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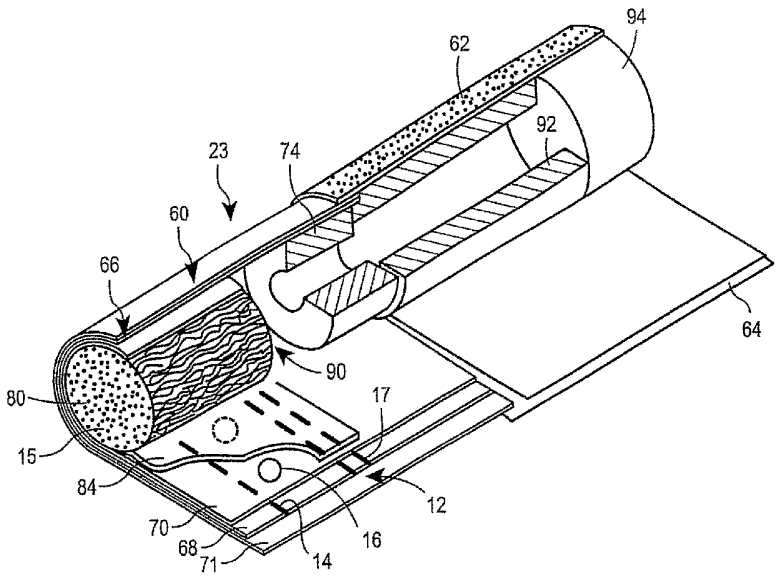
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(54) Title: ELECTRICALLY HEATED CIGARETTE INCLUDING CONTROLLED-RELEASE FLAVORING



(57) Abstract: An electrically heated cigarette (23) for an electrical smoking system, comprises at least one sorbent and a flavoring-release additive including at least one flavoring releasable in the electrically heated cigarette upon the flavoring-release additive being heated to at least a minimum temperature. The flavoring-release additive includes at least one flavoring. The flavoring-release additive can have various forms including, for example, beads, films and inclusion complexes. Electrical smoking systems including the electrically heated cigarettes, methods of making the cigarettes, and methods of smoking the cigarettes are also disclosed.

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ELECTRICALLY HEATED CIGARETTE INCLUDING CONTROLLED-RELEASE FLAVORING

RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Serial No. 10/695,760, filed October 30, 2003, which claims priority under 35 U.S.C. § 119 to U.S. Provisional Application No. 60/422,497 entitled ELECTRICALLY HEATED CIGARETTE INCLUDING CONTROLLED RELEASE FLAVORING and filed on October 31, 2002, the entire contents of which are hereby incorporated by reference.

BACKGROUND

Traditional cigarettes are smoked by lighting an end of a wrapped tobacco rod and drawing air predominately through the lit end by suction at a mouthpiece end of the cigarette. Traditional cigarettes deliver smoke as a result of combustion, during which tobacco is combusted at temperatures that typically exceed 800°C during a puff. The heat of combustion releases various gaseous combustion products and distillates from the tobacco. As these gaseous products are drawn through the cigarette, they cool and condense to form an aerosol, which provides the flavors and aromas associated with smoking.

Traditional cigarettes produce sidestream smoke during smoldering between puffs. Once lit, they normally are fully consumed or discarded. Relighting a traditional cigarette is possible, but is not desirable for subjunctive reasons including flavor, taste and odor.

An alternative to the more traditional cigarette is the electrically heated cigarette used in electrical smoking systems. As compared to traditional cigarettes, electrical smoking systems significantly reduce sidestream smoke, and also permit smokers to suspend and reinitiate smoking as desired. Exemplary electrical smoking systems are disclosed in US-A-6 026 820; US-A-5 988 176; US-A-5 915 387; US-A-5 692 526; US-A-5 692 525; US-A-5 666 976; US-A-5 499, 636; and US-A-5 388 594, each of which is hereby incorporated by reference in its entirety. Electrical smoking systems include an electrically powered lighter and an electrically heated

cigarette, which is constructed to cooperate with the lighter. It is desirable that electrical smoking systems be capable of delivering smoke in a manner similar to the smoker's experiences with traditional cigarettes, such as by providing an immediacy response (smoke delivery occurring immediately upon draw), a desired level of delivery (that correlates with FTC tar level), a desired resistance to draw (RTD), as well as puff-to-puff and cigarette-to-cigarette consistency.

Volatile flavorings have been incorporated in traditional cigarettes to add flavors and aromas to mainstream and sidestream tobacco smoke. See, for example, US-A-3 006 347; US-A-3 236 244; US-A-3 344 796; US-A-3 426 011; US-A-3 972 335; US-A-4 715 390; US-A-5 137 034; US-A-5 144 964; and US-A-6 325 859, and WO-A-01/80671. The added flavorings are desirably volatilized when the cigarette is smoked. However, volatile flavorings tend to migrate in the cigarette to other components and possibly through the entire cigarette. Volatile flavorings can be lost from cigarettes during storage and distribution at ordinary conditions prior to smoking of the cigarettes. The degree of migration of volatile flavorings in cigarettes depends on different factors, including the flavoring's vapor pressure, the solubility of the flavoring in other components of the cigarette, and temperature and humidity conditions. In addition, a large portion of the added flavoring can be lost to the side stream smoke in traditional cigarettes.

Flavorings that have been incorporated in traditional cigarettes also can chemically and/or physically deteriorate by contacting and/or reacting with other components of the cigarette, as well as with the environment. For example, activated carbon has been incorporated in traditional cigarettes to remove gas-phase constituents from mainstream smoke. However, flavorings that have been incorporated in the cigarettes along with the activated carbon have been adsorbed by the activated carbon, clogging pores of the activated carbon and consequently deactivating the activated carbon, thereby diminishing its ability to filter tobacco smoke.

For the foregoing reasons, flavorings that have been incorporated in traditional cigarettes have not been totally

satisfactorily delivered to the smoker. Consequently, the flavorings incorporated in some traditional cigarettes have not satisfactorily provided the desired taste effect to the smoker and the flavorings' desired value to the subjective quality of the cigarette has been less than desired. Due to the flavoring loss, the uniformity of flavored cigarettes has not been totally satisfactory. In addition, the sorption of flavorings by sorbents in the cigarettes has deactivated the sorbents and thereby reduced their ability to remove gas phase constituents from tobacco smoke.

SUMMARY

In view of the above-described problems that have been encountered in some traditional cigarettes including flavorings and those also including sorbents, an electrically heated cigarette is provided, which includes a sorbent and a controlled-release flavoring. In a preferred embodiment, the electrically heated cigarette comprises a sorbent and a flavoring incorporated in the cigarette in a form that preferably minimizes release and migration of the flavoring in the cigarette prior to smoking, for example, at ambient conditions, and thus preferably minimizes deactivation of the sorbent by the flavoring. In addition, the flavoring preferably is released in the cigarette in a controlled manner during smoking. Consequently, the flavoring preferably enhances subjective characteristics of the cigarette while the sorbent maintains its ability to remove gas-phase constituents from mainstream smoke.

A preferred embodiment of the electrically heated cigarette comprises at least one sorbent and a flavoring-release additive including one or more flavorings. The flavoring is releasable in the cigarette upon the flavoring-release additive being heated to at least a minimum temperature, which occurs during smoking of the cigarette.

The flavoring-release additive can be incorporated in various forms in the electrically heated cigarette. In one preferred embodiment, the flavoring-release additive comprises beads. In another preferred embodiment, the flavoring-release additive is a film. In yet another preferred embodiment, the flavoring-release

additive is an inclusion complex including a selected host molecule, and the flavoring as a guest molecule in the inclusion complex.

In another preferred embodiment, two or more different flavoring-release additives having different flavoring release temperatures are located at different locations in an electrically heated cigarette that reach different temperatures from each other. The flavoring-release additives can be located at locations in the electrically heated cigarette that reach the flavoring release temperature for those flavoring-release additives. Accordingly, the flavoring-release additive can provide efficient, controlled release of the flavoring during smoking.

The electrically heated cigarette can comprise various sorbents. By providing the flavoring in the flavoring-release additive, which preferably minimizes release and/or migration of the flavoring until the flavoring-release additive reaches the flavoring release temperature, the flavoring is preferably substantially prevented from being sorbed by, and thus deactivating, the sorbent, thereby not adversely affecting the sorbent's ability to remove selected gas-phase constituents from mainstream tobacco smoke. In addition, because the flavoring is temperature released in the cigarette, it can be effectively delivered to a smoker in a controlled manner during puff cycles of the cigarette.

A preferred embodiment of an electrical smoking system comprises a lighter and at least one electrically heated cigarette including at least one sorbent and a flavoring-release additive.

A preferred embodiment of a method of making an electrically heated cigarette comprises incorporating a sorbent and a flavoring-release additive into an electrically heated cigarette.

Another embodiment relates to an electrically heated cigarette having a flavoring-release additive in a tobacco mat, a sorbent in a filter component and a tobacco plug free of flavoring-release additive.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a preferred embodiment of an electrically heated cigarette for use in an electrical smoking system with the cigarette in a partially unassembled condition.

FIG. 2 illustrates the electrically heated cigarette shown in FIG. 1 in the assembled condition with one end of the cigarette contacting a stop piece of an electrically operated lighter of the electrical smoking system.

FIG. 3 illustrates another preferred embodiment of an electrically heated cigarette for use in an electrical smoking system with the cigarette in a partially unassembled condition.

FIG. 4 illustrates a preferred embodiment of an electrical smoking system with an electrically heated cigarette inserted into the electrically operated lighter.

FIG. 5 illustrates the electrical smoking system shown in FIG. 4 with the cigarette withdrawn from the lighter.

FIG. 6 illustrates a heater fixture of the electrical smoking system.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

An electrically heated cigarette includes one or more sorbents and at least one flavoring for affecting flavor, taste, and/or aroma of tobacco smoke. In a preferred embodiment, the flavoring is incorporated in the cigarette in a flavoring-release additive, which preferably minimizes the release and/or migration of the flavoring in the cigarette prior to smoking. Preferably, the flavoring is released from the flavoring-release additive in a controlled manner during smoking of the cigarette. The flavoring-release additive enables the flavoring to enhance subjective characteristics of the cigarette while avoiding an adverse impact on the effectiveness of the sorbent in removing selected gas-phase constituents from mainstream smoke.

In a preferred embodiment of the electrically heated cigarette, the flavoring is released in the cigarette upon the flavoring-release additive being heated to at least a minimum temperature (flavoring

release temperature), which occurs when a smoker draws mainstream smoke through the cigarette.

It has been determined that different regions of the electrically heated cigarette reach different temperatures when a smoker draws on the cigarette. In a preferred embodiment, different flavoring-release additives are selectively disposed at two or more locations in the electrically heated cigarette that respectively reach at least the minimum temperature at which the flavoring is released from the flavoring-release additive disposed at that location. By selectively locating one or more flavoring-release additives in the cigarette, the cigarette can provide efficient, controlled release of the flavoring during smoking.

The flavoring-release additive can have various constructions and compositions and can be located at one or more locations, and/or incorporated in one or more components of the electrically heated cigarette. The flavoring-release additives can be designed to have different associated flavoring release temperatures. Accordingly, the flavoring-release additives can be incorporated in the electrically heated cigarette at locations that are most suitable for providing efficient release of the flavoring from the particular flavoring-release additive.

The electrically heated cigarette can comprise one or more sorbents capable of removing selected gas-phase constituents from mainstream smoke. By providing the flavoring in the flavoring-release additive that preferably minimizes the release and/or migration of the flavoring in the cigarette until the flavoring-release additive reaches at least the minimum temperature, the flavoring is preferably substantially prevented from deactivating the sorbent. Thus, the ability of the sorbent to remove selected gas-phase constituents from mainstream tobacco smoke can be maintained. Preferably, the flavoring-release additive enables the flavoring to be effectively delivered to a smoker in a controlled manner.

As used herein, the term "sorption" denotes filtration by adsorption and/or absorption. Sorption is intended to encompass interactions on the outer surface of the sorbent, as well as

interactions within the pores and channels of the sorbent. In other words, a "sorbent" is a substance that has the ability to condense or hold molecules of other substances on its surface, and/or the ability to take up other substances, i.e., through penetration of the other substances into its inner structure, or into its pores. The term "sorbent" as used herein refers to either an adsorbent, an absorbent, or a substance that can function as both an adsorbent and an absorbent.

