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(54) TUBULAR HEATER FOR USE IN AN ELECTRICAL SMOKING ARTICLE

RÖHRENOFEN FÜR EINEN ELEKTRISCHEN RAUCHARTIKEL

DISPOSITIF DE CHAUFFE TUBULAIRE A UTILISER DANS UN ARTICLE ELECTRIQUE POUR FUMEURS

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Description

Technical Field of the Invention

[0001] The present invention relates generally to heaters for use in an electrical smoking article and more particularly to a tubular heater for use in an electrical smoking article.

Discussion of the Related Art

[0002] Previously known conventional smoking devices deliver flavor and aroma to the user as a result of combustion of tobacco. A mass of combustible material, primarily tobacco, is oxidized as the result of applied heat with typical combustion temperatures in a conventional cigarette being in excess of 800° C during puffing. Heat is drawn through an adjacent mass of tobacco by drawing on the mouth end. During this heating, inefficient oxidation of the combustible material takes place and yields various distillation and pyrolysis products. As these products are drawn through the body of the smoking device toward the mouth of the user, they cool and condense to form an aerosol or vapor which gives the consumer the flavor and aroma associated with smoking.

[0003] Conventional cigarettes have various perceived drawbacks associated with them. Among them is the production of sidestream smoke during smoldering between puffs, which may be objectionable to some non-smokers. Also, once lit, they must be fully consumed or be discarded. Relighting a conventional cigarette is possible but is usually an unattractive prospect for subjective reasons (flavor, taste, odor) to a discerning smoker.

[0004] Prior alternatives to the more conventional cigarettes include those in which the combustible material itself does not directly provide the flavorants to the aerosol inhaled by the smoker. In these smoking articles, a combustible heating element, typically carbonaceous in nature, is combusted to heat air as it is drawn over the heating element and through a zone which contains heatactivated elements that release a flavored aerosol. While this type of smoking device produces little or no sidestream smoke, it still generates products of combustion, and once lit it is not adapted to be snuffed for future use in the conventional sense.

[0005] In both the more conventional and carbon element heated smoking devices described above combustion takes place during their use. This process naturally gives rise to many by-products as the combusted material breaks down and interacts with the surrounding atmosphere.

[0006] Commonly assigned U.S. Patent Nos. 5,093,894; 5,225,498; 5,060,671 and 5,095,921 disclose various electrical resistive heating elements and flavor generating articles which significantly reduce sidestream smoke while permitting the smoker to selec-

tively suspend and reinitiate smoking. However, the cigarette articles disclosed in these patents are not very durable and may collapse, tear or break from extended or heavy handling. In certain circumstances, these prior cigarette articles may crush as they are inserted into the electric lighters. Once they are smoked, they are even weaker and may tear or break as they are removed from the lighter.

[0007] International patent application WO 94/06314, describes an electrical smoking system including a novel electrically powered lighter and novel cigarette that is adapted to cooperate with the lighter. The preferred embodiment of the lighter includes a plurality of metallic sinusoidal heaters disposed in a configuration that slidably receives a tobacco rod portion of the cigarette.

[0008] The preferred embodiment of the cigarette of WO 94/06314 preferably comprises a tobacco-laden tubular carrier, cigarette paper overwrapped about the tubular carrier, an arrangement of flow-through filter plugs at a mouthpiece end of the carrier and a filter plug at the opposite (distal) end of the carrier, which preferably limits air flow axially through the cigarette. The cigarette and the lighter are configured such that when the cigarette is inserted into the lighter, and as individual heaters are activated for each puff, localized charring occurs at spots about the cigarette in the locality where each heater was bearing against the cigarette. Once all the heaters have been activated, these charred spots are closely spaced from one another and encircle a central portion of the carrier portion of the cigarette. Depending on the maximum temperatures and total energies delivered at the heaters, the charred spots manifest more than mere discolorations of the cigarette paper. In most applications, the charring will create at least minute breaks in the cigarette paper and the underlying carrier material, which breaks tends to mechanically weaken the cigarette. For the cigarette to be withdrawn from the lighter, the charred spots must be at least partially slid past the heaters. In aggravated circumstances, such as when the cigarette is wet or toyed with or twisted, the cigarette may be prone to break or leave pieces upon its withdrawal from the lighter. Pieces left in the lighter fixture can interfere with the proper operation of the lighter and/or deliver an off-taste to the smoke of the next cigarette. If the cigarette breaks in two while being withdrawn, the smoker may be faced not only with the frustration of failed cigarette product, but also with the prospect of clearing debris from a clogged lighter before he or she can enjoy another cigarette.

