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NAPPI et al.

(54) **SUPPORT ELEMENT FOR AEROSOL GENERATING ARTICLE**

(71) Applicant: **Philip Morris Products S.A**, Neuchatel (CH)

(72) Inventors: **Leonardo NAPPI**, Vallamand (CH); **Jerome UTHURRY**, Neuchatel (CH)

(73) Assignee: **Philip Morris Products S.A**, Neuchatel (CH)

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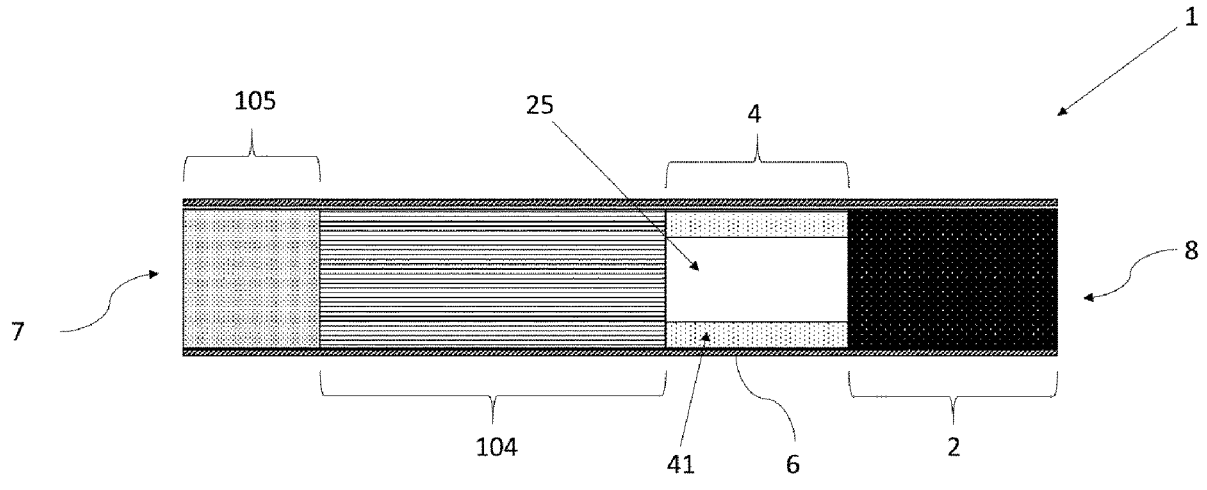
(57) **ABSTRACT**

An aerosol-generating article is provided, including an aerosol-forming substrate; and a hollow tubular support element including fibrous filtration material and being disposed immediately downstream of the aerosol-forming substrate, the hollow tubular support element defining an opening configured to allow aerosol to flow from the aerosol-forming substrate towards a mouth end of the aerosol-generating article, and at least a portion of the fibrous filtration material of the hollow tubular support element inwardly projects into the opening and defines at least one internal projection.



