AN ELECTRICALLY HEATED SMOKING SYSTEM

The present invention relates to an electrically heated smoking system for receiving an aerosol-forming substrate.

A number of prior art documents, for example US-A-5 060 671, US-A-5 388 594, US-A-5 505 214, US-A-5 591 368, WO-A-2004/043175, EP-A-0 358 002, EP-A-0 295 122, EP-A-1 618 803, EP–A-1 736 065 and WO-A-2007/131449, disclose electrically operated smoking systems, having a number of advantages. One advantage is that they significantly reduce sidestream smoke, while permitting the smoker to selectively suspend and reinitiate smoking.

Prior art documents, such as EP-A-0 295 122, EP-A-1 618 803 and EP-A-1 736 065, disclose electrical smoking systems which use a liquid as the aerosol-forming substrate. The liquid may be contained in a cartridge which is receivable in a housing. A power supply, such as a battery, is provided, connected to a heater to heat the liquid substrate during a puff, to form the aerosol which is provided to the smoker.

The electrically heated smoking systems of the prior art, including those described above, typically provide a high power pulse to the heater to provide the temperature range desired for operation and to release the volatile compounds for each puff.

The electrically heated smoking systems of the prior art, including those described above, do have a number of advantages, but there is still room for improvement. It is therefore an object of the invention to provide an improved electrically heated smoking system which offers additional functionality to the smoker.

According to a first aspect of the invention there is provided an electrically heated smoking system for receiving an aerosol-forming substrate, the system comprising: at least one heating element for heating the substrate to form an aerosol; a power supply for supplying power to the at least one heating element; electrical hardware connected to the power supply and the at least one heating element; and an interface for establishing a communications link for uploading data to and downloading data from an Internet-enabled host.

By providing an interface for establishing a communications link with an Internet-enabled host, the electrical hardware in the system itself can be relatively simple in terms of memory and processing power. This allows the electrically heated smoking system to remain relatively low cost to manufacture. The interface for establishing the communications link with the host allows interaction between the system and the host. Thus, extended features can be implemented via the host at the same time as keeping the hardware in the system itself relatively simple.

In the context of the invention, the host being Internet-enabled means that host is able to connect to one or more Internet sites in order to upload data or download data or both upload and download data. This allows extended features to be implemented from the Internet via the

host, at the same time as keeping the hardware in the system itself relatively simple. Throughout the specification, in the context of the present invention, the term "Internet" is used to refer to the worldwide, publicly accessible series of interconnected computer networks that transmit data using the standard Internet Protocol (IP). It includes the World Wide Web (www) but also includes other domestic, academic, business, government and other networks outside the World Wide Web.

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

Preferably, the aerosol-forming substrate further comprises an aerosol former. Examples of suitable aerosol formers are glycerine and propylene glycol. Additional examples of potentially suitable aerosol formers are described in EP-A-0 277 519 and US-A-5 396 911.

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

Optionally, the solid substrate may be provided on or embedded in a thermally stable carrier. The carrier may take the form of powder, granules, pellets, shreds, spaghettis, strips or sheets. Alternatively, the carrier may be a tubular carrier having a thin layer of the solid substrate deposited on its inner surface, such as those disclosed in US-A-5 505 214, US-A-5 591 368 and US-A-5 388 594, or on its outer surface, or on both its inner and outer surfaces. Such a tubular carrier may be formed of, for example, a paper, or paper like material, a non-woven carbon fibre mat, a low mass open mesh metallic screen, or a perforated metallic foil or any other thermally stable polymer matrix.

The solid substrate may be deposited on the surface of the carrier in the form of, for example, a sheet, foam, gel or slurry. The solid substrate may be deposited on the entire surface of the carrier, or alternatively, may be deposited in a pattern in order to provide a non-uniform flavour delivery during use.

Alternatively, the carrier may be a non-woven fabric or fibre bundle into which tobacco components have been incorporated, such as that described in EP-A-0 857 431. The non-woven fabric or fibre bundle may comprise, for example, carbon fibres, natural cellulose fibres, or cellulose derivative fibres.