As used herein, the term "remove" refers to adsorption and/or absorption of at least some portion of a component of mainstream tobacco smoke.

The term "mainstream smoke" includes the mixture of gases passing down the tobacco rod and issuing through the filter end, i.e., the amount of smoke issuing or drawn from the mouth end of a cigarette during smoking of the cigarette. The mainstream smoke contains air that is drawn in through the heated region of the cigarette and through the paper wrapper.

The term "molecular sieve" as used herein refers to a porous structure comprised of an inorganic material and/or organic material. Molecular sieves include natural and synthetic materials. Molecular sieves can sorb molecules of certain dimensions, while rejecting molecules having larger dimensions.

FIGS. 1 and 2 illustrate a preferred embodiment of the electrically heated cigarette 23. However, it should be understood that the electrically heated cigarette can have other configurations suitable for smoking in an electrically powered lighter. The electrically heated cigarette 23 comprises a tobacco rod 60 and a filter tipping 62 joined together by tipping paper 64. The tobacco rod 60 preferably includes a tobacco web or 'mat' 66 folded into a tubular form about a free-flow filter 74 at one end and a tobacco plug 80 at the other end.

An over wrap 71 surrounds the tobacco-containing mat 66 and is held together along a longitudinal seam. The over wrap 71 retains the mat 66 in a wrapped condition about the free-flow filter 74 and tobacco plug 80.

The mat 66 preferably comprises a base web 68 and a layer of tobacco material 70. The tobacco material 70 can be located along the inside surface or the outside surface of the base web 68. At the tipped end of the tobacco rod 60, the mat 66 and the over wrap 71 are wrapped about the free-flow filter plug 74. Preferably, the tobacco plug 80 comprises a relatively short tobacco column 82 of cut filler tobacco, which is retained by a surrounding inner wrap 84.

A void 90 is between the free-flow filter 74 and the tobacco plug 80. The void 90 is an unfilled portion of the tobacco rod 60 and is in fluid communication with the tipping 62 through the free flow filter 74.

The tipping 62 preferably comprises a free-flow filter 92 located adjacent the tobacco rod 60 and a mouthpiece filter plug 94 at the distal end of the tipping 62 from the tobacco rod 60. Preferably, the free-flow filter 92 is tubular and transmits air with very low pressure drop. The mouthpiece filter plug 94 closes off the free end of the tipping 62.

The cigarette 23 optionally includes at least one row of perforations 12 adjacent the free end 15 of the cigarette 23. The perforations can be formed as slits 17, which preferably extend through the over wrap 71, the mat 66 and the inner wrap 84.

To further improve delivery, at least one additional row of perforations 14 comprising slits 17 can optionally be formed at a location along the tobacco plug 80. The perforations 12 or 14 may comprise a single row or a dual row of slits 17. The number and extent of the slits 17 can be selected to control the resistance to draw (RTD) along the side walls of the cigarettes 23 and the delivery.

Optional holes 16 provided in the mat 66 are covered by the over wrap 71. The perforations 12, 14 can be used to approximate desired delivery levels for the cigarette 23, with the holes 16 being used to adjust delivery with a lesser effect on the RTD

The cigarette 23 preferably has a substantially constant diameter along its length. The diameter of the cigarette 23, like more traditional cigarettes, is preferably between about 7.5 mm to 8.5

mm so that the electrical smoking system 21 provides a smoker with a familiar "mouth feel" during smoking.

The tobacco column 82 preferably comprises cut filler of a typical blend of tobaccos, such as blends comprising bright, Burley, and Oriental tobaccos together with, optionally, reconstituted tobaccos and other blend components, including traditional cigarette flavors.

The free-flow filter 92 and the mouthpiece filter plug 94 are preferably joined together as a combined plug with a plug wrap 101. The plug wrap 101 is preferably a porous, low-weight plug wrap. The combined plug is attached to the tobacco rod 60 by the tipping paper 64.

As described above, the electrically heated cigarette 23 can comprise one or more sorbents that remove gas-phase constituents of tobacco smoke. The sorbent can comprise one or more porous materials through which tobacco smoke can flow. In a preferred embodiment, the sorbent is activated carbon. For example, the sorbent can comprise activated carbon granules located in a void in the filter, or activated carbon particles loaded on fibrous material or paper. The activated carbon can be in various forms including particles, fibers, beads, and the like. The activated carbon can have different porosity characteristics, such as a selected pore size and total pore volume.

In another preferred embodiment, the sorbent is one or more suitable molecular sieve sorbent materials. Molecular sieve sorbents that may be used in the electrically heated cigarette 23 include, but are not limited to, one or more of the zeolites, mesoporous silicates, alumino phosphates, mesoporous aluminosilicates, and other related porous materials, such as mixed oxide gels, which may optionally further WO-A-01/80973, which is incorporated herein by reference in its entirety.

In a preferred embodiment, the sorbent is one or more zeolites. Zeolites include crystalline aluminosilicates having pores, such as channels and/or cavities of uniform, molecular sized dimensions. There are many known unique zeolite structures having different sized and shaped pores, which can significantly affect the properties of

these materials with regard to sorption and separation processes. Molecules can be separated by zeolites by size and shape effects related to the possible orientation of the molecules in the pores, and/or by differences in strength of sorption. One or more zeolites having pores larger than one or more selected gas phase components of a gas that is desired to be filtered can be used in the electrically heated cigarette 23, such that only selected molecules that are small enough to pass through the pores of the molecular sieve material are able to enter the cavities and be sorbed on the zeolite.

The zeolite can be, but is not limited to, one or more of zeolite A; zeolite X; zeolite Y; zeolite K-G; zeolite ZK-5; zeolite BETA; zeolite ZK-4 and zeolite ZSM-5. In a preferred embodiment, zeolite ZSM-5 and/or zeolite BETA is used. ZSM-5 is in the MFI structural classification family and represented by the crystal chemical data $[Na_n(Al_nSi_{96-n}O_{192})\sim16H_2O$, with $n < 27$, orthorhombic, Pnma], while zeolite BETA is in the BEA structural classification family and represented by the crystal chemical data $[Na_7(Al_7Si_{57}O_{128})$ tetragonal, $P4_122]$. These two zeolites are thermally stable at temperatures up to about 800°C, allowing them to be incorporated in cigarette filters and/or the tobacco rod of the electrically heated cigarette 23.

In another preferred embodiment, the sorbent incorporated in the electrically heated cigarette 23 has a composite composition. In such embodiment, the sorbent comprises, for example, activated carbon and one or more molecular sieve materials, such as those described above. For example, sorbent fibers can be impregnated with at least one sorbent.

Microporous, mesoporous, and/or macroporous molecular sieves may be used in the electrically heated cigarette 23, depending on the selected component(s) desired to be removed from mainstream tobacco smoke.

The sorbent can be incorporated in one or more locations of the electrically heated cigarette 23. For example, the sorbent can placed in the passageway of the tubular free-flow filter 74, in the free-flow filter 92, and/or in the void space 90. The sorbent can additionally or alternatively be incorporated in the tobacco plug 80.

FIG. 3 shows another preferred embodiment of an electrically heated cigarette 23 including a filter 150. The filter 150 comprises a sorbent in the form of oriented fibers 152 and a sleeve 154, such as paper, surrounding the fibers. The sorbent can be, for example, one or more of activated carbon, silica gel, zeolite, and other molecular sieves in fibrous forms. The sorbents can be surface modified materials, for example, surface modified silica gel, such as amino propyl silyl (APS) silica gel. Sorbent mixtures can provide different filtration characteristics to achieve a targeted filtered mainstream smoke composition.

Alternatively, the fibers 152 can comprise one or more sorbent materials, such as carbon, silica, zeolite and the like, impregnated in microcavity fibers, such as TRIAD™ micro-cavity fiber, as disclosed in WO-A-+01/80973. In a preferred embodiment, the fibers are shaped microcavity fibers impregnated with particles of one or more sorbent materials, or alternatively continuous activated carbon fibers. The fibers preferably have a diameter of from about 10 microns to about 100 microns. The fibers can have a length of from about 10 microns to about 200 microns, for example.

In another preferred embodiment, the fibers are bundles of non-continuous fibers, which are preferably oriented parallel to the direction of mainstream smoke flow through the electrically heated cigarette.

The filters 150 including fibers 152 can be formed, for example, by stretching a bundle of non-crimped sorbent fiber material, preferably having a controlled total and per filament denier, through a pre-formed or in-situ formed sleeve 154 during the filter making process. The formed filter can be sized by cutting to a desired length. For example, the filters can have a length of from about 5 mm to about 30 mm.

The filter 150 including fibers 152 can be incorporated in the electrically heated cigarette at one or more desired locations. Referring also to FIGS. 1 and 2, in a preferred embodiment, the filter 150 can be substituted for the entire free-flow filter 92. In another preferred embodiment, the free-flow filter 150 can be substituted for

a portion of the free-flow filter 92. The filter 150 can be in contact with (i.e., abut) the free-flow filter 74, positioned between the free-flow filter 74 and the mouthpiece filter plug 94, or in contact with (i.e., abut) the mouthpiece filter plug 94. The filter 150 preferably has a diameter substantially equal to that of the outer diameter of the free-flow filter 92 to minimize by-pass of smoke during the filtration process.

The fibrous sorbents preferably have a high loft with a suitable packing density and fiber length such that parallel pathways are created between fibers. Such structure can effectively remove significant amounts of selected gas-phase constituents, such as formaldehyde and/or acrolein, while preferably removing only a minimal amount of particulate matter from the smoke, thereby achieving a significant reduction of the selected gas-phase constituents, while not significantly affecting the total particulate matter (TPM) in the gas. A sufficiently low packing density and a sufficiently short fiber length are preferred to achieve such filtration performance.

The amount of sorbent used in preferred embodiments of the electrically heated cigarette 23 depends on the amount of selected gas-phase constituents in the tobacco smoke and the amount of the constituents that is desired to be removed from the tobacco smoke.

As described above, the electrically heated cigarette 23 also comprises at least one flavoring-release additive. The flavoring can be, for example, one or more flavorings including, but not limited to, menthol, mint, such as peppermint and spearmint, chocolate, licorice, citrus and other fruit flavors, gamma octalactone, vanillin, ethyl vanillin, breath freshener flavors, spice flavors, such as cinnamon, methyl salicylate, linalool, bergamot oil, geranium oil, lemon oil, ginger oil, and tobacco flavor. In a preferred embodiment, the flavoring is menthol and optionally at least one mint flavoring.

As described above, the flavoring-release additive can have different structures and compositions in the electrically heated cigarette. In one preferred embodiment, the flavoring-release additive is in the form of beads. The beads preferably encapsulate

the flavoring and provide for controlled release of the flavoring in the cigarette during puff cycles.

The beads preferably comprise at least one encapsulating material and at least one flavoring. The encapsulating material preferably comprises a binder, which can be, for example, one or more of palm oil, konjac gum, xylitol, zein, hydroxypropylcellulose, sorbitol, maltitol, and hydroxypropylmethylcellulose. Other materials known in the art that can improve the bead-forming characteristics of the encapsulating material or enhance its stability can optionally also be added in the beads. In a preferred embodiment, the beads have a substantially homogenous composition in which flavoring is substantially uniformly distributed. By such structure, the flavoring can be released from the beads in a more uniform manner during smoking.

Depending on the composition of the beads, the minimum temperature at which the beads release the flavoring can be adjusted. Beads comprising one or more of the above-described binders preferably have a minimum temperature at which the flavoring is released of at least about 40°C, such as about 40°C to about 150°C. The beads protect the flavoring from exposure to undesired substances in the atmosphere (e.g., ambient air, inside a package) and undesired substances in the cigarette, and preferably minimize release and/or migration of the flavoring until the flavoring-release additive is heated to a sufficiently high temperature during smoking of the cigarette. Consequently, the flavoring is preferably substantially prevented from migrating in the cigarette, reacting with other substances in the cigarette or with the environment, and deactivating sorbent present in the cigarette.

The beads can have any desired shape, such as different regular and irregular shapes, including round, square, rectangular, oval, other polygonal shapes, cylindrical, fibrous, and the like. The beads can have various sizes. Preferably, the beads are microbeads having a maximum particle size of less than about 25 microns, and more preferably less than about 1 micron. Decreasing the size of the beads

can provide a more homogenous and controlled release of flavoring by providing increased surface area of the beads.

