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ELECTRONIC VAPOUR PROVISION SYSTEM AND METHOD

Abstract

An electronic vapour provision system 'EVPS' comprises an aerosol generator configured to generate aerosol for delivery to a user, a timer to measure timings of inhalation actions of the user, and an inhalation prediction processor configured to predict inhalation actions of the user based upon timing measurements from the timer, wherein the inhalation prediction processor is configured to initialise a first predetermined pre-heat mode of the aerosol generator if a predicted inhalation action meets a first predetermined pre-heat criterion.

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Background/Summary

TECHNICAL FIELD

[0001] The present invention relates to an electronic vapour provision system and method.

BACKGROUND

[0002] The “background” description provided herein is for the purpose of generally presenting the context of the disclosure. Work of the presently named inventors, to the extent it is described in this background section, as well as aspects of the description which may not otherwise qualify as prior art at the time of filing, are neither expressly or impliedly admitted as prior art against the present disclosure.

[0003] Aerosol provision systems (or equally, electronic vapour provision systems) are popular with users as they enable the delivery of active ingredients (such as nicotine) to the user in a convenient manner and on demand.

[0004] As an example of an aerosol provision system, electronic cigarettes (e-cigarettes) generally contain a reservoir of a source liquid containing a formulation, typically including nicotine, from which an aerosol is generated, e.g. through heat vaporisation. An aerosol source for an aerosol provision system may thus comprise a heater having a heating element arranged to receive source liquid from the reservoir, for example through wicking/capillary action. Other source materials may be similarly heated to create an aerosol, such as botanical matter, or a gel comprising an active ingredient and/or flavouring. Hence more generally, the e-cigarette may be thought of as comprising or receiving a payload for heat vaporisation.

[0005] While a user inhales on the device, electrical power is supplied to the heating element to vaporise the aerosol source (a portion of the payload) in the vicinity of the heating element, to generate an aerosol for inhalation by the user. Such devices are usually provided with one or more air inlet holes located away from a mouthpiece end of the system. When a user sucks on a mouthpiece connected to the mouthpiece end of the system, air is drawn in through the inlet holes and past the aerosol source. There is a flow path connecting between the aerosol source and an opening in the mouthpiece so that air drawn past the aerosol source continues along the flow path to the mouthpiece opening, carrying some of the aerosol from the aerosol source with it. The aerosol-carrying air exits the aerosol provision system through the mouthpiece opening for inhalation by the user.

[0006] Usually an electric current is supplied to the heater when a user is drawing/puffing on the device. Typically, the electric current is supplied to the heater, e.g. resistance heating element, in response to either the activation of an airflow sensor along the flow path as the user inhales/draw/puffs or in response to the activation of a button by the user. The heat generated by the heating element is used to vaporise a formulation. The released vapour mixes with air drawn through the device by the puffing consumer and forms an aerosol. Alternatively or in addition, the heating element is used to heat but typically not burn a botanical such as tobacco, to release active ingredients thereof as a vapour/aerosol.

[0007] It will be appreciated that as a frequently used electronic device that, in use, draws sufficient current from its battery to heat a portion of payload to the point where it generates a vapour, it is beneficial if the device activates in a manner that is convenient for the user and its use, and also preferably does so in a manner that is beneficial to the battery and/or other workings of the device.

[0008] The present invention seeks to address of mitigate this need.

SUMMARY OF THE INVENTION

[0009] Various aspects and features of the present invention are defined in the appended claims and within the text of the accompanying description.

[0010] In a first aspect, an electronic vapour provision system ‘EVPS’ is provided in accordance with claim **1**.

[0011] In another aspect, a method of electronic vapour provision is provided in accordance with claim **13**.

[0012] It is to be understood that both the foregoing general description of the invention and the following detailed description are exemplary, but are not restrictive, of the invention.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] A more complete appreciation of the disclosure and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

[0014] FIG. **1** is a schematic diagram of a vapour/aerosol provision system, in accordance with embodiments of the present description.

[0015] FIG. **2** is a schematic diagram of the body **20** of the system of FIG. **1**, in accordance with embodiments of the present description.

[0016] FIG. **3** is a schematic diagram of a cartomiser **30** of the system of FIG. **1**, in accordance with embodiments of the disclosure.

[0017] FIG. **4** is a schematic diagram a connector of the system of FIG. **1**, in accordance with embodiments of the disclosure.

[0018] FIG. **5**A is a schematic diagram of functional components of the system of FIG. **1**, in accordance with embodiments of the disclosure.

[0019] FIG. **5**B is a schematic diagram of functional components of a processor of the system of FIG. **1**, in accordance with embodiments of the disclosure.

[0020] FIG. **6** is a schematic diagram of a delivery ecosystem, in accordance with embodiments of the disclosure.

[0021] FIG. **7** is a schematic diagram of functional components of a mobile communication device, in accordance with embodiments of the disclosure.

[0022] FIG. **8** is a flow diagram of a method of electronic vapour provision, in accordance with embodiments of the disclosure.

DESCRIPTION OF THE EMBODIMENTS

[0023] An electronic vapour provision system and method are disclosed. In the following description, a number of specific details are presented in order to provide a thorough understanding of the embodiments of the present invention. It will be apparent, however, to a person skilled in the art that these specific details need not be employed to practice the present invention. Conversely, specific details known to the person skilled in the art are omitted for the purposes of clarity where appropriate.

[0024] Aerosol provision systems (or equally, electronic vapour provision systems) are similar terms for a delivery device for a user.

[0025] The term ‘delivery device’ and by extension ‘aerosol provision system’ or ‘electronic vapour provision system’ may encompass systems that deliver a least one substance to a user, and include non-combustible aerosol provision systems that release compounds from an aerosol-generating material without combusting the aerosol-generating material, such as electronic cigarettes, tobacco heating products, and hybrid systems to generate aerosol using a combination of aerosol-generating materials, wherein the at least one substance may or may not comprise nicotine.

[0026] The substance to be delivered may be an aerosol-generating material and as appropriate, may comprise one or more active constituents, one or more flavours, one or more aerosol-former materials, and/or one or more other functional materials.

[0027] Currently, the most common example of such a delivery device is an aerosol provision system (e.g. a non-combustible aerosol provision system) or electronic vapour provision system (EVPS), such as an e-cigarette. Throughout the following description the term "e-cigarette" is sometimes used but this term may be used interchangeably with these terms above except where stated otherwise or where context indicates otherwise. Similarly the terms 'vapour' and 'aerosol' are referred to equivalently herein.
[0028] Generally, the electronic vapour/aerosol provision system may be an electronic cigarette, also known as a vaping device or electronic nicotine delivery device (END), although it is noted that the presence of nicotine in the aerosol-generating (e.g. aerosolisable) material is not a requirement. In some embodiments, a non-combustible aerosol provision system is a tobacco heating system, also known as a heat-not-burn system. An example of such a system is a tobacco heating system. In some embodiments, the non-combustible aerosol provision system is a hybrid system to generate aerosol using a combination of aerosol-generating materials, one or a plurality of which may be heated. Each of the aerosol-generating materials may be, for example, in the form of a solid, liquid or gel and may or may not contain nicotine. In some embodiments, the hybrid system comprises a liquid or gel aerosol-generating material and a solid aerosol-generating material. The solid aerosol-generating material may comprise, for example, tobacco or a non-tobacco product. Meanwhile in some embodiments, the non-combustible aerosol provision system generates a vapour/aerosol from one or more such aerosol-generating materials.
[0029] Typically, the non-combustible aerosol provision system may comprise a non-combustible aerosol provision device and an article (otherwise referred to as a consumable) for use with the non-combustible aerosol provision system. However, it is envisaged that articles which themselves comprise a means for powering an aerosol generating component (e.g. an aerosol generator such as a heater, vibrating mesh or the like) may themselves form the non-combustible aerosol provision system. In one embodiment, the non-combustible aerosol provision device may comprise a power source and a controller. The power source may be an electric power source or an exothermic power source. In one embodiment, the exothermic power source comprises a carbon substrate which may be energised so as to distribute power in the form of heat to an aerosolisable material or heat transfer material in proximity to the exothermic power source. In one embodiment, the power source, such as an exothermic power source, is provided in the article so as to form the non-combustible aerosol provision. In one embodiment, the article for use with the non-combustible aerosol provision device may comprise an aerosolisable material.
[0030] In some embodiments, the aerosol generating component is a heater capable of interacting with the aerosolisable material so as to release one or more volatiles from the aerosolisable material to form an aerosol. In one embodiment, the aerosol generating component is capable of generating an aerosol from the aerosolisable material without heating. For example, the aerosol generating component may be capable of generating an aerosol from the aerosolisable material without applying heat thereto, for example via one or more of vibrational, mechanical, pressurisation or electrostatic means.
[0031] In some embodiments, the aerosolisable material may comprise an active material, an aerosol forming material and optionally one or more functional materials. The active material may comprise nicotine (optionally contained in tobacco or a tobacco derivative) or one or more other non-olfactory physiologically active materials. A non-olfactory physiologically active material is a material which is included in the aerosolisable material in order to achieve a physiological response other than olfactory perception. The aerosol forming material may comprise one or more of glycerine, glycerol, propylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, 1,3-butylene glycol, erythritol, meso-Erythritol, ethyl vanillate, ethyl laurate, a diethyl suberate, triethyl citrate, triacetin, a diacetin mixture, benzyl benzoate, benzyl phenyl acetate, tributyrin, lauryl acetate, lauric acid, myristic acid, and propylene carbonate. The one or more functional materials may comprise one or more of flavours, carriers, pH regulators, stabilizers, and/or

antioxidants.