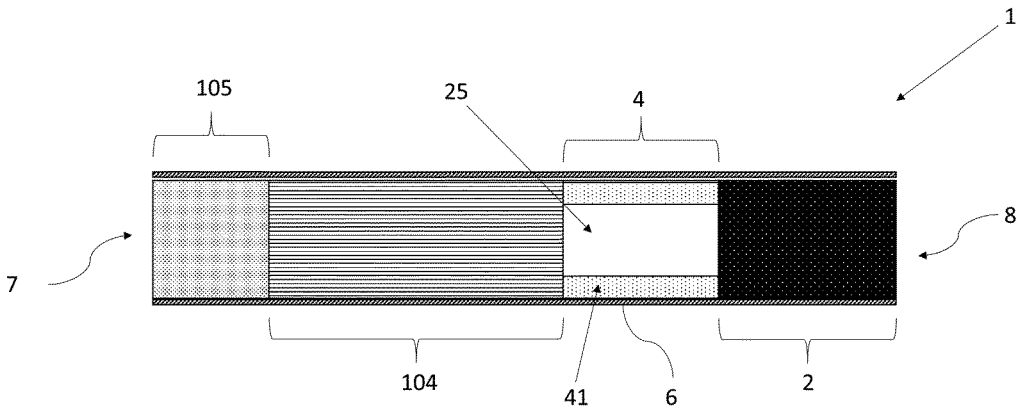


Figure 1

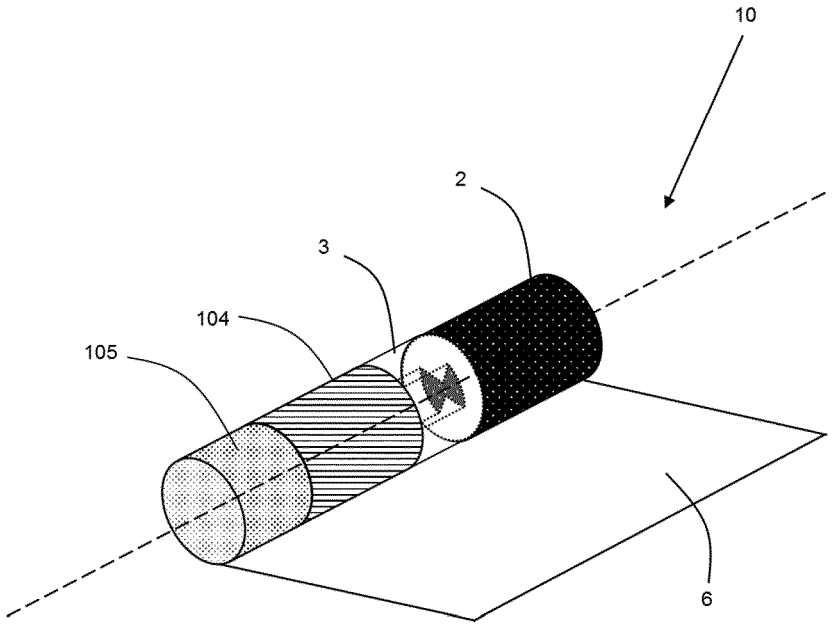


Figure 2

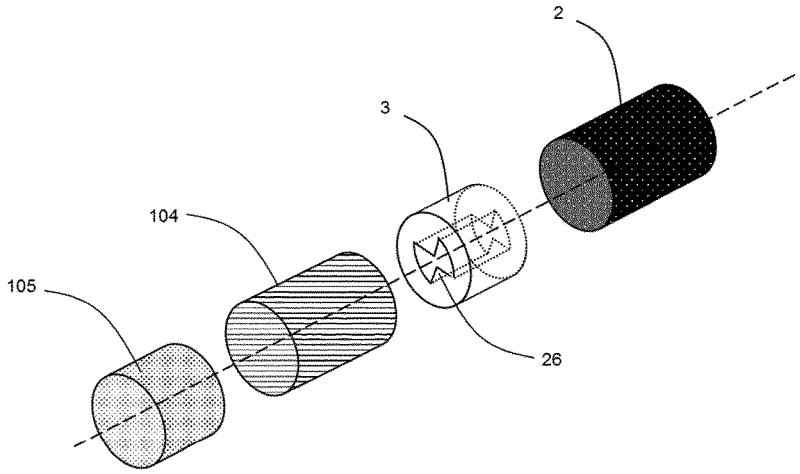


Figure 3

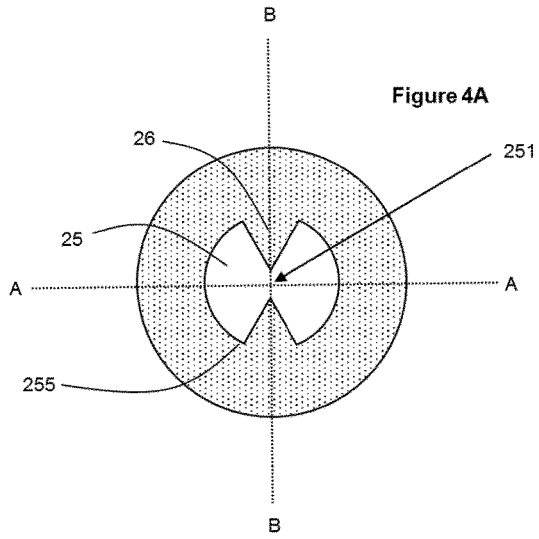


Figure 4A

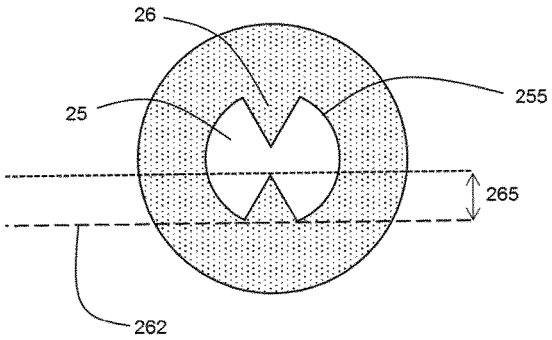


Figure 4B

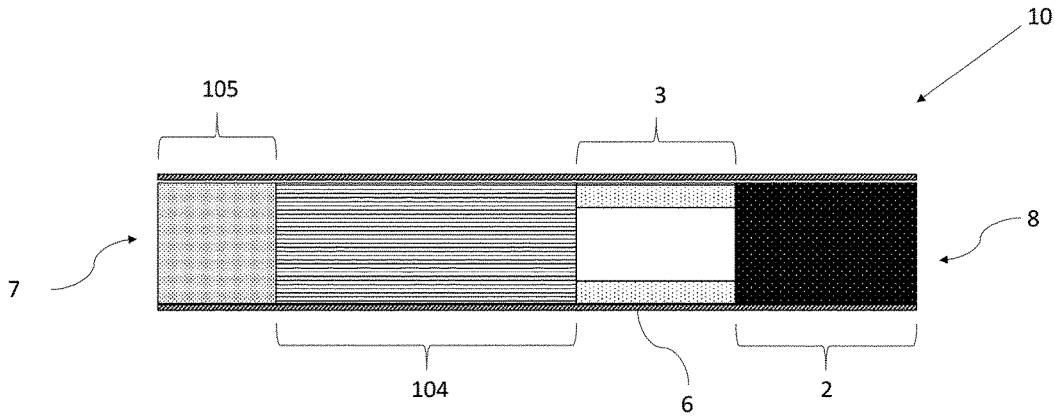


Figure 5A

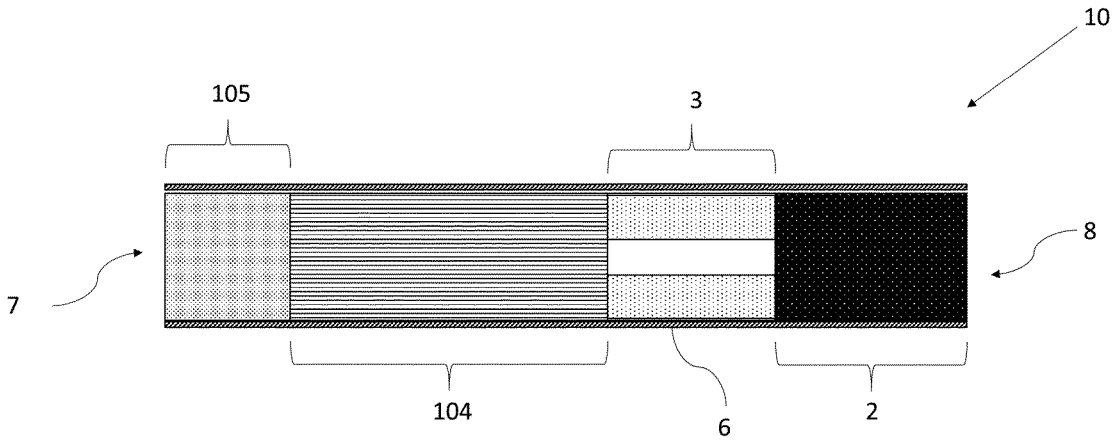


Figure 5B

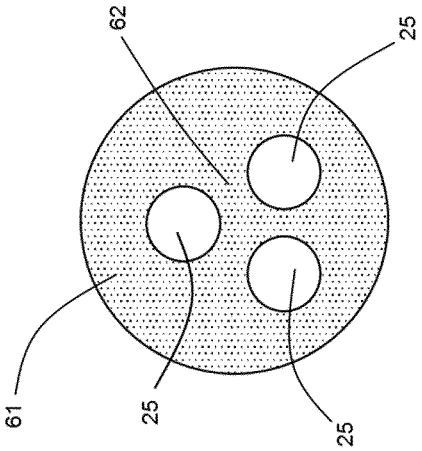


Figure 8

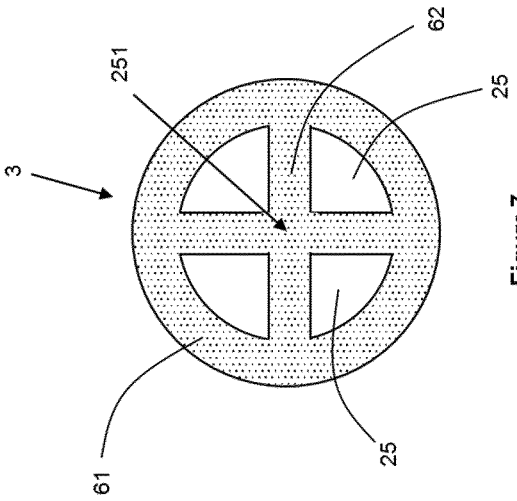


Figure 7

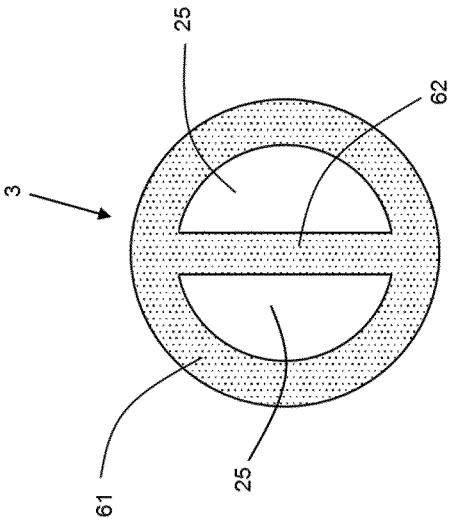


Figure 6

SUPPORT ELEMENT FOR AEROSOL GENERATING ARTICLE

[0001] The present invention relates to an aerosol-generating article comprising an aerosol-forming substrate for generating an inhalable aerosol when heated.

