preceding claim, wherein the heating surface of the porous body is convex in one or both of a first transverse direction and a second transverse direction, the first transverse direction being orthogonal to the second transverse direction.

12. An aerosol-generating system according to any preceding claim, wherein the heater assembly further comprises a thermally insulating layer having a lower thermal conductivity than the porous body, wherein the thermally insulating layer is disposed between and is in contact with each of the porous body and the heating element, and the thermally insulating layer is configured to reduce heat transfer from the heating element to the porous body.

13. An aerosol-generating system according to any preceding claim, wherein the heating element comprises a doped portion of the porous body.

14. An aerosol-generating system according to any preceding claim, wherein the average pore size of the porous body varies between the liquid absorption surface and the heating surface.

15. An aerosol-generating system according to any preceding claim, wherein the heating element comprises a plurality of tracks or track portions arranged electrically in parallel.

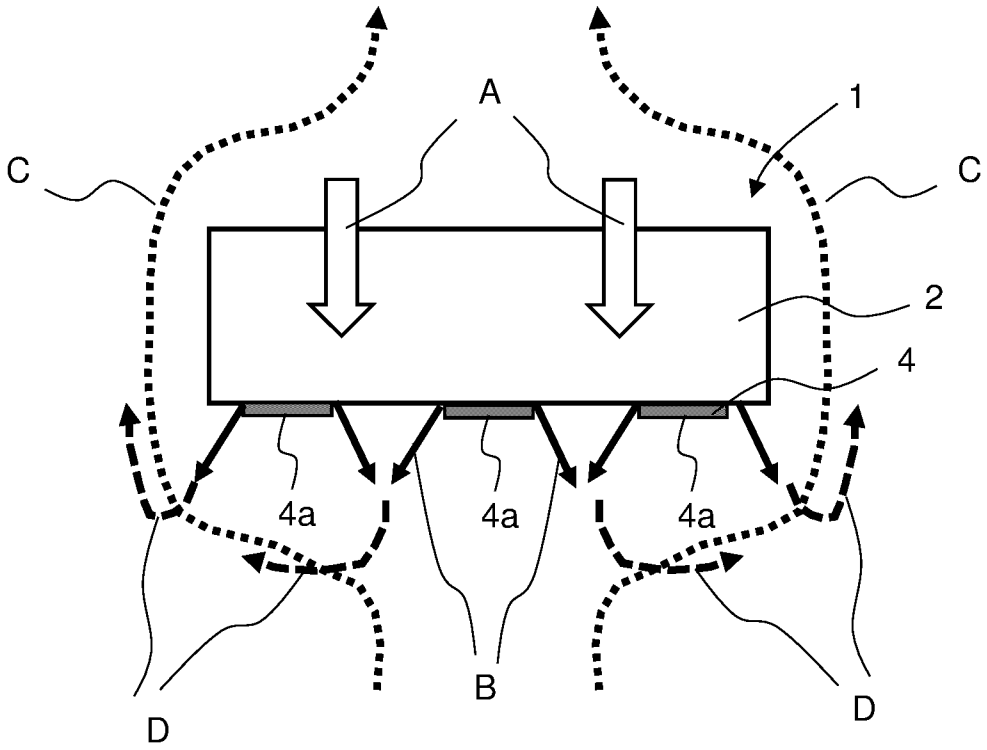


FIG. 1
(prior art)

