AN AEROSOL-GENERATING SYSTEM HAVING A FLUID-PERMEABLE HEATER ASSEMBLY

The present invention relates to aerosol-generating systems that comprise a heater assembly that is suitable for vapourising a liquid. In particular, the invention relates to handheld aerosol-generating systems, such as electrically operated smoking systems.

Electrically operated smoking systems that vapourise a liquid by heating to form an aerosol typically comprise a coil of wire that is wrapped around a capillary material that holds the liquid. Electric current passing through the wire causes resistive heating of the wire which vaporises the liquid in the capillary material. The capillary material is typically held within an airflow path so that air is drawn past the wick and entrains the vapour. The vapour subsequently cools to form an aerosol.

This type of system is effective at producing aerosol but it is challenging to manufacture in a low cost and repeatable way. And the wick and coil assembly, together with associated electrical connections, can be fragile and difficult to handle.

It would be desirable to provide a heater assembly suitable for an aerosol-generating system, such as a handheld electrically operated smoking system, that is inexpensive to produce and is robust. It would be further desirable to provide a heater assembly that is more efficient than prior heater assemblies in aerosol-generating systems.

In ~~one~~ a first aspect, there is provided an aerosol-generating system comprising a fluid-permeable electric heater assembly, the heater assembly comprising: an electrically insulating substrate, an aperture being formed in the electrically insulating substrate; and a heater element fixed to the electrically insulating substrate, the heater element spanning the aperture and comprising a plurality of electrically conductive filaments connected to first and second electrically conductive contact portions, the first and second electrically conductive contact portions positioned on opposite sides of the aperture to one another, and the plurality of electrically conductive filaments form interstices, and the interstices formed by the filaments have a width between 75 μm and 25 μm, wherein the first and second electrically conductive contact portions are configured to allow contact with an external power supply.

In a first embodiment, there is provided an aerosol-generating system comprising a fluid-permeable electric heater assembly, the heater assembly comprising: an electrically insulating substrate, an aperture being formed in the electrically insulating substrate; and a heater element fixed to the electrically insulating substrate, the heater element spanning the aperture and comprising a plurality of electrically conductive filaments connected to first and second electrically conductive contact portions, the first and second electrically conductive contact portions positioned on opposite sides of the aperture to one another,

wherein the first and second electrically conductive contact portions are configured to allow contact with an external power supply.

The plurality of electrically conductive filaments may form a mesh or array of filaments or may comprise a woven or non-woven fabric.

Advantageously, the heater element has a first face that is fixed to the electrically insulating substrate and the first and second electrically conductive contact portions are configured to allow contact with an external power supply on a second face of the heater element opposite to the first face.

The system may further comprise a liquid storage portion comprising a housing containing a liquid aerosol-forming substrate, wherein the heater assembly is fixed to the housing of the liquid storage portion. The housing is preferably a rigid housing and impermeable to fluid. As used herein "rigid housing" means a housing that is self-

supporting. The rigid housing of the liquid storage portion preferably provides mechanical support to the heater assembly.

The liquid storage portion may comprise a capillary material configured to convey liquid aerosol-forming substrate to the heater assembly.

The provision of a heater assembly of this type in an aerosol-generating system has several advantages over a conventional wick and coil arrangement. A heater element comprising a mesh or array of filaments allows for a greater area of the heater to be in contact with a liquid being vapourised. The heater assembly can be inexpensively produced, using readily available materials and using mass production techniques. The heater assembly is robust allowing it to be handled and fixed to other parts of the aerosol-generating system during manufacture, and in particular to form part of a removable cartridge. The provision of electrically conductive contact portions forming part of the heater element allows for reliable and simple connection of the heater assembly to a power supply.

The electrically conductive filaments may be substantially flat. As used herein, "substantially flat" means formed in a single plane and not wrapped around or other conformed to fit a curved or other non-planar shape. A flat heater assembly can be easily handled during manufacture and provides for a robust construction.

As mentioned in the first aspect, ~~The~~ the electrically conductive filaments ~~may~~ define interstices between the filaments. ~~and t~~The interstices may have a width of between 10 µm and 100 µm. Preferably the filaments give rise to capillary action in the interstices, so that in use, liquid to be vapourised is drawn into the interstices, increasing the contact area between the heater assembly and the liquid.

The electrically conductive filaments may form a mesh of size between 160 and 600 Mesh US (+/- 10%) (i.e. between 160 and 600 filaments per inch (+/- 10%)). From the first aspect, ~~The~~ the width of the interstices is ~~preferably~~ between 75 µm and 25 µm. The percentage of open area of the mesh, which is the ration of the area of the interstices to the total area of the mesh is preferably between 25 and 56%. The mesh may be formed using different types of weave or lattice structures. Alternatively, the electrically conductive filaments consist of an array of filaments arranged parallel to one another.

The mesh, array or fabric of electrically conductive filaments may also be characterised by its ability to retain liquid, as is well understood in the art.

