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(54) **Title:** AEROSOL-GENERATING ARTICLE HAVING UPSTREAM ELEMENT

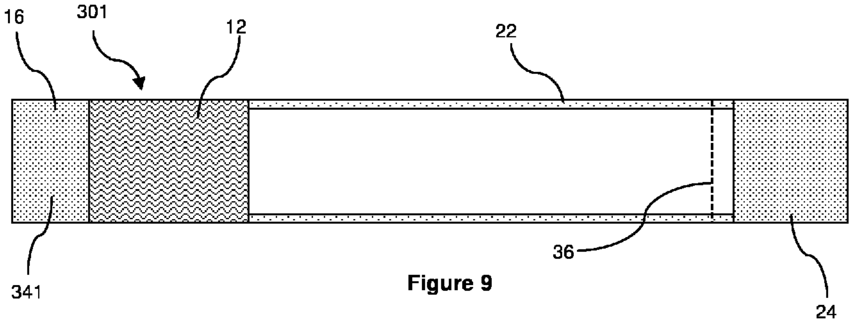

Figure 9

(57) **Abstract:** There is provided an aerosol-generating article. The aerosol-generating article comprises a rod of aerosol-generating substrate and a downstream section provided downstream of the rod of aerosol-generating substrate and extending to the downstream end of the aerosol-generating article. The downstream section comprises a hollow tubular cooling and has a length of greater than 45 millimetres. The aerosol-generating article further comprises an upstream element provided upstream of the rod of aerosol-generating substrate. The upstream element abuts an upstream end of the rod of aerosol-generating substrate and has a length of at least 3 millimetres.

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AEROSOL-GENERATING ARTICLE HAVING UPSTREAM ELEMENT

The present invention relates to an aerosol-generating article comprising an aerosol-generating substrate and adapted to produce an inhalable aerosol upon heating.

Aerosol-generating articles in which an aerosol-generating substrate, such as a tobacco-containing substrate, is heated rather than combusted, are known in the art. Typically, in such heated smoking articles an aerosol is generated by the transfer of heat from a heat source to a physically separate aerosol-generating substrate or material, which may be located in contact with, within, around, or downstream of the heat source. During use of the aerosol-generating article, volatile compounds are released from the aerosol-generating substrate by heat transfer from the heat source and are entrained in air drawn through the aerosol-generating article. As the released compounds cool, they condense to form an aerosol.

A number of prior art documents disclose aerosol-generating devices for consuming aerosol-generating articles. Such devices include, for example, electrically heated aerosol-generating devices in which an aerosol is generated by the transfer of heat from one or more electrical heater elements of the aerosol-generating device to the aerosol-generating substrate of a heated aerosol-generating article. For example, electrically heated aerosol-generating devices have been proposed that comprise an internal heater blade which is adapted to be inserted into the aerosol-generating substrate. Use of an aerosol-generating article in combination with an external heating system is also known. For example, WO 2020/115151 describes the provision of one or more heating elements arranged around the periphery of the aerosol-generating article when the aerosol-generating article is received in a cavity of the aerosol-generating device. As an alternative, inductively heatable aerosol-generating articles comprising an aerosol-generating substrate and a susceptor arranged within the aerosol-generating substrate have been proposed by WO 2015/176898.

Aerosol-generating articles in which a tobacco-containing substrate is heated rather than combusted present a number of challenges that were not encountered with conventional smoking articles. First of all, tobacco-containing substrates are typically heated to significantly lower temperatures compared with the temperatures reached by the combustion front in a conventional cigarette. This may have an impact on nicotine release from the tobacco-containing substrate and nicotine delivery to the consumer. At the same time, if the heating temperature is increased in an attempt to boost nicotine delivery, then the aerosol generated typically needs to be cooled to a greater extent and more rapidly before it reaches the consumer. However, technical solutions that were commonly used for cooling the mainstream smoke in conventional smoking articles, such as the provision of a high filtration efficiency segment at the mouth end of a cigarette, may have undesirable effects in an aerosol-generating article wherein a tobacco-containing substrate is heated rather than combusted, as they may reduce nicotine delivery. Accordingly, it would be desirable to provide novel aerosol-generating articles that can consistently ensure a satisfactory aerosol delivery to the consumer.

In addition, a need is generally felt for aerosol-generating articles that are easy to use and have improved practicality. For example, it would be desirable to provide an aerosol-generating article that can be easily inserted into a heating cavity of the aerosol-generating device, and that at the same time can be held securely within the heating cavity such that it does not slip out during use.

It would be further desirable to provide an aerosol-generating article that is adapted so that the aerosol-generating substrate can be more efficiently heated when the aerosol-generating article is inserted into the heating cavity of an aerosol-generating device, thereby minimising waste of tobacco material.

The present disclosure relates to an aerosol-generating article. The aerosol-generating article may comprise a rod of aerosol-generating substrate. The aerosol-generating article may comprise a downstream section provided downstream of the rod of aerosol-generating substrate and extending to the downstream end of the aerosol-generating article. The downstream section may comprise a hollow tubular cooling element. The downstream section may have a length of at least 45 millimetres. The aerosol-generating article may further comprise an upstream element provided upstream of the rod of aerosol-generating substrate. The upstream element may be abutting an upstream end of the rod of aerosol-generating substrate.

According to the present invention there is provided an aerosol-generating article comprising: a rod of aerosol-generating substrate; a downstream section provided downstream of the rod of aerosol-generating substrate and extending to the downstream end of the aerosol-generating article, wherein the downstream section comprises a hollow tubular cooling element and wherein the downstream section has a length of at least 45 millimetres; and an upstream element provided upstream of the rod of aerosol-generating substrate and abutting an upstream end of the rod of aerosol-generating substrate.

The present invention relates to an aerosol-generating article providing a combination of an upstream element with a relatively long downstream section having a length of at least 45 millimetres, which is significantly longer than the downstream sections of aerosol-generating articles of the prior art. This combination of features enables the length of the rod of aerosol-generating substrate to be reduced whilst retaining the overall length of the aerosol-generating article. The position of the rod of aerosol-generating substrate can also be retained as much as possible such that the placement of the rod of aerosol-generating substrate within the heating cavity of an aerosol-generating device is not significantly impacted. The inclusion of the upstream element therefore has a minimal impact on the generation of aerosol from the rod of aerosol-generating substrate during use.

It may be desirable to have a rod of aerosol-generating substrate with a reduced length, for example, in order to maximise the proportion of the rod of aerosol-generating substrate which is heated when the aerosol-generating article is inserted into the heating cavity of an aerosol-generating device. This in turn optimises the efficiency of aerosol generation from the rod of aerosol-generating substrate, so that the amount of aerosol-generating substrate can be minimised to the extent possible without impacting the generation of aerosol. The amount of aerosol-generating substrate that is effectively wasted, since it is not used to generate aerosol, can also be minimised. However, it may be also be important to retain the overall length of the aerosol-generating article so that the article can continue to be used in conjunction with existing aerosol-generating devices. It is also important that existing machinery and packaging can also be used, without the need for modification.

It may be further desirable to provide aerosol-generating article having a relatively long overall length, since this can improve the anchorage of the aerosol-generating article within the heating cavity of the aerosol-generating device and may provide an improvement in the mechanical integrity of the article.

In addition, the relatively long overall length of the aerosol-generating article as a result of the increased length of the downstream section means that the aerosol-generating articles according to the invention more closely resemble combustible cigarettes, which may be appealing to the consumer.

In the aerosol-generating articles of the present invention, the provision of a relatively long downstream section increases the available distance and time over which the aerosol can be cooled downstream of the rod of aerosol-generating substrate. The aerosol can therefore be more effectively cooled before being delivered to the consumer. For example, in preferred embodiments, the increased length of the downstream section enables the inclusion of a relatively long hollow tubular cooling element, thereby optimising the cooling provided in the downstream section as a result of the increased length and volume of the internal cavity along which the aerosol travels during use. This may be particularly advantageous for embodiments in which the aerosol-generating article has a reduced external diameter, for example, articles having a maximum external diameter of less than 7 millimetres. In such articles, the decrease in diameter of the hollow tubular cooling element has been found to decrease the effectiveness of the cooling, due to the decrease in surface area and volume. The additional length provided by a longer downstream section is therefore particularly important in order to ensure that the aerosol is delivered to the consumer at an acceptable temperature.

The inclusion of an upstream element in aerosol-generating articles according to the present invention also advantageously provides further benefits. Prior to use, the upstream element prevents loss of loose particles of aerosol-generating substrate, such as tobacco material, from the upstream end of the rod. This maybe particularly advantageous in embodiments in which the rod of aerosol-generating substrate comprises shredded tobacco material, such as cut filler. The presence of the upstream element may also enable the use of a lower density shredded tobacco material, which would have a higher risk of falling out of the aerosol-generating article due to the fact that it is more loosely packed within the rod.

During use of the aerosol-generating article, the provision of an upstream element in an abutting relationship with the substrate can advantageously provide retention of any condensed aerosol that forms within the article during use, so that it is contained within the article and substantially prevented from leaking out. It has been found that the condensed aerosol is naturally drawn towards the upstream element during use due to capillary action. The condensate is then retained within the upstream element, typically by means of surface tension or absorption.

Furthermore, the provision of an upstream element may improve the mechanical robustness of the upstream end of the aerosol-generating article and facilitate the insertion of the upstream end of the aerosol-generating article into the cavity of a heating device. It may also protect the upstream end of the rod of aerosol-generating substrate during the insertion. Once the aerosol-generating article is inserted within the cavity of the heating device, the upstream element may help to anchor the article inside the cavity so that it does not slide out during use.

In addition, the resistance to draw (RTD) of the upstream element can be readily adapted to take into account changes to the RTD levels of the rod of aerosol-generating substrate and the downstream section, which may arise due to changes in their lengths (or density, in the case of the rod of aerosol-generating substrate). A change in the RTD of the upstream element can advantageously be made without impacting the generation of aerosol, since this occurs downstream of the upstream element.

An aerosol-generating article in accordance with the present invention comprises a rod of aerosol-generating substrate. Further, an aerosol-generating article in accordance with the present invention comprises one or more elements provided downstream of the aerosol-generating substrate. Where present, the one or more elements downstream of the rod of aerosol-generating substrate form a downstream section of the aerosol-generating article. An aerosol-generating article in accordance with the present invention may comprise one or more elements provided upstream of the aerosol-generating substrate. Where present, the one or more elements upstream of the rod of aerosol-generating substrate form an upstream section of the aerosol-generating article.

The rod of aerosol-generating substrate is preferably circumscribed by a wrapper, such as a plug wrap.

The rod of aerosol-generating substrate preferably has a length of at least 10 millimetres. Preferably, the rod of aerosol-generating substrate has a length of at least 15 millimetres. More preferably, the rod of aerosol-generating substrate has a length of at least

17 millimetres. Even more preferably, the rod of aerosol-generating substrate has a length of at least 18 millimetres. Most preferably, the rod of aerosol-generating substrate has a length of at least 20 millimetres.

The rod of aerosol-generating substrate preferably has a length of less than 40 millimetres. Preferably, the rod of aerosol-generating substrate has a length of less than 35 millimetres. More preferably, the rod of aerosol-generating substrate has a length of less than 30 millimetres.

For example, the rod of aerosol-generating substrate preferably has a length of between 10 millimetres and 40 millimetres, or between 10 millimetres and 35 millimetres, or between 10 millimetres and 30 millimetres, or between 15 millimetres and 40 millimetres, or between 15 millimetres and 35 millimetres, or between 15 millimetres and 30 millimetres, or between 20 millimetres and 40 millimetres, or between 20 millimetres and 35 millimetres, or between 20 millimetres and 30 millimetres.

The rod of aerosol-generating substrate preferably has an external diameter that is approximately equal to the external diameter of the aerosol-generating article.

The "external diameter of the rod of aerosol-generating substrate" may be calculated as the average of a plurality of measurements of the diameter of the rod of aerosol-generating substrate taken at different locations along the length of the rod of aerosol-generating substrate.

Preferably, the rod of aerosol-generating substrate has an external diameter of at least about 5 millimetres. More preferably, the rod of aerosol-generating substrate has an external diameter of at least 5.25 millimetres. Even more preferably, the rod of aerosol-generating substrate has an external diameter of at least 5.5 millimetres.

The rod of aerosol-generating substrate preferably has an external diameter of less than 8 millimetres. More preferably, the rod of aerosol-generating substrate has an external diameter of less than 7.5 millimetres. Even more preferably, the rod of aerosol-generating substrate has an external diameter of less than 7 millimetres.

In general, it has been observed that the smaller the diameter of the rod of aerosol-generating substrate, the lower the temperature that is required to raise a core temperature of the rod of aerosol-generating substrate such that sufficient amounts of vaporizable species are released from the aerosol-generating substrate to form a desired amount of aerosol. At the same time, without wishing to be bound by theory, it is understood that a smaller diameter of the rod of aerosol-generating substrate allows for a faster penetration of heat supplied to the aerosol-generating article into the entire volume of aerosol-generating substrate. Nevertheless, where the diameter of the rod of aerosol-generating substrate is too small, a volume-to-surface ratio of the aerosol-generating substrate becomes less favourable, as the amount of available aerosol-generating substrate diminishes.

A diameter of the rod of aerosol-generating substrate falling within the ranges described herein is particularly advantageous in terms of a balance between energy consumption and aerosol delivery. This advantage is felt in particular when an aerosol-generating article comprising a rod of aerosol-generating substrate having a diameter as described herein is used in combination with an external heater arranged around the periphery of the aerosol-generating article. Under such operating conditions, it has been observed that less thermal energy is required to achieve a sufficiently high temperature at the core of the rod of aerosol-generating substrate and, in general, at the core of the article. Thus, when operating at lower temperatures, a desired target temperature at the core of the aerosol-generating substrate may be achieved within a desirably reduced time frame and by a lower energy consumption.

The use of a rod of aerosol-generating substrate having a smaller diameter may also advantageously reduce the overall weight of tobacco material that is needed in the aerosol-generating article whilst still being able to produce the desired levels of aerosol. The level of tobacco waste can therefore be reduced.

A ratio between the length of the rod of aerosol-generating substrate and an overall length of the aerosol-generating article is preferably at least 0.20. Preferably, a ratio between the length of the rod of aerosol-generating substrate and an overall length of the aerosol-generating article is at least 0.25. More preferably, a ratio between the length of the rod of aerosol-generating substrate and an overall length of the aerosol-generating article is at least 0.30.

A ratio between the length of the rod of aerosol-generating substrate and an overall length of the aerosol-generating article is preferably less than 0.50. Preferably, a ratio between the length of the rod of aerosol-generating substrate and an overall length of the aerosol-generating article is less than 0.45. More preferably, a ratio between the length of the rod of aerosol-generating substrate and an overall length of the aerosol-generating article is less than 0.40.

In some embodiments, a ratio between the length of the rod of aerosol-generating substrate and an overall length of the aerosol-generating article is from 0.20 to 0.50, preferably from 0.20 to 0.45, more preferably from 0.20 to 0.40. In other embodiments, a ratio between the length of the rod of aerosol-generating substrate and an overall length of the aerosol-generating article is from 0.25 to 0.50, preferably from 0.25 to 0.45, more preferably from 0.25 to 0.40. In further embodiments, a ratio between the length of the rod of aerosol-generating substrate and an overall length of the aerosol-generating article is from 0.30 to 0.50, preferably from 0.30 to 0.45, more preferably from 0.30 to 0.40. In yet further embodiments, a ratio between the length of the rod of aerosol-generating substrate and an overall length of the aerosol-generating article is from 0.30 to 0.50, preferably from 0.30 to 0.45, more preferably from 0.30 to 0.40.

Preferably, the rod of aerosol-generating substrate has a substantially uniform cross-section along the length of the rod. Particularly preferably, the rod of aerosol-generating substrate has a substantially circular cross-section.

Preferably, the density of the aerosol-generating substrate is at least 100 mg per cubic centimetre. More preferably, the density of the aerosol-generating substrate is at least 125 mg per cubic centimetre. More preferably, the density of the aerosol-generating substrate is at least 150 mg per cubic centimetre. Even more preferably, the density of the aerosol-generating substrate is at least 200 mg per cubic centimetre.

Preferably, the density of the aerosol-generating substrate is less than 1000 mg per cubic centimetre. More preferably, the density of the aerosol-generating substrate is less than 800 mg per cubic centimetre. More preferably, the density of the aerosol-generating substrate is less than 700 mg per cubic centimetre. More preferably, the density of the aerosol-generating substrate is less than 600 mg per cubic centimetre. More preferably, the density of the aerosol-generating substrate is less than 500 mg per cubic centimetre. More preferably, the density of the aerosol-generating substrate is less than 400 mg per cubic centimetre. More preferably, the density of the aerosol-generating substrate is less than 350 mg per cubic centimetre. More preferably, the density of the aerosol-generating substrate is less than 345 mg per cubic centimetre. More preferably, the density of the aerosol-generating substrate is less than 325 mg per cubic centimetre. More preferably, the density of the aerosol-generating substrate is less than 300 mg per cubic centimetre. More preferably, the density of the aerosol-generating substrate is less than 290 mg per cubic centimetre. Even more preferably, the density of the aerosol-generating substrate is less than 280 mg per cubic centimetre.

For example, the density of the aerosol-generating substrate is preferably from 100 mg per cubic centimetre to 1000 mg per cubic centimetre, preferably from 100 mg per cubic centimetre to 800 mg per cubic centimetre, more preferably from 100 mg per cubic centimetre to 700 mg per cubic centimetre, more preferably from 100 mg per cubic centimetre to 600 mg per cubic centimetre, more preferably from 100 mg per cubic centimetre to 500 mg per cubic centimetre, even more preferably from 100 mg per cubic centimetre to 400 mg per cubic centimetre.

For example, the density of the aerosol-generating substrate is preferably from 100 mg per cubic centimetre to 350 mg per cubic centimetre, preferably from 100 mg per cubic centimetre to 345 mg per cubic centimetre, preferably from 125 mg per cubic centimetre to 325 mg per cubic centimetre, more preferably from 150 mg per cubic centimetre to 300 mg per cubic centimetre, more preferably from 150 mg per cubic centimetre to 290 mg per cubic centimetre, even more preferably from 200 mg per cubic centimetre to 280 mg per cubic centimetre.

The aerosol-generating substrate may comprise a tobacco material. The rod of aerosol-generating substrate may comprise a tobacco material. The tobacco material may comprise a shredded tobacco material. The shredded tobacco material may be in the form of cut filler or tobacco cut filler.

Preferably, the tobacco material has a bulk density of at least 100 mg per cubic centimetre. More preferably, the tobacco material has a bulk density of at least 125 mg per cubic centimetre. More preferably, the tobacco material has a bulk density of at least 150 mg per cubic centimetre. Even more preferably, the tobacco material has a bulk density of at least 200 mg per cubic centimetre. Preferably, the tobacco material has a bulk density of less than 345 mg per cubic centimetre. More preferably, the tobacco material has a bulk density of less than 325 mg per cubic centimetre. Even more preferably, the tobacco material has a bulk density of less than 300 mg per cubic centimetre. Even more preferably, the tobacco material has a bulk density of less than 290 mg per cubic centimetre. Even more preferably, the tobacco material has a bulk density of less than 280 mg per cubic centimetre. For example the tobacco material may have a bulk density of from 100 mg per cubic centimetre to 350 mg per cubic centimetre, preferably from 100 mg per cubic centimetre to 345 mg per cubic centimetre, more preferably from 125 mg per cubic centimetre to 325 mg per cubic centimetre, more preferably from 150 mg per cubic centimetre to 300 mg per cubic centimetre, more preferably from 150 mg per cubic centimetre to 290 mg per cubic centimetre, even more preferably from 200 mg per cubic centimetre to 280 mg per cubic centimetre.

The term “density” as used herein in relation to the aerosol-generating substrate refers to the bulk density of the aerosol-generating substrate. This can be calculated by measuring the total weight of the aerosol-generating substrate and dividing this by the volume of the rod of aerosol-generating substrate (excluding any wrapper).

The bulk density of the tobacco material in the aerosol-generating substrate may be calculated by dividing the sum of the mass of the tobacco material in the rod of aerosol-generating substrate by the volume of the aerosol-generating substrate (excluding any wrapper). The mass of the tobacco material in the aerosol-generating substrate may be determined by removing the tobacco material from the aerosol-generating substrate, and weighing the tobacco material. The bulk density of the tobacco material in the aerosol-generating substrate may be determined after conditioning the aerosol-generating substrate in accordance with ISO Standard 3402:1999.

The aerosol-generating substrate may comprise a shredded tobacco material. The rod of aerosol-generating substrate may comprise a shredded tobacco material. The shredded tobacco material may be in the form of cut filler or tobacco cut filler. The density of such aerosol-generating substrate or shredded tobacco material may be in accordance with the below.

In certain preferred embodiments, the rod of aerosol-generating substrate comprises shredded tobacco material, for example tobacco cut filler, having a density of less than 350 mg per cubic centimetre, preferably less than 345 mg per cubic centimetre, preferably less than 325 mg per cubic centimetre, more preferably less than 300 mg per cubic centimetre, more preferably less than 290 mg per cubic centimetre, more preferably less than 280 mg per cubic centimetre. Preferably, the rod of aerosol-generating substrate comprises shredded tobacco material having a bulk density of at least 100 mg per cubic centimetre. More preferably, the rod of aerosol-generating substrate comprises shredded tobacco material having a bulk density of at least 125 mg per cubic centimetre. More preferably, the rod of aerosol-generating substrate comprises shredded tobacco material having a bulk density of at least 150 mg per cubic centimetre. Even more preferably, the rod of aerosol-generating substrate comprises shredded tobacco material having a bulk density of at least 200 mg per cubic centimetre. For example, the rod of aerosol-generating substrate may comprise shredded tobacco material having a density of from 100 mg per cubic centimetre to 350 mg per cubic centimetre, preferably from 100 mg per cubic centimetre to 345 mg per cubic centimetre, preferably from 125 mg per cubic centimetre to 325 mg per cubic centimetre, more preferably from 150 mg per cubic centimetre to 300 mg per cubic centimetre, more preferably from 150 mg per cubic centimetre to 290 mg per cubic centimetre, even more preferably from 200 mg per cubic centimetre to 280 mg per cubic centimetre.

The RTD of the rod of aerosol-generating substrate is preferably less than about 10 millimetres H_2O. More preferably, the RTD of the rod of aerosol-generating substrate is less than 9 millimetres H_2O. Even more preferably, the RTD of the rod of aerosol-generating substrate is less than 8 millimetres H_2O.

The RTD of the rod of aerosol-generating substrate is preferably at least 4 millimetres H_2O. More preferably, the RTD of the rod of aerosol-generating substrate is at least 5 millimetres H_2O. Even more preferably, the RTD of the rod of aerosol-generating substrate is at least 6 millimetres H_2O.

In some embodiments, the RTD of the rod of aerosol-generating substrate is from 4 millimetres H_2O to 10 millimetres H_2O, preferably from 5 millimetres H_2O to 10 millimetres H_2O, preferably from 6 millimetres H_2O to 25 millimetres H_2O. In other embodiments, the RTD of the rod of aerosol-generating substrate is from 4 millimetres H_2O to 20 millimetres H_2O, preferably from 5 millimetres H_2O to 18 millimetres H_2O preferably from 6 millimetres H_2O to 16 millimetres H_2O. In further embodiments, the RTD of the rod of aerosol-generating substrate is from 4 millimetres H_2O to 15 millimetres H_2O, preferably from 5 millimetres H_2O to 14 millimetres H_2O, more preferably from 6 millimetres H_2O to 12 millimetres H_2O.

Unless otherwise specified, the resistance to draw (RTD) of a component or the aerosol-generating article is measured in accordance with ISO 6565-2015. The RTD refers the pressure required to force air through the full length of a component. The terms “pressure drop” or “draw resistance” of a component or article may also refer to the “resistance to draw”. Such terms generally refer to the measurements in accordance with ISO 6565-2015 are normally carried out at under test at a volumetric flow rate of 17.5 millilitres per second at the output or downstream end of the measured component at a temperature of 22 degrees Celsius, a pressure of 101 kPa (about 760 Torr) and a relative humidity of 60%. Conditions for smoking and smoking machine specifications are set out in ISO Standard 3308 (ISO 3308:2000). Atmosphere for conditioning and testing are set out in ISO Standard 3402 (ISO 3402:1999).

The aerosol-generating substrate may be a solid aerosol-generating substrate. The aerosol-generating substrate preferably comprises an 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. The aerosol former may be facilitating that the aerosol is substantially resistant to thermal degradation at temperatures typically applied during use of the aerosol-generating article. Suitable aerosol formers are for example: polyhydric alcohols such as, for example, triethylene glycol, 1,3-butanediol, propylene glycol and glycerine; esters of polyhydric alcohols such as, for example, glycerol mono-, di- or triacetate; aliphatic esters of mono-, di- or polycarboxylic acids such as, for example, dimethyl dodecanedioate and dimethyl tetradecanedioate; and combinations thereof.

Preferably, the aerosol former comprises one or more of glycerine and propylene glycol. The aerosol former may consist of glycerine or propylene glycol or of a combination of glycerine and propylene glycol.

Preferably, the aerosol-generating substrate comprises at least 5 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate, more preferably at least 6 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate, at least 8 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate.

Preferably, the aerosol-generating substrate comprises less than 90 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate, more preferably less than 80 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate, more preferably less than 70 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate, more preferably less than 60 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate, more preferably less than 50 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate, more preferably less than 40 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate.

More preferably, the aerosol-generating substrate comprises less than 30 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate, more preferably less than 25 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate, more preferably less than 20 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate.

For example, the aerosol-generating substrate may comprise between 5 percent and 30 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate, more preferably between 6 percent and 25 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate, more preferably between 10 percent and 20 percent by weight of aerosol former on a dry weight basis of the aerosol-generating substrate.

For example, preferably, the aerosol-generating substrate may comprise between 5 percent and 30 percent by weight of glycerine on a dry weight basis of the aerosol-generating substrate, more preferably between 6 percent and 25 percent by weight of glycerine on a dry weight basis of the aerosol-generating substrate, more preferably between 10 percent and 20 percent by weight of glycerine on a dry weight basis of the aerosol-generating substrate. In certain preferred embodiments of the invention, the aerosol-generating substrate comprises shredded tobacco material. For example, the shredded tobacco material may be in the form of cut filler, as described in more detail below. Alternatively, the shredded tobacco material may be in the form of a shredded sheet of homogenised tobacco material. Suitable homogenised tobacco materials for use in the present invention are described below.

Within the context of the present specification, the term “cut filler” is used to describe to a blend of shredded plant material, such as tobacco plant material, including, in particular, one or more of leaf lamina, processed stems and ribs, homogenised plant material.

The cut filler may also comprise other after-cut, filler tobacco or casing.

Preferably, the cut filler comprises at least 25 percent of plant leaf lamina, more preferably, at least 50 percent of plant leaf lamina, still more preferably at least 75 percent of plant leaf lamina and most preferably at least 90 percent of plant leaf lamina. Preferably, the plant material is one of tobacco, mint, tea and cloves. Most preferably, the plant material is tobacco. However, as will be discussed below in greater detail, the invention is equally applicable to other plant material that has the ability to release substances upon the application of heat that can subsequently form an aerosol.

Preferably, the cut filler comprises tobacco plant material comprising lamina of one or more of bright tobacco, dark tobacco, aromatic tobacco and filler tobacco. With reference to the present invention, the term “tobacco” describes any plant member of the genus *Nicotiana*. Bright tobaccos are tobaccos with a generally large, light coloured leaves. Throughout the specification, the term “bright tobacco” is used for tobaccos that have been flue cured. Examples for bright tobaccos are Chinese Flue-Cured, Flue-Cured Brazil, US Flue-Cured such as Virginia tobacco, Indian Flue-Cured, Flue-Cured from Tanzania or other African Flue Cured. Bright tobacco is characterized by a high sugar to nitrogen ratio. From a sensorial perspective, bright tobacco is a tobacco type which, after curing, is associated with a spicy and lively sensation. Within the context of the present invention, bright tobaccos are tobaccos with a content of reducing sugars of between about 2.5 percent and about 20 percent of dry weight base of the leaf and a total ammonia content of less than about 0.12 percent of dry weight base of the leaf. Reducing sugars comprise for example glucose or fructose. Total ammonia comprises for example ammonia and ammonia salts.

Dark tobaccos are tobaccos with a generally large, dark coloured leaves. Throughout the specification, the term “dark tobacco” is used for tobaccos that have been air cured. Additionally, dark tobaccos may be fermented. Tobaccos that are used mainly for chewing, snuff, cigar, and pipe blends are also included in this category. Typically, these dark tobaccos are air cured and possibly fermented. From a sensorial perspective, dark tobacco is a tobacco type which, after curing, is associated with a smoky, dark cigar type sensation. Dark tobacco is characterized by a low sugar to nitrogen ratio. Examples for dark tobacco are Burley Malawi or other African Burley, Dark Cured Brazil Galpao, Sun Cured or Air Cured Indonesian Kasturi. According to the invention, dark tobaccos are tobaccos with a content of reducing sugars of less than about 5 percent of dry weight base of the leaf and a total ammonia content of up to about 0.5 percent of dry weight base of the leaf.