[0002] Aerosol-generating articles in which an aerosol-forming substrate, such as a tobacco containing substrate, is heated rather than combusted are known in the art. The aim of such heated aerosol-generating articles is to reduce known harmful smoke constituents produced by the combustion and pyrolytic degradation of tobacco in conventional cigarettes.

[0003] A conventional cigarette is lit when a user applies a flame to one end of the cigarette and draws air through the other end. The localised heat provided by the flame and the oxygen in the air drawn through the cigarette causes the end of the cigarette to ignite, and the resulting combustion generates an inhalable smoke. By contrast in heated aerosol-generating articles, an inhalable aerosol is typically generated by the transfer of heat from a heat source to a physically separate aerosol-forming substrate or material, which may be located within, around or downstream of the heat source. During consumption, volatile compounds are released from the aerosol-forming substrate by heat transfer from the heat source and entrained in air drawn through the aerosol-generating article. As the released compounds cool, they condense to form an aerosol that is inhaled by the consumer.

[0004] In one group of aerosol-generating articles, the aerosol-forming substrate is heated by a heater blade of an aerosol-generating device, which is inserted into the substrate. In such articles, a support element is included immediately downstream of the aerosol-forming substrate. The support element is provided in the form of an annular shaped tube of filtration material, often referred to as a hollow acetate tube. The support element is configured to resist downstream movement of the aerosol-forming substrate during insertion of the heating blade of the aerosol-generating device into the aerosol-forming substrate. The empty space within the hollow support element provides an opening for aerosol to flow from the aerosol-forming substrate towards the mouth end of the aerosol-generating article.

[0005] However, there may be inconsistencies in the experience that such aerosol-generating articles provide to consumers. In particular, the existence of the opening in the hollow support element means that some of the material in the aerosol-forming substrate can be undesirably pushed into the support element, when the heater blade is inserted into the aerosol-forming substrate. This can lead to different amounts of aerosol-forming substrate being heated by the heater blade, and different resistances to draw being experienced by a consumer, when the articles are used. Such differences can lead to an inconsistent experience for consumers.

[0006] It would therefore be desirable to provide an aerosol-generating article, which is less likely to suffer from inconsistencies.

[0007] According to a first aspect of the invention, there is provided an aerosol-generating article comprising: an aerosol-forming substrate; and a hollow tubular support element disposed immediately downstream of the aerosol-forming substrate. The hollow tubular support element defines an opening for aerosol to flow from the aerosol-forming substrate towards the mouth end of the article. At least a portion of the material of the hollow tubular support element inwardly projects into the opening to define one or more internal projections. The one or more internal projections can provide a support barrier for at least part of the aerosol-forming substrate.

[0008] In contrast to prior art aerosol-generating articles, the aerosol-generating article of the first aspect of the present invention comprises a hollow tubular support element having at least one projection that inwardly projects into its opening. The at least one projection acts to provide a support barrier for at least part of the aerosol-forming substrate. This can reduce the availability of free space for material from the aerosol-forming substrate to be pushed into, when, for example, a heater blade is inserted into the aerosol-forming substrate. Put another way, the at least one projection can provide a support barrier, which prevents or restricts downstream movement of at least part of the aerosol-forming substrate. Consequently, in the first aspect of the present invention, it is less likely that portions of aerosol-forming material will be pushed out of the aerosol forming substrate, when the article is being used. This can lead to a more consistent experience for a user.

[0009] Furthermore, because the support barrier of the hollow tubular support element is provided in the form of one or more internal projections, the support element can still retain a suitably sized opening for aerosol to flow from the aerosol-forming substrate towards the mouth end of the article. This means that the support element can still have a suitably low resistance to draw. This also means that the support element can still have a suitably low filtration effect.

[0010] Accordingly, the first aspect of the present invention provides an aerosol-generating article having improved consistency over known aerosol-generating articles, whilst also benefiting from some of the desired properties of such articles.

[0011] In the first aspect of the present invention, the hollow tubular support element is preferably formed from an elastically deformable material. Therefore, there may be provided an aerosol-generating article comprising: an aerosol-forming substrate; and a hollow tubular support element disposed immediately downstream of the aerosol-forming substrate, the hollow tubular support element being formed from an elastically deformable material. The hollow tubular support element defines an opening for aerosol to flow from the aerosol-forming substrate towards the mouth end of the article. At least a portion of the material of the hollow tubular support element inwardly projects into the opening to define one or more internal projections. The one or more internal projections can provide a support barrier for at least part of the aerosol-forming substrate.

[0012] This may provide a number of advantages, particularly in the context of aerosol-generating articles which are heated by virtue of a heater that is inserted into an aerosol-forming substrate portion of the article. For example, by forming the support element from an elastically deformable material, the barrier is able to deform slightly as a heater element, such as a heater blade is inserted into the aerosol-generating article. This can help to reduce the likelihood of damage being caused to the heater element by the barrier, as the heater element is inserted into the aerosol-generating article. An inwardly projecting, yet also elastically deformable support barrier, can therefore provide an optimal balance between preventing major damage or alteration to the aerosol-forming substrate, whilst also avoiding damaging the heater element of an aerosol-generating device.

[0013] The present invention is particularly suited to aerosol-generating articles having an aerosol-forming substrate in the form of a rod, which is configured to receive one or more heater blades. Such aerosol-forming substrates may have a number of suitable configurations. In some particularly preferred embodiments, the aerosol-forming substrate is in the form of a rod comprising a gathered sheet of aerosol-forming material, for example a gathered sheet of homogenised tobacco, or a gathered sheet comprising a nicotine salt and an aerosol former.

[0014] The opening in the hollow tubular portion provides an internal passageway for aerosol to flow from the aerosol-forming substrate towards the mouth end of the article. The opening preferably extends through the entire length of the hollow tubular support element, in the longitudinal direction of the aerosol-generating article. This can allow aerosol to pass unimpeded from the upstream end of the hollow tubular support element to the downstream end of the hollow tubular support element.

[0015] Preferably, the cross sectional area of the opening of the hollow tubular support element does not change along the entire length of the opening. In this case, preferably the projections reside along the entire length of the hollow tubular support element. That is, the at least one projection extends into the opening along the entire length of the opening. This may help to ease the manufacture of the hollow tubular support element. Alternatively, in some embodiments the cross sectional area of the opening of the hollow tubular support element changes along the length of the opening. For example, the opening of the hollow tubular support element may taper, such that it has a smaller cross sectional area at one end of the hollow tubular support element. As another example, the projections may only reside along a certain longitudinal part or parts of the hollow tubular support element. In this case, the projections may not reside at the downstream end of the hollow tubular support element, but instead reside at the upstream end of the hollow tubular support element. Preferably, the at least one projection extends into the opening at least at the upstream end portion of the hollow tubular support element. More preferably, the at least one projection extends into the opening at least at the upstream end face of the hollow tubular support element. This could enable the opening of the hollow tubular support element to have a more conventional shape (such as a circular shape) at its downstream end, whilst still benefiting from the advantages provided by the at least one projection, described above.