The beads can be manufactured by any suitable process that produces beads having the desired structure, composition, and size. For example, the beads can be manufactured by extrusion, spray drying, coating, or other suitable processes. In a preferred embodiment, the beads are formed by forming a solution, dispersion or emulsion containing a binder, flavoring and optional additives to form beads, which can be isolated and dried. Processes for preparing beads containing an active ingredient, such as a flavor, are disclosed in US-A-6 325 859, which is incorporated herein by reference in its entirety.

The electrically heated cigarette 23 preferably comprises an amount of the beads that provides a desired amount of the flavoring in the cigarette. In a preferred embodiment, the electrically heated cigarette comprises, based on the total weight of tobacco in the cigarette, up to about 20%, and more preferably about 10% to about 15%, of the beads. For example, a cigarette containing 100 mg of tobacco preferably contains up to about 20 mg of beads. The beads can preferably comprise up to about 20% of flavoring. The cigarette can comprise, for example, from about 1 mg to about 15 mg of flavoring.

In a preferred embodiment, the beads are disposed in at least one location in the electrically heated cigarette 23 that reaches at least the minimum temperature at which the flavoring is released from the beads and into the cigarette during smoking. For example, the beads can be disposed in the tobacco rod 60, in the void 90 between the tobacco plug 80 and the free-flow filter 74, on one or more surfaces of the free-flow filter 74, on or in the mat 66, and/or on or in the inner wrap 84 surrounding the tobacco plug 80.

In another preferred embodiment, different bead compositions having two or more different minimum flavoring-release temperatures can be incorporated at two or more locations in an electrically heated cigarette that reaches different temperatures at such locations during smoking. For example, beads having a first flavoring release temperature can be located at a first location in the cigarette that

reaches the first flavoring-release temperature, and beads having a second flavoring-release temperature higher than the first flavoring-release temperature can be located at a second location in the cigarette that reaches the second flavoring-release temperature. For example, the two flavoring release temperatures can vary by up to about 100°C. For example, these two temperatures can vary by up to about 10°C, 20°C, 30°C, 40°C, 50°C, 60°C, 70°C, 80°C, 90°C, or 100°C.

In another preferred embodiment, the flavoring-release additive includes a film. The film preferably encapsulates the flavoring and enables the controlled temperature release of the flavoring in the cigarette during smoking. In a preferred embodiment, the film comprises by weight up to 20%, more preferably about 10% to about 15%, of the flavoring. In a preferred embodiment, the film encapsulates menthol and optionally also mint.

The film-type flavoring-release additive preferably comprises at least one encapsulating material and at least one flavoring. The encapsulating material preferably comprises a binder, which can be, for example, one or more of carraghenan, gelatin, agar, gellan gum, gum arabic, guar gum, xanthum gum, and pectin. Other materials known in the art that can improve the film-forming characteristics of the encapsulating material or enhance its stability can optionally be added to the film. In a preferred embodiment, the film has a substantially homogenous composition in which flavoring is substantially uniformly distributed. By such structure, the flavoring can be released from the film in a more desired manner during smoking. The film encapsulating material provides a barrier to the release of the flavoring.

Depending on the composition of the film, the minimum temperature at which the film releases the flavoring can be adjusted/selected. A film comprising one or more of the above-described binders preferably has a minimum temperature at which the flavoring is released of at least about 50°C, such as up to about 120°C. The film protects the flavoring from exposure to undesired substances in the cigarette and atmosphere and substantially prevents

the flavoring from being released until the film is heated to the flavoring release temperature during smoking of the cigarette.

The film can be applied to one or more components of the electrically heated cigarette as a liquid coating, which is dried to a film. The dimensions of the dried film are not limited. Preferably, the dried film has a maximum thickness of about 50 microns to about 150 microns, and more preferably about 75 microns.

The film can be manufactured by any suitable process that produces a film having the desired structure, composition, and dimensions. For example, the film can be applied by a coating process, such as spray coating, a dipping process, electrostatic deposition, printing wheel application, gravure printing, ink jet application, and the like. In a preferred embodiment, an emulsion, suspension or slurry comprising the binder, flavoring, and optional additives is prepared and then applied as a coating to one or more selected surfaces of one or more selected components of the electrically heated cigarette. The coating is preferably dried to remove water and/or other solvents and form a solid film having desired dimensions. Exemplary processes that can be used to prepare the films are described in US-A-3 006 347 and commonly-owned US-A-4 715 390, each of which is incorporated herein by reference in its entirety.

The electrically heated cigarette 23 preferably comprises an amount of the film that releases a desired amount of the flavoring during smoking of the cigarette. In a preferred embodiment, the electrically heated cigarette comprises, based on the total weight of tobacco in the cigarette to which the film is applied, up to about 20%, and more preferably about 10% to about 15%, of the film. For example, if the film is applied to the mat, the weight of tobacco contained in the mat preferably is the weight basis for the amount of the film. If the film is applied to the mat and to the tobacco plug, the total weight of tobacco contained in the mat and the tobacco plug preferably is the weight basis for the amount of film applied in the cigarette. Preferably, the weight of tobacco contained in the mat is the weight basis for the amount of film applied to the mat, and the

weight of tobacco contained in the tobacco plug is the weight basis for the amount of film applied to the tobacco plug. In a preferred embodiment, the cigarette can comprise from about 1 mg to about 15 mg of flavoring.

In a preferred embodiment, the film is disposed in at least one location in the electrically heated cigarette 23 that reaches at least the flavoring release temperature. For example, the film can be disposed on the tobacco plug 80, on the inner wrap 84 surrounding the tobacco plug 80, on the mat 66, and/or on the over wrap 71 surrounding the mat. When the film is disposed on the inner wrap 84 and/or over wrap 71, the weight of the inner wrap 84 and/or over wrap 71 is the weight basis for the amount of the film. In another preferred embodiment, the film can be preformed, shredded and incorporated in the tobacco plug 80, and/or other selected locations that reach the flavoring release temperature.

In another preferred embodiment, different flavored films having two or more different minimum flavoring-release temperatures can be incorporated at different locations in an electrically heated cigarette, where during smoking of the cigarette, the temperatures at the different locations exceed the minimum release temperatures of the different films.

In another preferred embodiment, the flavoring-release additive is an inclusion complex. The inclusion complex comprises a "host molecule," and the flavoring is the "guest molecule" in the inclusion complex. The inclusion complex provides for controlled release of the flavoring in the cigarette during smoking. In a preferred embodiment, the flavoring is a lipophilic organic flavoring, which preferably concentrates within a hydrophobic cavity of the host molecule. Suitable flavorings include, but are not limited to, menthol, mint, such as peppermint and spearmint, chocolate, licorice, citrus and other fruit flavors, gamma octalactone, vanillin, ethyl vanillin, breath freshener flavors, spice flavors, such as cinnamon, methyl salicylate, linalool, bergamot oil, geranium oil, lemon oil, ginger oil, and tobacco flavor. In a preferred embodiment, the flavoring includes vanillin and gamma octalactone. In a preferred embodiment,

the inclusion complex comprises by weight up to about 20%, more preferably from about 10% to about 15%, of the flavoring.

The host molecule of the inclusion complex is preferably a cyclodextrin. Cyclodextrins are cyclic oligosaccharides including glucopyranose subunits, as described, for example, in US-A-3 426 011 and commonly-owned US-A-5 144 964, each of which is incorporated herein by reference in its entirety. The inclusion complex is formed when a flavoring material is mixed with a selected cyclodextrin in solution. The flavoring resides inside the cyclodextrin ring structure. The cyclodextrins and flavoring are typically co-precipitated, filtered, and dried.

Alpha-cyclodextrin, beta-cyclodextrin and gamma-cyclodextrin include six, seven and eight glucopyranose subunits, respectively. In a preferred embodiment, the inclusion complex comprises beta-cyclodextrin, which can desirably accommodate a wide variety of guest molecules and is readily available. Beta-cyclodextrin has a ring structure of the linked subunits with a three-dimensional torus configuration including a hydrophobic cavity with a 7.5 Å diameter and hydrophillic upper and lower edges.

The minimum temperature at which the inclusion complex comprising a cyclodextrin releases the flavoring is preferably at least about 60°C, such as from about 60°C to about 125°C. By incorporating the flavoring in the inclusion complex, the flavoring can be protected from exposure to undesired substances in the cigarette and the atmosphere release and/or migration of the flavoring is preferably minimized until the flavoring-release additive is heated to the flavoring release temperature during smoking of the cigarette.

The inclusion complex is preferably in powder form. The powder preferably has maximum size of less than about 200 microns.

The inclusion complex can be made by forming an aqueous solution of beta-cyclodextrin and the flavoring. The inclusion complex can be recovered from the solution in powder form. However, the solution can be applied directly to one or more selected locations of one or more components of the electrically heated cigarette by any suitable process. The inclusion complex powder can alternatively be

used to form a solution or a suspension. The inclusion complex can be applied by a coating process, such as slurry coating, spraying, a dipping process, electrostatic deposition, printing wheel application, gravure printing, ink jet application, and the like. In a preferred embodiment, a solution, suspension or slurry comprising the cyclodextrin and flavoring is prepared and applied as a coating to selected surfaces of selected components of the electrically heated cigarette. Exemplary processes that can be used to apply the inclusion complex in the electrically heated cigarette are described in commonly-owned US-A-5 144 964, which is incorporated herein by reference in its entirety.

The electrically heated cigarette 23 preferably comprises an amount of the inclusion complex that provides a desired amount of the flavoring in the cigarette. In a preferred embodiment, the electrically heated cigarette comprises, based on the weight of the over wrap or mat, up to about 15%, and more preferably less than about 8%, of the inclusion complex. For example, if the inclusion complex is applied to the mat, then the weight of the mat preferably is the weight basis for the amount of the inclusion complex applied to the mat. If the inclusion complex is applied to the mat and the over wrap, then the total weight of the mat and the over wrap preferably is the weight basis for the amount of the inclusion complex applied to the mat and the over wrap. The weight percent of the inclusion complex that is applied to the mat and/or over wrap can be the same or different. In a preferred embodiment, the cigarette comprises from about 1 mg to about 50 mg of flavoring.

In a preferred embodiment, the inclusion complex is disposed in at least one location in the electrically heated cigarette 23 that reaches at least the minimum temperature at which the flavoring is released from the inclusion complex in the cigarette during smoking. For example, the inclusion complex can be disposed on the inner wrap 84, mat 66, and/or the over wrap 71.

In another preferred embodiment, the electrically heated cigarette comprises two or more different types of flavoring-release additives, for example, a bead and a film and/or an inclusion complex,

with each flavoring-release additive having a different flavoring release temperature. The different flavoring-release additives can be incorporated at two or more locations in the same electrically heated cigarette that reach different temperatures during smoking in order to provide further controlled release of the flavoring during smoking.

FIGS. 4 and 5 illustrate a preferred embodiment of an electrical smoking system in which preferred embodiments of the electrically heated cigarette can be used. However, it should be understood that preferred embodiments of the electrically heated cigarette can be used in electrical smoking systems having other constructions, such as those having different electrically powered lighter constructions. The electrical smoking system 21 includes an electrically heated cigarette 23 and a reusable lighter 25. The cigarette 23 is constructed to be inserted into and removed from a cigarette receiver 27, which is open at a front end portion 29 of the lighter 25. Once the cigarette 23 is inserted, the smoking system 21 is used in a similar manner as a more traditional cigarette, but without lighting or smoldering of the cigarette 23. The cigarette 23 is discarded after smoking.

Preferably, each cigarette 23 provides a total of at least eight puffs (puff cycles) per smoke. However, the cigarette 23 can be constructed to provide a lesser or greater total number of available puffs.

The lighter 25 includes a housing 31 having front and rear housing portions 33 and 35, respectively. A power source 35a, such as one or more batteries, is located within the rear housing portion 35 and supplies energy to a heater fixture 39. The heater fixture 39 includes a plurality of electrically resistive, heating elements 37 (FIG. 6). The heating elements 37 are arranged within the front housing portion 33 to slidingly receive the cigarette 23. A stop 183 located in the heater fixture 39 defines a terminal end of the cigarette receiver 27 (FIG. 2).

Control circuitry 41 in the front housing portion 33 selectively establishes electrical communication between the power

source 35a and one or more of the heating elements 37 during each puff cycle.

