Innovation, Sciences et Développement économique Canada
Office de la Propriété Intellectuelle du Canada

Innovation, Science and Economic Development Canada
Canadian Intellectual Property Office

CA 3149242 A1 2021/04/29

(21) 3 149 242

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2020/10/23
(87) Date publication PCT/PCT Publication Date: 2021/04/29
(85) Entrée phase nationale/National Entry: 2022/02/23
(86) N° demande PCT/PCT Application No.: IB 2020/059994
(87) N° publication PCT/PCT Publication No.: 2021/079345
(30) Priorité/Priority: 2019/10/25 (EP19205471.6)

(51) Cl.Int./Int.Cl. *A61M 15/00* (2006.01),
A61M 15/06 (2006.01)

(71) Demandeur/Applicant:
PHILIP MORRIS PRODUCTS S.A., CH

(72) Inventeurs/Inventors:
CAMPITELLI, GENNARO, CH;
MOHSENI, FARHANG, CH

(74) Agent: RIDOUT & MAYBEE LLP

(54) Titre : SUPPORT POUR ARTICLE D'INHALATEUR
(54) Title: HOLDER FOR INHALER ARTICLE

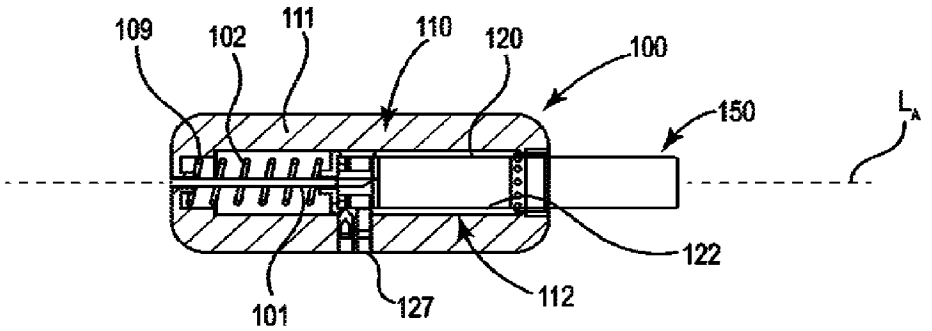

FIG. 2

(57) Abrégé/Abstract:
A holder for an inhaler article includes a housing comprising a housing cavity for receiving an inhaler article a sleeve configured to retain an inhaler article within the housing cavity. The sleeve includes a sleeve cavity and is movable within the housing cavity along a longitudinal axis of the housing. The sleeve includes a first open end and a second opposing end. The first open end is configured to receive an inhaler article and the second opposing end of the sleeve is configured to allow air to enter the sleeve cavity. The second opposing end of the sleeve is configured to induce a swirl on the air entering the sleeve cavity.

Date Submitted: 2022/02/23

CA App. No.: 3149242

Abstract:

A holder for an inhaler article includes a housing comprising a housing cavity for receiving an inhaler article a sleeve configured to retain an inhaler article within the housing cavity. The sleeve includes a sleeve cavity and is movable within the housing cavity along a longitudinal axis of the housing. The sleeve includes a first open end and a second opposing end. The first open end is configured to receive an inhaler article and the second opposing end of the sleeve is configured to allow air to enter the sleeve cavity. The second opposing end of the sleeve is configured to induce a swirl on the air entering the sleeve cavity.

HOLDER FOR INHALER ARTICLE

This disclosure relates to a holder for an inhaler article and inhaler systems that include the holder and an inhaler article. The holder is configured to generate swirling inhalation airflow and transmit the swirling airflow to the inhaler article during consumption.

Dry powder inhalers are not always fully suitable to provide dry powder particles to the lungs at inhalation or air flow rates that are within conventional smoking regime inhalation or air flow rates. Dry powder inhalers may be complex to operate or may involve moving parts. Dry powder inhalers often strive to provide an entire dry powder dose or capsule load in a single breath.

It would be desirable to provide an inhaler system that minimizes complex parts, especially with regard to an inhaler article of an inhaler system. It would be desirable to provide an inhaler system that efficiently depletes a capsule of particles during consumption. It would be desirable to provide a holder for an inhaler article that induces swirling inhalation airflow into an inhaler article.

It would be desirable to provide a holder for an inhaler article that activates the inhaler article and retain the inhaler article during consumption. It would be desirable to provide an inhaler system that includes a low-profile and reusable holder for an inhaler article that can activate the inhaler article. It would be desirable to provide a nicotine powder inhaler that provides nicotine particles to the lungs at inhalation or air flow rates that are within conventional smoking regime inhalation or air flow rates. It would also be desirable to deliver the nicotine powder with an inhaler article that has a form similar to a conventional cigarette.

This disclosure is directed to a holder for an inhaler article. The holder is configured to induce swirling inhalation airflow to an inhaler article during consumption. The holder and an inhaler article may form an inhaler system to which this disclosure is also directed.

According to an aspect of the present invention, a holder for an inhaler article includes a housing comprising a housing cavity for receiving an inhaler article and a sleeve configured to retain an inhaler article within the housing cavity. The sleeve comprising a sleeve cavity and being movable within the housing cavity along a longitudinal axis of the housing. The sleeve comprises a first open end and a second opposing end. The second opposing end of the sleeve

is configured to allow air to enter the sleeve cavity. The second opposing end of the sleeve is configured to induce a swirl on the air entering the sleeve cavity.

According to an aspect of the present invention, a holder for an inhaler article includes a housing comprising a housing cavity for receiving an inhaler article and a sleeve configured to retain an inhaler article within the housing cavity. The sleeve includes a sleeve cavity and is movable within the housing cavity along a longitudinal axis of the housing. The sleeve includes a first open end and a second opposing end. The first open end is configured to receive an inhaler article and the second opposing end of the sleeve includes a tubular element having a central passage in fluid communication with the sleeve cavity and at least one air inlet. The at least one air inlet extends in a direction that is tangential to the central passage to allow air to enter the sleeve cavity and to induce a swirled airflow pattern on the air entering the sleeve cavity.

Advantageously, incorporating a swirl generating structure into a reusable holder may simplify the construction of the inhaler articles and reduce the complexity of the inhaler system. Inhaler articles that receive swirling inhalation airflow may be easier to manufacture and have a simpler construction than inhaler articles that have to include structures to induce or form swirling inhalation airflow. The simpler inhaler articles may also present less environmental burden.

The second opposing end of the sleeve may comprise a tubular element having a central passage in fluid communication with the sleeve cavity. The second opposing end may include at least one air inlet allowing air to enter into the central passage. The air entering the central passage may be air external to the sleeve. The at least one air inlet may extend in a direction that is tangential to the central passage. The tubular element may comprise at least two air inlets that extend in a direction tangential to the central passage. The tubular element may comprise at least three air inlets that extend in a direction tangential to the central passage. Preferably, the at least one air inlet extends in a transverse direction of the sleeve. A transverse direction of the sleeve is a direction orthogonal or perpendicular to the longitudinal direction defined by the sleeve. Preferably, the sleeve is cylindrical. These tangential air inlets cooperate with inhalation airflow to form or induce a swirling or swirled airflow pattern into the central passage of the tubular member. Once an inhaler article is received in the sleeve and tubular element of the holder, this swirling or swirled airflow pattern is transmitted thorough the inhaler article and out the mouthpiece end of the inhaler article.

Advantageously, tangential inhalation airflow into the tubular element induces rotational or swirling airflow within the central passage. This rotational or swirling airflow may be provided or transmitted into a capsule cavity of an inhaler article received within the sleeve of the holder. The rotational or swirling airflow induces a capsule contained within the capsule cavity to rotate and release particles into the rotational or swirling airflow to the consumer.

The tubular element defining the central passage may extend into the sleeve cavity and may form an annular recess with the sleeve cavity configured to receive a distal end of an inhaler article. The tubular element defining the central passage may extend into the sleeve cavity and forms an annular recess with the sleeve cavity configured to retain a distal end of an inhaler article. The tubular element defining the central passage may be configured to extend into a distal end of an inhaler article received within the sleeve cavity. Substantially all of the inhalation air enters the tubular element in a direction that is tangential to the central passage.

Advantageously, providing features on the second opposing end of the sleeve that mate with a received inhaler article may improve the reliable airflow connection from the swirl inducing sleeve to the inhaler article received in the sleeve. An interference fit may also provide a secure engagement of the inhaler article received in the sleeve so that the inhaler article will not fall out of the sleeve or associated holder.

The holder may further include a piercing element fixed to and extending from a housing inner surface. The piercing element is configured to extend through the second opposing end of the sleeve and into the sleeve cavity along a longitudinal axis of the housing.