[0016] The length of the opening is measured in the longitudinal direction of the aerosol generating article.

[0017] The opening may only extend partially along the length of the hollow tubular support element. That is, the opening may extend from the upstream end of the hollow tubular support element to a point within the hollow tubular support element that is between the upstream and downstream ends of the hollow tubular support element. In such embodiments, the section of the hollow tubular support element that is disposed downstream of the opening is preferably porous. This can allow aerosol to continue to flow from the downstream end of the opening towards the mouth end of the article.

[0018] The at least one projection may have any suitable profile as viewed from the upstream end of the hollow tubular support element. In particular, the opening can have a perimeter as viewed from the upstream end of the hollow tubular support element. When viewed from the upstream end of the hollow tubular support element, each projection is delimited by a first portion of the perimeter and an imaginary straight line that intersects each end of the first portion of the perimeter. Preferably, the distance between the imaginary straight line and the point on the first portion of the perimeter furthest from the imaginary straight line, in a direction perpendicular to the imaginary straight line, is at least about 1 millimetre, more preferably, at least about 2 millimetres. Each projection may therefore have straight or curved side portions, as viewed from the upstream end of the hollow tubular support element. Each projection may have a pointed or rounded tip, as viewed from the upstream end of the hollow tubular support element. The upstream end of the hollow tubular support element is the end which abuts the aerosol-forming substrate.

[0019] Preferably, the shape of the opening has at least one degree of bilateral symmetry as viewed from the upstream end of the hollow tubular support element. Preferably, the shape of the opening has radial symmetry as viewed from the upstream end of the hollow tubular support element.

[0020] The hollow tubular support element may have only one projection. This can reduce the complexity of manufacturing the hollow tubular support element.

[0021] Alternatively, in some preferred embodiments, the hollow tubular support element comprises two or more projections that inwardly project into the opening. In such embodiments, preferably, two or more of the projections are uniformly disposed around the opening. For example, the hollow tubular support element may comprise two projections diametrically opposed around the opening. As another example, the hollow tubular support element may comprise three projections disposed around the opening, with each projection being disposed at the tip of an imaginary equilateral triangle, as viewed from the upstream end of the hollow tubular support element. This uniform distribution can enhance the effectiveness of the projections providing a barrier for the aerosol-forming substrate, whilst also allowing for a suitably sized opening for aerosol to flow.

[0022] The hollow tubular support element of the first aspect of the present invention acts to provide a support barrier for the aerosol-forming substrate, because the support element has one or more projections that extend inwardly into its opening. It is known to heat articles having an aerosol-forming substrate in the form of a cylindrical rod, with an aerosol-generating device having a heater blade. The heater blade is inserted into the rod during use. In such arrangements, it is normally desirable for the heater blade to be located centrally within the rod to optimise its interaction with the aerosol-forming material. Accordingly, it preferably for the one or more projections of the present invention to extend into the opening to a location close to the centre of the hollow tubular support element. This can enable the support barrier to reside at a radial location that is close to the radial location that the heater blade resides, when it is inserted into the aerosol forming rod. This can be particularly advantageous to ensure that minimal material is pushed by the heater blade into the opening of the hollow tubular support element, when in use.

[0023] Accordingly, preferably at least one of the projections extends towards the radial centre of the hollow tubular support element.

[0024] Preferably, the tip of at least one projection is located from the radial centre of the hollow tubular support

element by a distance of less than 40 percent, more preferably less than 30 percent, even more preferably less than 23 percent of the radius of the hollow tubular support element. It will be appreciated that this covers at least the following three sets of embodiments. Firstly, it covers embodiments where the projection does not extent through the radial centre of the hollow tubular support element. Secondly, it covers embodiments where the tip of the projection resides at the radial centre of the hollow tubular support element. Thirdly, it covers arrangements where the projection has extended through the radial centre of the hollow tubular support element, but where the tip of said projection is spaced from or extends beyond the radial centre of the hollow tubular support element by a distance of less than 40 percent of the radius of the hollow tubular support element.

[0025] In some particularly preferred embodiments, the tip of at least one projection is located from the radial centre of the hollow tubular support element by a distance of less than 20 percent of the radius of the hollow tubular support element.

[0026] The first aspect of the present invention involves an appreciation that there is an advantage of having material of the hollow tubular support element reside at, or close to, the radial centre of the hollow tubular support element. This is because such material can provide a support barrier for the aerosol-forming substrate. The first aspect of the present invention achieves this advantage by having one or more projection of material extend inwardly into the opening of the hollow tubular support element.

[0027] However, the present disclosure also recognises that this advantage may be achieved without a tipped projection per se, but instead by having at least some material of the hollow tubular support element extend through the radial centre of the hollow tubular support element, whilst still retaining one or more openings in the hollow tubular support element for aerosol to flow through.

[0028] Therefore, according to a second aspect of the invention, there is provided an aerosol-generating article comprising: an aerosol-forming substrate in the form of a rod comprising a gathered sheet of aerosol-forming material; and a hollow tubular support element disposed immediately downstream of the aerosol-forming substrate. The hollow tubular support element comprises: a peripheral portion of material that extends around the periphery of the hollow tubular support element; and an inner portion of material that extends from at least a first point on the peripheral portion to at least a second point on the peripheral portion through the radial centre of the hollow tubular support element. The peripheral and inner portions together define at least two openings in the hollow tubular support element for aerosol to flow from the aerosol-forming substrate towards the mouth end of the article.

[0029] Thus, the hollow tubular support element of the second aspect of the invention could be considered similar to a hollow tubular support element of the first aspect of the invention, where two or more projections have joined or merged together to form a bridge of material passing through the radial centre of the hollow tubular support element.

[0030] As used herein, 'radial centre' refers to the central point in a cross section of the hollow tubular support element, as taken orthogonally to the longitudinal direction of the hollow tubular support element. The cross section is taken at a point along which the projection or inner portion of material resides. This point is preferably the upstream end of the hollow tubular support element.

[0031] The second aspect of the invention can therefore benefit from many of the advantages and preferred features described above in relation to the first aspect of the invention. In particular, the inner portion of material of the hollow tubular support element can advantageously act as a support barrier for the aerosol-forming substrate. The at least two openings defined in the empty space between the inner and peripheral portion of material of the hollow tubular support element can ensure that support element can still have a suitably low resistance to draw. They can also ensure that the support element can still have a suitably low filtration effect.

[0032] Accordingly, the second aspect of the present invention provides an aerosol-generating article having improved consistency over known aerosol-generating articles, whilst also benefiting from some of the desired properties of such articles.