[0009] The preferred embodiment of the cigarette of WO 94/06314 is essentially a hollow tube between the filter plugs at the mouthpiece end of the cigarette and the plug at the distal end. This construction is believed to elevate delivery to the smoker by providing sufficient space into which aerosol can evolve off the carrier with minimal impingement and condensation of the aerosol on any nearby surfaces.

[0010] Several proposals have been advanced which

significantly reduce undesired sidestream smoke while permitting the smoker to suspend smoking of the article for a desired period and then to resume smoking. For example, commonly assigned U.S. Patent Nos. 5,093,894; 5,225,498; 5,060,671 and 5,095,921 disclose various heating elements and flavor generating articles. WO 94/06314 discloses an electrical smoking article having heaters which are actuated upon sensing of a draw by control and logic circuitry. The heaters are preferably a relatively thin serpentine structure to transfer adequate amounts of heat to the cigarette and is lightweight.

[0011] Although these devices and heaters overcome the observed problems and achieve the stated objectives, many embodiments are plagued by the formation of a significant amount of condensation formed as the tobacco flavor medium is heated to form vapors. These vapors can cause problems as they condense on relatively cooler various electrical contacts and the associated control and logic circuitry. In addition, condensation can influence the subjective flavor of the tobacco medium of the cigarette. Though not desiring to be bound by theory, it is believed that the condensation is the result of the flow pattern and pressure gradient of ambient air drawn through the article and the current designs of the heater assemblies. The heating of the tobacco flavor medium releases vapors which are then cooled to result in condensation on the surfaces of relatively cooler components. The condensation can cause shorting and other undesired malfunctions.

[0012] In addition, the proposed heaters are subject to mechanical weakening and possible failure due to stresses induced by inserting and removing the cylindrical tobacco medium and also by adjusting or toying with the inserted cigarette.

[0013] Also, the electrical smoking articles employ electrically resistive heaters which have necessitated relatively complex electrical connections which can be disturbed by insertion and removal of the cigarette.

[0014] According to the invention there is provided a heater for use in a smoking article having a source of electrical energy for heating tobacco flavor medium, the heater comprising:

a substrate of electrically conducting material;
 an electrical insulator deposited on at least a portion of said substrate; and
 an electrically resistive heater element deposited on said electrical insulator, a first end of said heater element being electrically connected to said electrically conducting substrate, wherein a second end of said heater element and a portion of said heater element between the first and second ends of said heater element are electrically insulated from said electrically conducting substrate by said insulator, wherein said substrate and said second end of said heater element are adapted to be electrically connected to the source of electrical energy, wherein a

resistive heating circuit is formed to heat said heating element, which in turn heats the tobacco flavor medium.

[0015] The invention also provides a heater for use in a smoking article having a source of electrical energy for heating a cylindrical cigarette, the heater comprising:

a cylindrical tube, of an electrically conducting material, and provided with a plurality gaps there-through to define (a) a plurality of electrically conducting blades defining a receptacle to receive an inserted cylindrical cigarette and (b) an electrically conducting, common end hub supported within the smoking article, the blades extending from the end hub;

an electrical insulator deposited on at least one of the plurality of electrically conducting blades;
 an electrically resistive heater element deposited on said insulator, a first end of said heater element being electrically connected to the at least one of the plurality of electrically conducting blades, and the second end of said heater element and a portion of said heater element between the first and second ends are electrically insulated from said at least one electrically conducting blade by said insulator;
 wherein said end hub is adapted for electrical contact with the source of electrical energy, and the second end of said heater element is adapted for electrical contact with the source of electrical energy whereby on electrical contact of the end hub and the second end a resistive heating circuit is formed to heat said electrically resistive heater element, which in turn heats the inserted cigarette.

[0016] The invention further provides a method of forming a heater for use in an electrical smoking article for heating a cylindrical cigarette, the method comprising the steps of:

providing an electrically conducting material; forming (a) a plurality of blades from the electrically conducting material having gaps therebetween, and (b) a common end section, the blades extending from the common end section;
 forming an electrical insulator on at least one of the plurality of electrically conducting blades;
 forming an electrically resistive heater on the formed electrical insulator such that a first end of the heater is in electrical contact with the at least one electrically conducting blade;
 forming an electrical contact on a second end of the formed heater; and
 forming the plurality of blades and the common section into a cylindrical receptacle to receive an inserted cigarette.

[0017] A heater embodying the invention has the ad-

vantage of generating from a tobacco medium without sustained combustion.

[0018] Embodiments of the invention may have the advantage that they reduce the creation of undesired sidestream smoke, and the further advantage of permitting the smoker to suspend and resume use.

[0019] Furthermore, the above mentioned advantages may be obtained while reducing aerosol or smoke condensation within the smoking article.