[0032] In some embodiments, the article for use with the non-combustible aerosol provision device may comprise aerosolisable material or an area for receiving aerosolisable material. In one embodiment, the article for use with the non-combustible aerosol provision device may comprise a mouthpiece. The area for receiving aerosolisable material may be a storage area for storing aerosolisable material. For example, the storage area may be a reservoir. In one embodiment, the area for receiving aerosolisable material may be separate from, or combined with, an aerosol generating area.

[0033] The aerosol provision system need not provide the aerosol directly to the user, but may provide it to an intermediary device or conveyor that causes/enables the introduction of an active ingredient into the body of the user in a manner that allows the active ingredient to take effect.

[0034] An example may thus include a device that disperses an aerosol into a receptacle, after which a user may take the receptacle from the device and inhale or sip the aerosol. Hence the delivery device does not necessarily have to be directly engaged with by the user at the point of consumption.

[0035] Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, FIG. **1** is a schematic diagram of a vapour/aerosol provision system such as an e-cigarette **10** (not to scale), providing a non-limiting example of a delivery device in accordance with some embodiments of the disclosure.

[0036] The e-cigarette has a generally cylindrical shape, extending along a longitudinal axis indicated by dashed line LA, and comprises two main components, namely a body **20** and a cartomiser **30**. The cartomiser includes an internal chamber containing a reservoir of a payload such as for example a liquid comprising nicotine, a vaporiser (such as a heater), and a mouthpiece **35**. References to ‘nicotine’ hereafter will be understood to be merely an example and can be substituted with any suitable active ingredient. References to ‘liquid’ as a payload hereafter will be understood to be merely an example and can be substituted with any suitable payload such as botanical matter (for example tobacco that is to be heated rather than burned), or a gel comprising an active ingredient and/or flavouring. The reservoir may be a foam matrix or any other structure for retaining the liquid until such time that it is required to be delivered to the vaporiser. In the case of a liquid/flowing payload, the vaporiser is for vaporising the liquid, and the cartomiser **30** may further include a wick or similar facility to transport a small amount of liquid from the reservoir to a vaporising location on or adjacent the vaporiser. In the following, a heater is used as a specific example of a vaporiser. However, it will be appreciated that other forms of vaporiser (for example, those which utilise ultrasonic waves) could also be used and it will also be appreciated that the type of vaporiser used may also depend on the type of payload to be vaporised.

[0037] The body **20** includes a re-chargeable cell or battery to provide power to the e-cigarette **10** and a circuit board for generally controlling the e-cigarette. When the heater receives power from the battery, as controlled by the circuit board, the heater vaporises the liquid and this vapour is then inhaled by a user through the mouthpiece **35**. In some specific embodiments the body is further provided with a manual activation device **265**, e.g. a button, switch, or touch sensor located on the outside of the body.

[0038] The body **20** and cartomiser **30** may be detachable from one another by separating in a direction parallel to the longitudinal axis LA, as shown in FIG. **1**, but are joined together when the device **10** is in use by a connection, indicated schematically in FIG. **1** as **25**A and **25**B, to provide mechanical and electrical connectivity between the body **20** and the cartomiser **30**. The electrical connector **25**B on the body **20** that is used to connect to the cartomiser **30** also serves as a socket for connecting a charging device (not shown) when the body **20** is detached from the cartomiser **30**. The other end of the charging device may be plugged into a USB socket to re-charge the cell in the body **20** of the e-cigarette **10**. In other implementations, a cable may be provided for direct connection between the electrical connector **25**B on the body **20** and a USB socket.

[0039] The e-cigarette **10** is provided with one or more holes (not shown in FIG. **1**) for air inlets. These holes connect to an air passage through the e-cigarette **10** to the mouthpiece **35**. When a user inhales through the mouthpiece **35**, air is drawn into this air passage through the one or more air inlet holes, which are suitably located on the outside of the e-cigarette. When the heater is activated to vaporise the nicotine from the cartridge, the airflow passes through, and combines with, the generated vapour, and this combination of airflow and generated vapour then passes out of the mouthpiece **35** to be inhaled by a user. Except in single-use devices, the cartomiser **30** may be detached from the body **20** and disposed of when the supply of liquid is exhausted (and replaced with another cartomiser if so desired).
[0040] It will be appreciated that the e-cigarette **10** shown in FIG. **1** is presented by way of example, and various other implementations can be adopted. For example, in some embodiments, the cartomiser **30** is provided as two separable components, namely a cartridge comprising the liquid reservoir and mouthpiece (which can be replaced when the liquid from the reservoir is exhausted), and a vaporiser comprising a heater (which is generally retained). As another example, the charging facility may connect to an additional or alternative power source, such as a car cigarette lighter.
[0041] FIG. **2** is a schematic (simplified) diagram of the body **20** of the e-cigarette **10** of FIG. **1** in accordance with some embodiments of the disclosure. FIG. **2** can generally be regarded as a cross-section in a plane through the longitudinal axis LA of the e-cigarette **10**. Note that various components and details of the body, e.g. such as wiring and more complex shaping, have been omitted from FIG. **2** for reasons of clarity.
[0042] The body **20** includes a battery or cell **210** for powering the e-cigarette **10** in response to a user activation of the device. Additionally, the body **20** includes a control unit (not shown in FIG. **2**), for example a chip such as an application specific integrated circuit (ASIC) or microcontroller, for controlling the e-cigarette **10**. The microcontroller or ASIC includes a CPU or micro-processor. The operations of the CPU and other electronic components are generally controlled at least in part by software programs running on the CPU (or other component). Such software programs may be stored in non-volatile memory, such as ROM, which can be integrated into the microcontroller itself, or provided as a separate component. The CPU may access the ROM to load and execute individual software programs as and when required. The microcontroller also contains appropriate communications interfaces (and control software) for communicating as appropriate with other devices in the body **10**.
[0043] The body **20** further includes a cap **225** to seal and protect the far (distal) end of the e-cigarette **10**. Typically there is an air inlet hole provided in or adjacent to the cap **225** to allow air to enter the body **20** when a user inhales on the mouthpiece **35**. The control unit or ASIC may be positioned alongside or at one end of the battery **210**. In some embodiments, the ASIC is attached to a sensor unit **215** to detect an inhalation on mouthpiece **35** (or alternatively the sensor unit **215** may be provided on the ASIC itself). In either case, the sensor unit **215**, with or without the ASIC, may be understood as an example of a sensor platform. An air path is provided from the air inlet through the e-cigarette, past the airflow sensor **215** and the heater (in the vaporiser or cartomiser **30**), to the mouthpiece **35**. Thus when a user inhales on the mouthpiece of the e-cigarette, the CPU detects such inhalation based on information from the airflow sensor **215**.
[0044] At the opposite end of the body **20** from the cap **225** is the connector **25**B for joining the body **20** to the cartomiser **30**. The connector **25**B provides mechanical and electrical connectivity between the body **20** and the cartomiser **30**. The connector **25**B includes a body connector **240**, which is metallic (silver-plated in some embodiments) to serve as one terminal for electrical connection (positive or negative) to the cartomiser **30**. The connector **25**B further includes an electrical contact **250** to provide a second terminal for electrical connection to the cartomiser **30** of opposite polarity to the first terminal, namely body connector **240**. The electrical contact **250** is mounted on a coil spring **255**. When the body**20** is attached to the cartomiser **30**, the connector **25**A

on the cartomiser **30** pushes against the electrical contact **250** in such a manner as to compress the coil spring in an axial direction, i.e. in a direction parallel to (co-aligned with) the longitudinal axis LA. In view of the resilient nature of the spring **255**, this compression biases the spring **255** to expand, which has the effect of pushing the electrical contact **250** firmly against connector **25**A of the cartomiser **30**, thereby helping to ensure good electrical connectivity between the body **20** and the cartomiser **30**. The body connector **240** and the electrical contact **250** are separated by a trestle **260**, which is made of a non-conductor (such as plastic) to provide good insulation between the two electrical terminals. The trestle **260** is shaped to assist with the mutual mechanical engagement of connectors **25**A and **25**B.