Alternatively, the carrier may be at least a part of the heating element of the electrically heated smoking system. In such cases, the heating element is typically disposable. For example, the solid substrate may be deposited as a thin layer on a metallic foil or on an electrically resistive support as described in US-A-5 060 671.

The aerosol-forming substrate may be a liquid substrate. If a liquid substrate is provided, the electrically heated smoking system preferably comprises means for retaining the liquid. For example, the liquid substrate may be retained in a container, such as that described in EP-A-0 893 071. Alternatively or in addition, the liquid substrate may be absorbed into a porous carrier material, as described in WO-A-2007/066374, EP-A-1 736 062, WO-A-2007/131449 and WO-A-2007/131450. The porous carrier material may be made from any suitable absorbent plug or body, for example, a foamed metal or plastics material, polypropylene, terylene, nylon fibres or ceramic. The liquid substrate may be retained in the porous carrier material prior to use of the electrically heated smoking system or alternatively, the liquid substrate material may be released into the porous carrier material during, or immediately prior to use. For example, the liquid substrate may be provided in a capsule, as described in WO-A-2007/077167. The shell of the capsule preferably melts upon heating and releases the liquid substrate into the porous carrier material. The capsule may optionally contain a solid in combination with the liquid.

If the aerosol-forming substrate is a liquid substrate, the electrically heated smoking system may further comprise means for heating a small amount of liquid at a time. The means for heating a small amount of liquid at a time may include, for example, a liquid passageway in communication with the liquid substrate, as described in EP-A-0 893 071. The liquid substrate is typically forced into the liquid passageway by capillary force. The heating element is preferably arranged such that, during use, only the small amount of liquid substrate within the liquid passageway, and not the liquid within the container, is heated and volatilised.

Alternatively, or in addition, if the aerosol-forming substrate is a liquid substrate, the electrically heated smoking system may further comprise an atomiser in contact with the liquid substrate source and including the at least one heating element. In addition to the heating element, the atomiser may include one or more electromechanical elements such as piezoelectric elements. Additionally or alternatively, the atomiser may also include elements that use electrostatic, electromagnetic or pneumatic effects. The electrically heated smoking system may still further comprise a condensation chamber.

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

system. Alternatively, during operation, the substrate may be partially contained within the electrically heated smoking system. In that case, the substrate may form part of a separate article and the user may puff directly on the separate article.

The at least one heating element may comprise a single heating element. Alternatively, the at least one heating element may comprise more than one heating element. The heating element or heating elements may be arranged appropriately so as to most effectively heat the aerosol-forming substrate.

The at least one heating element preferably comprises an electrically resistive material. Suitable electrically resistive materials include but are not limited to: semiconductors such as doped ceramics, electrically "conductive" ceramics (such as, for example, molybdenum disilicide), carbon, graphite, metals, metal alloys and composite materials made of a ceramic material and a metallic material. Such composite materials may comprise doped or undoped ceramics. Examples of suitable doped ceramics include doped silicon carbides. Examples of suitable metals include titanium, zirconium, tantalum and metals from the platinum group. Examples of suitable metal alloys include stainless steel, nickel-, cobalt-, chromium-, aluminium-titanium- zirconium-, hafnium-, niobium-, molybdenum-, tantalum-, tungsten-, tin-, gallium-, manganese- and iron-containing alloys, and super-alloys based on nickel, iron, cobalt, stainless steel, Timetal® and iron-manganese-aluminium based alloys. In composite materials, the electrically resistive material may optionally be embedded in, encapsulated or coated with an insulating material or vice-versa, depending on the kinetics of energy transfer and the external physicochemical properties required. Examples of suitable composite heating elements are disclosed in US-A-5 498 855, WO-A-03/095688 and US-A-5 514 630.

Alternatively, the at least one heating element may comprise an infra-red heating element, a photonic source such as, for example, those described in US-A-5 934 289, or an inductive heating element, such as, for example, those described in US-A-5 613 505.

