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(71) Applicant: **PHILIP MORRIS PRODUCTS S.A.** [CH/CH]; Quai Jeanrenaud 3, 2000 Neuchâtel (CH).

(72) Inventors: **FERNANDO, Felix**; 22 Park Lane, Old Basing RG24 7HF (GB). **GONZALEZ FLOREZ, Ana Isabel**; Avenue General Guisan 62, 1400 Yverdon-Les-Bains (CH).

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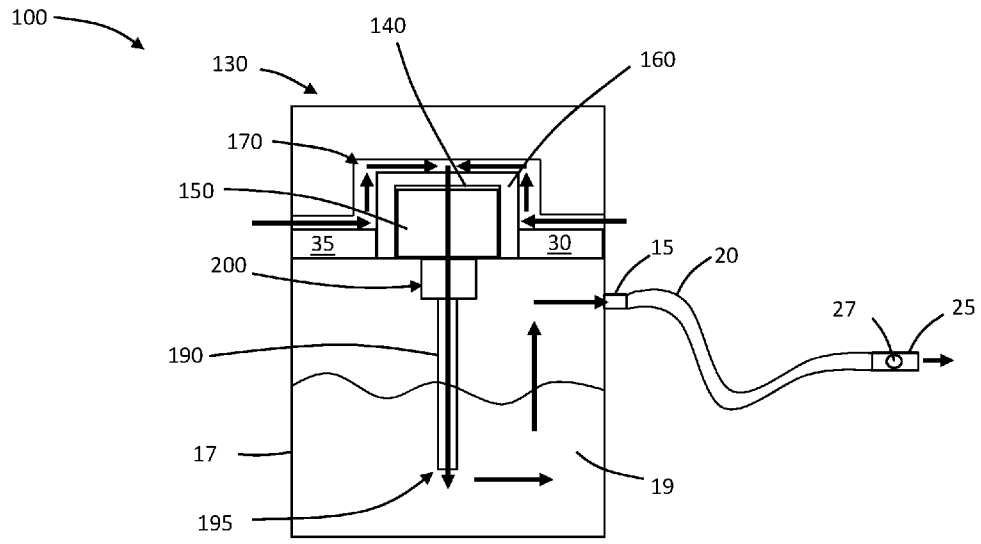

FIG. 1

(57) Abstract: A shisha device includes a vessel, an aerosol-generating element in fluid communication with the vessel, and a chamber between the vessel and the aerosol-generating element. The chamber is in fluid communication with the vessel and the aerosol-generating element. The chamber comprises an inlet configured to accelerate air containing aerosol that flows through the inlet from the aerosol-generating element. The chamber may include a main chamber in fluid communication with the inlet. The main chamber may be sized and shaped to allow deceleration of the aerosol in the main chamber when the aerosol exits the inlet and enters the main chamber.

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SHISHA DEVICE FOR ENHANCED AEROSOL CHARACTERISTICS

The present disclosure relates to shisha devices and in particular to shisha devices; more particularly, to shisha devices that heat an aerosol generating substrate without combusting the substrate and that enhance characteristics of generated aerosol.

Shisha devices are used to smoke tobacco and are configured such that vapor and smoke pass through a water basin before inhalation by a consumer. Shisha devices may include one outlet or more than one outlet so that the device can be used by more than one consumer at a time. Use of shisha devices is considered by many to be a leisure activity and a social experience.

The tobacco used in shisha devices may be mixed with other ingredients to, for example, increase the volume of the vapour and smoke produced, to alter flavour, or both. Charcoal pellets are typically used to heat the tobacco in a shisha device, which may cause full or partial combustion of the tobacco or other ingredients.

Some shisha devices have been proposed that use electrical heat sources to heat or combust the tobacco to, for example, avoid by-products of burning charcoal or to improve the consistency with which the tobacco is heated or combusted. However, substituting an electric heater for charcoal may result in unsatisfactory production of aerosol in terms of visible smoke or aerosol, total aerosol mass, or visible smoke or aerosol and aerosol mass.

It is desirable to provide a shisha device that employs an electric heater that produces a satisfactory amount of one or both of visible aerosol and total aerosol mass.

It is also desirable to provide a shisha device that heats a substrate in a manner that does not result in combustion by-products.

In various aspects of the present invention there is provided a shisha device comprising a vessel, an aerosol-generating element in fluid communication with the vessel, and a chamber between the vessel and the aerosol-generating element. The chamber is in fluid communication with the vessel and the aerosol-generating element. The chamber comprises an inlet configured to accelerate air containing aerosol that flows through the inlet from the aerosol-generating element. Preferably, the chamber comprises a main chamber in fluid communication with the inlet. The main chamber is sized and shaped to allow deceleration of the aerosol in the main chamber when the aerosol exits the inlet and enters the main chamber. The aerosol-generating element comprises an electric heating element, a receptacle for receiving a shisha aerosol generating substrate to be heated by the heating element; an inlet in

communication with the receptacle; and an outlet in communication with the receptacle. The shisha device is configured to sufficiently heat an aerosol generating substrate to produce an aerosol, without combusting the aerosol.

Various aspects or embodiments of the shisha devices described herein may provide one or more advantages relative to existing shisha devices. For example, one or more shisha devices described herein may produce substantially more visible aerosol, deliver substantially more total aerosol mass, or produce substantially more visible aerosol and deliver substantially more total aerosol mass than similar devices without a chamber having an air accelerating inlet. Accordingly, a user of the device may have an experience more typical of a shisha device in which an aerosol generating substrate is combusted with charcoal, but without combustion by-products of the charcoal. In addition, if the shisha device is configured to sufficiently heat an aerosol generating substrate to produce an aerosol, without combusting the aerosol, combustion by-products of the aerosol generating substrate may also be avoided. These and other advantages of the shisha devices described herein will be evident to those of skill in the art upon review of the present disclosure.

A shisha device of the present invention may comprise any suitable chamber having an air-accelerating inlet. The chamber is between the aerosol generating element and the vessel in an air flow path of the shisha device. Air containing aerosol travelling from the aerosol generating element to the vessel passes through the chamber. The chamber comprises an inlet that accelerates the air containing the aerosol as it enters the chamber. The air containing the aerosol exiting the inlet may decelerate, which may improve the nucleation process and cause an increase in visible aerosol relative to devices that do not include a chamber having an air-accelerating inlet. The amount of visible aerosol may be increased in the main chamber of the unit, in the headspace of the vessel, or in both the main chamber and the vessel. In addition or alternatively, the total aerosol mass delivered by the shisha device may be increased relative to devices that do not include a chamber having an air-accelerating inlet. For example, the total aerosol mass may increase about 1.5-fold or greater or about 2-fold or greater, such as about 3-fold.

The chamber may comprise a main chamber in fluid communication with the inlet. The main chamber is sized and shaped to allow deceleration of the air containing the aerosol in the main chamber when the air containing the aerosol exits the inlet and enters the main chamber. The main chamber may have any suitable size and shape that allows deceleration of the air containing the aerosol. Preferably, the main chamber is substantially cylindrical, but may be of any other suitable shape.

The main chamber may have any suitable diameter. For purposes of the present disclosure, “diameter” is a maximum transverse distance from a first end to a second end of the object that opposed the first end. By way of example, the “diameter” may be a diameter of an object having a circular transverse section or may be a width of an objection having rectangular transverse section. In some examples, the main chamber has a diameter of at least about 10 mm. For example, the diameter of the main chamber may be from about 10 mm to about 50 mm, such as about 30 mm.

The main chamber may have any suitable length. In some examples, the main chamber has a length of at least about 10 mm. For example, the length of the main chamber may be from about 10 mm to about 100 mm, such as about 40 mm.