The holder may further include a spring element configured to bias the sleeve away from the piercing element. The sleeve may include an elongated slot extending along a longitudinal length of the sleeve. The housing may further include a pin extending from an inner surface of the housing cavity. The pin may be configured to mate with the elongated slot.

The sleeve may define a first air inlet zone having at least one air aperture through the sleeve. The first air inlet zone is proximate to the first open end of the sleeve. The first air inlet zone may be configured to allow air to flow to an airflow channel formed between the sleeve and the housing. The sleeve includes a second air inlet zone downstream from the first air inlet zone. The second air inlet zone includes the second opposing end of the sleeve configured to allow air to enter the sleeve cavity.

According to another aspect of the present invention, an inhaler system comprises a holder for an inhaler article as described herein, and inhaler article. The sleeve of the holder retains the inhaler article received in the sleeve cavity. The inhaler article comprises a body extending along an inhaler longitudinal axis from a mouthpiece end to a distal end. A capsule is disposed within the inhaler article body.

Advantageously, a reusable holder that induces rotational or swirling airflow reduces the complexity of the associated consumable inhaler article. This may reduce the overall cost of manufacture of these inhaler systems and may improve the reliability or efficiency of capsule depletion.

The capsule is retained within a capsule cavity and configured to receive swirling inhalation airflow formed by the second opposing end of the sleeve. The capsule cavity is bounded downstream by a filter element and bounded upstream by an open tubular element.

The inhaler article open tubular element mates with the second opposing end of the sleeve tubular element. The mouthpiece end of the inhaler article may form the mouthpiece of the inhaler system

Advantageously, the inhaler system where an inhaler article has an open distal end that receives and transmits rotational or swirling airflow from the holder to the capsule cavity to induce rotation of the capsule within the inhaler article may reduce the overall manufacture cost of the inhaler system and may improve reliable depletion of the capsule during consumption. The replaceable consumable inhaler article provides a clean mouthpiece every time the consumed inhaler article is replaced with a fresh inhaler article.

Advantageously, the inhaler system provides an inhaler system that minimizes moving parts. Advantageously, the inhaler system utilizes a separate holder that induces rotational or swirling airflow to the inhaler article received within the holder. This may enable the holder to be reusable and the inhaler article to be disposable after a single use. Advantageously, the inhaler system efficiently provides nicotine particles to the lungs at inhalation or air flow rates that are within conventional smoking regime inhalation or air flow rates. The inhaler delivers the nicotine powder with an inhaler article that has a form similar to a conventional cigarette. The inhaler system described herein may provide a dry powder to the lungs at inhalation or air flow rates that are within conventional smoking regime inhalation or air flow rates. A consumer may take a plurality of inhalations or "puffs" where each "puff" delivers a fractional amount of dry powder

contained within a capsule contained within the capsule cavity. This inhaler article may have a form similar to a conventional cigarette and may mimic conventional smoking. This inhaler article may be simple to manufacture and convenient to use by a consumer.

Air flow management through a capsule cavity of the inhaler article may cause a capsule contained therein to rotate during inhalation and consumption. The capsule may contain particles containing nicotine (also referred to as "nicotine powder" or "nicotine particles") and optionally particles comprising flavour (also referred to as "flavour particles"). Rotation of the pierced capsule may suspend and aerosolize the nicotine particles released from the pierced capsule into the inhalation air moving through the inhaler article. The flavour particles may be larger than the nicotine particles and may assist in transporting the nicotine particles into the lungs of the user while the flavour particles preferentially remain in the mouth or buccal cavity of the user. The nicotine particles and optional flavor particles may be delivered with the inhaler article at inhalation or air flow rates that are within conventional smoking regime inhalation or air flow rates.

The term "nicotine" refers to nicotine and nicotine derivatives such as free-base nicotine, nicotine salts and the like.

The term "flavourant" or "flavour" refers to organoleptic compounds, compositions, or materials that alter and are intended to alter the taste or aroma characteristics of nicotine during consumption or inhalation thereof.

The terms "upstream" and "downstream" refer to relative positions of elements of the holder, inhaler article and inhaler systems described in relation to the direction of inhalation air flow as it is drawn through the body of the holder, inhaler article and inhaler systems.

The terms "proximal" and "distal" are used to describe the relative positions of components, or portions of components, of the holder, inhaler article, or system. Holders or elements (such as the sleeve) forming the holder, according to the invention have a proximal end which, in use, receives an inhaler article and an opposing distal end which may be a closed end, or have an end closer to the proximal end of the holder. Inhaler articles, according to the invention have a proximal end. In use, the nicotine particles exit the proximal end of the inhaler article for delivery to a user. The inhaler article has a distal end opposing the proximal end. The proximal end of the inhaler article may also be referred to as the mouth end.

The holder for an inhaler article described herein may be combined with an inhaler article containing a capsule for activating the inhaler article by piercing the capsule, providing reliable activation of the capsule (by puncturing the capsule with the piercing element of the holder) within inhaler article, and releasing the particles contained inside the capsule and enabling the article to deliver the particles to a consumer. The holder is separate from the inhaler article, but the consumer may utilize both the inhaler article and the holder while consuming the particles released within the inhaler article. A plurality of these inhaler articles may be combined with a holder to form a system or kit. A single holder may be utilized on 10 or more, or 25 or more, or 50 or more, or 100 or more, inhaler articles to activate (puncture or pierce) a capsule contained within each inhaler article and provide reliable activation and optionally, a visual indication (marking), for each inhaler article of the activation of the inhaler article.

A holder for an inhaler article includes a housing comprising a housing cavity for receiving an inhaler article and a sleeve configured to retain an inhaler article within the housing cavity. The sleeve comprising a sleeve cavity and being movable within the housing cavity along the longitudinal axis of the housing. The sleeve comprises a first open end and a second opposing end. The second opposing end of the sleeve is configured to allow air to enter the sleeve cavity. The second opposing end of the sleeve is configured to induce a swirl on the air entering the sleeve cavity.

An inhaler system comprises an inhaler article and a holder for an inhaler article as described herein. The sleeve of the holder retains the inhaler article received in the sleeve cavity. The inhaler article comprises a body extending along an inhaler longitudinal axis from a mouthpiece end to a distal end. A capsule is disposed within the inhaler article body.

A method includes, inserting an inhaler article into the sleeve of the holder for an inhaler article, as described herein. The inhaler article includes a body, the body extending along an inhaler longitudinal axis from a mouthpiece end to a distal end, a body length, and a capsule disposed within the inhaler article body. Then, moving the inhaler article and sleeve toward the piercing element until the piercing element pierces the capsule. Then drawing air into the second opposing end of the sleeve of the holder to form the swirling inhalation airflow. This swirling inhalation airflow is then transmitted into the inhaler article while the inhaler article is disposed within the holder for an inhaler article. The consumed inhaler article may then be

removed from the holder and discarded. Then a fresh inhaler article may be inserted into the holder and the method may be repeated.

The inhaler article is configured to receive swirling inhalation airflow directly into the distal end of the inhaler article. The swirling inhalation airflow then continues downstream into the capsule cavity and induces rotation of a capsule received in the capsule cavity. The activated capsule then releases a dose of particles into the swirling inhalation airflow downstream through the mouthpiece to the consumer. The distal end or upstream-most end of the inhaler article includes an open aperture that defines an open central passage of the open tubular element. Thus, the swirling inhalation airflow is created upstream from the inhaler article and swirling inhalation airflow enters the distal end or upstream-most end of the inhaler article.

An inhaler article comprises a body extending along an inhaler longitudinal axis from a mouthpiece end to a distal end. A capsule cavity is defined within the body bounded downstream by a filter element and bounded upstream by an open tubular element defining a central passage. The central passage forms an open air-inlet aperture extending from the distal end of the body to the capsule cavity. A capsule is disposed within the capsule cavity, wherein the central passage has a smaller diameter then the capsule. Thus the capsule may not pass through the central passage and is retained within the capsule cavity.

A holder for an inhaler article includes a housing comprising a housing cavity for receiving an inhaler article and a sleeve configured to retain an inhaler article within the housing cavity. The sleeve comprising a sleeve cavity and being movable within the housing cavity along the longitudinal axis of the housing. The sleeve comprises a first open end and a second opposing end. The second opposing end of the sleeve is configured to allow air to enter the sleeve cavity. The second opposing end of the sleeve is configured to induce a swirl on the air entering the sleeve cavity.

The second opposing end of the sleeve defines a swirl generating element that is configured to generate swirling or rotational inhalation airflow. This swirling or rotational inhalation airflow may be transmitted into an inhaler article to rotate a capsule and release dry powder contained within the capsule.

