



- (51) International Patent Classification:  
A24F 47/00 (2006.01)
- (21) International Application Number:  
PCT/US2013/047854
- (22) International Filing Date:  
26 June 2013 (26.06.2013)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
13/536,438 28 June 2012 (28.06.2012) US
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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

**Declarations under Rule 4.17:**

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

[Continued on next page]

(54) Title: RESERVOIR AND HEATER SYSTEM FOR CONTROLLABLE DELIVERY OF MULTIPLE AEROSOLIZABLE MATERIALS IN AN ELECTRONIC SMOKING ARTICLE

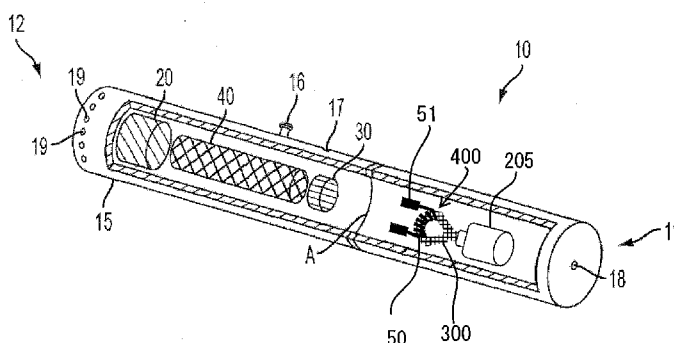


FIG. 1

(57) Abstract: The present disclosure relates to an electronic smoking article that provides for improved aerosol delivery. Particularly, the article provides for separate delivery of two or more components of an aerosol precursor composition from one or more reservoirs to one or more heaters so as to control the rate of delivery or the rate of heating of the separate components of the aerosol precursor composition.

WO 2014/004648 A1

**Published:**

— *with international search report (Art. 21(3))*

RESERVOIR AND HEATER SYSTEM FOR CONTROLLABLE DELIVERY OF MULTIPLE  
AEROSOLIZABLE MATERIALS IN AN ELECTRONIC SMOKING ARTICLE

FIELD OF THE INVENTION

The present invention relates to aerosol delivery articles and uses thereof for yielding tobacco components or other materials in an inhalable form. The articles can be made or derived from tobacco or otherwise incorporate tobacco for human consumption.

5

BACKGROUND OF THE INVENTION

Many smoking articles have been proposed through the years as improvements upon, or alternatives to, smoking products based upon combusting tobacco. Exemplary alternatives have included devices wherein a solid or liquid fuel is combusted to transfer heat to tobacco or wherein a chemical reaction is used to provide such heat source. Numerous references have proposed various smoking articles of a type that generate flavored vapor, visible aerosol, or a mixture of flavored vapor and visible aerosol. Some of those proposed types of smoking articles include tubular sections or longitudinally extending air passageways.

The point of the improvements or alternatives to smoking articles typically has been to provide the sensations associated with cigarette, cigar, or pipe smoking, without delivering considerable quantities of incomplete combustion and pyrolysis products. To this end, there have been proposed numerous smoking products, flavor generators, and medicinal inhalers which utilize electrical energy to vaporize or heat a volatile material, or attempt to provide the sensations of cigarette, cigar, or pipe smoking without burning tobacco.

General examples of alternative smoking articles are described in US Pat. No. 3,258,015 to Ellis et al.; US Pat. No. 3,356,094 to Ellis et al.; US Pat. No. 3,516,417 to Moses; US Pat. No. 4,347,855 to Lanzellotti et al.; US Pat. No. 4,340,072 to Bolt et al.; US Pat. No. 4,391,285 to Burnett et al.; US Pat. No. 4,917,121 to Riehl et al.; US Pat. No. 4,924,886 to Litzinger; and US Pat. No. 5,060,676 to Hearn et al. Many of those types of smoking articles have employed a combustible fuel source that is burned to provide an aerosol and/or to heat an aerosol-forming material. See, for example, the background art cited in US Pat. No. 4,714,082 to Banerjee et al. and US Pat. No. 4,771,795 to White et al.; which are incorporated herein by reference in their entireties. See, also, for example, those types of smoking articles described in US Pat. No. 4,756,318 to Clearman et al.; US Pat. No. 4,714,082 to Banerjee et al.; US Pat. No. 4,771,795 to White et al.; US Pat. No. 4,793,365 to Sensabaugh et al.; US Pat. No. 4,917,128 to Clearman et al.; US Pat. No.

