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(54) **SMOKING ARTICLE WITH IMPROVED FLOW RESTRICTION ELEMENT**

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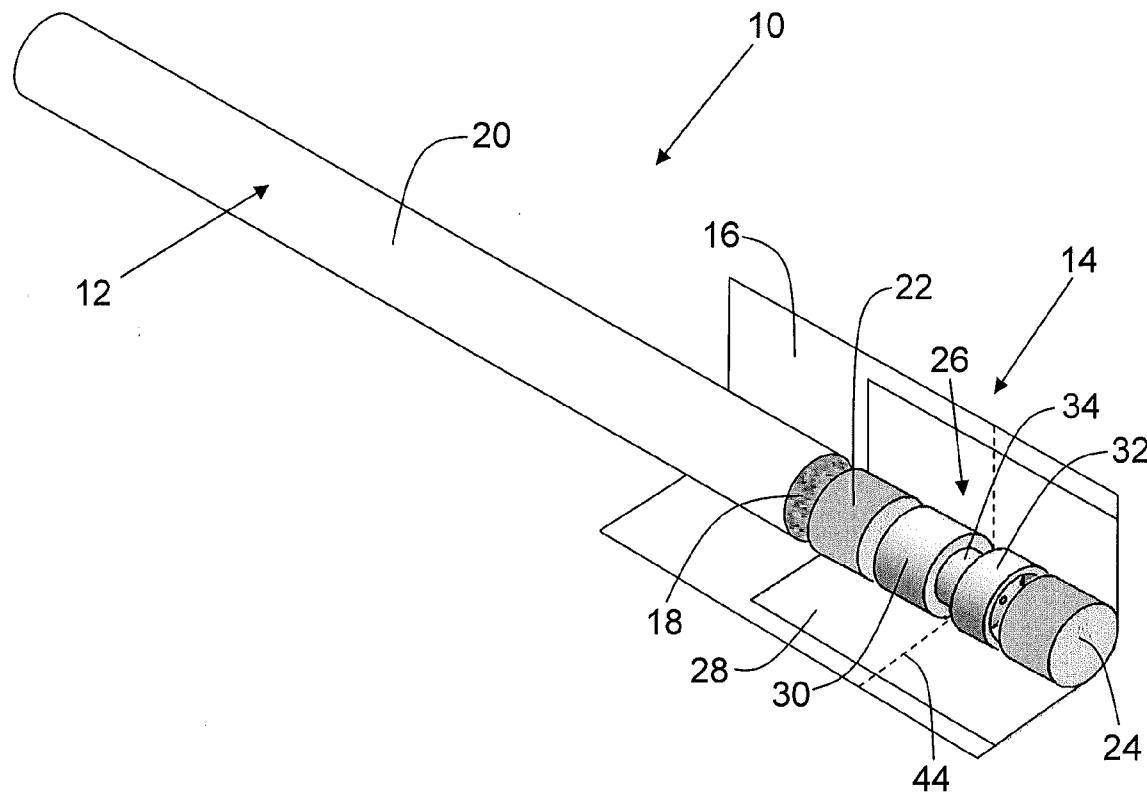
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(57) **ABSTRACT**

A smoking article includes a rod of smokable material and a filter including a flow restriction element attached to the rod of smokable material. The flow restriction element includes a first upstream integral tubular portion, a second downstream integral tubular portion of substantially the same external diameter as the first tubular portion, and a third central integral tubular portion located between the first and second tubular portions. The third tubular portion is of reduced external diameter compared to the first and second tubular portions. A transverse barrier having at least one orifice therein is disposed between a first upstream cavity at least partially defined by an inner periphery of the first tubular portion and a second downstream cavity at least partially defined by an inner periphery of the second tubular portion. A ventilation zone in communication with the second cavity is also provided at a location along the filter.