[0045] As mentioned above, a button **265**, which represents a form of manual activation device **265**, may be located on the outer housing of the body **20**. The button **265** may be implemented using any appropriate mechanism which is operable to be manually activated by the user—for example, as a mechanical button or switch, a capacitive or resistive touch sensor, and so on. It will also be appreciated that the manual activation device **265** may be located on the outer housing of the cartomiser **30**, rather than the outer housing of the body **20**, in which case, the manual activation device **265** may be attached to the ASIC via the connections **25**A, **25**B. The button **265** might also be located at the end of the body **20**, in place of (or in addition to) cap **225**.

[0046] FIG. **3** is a schematic diagram of the cartomiser **30** of the e-cigarette **10** of FIG. **1** in accordance with some embodiments of the disclosure. FIG. **3** can generally be regarded as a cross-section in a plane through the longitudinal axis LA of the e-cigarette **10**. Note that various components and details of the cartomiser **30**, such as wiring and more complex shaping, have been omitted from FIG. **3** for reasons of clarity.

[0047] The cartomiser **30** includes an air passage **355** extending along the central (longitudinal) axis of the cartomiser **30** from the mouthpiece **35** to the connector **25**A for joining the cartomiser **30** to the body **20**. A reservoir of liquid **360** is provided around the air passage **335**. This reservoir **360** may be implemented, for example, by providing cotton or foam soaked in liquid. The cartomiser **30** also includes a heater **365** for heating liquid from reservoir **360** to generate vapour to flow through air passage **355** and out through mouthpiece **35** in response to a user inhaling on the e-cigarette **10**. The heater **365** is powered through lines **366** and **367**, which are in turn connected to opposing polarities (positive and negative, or vice versa) of the battery **210** of the main body **20** via connector **25**A (the details of the wiring between the power lines **366** and **367** and connector **25**A are omitted from FIG. **3**).

[0048] The connector **25**A includes an inner electrode **375**, which may be silver-plated or made of some other suitable metal or conducting material. When the cartomiser **30** is connected to the body **20**, the inner electrode **375** contacts the electrical contact **250** of the body **20** to provide a first electrical path between the cartomiser **30** and the body **20**. In particular, as the connectors **25**A and **25**B are engaged, the inner electrode **375** pushes against the electrical contact **250** so as to compress the coil spring **255**, thereby helping to ensure good electrical contact between the inner electrode **375** and the electrical contact **250**.

[0049] The inner electrode **375** is surrounded by an insulating ring **372**, which may be made of plastic, rubber, silicone, or any other suitable material. The insulating ring is surrounded by the cartomiser connector **370**, which may be silver-plated or made of some other suitable metal or conducting material. When the cartomiser **30** is connected to the body **20**, the cartomiser connector **370** contacts the body connector **240** of the body **20** to provide a second electrical path between the cartomiser **30** and the body **20**. In other words, the inner electrode **375** and the cartomiser connector **370** serve as positive and negative terminals (or vice versa) for supplying power from the battery **210** in the body **20** to the heater **365** in the cartomiser **30** via supply lines **366** and **367** as appropriate.

[0050] The cartomiser connector **370** is provided with two lugs or tabs **380**A, **380**B, which extend in opposite directions away from the longitudinal axis of the e-cigarette **10**. These tabs are used to provide a bayonet fitting in conjunction with the body connector **240** for connecting the cartomiser **30** to the body **20**. This bayonet fitting provides a secure and robust connection between the cartomiser **30** and the body **20**, so that the cartomiser and body are held in a fixed position relative to one another, with minimal wobble or flexing, and the likelihood of any accidental disconnection is very small. At the same time, the bayonet fitting provides simple and rapid connection and disconnection by an insertion followed by a rotation for connection, and a rotation (in the reverse direction) followed by withdrawal for disconnection. It will be appreciated that other embodiments may use a different form of connection between the body **20** and the cartomiser **30**, such as a snap fit or a screw connection.

[0051] FIG. **4** is a schematic diagram of certain details of the connector **25**B at the end of the body **20** in accordance with some embodiments of the disclosure (but omitting for clarity most of the internal structure of the connector as shown in FIG. **2**, such as trestle **260**). In particular, FIG. **4** shows the external housing **201** of the body **20**, which generally has the form of a cylindrical tube. This external housing **201** may comprise, for example, an inner tube of metal with an outer covering of paper or similar. The external housing **201** may also comprise the manual activation device **265** (not shown in FIG. **4**) so that the manual activation device **265** is easily accessible to the user.

[0052] The body connector **240** extends from this external housing **201** of the body **20**. The body connector **240** as shown in FIG. **4** comprises two main portions, a shaft portion **241** in the shape of a hollow cylindrical tube, which is sized to fit just inside the external housing **201** of the body **20**, and a lip portion **242** which is directed in a radially outward direction, away from the main longitudinal axis (LA) of the e-cigarette. Surrounding the shaft portion **241** of the body connector **240**, where the shaft portion does not overlap with the external housing **201**, is a collar or sleeve **290**, which is again in a shape of a cylindrical tube. The collar **290** is retained between the lip portion **242** of the body connector **240** and the external housing **201** of the body, which together prevent movement of the collar **290** in an axial direction (i.e. parallel to axis LA). However, collar **290** is free to rotate around the shaft portion **241** (and hence also axis LA).

[0053] As mentioned above, the cap **225** is provided with an air inlet hole to allow air to flow when a user inhales on the mouthpiece **35**. However, in some embodiments the majority of air that enters the device when a user inhales flows through collar **290** and body connector **240** as indicated by the two arrows in FIG. **4**.

[0054] FIG. **5**A is a schematic diagram of the main functional components of the e-cigarette **10** of FIG. **1** in accordance with some embodiments of the disclosure. Notably FIG. **5**A is primarily concerned with electrical connectivity and functionality—it is not intended to indicate the physical sizing of the different components, nor details of their physical placement within the control unit **20** or cartomiser **30**. In addition, it will be appreciated that at least some of the components shown in FIG. **5**A located within the control unit **20** may be mounted on the circuit board **28**. Alternatively, one or more of such components may instead be accommodated in the control unit to operate in conjunction with the circuit board **28**, but not physically mounted on the circuit board itself. For example, these components may be located on one or more additional circuit boards, or they may be separately located (such as battery **54**).

[0055] As shown in FIG. **5**A, the cartomiser contains heater **310** which receives power through connector **31**B. The control unit **20** includes an electrical socket or connector **21**A for connecting to the corresponding connector **31**B of the cartomiser **30** (or potentially to a USB charging device). This then provides electrical connectivity between the control unit **20** and the cartomiser **30**.

[0056] The control unit **20** further includes a sensor unit **61**, which is located in or adjacent to the air path through the control unit **20** from the air inlet(s) to the air outlet (to the cartomiser **30** through the connector **21**A). The sensor unit contains a pressure sensor **62** and temperature sensor **63** (also in or adjacent to this air path). The control unit further includes a capacitor **220**, a processor **50**, a field effect transistor (FET) switch **210**, a battery **54**, input device **59** (or equivalently **265** in FIG. **1**), and output device **58**.

[0057] The operations of the processor **50** and other electronic components, such as the pressure sensor **62**, are generally controlled at least in part by software programs running on the processor (or other components). Such software programs may be stored in non-volatile memory, such as ROM, which can be integrated into the processor **50** itself, or provided as a separate component. The processor **50** may access the ROM to load and execute individual software programs as and when required. The processor **50** also contains appropriate communications facilities, e.g. pins or pads (plus corresponding control software), for communicating as appropriate with other devices in the control unit **20**, such as the pressure sensor **62**.