Aromatic tobaccos are tobaccos that often have small, light coloured leaves. Throughout the specification, the term “aromatic tobacco” is used for other tobaccos that have a high aromatic content, e.g. of essential oils. From a sensorial perspective, aromatic tobacco is a tobacco type which, after curing, is associated with spicy and aromatic sensation. Example for aromatic tobaccos are Greek Oriental, Oriental Turkey, semi-oriental tobacco but also Fire Cured, US Burley, such as Perique, Rustica, US Burley or Meriland. Filler tobacco is not a specific tobacco type, but it includes tobacco types which are mostly used to complement the other tobacco types used in the blend and do not bring a specific characteristic aroma direction to the final product. Examples for filler tobaccos are stems, midrib or stalks of other tobacco types. A specific example may be flue cured stems of Flue Cure Brazil lower stalk.

The cut filler suitable to be used with the present invention generally may resemble cut filler used for conventional smoking articles. The cut width of the cut filler preferably is between 0.3 millimetres and 2.0 millimetres, more preferably, the cut width of the cut filler is between 0.5 millimetres and 1.2 millimetres and most preferably, the cut width of the cut filler is between 0.6 millimetres and 0.9 millimetres. The cut width may play a role in the distribution of heat inside the rod of aerosol-generating substrate. Also, the cut width may play a role in the resistance to draw of the article. Further, the cut width may impact the overall density of the aerosol-generating substrate as a whole.

The strand length of the cut-filler is to some extent a random value as the length of the strands will depend on the overall size of the object that the strand is cut off from. Nevertheless, by conditioning the material before cutting, for example by controlling the moisture content and the overall subtlety of the material, longer strands can be cut. Preferably, the strands have a length of between about 10 millimetres and about 40 millimetres before the strands are collated to form the rod of aerosol-generating substrate. Obviously, if the strands are arranged in a rod of aerosol-generating substrate in a longitudinal extension where the longitudinal extension of the section is below 40 millimetres, the final rod of aerosol-generating substrate may comprise strands that are on average shorter than the initial strand length. Preferably, the strand length of the cut-filler is such that between about 20 percent and 60 percent of the strands extend along the full length of the rod of aerosol-generating substrate. This prevents the strands from dislodging easily from the rod of aerosol-generating substrate.

In preferred embodiments, the weight of the cut filler is between 80 milligrams and 400 milligrams, preferably between 150 milligrams and 250 milligrams, more preferably between 170 milligrams and 220 milligrams. This amount of cut filler typically allows for sufficient material for the formation of an aerosol. Additionally, in the light of the aforementioned constraints on diameter and size, this allows for a balanced density of the rod of aerosol-generating substrate between energy uptake, resistance to draw and fluid passageways within the rod of aerosol-generating substrate where the aerosol-generating substrate comprises plant material.

Preferably, the cut filler is soaked with aerosol former. Soaking the cut filler can be done by spraying or by other suitable application methods. The aerosol former may be applied to the blend during preparation of the cut filler. For example, the aerosol former may be applied to the blend in the direct conditioning casing cylinder (DCCC). Conventional machinery can be used for applying an aerosol former to the cut filler. The aerosol former may be any suitable known compound or mixture of compounds that, in use, facilitates formation of a dense and stable aerosol. The aerosol former may be facilitating that the aerosol is substantially resistant to thermal degradation at temperatures typically applied during use of the aerosol-generating article. Suitable aerosol formers are for example to: polyhydric alcohols such as, for example, triethylene glycol, 1,3-butanediol, propylene glycol and glycerine; esters of polyhydric alcohols such as, for example, glycerol mono-, di- or triacetate; aliphatic esters of mono-, di- or polycarboxylic acids such as, for example, dimethyl dodecanedioate and dimethyl tetradecanedioate; and combinations thereof.

Preferably, the aerosol former comprises one or more of glycerine and propylene glycol. The aerosol former may consist of glycerine or propylene glycol or of a combination of glycerine and propylene glycol.

Preferably, the amount of aerosol former is at least 5 percent by weight on a dry weight basis, preferably between 5 percent and 30 percent by weight on a dry weight basis of the cut filler, more preferably, the amount of aerosol former is between 6 percent and 20 percent by weight on a dry weight basis of the cut filler, for example the amount of aerosol former is between 8 percent and 15 percent by weight on a dry weight basis of the cut filler. When aerosol former is added to the cut filler in the amounts described above, the cut filler may become relatively sticky. This advantageously help retain the cut filler at a predetermined location within the article, as the particles of cut filler display a tendency to adhere to surrounding cut filler particles as well as to surrounding surfaces (for example, the internal surface of a wrapper circumscribing the cut filler).

For some embodiments the amount of aerosol former has a target value of about 13 percent by weight on a dry weight basis of the cut filler. The most efficient amount of aerosol former will depend also on the cut filler, whether the cut filler comprises plant lamina or homogenized plant material. For example, among other factors, the type of cut filler will determine to which extent the aerosol-former can facilitate the release of substances from the cut filler.

For these reasons, a rod of aerosol-generating substrate comprising cut filler as described above is capable of efficiently generating sufficient amount of aerosol at relatively low temperatures. A temperature of between 150 degrees Celsius and 200 degrees Celsius in the heating chamber may be sufficient for one such cut filler to generate sufficient amounts of aerosol while in aerosol-generating devices using tobacco cast leave sheets typically temperatures of about 250 degrees Celsius are employed.

A further advantage connected with operating at lower temperatures is that there is a reduced need to cool down the aerosol. As generally low temperatures are used, a simpler cooling function may be sufficient. This in turn allows using a simpler and less complex structure of the aerosol-generating article.

In other preferred embodiments, the aerosol-generating substrate comprises homogenised plant material, preferably a homogenised tobacco material.

As used herein, the term “homogenised plant material” encompasses any plant material formed by the agglomeration of particles of plant. For example, sheets or webs of homogenised tobacco material for the aerosol-generating substrates of the present invention may be formed by agglomerating particles of tobacco material obtained by pulverising, grinding or comminuting plant material and optionally one or more of tobacco leaf lamina and tobacco leaf stems. The homogenised plant material may be produced by casting, extrusion, paper making processes or other any other suitable processes known in the art.

The homogenised plant material can be provided in any suitable form.

In some embodiments, the homogenised plant material may be in the form of one or more sheets. As used herein with reference to the invention, the term “sheet” describes a laminar element having a width and length substantially greater than the thickness thereof.

The homogenised plant material may be in the form of a plurality of pellets or granules.

The homogenised plant material may be in the form of a plurality of strands, strips or shreds. As used herein, the term “strand” describes an elongate element of material having a length that is substantially greater than the width and thickness thereof. The term “strand” should be considered to encompass strips, shreds and any other homogenised plant material having a similar form. The strands of homogenised plant material may be formed from a sheet of homogenised plant material, for example by cutting or shredding, or by other methods, for example, by an extrusion method.

In some embodiments, the strands may be formed *in situ* within the aerosol-generating substrate as a result of the splitting or cracking of a sheet of homogenised plant material during formation of the aerosol-generating substrate, for example, as a result of crimping. The strands of homogenised plant material within the aerosol-generating substrate may be separate from each other. Alternatively, each strand of homogenised plant material within the aerosol-generating substrate may be at least partially connected to an adjacent strand or strands along the length of the strands. For example, adjacent strands may be connected by one or more fibres. This may occur, for example, where the strands have been formed due to the splitting of a sheet of homogenised plant material during production of the aerosol-generating substrate, as described above.

Where the homogenised plant material is in the form of one or more sheets, as described above, the sheets may be produced by a casting process. Alternatively, sheets of homogenised plant material may be produced by a paper-making process.

The one or more sheets as described herein may each individually have a thickness of between 100 micrometres and 600 micrometres, preferably between 150 micrometres and 300 micrometres, and most preferably between 200 micrometres and 250 micrometres. Individual thickness refers to the thickness of the individual sheet, whereas combined thickness refers to the total thickness of all sheets that make up the aerosol-generating substrate. For example, if the aerosol-generating substrate is formed from two individual sheets, then the combined thickness is the sum of the thickness of the two individual sheets or the measured thickness of the two sheets where the two sheets are stacked in the aerosol-generating substrate.

The one or more sheets as described herein may each individually have a grammage of between 100 grams per square metre and 600 grams per square metre.

The one or more sheets as described herein may each individually have a density of from 0.3 grams per cubic centimetre to 1.3 grams per cubic centimetre, and preferably from 0.7 grams per cubic centimetre to 1.0 gram per cubic centimetre.

In embodiments of the present invention in which the aerosol-generating substrate comprises one or more sheets of homogenised plant material, the sheets are preferably in the form of one or more gathered sheets. As used herein, the term “gathered” denotes that the sheet of homogenised plant material is convoluted, folded, or otherwise compressed or constricted substantially transversely to the cylindrical axis of a plug or a rod.

The one or more sheets of homogenised plant material may be gathered transversely relative to the longitudinal axis thereof and circumscribed with a wrapper to form a continuous rod or a plug.

The one or more sheets of homogenised plant material may advantageously be crimped or similarly treated. As used herein, the term “crimped” denotes a sheet having a plurality of substantially parallel ridges or corrugations. The one or more sheets of homogenised plant material may be embossed, debossed, perforated or otherwise deformed to provide texture on one or both sides of the sheet.

Preferably, one or more sheets of homogenised plant material may be crimped such that it has a plurality of ridges or corrugations substantially parallel to the cylindrical axis of the plug. This treatment advantageously facilitates gathering of the crimped sheet of homogenised plant material to form the plug. Preferably, the one or more sheets of homogenised plant material may be gathered. It will be appreciated that crimped sheets of homogenised plant material may alternatively or in addition have a plurality of substantially parallel ridges or corrugations disposed at an acute or obtuse angle to the cylindrical axis of the plug. The sheet may be crimped to such an extent that the integrity of the sheet becomes disrupted at the plurality of parallel ridges or corrugations causing separation of the material, and results in the formation of shreds, strands or strips of homogenised plant material.

The one or more sheets of homogenised plant material may be cut into strands as referred to above. In such embodiments, the aerosol-generating substrate comprises a plurality of strands of the homogenised plant material. The strands may be used to form a plug. Typically, the width of such strands is about 5 millimetres, or about 4 millimetres, or about 3 millimetres, or about 2 millimetres or less. The length of the strands may be greater than about 5 millimetres, between about 5 millimetres to about 15 millimetres, about 8 millimetres to about 12 millimetres, or about 12 millimetres. Preferably, the strands have substantially the same length as each other.

The homogenised plant material may comprise up to 95 percent by weight of plant particles, on a dry weight basis. Preferably, the homogenised plant material comprises up to 90 percent by weight of plant particles, more preferably up to 80 percent by weight of plant particles, more preferably up to 70 percent by weight of plant particles, more preferably up to 60 percent by weight of plant particles, more preferably up to 50 percent by weight of plant particles, on a dry weight basis.

For example, the homogenised plant material may comprise between 2.5 percent and 95 percent by weight of plant particles, or 5 percent and 90 percent by weight of plant particles, or between 10 percent and 80 percent by weight of plant particles, or between 15 percent and 70 percent by weight of plant particles, or between 20 percent and 60 percent by weight of plant particles, or between 30 percent and 50 percent by weight of plant particles, on a dry weight basis.

In certain embodiments of the invention, the homogenised plant material is a homogenised tobacco material comprising tobacco particles. Sheets of homogenised tobacco material for use in such embodiments of the invention may have a tobacco content of at least about 40 percent by weight on a dry weight basis, more preferably of at least about 50 percent by weight on a dry weight basis more preferably at least about 70 percent by weight on a dry weight basis and most preferably at least about 90 percent by weight on a dry weight basis.

With reference to the present invention, the term “tobacco particles” describes particles of any plant member of the genus *Nicotiana*. The term “tobacco particles” encompasses ground or powdered tobacco leaf lamina, ground or powdered tobacco leaf stems, tobacco dust, tobacco fines, and other particulate tobacco by-products formed during the treating, handling and shipping of tobacco. In a preferred embodiment, the tobacco particles are substantially all derived from tobacco leaf lamina. By contrast, isolated nicotine and nicotine salts are compounds derived from tobacco but are not considered tobacco particles for purposes of the invention and are not included in the percentage of particulate plant material.

The homogenised plant material may further comprise one or more aerosol formers. Upon volatilisation, an aerosol former can convey other vaporised compounds released from the aerosol-generating substrate upon heating, such as nicotine and flavourants, in an aerosol. Suitable aerosol formers for inclusion in the homogenised plant material are known in the art and include, but are not limited to: polyhydric alcohols, such as triethylene glycol, propylene glycol, 1,3-butanediol and glycerol; 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.

The homogenised plant material may have an aerosol former content of between 5 percent and 30 percent by weight on a dry weight basis, such as between 10 percent and 25 percent by weight on a dry weight basis, or between 15 percent and 20 percent by weight on a dry weight basis. The aerosol former may act as a humectant in the homogenised plant material.

In certain embodiments of the invention, the aerosol-generating article further comprises a susceptor element within the rod of aerosol-generating substrate. For example, an elongate susceptor element may be arranged substantially longitudinally within the rod of aerosol-generating substrate and is in thermal contact with the aerosol-generating substrate.

As used herein with reference to the present invention, the term “susceptor element” refers to a material that can convert electromagnetic energy into heat. When located within a fluctuating electromagnetic field, eddy currents induced in the susceptor element cause heating of the susceptor element. As the susceptor element is located in thermal contact with the aerosol-generating substrate, the aerosol-generating substrate is heated by the susceptor element.

When used for describing the susceptor element, the term “elongate” means that the susceptor element has a length dimension that is greater than its width dimension or its thickness dimension, for example greater than twice its width dimension or its thickness dimension.

The susceptor element is arranged substantially longitudinally within the rod. This means that the length dimension of the elongate susceptor element is arranged to be approximately parallel to the longitudinal direction of the rod, for example within plus or minus 10 degrees of parallel to the longitudinal direction of the rod. In preferred embodiments, the elongate susceptor element may be positioned in a radially central position within the rod, and extends along the longitudinal axis of the rod.

Preferably, the susceptor element extends all the way to a downstream end of the rod of aerosol-generating substrate. In some embodiments, the susceptor element may extend all the way to an upstream end of the rod of aerosol-generating substrate. In particularly preferred embodiments, the susceptor element has substantially the same length as the rod of aerosol-generating substrate, and extends from the upstream end of the rod to the downstream end of the rod.

The susceptor element is preferably in the form of a pin, rod, strip or blade.

The susceptor element preferably has a length from 10 millimetres to 40 millimetres, for example from 15 millimetres to 35 millimetres, or from 17 millimetres to 30 millimetres.

The susceptor element preferably has a length from 5 millimetres to 15 millimetres, for example from 6 millimetres to 12 millimetres, or from 8 millimetres to 10 millimetres.

The susceptor element preferably has a width from 1 millimetre to 5 millimetres.

The susceptor element may generally have a thickness from 0.01 millimetres to 2 millimetres, for example from 0.5 millimetres to 2 millimetres. In some embodiments, the susceptor element preferably has a thickness from 10 micrometres to 500 micrometres, more preferably from 10 micrometres to 100 micrometres.

If the susceptor element has a constant cross-section, for example a circular cross-section, it has a preferable width or diameter from 1 millimetre to 5 millimetres.

If the susceptor element has the form of a strip or blade, the strip or blade preferably has a rectangular shape having a width of preferably from 2 millimetres to 8 millimetres, more preferably from 3 millimetres to 5 millimetres. By way of example, a susceptor element in the form of a strip of blade may have a width of 4 millimetres.

If the susceptor element has the form of a strip or blade, the strip or blade preferably has a rectangular shape and a thickness from 0.03 millimetres to 0.15 millimetres, more preferably from 0.05 millimetres to 0.09 millimetres. By way of example, a susceptor element in the form of a strip of blade may have a thickness of 0.07 millimetres.

In a preferred embodiment, the elongate susceptor element is in the form of a strip or blade, preferably has a rectangular shape, and has a thickness from 55 micrometres to 65 micrometres.

More preferably, the elongate susceptor element has a thickness from 57 micrometres to 63 micrometres. Even more preferably, the elongate susceptor element has a thickness from 58 micrometres to 62 micrometres. In a particularly preferred embodiment, the elongate susceptor element has a thickness of 60 micrometres.

Preferably, the elongate susceptor element has a length which is the same or shorter than the length of the aerosol-generating substrate. Preferably, the elongate susceptor element has a same length as the aerosol-generating substrate.

The susceptor element may be formed from any material that can be inductively heated to a temperature sufficient to generate an aerosol from the aerosol-generating substrate. Preferred susceptor elements comprise a metal or carbon.

A preferred susceptor element may comprise or consist of a ferromagnetic material, for example a ferromagnetic alloy, ferritic iron, or a ferromagnetic steel or stainless steel. A suitable susceptor element may be, or comprise, aluminium. Preferred susceptor elements may be formed from 400 series stainless steels, for example grade 410, or grade 420, or grade 430 stainless steel. Different materials will dissipate different amounts of energy when positioned within electromagnetic fields having similar values of frequency and field strength. Thus, parameters of the susceptor element such as material type, length, width, and thickness may all be altered to provide a desired power dissipation within a known electromagnetic field. Preferred susceptor elements may be heated to a temperature in excess of 250 degrees Celsius.

Suitable susceptor elements 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. A susceptor element may have a protective external layer, for example a protective ceramic layer or protective glass layer encapsulating the susceptor element. The susceptor element may comprise a protective coating formed by a glass, a ceramic, or an inert metal, formed over a core of susceptor element material.

The susceptor element is arranged in thermal contact with the aerosol-generating substrate. Thus, when the susceptor element heats up the aerosol-generating substrate is heated up and an aerosol is formed. Preferably the susceptor element is arranged in direct physical contact with the aerosol-generating substrate, for example within the aerosol-generating substrate.

As set out above, the rod of aerosol-generating substrate may be circumscribed by a wrapper. The wrapper circumscribing the rod of aerosol-generating substrate may be a paper wrapper or a non-paper wrapper. Suitable paper wrappers for use in specific embodiments of the invention are known in the art and include, but are not limited to: cigarette papers; and filter plug wraps. Suitable non-paper wrappers for use in specific embodiments of the invention are known in the art and include, but are not limited to sheets of homogenised tobacco materials.

A paper wrapper may have a grammage of at least 15 gsm (grams per square metre), preferably at least 20 gsm. The paper wrapper may have a grammage of less than or equal to 35 gsm, preferably less than or equal to 30 gsm. The paper wrapper may have a grammage from 15 gsm to 35 gsm, preferably from 20 gsm to 30 gsm. In a preferred embodiment, the paper wrapper may have a grammage of 25 gsm. A paper wrapper may have a thickness of at least 25 micrometres, preferably at least 30 micrometres, more preferably at least 35 micrometres. The paper wrapper may have a thickness of less than or equal to 55 micrometres, preferably less than or equal to 50 micrometres, more preferably less than or equal to 45 micrometres. The paper wrapper may have a thickness from 25 micrometres to 55 micrometres, preferably from 30 micrometres to 50 micrometres, more preferably from 35 micrometres to 45 micrometres. In a preferred embodiment, the paper wrapper may have a thickness of 40 microns.

In certain preferred embodiments, the wrapper may be formed of a laminate material comprising a plurality of layers. Preferably, the wrapper is formed of an aluminium co-laminated sheet. The use of a co-laminated sheet comprising aluminium advantageously prevents combustion of the aerosol-generating substrate in the event that the aerosol-generating substrate should be ignited, rather than heated in the intended manner.

A paper layer of the co-laminated sheet may have a grammage of at least 35 gsm, preferably at least 40 gsm. The paper layer of the co-laminated sheet may have a grammage of less than or equal to 55 gsm, preferably less than or equal to 50 gsm. The paper layer of the co-laminated sheet may have a grammage from 35 gsm to 55 gsm, preferably from 40 gsm to 50 gsm. In a preferred embodiment, the paper layer of the co-laminated sheet may have a grammage of 45 gsm.

A paper layer of the co-laminated sheet may have a thickness of at least 50 micrometres, preferably at least 55 micrometres, more preferably at least 60 micrometres. The paper layer of the co-laminated sheet may have a thickness of less than or equal to 80 micrometres, preferably less than or equal to 75 micrometres, more preferably less than or equal to 70 micrometres.

The paper layer of the co-laminated sheet may have a thickness from 50 micrometres to 80 micrometres, preferably from 55 micrometres to 75 micrometres, more preferably from 60 micrometres to 70 micrometres. In a preferred embodiment, the paper layer of the co-laminated sheet may have a thickness of 65 microns.

A metallic layer of the co-laminated sheet may have a grammage of at least 12 gsm, preferably at least 15 gsm. The metallic layer of the co-laminated sheet may have a grammage of less than or equal to 25 gsm, preferably less than or equal to 20 gsm. The metallic layer of the co-laminated sheet may have a grammage from 12 gsm to 25 gsm, preferably from 15 gsm to 20 gsm. In a preferred embodiment, the metallic layer of the co-laminated sheet may have a grammage of 17 gsm.

A metallic layer of the co-laminated sheet may have a thickness of at least 2 micrometres, preferably at least 3 micrometres, more preferably at least 5 micrometres. The metallic layer of the co-laminated sheet may have a thickness of less than or equal to 15 micrometres, preferably less than or equal to 12 micrometres, more preferably less than or equal to 10 micrometres.

The metallic layer of the co-laminated sheet may have a thickness from 2 micrometres to 15 micrometres, preferably from 3 micrometres to 12 micrometres, more preferably from 5 micrometres to 10 micrometres. In a preferred embodiment, the metallic layer of the co-laminated sheet may have a thickness of 6 microns.

The wrapper circumscribing the rod of aerosol-generating substrate may be a paper wrapper comprising PVOH (polyvinyl alcohol) or silicone (or polysiloxane) (or polysiloxane). Addition of PVOH (polyvinyl alcohol) or silicone (or polysiloxane) may improve the grease barrier properties of the wrapper.

The PVOH or silicone (or polysiloxane) may be applied to the paper layer as a surface coating, such as disposed on an exterior surface of the paper layer of the wrapper circumscribing the rod of aerosol-generating substrate. The PVOH or silicone (or polysiloxane) may be disposed on and form a layer on the exterior surface of the paper layer of the wrapper. The PVOH or silicone (or polysiloxane) may be disposed on an interior surface of the paper layer of the wrapper. The PVOH or silicone (or polysiloxane) may be disposed on and form a layer on the interior surface of the paper layer of the aerosol generating article. The PVOH or silicone (or polysiloxane) may be disposed on the interior surface and the exterior surface of the paper layer of the wrapper. The PVOH or silicone (or polysiloxane) may be disposed on and form a layer on the interior surface and the exterior surface of the paper layer of the wrapper.

The paper wrapper comprising PVOH or silicone (or polysiloxane) may have a grammage of at least 20 gsm, preferably at least 25 gsm, more preferably at least 30 gsm. The paper wrapper comprising PVOH or silicone (or polysiloxane) may have a grammage of less than or equal to 50 gsm, preferably less than or equal to 45 gsm, more preferably less than or equal to 40 gsm. The paper wrapper comprising PVOH or silicone (or polysiloxane) may have a grammage from 20 gsm to 50 gsm, preferably from 25 gsm to 45 gsm, more preferably from 30 gsm to 40 gsm. In particularly preferred embodiments, the paper wrapper comprising PVOH or silicone (or polysiloxane) may have a grammage of 35 gsm.

The paper wrapper comprising PVOH or silicone (or polysiloxane) may have a thickness of at least 25 micrometres, preferably at least 30 micrometres, more preferably at least 35 micrometres. The paper wrapper comprising PVOH or silicone (or polysiloxane) may have a thickness of less than or equal to 50 micrometres, preferably less than or equal to 45 micrometres, more preferably less than or equal to 40 micrometres. The paper wrapper comprising PVOH or silicone (or polysiloxane) may have a thickness from 25 micrometres to 50 micrometres, preferably from 30 micrometres to 45 micrometres, more preferably from 35 micrometres to 40 micrometres. In particularly preferred embodiments, the paper wrapper comprising PVOH or silicone (or polysiloxane) may have a thickness of 37 micrometres.

The wrapper circumscribing the rod of aerosol-generating substrate may comprise a flame retardant composition comprising one or more flame retardant compounds. The term “flame retardant compounds” is used herein to describe chemical compounds that, when added to or otherwise incorporated into a carrier substrate, such as paper or plastic compounds, provide the carrier substrate with varying degrees of flammability protection. In practice, flame retardant compounds may be activated by the presence of an ignition source and are adapted to prevent or slow the further development of ignition by a variety of different physical and chemical mechanisms.

A flame retardant composition may typically further comprise one of more non-flame retardant compounds, that is, one or more compound – such as a solvent, an excipient, a filler – that does not actively contribute to providing the carrier substrate with flammability protection, but is used to facilitate the application of the flame retardant compound or compounds onto or into the wrapper or both. Some of the non-flame retardant compounds of a flame retardant composition – such as solvents – are volatile and may evaporate from the wrapper upon drying after the flame retardant composition has been applied onto or into the wrapping base material or both. As such, although such non-flame retardant compounds form part of the formulation of the flame retardant composition, they may no longer be present or they may only be detectable in trace amounts in the wrapper of an aerosol-generating article.

A number of suitable flame retardant compounds are known to the skilled person. In particular, several flame retardant compounds and formulations suitable for treating cellulosic materials are known and have been disclosed and may find use in the manufacture of wrappers for aerosol-generating articles in accordance with the present invention.

For example, the flame retardant composition may comprise a polymer and a mixed salt based on at least one mono, di- and/or tri-carboxylic acid, at least one polyphosphoric, pyrophosphoric and/or phosphoric acid, and a hydroxide or a salt of an alkali or an alkaline earth metal, where the at least one mono, di- and/or tri-carboxylic acid and the hydroxide or salt form a carboxylate and the at least one polyphosphoric, pyrophosphoric and/or phosphoric acid and the hydroxide or salt form a phosphate. Preferably, the flame retardant composition may further comprise a carbonate of an alkali or an alkaline earth metal. Alternatively, the flame retardant composition may comprise cellulose modified with at least one C_{10} or higher fatty acid, tall oil fatty acid (TOFA), phosphorylated linseed oil, phosphorylated downstream corn oil. Preferably, the at least one C_{10} or higher fatty acid is selected from the group consisting of capric acid, myristic acid, palmitic acid, and combinations thereof.

In a wrapper comprising a flame retardant composition suitable for use in an aerosol-generating article in accordance with the present invention, the flame retardant composition may be provided in a treated portion of the wrapper. This means that the flame retardant composition has been applied onto or into a corresponding portion of a wrapping base material of the wrapper or both. Thus, in the treated portion, the wrapper has an overall dry basis weight that is greater than the dry basis weight of the wrapping base material. The treated portion of the wrapper may extend over at least 10 percent of an outer surface area of the rod of aerosol-generating substrate circumscribed by the wrapper, preferably over at least 20 percent of an outer surface area of the rod of aerosol-generating substrate circumscribed by the wrapper, more preferably over at least 40 percent of an outer surface area of the rod of aerosol-generating substrate, even more preferably over at least 60 percent of an outer surface area of the rod of aerosol-generating substrate. Most preferably, the treated portion of the wrapper extends over at least 80 percent of an outer surface area of the rod of aerosol-generating substrate. In particularly preferred embodiments, the treated portion of the wrapper extends over at least 90 or even 95 percent of an outer surface area of the rod of aerosol-generating substrate. Most preferably, the treated portion of the wrapper extends substantially over the entire outer surface area of the rod of aerosol-generating substrate.

The wrapper comprising a flame retardant composition may have a grammage of at least 20 gsm, preferably at least 25 gsm, more preferably at least 30 gsm. The wrapper comprising a flame retardant composition may have a grammage of less than or equal to 45 gsm, preferably less than or equal to 40 gsm, more preferably less than or equal to 35 gsm. The wrapper comprising a flame retardant composition may have a grammage from 20 gsm to 45 gsm, preferably from 25 gsm to 40 gsm, more preferably from 30 gsm to 35 gsm. In some preferred embodiments, the wrapper comprising a flame retardant composition may have a grammage of 33 gsm.

The wrapper comprising a flame retardant composition may have a thickness of at least 25 micrometres, preferably at least 30 micrometres, even more preferably 35 micrometres. The wrapper comprising a flame retardant composition may have a thickness of less than or equal to 50 micrometres, preferably less than or equal to 45 micrometres, even more preferably less than or equal to 40 micrometres. In some embodiments, the wrapper comprising a flame retardant composition may have a thickness of 37 micrometres.

Aerosol-generating articles according to the present disclosure may further comprise an upstream section located upstream of the rod of aerosol-generating substrate. The upstream section is preferably located immediately upstream of the rod of aerosol-generating substrate. The upstream section preferably extends between the upstream end of the aerosol-generating article and the rod of aerosol-generating substrate. The upstream section may comprise one or more upstream elements located upstream of the rod of aerosol-generating substrate. Such one or more upstream elements are described within the present disclosure.