The second opposing end of the sleeve includes a tubular element having a central passage in fluid communication with the sleeve cavity. The second opposing end of the sleeve

has at least one air inlet allowing air to enter into the central passage. The at least one air inlet extends in a direction that is tangential to the central passage.

The second opposing end of the sleeve may have at least two air inlets allowing air to enter into the central passage. The at least two air inlets extend in a direction that is tangential to the central passage. The second opposing end of the sleeve may have two air inlets allowing air to enter into the central passage. The two air inlets extend in a direction that is tangential to the central passage.

The second opposing end of the sleeve may have at least three air inlets allowing air to enter into the central passage. The at least three air inlets extend in a direction that is tangential to the central passage. The second opposing end of the sleeve may three air inlets allowing air to enter into the central passage. The three air inlets extend in a direction that is tangential to the central passage.

The second opposing end of the sleeve may have four air inlets allowing air to enter into the central passage. The four air inlets extend in a direction that is tangential to the central passage.

The tubular element may be coaxial with the longitudinal axis of the housing. The tubular element may be coaxial with the sleeve cavity. The tubular element may be coaxial with both the longitudinal axis of the housing and the sleeve cavity.

The tubular element having a central passage may have a diameter in a range from about 30% to about 70% of a diameter of the sleeve cavity. The tubular element having a central passage may have a diameter in a range from about 40% to about 60% of a diameter of the sleeve cavity.

The tubular element having a central passage may extend into the sleeve cavity and form an annular recess with the sleeve cavity configured to receive a distal end of an inhaler article. The tubular element having a central passage may extend into the sleeve cavity and form an annular recess with the sleeve cavity configured to retain a distal end of an inhaler article.

The tubular element having a central passage may extend into a distal end of an inhaler article received within the sleeve cavity. The annular recess may be configured to retain the distal end of an inhaler article with an interference fit.

At least a portion of the tubular element having a central passage is located upstream from an inhaler article received in the sleeve. The tubular element having a central passage preferably is coaxial with the longitudinal axis of the received inhaler article.

The sleeve tubular element having a central passage may be sized to mate with an inhaler article distal end open tubular element defining a central passage. The sleeve tubular element having a central passage may abut the inhaler article distal end open tubular element defining a central passage. The sleeve tubular element having a central passage may interlock with an inhaler article distal end open tubular element defining a central passage. The sleeve tubular element having a central passage may fit within an inhaler article distal end tubular element defining a central passage. The sleeve tubular element central passage may have an inner diameter in a range from about 3 mm to about 5 mm, or about 4 mm.

The sleeve tubular element having a central passage may include at least one air inlet that extends in a direction that is tangential to the central passage. The tubular element may include at least two air inlets that extend in a direction tangential to the central passage. The tubular element may include at least three air inlets that extend in a direction tangential to the central passage.

The one or more air inlets may extend through the sidewall forming the opposing second end of the sleeve. The one or more air inlets may extend in a direction orthogonal to the longitudinal axis of the sleeve or housing. The one or more air inlets may extend in a direction orthogonal to the longitudinal axis of the tubular element having a central passage.

The sleeve tubular element having a central passage may include one air inlet that extends in a direction that is tangential to the central passage. The sleeve tubular element having a central passage may include two air inlets that extend in a direction tangential to the central passage. The sleeve tubular element having a central passage may include three air inlets that extend in a direction tangential to the central passage. The sleeve tubular element having a central passage may include four air inlets that extend in a direction tangential to the central passage.

Preferably the at least one air inlet enters the central passage at the inner diameter of the tubular element defining the inner diameter or periphery of the central passage. Preferably the at least two air inlets enter the central passage at the inner diameter of the tubular element defining the inner diameter or periphery of the central passage. Preferably the at least three air inlets enter the central passage at the inner diameter of the tubular element defining the inner

diameter or periphery of the central passage. Preferably the four air inlets enter the central passage at the inner diameter of the tubular element defining the inner diameter or periphery of the central passage.

The two or more air inlets are preferably equally spaced from get other around the circumference of the central passage.

The at least one air inlet that extends in a direction tangential to the central passage enters the central passage proximate to an end surface defining a distal end of the sleeve. The expression "one air inlet that extends in a direction that is tangential to the central passage" may refer to any portion of the air inlet that follows the direction of an imaginary line that touches the edge, or boundary, of the central passage at one point, but does not cross it. The end surface forms a substantially closed end surface allowing only a piercing element to extend through the end surface. The end surface extends orthogonally to the longitudinal axis of the sleeve. The end surface prevents inhalation air from flowing out through the distal end of the sleeve. The end surface directs inhalation air toward the sleeve cavity.

Preferably the at least one air inlet that extends in a direction that is tangential to the central passage enters the tubular element having a central passage at the end surface. Improved capsule depletion occurs when the tangential air inlets are located closer to the end surface of the central passage.

The tubular element may be a unitary construction with the sleeve (that is, integral to the sleeve) configured to retain an inhaler article within the housing cavity. The tubular element may form a portion of the second opposing end of the sleeve. The tubular element and sleeve may be formed with an injection moulding process. The tubular element and sleeve may be formed simultaneous with an injection moulding process.

The tubular element having a central passage may extend or protrude into the sleeve cavity. This tubular element having a central passage may have an outer surface having an outer diameter that faces the inner surface of the sleeve. The inner surface of the sleeve defining the sleeve cavity.

The tubular element having a central passage may extend into the sleeve cavity a distance in a range from about 2 mm to about 10 mm, or from about 3 mm to about 7 mm or from about 4 mm to about 6 mm, or about 5 mm. In these and other embodiments, the tubular element having a central passage may have an outer diameter in a range from about 4 to about

6.5 mm or from about 5 mm to about 6 mm, or from about 5 mm to about 5.5 mm, or preferably about 5.25 mm. At least a portion of the tubular element having a central passage may be inserted into the received inhaler article. Preferably at least 50% of the tubular element having a central passage may be inserted into the received inhaler article.

The tubular element having a central passage extending into the sleeve cavity may form an annular recess with the sleeve cavity configured to receive a distal end of an inhaler article. The tubular element having a central passage extending into the sleeve cavity may form an annular protrusion with the sleeve cavity configured to be received by a distal end of an inhaler article. The tubular element having a central passage extending into the sleeve cavity may form both an annular recess and an annular protrusion within the sleeve cavity configured to receive a distal end of an inhaler article.

The distal end of the inhaler article may be configured to mate with the annular recess formed by the tubular element having a central passage extending into the sleeve cavity. The distal end of the inhaler article may be configured to mate with the annular protrusion formed by the tubular element having a central passage extending into the sleeve cavity. The distal end of the inhaler article may be configured to mate with the annular recess and annular protrusion formed by the tubular element having a central passage extending into the sleeve cavity. The tubular element having a central passage may be configured to extend into a distal end of an inhaler article received within the sleeve cavity.

The annular protrusion formed by the tubular element having a central passage extending into the sleeve cavity may fit into or slide into the received inhaler article distal end open tubular element. The annular protrusion formed by the tubular element having a central passage extending into the sleeve cavity may fit within an inhaler article distal end open tubular element. The annular protrusion formed by the tubular element having a central passage extending into the sleeve cavity may form an interference fit within an inhaler article distal end open tubular element. Thus, the central passage of the sleeve tubular element having a central passage may fit into the inhaler article distal end open tubular element having a central passage.

The holder for an inhaler article may include a piercing element configured to pierce or activate a capsule within an inhaler article. The piercing element may be fixed to and extend from a housing inner surface. The piercing element may be configured to extend through the

end surface of the second opposing surface of the sleeve and into the sleeve cavity along a longitudinal axis of the housing.

The piercing element may extend through an aperture in the end surface of the sleeve. The piercing element may extend through a resealable element in the end surface of the sleeve. The resealable element may form an airtight seal or barrier at the end surface of the sleeve when a piercing element is not within the resealable element. The piercing element may extend through an aperture in the end surface of the sleeve and substantially block air flow thought the aperture.

The piercing element may pass through the end surface and puncture the capsule within the capsule cavity. The resealable element, if present in the piercing aperture, may reseal once the piercing element is retracted or removed from the resealable element. Resealable elements or membranes may include a septum or septum-like element. Resealable elements or membranes may be formed of elastic material such as rubber, silicone, metal foil co-laminated with a polymer, or latex and the like, or cellulose acetate tow, such as high-density cellulose acetate tow.

The piercing element may be fixed to and extend from the housing inner surface, into the housing cavity along a piercing element longitudinal axis a piercing element length. The piercing element may be recessed from an open proximal end of the housing by a recessed distance.

The distal end or upstream-most end of the inhaler article may contact the second opposing end of the sleeve and urge the sleeve to travel toward the piercing element. The sleeve may be co-axial with the piercing element. The sleeve may align the inhaler article so that the piercing element reliably activates capsule within the inhaler article. The sleeve or holder may also mechanically hold the piercing element and support the piercing element to prevent or mitigate deflection of the piercing element.

