(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 November 2013 (21.11.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/173440 A1

(51) International Patent Classification:
A24D 3/06 (2006.01) *A24D 3/04* (2006.01)
A24D 3/02 (2006.01) *A24D 1/00* (2006.01)

(21) International Application Number:
PCT/US2013/041113

(22) International Filing Date:
15 May 2013 (15.05.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/648,269 17 May 2012 (17.05.2012) 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, KM, 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, ML, MR, NE, SN, TD, TG).

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

(54) **Title**: METHODS AND ARTICLES TO CONTROL THE GAS-PARTICLE PARTITION OF AN AEROSOL TO ENHANCE ITS TASTE CHARACTERISTICS

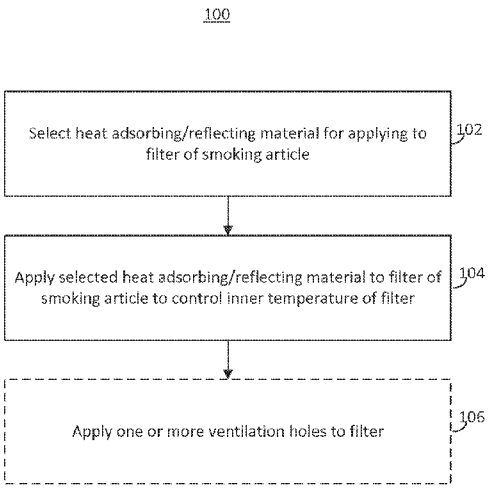

FIG. 1

(57) **Abstract**: A method and article are provided for controlling an inner filter temperature of an aerosol-generating product or device to alter the aerosol taste characteristics. The method comprises selecting a heat adsorbing or reflecting material to apply to a filter of a smoking article, the heat adsorbing or reflecting material having one or more properties associated therewith; and applying the heat adsorbing or reflecting material to the filter, the at least one heat adsorbing or reflecting materials being configured to control the inner temperature of the filter.

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METHODS AND ARTICLES TO CONTROL THE GAS-PARTICLE PARTITION OF AN AEROSOL TO ENHANCE ITS TASTE CHARACTERISTICS

CROSS REFERENCE TO PRIOR APPLICATIONS

[0001] This application claims priority under 35 U.S.C. §119(e) to U.S. Provisional Patent Application No. 61/648,269, filed May 17, 2012, titled "METHOD AND APPARATUS TO CONTROL THE GAS-PARTICLE PARTITION OF AN AEROSOL TO ENHANCE ITS TASTE CHARACTERISTICS," the disclosure of which is hereby expressly incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates generally to altering the taste characteristics of an aerosol, and more particularly, to a method and articles for controlling an inner filter temperature of an aerosol-generating product or device to alter the aerosol taste characteristics.

BACKGROUND

[0003] Conventional mentholated and non-mentholated less than full flavor cigarettes include perforated or porous filter paper wrapper to provide air dilution of the mainstream smoke. During puffing of a cigarette, fresh air penetrates the perforated filter wrapper paper and dilutes the cigarette mainstream smoke. Accordingly, total delivered cigarette mainstream smoke is reduced by the air dilution. In this manner, the overall particulate and gas phase components of the mainstream smoke are reduced.

[0004] Even though the use of air dilution to reduce total mainstream smoke delivery is very effective and controllable, it might result in unfavorable influences on taste signature because it dilutes the tobacco taste and it is known to produce an undesirable harshness to the

smoker. Cigarette designers typically undertake extensive development efforts at significant costs to develop specific tobacco blends in an effort to overcome these undesirable influences on the cigarette taste characteristics.

[0005] Other technologies used in the industry to reduce specific gas phase constituents include incorporating carbon particles, polymeric resins and clays in the filter structure. These additives remove non-desirable components such as aldehydes, ketones, aromatic hydrocarbons, and other volatile organic compounds from the mainstream smoke. They have been found to be very effective abatement technologies. However, smokers report these cigarettes tend to exhibit off-taste. These taste changes potentially affect the rate of adoption of these potentially reduced exposure smoking articles.