The electrically conductive filaments may have a diameter of between 8 µm and 100 µm, preferably between 8 µm and 50 µm, and more preferably between 8 µm and 39 µm.

The area of the mesh, array or fabric of electrically conductive filaments may be small, preferably less than or equal to 25 mm^2, allowing it to be incorporated in to a handheld system. The mesh, array or fabric of electrically conductive filaments may, for

handheld aerosol-generating system. The aerosol-generating system may have a size comparable to a conventional cigar or cigarette. The smoking system may have a total length between approximately 30 mm and approximately 150 mm. The smoking system may have an external diameter between approximately 5 mm and approximately 30mm.

In a second aspect, there is provided a method of manufacturing a fluid-permeable electric heater assembly suitable for use in an aerosol-generating system, comprising: providing an electrically insulating substrate; forming one or more apertures in the substrate; providing at least two planar electrically conductive contact portions on the substrate on opposite sides of the one or more apertures to one another; and providing a plurality of electrically conductive filaments on the substrate extending between the at least two planar electrically conductive contact portions across the one of more apertures wherein the plurality of electrically conductive filaments form interstices, and the interstices formed by the filaments have a width between 75 µm and 25 µm.

In a second ~~aspect~~embodiment, there is provided a fluid-permeable electric heater assembly comprising: an electrically insulating substrate, an aperture being formed in the electrically insulating substrate; and a heater element spanning the aperture and having a first face fixed to the electrically insulating substrate, the heater element comprising a plurality of electrically conductive filaments connected to first and second electrically conductive contact portions, the first and second electrically conductive contact portions positioned on opposite sides of the aperture to one another, wherein the first and second electrically conductive, contact portions are configured to allow contact with an external power supply.

In a third ~~aspect~~embodiment, there is provided a method of manufacturing a fluid-permeable electric heater assembly suitable for use in an aerosol-generating system, comprising:

providing an electrically insulating substrate;

forming one or more apertures in the substrate;

providing a heater element on the substrate spanning the one or more apertures, the heater element comprising a plurality of electrically conductive filaments and at least two electrically conductive contact portions on opposite sides of the one or more apertures to one another.

In a fourth ~~aspect~~embodiment, there is provided a method of manufacturing a plurality of fluid-permeable electric heater assemblies suitable for use in an aerosol-generating system, comprising:

providing an electrically insulating substrate;

forming a plurality of apertures in the substrate;

providing a plurality of electrically conductive contact portions on the substrate on opposite sides of each of the plurality of apertures to one another;

providing a plurality of electrically conductive filaments on the substrate extending between the electrically conductive contact portions across each of the plurality apertures to provide a heater assembly array;

cutting a plurality of individual heater assemblies from the heater assembly array, each heater assembly including one of the apertures.

The electrically insulating substrate may be a flexible sheet material. The electrically conductive contact portions and electrically conductive filaments may be integrally formed with one another.

Features described in relation to one aspect or embodiment may equally be applied to other aspects or embodiments of the invention. In particular, features described in relation to the heater assembly

in the first aspect or the first embodiment of the invention, may equally be applied to the heater assembly of the second aspect or the second embodiment of the invention.

As used herein, "electrically conductive" means formed from a material having a resistivity of $1x10^{-4}\Omega m$, or less. As used herein, "electrically insulating" means formed from a material having a resistivity of $1x10^{4}\ \Omega m$ or more. Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figures 1a to 1d are schematic illustrations of a system, incorporating a cartridge, in accordance with an embodiment of the invention;

Figure 2 is a schematic illustration of a clasp mechanism for the mouthpiece portion of the system of Figure 1;

Figure 3 is an exploded view of the cartridge of Figures 1a to 1d;

Figure 4 is an exploded view of an alternative cartridge for use in a system as shown in Figures 1a to 1d;

Figure 5a is a perspective underside view of the cartridge of Figure 2;

Figure 5b is a perspective topside view of the cartridge of Figure 2, with the cover removed;

Figure 6 is a detail view of a heater assembly used in the cartridge shown in Figure 2;

Figure 7 is a detail view of an alternative heater assembly that can be used in the cartridge shown in Figure 2;

Figure 8 is a detail view of a further alternative heater assembly that can be used in the cartridge shown in Figure 2;

Figure 9 is a detail view of a still further alternative heater assembly that can be used in the cartridge shown in Figure 2;

Figure 10 is a detail view of alternative mechanism for making electrical contact between the device and the heater assembly;

Figure 11a and 11b illustrate some cartridge housing shapes that can be used to ensure correct alignment of the cartridge in the device;

Figure 12a is a detailed view of the filaments of the heater, showing a meniscus of liquid aerosol-forming substrate between the filaments;

Figure 12b is a detailed view of the filaments of the heater, showing a meniscus of liquid aerosol-forming substrate between the filaments and a capillary material extending between the filaments;

Figures 13a, 13b and 13c illustrate alternative methods of manufacture for a heater assembly in accordance with the invention; and

Figure 14 illustrates an alternative design for a liquid storage portion incorporating a heater assembly.