The sleeve may define a first air inlet zone comprising at least one air aperture through the sleeve. The first air inlet zone may include two or more, three or more, four or more, or from about 1 to about 10 air apertures, or from about 3 to about 9 air apertures. The first air inlet zone is proximate to the first open end of the sleeve. The first air inlet zone is configured to allow air to flow to an airflow channel formed between the sleeve and the housing.

The sleeve may comprise a second air inlet zone downstream from the first air inlet zone. The second air inlet zone comprising the second opposing end of the sleeve configured to

allow air to enter the sleeve cavity. The second air inlet zone may include one, two or more, three or more, or four or more air apertures the direct inlet or inhalation air into the second opposing end of the sleeve at a tangent to the tubular element central passage to form swirling inhalation airflow.

The holder may include a retaining ring element fixed to the open proximal end of the housing. The retaining ring element retains the sleeve within the inhaler article cavity. The retaining ring has a thickness sufficient to stop or retain the movement of the sleeve within the inhaler article cavity of the holder.

The holder may include a spring element configured to bias the sleeve between a relaxed (or undeformed) state and compressed (or deformed) state towards the open proximal end of the housing or away from piercing element. The spring element may be contained within the housing cavity of the holder and be compressed as the movable sleeve and inhaler article move toward the piercing element. The spring element may be located between the sleeve and closed end of the housing and contacts the sleeve and closed end of the housing. The spring element may be disposed about the piercing element. The spring element may be co-axial with the piercing element. The spring element may be a conical spring.

The spring element may be fixed to the distal end or closed of the holder. The spring element may be fixed to the second opposing end of the sleeve. The spring element may be fixed to both the closed end of the holder and the second opposing end of the sleeve. The spring element may be a conical spring. The conical spring advantageously may provide a low-profile or slimmer design so that it may provide a more flexible design and smaller overall compression thickness. The provision of a conical spring may also advantageously reduce the likelihood that the spring will buckle when compressed compared to a cylindrical spring.

The spring element biases the inhaler article off of and away from the piercing element once the piercing element activates the inhaler article. The spring element may be disposed about the piercing element. The spring element may be coaxial with the piercing element. The piercing element may extend beyond the spring element when the spring element is in a relaxed position. The piercing element may extend beyond the spring element when the spring element is in a compressed position. The piercing element may extend beyond the spring element when the spring element is in both the relaxed position and the compressed position. The piercing element may extend beyond the spring element when the sleeve compresses the spring element.

The sleeve may include an elongated slot extending along a longitudinal length of the sleeve. When the sleeve comprises an elongated slot, the housing may further comprise an alignment pin extending from the inner surface of the housing cavity. The alignment pin may be configured to mate with the elongated slot. Advantageously, the elongated slot and alignment pin provides for a reliable movement path between a relaxed and compressed position.

The holder may include a marking element that extends into the inhaler article cavity. The marking element may be configured to mark the surface of an inhaler article. The marking element may extend orthogonally to the holder or inhaler article longitudinal axis. The marking element may be configured to mark the outer surface of an inhaler article in a mechanical manner. For example, the marking element may be configured to scratch, cut, abrade, score, fold, or bend the outer surface of the inhaler article. The marking element may have a sharp end configured to scratch the inhaler outer surface when received within the inhaler article cavity. The marking element may apply a color to the inhaler outer surface when received within the inhaler article cavity. The marking element may mark the inhaler outer surface when the piercing element penetrates a capsule disposed within the inhaler article. Thus, indicating that the inhaler article has been activated and may be consumed by a user. This may also advantageously prevent a user trying to reuse an inhaler article which has already been previously activated.

The marking element may extend orthogonally to the holder or inhaler article longitudinal axis. The marking element may be formed of a rigid material configured to provide a visual indication that the marking element has contacted the inhaler outer surface. The marking element may be fixed to the holder housing. The marking element may form the alignment pin, as described above.

The marking element may extend though at least a portion of a thickness of the holder. The marking element may extend through the sleeve. The marking element may extend into the inhaler article cavity and into the sleeve. The marking element may extend beyond the at least the sleeve a marking distance so that the marking element contacts the inhaler outer surface when the inhaler article is received within the inhaler article cavity. The marking element may be aligned with and mate with the elongated slot of the sleeve.

Recessing the piercing element into the housing protects the piercing element from coming into contact with surfaces not intended to be received within the piercing element.

Recessing the piercing element into the housing may also protect the piercing element from being damaged or modified by surfaces not intended to be received within the piercing element.

The piercing element may be recessed from the open proximal end by any suitable recessed distance. For example, the piercing element may be recessed from the open proximal end a recessed distance of at least about 10%, at least about 20%, at least about 25%, or at least about 30%, or at least about 35%, or at least about 40%, of the housing length. The piercing element may be recessed from the open proximal end a recessed distance of in a range from about 5% to about 50%, or from about 10% to about 40%, or from about 15% to about 40%, or about 20% to about 40%, of the housing length.

The piercing element length may be any suitable length relative to the housing length. For example, the piercing element length may be about 25% to about 60%, or about 30% to about 50%, of the housing length. A distal end of the piercing element may be fixed to the distal end adjacent to or at the distal end of the housing. The piercing element entire length may be coextensive within the housing length.

The housing inner surface has an open proximal end diameter and a distal end diameter. The distal end diameter may be less than the open proximal end diameter. The housing inner surface diameter may taper down from the open proximal end diameter to the distal end diameter. The housing inner surface diameter may taper down by any suitable amount. For example, the housing inner surface diameter may taper down in a range from about 3% to about 13%, or about 5% to about 10% of the housing inner diameter at the proximal end.

The piercing element is formed of a rigid material. The rigid material is sufficiently rigid to pierce, puncture or activate a capsule contained within the inhaler article. The piercing element may be formed of a metal. The piercing element may be formed of stainless steel, such as 316 stainless steel, for example. The piercing element may be formed of a polymeric material. The piercing element may be formed of a fibre-reinforced polymeric material.

The housing may be formed of any rigid material. The housing may be formed of a polymeric material. Polymeric materials useful for forming the housing include polycarbonate, polypropylene, polyethylene, nylon, acrylonitrile butadiene styrene, styrene acrylonitrile, polyacrylate, polystyrene, PBT polyester, PET polyester, polyoxymethylene, polysulfone, polyethersulfone, polyethereetherketone, or liquid crystal polymer,

The inhaler article may be received into the holder such that the inhaler article outer surface and the holder housing outer surface are concentric. The piercing element longitudinal axis may be coaxial with the housing longitudinal axis, and the inhaler longitudinal axis, when the inhaler article is received within the holder. At least about 50%, or at least about 75% of the housing length may be coextensive with the inhaler length, when the inhaler article is received within the holder.

The holder may be formed by insertion moulding techniques. The piercing element may first be formed by moulding, for example, and then the housing may be moulded around the piercing element bonding to the piercing element. The piercing element may be a metal piercing element, the housing may be moulded around the metal piercing element fixing the metal piercing element to the housing. A metal piercing element may include protrusions or recesses at the distal end of the piercing element to increase surface area of the distal end of the piercing element and improve fixation within the housing moulded material.

The inhaler article associated with the holder described above is configured to receive swirling inhalation airflow directly into the distal end of the inhaler article. The swirling inhalation airflow continues downstream into the capsule cavity and induces rotation of a capsule received, or located, in the capsule cavity. The activated capsule releases a dose of particles into the swirling inhalation airflow downstream through the mouthpiece to the consumer. The distal end or upstream-most end of the inhaler article includes an open tubular element that defines an open central passage. Thus, the swirling inhalation airflow is created upstream from the inhaler article and swirling inhalation airflow enters the distal end or upstream-most end of the inhaler article and transmits into the capsule cavity to rotate or spin a capsule located within the capsule cavity.

An inhaler article comprises a body extending along an inhaler longitudinal axis from a mouthpiece end to a distal end. A capsule cavity is defined within the body bounded downstream by a filter element and bounded upstream by an open tubular element defining a central passage. The central passage forms an open air-inlet aperture extending from the distal end of the body to the capsule cavity. A capsule is disposed within the capsule cavity, wherein the central passage has a smaller diameter than the capsule.

The inhaler body may resemble a smoking article or cigarette in size and shape. The inhaler body may have an elongated body extending along the longitudinal axis of the inhaler article. The inhaler body may have a substantially uniform outer diameter along the length of the

elongated body. The inhaler body may have a circular cross-section that may be uniform along the length of the elongated body. The inhaler body may have an outer diameter in a range from about 6 mm to about 10 mm, or from about 7 mm to about 10 mm, or about 7 mm to about 9 mm, or about 7 mm to about 8 mm or about 7.2 mm. The inhaler body may have a length (along the longitudinal axis) in a range from about 40 mm to about 80 mm, or from about 40 mm to about 70 mm, or about 40 mm to about 50 mm, or about 45 mm.