[0006] The off-taste changes in taste signature resulting from the abatement technologies occur because the abatement technologies are not singularly specific to any smoke chemical component and remove desirable chemical components from the smoke stream.

[0007] On the whole, cigarette mainstream smoke is characterized as formed by particulates, semi-volatiles, and volatile components. The distributions of these components determine the smoking experience. Abatement technologies implemented upstream the cigarette mouth piece and toward the heating zone (i.e., air dilution, adsorption beads, column aeration modification, incorporation of modified tobacco leaf and stem) change the smoke component distribution and the rate of smoke fraction delivered as well. These changes, because they might alter the gas-particulate distribution/amount, affect the organoleptic characteristics of the delivered smoke.

[0008] Furthermore, the perceived taste or strength of the cigarettes classified as having lower levels of "tar" and nicotine are progressively lower than that of cigarettes which are

classified as "full flavor" cigarettes. It has been proposed to add numerous flavorants to the cut filler of lower "tar" cigarettes to enhance the taste, strength and satisfaction of such cigarettes. However, such addition of flavorants generally results in cigarettes that might be perceived as harsh or irritating to the mouth, nose and throat of the smoker.

[0009] Because of these shortcomings, the art is continually searching for means to improve the flavor of smoke produced by a burning tobacco rod. Therefore it is desirable to provide less than full flavor cigarettes such as "low tar" or/and "ultra-low tar" cigarettes capable of delivering a good tobacco taste, strength and smoking satisfaction characteristic of a full flavor low tar cigarette while being perceived as palatable but not as overly harsh, irritating or having off-taste.

SUMMARY OF THE INVENTION

[0010] The present invention is directed to methods, compositions, and cigarette designs to control the gas-particulate partition of smoke components in the delivered smoke of smoking articles to enhance their organoleptic properties with respect to full flavor (FF) cigarettes and reduced tar or less than full flavor (LF) cigarettes.

[0011] According to an aspect of the invention, a method of manufacturing a smoking article having enhanced taste characteristics is provided. The method comprises: selecting a heat adsorbing or reflecting material to apply to a filter of the smoking article, the heat adsorbing or reflecting material having one or more properties associated therewith; and applying the heat adsorbing or reflecting material to the filter, the at least one heat adsorbing or reflecting materials being configured to control the inner temperature of the filter.

[0012] The heat adsorbing or reflecting material may comprise a metallized foil material.

[0013] The metallized foil material may comprise one of aluminum, silver, copper or

gold.

[0014] The applying the heat adsorbing or reflecting material may comprise inserting the heat adsorbing or reflecting material into the body of the filter.

[0015] The applying the heat adsorbing or reflecting material may comprise wrapping a filter absorbing matrix of the filter with the heat adsorbing or reflecting material.

[0016] The smoking article may comprise a less than full flavor smoking article, and the method may further comprise applying one or more ventilation holes to the filter.

[0017] The one or more properties may comprise at least one of a type of heat adsorbing or reflecting material, a surface roughness, or a mass.

[0018] The selecting the heat adsorbing or reflecting material to apply may be based on at least one of the one or more properties.

[0019] The smoking article may comprise a full flavor smoking article, and wherein the applied heat adsorbing or reflecting material is configured to raise the inner temperature of the filter.

[0020] The smoking article may comprise a less than full flavor smoking article, and the applied heat adsorbing or reflecting material may be configured to lower the inner temperature of the filter.

[0021] The method may further comprise determining at least one of a position, size, number and shape of one or more ventilation holes to be applied to the filter to control a temperature gradient of the filter.

[0022] The method may further comprise determining at least one of a size and a material composition of the heat adsorbing or reflecting material to control a temperature gradient of the filter.