The rear housing portion 35 of the housing 31 is constructed to be opened and closed to facilitate replacement of the power source 35a. Preferably, the front housing portion 33 is removably attached to the rear housing portion 35 by mechanical engagement.

Referring to FIG. 5, in a preferred embodiment, the control circuitry 41 is activated by a puff-actuated sensor 45, which is sensitive to either changes in pressure or changes in the rate of air flow that occur upon initiation of a draw on the cigarette 23 by a smoker. The puff-actuated sensor 45 is preferably located within the front housing portion 33 of the lighter 25 and communicates with a space inside the heater fixture 39 via a port 45a extending through a side wall portion 182 of the heater fixture 39. Once actuated by the sensor 45, the control circuitry 41 directs electric current to an appropriate one of the heating elements 37.

In a preferred embodiment, an indicator 51 is provided at a location along the exterior of the lighter 25 to visually indicate the number of puffs remaining in a cigarette 23, or other selected information. The indicator 51 preferably includes a liquid crystal display. In a preferred embodiment, the indicator 51 displays a selected image when a cigarette detector 57 detects the presence of a cigarette in the heater fixture 39. The detector 57 can comprise any arrangement that senses the presence of an electrically heated cigarette. For example, the detector can comprise an inductive coil 1102 adjacent the cigarette receiver 27 of the heater fixture 39 and electric leads 1104 that communicate the coil 1102 with an oscillator circuit within the control circuitry 41. In such case, the cigarette 23 can include a metallic element (not shown), which can affect inductance of the coil winding 1102 such that whenever a suitable cigarette 23 is inserted into the receiver 27, the detector 57 generates a signal to the circuitry 41 indicating the cigarette is present. The control circuitry 41 provides a signal to the indicator 51. When the cigarette 23 is removed from the lighter 25, the

cigarette detector 57 no longer detects the presence of a cigarette 23 and the indicator 51 is turned off.

The heater fixture 39 supports an inserted cigarette 23 in a fixed relation to the heating elements 37 such that the heating elements 37 are positioned alongside the cigarette 23 at approximately the same location for each newly inserted cigarette 23. In a preferred embodiment, the heater fixture 39 includes eight mutually parallel heater elements 37, which are disposed concentrically about the axis of symmetry of the cigarette receiver 27. The location where each heating element 37 touches a fully inserted cigarette 23 is referred to herein as the heater footprint or char zone 42.

As shown in FIG. 6, the heating elements 37 preferably each include at least first and second serpentine, elongate members 53a and 53b adjoined at a tip 54. The heater portions 53a, 53b and 54 form a heater blade 120. The tips 54 are adjacent the opening 55 of the cigarette receiver 27. The opposite ends 56a and 56b of each heating element 37 are electrically connected to the opposite poles of the power source 35a as selectively established by the controller 41. An electrical pathway through each heating element 37 is established, respectively, through a terminal pin 104, a connection 121 between the pin 104 and a free end portion 56a of one of the serpentine members 53a, through at least a portion of the tip 54 to the other serpentine member 53b and its end portion 56b. Preferably, a connection ring 110 provides a common electrical connection to each of the end portions 56b. In a preferred embodiment, the ring 110 is connected to the positive terminal of the power source 35a through a connection 123 between the ring 110 and a pin 105.

Preferably, the heating elements 37 are individually energized by the power source 35a under the control of the control circuitry 41 to heat the cigarette 23 preferably eight times at spaced locations about the periphery of the cigarette 23. The heating renders eight puffs from the cigarette 23, as is commonly achieved with the smoking of a more traditional cigarette. It may be preferred to activate more than one heating element simultaneously for one or more or all of the puffs.

The heater fixture 39 includes an air inlet port 1200 through which air is drawn into the lighter. A pressure drop is induced upon the air entering the lighter such that the puff sensor 45 is operative to recognize initiation of a puff. The range of pressure drop induced is selected such that it is within the range of pressure drop detectable by the pressure sensor 45.

The length of the tobacco plug 80 and its relative position along the tobacco rod 60 is preferably selected based on the construction and location of the heating elements 37 of the electrical smoking system 21. When a cigarette 23 is properly positioned against a stop 182 (FIG. 2) within the lighter of the electrical smoking system, a portion of each heating element contacts the tobacco rod 60. This region of contact is referred to as a heater footprint 95, which is that region of the tobacco rod 60 where the heating element 37 is expected to reach a temperature high enough to allow smoking of the cigarette without combustion of the cigarette paper, mat or tobacco. The heater foot print 95 can consistently locate along the tobacco rod 60 at the same predetermined distance 96 from the free end 78 of the tobacco rod 60 for every cigarette 23 that is fully inserted into the lighter 25.

Preferably, the length of the tobacco plug 80 of the cigarette 23, the length of the heater footprint 95, and the distance between the heater footprint 95 and the stop 182 are selected such that the heater footprint 95 extends beyond the tobacco plug 80 and superposes a portion of the void 91 by a distance 98. The distance 98 is also referred to as the "heater-void overlap" 98. The distance over which the remainder of the heater footprint 95 superposes the tobacco plug 80 is referred to as the "heater-filler overlap" 99.

The length of the void 91, tobacco plug 80, and the distribution of the perforation holes 263 may be adjusted to adjust the smoking characteristics of the cigarette 23, including adjustments in its taste, draw and delivery. The pattern of holes 263, the length of the void 90 and the amount of heater-filler overlap 99 (and heater-void overlap 98) may also be manipulated to adjust the immediacy of response, to promote consistency in delivery.

Electrically heated cigarettes according to preferred embodiments can provide advantages. By encapsulating one or more added flavorings, especially volatile flavoring, the flavoring(s) can be retained in the cigarette until it is smoked. In addition, the flavoring is preferably temperature released in a controlled manner during smoking, thereby providing the smoker with an enhanced subjective characteristic of the cigarette. As the flavoring can be retained in the flavoring-release additive until the cigarette is smoked, deactivation of the sorbent in the cigarette is preferably minimized. Consequently, the sorbent maintains its ability to remove selected gas phase constituents from mainstream smoke.

Preferably, the sorbent comprises creped carbon paper adjacent the mouthpiece plug. In a preferred cigarette, a poly-propylene sleeve is provided about the creped carbon paper which inhibits cigarette to cigarette migration of flavor volatiles and consequent deactivation of the sorbent while the cigarettes are stored in a cigarette pack. If the carbon paper is located in a cellulose acetate tube, the activity level of the carbon could be degraded due to the adsorption of triacitin by the carbon. The carbon paper is available from Schweitzer-Mauduit, and filter plugs comprising the poly-propylene sleeve and carbon paper are obtainable from Filtrona. Electrically heated cigarettes containing a sorbent comprising creped carbon paper in a poly-propylene sleeve, located in a filter of the cigarette, exhibit desirable RTD.

FIGS. 7 and 8 show other preferred embodiments of an electrically heated cigarette 23 including a filter 150. The filter 150 comprises a sorbent in the form of creped carbon paper and a poly-propylene sleeve 154 surrounding the creped carbon paper. In FIG. 7, a free-flow filter 74 is in contact with (i.e., abut) a free-flow filter 92, which is in contact with (i.e., abut) the filter 150, which is in contact with (i.e., abut) a mouthpiece filter plug 94. Alternatively, in FIG. 8, the free-flow filter 74 is in contact with (i.e., abut) a solid segment 151, similar to the mouthpiece filter plug 94, which is in contact with (i.e., abut) the filter 150, which is in contact with (i.e., abut) the mouthpiece filter plug 94.

In an embodiment, flavoring-release additive is located in the tobacco mat, which surrounds the tobacco plug. The tobacco plug is preferably free of flavoring-release additive, which allows cigarette manufacture with the same blend of tobaccos in the tobacco plug for either menthol or non-menthol cigarettes. Having the flavor in the tobacco mat preferably provides a more efficient delivery of flavors during smoking and a more immediate delivery of flavors during initiation of a puff. As explained in commonly-owned US-A-5 692 525, the length of the tobacco plug, void and heater-filler overlap can be adjusted to provide a desired taste, draw and delivery as well as immediacy of response and/or consistency of delivery.

The encapsulation and placement of flavors within the matrix of the tobacco mat also reduces the tendency of volatile flavors such as menthol to migrate from the tobacco rod into the carbon bearing portion of the filter. Accordingly, the activity level of the carbon has enhanced shelf life and maintenance of its activity level.

Menthol flavoring is preferably provided in the form of a temperature sensitive powder, such as a multi-stage dried (MSD) powder. By using additive materials in the form of temperature sensitive powders such as MSD powders, the additive materials can be stored with reduced migration properties and can be controllably released upon an application of a predetermined stimulus mechanism, such as heat. Thus, the additive materials in the temperature sensitive powders such as MSD powder can have decreased levels of evaporation and migration over time within the smoking article because of the properties rendered by the use of temperature sensitive powder. Suitable menthol-containing powders can be obtained from Mane SA located in Le Bar Sur Loup, France.

In a MSD process, additive materials are generally formed by spray drying, fluid bed drying and/or belt drying in multiple steps to form MSD powder. In order to maintain the effectiveness of the additive materials, the drying is completed at low temperature, where the temperature is effective to dry but does not harm the additive materials being dried. For example, if the MSD powder contains a flavorant, then drying temperatures used in making the MSD powder are

below the flavorants' volatilization temperature. For example, MSD powder containing flavorants can be dried in multiple stages at temperatures such as 20-50°C, 50-100°C, 100-150°C or 150-200°C.

Also, if spray drying is utilized, for example, the additive materials can be atomized from a liquid feed into a spray of droplets, wherein the droplets can be placed in contact with a first temperature drying air in a process chamber to remove moisture. Next, the droplets can be further dried in a second temperature drying air to form dry temperature sensitive powder. Preferably, the second temperature is cooler than the first temperature, but is still sufficiently warm enough to provide effective drying properties. For example, an additive material, such as menthol with a volatilization temperature about 250°F, can be sprayed onto a substrate then passed through a tunnel drier at 200°F to flash off a majority of the liquid, then can be air dried at room temperature to form a final temperature sensitive powder.

As the powder is temperature sensitive, the powder contains and reduces migration of the additive material until a temperature change occurs, such as when heat is applied. For example, a flavorant additive material in a temperature sensitive powder in a cigarette can be used for encapsulating and/or isolating the flavorant from other parts of the cigarette, such as a sorbent, until a sufficient amount of heat is applied to release the flavorant from the temperature sensitive powder.

Consequently, the temperature sensitive powder can be used effectively in smoking articles, which include sorbents, where the additive materials would otherwise be sorbed by the sorbents. The use of temperature sensitive powder allows additive materials to be released upon smoking of a cigarette while not being released during storage, and also allows for the additive materials to modify smoke properties from the cigarette.

Using additive materials, such as flavors, in temperature sensitive powders, such as MSD powders, in a smoking article provides advantages particularly for cigarettes containing sorbents. By using the temperature sensitive powders, such as MSD powders, in cigarettes

containing sorbents, sorption of the additive materials in the temperature sensitive powders by the sorbents is substantially prevented and controlled release of the additive materials is provided.

For purposes of discussion the term "MSD powder" will be used to describe the temperature sensitive powder even though any temperature sensitive powder capable of controllably releasing additive materials is contemplated herein. However, it is also noted that MSD powder is a preferred temperature sensitive powder due to its manufacturing ease and consistency.

The term "temperature sensitive" is used herein to refer to a temperature controlled response by a powder. For example, as used herein, a temperature sensitive powder containing additive materials releases the additive materials when a predetermined amount of heat is applied to release additive properties from the temperature sensitive powder.

The terms "releasably disposed" or "controllably released" are used herein to refer to the containment and controlled release of additive materials properties from their MSD powder form. In the MSD powder form, the additive materials are sufficiently contained to substantially avoid or minimize unwanted migration, such as, for example, during storage of the smoking article with the MSD powder therein. This term also includes, but is not limited to, the additive materials in the MSD powder form being mobile enough to be controllably released when, for example, the MSD powder is subjected to heat or combustion.

The MSD powder is a temperature sensitive powder, as mentioned above, where the additive materials can emanate from the MSD powder due to melting or other heat interactions with the powder. The temperature sensitive characteristics of the additive materials and the other constituents of the MSD powder allow for the additive materials to be controllably released with heat. For example, if liquid menthol is incorporated into a MSD powder, where starch in combination with a MSD process is used to form a MSD powder, the

temperature at which the menthol liquefies is the critical temperature for releasing (by melting) the menthol from the MSD powder.