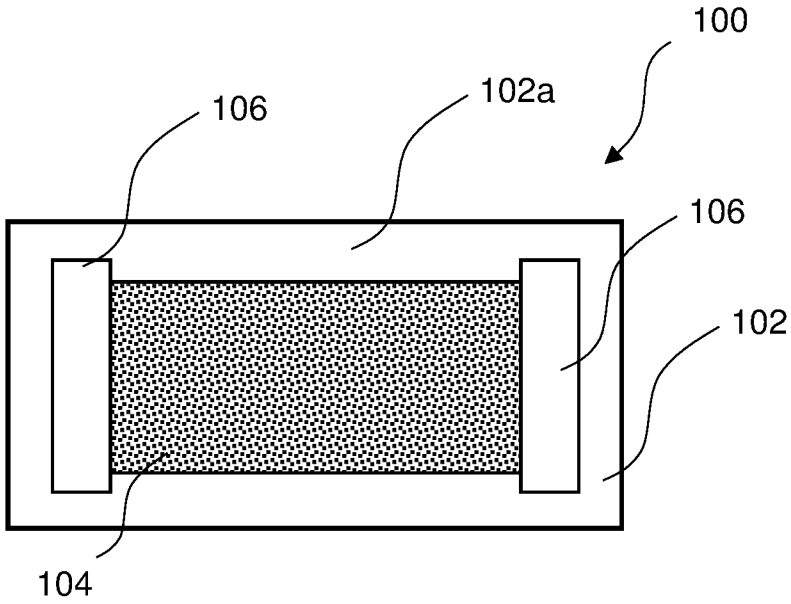


FIG. 2

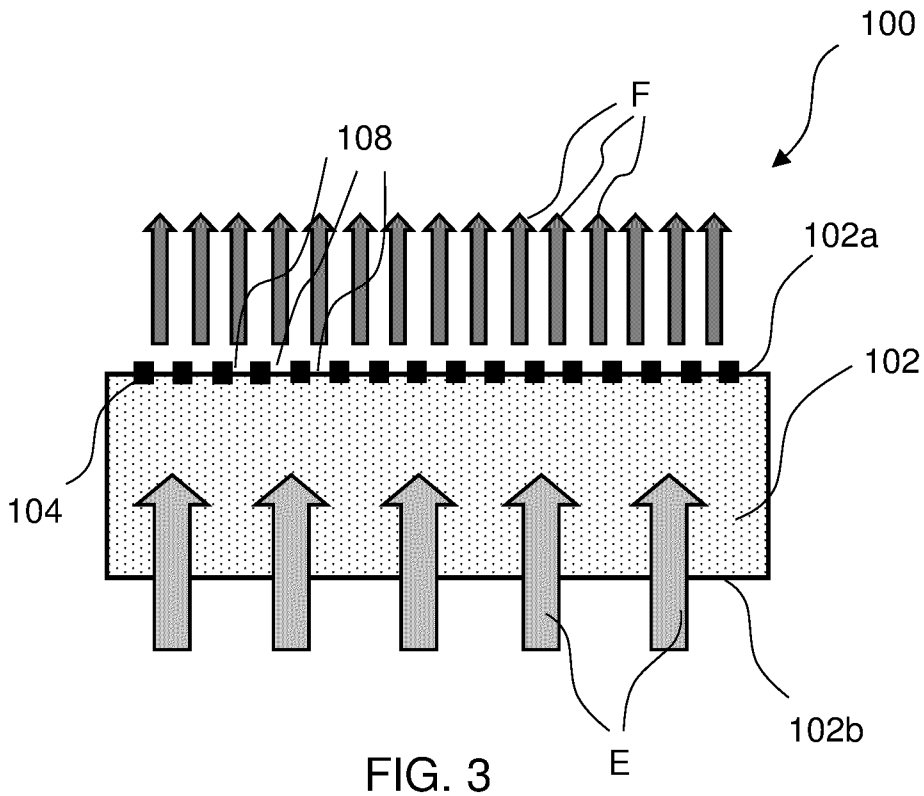


FIG. 3

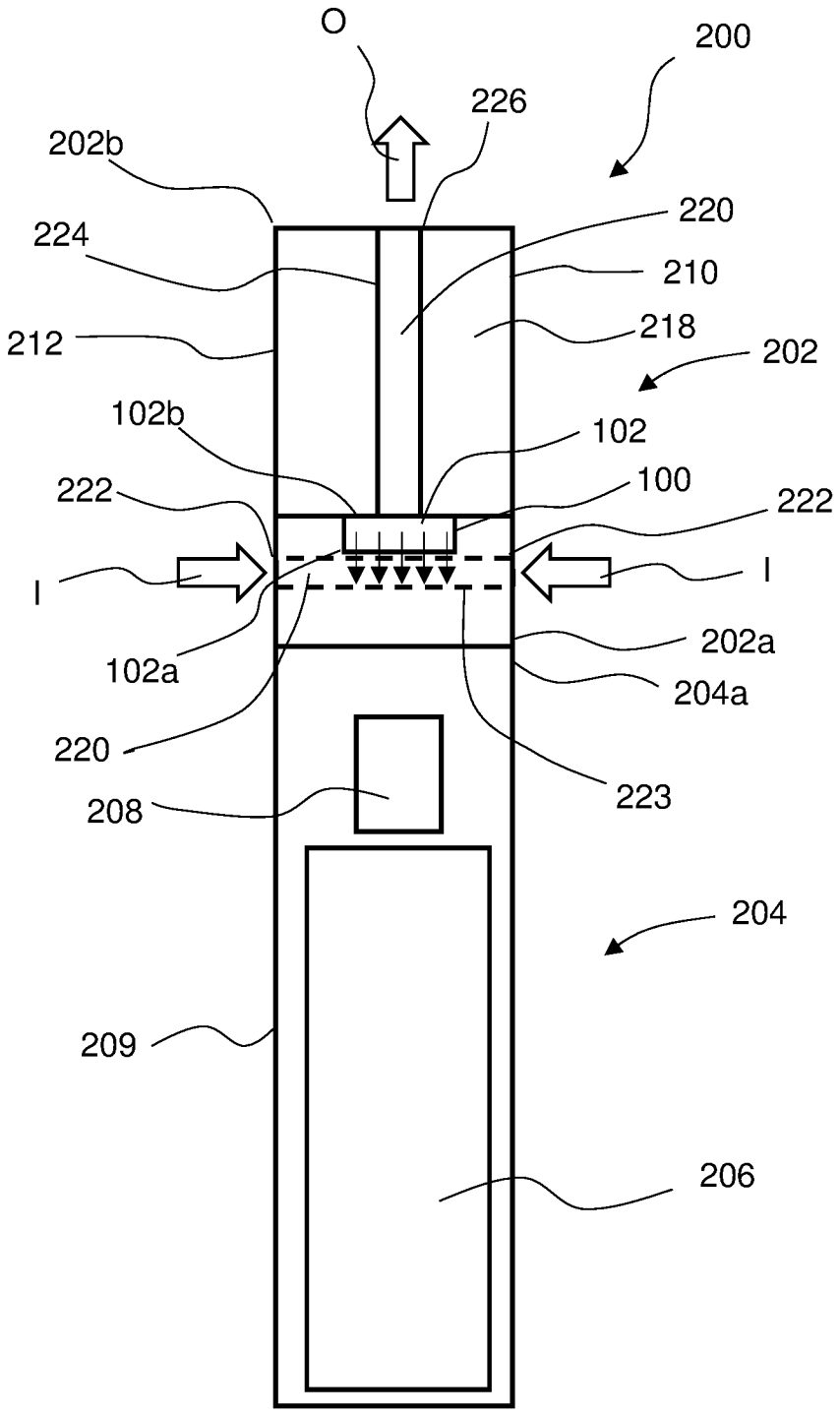

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FIG. 4

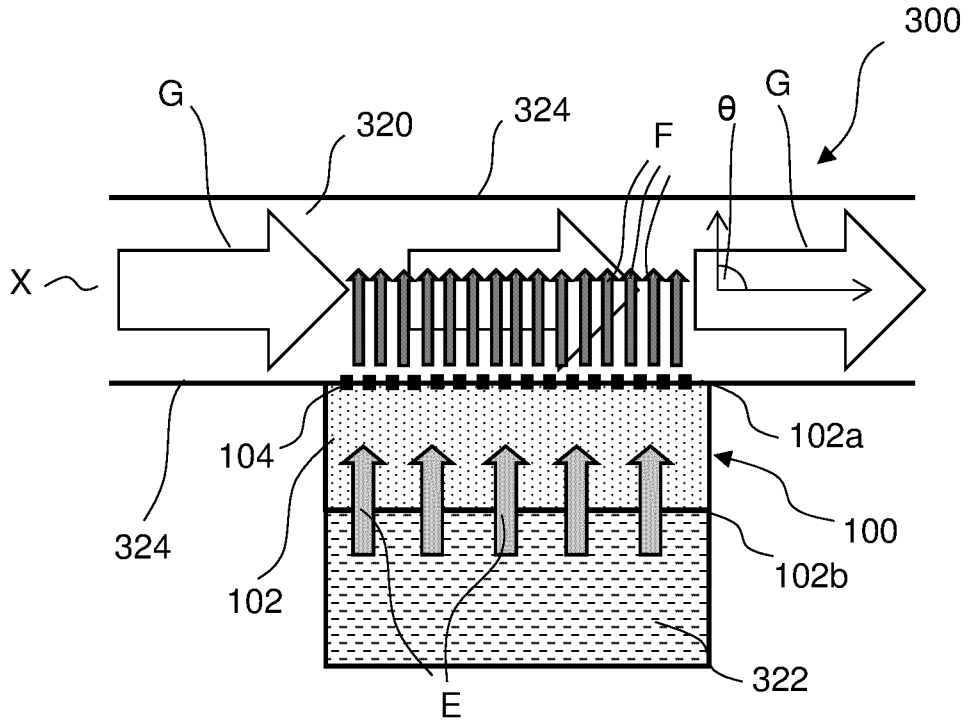

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FIG. 5

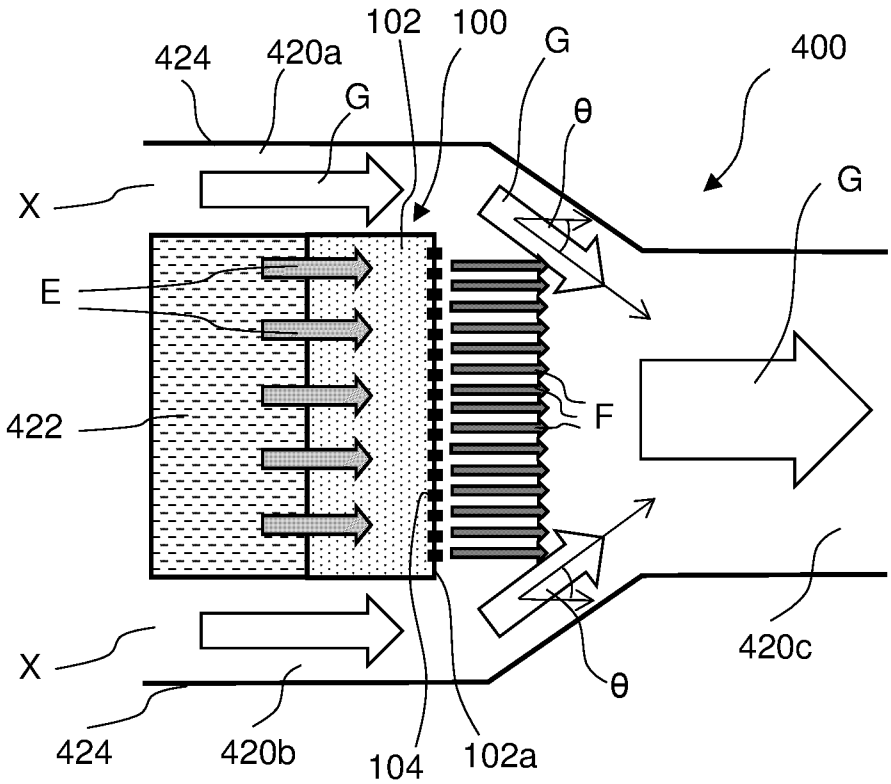