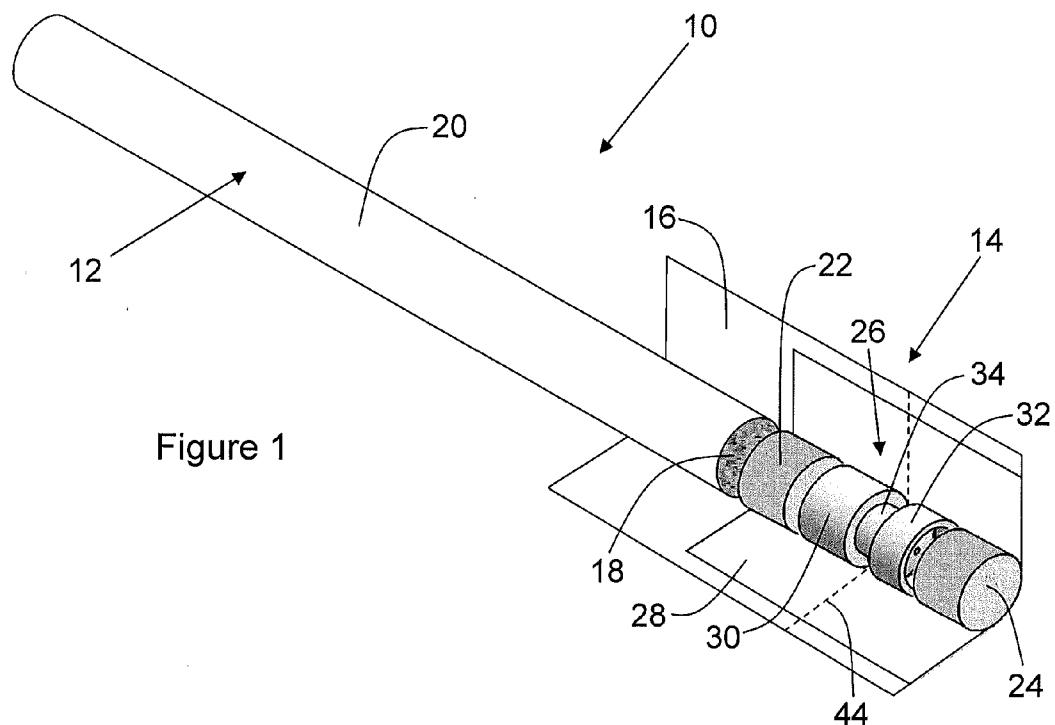


Figure 1

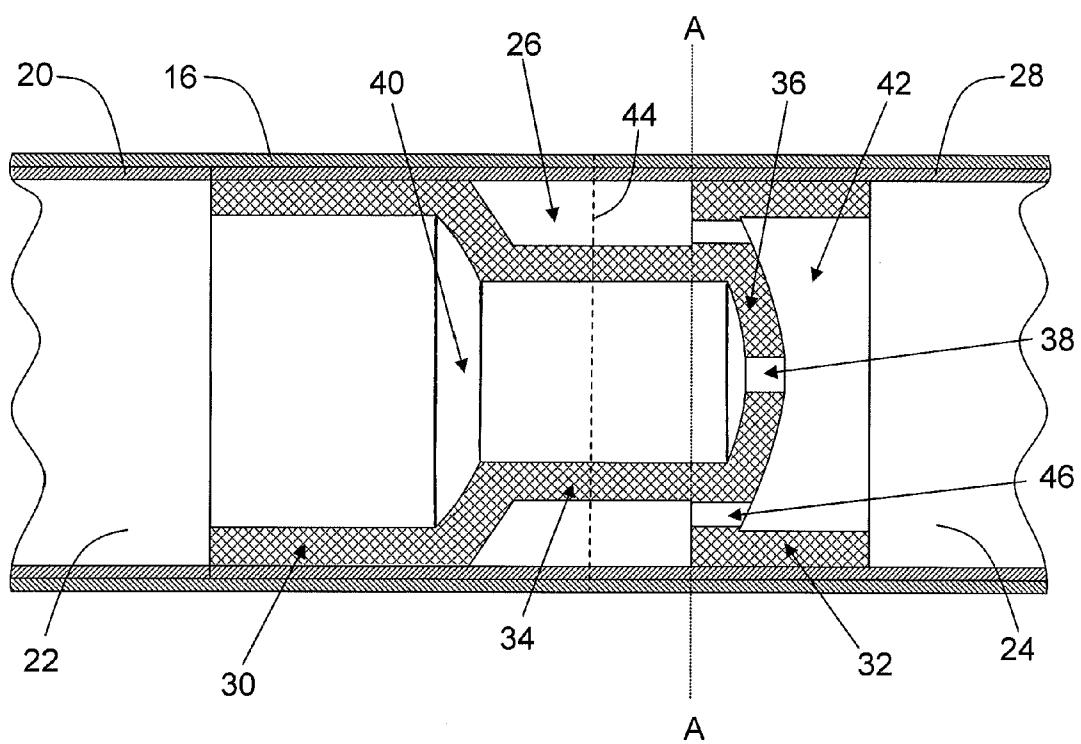


Figure 2

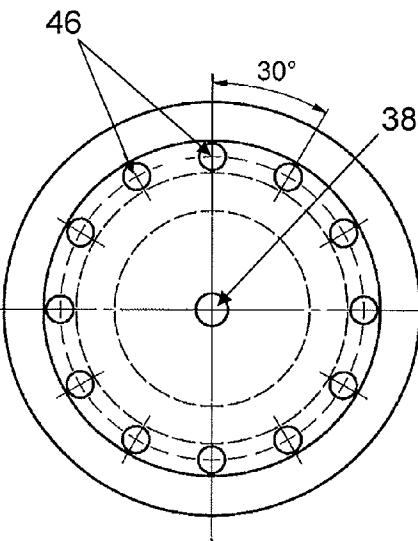


Figure 3

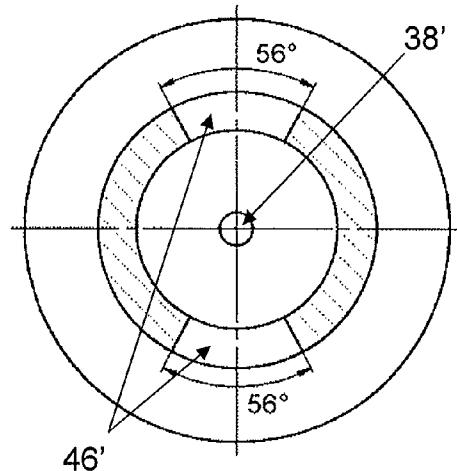


Figure 5

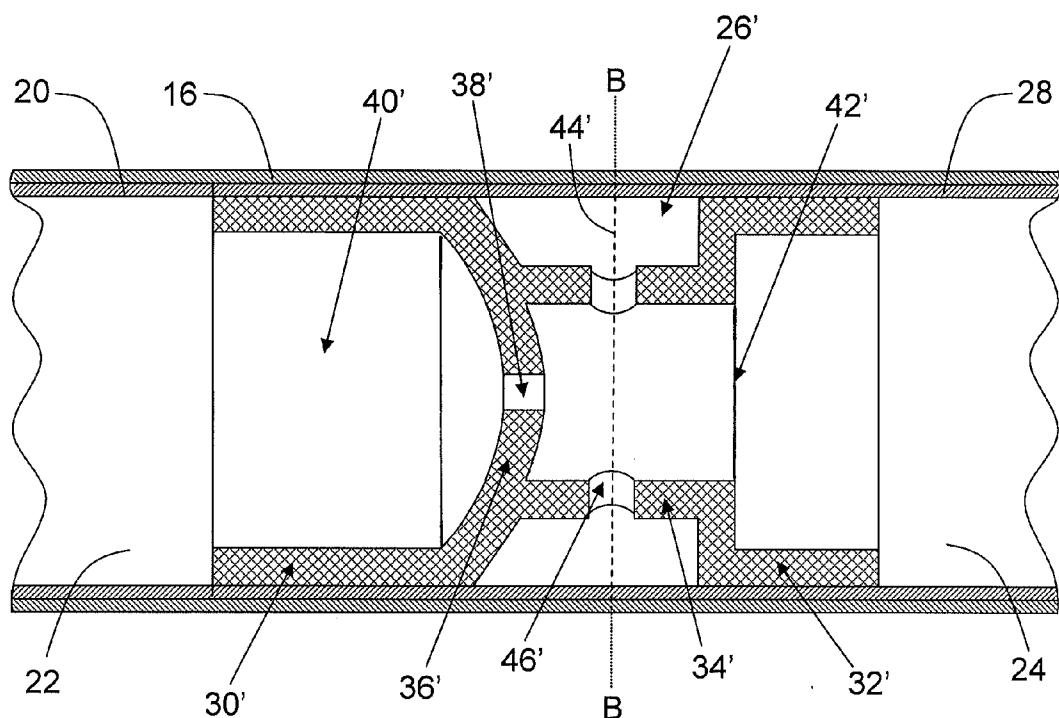


Figure 4

SMOKING ARTICLE WITH IMPROVED FLOW RESTRICTION ELEMENT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to European Application No. 09251336.5, filed May 18, 2009, the entire content of which is incorporated herein by this reference thereto.