[0033] In the second aspect of the present invention, the hollow tubular support element is preferably formed from an elastically deformable material. Therefore, there may be provided an aerosol-generating article comprising: an aerosol-forming substrate in the form of a rod comprising a gathered sheet of aerosol-forming material; and a hollow tubular support element disposed immediately downstream of the aerosol-forming substrate, the hollow tubular support element being formed from an elastically deformable material. The hollow tubular support element comprises: a peripheral portion of material that extends around the periphery of the hollow tubular support element; and an inner portion of material that extends from at least a first point on the peripheral portion to at least a second point on the peripheral portion through the radial centre of the hollow tubular support element. The peripheral and inner portions together define at least two openings in the hollow tubular support element for aerosol to flow from the aerosol-forming substrate towards the mouth end of the article

[0034] This may provide a number of advantages, particularly in the context of aerosol-generating articles which are heated by virtue of a heater that is inserted into an aerosol-forming substrate portion of the article. For example, by forming the support element from an elastically deformable material, the inner portion of material of the hollow tubular support element is able to deform slightly as a heater element, such as a heater blade is inserted into the aerosol-generating article. This can help to reduce the likelihood of damage being caused to the heater element by the inner portion, as the heater element is inserted into the aerosol-generating article. A support element having such an elastically deformable inner portion, can therefore provide an optimal balance between preventing major damage or alteration to the aerosol-forming substrate, whilst also avoiding damaging the heater element of an aerosol-generating device.

[0035] In the second aspect of the invention, the peripheral portion can be substantially annular shaped. For example, it can be in the form of an annular shaped tube of filtration material, similar to the shape of hollow tubular support elements known in the art.

[0036] The inner portion of material can have the form of one or more bars which extend across the space within the peripheral portion, with at least one bar extending through the radial centre of the hollow tubular support element. For example, the inner portion may consist of a single bar

extending across the space within the peripheral portion and through the radial centre of the hollow tubular support element. In such an embodiment, the inner portion and peripheral portion define two openings in the empty space between their edges. Each opening may have a semi-circular shape, as viewed from the upstream end of the hollow tubular support element.

[0037] In another embodiment, the inner portion may consist of two bars, each extending across the space within the peripheral portion and through the radial centre of the hollow tubular support element. In such an embodiment, the inner portion and peripheral portion define four openings in the empty space between their edges. If the two bars are orthogonal to one another, each opening may have a quadrant shape, as viewed from the upstream end of the hollow tubular support element.

[0038] In another embodiment, the inner portion may not have a distinct bar shape, as viewed from the upstream end of the hollow tubular support element. Instead, the hollow tubular support element may have two or more elliptical shaped openings, with the inner portion and peripheral portions together providing the material that surrounds said elliptical shaped openings. The elliptical shaped openings may be circular shaped openings.

[0039] As noted above, preferred features described above in relation to the first aspect of the invention, may equally be applicable to the second aspect of the invention. For example, the at least two openings in the hollow tubular support element of the second aspect of the invention may have one or more of the features described above in relation to the first aspect of the invention. In particular, preferably the cross sectional area or areas of the at least two openings of the hollow tubular support element do not change along the entire length of the hollow tubular support element. In this case, preferably the inner portion of material resides along the entire length of the hollow tubular support element. This may help to ease the manufacture of the hollow tubular support element. Alternatively, in some embodiments the cross sectional area or areas of the at least two openings of the hollow tubular support element may change along the length of the opening. For example, the each or all of the openings of the hollow tubular support element may taper, such that they have a smaller cross sectional area at one end of the hollow tubular support element.

[0040] Preferably, the inner portion of material resides at least at the upstream end portion of the hollow tubular support element. More preferably, the inner portion of material resides at least at the upstream end face of the hollow tubular support element. This could enable the opening of the hollow tubular support element to have a more conventional shape (such as a circular shape) at its downstream end, whilst still benefiting from the advantages provided by the inner portion of material, described above.

[0041] The hollow tubular support element of the first or second aspects of the invention may be formed from any suitable material. Preferably, the hollow tubular support element is formed from an elastically deformable material. For example, the hollow tubular support element may be formed from foamed material or rubber. Preferably, the elastically deformable material of the hollow tubular support element comprises fibrous filtration material. The fibrous filtration material may comprise cellulose based fibers, such as cellulose acetate fibers. In such embodiments, the hollow tubular support element may be understood to be a type of hollow acetate tube.

[0042] Preferably, the material of the hollow tubular support element is porous. This can allow aerosol that is formed at the aerosol forming substrate to also pass through the material of the hollow tubular support element as it flows towards the mouth end of the article. In particular, such a porous structure can mean that the hollow tubular support element can contribute a very low amount or substantially no resistance to draw (RTD). A porous hollow tubular support element having the structure of the first or second aspects of the present invention can therefore advantageously ensure that there is a sufficient barrier for the aerosol-forming substrate, whilst also ensuring that aerosol can largely flow unimpeded from the aerosol-forming substrate through the support element. Put another way, the porous structure of the hollow tubular support element can help to enhance the amount of aerosol that is delivered to a consumer.

[0043] The hollow tubular support element may therefore have resistance to draw of less than about 0.1 mm H_2O per millimetre length, more preferably less than about 0.05 mm H_2O per millimetre length, and even more preferably less than about 0.01 mm H_2O per millimetre length.

[0044] Where the hollow tubular support element is formed of fibrous filtration material, a plasticiser may be added to the fibrous filtration material to adjust the elastic properties of the hollow tubular support element. Such plasticisers include triacetin, and triethylenglycol di-acetate. Where a plasticiser is included in the hollow tubular support element, preferably the plasticiser is included in an amount of from about 13 percent weight to about 25 percent weight of the total weight of the hollow tubular support element.

[0045] Preferably, the hollow tubular support element has a length in the longitudinal direction of the mouthpiece of from about 4 millimetres to about 26 millimetres, more preferably about 6 millimetres to about 21 millimetres, most preferably about 8 millimeters.

[0046] The aerosol generating article preferably comprises a filter segment. Preferably, the filter segment is located at the mouth end of the rod. Preferably the filter segment is in the form of a plug. Preferably, the filter segment comprise fibres. Preferably, the fibres of the filter segment comprise cellulose acetate.

[0047] Preferably, the filter segment has a resistance to draw of from about 0.4 mm H_2O to about 3 mm H_2O per millimetre length. Preferably, the aerosol-generating article has a total resistance to draw of from about 0.6 mm H_2O to about 1.5 mm H_2O per millimetre length, more preferably of from about 0.8 mm H_2O to about 1.2 mm H_2O per millimetre length.

[0048] An aerosol-cooling element may be located downstream of the aerosol-forming substrate, for example an aerosol-cooling element may be located immediately downstream of a support element, and may abut the support element.

