AN AEROSOL-GENERATING SYSTEM COMPRISING A FLUID PERMEABLE SUSCEPTOR ELEMENT

The disclosure relates to aerosol-generating systems that operate by heating an aerosol-forming substrate. In particular the invention relates to aerosol-generating systems that comprise a device portion containing a power supply and a replaceable cartridge portion comprising the consumable aerosol-forming substrate.

One type of aerosol-generating system is an electronic cigarette. Electronic cigarettes typically use a liquid aerosol-forming substrate which is vapourised to form an aerosol. An electronic cigarette typically comprises a power supply, a liquid storage portion for holding a supply of the liquid aerosol-forming substrate and an atomiser.

The liquid aerosol-forming substrate becomes exhausted in use and so needs to be replenished. The most common way to supply refills of liquid aerosol-forming substrate is in a cartomiser type cartridge. A cartomiser comprises both a supply of liquid substrate and the atomiser, usually in the form of an electrically operated resistance heater wound around a capillary material soaked in the aerosol-forming substrate. Replacing a cartomiser as a single unit has the benefit of being convenient for the user and avoids the need for the user to have to clean or otherwise maintain the atomiser.

However, it would be desirable to be able to provide a system that allows for refills of aerosol-forming substrate that are less costly to produce and are more robust that the cartomisers available today, while still being easy and convenient to use for consumers. In addition it would be desirable to provide a system that removes the need for soldered joints and that allows for a sealed device that is easy to clean.

In a first aspect, there is provided an electrically heated aerosol-generating system comprising an aerosol-generating device and a cartridge configured to be used with the device, the device comprising:

a device housing comprising a cavity for receiving at least a portion of the cartridge when the device housing is engaged with the cartridge;

an inductor coil positioned around or adjacent to the cavity; and

a power supply connected to the inductor coil and configured to provide a high frequency oscillating current to the inductor coil;

the cartridge comprising:

a cartridge housing configured to engage the device housing and containing an aerosol-forming substrate, the housing having an external surface surrounding the aerosol-forming substrate, at least a portion of the external surface being formed by a fluid permeable susceptor element, wherein the susceptor element is in the form of a sheet that extends across an opening in the cartridge housing.

In a second aspect, there is provided a cartridge for use in an electrically heated aerosol-generating system, the electrically heated aerosol-generating system comprising an aerosol-generating device, the cartridge configured to be used with the device, wherein the device comprises a device housing defining a cavity for receiving at least a portion of the cartridge; an inductor coil positioned around or adjacent to the cavity; and a power supply connected to the inductor coil and configured to provide a high frequency oscillating current to the inductor coil; the cartridge comprising a cartridge housing containing an aerosol-forming substrate, the housing having an external surface, at least a portion of the external surface being formed by a fluid permeable susceptor element, wherein the susceptor element is electrically isolated from any other electrically conductive components and wherein the susceptor element is in the form of a sheet and extends across an opening in the cartridge housing.

Herein disclosed is an electrically heated aerosol-generating system comprising an aerosol-generating device and a cartridge configured to be used with the device, the device comprising:

a device housing;

an inductor coil positioned around or adjacent to the cavity; and

a power supply connected to the inductor coil and configured to provide a high frequency oscillating current to the inductor coil;

the cartridge comprising:

a cartridge housing configured to engage the device housing and containing an aerosol-forming substrate, the housing having an external surface surrounding the aerosol-forming substrate, at least a portion of the external surface being formed by a fluid permeable susceptor element.

In operation a high frequency oscillating current is passed through the flat spiral inductor coil to generate an alternating magnetic field that induces a voltage in the

susceptor element. The induced voltage causes a current to flow in the susceptor element and this current causes Joule heating of the susceptor that in turn heats the aerosol-forming substrate. If the susceptor element is ferromagnetic, hysteresis losses in the susceptor element may also generate heat. The vapourised aerosol-forming substrate can pass through the susceptor element and subsequently cool to form an aerosol delivered to a user.

This arrangement using inductive heating has the advantage that no electrical contacts need be formed between the cartridge and the device. And the heating element, in this case the susceptor element, need not be electrically joined to any other components, eliminating the need for solder or other bonding elements. Furthermore, the coil is provided as part of the device making it possible to construct a cartridge that is simple, inexpensive and robust. Cartridges are typically disposable articles produced in much larger numbers than the devices with which they operate. Accordingly reducing the cost of cartridges, even if it requires a more expensive device, can lead to significant cost savings for both manufacturers and consumers.

As used herein, a high frequency oscillating current means an oscillating current having a frequency of between 500kHz and 30MHz. The high frequency oscillating current may have a frequency of between 1 and 30MHz, preferably between 1 and 10 MHz and more preferably between 5 and 7 MHz.