4,961,438 to Korte; US Pat. No. 4,966,171 to Serrano et al.; US Pat. No. 4,969,476 to Bale et al.;  
US Pat. No. 4,991,606 to Serrano et al.; US Pat. No. 5,020,548 to Farrier et al.; US Pat. No.  
5,033,483 to Clearman et al.; US Pat. No. 5,040,551 to Schlatter et al.; US Pat. No. 5,050,621 to  
Creighton et al.; US Pat. No. 5,065,776 to Lawson; US Pat. No. 5,076,296 to Nystrom et al.; US  
5 Pat. No. 5,076,297 to Farrier et al.; US Pat. No. 5,099,861 to Clearman et al.; US Pat. No.  
5,105,835 to Drewett et al.; US Pat. No. 5,105,837 to Barnes et al.; US Pat. No. 5,115,820 to  
Hauser et al.; US Pat. No. 5,148,821 to Best et al.; US Pat. No. 5,159,940 to Hayward et al.; US  
Pat. No. 5,178,167 to Riggs et al.; US Pat. No. 5,183,062 to Clearman et al.; US Pat. No. 5,211,684  
to Shannon et al.; US Pat. No. 5,240,014 to Deevi et al.; US Pat. No. 5,240,016 to Nichols et al.;  
10 US Pat. No. 5,345,955 to Clearman et al.; US Pat. No. 5,551,451 to Riggs et al.; US Pat. No.  
5,595,577 to Bensalem et al.; US Pat. No. 5,819,751 to Barnes et al.; US Pat. No. 6,089,857 to  
Matsuura et al.; US Pat. No. 6,095,152 to Beven et al.; US Pat. No. 6,578,584 Beven; and US Pat.  
No. 6,730,832 to Dominguez; which are incorporated herein by reference in their entireties.  
Furthermore, certain types of cigarettes that employ carbonaceous fuel elements have been  
15 commercially marketed under the brand names "Premier" and "Eclipse" by R. J. Reynolds Tobacco  
Company. See, for example, those types of cigarettes described in Chemical and Biological Studies  
on New Cigarette Prototypes that Heat Instead of Burn Tobacco, R. J. Reynolds Tobacco Company  
Monograph (1988) and Inhalation Toxicology, 12:5, p. 1-58 (2000). See also US Pat. Pub. No.  
2005/0274390 to Banerjee et al., US Pat. Pub. No. 2007/0215167 to Crooks et al., US Pat. Pub. No.  
20 2010/0065075 to Banerjee et al., and US Pat. Pub. No. 2012/0042885 to Stone et al., the  
disclosures of which are incorporated herein by reference in their entireties.

Certain proposed cigarette-shaped tobacco products purportedly employ tobacco in a form  
that is not intended to be burned to any significant degree. See, for example, US Pat. No. 4,836,225  
to Sudoh; US Pat. No. 4,972,855 to Kuriyama et al.; and US Pat. No. 5,293,883 to Edwards, which  
25 are incorporated herein by reference in their entireties. Yet other types of smoking articles, such as  
those types of smoking articles that generate flavored vapors by subjecting tobacco or processed  
tobaccos to heat produced from chemical or electrical heat sources, are described in US Pat. No.  
4,848,374 to Chard et al.; US Patent Nos. 4,947,874 and 4,947,875 to Brooks et al.; US Pat. No.  
5,060,671 to Counts et al.; US Pat. No. 5,146,934 to Deevi et al.; US Pat. No. 5,224,498 to Deevi;  
30 US Pat. No. 5,285,798 to Banerjee et al.; US Pat. No. 5,357,984 to Farrier et al.; US Pat. No.  
5,593,792 to Farrier et al.; US Pat. No. 5,369,723 to Counts; US Pat. No. 5,692,525 to Counts et al.;  
US Pat. No. 5,865,185 to Collins et al.; US Pat. No. 5,878,752 to Adams et al.; US Pat. No.  
5,880,439 to Deevi et al.; US Pat. No. 5,915,387 to Baggett et al.; US Pat. No. 5,934,289 to  
Watkins et al.; US Pat. No. 6,033,623 to Deevi et al.; US Pat. No. 6,053,176 to Adams et al.; US

Pat. No. 6,164,287 to White; US Pat. No. 6,289,898 to Fournier et al.; US Pat. No. 6,615,840 to Fournier et al.; U.S. Pat. Pub. No. 2003/0131859 to Li et al.; U.S. Pat. Pub. No. 2005/0016549 to Banerjee et al.; and U.S. Pat. Pub. No. 2006/0185687 to Hearn et al., each of which is incorporated herein by reference in its entirety.

5 Certain attempts have been made to deliver vapors, sprays or aerosols, such as those possessing or incorporating flavors and/or nicotine. See, for example, the types of devices set forth in US Pat. Nos. 4,190,046 to Virag; 4,284,089 to Ray; 4,635,651 to Jacobs; 4,735,217 to Gerth et al.; 4,800,903 to Ray et al.; 5,388,574 to Ingebrethsen et al.; 5,799,663 to Gross et al.; 6,532,965 to Abhulimen et al.; and 6,598,607 to Adiga et al; and EP 1,618,803 to Hon; which are incorporated  
10 herein by reference in their entireties. See also, US Pat. No. 7,117,867 to Cox et al. and the devices set forth on the website, [www.e-cig.com](http://www.e-cig.com), which are incorporated herein by reference in their entireties.