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FIG. 6

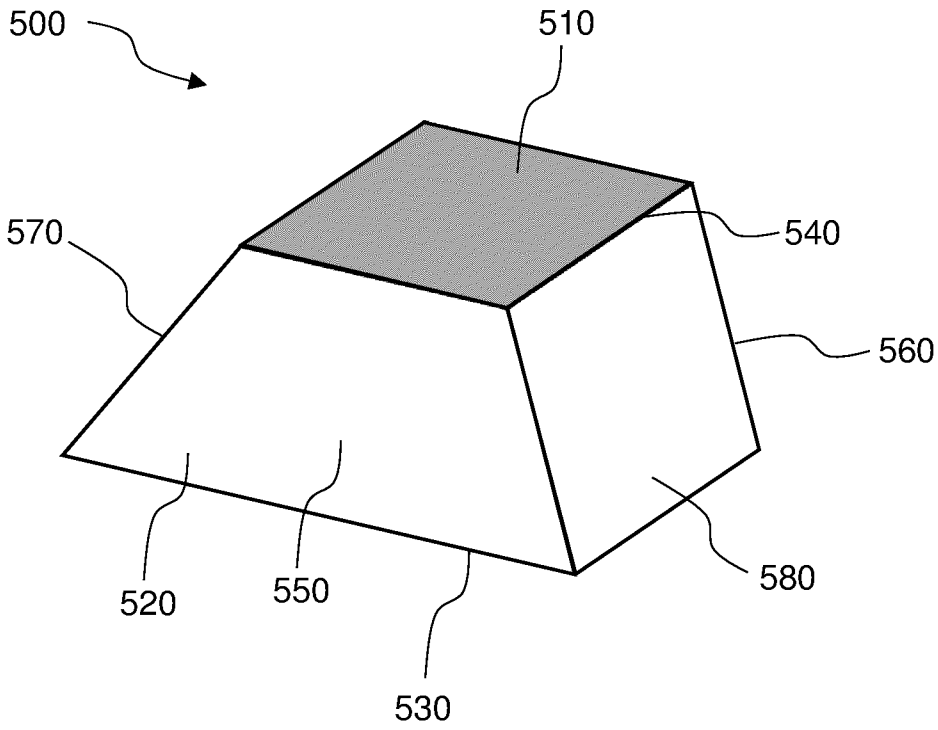

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FIG. 7

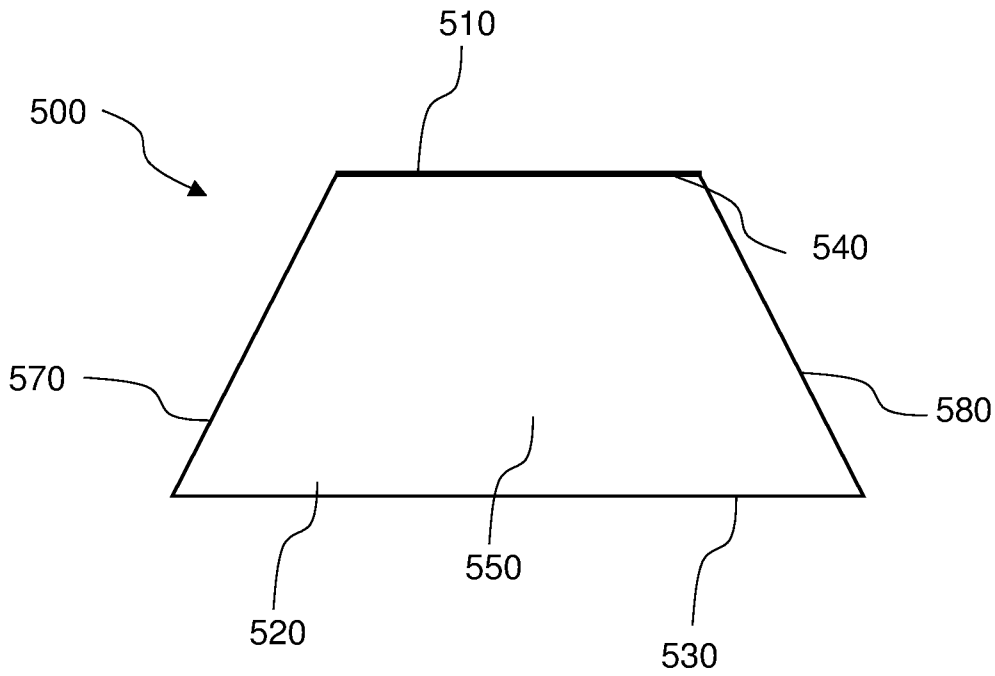

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FIG. 8

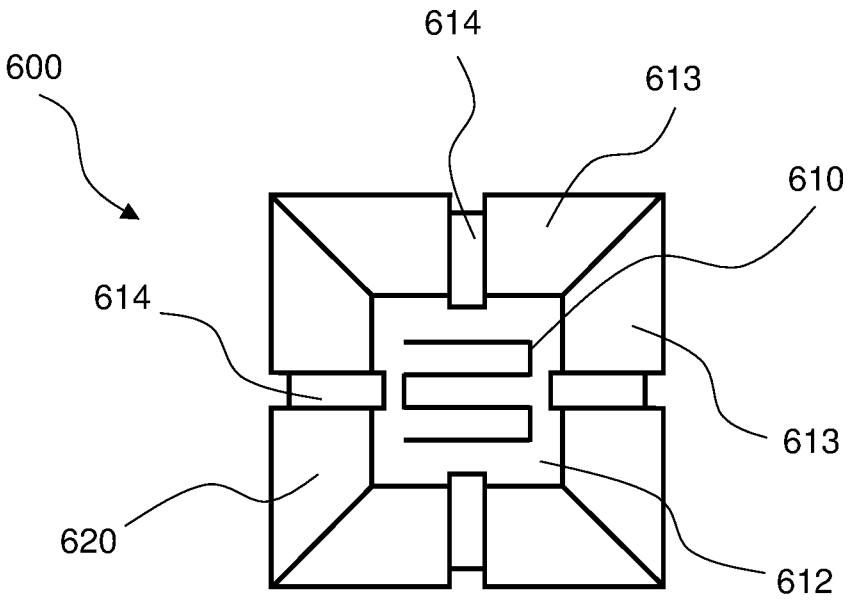


FIG. 9

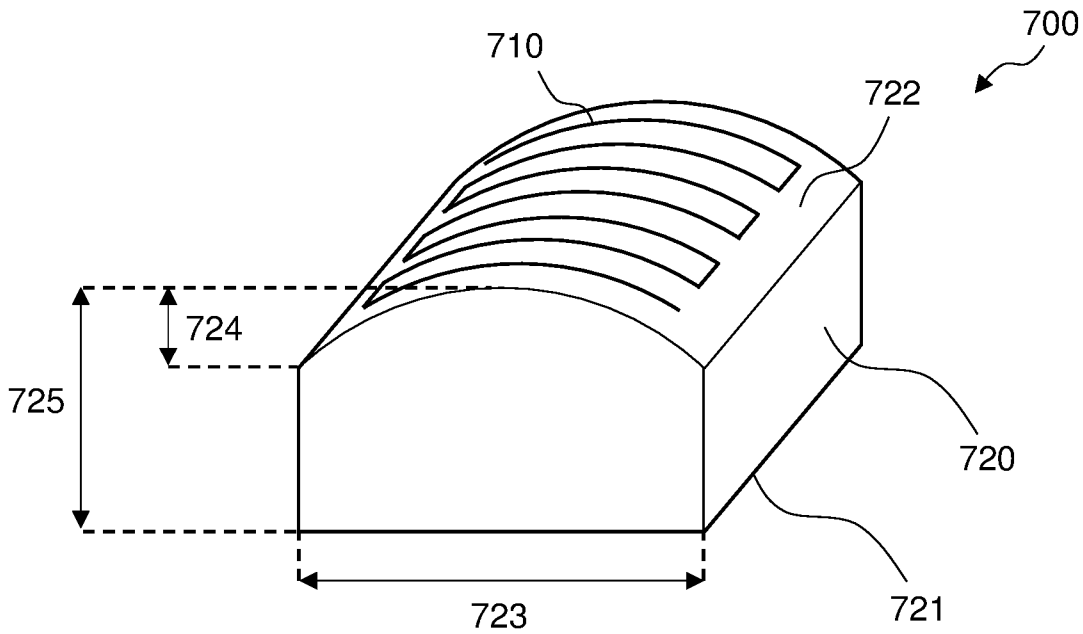