[0058] The output device(s) **58** may provide visible, audio and/or haptic output. For example, the output device(s) may include a speaker **58**, a vibrator, and/or one or more lights. The lights are typically provided in the form of one or more light emitting diodes (LEDs), which may be the same or different colours (or multi-coloured). In the case of multi-coloured LEDs, different colours are obtained by switching red, green or blue LEDs on, optionally at different relative brightnesses to give corresponding relative variations in colour. Where red, green and blue LEDs are provided together, a full range of colours is possible, whilst if only two out of the three red, green and blue LEDs are provided, only a respective sub-range of colours can be obtained.

[0059] The output from the output device may be used to signal to the user various conditions or states within the e-cigarette, such as a low battery warning. Different output signals may be used for signalling different states or conditions. For example, if the output device **58** is an audio speaker, different states or conditions may be represented by tones or beeps of different pitch and/or duration, and/or by providing multiple such beeps or tones. Alternatively, if the output device **58** includes one or more lights, different states or conditions may be represented by using different colours, pulses of light or continuous illumination, different pulse durations, and so on. For example, one indicator light might be utilised to show a low battery warning, while another indicator light might be used to indicate that the liquid reservoir **58** is nearly depleted. It will be appreciated that a given e-cigarette may include output devices to support multiple different output modes (audio, visual) etc.

[0060] The input device(s) **59** may be provided in various forms. For example, an input device (or devices) may be implemented as buttons on the outside of the e-cigarette—e.g. as mechanical, electrical or capacitor (touch) sensors. Some devices may support blowing into the e-cigarette as an input mechanism (such blowing may be detected by pressure sensor **62**, which would then be also acting as a form of input device **59**), and/or connecting/disconnecting the cartomiser **30** and control unit **20** as another form of input mechanism. Again, it will be appreciated that a given e-cigarette may include input devices **59** to support multiple different input modes.

[0061] As noted above, the e-cigarette **10** provides an air path from the air inlet through the e-cigarette, past the pressure sensor **62** and the heater **310** in the cartomiser **30** to the mouthpiece **35**. Thus when a user inhales on the mouthpiece of the e-cigarette, the processor **50** detects such inhalation based on information from the pressure sensor **62**. In response to such a detection, the CPU supplies power from the battery **54** to the heater, which thereby heats and vaporises the nicotine from the liquid reservoir **38** for inhalation by the user. Meanwhile for example, for a device which is button activated (e.g. by detecting a button push rather than an airflow), a different air path may be used (for example not entering the battery section).

[0062] In the particular non-limiting implementation shown in FIG. **5**A, a FET **210** is connected between the battery **54** and the connector **21**A. This FET **210** acts as a switch. The processor **50** is connected to the gate of the FET to operate the switch, thereby allowing the processor to switch on and off the flow of power from the battery **54** to heater **310** according to the status of the detected airflow. It will be appreciated that the heater current can be relatively large, for example, in the range 1-5 amps, and hence the FET **210** should be implemented to support such current control (likewise for any other form of switch that might be used in place of FET **210**).

[0063] In order to provide more fine-grained control of the amount of power flowing from the battery **54** to the heater **310**, a pulse-width modulation (PWM) scheme may be adopted. A PWM scheme may be based on a repetition period of say 1 ms. Within each such period, the switch **210** is turned on for a proportion of the period, and turned off for the remaining proportion of the period. This is parameterised by a duty cycle, whereby a duty cycle of 0 indicates that the switch is off for all of each period (i.e. in effect, permanently off), a duty cycle of 0.33 indicates that the switch is on for a third of each period, a duty cycle of 0.66 indicates that the switch is on for two-thirds of each period, and a duty cycle of 1 indicates that the FET is on for all of each period (i.e. in effect, permanently on). It will be appreciated that these are only given as example settings for the duty cycle, and intermediate values can be used as appropriate.
[0064] The use of PWM provides an effective power to the heater which is given by the nominal available power (based on the battery output voltage and the heater resistance) multiplied by the duty cycle. The processor **50** may, for example, utilise a duty cycle of 1 (i.e. full power) at the start of an inhalation to initially raise the heater **310** to its desired operating temperature as quickly as possible. Once this desired operating temperature has been achieved, the processor **50** may then reduce the duty cycle to some suitable value in order to maintain the heater **310** at the desired operating temperature.
[0065] As shown in FIG. **5**A, the processor **50** includes a communications interface **55** for wireless communications, in particular, support for Bluetooth® Low Energy (BLE) communications.
[0066] Optionally the heater **310** may be utilised as an antenna for use by the communications interface **55** for transmitting and receiving the wireless communications. One motivation for this is that the control unit **20** may have a metal housing **202**, whereas the cartomiser portion **30** may have a plastic housing **302** (reflecting the fact that the cartomiser **30** is disposable, whereas the control unit **20** is retained and therefore needs to be more durable). The metal housing acts as a screen or barrier which makes it difficult to locate an antenna within the control unit **20** itself. However, utilising the heater **310** as the antenna for the wireless communications avoids this metal screening because of the plastic housing of the cartomiser, but without adding additional components or complexity (or cost) to the cartomiser. Alternatively a separate antenna may be provided (not shown), or a portion of the metal housing may be used.
[0067] If the heater is used as an antenna then as shown in FIG. **5**A, the processor **50**, more particularly the communications interface **55**, may be coupled to the power line from the battery **54** to the heater **310** (via connector **31**B) by a capacitor **220**. This capacitive coupling occurs downstream of the switch **210**, since the wireless communications may operate when the heater is not powered for heating (as discussed in more detail below). It will be appreciated that capacitor **220** prevents the power supply from the battery **54** to the heater **310** being diverted back to the processor **50**.
[0068] Note that the capacitive coupling may be implemented using a more complex LC (inductor-capacitor) network, which can also provide impedance matching with the output of the communications interface **55**. (As known to the person skilled in the art, this impedance matching supports proper transfer of signals between the communications interface **55** and the heater **310** acting as the antenna, rather than having such signals reflected back along the connection).
[0069] In some implementations, the processor **50** and communications interface are implemented using a Dialog DA14580 chip from Dialog Semiconductor PLC, based in Reading, United Kingdom. Further information (and a data sheet) for this chip is available at: http://www.dialog-semiconductor.com/products/bluetooth-smart/smartbond-da14580.
[0070] FIG. **5**B presents a high-level and simplified overview of this chip **50**, including the communications interface **55** for supporting Bluetooth® Low Energy. This interface includes in particular a radio transceiver **520** for performing signal modulation and demodulation, etc, link layer hardware **512**, and an advanced encryption facility (128 bits) **511**. The output from the radio transceiver **520** is connected to the antenna (for example, to the heater **310** acting as the antenna via

capacitive coupling **220** and connectors **21**A and **31**B).

[0071] The remainder of processor **50** includes a general processing core **530**, RAM **531**, ROM **532**, a one-time programming (OTP) unit **533**, a general purpose I/O system **560** (for communicating with other components on the PCB **28**), a power management unit **540** and a bridge **570** for connecting two buses. Software instructions stored in the ROM **532** and/or OTP unit **533** may be loaded into RAM **531** (and/or into memory provided as part of core **530**) for execution by one or more processing units within core **530**. These software instructions cause the processor **50** to implement various functionality described herein, such as interfacing with the sensor unit **61** and controlling the heater accordingly. Note that although the device shown in FIG. **5**B acts as both a communications interface **55** and also as a general controller for the electronic vapour provision system **10**, in other embodiments these two functions may be split between two or more different devices (chips)—e.g. one chip may serve as the communications interface **55**, and another chip as the general controller for the electronic vapour provision system **10**.

[0072] In some implementations, the processor **50** may be configured to prevent wireless communications when the heater is being used for vaporising liquid from reservoir **38**. For example, wireless communications may be suspended, terminated or prevented from starting when switch **210** is switched on. Conversely, if wireless communications are ongoing, then activation of the heater may be prevented—e.g. by discarding a detection of airflow from the sensor unit **61**, and/or by not operating switch **210** to turn on power to the heater **310** while the wireless communications are progressing.