The aerosol-generating articles of the present invention preferably comprise an upstream element located upstream of and adjacent to the aerosol-generating substrate. The upstream element advantageously prevents direct physical contact with the upstream end of the aerosol-generating substrate. For example, where the aerosol-generating substrate comprises a susceptor element, the upstream element may prevent direct physical contact with the upstream end of the susceptor element. This helps to prevent the displacement or deformation of the susceptor element during handling or transport of the aerosol-generating article. This in turn helps to secure the form and position of the susceptor element. Furthermore, the presence of an upstream element helps to prevent any loss of the substrate, which may be advantageous, for example, if the substrate contains particulate plant material.

Where the aerosol-generating substrate comprises shredded tobacco, such as tobacco cut filler, the upstream section or element thereof may additionally help to prevent the loss of loose particles of tobacco from the upstream end of the article. This may be particularly important when the shredded tobacco has a relatively low density, for example.

The upstream section, or upstream element thereof, may also additionally provide a degree of protection to the aerosol-generating substrate during storage, as it covers at least to some extent the upstream end of the aerosol-generating substrate, which may otherwise be exposed.

For aerosol-generating articles that are intended to be inserted into a cavity in an aerosol-generating device such that the aerosol-generating substrate can be externally heated within the cavity, the upstream section, or upstream element thereof, may advantageously facilitate the insertion of the upstream end of the article into the cavity. The inclusion of the upstream element may additionally protect the end of the rod of aerosol-generating substrate during the insertion of the article into the cavity such that the risk of damage to the substrate is minimised.

The upstream section, or upstream element thereof, may also provide an improved appearance to the upstream end of the aerosol-generating article. Furthermore, if desired, the upstream section, or upstream element thereof, may be used to provide information on the aerosol-generating article, such as information on brand, flavour, content, or details of the aerosol-generating device that the article is intended to be used with.

An upstream element may be a porous plug element. Preferably, an upstream element has a porosity of at least 50 percent in the longitudinal direction of the aerosol-generating article. More preferably, an upstream element has a porosity of between 50 percent and 90 percent in the longitudinal direction. The porosity of an upstream element in the longitudinal direction is defined by the ratio of the cross-sectional area of material forming the upstream element and the internal cross-sectional area of the aerosol-generating article at the position of the upstream element.

An upstream element may be made of a porous material or may comprise a plurality of openings. This may, for example, be achieved through laser perforation. Preferably, the plurality of openings is distributed homogeneously over the cross-section of the upstream element.

The porosity or permeability of an upstream element may advantageously be designed in order to provide an aerosol-generating article with a particular overall resistance to draw (RTD) without substantially impacting the filtration provided by other portions of the article.

An upstream element may be formed from a material that is impermeable to air. In such embodiments, the aerosol-generating article may be configured such that air flows into the rod of aerosol-generating substrate through suitable ventilation means provided in a wrapper.

In certain preferred embodiments of the invention, it may be desirable to minimise the RTD of an upstream element. For example, this may be the case for articles that are intended to be inserted the cavity of an aerosol-generating device such that the aerosol-generating substrate is externally heated, as described herein. For such articles, it is desirable to provide the article with as low an RTD as possible, so that the majority of the RTD experience by the consumer is provided by the aerosol-generating device and not the article.

The RTD of an upstream element is preferably less than 30 millimetres H_2O. More preferably, the RTD of an upstream element is less than 20 millimetres H_2O. Even more preferably, the RTD of an upstream element is less than or equal to 10 millimetres H_2O. Even more preferably, the RTD of the upstream element is less than or equal to 5 millimetres H_2O. Even more preferably, the RTD of the upstream element is less than or equal to 2 millimetres H_2O.

The RTD of an upstream element may be at least 0.1 millimetres H_2O, or at least 0.25 millimetres H_2O or at least 0.5 millimetres H_2O.

In some embodiments, the RTD of an upstream element is from 0.1 millimetres H_2O to 30 millimetres H_2O, preferably from 0.25 millimetres H_2O to 30 millimetres H_2O, preferably from 0.5 millimetres H_2O to 30 millimetres H_2O. In other embodiments, the RTD of an upstream element is from 0.1 millimetres H_2O to 20 millimetres H_2O, preferably from 0.25 millimetres H_2O to 20 millimetres H_2O preferably from 0.5 millimetres H_2O to 20 millimetres H_2O. In further embodiments, the RTD of an upstream element is from 0.1 millimetres H_2O to 10 millimetres H_2O, preferably from 0.25 millimetres H_2O to 10 millimetres H_2O, more preferably from 0.5 millimetres H_2O to 10 millimetres H_2O. In further embodiments, the RTD of an upstream element is from 0.1 millimetres H_2O to 5 millimetres H_2O, preferably from 0.25 millimetres H_2O to 5 millimetres H_2O, more preferably from 0.5 millimetres H_2O to 5 millimetres H_2O. In further embodiments, the RTD of an upstream element is from 0.1 millimetres H_2O to 2 millimetres H_2O, preferably from 0.25 millimetres H_2O to 2 millimetres H_2O, more preferably from 0.5 millimetres H_2O to 2 millimetres H_2O.

Preferably, an upstream element has an RTD of less than 2 millimetres H_2O per millimetre of length, more preferably less than 1.5 millimetres H_2O per millimetre of length, more preferably less than 1 millimetre H_2O per millimetre of length, more preferably less than

0.5 millimetres H_2O per millimetre of length, more preferably less than 0.3 millimetres H_2O per millimetre of length, more preferably less than 0.2 millimetres H_2O per millimetre of length.

Preferably, the combined RTD of the upstream section, or upstream element thereof, and the rod of aerosol-generating substrate is less than 15 millimetres H_2O, more preferably less than 12 millimetres H_2O, more preferably less than 10 millimetres H_2O.

In certain preferred embodiments, an upstream element is formed of a solid cylindrical plug element having a filled cross-section. Such a plug element may be referred to as a ‘plain’ element. The solid plug element may be porous, as described above, but does not have a tubular form and therefore does not provide a longitudinal flow channel. The solid plug element preferably has a substantially uniform transverse cross section.

In other preferred embodiments, an upstream element is formed of a hollow tubular segment defining a longitudinal cavity providing an unrestricted flow channel. In such embodiments, an upstream element can provide protection for the aerosol-generating substrate, as described above, whilst having a minimal effect on the overall resistance to draw (RTD) and filtration properties of the article.

Preferably, the diameter of the longitudinal cavity of the hollow tubular segment forming an upstream element is at least 3 millimetres, more preferably at least 3.5 millimetres, more preferably at least 4 millimetres and more preferably at least 4.5 millimetres. Preferably, the diameter of the longitudinal cavity is maximised in order to minimise the RTD of the upstream section, or upstream element thereof.

Preferably, the wall thickness of the hollow tubular segment is less than 2 millimetres, more preferably less than 1.5 millimetres and more preferably less than 1 millimetre.

An upstream element of the upstream section may be made of any material suitable for use in an aerosol-generating article. The upstream element may, for example, be made of a same material as used for one of the other components of the aerosol-generating article, such as the downstream filter segment or the hollow tubular cooling element. Suitable materials for forming the upstream element include filter materials, ceramic, polymer material, cellulose acetate, cardboard, zeolite or aerosol-generating substrate. The upstream element may comprise a plug of cellulose acetate. The upstream element may comprise a hollow acetate tube, or a cardboard tube.

Preferably, an upstream element is formed of a heat resistant material. For example, preferably an upstream element is formed of a material that resists temperatures of up to 350 degrees Celsius. This ensures that an upstream element is not adversely affected by the heating means for heating the aerosol-generating substrate.

Preferably, the upstream section, or an upstream element thereof, has an external diameter that is approximately equal to the external diameter of the aerosol-generating article. Preferably, the external diameter of the upstream section, or an upstream element thereof, is between 5 millimetres and 8 millimetres, more preferably between 5.25 millimetres and 7.5 millimetres, more preferably between 5.5 millimetres and 7 millimetres.

Preferably, the upstream section or an upstream element has a length of at least 2 millimetres, more preferably at least 3 millimetres, more preferably at least 4 millimetres.

Preferably, the upstream section or an upstream element has a length of between 2 millimetres and 10 millimetres, more preferably between 3 millimetres and 8 millimetres, more preferably between 2 millimetres and 6 millimetres, more preferably between 3 millimetres and 6 millimetres, more preferably between 4 millimetres and 8 millimetres, more preferably between 4 millimetres and 6 millimetres. In a particularly preferred embodiment, the upstream section or an upstream element has a length of 5 millimetres. The length of the upstream section or an upstream element can advantageously be varied in order to provide the desired total length of the aerosol-generating article. For example, where it is desired to reduce the length of one of the other components of the aerosol-generating article, the length of the upstream section or an upstream element may be increased in order to maintain the same overall length of the article.

In addition, the length of the upstream section, or an upstream element thereof, can be used to control the position of the aerosol-generating article within the cavity of an aerosol-generating device, for articles which are intended to be externally heated. This can advantageously ensure that the position of the aerosol-generating substrate within the cavity can be optimised for heating and the position of any ventilation can also be optimised.

The upstream section is preferably circumscribed by a wrapper, such as a plug wrap. The wrapper circumscribing the upstream section is preferably a stiff plug wrap, for example, a plug wrap having a basis weight of at least 80 grams per square metre (gsm), or at least 100 gsm, or at least 110 gsm. This provides structural rigidity to the upstream section.

The upstream section is preferably connected to the rod of aerosol-generating substrate and optionally at least a part of the downstream section by means of an outer wrapper, as described herein.

As mentioned above, an aerosol-generating article according to the present invention comprises a downstream section located downstream of the rod of aerosol-generating substrate. The downstream section is preferably located immediately downstream of the rod of aerosol-generating substrate. The downstream section of the aerosol-generating article preferably extends between the rod of aerosol-generating substrate and the downstream end of the aerosol-generating article. The downstream section may comprise one or more elements, each of which will be described in more detail within the present disclosure.

A length of the downstream section may be at least 40 millimetres. A length of the downstream section may be at least 45 millimetres. A length of the downstream section may be greater than 45 millimetres. A length of the downstream section may be at least 48 millimetres. A length of the downstream section may be at least 50 millimetres.

A length of the downstream section may be less than 75 millimetres. A length of the downstream section may be equal to or less than 70 millimetres. A length of the downstream section may be equal to or less than 65 millimetres.

For example, a length of the downstream section may be between 40 millimetres and 75 millimetres, or between 45 millimetres and 75 millimetres, or between 48 millimetres and 75 millimetres, or between 50 millimetres and 75 millimetres. In other embodiments, a length of the downstream section may be between 40 millimetres and 70 millimetres, or between 45 millimetres and 70 millimetres, or between 48 millimetres and 70 millimetres, or between 50 millimetres and 70 millimetres. In other embodiments, a length of the downstream section may be between 40 millimetres and 65 millimetres, or between 45 millimetres and 65 millimetres, or between 48 millimetres and 65 millimetres, or between 50 millimetres and 65 millimetres.

Providing a relatively long downstream section, ensures that a suitable length of the aerosol-generating article protrudes from an aerosol-generating device when the article is received therein. Such a suitable protrusion length facilitates the ease of insertion and extraction of the article from the device, which also ensures that the upstream portions of the article are suitably inserted into the device with reduced risk of damage, particularly during insertion.

A ratio between a length of the downstream section and an overall length of the aerosol-generating article may be less than 0.85. Preferably, a ratio between a length of the downstream section and an overall length of the aerosol-generating article may be less than 0.80. More preferably, a ratio between a length of the downstream section and an overall length of the aerosol-generating article may be less than 0.75. Even more preferably, a ratio between a length of the downstream section and an overall length of the aerosol-generating article may be less than 0.70.

A ratio between a length of the downstream section and an overall length of the aerosol-generating article may be at least 0.50. Preferably, a ratio between a length of the downstream section and an overall length of the aerosol-generating article may be at least 0.55. More preferably, a ratio between a length of the downstream section and an overall length of the aerosol-generating article may be at least 0.60. Even more preferably, a ratio between a length of the downstream section and an overall length of the aerosol-generating article may be at least 0.65.

In some embodiments, a ratio between a length of the downstream section and an overall length of the aerosol-generating article is from 0.50 to 0.85, preferably from 0.55 to 0.85, more preferably from 0.60 to 0.85, even more preferably from 0.65 to 0.85. In other embodiments, a ratio between a length of the downstream section and an overall length of the aerosol-generating article is from 0.50 to 0.80, preferably from 0.55 to 0.80, more preferably from 0.60 to 0.80, even more preferably from 0.65 to 0.80. In further embodiments, a ratio between a length of the downstream section and an overall length of the aerosol-generating article is from 0.50 to 0.75, preferably from 0.55 to 0.75, more preferably from 0.60 to 0.75, even more preferably from 0.65 to 0.75. In further embodiments, a ratio between a length of the downstream section and an overall length of the aerosol-generating article is from 0.50 to 0.70, preferably from 0.55 to 0.70, more preferably from 0.60 to 0.70, even more preferably from 0.65 to 0.70.

A ratio between a length of the downstream section and a length of the upstream section may be less than 30. Preferably, a ratio between a length of the downstream section and a length of the upstream section may be less than 20. More preferably, a ratio between a length of the downstream section and a length of the upstream section may be less than 15. Even more preferably, a ratio between a length of the downstream section and a length of the upstream section may be less than 10.

A ratio between a length of the downstream section and a length of the upstream section may be at least 4. Preferably, a ratio between a length of the downstream section and a length of the upstream section may be at least 5. More preferably, a ratio between a length of the downstream section and a length of the upstream section may be at least 6. Even more preferably, a ratio between a length of the downstream section and a length of the upstream section may be at least 7.

In some embodiments, a ratio between a length of the downstream section and a length of the upstream section is from 4 to 30, preferably from 5 to 30, more preferably from 6 to 30, even more preferably from 7 to 18. In other embodiments, a ratio between a length of the downstream section and a length of the upstream section is from 4 to 20, preferably from 5 to 20, more preferably from 6 to 20, even more preferably from 7 to 20. In further embodiments, a ratio between a length of the downstream section and a length of the upstream section is from 4 to 15, preferably from 5 to 15, more preferably from 6 to 15, even more preferably from 7 to 15. In further embodiments, a ratio between a length of the downstream section and a length of the upstream section is from 4 to 10, preferably from 5 to 10, more preferably from 6 to 10, even more preferably from 7 to 10.

A ratio between the length of the downstream section and the length of the rod of aerosol-generating substrate is preferably at least 1.0. More preferably, a ratio between the length of the downstream section and the length of the rod of aerosol-generating substrate is at least 1.25. More preferably, a ratio between the length of the downstream section and the length of the rod of aerosol-generating substrate is at least 1.5. More preferably, a ratio between the length of the downstream section and the length of the rod of aerosol-generating substrate is at least 1.75.

A ratio between the length of the downstream section and the length of the rod of aerosol-generating substrate is preferably less than 3.5. Preferably, a ratio between the length of the downstream section and the length of the rod of aerosol-generating substrate is less than 3.25. More preferably, a ratio between the length of the downstream section and the length of the rod of aerosol-generating substrate is less than 3.0. Even more preferably, a ratio between the length of the downstream section and the length of the rod of aerosol-generating substrate is less than 2.75.

In some embodiments, a ratio between the length of the downstream section and the length of the rod of aerosol-generating substrate is from 1.0 to 3.5, preferably from 1.25 to 3.5, more preferably from 1.50 to 3.5, even more preferably from 1.75 to 3.5. In other embodiments, a ratio between the length of the downstream section and the length of the rod of aerosol-generating substrate is from 1.0 to 3.25, preferably from 1.25 to 3.25, more preferably from 1.50 to 3.25, even more preferably from 1.75 to 3.25. In further embodiments, a ratio between the length of the downstream section and the length of the rod of aerosol-generating substrate is from 1.0 to 3.0, preferably from 1.25 to 3.0, more preferably from 1.50 to 3.0, even more preferably from 1.75 to 3.0. In further embodiments, a ratio between the length of the downstream section and the length of the rod of aerosol-generating substrate is from 1.0 to 2.75, preferably from 1.25 to 2.75, more preferably from 1.50 to 2.75, even more preferably from 1.75 to 2.75.

The downstream section of an aerosol-generating article according to the present invention preferably comprises a hollow tubular cooling element provided downstream of the rod of aerosol-generating substrate. The hollow tubular cooling element may advantageously provide an aerosol-cooling element for the aerosol-generating article.

The hollow tubular cooling element may be provided immediately downstream of the rod of aerosol-generating substrate. In other words, the hollow tubular cooling element may abut a downstream end of the rod of aerosol-generating substrate. The hollow tubular cooling element may define an upstream end of the downstream section of the aerosol-generating article. The downstream end of the aerosol-generating article may coincide with the downstream end of the downstream section. In some embodiments, the downstream section of the aerosol-generating article comprises a single hollow tubular element. In other words, the downstream section of the aerosol-generating article may comprise only one hollow tubular element. In other embodiments, the downstream section comprises two or more hollow tubular elements, as described below.

As used throughout the present disclosure, the term "hollow tubular element" denotes a generally elongate element defining a lumen or airflow passage along a longitudinal axis thereof. In particular, the term "tubular" will be used in the following with reference to a tubular element having a substantially cylindrical cross-section and defining at least one airflow conduit establishing an uninterrupted fluid communication between an upstream end of the tubular element and a downstream end of the tubular element. However, it will be understood that alternative geometries (for example, alternative cross-sectional shapes) of the tubular element may be possible. The hollow tubular cooling element may be an individual, discrete element of the aerosol-generating article which has a defined length and thickness.

An internal volume defined by the hollow tubular cooling element may be at least 100 cubic millimetres. In other words, a volume of the cavity or lumen defined by the hollow tubular cooling element may be at least 100 cubic millimetres. Preferably, an internal volume defined by the hollow tubular cooling element may be at least 300 cubic millimetres. An internal volume defined by the hollow tubular cooling element may be at least 700 cubic millimetres.

An internal volume defined by the hollow tubular cooling element may be less than or equal to 1200 cubic millimetres. Preferably, an internal volume defined by the hollow tubular cooling element may be less than or equal to 1000 cubic millimetres. An internal volume defined by the hollow tubular cooling element may be less than or equal to 900 cubic millimetres.

An internal volume defined by the hollow tubular cooling element may be between 100 and 1200 cubic millimetres. Preferably, an internal volume defined by the hollow tubular cooling element may be between 300 and 1000 cubic millimetres. An internal volume defined by the hollow tubular cooling element may be between 700 and 900 cubic millimetres.

In the context of the present invention, a hollow tubular cooling element provides an unrestricted flow channel. This means that the hollow tubular cooling element provides a negligible level of resistance to draw (RTD). The term “negligible level of RTD” is used to describe an RTD of less than 1 millimetres H_2O per 10 millimetres of length of the hollow tubular cooling element, preferably less than 0.4 millimetres H_2O per 10 millimetres of length of the hollow tubular cooling element, more preferably less than 0.1 millimetres H_2O per 10 millimetres of length of the hollow tubular cooling element.

The RTD of a hollow tubular cooling element is preferably less than or equal to 10 millimetres H_2O. More preferably, the RTD of a hollow tubular cooling element is less than or equal to 5 millimetres H_2O. Even more preferably, the RTD of a hollow tubular cooling element is less than or equal to 2.5 millimetres H_2O. Even more preferably, the RTD of the hollow tubular cooling element is less than or equal to 2 millimetres H_2O. Even more preferably, the RTD of the hollow tubular cooling element is less than or equal to 1 millimetre H_2O.

The RTD of a hollow tubular cooling element may be at least 0 millimetres H_2O, or at least 0.25 millimetres H_2O or at least 0.5 millimetres H_2O or at least 1 millimetre H_2O.

In some embodiments, the RTD of a hollow tubular cooling element is from 0 millimetre H_2O to 10 millimetres H_2O, preferably from 0.25 millimetres H_2O to 10 millimetres H_2O, preferably from 0.5 millimetres H_2O to 10 millimetres H_2O. In other embodiments, the RTD of a hollow tubular cooling element is from 0 millimetres H_2O to 5 millimetres H_2O, preferably from 0.25 millimetres H_2O to 5 millimetres H_2O preferably from 0.5 millimetres H_2O to 5 millimetres H_2O. In other embodiments, the RTD of a hollow tubular cooling element is from 1 millimetre H_2O to 5 millimetres H_2O. In further embodiments, the RTD of a hollow tubular cooling element is from 0 millimetres H_2O to 2.5 millimetres H_2O, preferably from 0.25 millimetres H_2O to 2.5 millimetres H_2O, more preferably from 0.5 millimetres H_2O to 2.5 millimetres H_2O. In further embodiments, the RTD of a hollow tubular cooling element is from 0 millimetres H_2O to 2 millimetres H_2O, preferably from 0.25 millimetres H_2O to 2 millimetres H_2O, more preferably from 0.5 millimetres H_2O to 2 millimetres H_2O. In a particularly preferred embodiment, the RTD of a hollow tubular cooling element is 0 millimetre H_2O.

In aerosol-generating articles in accordance with the present invention the overall RTD of the article depends essentially on the RTD of the rod and optionally on the RTD of the downstream and/or upstream elements. This is because the hollow tubular cooling element is substantially empty and, as such, substantially only marginally contribute to the overall RTD of the aerosol-generating article.

The flow channel should therefore be free from any components that would obstruct the flow of air in a longitudinal direction. Preferably, the flow channel is substantially empty and particularly preferably the flow channel is empty.

As will be described in greater detail within the present disclosure, the aerosol-generating article may comprise a ventilation zone at a location along the downstream section. In some embodiments, the aerosol-generating article may comprise a ventilation zone at a location along the hollow tubular cooling element. Such, or any, ventilation zone may extend through the peripheral wall of the hollow tubular cooling element. As such, fluid communication is established between the flow channel internally defined by the hollow tubular cooling element and the outer environment. The ventilation zone is further described within the present disclosure.

Preferably, the length of the hollow tubular cooling element is at least 20 millimetres. More preferably, the length of the hollow tubular cooling element is at least 30 millimetres. The length of the hollow tubular cooling element may be at least 40 millimetres. More preferably, the length of the hollow tubular cooling element is at least 45 millimetres.

The length of the hollow tubular cooling element is preferably less than 60 millimetres. More preferably, the length of the hollow tubular cooling element is less than 55 millimetres. More preferably, the length of the hollow tubular cooling element is less than 50 millimetres.

For example, the length of the hollow tubular cooling element may be between 20 millimetres and 60 millimetres, or between 30 millimetres and 60 millimetres, or between 40 millimetres and 60 millimetres, or between 45 millimetres and 60 millimetres. In other embodiments, the length of the hollow tubular cooling element may be between 20 millimetres and 55 millimetres, or between 30 millimetres and 55 millimetres, or between 40 millimetres and 55 millimetres, or between 45 millimetres and 55 millimetres. In other embodiments, the length of the hollow tubular cooling element may be between 20 millimetres and 50 millimetres, or between 30 millimetres and 50 millimetres, or between 40 millimetres and 50 millimetres, or between 45 millimetres and 50 millimetres.

A relatively long hollow tubular cooling element provides and defines a relatively long internal cavity within the aerosol-generating article and downstream of the rod of aerosol-generating substrate. As discussed in the present disclosure, providing an empty cavity downstream (preferably, immediately downstream) of the aerosol-generating substrate enhances the nucleation of aerosol particles generated by the substrate. Providing a relatively long cavity maximises such nucleation benefits, thereby improving aerosol formation and cooling.

A ratio between the length of the hollow tubular cooling element and the length of the rod of aerosol-generating substrate is preferably at least 1.0. More preferably, a ratio between the length of the hollow tubular cooling element and the length of the rod of aerosol-generating substrate is at least 1.25. More preferably, a ratio between the length of the hollow tubular cooling element and the length of the rod of aerosol-generating substrate is at least 1.5. More preferably, a ratio between the length of the hollow tubular cooling element and the length of the rod of aerosol-generating substrate is at least 1.75.

A ratio between the length of the hollow tubular cooling element and the length of the rod of aerosol-generating substrate is preferably less than 3.5. Preferably, a ratio between the length of the hollow tubular cooling element and the length of the rod of aerosol-generating substrate is less than 3.25. More preferably, a ratio between the length of the hollow tubular cooling element and the length of the rod of aerosol-generating substrate is less than 3.0. Even more preferably, a ratio between the length of the hollow tubular cooling element and the length of the rod of aerosol-generating substrate is less than 2.75.

In some embodiments, a ratio between the length of the hollow tubular cooling element and the length of the rod of aerosol-generating substrate is from 1.0 to 3.5, preferably from 1.25 to 3.5, more preferably from 1.50 to 3.5, even more preferably from 1.75 to 3.5. In other embodiments, a ratio between the length of the hollow tubular cooling element and the length of the rod of aerosol-generating substrate is from 1.0 to 3.25, preferably from 1.25 to 3.25, more preferably from 1.50 to 3.25, even more preferably from 1.75 to 3.25. In further embodiments, a ratio between the length of the hollow tubular cooling element and the length of the rod of aerosol-generating substrate is from 1.0 to 3.0, preferably from 1.25 to 3.0, more preferably from 1.50 to 3.0, even more preferably from 1.75 to 3.0. In further embodiments, a ratio between the length of the hollow tubular cooling element and the length of the rod of aerosol-generating substrate is from 1.0 to 2.75, preferably from 1.25 to 2.75, more preferably from 1.50 to 2.75, even more preferably from 1.75 to 2.75.

A ratio between a length of the hollow tubular cooling element and a length of the downstream section may be less than 1. Preferably, a ratio between a length of the hollow tubular cooling element and a length of the downstream section may be less than 0.90. More preferably, a ratio between a length of the hollow tubular cooling element and a length of the downstream section may be less than 0.85. Even more preferably, a ratio between a length of the hollow tubular cooling element and a length of the downstream section may be less than 0.80.

A ratio between a length of the hollow tubular cooling element and a length of the downstream section may be at least 0.35. Preferably, a ratio between a length of the hollow tubular cooling element and a length of the downstream section may be at least 0.45. More preferably, a ratio between a length of the hollow tubular cooling element and a length of the downstream section may be at least 0.50. Even more preferably, a ratio between a length of the hollow tubular cooling element and a length of the downstream section may be at least 0.60.

In some embodiments, a ratio between a length of the hollow tubular cooling element and a length of the downstream section is from 0.35 to 1, preferably from 0.45 to 1, more preferably from 0.50 to 1, even more preferably from 0.60 to 1. In other embodiments, a ratio between a length of the hollow tubular cooling element and a length of the downstream section is from 0.35 to 0.90, preferably from 0.45 to 0.90, more preferably from 0.50 to 0.90, even more preferably from 0.60 to 0.90. In further embodiments, a ratio between a length of the hollow tubular cooling element and a length of the downstream section is from 0.35 to 0.85, preferably from 0.45 to 0.85, more preferably from 0.50 to 0.85, even more preferably from 0.60 to 0.85. By way of example, a ratio between a length of the hollow tubular cooling element and a length of the downstream section may preferably be 0.75.

A ratio between a length of the hollow tubular cooling element and an overall length of the aerosol-generating article may be less than or equal to 0.80. Preferably, a ratio between a length of the hollow tubular cooling element and an overall length of the aerosol-generating article may be less than or equal to 0.75. More preferably, a ratio between a length of the hollow tubular cooling element and an overall length of the aerosol-generating article may be less than or equal to 0.70. Even more preferably, a ratio between a length of the hollow tubular cooling element and an overall length of the aerosol-generating article may be less than or equal to 0.65.

A ratio between a length of the hollow tubular cooling element and an overall length of the aerosol-generating article may be at least 0.40. Preferably, a ratio between a length of the hollow tubular cooling element and an overall length of the aerosol-generating article may be at least 0.45. More preferably, a ratio between a length of the hollow tubular cooling element and an overall length of the aerosol-generating article may be at least 0.50. Even more preferably, a ratio between a length of the hollow tubular cooling element and an overall length of the aerosol-generating article may be at least 0.6.

In some embodiments, a ratio between a length of the hollow tubular cooling element and an overall length of the aerosol-generating article is from 0.40 to 0.80, preferably from 0.45 to 0.80, more preferably from 0.50 to 0.80, even more preferably from 0.60 to 0.80. In other embodiments, a ratio between a length of the hollow tubular cooling element and an overall length of the aerosol-generating article is from 0.40 to 0.75, preferably from 0.45 to 0.75, more preferably from 0.50 to 0.75, even more preferably from 0.60 to 0.75. In further embodiments, a ratio between a length of the hollow tubular cooling element and an overall length of the aerosol-generating article is from 0.40 to 0.70, preferably from 0.45 to 0.70, more preferably from 0.50 to 0.70, even more preferably from 0.60 to 0.70. In further embodiments, a ratio between a length of the hollow tubular cooling element and an overall length of the aerosol-generating article is from 0.40 to 0.65, preferably from 0.45 to 0.65, more preferably from 0.50 to 0.65, even more preferably from 0.60 to 0.65.

Providing a downstream section or hollow tubular cooling element with the ratios listed above maximises the aerosol cooling and formation benefits of having a relatively long hollow tubular cooling element while providing a sufficient amount of filtration for an aerosol-generating article that is configured to be heated, not combusted. Further, providing a longer hollow tubular cooling element may advantageously lower the effective RTD of the downstream section of the aerosol-generating article, which would primarily be defined by the RTD of a downstream filter segment.