BACKGROUND

[0002] In a number of jurisdictions there are regulations stipulating the maximum carbon monoxide, tar and nicotine yields for cigarettes.

[0003] It is known to provide cigarettes and other smoking articles with wrappers having a low permeability in order to reduce the sidestream smoke generated during smoking thereof. However, while advantageously reducing sidestream smoke, the inclusion of a low permeability wrapper may disadvantageously increase the carbon monoxide yields and hence carbon monoxide to tar ratios of the mainstream smoke generated by such smoking articles.

[0004] While ventilation may be used to reduce the carbon monoxide and tar deliveries, high levels of ventilation can disadvantageously result in unacceptably low levels of resistance to draw (RTD). Moreover, as ventilation reduces both gas phase and particulate phase deliveries, it has little effect on carbon monoxide to tar ratios.

[0005] The inclusion of, for example, one or more high density cellulose acetate filter segments may be used to increase the overall RTD of smoking articles with low permeability wrappers and high levels of ventilation to an acceptable level. However, high density cellulose acetate filter segments typically reduce tar deliveries while having little or no effect on carbon monoxide deliveries.

[0006] Therefore, it would be desirable to provide a smoking article having a sidestream smoke reducing wrapper and a carbon monoxide to tar ratio of less than or equal to 1.

SUMMARY

[0007] In a preferred embodiment, a smoking article includes a rod of smokable material and a filter including a flow restriction element attached to the rod of smokable material. Preferably, the flow restriction element includes a first upstream integral tubular portion, a second downstream integral tubular portion of substantially the same external diameter as the first tubular portion, a third central integral tubular portion located between the first and second tubular portions, the third tubular portion being of reduced external diameter compared to the first and second tubular portions, and a transverse barrier having at least one orifice provided therein. The transverse barrier is disposed between a first upstream cavity at least partially defined by an inner periphery of the first tubular portion and a second downstream cavity at least partially defined by an inner periphery of the second tubular portion. A ventilation zone in communication with the second cavity is included at a location along the filter.

[0008] In the preferred embodiment, the transverse barrier has a single substantially central orifice having a diameter ranging from about 0.4 mm to about 0.8 mm provided therein. Preferably, the filter is attached to the rod of smokable material by a band of tipping paper and the ventilation zone includes at least one circumferential row of perforations provided through a portion of the tipping paper overlying the

third tubular portion of the flow restriction element. Also preferably, the first cavity of the flow restriction element is at least partially defined by an inner periphery of the first and third tubular portions. Moreover, one or more openings are provided in an upstream transverse end surface of the second tubular portion that form a communication path between the second cavity and the at least one circumferential row of perforations. Also in the preferred embodiment, the second cavity of the flow restriction element is at least partially defined by an inner periphery of the second and third tubular portions. Preferably, one or more openings are provided in a circumferential surface of the third tubular portion that form a communication path between the second cavity and the at least one circumferential row of perforations. Also preferably, the filter further includes a first filter segment upstream of the flow restriction element and a second filter segment downstream of the flow restriction element. Moreover, the wrapper has a basis weight ranging from about 35 g/m² to about 60 g/m², a filler loading ranging from about 20 percent to about 50 percent by weight, a permeability ranging from about 2 Coresta units to about 18 Coresta units, and about 0.3 percent to about 5 percent by weight of a burn modifier. Preferably, the smoking article has a ventilation level of at least about 50 percent, preferably of at least about 60 percent. Also preferably, the flow restriction element is at least about 10 mm in length, more preferably at least about 13 mm in length. Moreover, the transverse barrier is concave relative to the direction of mainstream smoke drawn from the rod of smokable material through the filter. In the preferred embodiment, the smoking article has a carbon monoxide to tar ratio of less than or equal to 1.

[0009] In another embodiment, a flow restriction element includes a first integral tubular portion, a second integral tubular portion of substantially the same external diameter as the first tubular portion, a third central integral tubular portion located between the first and second tubular portions the third tubular portion being of reduced external diameter compared to the first and second tubular portions, a transverse barrier having at least one orifice provided therein, the transverse barrier being disposed between a first cavity at least partially defined by an inner periphery of the first tubular portion and a second cavity at least partially defined by an inner periphery of the second tubular portion, and one or more openings in a surface of the second or third tubular portion in communication with the second cavity.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The invention will be further described, by way of example only, with reference to the accompanying drawings.

[0011] FIG. 1 is an expanded perspective view of a smoking article according to a first embodiment of the invention with the tipping paper and filter plug wrap partially unfolded to reveal the internal components of the filter.

[0012] FIG. 2 is a partial longitudinal cross-sectional view of the filter of the smoking article of FIG. 1.

[0013] FIG. 3 is a transverse cross-sectional view of the flow restriction element of the filter of the smoking article of FIG. 2 along the line A-A (shown by a dotted line in FIG. 2).

[0014] FIG. 4 is a partial longitudinal cross-sectional view of the filter of a smoking article according to a second embodiment of the invention.

[0015] FIG. 5 is a transverse cross-sectional view of the flow restriction element of the filter of the smoking article of FIG. 4 along the line B-B (shown by a dotted line in FIG. 3).

DETAILED DESCRIPTION

[0016] In a preferred embodiment, a smoking article includes a rod of smokable material and a filter including a flow restriction element attached to the rod of smokable material. Preferably, the flow restriction element includes: a first upstream integral tubular portion; a second downstream integral tubular portion of substantially the same external diameter as the first tubular portion; and a third central integral tubular portion located between the first and second tubular portions, the third tubular portion being of reduced external diameter compared to the first and second tubular portions. A transverse barrier having at least one orifice provided therein is disposed between a first upstream cavity at least partially defined by an inner periphery of the first tubular portion and a second downstream cavity at least partially defined by an inner periphery of the second tubular portion. A ventilation zone in communication with the second cavity is provided at a location along the filter.

[0017] In another embodiment, a flow restriction element for inclusion in a smoking article includes: a first integral tubular portion; a second integral tubular portion of substantially the same external diameter as the first tubular portion; a third central integral tubular portion located between the first and second tubular portions, the third tubular portion being of reduced external diameter compared to the first and second tubular portions; a transverse barrier having at least one orifice provided therein disposed between a first cavity at least partially defined by an inner periphery of the first tubular portion and a second cavity at least partially defined by an inner periphery of the second tubular portion; and one or more openings in a surface of the second or third tubular portion in communication with the second cavity.

[0018] In yet another embodiment, a filter for a smoking article including a flow restriction element is provided.