FIG. 10

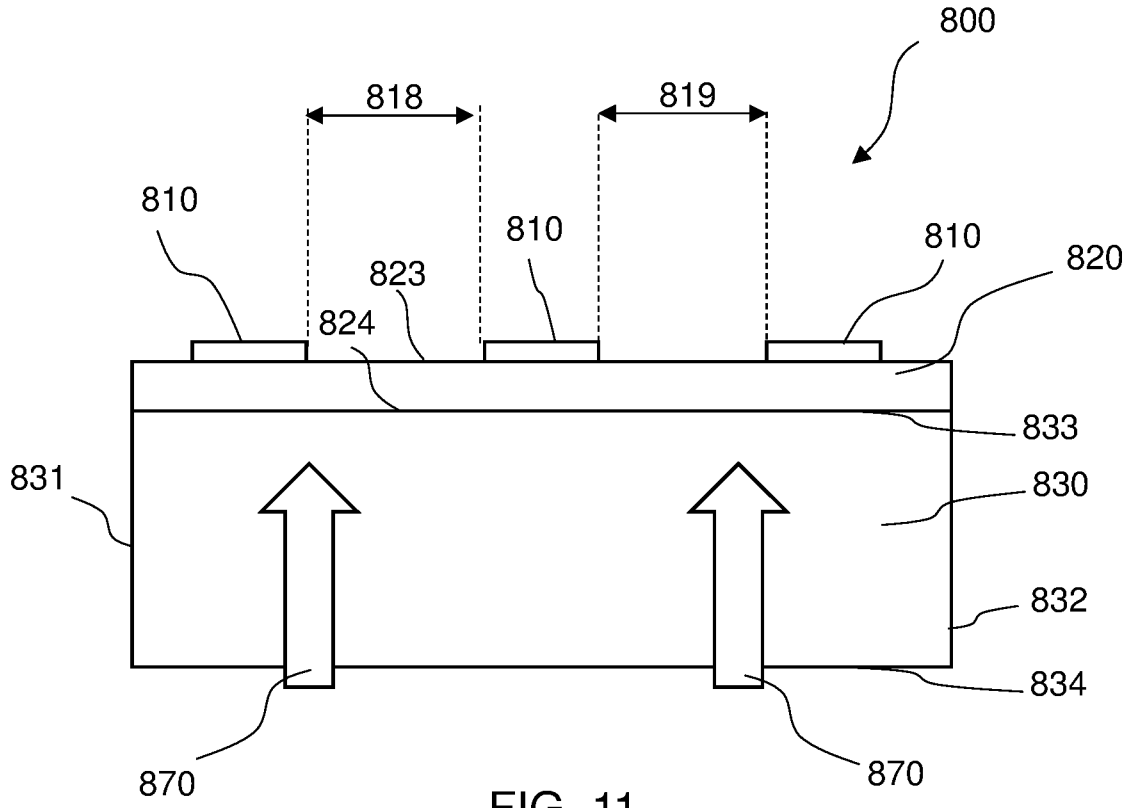

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FIG. 11

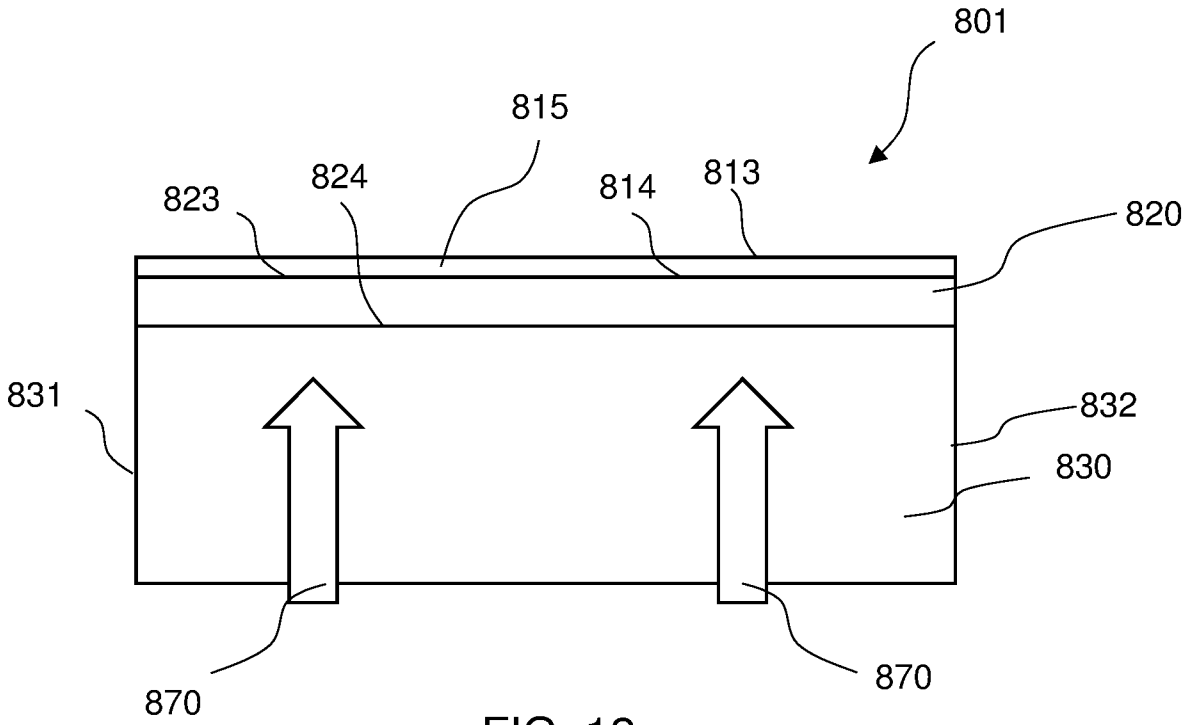

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FIG. 12

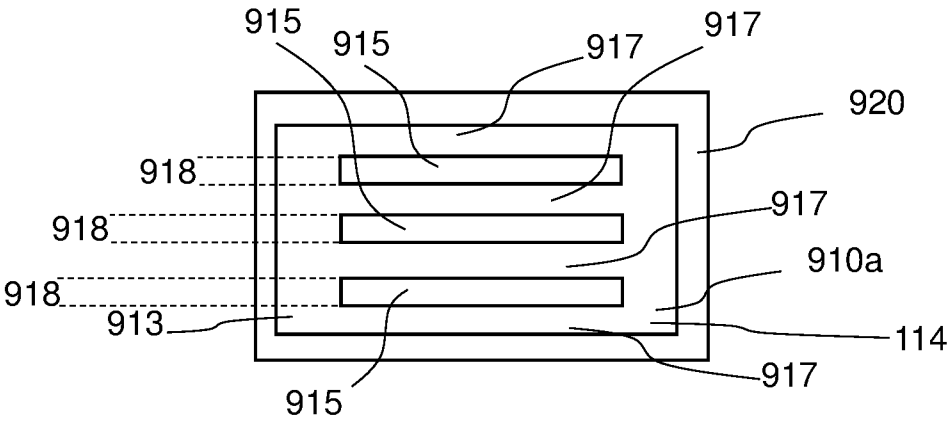


FIG. 13a

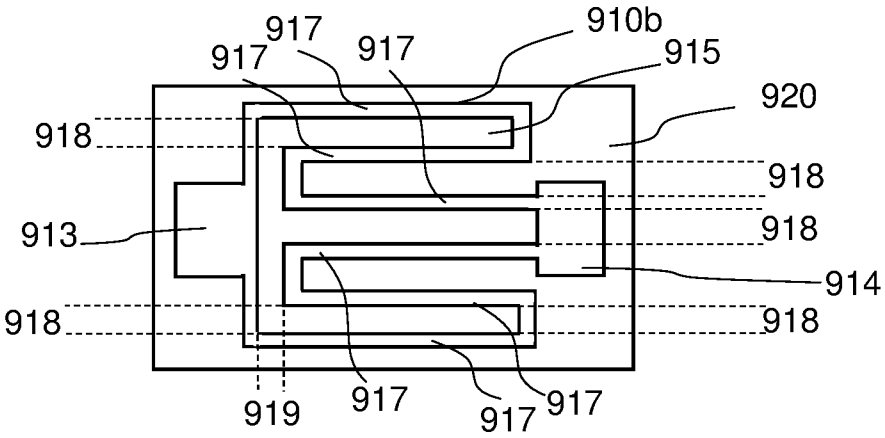


FIG. 13b