The thickness of a peripheral wall (in other words, the wall thickness) of the hollow tubular cooling element may be at least 100 micrometres. The wall thickness of the hollow tubular cooling element may be at least 150 micrometres. The wall thickness of the hollow tubular cooling element may be at least 200 micrometres, preferably at least 250 micrometres and even more preferably at least 500 micrometres (or 0.5 millimetres).

The wall thickness of the hollow tubular cooling element may be less than or equal to 2 millimetres, preferably less than or equal to 1.5 millimetres and even more preferably less than or equal to 1.25 millimetres. The wall thickness of the hollow tubular cooling element may be less than or equal to 1 millimetre. The wall thickness of the hollow tubular cooling element may be less than or equal to 500 micrometres.

The wall thickness of the hollow tubular cooling element may between 100 micrometres and 2 millimetres, preferably between 150 micrometres and 1.5 millimetres, even more preferably between 200 micrometres and 1.25 millimetres.

The wall thickness of the hollow tubular cooling element may preferably be 250 micrometres (0.25 millimetres).

At the same time, keeping the thickness of the peripheral wall of the hollow tubular cooling element relatively low ensures that the overall internal volume of the hollow tubular cooling element – which is made available for the aerosol to begin the nucleation process as soon as the aerosol components leave the rod of aerosol-generating substrate – and the cross-sectional surface area of the hollow tubular cooling element are effectively maximised, whilst at the same time ensuring that the hollow tubular cooling element has the necessary structural strength to prevent a collapse of the aerosol-generating article as well as to provide some support to the rod of aerosol-generating substrate, and that the RTD of the hollow tubular cooling element is minimised. Greater values of cross-sectional surface area of the cavity of the hollow tubular cooling element are understood to be associated with a reduced speed of the aerosol stream travelling along the aerosol-generating article, which is also expected to favour aerosol nucleation. Further, it would appear that by utilising a hollow tubular cooling element having a relatively low thickness, it is possible to substantially prevent diffusion of the ventilation air prior to its contacting and mixing with the stream of aerosol, which is also understood to further favour nucleation phenomena. In practice, by providing a more controllably localised cooling of the stream of volatilised species, it is possible to enhance the effect of cooling on the formation of new aerosol particles.

The hollow tubular cooling element preferably has an outer diameter that is approximately equal to the outer diameter of the rod of aerosol-generating substrate and to the outer diameter of the aerosol-generating article.

The hollow tubular cooling element may have an outer diameter of between 5 millimetres and 10 millimetres, for example of between 5.5 millimetres and 9 millimetres or of between 6 millimetres and 8 millimetres. In a preferred embodiment, the hollow tubular cooling element has an outer diameter of less than 7 millimetres.

The hollow tubular cooling element may have an internal diameter. Preferably, the hollow tubular cooling element may have a constant internal diameter along a length of the hollow tubular cooling element. However, the internal diameter of the hollow tubular cooling element may vary along the length of the hollow tubular cooling element.

The hollow tubular cooling element may have an internal diameter of at least 2 millimetres. For example, the hollow tubular cooling element may have an internal diameter of at least 3 millimetres, at least 4 millimetres, or at least 5 millimetres.

The provision of a hollow tubular cooling element having an internal diameter as set out above may advantageously provide sufficient rigidity and strength to the hollow tubular cooling element.

The hollow tubular cooling element may have an internal diameter of no more than 10 millimetres. For example, the hollow tubular cooling element may have an internal diameter of no more than 9 millimetres, no more than 8 millimetres, or no more than 7 millimetres.

The provision of a hollow tubular cooling element having an internal diameter as set out above may advantageously reduce the resistance to draw of the hollow tubular cooling element.

The hollow tubular cooling element may have an internal diameter of between 2 millimetres and 10 millimetres, between 3 millimetres and 9 millimetres, between 4 millimetres and 8 millimetres, or between 5 millimetres and 7 millimetres.

The ratio between an internal diameter of the hollow tubular cooling element and the external diameter of the hollow tubular cooling element may be at least 0.8. For example, the ratio between an internal diameter of the hollow tubular cooling element and the external diameter of the hollow tubular cooling element may be at least 0.85, at least 0.9, or at least 0.95.

The ratio between an internal diameter of the hollow tubular cooling element and the external diameter of the hollow tubular cooling element may be no more than 0.99. For example, the ratio between an internal diameter of the hollow tubular cooling element and the external diameter of the hollow tubular cooling element may be no more than 0.98.

The ratio between an internal diameter of the hollow tubular cooling element and the external diameter of the hollow tubular cooling element may be 0.97.

The provision of a relatively large internal diameter may advantageously reduce the resistance to draw of the hollow tubular cooling element and enhance cooling and nucleation of aerosol particles.

The lumen or cavity of the hollow tubular cooling element may have any cross sectional shape. The lumen of the hollow tubular cooling element may have a circular cross sectional shape.

The hollow tubular cooling element may comprise a paper-based material. The hollow tubular cooling element may comprise at least one layer of paper. The paper may be very rigid paper. The paper may be crimped paper, such as crimped heat resistant paper or crimped parchment paper.

Preferably, the hollow tubular cooling element may comprise cardboard. The hollow tubular cooling element may be a cardboard tube. The hollow tubular cooling element may be formed from cardboard. Advantageously, cardboard is a cost-effective material that provides a balance between being deformable in order to provide ease of insertion of the article into an aerosol-generating device and being sufficiently stiff to provide suitable engagement of the article with the interior of the device. A cardboard tube may therefore provide suitable resistance to deformation or compression during use.

The hollow tubular cooling element may be paper tube. The hollow tubular cooling element may be a tube formed from spirally wound paper. The hollow tubular cooling element may be formed from a plurality of layers of the paper. The paper may have a basis weight of at least 50 grams per square meter, at least 60 grams per square meter, at least 70 grams per square meter, or at least 90 grams per square meter.

The hollow tubular cooling element may comprise a polymeric material. For example, the hollow tubular cooling element may comprise a polymeric film. The polymeric film may comprise a cellulosic film. The hollow tubular cooling element may comprise low density polyethylene (LDPE) or polyhydroxyalkanoate (PHA) fibres. The hollow tube may comprise cellulose acetate tow.

Where the hollow tubular cooling element comprises cellulose acetate tow, the cellulose acetate tow may have a denier per filament of between 2 and 4 and a total denier of between 25 and 40.

In some embodiments, the aerosol-generating article according to the present invention may comprise a ventilation zone at a location along the downstream section. In more detail, in those embodiments wherein the downstream section comprises a hollow tubular cooling element, the ventilation zone may be provided at a location along the hollow tubular cooling element. Alternatively, in those embodiments where the downstream section comprises a downstream hollow tubular element, as described below, the ventilation zone may be provided at a location along the downstream hollow tubular element.

As such, a ventilated cavity is provided downstream of the rod of aerosol-generating substrate. This provides several potential technical benefits.

First of all, the inventors have found that one such ventilated hollow tubular cooling element provides a particularly efficient cooling of the aerosol. Thus, a satisfactory cooling of the aerosol can be achieved even by means of a relatively short downstream section. This is especially desirable as it enables the provision of an aerosol-generating article wherein an aerosol-generating substrate (and particularly a tobacco-containing one) is heated rather than combusted that combines a satisfactory aerosol delivery with an efficient cooling of the aerosol down to temperatures that are desirable for the consumer.

Secondly, the inventors have surprisingly found that such rapid cooling of the volatile species released upon heating the aerosol-generating substrate promotes enhances nucleation of aerosol particles. This effect is felt particularly when, as will be described in more detail below, the ventilation zone is arranged at a precisely defined location along the length of the hollow tubular cooling element relative to other components of the aerosol-generating article. In effect, the inventors have found that the favourable effect of the enhanced nucleation is capable of significantly countering potentially less desirable effects of the dilution induced by the introduction of ventilation air.

A distance between the ventilation zone and an upstream end of the upstream element may be at least 25 millimetres. As used herein, the term ‘distance between the ventilation zone and another element or portion of the aerosol-generating article’ refers to a distance measures in the longitudinal direction, that is, in a direction extending along, or parallel to, the cylindrical axis of the aerosol-generating article.

Preferably, a distance between the ventilation zone and an upstream end of the upstream element is at least 26 millimetres. More preferably, a distance between the ventilation zone and an upstream end of the upstream element is at least 27 millimetres.

A distance between the ventilation zone and an upstream end of the upstream element may be less than or equal to 34 millimetres. Preferably, a distance between the ventilation zone and an upstream end of the upstream element is less than or equal to 33 millimetres. More preferably, a distance between the ventilation zone and an upstream end of the upstream element is less than or equal to 31 millimetres.

In some embodiments, a distance between the ventilation zone and an upstream end of the upstream element is from 25 millimetres to 34 millimetres, preferably from 26 millimetres to 34 millimetres, more preferably from 27 millimetres to 34 millimetres.

In other embodiments, a distance between the ventilation zone and an upstream end of the upstream element is from 25 millimetres to 33 millimetres, preferably from 26 millimetres to 33 millimetres, more preferably from 27 millimetres to 33 millimetres.

In further embodiments, a distance between the ventilation zone and an upstream end of the upstream element is from 25 millimetres to 31 millimetres, preferably from 26 millimetres to 31 millimetres, more preferably from 27 millimetres to 31 millimetres.

In some particularly preferred embodiments, a distance between the ventilation zone and an upstream end of the upstream element is from 28 millimetres to 30 millimetres.

Aerosol-generating articles comprising a ventilation zone at a location along the hollow tubular cooling element at a distance from an upstream end of the upstream element falling within the ranges described above have been found to present multiple benefits.

Firstly, such articles have been observed to provide particularly satisfactory aerosol deliveries to the consumer, particularly where the aerosol-generating substrate comprises tobacco.

Without wishing to be bound by theory, the intense cooling caused by the ambient air drawn into the cavity of the hollow tubular cooling element at the ventilation zone is understood to accelerate the condensation of droplets of aerosol former (for example, glycerin) that has been released from the aerosol-generating substrate upon heating. In turn, the volatilised nicotine and organic acids similarly released from the tobacco substrate accumulate onto the newly formed droplets of aerosol former, and subsequently combine into nicotine salts. Accordingly, the overall proportion of the aerosol particulate phase to the aerosol gas phase may be enhanced compared with existing aerosol-generating articles.

Positioning the ventilation zone at a distance from an upstream end of the upstream element as described above advantageously reduces the fly time of the volatilised nicotine before the volatilised nicotine particles reach the droplets of aerosol former. At the same time, one such positioning of the ventilation zone relative to an upstream end of the upstream element ensures there are enough time and room for the accumulation of nicotine and formation of nicotine salts to occur in a significant proportion before the flow of aerosol reaches the consumer’s mouth.

The ventilation zone may typically comprise a plurality of perforations through the peripheral wall of the hollow tubular cooling element. Preferably, the ventilation zone comprises at least one circumferential row of perforations. In some embodiments, the ventilation zone may comprise two circumferential rows of perforations. For example, the perforations may be formed online during manufacturing of the aerosol-generating article. Preferably, each circumferential row of perforations comprises from 8 to 30 perforations.

An aerosol-generating article in accordance with the present invention may have a ventilation level of at least 2 percent.

The term “ventilation level” is used throughout the present specification to denote a volume ratio between of the airflow admitted into the aerosol-generating article via the ventilation zone (ventilation airflow) and the sum of the aerosol airflow and the ventilation airflow. The greater the ventilation level, the higher the dilution of the aerosol flow delivered to the consumer. The aerosol-generating article preferably has a ventilation level of at least 5 percent, more preferably at least 10 percent, even more preferably at least 12 percent or at least 15 percent.

An aerosol-generating article in accordance with the present invention may have a ventilation level of up to 90 percent. Preferably, an aerosol-generating article in accordance with the present invention has a ventilation level of less than or equal to 80 percent, more preferably less than or equal to 70 percent, even more preferably less than or equal to 60 percent, most preferably less than or equal to 50 percent.

Thus, an aerosol-generating article in accordance with the present invention may have a ventilation level from 2 percent to 90 percent, preferably from 5 percent to 90 percent, more preferably from 10 percent to 90 percent, even more preferably from 15 percent to 90 percent. An aerosol-generating article in accordance with the present invention may have a ventilation level from 2 percent to 80 percent, preferably from 5 percent to 80 percent, more preferably from 10 percent to 80 percent, even more preferably from 15 percent to 80 percent. An aerosol-generating article in accordance with the present invention may have a ventilation level from 2 percent to 70 percent, preferably from 5 percent to 70 percent, more preferably from 10 percent to 70 percent, even more preferably from 15 percent to 70 percent. An aerosol-generating article in accordance with the present invention may have a ventilation level from 2 percent to 60 percent, preferably from 5 percent to 60 percent, more preferably from 10 percent to 60 percent, even more preferably from 15 percent to 60 percent. An aerosol-generating article in accordance with the present invention may have a ventilation level from 2 percent to 50 percent, preferably from 5 percent to 50 percent, more preferably from 10 percent to 50 percent, even more preferably from 15 percent to 50 percent. The aerosol-generating article preferably has a ventilation level of less than or equal to 30 percent, preferably less than or equal to 25 percent, more preferably less than or equal to 20 percent, even more preferably less than or equal to 18 percent.

In some embodiments, the aerosol-generating article has a ventilation level from 10 percent to 30 percent, preferably from 12 percent to 30 percent, more preferably from 15 percent to 30 percent. In other embodiments, the aerosol-generating article has a ventilation level from 10 percent to 25 percent, preferably from 12 percent to 25 percent, more preferably from 15 percent to 25 percent. In further embodiments, the aerosol-generating article has a ventilation level from 10 percent to 20 percent, preferably from 12 percent to 20 percent, more preferably from 15 percent to 20 percent. In particularly preferred embodiments, the aerosol-generating article has a ventilation level from 10 percent to 18 percent, preferably from 12 percent to 18 percent, more preferably from 15 percent to 18 percent.

Without wishing to be bound by theory, the inventors have found that the temperature drop caused by the admission of cooler, external air into the hollow tubular cooling element via the ventilation zone may have an advantageous effect on the nucleation and growth of aerosol particles.

Formation of an aerosol from a gaseous mixture containing various chemical species depends on a delicate interplay between nucleation, evaporation, and condensation, as well as coalescence, all the while accounting for variations in vapour concentration, temperature, and velocity fields. The so-called classical nucleation theory is based on the assumption that a fraction of the molecules in the gas phase are large enough to stay coherent for long times with sufficient probability (for example, a probability of one half). These molecules represent some kind of a critical, threshold molecule clusters among transient molecular aggregates, meaning that, on average, smaller molecule clusters are likely to disintegrate rather quickly into the gas phase, while larger clusters are, on average, likely to grow. Such critical cluster is identified as the key nucleation core from which droplets are expected to grow due to condensation of molecules from the vapour. It is assumed that virgin droplets that just nucleated emerge with a certain original diameter, and then may grow by several orders of magnitude. This is facilitated and may be enhanced by rapid cooling of the surrounding vapour, which induces condensation. In this connection, it helps to bear in mind that evaporation and condensation are two sides of one same mechanism, namely gas–liquid mass transfer. While evaporation relates to net mass transfer from the liquid droplets to the gas phase, condensation is net mass transfer from the gas phase to the droplet phase. Evaporation (or condensation) will make the droplets shrink (or grow), but it will not change the number of droplets.

In this scenario, which may be further complicated by coalescence phenomena, the temperature and rate of cooling can play a critical role in determining how the system responds. In general, different cooling rates may lead to significantly different temporal behaviours as concerns the formation of the liquid phase (droplets), because the nucleation process is typically nonlinear. Without wishing to be bound by theory, it is hypothesised that cooling can cause a rapid increase in the number concentration of droplets, which is followed by a strong, short-lived increase in this growth (nucleation burst). This nucleation burst would appear to be more significant at lower temperatures. Further, it would appear that higher cooling rates may favour an earlier onset of nucleation. By contrast, a reduction of the cooling rate would appear to have a favourable effect on the final size that the aerosol droplets ultimately reach.

Therefore, the rapid cooling induced by the admission of external air into the hollow tubular cooling element via the ventilation zone can be favourably used to favour nucleation and growth of aerosol droplets. However, at the same time, the admission of external air into the hollow tubular cooling element has the immediate drawback of diluting the aerosol stream delivered to the consumer.

The inventors have surprisingly found how the favourable effect of enhanced nucleation promoted by the rapid cooling induced by the introduction of ventilation air into the article is capable of significantly countering the less desirable effects of dilution. As such, satisfactory values of aerosol delivery are consistently achieved with aerosol-generating articles in accordance with the invention.

The inventors have also surprisingly found that the diluting effect on the aerosol – which can be assessed by measuring, in particular, the effect on the delivery of aerosol former (for example, glycerol) included in the aerosol-generating substrate – is advantageously minimised when the ventilation level is within the ranges described above.

In particular, ventilation levels between 10 percent and 20 percent, and even more preferably between 12 and 18 percent, have been found to lead to particularly satisfactory values of glycerol delivery.

As the ventilated hollow tubular cooling element substantially does not contribute to the overall RTD of the aerosol-generating article, in aerosol-generating articles in accordance with the invention the overall RTD of the article can advantageously be fine-tuned by adjusting the length and density of the rod of aerosol-generating substrate or the length and optionally the length and density of any segment of filtration material forming part of the downstream section, such as for example a downstream filter segment, or the length and density of a segment of filtration material provided upstream of the aerosol-generating substrate. Thus, aerosol-generating articles that have a predetermined RTD can be manufactured consistently and with great precision, such that satisfactory levels of RTD can be provided for the consumer even in the presence of ventilation.

A distance between the ventilation zone and a downstream end of the rod of aerosol-generating substrate may be at least 4 millimetres or at least 6 millimetres or at least 8 millimetres. Preferably, a distance between the ventilation zone and a downstream end of the rod of aerosol-generating substrate is at least 9 millimetres. More preferably, a distance between the ventilation zone and a downstream end of the rod of aerosol-generating substrate is at least 10 millimetres.

A distance between the ventilation zone and a downstream end of the rod of aerosol-generating substrate is preferably less than 17 millimetres. More preferably, a distance between the ventilation zone and a downstream end of the rod of aerosol-generating substrate is less than 16 millimetres. Even more preferably, a distance between the ventilation zone and a downstream end of the rod of aerosol-generating substrate is less than 16 millimetres.

In particularly preferred embodiments, a distance between the ventilation zone and a downstream end of the rod of aerosol-generating substrate is less than 15 millimetres.

In some embodiments, a distance between the ventilation zone and a downstream end of the rod of aerosol-generating substrate is from 4 millimetres to 17 millimetres, preferably from 7 millimetres to 17 millimetres, more preferably from 10 millimetres to 17 millimetres. In other embodiments, a distance between the ventilation zone and a downstream end of the rod of aerosol-generating substrate is from 8 millimetres to 16 millimetres, preferably from 9 millimetres to 16 millimetres, more preferably from 10 millimetres to 16 millimetres. In further embodiments, a distance between the ventilation zone and a downstream end of the rod of aerosol-generating substrate is from 8 millimetres to 15 millimetres, preferably from 9 millimetres to 15 millimetres, more preferably from 10 millimetres to 15 millimetres. By way of example, a distance between the ventilation zone and a downstream end of the rod of aerosol-generating substrate may be from 10 millimetres to 14 millimetres, preferably from 10 millimetres to 13 millimetres, more preferably from 10 millimetres to 12 millimetres.

Positioning the ventilation zone at a distance from a downstream end of the rod of aerosol-generating substrate within the ranges described above has the benefit of generally ensuring that, during use, the ventilation zone is just outside of the heating device when the aerosol-generating article is inserted in the heating device while reducing the risk of the ventilation zone being inadvertently obstructed by a user’s lips or hands. Additionally, it has been found that positioning the ventilation zone at a distance from a downstream end of the rod of aerosol-generating substrate within the ranges described above may advantageously enhance nucleation and aerosol formation and delivery.

A distance between the ventilation zone and a downstream end of the hollow tubular cooling element may be at least 3 millimetres. Preferably, a distance between the ventilation zone and a downstream end of the hollow tubular cooling element is at least 5 millimetres. More preferably, a distance between the ventilation zone and a downstream end of the hollow tubular cooling element is at least 7 millimetres.

A distance between the ventilation zone and a downstream end of the hollow tubular cooling element is preferably less than or equal to 14 millimetres. More preferably, a distance between the ventilation zone and a downstream end of the hollow tubular cooling element is less than or equal to 12 millimetres. Even more preferably, a distance between the ventilation zone and a downstream end of the hollow tubular cooling element is less than or equal to 10 millimetres.

In some embodiments, a distance between the ventilation zone and a downstream end of the hollow tubular cooling element is from 3 millimetres to 14 millimetres, preferably from 5 millimetres to 14 millimetres, more preferably from 7 millimetres to 14 millimetres. In further embodiments, a distance between the ventilation zone and a downstream end of the hollow tubular cooling element is from 3 millimetres to 12 millimetres, preferably from 5 millimetres to

12 millimetres, more preferably from 7 millimetres to 12 millimetres. In other embodiments, a distance between the ventilation zone and a downstream end of the hollow tubular cooling element is from 3 millimetres to 10 millimetres, preferably from 5 millimetres to 10 millimetres, more preferably from 7 millimetres to 10 millimetres.

Positioning the ventilation zone at a distance from a downstream end of the hollow tubular cooling element within the ranges described above has the benefit of generally ensuring that, during use, the ventilation zone is just outside of the heating device when the aerosol-generating article is inserted in the heating device while reducing the risk of the ventilation zone being inadvertently obstructed by a user's lips or hands. Additionally, it has been found that positioning the ventilation zone at a distance from a downstream end of the hollow tubular cooling element within the ranges described above may advantageously lead to the formation and delivery of a comparatively more homogenous aerosol.

A distance between the ventilation zone and a downstream end of the aerosol-generating article may be at least 10 millimetres. Preferably, a distance between the ventilation zone and a downstream end of the aerosol-generating article is at least 12 millimetres. More preferably, a distance between the ventilation zone and a downstream end of the aerosol-generating article is at least 15 millimetres.

A distance between the ventilation zone and a downstream end of the aerosol-generating article is preferably less than or equal to 21 millimetres. More preferably, a distance between the ventilation zone and a downstream end of the aerosol-generating article is less than or equal to 19 millimetres. Even more preferably, a distance between the ventilation zone and a downstream end of the aerosol-generating article is less than or equal to 17 millimetres.

In some embodiments, a distance between the ventilation zone and a downstream end of the aerosol-generating article is from 10 millimetres to 21 millimetres, preferably from 12 millimetres to 21 millimetres, more preferably from 15 millimetres to 21 millimetres. In further embodiments, a distance between the ventilation zone and a downstream end of the aerosol-generating article is from 10 millimetres to 19 millimetres, preferably from 12 millimetres to 19 millimetres, more preferably from 15 millimetres to 19 millimetres. In other embodiments, a distance between the ventilation zone and a downstream end of the aerosol-generating article is from 10 millimetres to 17 millimetres, preferably from 12 millimetres to 17 millimetres, more preferably from 15 millimetres to 17 millimetres.

Positioning the ventilation zone at a distance from a downstream end of the aerosol-generating article within the ranges described above has the benefit of generally ensuring that, during use, when the aerosol-generating article is partially received within the heating device, a portion of the aerosol-generating article extending outside of the heating device is long enough for the consumer to comfortably hold the article between their lips while reducing the risk of the ventilation zone being inadvertently obstructed by a user's lips or hands. At the same time, evidence suggests that a length of the portion of the aerosol-generating article extending outside of the heating device were greater, it may become easy to inadvertently and undesirably bend the aerosol-generating article, and this may impair aerosol delivery or in general the intended use of the aerosol-generating article.

As discussed in the present disclosure, the downstream section may comprise a downstream filter segment. The downstream filter segment may extend to a downstream end of the downstream section. The downstream filter segment may be located at the downstream end of the aerosol-generating article. The downstream end of the downstream filter segment may define the downstream end of the aerosol-generating article.

The downstream filter segment may be located downstream of a hollow tubular cooling element, which is described above. The downstream filter segment may extend between the hollow tubular cooling element and the downstream end of the aerosol-generating article.

The downstream filter segment is preferably a solid plug, which may also be described as a ‘plain’ plug and is non-tubular. The filter segment therefore preferably has a substantially uniform transverse cross section.

The downstream filter segment is preferably formed of a fibrous filtration material. The fibrous filtration material may be for filtering the aerosol that is generated from the aerosol-generating substrate. Suitable fibrous filtration materials would be known to the skilled person. Particularly preferably, the at least one downstream filter segment comprises a cellulose acetate filter segment formed of cellulose acetate tow.

In certain preferred embodiments, the downstream section includes a single downstream filter segment. In alternative embodiments, the downstream section includes two or more downstream filter segments axially aligned in an abutting end to end relationship with each other.

The downstream filter segment may optionally comprise a flavourant, which may be provided in any suitable form. For example, the downstream filter segment may comprise one or more capsules, beads or granules of a flavourant, or one or more flavour loaded threads or filaments.

Preferably, the downstream filter segment has a low particulate filtration efficiency.

Preferably, the downstream filter segment is circumscribed by a plug wrap. Preferably, the downstream filter segment is unventilated such that air does not enter the aerosol-generating article along the downstream filter segment.

The downstream filter segment is preferably connected to one or more of the adjacent upstream components of the aerosol-generating article by means of a tipping wrapper.

The downstream filter segment preferably has an external diameter that is approximately equal to the external diameter of the aerosol-generating article. The diameter of a downstream filter segment may be substantially the same as the outer diameter of the hollow tubular cooling element.

The outer diameter of the downstream filter segment may be between 5 millimetres and 10 millimetres. The diameter of the downstream filter segment may be between 5.5 millimetres and 9 millimetres. The diameter of the downstream filter segment may be between 6 millimetres and 8 millimetres. In preferred embodiments, the diameter of the downstream filter segment is less than 7 millimetres.

The resistance to draw (RTD) of the downstream section may be at least 0 millimetres H_2O. The RTD of the downstream section may be at least 3 millimetres H_2O. The RTD of the downstream section may be at least 6 millimetres H_2O.

The RTD of the downstream section may be no greater than 12 millimetres H_2O. The RTD of the downstream section may be no greater than 11 millimetres H_2O. The RTD of the downstream section may be no greater than 10 millimetres H_2O.

The resistance to draw of the downstream section may be greater than or equal to 0 millimetres H_2O and less than 12 millimetres H_2O. Preferably, the resistance to draw of the downstream section may be greater than or equal to 3 millimetres H_2O and less than 12 millimetres H_2O. The resistance to draw of the downstream section may be greater than or equal to 0 millimetres H_2O and less than 11 millimetres H_2O. Even more preferably, the resistance to draw of the downstream section may be greater than or equal to 3 millimetres H_2O and less than 11 millimetres H_2O. Even more preferably, the resistance to draw of the downstream section may be greater than or equal to 6 millimetres H_2O and less than 10 millimetres H_2O. Preferably, the resistance to draw of the downstream section may be 8 millimetres H_2O.

The resistance to draw (RTD) characteristics of the downstream section may be wholly or mostly attributed to the RTD characteristics of the downstream filter segment of the downstream section. In other words, the RTD of the downstream filter segment of the downstream section may wholly define the RTD of the downstream section.

The resistance to draw (RTD) of the downstream filter segment may be at least 0 millimetres H_2O. The RTD of the downstream filter segment may be at least 3 millimetres H_2O. The RTD of the downstream filter segment may be at least 6 millimetres H_2O.

The RTD of the downstream filter segment may be no greater than 12 millimetres H_2O. The RTD of the downstream filter segment may be no greater than 11 millimetres H_2O. The RTD of the downstream filter segment may be no greater than 10 millimetres H_2O.

The resistance to draw of the downstream filter segment may be greater than or equal to 0 millimetres H_2O and less than 12 millimetres H_2O. Preferably, the resistance to draw of the downstream filter segment may be greater than or equal to 3 millimetres H_2O and less than 12 millimetres H_2O. The resistance to draw of the downstream filter segment may be greater than or equal to 0 millimetres H_2O and less than 11 millimetres H_2O. Even more preferably, the resistance to draw of the downstream filter segment may be greater than or equal to 3 millimetres H_2O and less than 11 millimetres H_2O. Even more preferably, the resistance to draw of the downstream filter segment may be greater than or equal to 6 millimetres H_2O and less than 10 millimetres H_2O. Preferably, the resistance to draw of the downstream filter segment may be 8 millimetres H_2O.

As mentioned above, the downstream filter segment may be formed of a fibrous filtration material. The downstream filter segment may be formed of a porous material. The downstream filter segment may be formed of a biodegradable material. The downstream filter segment may be formed of a cellulose material, such as cellulose acetate. For example, a downstream filter segment may be formed from a bundle of cellulose acetate fibres having a denier per filament between 10 and 15. For example, a downstream filter segment formed from relatively low density cellulose acetate tow, such as cellulose acetate tow comprising fibres of 12 denier per filament.