[0019] Throughout the specification, the terms 'upstream' and 'downstream' are used to describe the relative positions of components of the smoking article of the invention in relation to the direction of mainstream smoke drawn from the rod of smokable material through the filter during smoking thereof.

[0020] The inclusion of a filter including a flow restriction element and ventilation zone having the features specified above advantageously enables the production of highly ventilated smoking articles according to the invention with a desired RTD in which the carbon monoxide to tar ratio of the mainstream smoke is maintained to at an acceptable value. As described in more detail below, this is the case even when the rod of smokable material of the smoking article includes a sidestream smoke reducing wrapper.

[0021] Smoking articles according to the invention with filters including a flow restriction element having the features specified above may be advantageously produced using existing filter combining and cigarette manufacturing equipment without the need for significant modification. Due to its shape, the flow restriction element is resilient and can be compressed during manufacture of filters and smoking articles according to the invention, in particular during the process of attaching filters according to the invention to rods of smokable material in order to produce smoking articles according to the invention. This advantageously facilitates

the manufacture of filters and smoking articles according to the invention using existing filter combining and cigarette manufacturing equipment.

[0022] The reduced external diameter of the third tubular portion of the flow restriction element compared to the first and second tubular portions thereof advantageously establishes a ventilation zone between the periphery of the filter and the exterior of the third tubular portion. At the same time, the increased external diameter of the first and second tubular portions of the flow restriction element compared to the third tubular portion advantageously provide reinforcement so that the filter does not collapse when, for example, the smoking article is held between a consumer's fingers.

[0023] The first upstream cavity of the flow restriction element advantageously allows mainstream smoke drawn through the rod of smokable material in use to concentrate around the at least one orifice in the transverse barrier before being drawn further downstream through the at least one orifice. In addition, the first upstream cavity helps to prevent blockage of the at least one orifice during smoking.

[0024] The number of orifices provided in the transverse barrier and the dimensions thereof may be selected in order to achieve a desired RTD and carbon monoxide to tar ratio. Preferably, the transverse barrier includes a single orifice, more preferably a substantially central single orifice. Where the transverse barrier includes a single substantially central orifice, the orifice is preferably between about 0.4 mm and about 0.8 mm in diameter, more preferably about 0.6 mm in diameter.

[0025] Preferably, the at least one orifice is between about 0.2 mm and about 1 mm in length, more preferably about 0.7 mm in length. Throughout the specification, the term 'length' is used to denote the dimension in the longitudinal direction of the smoking article. The length of the at least one orifice is equal to the thickness of the transverse barrier.

[0026] Preferably the at least one orifice is sized to contribute sufficient pressure drop such that the smoking article has a RTD of between about 30 mm WG (water gauge) and about 120 mm WG, more preferably of at least about 40 mm WG.

[0027] The smoke impermeable transverse barrier may be of any suitable shape. For example, the transverse barrier may be substantially perpendicular to the longitudinal axis of the smoking article. Alternatively, the transverse barrier may be frustoconical and convergent or divergent relative to the direction of mainstream smoke drawn from the rod of smokable material through the filter. In yet further embodiments, the transverse barrier may be concave or convex relative to the direction of mainstream smoke drawn from the rod of smokable material through the filter. Preferably, the transverse barrier is concave relative to the direction of mainstream smoke drawn from the rod of smokable material through the filter. This advantageously eases compression of the flow restriction element during manufacture of filters and smoking articles according to the invention, in particular during the process of attaching filters according to the invention to rods of smokable material in order to produce smoking articles according to the invention.

[0028] The second downstream cavity of the flow restriction element advantageously allows mainstream smoke drawn through the one or more orifices provided in the transverse barrier to mix with air drawn through the ventilation zone prior to being drawn into a consumer's mouth.

[0029] The ventilation zone provides ventilation of mainstream smoke drawn from the rod of smokable material in the

second cavity of the flow restriction element of the filter, that is at a location downstream of the at least one orifice in the transverse barrier of the flow restriction element. Preferably, no ventilation is provided upstream of the at least one orifice in the transverse barrier. Provision of ventilation only downstream of the at least one orifice advantageously limits the extent to which a consumer may attempt to draw harder on the smoking article during a puff. As the flow rate of a puff increases, pressure drop at the flow restriction element increases more rapidly compared to in a smoking article including a conventional cellulose acetate tow filter. Thus a consumer drawing harder during a puff results in increased ventilation of the mainstream smoke rather than increased mainstream smoke delivery. Furthermore, provision of ventilation only downstream of the at least one orifice in the transverse wall of the flow restriction element advantageously separates the functions of the ventilation zone and at least one orifice (ventilation levels and RTD, respectively).

[0030] Preferably, the filter is attached to the rod of smokeable material by a band of substantially air impermeable tipping paper. Preferably, the ventilation zone includes at least one circumferential row of perforations provided through a portion of the tipping paper, more preferably at least one circumferential row of perforations provided through a portion of the tipping paper overlying the third tubular portion of the flow restriction element.

[0031] Preferably, the at least one circumferential row of perforations is located at least 12 mm from the mouth end of the smoking article.

[0032] The perforations in the tipping paper may be made prior to or during construction of the smoking article using conventional techniques. For example, the perforations in the tipping paper may be created using online laser perforation, mechanical perforation or electrostatic perforation. Preferably, the tipping paper is pre-perforated.

[0033] In the preferred embodiment, the first cavity of the flow restriction element is at least partially defined by an inner periphery of the first and third tubular portions of the flow restriction element and the second cavity of the flow restriction element is at least partially defined by an inner periphery of the second tubular portion of the flow restriction element.

[0034] In this embodiment, one or more openings are preferably provided in an upstream transverse end surface of the second tubular portion that form a communication path between the second cavity and the at least one circumferential row of perforations of the ventilation zone. More preferably, a plurality of substantially equally circumferentially spaced apart openings are provided in an upstream transverse end surface of the second tubular portion that form a communication path between the second cavity and the at least one circumferential row of perforations of the ventilation zone. For example, twelve substantially equally circumferentially spaced apart openings may be provided in the upstream transverse end surface of the second tubular portion that extends radially outward from the third tubular portion.

[0035] Preferably, the one or more openings have a diameter ranging from about 0.3 mm to about 0.8 mm, more preferably of about 0.5 mm.

[0036] In an alternative embodiment, the first cavity of the flow restriction element is at least partially defined by an inner periphery of the first tubular portion of the flow restriction element and the second cavity of the flow restriction element is at least partially defined by an inner periphery of the second and third tubular portions of the flow restriction element.

