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(71) Applicant: **NERUDIA LIMITED**
Liverpool Merseyside L24 9HP (GB)

(72) Inventor: **The designation of the inventor has not yet been filed**

(74) Representative: **Mewburn Ellis LLP**
Aurora Building
Counterslip
Bristol BS1 6BX (GB)

(54) AEROSOL DELIVERY APPARATUS

(57) An aerosol delivery apparatus (150a, 150b, 150c) comprising an air passage (170), an aerosol generator arranged in the air passage (170), a first one-way valve (166a) arranged upstream of the aerosol generator along the air passage (170), and configured to allow air to flow along the air passage (170) in an upstream to downstream direction, and a second one-way valve (166b) arranged downstream of the aerosol generator along the air passage (170), and configured to allow air to flow along the air passage (170) in an upstream to downstream direction.

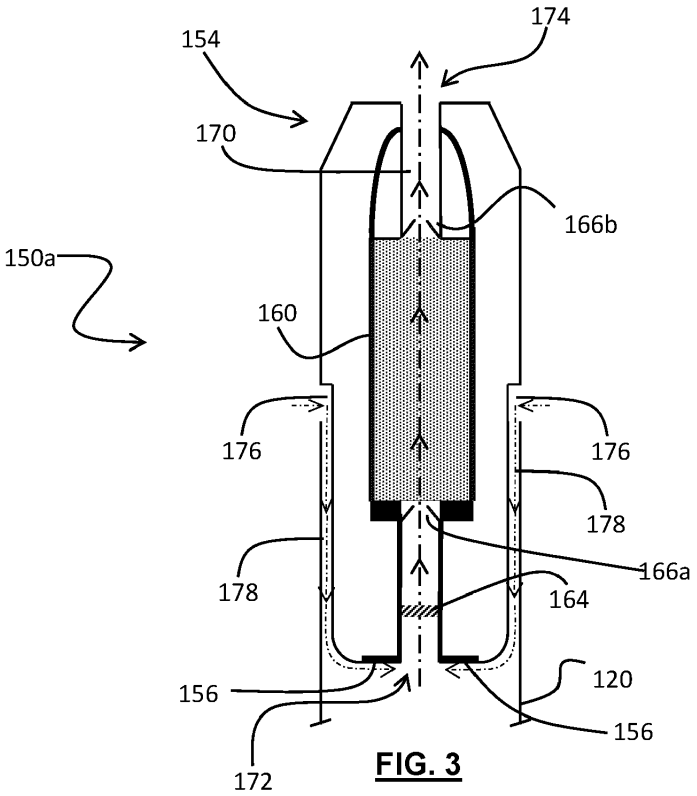

FIG. 3

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Description

Field of the Invention

[0001] The present invention relates to an aerosol delivery apparatus. Such an apparatus is of particular, but not necessary exclusive interest as a smoking substitute apparatus. It is a preferred feature of operation of the apparatus that it is able to deliver an active ingredient (such as nicotine) to a user for inhalation without producing a visible vapour cloud.

Background

[0002] The smoking of tobacco is generally considered to expose a smoker to potentially harmful substances. It is thought that a significant amount of the potentially harmful substances are generated through the burning and/or combustion of the tobacco and the constituents of the burnt tobacco in the tobacco smoke itself.

[0003] Low temperature combustion of organic material such as tobacco is known to produce tar and other potentially harmful by-products. There have been proposed various smoking substitute systems in which the conventional smoking of tobacco is avoided.

[0004] Such smoking substitute systems can form part of nicotine replacement therapies aimed at people who wish to stop smoking and overcome a dependence on nicotine.

[0005] Known smoking substitute systems include electronic systems that permit a user to simulate the act of smoking by producing an aerosol (also referred to as a "vapour") that is drawn into the lungs through the mouth (inhaled) and then exhaled. The inhaled aerosol typically bears nicotine and/or a flavourant without, or with fewer of, the health risks associated with conventional smoking.

[0006] In general, smoking substitute systems are intended to provide a substitute for the rituals of smoking, whilst providing the user with a similar, or improved, experience and satisfaction to those experienced with conventional smoking and with combustible tobacco products.

[0007] The popularity and use of smoking substitute systems has grown rapidly in the past few years. Although originally marketed as an aid to assist habitual smokers wishing to quit tobacco smoking, consumers are increasingly viewing smoking substitute systems as desirable lifestyle accessories. There are a number of different categories of smoking substitute systems, each utilising a different smoking substitute approach. Some smoking substitute systems are designed to resemble a conventional cigarette and are cylindrical in form with a mouthpiece at one end. Other smoking substitute devices do not generally resemble a cigarette (for example, the smoking substitute device may have a generally box-like form, in whole or in part).

[0008] One approach is the so-called "vaping" approach, in which a vaporisable liquid, or an aerosol former, sometimes typically referred to herein as "e-liquid", is heated by a heating device (sometimes referred to herein as an electronic cigarette or "e-cigarette" device) to produce an aerosol vapour which is inhaled by a user. The e-liquid typically includes a base liquid, nicotine and may include a flavourant. The resulting vapour therefore also typically contains nicotine and/or a flavourant. The base liquid may include propylene glycol and/or vegetable glycerine.

[0009] A typical e-cigarette device includes a mouthpiece, a power source (typically a battery), a tank for containing e-liquid and a heating device. In use, electrical energy is supplied from the power source to the heating device, which heats the e-liquid to produce an aerosol (or "vapour") which is inhaled by a user through the mouthpiece.

[0010] E-cigarettes can be configured in a variety of ways. For example, there are "closed system" vaping smoking substitute systems, which typically have a sealed tank and heating element. The tank is prefilled with e-liquid and is not intended to be refilled by an end user. One subset of closed system vaping smoking substitute systems include a main body which includes the power source, wherein the main body is configured to be physically and electrically couplable to a consumable including the tank and the heating element. In this way, when the tank of a consumable has been emptied of e-liquid, that consumable is removed from the main body and disposed of. The main body can then be reused by connecting it to a new, replacement, consumable. Another subset of closed system vaping smoking substitute systems are completely disposable, and intended for one-use only.

[0011] There are also "open system" vaping smoking substitute systems which typically have a tank that is configured to be refilled by a user. In this way the entire device can be used multiple times.

[0012] An example vaping smoking substitute system is the myblu™ e-cigarette. The myblu™ e-cigarette is a closed system which includes a main body and a consumable. The main body and consumable are physically and electrically coupled together by pushing the consumable into the main body. The main body includes a rechargeable battery. The consumable includes a mouthpiece and a sealed tank which contains e-liquid. The consumable further includes a heater, which for this device is a heating filament coiled around a portion of a wick. The wick is partially immersed in the e-liquid, and conveys e-liquid from the tank to the heating filament. The system is controlled by a microprocessor on board the main body. The system includes a sensor for detecting when a user is inhaling through the mouthpiece, the microprocessor then activating the device in response. When the system is activated, electrical energy is supplied from the power source to the heating device, which heats e-liquid from the tank to produce a vapour which is inhaled by a user through the mouthpiece.

[0013] An alternative to the "vaping" approach is the

so-called Heated Tobacco ("HT") approach in which tobacco (rather than an e-liquid) is heated or warmed to release vapour. HT is also known as "heat not burn" ("HNB"). The tobacco may be leaf tobacco or reconstituted tobacco. In the HT approach the intention is that the tobacco is heated but not burned, i.e. the tobacco does not undergo combustion.

[0014] The heating, as opposed to burning, of the tobacco material is believed to cause fewer, or smaller quantities, of the more harmful compounds ordinarily produced during conventional smoking. Consequently, the HT approach may reduce the odour and/or health risks that can arise through the burning, combustion and pyrolytic degradation of tobacco.

[0015] A typical HT smoking substitute system may include a device and a consumable. The consumable may include the tobacco material. The device and consumable may be configured to be physically coupled together. In use, heat may be imparted to the tobacco material by a heating element of the device, wherein airflow through the tobacco material causes components in the tobacco material to be released as vapour. A vapour may also be formed from a carrier in the tobacco material (this carrier may for example include propylene glycol and/or vegetable glycerine) and additionally volatile compounds released from the tobacco. The released vapour may be entrained in the airflow drawn through the tobacco.

[0016] As the vapour passes through the consumable (entrained in the airflow) from the location of vapourisation to an outlet of the consumable (e.g. a mouthpiece), the vapour cools and condenses to form an aerosol for inhalation by the user. The aerosol may contain nicotine and/or flavour compounds.

[0017] A further alternative to vaping-type smoking substitute systems and HNB systems is an inhaler apparatus, of which a particular example is the Nicorette® inhalator (trade name). Such systems are often passive in the sense that they do not require a source of heat or other activation energy in order to generate a vapour. As with an e-cigarette, such an inhaler typically includes a mouthpiece and a main body containing a source of nicotine. In use, a user may inhale or "puff on the mouthpiece to draw air over or through the nicotine source. The nicotine source may be, for example, an air-permeable substrate impregnated with nicotine. When the supply of nicotine in the nicotine source is depleted, such that the user no longer receives sufficient (or any) nicotine with each puff, the user can replace the nicotine source in order to continue nicotine delivery.

Summary of the Invention

[0018] Smoking substitute systems (e.g. e-cigarettes) are generally regarded as having fewer of the health risks associated with conventional smoking. However, condensation of the generated aerosol or vapour within the device may present a hygiene issue in long-term usage of the system.

[0019] Accordingly, it would be advantageous to provide a smoking substitute system wherein the movement of vapour within the system can be controlled so as to reduce condensation in undesired parts of the fluid passages within such a system.

[0020] Still further, based on the insight of the present inventors, it would be advantageous to provide an aerosol delivery apparatus, not necessarily limited to a smoking substitute apparatus, for the delivery of an active ingredient to a user by inhalation, providing the beneficial effects referred to above.

[0021] The present disclosure has been devised in the light of the above considerations.

[0022] In a general aspect, the present invention relates to an aerosol delivery apparatus comprising one-way valves both upstream and downstream of the aerosol generating part so as to control air flow through the apparatus.

[0023] According to a first preferred aspect there is provided an aerosol delivery apparatus comprising an air passage, an aerosol generator arranged in the air passage, a first one-way valve arranged upstream of the aerosol generator along the air passage and configured to allow air to flow along the air passage in an upstream to downstream direction, and a second one-way valve arranged downstream of the aerosol generator along the air passage, and configured to allow air to flow along the air passage in an upstream to downstream direction.

[0024] Providing one one-way valves arranged both upstream and downstream of an aerosol generator in the air passage can reduce, substantially prevent or prevent air flow along the air passage in a downstream to upstream direction, controlling flow of both air and vapour through the passage and apparatus.

[0025] Optionally, a one-way valve of the one-way valves may be a duckbill valve.

[0026] Conveniently, a one-way valve of the one-way valves may be a ball one-way valve.

[0027] Advantageously, the ball one-way valve may further comprise a spring to locate the ball within the valve.