[0023] According to another aspect of the disclosure, a smoking article is provided. The smoking article comprises: a filter material that captures and substantially removes unwanted components in an aerosol; and a foil that is configured to control temperature of the aerosol, so as to provide a full-bodied flavor to the aerosol.

[0024] A longitudinal length of the foil in the smoking article may comprise at least 50% of a longitudinal length of the filter material.

[0025] The smoking article may further comprise a hole provided in the foil to control a temperature of the aerosol.

[0026] The foil may comprise an annular axial foil material. The foil may comprise: aluminum; silver; copper; or gold. The foil may be configured to decrease temperature of the aerosol.

[0027] According to a still further aspect of the invention, a smoking article is provided that comprises: a filter material that captures and substantially removes unwanted components in an aerosol; and a foil that is configured to control temperature of the aerosol, so as to provide a full-bodied flavor to the aerosol, wherein: a longitudinal length of the foil comprises at least 50% of a longitudinal length of the filter material; the foil comprises a hole to control temperature of the filter material; the foil comprises an annular axial foil made of at least one of aluminum, silver, copper, and gold.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The invention will be better understood after a reading of the following description of the preferred embodiments when considered with the drawings in which:

[0029] FIG. 1 is a flowchart showing a method for manufacturing a smoking article having enhanced taste characteristics;

[0030] FIG. 2 is a schematic of an example of a smoking article having a metallized foil outer wrapper;

[0031] FIGs. 3A and 3B are schematics of an example of a smoking article having an annular coaxial metallized foil wrapper;

[0032] FIGs. 4A and 4B are schematics of an example of a smoking article having a centered coaxial metallized foil wrapper;

[0033] FIGs. 5A and 5B are schematics of an example of a smoking article having a centered coaxial metallized foil insert;

[0034] FIGs. 6A and 6B are schematics of an example of a smoking article having external and internal metallized foil wrappers;

[0035] FIGs. 7A and 7B are schematics of an example of a smoking article having multiple insert foil wrappers;

[0036] FIG. 8 is a graph showing the filter temperature change as a function of puffs over time with respect to conventional cigarettes;

[0037] FIG. 9 is a chart illustrating relative consumer preferences of the taste characteristics of a non-mentholated cigarette embodying the present invention compared to a non-mentholated prior art cigarette;

[0038] FIG. 10 is a chart illustrating relative consumer preferences of the taste characteristics of a mentholated cigarette embodying the present invention compared to a mentholated prior art cigarette;

[0039] FIG. 11 is a chart showing the mainstream smoke analyte levels for various cigarettes embodying the present invention.

[0040] FIG. 12A is a schematic of a method and apparatus for measuring the gas phase and particulate phase components of cigarette mainstream smoke; and

[0041] FIG. 12B shows an example of a gas and particulate phase component (GPPC) measuring apparatus that for measuring the gas phase and particulate phase components of cigarette mainstream smoke;

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0042] Referring now to the drawings in general, it will be understood that the illustrations are for the purpose of describing preferred embodiments of the invention and are not intended to limit the invention thereto.

[0043] Methods and articles are described herein for enhancing the taste characteristics of the smoke produced by a smoking article during a smoking experience by controlling the temperature of an inner filter associated with the smoking article. A heat adsorption or reflective material, such as a metallized foil material, may be applied to the filter to exercise the temperature control. The metallized foil may be, for example, a metallized foil insert, a metallized foil wrapper, a metallized foil core, etc. The methods described herein may apply to less than full flavor smoking articles, enhancing the taste characteristics to more closely replicate the taste characteristics of a full flavor smoking article. In some aspects, the taste characteristics of a full flavor smoking article may also be further enhanced.

[0044] It is understood that the smoking article mainstream smoke is formed by combustion products and vaporized effluents, and they are normally classified as particulates, semi-volatiles, and volatiles. During smoking, they reach the filter and they might condense in the filter depending on their condensation temperature/rate, therefore the smoke stream shows different gas-particle compositional distribution.