[0037] In this embodiment, one or more openings are preferably provided in a circumferential surface of the third tubular portion that form a communication path between the second cavity and the at least one circumferential row of perforations of the ventilation zone.

[0038] For example, a pair of elongate opposed openings may be provided in the upstream circumferential surface of the third tubular portion.

[0039] Preferably, smoking articles according to the invention have a ventilation level ranging from about 50 percent to about 90 percent, more preferably ranging from about 60 percent to about 80 percent, most preferably of about 70 percent.

[0040] The flow restriction element may be made from any suitable materials or combination or materials. Suitable materials from which the flow restriction element may be formed include, but not limited to, plastic (for example, polypropylene, polyethylene, polystyrene, nylon, polysulfone, polyester and polyurethane), cellulosic material and combinations or composites thereof.

[0041] Preferably, the flow restriction element is made from a biodegradable material, more preferably from a biodegradable polymeric material. Suitable biodegradable polymeric materials are known in the art and commercially available under the brand name Mater-Bi® from Novamont of Novara, Italy and under the brand names Ecoflex® and Ecovio® from BASF of Ludwigshafen, Germany.

[0042] Preferably, the flow restriction element is a single piece, more preferably a single injection molded piece.

[0043] Preferably, the flow restriction element ranges from about 10 mm to about 20 mm in length, more preferably from about 12 mm to about 14 mm in length, most preferably about 13 mm in length.

[0044] Preferably, the first tubular portion of the flow restriction element is at least about 4 mm in length, more preferably at least about 5 mm in length.

[0045] Preferably, the second tubular portion of the flow restriction element is at least about 3 mm in length, most preferably about 3.5 mm in length.

[0046] Preferably, the third tubular portion of the flow restriction element is at least about 3 mm in length, most preferably about 3.5 mm in length.

[0047] Preferably, the transverse barrier is at least about 1 mm, more preferably at least about 1.5 mm from the downstream end of the second tubular portion of the flow restriction element.

[0048] Preferably, the external diameter of the first and second tubular portions of the flow restriction element ranges from about 6 mm to about 9 mm, more preferably ranges from about 7 mm to about 8.4 mm, most preferably from about 7.5 mm to about 7.9 mm.

[0049] Preferably, the external diameter of the third tubular portion of the flow restriction element ranging from about 4 mm to about 7.5 mm, more preferably from about 4.5 mm to about 6.8 mm, most preferably from about 4.5 mm to about 5.5 mm.

[0050] The filter may further include one or more filter segments upstream of the flow restriction element. Alternatively, or in addition, the filter may further include one or more filter segments downstream of the flow restriction element. In a preferred embodiment, the filter further includes a first filter segment upstream of the flow restriction element and a second filter segment downstream of the flow restriction element. Preferably, the first and second filter segments are

between about 5 mm and about 12 mm in length, more preferably between about 6 mm and about 8 mm in length, most preferably about 7 mm in length.

[0051] Where the filter includes one or more filter segments upstream of the flow restriction element and one or more filter segments downstream of the flow restriction element, the upstream and downstream filter segments may be the same or different. For example, the filter may include a pair of identical segments of cellulose acetate tow disposed on either side of the flow restriction element. Alternatively, the filter may include a plug of cellulose acetate tow upstream of the flow restriction element and a hollow tube of for example, paper, cardboard or cellulose acetate downstream of the flow restriction element.

[0052] Preferably, the one or more filter segments include filtration material of low particulate phase filtration efficiency. Preferably, the particulate phase filtration efficiency of each of the one or more filter segments is less than about 30 percent, more preferably less than about 20 percent. In a particularly preferred embodiment, the filter includes a first filter segment of low particulate phase filtration efficiency upstream of the flow restriction element and a second filter segment of low particulate phase filtration efficiency downstream of the flow restriction element.

[0053] The one or more filter segments may include cellulosic material, such as cellulose acetate tow, or other suitable fibrous filtration material of low filtration efficiency. Where the one or more filter segments include cellulose acetate tow, the denier per filament and total denier of the tow may be selected in order to achieve a desired particulate phase efficiency and RTD. Preferably, the cellulose acetate tow has a denier per filament of about 8 or greater and a total denier of about 28,000 or less.

[0054] Preferably, the flow restriction element and, where present, one or more filter segments are circumscribed by a band of plug wrap. In one embodiment, the flow restriction element and one or more filter segments are circumscribed by a band of substantially air impermeable plug wrap, preferably a band of plug wrap having a permeability of between about 7,000 Coresta units and about 20,000 Coresta units. In an alternative embodiment, the flow restriction element and one or more filter segments are circumscribed by a band of substantially air permeable plug wrap.

[0055] Preferably, the band of plug wrap is affixed to the circumferential outer surface of the first tubular portion of the flow restriction element. More preferably, the plug wrap is affixed to the circumferential outer surface of the first tubular portion of the flow restriction element so as to establish a substantially air-tight seal at the outer surface of the first tubular portion. Most preferably, the band of plug wrap is affixed to the circumferential outer surfaces of the first and second tubular portions of the flow restriction element.

[0056] Where the filter includes a filter segment upstream of the flow restriction element, the band of plug wrap is preferably affixed to the circumferential outer surface of the upstream filter segment. More preferably, the plug wrap is affixed to the circumferential outer surfaces of the upstream filter segment and the first tubular portion of the flow restriction element so as to establish a substantially air-tight seal at the outer surface of the first tubular portion of the flow restriction element.

[0057] Where the filter includes a filter segment downstream of the flow restriction element, the band of plug wrap is preferably affixed to the circumferential outer surface of the downstream filter segment.

[0058] The band of plug wrap may be affixed to the flow restriction element and one or more filter segments using, for example, an adhesive. An air-tight seal between the band of plug wrap and the first tubular portion of the flow restrictor may be obtained through the use of an adhesive offering a good cohesion and a high surface tackiness. Suitable adhesives are known in the art and commercially available under the brand name Adhesin from Henkel of Dusseldorf, Germany.

[0059] As stated above, the filter including the band of plug wrap is preferably attached to the rod of smokable material by a band of substantially air impermeable tipping paper.

[0060] Where the filter includes a band of substantially air impermeable plug wrap, the ventilation zone preferably includes at least one circumferential row of perforations provided through a portion of the tipping paper and the plug wrap that are formed online during manufacture of the smoking article.

[0061] Where the filter includes a band of substantially air permeable plug wrap, the filter is preferably attached to the rod of smokable material by a band of pre-perforated tipping paper including at least one circumferential row of perforations.