[0028] In some embodiments, the aerosol delivery apparatus is a smoking substitute apparatus. In such embodiments, the active ingredient may comprise or consist of nicotine.

[0029] Optionally, the aerosol generator may comprise a reservoir formed from an air-permeable substrate and arranged in the air passage to allow air to be drawn through the reservoir, the reservoir being loaded with a source of an active ingredient (e.g. nicotine).

[0030] The incorporation of a one-way valve may allow there to be a threshold pressure difference below which air flow will be blocked by the valve even in the upstream to downstream direction. This can ensure that the one-way valve is only opened, for example, when a user draws air through the apparatus. Such an arrangement can serve to prolong the useful lifetime of the reservoir formed from an air-permeable substrate.

[0031] Conveniently, the aerosol delivery apparatus may further comprise a heater arranged in the air passage and upstream of the reservoir, the heater being operable to heat air passing through the air passage.

[0032] Advantageously, a one-way valve of the one-way valves may be arranged upstream of the heater.

[0033] Optionally, the heater for heating the air in the air passage may comprise an electrically heatable mesh.

[0034] Conveniently, the heater for heating the air in the air passage may be heatable by resistive heating using an electrical current.

[0035] Advantageously, the aerosol generator may comprise a porous wick which, in use, wicks aerosol precursor from a reservoir to the first passage for entrainment in air flowing downstream of the aerosol generator.

[0036] Optionally, the aerosol delivery apparatus may further comprise a heater operable to generate the aerosol from the aerosol precursor, the heater being a heating filament that is wound around a portion of the porous wick.

[0037] Conveniently, the heater for generating the aerosol from the aerosol precursor may be heatable by resistive heating using an electrical current.

[0038] Advantageously, the passage may comprise a vaporisation chamber in which the aerosol generator is arranged, wherein the vaporisation chamber has a larger cross sectional diameter than a downstream part of the passage.

[0039] Optionally, the aerosol generator may comprise an aerosol-forming substrate comprising tobacco material, and a heating element operable to heat the aerosol-forming substrate to generate an aerosol for entrainment in air flowing downstream of the aerosol generator.

[0040] Conveniently, the heating element for heating the aerosol-forming substrate may comprise an electrically heatable rod.

[0041] Advantageously, the heating element for heating the aerosol-forming substrate may be heatable by resistive heating using an electrical current.

[0042] According to a second preferred aspect, there is provided an aerosol delivery apparatus according to the first aspect, wherein the aerosol delivery apparatus is comprised by or within a cartridge configured for engagement with a base unit, the cartridge and base unit together forming an aerosol delivery system.

[0043] According to a third preferred aspect, there is provided an aerosol delivery system comprising a base unit and an aerosol delivery apparatus of the second aspect, wherein the aerosol delivery apparatus is removably engageable with the base unit.

[0044] According to a fourth preferred aspect, there is provided a method of using an aerosol delivery apparatus of the first or second aspects to generate an aerosol.

[0045] The aerosol delivery apparatus may be in the form of a consumable. The consumable may be configured for engagement with a main body. When the consumable is engaged with the main body, the combination of the consumable and the main body may form an aerosol delivery system such as a closed aerosol delivery system. For example, the consumable may comprise components of the system that are disposable, and the main body may comprise non-disposable or non-consumable components (e.g. power supply, controller, sensor, etc.) that facilitate the generation and/or delivery of aerosol by the consumable. In such an embodiment, an aerosol precursor (e.g. e-liquid) and/or other nicotine source (e.g. nicotine-infused air-permeable substrate) may be replenished by replacing a used consumable with an unused consumable.

[0046] Alternatively, the aerosol delivery apparatus may be a non-consumable apparatus (e.g. that is in the form of an open aerosol delivery system). In such embodiments an aerosol former (e.g. e-liquid) of the system may be replenished by re-filling, e.g. a reservoir of the aerosol delivery apparatus, with the aerosol precursor (rather than replacing a consumable component of the apparatus).

[0047] In light of this, it should be appreciated that some of the features described herein as being part of the aerosol delivery apparatus may alternatively form part of a main body for engagement with the aerosol delivery apparatus. This may be the case in particular when the aerosol delivery apparatus is in the form of a consumable.

[0048] Where the aerosol delivery apparatus is in the form of a consumable, the main body and the consumable may be configured to be physically coupled together. For example, the consumable may be at least partially received in a recess of the main body, such that there is an interference fit between the main body and the consumable. Alternatively, the main body and the consumable may be physically coupled together by screwing one onto the other, or through a bayonet fitting, or the like.

[0049] Thus, the aerosol delivery apparatus may comprise one or more engagement portions for engaging with a main body. In this way, one end of the aerosol delivery apparatus may be coupled with the main body, whilst an opposing end of the aerosol delivery apparatus may define a mouthpiece of the aerosol delivery system.

[0050] In order to generate an aerosol, the aerosol generator comprises at least one volatile compound that is intended to be vaporised/aerosolised and that may provide the user with a recreational, wellness, nutritional, physiological and/or medicinal effect when inhaled. Such a volatile compound is referred to herein as an "active agent" or "active ingredient".

[0051] The active ingredient may comprise or consist of nicotine. However, in some embodiments, the active ingredient may not comprise nicotine, and may instead comprise or consist of one or more of a nutritional agent, a pharmaceutical agent or a flavour agent.

[0052] Suitable active agents include the group consisting of: nicotine, cocaine, caffeine (anhydrous or salts thereof), vitamins, minerals, amino acids, plant or herbal concentrated extracts, sugars, opiates and opioids, cathine and cathinone, kavalactones, mysticin, beta-car-

boline alkaloids, salvinorin A, cannabinoids, phytocannabinoids, one or more flavourants, together with any combinations, functional equivalents to, and/or synthetic alternatives of the foregoing.

[0053] Example flavourants may include menthol, liquorice, chocolate, fruit flavour (including e.g. citrus, cherry etc.), vanilla, spice (e.g. ginger, cinnamon) and tobacco flavour.

[0054] Cannabinoid compounds include phyto-cannabinoids which include:

- cannabidiol (CBD) and its derivatives/homologues (e.g. cannabidiol mono(m)ethyl ether, cannabidivarin (CBDV), cannabidiorcol, cannabidiolic acid, cannabidivarinic acid);
- cannabinodiol (CBND) and its derivatives/homologues (e.g. carrabinodivarin);
- cannabigerol (CBG) and its derivatives/homologues (e.g. cannabigerol mono(m)ethyl ether, cannabinerolic acid A, cannabigerovarin, cannabigerolic acid A, cannabigerolic acid A mono(m)ethyl ether, cannabigerovarinic acid A);
- cannabinol (CBN) and its derivatives/homologues (e.g. cannabivarin/cannabivarol (CBV), cannabiorcol, cannabinolic acid, cannabinol (m)ethyl ester);
- tetrahydrocannabinol (THC) and its derivatives/homologues (e.g. tetrahydrocannabivarin (THCV), tetrahydrocannabiorcol, tetrahydrocannabinolic acid A/B, tetrahydrocannabivarinic acid A, tetrahydrocannabiorcolic acid A/B, isotetrahydrocannabinol, isotetrahydrocannabivarin);
- cannabicyclol (CBL) and its derivatives/homologues (e.g. cannabicyclolic acid, cannabicyclovarin);
- cannabichromene (CBC) and its derivatives/homologues (e.g. cannabichromenic acid A, cannabichromevarin (CBCV), cannabichromevarinic acid A);
- cannabielsoin (CBE) and its derivatives/homologues (e.g. cannabielsoic acid A/B, cannabiglendol, dehydrocannabifuran, cannabifuran);
- cannabicitran (CBT) and its derivatives/homologues;
- cannabitriol and its derivatives/homologues (e.g. ethyl cannabitriol, dihydroxy-tetrahydrocannabinol, cannabidiolic acid A cannabitriol ester, dihydroxy-hexahydrocannabinol (cannabiripsol), cannabitetrol, oxo-tetrahydrocannabinol); and
- cannabichromanone (CBCN) and its derivatives/homologues (e.g. cannabicoumaronone).

[0055] In some embodiments, the cannabinoid compound is selected from at least one of cannabidiol (CBD) and its derivatives/homologues e.g. cannabiodiol-C_5 (CBD-C_5), cannabidiol-C_4 (CBD-C_4), cannabidiol mono(m)ethyl ether (CBDM-C_5), cannabidivarin (CBDV-C_3), cannabidiorcol (CBD-C_1), cannabidiolic acid (CBDA-C_5), cannabidivarinic acid (CBDVA-C_3).

[0056] In some embodiments, the cannabinoid compound is selected from at least one of tetrahydrocannabinol (THC) and its derivatives/homologues, e.g. Δ^9-tetrahydrocannabinol (Δ^9-THC-C_5 / *cis*-Δ^9-THC-C_5), Δ^8-tetrahydrocannabinol (Δ^8-THC-C_5), Δ^8-tetrahydrocannabinolic acid A (Δ^8-THCA-C_5 A), Δ^9-tetrahydrocannabinol-C_4 (Δ^9-THC-C_4), Δ^9-tetrahydrocannabivarin (Δ^9-THCV-C_3), Δ^9-tetrahydrocannabiorcol (Δ^9-THCO-C_1), Δ^9-tetrahydrocannabinolic acid A (Δ^9-THCA-C_5 A), Δ^9-tetrahydrocannabinolic acid B (Δ^9-THCA-C_5 B), Δ^9-tetrahydrocannabinolic acid-C_4 A and/or B (Δ^9-THCA-C_4 A and/or B), Δ^9-tetrahydrocannabivarinic acid A (Δ^9-THCVA-C_3 A), Δ^9-tetrahydrocannabiorcolic acid A and/or B (Δ^9-THCOA-C_1 A and/or B), isotetrahydrocannabinol and isotetrahydrocannabivarin.

[0057] The total amount of cannabinoid compounds in the substrate may be at least 200 mg; for example, it may be at least 250 mg, at least 300 mg, at least 400 mg, at least 500 mg. In some cases, lower amounts may be preferred. The total amount of cannabinoid compounds in the substrate may therefore be at least 10 mg, at least 20 mg, at least 30 mg, at least 40 mg, at least 50 mg, at least 75 mg, at least 100 mg.

[0058] In some cases, it may be desirable to limited the total amount of cannabinoid compounds, which may be not more than 200 mg, not more than 175 mg, not more than 150 mg, not more than 125 mg, not more than 100 mg, not more than 75 mg, not more than 50 mg, not more than 40 mg, not more than 30 mg, not more than 20 mg, not more than 10 mg. In some cases, the total amount of the cannabinoid compounds may be not more than 5 mg.

[0059] Where THC is included, either as one cannabinoid compound in a mixture or as the only cannabinoid, the total of amount of THC may be limited. In some cases, the total amount of THC in the substrate is not more than 100 mg, not more than 75 mg, not more than 50 mg, not more than 40 mg, not more than 30 mg, not more than 20 mg, not more than 15 mg, not more than 10 mg, not more than 5 mg, not more than 3 mg. In some cases, the amount of THC may be 0.1 to 30 mg, for example 1 to 30 mg, for example 1 to 20 mg, for example 1 to 10 mg, for example 1 to 5 mg, for example 1 to 3 mg.