[0045] According to the equilibrium gas/particle theory for aerosol developed by Pankow, Chen, and Hennigan, the gas to particle partitioning coefficient, Kp, for aerosol may be determined as follows:

$$Kp = \frac{Cp / Mo}{Cg} = \frac{760\ RT\ f_{om}}{106\ MW_{om}\ t\ p} \quad (1)$$

In Equation (1), Cp is the compound's particle-phase concentration, Mo is the mass concentration of the absorbing organic phase (including water), and Cg is the compound's gas-phase concentration. Kp can also be predicted from the properties of the partitioning species, where R is the ideal gas constant, T is temperature, f_{om} is the organic fraction of total particulate mass, MW_{om} is the average molecular weight of the absorbing organic (and aqueous) phase, t is the particle-phase activity coefficient, and p is the saturation vapor pressure.

[0046] As reported in R.J. Reynolds Internal Document No. 50220 (Bates 502208295-502208361) dated May 1985, the statistical relationship for N=40 smokers between ventilation technology and harshness, taste, and other subjective attributes is well documented. Provided below in Table I is a summary of these statistical relationships which show that mainstream smoke air dilution produced by air ventilation is negatively correlated with a number of subjective customer measurements. These negative correlations are caused by changes in filter inner temperature which affect component condensation rates and gas-particle partition. Accordingly, technologies that affect filter temperature also affect the smoke gas-particle phase balance with a consequent reduction in customer satisfaction with regard to organoleptic smoke attributes.

	Strength	Harshness	Mildness	Tobacco Taste	Smooth
Dilution	-0.55	-0.48	0.49	-0.5	****
Puff Volume	-0.54	****	****	****	****
Rod Volume	-0.69	-0.65	****	-0.57	0.75

	Throat Scratch	Mouth Sensation	Impact	Tobacco Taste	Smoke Conc.
Dilution	****	-0.51	-0.8	-0.73	-0.59
Puff Volume	****	-0.57	-0.85	-0.74	-0.48
Rod Volume	-0.77	-0.86	-0.96	-0.92	-0.5

Table I. Cigarette variables to subjective measurement correlations. R.J. Reynolds Internal Document No. 50220 (Bates 502208295-502208361) dated May 1985. [****= no data]

[0047] Based on the mainstream smoke gas-particle balance described in equation (1) that relates gas-particle partition to temperature, it was discovered that by modulating and/or controlling Kp, it is possible to improve the organoleptic properties of smoking articles and increase low tar products acceptability by adult consumers. In particular, this is useful when the smoking articles include abatement technologies, such as dilution and adsorbing filters that, change the gas to particle balance of acceptable smoking articles.

[0048] Furthermore, it was discovered that the application of equation (1) to cigarette filter configurations indicates that Kp depends on the filter temperature, the smoke vapor pressure of its chemical components, the average mass of the particle phase, and the overall mole fraction activity coefficients of the particle phase taste-given compounds. In accordance with some aspects of the invention, strategies to control Kp to enhance and/or control smoking articles organoleptic properties include, for example, controlling temperature,

controlling saturation vapor pressure, and/or controlling the average molecular weight of adsorbing phases. As described in more detail herein, in accordance with some aspects of the invention, the inner temperature of a filter of a smoking article can be controlled by wrapping the filter with metallized foils or other heat adsorbing or heat reflecting material.