The downstream filter segment may be formed of a polylactic acid based material. The downstream filter segment may be formed of a bioplastic material, preferably a starch-based bioplastic material. The downstream filter segment may be made by injection moulding or by extrusion. Bioplastic-based materials are advantageous because they are able to provide downstream filter segment structures which are simple and cheap to manufacture with a particular and complex cross-sectional profile, which may comprise a plurality of relatively large air flow channels extending through the downstream filter segment material, that provides suitable RTD characteristics.

The downstream filter segment may be formed from a sheet of suitable material that has been crimped, pleated, gathered, woven or folded into an element that defines a plurality of longitudinally extending channels. Such sheet of suitable material may be formed of paper, cardboard, a polymer, such as polylactic acid, or any other cellulose-based, paper-based material or bioplastic-based material. A cross-sectional profile of such a downstream filter segment may show the channels as being randomly oriented.

The downstream filter segment may be formed in any other suitable manner. For example, the downstream filter segment may be formed from a bundle of longitudinally extending tubes. The longitudinally extending tubes may be formed from polylactic acid. The downstream filter segment may be formed by extrusion, moulding, lamination, injection, or shredding of a suitable material. Thus, it is preferred that there is a low-pressure drop (or RTD) from an upstream end of the downstream filter segment to a downstream end of the downstream filter segment.

The length of the downstream filter segment may be at least 5 millimetres. The length of the downstream filter segment may be at least 10 millimetres. The length of the downstream filter segment may less than 25 millimetres. The length of the downstream filter segment may be less than 20 millimetres. For example, the length of the downstream filter segment may be between 5 millimetres and 25 millimetres, or between 10 millimetres and 25 millimetres, or between 5 millimetres and 20 millimetres, or between 10 millimetres and 20 millimetres.

A ratio between a length of the downstream filter segment and a length of the downstream section may be less than or equal to 0.55. Preferably, a ratio between a length of the downstream filter segment and a length of the downstream section may be less than or equal to 0.45. More preferably, a ratio between a length of the downstream filter segment and a length of the downstream section may be less than or equal to 0.35. Even more preferably, a ratio between a length of the downstream filter segment and a length of the downstream section may be less than or equal to 0.25.

A ratio between a length of the downstream filter segment and a length of the downstream section may be at least 0.05. Preferably, a ratio between a length of the downstream filter segment and a length of the downstream section may be at least 0.10. More preferably, a ratio between a length of the downstream filter segment and a length of the downstream section may be at least 0.15. Even more preferably, a ratio between a length of the downstream filter segment and a length of the downstream section may be at least 0.20.

In some embodiments, a ratio between a length of the downstream filter segment and a length of the downstream section is from 0.05 to 0.55, preferably from 0.10 to 0.55, more preferably from 0.15 to 0.55, even more preferably from 0.20 to 0.55. In other embodiments, a ratio between a length of the downstream filter segment and a length of the downstream section is from 0.05 to 0.45, preferably from 0.10 to 0.45, more preferably from 0.15 to 0.45, even more preferably from 0.20 to 0.45. In further embodiments, a ratio between a length of the downstream filter segment and a length of the downstream section is from 0.05 to 0.35, preferably from 0.10 to 0.35, more preferably from 0.15 to 0.35, even more preferably from 0.20 to 0.35. By way of example, a ratio between a length of the downstream filter segment and a length of the downstream section may preferably between 0.20 and 0.25, more preferably a ratio between a length of the downstream filter segment and a length of the downstream section may be 0.25.

A ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article may be less than or equal to 0.40. Preferably, a ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article may be less than or equal to 0.30. More preferably, a ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article may be less than or equal to 0.25. Even more preferably, a ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article may be less than or equal to 0.20.

A ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article may be at least 0.05. Preferably, a ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article may be at least 0.07. More preferably, a ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article may be at least 0.10. Even more preferably, a ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article may be at least 0.15.

In some embodiments, a ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article is from 0.05 to 0.40, preferably from 0.07 to 0.40, more preferably from 0.10 to 0.40, even more preferably from 0.15 to 0.40. In other embodiments, a ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article is from 0.05 to 0.30, preferably from 0.07 to 0.30, more preferably from 0.10 to 0.30, even more preferably from 0.15 to 0.30. In further embodiments, a ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article is from 0.05 to 0.25, preferably from 0.07 to 0.25, more preferably from 0.10 to 0.25, even more preferably from 0.15 to 0.25. By way of example, a ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article may be between 0.15 and 0.20, more preferably ratio between a length of the downstream filter segment and an overall length of the aerosol-generating article may be 0.16.

In embodiments where the downstream section comprises a hollow tubular cooling element a and a downstream filter segment, a ratio of the length of the hollow tubular cooling element to the length of the downstream filter segment may be at least 1.25. In other words, the length of the hollow tubular cooling element may be equivalent to 125% of the length of the downstream filter segment. A ratio of the length of the hollow tubular cooling element to the length of the downstream filter segment may be at least 1.5. A ratio of the length of the hollow tubular cooling element to the length of the downstream filter segment may be at least 2.

A ratio of the length of the hollow tubular cooling element to the length of the downstream filter segment may be equal to or less than 8.5. A ratio of the length of the hollow tubular cooling element to the length of the downstream filter segment may be equal to or less than 6. A ratio of the length of the hollow tubular cooling element to the length of the downstream filter segment may be equal to or less than 4.

A ratio of the length of the hollow tubular cooling element to the length of the downstream filter segment may be between 1.25 and 8.5. A ratio of the length of the hollow tubular cooling element to the length of the downstream filter segment may be between 1.5 and 6. A ratio of the length of the hollow tubular cooling element to the length of the downstream filter segment may be between 2 and 4.

In certain preferred embodiments, the downstream section may comprise a ventilation zone at a location downstream of the downstream filter segment. In one example, the ventilation zone at a location downstream of the downstream filter segment may be provided instead of a ventilation zone at a location along the hollow tubular cooling element. In another example, the ventilation zone at a location downstream of the downstream filter segment may be provided in addition to the ventilation zone provided at a location on the hollow tubular cooling element.

The ventilation zone downstream of the filter segment may comprise a plurality of perforations. Preferably, the ventilation zone downstream of the filter segment comprises at least one circumferential row of perforations. In some embodiments, the ventilation zone downstream of the filter segment may comprise two circumferential rows of perforations. For example, the perforations may be formed online during manufacturing of the aerosol-generating article. Preferably, each circumferential row of perforations comprises from 8 to 30 perforations.

The downstream section may further comprise one or more additional hollow tubular elements.

In certain embodiments, the downstream section may comprise a hollow tubular support element upstream of the hollow tubular cooling element described above. Preferably, the hollow tubular support element abuts the downstream end of the rod of aerosol-generating substrate. Preferably, the hollow tubular support element abuts the upstream end of the hollow tubular cooling element. Preferably, the hollow tubular support element and the hollow tubular cooling element are adjacent to each other and together provide a hollow tubular section within the downstream section.

The hollow tubular support element may be formed from any suitable material or combination of materials. For example, the support element may be formed from one or more materials selected from the group consisting of: cellulose acetate; cardboard; crimped paper, such as crimped heat resistant paper or crimped parchment paper; and polymeric materials, such as low density polyethylene (LDPE). In a preferred embodiment, the support element is formed from cellulose acetate. Other suitable materials include polyhydroxyalkanoate (PHA) fibres. In a preferred embodiment, the hollow tubular support element comprises a hollow acetate tube.

The hollow tubular support element preferably has an outer diameter that is approximately equal to the outer diameter of the rod of aerosol-generating substrate and to the outer diameter of the aerosol-generating article.

The hollow tubular support element may have an outer diameter of between 5 millimetres and 10 millimetres, for example of between 5.5 millimetres and 9 millimetres or of between 6 millimetres and 8 millimetres. In a preferred embodiment, the hollow tubular support element has an external diameter of less than 7 millimetres.

The hollow tubular support element may have a wall thickness of at least 1 millimetre, preferably at least 1.5 millimetres, more preferably at least 2 millimetres.

The hollow tubular support element may have a length of at least 5 millimetres. Preferably, the support element has a length of at least 6 millimetres, more preferably at least 7 millimetres.

The hollow tubular support element may have a length of less than 15 millimetres. Preferably, the hollow tubular support element has a length of less than 12 millimetres, more preferably less than 10 millimetres.

In some embodiments, the support element has a length from 5 millimetres to 15 millimetres, preferably from 6 millimetres to 15 millimetres, more preferably from 7 millimetres to 15 millimetres. In other embodiments, the support element has a length from 5 millimetres to 12 millimetres, preferably from 6 millimetres to 12 millimetres, more preferably from 7 millimetres to 12 millimetres. In further embodiments, the support element has a length from 5 millimetres to 10 millimetres, preferably from 6 millimetres to 10 millimetres, more preferably from 7 millimetres to 10 millimetres.

Preferably, the length of the hollow tubular section is at least 20 millimetres. More preferably, the length of the hollow tubular section is at least 30 millimetres. The length of the hollow tubular section may be at least 40 millimetres. More preferably, the length of the hollow tubular section is at least 45 millimetres.

The length of the hollow tubular section is preferably less than 60 millimetres. More preferably, the length of the hollow tubular section is less than 55 millimetres. More preferably, the length of the hollow tubular section is less than 50 millimetres.

For example, the length of the hollow tubular section may be between 20 millimetres and 60 millimetres, or between 30 millimetres and 60 millimetres, or between 40 millimetres and 60 millimetres, or between 45 millimetres and 60 millimetres. In other embodiments, the length of the hollow tubular section may be between 20 millimetres and 55 millimetres, or between 30 millimetres and 55 millimetres, or between 40 millimetres and 55 millimetres, or between 45 millimetres and 55 millimetres. In other embodiments, the length of the hollow tubular section may be between 20 millimetres and 50 millimetres, or between 30 millimetres and 50 millimetres, or between 40 millimetres and 50 millimetres, or between 45 millimetres and 50 millimetres.

Alternatively or in addition to the hollow tubular support element, the downstream section may further comprise a downstream hollow tubular element downstream of the hollow tubular cooling element. The downstream hollow tubular element may be provided immediately adjacent to the hollow tubular cooling element. Alternatively and preferably, the the downstream hollow tubular element is separated from the hollow tubular cooling element by at least one other component. For example, the downstream section may comprise a downstream filter segment between the hollow tubular cooling element and the downstream hollow tubular element. The downstream hollow tubular element is therefore located downstream of the downstream filter segment and preferably, the downstream hollow tubular element abuts the downstream end of the downstream filter segment.

The downstream hollow tubular element preferably extends to the downstream end of the downstream section. The downstream hollow tubular element therefore preferably extends to the downstream end of the aerosol-generating article. In certain embodiments, an additional downstream hollow tubular element may be provided, so that the downstream section comprises two adjacent downstream hollow tubular elements, downstream of the downstream filter segment.

The RTD of the downstream hollow tubular element is preferably less than or equal to 10 millimetres H_2O. More preferably, the RTD of the downstream hollow tubular element is less than or equal to 5 millimetres H_2O. Even more preferably, the RTD of the downstream hollow tubular element is less than or equal to 2.5 millimetres H_2O. Even more preferably, the RTD of the downstream hollow tubular element is less than or equal to 2 millimetres H_2O. Even more preferably, the RTD of the downstream hollow tubular element is less than or equal to 1 millimetre H_2O.

The RTD of the downstream hollow tubular element may be at least 0 millimetres H_2O, or at least 0.25 millimetres H_2O or at least 0.5 millimetres H_2O or at least 1 millimetre H_2O.

In some embodiments, the RTD of the downstream hollow tubular element is from 0 millimetre H_2O to 10 millimetres H_2O, preferably from 0.25 millimetres H_2O to 10 millimetres H_2O, preferably from 0.5 millimetres H_2O to 10 millimetres H_2O. In other embodiments, the RTD of the downstream hollow tubular element is from 0 millimetres H_2O to 5 millimetres H_2O, preferably from 0.25 millimetres H_2O to 5 millimetres H_2O preferably from 0.5 millimetres H_2O to 5 millimetres H_2O. In other embodiments, the RTD of the downstream hollow tubular element is from 1 millimetre H_2O to 5 millimetres H_2O. In further embodiments, the RTD of the downstream hollow tubular element is from 0 millimetres H_2O to 2.5 millimetres H_2O, preferably from 0.25 millimetres H_2O to 2.5 millimetres H_2O, more preferably from 0.5 millimetres H_2O to 2.5 millimetres H_2O. In further embodiments, the RTD of the downstream hollow tubular element is from 0 millimetres H_2O to 2 millimetres H_2O, preferably from 0.25 millimetres H_2O to 2 millimetres H_2O, more preferably from 0.5 millimetres H_2O to 2 millimetres H_2O. In a particularly preferred embodiment, the RTD of the downstream hollow tubular element is 0 millimetre H_2O.

The flow channel of the downstream hollow tubular element should therefore be free from any components that would obstruct the flow of air in a longitudinal direction. Preferably, the flow channel is substantially empty and particularly preferably the flow channel is empty.

Preferably, the length of the downstream hollow tubular element is at least 3 millimetres. More preferably, the length of the downstream hollow tubular element is at least 4 millimetres. The length of the downstream hollow tubular element may be at least 5 millimetres. More preferably, the length of the downstream hollow tubular element is at least 6 millimetres.

The length of the downstream hollow tubular element is preferably less than 20 millimetres. More preferably, the length of the downstream hollow tubular element is less than 15 millimetres. More preferably, the length of the downstream hollow tubular element is less than 12 millimetres. More preferably, the length of the downstream hollow tubular element is less than 10 millimetres.

For example, the length of the downstream hollow tubular element may be between 3 millimetres and 20 millimetres, or between 4 millimetres and 20 millimetres, or between 5 millimetres and 20 millimetres, or between 6 millimetres and 20 millimetres. In other embodiments, the length of the downstream hollow tubular element may be between 3 millimetres and 15 millimetres, or between 4 millimetres and 15 millimetres, or between 5 millimetres and 15 millimetres, or between 6 millimetres and 15 millimetres. In other embodiments, the length of the downstream hollow tubular element may be between 3 millimetres and 12 millimetres, or between 4 millimetres and 12 millimetres, or between 5 millimetres and 12 millimetres, or between 6 millimetres and 12 millimetres. In other embodiments, the length of the downstream hollow tubular element may be between 3 millimetres and 10 millimetres, or between 4 millimetres and 10 millimetres, or between 5 millimetres and 10 millimetres, or between 6 millimetres and 10 millimetres.

Where a downstream hollow tubular element is included in the downstream section, the combined length of the hollow tubular cooling element and the downstream hollow tubular element (or elements) is preferably at least 20 millimetres. This corresponds to the sum of the length of the hollow tubular cooling element and the length of the downstream hollow tubular element (or elements), not taking into account the length of any components provided in between. More preferably, the combined length is at least 30 millimetres. The combined length may be at least 40 millimetres. More preferably, the combined length is at least 45 millimetres.

The combined length of the hollow tubular cooling element and the downstream hollow tubular element (or elements) is preferably less than 60 millimetres. More preferably, the combined length is less than 55 millimetres. More preferably, the combined length is less than 50 millimetres.

For example, the combined length of the hollow tubular cooling element and the downstream hollow tubular element (or elements) may be between 20 millimetres and 60 millimetres, or between 30 millimetres and 60 millimetres, or between 40 millimetres and 60 millimetres, or between 45 millimetres and 60 millimetres. In other embodiments, the combined length may be between 20 millimetres and 55 millimetres, or between 30 millimetres and 55 millimetres, or between 40 millimetres and 55 millimetres, or between 45 millimetres and 55 millimetres. In other embodiments, the combined length may be between 20 millimetres and 50 millimetres, or between 30 millimetres and 50 millimetres, or between 40 millimetres and 50 millimetres, or between 45 millimetres and 50 millimetres.

By providing a combined length within the ranges set out above, the overall length of the hollow tubular elements in the downstream section is relatively long, with the benefits as set out above in relation to the length of the hollow tubular cooling element.

The lumen or cavity of the downstream hollow tubular element may have any cross sectional shape. The lumen of the downstream hollow tubular element may have a circular cross sectional shape.

The downstream hollow tubular element may comprise a paper-based material. The downstream hollow tubular element may comprise at least one layer of paper. The paper may be very rigid paper. The paper may be crimped paper, such as crimped heat resistant paper or crimped parchment paper.

The downstream hollow tubular element may comprise cardboard. The downstream hollow tubular element may be a cardboard tube.

The downstream hollow tubular element may be a paper tube. The downstream hollow tubular element may be a tube formed from spirally wound paper. The downstream hollow tubular element may be formed from a plurality of layers of the paper. The paper may have a basis weight of at least 50 grams per square meter, at least 60 grams per square meter, at least 70 grams per square meter, or at least 90 grams per square meter.

The downstream hollow tubular element may comprise a polymeric material. For example, the downstream hollow tubular element may comprise a polymeric film. The polymeric film may comprise a cellulosic film. The downstream hollow tubular element may comprise low density polyethylene (LDPE) or polyhydroxyalkanoate (PHA) fibres. Preferably, the downstream hollow tubular element comprises cellulose acetate tow. For example, in preferred embodiments, the downstream hollow tubular element comprises a hollow acetate tube.

Where the downstream hollow tubular element comprises cellulose acetate tow, the cellulose acetate tow may have a denier per filament of between 2 and 4 and a total denier of between 25 and 40.

Where the downstream section further comprises an additional downstream hollow tubular element, as described above, the additional downstream hollow tubular element may be formed of the same material as the downstream hollow tubular element, or a different material.

In certain preferred embodiments, the downstream section may comprise a ventilation zone at a location on the downstream hollow tubular element. In one example, this ventilation zone at a location on the downstream hollow tubular element may be provided instead of a ventilation zone at a location on the hollow tubular cooling element. In another example, the ventilation zone at a location on the downstream hollow tubular element may be provided in addition to the ventilation zone provided at a location on the hollow tubular cooling element.

The ventilation zone at a location along the downstream hollow tubular element may comprise a plurality of perforations through the peripheral wall of the downstream hollow tubular element. Preferably, the ventilation zone at a location along the downstream hollow tubular element comprises at least one circumferential row of perforations. In some embodiments, the ventilation zone may comprise two circumferential rows of perforations. For example, the perforations may be formed online during manufacturing of the aerosol-generating article. Preferably, each circumferential row of perforations comprises from 8 to 30 perforations.

A distance between the ventilation zone and an upstream end of the downstream hollow tubular element may be at least 1 millimetre. A distance between the ventilation zone and an upstream end of the downstream hollow tubular element may be at least 2 millimetres. Preferably, a distance between the ventilation zone and an upstream end of the downstream hollow tubular element is at least 3 millimetres.

A distance between the ventilation zone and an upstream end of the downstream hollow tubular element is preferably less than or equal to 10 millimetres. More preferably, a distance between the ventilation zone and an upstream end of the downstream hollow tubular element is less than or equal to 7 millimetres. Even more preferably, a distance between the ventilation zone and an upstream end of the downstream hollow tubular element is less than or equal to 5 millimetres.

In some embodiments, a distance between the ventilation zone and an upstream end of the downstream hollow tubular element is from 1 millimetre to 10 millimetres, preferably from 1 millimetre to 7 millimetres, more preferably from 1 millimetres to 5 millimetres. In further embodiments, a distance between the ventilation zone and an upstream end of the downstream hollow tubular element is from 2 millimetres to 10 millimetres, preferably from 2 millimetres to 7 millimetres, more preferably from 2 millimetres to 5 millimetres. In other embodiments, a distance between the ventilation zone and an upstream end of the downstream hollow tubular element is from 3 millimetres to 10 millimetres, preferably from 3 millimetres to 7 millimetres, more preferably from 3 millimetres to 5 millimetres.

Positioning the ventilation zone at a distance from an upstream end of the downstream hollow tubular element within the ranges described above has the benefit of generally ensuring that, during use, the ventilation zone is just outside of the heating device when the aerosol-generating article is inserted in the heating device while reducing the risk of the ventilation zone being inadvertently obstructed by a user’s lips or hands.

The downstream section may optionally further comprise may further comprise an additional cooling element defining a plurality of longitudinally extending channels such as to make a high surface area available for heat exchange. In other words, one such additional cooling element is adapted to function substantially as a heat exchanger. The plurality of longitudinally extending channels may be defined by a sheet material that has been pleated, gathered or folded to form the channels. The plurality of longitudinally extending channels may be defined by a single sheet that has been pleated, gathered or folded to form multiple channels. The sheet may also have been crimped prior to being pleated, gathered or folded. Alternatively, the plurality of longitudinally extending channels may be defined by multiple sheets that have been crimped, pleated, gathered or folded to form multiple channels. In some embodiments, the plurality of longitudinally extending channels may be defined by multiple sheets that have been crimped, pleated, gathered or folded together – that is by two or more sheets that have been brought into overlying arrangement and then crimped, pleated, gathered or folded as one.

As used herein, the term ‘crimped’ denotes a sheet having a plurality of substantially parallel ridges or corrugations. Preferably, when the aerosol-generating article has been assembled, the substantially parallel ridges or corrugations extend in a longitudinal direction with respect to the rod. As used herein, the terms ‘gathered’, ‘pleated’, or ‘folded’ denote that a sheet of material is convoluted, folded, or otherwise compressed or constricted substantially transversely to the cylindrical axis of the rod. A sheet may be crimped prior to being gathered, pleated or folded. A sheet may be gathered, pleated or folded without prior crimping.

One such additional cooling element may have a total surface area of between about 300 square millimetre per millimetre length and about 1000 square millimetres per millimetre length.

The additional cooling element preferably offers a low resistance to the passage of air through additional cooling element. Preferably, the additional cooling element does not substantially affect the resistance to draw of the aerosol-generating article. To achieve this, it is preferred that the porosity in a longitudinal direction is greater than 50 percent and that the airflow path through the additional cooling element is relatively uninhibited. The longitudinal porosity of the additional cooling element may be defined by a ratio of the cross-sectional area of material forming the additional cooling element and an internal cross-sectional area of the aerosol-generating article at the portion containing the additional cooling element.

The additional cooling element preferably comprises a sheet material selected from the group comprising a metallic foil, a polymeric sheet, and a substantially non-porous paper or cardboard. In some embodiments, the aerosol-cooling element may comprise a sheet material selected from the group consisting of polyethylene (PE), polypropylene (PP), polyvinylchloride (PVC), polyethylene terephthalate (PET), polylactic acid (PLA), cellulose acetate (CA), and aluminium foil. In a particularly preferred embodiment, the additional cooling element comprises a sheet of PLA.

The aerosol-generating article may have an overall length from 45 millimetres to 100 millimetres.

Preferably, an overall length of an aerosol-generating article in accordance with the invention is at least 50 millimetres. More preferably, an overall length of an aerosol-generating article in accordance with the invention is at least 60 millimetres. Even more preferably, an overall length of an aerosol-generating article in accordance with the invention is at least 70 millimetres.

An overall length of an aerosol-generating article in accordance with the invention is preferably less than or equal to 90 millimetres. More preferably, an overall length of an aerosol-generating article in accordance with the invention is preferably less than or equal to 85 millimetres. Even more preferably, an overall length of an aerosol-generating article in accordance with the invention is preferably less than or equal to 80 millimetres.

In some embodiments, an overall length of the aerosol-generating article is preferably from 50 millimetres to 90 millimetres, more preferably from 60 millimetres to 90 millimetres, even more preferably from 70 millimetres to 90 millimetres. In other embodiments, an overall length of the aerosol-generating article is preferably from 50 millimetres to 85 millimetres, more preferably from 60 millimetres to 85 millimetres, even more preferably from 70 millimetres to 85 millimetres. In further embodiments, an overall length of the aerosol-generating article is preferably from 50 millimetres to 80 millimetres, more preferably from 60 millimetres to 80 millimetres, even more preferably from 70 millimetres to 80 millimetres. In an exemplary embodiment, an overall length of the aerosol-generating article is 75 millimetres.

The aerosol-generating article preferably has an external diameter of at least 5 millimetres along the full length of the article. Where the diameter varies along the length of the aerosol-generating article, the external diameter is preferably at least 5 millimetres at all locations along the length of the article.

Preferably, the aerosol-generating article has an external diameter of at least 5.5 millimetres along the full length of the article. More preferably, the aerosol-generating article has an external diameter of at least 6 millimetres along the full length of the article.

Preferably, the aerosol-generating article has a maximum external diameter of less than 10 millimetres. This means that if the diameter of the aerosol-generating article varies along the length of the article, the diameter at all locations along the length is less than 10 millimetres. More preferably, the aerosol-generating article has a maximum external diameter of less than 9 millimetres. Even more preferably, the aerosol-generating article has a maximum external diameter of less than 8 millimetres. Even more preferably, the aerosol-generating article has a maximum external diameter of less than 7 millimetres.

In some embodiments, the aerosol-generating article has an external diameter from 5 millimetres to 10 millimetres, preferably from 5.5 millimetres to 10 millimetres, more preferably from 6 millimetres to 10 millimetres. In other embodiments, the aerosol-generating article has an external diameter from 5 millimetres to 9 millimetres, preferably from 5.5 millimetres to 9 millimetres, more preferably from 6 millimetres to 9 millimetres. In further embodiments, the aerosol-generating article has an external diameter from 5 millimetres to 8 millimetres, preferably from 5.5 millimetres to 8 millimetres, more preferably from 6 millimetres to 8 millimetres. In further embodiments, the aerosol-generating article has an external diameter from 5 millimetres to 7 millimetres, preferably from 5.5 millimetres to 7 millimetres, more preferably from 6 millimetres to 7 millimetres.

The external diameter of the aerosol-generating article may be substantially constant over the whole length of the article. As an alternative, different portions of the aerosol-generating article may have different external diameters.

In particularly preferred embodiments, one or more of the components of the aerosol-generating article are individually circumscribed by their own wrapper.

In an embodiment, the rod of aerosol-generating substrate and the downstream filter segment are individually wrapped. The upstream element, the rod of aerosol-generating substrate and the hollow tubular element are then combined together with an outer wrapper. Subsequently, they are combined with the downstream filter segment – which has its own wrapper – by means of tipping paper.

Preferably, at least one of the components of the aerosol-generating article is wrapped in a hydrophobic wrapper.

The term “hydrophobic” refers to a surface exhibiting water repelling properties. One useful way to determine this is to measure the water contact angle. The “water contact angle” is the angle, conventionally measured through the liquid, where a liquid/vapour interface meets a solid surface. It quantifies the wettability of a solid surface by a liquid via the Young equation. Hydrophobicity or water contact angle may be determined by utilizing TAPPI T558 test method and the result is presented as an interfacial contact angle and reported in “degrees” and can range from near zero to near 180 degrees.

In preferred embodiments, the hydrophobic wrapper is one including a paper layer having a water contact angle of about 30 degrees or greater, and preferably about 35 degrees or greater, or about 40 degrees or greater, or about 45 degrees or greater.

By way of example, the paper layer may comprise PVOH (polyvinyl alcohol) or silicon. The PVOH may be applied to the paper layer as a surface coating, or the paper layer may comprise a surface treatment comprising PVOH or silicon.

In a particularly preferred embodiment, an aerosol-generating article in accordance with the present invention comprises, in linear sequential arrangement, an upstream element, a rod of aerosol-generating substrate located immediately downstream of the upstream element, a hollow tubular cooling element located immediately downstream of the rod of aerosol-generating substrate, a downstream filter segment located immediately downstream of the hollow tubular cooling element, a downstream hollow tubular element located immediately downstream of the downstream filter segment and one or more outer wrappers combining the components. The upstream element defines an upstream section of the aerosol-generating article. The hollow tubular cooling element, the downstream filter segment and the downstream hollow tubular element form a downstream section of the aerosol-generating article.

The rod of aerosol-generating substrate may abut the upstream element. The hollow tubular cooling element may abut the rod of aerosol-generating substrate. The downstream filter segment may abut the hollow tubular cooling element. The downstream hollow tubular element may abut the downstream filter segment. Preferably, the hollow tubular cooling element abuts the rod of aerosol-generating substrate, the downstream filter segment abuts the hollow tubular cooling element and the downstream hollow tubular element abuts the downstream filter segment.

The present disclosure also relates to an aerosol-generating system comprising an aerosol-generating device having a distal end and a mouth end. The aerosol-generating device may comprise a body. The body or housing of the aerosol-generating device may define a device cavity for removably receiving the aerosol-generating article at the mouth end of the device. The aerosol-generating device may comprise a heating element or heater for heating the aerosol-generating substrate when the aerosol-generating article is received within the device cavity.

The device cavity may be referred to as the heating chamber of the aerosol-generating device. The device cavity may extend between a distal end and a mouth, or proximal, end. The distal end of the device cavity may be a closed end and the mouth, or proximal, end of the device cavity may be an open end. An aerosol-generating article may be inserted into the device cavity, or heating chamber, via the open end of the device cavity. The device cavity may be cylindrical in shape so as to conform to the same shape of an aerosol-generating article.

The expression “received within” may refer to the fact that a component or element is fully or partially received within another component or element. For example, the expression “aerosol-generating article is received within the device cavity” refers to the aerosol-generating article being fully or partially received within the device cavity of the aerosol-generating article. When the aerosol-generating article is received within the device cavity, the aerosol-generating article may abut the distal end of the device cavity. When the aerosol-generating article is received within the device cavity, the aerosol-generating article may be in substantial proximity to the distal end of the device cavity. The distal end of the device cavity may be defined by an end-wall.