[0060] The aerosol delivery apparatus may comprise a reservoir configured to store an aerosol precursor. The aerosol precursor may be formulated so as to produce a non-visible or substantially non-visible vapour. The aerosol precursor may comprise a base liquid. The aerosol precursor may additionally comprise nicotine. The aero-

sol precursor may be an e-liquid. The aerosol precursor may consist substantially of nicotine or a nicotine compound. The aerosol precursor may further comprise a flavourant. Alternatively, the aerosol precursor may be substantially flavourless. That is, the aerosol precursor may not contain any deliberately added additional flavourant. A flavourant may be provided as a separate flavourant aerosol precursor, such that the aerosol precursor and flavourant aerosol precursor may be separately vaporised to form an aerosol comprising both the aerosol precursor and the flavourant aerosol precursor.

[0061] The reservoir configured to store the aerosol precursor and/or the flavourant aerosol precursor may consist of an air-permeable substrate impregnated with the aerosol precursor and/or the flavourant aerosol precursor. The substrate material may be a foamed polymer which will allow for airflow to pass through the substrate at a given pressure drop value, so as to provide a comfortable 'draw' sensation for the user. The substrate may be, for example, a sintered polyethylene or a PET foam.

[0062] The substrate may be impregnated with nicotine via immersion in a liquid containing nicotine and a volatile carrier (for example a solution of nicotine in ethanol). The substrate may be immersed to evenly soak the substrate. Once removed and left to dry or baked in an oven, the carrier may be evaporated and the nicotine may be left evenly spread throughout the substrate.

[0063] The aerosol precursor and/or the flavourant aerosol precursor may be formulated to form a vapour when ambient air is drawn through the reservoir. Alternatively, the aerosol precursor and/or the flavourant aerosol precursor may be formulated to form a vapour when heated air is drawn through the reservoir. The reservoir may comprise a monolithic substrate. The reservoir may consist of a plurality of substrates, each arranged to allow air to be drawn therethrough, and each comprising one or both of an aerosol precursor and the flavourant aerosol precursor. The aerosol precursor and/or the flavourant aerosol precursor may be provided in spatially coterminous or spatially distinct regions of the reservoir.

[0064] Alternatively, the aerosol precursor reservoir may be in the form of a tank. At least a portion of the tank may be light-transmissive. For example, the tank may comprise a window to allow a user to visually assess the quantity of aerosol precursor in the tank. A housing of the smoking substitute apparatus may comprise a corresponding aperture (or slot) or window that may be aligned with a light-transmissive portion (e.g. window) of the tank. The reservoir may be referred to as a "clearomizer" if it includes a window, or a "cartomizer" if it does not.

[0065] The aerosol delivery apparatus may comprise an additional reservoir configured to store a second aerosol precursor such as an e-liquid. The second aerosol precursor may, for example, comprise a base liquid. The second aerosol precursor may further comprise nicotine. The second aerosol precursor, when vapourised, may form a visible vapour. The base liquid may include propylene glycol and/or vegetable glycerine. The e-liquid may be substantially flavourless. That is, the e-liquid may not contain any deliberately added additional flavourant and may consist solely of a base liquid of propylene glycol and/or vegetable glycerine and nicotine.

[0066] The second aerosol precursor reservoir may be in the form of a tank. At least a portion of the tank may be light-transmissive. For example, the tank may comprise a window to allow a user to visually assess the quantity of e-liquid in the tank. A housing of the smoking substitute apparatus may comprise a corresponding aperture (or slot) or window that may be aligned with a light-transmissive portion (e.g. window) of the tank.

[0067] The smoking substitute apparatus may comprise one or more passages for fluid (e.g. air) flow therethrough. Where more than one passage is present, one or more of the passages may be distinct, such that there is no intersection between the passages. One or more of the passages may comprise junctions or openings therebetween such that fluid within the passages can mix within the aerosol delivery apparatus.

[0068] In addition to the two or more one-way valves within the one or more passages, the aerosol delivery apparatus may further comprise one or more valves operable to open and close the passage such that fluid is enabled to or prevented from flowing through the passage. More than one such valve may be linked such that the valves may be operated in combination or in synchronism with each other. A valve to open and close a passage may be controlled by mechanical means (i.e. the user moves the valve using a control lever or similar) or by electrical control (i.e. moved in response to a control signal from a processor or control system of the aerosol delivery apparatus).

[0069] The passages may extend through (at least a portion of) the aerosol delivery apparatus, between openings that may define an inlet and an outlet of a passage. Each inlet and outlet may be in fluid communication with only one passage, or a subset of the passages, or all the passages in the aerosol delivery apparatus. The outlet or outlets may be at a mouthpiece of the aerosol delivery apparatus. In this respect, a user may draw fluid (e.g. air) into and through a passage by inhaling at the outlet (i.e. using the mouthpiece).

[0070] A passage through the aerosol delivery apparatus may be at least partially defined by a tank forming the first or second aerosol precursor reservoir. The tank may substantially (or fully) define the passage, for at least a part of the length of the passage. In this respect, the tank may surround the passage, e.g. in an annular arrangement around the passage.

[0071] One or more of the fluid passages may comprise a heater for heating the fluid (i.e. air) passing through the passage. The heater may, for example, be arranged upstream of a reservoir formed from an air permeable substrate such that air warmed by the heater is drawn through the reservoir to enable or increase nicotine or flavourant vapourisation and subsequent entrain-

ment in the air-flow. The heater to heat the air may comprise one or more meshes arranged within the fluid passage. The heater to heat the air may comprise one or more thermally conductive elements to conduct heat from a heater to the air passage or to increase the heat transfer between the heater and the air. Alternatively, the heat source may be non-electrical. For example, the heat to heat the air may be generated by an exothermic reaction. An exothermic reaction heat source may comprise a single-use (i.e. consumable) reaction container. Alternatively, an exothermic reaction heat source may be rechargeable (e.g. by using a reversible reaction such as a crystallisation process).

[0072] One or more of the fluid passages may comprise a wick in fluid communication with a tank containing an aerosol precursor. The wick may comprise a porous material, capable of wicking the aerosol precursor. A portion of the wick may be exposed to air flow in the passage. The wick may also comprise one or more portions in contact with liquid stored in the reservoir. For example, opposing ends of the wick may protrude into the reservoir and an intermediate portion (between the ends) may extend across the passage so as to be exposed to air flow in the passage. Thus, liquid may be drawn (e.g. by capillary action) along the wick, from the reservoir to the portion of the wick exposed to air flow.

[0073] The wick may be heated by a heater. The heater of the wick may comprise a heating element, which may be in the form of a filament wound about the wick (e.g. the filament may extend helically about the wick in a coil configuration). The heating element may be wound about the intermediate portion of the wick that is exposed to air flow in the passage. The heating element may be electrically connected (or connectable) to a power source. Thus, in operation, the power source may apply a voltage across the heating element so as to heat the heating element by resistive heating. This may cause liquid stored in the wick (i.e. drawn from the tank) to be heated so as to form a vapour and become entrained in air flowing through the passage. This vapour may subsequently cool to form an aerosol in the passage, typically downstream from the heating element.

[0074] In an arrangement where the aerosol delivery apparatus comprises a wick arranged so as to be exposed to air flow in the passage, the aerosol delivery apparatus may comprise a vaporisation chamber. The vaporisation chamber may form part of the passage in which the heater is located. The vaporisation chamber may be arranged to be in fluid communication with the inlet and outlet of the passage. The vaporisation chamber may be an enlarged portion of the passage. In this respect, the air as drawn in by the user may entrain the generated vapour in a flow away from heater. The entrained vapour may form an aerosol in the vaporisation chamber, or it may form the aerosol further downstream along the passage. The vaporisation chamber may be at least partially defined by the tank. The tank may substantially (or fully) define the vaporisation chamber. In this respect, the tank may surround the vaporisation chamber, e.g. in an annular arrangement around the vaporisation chamber.

[0075] The aerosol delivery apparatus (or main body engaged with the smoking substitute apparatus) may comprise a power source. The power source may be electrically connected (or connectable) to a heater of the aerosol delivery apparatus (e.g. when the aerosol delivery apparatus is engaged with the main body). The power source may be a battery (e.g. a rechargeable battery). A connector in the form of e.g. a USB port may be provided for recharging this battery.

[0076] When the aerosol delivery apparatus is in the form of a consumable, the aerosol delivery apparatus may comprise an electrical interface for interfacing with a corresponding electrical interface of the main body. One or both of the electrical interfaces may include one or more electrical contacts. Thus, when the main body is engaged with the consumable, the electrical interface of the main body may be configured to transfer electrical power from the power source to a heater of the consumable via the electrical interface of the consumable.

[0077] The electrical interface of the aerosol delivery apparatus may also be used to identify the aerosol delivery apparatus (in the form of a consumable) from a list of known types. For example, the consumable may have a certain concentration of nicotine and the electrical interface may be used to identify this. The electrical interface may additionally or alternatively be used to identify when a consumable is connected to the main body.

[0078] Again, where the aerosol delivery apparatus is in the form of a consumable, the main body may comprise an identification means, which may, for example, be in the form of an RFID reader, a barcode or QR code reader. This identification means may be able to identify a characteristic (e.g. a type) of a consumable engaged with the main body. In this respect, the consumable may include any one or more of an RFID chip, a barcode or QR code, or memory within which is an identifier and which can be interrogated via the identification means.

[0079] The aerosol delivery apparatus or main body may comprise a controller, which may include a microprocessor. The controller may be configured to control the supply of power from the power source to the heater(s) of the aerosol delivery apparatus (e.g. via the electrical contacts). A memory may be provided and may be operatively connected to the controller. The memory may include non-volatile memory. The memory may include instructions which, when implemented, cause the controller to perform certain tasks or steps of a method.

[0080] The main body or aerosol delivery apparatus may comprise a wireless interface, which may be configured to communicate wirelessly with another device, for example a mobile device, e.g. via Bluetooth®. To this end, the wireless interface could include a Bluetooth® antenna. Other wireless communication interfaces, e.g. WiFi®, are also possible. The wireless interface may also be configured to communicate wirelessly with a remote

server.

[0081] A puff sensor may be provided that is configured to detect a puff (i.e. inhalation from a user). The puff sensor may be operatively connected to the controller so as to be able to provide a signal to the controller that is indicative of a puff state (i.e. puffing or not puffing). The puff sensor may, for example, be in the form of a pressure sensor or an acoustic sensor. That is, the controller may control power supply to the heater(s) of the consumable and/or smoking substitute apparatus in response to a puff detection by the sensor. The control may be in the form of activation of the heater(s) in response to a detected puff. That is, the aerosol delivery apparatus may be configured to be activated when a puff is detected by the puff sensor. When the aerosol delivery apparatus is in the form of a consumable, the puff sensor may be provided in the consumable or alternatively may be provided in the main body. Where multiple independent passages are provided within the aerosol delivery apparatus, each of the passages may have a puff sensor.