[0062] The RTD of smoking articles according to the invention may be adjusted by use of pre-perforated tipping paper and air permeable plug wrap. The at least one orifice of the flow restriction element may be sized to allow substantially all of the ventilating air that, in use, flows through the perforations in the tipping paper and air permeable plug wrap to flow into the second downstream cavity. In addition, by providing the perforations in a portion of the tipping paper overlying the third tubular portion of the flow restriction element, and hence ventilation zone, and separating the ventilation zone from the second downstream cavity, where mainstream smoke drawn from the rod of smokable material mixes with the ventilating air, the mainstream smoke does not flow upstream and exit through the perforations in the tipping paper. The levels of ventilation of smoking articles according to the invention may thus be advantageously varied through the use of different pre-perforated tipping papers or plug wraps with different porosity levels or combinations thereof.

[0063] Preferably, the filter has an overall length ranging from about 20 mm to about 34 mm, more preferably from about 25 mm to about 30 mm, most preferably about 27 mm.

[0064] Preferably, the filters of smoking articles according to the invention have an overall encapsulated RTD ranging from about 250 mm WG to about 350 mm WG, more preferably of between about 275 mm WG and 325 mm WG.

[0065] Preferably, smoking articles according to the invention have an unencapsulated RTD of at least about 30 mm WG, more preferably of at least about 40 mm WG.

[0066] Preferably, the rod of smokable material includes tobacco circumscribed by a wrapper, more preferably tobacco cut filler circumscribed by a wrapper.

[0067] Preferably, the rod of smokable material includes a wrapper that results in the production of reduced amounts of sidestream smoke. Suitable sidestream smoke reducing wrappers for use in smoking articles according to the inven-

tion, and methods for producing such wrappers, are well known in the art and described in, for example, U.S. Pat. No. 5,152,304.

[0068] Preferably, the wrapper has a high basis weight and a low permeability. More preferably, the wrapper is of the type described in U.S. Pat. No. 5,152,304.

[0069] Preferably, the wrapper has a basis weight of at least about 35 g/m², more preferably a basis weight of between about 35 g/m² and about 60 g/m², most preferably a basis weight of between about 40 g/m² and about 50 g/m².

[0070] Preferably, the wrapper has a permeability of about 18 Coresta units or less, more preferably ranging from about 4 Coresta units to about 18 Coresta units, most preferably ranging from about 5 Coresta units to about 8 Coresta units.

[0071] Preferably, the wrapper includes a filler, more preferably an inorganic filler, most preferably calcium carbonate. Preferably, the wrapper has a filler loading of between about 20 percent and about 50 percent by weight, more preferably of about 40 percent by weight.

[0072] Preferably, the wrapper further includes a burn modifier. More preferably, the wrapper includes between 0.3 percent and 5 percent by weight of a burn modifier. Suitable burn modifiers are known in the art and include, but are not limited to, acidic salts of inorganic or organic acids, including monobasic potassium and sodium salts of polyvalent inorganic acids (such as phosphoric, pyrophosphoric, boric, and sulfuric acids) and mono-potassium and sodium salts of carboxylic acids (such as citric, succinic, and fumaric acids), compounds that thermally decompose to generate acidic species in situ, including salts of polyvalent acids with at least one labile proton, various esters that are acidic precursors, including phosphate esters (such as the potassium salt of α -D-glucose-1-phosphate), and combinations thereof. Preferably, the burn modifier is an acidic salt, more preferably monobasic potassium phosphate.

[0073] Preferably, smoking articles according to the invention have a carbon monoxide to tar ratio of less than or equal to 1.

[0074] Preferably, smoking articles according to the invention have a total nicotine free dry particulate matter (NFDPM) or 'tar' delivery ranging from about 3 mg to about 12 mg.

[0075] The smoking article 10 according to the first embodiment of the invention shown in FIG. 1 includes a cylindrical tobacco rod 12 and a filter 14. The filter 14 is attached to the tobacco rod 12 by a band of tipping paper 16, which circumscribes the filter 14 and an adjacent portion of the tobacco rod 12, which includes a charge of smokable material such as tobacco cut filler 18 circumscribed preferably by a high basis weight, low permeability, paper wrapper 20.

[0076] The filter 14 includes a first filter segment 22 adjacent to and abutting the tobacco rod 12, a second filter segment 24 at the mouth end of the smoking article 10 and a one-piece, injection molded, flow restriction element 26 disposed between the first filter segment 22 and the second filter segment 24. The first and second filter segments 22, 24 are preferably low particulate efficiency cellulose acetate tow filter segments.

[0077] The first and second filter elements 22, 24 and the flow restriction element 26 are circumscribed by a band of plug wrap 28.

[0078] As shown in more detail in FIG. 2, the flow restriction element 26, which is preferably formed of biodegradable polymeric material, includes a first upstream integral tubular

portion 30 adjacent to and abutting the first filter segment 22, a second downstream integral tubular portion 32 of substantially the same external diameter as the first tubular portion 30, which is adjacent to and abuts the second filter segment 24, and a third central integral tubular portion 34 located between and of reduced external diameter compared to the first and second tubular portions 30, 32. The plug wrap 28 is affixed to the circumferential outer surfaces of the first filter element 22 and the first tubular portion 30 of the flow restriction element 26 by an adhesive (not shown) so as to form a substantially air-tight connection or joint at the outer surface of the first tubular portion 30 of the flow restriction element 26.

[0079] Due to the reduced external diameter of the third tubular portion 34 compared to the first and second tubular portions 30, the inner surface of the plug wrap 28 is spaced apart from the circumferential outer surface of the third tubular portion 34 as shown in FIG. 2. As described further below, the space between the plug wrap 28 and overlying band of tipping paper 16 and the circumferential outer surface of the third tubular portion 34 forms a ventilation zone.

[0080] The flow restriction element 26 further includes a transverse barrier 36 with a single central orifice 38 of reduced diameter provided therein. As shown in FIG. 2, the transverse barrier 36 is disposed between a first upstream cavity 40, which is at least partially defined by the inner peripheries of the first and third tubular portions 30, 34 of the flow restriction element 26, and a second downstream cavity 42, which is at least partially defined by the inner periphery of the second tubular portion 32 of the flow restriction element.