The at least one heating element may take any suitable form. For example, the at least one heating element may take the form of a heating blade, such as those described in US-A-5 388 594, US-A-5 591 368 and US-A-5 505 214. Alternatively, the at least one heating element may take the form of a casing or substrate having different electro-conductive portions, as described in EP-A-1 128 741, or an electrically resistive metallic tube, as described in WO-A-2007/066374. Where the aerosol-forming substrate is a liquid provided within a container, the container may incorporate a disposable heating element. Alternatively, one or more heating needles or rods that run through the centre of the aerosol-forming substrate, as described in KR-A-100636287 and JP-A-2006320286, may also be suitable. Alternatively, the at least one heating element may be a disk (end) heater or a combination of a disk heater with heating

needles or rods. Other alternatives include a heating wire or filament, for example a Ni-Cr, platinum, tungsten or alloy wire, such as those described in EP-A-1 736 065, or a heating plate. Optionally, the heating element may be deposited in or on a rigid carrier material.

The at least one heating element may comprise a heat sink, or heat reservoir comprising a material capable of absorbing and storing heat and subsequently releasing the heat over time to the aerosol-forming substrate. Suitable heat sinks are described in EP-A-0 857 431, US-A-2006/118128 and WO-A-2008/015441. The heat sink may be formed of any suitable material, such as a suitable metal or ceramic material. Preferably, the material has a high heat capacity (sensible heat storage material), or is a material capable of absorbing and subsequently releasing heat via a reversible process, such as a high temperature phase change. Suitable sensible heat storage materials include silica gel, alumina, carbon, glass mat, glass fibre, minerals, a metal or alloy such as aluminium, silver or lead, and a cellulose material such as paper. Other suitable materials which release heat via a reversible phase change include paraffin, sodium acetate, naphthalene, wax, polyethylene oxide, a metal, metal salt, a mixture of eutectic salts or an alloy.

The heat sink or heat reservoir may be arranged such that it is directly in contact with the aerosol-forming substrate and can transfer the stored heat directly to the substrate, as described in EP-A-0 857 431. Alternatively, the heat stored in the heat sink or heat reservoir may be transferred to the aerosol-forming substrate by means of a heat conductor, such as a metallic tube, as described in WO-A-2008/015441.

The at least one heating element may heat the aerosol-forming substrate by means of conduction. The heating element may be at least partially in contact with the substrate, or the carrier on which the substrate is deposited. Alternatively, the heat from the heating element may be conducted to the substrate by means of a heat conductive element.

Alternatively, the at least one heating element may transfer heat to the incoming ambient air that is drawn through the electrically heated smoking system during use, which in turn heats the aerosol-forming substrate by convection. The ambient air may be heated before passing through the aerosol-forming substrate, as described in WO-A-2007/066374. Alternatively, if the aerosol-forming substrate is a liquid substrate, the ambient air may be first drawn through the substrate and then heated, as described in WO-A-2007/078273.

In a first embodiment, the power supply for supplying power to the at least one heating element comprises a power cell contained in the electrically heated smoking system. In that case, the power supply may be a Lithium-ion battery or one of its variants, for example, a Lithium-ion polymer battery. Alternatively, the power supply may be a Nickel-metal hydride battery or a Nickel cadmium battery or a fuel cell. In that case, preferably, the electrically heated

smoking system is usable by a smoker until the energy in the power cell is used up. Preferably, the power cell is entirely self-contained within the electrically heated smoking system.

In a second embodiment, the power supply for supplying power to the at least one heating element comprises circuitry chargeable by an external charging portion. The external charging portion may form part of the electrically heated smoking system. For example, the electrically heated smoking system may comprise a portion to be held by a user, and the external charging portion. The external charging portion may take the form of a docking station. Or, the external charging portion may form part of the host. In that case, the circuitry may be charged by connection of the electrically heated smoking system with the host via the communications link. In the second embodiment, preferably the circuitry, when charged, provides power for a pre-determined number of puffs, after which the circuitry must be reconnected to the external charging portion. An example of suitable circuitry is one or more capacitors or re-chargeable batteries.