[0082] The term "flavourant" is used to describe a compound or combination of compounds that provide flavour and/or aroma. For example, the flavourant may be configured to interact with a sensory receptor of a user (such as an olfactory or taste receptor). The flavourant may include one or more volatile substances.

[0083] The flavourant may be provided in solid or liquid form. The flavourant may be natural or synthetic. For example, the flavourant may include menthol, liquorice, chocolate, fruit flavour (including e.g. citrus, cherry etc.), vanilla, spice (e.g. ginger, cinnamon) and tobacco flavour. The flavourant may be evenly dispersed or may be provided in isolated locations and/or varying concentrations.

[0084] Where the aerosol generator comprises an air-permeable substrate, the air-permeable substrate may comprise plant material. The plant material may comprise least one plant material selected from the list including *Amaranthus dubius, Arctostaphylos uva-ursi* (Bearberry), *Argemone mexicana, Amica, Artemisia vulgaris,* Yellow Tees, *Galea zacatechichi, Canavalia maritima* (Baybean), *Cecropia mexicana* (Guamura), *Cestrum noctumum, Cynoglossum virginianum* (wild comfrey), *Cytisus scoparius, Damiana, Entada rheedii, Eschscholzia califomica* (California Poppy), *Fittonia albivenis, Hippobroma longiflora, Humulus japonica* (Japanese Hops), *Humulus lupulus* (Hops), *Lactuca virosa* (Lettuce Opium), *Laggera alata, Leonotis leonurus, Leonurus cardiaca* (Motherwort), *Leonurus sibiricus* (Honeyweed), *Lobelia cardinalis, Lobelia inflata* (Indian-tobacco), *Lobelia siphilitica, Nepeta cataria* (Catnip), *Nicotiana species* (Tobacco), *Nymphaea alba* (White Lily), *Nymphaea caerulea* (Blue Lily), Opium poppy, *Passiflora incamata* (Passionflower), *Pedicularis densiflora* (Indian Warrior), *Pedicularis groenlandica* (Elephant's Head), *Salvia divinorum, Salvia dorrii* (Tobacco Sage), Salvia species (Sage), *Scutellaria galericulata, Scutellaria lateriflora, Scutellaria nana, Scutellaria* species (Skullcap), *Sida acuta* (Wireweed), *Sida rhombifolia, Silene capensis, Syzygium aromaticum* (Clove), *Tagetes lucida* (Mexican Tarragon), *Tarchonanthus camphoratus, Tumera diffusa* (Damiana), *Verbascum* (Mullein), *Zamia latifolia* (Maconha Brava) together with any combinations, functional equivalents to, and/or synthetic alternatives of the foregoing.

[0085] In some embodiments, the plant material is tobacco. Any type of tobacco may be used. This includes, but is not limited to, flue-cured tobacco, burley tobacco, Maryland Tobacco, dark-air cured tobacco, oriental tobacco, dark-fired tobacco, perique tobacco and rustica tobacco. This also includes blends of the above mentioned tobaccos.

[0086] Any suitable parts of the tobacco plant may be used. This includes leaves, stems, roots, bark, seeds and flowers.

[0087] The tobacco may comprise one or more of leaf tobacco, stem tobacco, tobacco powder, tobacco dust, tobacco derivatives, expanded tobacco, homogenised tobacco, shredded tobacco, extruded tobacco, cut rag tobacco and/or reconstituted tobacco (e.g. slurry recon or paper recon).

[0088] The air-permeable substrate may comprise a gathered sheet of homogenised (e.g. paper/slurry recon) tobacco or gathered shreds/strips formed from such a sheet.

[0089] In some embodiments, the sheet used to form the aerosol-forming substrate has a grammage greater than or equal to 100 g/m^2, e.g. greater than or equal to 110 g/m^2 such as greater than or equal to 120 g/m^2.

[0090] The sheet may have a grammage of less than or equal to 300 g/m^2 e.g. less than or equal to 250 g/m^2 or less than or equal to 200 g/m^2.

[0091] The sheet may have a grammage of between 120 and 190 g/m^2.

[0092] The air-permeable substrate may comprise at least 50 wt% plant material, e.g. at least 60 wt% plant material e.g. around 65 wt% plant material. The air-permeable substrate may comprise 80 wt% or less plant material e.g. 75 or 70 wt% or less plant material.

[0093] The air-permeable substrate may comprise one or more additives selected from flavourants, fillers and binders.

[0094] Typically, the air-permeable substrate does not comprise a humectant. Humectants may be provided in heat not burn (HNB) tobacco charges. In such cases, humectants are provided as vapour generators, the generated vapour being used to help carry volatile active compounds and to increase visible vapour. Accordingly, it is preferred that the air-permeable substrate does not comprise one or more humectants such as polyhydric alcohols (e.g. propylene glycol (PG), triethylene glycol, 1,2-butane diol and vegetable glycerine (VG)) and their esters (e.g. glycerol mono-, di- or tri-acetate). If such humectants are present in the air-permeable substrate, they may be present at a low level, such as less than 0.5 wt%, more preferably less than 0.1 wt%.

[0095] Suitable binders are known in the art and may

act to bind together the components forming the air-permeable substrate. Binders may comprise starches and/or cellulosic binders such as methyl cellulose, ethyl cellulose, hydroxypropyl cellulose, hydroxyethyl cellulose and methyl cellulose, gums such as xanthan, guar, arabic and/or locust bean gum, organic acids and their salts such as alginic acid/ sodium alginate, agar and pectins.

[0096] Preferably the binder content is 5 to 10 wt% of the air-permeable substrate e.g. around 6 to 8 wt%.

[0097] Suitable fillers are known in the art and may act to strengthen the air-permeable substrate. Fillers may comprise fibrous (non-tobacco) fillers such as cellulose fibres, lignocellulose fibres (e.g. wood fibres), jute fibres and combinations thereof.

[0098] Preferably, the filler content is 5 to 10 wt% of the aerosol-forming substrate e.g. around 6 to 9 wt%.

[0099] The air-permeable substrate may comprise an aqueous and/or non-aqueous solvent. In some embodiments, the air-permeable substrate has a water content of between 4 and 10 wt% e.g. between 6-9 wt% such as between 7-9 wt%. Such low moisture content in the air-permeable substrate typically has the effect that, when the air-permeable substrate is exposed to heated air, there would typically not be produced a substantial visible vapour. It is to be noted that in one embodiment it is possible to use as the air-permeable substrate a low moisture tobacco material with its natural nicotine content. The natural nicotine content then meets the requirements of the active agent.

[0100] The air-permeable substrate may be at least partly circumscribed by a wrapping layer e.g. a paper wrapping layer. The wrapping layer may overlie an inner foil layer or may comprise a paper/foil laminate (with the foil innermost).

[0101] The plant material may comprise cannabis plant material including *Cannabis sativa, Cannabis indica* and *Cannabis rudealis.* The plant material may comprise *Echinacea purpurea, Echinacea angustifolia, Acmella oleracea, Helichrysum umbraculigerum,* or *Radula marginata.* This also includes blends of the above mentioned plant material.

[0102] In some embodiments, the cannabinoid-containing plant material is cannabis. The plant may be a traditional strain, or may be a strain bred or other modified (e.g. genetically) to produce certain levels of some cannabinoids compounds, e.g. low levels of THC or high levels of THC.

[0103] Any suitable parts of the cannabinoid-containing plant may be used. Thus the cannabinoid-containing plant material may comprise leaves, stems, roots, bark, seeds, buds and flowers (which may be cured).

[0104] The invention includes the combination of the aspects and preferred features described except where such a combination is clearly impermissible or expressly avoided.

Summary of the Figures

[0105] So that the invention may be understood, and so that further aspects and features thereof may be appreciated, embodiments illustrating the principles of the invention will now be discussed in further detail with reference to the accompanying figures, in which:

Figure 1 is a schematic front view of a smoking substitute system, according to a first embodiment, in an engaged position;

Figure 2 is a schematic front view of the smoking substitute system of the first embodiment in a disengaged position;

Figure 3 is a schematic longitudinal cross sectional view of a smoking substitute apparatus of the first embodiment;

Figure 4 is a schematic longitudinal cross sectional view of a smoking substitute apparatus of the second embodiment;

Figure 5 is an enlarged schematic cross sectional view of part of the air passage and vaporisation chamber of the second embodiment;

Figure 6 is a schematic longitudinal cross sectional view of a smoking substitute apparatus of the third embodiment;

Figure 7A is a schematic longitudinal cross sectional view of a duckbill one-way valve in a closed position;

Figure 7B is a schematic longitudinal cross sectional view of a duckbill one-way valve in an open position;

Figure 8A is a schematic longitudinal cross sectional view of a ball one-way valve in a closed position; and

Figure 8B is a schematic longitudinal cross sectional view of a ball one-way valve in an open position.

Detailed Description of the Invention

[0106] Further background to the present invention and further aspects and embodiments of the present invention will now be discussed with reference to the accompanying figures. Further aspects and embodiments will be apparent to those skilled in the art. The contents of all documents mentioned in this text are incorporated herein by reference in their entirety.

[0107] The embodiments of the invention are described as smoking substitute apparatuses or systems, in which the active ingredient typically comprises or consists of nicotine. However, on the basis of the present disclosure it will be apparent that the invention can be

embodied more generally as an aerosol delivery apparatus or system. In such aerosol delivery apparatuses or systems the active ingredient may not comprise nicotine, and may instead comprise or consist of one or more of a nutritional agent, a pharmaceutical agent or a flavour agent.

[0108] Figures 1 and 2 illustrate a smoking substitute system in the form of an e-cigarette system 110. The system 110 comprises a main body 120 of the system 110, and a smoking substitute apparatus in the form of an e-cigarette consumable (or "pod") 150. In the illustrated embodiment the consumable 150 (sometimes referred to herein as a smoking substitute apparatus) is removable from the main body 120, so as to be a replaceable component of the system 110. The e-cigarette system 110 is a closed system in the sense that it is not intended that the consumable should be refillable with e-liquid by a user.

[0109] As is apparent from Figures 1 and 2, the consumable 150 is configured to engage the main body 120. Figure 1 shows the main body 120 and the consumable 150 in an engaged state, whilst Figure 2 shows the main body 120 and the consumable 150 in a disengaged state. When engaged, a portion of the consumable 150 is received in a cavity of corresponding shape in the main body 120 and is retained in the engaged position by way of a snap-engagement mechanism. In other embodiments, the main body 120 and consumable 150 may be engaged by screwing one into (or onto) the other, or through a bayonet fitting, or by way of an interference fit. In the illustrated embodiment, the consumable 150 is a "single-use" consumable 150. The term "single-use" does not necessarily mean the consumable is designed to be disposed of after a single smoking session. Rather, it defines that the consumable 150 is not designed to be refilled, and is instead disposed of and replaced after usage.