Still further representative cigarettes or smoking articles that have been described and, in some instances, been made commercially available include those described in US Pat No.  
15 4,922,901 to Brooks et al.; US Pat. No. 5,249,586 to Morgan et al.; US Pat. No. 5,388,594 to Counts et al.; US Pat. No. 5,666,977 to Higgins et al.; US Pat No. 6,196,218 to Voges; US Pat. No. 6,810,883 to Felter et al.; US Pat. No. 6,854,461 to Nichols; US Pat. No. 7,832,410 to Hon; US Pat. No. 7,513,253 to Kobayashi; U.S. Pat. No. 7,726,320 to Robinson et al.; US Pat. No. 7,896,006 to Hamano; US Pat. No. 6,772,756 to Shayan; US Pat. Pub. No. 2009/0095311 to Hon; US Pat. Pub.  
20 Nos. 2006/0196518, 2009/0126745, and 2009/0188490 to Hon; US Pat. Pub. No. 2009/0272379 to Thorens et al.; US Pat. Pub. Nos. 2009/0260641 and 2009/0260642 to Monsees et al.; US Pat. Pub. Nos. 2008/0149118 and 2010/0024834 to Oglesby et al.; US Pat. Pub. No. 2010/0307518 to Wang; and WO 2010/091593 to Hon. See also US Pat. No. D657,047 to Minskoff et al. and US Pat. Pub. Nos. 2011/0277757, 2011/0277760, and US 2011/0277764 to Terry et al. Still further examples  
25 include electronic cigarette products commercially available under the names ACCORD<sup>®</sup>; HEATBAR<sup>™</sup>; HYBRID CIGARETTE<sup>®</sup>, VEGAS<sup>™</sup>; E-GAR<sup>™</sup>; C-GAR<sup>™</sup>; E-MYSTICK<sup>™</sup>; IOLITE<sup>®</sup> Vaporizer, GREEN SMOKE<sup>®</sup>, BLU<sup>™</sup> Cigs, WHITE CLOUD<sup>®</sup> Cirrus, V2CIGS<sup>™</sup>, SOUTH BEACH SMOKE<sup>™</sup>, SMOKETIP<sup>®</sup>, SMOKE STIK<sup>®</sup>, NJOY<sup>®</sup>, LUCI<sup>®</sup>, Royal Blues, SMART SMOKER<sup>®</sup>, SMOKE ASSIST<sup>®</sup>, Knight Sticks, GAMUCCI<sup>®</sup>, InnoVapor, SMOKING  
30 EVERYWHERE<sup>®</sup>, Crown 7, CHOICE<sup>™</sup> NO.7<sup>™</sup>, VAPORKING<sup>®</sup>, EPUFFER<sup>®</sup>, LOGIC<sup>™</sup> ecig, VAPOR4LIFE<sup>®</sup>, NICOTEK<sup>®</sup>, METRO<sup>®</sup>, and PREMIUM<sup>™</sup>.

Smoking articles that employ tobacco substitute materials and smoking articles that employ sources of heat other than burning tobacco cut filler to produce tobacco-flavored vapors or tobacco-flavored visible aerosols have not received widespread commercial success. Articles that produce

the taste and sensation of smoking by electrically heating tobacco particularly have suffered from inconsistent release of flavors or other inhalable materials. Electrically heated smoking devices have further been limited in many instances to the requirement of an external heating device that was inconvenient and that detracted from the smoking experience. Accordingly, it can be desirable to provide a smoking article that can provide the sensations of cigarette, cigar, or pipe smoking, that does so without combusting tobacco, that does so without the need of a combustion heat source, and that does so without necessarily delivering considerable quantities of incomplete combustion and pyrolysis products.

#### BRIEF SUMMARY OF THE INVENTION

The present invention provides a smoking article and methods of use thereof for controllably delivering aerosol precursor components. In particular, disclosed herein is a system that can transport and heat the various chemical compounds present in the aerosol precursor composition under controlled conditions so as to achieve a uniform puff chemistry. In various embodiments, smoking articles as disclosed herein can incorporate certain elements useful to achieve such uniform puff chemistry. For example, a plurality of separate transport elements (e.g., wicks) can be used to transport separate components of the aerosol precursor composition from a reservoir to an aerosolization zone (i.e., at or around a heater) within the article. Individual transport elements can be formed from different materials (e.g., different fiber types, sintered materials, solid foams, or other porous materials) and can be formed to have different designs (e.g., cross-sectional shape, coatings, woven fibers, non-woven fibers, and bundle size) and thus exhibit different transport properties (e.g., flow rate, wicking properties, or capillary action). A plurality of separate reservoirs can be provided to store separate components of the aerosol precursor composition or separate combinations of components of the aerosol precursor composition. Separate heaters can be associated with separate components (or combinations of components) of the aerosol precursor composition such that the separate components (or combinations of components) can be heated separately at different temperatures, thermal energy fluxes, or thermal energy inputs.