The inhaler article has an open distal end or upstream-most end defined by an open tubular element defining an open central passage. The open central passage defines a cylindrical open aperture extending from the capsule cavity to the open distal end or upstream-most end of the inhaler article. The open tubular element defining an open central passage may have a length in a range from about 3 mm to about 12 mm, or from about 3 mm to about 7 mm or about 4 mm to about 6 mm, or about 5 mm.

The central passage may have a uniform inner or open diameter extending from the capsule cavity to the open distal end or upstream-most end of the inhaler article. The central passage may have an inner diameter that is at least about 50%, or at least about 70%, or at least about 75% of a diameter of the body distal end. The central passage may have a uniform inner or open diameter in a range from about 3 mm about 6.5 mm, or from about 4 mm to about 6 mm, or from about 5 mm to about 6 mm or about 5.5 mm.

The open tubular element defining an open central passage may be formed of a cellulose material. The open tubular element defining an open central passage may be formed of a cellulose acetate material. Preferably the open tubular element is formed of a biodegradable material. The open tubular element defining an open central passage may have a thickness in a range from about 0.5 mm to about 1.5 mm, or about 0.5 mm to about 1 mm.

The filter element located downstream of the capsule cavity may extend from the capsule cavity to the mouthpiece end of the inhaler article. The filter element may have a length in a range from about 10 mm to about 30 mm, preferably from about 15 mm to about 25 mm and more preferably from about 20 mm to about 22 mm.

The capsule cavity may be defined by an inhaler article open tubular element. The open tubular element may be joined between and in abutting alignment with the tubular element forming the distal end of the inhaler article and the filter element. These elements may be joined with a wrapper. The open tubular element defining the capsule cavity may be formed of a biodegradable material, such as cardboard or paperboard.

The capsule cavity may have an inner diameter in a range from about 6 mm to about 7 mm, or about 6.5 mm to about 6.7 mm. The capsule cavity may have a lateral length in a range from about 15 mm to about 30 mm, or from about 20 mm to about 25 mm.

The capsule cavity may be defined by an inhaler article open tubular element. The open tubular element may be joined between and in abutting alignment with the tubular element forming the distal end of the inhaler article and the filter element. These elements may be joined with a wrapper. The open tubular element defining the capsule cavity may be formed of a biodegradable material, such as cardboard or paperboard.

The capsule cavity may have an inner diameter in a range from about 6 mm to about 7 mm, or about 6.5 mm to about 6.7 mm. The capsule cavity may have a lateral length in a range from about 15 mm to about 30 mm, or from about 20 mm to about 25 mm.

The capsule cavity may define a cylindrical space configured to contain a capsule (the capsule may have an obround shape or a circular cross-section, for example). The capsule cavity may have a substantially uniform or uniform diameter along the length of the capsule cavity. The capsule cavity may have a fixed cavity length. The capsule cavity has a cavity inner diameter, orthogonal to the longitudinal axis, and the capsule has a capsule outer diameter. The capsule cavity may be sized to contain an obround capsule. The capsule cavity may have a substantially cylindrical or cylindrical cross-section along the length of the capsule cavity. The capsule cavity may have a uniform inner diameter. The capsule may have an outer diameter that is about 80% to about 95% of the inner diameter of the capsule cavity. The configuration of the capsule cavity relative to the capsule may promote limited movement of the capsule during activation or piercing of the capsule.

The capsule cavity may be defined by an open tubular element. The open tubular element may be joined between and in abutting alignment with the open tubular element forming the distal end of the inhaler article and the filter element. These elements may be joined with a wrapper. The open tubular element defining the capsule cavity may be formed of a biodegradable material, such as cardboard or paperboard.

The configuration of the capsule cavity relative to the capsule may promote the capsule to rotate with stability within the capsule cavity. The longitudinal axis of the capsule may rotate with stability co-axially with the longitudinal axis of the inhaler body during inhalation. The configuration of the capsule cavity relative to the capsule may promote the capsule to rotate with some shaking within the capsule cavity

Stable rotation refers to the longitudinal axis of the inhaler body being substantially parallel or co-axial with the axis of rotation of the capsule. Stable rotation may refer to the absence of procession of the rotating capsule. Preferably the longitudinal axis of the inhaler body may be substantially coextensive with the axis of rotation of the capsule. Stable rotation of the capsule may provide a uniform entrainment of a portion of nicotine particles from the capsule over two or more, or five or more, or ten or more "puffs" or inhalations by a consumer.

The capsule may be sealed within the inhaler article prior to consumption. The inhaler article may be contained within a sealed or airtight container or bag. The inhaler article may include one or more peelable or removable seal layers to cover the one or more air inlet channels or the air outlet or mouthpiece of the inhaler article.

The capsule may rotate about its longitudinal or central axis when air flows through the inhaler article. The capsule may be formed of an airtight material that may be pierced or punctured by a piercing element that may be separate or combined with the inhaler. The capsule may be formed of a metallic or polymeric material that serves to keep contaminates out of the capsule but may be pierced or punctured by a piercing element prior to consumption of the nicotine particles within the capsule. The capsule may be formed of a polymer material. The polymer material may be hydroxypropylmethylcellulose (HPMC). The capsule may be a size 1 to size 4 capsule, or a size 3 capsule.

The separate holder, as described herein, forms a single aperture through the capsule received in the capsule cavity.

The capsule contains pharmaceutically active particles. The pharmaceutically active particles may comprises nicotine (also referred to as "nicotine powder" or "nicotine particles") and optionally particles comprising flavour (also referred to as "flavour particles). The capsule may contain a predetermined amount of nicotine particles and optional flavour particles. The capsule may contain enough nicotine particles to provide at least 2 inhalations or "puffs", or at least about 5 inhalations or "puffs", or at least about 10 inhalations or "puffs". The capsule may contain enough nicotine particles to provide from about 5 to about 50 inhalations or "puffs", or from about 10 to about 30 inhalations or "puffs". Each inhalation or "puff" may deliver from about 0.1 mg to about 3 mg of nicotine particles to the lungs of the user or from about 0.2 mg to about 2 mg of nicotine particles to the lungs of the user or about 1 mg of nicotine particles to the lungs of the user.

The nicotine particles may have any useful concentration of nicotine based on the particular formulation employed. The nicotine particles may have at least about 1%wt nicotine up to about 30%wt nicotine, or from about 2%wt to about 25%wt nicotine, or from about 3%wt to about 20%wt nicotine, or from about 4%wt to about 15%wt nicotine, or from about 5%wt to about 13%wt nicotine. Preferably, about 50 to about 150 micrograms of nicotine may be delivered to the lungs of the user with each inhalation or "puff".

The capsule may hold or contain at least about 5 mg of nicotine particles or at least about 10 mg of nicotine particles. The capsule may hold or contain less than about 900 mg of nicotine particles, or less than about 300 mg of nicotine particles, or less than 150 mg of nicotine particles. The capsule may hold or contain from about 5 mg to about 300 mg of nicotine particles or from about 10 mg to about 200 mg of nicotine particles.

When flavour particles are blended or combined with the nicotine particles within the capsule, the flavour particles may be present in an amount that provides the desired flavour to each inhalation or "puff" delivered to the user.

The nicotine particles may have any useful size distribution for inhalation delivery preferentially into the lungs of a user. The capsule may include particles other than the nicotine particles. The nicotine particles and the other particles may form a powder system.

The capsule may hold or contain at least about 5 mg of a dry powder (also referred to as a powder system) or at least about 10 mg of a dry powder. The capsule may hold or contain less than about 900 mg of a dry powder, or less than about 300 mg of a dry powder, or less than about 150 mg of a dry powder. The capsule may hold or contain from about 5 mg to about 300 mg of a dry powder, or from about 10 mg to about 200 mg of a dry powder, or from about 25 mg to about 100 mg of a dry powder.

The dry powder or powder system may have at least about 40%, or at least about 60%, or at least about 80%, by weight of the powder system comprised in nicotine particles having a particle size of about 5 micrometers or less, or in a range from about 1 micrometer to about 5 micrometres.

The particles comprising nicotine may have a mass median aerodynamic diameter of about 5 micrometres or less, or in a range from about 0.5 micrometres to about 4 micrometres, or in a range from about 1 micrometres to about 3 micrometres or in a range from about 1.5

micrometres to about 2.5 micrometres. The mass median aerodynamic diameter is preferably measured with a cascade impactor.