[0110] The power source of the main body 120 may be in the form of a battery (e.g. a rechargeable battery such as a lithium ion battery). The main body 120 may comprise a connector in the form of e.g. a USB port for recharging this battery. The main body 120 may also comprise a controller that controls the supply of power from the power source to the main body electrical contacts (and thus to the filament 264, heater 164 or heating element 364). That is, the controller may be configured to control a voltage applied across the main body electrical contacts, and thus the voltage applied across the heater 164, filament 264 or heating element 364. In this way, the heater 164, filament 264 or heating element 364 may only be heated under certain conditions (e.g. during a puff and/or only when the system is in an active state). In this respect, the main body 120 may include a puff sensor (not shown) that is configured to detect a puff (i.e. inhalation). The puff sensor may be operatively connected to the controller so as to be able to provide a signal, to the controller, which is indicative of a puff state (i.e. puffing or not puffing). The puff sensor may, for example, be in the form of a pressure sensor or an acoustic sensor.

[0111] Although not shown, the main body 120 and consumable 150 may comprise a further interface which may, for example, be in the form of an RFID reader, a barcode or QR code reader. This interface may be able to identify a characteristic (e.g. a type) of a consumable 150 engaged with the main body 120. In this respect, the consumable 150 may include any one or more of an RFID chip, a barcode or QR code, or memory within which is an identifier and which can be interrogated via the interface.

[0112] The system 110 is configured to vaporise an aerosol precursor, which in the illustrated first embodiment is a nicotine-based liquid impregnated into a substrate 160. The nicotine-impregnated substrate 160 may be referred to as an aerosol generator. When air is drawn through or over the nicotine-impregnated substrate 160, the nicotine is vaporised and entrained in the airflow to thereby be delivered to a user. The vapour or aerosol produced by the aerosol generator is less visible than that produced by a conventional e-liquid from an e-cigarette when exhaled by a user. Preferably, the vapour or aerosol generated by the aerosol generator is invisible or substantially invisible when exhaled by a user.

[0113] A substrate 160 may be impregnated with nicotine by immersion in a solution of nicotine in a volatile carrier solvent (e.g. ethanol) such that the substrate 160 is evenly soaked. The substrate 160 can then be removed and left to dry or baked in an oven, meaning that the carrier is evaporated and the nicotine is left evenly spread throughout the substrate.

[0114] The nicotine-impregnated substrate 160 may be provided within a consumable 150a. In such an embodiment, when the supply of nicotine in the nicotine-impregnated substrate 160 is depleted, the consumable 150a may be replaced. In other embodiments, the nicotine-impregnated substrate 160 itself may be a consumable component of the system 110. For example, the nicotine-impregnated substrate may be locatable within and removable from the system 110.

[0115] Further details are now set out relating to the air-permeable substrate and its impregnation with an active ingredient.

[0116] Suitable materials and methods for manufacturing air permeable substrates are disclosed, for example, in US4800903, US4284089, US4813437, and US5167242, the entire contents of which are incorporated herein by reference.

[0117] US4800903 discloses that preferred materials for a polymeric plug are olefinic polymers, and preferably polyethylene or polypropylene, most preferably high density polyethylene. Use of high density polyethylene is preferred over, for example, amorphous polyethylene, since it provides a balance between ease of manufacturing and capacity for reversible nicotine absorption.

[0118] Meanwhile, some polymers are considered to be inherently unsuitable for use as an air permeable substrate. For example, some polymeric substances such

as polystyrene and polycarbonate are dissolved by nicotine, rendering them unsuitable for forming a nicotine impregnated substrate. Furthermore, polymers containing halogens or nitrogen or sulphur are undesirable since they can produce noxious fumes.

[0119] To improve user satisfaction, it may be preferable to use an air permeable substrate that provides an equivalent resistance to draw to that of a conventional cigarette. For example, US4284089 discloses that a non-combustible cigarette with a draw resistance approximating that of a conventional cigarette would permit about 35 millilitres of air to be drawn through it during a 2 second period.

[0120] A substrate may be impregnated with nicotine by a variety of methods. For example, US4800903 indicates that liquid nicotine, nicotine vapour or a solution of nicotine may be used, and suggests that a solution of nicotine in supercritical liquid carbon dioxide may advantageously be used to impregnate the substrate. Alternatively, the substrate may be impregnated with nicotine via immersion in a liquid containing nicotine and a volatile carrier (for example a solution of nicotine in ethanol). The substrate is immersed to evenly soak the substrate. Once the substrate is removed from the liquid it can be left to dry or baked in an oven, evaporating away the carrier so that the nicotine is left evenly distributed throughout the substrate.

[0121] US5167242 discloses that a polyethylene plug can be charged or loaded with a mixture of nicotine, menthol and ethanol in a weight ratio (nicotine:menthol:ethanol) of about 10:1:120 or 10:1:160. The menthol and nicotine are sequentially added to the ethanol in a mixing vessel to produce a solution. Meanwhile, the plugs are placed in a vacuum dryer, which is partially evacuated to create a lower internal pressure than that of the mixing vessel, allowing the nicotine/ethanol/methanol solution to be sucked into the vacuum dryer. The plugs remain immersed in the solution within the vacuum dryer for 10 minutes, after which the temperature is raised and the vacuum pump is started to evaporate the ethanol. The vacuum dryer is then filled with nitrogen, and a nitrogen atmosphere is maintained for the remainder of the packaging procedure to prevent oxygen contamination of the nicotine.

[0122] In alternative embodiments, the air-permeable substrate may be formed in a different manner. For example, the air-permeable substrate may be formed from tobacco. The tobacco may be leaf tobacco, tobacco derivatives, expanded tobacco, shredded tobacco, reconstituted tobacco or tobacco substitutes. Preferably the tobacco has a relatively low moisture content, for example less than 10wt% moisture. A typical minimum moisture content for the tobacco is not less than 4wt% moisture. Such low moisture content tobacco, when exposed to heated air, would typically not produce a substantial vapour. Accordingly, such an air-permeable substrate may be loaded with a source of an active ingredient, as described above.

[0123] Where the air-permeable substrate is formed for example of tobacco, the active agent may be applied to the air-permeable substrate by mixing and/or dissolving the active agent in a suitable carrier liquid such as a solvent (e.g. water, ethanol, PG, glycerine, macrogol, caster oil, paraffin, (and derivatives thereof)).

[0124] The air is typically heated to a suitable temperature. This temperature may be at least 30°C. This is in order to promote vaporisation of the active ingredient. The temperature is typically not greater than 80°C, or typically not greater than 70°C. This is in order to promote user comfort. It may also reduce or prevent the degradation of the air-permeable substrate and/or the active ingredient.

[0125] Figure 3 shows a schematic longitudinal cross-sectional view of the aerosol generator which forms part of the substitute smoking system shown in Figures 1 and 2. In Figure 3, the nicotine-impregnated substrate 160 is arranged within a passage 170. The passage 170 extends between an aerosol generator inlet 172 and an aerosol generator outlet 174 at opposing ends of the consumable 150. In this respect, the passage 170 comprises an upstream end at the end of the consumable 150 that engages with the main body 120, and a downstream end at an opposing end of the consumable 150 that comprises a mouthpiece 154 of the system 110.

[0126] When the consumable 150a is received in the cavity of the main body 120 as shown in Figure 3, a plurality of device air inlets 176 are formed at the boundary between the casing of the consumable and the casing of the main body. The device air inlets 176 are in fluid communication with the aerosol generator inlet 172 through an inlet flow channel 178 formed in the cavity of the main body which is of corresponding shape to receive a part of the consumable 150a. Air from outside of the system 110 can therefore be drawn into the passage 170 through the device air inlets 176 and the inlet flow channels 178.

[0127] When the consumable 150a is engaged with the main body 120, a user can inhale (i.e. take a puff) via the mouthpiece 154 so as to draw air through the passage 170, and so as to form an airflow (indicated by the dashed arrows in Figure 3) in a direction from the aerosol generator inlet 172 to the aerosol generator outlet 174. Air is thereby drawn through and/or around the nicotine-impregnated substrate 160, such that nicotine from the nicotine-impregnated substrate 160 can be entrained in the airflow. The nicotine-impregnated substrate 160 is arranged to extend across a cross-section of at least a portion of the passage 170, such that substantially all of the air drawn through the passage 170 passes through at least a part of the reservoir 160. The resistance to drawing air through the consumable 150a may be configured by altering the air permeability of the nicotine-impregnated substrate, or by the provision of one or more bypass passages separate from the passage 170 (not illustrated).

[0128] In this embodiment, a heater 164 is arranged upstream of the nicotine-impregnated substrate 160

along the passageway 170. The heater 164 is operable to heat air passing through the passageway 170 to enable or enhance nicotine entrainment. In this embodiment, the heater 164 comprises an electrically heatable mesh located in the airflow stream. The mesh may be formed of a material that is heatable by resistive heating using an electrical current. In other embodiments, the heater 164 may comprise a plurality of meshes. The heater 164 may be located in a passage in the base unit 120 (not illustrated), with the base unit passageway being in fluid communication with the passageway 170 of the consumable 150a. In further embodiments, the heater 164 may be located externally of the passageway 170 but placed in thermal communication with the airflow via thermally conductive elements which extend into or across the passageway 170 (not illustrated). In still further embodiments, the heater may be omitted.

[0129] When the consumable 150a is engaged with the main body 120, electrical contacts 156 make contact with corresponding electrical contacts (not shown) of the main body 120. The main body electrical contacts are electrically connectable to a power source (not shown) of the main body 120, such that (in the engaged position) the heater 164 is electrically connectable to the power source. In this way, power can be supplied by the main body 120 to the heater 164 in order to heat the heater 164.

[0130] The system 110 may alternatively be configured to vaporise an aerosol precursor, which in the illustrated second embodiment is in the form of a nicotine-based e-liquid 260. Components of the system 110 which are common with the first embodiment are referred to by the same reference numeral, and will not be further explained. The e-liquid 260 comprises nicotine and a base liquid including propylene glycol and/or vegetable glycerine. In the present embodiment, the e-liquid 260 is flavoured by a flavourant. In other embodiments, the e-liquid 260 may be flavourless and thus may not include any added flavourant.

[0131] The aerosol precursor is vaporised by the aerosol generator of the system 110. Figure 4 shows a schematic longitudinal cross-sectional view of the aerosol generator which can form part of the substitute smoking system shown in Figures 1 and 2. In Figure 4, the e-liquid 260 is stored within a reservoir in the form of a tank 252 that forms part of the system 110 or a consumable 150b.