In a third embodiment, the power supply for supplying power to the at least one heating element comprises an interface for connection to an external power source. Preferably, the interface is connected to the external power source at all times during use. In the third embodiment, the interface will preferably need to be connected to the external power source whenever a smoker wishes to use the system, since there is preferably no power source in the system itself. In the third embodiment, the interface may be connected to the external power source by connection of the electrically heated smoking system with the host via the communications link. That is, power may be supplied to the interface from the host, via the communications link.

Thus, in the context of the invention, the term "power supply" should be inferred to mean either a self-contained power cell, or chargeable circuitry, or an interface for connection to an external source or a combination of two or more of these.

The communications link may be a wireless communications link. Alternatively, the communications link may be a wired communications link. The communications link may be suitable for flow of data from the electrically heated smoking system to the host. The communications link may be suitable for flow of data from the host to the electrically heated smoking system. Preferably, the communications link is suitable for bi-directional flow of data, from the electrically heated smoking system to the host and from the host to the electrically heated smoking system. Preferably, the communications link is suitable for providing electrical power from the host to the electrically heated smoking system.

Preferably, the communications link operates under an interface standard. An interface standard is a standard that describes one or more functional characteristics, such as code

conversion, line assignments, or protocol compliance, or physical characteristics, such as electrical, mechanical, or optical characteristics, necessary to allow the exchange of information between two or more systems or pieces of equipment. Examples of suitable interface standards for the communications link include, but are not limited to, the Recommended Standard 232 (RS-232) family of standards; Universal Serial Bus (USB); Bluetooth; FireWire (a brand name of Apple, Inc for their IEEE 1394 interface), IrDA (Infrared Data Association – a communications standard for the short-range exchange of data by Infrared light); Zigbee (a specification based on the IEEE 802.15.4 standard for wireless personal area networks) and other Wi-Fi standards.

In a preferred embodiment, the communications link is a Universal Serial Bus – USB – link. This is advantageous because a USB communications link provides bi-directional communication and also a power link (usually 5 V).

The host may be a personal computer. The personal computer may be a desktop computer. The personal computer may be a laptop computer or a notebook computer. The personal computer may be a tablet computer such as a Personal Digital Assistant (PDA), a Personal Information Device (PID), a Portable Media Player (PMP, such as an Apple, Inc iPod®) or a Portable Video Player (PVP). The host may be a mobile cellular telephone.

The interface is an interface suitable for the particular communications link. For example, in the case of a wireless communications link, the interface may comprise one of: a receiver for receipt of wireless signals from the host; a transmitter for sending wireless signals to the host; and a transceiver for receiving wireless signals from, and sending wireless signals to, the host. For example, in the case of a wired communications link, the interface may comprise one or both of: a male connector for connection with a female connector on or connected to the host; and a female connector for connection with a male connector on or connected to the host.

The communications link is preferably suitable for one or more of the following functions: for downloading software from the host to the system; for downloading information from the host to the system; for charging the system; for uploading information from the system to the host; and for registering the system with the host. Those functions may take place whilst the host is accessing an Internet site, or separately from the host accessing an Internet site.

Preferably, the electrical hardware is programmable by software. The software may be downloadable from the host via the communications link.

Preferably the electrical hardware comprises a sensor to detect air flow indicative of a user taking a puff. The sensor may be an electro-mechanical device. Alternatively, the sensor may be any of: a mechanical device, an optical device, an opto-mechanical device and a micro electro-mechanical-systems (MEMS) based sensor. In that case, preferably the electrical

hardware is arranged to provide an electric current pulse to the at least one heating element when the sensor senses a user taking a puff. Preferably the time-period of the electric current pulse is pre-set, depending on the amount of aerosol desired. The electrical hardware is preferably programmable for this purpose.