[0020] A preferred embodiment of the invention may have the advantage of providing a desired number of puffs and which may be modified straightforwardly to change the number and or duration of puffs provided without sacrificing subjective qualities of the tobacco.

[0021] Embodiments of the invention may have the advantage of providing a heating element for a smoking article which is mechanically suitable for insertion and removal of a cigarette; which simplify connections of an electrically resistive heater to an associated power source; and which provide a heater which is more economical to manufacture. Preferably these advantages are achieved in a simple and straightforward manner.

[0022] In a preferred embodiment of the invention, a cylindrical tube is provided of a mechanically strong and flexible electrical conductor such as a metal and has a plurality of separated regions. An electrically insulating layer such as a ceramic is applied on the outer surface except for one exposed portion. Electrically resistive materials are then applied to the insulated regions and are electrically connected at one end to the underlying electrical conducting region to form heater elements. This electrical conducting region is connected to the negative terminal of a power source. The other end of all the heaters are adapted to be connected to the positive terminal of the source. Accordingly, an electrically resistive heating circuit is formed wherein the tube serves as a common for all of the heating elements.

[0023] The tubular heater can comprise an exposed end hub with a plurality of blades extending therefrom. Each blade can have an individual heater deposited thereon. Alternatively, every other blade can have a heater deposited thereon. The blades having no heater function as barriers to minimize outward escape of generated vapors. These barrier blades also function as heat sinks for the heaters on adjacent blades.

[0024] Embodiments of the invention will now be described, by way of example, and with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

FIG. 1 is a partially exposed perspective view of a smoking article employing a heater embodying the present invention;

FIG. 2 is a side, cross-sectional view of a cigarette used in conjunction with an embodiment of the

present invention;

FIG. 3 is a side, cross-sectional view of a heater fixture embodying the present invention;

FIG. 4 is an exposed side view of a tubular heater embodying the present invention;

FIG. 5 is an exposed side view of a heater blade having a metal substrate;

FIG. 6A is a perspective view of dual hubs having a plurality of alternating barrier and heater blades extending therebetween;

FIG. 6B is an embodiment similar to that of FIG. 6A except that the gaps between blades are shaped as an elongated U;

FIG. 7 is a perspective view of the embodiment depicted in FIG. 6A having heater elements deposited on every defined blade;

FIG. 8 is a perspective view of a heater having a single supporting hub;

FIG. 9 is a perspective view of tubular heater having spiralled gaps;

FIG. 10 is an exposed side view of a tubular heater having heater elements on inner faces of heater blades;

FIG. 11 is a perspective view of an arrangement of heater blades prior to rolling;

FIG. 12 is a perspective view of a tubular heater having a common blade;

FIG. 13 is a top view of an arrangement of heater blades prior to folding; and

FIG. 14 is a perspective view of another arrangement of a tubular heater.

DETAILED DESCRIPTION OF BEST MODE

[0026] A smoking system 21 embodying the present invention is generally seen with reference to FIGS. 1 and 2. The smoking system 21 includes a cylindrical aerosol generating tube or cigarette 23 and a reusable lighter 25. The cigarette 23 is adapted to be inserted in and removed from an orifice 27 at a front end 29 of the lighter 25. The smoking system 21 is used in much the same fashion as a conventional cigarette. The cigarette 23 is disposed of after one or more puff cycles. The lighter 25 is preferably disposed of after a greater number of puff cycles than the cigarette 23.

[0027] The lighter 25 includes a housing 31 and has front and rear portions 33 and 35. A power source 37 for supplying energy to heating elements for heating the cigarette 23 is preferably disposed in the rear portion 35 of the lighter 25. The rear portion 35 is preferably adapted to be easily opened and closed, such as with screws or with snap-fit components, to facilitate replacement of the power source 37. The front portion 33 preferably houses heating elements and circuitry in electrical communication with the power source 37 in the rear portion 35. The front portion 33 is preferably easily joined to the rear portion 35, such as with a dovetail joint or by a socket fit. The housing 31 is preferably made from a hard,

heat-resistant material. Preferred materials include metal-based or, more preferably, polymer-based materials. The housing 31 is preferably adapted to fit comfortably in the hand of a smoker and, in a presently preferred embodiment, has overall dimensions of 10.7 cm by 3.8 cm by 1.5 cm.

[0028] The power source 37 is sized to provide sufficient power for heating elements that heat the cigarette 23. The power source 37 is preferably replaceable and rechargeable and may include devices such as a capacitor, or more preferably, a battery. In a presently preferred embodiment, the power source is a replaceable, rechargeable battery such as four nickel cadmium battery cells connected in series with a total, non-loaded voltage of approximately 4.8 to 5.6 volts. The characteristics required of the power source 37 are, however, selected in view of the characteristics of other components in the smoking system 21, particularly the characteristics of the heating elements. U.S. Patent No. 5,144,962 describes several forms of power sources useful in connection with the smoking system of the present invention, such as rechargeable battery sources and quick-discharging capacitor power sources that are charged by batteries.