[0049] As used herein, 'aerosol-cooling element' refers to a component of an aerosol-generating article located downstream of the aerosol-forming substrate such that, in use, an aerosol formed by volatile compounds released from the aerosol-forming substrate passes through and is cooled by the aerosol cooling element before being inhaled by a user. Preferably, the aerosol-cooling element is positioned

between the aerosol-forming substrate and the mouthpiece. An aerosol cooling element has a large surface area, but causes a low pressure drop. Filters and other mouthpieces that produce a high pressure drop, for example filters formed from bundles of fibres, are not considered to be aerosol-cooling elements. Chambers and cavities within an aerosol-generating article are not considered to be aerosol cooling elements.

[0050] As used herein, the term 'rod' is used to denote a generally cylindrical element of substantially circular, oval or elliptical cross-section.

[0051] The plurality of longitudinally extending channels may be defined by a sheet material that has been crimped, 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. 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.

[0052] As used herein, the term 'sheet' denotes a laminar element having a width and length substantially greater than the thickness thereof.

[0053] As used herein, the term 'longitudinal direction' refers to a direction extending along, or parallel to, the cylindrical axis of a rod.

[0054] 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.

[0055] 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.

[0056] Alternatively, the aerosol-generating article may not have an aerosol-cooling element. In this case, the filter segment may be located immediately downstream of the aerosol-forming substrate, or immediately downstream of the support element (if present). A cavity may be provided in the aerosol-generating article between the filter segment and the aerosol-forming substrate, or between the filter segment and the support element (if present). The cavity preferably extends from the aerosol-generating substrate to the filter segment, or from the support element (if present) to the filter segment.

[0057] The aerosol-cooling element may have a total surface area of between approximately 300 square millimetres per millimetre length and approximately 1000 square millimetres per millimetre length. In a preferred embodiment, the aerosol-cooling element has a total surface area of approximately 500 square millimetres per millimetre length. In some embodiments, the aerosol-cooling element may have a substantially circular cross-section and a diameter of about 5 mm to about 10 mm. For example, an aerosol-cooling element may have a diameter of about 7 mm.

[0058] The aerosol-cooling element may be alternatively termed a heat exchanger.

[0059] The aerosol-cooling element preferably has a low resistance to draw. That is, the aerosol-cooling element preferably offers a low resistance to the passage of air through the aerosol-generating article. Preferably, the aerosol-cooling element does not substantially affect the resistance to draw of the aerosol-generating article.

[0060] The aerosol-cooling element may comprise a plurality of longitudinally extending channels. The plurality of longitudinally extending channels may be defined by a sheet material that has been one or more of crimped, pleated, gathered and folded to form the channels. The plurality of longitudinally extending channels may be defined by a single sheet that has been one or more of crimped, pleated, gathered and folded to form multiple channels. The plurality of longitudinally extending channels may be defined by multiple sheets that have been one or more of crimped, pleated, gathered and folded to form multiple channels.

[0061] The aerosol-cooling element may comprise a gathered sheet of material selected from the group consisting of metallic foil, polymeric material, and substantially non-porous paper or cardboard. In some embodiments, the aerosol-cooling element may comprise a gathered sheet of 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.

[0062] Preferably, the aerosol-cooling element comprises a gathered sheet of biodegradable material. For example, a gathered sheet of non-porous paper or a gathered sheet of biodegradable polymeric material, such as polylactic acid or a grade of Mater-Bi® (a commercially available family of starch based copolyesters).

[0063] In a particularly preferred embodiment, the aerosol-cooling element comprises a gathered sheet of polylactic acid.

[0064] The aerosol-cooling element may be formed from a gathered sheet of material having a specific surface area of between approximately 10 square millimetres per milligram and approximately 100 square millimetres per milligram weight. In some embodiments, the aerosol-cooling element may be formed from a gathered sheet of material having a specific surface area of approximately 35 mm2/mg.

[0065] The aerosol-generating article of the present invention comprises an aerosol-forming substrate. As used herein, the term 'aerosol-forming substrate' relates to a substrate capable of releasing volatile compounds that can form an aerosol. Such volatile compounds may be released by heating the aerosol-forming substrate. An aerosol-forming substrate may be adsorbed, coated, impregnated or otherwise loaded onto a carrier or support. An aerosol-forming substrate may conveniently be part of an aerosol-generating article or smoking article.

[0066] The aerosol-generating article of the present invention may be configured for use with an aerosol-generating device. As used herein, an 'aerosol-generating device' relates to a device that interacts with an aerosol-forming substrate to generate an aerosol.

[0067] Preferably, the aerosol-forming substrate comprises plant material and an aerosol former. Preferably, the plant material is a plant material comprising an alkaloid, more preferably a plant material comprising nicotine, and more preferably a tobacco-containing material.

[0068] Preferably, the aerosol-forming substrate comprises at least 70 percent of plant material, more preferably at least 90 percent of plant material by weight on a dry weight basis. Preferably, the aerosol-forming substrate com-

prises less than 95 percent of plant material by weight on a dry weight basis, such as from 90 to 95 percent of plant material by weight on a dry weight basis.

[0069] Preferably, the aerosol-forming substrate comprises at least 5 percent of aerosol former, more preferably at least 10 percent of aerosol former by weight on a dry weight basis. Preferably, the aerosol-forming substrate comprises less than 30 percent of aerosol former by weight on a dry weight basis, such as from 5 to 30 percent of aerosol former by weight on a dry weight basis.

[0070] In some particularly preferred embodiments, the aerosol-forming substrate comprises plant material and an aerosol former, wherein the substrate has an aerosol former content of between 5% and 30% by weight on a dry weight basis. The plant material is preferably a plant material comprising an alkaloid, more preferably a plant material comprising nicotine, and more preferably a tobacco-containing material. Alkaloids are a class of naturally occurring nitrogen-containing organic compounds. Alkaloids are found mostly in plants, but are also found in bacteria, fungi and animals. Examples of alkaloids include, but are not limited to, caffeine, nicotine, theobromine, atropine and tubocurarine. A preferred alkaloid is nicotine, which may be found in tobacco.

[0071] An aerosol-forming substrate may comprise nicotine. An aerosol-forming substrate may comprise tobacco, for example may comprise a tobacco-containing material containing volatile tobacco flavour compounds, which are released from the aerosol-forming substrate upon heating. In preferred embodiments an aerosol-forming substrate may comprise homogenised tobacco material, for example cast leaf tobacco. The aerosol-forming substrate may comprise both solid and liquid components. The aerosol-forming substrate may comprise a tobacco-containing material containing volatile tobacco flavour compounds, which are released from the substrate upon heating. The aerosol-forming substrate may comprise a non-tobacco material. The aerosol-forming substrate may further comprise an aerosol former. Examples of suitable aerosol formers are glycerine and propylene glycol.

[0072] In some preferred embodiments, the aerosol-forming substrate may comprise a textured sheet of homogenised tobacco material with an aerosol former content of between 5% and 30% by weight on a dry weight basis. Use of a textured sheet of homogenised tobacco material may advantageously facilitate gathering of the sheet of homogenised tobacco material to form the aerosol-forming substrate.