The length of the device cavity may be between 10 millimetres and 50 millimetres. The length of the device cavity may be between 20 millimetres and 40 millimetres. The length of the device cavity may be between 25 millimetres and 30 millimetres.

The length of the device cavity (or heating chamber) may be the same as or greater than the length of the rod of the aerosol-generating substrate. The length of the device cavity may be the same as or greater than the combined length of the upstream section or element and rod of aerosol-generating substrate. Preferably, the length of the device cavity is such that at least 75 percent of the length of the rod of aerosol-generating substrate is inserted or received within the device cavity, when the aerosol-generating article is received with the aerosol-generating device. More preferably, the length of the device cavity is such that at least 80 percent of the length of the rod of aerosol-generating substrate is inserted or received within the device cavity, when the aerosol-generating article is received with the aerosol-generating device. More preferably, the length of the device cavity is such that at least 90 percent of the length of the rod of aerosol-generating substrate is inserted or received within the device cavity, when the aerosol-generating article is received with the aerosol-generating device. This maximises the length of the rod of aerosol-generating substrate along which the aerosol-generating substrate can be heated during use, thereby optimising the generation of aerosol from the aerosol-generating substrate and reducing tobacco waste.

The length of the device cavity may be such that the downstream section or a portion thereof is configured to protrude from the device cavity, when the aerosol-generating article received within the device cavity. The length of the device cavity may be such that a portion of the downstream section (such as the hollow tubular cooling element or downstream filter segment) is configured to protrude from the device cavity, when the aerosol-generating article received within the device cavity. The length of the device cavity may be such that a portion of the downstream section (such as the hollow tubular cooling element or downstream filter segment) is configured to be received within the device cavity, when the aerosol-generating article received within the device cavity.

At least 25 percent of the length of the downstream section may be inserted or received within the device cavity, when the aerosol-generating article is received within the device. At least 30 percent of the length of the downstream section may be inserted or received within the device cavity, when the aerosol-generating article is received within the device.

At least 30 percent of the length of the hollow tubular element may be inserted or received within the device cavity, when the aerosol-generating article is received within the device. At least 40 percent of the length of the hollow tubular element may be inserted or received within the device cavity, when the aerosol-generating article is received within the device. At least 50 percent of the length of the hollow tubular element may be inserted or received within the device cavity, when the aerosol-generating article is received within the device. Various lengths of the hollow tubular element are described in more detail within the present disclosure.

Optimising the amount or length of the article that is inserted into the aerosol-generating device may enhance the article's resistance to inadvertently falling out during use. Particularly, during the heating of the aerosol-generating substrate, the substrate may shrink such that its external diameter may have reduced, thereby reducing the extent to which the inserted portion of the article inserted into the device can frictionally engage with the device cavity. The inserted portion of the article, or the portion of the article configured to be received within the device cavity, may be the same length as the device cavity.

The length of the device cavity may be between 15 millimetres and 80 millimetres. Preferably, the length of the device cavity is between 20 millimetres and 70 millimetres. More preferably, the length of the device cavity is between 25 millimetres and 60 millimetres. More preferably, the length of the device is between 25 millimetres and 50 millimetres.

The length of the device cavity may be between 25 millimetres and 29 millimetres. Preferably, the length of the device cavity is between 25 millimetres and 29 millimetres. More preferably, the length of the device cavity is between 26 millimetres and 29 millimetres. Even more preferably, the length of the device cavity is 27 millimetres or 28 millimetres.

A diameter of the device cavity may be between 4 millimetres and 10 millimetres. A diameter of the device cavity may be between 5 millimetres and 9 millimetres. A diameter of the device cavity may be between 6 millimetres and 8 millimetres. A diameter of the device cavity may be between 6 millimetres and 7 millimetres.

A diameter of the device cavity may be substantially the same as or greater than a diameter of the aerosol-generating article. A diameter of the device cavity may be the same as a diameter of the aerosol-generating article in order to establish a tight fit with the aerosol-generating article.

The device cavity may be configured to establish a tight fit with an aerosol-generating article received within the device cavity. Tight fit may refer to a snug fit. The aerosol-generating device may comprise a peripheral wall. Such a peripheral wall may define the device cavity, or heating chamber. The peripheral wall defining the device cavity may be configured to engage with an aerosol-generating article received within the device cavity in a tight fit manner, so that there is substantially no gap or empty space between the peripheral wall defining the device cavity and the aerosol-generating article when received within the device.

Such a tight fit may establish an airtight fit or configuration between the device cavity and an aerosol-generating article received therein.

With such an airtight configuration, there would be substantially no gap or empty space between the peripheral wall defining the device cavity and the aerosol-generating article for air to flow through.

The tight fit with an aerosol-generating article may be established along the entire length of the device cavity or along a portion of the length of the device cavity.

The aerosol-generating device may comprise an air-flow channel extending between a channel inlet and a channel outlet. The air-flow channel may be configured to establish a fluid communication between the interior of the device cavity and the exterior of the aerosol-generating device. The air-flow channel of the aerosol-generating device may be defined within the housing of the aerosol-generating device to enable fluid communication between the interior of the device cavity and the exterior of the aerosol-generating device. When an aerosol-generating article is received within the device cavity, the air-flow channel may be configured to provide air flow into the article in order to deliver generated aerosol to a user drawing from the mouth end of the article.

The air-flow channel of the aerosol-generating device may be defined within, or by, the peripheral wall of the housing of the aerosol-generating device. In other words, the air-flow channel of the aerosol-generating device may be defined within the thickness of the peripheral wall or by the inner surface of the peripheral wall, or a combination of both. The air-flow channel may partially be defined by the inner surface of the peripheral wall and may be partially defined within the thickness of the peripheral wall. The inner surface of the peripheral wall defines a peripheral boundary of the device cavity.

The air-flow channel of the aerosol-generating device may extend from an inlet located at the mouth end, or proximal end, of the aerosol-generating device to an outlet located away from mouth end of the device. The air-flow channel may extend along a direction parallel to the longitudinal axis of the aerosol-generating device.

The heater may be any suitable type of heater. Preferably, in the present invention, the heater is an external heater.

Preferably, the heater may externally heat the aerosol-generating article when received within the aerosol-generating device. Such an external heater may circumscribe the aerosol-generating article when inserted in or received within the aerosol-generating device.

In some embodiments, the heater is arranged to heat the outer surface of the aerosol-generating substrate. In some embodiments, the heater is arranged for insertion into an aerosol-generating substrate when the aerosol-generating substrate is received within the cavity. The heater may be positioned within the device cavity, or heating chamber.

The heater may comprise at least one heating element. The at least one heating element may be any suitable type of heating element. In some embodiments, the device comprises only one heating element. In some embodiments, the device comprises a plurality of heating elements. The heater may comprise at least one resistive heating element. Preferably, the heater comprises a plurality of resistive heating elements. Preferably, the resistive heating elements are electrically connected in a parallel arrangement. Advantageously, providing a plurality of resistive heating elements electrically connected in a parallel arrangement may facilitate the delivery of a desired electrical power to the heater while reducing or minimising the voltage required to provide the desired electrical power. Advantageously, reducing or minimising the voltage required to operate the heater may facilitate reducing or minimising the physical size of the power supply.

Suitable materials for forming the at least one resistive heating element include but are not limited to: semiconductors such as doped ceramics, electrically ‘conductive’ ceramics (such as, for example, molybdenum disilicide), carbon, graphite, metals, metal alloys and composite materials made of a ceramic material and a metallic material. Such composite materials may comprise doped or undoped ceramics. Examples of suitable doped ceramics include doped silicon carbides. Examples of suitable metals include titanium, zirconium, tantalum and metals from the platinum group. Examples of suitable metal alloys include stainless steel, nickel-, cobalt-, chromium-, aluminium- titanium- zirconium-, hafnium-, niobium-, molybdenum-, tantalum-, tungsten-, tin-, gallium-, manganese- and iron-containing alloys, and super-alloys based on nickel, iron, cobalt, stainless steel, Timetal® and iron-manganese-aluminium based alloys.

In some embodiments, the at least one resistive heating element comprises one or more stamped portions of electrically resistive material, such as stainless steel. Alternatively, the at least one resistive heating element may comprise a heating wire or filament, for example a Ni-Cr (Nickel-Chromium), platinum, tungsten or alloy wire.

In some embodiments, the at least one heating element comprises an electrically insulating substrate, wherein the at least one resistive heating element is provided on the electrically insulating substrate.

The electrically insulating substrate may comprise any suitable material. For example, the electrically insulating substrate may comprise one or more of: paper, glass, ceramic, anodized metal, coated metal, and Polyimide. The ceramic may comprise mica, Alumina (Al_2O_3) or Zirconia (ZrO_2). Preferably, the electrically insulating substrate has a thermal conductivity of less than or equal to about 40 Watts per metre Kelvin, preferably less than or equal to about 20 Watts per metre Kelvin and ideally less than or equal to about 2 Watts per metre Kelvin.

The heater may comprise a heating element comprising a rigid electrically insulating substrate with one or more electrically conductive tracks or wire disposed on its surface. The size and shape of the electrically insulating substrate may allow it to be inserted directly into an aerosol-generating substrate. If the electrically insulating substrate is not sufficiently rigid, the heating element may comprise a further reinforcement means. A current may be passed through the one or more electrically conductive tracks to heat the heating element and the aerosol-generating substrate.

In some embodiments, the heater comprises an inductive heating arrangement. The inductive heating arrangement may comprise an inductor coil and a power supply configured to provide high frequency oscillating current to the inductor coil. As used herein, a high frequency oscillating current means an oscillating current having a frequency of between about 500 kHz and about 30 MHz. The heater may advantageously comprise a DC/AC inverter for converting a DC current supplied by a DC power supply to the alternating current. The inductor coil may be arranged to generate a high frequency oscillating electromagnetic field on receiving a high frequency oscillating current from the power supply. The inductor coil may be arranged to generate a high frequency oscillating electromagnetic field in the device cavity. In some embodiments, the inductor coil may substantially circumscribe the device cavity. The inductor coil may extend at least partially along the length of the device cavity.

The heater may comprise an inductive heating element. The inductive heating element may be a susceptor element. As used herein, the term 'susceptor element' refers to an element comprising a material that is capable of converting electromagnetic energy into heat. When a susceptor element is located in an alternating electromagnetic field, the susceptor is heated. Heating of the susceptor element may be the result of at least one of hysteresis losses and eddy currents induced in the susceptor, depending on the electrical and magnetic properties of the susceptor material.

A susceptor element may be arranged such that, when the aerosol-generating article is received in the cavity of the aerosol-generating device, the oscillating electromagnetic field generated by the inductor coil induces a current in the susceptor element, causing the susceptor element to heat up. In these embodiments, the aerosol-generating device is preferably capable of generating a fluctuating electromagnetic field having a magnetic field strength (H-field strength) of between 1 and 5 kilo amperes per metre (kA m), preferably between 2 and 3 kA/m, for example about 2.5 kA/m. The electrically-operated aerosol-generating device is preferably capable of generating a fluctuating electromagnetic field having a frequency of between 1 and 30 MHz, for example between 1 and 10 MHz, for example between 5 and 7 MHz.

In these embodiments, the susceptor element is preferably located in contact with the aerosol-generating substrate. In some embodiments, a susceptor element is located in the aerosol-generating device. In these embodiments, the susceptor element may be located in the cavity. The aerosol-generating device may comprise only one susceptor element. The aerosol-generating device may comprise a plurality of susceptor elements. In some embodiments, the susceptor element is preferably arranged to heat the outer surface of the aerosol-generating substrate.

The susceptor element may comprise any suitable material. The susceptor element may be formed from any material that can be inductively heated to a temperature sufficient to release volatile compounds from the aerosol-generating substrate. Suitable materials for the elongate susceptor element include graphite, molybdenum, silicon carbide, stainless steels, niobium, aluminium, nickel, nickel containing compounds, titanium, and composites of metallic materials. Some susceptor elements comprise a metal or carbon. Advantageously the susceptor element may comprise or consist of a ferromagnetic material, for example, ferritic iron, a ferromagnetic alloy, such as ferromagnetic steel or stainless steel, ferromagnetic particles, and ferrite. A suitable susceptor element may be, or comprise, aluminium. The susceptor element preferably comprises more than about 5 percent, preferably more than 20 percent, more preferably more than 50 percent or more than 90 percent of ferromagnetic or paramagnetic materials. Some elongate susceptor elements may be heated to a temperature in excess of 250 degrees Celsius.

The susceptor element may comprise a non-metallic core with a metal layer disposed on the non-metallic core. For example, the susceptor element may comprise metallic tracks formed on an outer surface of a ceramic core or substrate.

In some embodiments the aerosol-generating device may comprise at least one resistive heating element and at least one inductive heating element. In some embodiments the aerosol-generating device may comprise a combination of resistive heating elements and inductive heating elements.

During use, the heater may be controlled to operate within a defined operating temperature range, below a maximum operating temperature. An operating temperature range between about 150 degrees Celsius and about 300 degrees Celsius in the heating chamber (or device cavity) is preferable. The operating temperature range of the heater may be between about 150 degrees Celsius and about 250 degrees Celsius.

Preferably, the operating temperature range of the heater may be between about 150 degrees Celsius and about 200 degrees Celsius. More preferably, the operating temperature range of the heater may be between about 180 degrees Celsius and about 200 degrees Celsius. In particular, it has been found that optimal and consistent aerosol delivery may be achieved when using an aerosol-generating device having an external heater, which has an operating temperature range between about 180 degrees Celsius and about 200 degrees Celsius, with aerosol-generating articles having a relatively low RTD (for example, with a downstream section RTD of less than 15 millimetres H_2O), as mentioned in the present disclosure.

In embodiments where the aerosol-generating article comprises a ventilation zone at a location along the downstream section or the hollow tubular element, the ventilation zone may be arranged to be exposed when the aerosol-generating article is received within the device cavity. Thus, the length of the device cavity or heating chamber may be less than the distance of the upstream end of the aerosol-generating article to a ventilation zone located along the downstream section. In other words, when the aerosol-generating article is received within the aerosol-generating device, the distance between the ventilation zone and the upstream end of the upstream element may be greater than the length of the heating chamber.

When the article is received within the device cavity, the ventilation zone may be located at least 0.5 millimetres away (in the downstream direction of the article) from the mouth end (or mouth end face) of the device cavity or device itself. When the article is received within the device cavity, the ventilation zone may be located at least 1 millimetres away (in the downstream direction of the article) from the mouth end (or mouth end face) of the device cavity or device itself. When the article is received within the device cavity, the ventilation zone may be located at least 2 millimetres away (in the downstream direction of the article) from the mouth end (or mouth end face) of the device cavity or device itself.

Preferably, a ratio between the distance between the ventilation zone and the upstream end of the upstream element and a length of the heating chamber is from 1.03 to 1.13.

Such positioning of the ventilation zone ensures the ventilation zone is not occluded within the device cavity itself, while also minimising the risk of occlusion by a user's lips or hands as the ventilation zone is located at the most upstream position from the downstream end of the article as reasonably possible without being occluded within the device cavity.

The aerosol-generating device may comprise a power supply. The power supply may be a DC power supply. In some embodiments, the power supply is a battery. The power supply may be a nickel-metal hydride battery, a nickel cadmium battery, or a lithium based battery, for example a lithium-cobalt, a lithium-iron-phosphate or a lithium-polymer battery. However, in some embodiments the power supply may be another form of charge storage device, such as a capacitor. The power supply may require recharging and may have a capacity that allows for the storage of enough energy for one or more user operations, for example one or more aerosol-generating experiences. For example, the power supply may have sufficient capacity to allow for continuous heating of an aerosol-generating substrate for a period of around six minutes, corresponding to the typical time taken to smoke a conventional cigarette, or for a period that is a multiple of six minutes. In another example, the power supply may have sufficient capacity to allow for a predetermined number of puffs or discrete activations of the heater.

Below, there is provided a non-exhaustive list of non-limiting examples. Any one or more of the features of these examples may be combined with any one or more features of another example, embodiment, or aspect described herein.

EX1. An aerosol-generating article comprising: a rod of aerosol-generating substrate.

EX2. An aerosol-generating article according to example EX1, wherein the rod of aerosol-generating substrate has a length of at least 17 millimetres.

EX3. An aerosol-generating article according to any preceding example, wherein the rod of aerosol-generating substrate comprises a tobacco material.

EX4. An aerosol-generating article according to example EX3, wherein the tobacco material has a density of less than 350 milligrams per cubic centimetre.

EX5. An aerosol-generating article according to example EX4, wherein the tobacco material has a density of less than 300 milligrams per cubic centimetre.

EX6. An aerosol-generating article according to example EX3, EX4 or EX5, wherein the tobacco material has a density of at least 100 milligrams per cubic centimetre.

EX7. An aerosol-generating article according to example EX3, wherein the tobacco material has a density of between 150 milligrams per cubic centimetre and 500 milligrams per cubic centimetre.

EX8. An aerosol-generating article according to example EX7, wherein the tobacco material has a density of between 200 milligrams per cubic centimetre and 400 milligrams per cubic centimetre.

EX9. An aerosol-generating article according to any preceding example, comprising a downstream section provided downstream of the rod of aerosol-generating substrate.

EX10. An aerosol-generating article according to example EX9, wherein the downstream section comprises a hollow tubular element abutting a downstream end of the rod of aerosol-generating substrate.

EX11. An aerosol-generating article according to example EX10, wherein the hollow tubular element has a length of at least 40 millimetres.

EX12. An aerosol-generating article according to example EX9, wherein the downstream section comprises a downstream filter segment.

EX13. An aerosol-generating article according to example EX12, wherein the downstream section comprises a ventilation zone at a location downstream of the downstream filter segment.

EX14. An aerosol-generating article according to example EX12 or EX13, wherein the downstream filter segment is a solid plug.

EX15. An aerosol-generating article according to any one of examples EX12 to EX14, comprising a downstream hollow tubular element, the downstream tubular element being located downstream of the downstream filter segment.

EX16. An aerosol-generating article according to example EX15, wherein the downstream hollow tubular element abuts a downstream end of the downstream filter segment.

EX17. An aerosol-generating article according to example EX15 or EX16, wherein the ventilation zone is at a location along the downstream hollow tubular element.

EX18. An aerosol-generating article according to example EX17, wherein the ventilation zone is at a location towards an upstream end of the downstream hollow tubular element.

EX19. An aerosol-generating article according to any one of examples EX12 to EX18, wherein the downstream section comprises a hollow tubular cooling element and wherein the downstream filter segment abuts a downstream end of the hollow tubular cooling element

EX20. An aerosol-generating article according to any one of examples EX12 to EX19, wherein the downstream filter segment has a length of at least 5 millimetres

EX21. An aerosol-generating article according to any one of examples EX12 to EX20, wherein the downstream filter segment has a length of less than or equal 20 millimetres.

EX22. An aerosol-generating article according to any one of examples EX12 or EX21, wherein the downstream filter segment has a length of between 5 millimetres and 20 millimetres.

EX23. An aerosol-generating article according to example EX9, wherein the downstream section extends to a downstream end of the aerosol-generating article.

EX24. An aerosol-generating article according to example EX9 or EX23, wherein the downstream section comprises a hollow tubular cooling element.

EX25. An aerosol-generating article according to example EX24, wherein the hollow tubular cooling element has a length of at least 20 millimetres.

EX26. An aerosol-generating article according to example EX25, wherein the hollow tubular cooling element has a length of at least 25 millimetres.

EX27. An aerosol-generating article according to any one of examples EX24 to EX26, wherein the hollow tubular cooling element has a length less than or equal to 50 millimetres.

EX28. An aerosol-generating article according to example EX27, wherein the hollow tubular cooling element has a length of between 20 millimetres and 50 millimetres.

EX29. An aerosol-generating article according to any one of examples EX9, or EX23 to EX26, wherein the downstream section has a length of at least 45 millimetres.

EX30. An aerosol-generating article according to any preceding example, wherein the maximum external diameter of the aerosol-generating article is less than 8 millimetres.

EX31. An aerosol-generating article according to example EX30, wherein the aerosol-generating article has a maximum external diameter between 5 millimetres and 8 millimetres.

EX32. An aerosol-generating article according to example EX30 or EX31, wherein the aerosol-generating article has a maximum external diameter less than or equal to 7 millimetres.

EX33. An aerosol-generating article according to example EX32, wherein the aerosol-generating article has a maximum external diameter between 5.5 millimetres and 7 millimetres.

EX34. An aerosol-generating article according to example EX9, wherein the ratio of the length of the downstream section to the length of the rod of aerosol-generating substrate is at least 1.5.

EX35. An aerosol-generating article according to example EX9, wherein the ratio of the length of the downstream section to the total length of the aerosol-generating article is at least 0.6.

EX36. An aerosol-generating article according to any preceding example, wherein the aerosol-generating article has a total length of at least 50 millimetres.

EX37. An aerosol-generating article according to any preceding example, wherein the rod of aerosol-generating substrate has a length less than or equal to 40 millimetres.

EX38. An aerosol-generating article according to example EX37, wherein the rod of aerosol-generating substrate has a length less than or equal to 36 millimetres.

EX39. An aerosol-generating article according to any preceding example, wherein the rod of aerosol-generating substrate has a length less than or equal to 30 millimetres.

EX40. An aerosol-generating article according to any preceding example, wherein the rod of aerosol-generating substrate has a length less than or equal to 25 millimetres.

EX41. An aerosol-generating article according to any preceding example, wherein the rod of aerosol-generating substrate has a length less than or equal to 20 millimetres.

EX42. An aerosol-generating article according to any preceding example, wherein a ratio of the length of the rod of aerosol-generating substrate to the total length of the aerosol-generating article is less than or equal to 0.4.

EX43. An aerosol-generating article according to any preceding example, wherein the rod of aerosol-generating substrate has a length of at least 17 millimetres.

EX44. An aerosol-generating article according to any preceding example, wherein the rod of aerosol-generating substrate has a length of at least 20 millimetres.

EX45. An aerosol-generating article according to any preceding example, wherein the rod of aerosol-generating substrate has a length of at least 25 millimetres.

EX46. An aerosol-generating article according to any preceding example, wherein the rod of aerosol-generating substrate has a length of at least 29 millimetres.

EX47. An aerosol-generating article according to any preceding example, wherein the rod of aerosol-generating substrate has a length of between 29 millimetres and 36 millimetres.

EX48. An aerosol-generating article according to any preceding example, comprising an upstream element.

EX49. An aerosol-generating article according to example EX48, wherein the upstream element is provided upstream of the rod of aerosol-generating substrate.

EX50. An aerosol-generating article according to example EX48 or EX49, wherein the upstream element is provided abutting an upstream end of the rod of aerosol-generating substrate.

EX51. An aerosol-generating article according to any one of examples EX48 to EX50, wherein the upstream element has a length of between 2 millimetres and 8 millimetres.

EX52. An aerosol-generating article according to any one of examples EX48 to EX51, wherein the upstream element has a length of between 2 millimetres and 6 millimetres.

EX53. An aerosol-generating article according to any one of examples EX48 to EX52, wherein the upstream element has a length of between 4 millimetres and 6 millimetres.

EX54. An aerosol-generating article according to any one of examples EX48 to EX53, wherein the upstream element comprises a hollow support segment having a central longitudinal cavity extending through it.

EX55. An aerosol-generating article according to example EX54, wherein the hollow tubular support element has a wall thickness of less than 1 millimetre.

EX56. An aerosol-generating article according to one of examples EX48 to EX55, wherein the resistance to draw (RTD) of the upstream element is less than or equal to 10 millimetres H_2O.

EX57. An aerosol-generating article according to any preceding example, wherein the aerosol-generating article has a total length of at least 60 millimetres.

EX58. An aerosol-generating article according to example EX57, wherein the aerosol-generating article has a total length of at least 65 millimetres.

EX59. An aerosol-generating article according to any preceding example, wherein the aerosol-generating article has a total length of less than or equal to 90 millimetres.

EX60. An aerosol-generating article according to any preceding example, wherein the aerosol-generating article has a total length of between 65 millimetres and 90 millimetres.

EX61. An aerosol-generating article according to any preceding example, wherein the rod of aerosol-generating substrate comprises one or more aerosol formers.

EX62. An aerosol-generating article according to example EX61, wherein the rod of aerosol-generating substrate has an aerosol former content of less than or equal to 30 percent by weight on a dry weight basis.

EX63. An aerosol-generating article according to example EX62, wherein the rod of aerosol-generating substrate has an aerosol former content of less than or equal to 20 percent by weight on a dry weight basis.

EX64. An aerosol-generating article according to example EX63, wherein the rod of aerosol-generating substrate has an aerosol former content of less than or equal to 10 percent by weight on a dry weight basis.

EX65. An aerosol-generating article according to example EX62, wherein the rod of aerosol-generating substrate has an aerosol former content of between 10 percent and 30 percent by weight on a dry weight basis.

EX66. An aerosol-generating article according to any one of examples EX61 to EX65, wherein the one or more aerosol formers comprise one or more of glycerine and propylene glycol.

EX67. An aerosol-generating article according to any preceding example, wherein the ratio of the length of the upstream element to the length of the hollow tubular element of the downstream section is between 0.01 and 0.15.

EX68. An aerosol-generating article according to any one of examples EX3 to EX67, wherein the tobacco material comprises a shredded tobacco material.

EX69. An aerosol-generating article according to any preceding example, wherein a ratio of the length of the rod of aerosol-generating substrate to the total length of the aerosol-generating article is at least 0.2, preferably 0.25.

EX70. An aerosol-generating system comprising:

an aerosol-generating article according to any preceding example; and

an aerosol-generating device comprising a heating chamber for receiving the aerosol-generating article and at least a heating element provided at or about the periphery of the heating chamber.

In the following, the invention will be further described with reference to the drawings of the accompanying Figures, wherein:

Figure 1 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 2 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figures 3a & 3b shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 4a & 4b shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 5 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 6 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 7 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 8 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 9 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 10 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 11 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 12 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 13 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 14 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure;

Figure 15 shows a schematic side sectional view of an aerosol-generating article in accordance with the present disclosure; and

Figure 16 shows a schematic side sectional view of an aerosol-generating system comprising an aerosol-generating device and an aerosol-generating article in accordance with the present disclosure.

Aerosol-generating articles shown in all Figures of the present disclosure comprise a rod 12 of aerosol-generating substrate and a downstream section 14 located downstream of the rod 12 of aerosol-generating substrate. Aerosol-generating articles extend from an upstream or distal end 18 to a downstream or mouth end 19. The downstream or mouth end 19 is defined by the downstream end of the downstream section 14.

Each of the components of the aerosol-generating articles shown in the Figures and described in the present disclosure may be circumscribed by corresponding wrappers or may be joined together by one or more wrappers, which are not shown in the Figures. A maximum external diameter of each of the aerosol-generating articles shown in the Figures is about 6.5 mm, unless specified otherwise.

The rod 12 of aerosol-generating substrate is circumscribed by a wrapper (not shown), and comprises at least one of the types of aerosol-generating substrate described in the present disclosure, such as plant cut filler, particularly tobacco cut filler, homogenised tobacco, a gel formulation, or a homogenised plant material comprising particles of a plant other than tobacco. The rod 12 of the aerosol-generating articles shown in all Figures have an average tobacco density of about 250 mg per cubic centimetre.

The downstream section 14 of the aerosol-generating article 10 shown in Figure 1 comprises a hollow tubular cooling element 22, a downstream filter segment 24, and a downstream, or mouth end, hollow tubular element 26. The hollow tubular cooling element 22 is located immediately downstream of the rod 12 of aerosol-generating substrate. In other words, the hollow tubular cooling element 22 abuts the downstream end of the rod 12. The downstream filter segment 24 abuts the downstream end of the hollow tubular cooling element 22 and the downstream hollow tubular element 26 abuts the downstream end of the downstream filter segment 24. The downstream filter segment 24 is therefore located between the hollow tubular cooling element 22 and the downstream hollow tubular element 26. The downstream end 19 of the article 10 is defined by the downstream end of the downstream hollow tubular element 26.

The length of the rod 12 of aerosol-generating substrate is about 40 mm.

The hollow tubular cooling element 22 is provided in the form of a hollow cylindrical tube made of cardboard or cellulose acetate. The hollow tubular cooling segment 22 defines an internal cavity that extends all the way from an upstream end of the hollow tubular cooling element 22 to an downstream end of the hollow tubular cooling element 22. The internal cavity is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity. The hollow tubular cooling element 22 may not substantially contribute to the overall RTD of the aerosol-generating article 10. The length of the hollow tubular cooling element 22 is about 25 mm. The wall thickness of the hollow tubular cooling element 22 is about 250 micrometres (μm).

The downstream filter segment 24 comprises a cylindrical plug of cellulose acetate tow. The length of the downstream filter segment 24 is about 10 mm.

The downstream hollow tubular element 26 is provided in the form of a hollow cylindrical tube made of cellulose acetate. The downstream hollow tubular element 26 defines an internal cavity that extends all the way from an upstream end of the downstream hollow tubular element 26 to an downstream end of the downstream hollow tubular element 26. The internal cavity is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity. The downstream hollow tubular element 26 does not substantially contribute to the overall RTD of the aerosol-generating article 10. The length of the downstream hollow tubular element 26 is about 6 mm. The wall thickness of the downstream hollow tubular element 26 is about 1 mm.