In some embodiments, a smoking article according to the present disclosure can comprise an aerosolization zone including at least one heater. The article further can comprise an electrical power source in electrical connection with the at least one heater. Further, the article can comprise an aerosol precursor composition that is formed of a first component and at least a second separate component. For example, the first component can be a first compound or a mixture of compounds, and the second component can be a second compound or a mixture of compounds. When mixtures

of compounds are used, it is possible according to the invention for the two components of the composition to each include one or more of the same chemical compounds so long as they include different ratios. For example, component 1 can comprise compound A and compound B in an A:B ratio of 80:20 (e.g., based on weight or volume), and component 2 can comprise compound A and compound B in a 20:80 ratio (based on weight or volume). Thus, components 1 and 2 are different because they have different ratios of the individual compounds present. Such also can apply where component 1 is formed completely of a single compound while component 2 includes the same compound in mixture with one or more additional compounds. Thus, separate components of the aerosol precursor composition can encompass a variety of embodiments. The aerosol precursor composition specifically is in fluid communication with the aerosolization zone such that the components of the aerosol precursor composition transport from one or more reservoirs to the aerosolization zone, such as via capillary action.

The heater and the electrical power source in the smoking article can be removably connected. For example, the smoking article can comprise a first unit that is engageable and disengageable with a second unit, the first unit comprising the aerosolization zone including the heater, and the second unit comprising the electrical power source. The electrical power source can be selected from the group consisting of a battery, a capacitor, and combinations thereof. The smoking article further can comprise one or more control components that actuate or regulate current flow from the electrical power source. Such control components particularly can be located in the second unit with the electrical power source.

The first unit of the smoking article can comprise a distal end that engages the second unit and an opposing, proximate end that includes a mouthpiece with an opening at a proximate end thereof. Further, the first unit can comprise an air flow path opening into the mouthpiece, and the air flow path can provide for passage of aerosol from the aerosolization zone into the mouthpiece. In specific embodiments, the first unit can be disposable. The first unit of the smoking article specifically can comprise the reservoirs that can be used for storing the components of the aerosol precursor composition.

In light of the structure of the smoking article, transport of the aerosol precursor composition to the aerosolization zone can be customized. For example, different combinations of one or more reservoirs, one or more transport elements, and one or more heaters can be used to form a desired aerosol composition. Beneficially, customization can be further achieved by utilizing specific materials in forming the reservoir(s), using specific materials in forming the transport element(s), and using multiple heating elements operating under the same or different conditions.

When a plurality of transport elements is used, two or more transport elements can transport their respective components of the aerosol precursor composition to the same heater. In other embodiments, separate transport elements can transport their respective components of the aerosol precursor composition to two or more heaters. The heaters can operate at the same or different  
5 temperatures (e.g., the operating temperatures differing by about 5 °C or greater). The heaters can operate under different sets of conditions. In other words, electrical energy can be controllably delivered from the electrical power source to a first heater via a first control scheme, and electrical energy can be controllably delivered from the electrical power source to one or more further heaters via one or more, different control schemes. For example, the control schemes can differ in the  
10 period of time for which electrical current is delivered to the heaters. Likewise, the first heater can function according to a first duty cycle, and one or more further heaters can function according to one or more further, different duty cycles.

The aerosol precursor composition used in the smoking article can comprise a variety of components. For example, the aerosol precursor composition can comprise a polyhydric alcohol  
15 which, in some embodiments, can be selected from the group consisting of glycerin, propylene glycol, and combinations thereof. The aerosol precursor composition also can comprise a medicament, a tobacco component, or a tobacco-derived material. In some embodiments, the aerosol precursor composition can comprise a slurry or solution including tobacco, a tobacco component, or a tobacco-derived material. Further, the aerosol precursor composition can comprise  
20 a flavorant.

The reservoir used in the smoking article for storing the aerosol precursor composition can take on a variety of forms. Specifically, the aerosol precursor composition can be coated on, adsorbed by, or absorbed in a substrate or a part thereof (e.g., a reservoir formed of a porous material, such as ceramics and porous carbon (e.g., a foam), or a fibrous material). Such reservoir  
25 can be considered to be at least partially saturated with the component of the aerosol precursor composition. The aerosol precursor composition specifically can be provided within a container (i.e., a bottle). Such substrate or bottle can be characterized as a reservoir.

In some embodiments, a smoking article according to the present disclosure can comprise the following: an aerosol precursor composition in liquid form comprising at least a first  
30 component and a second component; a reservoir system formed of one or more reservoirs; a heater system formed of one or more heaters; and a plurality of transport elements defining a fluid communication between the reservoir system and the heater system. In particular, the article can comprise two or more reservoirs in fluid communication with one or more heaters; one or more

reservoirs in fluid communication with two or more heaters; or two or more reservoirs in fluid communication with two or more heaters.

In particular embodiments, a smoking article according to the present disclosure can comprise the following: an aerosolization zone including a heater; an aerosol precursor composition in liquid form comprising a first component and a second component; a first reservoir comprising a porous material that is at least partially saturated with the first component of the aerosol precursor composition; a second reservoir comprising the second component of the aerosol precursor composition; a first transport element providing fluid communication between the first reservoir and the aerosolization zone; and a second transport element providing fluid communication between the second reservoir and the aerosolization zone. In other embodiments, the second reservoir also can comprise a porous material and can be at least partially saturated with the second component of the aerosol precursor composition. In specific embodiments, the smoking article can comprise a plurality of heaters. In further embodiments, the smoking article can comprise a first heater and a second heater, wherein the first transport element provides fluid communication between the first reservoir and the first heater, and wherein the second transport element provides fluid communication between the second reservoir and the second heater. Likewise, the smoking article can comprise a control component adapted to operate the first heater by a first heating protocol and operate the second heater by a second, different heating protocol. More specifically, the smoking article can comprise an electrical power source, and the control component can be adapted to control electrical current flow from the power source to the first heater and the second heater such that the respective heating elements heat to different temperatures or heat for different lengths of time or both heat to different temperatures and heat for different lengths of time.