[0073] As used herein, the term 'crimped sheet' 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 along or parallel to the longitudinal axis of the aerosol-generating article. This advantageously facilitates gathering of the crimped sheet of homogenised tobacco material to form the aerosol-forming substrate. However, it will be appreciated that crimped sheets of homogenised tobacco material for inclusion in the aerosol-generating article may alternatively or in addition have a plurality of substantially parallel ridges or corrugations that are disposed at an acute or obtuse angle to the longitudinal axis of the aerosol-generating article when the aerosol-generating article has been assembled.

[0074] The aerosol-forming substrate may be in the form of a plug comprising an aerosol-forming material circumscribed by a paper or other wrapper. Where an aerosol-forming substrate is in the form of a plug, the entire plug including any wrapper is considered to be the aerosol-forming substrate.

[0075] The aerosol-forming substrate of the present invention preferably comprises an aerosol former. As used herein, the term 'aerosol former' is used to describe any suitable known compound or mixture of compounds that, in use, facilitates formation of an aerosol and that is substantially resistant to thermal degradation at the operating temperature of the aerosol-generating article.

[0076] Suitable aerosol-formers are known in the art and include, but are not limited to: polyhydric alcohols, such as propylene glycol, triethylene glycol, 1,3-butanediol and glycerine; esters of polyhydric alcohols, such as glycerol mono-, di- or triacetate; and aliphatic esters of mono-, di- or polycarboxylic acids, such as dimethyl dodecanedioate and dimethyl tetradecanedioate. Preferred aerosol formers are polyhydric alcohols or mixtures thereof, such as propylene glycol, triethylene glycol, 1,3-butanediol and, most preferred, glycerine.

[0077] The aerosol-forming substrate may comprise a single aerosol former. Alternatively, the aerosol-forming substrate may comprise a combination of two or more aerosol formers.

[0078] Preferably, the aerosol-forming substrate is in the form of a rod comprising a gathered sheet of aerosol-forming material, for example a gathered sheet of homogenised tobacco, or a gathered sheet comprising a nicotine salt and an aerosol former.

[0079] Aerosol-forming substrates comprising gathered sheets of homogenised tobacco for use in the aerosol-generating article may be made by methods known in the art, for example the methods disclosed in WO 2012/164009 A2.

[0080] Preferably, the aerosol-forming substrate has an external diameter of at least 5 mm. The aerosol-forming substrate may have an external diameter of between approximately 5 mm and approximately 12 mm, for example of between approximately 5 mm and approximately 10 mm or of between approximately 6 mm and approximately 8 mm. In a preferred embodiment, the aerosol-forming substrate has an external diameter of 7.2 mm+/−10%.

[0081] The aerosol-forming substrate may have a length of between approximately 5 mm and approximately 15 mm, for example between about 8 mm and about 12 mm. In one embodiment, the aerosol-forming substrate may have a length of approximately 10 mm. In a preferred embodiment, the aerosol-forming substrate has a length of approximately 12 mm. Preferably, the aerosol-forming substrate is substantially cylindrical.

[0082] It will be appreciated that preferred features described above in relation to the first aspect of the invention may also be applicable to the second aspect of the invention.

[0083] The terms "upstream" and "downstream" refer to relative positions of elements of the smoking article or mouthpiece described in relation to the direction of mainstream smoke as it is drawn from the aerosol generating substrate and through the filter or mouthpiece.

[0084] As used herein, the term "longitudinal" refers to a direction parallel to the length of the aerosol-generating article.

[0085] Aerosol-generating articles according to the present invention may be filter cigarettes or other smoking articles in which an aerosol-generating substrate comprises

a tobacco material that is combusted to form smoke. Therefore, in any of the embodiments described above, the aerosol-generating substrate may comprise a tobacco rod. Furthermore, in any of the embodiments described above, the mouthpiece, if present, may be a filter. In such embodiments, the filter may be secured to the tobacco rod by a tipping paper.

[0086] Alternatively, aerosol-generating articles according to the present invention may preferably be articles in which a tobacco material is heated to form an aerosol, rather than combusted. In one type of heated aerosol-generating article, a tobacco material is heated by one or more electrical heating elements to produce an aerosol.

[0087] The invention will now be further described, by way of example only, with reference to the accompanying drawings in which:

[0088] FIG. **1** is a schematic cross-sectional diagram of a prior art aerosol-generating article, as taken along the longitudinal axis of the article;

[0089] FIG. **2** shows a partially transparent perspective view of an aerosol-generating article according to a first embodiment of the present invention, in an unwrapped configuration;

[0090] FIG. **3** shows an exploded view of some of the components of FIG. **2**;

[0091] FIGS. **4**A and **4**B show cross-sectional views of the upstream end face of the hollow tubular support element of FIG. **3**;

[0092] FIG. **5**A shows a cross-sectional diagram of the article of FIG. **2** as taken along plane A-A of FIG. **4**A;

[0093] FIG. **5**B shows a cross-sectional diagram of the article of FIG. **2** as taken along plane B-B of FIG. **4**A;

[0094] FIG. **6** shows a cross-sectional view of the upstream end face of a hollow tubular support element according to a second embodiment of the present invention;

[0095] FIG. **7** shows a cross-sectional view of the upstream end face of a hollow tubular support element according to a third embodiment of the present invention; and

[0096] FIG. **8** shows a cross-sectional view of the upstream end face of a hollow tubular support element according to a fourth embodiment of the present invention.

[0097] FIG. **1** illustrates a prior art aerosol-generating article **1**. The article **1** comprises four elements. The elements are: an aerosol generating substrate **2**, a hollow tubular support element **4**, an aerosol-cooling element **104** and a filter segment **105**. The hollow tubular support element **4** has an annular shaped peripheral region of material **41**, which surrounds an opening **25**. The opening extends from the upstream end of the hollow tubular support element **4** to its downstream end. Aerosol can flow unimpeded from the aerosol generating substrate **2** through the opening **25** towards the downstream end **7** of the article **1**.

[0098] The four elements are arranged sequentially and in coaxial alignment and are assembled by a cigarette paper **6** to form a rod. The rod has a mouth-end **7**, which a user inserts into his or her mouth during use, and a distal end **8** located at the opposite end of the rod to the mouth end **7**. Elements located between the mouth-end **7** and the distal end **8** can be described as being upstream of the mouth-end **7** or, alternatively, downstream of the distal end **8**. When assembled, the rod is 52 millimetres long and has a diameter of 7.2 millimetres. The filter segment **105** has a length of 8 millimetres and the aerosol-cooling element **104** has a length of 17 millimetres.

[0099] FIG. **2** illustrates an aerosol-generating article **10** according to a first embodiment of the present invention. The article differs from the prior art article **1** of FIG. **1**, in that two portions of the hollow tubular support element **3** of FIG. **2** inwardly projects into the opening **25** to define two internal projections **26**. These projections **26** provide a support barrier for at least part of the aerosol-forming substrate **2**. The hollow tubular support element **3** and its projections **26** can be best seen from the exploded view of FIG. **3**.