[0049] Turning now to Figure 1, an example of a method 100 for manufacturing a smoking article having enhanced taste characteristics is shown. As seen at 102, a heat adsorbing or reflecting material may be selected for applying to a filter of the smoking article. The heat adsorbing or reflecting material may have one or more properties associated therewith, such as a type, a surface roughness, or a mass, and in some aspects, the selected heat adsorbing or reflecting material is selected based on at least one of the one or more properties. The heat adsorbing or reflecting material may include a metallized foil or film, such as aluminum, silver, copper, or gold. In some aspects, metallized foils or films can be made from chemically inert films (i.e. paper, ceramic layers, polymer layer(s) or combination thereof) coated with a thin layer of metal, usually but not limited to, aluminum. Metallization may be performed by using a physical vapor deposition process. Aluminum is the most common metal used for deposition, but other metals such as gold, silver, nickel or chromium may also be used. The metal may be heated and evaporated under vacuum conditions. The metal molecules may condense on a cold inert substrate or polymer film, which may be unwound near the metal vapor source. The resultant coating is much thinner than a metal foil could be made, in the range of about 0.5 micrometers.

[0050] The metallized foil or film may behave as a thermal insulator and/or heat exchanger. As described above, the foil properties may be controlled by varying the type, the surface roughness or/and the mass of the foil. For example, aluminum foil alloys may have a

thermal conductivity in the range of about 120-180 W/ (m.K) compared with about 429 W/ (m. K) for silver foil. Likewise, aluminum foil alloys may have a heat capacity of about 0.90 J/(g.K) compared with about 0.23 (J/g. K) for silver. Accordingly, silver material when used as part of a filter wrapper of a smoking article can remove heat faster from the smoke stream than an aluminum wrapper. Different metal foils can be used alone or in combination to create zones with different thermal properties.

[0051] As seen at 104, the selected heat adsorbing or reflecting material may be applied to the filter, wherein the heat adsorbing or reflecting material may be configured to control the inner temperature of the filter. In accordance with some aspects, the heat adsorbing or reflecting material may be provided in the body of the smoking article filter or applied as single/multiple filter wrapper layers, and/or co/off-axial wrappers in intimate contact with the filter material matrix. The heat adsorbing or reflecting material may be configured to cover 50% or more (e.g., along the axial length of the filter) of the plug wrap. It is noted that the heat adsorbing or reflecting material may be configured to cover less than 50% of the plug wrap. The smoking article may be a full flavor smoking article or a less than full flavor smoking article. Where the smoking article is a full flavor smoking article, the applied heat adsorbing or reflecting material may be configured to raise the inner temperature of the filter.

[0052] In accordance with some aspects, the smoking article may be a less than full flavor smoking article, wherein the applied heat adsorbing or reflecting material is configured to lower the inner temperature of the filter. When applied to a less than full flavor smoking article, the method 100 may additionally include applying one or more ventilation holes to the filter, as seen at 106. Applying the one or more ventilation holes may include determining a position, size, number, and/or shape of the one or more ventilation holes to apply to the filter in order to

control a temperature gradient of the filter.

[0053] Various examples of the present invention comprising metallized foiled filter structures with and without ventilation holes are illustrated and described below. It will be understood that even though the illustrations show the metallized foils only in a portion of the filter, the foil could be extended to cover, if desired, both the mouth piece and the tobacco column. These illustrations do not show the final filter wrapper "tipping paper" that hold the cigarette filter to the tobacco column. These are non-limiting examples that could be used independently or combined with each other as required to meet desired filtering cigarette performance. For example, the filter may optionally include fragrance encapsulates, a tobacco matrix, adsorbent resins and other filter functionality modifiers in the filter material with the metallized foil function.

[0054] FIG. 2 shows an example of a smoking article 200 that is constructed in accordance with an aspect of the invention. The smoking article 200 may include a tobacco column 202, a filter absorbing matrix 204, and a mouthpiece 206. Filter absorbing matrix 204 may comprise, for example, cellulose acetate, paper, etc. As seen in Figure. 2, the filter absorbing matrix 204 may be wrapped with a heat adsorbing or reflecting material 208, such as a metallized foil described herein. A portion (or whole) of the mouthpiece 206 and/or a portion of the tobacco column 202 may also be wrapped with the heat adsorbing or reflecting material 208. The heat adsorbing or reflecting material 208 may be configured to cover 50% or more (e.g., along the axial length of the filter) of the plug wrap. It is noted that the heat adsorbing or reflecting material 208 may be configured to cover less than 50% of the plug wrap. For less than full flavor smoking articles, one or more ventilation holes 210 may be included in the heat adsorbing/reflecting material 208.