Preferably, the inlet protrudes into the main chamber. For example, a first end of the inlet may be formed at an exterior surface of a housing of the chamber, and a second end of the inlet may extend into the main chamber.

Any suitable inlet that accelerates the air carrying the aerosol may be used. A suitable inlet may include guides defining a constricted air flow cross section, which will force the air to accelerate substantially in the axial direction. In some examples, the inlet comprises a first aperture in proximity to the aerosol-generating element and a second aperture in proximity to the main chamber. Aerosol from the aerosol-generating element flows into the inlet through the first aperture and out of the second aperture into the main chamber. The first aperture has a diameter larger than the second aperture.

The first aperture may have any suitable dimensions. For example, the first aperture of the inlet may have a diameter in a range from about 1 mm to about 10 mm, such as from about 2 mm to about 9 mm, or about 7 mm.

The second aperture of the inlet may have any suitable dimensions. For example, the second aperture may have a diameter in a range from about 0.5 mm to about 4 mm, such as from about 0.5 mm to about 2 mm, or about 1 mm.

The inlet may have any suitable length. For example, the length of the inlet from the first aperture to the second aperture may be from about 1 mm to about 30 mm, such as from about 1 mm to about 20 mm or from about 5 mm to about 30 mm, such as about 20 mm.

Preferably, the inlet has a frustroconical shape. For example, the inlet may be in the form of a nozzle. An inlet having a frustroconical shape may allow for efficient acceleration of the air containing the inlet as the air is drawn through the inlet.

The chamber may comprise any suitable number of air-accelerating inlets. For example, the chamber may comprise one or more air-accelerating inlet. In some example, the chamber may comprise 2, 3, 4, or 5 or more air-accelerating inlets.

The chamber may comprise one or more parts. For example, the main chamber and the one or more inlets may be formed from the same part or from different parts. Preferably, the main chamber is formed from material that allows a user to observe aerosol within the chamber. For example, the main chamber may be formed from optically transparent or opaque material.

The chamber is positioned in an air flow path between the aerosol-generating element and the vessel configured to contain the liquid. A conduit may connect the aerosol-generating element to the chamber to an outlet of the aerosol-generating element. Alternatively, the inlet of the chamber may be the outlet of the aerosol-generating element.

The shisha device may comprise a conduit that extends from the chamber into the vessel. Preferably, the conduit extends into the vessel below a liquid fill level of the vessel. In some examples, the main chamber of the chamber is fluidly connected to the conduit. In other examples, the conduit extending into the vessel forms the main chamber of the chamber.

A shisha device of the present invention may comprise any suitable aerosol-generating element for heating an aerosol generating substrate to produce an aerosol. Preferably, the aerosol generating substrate is heated by an electric heating element. The aerosol generating element contains a receptacle for containing the aerosol generating substrate to be heated by the heating element. Preferably, the aerosol generating substrate is in a cartridge when heated by the heating element, and, thus, the aerosol generating element comprises a cartridge receptacle configured to receive the cartridge. Alternatively, aerosol-generating substrate that is not in a cartridge may be placed in the receptacle. The aerosol-generating element comprises a fresh air inlet and an aerosol outlet. When a user draws on the shisha device, fresh air may enter the fresh air inlet, pass over or through the aerosol generating substrate, and exit the aerosol outlet for entry into the inlet of the chamber. In some examples, the aerosol outlet of the aerosol-generating element is, or forms at least a part of, the inlet of the chamber.

Preferably, the heating element of the aerosol-generating element defines at least one surface of the receptacle for holding the aerosol generating substrate or cartridge. More preferably, the heating element defines at least two surfaces of the receptacle. For example, the heating element may form at least a portion of two or more of a top surface, a side surface, and a bottom surface. Preferably, the heating element defines at least a portion of the top surface and at least a portion of a side surface. More preferably, the heating element forms the

entire top surface and an entire side wall surface of the receptacle. The heating element may be disposed on an inner surface or an outer surface of the receptacle.

Any suitable heating element may be employed. For example, the heating element may comprise one or both of resistive and inductive heating components. Preferably, the heating element comprises a resistive heating component. For example, the heating element may comprise one or more resistive wires or other resistive elements. The resistive wires may be in contact with a thermally conductive material to distribute heat produced over a broader area. Examples of suitable conductive materials include aluminium, copper, zinc, nickel, silver, and combinations thereof. For purposes of this disclosure, if resistive wires are in contact with a thermally conductive material, both the resistive wires and the thermally conductive material are part of the heating element that forms at least a portion of the surface of the cartridge receptacle.

In some examples, a heating element comprises an inductive heating element. For example, the heating element may comprise a susceptor material that forms a surface of the cartridge receptacle. As used herein, the term 'susceptor' refers to a material that is capable to convert electromagnetic energy into heat. When located in an alternating electromagnetic field, typically eddy currents are induced and hysteresis losses may occur in the susceptor causing heating of the susceptor. As the susceptor is located in thermal contact or close thermal proximity with the aerosol-forming substrate, the substrate is heated by the susceptor such that an aerosol is formed. Preferably, the susceptor is arranged at least partially in direct physical contact with the aerosol-forming substrate.

The susceptor may be formed from any material that can be inductively heated to a temperature sufficient to generate an aerosol from the aerosol-forming substrate. Preferred susceptors comprise a metal or carbon. A preferred susceptor may comprise or consist of a ferromagnetic material, for example ferritic iron, a ferromagnetic alloy, such as ferromagnetic steel or stainless steel, and ferrite. A suitable susceptor may be, or comprise, aluminium.

Preferred susceptors are metal susceptors, for example stainless steel. However, susceptor materials may also comprise or be made of graphite, molybdenum, silicon carbide, aluminum, niobium, Inconel alloys (austenite nickel-chromium-based superalloys), metallized films, ceramics such as for example zirconia, transition metals such as for example Fe, Co, Ni, or metalloids components such as for example B, C, Si, P, Al.

A susceptor preferably comprises more than 5%, preferably more than 20%, preferably more than 50% or 90% of ferromagnetic or paramagnetic materials. Preferred susceptors may be heated to a temperature in excess of 250 degrees Celsius. Suitable susceptors may

comprise a non-metallic core with a metal layer disposed on the non-metallic core, for example metallic tracks formed on a surface of a ceramic core.

In the system according to the invention, at least one surface of the receptacle or of a cartridge containing aerosol generating substrate for placement in the receptacle may comprise susceptor material. Preferably, at least two surfaces of the receptacle comprise susceptor material. For example, the base and at least one side wall of the receptacle may comprise susceptor material. Advantageously, at least portions of an outer surface of the cartridge receptacle are made of susceptor material. However, also at least portions of an inner side of the cartridge receptacle may be coated or lined with susceptor material. Preferably, a lining is attached or fixed to the shell such as to form an integral part of the shell.

In addition, or alternatively, the cartridge may comprise a susceptor material.

The shisha device may also comprise one or more induction coil configured to induce eddy currents and/or hysteresis losses in a susceptor material, which results in heating of the susceptor material. A susceptor material may also be positioned in the cartridge containing the aerosol generating substrate. A susceptor element comprising the susceptor material may comprise any suitable material, such as those described in, for example, PCT Published Patent Applications WO 2014/102092 and WO 2015/177255.

The shisha device may comprise control electronics operably coupled to the resistive heating element or induction coil. The control electronics are configured to control heating of the heating element.

The control electronics may be provided in any suitable form and may, for example, include a controller or a memory and a controller. The controller may include one or more of an Application Specific Integrated Circuit (ASIC) state machine, a digital signal processor, a gate array, a microprocessor, or equivalent discrete or integrated logic circuitry. Control electronics may include memory that contains instructions that cause one or more components of the circuitry to carry out a function or aspect of the control electronics. Functions attributable to control electronics in this disclosure may be embodied as one or more of software, firmware, and hardware.