The particles comprising flavour may have a mass median aerodynamic diameter of about 20 micrometres or greater, or about 50 micrometres or greater, or in a range from about 50 to about 200 micrometres, or from about 50 to about 150 micrometres. The mass median aerodynamic diameter is preferably measured with a cascade impactor.

The dry powder may have a mean diameter of about 60 micrometres or less, or in a range from about 1 micrometres to about 40 micrometres, or in a range from about 1.5 micrometres to about 25 micrometres. The mean diameter refers to the mean diameter per mass and is preferably measured by laser diffraction, laser diffusion or an electronic microscope.

Nicotine in the powder system or nicotine particles may be a pharmaceutically acceptable free-base nicotine, or nicotine salt or nicotine salt hydrate. Useful nicotine salts or nicotine salt hydrates include nicotine pyruvate, nicotine citrate, nicotine aspartate, nicotine lactate, nicotine bitartrate, nicotine salicylate, nicotine fumarate, nicotine mono-pyruvate, nicotine glutamate or nicotine hydrochloride, for example. The compound combining with nicotine to form the salt or salt hydrate may be chosen based on its expected pharmacological effect.

The nicotine particles preferably include an amino acid. Preferably the amino acid may be leucine such as L-leucine. Providing an amino acid such as L-leucine with the particles comprising nicotine, may reduce adhesion forces of the particles comprising nicotine and may reduce attraction between nicotine particles and thus reduce agglomeration of nicotine particles. Similarly, adhesion forces to particles comprising flavour may also be reduced thus agglomeration of nicotine particles with flavour particles is also reduced. The powder system described herein thus may be a free-flowing material and possess a stable relative particle size of each powder component even when the nicotine particles and the flavour particles are combined.

Preferably, the nicotine may be a surface modified nicotine salt where the nicotine salt particle comprises a coated or composite particle. A preferred coating or composite material may be L-leucine. One particularly useful nicotine particle may be nicotine bitartrate with L-leucine.

The powder system may include a population of flavour particles. The flavour particles may have any useful size distribution for inhalation delivery selectively into the mouth or buccal cavity of a user.

The powder system may have at least about 40%, or at least about 60%, or at least about 80%, by weight of the population of flavour particles of the powder system comprised in particles having a particle size of about 20 micrometres or greater. The powder system may have at least about 40% or at least about 60%, or at least about 80%, by weight of the population of flavour particles of the powder system comprised in particles having a particle size of about 50 micrometres or greater. The powder system may have at least about 40% or at least about 60%, or at least about 80%, by weight of the population of flavour particles of the powder system comprised in particles having a particle size in a range from about 50 micrometer to about 150 micrometres.

The particles comprising flavour may include a compound to reduce adhesion forces or surface energy and resulting agglomeration. The flavour particle may be surface modified with an adhesion reducing compound to form a coated flavour particle. One preferred adhesion reducing compound may be magnesium stearate. Providing an adhesion reducing compound such as magnesium stearate with the flavour particle, especially coating the flavour particle, may reduce adhesion forces of the particles comprising flavour and may reduce attraction between flavour particles and thus reduce agglomeration of flavour particles. Thus, agglomeration of flavour particles with nicotine particles may also be reduced. The powder system described herein thus may possess a stable relative particle size of the particles comprising nicotine and the particles comprising flavour even when the nicotine particles and the flavour particles are combined. The powder system preferably may be free flowing.

Conventional formulations for dry powder inhalation contain carrier particles that serve to increase the fluidization of the active particles since the active particles may be too small to be influenced by simple airflow though the inhaler. The powder system may comprise carrier particles. These carrier particles may be a saccharide such as lactose or mannitol that may have a particle size greater than about 50 micrometres. The carrier particles may be utilized to improve dose uniformity by acting as a diluent or bulking agent in a formulation.

The powder system utilized with the nicotine powder delivery system described herein may be carrier-free or substantially free of a saccharide such as lactose or mannitol. Being carrier-free or substantially free of a saccharide such as lactose or mannitol may allow the

nicotine and to be inhaled and delivered to the user's lungs at inhalation or airflow rates that are similar to typical smoking regime inhalation or airflow rates.

The nicotine particles and a flavour may be combined in a single capsule. As described above, the nicotine particles and a flavour may each have reduced adhesion forces that result in a stable particle formulation where the particle size of each component does not substantially change when combined. Alternatively, the powder system includes nicotine particles contained within a single capsule and the flavour particles contained within a second capsule.

The nicotine particles and flavour particles may be combined in any useful relative amount so that the flavour particles are detected by the user when consumed with the nicotine particles. Preferably the nicotine particles and a flavour particles form at least about 90%wt or at least about 95%wt or at least about 99%wt or 100%wt of the total weight of the powder system.

The inhaler and inhaler system may be less complex and have a simplified airflow path as compared to conventional dry powder inhalers. Advantageously, rotation of the capsule within the inhaler body aerosolizes the nicotine particles or powder system and may assist in maintaining a free-flowing powder. Thus, the inhaler article may not require the elevated inhalation rates typically utilized by conventional inhalers to deliver the nicotine particles described above deep into the lungs.

The inhaler article may use a flow rate of less than about 5 L/min or less than about 3 L/min or less than about 2 L/min or about 1.6 L/min. Preferably, the flow rate may be in a range from about 1 L/min to about 3 L/min or from about 1.5 L/min to about 2.5 L/min. Preferably, the inhalation rate or flow rate may be similar to that of Health Canada smoking regime, that is, about 1.6 L/min.

The inhaler system may be used by a consumer like smoking a conventional cigarette or vaping an electronic cigarette. Such smoking or vaping may be characterized by two steps: a first step during which a small volume containing the full amount of nicotine desired by the consumer is drawn into the mouth cavity, followed by a second step during which this small volume comprising the aerosol comprising the desired amount of nicotine is further diluted by fresh air and drawn deeper into the lungs. Both steps are controlled by the consumer. During the first inhalation step the consumer may determine the amount of nicotine to be inhaled. During the second step, the consumer may determine the volume for diluting the first volume to

be drawn deeper into the lungs, maximizing the concentration of active agent delivered to the airway epithelial surface. This smoking mechanism is sometimes called "puff-inhale-exhale".

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 herein, the singular forms "a", "an", and "the" encompass embodiments having plural referents, unless the content clearly dictates otherwise.

As used herein, "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise. The term "and/or" means one or all of the listed elements or a combination of any two or more of the listed elements.

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.

The invention will now be further described with reference to the figures in which:

FIG. 1 is a perspective view of an illustrative inhaler system;

FIG. 2 is a cross-sectional schematic diagram of an illustrative inhaler system of FIG. 1;

FIG. 3 is a cross-sectional schematic diagram of an illustrative inhaler article;

FIG. 4 is a cross-sectional schematic diagram of an illustrative inhaler article of received in the sleeve illustrated in FIG. 2;

FIG. 5 is a cross-sectional schematic diagram of the illustrative sleeve;

FIG. 6 is a cross-sectional schematic diagram of another illustrative sleeve; and

FIG.s 7-10 cross-sectional schematic diagrams of illustrative vortex tunnels with one to four tangential air inlets.

The schematic drawings are not necessarily to scale and are presented for purposes of illustration and not limitation. The drawings depict one or more aspects described in this disclosure. However, it will be understood that other aspects not depicted in the drawing fall within the scope and spirit of this disclosure.

FIG. 1 is a perspective view of an illustrative inhaler system 100. FIG. 2 is a cross-sectional schematic diagram of an illustrative inhaler system 100 of FIG. 1. FIG. 3 is a cross-sectional schematic diagram of an illustrative inhaler article 150. FIG. 4 is a cross-sectional schematic diagram of an illustrative inhaler article 150 of received in the sleeve 120 illustrated in FIG. 2.

The inhaler system 100 includes an inhaler article 150 and a separate holder 110. The inhaler article 150 may be received within the holder 110 to activate or pierce a capsule 160 disposed within the inhaler article 150. The inhaler article 150 remains in the holder 110 during use by the consumer. The holder 110 is configured to form or induce swirling inhalation airflow entering the received inhaler article 150.

An inhaler system 100 includes an inhaler article 150 and a holder 110. The inhaler article 150 includes a body 151 extending along an inhaler longitudinal axis L_A from a mouthpiece end 154 to a distal end 156, and the capsule 160 disposed within the inhaler article body 151. The holder 110 includes a movable sleeve 120 that retains the inhaler article 150 received in a sleeve cavity 122.