The MSD powder is preferably incorporated into a tobacco mat to provide encapsulated flavor that has reduced storage migration properties with controlled release properties.

The MSD powder can include any material in addition to the additive materials that will allow and potentially aid the controlled release of the additive material or affect the properties of the additive materials or the MDS powder upon application of heat or burning. For example, the MSD powder can include spray dryable products, preferably food grade spray dryable products, such as starch, sorbitol, maltodextrin or the like, which can provide encapsulation of the additive materials, such as menthol, while not significantly modifying desired characteristics, such as menthol flavor, in the additive materials.

The MSD powder may be formed by any suitable MSD powder forming technique, such as spray drying, fluid bed drying and/or belt drying, where the drying is completed at temperatures below the melting or volatilization levels of the additive materials and/or the MSD powder, in order to produce additive materials in dried powder form. Should too high a temperature be used, the additive material and/or the MSD powder may melt or volatilize during processing and cause agglomeration of the MSD powder or release of the additive materials from the MSD powder form.

MSD powder with additive materials therein are formed by a multi-stage drying process. In an exemplary multi-stage drying process, an additive material is provided in liquid form, and then sprayed through pressure nozzles or a rotary atomizer into heated air at a first temperature to form droplets, where the heated air removes excess liquid to form semi-dried droplets. Next, the semi-dried droplets are fed into a secondary drying area, which is heated at a second temperature different from the first temperature, where the secondary drying area is used to remove excess liquid and dry the semi-dried droplets into MSD powder. In this way, liquid or viscous products, such as liquid menthol (with emulsifiers and spray dryable products)

can be converted into dried, heat sensitive powder, where improved retention of the properties of the liquid products can be accomplished.

A preferred method of making a MSD powder which provides an encapsulated additive material includes liquefying an additive material and mixing the liquefied additive material with an emulsifier, such as modified food starch, to form an emulsion. The additive material can be a liquid or viscous additive, such as liquid menthol, or can be a solid additive, where the solid additive can be liquefied through the use of solvent, heat, or other liquefying methods.

The emulsion can then be mixed with a powder or other spray dryable media, such as maltodextrin and/or sorbitol, where the powder encapsulates the emulsion of additive and emulsifier. Next, the mixture of emulsion and powder can be sprayed and dried. Preferably, the drying occurs in two stages. First, the sprayed mixture can be sprayed through a heated air drier at a first temperature to remove a majority of the liquid. Second, the sprayed mixture can be dried at a second temperature for removing the remainder of the liquid from the powder. Preferably, the first temperature is hotter than the second temperature to reduce any damage that may be caused by prolonged exposure to the higher temperature while allowing for efficient drying of the final product. By using a plurality of temperature stages, the additive material can be encapsulated and dried to a MSD powder, where the additive material is releasably disposed in the MSD powder.

A tobacco mat is preferably formed by using a paper making-type process to form a base web while concurrently or thereafter applying a tobacco flavor material onto the base web. In the first portion of this process, tobacco strip is washed with water and the solubles are collected for use in a later coating step. The remaining (extracted) tobacco fiber is used in the preparation of a slurry that will be used in web/paper forming techniques to form the base web. To strengthen the base web, carbon fibers may be added to the slurry by dispersing a stock of carbon fibers in water and adding, for example, sodium alginate, to promote dispersion. The carbon fiber dispersion is then

added (optionally) to the tobacco-fiber slurry together with (optionally) conventional flavors. Any other hydrocolloid, may be added in lieu of the sodium alginate as long as it preferably does not interfere with the flavored tobacco response, is water soluble and has a suitable molecular weight to impart strength to the tobacco mat. The resultant mixture is then wet-laid onto a Fourdrinier wire of a conventional paper-making machine or the like (such as a steel belt) to form a base web. The solubles previously removed by washing the tobacco strip are mixed with ground tobacco, and the mixture is coated onto one side of the base web, preferably with a standard reverse roll coater located after a drum or Yankee dryer beyond the Fourdrinier wire. The ratio of tobacco solubles to tobacco dust or particulates in the added slurry is preferably set at a value between about 1:1 and 20:1, but preferably at or about 4 to 1. The added slurry may also be cast or extruded onto the base web. Alternatively, the coating step may be executed off-line separate from the production of the base web. During or after the coating step, flavors that are conventional in the cigarette industry are preferably added. Pectin or other hydrocolloids are added, preferably in a range of between 0.1 to 2.0% by weight of the tobacco mat, to improve the coatability of the slurry.

A preferred method of incorporating a flavoring-release additive such as MSD powder into a tobacco mat is provided, where the tobacco mat includes a flavoring-release additive such as MSD powder in a layer on the tobacco mat for controlled release when a cigarette incorporating the tobacco mat is smoked. A preferred method includes forming a tobacco mat by forming a base web, then applying a slurry of a flavoring-release additive such as MSD powder and a liquid, preferably water, onto the base web, where the base web includes ground tobacco. The slurry can be spread across the tobacco mat. Finally, the slurry can be dried through exposure to ambient air, or can be dried by applying heat to the slurry, where the temperature of the heat applied is effective to not melt or volatilize the additive material in the flavoring-release additive.

Preferably, the slurry of a flavoring-release additive such as MSD powder and liquid is prepared just prior to application onto the base web, so as to minimize the amount of time that the flavoring-release additive is contained in the slurry, in order to avoid volatilization of the additive material. More generically, the heat-activated flavoring-release additive preferably has a low solubility in water so as to be compatible with the process of tobacco mat-making or the process of incorporating the flavoring-release additive in a tobacco mat. The temperature of the slurry is preferably maintained at a suitable temperature such as 80 to 100°F or about 90°F in order to prevent crystallization of the additive material, such as menthol, at lower temperatures and volatilization of the additive material at higher temperatures.

Additionally, glycerine, pectin, and tobacco dust can also be used in the wet slurry for structural and aesthetic purposes, where the slurry can be spread with a doctor's knife (blade) to provide a relatively uniform thickness for the tobacco mat.

A preferred method of making an encapsulating film on a tobacco mat containing MSD powder is also provided, where the film allows further reduction in migration of additive materials in the MSD powder into a smoking article. By providing the film, the MSD powder can be further isolated from other portions of a smoking article or other smoking articles when packaged together thus reducing any interaction between the additive material and the other portions of the smoking article. The preferred method includes forming a tobacco mat, then spraying a film onto the mat with a spray nozzle where the temperature of the film in the spray nozzle is between 120°F and 160°F, more preferably about 140°F, during spraying. Next, the film can be put in a drier to expedite and complete drying, where the temperature in the drier does not cause the film or the MSD powder to melt, burn or be otherwise adversely affected.

A preferred embodiment of making a cigarette with MSD powder is provided, where the MSD powder allows for controlled release of additive materials to the cigarette when the cigarette is smoked. A preferred method includes grinding tobacco and removing the tobacco

liquid, also known as the concentrated extract liquor (CEL). Next, the remaining tobacco solids can be mixed with cellulose or the like to form a base web. Then, slurry including the MSD powder, CEL, glycerine and/or pectin can be formed on the base web to form a MSD powder layer on the base web.

Next, an optional layer of a tobacco dust can be applied and spread across the base web on the slurry to provide further aesthetic enhancements, such as additional tobacco flavoring, where the base web and slurry can then be dried. Finally, a film, preferably of carrageenan or another relatively flavorless, heat responsive, food grade film can be formed on the dried base web with the dried slurry layer to seal the slurry constituents including the MSD powder, CEL, glycerine and/or pectin under the film and thus prevent migration of any portion of the base web or slurry including the MSD powder.

A preferred embodiment of making a tobacco mat including MSD powder for a cigarette is provided, where the MSD powder allows flavor components of tobacco smoke to be releasably disposed in the tobacco mat. A preferred method includes forming a tobacco mat with MSD powder incorporated therein by mixing the MSD powder with tobacco, then forming a tobacco mat from the mixture. Preferably, the tobacco is ground or reconstituted tobacco such that the tobacco and the MSD powder are miscible prior to forming the tobacco mat from the tobacco and the MSD powder.

Preferably, the tobacco mat is formed such that the width of the formed tobacco mat is greater than a width of the tobacco mat used in a cigarette. For example, a tobacco mat can be formed about 12 to 18 inches wide.

Additionally, a film can optionally be sprayed onto the tobacco mat using a spray nozzle, where the film is preferably heated to liquefy the film material. For example, if carrageenan is used for the film, the carrageenan can be heated to between about 120°F and 160°F, more preferably about 140°F to provide a desirable spraying viscosity. Next, the film can be dried in ambient air, or a dryer or a vacuum may be used to enhance the drying process.

After the tobacco mat is formed (and the film formed if desired), the tobacco mat can be slit or cut into sizes for use in a smoking article. For example, if the tobacco mat is to be used in a standard sized non-traditional cigarette, such as cigarettes used in electrically heated cigarette smoking systems, tobacco mat widths of about 23.2 mm would be desired.

Another method of forming a film on a tobacco mat including MSD powder for a cigarette is provided, where the drying process for the film is part of a tobacco mat rolling process. A preferred method includes forming a first bobbin of tobacco mat including the MSD powder prior to the forming of a film thereon. The tobacco mat from the first bobbin can then be unwound from the first bobbin to a second bobbin and wound onto the second bobbin for later incorporation in a cigarette. Between the first and second bobbins as the tobacco mat travels from the first bobbin to the second bobbin, a film can be applied to the tobacco mat. Preferably, the first bobbin is located a distance away from the second bobbin, where the distance allows for the film to dry prior to being rolled into the second bobbin.

Preferably, the film is applied in several lines onto the tobacco mat, where surface tension spreads the film across the surface of the tobacco mat. Optionally, heat can be applied to the film and the tobacco mat to dry the film while the tobacco mat is wound toward and onto the second bobbin; however, preferably, the distance between the first and second bobbins is a distance effective to allow drying of the film between the first and second bobbins without the use of added heat. For example, a distance effective to allow drying of a film made of carrageenan on a tobacco mat about 16 inches wide, is about 33 feet between the first and second bobbin rolls.

Similarly, inclusion complexes comprising beta-cyclodextrin, e.g., for non-menthol cigarettes, are preferably incorporated into tobacco mats, as disclosed above, to provide encapsulated flavor that has reduced storage migration properties with controlled release properties.

The invention may be embodied in other specific forms without departing from the spirit of the invention. Thus, while the invention

has been illustrated and described in accordance with various preferred embodiments, it is recognized that variations and changes may be made therein without departing from the invention as set forth in the claims.

Claims:

1. An electrically heated cigarette for an electrical smoking system, comprising:

at least one sorbent; and

a flavoring-release additive including at least one flavoring releasable in the electrically heated cigarette upon the flavoring-release additive being heated to at least a minimum temperature.

2. The electrically heated cigarette of Claim 1, wherein the sorbent is activated carbon.

3. The electrically heated cigarette of Claim 1, wherein the sorbent is zeolite.

4. The electrically heated cigarette of Claim 1, wherein the flavoring is (i) menthol, or (ii) vanillin and gamma octalactone.

5. The electrically heated cigarette of Claim 1, wherein the flavoring is at least one flavoring selected from the group consisting of menthol, mint, chocolate, licorice, fruit flavors, gamma octalactone, vanillin, ethyl vanillin, breath freshener flavors, spice flavors, methyl salicylate, linalool, bergamot oil, geranium oil, lemon oil, ginger oil, and tobacco flavor.

6. The electrically heated cigarette of Claim 1, wherein the flavoring-release additive is in the form of beads.

7. The electrically heated cigarette of Claim 6, wherein the beads comprise a binder selected from the group consisting of palm oil, konjac gum, hydroxypropylcellulose, xylitol, zein, sorbitol, maltitol, and hydroxypropylmethylcellulose.

8. The electrically heated cigarette of Claim 6, wherein the beads have a maximum particle size of less than about 25 microns.

9. The electrically heated cigarette of Claim 8, wherein the beads have a maximum particle size of less than about 1 micron.

10. The electrically heated cigarette of Claim 6, which comprises, based on the total weight of tobacco in the electrically heated cigarette, up to about 20% by weight of the beads.

11. The electrically heated cigarette of Claim 6, wherein the beads comprise by weight up to about 20% of the flavoring.

12. The electrically heated cigarette of Claim 6, wherein the minimum temperature is about 40°C and the beads are disposed in at least one location in the electrically heated cigarette that reaches at least about 40°C during smoking of the cigarette.