The electronic circuitry may comprise a microprocessor, which may be a programmable microprocessor. The electronic circuitry may be configured to regulate a supply of power. The power may be supplied to the heater element or induction coil in the form of pulses of electrical current.

If the heating element is a resistive heating element, the control electronics may be configured to monitor the electrical resistance of the heating element and to control the supply of power to the heating element depending on the electrical resistance of the heating element. In this manner, the control electronics may regulate the temperature of the resistive element.

If the heating components comprise an induction coil and the heating element comprises a susceptor material, the control electronics may be configured to monitor aspect of the induction coil and to control the supply of power to the induction coil depending on the aspects of the coil such as described in, for example, WO 2015/177255. In this manner, the control electronics may regulate the temperature of the susceptor material.

The shisha device may comprise a temperature sensor, such as a thermocouple, operably coupled to the control electronics to control the temperature of the heating elements. The temperature sensor may be positioned in any suitable location. For example, the temperature sensor may be configured to insert into the aerosol generating substrate or a cartridge received within the receptacle to monitor the temperature of the aerosol-generating substrate being heated. In addition or alternatively, the temperature sensor may be in contact with the heating element. In addition or alternatively, the temperature sensor may be positioned to detect temperature at an aerosol outlet of the shisha device, such as the aerosol outlet of the aerosol-generating element. The sensor may transmit signals regarding the sensed temperature to the control electronics, which may adjust heating of the heating elements to achieve a suitable temperature at the sensor.

Regardless of whether the shisha device includes a temperature sensor, the device is preferably configured to heat an aerosol generating substrate received in the receptacle to an extent sufficient to generate an aerosol without combusting the aerosol generating substrate.

The control electronics may be operably coupled to a power supply. The shisha device may comprise any suitable power supply. For example, a power supply of a shisha device may be a battery, or set of batteries. In some examples, the cathode and anode elements can be rolled and assembled to match geometries of a portion of a shisha device in which they are disposed. The batteries of power supply unit can be rechargeable, as well as it may be removable and replaceable. Any suitable battery may be used. For example, heavy duty type or standard batteries existing in the market, such as used for industrial heavy duty electrical power-tools. Alternatively the power supply unit can be any type of electric power supply including a super or hyper-capacitor. Alternatively the device can be powered connected to an external electrical power source, and electrically and electronically designed for such purpose. Regardless of the type of power supply employed, the power supply preferably provides

sufficient energy for the normal functioning of the device for approximately 70 minutes of continuous operation of the device, before being recharged or needing to connect to an external electrical power source.

The shisha device comprises a fresh air inlet channel in fluid connection with the receptacle for containing the aerosol generating substrate. Fresh air flows through the channel to the receptacle and the substrate disposed in the receptacle to carry aerosol generated from the aerosol generating substrate to the aerosol outlet when the shisha device is in use. Preferably, at least a portion of the channel is formed by a heating element to preheat the air prior to entering the receptacle. Preferably, a portion of the heating element that forms a surface of the receptacle forms a portion of the fresh air inlet channel. Preferably the fresh air inlet channel is formed from one or both of the top surface of the receptacle and a side wall of the receptacle that if formed by the heating element. Preferably, the air inlet channel is formed by both the top surface of the receptacle and a side wall of the receptacle that if formed by the heating element.

Any suitable portion of the air inlet channel may be formed by the heating element. Preferably, about 50% or more of the length of the air inlet channel is formed by the heating element. In many examples, the heating element will form 95% or less of the length of the fresh air inlet channel.

Air flowing through the fresh air inlet channel may be heated by any suitable amount by the heating element. In some examples, the air will be sufficiently heated to cause an aerosol to form when the heated air flows through the aerosol generating substrate or a cartridge containing aerosol generating substrate. In some examples, the air is not sufficiently heated to cause aerosol formation on its own, but facilitates heating of the substrate by the heating element. Preferably, the amount of energy supplied to the heating element to heat the substrate and cause aerosol formation is reduced by 5% or more, such as 10% or more, or 15% or more, when the air is pre-heated in accordance with the present invention, relative to designs in which air is not pre-heated. Typically, the energy savings will be less than 75%.

The substrate is preferably heated, through a combination of the preheated air and heating from the heating elements, to a temperature in a range from about 150ºC to about 250ºC; more preferably from about 180ºC to about 230ºC or from about 200ºC to about 230ºC.

Preferably at least a portion of the air flow channel is formed between the heating element and a heat shield. Preferably, substantially the entire portion of the fresh air inlet channel that is formed by the fresh air inlet channel is also formed by the heat shield. The heat shield and the heating element may form opposing surfaces of the fresh air inlet channel, such

that the air flows between the heat shield and the heating element. Preferably, the heat shield is positioned exterior to an interior formed by the receptacle.

Any suitable heat shield material may be employed. Preferably, the heat shield material comprises a surface that is thermally reflective. The thermally reflective surface may be backed with an insulating material. In some examples, the thermally reflective material comprises an aluminium metalized film or other suitable thermally reflective material. In some examples, the insulating material comprises a ceramic material. In some examples, the heat shield comprises an aluminium metalized film and a ceramic material backing.

The fresh air inlet channel may comprise one or more apertures through the receptacle such that fresh air from outside the shisha device may flow through the channel and into the receptacle through the apertures. If a channel comprises more than one aperture, the channel may comprise a manifold to direct air flowing through the channel to each aperture. Preferably, the shisha device comprises two or more fresh air inlet channels.

The receptacle may comprise any suitable number of apertures in communication with one or more fresh air inlet channels. For example, the receptacle may comprise 1 to 1000 apertures, such as 10 to 500 apertures. The apertures may be of uniform size or non-uniform size. The apertures may be uniformly distributed or non-uniformly distributed. The apertures may be formed in the cartridge receptacle at any suitable location. For example, the apertures may be formed in one or both of a top or a sidewall of the receptacle. Preferably, the apertures are formed in the top of the receptacle.

The receptacle is preferably shaped and sized to allow contact between one or more wall or ceiling of the receptacle and the aerosol generating substrate or a cartridge containing the aerosol generating substrate when the substrate or cartridge is received by the receptacle to facilitate conductive heating of the aerosol generating substrate by the heating element forming a surface of the receptacle. In some examples, an air gap may be formed between at least a portion of a cartridge containing the aerosol generating substrate and a surface of the receptacle, where the air gaps serves as a portion of the fresh air inlet channel.

Preferably, the interior of the receptacle and the exterior of the cartridge containing the aerosol generating substrate are of similar size and dimensions. Preferably, the interior of the receptacle and the exterior of the cartridge has a height to a base width (or diameter) ratio of greater than about 1.5 to 1 or a base width (or diameter) ratio of greater than about 1.5 to 1. Such ratios may allow for more efficient depletion of the aerosol generating substrate within the cartridge during use by allowing heat from the heating elements to penetrate to the middle of the cartridge. For example, the receptacle and cartridge may have a base diameter (or width)

about 1.5 to about 5 times the height, or about 1.5 to about 4 times the height, or about 1.5 to about 3 times the height. Similarly, the receptacle and cartridge may have a height about 1.5 to about 5 times the base diameter (or width), or about 1.5 to about 4 times the base diameter (or width), or about 1.5 to about 3 times the base diameter (or width). Preferably, the receptacle and cartridge have a height to base diameter ratio or base diameter to height ratio of from about 1.5 to 1 to about 2.5 to 1.

In some examples, the interior of the receptacle and the exterior of the cartridge has a height in a range from about 15 mm to about 25 mm and a base diameter in a range from about 40 mm to about 60 mm.