[0073] One reason for preventing the simultaneous operation of heater **310** for both heating and wireless communications is to avoid any potential interference from the PWM control of the heater. This PWM control has its own frequency (based on the repetition frequency of the pulses), albeit much lower than the frequency of the wireless communications, and the two could potentially interfere with one another. In some situations, such interference may not, in practice, cause any problems, and simultaneous operation of heater **310** for both heating and wireless communications may be allowed (if so desired). This may be facilitated, for example, by techniques such as the appropriate selection of signal strengths and/or PWM frequency, the provision of suitable filtering, etc.

[0074] Referring now to FIG. **6**, the e-cigarette **10** (or more generally any delivery device as described elsewhere herein) may operate within a wider delivery ecosystem **1**.

[0075] Within the wider delivery ecosystem, a number of devices may communicate with each other, either directly (for example via Bluetooth®) or indirectly (for example via the internet **500**). Examples include but are not limited to a mobile phone **400** and a remote server **1000**.

[0076] With regards to Bluetooth®, a delivery device **10** may communicate with a mobile communication device using Bluetooth® or Bluetooth® Low Energy communications (or similar schemes) to functionally link the delivery device **10** and an application (app) running on a smartphone **400** or other suitable mobile communication device (tablet, laptop, smartwatch, etc). Such communications can be used for a wide range of purposes, for example, to upgrade firmware on the e-cigarette **10**, to retrieve usage and/or diagnostic data from the e-cigarette **10**, to reset or unlock the e-cigarette **10**, to control settings on the e-cigarette, etc, or to share processing operations.

[0077] In general terms, when the e-cigarette **10** is switched on, such as by using input device **59** (or equivalently **265**), or possibly by joining the cartomiser **30** to the control unit **20**, it starts to advertise for Bluetooth® Low Energy communication. If this outgoing communication is received by smartphone **400**, then the smartphone **400** requests a connection to the e-cigarette **10**. The e-cigarette may notify this request to a user via output device **58**, and wait for the user to accept or reject the request via input device **59**. Assuming the request is accepted, the e-cigarette **10** is able to communicate further with the smartphone **400**. Note that the e-cigarette may remember the identity of smartphone **400** and be able to accept future connection requests automatically from that smartphone. Once the connection has been established, the smartphone **400** and the e-cigarette **10** operate in a client-server mode, with the smartphone operating as a client that initiates and sends requests to the e-cigarette which therefore operates as a server (and responds to the requests as appropriate).

[0078] A Bluetooth® Low Energy link (also known as Bluetooth Smart®) implements the IEEE 802.15.1 standard, and operates at a frequency of 2.4-2.5 GHZ, corresponding to a wavelength of about 12 cm, with data rates of up to 1 Mbit/s. The set-up time for a connection is less than 6 ms, and the average power consumption can be very low—of the order 1 mW or less. A Bluetooth Low Energy link may extend up to some 50 m. However, for the situation shown in FIG. **4**, the e-cigarette **10** and the smartphone **400** will typically belong to the same person, and will therefore be in much closer proximity to one another—e.g. 1 m. Further information about Bluetooth Low Energy can be found at: http://www.bluetooth.com/Pages/Bluetooth-Smart.aspx

[0079] It will be appreciated that e-cigarette **10** may support other communications protocols for communication with smartphone **400** (or any other appropriate device). Such other communications protocols may be instead of, or in addition to, Bluetooth Low Energy. Examples of such other communications protocols include Bluetooth® (not the low energy variant), see for example, www.bluetooth.com, near field communications (NFC), as per ISO 13157, and WiFi®. NFC communications operate at much lower wavelengths than Bluetooth (13.56 MHz) and generally have a much shorter range—say <0.2 m. However, this short range is still compatible with many usage scenarios where the user holds or carries both devices. Meanwhile, low-power WiFi® communications, such as IEEE802.11ah, IEEE802.11v, or similar, may be employed between the e-cigarette **10** and a remote device, for example via a wireless access point. In each case, a suitable communications chipset may be included on PCB **28**, either as part of the processor **50** or as a separate component. The skilled person will be aware of other wireless communication protocols that may be employed in e-cigarette **10**.

[0080] Turning now to FIG. **7**, a typical mobile communication device **400** such as a smart phone comprises a central processing unit (CPU) (**410**). The CPU may communicate with components of the smart phone either through direct connections or via an I/O bridge **414** and/or a bus **430** as applicable.

[0081] In the example shown in FIG. **7**, the CPU communicates directly with a memory **412**, which may comprise a persistent memory such as for example Flash @ memory for storing an operating system and applications (apps), and volatile memory such as RAM for holding data currently in use by the CPU.

[0082] Typically persistent and volatile memories are formed by physically distinct units (not shown). In addition, the memory may separately comprise plug-in memory such as a microSD card, and also subscriber information data on a subscriber information module (SIM) (not shown).

[0083] The smart phone may also comprise a graphics processing unit (GPU) **416**. The GPU may communicate directly with the CPU or via the I/O bridge, or may be part of the CPU. The GPU may share RAM with the CPU or may have its own dedicated RAM (not shown) and is connected to the display **418** of the mobile phone. The display is typically a liquid crystal (LCD) or organic light-emitting diode (OLED) display, but may be any suitable display technology, such as e-ink. Optionally the GPU may also be used to drive one or more loudspeakers **420** of the smart phone.

[0084] Alternatively, the speaker may be connected to the CPU via the I/O bridge and the bus. Other components of the smart phone may be similarly connected via the bus, including a touch surface **432** such as a capacitive touch surface overlaid on the screen for the purposes of providing a touch input to the device, a microphone **434** for receiving speech from the user, one or more cameras **436** for capturing images, a global positioning system (GPS) unit **438** for obtaining an estimate of the smart phones geographical position, and wireless communication means **440**.

[0085] The wireless communication means **440** may in turn comprise several separate wireless communication systems adhering to different standards and/or protocols, such as Bluetooth®

(standard or low-energy variants), near field communication and Wi-Fi® as described previously, and also phone based communication such as 2G, 3G and/or 4G.

[0086] The systems are typically powered by a battery (not shown) that may be chargeable via a power input (not shown) that in turn may be part of a data link such as USB (not shown).

[0087] It will be appreciated that different smartphones may include different features (for example a compass or a buzzer) and may omit some of those listed above (for example a touch surface).

[0088] Thus more generally, in embodiments of the present invention a suitable mobile communication device such as smart phone **400** will comprise a CPU and a memory for storing and running an app, and wireless communication means operable to instigate and typically maintain wireless communication with the e-cigarette **10**. It will be appreciated however that the mobile communication device may be any device that has these capabilities, such as a tablet, laptop, smart TV or the like.

[0089] Such a mobile communication device may also act as a bridge between the delivery device **10** and a remote device such as a server, by accessing the server over the internet via WiFi® or mobile data. Alternatively or in addition, the delivery device **10** may be capable of internet access on its own.

[0090] In embodiments of the description, an electronic vapour provision system 'EVPS' (e.g. a delivery device or aerosol delivery device as described elsewhere herein) comprises the following.

[0091] Firstly, an aerosol generator (**30**, **365**) configured to generate aerosol for delivery to a user, as described elsewhere herein.

[0092] Secondly, a timer to measure timings of inhalation actions of the user. The timer may be a dedicated component, or implemented by the processor **50** of the EVPS or the processor **410** of a companion device in communication with the EVPS as described previously herein.

[0093] The measured timings of inhalation actions comprise the times between inhalation actions (for example being detected as described previously herein). As described elsewhere herein, these can be treated as characteristic of the current behaviour of the user—for example whether they are in an ongoing usage session with relatively frequent inhalations, using occasionally ('grazing'), or in a period of prolonged non-use.

[0094] Thirdly, an inhalation prediction processor (e.g. the processor **50** of the EVPS or the processor **410** of a companion device **400** or a combination of the two) configured (for example by suitable software instruction) to predict inhalation actions of the user based upon timing measurements from the timer.

[0095] The inhalation prediction processor may use any suitable analysis scheme to make these predictions.

[0096] To a first approximation, the prediction may be based on recent or N most recent inhalation actions ('puffs') within a current usage period, where a usage period begins when a user takes a first puff after a period of prolonged non-use.