13. The electrically heated cigarette of Claim 6, wherein the beads are disposed in a tobacco rod, in a void between a tobacco plug and a free-flow filter, on a free-flow filter, on a tobacco-containing mat, and/or on an inner wrap surrounding the tobacco plug.

14. The electrically heated cigarette of Claim 1, wherein the flavoring-release additive is a film.

15. The electrically heated cigarette of Claim 14, wherein the film comprises a binder selected from the group consisting of carraghenan, gelatin, agar, gellan gum, gum arabic, guar gum, xanthum gum, and pectin.

16. The electrically heated cigarette of Claim 14, wherein the film has a thickness of less than about 150 microns.

17. The electrically heated cigarette of Claim 14, which comprises, based on the total weight of tobacco in the electrically heated cigarette, up to about 20% by weight of the film.

18. The electrically heated cigarette of Claim 14, wherein the film comprises by weight up to about 20% of the flavoring.

19. The electrically heated cigarette of Claim 14, wherein the film is in shredded form.

20. The electrically heated cigarette of Claim 14, wherein the minimum temperature is about 50°C, and the film is disposed in at least one location in the electrically heated cigarette that reaches at least about 50°C during smoking of the cigarette.

21. The electrically heated cigarette of Claim 14, wherein the film is disposed in a tobacco plug, on an inner wrap surrounding the tobacco plug, on a tobacco-containing mat, and/or on an over wrap surrounding the mat.

22. The electrically heated cigarette of Claim 1, wherein the flavoring-release additive is an inclusion complex which includes a host molecule and the flavoring is a guest molecule in the inclusion complex.

23. The electrically heated cigarette of Claim 22, wherein the host molecule is beta-cyclodextrin.

24. The electrically heated cigarette of Claim 22, which comprises, based on the weight of an over wrap and/or mat, less than about 15% by weight of the inclusion complex.

25. The electrically heated cigarette of Claim 22, wherein the inclusion complex comprises up to about 20% of the flavoring.

26. The electrically heated cigarette of Claim 22, wherein the minimum temperature is about 60°C, and the inclusion complex is disposed in at least one location in the electrically heated cigarette that reaches at least about 60°C during smoking of the cigarette.

27. The electrically heated cigarette of Claim 22, wherein the flavoring-release additive is disposed on an inner wrap surrounding a tobacco plug, on a tobacco-containing mat, and/or on an over wrap surrounding the mat.

28. The electrically heated cigarette of Claim 1, wherein the sorbent is fibers.

29. The electrically heated cigarette of Claim 28, wherein the fibers are continuous or non-continuous fibers.

30. The electrically heated cigarette of Claim 28, wherein the fibers are impregnated with at least one sorbent.

31. A method of making an electrically heated cigarette according to Claim 1, comprising incorporating into an electrically heated cigarette (a) the at least one sorbent, and (b) the flavoring-release additive including at least one flavoring releasable in the electrically heated cigarette upon the flavoring-release additive being heated to at least the minimum temperature.

32. A method of smoking the electrically heated cigarette of Claim 1, comprising heating a portion of the electrically heated cigarette to form smoke and drawing the smoke through the electrically heated cigarette, the sorbent removing at least one selected gas-phase constituent from mainstream smoke.

33. An electrical smoking system, comprising:

a lighter; and

at least one electrically heated cigarette including:

at least one sorbent; and

a flavoring-release additive including at least one flavoring which is releasable in the electrically heated cigarette upon the flavoring-release additive being heated to at least a minimum temperature.

34. An electrically heated cigarette, comprising:

at least one sorbent; and

at least one flavoring-release additive in a form selected from the group consisting of beads, film, and an inclusion complex, each flavoring-release additive including at least one flavoring releasable in the electrically heated cigarette upon the flavoring-release additive being heated to at least a minimum temperature.

35. The electrically heated cigarette of Claim 34, wherein the flavoring-release additive comprises at least two flavoring-release additives in the form of beads, film, and/or an inclusion complex, each flavoring-release additive having a different minimum temperature at which the flavoring is released during smoking of the electrically heated cigarette.

36. A method of making an electrically heated cigarette according to Claim 34, comprising incorporating into an electrically heated cigarette (a) the at least one sorbent, and (b) the at least one flavoring-release additive in the form of beads, film, and/or an inclusion complex, the flavoring-release additive including at least one flavoring releasable in the electrically heated cigarette upon the flavoring-release additive being heated to at least the minimum temperature.

37. A method of smoking the electrically heated cigarette of Claim 34, comprising heating a portion of the electrically heated cigarette to form smoke and drawing the smoke through the electrically heated cigarette, the sorbent removing at least one selected gas-phase constituent from mainstream smoke.

38. The electrically heated cigarette of Claim 1, wherein the sorbent comprises creped carbon paper, wherein the creped carbon paper is located in a poly-propylene sleeve, which is located in a filter of the electrically heated cigarette.

39. The electrically heated cigarette of Claim 1, wherein the flavoring-release additive is located in a tobacco mat, which surrounds a tobacco plug.

40. The electrically heated cigarette of Claim 39, wherein the tobacco plug is free of flavoring-release additive.

41. The electrically heated cigarette of Claim 39, wherein the flavoring-release additive comprises an inclusion complex comprising beta-cyclodextrin incorporated into the tobacco mat.

42. The electrically heated cigarette of Claim 41, wherein the flavoring-release additive comprises non-menthol flavoring.

43. The electrically heated cigarette of Claim 39, wherein the flavoring-release additive comprises a multi-stage dried powder incorporated into the tobacco mat.

44. The electrically heated cigarette of Claim 43, wherein the flavoring-release additive comprises menthol flavoring.

45. A cigarette of an electrical smoking system comprising:

a tobacco rod comprising a plug of tobacco adjacent a first end of said tobacco rod, a tubular tobacco mat disposed about said tobacco plug and a flavoring release additive located along said tobacco mat;

said tubular tobacco mat including a tobacco mat portion at least partially surrounding a void located within said tobacco rod;

said tobacco plug being essentially free of flavoring release additive;

at least some of said flavoring release additive adjacent said void so as to be releaseable from said tobacco mat portion into said void upon heating of said tobacco mat portion so as to achieve an immediate flavored tobacco response from said cigarette.