The receptacle may be formed from one or more parts. Preferably, the receptacle is formed by two or more parts. Preferably, at least one part of the receptacle is movable relative to another part to allow access to the interior of the receptacle for inserting the cartridge into the receptacle. For example, one part may be removably attachable to another part to allow insertion of the aerosol generating substrate or the cartridge containing the aerosol generating substrate when the parts are separated. The parts may be attachable in any suitable manner, such as through threaded engagement, interference fit, snap fit, or the like. In some examples, the parts are attached to one another via a hinge. When the parts are attached via a hinge, the parts may also include a locking mechanism to secure the parts relative to one another when the receptacle is in a closed position. In some examples, the receptacle comprises a drawer that may be slid open to allow the aerosol generating substrate or cartridge to be placed into the drawer and may be slid closed to allow the shisha device to be used.

Any suitable aerosol generating cartridge may be used with a shisha device as described herein. Preferably, the cartridge comprises a thermally conductive housing. For example, the housing may be formed from aluminium, copper, zinc, nickel, silver, and combinations thereof. Preferably, the housing is formed from aluminium. In some examples, the cartridge is formed from one or more material less thermally conductive than aluminium. For example, the housing may be formed from any suitable thermally stable polymeric material. If the material is sufficiently thin sufficient heat may be transferred through the housing despite the housing being formed from material that is not particularly thermally conductive.

The cartridge may comprise one or more apertures formed in the top and bottom of the housing to allow air flow through the cartridge when in use. If the top of the receptacle comprises one or more apertures, at least some of the apertures in the top of the cartridge may aligned with the apertures in the top of the receptacle. The cartridge may comprise an alignment feature configured to mate with a complementary alignment feature of the receptacle

to align the apertures of the cartridge with the apertures of the receptacle when the cartridge is inserted into the receptacle. The apertures in the housing of the cartridge may be covered during storage to prevent aerosol generating substrate stored in the cartridge from spilling out of the cartridge. In addition or alternatively, the apertures in the housing may have dimensions sufficiently small to prevent or inhibit the aerosol generating substrate from exiting the cartridge. If the apertures are covered, a consumer may remove the cover prior to inserting the cartridge into the receptacle. In some examples, the receptacle is configured to puncture the cartridge to form apertures in the cartridge. Preferably, the receptacle is configured to puncture the top of the cartridge.

The cartridge may be of any suitable shape. Preferably, the cartridge has a frustro-conical shape.

Any suitable aerosol-generating substrate may be placed in a cartridge for use with shisha devices of the invention or may be placed in the receptacle of the aerosol-generating unit. The aerosol-generating substrate is preferably a substrate capable of releasing volatile compounds that may form an aerosol. The volatile compounds may be released by heating the aerosol-generating substrate. The aerosol-generating substrate may be solid or liquid or comprise both solid and liquid components. Preferably, the aerosol-generating substrate is solid.

The aerosol-generating substrate may comprise nicotine. The nicotine containing aerosol-generating substrate may comprise a nicotine salt matrix. The aerosol-generating substrate may comprise plant-based material. The aerosol-generating substrate may comprise tobacco, and preferably the tobacco containing material contains volatile tobacco flavor compounds, which are released from the aerosol-generating substrate upon heating.

The aerosol-generating substrate may comprise homogenized tobacco material. Homogenized tobacco material may be formed by agglomerating particulate tobacco. Where present, the homogenized tobacco material may have an aerosol-former content of equal to or greater than 5% on a dry weight basis, and preferably between greater than 30% by weight on a dry weight basis. The aerosol-former content may be less than about 95% on a dry weight basis.

The aerosol-generating substrate may alternatively or additionally comprise a non-tobacco-containing material. The aerosol-generating substrate may comprise homogenized plant-based material.

The aerosol-generating substrate may comprise, for example, one or more of: powder, granules, pellets, shreds, spaghettis, strips or sheets containing one or more of: herb leaf, tobacco leaf, fragments of tobacco ribs, reconstituted tobacco, homogenized tobacco, extruded tobacco and expanded tobacco.

The aerosol-generating substrate may comprise at least one aerosol-former. The aerosol-former may be any suitable known compound or mixture of compounds that, in use, facilitates formation of a dense and stable aerosol and that is substantially resistant to thermal degradation at the operating temperature of the aerosol-generating device. Suitable aerosol-formers are well known in the art and include, but are not limited to: polyhydric alcohols, such as triethylene glycol, 1,3-butanediol and glycerine; esters of polyhydric alcohols, such as glycerol mono-, di- or triacetate; and aliphatic esters of mono-, di- or polycarboxylic acids, such as dimethyl dodecanedioate and dimethyl tetradecanedioate. Particularly preferred aerosol formers are polyhydric alcohols or mixtures thereof, such as triethylene glycol, 1,3-butanediol and, most preferred, glycerine. The aerosol-forming substrate may comprise other additives and ingredients, such as flavorants. The aerosol-generating substrate preferably comprises nicotine and at least one aerosol-former. In a particularly preferred embodiment, the aerosol-former is glycerine.

The solid aerosol-forming substrate may be provided on or embedded in a thermally stable carrier. The carrier may comprise a thin layer on which the solid substrate deposited on a first major surface, on second major outer surface, or on both the first and second major surfaces. The carrier may be formed of, for example, a paper, or paper like material, a non-woven carbon fiber mat, a low mass open mesh metallic screen, or a perforated metallic foil or any other thermally stable polymer matrix. Alternatively, the carrier may take the form of powder, granules, pellets, shreds, spaghettis, strips or sheets. The carrier may be a non-woven fabric or fiber bundle into which tobacco components have been incorporated. The non-woven fabric or fiber bundle may comprise, for example, carbon fibers, natural cellulose fibers, or cellulose derivative fibers.

In some examples, the aerosol generating substrate is in the form of a suspension. For example, the aerosol generating substrate may be in the form of a thick, molasses-like, suspension.

Air that enters the cartridge flows across the aerosol generating substrate, entrains aerosol, and exits the cartridge and receptacle via an aerosol outlet. From the aerosol outlet, the air carrying the aerosol enters a vessel.

The shisha device may comprise any suitable vessel defining an interior volume configured to contain a liquid and defining an outlet in head-space above a liquid fill level. The vessel may comprise an optically transparent or opaque housing to allow a consumer to observe contents contained in the vessel. The vessel may comprise a liquid fill demarcation, such as a liquid fill line. The vessel housing may be formed of any suitable material. For example, the vessel housing may comprise glass or suitable rigid plastic material. Preferably, the vessel is removable from a portion of the shisha device comprising the aerosol-generation element to allow a consumer to fill or clean the vessel.

The vessel may be filled to a liquid fill level by a consumer. The liquid preferably comprises water, which may optionally be infused with one or more colorants, flavorants, or colorant and flavorants. For example, the water may be infused with one or both of botanical or herbal infusions.

Aerosol entrained in air exiting the chamber may travel through a conduit positioned in the vessel. The conduit may be coupled to the chamber and may have an opening below the liquid fill level of the vessel, such that aerosol flowing through the vessel flows through the opening of the conduit, then through the liquid, into headspace of the vessel and exits the headspace outlet for delivery to a consumer.

The headspace outlet may be coupled to a hose comprising a mouthpiece for delivering the aerosol to a consumer. The mouthpiece may comprise a switch activatable by a user or a puff sensor operably coupled to the control electronics of the shisha device. Preferably, the switch or puff sensor is wirelessly coupled to the control electronics. Activation of a switch or puff sensor may cause the control electronics to activate the heating element, rather than constantly supplying energy to the heating element. Accordingly, the use of a switch or puff sensor may serve to save energy relative to devices not employing such elements to provide on-demand heating rather than constant heating.