In the smoking article, the first transport element can be of a different construction than the second transport element. For example, the first transport element and the second transport element can differ in one or more of cross-sectional shape, material type, surface treatment, and overall dimensions. Further, one or both of the first transport element and the second transport element can be a wick having a defined capillary action. In specific embodiments, the first transport element and the second transport element can both be wicks. Beneficially, the first wick can have a first wicking rate, and the second wick can have a second, different wicking rate. More specifically, a wick can comprise a material selected from the group consisting of fibrous materials, carbon foams, sintered material, capillary tubes, temperature adaptive polymers, and combinations thereof. If desired, the first transport element and the second transport element can be interconnected in the aerosolization zone.

In specific embodiments, the smoking article can comprise a further heater in substantial contact with one or more of the first reservoir, the second reservoir, the first transport element, and the second transport element. In other embodiments, the smoking article can comprise a control component adapted to operate the further heater to warm one or more of the first reservoir, the second reservoir, the first transport element, and the second transport element to a temperature that is below a vaporization temperature of the respective component of the aerosol precursor composition. Such heating element can be useful to pre-heat the component of the aerosol precursor composition to alter the characteristics thereof (e.g., reduce viscosity and increase flow rate).

In another aspect, the present invention also provides methods of forming an aerosol in a smoking article from a plurality of aerosol precursor components. In certain embodiments, such method can comprise the following steps: activating a power source within the smoking article to cause flow of electrical current from the power source to a heater positioned within an aerosolization zone in the smoking article; transporting a first component of an aerosol precursor composition from a first reservoir comprising a porous material that is at least partially saturated with the first component of the aerosol precursor composition to the aerosolization zone via a first transport element; transporting a second component of the aerosol precursor composition from a second reservoir to the aerosolization zone via a second transport element; and heating the aerosol precursor components to form an aerosol. More particularly, the first aerosol precursor component can be transported at a first rate, and the second precursor component can be transported at second, different rate.

In further embodiments, the method can comprise transporting the first component of the aerosol precursor composition from the first reservoir to the heater in the aerosolization zone and transporting the second component of the aerosol precursor composition from the second reservoir to a second heater in the aerosolization zone. Further, the method can comprise controlling the flow of electrical current from the power source to the heater and to the second heater such that heater is heated by a first heating protocol and the second heater is heated by a second, different heating protocol. More particularly, the method can comprise controlling the flow of electrical current from the power source to the heater and the second heater such that the respective heating elements heat to different temperatures or heat for different lengths of time or both heat to different temperatures and heat for different lengths of time. In yet further embodiments, the method can comprise heating one or more of the first reservoir, the second reservoir, the first transport element, and the second transport to a temperature that is below a vaporization temperature of the respective component of the aerosol precursor composition.

The invention includes, without limitation, the following embodiments.

Embodiment 1: A smoking article comprising: an aerosol precursor composition in liquid form comprising at least a first component and a second component; a reservoir system formed of one or more reservoirs; a heater system formed of one or more heaters; and a plurality of transport elements defining a fluid communication between the reservoir system and the heater system; 5 wherein the article comprises two or more reservoirs in fluid communication with one or more heaters, or wherein the article comprises one or more reservoirs in fluid communication with two or more heaters, or wherein the article comprises two or more reservoirs in fluid communication with two or more heaters.

10 Embodiment 2: The smoking article of any preceding or subsequent embodiment, wherein: the reservoir system comprises a first reservoir formed of a porous material that is at least partially saturated with the first component of the aerosol precursor composition and a second reservoir including the second component of the aerosol precursor composition; and the plurality of transport elements comprise a first transport element providing fluid communication between the first 15 reservoir and the heater system, and a second transport element providing fluid communication between the second reservoir and the heater system.

Embodiment 3: The smoking article of any preceding or subsequent embodiment, wherein the heater system comprises at least a first heater and a second heater.

20 Embodiment 4: The smoking article of any preceding or subsequent embodiment, wherein the first transport element provides fluid communication between the first reservoir and the first heater, and wherein the second transport element provides fluid communication between the second reservoir and the second heater.

25 Embodiment 5: The smoking article of any preceding or subsequent embodiment, comprising a control component adapted to operate the first heater by a first heating protocol and operate the second heater by a second, different heating protocol.

30 Embodiment 6: The smoking article of any preceding or subsequent embodiment, wherein the article comprises an electrical power source, and wherein the control component is adapted to control electrical current flow from the power source to the first heater and the second heater such that the respective heaters heat to different temperatures or heat for different lengths of time or both heat to different temperatures and heat for different lengths of time.