The aerosol-generating article 10 comprises a ventilation zone 36 provided at a location along the hollow tubular cooling element 22. The ventilation zone 36 comprises at least one circumferential row of perforations extending through the peripheral wall of the hollow tubular cooling element 22 and any wrapper (not shown) circumscribing the hollow tubular cooling element 22. The ventilation zone 36 is provided at about 2 millimetres from the downstream end of the hollow tubular cooling element 22.

The aerosol-generating article 101 shown in Figure 2 is similar to the aerosol-generating article 10 shown in Figure 1 and differs only in the following aspects. The rod 12 of aerosol-generating substrate is shorter and the hollow tubular cooling element 22 is longer. The length of the rod 12 of aerosol-generating substrate is about 25 mm. The length of the hollow tubular cooling element 22 is about 40 mm.

The aerosol-generating article 102 shown in Figure 3a is similar to the aerosol-generating article 101 shown in Figure 2 and differs only in the following aspects. The hollow tubular cooling element 22 is shorter and the downstream hollow tubular element 27 is longer. The length of the hollow tubular cooling element 22 is about 25 mm. The length of the downstream hollow tubular element 27 is about 20 mm. Further, the ventilation zone 36 is provided along the downstream hollow tubular element 27. The ventilation zone 36 is provided at about 2 millimetres from the upstream end of the downstream hollow tubular element 26. The ventilation zone 36 comprises at least one circumferential row of perforations extending through the peripheral wall of the downstream hollow tubular element 27 and any wrapper (not shown) circumscribing the downstream hollow tubular element 27.

The aerosol-generating article 103 shown in Figure 3b is similar to the aerosol-generating article 102 shown in Figure 3a and differs only in the following aspects. The downstream hollow tubular element 27 comprises two abutting hollow tubular segments 271, 272. The first hollow tubular segment 271 is located between the downstream filter segment 24 and the second first hollow tubular segment 272.

In Figure 3b, the first hollow tubular segment 271 is provided in the form of a hollow cylindrical tube made of cardboard. The first hollow tubular segment 271 defines an internal cavity that extends all the way from an upstream end of the first hollow tubular segment 271 to an downstream end of the first hollow tubular segment 271. The internal cavity is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity. The first hollow tubular segment 271 may not substantially contribute to the overall RTD of the aerosol-generating article 103. The length of the first hollow tubular segment 271 is about 10 mm. The wall thickness of the first hollow tubular segment 271 is about 250 micrometres (µm). The ventilation zone 36 is provided at about 2 millimetres from the upstream end of the first hollow tubular segment 271 of the downstream hollow tubular element 27.

In Figure 3b, the second hollow tubular segment 272 is provided in the form of a hollow cylindrical tube made of cellulose acetate. The second hollow tubular segment 272 defines an internal cavity that extends all the way from an upstream end of the second hollow tubular segment 272 to an downstream end of the second hollow tubular segment 272. The internal cavity is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity. The second hollow tubular segment 272 does not substantially contribute to the overall RTD of the aerosol-generating article 103. The length of the second hollow tubular segment 272 is about 10 mm. The wall thickness of the second hollow tubular segment 272 is about 1 mm.

The aerosol-generating articles 104, 105 shown in Figures 4a & 4b are similar to the aerosol-generating article 101 shown in Figure 2 and differ only in that the aerosol-generating articles 104, 105 further comprise an upstream section 16 located upstream of the rod 12 of aerosol-generating substrate. The distal end 18 of the articles 104, 105 is defined by the upstream end of the upstream section 16. The upstream section 16 comprises an upstream element 341, 342 abutting the upstream end of the rod 12. The length of the upstream element 341, 342 is about 5 mm. In the article 104 shown in Figure 4a, the upstream element 341 is provided in the form of a cylindrical plug of cellulose acetate tow. In the article 105 shown in Figure 4b, the upstream element 342 is provided in the form of a hollow cylindrical tube made of cellulose acetate having a wall thickness of about 1 mm.

The downstream section 14 of the aerosol-generating article 20 shown in Figure 5 comprises a hollow tubular support element 28, a cooling element 32, and a downstream filter segment 24. The hollow tubular support element 28 is located immediately downstream of the rod 12 of aerosol-generating substrate. In other words, the hollow tubular support element 28 abuts the downstream end of the rod 12. The cooling element 32 abuts the downstream end of the hollow tubular support element 28 and the downstream filter segment 24 abuts the downstream end of the cooling element 32. The cooling element 32 is therefore located between the hollow tubular support element 28 and the downstream filter segment 24. The downstream end 19 of the article 20 is defined by the downstream end of the downstream filter segment 24.

The length of the rod 12 of aerosol-generating substrate is about 25 mm.

The hollow tubular support element 28 is provided in the form of a hollow cylindrical tube made of cellulose acetate. The hollow tubular support element 28 defines an internal cavity that extends all the way from an upstream end of the hollow tubular support element 28 to an downstream end of the hollow tubular support element 28. The internal cavity is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity. The hollow tubular support element 28 may not substantially contribute to the overall RTD of the aerosol-generating article 20. The length of hollow tubular support element 28 is about 8 mm. The wall thickness of the hollow tubular support element 28 is about 1.5 mm.

The cooling element 32 is formed by thin polylactic acid (PLA) sheet material that has been crimped, pleated, gathered, or folded to form the channels. The length of the cooling element 32 is about 18 mm.

The downstream filter segment 24 comprises a cylindrical plug of cellulose acetate tow. The length of the downstream filter segment 24 is about 7 mm.

A maximum external diameter of the aerosol-generating article 20 is about 7.3 mm.

The aerosol-generating article 201 shown in Figure 6 is similar to the aerosol-generating article 20 shown in Figure 5 and differs in that it further comprises a hollow tubular cooling element 22 and in that the rod 12 of aerosol-generating substrate is shorter. The length of the rod 12 of aerosol-generating substrate is about 12 mm. The hollow tubular cooling element 22 is located immediately downstream of the cooling element 32 and immediately upstream of the downstream filter segment 24. In other words, the hollow tubular cooling element 22 abuts the cooling element 32 and the downstream filter segment 24.

The hollow tubular cooling element 22 is provided in the form of a hollow cylindrical tube made of cardboard. The hollow tubular cooling segment 22 defines an internal cavity that extends all the way from an upstream end of the hollow tubular cooling element 22 to an downstream end of the hollow tubular cooling element 22. The internal cavity is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity. The hollow tubular cooling element 22 may not substantially contribute to the overall RTD of the aerosol-generating article 201. The length of the hollow tubular cooling element 22 is about 25 mm. The wall thickness of the hollow tubular cooling element 22 is about 250 micrometres (μm).

The aerosol-generating article 202 shown in Figure 7 is similar to the aerosol-generating article 201 shown in Figure 6 and differs only in that it further comprises a downstream hollow tubular element 27. The downstream hollow tubular element 27 abuts the downstream end of the downstream filter segment 24. The downstream filter segment 24 is therefore located between the hollow tubular cooling element 22 and the downstream hollow tubular element 27. The downstream end 19 of the article 202 is defined by the downstream end of the downstream hollow tubular element 27.

The downstream hollow tubular element 27 is provided in the form of a hollow cylindrical tube made of cellulose acetate. The downstream hollow tubular element 27 defines an internal cavity that extends all the way from an upstream end of the downstream hollow tubular element 27 to an downstream end of the downstream hollow tubular element 27. The internal cavity is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity. The downstream hollow tubular element 27 may not substantially contribute to the overall RTD of the aerosol-generating article 202. The length of the downstream hollow tubular element 27 is about 5 mm. The wall thickness of the downstream hollow tubular element 27 is about 1 mm.

The aerosol-generating article 30 shown in Figure 8 comprises a rod 12 of aerosol-generating substrate and a downstream section 14 located downstream of the rod 12 of aerosol-generating substrate. Further, the aerosol-generating article 30 comprises an upstream section 16 located upstream of the rod 12 of aerosol-generating substrate. The distal end 18 of the article 30 is defined by the upstream end of the upstream section 16.

The downstream section 14 of the aerosol-generating article 30 shown in Figure 8 comprises a hollow tubular cooling element 22 and a downstream filter segment 24. The hollow tubular cooling element 22 is located immediately downstream of the rod 12 of aerosol-generating substrate. In other words, the hollow tubular cooling element 22 abuts the downstream end of the rod 12. The downstream filter segment 24 abuts the downstream end of the hollow tubular cooling element 22. The hollow tubular cooling element 22 is therefore located between the rod 12 and the downstream filter segment 24. The downstream end 19 of the article 30 is defined by the downstream end of the downstream filter segment 24.

The length of the rod 12 of aerosol-generating substrate is about 25 mm.

The hollow tubular cooling element 22 is provided in the form of a hollow cylindrical tube made of cardboard or cellulose acetate. The hollow tubular cooling segment 22 defines an internal cavity that extends all the way from an upstream end of the hollow tubular cooling element 22 to an downstream end of the hollow tubular cooling element 22. The internal cavity is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity. The hollow tubular cooling element 22 may not substantially contribute to the overall RTD of the aerosol-generating article 30. The length of the hollow tubular cooling element 22 is about 21 mm. The wall thickness of the hollow tubular cooling element 22 is about 250 micrometres (μm).

The downstream filter segment 24 comprises a cylindrical plug of cellulose acetate tow. The length of the downstream filter segment 24 is about 7 mm.

The upstream section 16 comprises an upstream element 341 abutting the upstream end of the rod 12. The upstream element 341 is provided in the form of a cylindrical plug of cellulose acetate tow. The length of the upstream element 341 is about 5 mm.

The aerosol-generating article 30 comprises a ventilation zone 36 provided at a location along the hollow tubular cooling element 22. The ventilation zone 36 comprises at least one circumferential row of perforations extending through the peripheral wall of the hollow tubular cooling element 22 and any wrapper (not shown) circumscribing the hollow tubular cooling element 22. The ventilation zone 36 is provided at about 2 millimetres from the downstream end of the hollow tubular cooling element 22.

The aerosol-generating article 301 shown in Figure 9 is similar to the aerosol-generating article 30 shown in Figure 8 and differs only in that the rod 12 is shorter and the hollow tubular cooling element 22 is longer. In Figure 9, the length of the rod 12 of aerosol-generating substrate is about 12 mm and the length of the hollow tubular cooling element 22 is about 45 mm.

The aerosol-generating article 302 shown in Figure 10 is similar to the aerosol-generating article 301 shown in Figure 8 and differs in that the rod 12 is shorter and the hollow tubular cooling element 22 is longer, and that the article 302 further comprises a downstream hollow tubular element 27. In Figure 10, the length of the rod 12 of aerosol-generating substrate is about 12 mm and the length of the hollow tubular cooling element 22 is about 40 mm. The downstream filter segment 24 is therefore located between the hollow tubular cooling element 22 and the downstream hollow tubular element 27. The downstream end 19 of the article 302 is defined by the downstream end of the downstream hollow tubular element 27.

The downstream hollow tubular element 27 is provided in the form of a hollow cylindrical tube made of cellulose acetate. The downstream hollow tubular element 27 defines an internal cavity that extends all the way from an upstream end of the downstream hollow tubular element 27 to an downstream end of the downstream hollow tubular element 27. The internal cavity is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity. The downstream hollow tubular element 27 may not substantially contribute to the overall RTD of the aerosol-generating article 302. The length of the downstream hollow tubular element 27 is about 5 mm. The wall thickness of the downstream hollow tubular element 27 is about 1 mm.

The aerosol-generating article 304 shown in Figure 11 is similar to the aerosol-generating article 302 shown in Figure 10 and differs in that the ventilation zone 36 is instead provided along the downstream hollow tubular element 27. The ventilation zone 36 is provided at about 2 millimetres from the upstream end of the downstream hollow tubular element 27. The ventilation zone 36 comprises at least one circumferential row of perforations extending through the peripheral wall of the downstream hollow tubular element 27 and any wrapper (not shown) circumscribing the downstream hollow tubular element 27.

The aerosol-generating article 40 shown in Figure 12 comprises a rod 12 of aerosol-generating substrate and a downstream section 14 located downstream of the rod 12 of aerosol-generating substrate. Further, the aerosol-generating article 40 comprises an upstream section 16 located upstream of the rod 12 of aerosol-generating substrate. The distal end 18 of the article is defined by the upstream end of the upstream section 16.

The downstream section 14 of the aerosol-generating article 40 shown in Figure 3 comprises a hollow tubular support element 28, a hollow tubular cooling element 22, and a downstream filter segment 24. The hollow tubular support element 28 is located immediately downstream of the rod 12 of aerosol-generating substrate. In other words, the hollow tubular support element 28 abuts the downstream end of the rod 12. The hollow tubular cooling element 22 abuts the downstream end of the hollow tubular support element 28 and the downstream filter segment 24 abuts the downstream end of the hollow tubular cooling element 22. The hollow tubular cooling element 22 is therefore located between the hollow tubular support element 28 and the downstream filter segment 24. The downstream end 19 of the article 40 is defined by the downstream end of the downstream filter segment 24.

The length of the rod 12 of aerosol-generating substrate is about 20 mm.

The hollow tubular support element 28 is provided in the form of a hollow cylindrical tube made of cellulose acetate. The hollow tubular support element 28 defines an internal cavity that extends all the way from an upstream end of the hollow tubular support element 28 to an downstream end of the hollow tubular support element 28. The internal cavity is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity. The hollow tubular support element 28 may not substantially contribute to the overall RTD of the aerosol-generating article 40. The length of the hollow tubular support element 28 is about 8 mm. The wall thickness of the hollow tubular support element 28 is about 1.5 mm.

The hollow tubular cooling element 22 is provided in the form of a hollow cylindrical tube made of cardboard or cellulose acetate. The hollow tubular cooling segment 22 defines an internal cavity that extends all the way from an upstream end of the hollow tubular cooling element 22 to an downstream end of the hollow tubular cooling element 22. The internal cavity is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity. The hollow tubular cooling element 22 may not substantially contribute to the overall RTD of the aerosol-generating article 40. The length of the hollow tubular cooling element 22 is about 8 mm. The wall thickness of the hollow tubular cooling element 22 is about 250 micrometres (μm).

The downstream filter segment 24 comprises a cylindrical plug of cellulose acetate tow. The length of the downstream filter segment 24 is about 12 mm.

The upstream section 16 comprises an upstream element 341 abutting the upstream end of the rod 12. The upstream element 341 is provided in the form of a cylindrical plug of cellulose acetate tow. The length of the upstream element 341 is about 5 mm.

The aerosol-generating article 40 comprises a ventilation zone 36 provided at a location along the hollow tubular cooling element 22. The ventilation zone 36 comprises at least one circumferential row of perforations extending through the peripheral wall of the hollow tubular cooling element 22 and any wrapper (not shown) circumscribing the hollow tubular cooling element 22. The ventilation zone 36 is provided at about 2 millimetres from the downstream end of the hollow tubular cooling element 22.

The aerosol-generating article 40 comprises an elongate susceptor element 44 located within the rod 12 of aerosol-generating substrate. The susceptor element 44 is arranged substantially longitudinally within the rod 12, such as to be approximately parallel to the longitudinal direction of the rod 12. As the elongate susceptor element 44 is located in thermal contact with the aerosol-generating substrate, the aerosol-generating substrate is heated by the susceptor element 44, when the susceptor element 44 is inductively heated when located within a fluctuating electromagnetic field.

As shown in Figure 12, the susceptor element 44 is positioned in a radially central position within the rod and extends effectively along the longitudinal axis of the rod 12. The susceptor element 44 extends all the way from an upstream end to a downstream end of the rod 12. In effect, the susceptor element 44 has substantially the same length as the rod 12 of aerosol-generating substrate.

The susceptor element 44 is provided in any form described in the present disclosure and has a length substantially equal to the length of the rod 12. The upstream section 16 advantageously prevents the susceptor element 44 from being dislodged. Further, this ensures that the consumer cannot accidentally contact the heated susceptor element 44 after use.

The aerosol-generating article 401 shown in Figure 13 is similar to the aerosol-generating article 40 shown in Figure 12 and differs only in that the rod 12 is shorter and the hollow tubular cooling element 22 is longer. In Figure 13, the length of the rod 12 of aerosol-generating substrate is about 12 mm and the length of the hollow tubular cooling element 22 is about 25 mm.

The aerosol-generating article 402 shown in Figure 14 is similar to the aerosol-generating article 40 shown in Figure 12 and differs in that the rod 12 is shorter and the hollow tubular cooling element 22 is longer, and in that the article 402 further comprises a downstream hollow tubular element 27. In the article 402 shown in Figure 14, the length of the rod 12 of aerosol-generating substrate is about 12 mm and the length of the hollow tubular cooling element 22 is about 20 mm. The downstream filter segment 24 is therefore located between the hollow tubular cooling element 22 and the downstream hollow tubular element 27. The downstream end 19 of the article 402 is defined by the downstream end of the downstream hollow tubular element 27.

The downstream hollow tubular element 27 is provided in the form of a hollow cylindrical tube made of cellulose acetate. The downstream hollow tubular element 27 defines an internal cavity that extends all the way from an upstream end of the downstream hollow tubular element 27 to an downstream end of the downstream hollow tubular element 27. The internal cavity is substantially empty, and so substantially unrestricted airflow is enabled along the internal cavity. The downstream hollow tubular element 27 may not substantially contribute to the overall RTD of the aerosol-generating article 402. The length of the downstream hollow tubular element 27 is about 5 mm. The wall thickness of the downstream hollow tubular element 27 is about 1 mm.

The aerosol-generating article 403 shown in Figure 15 is similar to the aerosol-generating article 402 shown in Figure 14 and differs in that the ventilation zone 36 is provided along the downstream hollow tubular element 27. The ventilation zone 36 is provided at about 2 millimetres from the upstream end of the downstream hollow tubular element 27. The ventilation zone 36 comprises at least one circumferential row of perforations extending through the peripheral wall of the downstream hollow tubular element 27 and any wrapper (not shown) circumscribing the downstream hollow tubular element 27.

Figure 16 illustrates an aerosol-generating system 1 comprising an exemplary aerosol-generating device 50 and an aerosol-generating article according to any one shown in Figures 1 to 15 and described above.

Figure 16 illustrates a downstream, mouth end portion of the aerosol-generating device 50 where the device cavity is defined and the aerosol-generating article can be received. The aerosol-generating device 50 comprises a housing (or body) 4, extending between a mouth end 2 and a distal end (not shown). The housing 4 comprises a peripheral wall 6. The peripheral wall 6 defines a device cavity for receiving an aerosol-generating article 10. The device cavity is defined by a closed, distal end and an open, mouth end. The mouth end of the device cavity is located at the mouth end of the aerosol-generating device 1. The aerosol-generating article 10 is configured to be received through the mouth end of the device cavity and is configured to abut a closed end of the device cavity.

A device air flow channel 5 is defined within the peripheral wall 6. The air-flow channel 5 extends between an inlet 7 located at the mouth end of the aerosol-generating device 1 and the closed end of the device cavity. Air may enter the aerosol-generating substrate 12 via an aperture (not shown) provided at the closed end of the device cavity, ensuring fluid communication between the air flow channel 5 and the aerosol-generating substrate 12.

The aerosol-generating device 1 further comprises a heater (not shown) and a power source (not shown) for supplying power to the heater. A controller (not shown) is also provided to control such supply of power to the heater. The heater is configured to controllably heat the aerosol-generating article during use, when the aerosol-generating article is received within the device 1. The heater is preferably arranged to externally heat the aerosol-generating substrate of the aerosol-generating article for optimal aerosol generation. The ventilation zone of an aerosol-generating article is arranged to be exposed when the aerosol-generating article is received within the aerosol-generating device 1.

For the purpose of the present description and of the appended claims, except where otherwise indicated, all numbers expressing amounts, quantities, percentages, and so forth, are to be understood as being modified in all instances by the term "about". Also, all ranges include the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein. In this context, therefore, a number A is understood as A ± 10% of A. Within this context, a number A may be considered to include numerical values that are within general standard error for the measurement of the property that the number A modifies. The number A, in some instances as used in the appended claims, may deviate by the percentages enumerated above provided that the amount by which A deviates does not materially affect the basic and novel characteristic(s) of the claimed invention. Also, all ranges include the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein.

CLAIMS

1. An aerosol-generating article comprising:

a rod of aerosol-generating substrate;

a downstream section provided downstream of the rod of aerosol-generating substrate and extending to the downstream end of the aerosol-generating article, wherein the downstream section comprises a hollow tubular cooling element and wherein the downstream section has a length of greater than 45 millimetres;

an upstream element provided upstream of the rod of aerosol-generating substrate and abutting an upstream end of the rod of aerosol-generating substrate, wherein the upstream element has a length of at least 3 millimetres.

2. An aerosol-generating article according to claim 1, wherein the rod of aerosol-generating substrate has a length of less than 30 millimetres.

3. An aerosol-generating article according to claim or 2, wherein the aerosol-generating article has a total length of at least 60 millimetres.

4. An aerosol-generating article according to any preceding claim, wherein the hollow tubular cooling element of the downstream section has a length of at least 40 millimetres.

5. An aerosol-generating article according to any preceding claim, wherein the hollow tubular cooling element abuts the downstream end of the rod of aerosol-generating substrate.

6. An aerosol-generating article according to any preceding claim, wherein the ratio of the length of the hollow tubular cooling element of the downstream section to the length of the rod of aerosol-generating substrate is at least 1.5.

7. An aerosol-generating article according to any preceding claim, wherein the ratio of the length of the upstream element to the length of the hollow tubular element of the downstream section is between 0.01 and 0.15.

8. An aerosol-generating article according to any preceding claim, wherein the maximum external diameter of the aerosol-generating article is less than 7 millimetres.

9. An aerosol-generating article according to any preceding claim, wherein the upstream element has a length of between 3 millimetres and 6 millimetres.

10. An aerosol-generating article according to any preceding claim, wherein the upstream element comprises a hollow tubular segment having a central longitudinal cavity extending through it.

11. An aerosol-generating article according to claim 10, wherein the hollow tubular segment of the upstream element has a wall thickness of less than 1 millimetre.

12. An aerosol-generating article according to any preceding claim, wherein the resistance to draw (RTD) of the upstream element is less than or equal to 10 millimetres H_2O.

13. An aerosol-generating article according to any preceding claim, further comprising a ventilation zone at a location along the hollow tubular cooling element of the downstream section.

14. An aerosol-generating article according to any preceding claim, wherein the wall thickness of the hollow tubular cooling element of the downstream section is less than 0.5 millimetres.

15. An aerosol-generating article according to any preceding claim, wherein the downstream section further comprises a downstream filter segment provided downstream of the hollow tubular cooling element.