A holder 110 for an inhaler article 150 includes a housing 111 comprising a housing cavity 112 for receiving an inhaler article 150 and a sleeve 120 configured to retain an inhaler article 150 within the housing cavity 112. The sleeve 120 defines the sleeve cavity 122 and is movable within the housing cavity 112 along the longitudinal axis L_A of the housing 111. The sleeve 120 comprises a first open end 124 and a second opposing end 126. The second opposing end 126 of the sleeve 120 is configured to allow air to enter the sleeve cavity 122. The second opposing end 126 of the sleeve 120 is configured to form or induce a swirl on the air entering the sleeve cavity 122.

The holder 110 may include a piercing element 101 fixed to and extending from a housing inner surface 109. The piercing element 101 may be configured to extend through the second opposing end 126 of the sleeve 120 and into the sleeve cavity 122 along a longitudinal axis of the housing 111. The holder 110 may include a spring element 102 configured to bias the sleeve 120 away from the piercing element 101.

The sleeve 120 may include an elongated slot 128 (see FIG. 5) extending along a longitudinal length of the sleeve 120. The housing 111 may further comprises a pin 127 extending from the inner surface 109 of the housing cavity 112. The pin 127 may be configured to mate with the elongated slot 128.

An inhaler article 150 comprises the body 151 which extends along an inhaler longitudinal axis L_A from the mouthpiece end 154 to a distal end 156. A capsule cavity 155 is disposed within the body 151 and is bounded downstream by a filter element 157 and bounded upstream by an open tubular element 153 defining a central passage 152. The central passage 152 forms an open air-inlet aperture extending from the distal end 156 of the body to the capsule cavity 155. The capsule 160 is disposed within the capsule cavity 155. The central passage 152 has a smaller diameter then the capsule 160.

As illustrated with reference to FIG. 4 and FIG. 5, the central passage 152 of the inhaler article 150 open tubular element 153 aligns and mates with a central passage 132 of the sleeve tubular element 130.

Inhalation air inlets 138 enter the sleeve tubular element 130 at a tangent to the sleeve tubular element 130 and form swirling inhalation airflow to the central passage 152 of a received inhaler article 150 open tubular element 153. The swirling inhalation airflow flows along the central passage 152 of a received inhaler article 150 open tubular element 153 downstream to the capsule cavity to induce capsule rotation and release particles into the inhalation airflow.

The sleeve 120 defines a first air inlet zone 170 comprising at least one air aperture 129 through the sleeve 120. The first air inlet zone 170 proximate to the first open end 124 of the sleeve 120. The first air inlet zone 170 is configured to allow air to flow to an airflow channel formed between the sleeve 120 and the housing 111. The sleeve comprises a second air inlet zone 180 in downstream from the first air inlet zone 170. The second air inlet zone 180 comprising the second opposing end 126 of the sleeve 120 is configured to allow air to enter the sleeve cavity 122. The second air inlet zone 180 comprising at least one air aperture or air inlet

138 through the sleeve 120 and into the sleeve tubular element 130 having the central passage 132.

FIG. 6 is a cross-sectional schematic diagram of another illustrative sleeve 120. The second opposing end 126 of the sleeve 120 comprises the sleeve tubular element 130 defining the central passage 132, an end surface 136 and an open end 134. The central passage 132 in fluid communication with the sleeve cavity 122. The sleeve tubular element 130 open end 132 may extend into the sleeve cavity 122. The sleeve tubular element 130 includes at least one air inlet 138 allowing air to enter into the central passage 132. The at least one air inlet 138 extends in a direction that is tangential to the central passage 132.

The distal end 156 of the inhaler article 150 may slides onto the sleeve tubular element 130. Inhalation air inlets 138 enter the sleeve tubular element 130 at a tangent to the central passage 132 and form swirling inhalation airflow to the central passage 152 of a received inhaler article 150 open tubular element 153. The swirling inhalation airflow flows along the central passage 152 of a received inhaler article 150 open tubular element 153 downstream to the capsule cavity to induce capsule rotation and release particles into the inhalation airflow.

The sleeve tubular element 130 may extend into the sleeve cavity 122 and forms an annular recess 131 with the sleeve cavity 122 configured to receive a distal end 156 of an inhaler article 150. The projection formed by the sleeve tubular element 130 slides into the inhaler article 150 open tubular element 153. The sleeve tubular element 130 is configured here to extend into a distal end 156 of an inhaler article 150 received within the sleeve cavity 122.

The sleeve tubular element 130 may extend into the sleeve cavity 122 about 5 mm and have an outer diameter of about 5.5 mm and an inner diameter of about 4 mm. The central passage 152 of a received inhaler article 150 open tubular element 153 may have an inner diameter of about 5.5 mm to provide an interference fit with the sleeve tubular element 130 and annular recess 131.

FIG.s 7-10 cross-sectional schematic diagrams of illustrative sleeve tubular element 130 with central passages 132 with one to four tangential air inlets 138. The inner diameter of the sleeve tubular element 130 may be about 4 mm. FIG. 7 illustrates a single tangential air inlet 138 having a diameter of about 1.45 mm. FIG. 8 illustrates two tangential air inlets 138 each having a diameter of about 1 mm entering the sleeve tubular element 130 at 180 degrees from each other. FIG. 9 illustrates three tangential air inlets 138 each having a diameter of about 0.85

mm entering the sleeve tubular element 130 at 120 degrees from each other. FIG. 10 illustrates four tangential air inlets 138 each having a diameter of about 0.6 mm entering the sleeve tubular element 130 at 90 degrees from each other.

CLAIMS:

1. A holder for an inhaler article comprising:

a housing comprising a housing cavity for receiving an inhaler article;

a sleeve configured to retain an inhaler article within the housing cavity, the sleeve comprising a sleeve cavity and being movable within the housing cavity along a longitudinal axis of the housing, wherein the sleeve comprises a first open end and a second opposing end, the first open end is configured to receive an inhaler article and the second opposing end of the sleeve comprises a tubular element having a central passage in fluid communication with the sleeve cavity and at least one air inlet;

wherein the at least one air inlet extends in a direction that is tangential to the central passage to allow air to enter the sleeve cavity and to induce a swirled airflow pattern on the air entering the sleeve cavity.

2. The holder according to claim 1, wherein the tubular element comprises at least two air inlets, the at least two air inlets extend in a direction that is tangential to the central passage to allow air to enter the sleeve cavity and to induce a swirled airflow pattern on the air entering the sleeve cavity.

3. The holder according to any preceding claim, wherein the tubular element extends into the sleeve cavity and forms an annular recess with the sleeve cavity configured to receive a distal end of an inhaler article.

4. The holder according to any preceding claim, wherein the tubular element extends into the sleeve cavity and forms an annular recess with the sleeve cavity configured to retain a distal end of an inhaler article.

5. The holder according to any preceding claim, wherein the tubular element is coaxial with the longitudinal axis of the housing.

6. The holder according to any preceding claim, wherein the tubular element is configured to extend into a distal end of an inhaler article received within the sleeve cavity.

7. The holder according to any preceding claim, further comprising a piercing element fixed to and extending from a housing inner surface, the piercing element being configured to extend through the second opposing end of the sleeve and into the sleeve cavity along a longitudinal axis of the housing.

8. The holder according to claim 7, further comprising a spring element configured to bias the sleeve away from the piercing element.

9. The holder according to any preceding claim, wherein substantially all of the inhalation air enters the tubular element in a direction that is tangential to the central passage.

10. The holder according to any preceding claim, wherein the sleeve comprises an elongated slot extending along a longitudinal length of the sleeve, and the housing further comprises a pin extending from an inner surface of the housing cavity, the pin configured to mate with the elongated slot.

11. The holder according to any preceding claim, wherein the sleeve defines an first air inlet zone comprising at least one air aperture through the sleeve, the first air inlet zone proximate to the first open end of the sleeve, the first air inlet zone configured to allow air to flow to an airflow channel formed between the sleeve and the housing, and the sleeve comprises a second air inlet zone downstream from the first air inlet zone, the second air inlet zone comprising the second opposing end of the sleeve configured to allow air to enter the sleeve cavity.

12. An inhaler system comprising:

an inhaler article comprising a body extending along an inhaler longitudinal axis from a mouthpiece end to a distal end, and a capsule disposed within the inhaler article body; and

the holder for an inhaler article according to any preceding claim, wherein the sleeve retains the inhaler article received in the sleeve cavity.

13. An inhaler system according to claim 12, wherein the capsule is retained within a capsule cavity and configured to receive swirling inhalation airflow formed by the second opposing end of the sleeve, the capsule cavity is bounded downstream by a filter element and bounded upstream by an open tubular element.

14. An inhaler system according to claim 13, wherein the inhaler article open tubular element mates with the second opposing end of the sleeve tubular element.

15. The inhaler system according to according to any one of claims 12 to 14, wherein the mouthpiece end of the inhaler article forms the mouthpiece of the inhaler system.