Embodiment 7: The smoking article of any preceding or subsequent embodiment, wherein the first transport element is of a different construction than the second transport element.

Embodiment 8: The smoking article of any preceding or subsequent embodiment, wherein the first transport element and the second transport element differ in one or more of cross-sectional shape, material type, surface treatment, and overall dimensions.

5 Embodiment 9: The smoking article of any preceding or subsequent embodiment, wherein one or both of the first transport element and the second transport element is a wick having a defined capillary action.

Embodiment 10: The smoking article of any preceding or subsequent embodiment, wherein the first transport element and the second transport element are both wicks.

10 Embodiment 11: The smoking article of any preceding or subsequent embodiment, wherein the first wick has a first wicking rate, and wherein the second wick has a second, different wicking rate.

Embodiment 12: The smoking article of any preceding or subsequent embodiment, wherein the wick comprises a material selected from the group consisting of fibrous materials, carbon foams, sintered material, capillary tubes, temperature adaptive polymers, and combinations thereof.

15 Embodiment 13: The smoking article of any preceding or subsequent embodiment, wherein the second reservoir comprises a porous material that is at least partially saturated with the second component of the aerosol precursor composition.

20 Embodiment 14: The smoking article of any preceding or subsequent embodiment, wherein the first transport element and the second transport element are interconnected at one or more points.

Embodiment 15: The smoking article of any preceding or subsequent embodiment, wherein the article comprises a further heater in substantial contact with one or more of the reservoir system and the plurality of transport elements.

25 Embodiment 16: The smoking article of any preceding or subsequent embodiment, wherein the article comprises a control component adapted to operate the further heater to warm one or more of the reservoir system and the plurality of transport elements to a temperature that is below a vaporization temperature of the respective component of the aerosol precursor composition.

Embodiment 17: The smoking article of any preceding or subsequent embodiment, wherein the aerosol precursor composition comprises a polyhydric alcohol.

30 Embodiment 18: The smoking article of any preceding or subsequent embodiment, wherein the aerosol precursor composition comprises a component selected from the group consisting of medicaments, tobacco-derived materials, flavorants, and combinations thereof.

Embodiment 19: A method of forming an aerosol in a smoking article, the method comprising: activating a power source within the smoking article to cause flow of electrical current

from the power source to a heater positioned within an aerosolization zone in the smoking article; transporting a first component of an aerosol precursor composition from a first reservoir comprising a porous material that is at least partially saturated with the first component of the aerosol precursor composition to the aerosolization zone via a first transport element; transporting a second  
5 component of the aerosol precursor composition from a second reservoir to the aerosolization zone via a second transport element; and heating the aerosol precursor components to form an aerosol.

Embodiment 20: The method of any preceding or subsequent embodiment, wherein the first aerosol precursor component is transported at a first rate, and the second precursor component is transported at second, different rate.

10 Embodiment 21: The method of any preceding or subsequent embodiment, comprising transporting the first component of the aerosol precursor composition from the first reservoir to the heater and transporting the second component of the aerosol precursor composition from the second reservoir to a second heater.

15 Embodiment 22: The method of any preceding or subsequent embodiment, comprising controlling the flow of electrical current from the power source to the heater and to the second heater such that the heater is heated by a first heating protocol and the second heater is heated by a second, different heating protocol.

20 Embodiment 23: The method of any preceding or subsequent embodiment, comprising controlling the flow of electrical current from the power source to the heater and the second heater such that the respective heaters heat to different temperatures or heat for different lengths of time or both heat to different temperatures and heat for different lengths of time.

25 Embodiment 24: The method of any preceding or subsequent embodiment, comprising heating one or more of the first reservoir, the second reservoir, the first transport element, and the second transport to a temperature that is below a vaporization temperature of the respective component of the aerosol precursor composition.

30 These and other features, aspects, and advantages of the disclosure will be apparent from a reading of the following detailed description together with the accompanying drawings, which are briefly described below. The disclosure includes any combination of two, three, four, or more of the above-noted embodiments as well as combinations of any two, three, four, or more features or elements set forth in this disclosure, regardless of whether such features or elements are expressly combined in a specific embodiment description herein. This disclosure is intended to be read holistically such that any separable features or elements of the disclosed subject matter, in any of its various aspects and embodiments, should be viewed as intended to be combinable unless the context clearly dictates otherwise.

## BRIEF DESCRIPTION OF THE FIGURES

Having thus described the invention in the foregoing general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

5 FIG. 1 is a perspective view of an example embodiment of a smoking article according to the invention, wherein a portion of an outer shell of the article is cut away to reveal the interior components thereof;

10 FIG. 2 is a cross-section of an example embodiment of a smoking article according to the invention, wherein the cross-section is immediately downstream of a transport element surrounded by a resistive heating element;

FIG. 3 is a perspective view of an example embodiment of a smoking article according to the invention, wherein the article comprises a control body and a cartridge that are attachable and detachable therefrom;

15 FIG. 4 is a longitudinal cross-section of a smoking article according to an example embodiment of the invention; and

FIG. 5 is a cross-section of the cartridge portion of a smoking article according to another example embodiment of the invention.