Alternatively, the electrical hardware may comprise a manually operable switch for a user to initiate a puff. In that case, preferably the electrical hardware is arranged to provide an electric current pulse to the at least one heating element when the user initiates a puff. Preferably, the time period of the electric current pulse is pre-set depending on the amount of aerosol desired. The electrical hardware is preferably programmable for this purpose.

The electrically heated smoking system may further comprise a puff indicator for indicating when the heating element is activated. In the embodiment in which the electrical hardware comprises a sensor to detect air flow indicative of a user taking a puff, the indicator may be activated when the sensor senses air flow indicative of the user taking a puff. In the embodiment in which the electrical hardware comprises a manually operable switch, the indicator may be activated by the switch.

The electrically heated smoking system may further comprise a housing for receiving the aerosol-forming substrate and designed to be grasped by a user. The housing may comprise a shell and a replaceable mouthpiece.

The invention will be further described, by way of example only, with reference to accompanying Figure 1 which shows an embodiment of the electrically heated smoking system connected to a host via a USB link.

Referring to Figure 1, in this embodiment, the electrically heated smoking system in the form of device 101 comprises a housing 103 containing a power supply in the form of a Lithium-ion battery (not shown), electrical hardware in the form of a printed circuit board (not shown), an aerosol-forming substrate in the form of a tobacco plug (not shown) and a heating element in the form of a heating blade (not shown) in contact with the tobacco plug. The housing 103 includes an interface in the form of a USB socket 105 for receiving a first end 107a of a communications link in the form of a USB connector 107. The second end 107b of the USB connector 107 is plugged into the host, in the form of Personal Computer (PC) 109. The PC 109 is Internet-enabled.

The hardware in the device 101 comprises a limited set of software-supporting components. This allows the device itself to remain relatively simple in terms of memory and processing power. Extended capabilities for the device (to be discussed below) are hosted on the Internet-enabled PC 109 and transferred to and from the device 101 as required. Thus, the device may be connected, via the PC 109, to one or more approved Internet sites. In this

embodiment, the link is a USB link which provides bi-directional communication and can also provide power to the device.

A number of extended capabilities are possible, as follows:

Firstly, software may be downloaded from the PC to the device. The software may include updated versions of software, as software develops, or to fix a specific bug. Alternatively, or in addition, the software may include additional features, which are, for example downloadable after payment by the user. This removes the need for the device to be returned to the supplier or manufacturer for software downloads. This capability is not limited to the device 101 and PC 109 of Figure 1, but may apply to any electrically heated smoking system according to the invention.

Secondly, information may be downloaded from the PC to the device. For example, a user may personalise the device by specifying information such as a maximum number of puffs permitted per time period, and a minimum interval between puffs. This may assist with managing smoking behaviour. Alternatively, or in addition, the user may specify the brand of tobacco plug being used and control parameters can then be downloaded from the PC to the device, to optimise the smoking experience for that brand. Alternatively, or in addition, further features could be downloaded, for example auto-shutdown after a selected period of inactivity. This could be used as a security feature to prevent a lost or stolen device being used without authorisation. Again, this capability is not limited to the device 101 and PC 109 of Figure 1, but may apply to any electrically heated smoking system according to the invention. If the user specifies a brand, this will be the brand of the particular aerosol-forming substrate being used.

Thirdly, the PC may provide electrical power to the device. For example, if the device contains a rechargeable battery or other chargeable circuitry, the connection could be used to re-charge the battery or circuitry. This may be the case in the Figure 1 embodiment. Or, if the device does not contain an internal power source, the PC may provide electrical power to the device while the device is being used by a smoker. This will mean that it is necessary to have the device and PC connected, while the device is being used. This capability is not limited to the device 101 and PC 109 of Figure 1, but may apply to any electrically heated smoking system according to the invention.

Fourthly, information may be uploaded from the device to the PC. For example, for acquiring smoking behaviour information during clinical trials, the user can simply connect the device to the PC to upload data. This would automate much of the data collection and analysis, speeding up the process whilst minimising the data errors that are inherent in manual systems. Or, for assistance with managing smoking behaviour, the user could upload smoking behaviour information, to track the data and note improvements. Again, this capability is not limited to the

device 101 and PC 109 of Figure 1, but may apply to any electrically heated smoking system according to the invention.