[0097] A period of prolonged non-use may be treated as a predetermined threshold period of for example 5, 10, 15, 30, or 60 minutes, or, over time, an average of measured periods of prolonged non-use (excluding periods such as overnight or when charging, i.e. whilst normal usage is likely). Within a given session, which is noted elsewhere may be an ongoing usage session or an occasional usage grazing session, the first puff may indicate the start of the session, whilst the second puff provides an initial estimate of the usage rate based on the intervening time between puffs. The inhalation prediction processor may then predict when a third puff may occur based on this measured intervening time (for example predicting that the next puff will occur after a similar intervening time). As more puffs occur, the estimate may improve (e.g. up to N recent puffs). Such an estimate may be based on average puff intervals, or a more sophisticated model identifying any patterns or cadence in the sequence of puffs.

[0098] Whilst the above estimate was described as being initialised by the current session, it will be appreciated that information such as average puff intervals and any patterns or cadence in the

sequence of puffs may be derived during one or more previous sessions and such historical information may be used to bootstrap estimates for the current session.
[0099] Hence for example when a first puff within a current session is detected, then an estimate based upon an average from previous inhalations, and/or patterns or cadence from previous inhalations, may be used immediately, and then suddenly updated with information from the current session.
[0100] It will be appreciated that averages, patterns, and/or cadence will differ between ongoing usage sessions and occasional grazing sessions, and so separate historical information (e.g. respective statistical models) may be stored for these different types of session. In this case, the inhalation prediction processor may base an initial prediction for a new current session on the previous type of session, and optionally switch the type of historical information used if the intervals between puffs in the current session appear to fall within typical periods of the other type of session—for example within a standard deviation of the mean for the average of a type of session, or simply if the interval between puffs (or the current session average thereof) appear to be closer to the average of one type of session than the other. In this case, the inhalation prediction processor may use current session information to update both sets of historical information but then discard the update to one set of historical information when it becomes clear that the current session better fits the other set. Alternatively, the information processor may buffer current session information and only update the historical information for one type of session when it becomes clear that the current session better fits that type of session.
[0101] Hence more generally the inhalation prediction processor may build a statistical model of puff intervals in a current usage session, either starting from scratch for that session or based upon an earlier model, and where the inhalation prediction processor maintains earlier models for different types of usage session, then initially using the model corresponding to the previous session, but optionally switching to the model that best fits the current session's puff intervals.
[0102] Optionally all of the above can be modified based on a variety of external factors so that different statistical models may be maintained for example for different times of day (e.g. work hours vs. evenings) and days of the week (e.g. the working week and weekends). This may improve the predictions of the inhalation addiction processor, if the user's patterns of behaviour change with these circumstances.
[0103] Statistical models based on timing may also be built in response to patterns of usage sessions over 24-hour periods and/or over seven-day periods; hence for example this may reveal a pattern of heavy usage during a user's commute, and thereby also establish the users typical working times.
[0104] In addition to the time and/or the day, other factors may include the user's location (which may be determined for example from a companion mobile device **400**), profile data associated with the user (for example based on a questionnaire of usage, demographic information, or data obtained from one or more other EVPS devices owned by the user either concurrently or previously), and other contextual information such as the duration of non-use prior to the current usage session, which may be indicative of whether the user will be starting with an ongoing user session or a grazing session, and/or indicative of a more rapid usage rate after a longer non-use period; hence different historical models may be built according to different predetermined threshold non-use periods.
[0105] Regardless of the type or number of statistical models built, the information production processor predicts inhalation actions of the user based upon timing measurements from the timer, and is further configured to initialise a first predetermined pre-heat mode of the aerosol generator if a predicted inhalation action meets a first predetermined preheat criterion.
[0106] In some embodiments of the present description, the first predetermined pre-heat criterion is whether the predicted inhalation action is predicted to occur within a predetermined period after the last actual inhalation action, the predetermined period being a threshold period within which the

user is assumed to be within an ongoing usage session of the EVPS.

[0107] Hence typically the inhalation prediction processor is configured to predict the elapsed time between the last actual inhalation action of the user and the next expected inhalation action.

[0108] Hence for example the predicted inhalation action may be predicted to occur within 1-2 minutes of the preceding actual puff, being less than a threshold period of two minutes within which the user is assumed to be within an ongoing usage session. It will be appreciated that the value of this threshold period may be determined empirically to be a whole or partial number of minutes or seconds, and/or may be based upon modelling the usage behaviour of the current user, for example using K-means clustering to model two or more average periods (corresponding to 2 or more types of use including for example ongoing and grazing as described elsewhere herein), or using the means of respective historical models described elsewhere herein, and determining a midpoint between these means as the threshold.

[0109] In such embodiments, the first predetermined pre-heat mode heats a heater of the aerosol generator to a first temperature that is higher than a pre-heat mode used if the user is assumed to be engaging in occasional use.

[0110] Hence where it is predicted that (due to the user engaging in ongoing use rather than occasional use) the next puff will be within the threshold period, the EVPS engages a pre-heat mode that maintains all or part of the heater at a higher temperature than in a different pre-heat mode described elsewhere herein for use if the user is engaging in occasional use.

[0111] The higher temperature makes the device more responsive, but at the cost of a higher load on the battery; however, this higher load in turn is anticipated to be compensated for by the predicted shorter duration of this preheat mode. The pre-heat mode is particularly suitable for aerosol-generating materials that may require greater amounts of energy to reach a vaporisation temperature (for instance, solids or gels). Without the pre-heat mode, the time required to reach the vaporisation may be relatively long and, in some instances, may be longer than the duration of an inhalation or the duration taken to bring the EVPS to the user's mouth ready for inhalation. The time required to reach the vaporisation may be shortened by increasing the power supplied to the aerosol generator; however, this may negatively impact battery life (e.g., by having a greater discharge current) and/or may run the risk of overheating the aerosol-generating material which may impact the user's experience when using the EVPS.

[0112] Furthermore, by maintaining the heater at the relatively higher preheat temperature, the battery does not have to change its load as much during and between puffs of the ongoing session, which can extend operational battery life over the lifetime of the device.

[0113] In some embodiments of the description, the inhalation prediction processor is configured to initialise a second predetermined pre-heat mode of the aerosol generator if a predicted inhalation action meets a second predetermined pre-heat criterion.

[0114] In such embodiments, optionally the second predetermined pre-heat criterion is whether the predicted inhalation action is predicted to occur outside a predetermined period after the last actual inhalation action, the predetermined period being a threshold period outside which the user is assumed to be engaging in occasional use.

[0115] It will be appreciated that this threshold period may be the same as the threshold period used when determining the first determined preheat criterion as described elsewhere herein, and acts as the threshold period that distinguishes between the two criteria.

[0116] Alternatively, this threshold period may be a second threshold period longer than the threshold period for determining the first predetermined preheat criterion. In this case there would be an interval period between the two thresholds; this interval may be used to implement a form of hysteresis so that if the time between the user's puffs strayed into this interval period, then whilst it is notionally outside the range of the current session type, the EVPS would continue to operate as if the user was within the current session type. Optionally statistical models for the current session type would not be updated with into puff timings fall into this interval period, to avoid separate

statistical models starting to converge due to possible mischaracterisation of these timings.
[0117] In such embodiments optionally the second predetermined pre-heat mode heats a heater of the aerosol generator to a second temperature that is lower than a pre-heat mode used if the user is assumed to be within an ongoing usage session.
[0118] Hence where it is predicted that (due to the user engaging in occasional use) the next puff will be outside the threshold period, the EVPS engages a pre-heat mode that maintains all or part of the heater at a lower temperature than in a different pre-heat mode described elsewhere herein for use if the user is engaging in ongoing use.
[0119] The lower temperature makes the device more responsive than if there was no preheat, and does so at a lower loading cost on the battery than in the previously described case of ongoing use; this lower load helps compensate for the predicted longer duration of this preheat mode.
[0120] Furthermore, by maintaining the heater at a preheat temperature (albeit a relatively lower one), the battery does not have to change its load as much during and between puffs of the ongoing session, which can again extend operational battery life over the lifetime of the device.
[0121] As noted elsewhere herein, the inhalation prediction processor is configured to predict the elapsed time between the last actual inhalation action of the user and the next expected inhalation action based on the timings between two or more previous inhalation actions of a usage session, and/or previous inhalation actions of one or more previous usage sessions.
[0122] The sessions themselves may be identified by the inhalation prediction processor as being when an inhalation action occurs after a prolonged period of non-use, followed by one or more inhalation actions within a predetermined period of time being a threshold period within which the user is assumed to be within a usage session (e.g. either an ongoing or grazing session), as described previously herein.
[0123] As noted previously, period of prolonged non-use may be treated as a predetermined threshold period of for example 1, 2, 3, 5, 10, 15, 30, or 60 minutes, or, over time, an average of measured periods of prolonged non-use (excluding periods such as overnight or when charging, i.e. whilst normal usage is likely).
[0124] Actual periods such as overnight will typically automatically qualify as periods of prolonged use, or may be set for example via a user interface as times for the device to sleep or enter a standby mode.
[0125] Meanwhile periods such as when the device is charging, or when the user is otherwise modifying the device so that it functions in a different manner (for example by increasing a heating setting, or changing a payload mix or concentration), or modifying the device for example by changing the payload, may be considered as periods of prolonged use regardless of the actual time taken, as they indicate a desire by the user to change the operational circumstances of the device, which may be assumed to also indicate a desire by the user to change their imminent usage of the device, or at least a likelihood that the users usage of the device will change in response to changes in the operational circumstances of the device.
[0126] In some embodiments, one or more threshold periods described elsewhere herein are selected based upon additional factors including one or more selected from the list consisting of the time of day, the day of the week, the location, the duration of non-use prior to the current usage session, profile data associated with the user, and periodicity averaged over multiple prior usage sessions, as also previously described in relation to the statistical models.
[0127] In some embodiments of the present description, the inhalation prediction processor is configured to initialise a warm-down mode of the aerosol generator if inhalation actions meet a predetermined warm-down criterion. In this case, inhalation prediction processor predicts that the session has ended, and the warm-down function provides heat primarily for the purposes of reducing residual condensation within the EPVS.
[0128] In such embodiments, the predetermined warm-down criterion comprises one or more of the following optional criteria.