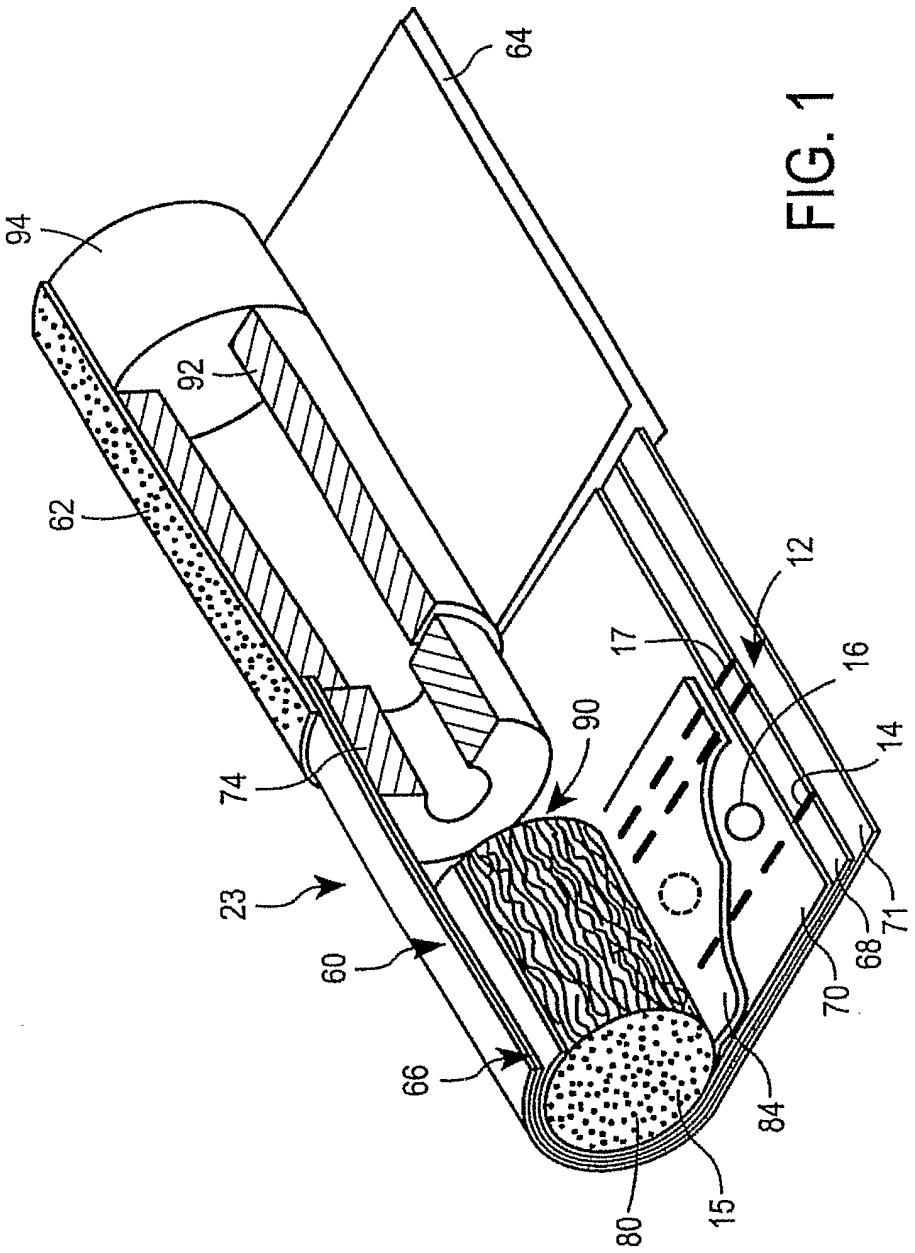


FIG. 1

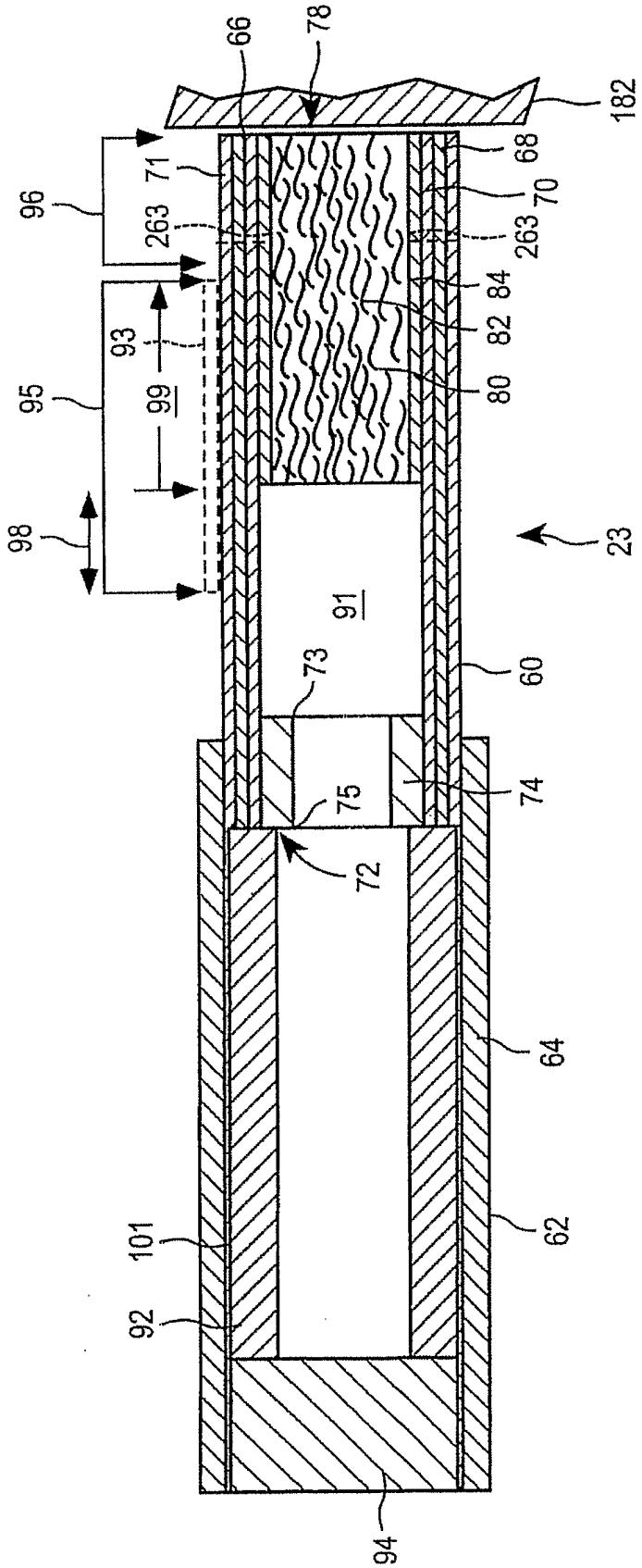

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FIG. 2

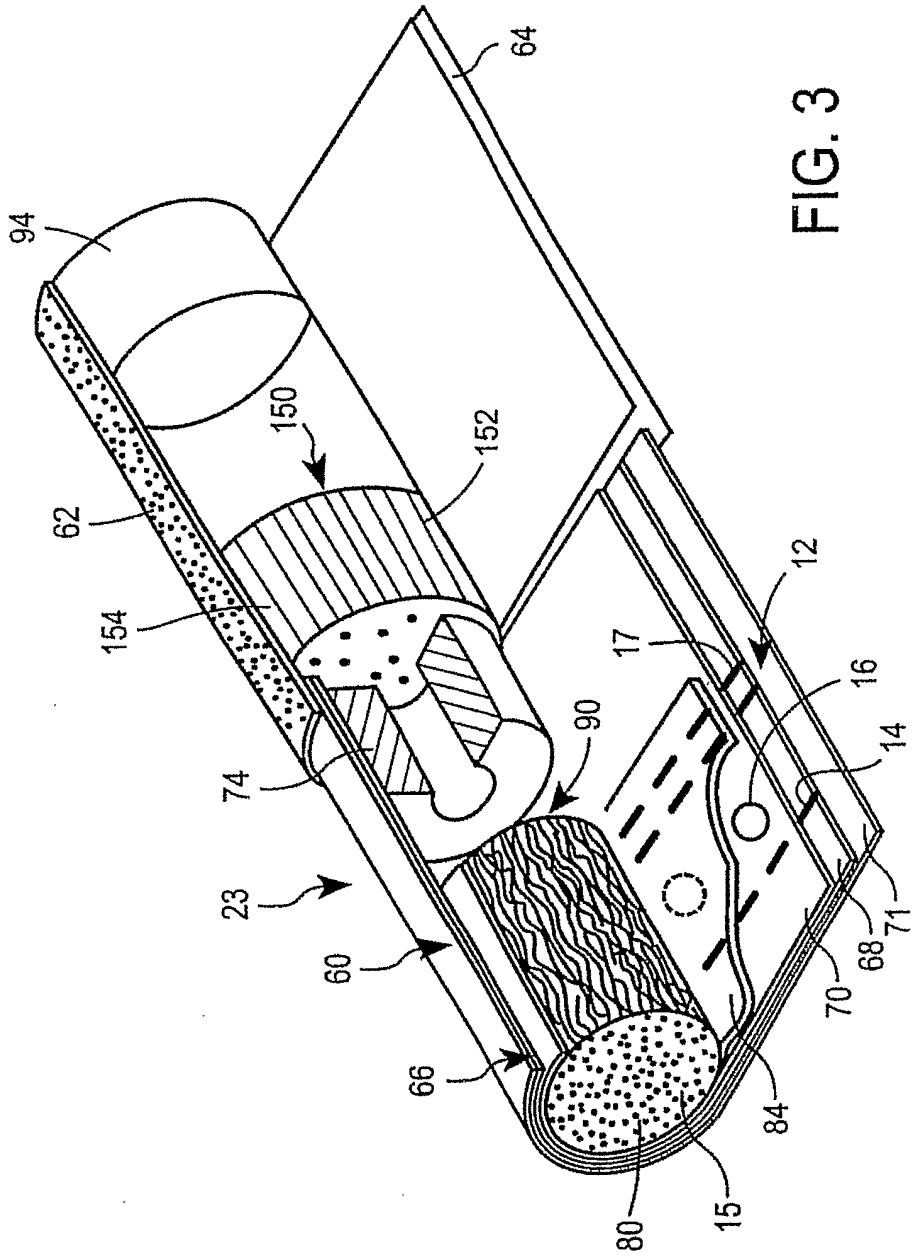


FIG. 3

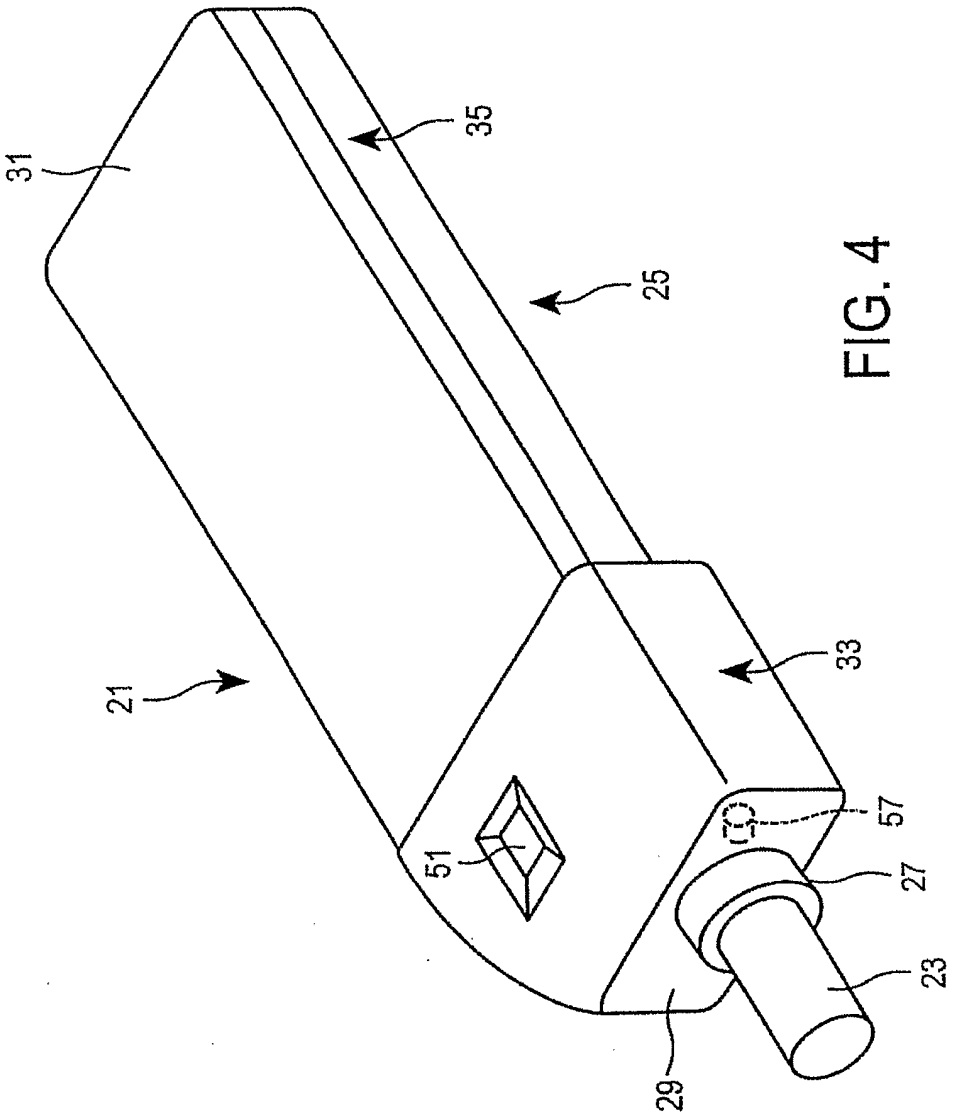


FIG. 4

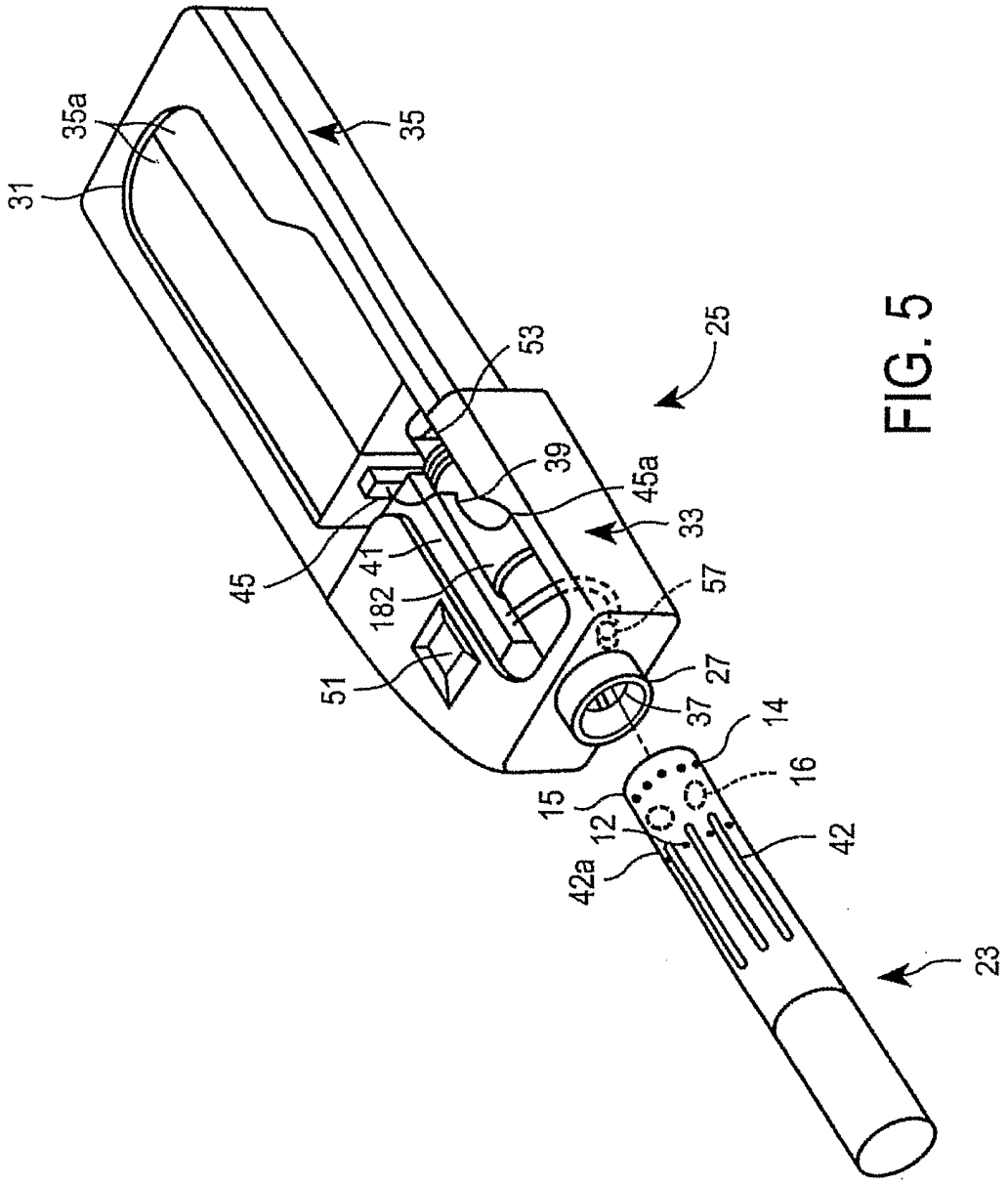


FIG. 5

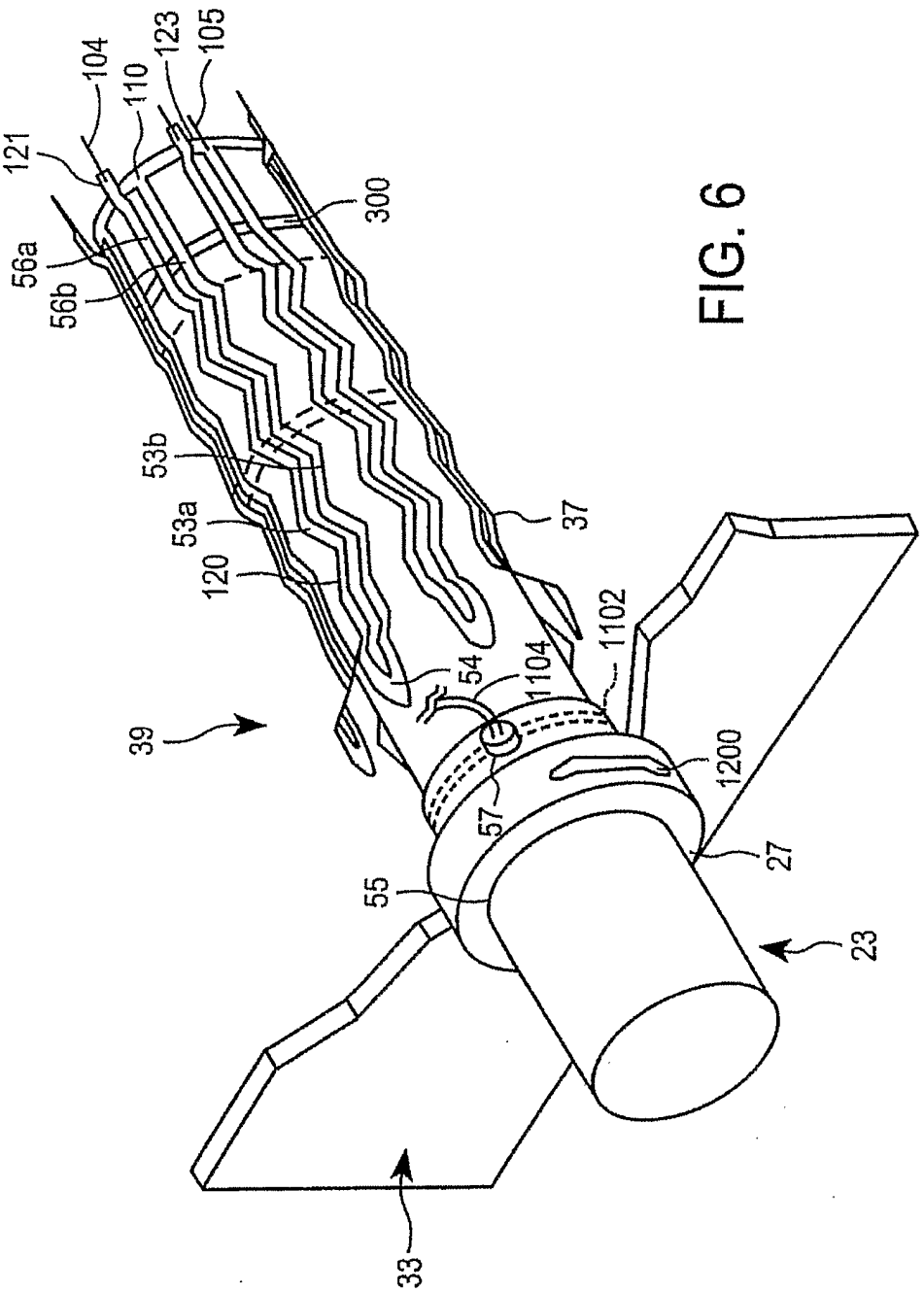

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FIG. 6

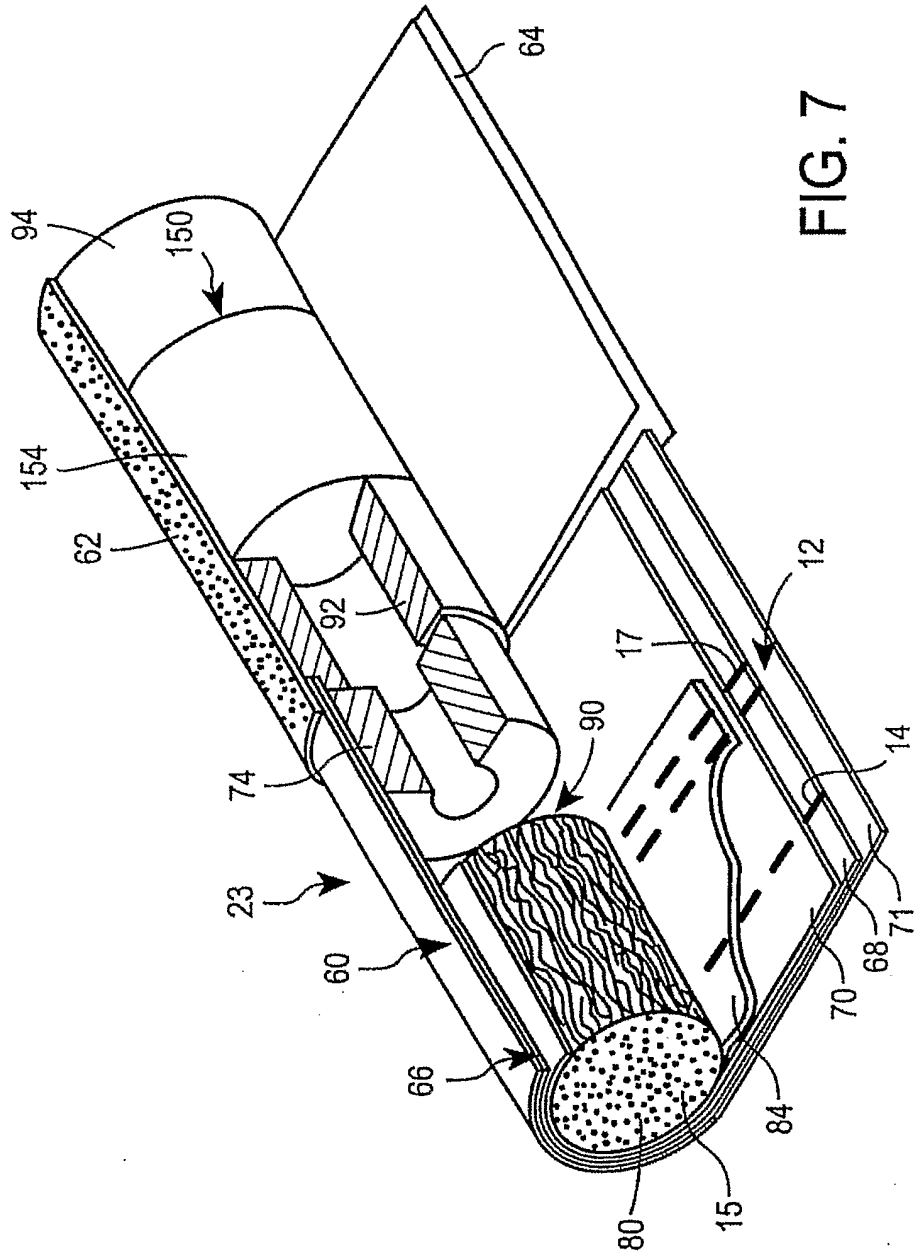


FIG. 7

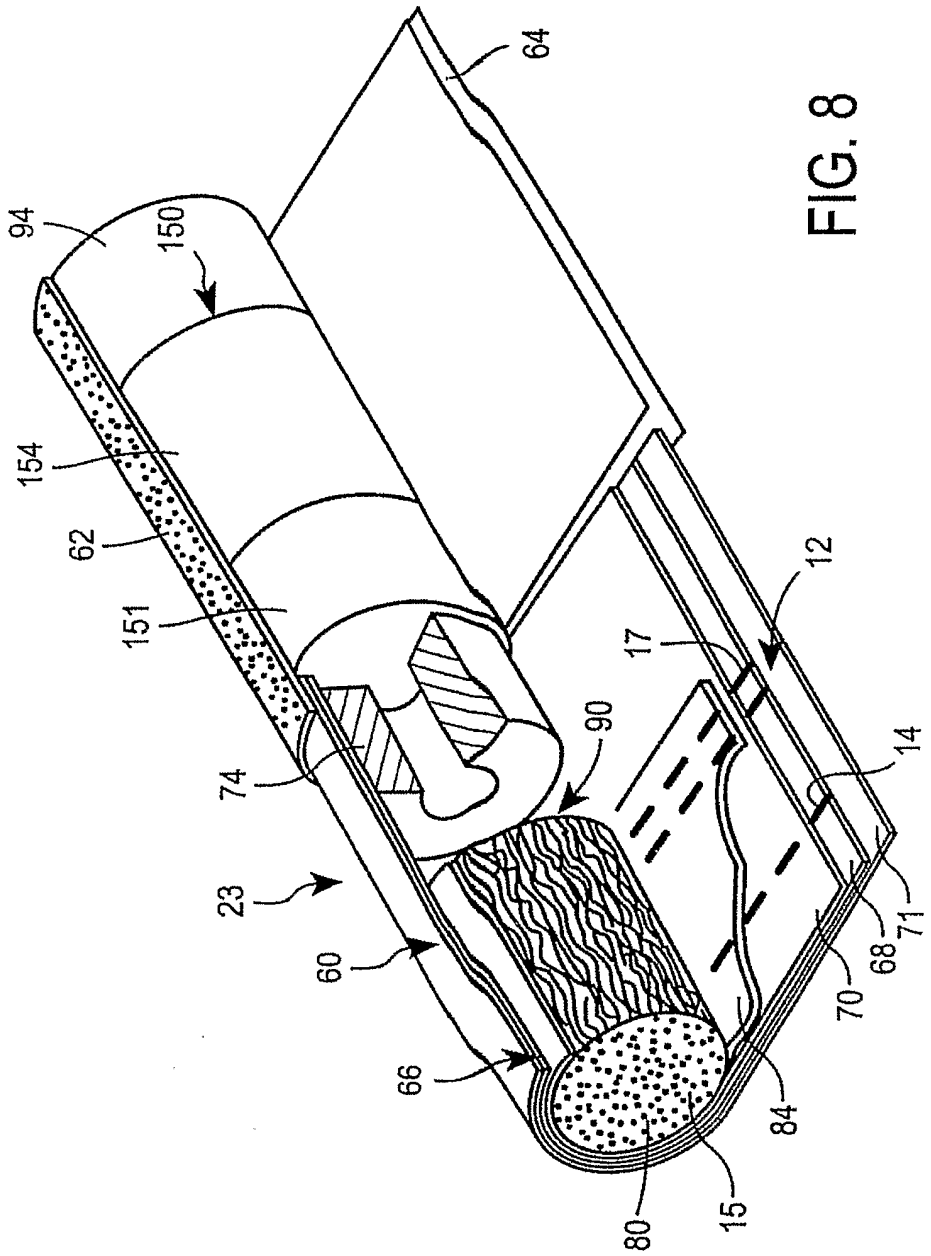


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
.../IB2005/003617

A. CLASSIFICATION OF SUBJECT MATTER
A24F47/00 A24B15/28

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A24F A24B A24D

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 2004/041007 A (PHILIP MORRIS PRODUCTS S.A; WOODSON, BEVERLEY, C; NEWMAN, DEBORAH, J) 21 May 2004 (2004-05-21) the whole document	1-37, 39-42,45 43,44
Y	US 4 068 671 A (CASEY ET AL) 17 January 1978 (1978-01-17) column 2, line 20 - column 4, line 37	43,44
A	WO 03/041521 A (VECTOR TOBACCO INC; SHI, XULING) 22 May 2003 (2003-05-22) page 13, line 5 - page 18, line 19	43,44
A	GB 1 208 465 A (CESKOSLOVENSKA AKADEMIE VED) 14 October 1970 (1970-10-14) example 1	38

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

[X] See patent family annex.

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

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

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

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

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

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Date of the actual completion of the international search	Date of mailing of the international search report
23 February 2006	06/03/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	MARZANO MONTEROSSO

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INTERNATIONAL SEARCH REPORT

International application No
.../IB2005/003617

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 026 820 A (BAGGETT, JR. ET AL) 22 February 2000 (2000-02-22) cited in the application the whole document -----	38-45

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2005/003617

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2004041007 A	21-05-2004	AU 2003284199 A1	07-06-2004
		BR 0315829 A	13-09-2005
		CA 2502171 A1	21-05-2004
		CN 1708241 A	14-12-2005
		EP 1555898 A2	27-07-2005
US 4068671 A	17-01-1978	NONE	
WO 03041521 A	22-05-2003	EP 1441603 A2	04-08-2004
		JP 2005508648 T	07-04-2005
GB 1208465 A	14-10-1970	CS 162852 B1	15-07-1975
US 6026820 A	22-02-2000	NONE	