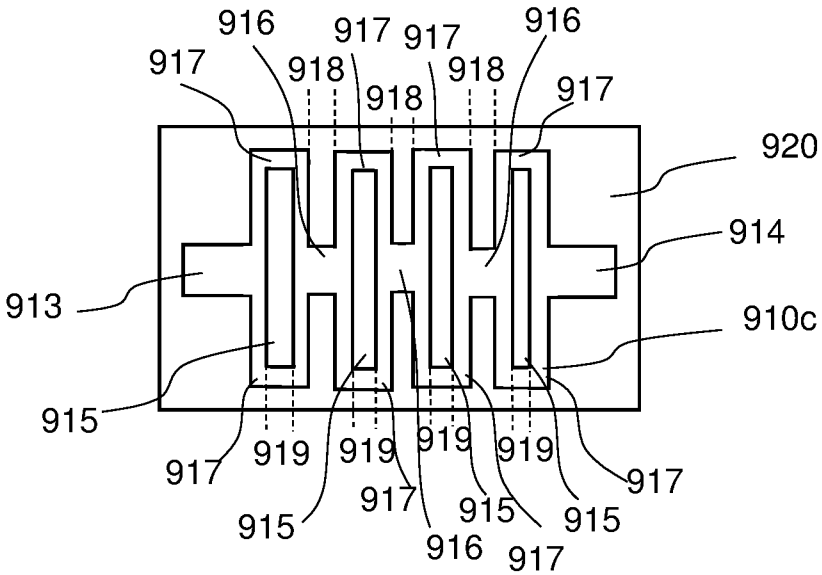


FIG. 13c

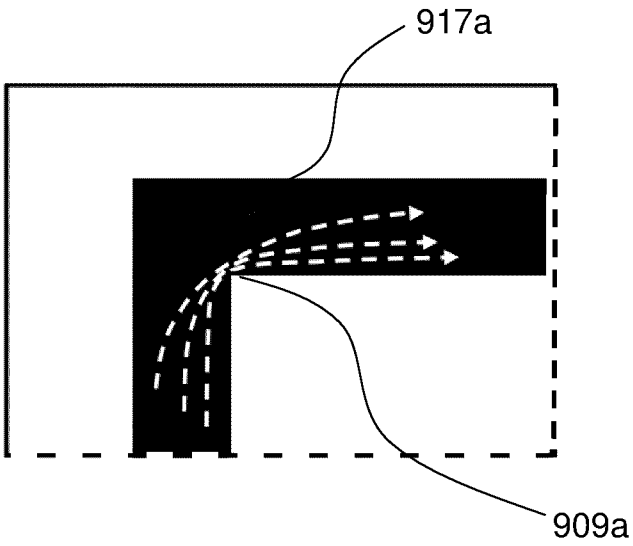


FIG. 14a

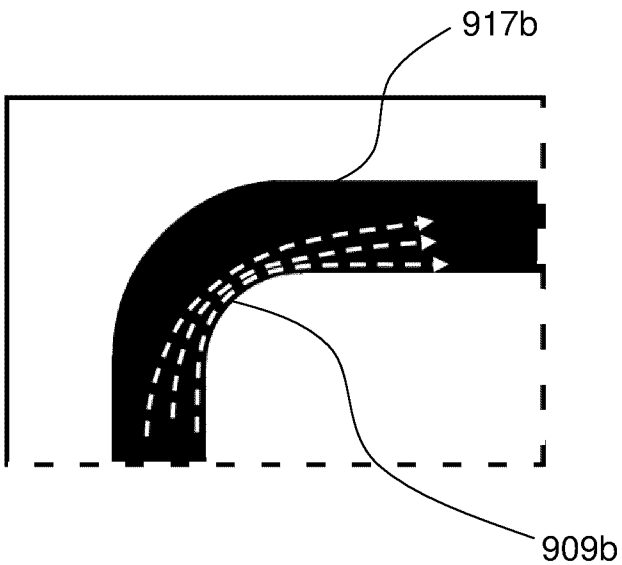


FIG. 14b

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/058629

A. CLASSIFICATION OF SUBJECT MATTER

INV. A24F40/44 A24F40/46 A24F40/485
ADD. A24F40/10

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

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2021/244101 A1 (FRASER RORY [GB] ET AL) 12 August 2021 (2021-08-12) figures 8, 15-17, 20 paragraph [0096] - paragraph [0099] paragraph [0150] - paragraph [0160]	1-15
A	EP 2 809 182 A2 (ALTRIA CLIENT SERVICES INC [US]) 10 December 2014 (2014-12-10) abstract; figures 1A, 1B, 9, 11, 15 paragraph [0005] paragraph [0013] - paragraph [0017] paragraph [0035]	1-15

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[x] Further documents are listed in the continuation of Box C.

[x] See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 June 2024	04/07/2024

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Alaguero, Daniel

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/058629

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 2016/172441 A1 (ALTRIA CLIENT SERVICES LLC [US]) 27 October 2016 (2016-10-27) abstract; figure 3A	1-15

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2024/058629

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