[0132] The tank may include a vent (not shown) to allow ingress of air to replace e-liquid that has been used from the tank. The consumable 150b preferably includes a window 158 (see Figures 1 and 2), so that the amount of e-liquid in the tank 252 can be visually assessed. The main body 120 includes a slot 157 so that the window 158 of the consumable 150b can be seen whilst the rest of the tank 252 is obscured from view when the consumable 150b is received in the cavity of the main body 120. The consumable 150b may be referred to as a "clearomizer" when it includes a window 158, or a "cartomizer" when it does not.

[0133] In other embodiments, the tank may be refillable with e-liquid or the e-liquid may be stored in a non-consumable component of the system. For example, in such other embodiments, the e-liquid may be stored in a tank located in the main body or stored in another component that is itself not single-use (e.g. a refillable cartomizer).

[0134] In Figure 4, the tank 252 annularly surrounds, and thus defines a portion of, a passage 170 that extends between an aerosol generator inlet 172 and an outlet 174 at opposing ends of the consumable 150b. In this respect, the passage 170 comprises an upstream end at the end of the consumable 150b that engages with the main body 120, and a downstream end at an opposing end of the consumable 150b that comprises a mouthpiece 154 of the system 110.

[0135] When the consumable 150b is received in the cavity of the main body 120 as shown in Figure 4, a plurality of device air inlets 176 are formed at the boundary between the casing of the consumable and the casing of the main body. The device air inlets 176 are in fluid communication with the aerosol generator inlet 172 through an inlet flow channel 178 formed in the cavity of the main body which is of corresponding shape to receive a part of the consumable 150b. Air from outside of the system 110 can therefore be drawn into the passage 170 through the device air inlets 176 and the inlet flow channels 178.

[0136] When the consumable 150b is engaged with the main body 120, a user can inhale (i.e. take a puff) via the mouthpiece 154 so as to draw air through the passage 170, and so as to form an airflow (indicated by the dashed arrows in Figure 4) in a direction from the aerosol generator inlet 172 to the outlet 174. Although not illustrated, the passage 170 may be partially defined by a tube (e.g. a metal tube) extending through the consumable 150b. In Figure 3, for simplicity, the passage 170 is shown with a substantially circular cross-sectional profile with a constant diameter along its length. In other embodiments, the passage may have other cross-sectional profiles, such as oval shaped, racetrack shaped or polygonal shaped profiles. Further, in other embodiments, the cross sectional profile and the diameter (or hydraulic diameter) of the passage may vary along its longitudinal axis.

[0137] The aerosol generator of the smoking substitute system 110 is configured to vaporise the e-liquid 260 for inhalation by a user. To provide this operability, the aerosol generator comprises a heater having a porous wick 262 and a resistive heating element in the form of a heating filament 264 that is helically wound (in the form of a coil) around a portion of the porous wick 262. The porous wick 262 extends across the passage 170 (i.e. transverse to a longitudinal axis of the passage 170 and thus also transverse to the air flow along the passage 170 during use) and opposing ends of the wick 262 extend into the tank 252 (so as to be immersed in the e-liquid 260). In this way, e-liquid 260 contained in the tank 252 is conveyed from the opposing ends of the porous wick 262 to a central portion of the porous wick 262 so as to be exposed to the airflow in the passage 170.

[0138] The helical filament 264 is wound about the ex-

posed central portion of the porous wick 262 and is electrically connected to an electrical interface in the form of electrical contacts 156 mounted at the end of the consumable that is proximate the main body 120 (when the consumable and the main body are engaged). When the consumable 150b is engaged with the main body 120, electrical contacts 156 make contact with corresponding electrical contacts (not shown) of the main body 120. The main body electrical contacts are electrically connectable to a power source (not shown) of the main body 120, such that (in the engaged position) the filament 264 is electrically connectable to the power source. In this way, power can be supplied by the main body 120 to the filament 264 in order to heat the filament 264. This heats the porous wick 262 which causes e-liquid 260 conveyed by the porous wick 262 to vaporise and thus to be released from the porous wick 262. The vaporised e-liquid becomes entrained in the airflow and, as it cools in the airflow (between the heated wick and the outlet 174 of the passage 170), condenses to form an aerosol. This aerosol is then inhaled, via the mouthpiece 154, by a user of the system 110. As e-liquid is lost from the heated portion of the wick, further e-liquid is drawn along the wick from the tank to replace the e-liquid lost from the heated portion of the wick.

[0139] The filament 264 and the exposed central portion of the porous wick 262 are positioned across the passage 170. More specifically, the part of passage that contains the filament 264 and the exposed portion of the porous wick 262 forms a vaporisation chamber. In the illustrated example, the vaporisation chamber has the same cross-sectional diameter as the passage 170. However, in other embodiments the vaporisation chamber may have a different cross sectional profile as the passage 170. For example, the vaporisation chamber may have a larger cross sectional diameter than at least some of the downstream part of the passage 170 so as to enable a longer residence time for the air inside the vaporisation chamber.

[0140] Figure 5 illustrates in more detail the vaporisation chamber and therefore the region of the consumable 150 around the wick 262 and filament 264. The helical filament 264 is wound around a central portion of the porous wick 262. The porous wick extends across passage 170. E-liquid 260 contained within the tank 252 is conveyed as illustrated schematically by arrows 401, i.e. from the tank and towards the central portion of the porous wick 262.

[0141] When the user inhales, air is drawn from through the inlets 176 shown in Figure 4, along inlet flow channel 178 to vaporisation chamber inlet 172 and into the vaporisation chamber containing porous wick 262. The porous wick 262 extends substantially transverse to the airflow direction. The airflow passes around the porous wick, at least a portion of the airflow substantially following the surface of the porous wick 262. In examples where the porous wick has a cylindrical cross-sectional profile, the airflow may follow a curved path around an outer periphery of the porous wick 262.

[0142] At substantially the same time as the airflow passes around the porous wick 262, the filament 264 is heated so as to vaporise the e-liquid which has been wicked into the porous wick. The airflow passing around the porous wick 262 picks up this vaporised e-liquid, and the vapour-containing airflow is drawn in direction 403 further down passage 170.

[0143] The system 110 may alternatively generate vapour via heating of tobacco material in the form of an aerosol forming substrate 360, as shown in the illustrated third embodiment of Figure 6. Components of the system 110 which are common with the first and second embodiments are referred to by the same reference numeral, and will not be further explained. The aerosol forming substrate 360 comprises tobacco material that may, for example, include any suitable parts of the tobacco plant (e.g. leaves, stems, roots, bark, seeds and flowers). In order to generate an aerosol, the aerosol forming substrate 360 comprises at least one volatile compound that is intended to be vaporised/aerosolised and that may provide the user with a recreational and/or medicinal effect when inhaled. The aerosol-forming substrate 360 may further comprise one or more additives. For example, such additives may be in the form of humectants (e.g. propylene glycol and/or vegetable glycerine), flavourants, fillers, aqueous/non-aqueous solvents and/or binders.

[0144] The system 110 is configured to heat the aerosol-forming substrate 360 so as to form an aerosol for inhalation by a user. To provide this operability, the aerosol generator comprises a heating element 364 that projects into the aerosol-forming substrate 360. This heating element 364 is electrically connected to a power supply (not shown) of the system 110 and, when activated, heats the aerosol-forming substrate 360 such that vapour is released from the aerosol-forming substrate 360. When a user inhales via the mouth end 154, air is drawn through the heated aerosol-forming substrate 360 and the vapour becomes entrained in the resultant airflow. As the vapour flows from the aerosol-forming substrate 360 to the downstream end 172 of the passage 170, it condenses into an aerosol and the aerosol is inhaled by the user.

[0145] In each of the foregoing embodiments, the passageway 170 of the smoking substitute apparatus 150a, 150b, 150c comprises two or more one-way valves 166. The valves serve to control airflow through the passageway 170. More specifically, the valves are provided to prevent, substantially prevent or reduce airflow from a downstream to upstream direction along the passageway 170. A one-way valve may also be referred to as a check valve. As illustrated in Figures 3, 4, 6, a first valve 166a is located upstream of the aerosol generator, and a second valve 166a is located downstream of the aerosol generator.

[0146] The valves 166a, 166b may be located immediately upstream and immediately downstream of the

aerosol generator. Providing valves 166a, 166b immediately upstream and immediately downstream of the nicotine-impregnated substrate 160 is advantageous for preventing nicotine or nicotine infused liquid from escaping from the nicotine-impregnated substrate 160 when the smoking substitute apparatus 150 is not in use.

[0147] In embodiments where a heater 164 is provided to heat air in the air passage 170, the upstream valve 166a may be located upstream of the heater 164. Providing a valve 166a upstream of a heater 164 allows control over the airflow, while not requiring the valve to be suitable to operate with heated air. A valve 166a provided upstream of a heater 164 may also improve the efficiency of utilisation for the heater, since heated air is prevented from flowing in an upstream direction from the heater 164.

[0148] At least one of the one-way valves 166 may be a duckbill valve, as illustrated exemplarily in Figures 7A, 7B. A duckbill valve comprises an elastomeric material diaphragm 202 in which a portion is shaped like the bill or beak of a duck, comprising an opening or aperture therethrough. Fluid flow in the "allowed" direction opens the duckbill shaped portion (Fig. 7B), while fluid flow in a reverse direction (or absence of any fluid flow) cases the duckbill shaped portion to close (Fig. 7A). A pressure differential across the valve 166 from the upstream to downstream side may be required to open the valve and allow fluid to flow.

[0149] At least one of the one-way valves 166 may be a ball one-way valve, as illustrated exemplarily in Figures 8A and 8B. A ball one-way valve comprises a ball 204 located in a tapered passage so as to prevent fluid flow in a reverse direction (Figure 8A). Fluid flow in an allowed direction moves the ball 204, allowing flow around the ball 204 (Figure 8B). A ball one-way valve may further comprise a spring 206 to position the ball 204 within the valve. In some embodiments, the spring 206 may be omitted. As with the duckbill valve, a one-way ball valve may require a pressure differential across the valve 166 in an upstream to downstream direction to open the valve 166 and allow flow through the valve 166, particularly in valves where a spring 206 is present.

[0150] The features disclosed in the foregoing description, or in the following claims, or in the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for obtaining the disclosed results, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

[0151] While the invention has been described in conjunction with the exemplary embodiments described above, many equivalent modifications and variations will be apparent to those skilled in the art when given this disclosure. Accordingly, the exemplary embodiments of the invention set forth above are considered to be illustrative and not limiting. Various changes to the described embodiments may be made without departing from the spirit and scope of the invention.

[0152] For the avoidance of any doubt, any theoretical explanations provided herein are provided for the purposes of improving the understanding of a reader. The inventors do not wish to be bound by any of these theoretical explanations.

[0153] Any section headings used herein are for organizational purposes only and are not to be construed as limiting the subject matter described.

[0154] Throughout this specification, including the claims which follow, unless the context requires otherwise, the words "have", "comprise", and "include", and variations such as "having", "comprises", "comprising", and "including" will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

[0155] It must be noted that, as used in the specification and the appended claims, the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise. Ranges may be expressed herein as from "about" one particular value, and/or to "about" another particular value. When such a range is expressed, another embodiment includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by the use of the antecedent "about," it will be understood that the particular value forms another embodiment. The term "about" in relation to a numerical value is optional and means, for example, +/- 10%.