For purposes of example, one method for using a shisha device as described herein is provided below in chronological order. The vessel may be detached from other components of the shisha device and filled with water. One or more of natural fruit juices, botanicals, and herbal infusions may be added to the water for flavoring. The amount of liquid added should cover a portion of the conduit but should not exceed a fill level mark that may optionally exist on the vessel. The vessel is then reassembled to the shisha device. A portion of the aerosol generating element may be removed or opened to allow the aerosol generating substrate or the cartridge to be inserted into the receptacle. The aerosol generating element is then reassembled or closed. The device may then be turned on. A user may puff from a mouth piece

until a desired volume of aerosol is produced to fill the chamber having the air-accelerating inlet. The user may puff on the mouth piece as desired. The user may continue using the device until no more aerosol is visible in the chamber. Preferably, the device will automatically shut off when the cartridge or substrate is depleted of usable aerosol-generating substrate. Alternatively or in addition, the consumer may refill the device with fresh aerosol generating substrate or a fresh cartridge after, for example, receiving the cue from the device that the consumables are depleted or nearly depleted. If refilled with fresh substrate or a fresh cartridge, the device may continue to be used. Preferably, the shisha device may be turned off at any time by a consumer by, for example, switching off the device.

In some examples, a user may activate one or more heating elements by using an activation element on, for example, the mouthpiece. The activation element may be, for example, in wireless communication with the control electronics and may signal control electronics to activate the heating element from standby mode to full heating. Preferably, such manual activation is only enabled while the user puffs on the mouthpiece to prevent overheating or unnecessary heating of aerosol-generating substrate in the cartridge.

In some examples, the mouthpiece includes a puff sensor in wireless communication with the control electronics and puffing on the mouthpiece by a consumer causes activation of the heating elements from a standby mode to full heating.

A shisha device of the invention may have any suitable air management. In one example, puffing action from the user will create a suction effect causing a low pressure inside the device which will cause external air to flow through air inlet of the device, into the fresh air inlet channel, and into the receptacle of the aerosol-generating element. The air may then flow through aerosol generating substrate or a cartridge containing the substrate in the receptacle to carry aerosol through the aerosol outlet of the receptacle. The air containing the aerosol then may flow into a first aperture of the air-accelerating inlet of the chamber (unless the outlet of the aerosol-generating element also serves as the air-accelerating inlet of the chamber). As the air flows through the inlet of the chamber the air is accelerated. The accelerated air exits the inlet through a second aperture to enter the main chamber of the chamber, where the air is decelerated. Deceleration in the main chamber may improve nucleation leading to enhanced visible aerosol in the chamber. The aerosolized air then may exit the chamber and flow through the conduit (unless the conduit is the main chamber of the chamber) to the liquid inside the vessel. The aerosol will then bubble out of the liquid and into head space in the vessel above the level of the liquid, out the headspace outlet, and through the hose and mouthpiece for delivery to the consumer. The flow of external air and the flow of the aerosol inside the shisha device may be driven by the action of puffing from the user.

Preferably, assembly of all main parts of a shisha device of the invention assures hermetic functioning of the device. Hermetic function should assure that proper air flow management occurs. Hermetic functioning may be achieved in any suitable manner. For example, seals such as sealing rings and washers maybe used to ensure hermetic sealing.

Sealing rings and sealing washers or other sealing elements may be made of any suitable material or materials. For example, the seals may comprise one or more of graphene compounds and silicon compounds. Preferably, the materials are approved for use in humans by the U.S. Food and Drug Administration.

Main parts, such as the chamber, the conduit from the chamber, a cover housing of the receptacle, and the vessel may be made of any suitable material or materials. For example, these parts may independently be made of glass, glass-based compounds, polysulfone (PSU), polyethersulfone (PES), or polyphenylsulfone (PPSU). Preferably, the parts are formed of materials suitable for use in standard dish washing machines.

In some examples, a mouthpiece of the invention incorporates a quick coupling male/female feature to connect to a hose unit.

Reference will now be made to the drawings, which depict one or more aspects described in this disclosure. However, it will be understood that other aspects not depicted in the drawings fall within the scope and spirit of this disclosure. Like numbers used in the figures refer to like components, steps and the like. However, it will be understood that the use of a number to refer to a component in a given figure is not intended to limit the component in another figure labeled with the same number. In addition, the use of different numbers to refer to components in different figures is not intended to indicate that the different numbered components cannot be the same or similar to other numbered components. The figures are presented for purposes of illustration and not limitation. Schematic drawings presented in the figures are not necessarily to scale.

Referring now to **FIG. 1**, a schematic sectional drawing of an example of a shisha device **100** is shown. The device **100** includes a vessel **17** defining an interior volume configured to contain liquid **19** and defining a headspace outlet **15** above a fill level for the liquid **19**. The liquid **19** preferably comprises water, which may optionally be infused with one or more colorants, one or more flavorants, or one or more colorants and one or more flavorants. For example, the water may be infused with one or both of botanical infusions or herbal infusions.

The device **100** also includes an aerosol-generating element **130**. The aerosol-generating element **130** includes a receptacle **140** configured to receive a cartridge **150**

containing an aerosol-generating substrate (or receive aerosol-generating substrate that is not in a cartridge). The aerosol-generating element **130** also includes a heating element **160** that forms at least one surface of the receptacle **140**. In the depicted embodiment, the heating element **160** defines the top and side surfaces of the receptacle **140**. The aerosol-generating element **130** also includes a fresh air inlet channel **170** that draws fresh air into the device **100**. A portion of the fresh air inlet channel **170** is formed by the heating element **160** to heat the air before the air enters the receptacle **140**. The pre-heated air then enters the cartridge **150** (or substrate that is not a cartridge), which is also heated by heating element **160**, to carry aerosol generated by aerosol generating substrate. The air exits an outlet of the aerosol-generating element **130** and enters a chamber **200**.

A conduit **190** carries the air and aerosol from the chamber **200** into the vessel **17** below the level of the liquid **19**. The air and aerosol may bubble through the liquid **19** and exit the headspace outlet **15** of the vessel **17**. A hose **20** may be attached to the headspace outlet **15** to carry the aerosol to the mouth of a user. A mouthpiece **25** may be attached to, or form a part of, the hose **20**.

The air flow path of the device, in use, is depicted by thick arrows in **FIG. 1**.

The mouthpiece **25** may include an activation element **27**. The activation element **27** may be a switch, button or the like, or may be a puff sensor or the like. The activation element **27** may be placed at any other suitable location of the device **100**. The activation element **27** may be in wireless communication with the control electronics **30** to place the device **100** in condition for use or to cause control electronics to activate the heating element **160**; for example, by causing power supply **35** to energize the heating element **140**.

The control electronics **30** and power supply **35** may be located in any suitable position of the aerosol generating element **130** other than the bottom portion of the element **130** as depicted in **FIG. 1**.

FIG. 2 shows a schematic sectional view of an example of a chamber **200**. The chamber **200** comprises a housing **210** defining a main chamber **230**. The chamber **200** includes an inlet **220** extending or protruding into the main chamber **230**. The inlet includes a first aperture **223** and a second aperture **227**. Air containing aerosol from the aerosol-generating element enters the inlet **220** through the first aperture **223** and enters the main chamber **230** through the second aperture **227**. The first aperture **223** has a diameter greater than the second aperture **227** so that air flowing through the inlet **220** from the first aperture **223** to the second aperture **227** is accelerated. The accelerated air may exit the second aperture

227 to enter the main chamber **230**. The air is decelerated as it exits the second aperture **227** and enters the main chamber **230**. The decelerated air containing the aerosol may then exit the main chamber **230** through an outlet **240**, which may be fluidly coupled with a conduit (such as conduit **190** depicted in **FIG. 1**) to carry the aerosol to the vessel.