## DETAILED DESCRIPTION OF THE INVENTION

20 The present invention will now be described more fully hereinafter with reference to exemplary embodiments thereof. These exemplary embodiments are described so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Indeed, the invention can be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so  
25 that this disclosure will satisfy applicable legal requirements. As used in the specification, and in the appended claims, the singular forms "a", "an", "the", include plural referents unless the context clearly dictates otherwise.

The present invention provides articles that use electrical energy to heat a material (preferably without combusting the material to any significant degree) to form an inhalable  
30 substance, the articles being sufficiently compact to be considered "hand-held" devices. In certain embodiments, the articles can particularly be characterized as smoking articles. As used herein, the term is intended to mean an article that provides the taste and/or the sensation (e.g., hand-feel or mouth-feel) of smoking a cigarette, cigar, or pipe without substantial combustion of any component of the article. The term smoking article does not necessarily indicate that, in operation, the article

produces smoke in the sense of the by-product of combustion or pyrolysis. Rather, smoking relates to the physical action of an individual in using the article – e.g., holding the article, drawing on one end of the article, and inhaling from the article. In further embodiments, the inventive articles can be characterized as being vapor-producing articles, aerosolization articles, or medicament delivery articles. Thus, the articles can be arranged so as to provide one or more substances in an inhalable state. In other embodiments, the inhalable substance can be substantially in the form of a vapor (i.e., a substance that is in the gas phase at a temperature lower than its critical point). In other embodiments, the inhalable substance can be in the form of an aerosol (i.e., a suspension of fine solid particles or liquid droplets in a gas). The physical form of the inhalable substance is not necessarily limited by the nature of the inventive articles but rather can depend upon the nature of the medium and the inhalable substance itself as to whether it exists in a vapor state or an aerosol state. In some embodiments, the terms can be interchangeable. Thus, for simplicity, these terms as used to describe the invention are understood to be interchangeable unless stated otherwise.

In one aspect, the present invention provides a smoking article. The smoking article generally can include a number of components provided within an elongated body, which can be a single, unitary shell or which can be formed of two or more separable pieces. For example, a smoking article according to one embodiment can comprise a shell (i.e., the elongated body) that can be substantially tubular in shape, such as resembling the shape of a conventional cigarette or cigar. Within the shell can reside all of the components of the smoking article. In other embodiments, a smoking article can comprise two shells that are joined and are separable. For example, a control body can comprise a shell containing one or more reusable components and having an end that removably attaches to a cartridge. The cartridge can comprise a shell containing one or more disposable components and having an end that removably attaches to the control body. More specific arrangements of components within the single shell or within the separable control body and cartridge are evident in light of the further disclosure provided herein.

Smoking articles useful according to the invention particularly can comprise some combination of a power source (i.e., an electrical power source), one or more control components (e.g., to control/actuate/regulate flow of power from the power source to one or more further components of the article), a heater component, and an aerosol precursor component. The smoking article further can include a defined air flow path through the article such that aerosol generated by the article can be withdrawn therefrom by a user drawing on the article. Alignment of the components within the article can vary. In specific embodiments, the aerosol precursor component can be located near an end of the article that is proximal to the mouth of a user so as to maximize aerosol delivery to the user. Other configurations, however, are not excluded. Generally, the

heater component can be positioned sufficiently near that aerosol precursor component so that heat from the heater component can volatilize the aerosol precursor (as well as one or more flavorants, medicaments, or the like that can likewise be provided for delivery to a user) and form an aerosol for delivery to the user. When the heating member heats the aerosol precursor component, an aerosol (alone or including a further inhalable substance) is formed, released, or generated in a physical form suitable for inhalation by a consumer. It should be noted that the foregoing terms are meant to be interchangeable. As such, the terms release, generate, and form can be interchangeable, the terms releasing, generating, and forming can be interchangeable, the terms releases, forms, and generates can be interchangeable, and the terms released, formed, and generated can be interchangeable. Specifically, an inhalable substance is released as a vapor or aerosol or mixture thereof.

A smoking article according to the invention generally can include an electrical power source (or electrical power sources) to provide current flow sufficient to provide various functionalities to the article, such as resistive heating, powering of indicators, and the like. The power source for the inventive smoking article can take on various embodiments. Preferably, the power source is able to deliver sufficient power to rapidly heat the heating member to provide for aerosol formation and power the article through use for the desired duration of time. The power source preferably is sized to fit conveniently within the article. Examples of useful power sources include lithium ion batteries that preferably are rechargeable (e.g., a rechargeable lithium-manganese dioxide battery). In particular, lithium polymer batteries can be used. Other types of batteries – e.g., N50-AAA CADNICA nickel-cadmium cells – can also be used. Even further examples of batteries that can be used according to the invention are described in US Pub. App. No. 2010/0028766, the disclosure of which is incorporated herein by reference in its entirety. Thin film batteries can be used in certain embodiments of the invention. Any of these batteries or combinations thereof can be used in the power source, but rechargeable batteries are preferred because of cost and disposal considerations associated with disposable batteries. In embodiments wherein disposable batteries are provided, the smoking article can include access for removal and replacement of the battery. Alternatively, in embodiments where rechargeable batteries are used, the smoking article can comprise charging contacts for interaction with corresponding contacts in a conventional recharging unit deriving power from a standard 120-volt AC wall outlet, or other sources such as an automobile electrical system or a separate portable power supply, including USB connections. Means for recharging the battery can be provided in a portable charging case that can include, for example, a relatively larger battery unit that can provide multiple charges for the relatively smaller batteries present in the smoking article. The article further can include

components for providing a non-contact inductive recharging system such that the article can be charged without being physically connected to an external power source. Thus, the article can include components to facilitate transfer of energy from an electromagnetic field to the rechargeable battery within the article.