Fifthly, the connection could be used for a user to register the device with an Internet application supported on the PC. For example, this could be used as a security feature if the device is supplied by post, so that the device is only enabled after registration. This capability is not limited to the device 101 and PC 109 of Figure 1, but may apply to any electrically heated smoking system according to the invention.

Other possible capabilities include, but are not limited to:

- Pay-as-you-smoke functionality. For example the user buys daily or weekly or monthly smoking time from the Internet application supported on the PC, or the user obtains smoking time credits based on cigarettes and other smoking articles bought via the Internet application.
- The device could be pre-loaded with credit which could be used to buy items, such as smoking articles, from the Internet application.
- The Internet application hosted on the PC could be an approved support group Internet site for assistance with smoking cessation. The Internet application could offer a controlled amount of smoking time whilst monitoring the smoking behaviour.
- If the device operates with separate smoking articles, the Internet application could recommend the most suitable smoking articles for the device, when the device is connected to the PC. Or similarly, for any type of aerosol-forming substrate, the Internet application could recommend the most suitable brands for the device.
- If the device operates with separate smoking articles, the Internet application could monitor usage and automatically pre-order additional smoking articles when required. Or similarly, for any type of aerosol-forming substrate, the Internet application could monitor usage and pre-order aerosol-forming substrate when appropriate.
- The Internet application could monitor usage of the device and recommend maintenance at appropriate junctures.
- The device could include additional functionality, such as an MP3 player, satellite navigation and so forth, which could be downloaded to the device from the PC.

Clearly, these capabilities are not limited to the device 101 and PC 109 of Figure 1, but may apply to any electrically heated smoking system according to the invention.

Thus, a large number of extended capabilities may be provided, not limited to those listed above. The interface for connection via a communications link to the host, allows the electrically heated smoking system itself to be kept relatively simple and low-cost to manufacture, whilst providing capability for advanced functionality via the communications link.

CLAIMS

1. An electrically heated smoking system for receiving an aerosol-forming substrate, the system comprising:

at least one heating element for heating the substrate to form an aerosol;

a power supply for supplying power to the at least one heating element;

electrical hardware connected to the power supply and the at least one heating element; and

an interface for establishing a communications link for uploading data to and downloading data from an Internet-enabled host.

2. An electrically heated smoking system according to claim 1, wherein the aerosol-forming substrate is a solid substrate.

3. An electrically heated smoking system according to claim 1 or claim 2, wherein the aerosol-forming substrate is a liquid substrate.

4. An electrically heated smoking system according to any preceding claim, wherein the power supply comprises a power cell contained in the electrically heated smoking system.

5. An electrically heated smoking system according to any preceding claim, wherein the power supply comprises circuitry chargeable by an external charging portion.

6. An electrically heated smoking system according to any preceding claim, wherein the power supply comprises an interface for connection to an external power source.

7. An electrically heated smoking system according to any preceding claim, wherein the communications link is suitable for providing electrical power from the host to the electrically heated smoking system.

8. An electrically heated smoking system according to any preceding claim, wherein the communications link is a wireless communications link.

9. An electrically heated smoking system according to any of claims 1 to 7, wherein the communications link is a wired communications link.

10. An electrically heated smoking system according to claim 9, wherein the communications link is a Universal Serial Bus link.

11. An electrically heated smoking system according to any preceding claim, wherein the electrical hardware is programmable by software.

12. An electrically heated smoking system according to any preceding claim, wherein the electrical hardware comprises a sensor to detect air flow indicative of a user taking a puff.

13. An electrically heated smoking system according to any preceding claim, further comprising a puff indicator for indicating when the at least one heating element is activated.

14. An electrically heated smoking system according to any preceding claim, further comprising a housing for receiving the aerosol-forming substrate and designed to be grasped by a user, the housing comprising a shell and a replaceable mouthpiece.