FIG. 3 shows a schematic sectional view of an example of a chamber **200** operably connected to an aerosol-generating element **130** and a conduit **190**. Not all components are shown for purposes of brevity and clarity. In the illustrated embodiment, air (arrows) enters in air inlets **171** in an upper part **131** of the aerosol-generating element **130**, then passes through a heat shield **165**, then follows the outside surface of the heating element **160** and arrives to the top of the heating element **160**. The heated air then goes through a top surface of a housing of the cartridge **150**, through the aerosol-generating substrate **155**, and through a void in a bottom part **133**, down to the aerosol outlet **180**. The aerosolized air then enters the inlet **220** of the chamber **200**, as the aerosolized air travels through the inlet **220**, it is accelerated. The accelerated air exits the inlet **220** via the second aperture **227** and enters the main chamber **230**, where the accelerated air is expanded. The decelerated air exits the chamber **200** via outlet **240** and enters conduit **190** for travel into the vessel.

In embodiment depicted in **FIG. 3**, the air travels along the outer surface of the heating element **160** and then through the heating element **160**. In other embodiments (not depicted), the air may travel along an inner surface of the heating element **160**.

In the example depicted in **FIG. 3**., the upper part **131** of the aerosol-generating element **130** may be removed from the lower part **133** to allow the cartridge **150** (or aerosol generating substrate that is not in a cartridge) to be inserted or removed from the receptacle formed by the heating element **160** and the top surface of the bottom part **131**. The bodies of the upper part **131** and the lower part **133** may be formed from thermally insulating material.

In the embodiment, depicted in the schematic sectional view of **FIG. 4** the aerosol-generating element **130** includes a thermocouple **199** operably coupled to control electronics (not shown in **FIG. 4**). In the depicted example, the thermocouple **199** penetrates into the cartridge **150** and aerosol generating substrate **155**. The thermocouple **199** may penetrate into the cartridge **150** when the cartridge **150** is positioned on the bottom part **133** and the upper part **131** is placed over the bottom part **131**. The thermocouple **199** may be in contact with the heating element **160**, in proximity to the outlet **180**, or in any other suitable location to provide feedback of a relevant temperature when the shisha device is in use.

Referring now to **FIG. 5**, a schematic perspective view of an example of a cartridge **150** that may be used with a shisha device described herein is shown. The cartridge **150** includes a housing **151** and a plurality of apertures **153** formed in the top surface of the housing to allow air flow through the cartridge **150** and aerosol generating substrate contained in the housing. The bottom of the cartridge **150** may also contain one or more apertures to allow air flow through the cartridge **150**.

In some examples, such as in **FIG. 3**, where air flows through the top of the receptacle, the top of the receptacle may have a similar distribution of apertures as the cartridge shown in **FIG. 5**.

The features described above in relation to one aspect of the invention may also be applicable to another aspect of the invention.

In the following non-limiting example, the ability of a chamber to increase the visible amount of aerosol and to increase the total aerosol mass deliverable to a user is described. A chamber having length of 40 mm and a diameter of 30 mm was constructed by 3D printing using a high temperature resin. The chamber had an inlet nozzle having a first aperture diameter of 7 mm and a second aperture diameter of 1.6 mm. The frustroconical nozzle had a length of 30 mm. The nozzle employed was a laboratory pipette tip.

A shisha device with the chamber was assembled, and a shisha device without the chamber was assembled. The two shisha devices were essentially the same except for the presence or absence of the chamber and associated inlet.

An aerosol-generating element containing a cartridge receptacle and a wound-wire heating element was coupled to the chamber or to a conduit in the device that did not include the chamber. The chamber was coupled to a conduit. In both devices, the conduit extended below a liquid level in a vessel.

A cartridge filled with 10 g of commercially available Al-Fakher tobacco molasses was placed in contact with the wound-wire heating element in both devices. The wound-wire was set at a constant temperature of 230 ºC.

The created aerosol was collected using a total of 10 Cambridge pads whose weight was recorded before and after the smoking experience. The total duration of the experience corresponds to 105 puffs. To achieve the desired puffing experience, four Programmable Dual Syringe Pumps (PDSP) were used simultaneously to create the following puffing regime:

- *Puff volume: 530 mL*
- *Puff duration: 2600 ms*
- *Duration between puffs: 17 s*

The amount of visible aerosol in the headspace of the vessel was drastically increased in the shisha device having the chamber, as shown in **FIGS. 6A-B**. **FIG. 6A** shows the shisha device without the chamber. **FIG. 6B** show the shisha device with the chamber.

In the device without the chamber, the substrate is electrically heated and the created vapor passes directly from the bottom of the cartridge to the conduit (stem pipe) and then through the water. In the device with the chamber, the air is accelerated upon passage through a nozzle and subsequently decelerated in the chamber. As a result, the amount of generated visible smoke is substantially increased.

In addition, the total amount of collected aerosol increased from 374 mg (without chamber) to 1159 mg (with chamber).

The experimental setup was arranged such that only two of the ten Cambridge pads collect the generated aerosol at a given moment. Every 20 puffs, a check valve ensured that the aerosol was diverted to the correct pair of Cambridge pads. Thus, the production of aerosol could be monitored as a function of time.

In **FIG. 7**, the average total aerosol mass (TAM) per puff is shown for puffs 20, 40, 60, 80, and 105 for two different configurations. The average TAM per puff obtained by the electric shisha without the chamber is depicted using triangles. The TAM obtained using the same device with the addition of the chamber compromising a nozzle is displayed using circles.

All scientific and technical terms used herein have meanings commonly used in the art unless otherwise specified. The definitions provided herein are to facilitate understanding of certain terms used frequently herein.

As used in this specification and the appended claims, the singular forms “a”, “an”, and “the” encompass embodiments having plural referents, unless the content clearly dictates otherwise.

As used in this specification and the appended claims, the term “or” is generally employed in its sense including “and/or” unless the content clearly dictates otherwise.

As used herein, “have”, “having”, “include”, “including”, “comprise”, “comprising” or the like are used in their open-ended sense, and generally mean “including, but not limited to”. It will be understood that “consisting essentially of”, “consisting of”, and the like are subsumed in “comprising,” and the like.

The words “preferred” and “preferably” refer to embodiments of the invention that may afford certain benefits under certain circumstances. However, other embodiments may also be preferred under the same or other circumstances. Furthermore, the recitation of one or more preferred embodiments does not imply that other embodiments are not useful, and is not intended to exclude other embodiments from the scope of the disclosure, including the claims.

Any direction referred to herein, such as "top," "bottom," "left," "right," "upper," "lower," and other directions or orientations are described herein for clarity and brevity are not intended to be limiting of an actual device or system. Devices and systems described herein may be used in a number of directions and orientations.

The embodiments exemplified above are not limiting. Other embodiments consistent with the embodiments described above will be apparent to those skilled in the art.

CLAIMS

1. A shisha device comprising:

a vessel defining an interior configured to contain a volume of liquid, the vessel comprising a head space outlet;

an aerosol-generating element in fluid connection with the vessel, wherein the aerosol-generating element comprises

an electric heating element;

a receptacle for receiving a shisha aerosol generating substrate to be heated by the heating element;

an inlet in communication with the receptacle; and

an outlet in communication with the receptacle; and

a chamber between the vessel and the aerosol-generating element and in fluid connection with the vessel and the aerosol-generating element, wherein the chamber comprises an inlet configured to accelerate air containing aerosol that flows through the inlet from the aerosol-generating element,

wherein the shisha device is configured to heat the aerosol generating substrate received in the receptacle to an extent sufficient to generate an aerosol without combusting the aerosol generating substrate.

2. A shisha device according to claim 1, wherein the chamber comprises a main chamber in fluid communication with the inlet, wherein the main chamber is sized and shaped to allow deceleration of the air containing the aerosol in the main chamber when the air containing the aerosol exits the inlet and enters the main chamber.