[0081] One or more circumferential rows of perforations 44 (shown by dashed lines in FIGS. 1 and 2) are provided through a portion of the tipping paper 16 and plug wrap 28 overlying the third tubular portion 34 of the flow restriction element 26. As shown in FIG. 3, a plurality of substantially equally circumferentially spaced apart openings 46 are provided in the upstream transverse end surface of the second tubular portion 32 that extends radially outward around the third tubular portion 34. These openings 46 form a communication path between the one or more circumferential rows of perforations 44 provided in the tipping paper 16 and plug wrap 28 and the second cavity 42, as shown in FIG. 2.

[0082] In use, mainstream smoke from the tobacco rod 12 of the smoking article 10 is drawn downstream through the first filter segment 22 of the filter 14 into the first cavity 40 of the flow restriction element 26. Mainstream smoke drawn into the first cavity 40 concentrates around the central orifice 38 of the transverse barrier 36 of the flow restriction element 26 before being drawn further downstream through the central orifice 38 into the second cavity 42 of the flow restriction element 26.

[0083] Ventilating air is also drawn into the second cavity 42 through the one or more circumferential rows of perforations 44 in the tipping paper 16 and plug wrap 28 and the plurality of substantially equally circumferentially spaced apart openings 46 provided in the upstream transverse end surface of the second tubular portion 32. Mainstream smoke drawn through the central orifice 38 in the transverse barrier 36 mixes with the ventilating air in the second cavity 42 before being drawn further downstream through the second filter element 24.

[0084] During smoking, the high basis weight, low permeability paper wrapper **20** of the tobacco rod **12** advantageously reduces the sidestream smoke generated by the smoking article **10** in a known manner.

[0085] The smoking article according to the second embodiment of the invention shown in FIGS. 4 and 5 is of largely similar construction and design as the smoking article **10** according to the first embodiment of the invention shown in FIGS. 1 to 3. The similar reference numerals are used in FIGS. 4 and 5 for features of the smoking article according to the second embodiment of the invention that correspond to features of the smoking article according to the first embodiment of the invention previously described.

[0086] The principal differences between the smoking article **10** according to the first embodiment of the invention shown in FIGS. 1 to 3 and the smoking article according to the second embodiment of the invention shown in FIGS. 4 and 5 are the locations of the openings that form a communication path between the one or more circumferential rows of perforations in the tipping paper and plug wrap and the second cavity, and the location of the transverse barrier in the flow restriction element.

[0087] As shown in FIG. 4 in the flow restriction element **26'** of the filter **14** of the smoking article according to the second embodiment of the invention, the transverse barrier **36'** is disposed between a first upstream cavity **40'**, which is at least partially defined by the inner periphery of the first tubular portion **30'** of the flow restriction element **26**, and a second downstream cavity **42'**, which is at least partially defined by the inner peripheries of the second and third tubular portions **32', 34'** of the flow restriction element **26'**.

[0088] In the second embodiment, a pair of opposed elongate openings **46'**, which form a communication path between the one or more circumferential rows of perforations **44** in the tipping paper **16** and plug wrap **28** and the second cavity **42'**, are provided in the circumferential surface of the third tubular body portion **34'** of the flow restriction element **26'** as shown in FIG. 5.

[0089] In use, ventilating air is drawn into the second cavity **42'** through the one or more circumferential rows of perforations **44** in the tipping paper **16** and plug wrap **28** and the pair of opposed elongate openings **46'** provided in the circumferential surface of the third tubular body portion **34'**, where it mixes with mainstream smoke drawn through the central orifice **38'** in the transverse barrier **36'**.

[0090] The tobacco rods **12** of the smoking articles according to the first and second embodiments of the invention may be constructed using conventional cigarette rod making equipment wherein the tobacco cut filler **18** is air formed into a continuous rod on a travelling belt and enwrapped with a continuous ribbon of the high basis weight, low permeability, paper wrapper **20**, which is then glued along its longitudinal seam.

[0091] The filters **14** of the smoking articles according to the first and second embodiments of the invention may also be constructed using existing high speed filter rod making equipment employing known combining techniques.

[0092] The filters **14** and the tobacco rods **12** may then be combined and attached to one another by affixing the band of tipping paper **16** around the filter **14** and an adjacent portion of the tobacco rod **12** using existing machinery employed for attaching filters to tobacco rods during the production of known filter cigarettes.

[0093] Table 1 provides the puff count, total amounts of smoke nicotine (SN), tar and carbon monoxide (CO) and CO/tar and CO/SN ratios for: a first cigarette (Cigarette A) constructed in accordance with the first embodiment of the invention shown in FIGS. 1 to 3 in which the first and second filter segments are plugs of low particulate efficiency cellulose acetate tow; a second cigarette (Cigarette B) according to the invention of largely identical construction to Cigarette A, but in which the second filter segment is replaced by a hollow cylindrical tube of cellulose acetate tow; and a third cigarette (Cigarette C) according to the invention of largely identical construction to Cigarette A, but in which the high basis weight, low permeability wrapper of the tobacco rod is replaced by a paper wrapper of conventional basis weight and permeability.

[0094] For comparison, Table 1 also provides the puff count, total amounts of smoke nicotine (SN), tar and carbon monoxide (CO) and CO/tar and CO/SN ratios for three cigarettes not in accordance with the invention having conventional cellulose acetate tow filters. Two of the cigarettes have tobacco rods with high basis weight, low permeability wrappers (Cigarettes D and E), and one of the cigarettes has a tobacco with a wrapper of conventional basis weight and permeability (Cigarette F).

[0095] As shown in Table 1, for the cigarettes having conventional cellulose acetate tow filters inclusion of a high basis weight, low permeability wrapper (Cigarettes D and E) leads to an increase carbon monoxide yield. Furthermore, while increasing the ventilation level of the cigarettes having conventional cellulose acetate tow filters and a high basis weight, low permeability wrapper (cigarettes D and E) significantly reduces the carbon monoxide yield, it does not significantly affect the carbon monoxide to tar ratio.

[0096] In contrast to the cigarettes having conventional cellulose acetate tow filters, the cigarettes according to the invention (Cigarettes A, B and C) all have carbon monoxide to tar ratios of less than 1.0. In particular, as shown in Table 1, the puff count and smoke nicotine (SN) and tar yields of the cigarette according to the invention having a high basis weight, low permeability wrapper and a second filter segment consisting of a hollow cylindrical tube of cellulose acetate tow (Cigarette B) are very similar to those of the cigarette having a conventional cellulose acetate tow filter and a wrapper of conventional basis weight and permeability (Cigarette F). However, despite the inclusion of a side stream smoke reducing wrapper, the carbon monoxide yield and carbon monoxide to tar and carbon monoxide to smoke nicotine ratios of Cigarette B are advantageously significantly reduced compared to Cigarette F.