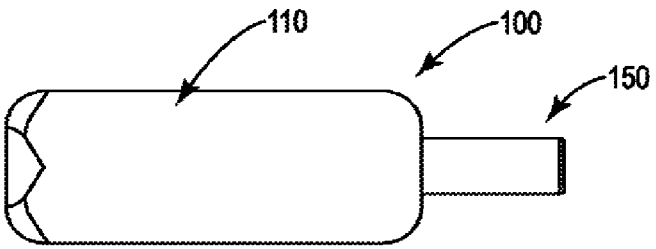

FIG. 1

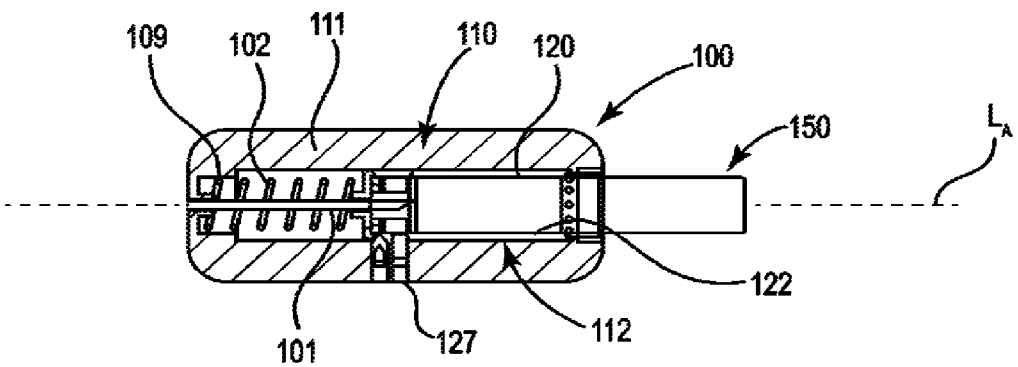

FIG. 2

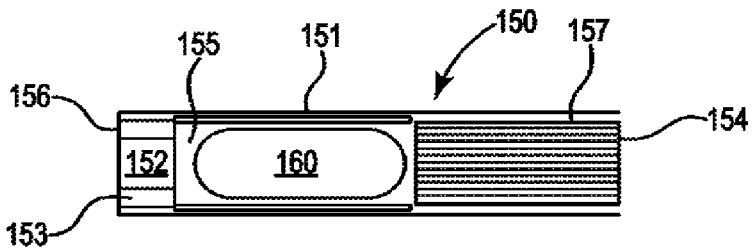
155
151
150
157
156
154
152
160
153

FIG. 3

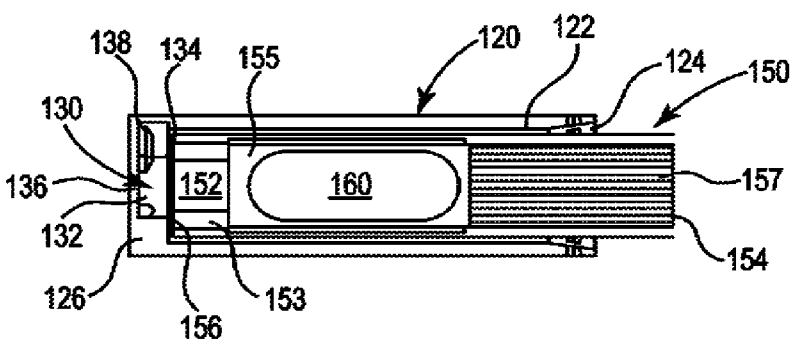
138
134
155
120
122
124
150
130
136
152
160
157
132
154
126
156
153

FIG. 4

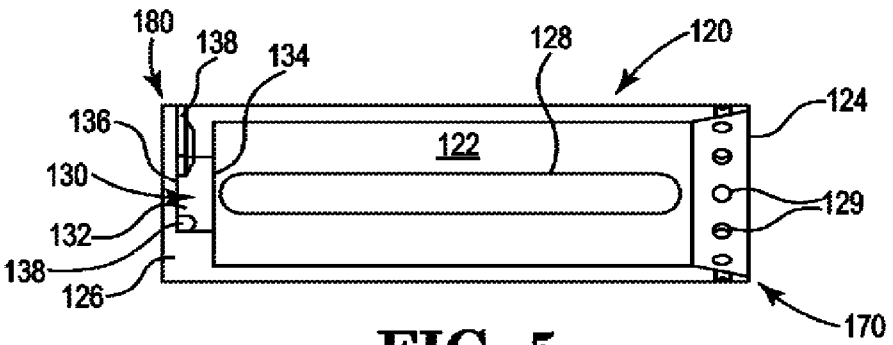
180
138
134
128
120
124
136
122
130
129
132
138
126
170

FIG. 5

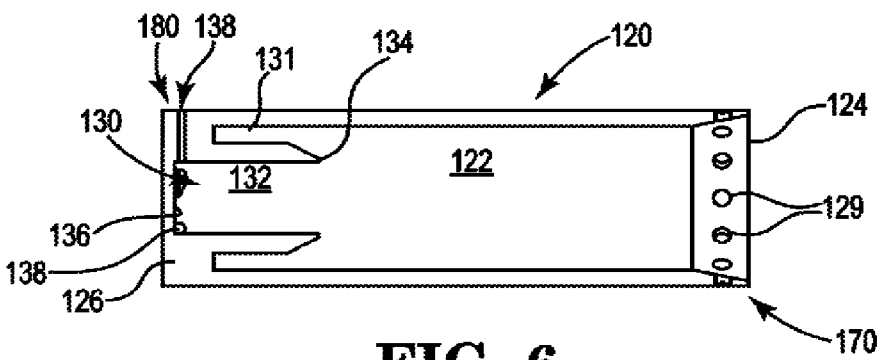
180
138
131
134
120
124
130
122
132
129
136
138
126
170

FIG. 6

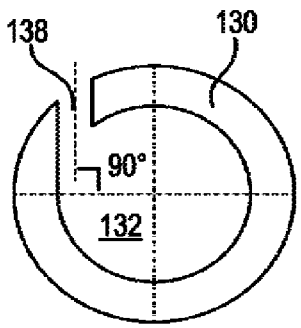

FIG. 7

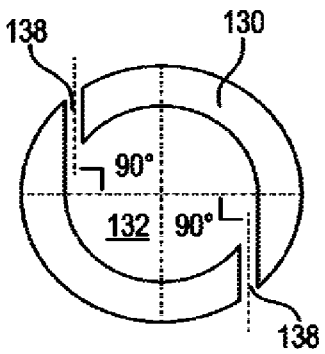

FIG. 8

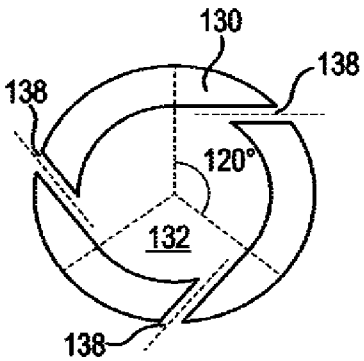

FIG. 9

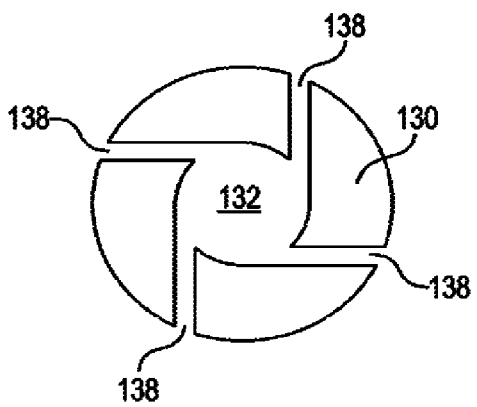

FIG. 10

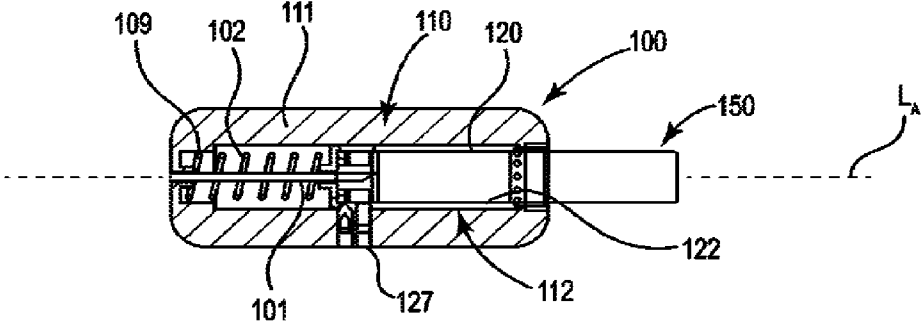

FIG. 2