As used herein, a "susceptor element" means a conductive element that heats up when subjected to a changing magnetic field. This may be the result of eddy currents induced in the susceptor element and/or hysteresis losses. Possible materials for the susceptor elements include graphite, molybdenum, silicon carbide, stainless steels, niobium, aluminium and virtually any other conductive elements. Advantageously the susceptor element is a ferrite element. The material and the geometry for the susceptor element can be chosen to provide a desired electrical resistance and heat generation. The susceptor element may comprise, for example, a mesh, flat spiral coil, fibres or a fabric.

As used herein a "fluid permeable" element means an element that allowing liquid or gas to permeate through it. The susceptor element may have a plurality of openings formed in it to allow fluid to permeate through it. In particular, the susceptor element allows the aerosol-forming substrate, in either gaseous phase or both gaseous and liquid phase, to permeate through it.

As mentioned in the first aspect, the susceptor element is in the form of a sheet that extends across an opening in the cartridge housing. The susceptor element may extend around a perimeter of the cartridge housing.

The device housing comprises a cavity for receiving at least a portion of the cartridge when the cartridge housing is engaged with the device housing, the cavity having

change can be detected and communicated to a microcontroller which then interrupts the generation of AC power until the temperature has cooled down below the Curie temperature again, whereupon AC power generation can be resumed.

The system may further comprise electric circuitry connected to the inductor coil and to an electrical power source. The electric circuitry may comprise a microprocessor, which may be a programmable microprocessor, a microcontroller, or an application specific integrated chip (ASIC) or other electronic circuitry capable of providing control. The electric circuitry may comprise further electronic components. The electric circuitry may be configured to regulate a supply of current to the coil. Current may be supplied to the inductor coil continuously following activation of the system or may be supplied intermittently, such as on a puff by puff basis. The electric circuitry may advantageously comprise DC/AC inverter, which may comprise a Class-D or Class-E power amplifier.

The system advantageously comprises a power supply, typically a battery such as a lithium iron phosphate battery, within the main body of the housing. As an alternative, the power supply may be another form of charge storage device such as a capacitor. The power supply may require recharging and may have a capacity that allows for the storage of enough energy for one or more smoking experiences. 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 inductor coil.

The system may be an electrically operated smoking system. The system may be a 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.

Herein disclosed is a cartridge for use in an electrically heated aerosol-generating system, the electrically heated aerosol-generating system comprising an aerosol-generating device, the cartridge configured to be used with the device, wherein the device comprises a device housing defining a cavity for receiving at least a portion of the cartridge; an inductor coil positioned around or adjacent to the cavity; and a power supply connected to the inductor coil and configured to provide a high frequency oscillating current to the inductor coil; the cartridge comprising a cartridge housing containing an aerosol-forming substrate, the housing having an external surface, at least a portion of the external surface being formed by a fluid permeable susceptor element, wherein the

susceptor element is electrically isolated from any other electrically conductive components.

As mentioned in the second aspect, the susceptor element is in the form of a sheet and extend across an opening in the cartridge housing. The susceptor element may extend around a perimeter of the cartridge housing.

Features described in relation to one aspect may be applied to other aspects of the disclosure. In particular advantageous or optional features described in relation to the first aspect of the disclosure may be applied to the second aspect of the invention.

Embodiments of a system in accordance with the disclosure will now be described in detail, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of a first embodiment of an aerosol-generating system, using a flat spiral inductor coil;

Figure 2 shows the cartridge of Figure 1;

Figure 3 shows the inductor coil of Figure 1;

Figure 4 shows an alternative susceptor element for the cartridge of Figure 2;

Figure 5 shows a further alternative susceptor element for the cartridge of Figure 1;

Figure 6 is a schematic illustration of a second embodiment, using a flat spiral inductor coil;

Figure 7 is a schematic illustration of a third embodiment, using flat spiral inductor coils;

Figure 8 shows the cartridge of Figure 7;

Figure 9 shows the inductor coil of Figure 7;

Figure 10 is a schematic illustration of a fourth embodiment;

Figure 11 shows the cartridge of Figure 10;

Figure 12 shows the coil of Figure 10;

Figure 13 is a schematic illustration of a fifth embodiment;

Figure 14 is a schematic illustration of a sixth embodiment;

Figure 15 is a schematic illustration of an eighth embodiment, using a unit dose cartridge;

Figure 16A is a first example of a driving circuit for generating the high frequency signal for an inductor coil; and

Figure 16B is a second example of a driving circuit for generating the high frequency signal for an inductor coil.

The embodiments shown in the figures all rely on inductive heating. Inductive heating works by placing an electrically conductive article to be heated in a time varying magnetic field. Eddy currents are induced in the conductive article. If the conductive article is electrically isolated the eddy currents are dissipated by Joule heating of the conductive