3. A shisha device according to claim 1 or claim 2, wherein the chamber results in an increase in total aerosol mass that exits the head space outlet during use of the shisha device relative to a device that does not include the chamber.

4. A shisha device according to claim 3, wherein the increase in total aerosol mass is 1.5-fold or greater.

5. A shisha device according to any one of the claims 2-4, wherein the inlet has a first aperture in proximity to the aerosol-generating element and a second aperture in the main chamber, wherein aerosol from the aerosol-generating element flows into the inlet through the first aperture and out of the second aperture into the main chamber.

6. A shisha device according to claim 5, wherein the first aperture has a diameter larger than the second aperture.

7. A shisha device according to claim 5 or claim 6 wherein the first aperture has a diameter in a range from about 1 mm to about 10 mm.

8. A shisha device according to any one of claims 5 to 7, wherein the second aperture has a diameter in a range from about 0.5 mm to about 4 mm.

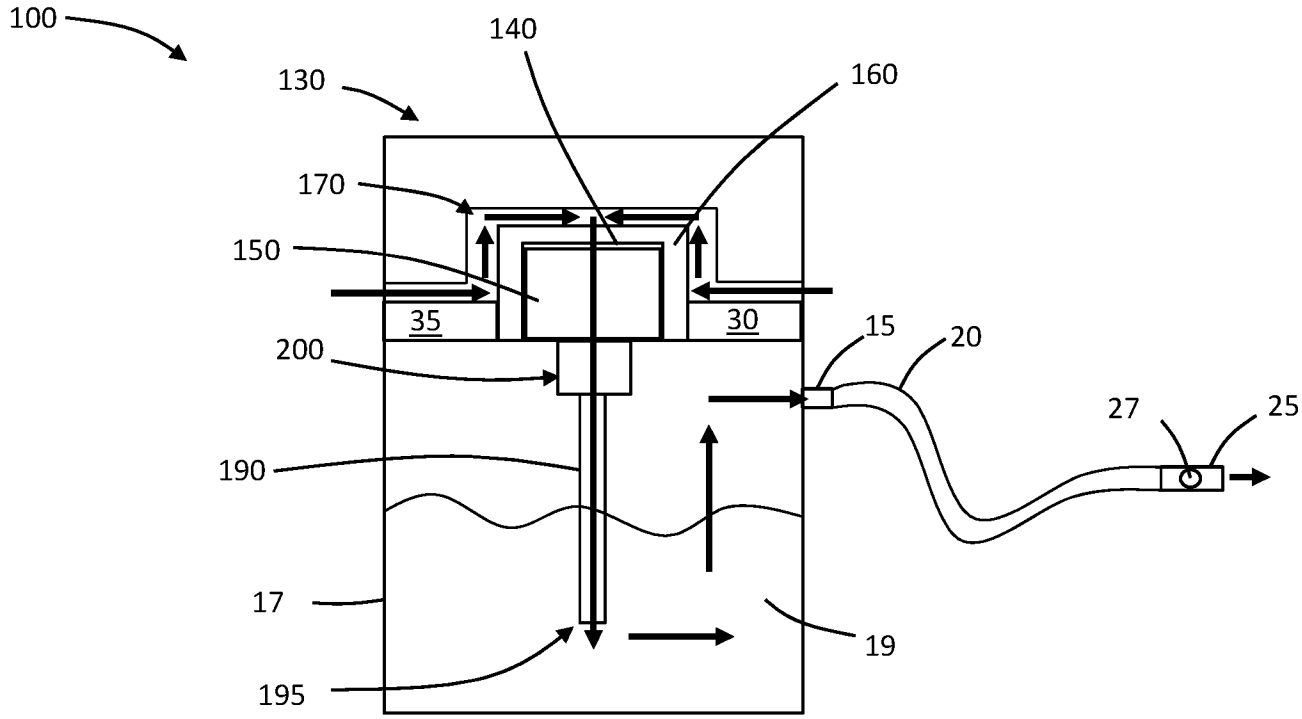
9. A shisha device according to any one of claims 5 to 8, wherein the inlet has a length from the first aperture to the second aperture of about 1 mm to about 20 mm.

10. A shisha device according to any one of claims 2 to 9, wherein the inlet protrudes into the main chamber.

11. A shisha device according to any one of claims 2 to 10, wherein the inlet has a frustroconical shape.

12. A shisha device according to any one of claims 2 to 11, wherein the main chamber has a diameter of at least about 10 mm.

13. A shisha device according to any one of claims 2 to 12, wherein the main chamber has a length of at least about 10 mm.


100
140
130
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170
150
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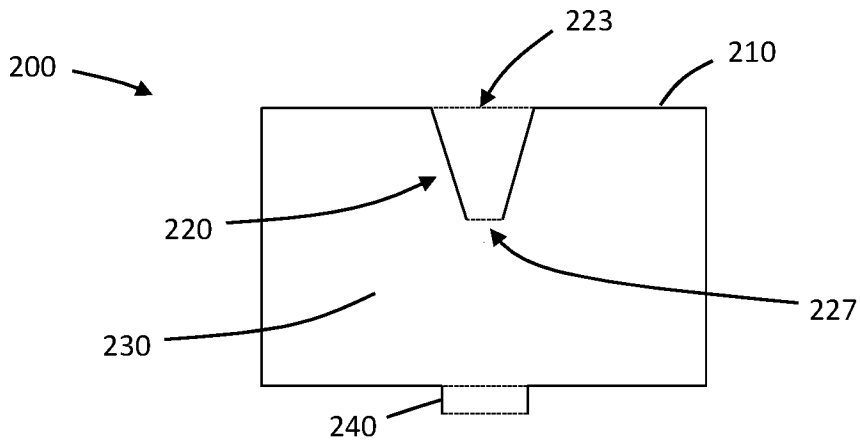
30
15
20
200
27
25
190
17
19
195