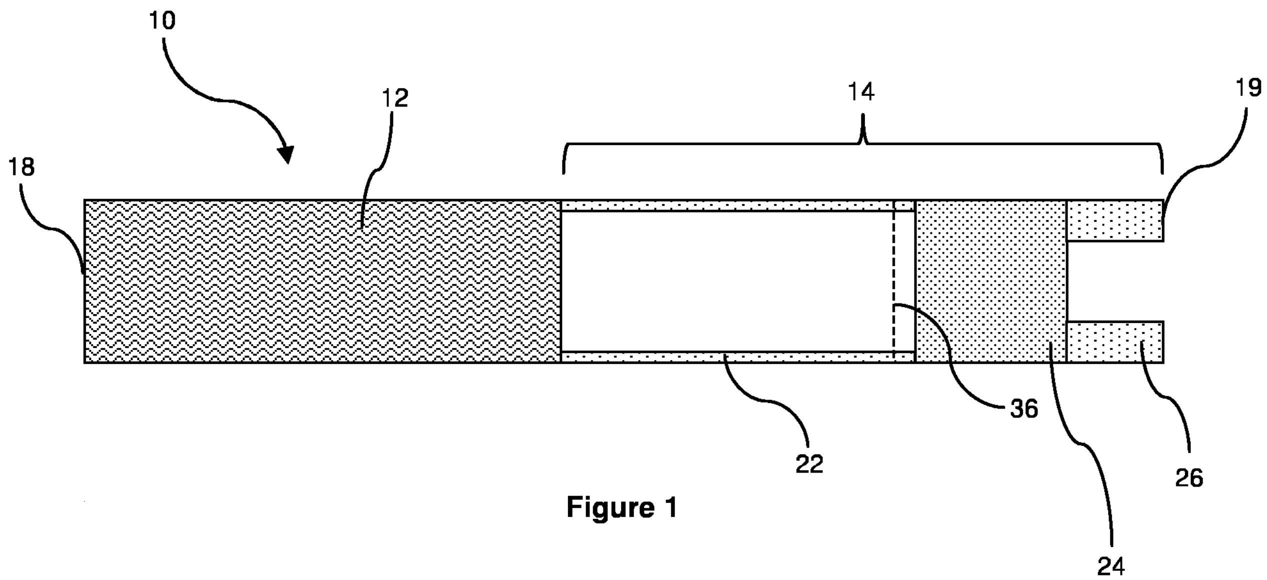


Figure 1

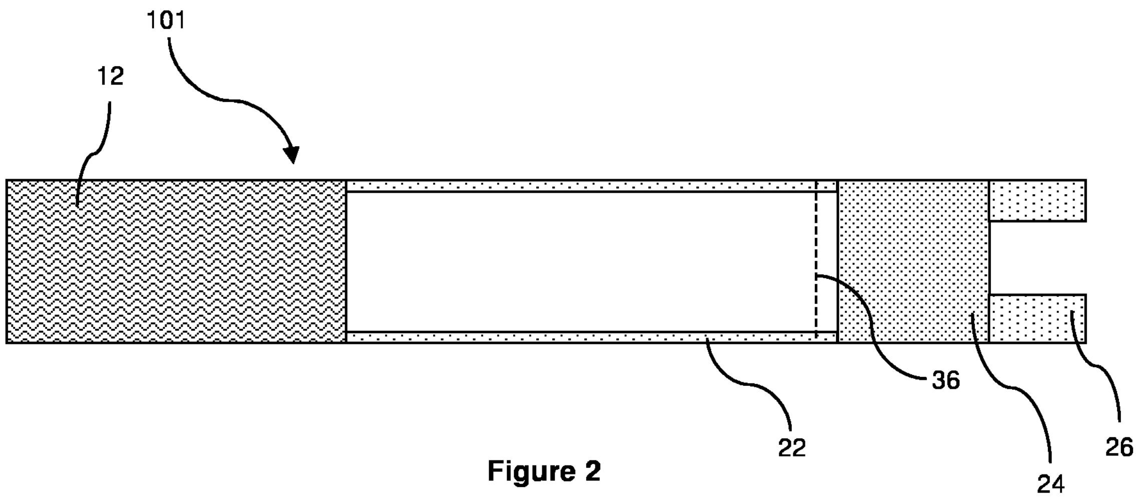


Figure 2

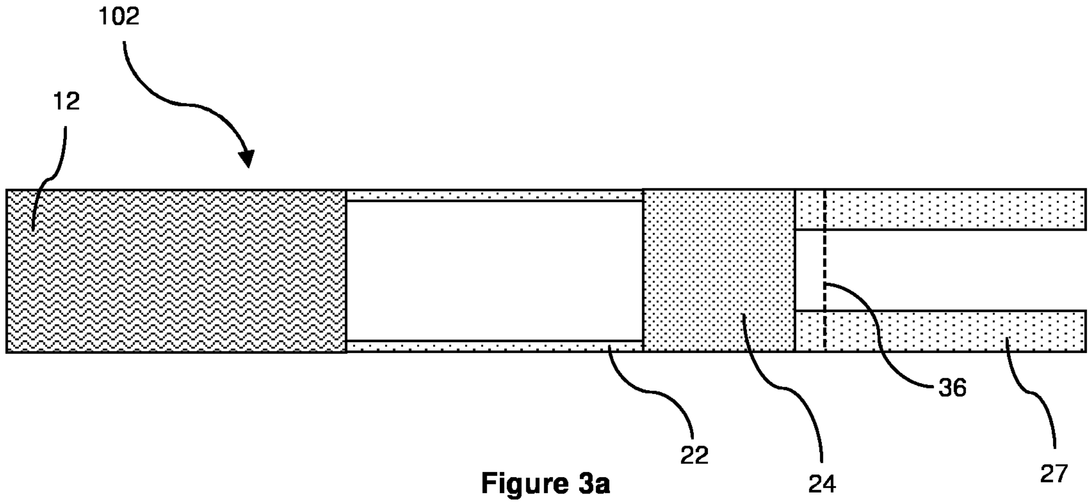


Figure 3a

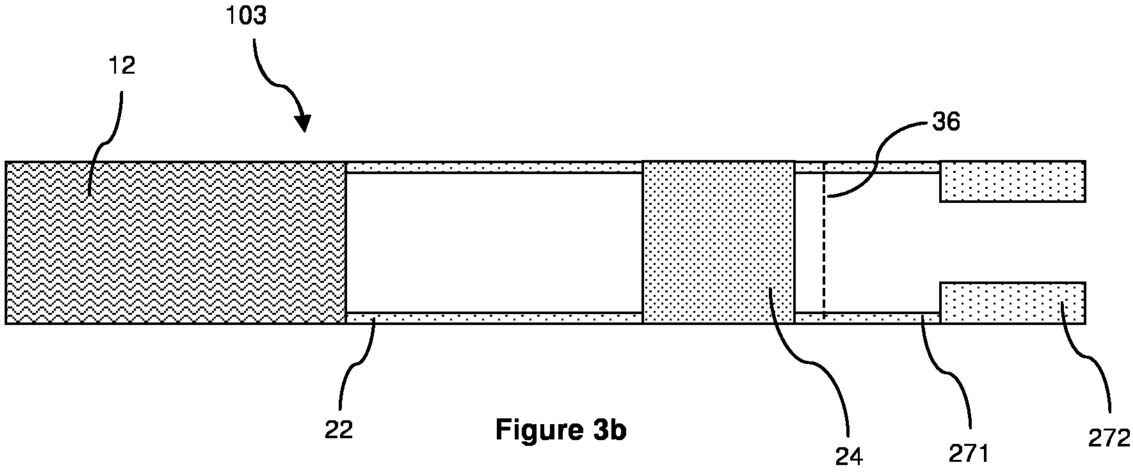


Figure 3b

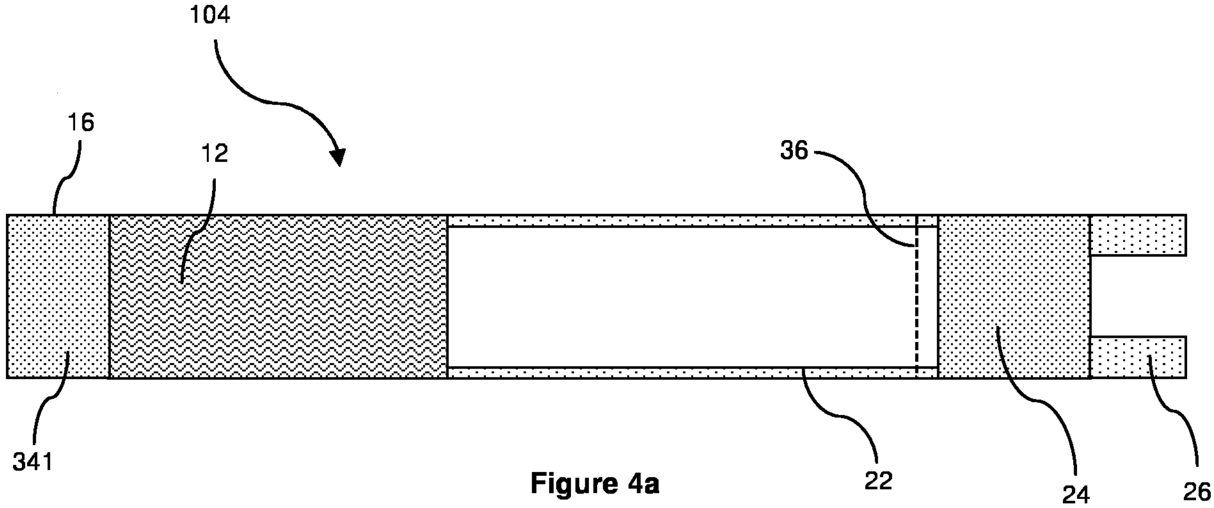


Figure 4a

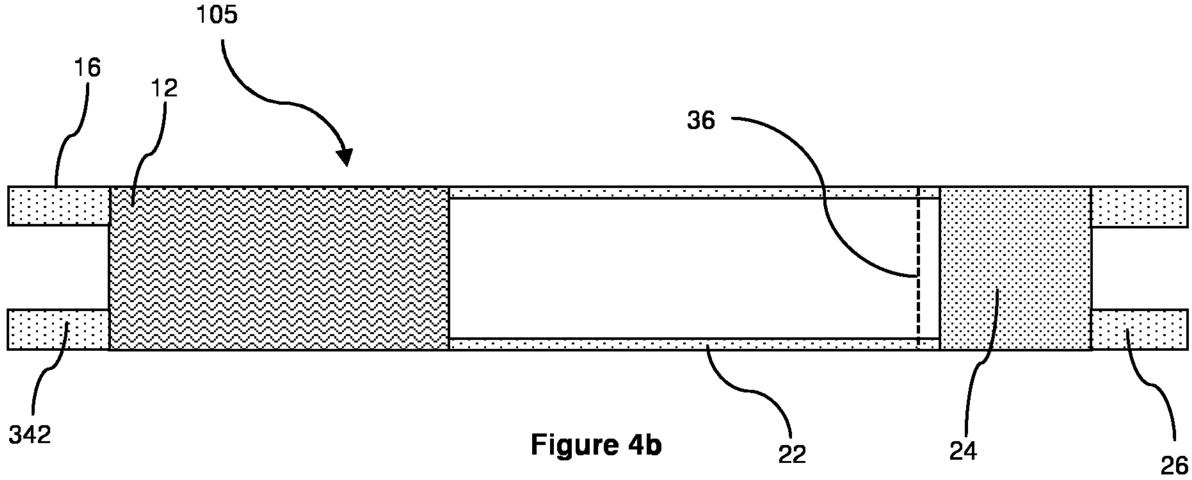


Figure 4b

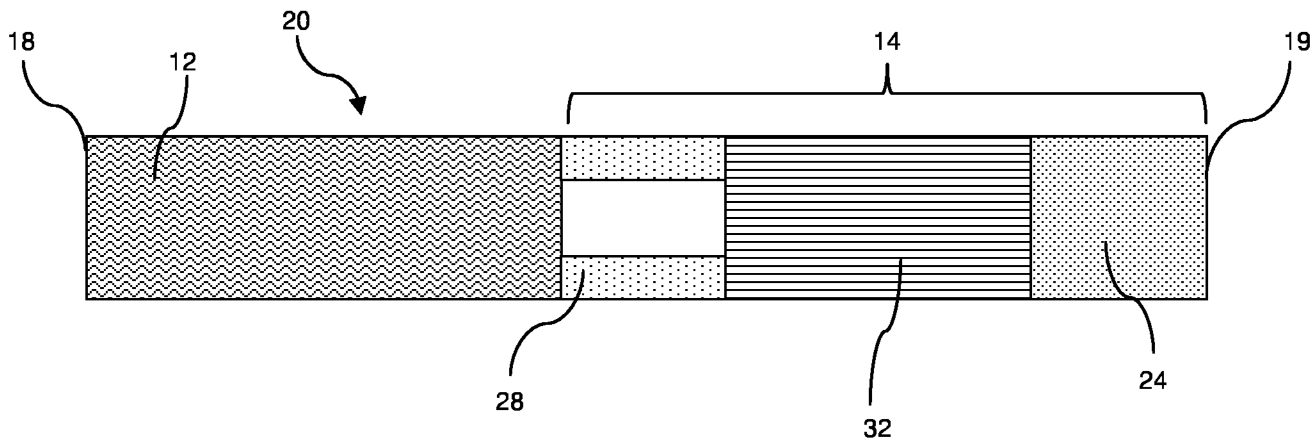


Figure 5

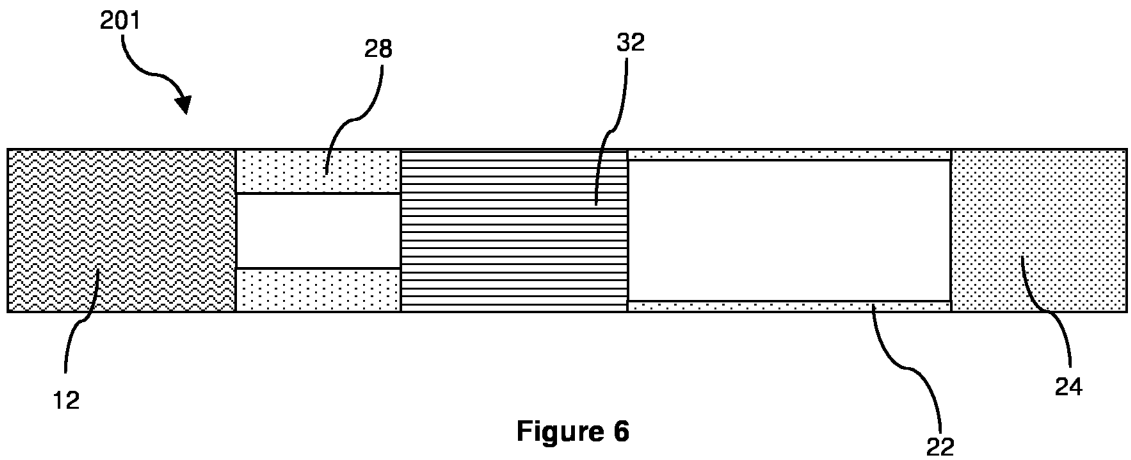


Figure 6

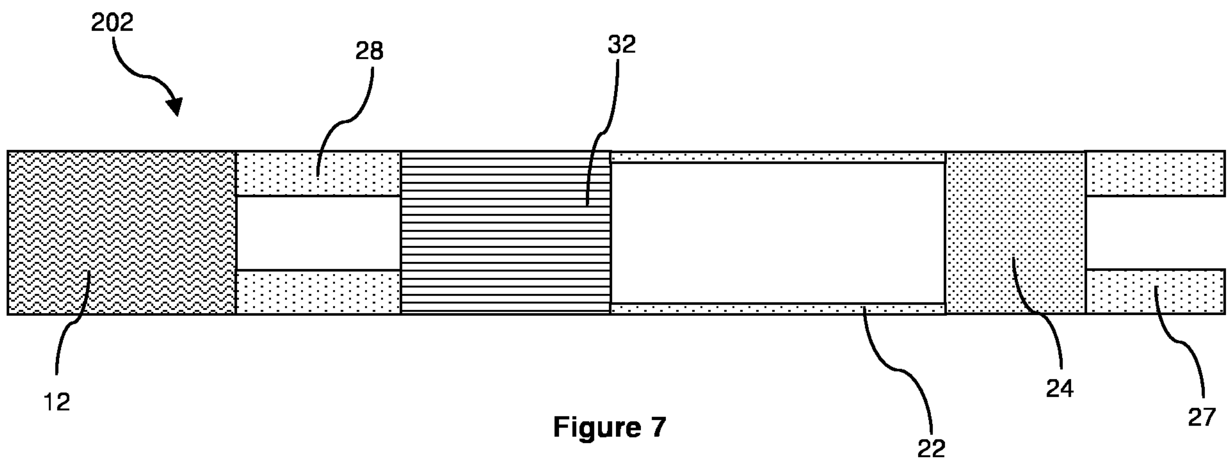


Figure 7

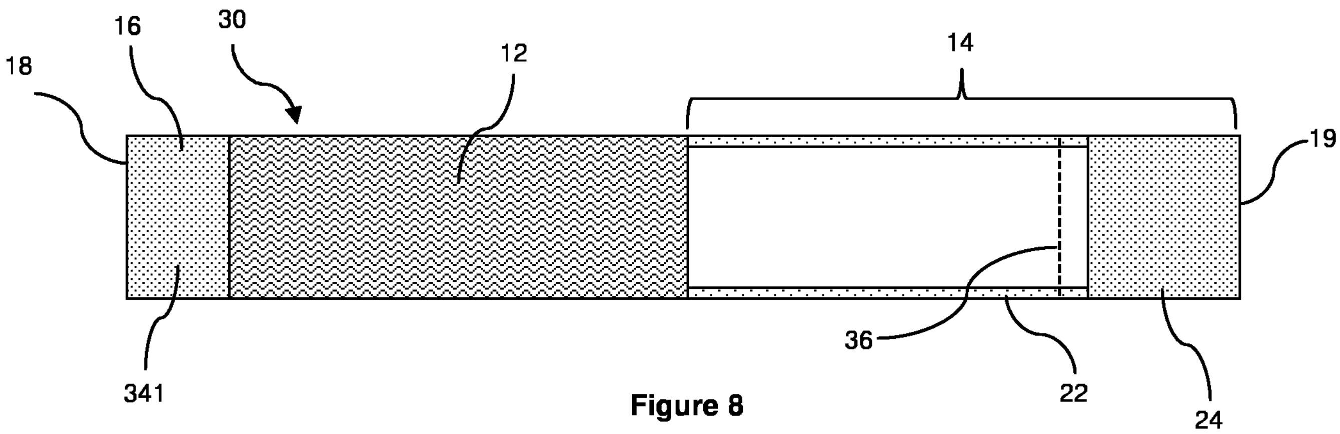


Figure 8

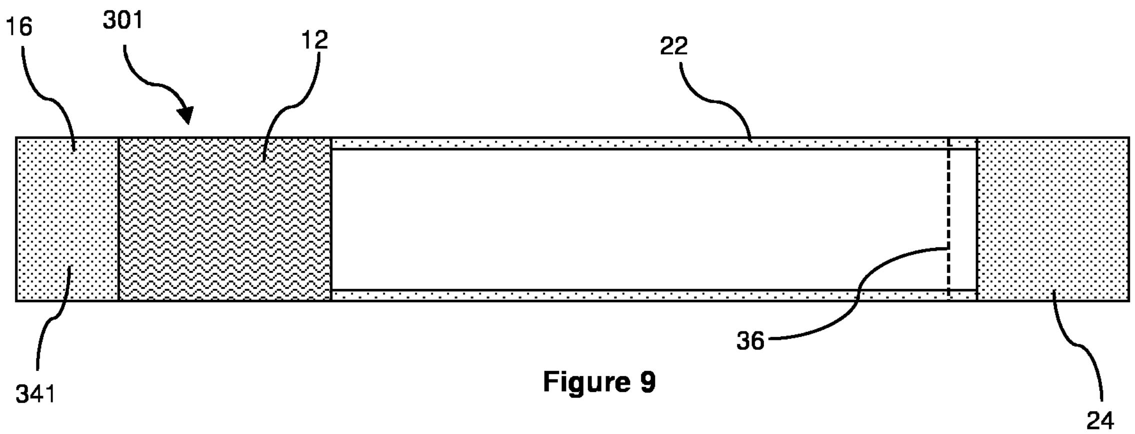


Figure 9

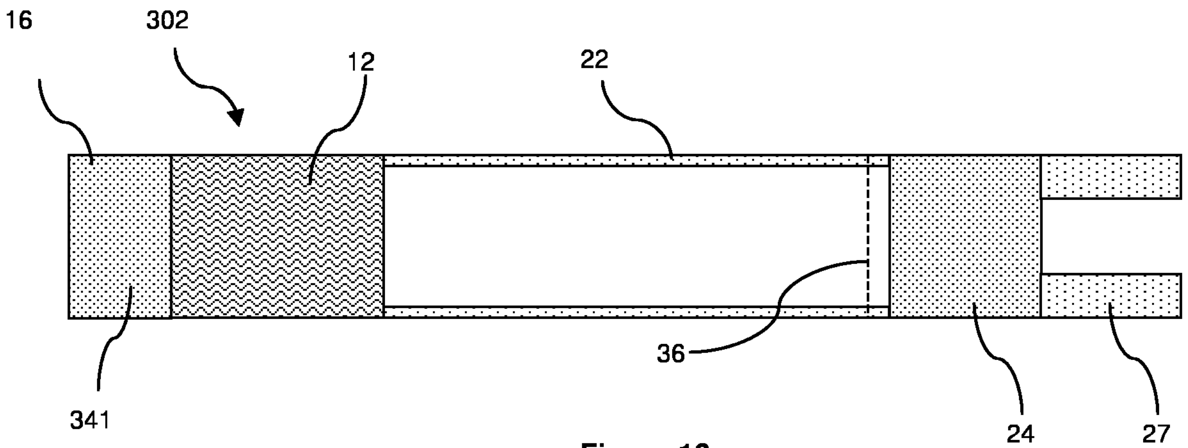


Figure 10

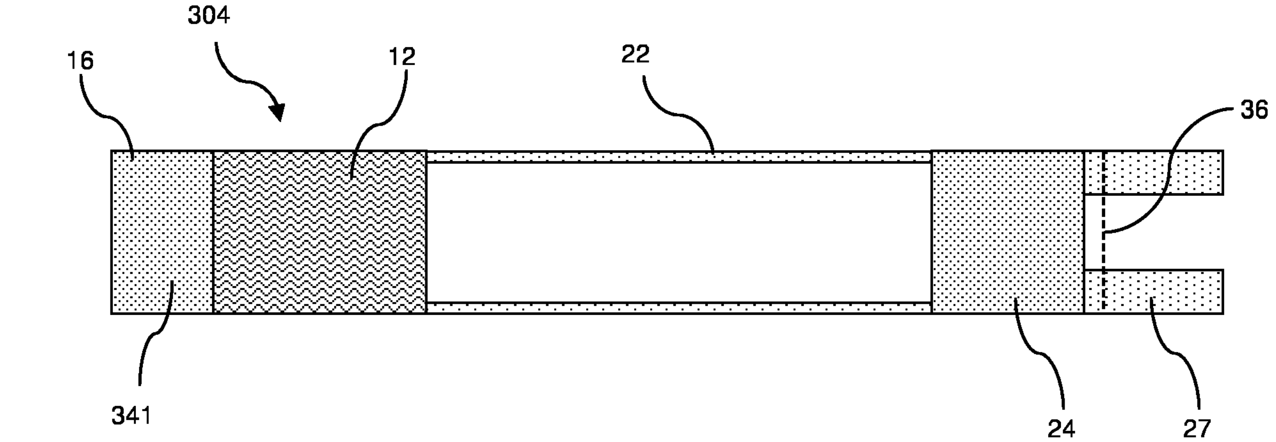


Figure 11

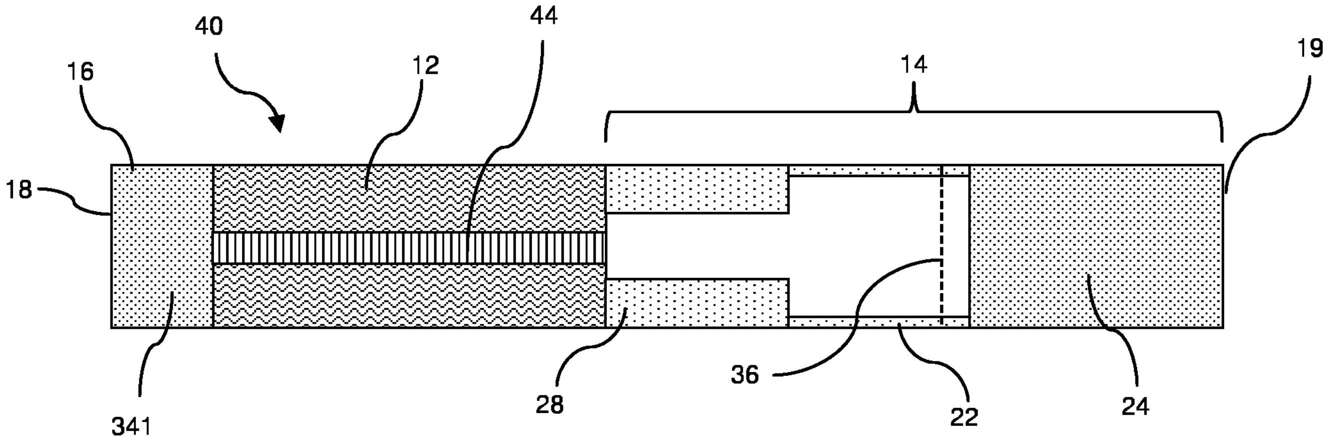


Figure 12

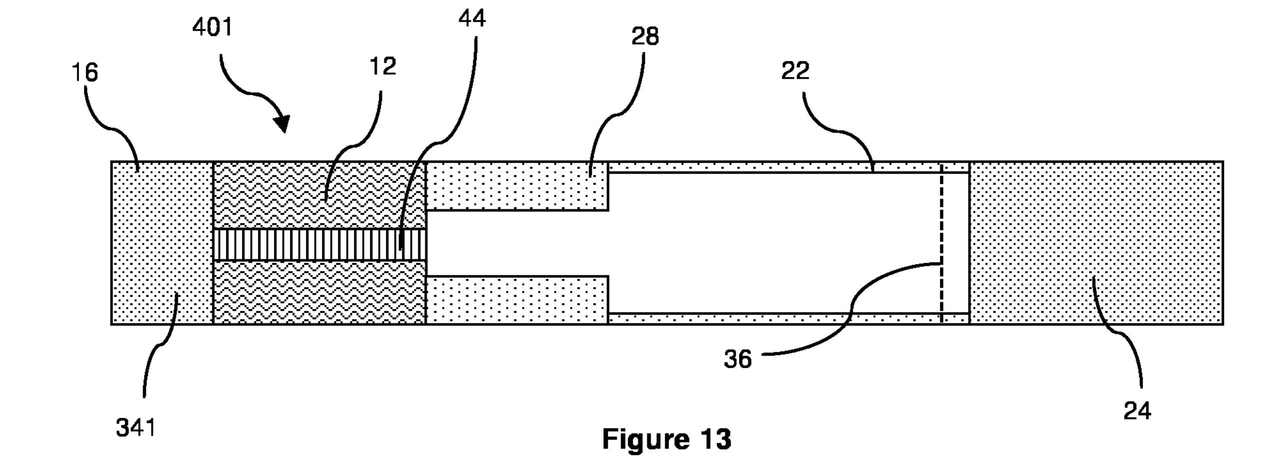


Figure 13

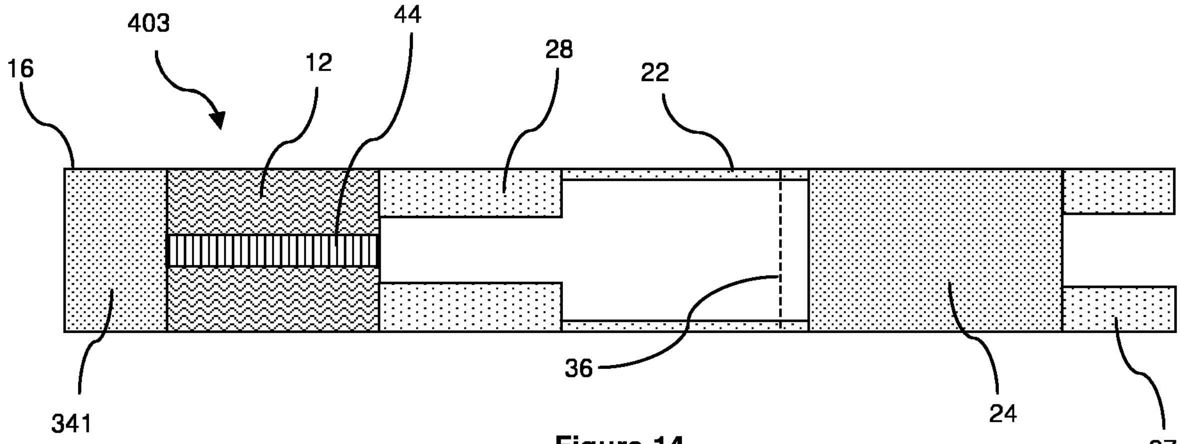


Figure 14

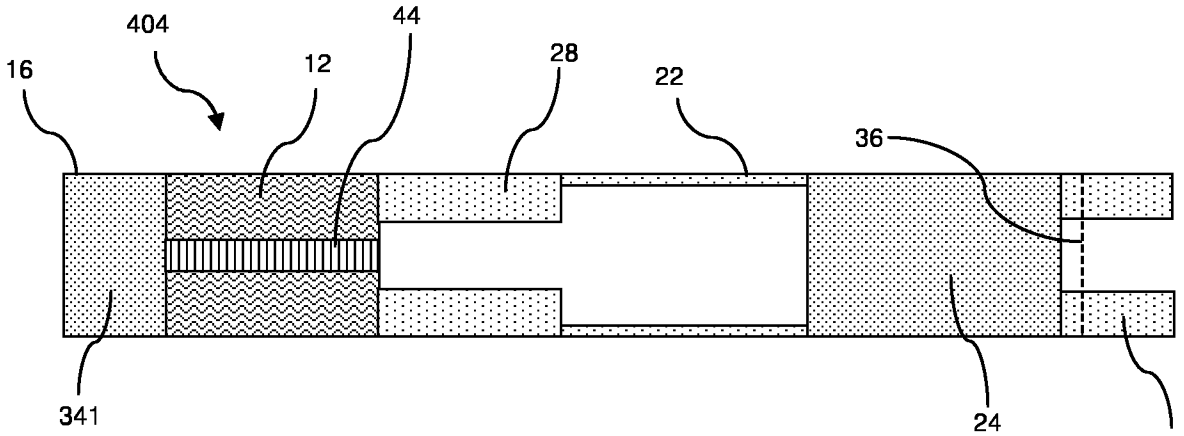
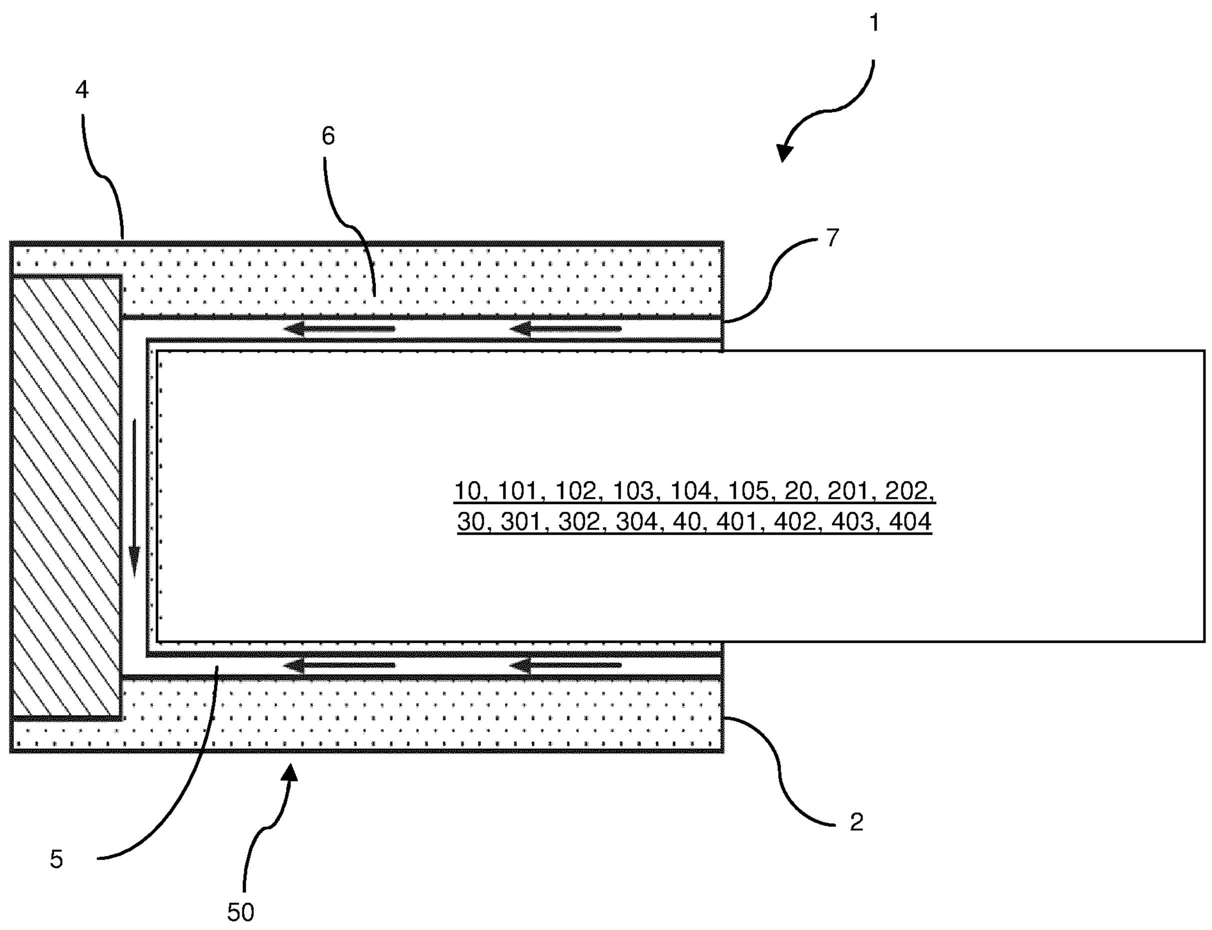


Figure 15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10, 101, 102, 103, 104, 105, 20, 201, 202,
30, 301, 302, 304, 40, 401, 402, 403, 404
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Figure 16

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/059525

A. CLASSIFICATION OF SUBJECT MATTER
INV. A24D1/20
ADD.

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)
A24D

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

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X	EP 3 861 868 A1 (JAPAN TOBACCO INC [JP]) 11 August 2021 (2021-08-11)	1-3
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A	figure 1	4,7

Y	WO 2017/198838 A1 (BRITISH AMERICAN TOBACCO LTD [GB]) 23 November 2017 (2017-11-23) page 5, line 1 - page 9, line 22; figure 1	10-15

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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 :

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Date of the actual completion of the international search	Date of mailing of the international search report
29 June 2023	11/07/2023

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	Kock, Søren

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/059525

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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