[0156] The words "preferred" and "preferably" are used herein refer to embodiments of the invention that may provide certain benefits under some circumstances. It is to be appreciated, however, that other embodiments may also be preferred under the same or different circumstances. The recitation of one or more preferred embodiments therefore does not mean or imply that other embodiments are not useful, and is not intended to exclude other embodiments from the scope of the disclosure, or from the scope of the claims.

Claims

1. An aerosol delivery apparatus (150a, 150b, 150c) comprising:

   an air passage (170);
   an aerosol generator arranged in the air passage (170);
   a first one-way valve (166a) arranged upstream of the aerosol generator along the air passage (170), and configured to allow air to flow along the air passage (170) in an upstream to downstream direction; and
   a second one-way valve (166b) arranged downstream of the aerosol generator along the air passage (170), and configured to allow air to flow along the air passage (170) in an upstream

to downstream direction.

2. An aerosol delivery apparatus (150a, 150b, 150c) according to claim 1, wherein:
a one-way valve (166) of the one-way valves (166) is a duckbill valve.

3. An aerosol delivery apparatus (150a, 150b, 150c) according to either of claims 1 or 2, wherein:
a one-way valve (166) of the one-way valves (166) is a ball one-way valve.

4. An aerosol delivery apparatus (150a, 150b, 150c) according to claim 3, wherein:
the ball one-way valve (166) further comprises a spring (206) to locate the ball within the valve (166).

5. An aerosol delivery apparatus (150a) according to any preceding claim, wherein:
the aerosol generator comprises a reservoir (160) formed from an air-permeable substrate and arranged in the air passage (170) to allow air to be drawn through the reservoir (160), the reservoir (160) being loaded with a source of an active ingredient.

6. An aerosol delivery apparatus (150a) according to claim 5, further comprising:
a heater (164) arranged in the air passage (170) and upstream of the reservoir (160), the heater (164) being operable to heat air passing through the air passage (170).

7. An aerosol delivery apparatus (150a) according to claim 6, wherein:
the heater (164) for heating the air in the air passage (170) comprises an electrically heatable mesh.

8. An aerosol delivery apparatus (150b) according to any of claims 1 to 4, wherein:
the aerosol generator comprises a porous wick (262) which, in use, wicks aerosol precursor (260) from a reservoir (252) to the first passage (170) for entrainment in air flowing downstream of the aerosol generator.

9. An aerosol delivery apparatus (150b) according to claim 8, further comprising:
a heater operable to generate the aerosol from the aerosol precursor (260), the heater being a heating filament (264) that is wound around a portion of the porous wick (262).

10. An aerosol delivery apparatus (150b) according to either of claims 8 or 9, wherein:

the passage (170) comprises a vaporisation chamber in which the aerosol generator is arranged, and wherein
the vaporisation chamber has a larger cross sectional diameter than a downstream part of the passage (170).

11. An aerosol delivery apparatus (150c) according to any one of claims 1 to 4, wherein:

the aerosol generator comprises an aerosol-forming substrate (360) comprising tobacco material; and
a heating element (364) operable to heat the aerosol-forming substrate (360) to generate an aerosol for entrainment in air flowing downstream of the aerosol generator.

12. An aerosol delivery apparatus (150c) according to claim 11, wherein:
the heating element (364) comprises an electrically heatable rod.

13. An aerosol delivery apparatus (150a, 150b, 150c) according to any one of claim 1 to claim 12, wherein the aerosol delivery apparatus (150a, 150b, 150c) is comprised by or within a cartridge configured for engagement with a base unit (120), the cartridge and base unit together forming an aerosol delivery system (110).

14. An aerosol delivery system (110) comprising:

a base unit (120), and
an aerosol delivery apparatus (150a, 150b, 150c) according to claim 13, wherein the aerosol delivery apparatus (150a, 150b, 150c) is removably engageable with the base unit (120).

15. A method of using an aerosol delivery apparatus (150a, 150b, 150c) according to any one of claims 1 to 13 to generate an aerosol.

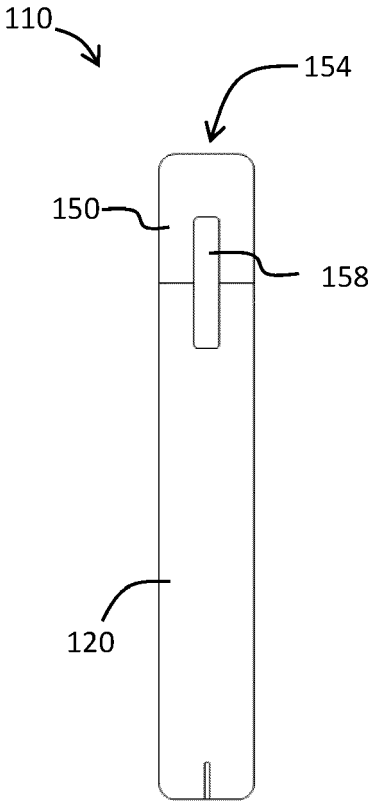


FIG. 1

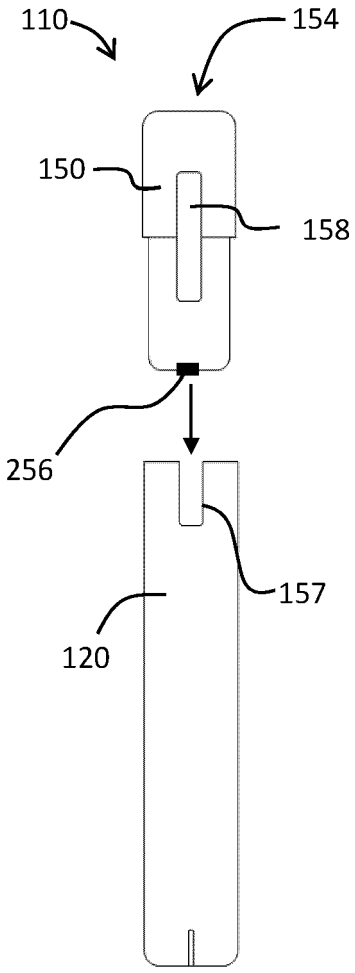


FIG. 2

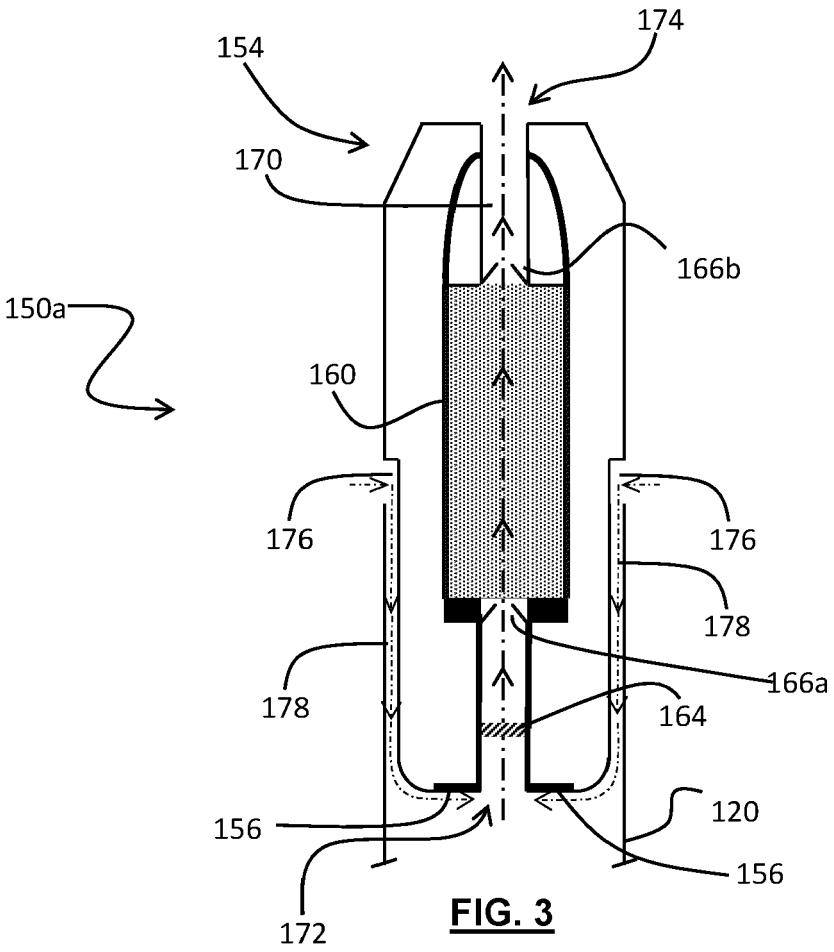
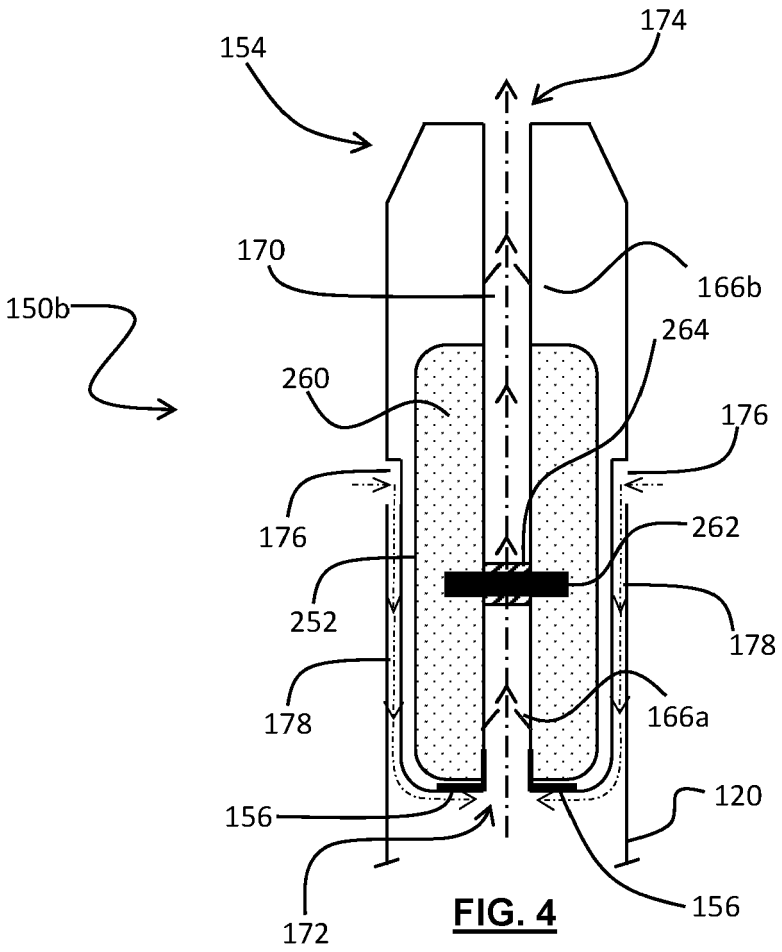