[0100] FIG. **4**A show cross-sectional views of the upstream end face of the hollow tubular support element **3** of FIG. **3**. As can be seen from FIG. **4**A, the projections **26** help to ensure that additional material resides close to the radial centre **251** of the hollow tubular support element **3**. This helps to provide a support barrier to reduce the likelihood of aerosol forming material being pushed into the opening of the support element **3**, when a heating blade is inserted into the aerosol forming substrate **2**. The opening helps to ensure that sufficient aerosol can pass unimpeded through the support element **3**.

[0101] As can be seen from FIG. **4**B, the opening **25** has a perimeter **255** as viewed from the upstream end face of the hollow tubular support element **3**. Each projection **26** of the hollow tubular support element **3** is delimited by a first portion of the perimeter and an imaginary straight line **262** that interests each end of the first portion of the perimeter. The distance **265** between the straight line **262** and the point on the first portion of the perimeter furthest from the straight line in a direction perpendicular to the straight line corresponds to the 'height' **265** of the projection **26**.

[0102] The reduction in the opening **25** that results from the projections **26** can be further appreciated from FIGS. **5**A and **5**B. In particular, the view of FIG. **5**A does not include the projections **26**. Consequently, the opening appears much wider, and more comparable to that of FIG. **1**. No material is provided near the radial centre **251** of the support element **3**. In contrast, the view of FIG. **5**B does include the projections. Consequently, the opening **25** appears much narrower, in comparison to that of FIG. **1**. This results in material of the support element being provided near the radial centre **251** of the support element **3**, and thus providing an effective support barrier for the aerosol forming substrate **2**.

[0103] FIG. **6** shows a cross-sectional view of the upstream end face of a hollow tubular support element according to a second embodiment of the present invention.

[0104] In this embodiment, the hollow tubular support element **3** comprises: a peripheral portion of material **61** that extends around the periphery of the hollow tubular support element **3**, and an inner portion of material **62**. The inner portion **62** extends from at least a first point on the peripheral portion **61** to at least a second point on the peripheral portion **61** through the radial centre **251** of the hollow tubular support element **3**. The peripheral and inner portions together define two openings **25** in the hollow tubular support element **3** for aerosol to flow from the aerosol-forming substrate **2** towards the mouth end of the article.

[0105] In the FIG. **6** embodiment, the inner portion **62** consists of a single bar extending across the space within the peripheral portion **61** and through the radial centre of the

hollow tubular support element. As a result, the inner portion and peripheral portion define two openings in the empty space between their edges. Each opening has a semi-circular shape, as viewed from the upstream end of the hollow tubular support element.

[0106] FIG. **7** shows a cross-sectional view of the upstream end face of a hollow tubular support element according to a third embodiment of the present invention. The third embodiment differs from the second embodiment, in that the inner portion **62** of the hollow tube now consists of two bars, each extending across the space within the peripheral portion **61** and through the radial centre **251** of the hollow tubular support element **3**. As a result, the inner portion and peripheral portion define four openings **25** in the empty space between their edges. In FIG. **7**, the two bars of the inner portion **62** are orthogonal to one another, such that each opening **25** has a quadrant shape, as viewed from the upstream end of the hollow tubular support element **3**.

[0107] FIG. **8** shows a cross-sectional view of the upstream end face of a hollow tubular support element according to a fourth embodiment of the present invention. The fourth embodiment differs from the second and third embodiment, in that the inner portion **62** does not have a distinct bar shape, as viewed from the upstream end of the hollow tubular support element **3**. Instead, the hollow tubular support element **3** has three elliptical shaped openings **25**, with the inner portion **62** and peripheral portions **61** together providing the material that surrounds said elliptical shaped openings **25**. The elliptical shaped openings **25** in this embodiment are circular shaped.

1.-**15**. (canceled)

16. An aerosol-generating article, comprising:

an aerosol-forming substrate; and

a hollow tubular support element comprising fibrous filtration material and being disposed immediately downstream of the aerosol-forming substrate,

wherein the hollow tubular support element defines an opening configured to allow aerosol to flow from the aerosol-forming substrate towards a mouth end of the aerosol-generating article, and

wherein at least a portion of the fibrous filtration material of the hollow tubular support element inwardly projects into the opening and defines at least one internal projection.

17. The aerosol-generating article according to claim **16**, wherein the opening extends through an entire length of the hollow tubular support element.

18. The aerosol-generating article according to claim **16**, wherein the at least one projection extends into the opening at least at an upstream end portion of the hollow tubular support element.

19. The aerosol-generating article according to claim **16**, wherein the hollow tubular support element comprises two or more projections that inwardly project into the opening, the two or more projections being uniformly disposed around the opening.

20. The aerosol-generating article according to claim **16**, wherein a tip of the at least one projection is located from a radial centre of the hollow tubular support element by a distance of less than 23 percent of a radius of the hollow tubular support element.

21. The aerosol-generating article according to claim **16**, wherein a tip of the at least one projection is located at a radial centre of the hollow tubular support element.

22. The aerosol-generating article according to claim **16**, wherein the at least one projection extends through a radial centre of the hollow tubular support element, and

wherein the tip of the at least one projection extends beyond the radial centre of the hollow tubular support element by a distance of less than 23 percent of a radius of the hollow tubular support element.

23. An aerosol-generating article, comprising:

an aerosol-forming substrate in a form of a rod; and

a hollow tubular support element comprising fibrous filtration material and being disposed immediately downstream of the aerosol-forming substrate,

wherein the hollow tubular support element further comprises:

a peripheral portion of material that extends around a periphery of the hollow tubular support element, and

an inner portion of material that extends from at least a first point on the peripheral portion to at least a second point on the peripheral portion through a radial centre of the hollow tubular support element, and

wherein the peripheral and the inner portions together define at least two openings in the hollow tubular support element configured to allow aerosol to flow from the aerosol-forming substrate towards a mouth end of the aerosol-generating article.

24. The aerosol-generating article according to claim **23**, wherein the peripheral portion of the material of the hollow tubular support element is substantially annular shaped.

25. The aerosol-generating article according to claim **23**, wherein the inner portion of the material comprises one or more bars, which extend across a space within the peripheral portion, with at least one bar extending through the radial centre of the hollow tubular support element.

26. The aerosol-generating article according to claim **23**, wherein the inner portion of the material resides at least at an upstream end portion of the hollow tubular support element.

27. The aerosol-generating article according to claim **16**, wherein the hollow tubular support element is formed from an elastically deformable material.

28. The aerosol-generating article according to claim **23**, wherein the hollow tubular support element is formed from an elastically deformable material.

29. The aerosol-generating article according to claim **16**, further comprising a filter segment at the mouth end of the aerosol-generating article.

30. The aerosol-generating article according to claim **23**, further comprising a filter segment at the mouth end of the aerosol-generating article.

31. The aerosol-generating article according to claim **16**, further comprising an aerosol-cooling element downstream of the hollow tubular support element.

32. The aerosol-generating article according to claim **23**, further comprising an aerosol-cooling element downstream of the hollow tubular support element.

33. An aerosol-generating system, comprising:

an aerosol-generating article according to claim **16**; and

an aerosol-generating device comprising a heater blade configured to be inserted into an aerosol-forming substrate of the aerosol-generating article.

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