5           In further embodiments, the power source also can comprise a capacitor. Capacitors are capable of discharging more quickly than batteries and can be charged between puffs, allowing the battery to discharge into the capacitor at a lower rate than if it were used to power the heating member directly. For example, a supercapacitor – i.e., an electric double-layer capacitor (EDLC) – can be used separate from or in combination with a battery. When used alone, the supercapacitor  
10 can be recharged before each use of the article. Thus, the invention also can include a charger component that can be attached to the smoking article between uses to replenish the supercapacitor.

The smoking article can further include a variety of power management software, hardware, and/or other electronic control components. For example, such software, hardware, and/or electronic controls can include carrying out charging of the battery, detecting the battery charge and  
15 discharge status, performing power save operations, preventing unintentional or over-discharge of the battery, puff counting, puff delimiting, puff duration, identifying cartridge status, temperature control, or the like.

A “controller” or “control component” according to the present invention can encompass a variety of elements useful in the present smoking article. Moreover, a smoking article according to  
20 the invention can include one, two, or even more control components that can be combined into a unitary element or that can be present at separate locations within the smoking article, and individual control components can be utilized for carrying out different control aspects. For example, a smoking article can include a control component that is integral to or otherwise combined with a battery so as to control power discharge from the battery. The smoking article  
25 separately can include a control component that controls other aspects of the article. Alternatively, a single controller can be provided that carries out multiple control aspects or all control aspects of the article. Likewise, a sensor (e.g., a puff sensor) used in the article can include a control component that controls the actuation of power discharge from the power source in response to a stimulus. The smoking article separately can include a control component that controls other  
30 aspects of the article. Alternatively, a single controller can be provided in or otherwise associated with the sensor for carrying out multiple control aspects or all control aspects of the article. Thus, it can be seen that a variety of combinations of controllers can be combined in the present smoking article to provide the desired level of control of all aspects of the device.

The smoking article also can comprise one or more controller components useful for controlling flow of electrical energy from the power source to further components of the article, such as to a heater. Specifically, the article can comprise a control component that actuates current flow from the power source, such as to the heater. For example, in some embodiments, the article can include a pushbutton that can be linked to a control circuit for manual control of power flow. For example, a consumer can use the pushbutton to turn on the article and/or to actuate current flow into the heater. Multiple buttons can be provided for manual performance of powering the article on and off, and for activating heating for aerosol generation. One or more pushbuttons present can be substantially flush with an outer surface of the smoking article.

Instead of (or in addition to) the pushbutton, the inventive article can include one or more control components responsive to the consumer's drawing on the article (i.e., puff-actuated heating). For example, the article can include a switch that is sensitive either to pressure changes or air flow changes as the consumer draws on the article (i.e., a puff-actuated switch). Other suitable current actuation/deactuation mechanisms can include a temperature actuated on/off switch or a lip pressure actuated switch. An exemplary mechanism that can provide such puff-actuation capability includes a Model 163PC01D36 silicon sensor, manufactured by the MicroSwitch division of Honeywell, Inc., Freeport, Ill. With such sensor, the heater can be activated rapidly by a change in pressure when the consumer draws on the article. In addition, flow sensing devices, such as those using hot-wire anemometry principles, can be used to cause the energizing of the heater sufficiently rapidly after sensing a change in air flow. A further puff actuated switch that can be used is a pressure differential switch, such as Model No. MPL-502-V, range A, from Micro Pneumatic Logic, Inc., Ft. Lauderdale, Fla. Another suitable puff actuated mechanism is a sensitive pressure transducer (e.g., equipped with an amplifier or gain stage) which is in turn coupled with a comparator for detecting a predetermined threshold pressure. Yet another suitable puff actuated mechanism is a vane which is deflected by airflow, the motion of which vane is detected by a movement sensing means. Yet another suitable actuation mechanism is a piezoelectric switch. Also useful is a suitably connected Honeywell MicroSwitch Microbridge Airflow Sensor, Part No. AWM 2100V from MicroSwitch Division of Honeywell, Inc., Freeport, Ill. Further examples of demand-operated electrical switches that can be employed in a heating circuit according to the present invention are described in US Pat. No. 4,735,217 to Gerth et al., which is incorporated herein by reference in its entirety. Other suitable differential switches, analog pressure sensors, flow rate sensors, or the like, will be apparent to the skilled artisan with the knowledge of the present disclosure. A pressure-sensing tube or other passage providing fluid connection between



























































