[0129] Firstly, the user having performed a threshold number of inhalation actions within a current usage session; hence as part of the statistical model, the inhalation prediction processor may determine a typical number of inhalations within a given session; for example due to habit the user may unknowingly take a number of puffs and within a period both roughly similar to the number of puffs and period taken to smoke a conventional cigarette. When the user reaches this characteristic number of puffs, optionally within this characteristic overall period, and inhalation prediction processor may predicts the session is over and enter a warm-down mode.
[0130] Secondly the period between the last inhalation action and the next inhalation exceeds a predetermined period of time being a threshold period within which the user is assumed to be within an ongoing usage session; in this case it is assumed that a user does not transition from an ongoing session to a grazing session; rather, if the user finishes on ongoing session, then there will be a period of prolonged non-use.
[0131] Thirdly, the user removes or otherwise functionally disengages from the EVPS a component required for normal use; as noted previously herein, such actions are indicative of an intention by the user to end a current session.
[0132] Fourthly, the user removes or otherwise functionally disengages from the EVPS a consumable required for normal use. Again as noted previously herein, such an action is indicative of an intention by the user to end a current session.
[0133] The temperature in the warm-down mode is sufficient to prevent or reduce condensation within the device, and/or may be similar to the temperature of the second predetermined preheat mode, and may last either for a predetermined period considered sufficient to prevent or reduce condensation within the device, and/or for a predetermined period similar to either the threshold period delimiting ongoing sessions from grazing sessions, or the mean period determined for grazing sessions. The first option provides a battery efficient warm-down function, in which the heater is maintained only for the period considered necessary to prevent or reduce condensation, whereas the latter options provide a hedge against the prediction being incorrect by maintaining the heating function for a period that would encompass a grazing puff, and thus mitigate against a sudden change in battery load if such a puff occurs. For the latter options, where the temperature required to prevent or reduce condensation within the device is higher than the temperature of the second predetermined preheat mode, then optionally the warm-down mode may start with the higher temperature and after the predetermined period considered sufficient to prevent or reduce condensation, transition to the lower temperature of the second predetermined preheat mode, until the threshold or mean period had elapsed.
[0134] In some embodiments of the present description, the inhalation prediction processor is configured to predict whether back to back usage sessions will occur, back to back usage sessions being usage sessions with an intervening non-use period greater than a predetermined period of time being a threshold period within which the user is assumed to be within an ongoing usage session but less than a second, longer threshold period indicative of protracted non-use.
[0135] Hence in this case the inhalation prediction processor predicts that the current session has ended, but another session will begin before the device is deemed to be within a period of protracted non-use.
[0136] If the inhalation prediction processor predicts such a back to back or chain usage session, the inhalation prediction processor is configured to initialise an interim heating mode that heats a heater of the aerosol generator to a third temperature that is lower than in a pre-heat mode used if the user is assumed to be within an ongoing usage session.
[0137] Hence whilst the previously described first temperature relates to a comparatively short first predicted period, and the previously describes second temperature relates to a comparatively longer second predicted period than the first, thereby providing a trade-off between battery consumption, responsiveness, and potentially damaging changes in battery load, the third temperature follows this trend by maintaining the heater at a still lower temperature, but for a predicted still longer

period.

[0138] It will be appreciated that the above systems implement the methods and techniques described herein (for example by use of suitable software instruction), and these are also envisaged within the scope of the application.

[0139] Therefore turning now to FIG. **8**, in a summary embodiment of the present application a typically non-therapeutic electronic vapour provision method comprises the following steps: [0140] a first, aerosol generation step (s**810**) comprising generating aerosol for delivery to a user, as described elsewhere herein; [0141] a second, timing step (s**820**) comprising measuring timings of inhalation actions of the user, as described elsewhere herein; [0142] a third, inhalation prediction step (s**830**) comprising predicting inhalation actions of the user based upon timing measurements from the timing step, as described elsewhere herein; and [0143] a fourth, initialisation step (s**840**) comprising initialising a first predetermined pre-heat mode for the aerosol generation step if a predicted inhalation action meets a first predetermined pre-heat criterion, as described elsewhere herein.

[0144] It will be apparent to a person skilled in the art that variations in the above method corresponding to operation of the various embodiments of the apparatus as described and claimed herein are considered within the scope of the present invention, including but not limited to that: [0145] in an instance of the summary embodiment, the first predetermined pre-heat criterion is whether the predicted inhalation action is predicted to occur within a predetermined period after the last actual inhalation action, the predetermined period being a threshold period within which the user is assumed to be within an ongoing usage session of the EVPS, and the first predetermined pre-heat mode heats a heater of an aerosol generator to a first temperature that is higher than a pre-heat mode used if the user is assumed to be engaging in occasional use, as described elsewhere herein; [0146] in an instance of the summary embodiment, the inhalation prediction step comprises initialising a second predetermined pre-heat mode of the aerosol generation step if a predicted inhalation action meets a second predetermined pre-heat criterion, as described elsewhere herein; [0147] in this instance, optionally the second predetermined pre-heat criterion is whether the predicted inhalation action is predicted to occur outside a predetermined period after the last actual inhalation action, the predetermined period being a threshold period outside which the user is assumed to be engaging in occasional use, and the second predetermined pre-heat mode heats a heater of an aerosol generator to a second temperature that is lower than a pre-heat mode used if the user is assumed to be within an ongoing usage session, as described elsewhere herein; [0148] in an instance of the summary embodiment, the inhalation prediction step comprises predicting the elapsed time between the last actual inhalation action of the user and the next expected inhalation action, as described elsewhere herein; [0149] in this instance, optionally the inhalation prediction step comprises predicting the elapsed time between the last actual inhalation action of the user and the next expected inhalation action based on the timings between two or more previous inhalation actions, as described elsewhere herein; [0150] in this case, further optionally the inhalation prediction step comprises predicting the elapsed time between the last actual inhalation action of the user and the next expected inhalation action based on the timings between two or more previous inhalation actions of a usage session, and the inhalation prediction step comprises identifying a usage session as being when an inhalation action occurs after a predetermined period of non-use, followed by one or more inhalation actions within a predetermined period of time being a threshold period within which the user is assumed to be within an ongoing usage session, as described elsewhere herein; [0151] yet further optionally the threshold period is one selected from the list consisting of 1 minute, 2 minutes, 3 minutes, and a period based on an inter-inhalation period averaged over multiple previous usage sessions, as described elsewhere herein; [0152] similarly further optionally the threshold period is selected based upon additional factors including one or more selected from the list consisting of the time of day, the day of the week, the location, the duration of non-use prior to the current usage session, profile data associated with the user, and periodicity averaged over multiple prior usage sessions, as described elsewhere herein; [0153] in an instance of the summary embodiment, the inhalation prediction step comprises initialising a warm-down mode of the aerosol generator if inhalation actions meet a predetermined warm-down criterion, as described elsewhere herein; [0154] in this instance, optionally the predetermined warm-down criterion comprises one or more selected from the list consisting of the user having performed a threshold number of inhalation actions within a current usage session, the period between the last inhalation action and the next inhalation exceeds a predetermined period of time being a threshold period within which the user is assumed to be within an ongoing usage session, the user removes or otherwise functionally disengages from the EVPS a component required for normal use, and the user removes or otherwise functionally disengages from the EVPS a consumable required for normal use, as described elsewhere herein; and [0155] in an instance of the summary embodiment, the inhalation prediction step comprises predicting whether back to back usage sessions will occur, back to back usage sessions being usage sessions with an intervening non-use period greater than a predetermined period of time being a threshold period within which the user is assumed to be within an ongoing usage session but less than a second, longer threshold period indicative of protracted non-use, and if the inhalation prediction step predicts a back to back usage session, the inhalation prediction step further comprises initialising an interim heating mode that heats a heater of the aerosol generator to a third temperature that is lower than in a pre-heat mode used if the user is assumed to be within an ongoing usage session, as described elsewhere herein.