[0029] A substantially cylindrical heating fixture 39 for heating the cigarette 23, and, preferably, for holding the cigarette in place relative to the lighter 25, and electrical control circuitry 41 for delivering a predetermined amount of energy from the power source 37 to heating elements (not seen in FIGS. 1 and 2) of the heating fixture are preferably disposed in the front 33 of the lighter. As described in greater detail below, a generally circular, terminal end hub 110 is fixed, e.g., welded, to be disposed within the interior of heater fixture 39, e.g., is fixed to spacer 49, as shown in FIG. 3. If the heater has two end hubs, either hub can serve as the fixed terminal end. In the presently preferred embodiment, the heating fixture 39 includes a plurality of radially spaced heating elements 122 supported to extend from the hub, seen in FIG. 3 and described in greater detail below, that are individually energized by the power source 37 under the control of the circuitry 41 to heat a number of, e.g., eight, areas around the periphery of the inserted cigarette 23. Eight heating elements 122 are preferred to develop eight puffs as in a conventional cigarette and eight heater elements also lend themselves to electrical control with binary devices. A desired number of puffs can be generated, e.g., any number between 5-16, and preferably 6-10 or 8 per inserted cigarette. As discussed below, the number of heaters can exceed the desired number of puffs/cigarette.

[0030] The circuitry 41 is preferably activated by a puff-actuated sensor 45, seen in FIG. 1, that is sensitive either to pressure drops that occur when a smoker draws on the cigarette 23. The puff-actuated sensor 45 is preferably disposed in the front 33 of the lighter 25 and communicates with a space inside the heater fixture 39 and near the cigarette 23 through a passageway ex-

tending through a spacer and a base of the heater fixture and, if desired, a puff sensor tube (not shown). A puff-actuated sensor 45 suitable for use in the smoking system 21 is described in U.S. Patent No. 5,060,671, and is in the form of a Model 163PC01D35 silicon sensor, manufactured by the MicroSwitch division of Honeywell, Inc., Freeport, Illinois, which activates an appropriate one of the heater elements 122 as a result of a change in pressure when a smoker draws on the cigarette 23. Flow sensing devices, such as those using hot-wire anemometry principles, have also been successfully demonstrated to be useful for activating an appropriate one of the heater elements 122 upon detection of a change in air flow.

[0031] An indicator 51 is preferably provided on the exterior of the lighter 25, preferably on the front 33, to indicate the number of puffs remaining on a cigarette 23 inserted in the lighter. The indicator 51 preferably includes a seven-segment liquid crystal display. In a presently preferred embodiment, the indicator 51 displays the digit "8" for use with an eight-puff cigarette when a light beam emitted by a light sensor 53, seen in FIG. 1, is reflected off of the front of a newly inserted cigarette 23 and detected by the light sensor. The light sensor 53 is preferably mounted in an opening in the spacer and the base of the heater fixture 39. The light sensor 53 provides a signal to the circuitry 41 which, in turn, provides a signal to the indicator 51. For example, the display of the digit "8" on the indicator 51 reflects that the preferred eight puffs provided on each cigarette 23 are available, i.e., none of the heater elements 43 have been activated to heat the new cigarette. After the cigarette 23 is fully smoked, the indicator displays the digit "0". When the cigarette 23 is removed from the lighter 25, the light sensor 53 does not detect the presence of a cigarette 23 and the indicator 51 is turned off. The light sensor 53 is modulated so that it does not constantly emit a light beam and provide an unnecessary drain on the power source 37. A presently preferred light sensor 53 suitable for use with the smoking system 21 is a Type OPR5005 Light Sensor, manufactured by OPTEX Technology, Inc., 1215 West Crosby Road, Carrollton, Texas 75006 U.S.A.

[0032] As one of several possible alternatives to using the above-noted light sensor 53, a mechanical switch (not shown) may be provided to detect the presence or absence of a cigarette 23 and a reset button (not shown) may be provided for resetting the circuitry 41 when a new cigarette is inserted in the lighter 25, e.g., to cause the indicator 51 to display the digit "8", etc. Power sources, circuitry, puff-actuated sensors, and indicators useful with the smoking system 21 of the present invention are described in U.S. Patent No. 5,060,671 and WO 94/06314, both of which are incorporated by reference. The passageway and the opening 50 in the spacer and the heater fixture base are preferably air-tight during smoking.

[0033] A presently preferred cigarette 23 for use with

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