174
154
170
166b
150a
160
176
176
178
178
166a
164
120
156
156
172

FIG. 3


174
154
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166b
150b
264
260
176
176
262
252
178
178
166a
120
156
156
172

FIG. 4

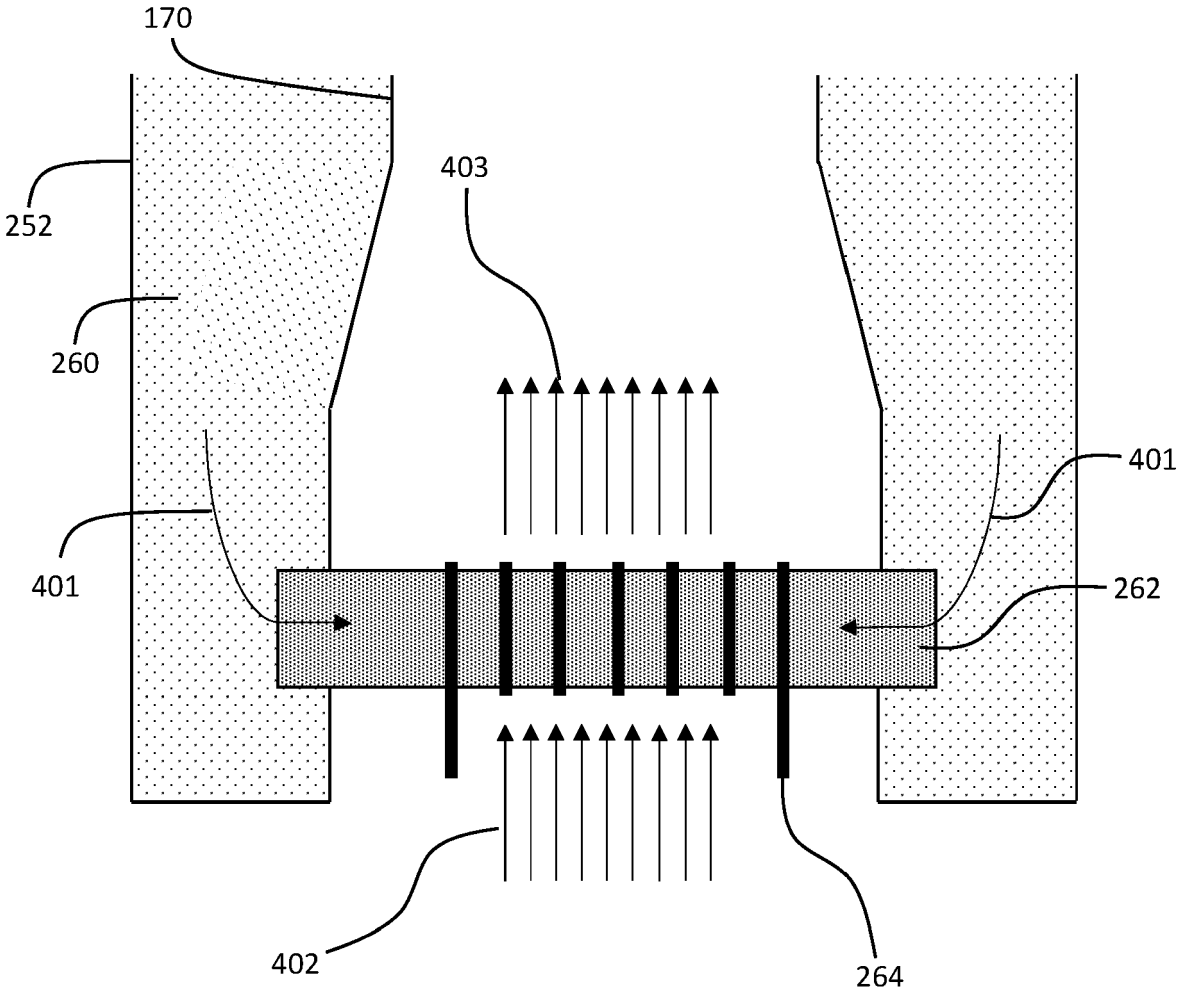

FIG. 5

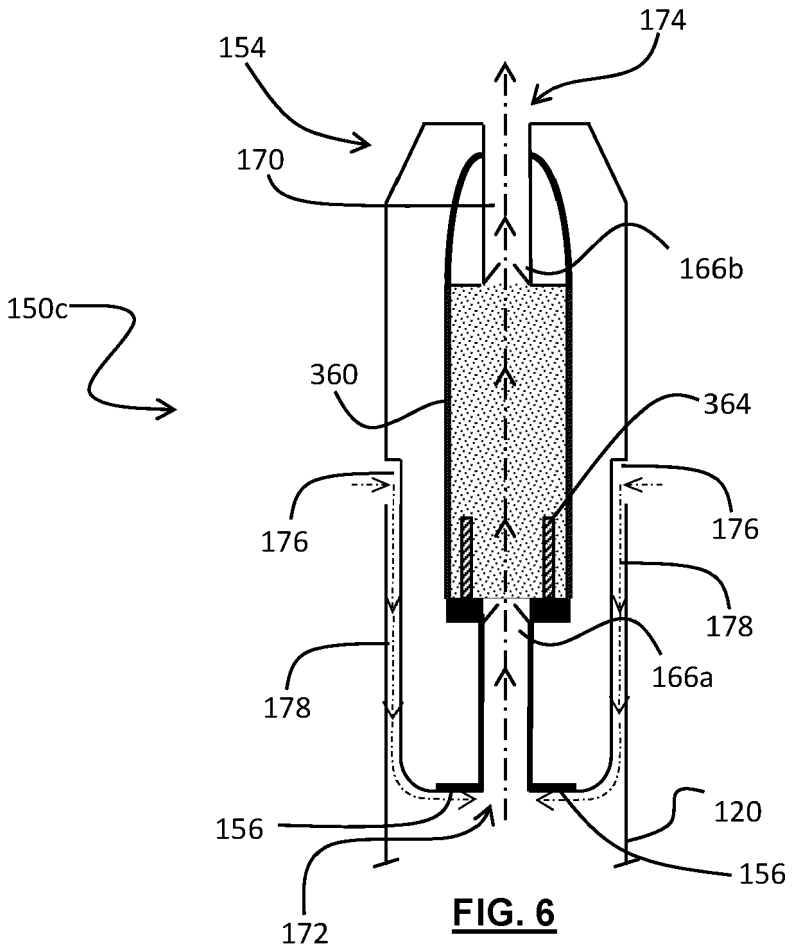
174
154
170
166b
150c
360
364
176
176
178
166a
178
120
156
156
172

FIG. 6

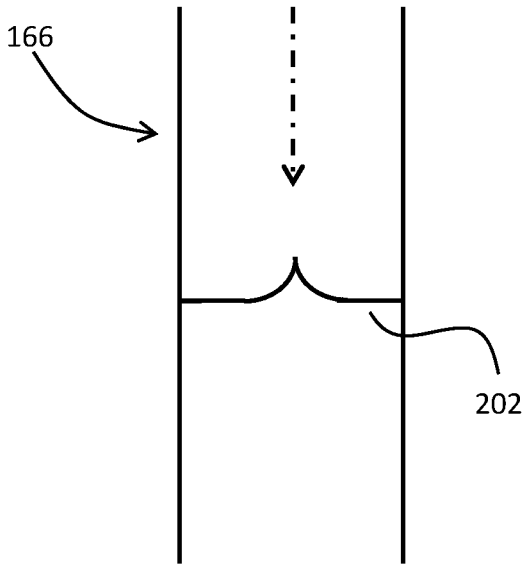

FIG. 7A

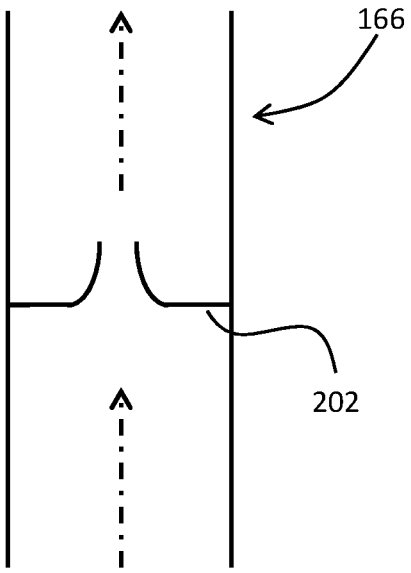

FIG. 7B

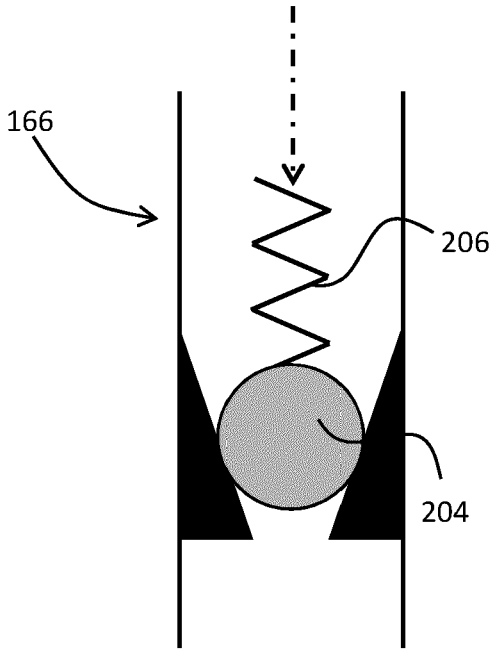

FIG. 8A

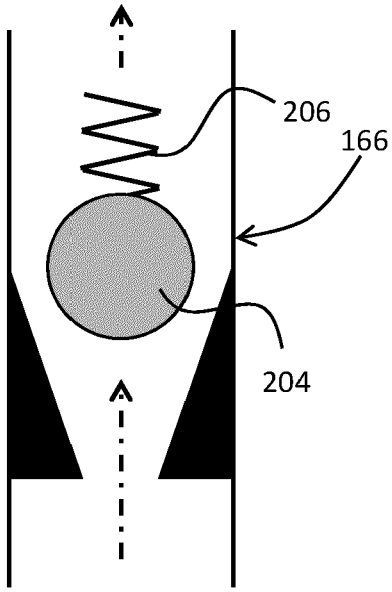

FIG. 8B

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EUROPEAN SEARCH REPORT

Application Number
EP 20 15 4513

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X A	WO 2015/179292 A1 (REYNOLDS TOBACCO CO R [US]) 26 November 2015 (2015-11-26) * page 40, line 7 - page 22; figure 18 *	1-4, 8-10, 13-15 5-7,11, 12	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 July 2020	Marzano Monterosso

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L : document cited for other reasons

& : member of the same patent family, corresponding document

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