FIG. 1


223
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200
220
227
230
240

FIG. 2

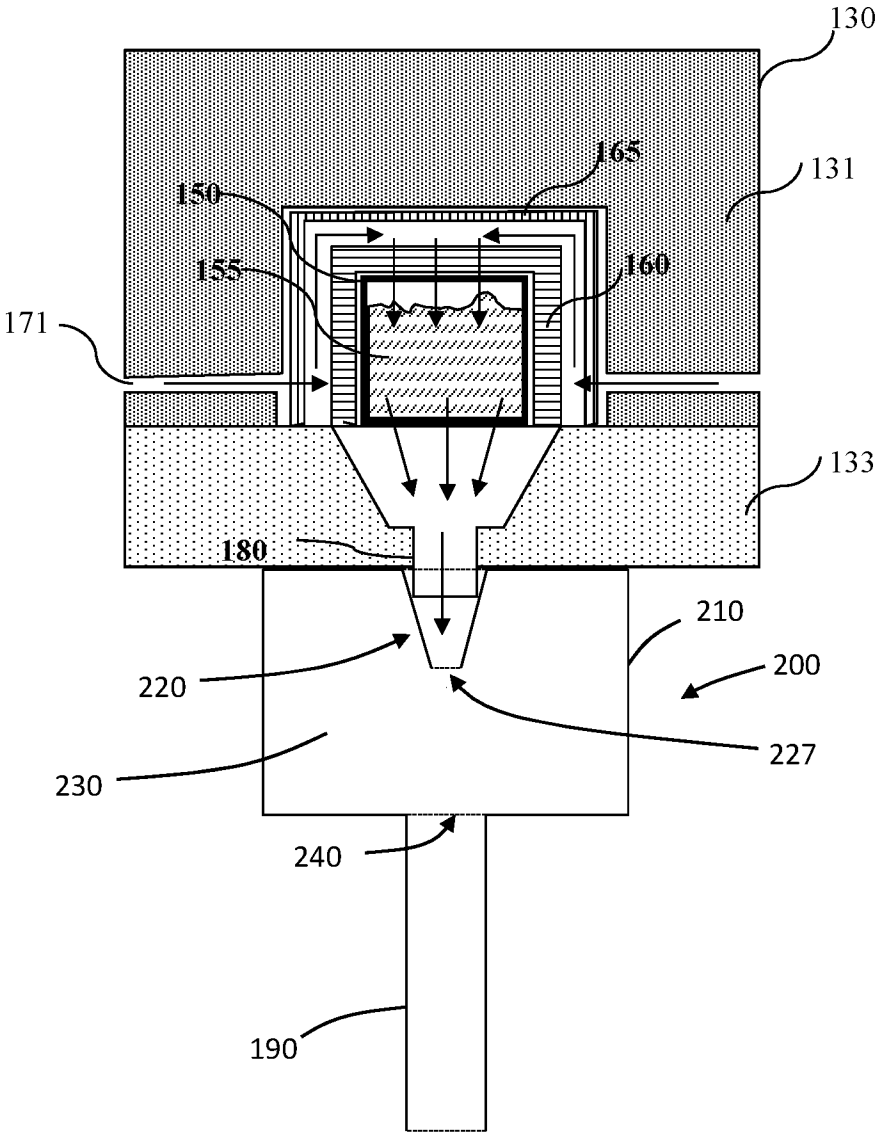

FIG. 3

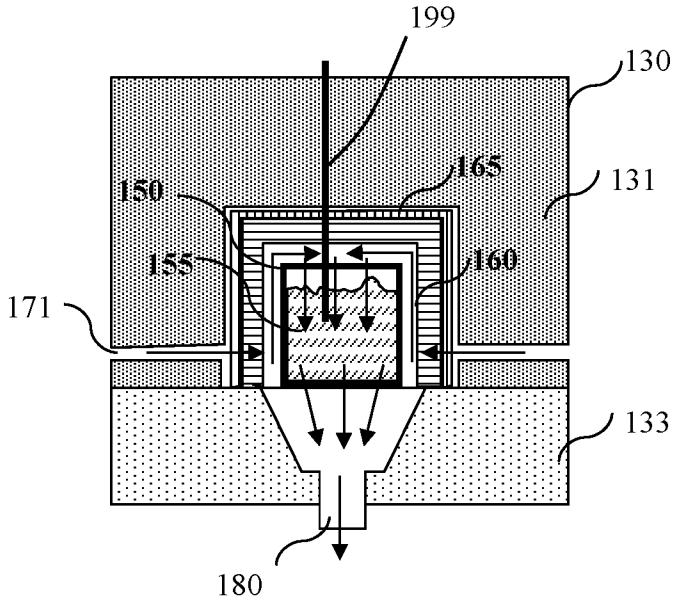

FIG. 4

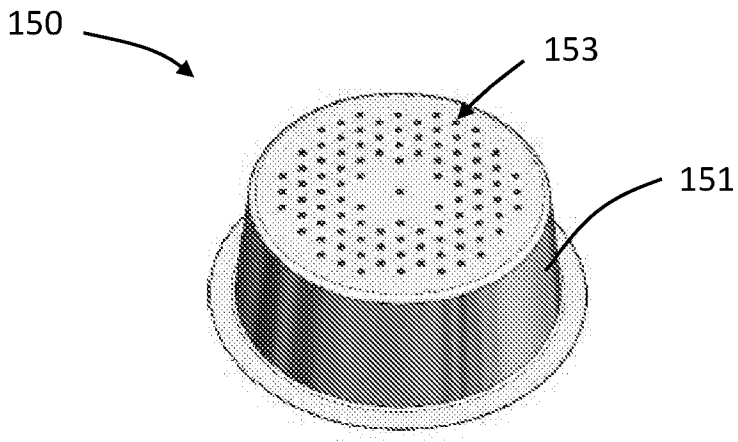

FIG. 5

FIG. 6A

FIG. 6B

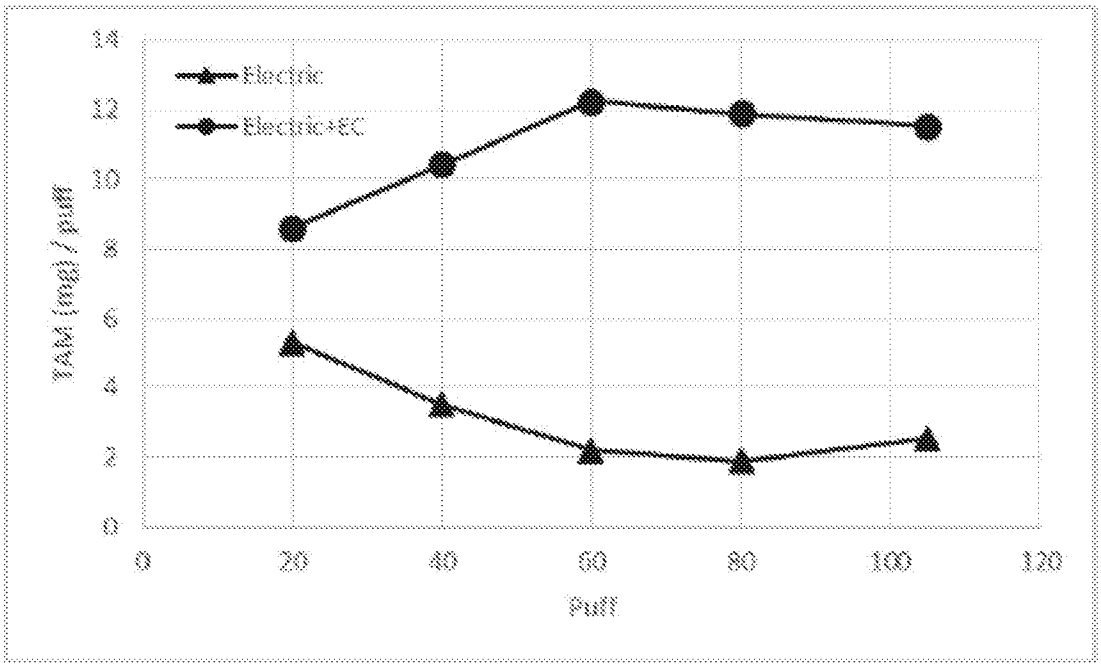

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/055354

A. CLASSIFICATION OF SUBJECT MATTER
INV. A24F1/30
ADD. A24F1/06 A24F47/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2016/019573 A1 (LIU SHUIGEN [CN]) 11 February 2016 (2016-02-11)	1-3,5-9, 12,13
A	paragraph [0029] - paragraph [0041]; figures 1,3	4,10,11
Y	US 2016/157520 A1 (ALFAWAZ ABDALLA [US] ET AL) 9 June 2016 (2016-06-09)	1-3,5, 7-9,12, 13
A	paragraph [0044] - paragraph [0051]	4,6,10, 11
Y	US 2017/055570 A1 (ELHALWANI WAEL SALIM [AE]) 2 March 2017 (2017-03-02)	1-3,5, 7-9,12, 13
A	paragraph [0026] - paragraph [0035]; figure 2	4,6,10, 11

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 November 2018	26/11/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Koob, Michael

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/055354

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 20 2016 003899 U1 (BARZ FYNN [DE]; KECK ADRIAN [DE]) 23 August 2016 (2016-08-23)	1-3,5, 7-9,12, 13
A	paragraph [0004]	4,6,10, 11

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2018/055354

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		WO 2016019573 A1	11-02-2016
US 2016157520 A1	09-06-2016	NONE	
US 2017055570 A1	02-03-2017	NONE	
DE 202016003899 U1	23-08-2016	NONE	