TABLE 1

	Cigarette					
	A	B	C	D	E	F
<u>Tobacco rod</u>						
Length (mm)	57	57	57	57	57	57
Basis weight of wrapper (g/m ²)	45	45	25	45	45	25
Permeability of wrapper (Coresta Unit)	6	6	56	6	6	56
<u>Filter</u>						
Overall length (mm)	27	27	27	27	27	27
Resistance to draw (mm WG)	298	298	298	65	67	108
Ventilation (percent)	71	70	70	53	39	46
Length of first filter segment	7	7	7	27	27	27
Length of flow restriction element	13	13	13	—	—	—
Length of second filter segment	7	7	7	—	—	—
Denier per filament of the cellulose acetate tow of the or each filter segment	8Y	8Y	8Y	5.5Y	5.5Y	2.5Y
Total denier of the cellulose acetate tow of the or each filter segment	28,000	28,000	28,000	35,000	35,000	37,000
Length of flow restriction element	13	13	13	—	—	—
<u>Cigarette</u>						
Resistance to draw (mm WG)	42	33	44	71	82	109
SN (mg/cigarette)	0.49	0.58	0.49	0.63	0.76	0.56
Tar (mg/cigarette)	5.09	5.90	4.46	7.00	8.90	5.98
CO (mg/cigarette)	4.12	4.03	2.95	9.30	12.80	7.03
Puff count (number/cigarette)	7.60	7.33	6.95	7.60	7.00	7.50
CO/Tar	0.8	0.7	0.7	1.3	1.4	1.2
CO/SN	8.4	6.9	6.0	14.8	16.8	12.6

[0097] The invention has been exemplified above with respect to smoking articles including filters having first and second filter segments including plugs of cellulose acetate tow. However, it will be appreciated that smoking articles according to the invention may include filters having one or more filter segments including other materials such as paper (for example, filter paper or carbon paper), cardboard, plastic (for example, polypropylene, polyethylene, polystyrene, nylon, polysulfone, polyester or polyurethane), biopolymers and combinations thereof.

[0098] Furthermore, while the invention has been exemplified above with respect to smoking articles including filters having flow restriction elements including transverse barriers with a single substantially central orifice provided therein, it will be appreciated that smoking articles according to the invention may include filters including transverse barriers with a single non-central orifice or two or more orifices provided therein.

[0099] In this specification, the word "about" is often used in connection with numerical values to indicate that mathematical precision of such values is not intended. Accordingly, it is intended that where "about" is used with a numerical value, a tolerance of $\pm 10\%$ is contemplated for that numerical value.

[0100] In this specification the words "generally" and "substantially" are sometimes used with respect to terms. When used with geometric terms, the words "generally" and "substantially" are intended to encompass not only features which

meet the strict definitions but also features which fairly approximate the strict definitions.

[0101] While the foregoing describes in detail a preferred smoking article including a filter having a flow restriction element with reference to a specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications may be made to the smoking article, which do not materially depart from the spirit and scope of the foregoing description. Accordingly, all such changes, modifications, and equivalents that fall within the spirit and scope of the appended claims are intended to be encompassed thereby.

We claim:

1. A smoking article comprising:
a rod of smokable material;
a filter including a flow restriction element attached to the rod of smokable material, the flow restriction element including:
a first upstream integral tubular portion;
a second downstream integral tubular portion of substantially the same external diameter as the first tubular portion;
a third central integral tubular portion located between the first and second tubular portions, the third tubular portion being of reduced external diameter compared to the first and second tubular portions; and
a transverse barrier having at least one orifice provided therein, the transverse barrier being disposed between a first upstream cavity at least partially defined by an

inner periphery of the first tubular portion and a second downstream cavity at least partially defined by an inner periphery of the second tubular portion; and a ventilation zone in communication with the second cavity at a location along the filter.

2. The smoking article of claim **1**, wherein the transverse barrier has a single substantially central orifice having a diameter ranging from about 0.4 mm to about 0.8 mm provided therein.

3. The smoking article of claim **1**, wherein the filter is attached to the rod of smokable material by a band of tipping paper and the ventilation zone includes at least one circumferential row of perforations provided through a portion of the tipping paper overlying the third tubular portion of the flow restriction element.

4. The smoking article of claim **3**, wherein the first cavity of the flow restriction element is at least partially defined by an inner periphery of the first and third tubular portions.

5. The smoking article of claim **4**, wherein one or more openings are provided in an upstream transverse end surface of the second tubular portion that form a communication path between the second cavity and the at least one circumferential row of perforations.

6. The smoking article of claim **3**, wherein the second cavity of the flow restriction element is at least partially defined by an inner periphery of the second and third tubular portions.

7. The smoking article of claim **6**, wherein one or more openings are provided in a circumferential surface of the third tubular portion that form a communication path between the second cavity and the at least one circumferential row of perforations.

8. The smoking article of claim **1**, wherein the filter further includes a first filter segment upstream of the flow restriction element and a second filter segment downstream of the flow restriction element.

9. The smoking article of claim **1**, wherein the wrapper has a basis weight ranging from about 35 g/m² to about 60 g/m²,

a filler loading ranging from about 20 percent to about 50 percent by weight, a permeability ranging from about 2 Coresta units to about 18 Coresta units, and about 0.3 percent to about 5 percent by weight of a burn modifier.

10. The smoking article of claim **1**, wherein the smoking article has a ventilation level of at least about 50 percent, preferably of at least about 60 percent.

11. The smoking article of claim **1**, wherein the flow restriction element is at least about 10 mm in length, more preferably at least about 13 mm in length.

12. The smoking article of claim **1**, wherein the transverse barrier is concave relative to the direction of mainstream smoke drawn from the rod of smokable material through the filter.

13. The smoking article of claim **1**, wherein the smoking article has a carbon monoxide to tar ratio of less than or equal to 1.

14. A flow restriction element for inclusion in a smoking article of claim **1**, the flow restriction element including:

a first integral tubular portion;
a second integral tubular portion of substantially the same external diameter as the first tubular portion;
a third central integral tubular portion located between the first and second tubular portions the third tubular portion being of reduced external diameter compared to the first and second tubular portions;
a transverse barrier having at least one orifice provided therein, the transverse barrier being disposed between a first cavity at least partially defined by an inner periphery of the first tubular portion and a second cavity at least partially defined by an inner periphery of the second tubular portion; and
one or more openings in a surface of the second or third tubular portion in communication with the second cavity.

15. A filter for a smoking article including the flow restriction element of claim **14**.

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