[0156] As noted previously herein, it will be appreciated that the above methods may be carried out on conventional hardware suitably adapted as applicable by software instruction or by the inclusion or substitution of dedicated hardware.

[0157] Thus the required adaptation to existing parts of a conventional equivalent device may be implemented in the form of a computer program product comprising processor implementable instructions stored on a non-transitory machine-readable medium such as a floppy disk, optical disk, hard disk, solid state disk, PROM, RAM, flash memory or any combination of these or other storage media, or realised in hardware as an ASIC (application specific integrated circuit) or an FPGA (field programmable gate array) or other configurable circuit suitable to use in adapting the conventional equivalent device. Separately, such a computer program may be transmitted via data signals on a network such as an Ethernet, a wireless network, the Internet, or any combination of these or other networks.

[0158] The foregoing discussion discloses and describes merely exemplary embodiments of the present invention. As will be understood by those skilled in the art, the present invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. Accordingly, the disclosure of the present invention is intended to be illustrative, but not limiting of the scope of the invention, as well as other claims. The disclosure, including any readily discernible variants of the teachings herein, defines, in part, the scope of the foregoing claim terminology such that no inventive subject matter is dedicated to the public.

Claims

1. An electronic vapour provision system ‘EVPS’, comprising: an aerosol generator configured to generate aerosol for delivery to a user; a timer to measure timings of inhalation actions of the user; and an inhalation prediction processor configured to predict inhalation actions of the user based upon timing measurements from the timer; wherein the inhalation prediction processor is configured to initialise a first predetermined pre-heat mode of the aerosol generator if a predicted inhalation action meets a first predetermined pre-heat criterion.

2. The EVPS of claim 1, in which the first predetermined pre-heat criterion is whether the predicted inhalation action is predicted to occur within a predetermined period after the last actual inhalation action, the predetermined period being a threshold period within which the user is assumed to be within an ongoing usage session of the EVPS; and the first predetermined pre-heat mode heats a heater of the aerosol generator to a first temperature that is higher than a pre-heat mode used if the user is assumed to be engaging in occasional use.

3. The EVPS of claim 1, wherein the inhalation prediction processor is configured to initialise a second predetermined pre-heat mode of the aerosol generator if a predicted inhalation action meets a second predetermined pre-heat criterion.

4. The EVPS of claim 3, wherein the second predetermined pre-heat criterion is whether the predicted inhalation action is predicted to occur outside a predetermined period after the last actual inhalation action, the predetermined period being a threshold period outside which the user is assumed to be engaging in occasional use; and the second predetermined pre-heat mode heats a heater of the aerosol generator to a second temperature that is lower than a pre-heat mode used if the user is assumed to be within an ongoing usage session.

5. The EVPS of claim 1, wherein the inhalation prediction processor is configured to predict the elapsed time between the last actual inhalation action of the user and the next expected inhalation action.

6. The EVPS of claim 5, in which the inhalation prediction processor is configured to predict the elapsed time between the last actual inhalation action of the user and the next expected inhalation action based on the timings between two or more previous inhalation actions.

7. The EVPS of claim 6, in which the inhalation prediction processor is configured to predict the elapsed time between the last actual inhalation action of the user and the next expected inhalation action based on the timings between two or more previous inhalation actions of a usage session; and the inhalation prediction processor is configured to identify a usage session as being when an inhalation action occurs after a predetermined period of non-use, followed by one or more inhalation actions within a predetermined period of time being a threshold period within which the user is assumed to be within an ongoing usage session.

8. The EVPS of claim 7, in which the threshold period is one selected from the list consisting of: i. 1 minute; ii. 2 minutes; iii. 3 minutes; and iv. a period based on an inter-inhalation period averaged over multiple previous usage sessions.

9. The EVPS of claim 1, wherein one or more threshold periods selected based upon additional factors including one or more selected from the list consisting of: i. the time of day; ii. the day of the week; iii. the location; iv. the duration of non-use prior to the current usage session; V. profile data associated with the user; and vi. periodicity averaged over multiple prior usage sessions.

10. The EVPS of claim 1, wherein: the inhalation prediction processor is configured to initialise a warm-down mode of the aerosol generator if inhalation actions meet a predetermined warm-down criterion.

11. The EVPS of claim 10 in which: the predetermined warm-down criterion comprises one or more selected from the list consisting of: i. the user having performed a threshold number of inhalation actions within a current usage session; ii. the period between the last inhalation action and the next inhalation exceeds a predetermined period of time being a threshold period within which the user is assumed to be within an ongoing usage session; iii. the user removes or otherwise functionally disengages from the EVPS a component required for normal use; and iv. the user removes or otherwise functionally disengages from the EVPS a consumable required for normal use.

12. The EVPS of claim 1, wherein the inhalation prediction processor is configured to predict whether back to back usage sessions will occur, back to back usage sessions being usage sessions with an intervening non-use period greater than a predetermined period of time being a threshold period within which the user is assumed to be within an ongoing usage session but less than a second, longer threshold period indicative of protracted non-use; and if the inhalation prediction processor predicts a back to back usage session, the inhalation prediction processor is configured to initialise an interim heating mode that heats a heater of the aerosol generator to a third temperature that is lower than in a pre-heat mode used if the user is assumed to be within an ongoing usage session.

13. An electronic vapour provision method comprising: an aerosol generation step comprising generating aerosol for delivery to a user; a timing step comprising measuring timings of inhalation actions of the user; an inhalation prediction step comprising predicting inhalation actions of the user based upon timing measurements from the timing step; and an initialisation step comprising initialising a first predetermined pre-heat mode for the aerosol generation step if a predicted inhalation action meets a first predetermined pre-heat criterion.

14. The method of claim 13, in which the first predetermined pre-heat criterion is whether the predicted inhalation action is predicted to occur within a predetermined period after the last actual inhalation action, the predetermined period being a threshold period within which the user is assumed to be within an ongoing usage session of the EVPS; and the first predetermined pre-heat mode heats a heater of an aerosol generator to a first temperature that is higher than a pre-heat mode used if the user is assumed to be engaging in occasional use.

15. The method of claim 13, wherein the inhalation prediction step comprises initialising a second predetermined pre-heat mode of the aerosol generation step if a predicted inhalation action meets a second predetermined pre-heat criterion.

16. The method of claim 15, in which the second predetermined pre-heat criterion is whether the predicted inhalation action is predicted to occur outside a predetermined period after the last actual inhalation action, the predetermined period being a threshold period outside which the user is assumed to be engaging in occasional use; and the second predetermined pre-heat mode heats a heater of an aerosol generator to a second temperature that is lower than a pre-heat mode used if the user is assumed to be within an ongoing usage session.

17. The method of claim 13, wherein the inhalation prediction step comprises predicting the elapsed time between the last actual inhalation action of the user and the next expected inhalation action.

18. The method of claim 17, in which the inhalation prediction step comprises predicting the elapsed time between the last actual inhalation action of the user and the next expected inhalation action based on the timings between two or more previous inhalation actions.

19-21. (canceled)

22. The method of claim 13, wherein the inhalation prediction step comprises initialising a warm-down mode of the aerosol generator if inhalation actions meet a predetermined warm-down criterion.

23. (canceled)

24. (canceled)

25. A computer program comprising computer executable instructions adapted to cause a computer system to perform the method of claim 13.