[0055] Figures 3A and 3B illustrate different views of another example of a smoking article 300 that is constructed in accordance with an aspect of the invention. Figure 3A shows a longitudinal lengthwise-cut view and Figure 3B shows a cross-sectional view of a portion of the smoking article 300. Smoking article 300 includes a tobacco column 302 and a mouthpiece 306. An inner adsorbing matrix 304 of the smoking article 300 may be wrapped with a metallized foil 308. A portion (or whole) of the mouthpiece 306 and/or a portion of the tobacco column 302 may also be provided with the heat adsorbing or reflecting material 308. An outer layer 310 of wrap may be wrapped around the adsorbing matrix 304 and adsorbing or reflecting material 308. For less than full flavor smoking articles, one or more ventilation holes 312 may be included in the outer layer 310.

[0056] In accordance with some aspects of the invention, the densities, materials, and formulations of the inner and outer adsorbing layers 304, 310 may be different or substantially the same, as required to meet desired taste and filtering performance. For example, the inner core (or layer) 304 may include carbon embedded artificial/natural fibers and the outer layer 310 may include virgin cellulose acetate fibers. In another example, both the inner and outer layers 304, 310 may include cellulose acetate having different densities.

[0057] Figures 4A and 4B illustrate yet another example of a smoking article 400, in accordance with an aspect of the disclosure. Figure 4A illustrates a longitudinal lengthwise-cut view of the smoking article 400 and Figure 4B illustrates a cross-sectional view of the smoking article 400. Smoking article 400 includes a tobacco column 402, a mouthpiece 406, an inner annular coaxial metallized foil 408, an outer annular coaxial metalized foil 412 and a filtering material 404. The filtering material 404 may be provided in the substantially cylindrical area formed by the inner metallized foil 408. The filtering material 404 may be provided in the

substantially cylindrical area formed between the inner and outer metallized foils 408 and 412, surrounding the metallized foil 408 and being surrounded by the outer metallized foil 412. For less than full flavor smoking articles, thermal conditions and tar may be controlled by providing one or more ventilation holes 410 in the outer metalized foil 412 and/or inner metalized foil 408 (not shown).

[0058] Figures 5A and 5B show another example of a smoking article 500 that is constructed according to an aspect of the invention. Figure 5A shows a longitudinal lengthwise-cut view of the smoking article 500 and Figure 5B shows a cross-sectional view of the filter portion of the smoking article 500. In this example, a core of non-circular metallized foil (foil core) 508 is provided in a central portion of an adsorbing matrix 504. The metalized foil core 508 may be positioned along and locate at the central axis of the filter portion. For less than full flavor smoking articles, one or more ventilation holes, such as ventilation hole 510 may be included in the adsorbing matrix 504. It is noted that the smoking article 500 may include a plurality of metallized foil cores 508 (not shown) that may be positioned equi-distally from each other in the filter portion of the smoking article 500. The plurality of metallized foil cores 508 may be aligned along the longitudinal axis of the filter portion and located radially (e.g., in the shape of a circle, a star, a square, or any other shape) with respect to the central axis of the filter portion.

[0059] Figures 6A and 6B illustrate yet another example of a smoking article 600, in accordance with another aspect of the invention. The smoking article 600 comprises an inner longitudinal cross-shaped metallized foil (foil core) 608 provided in the center of an adsorbing matrix 604 of the filter portion. The smoking article 600 may comprise an outer annular metallized foil 602 that is wrapped around the adsorbing matrix 604. In the filter portion of the

smoking article 600, heat is conducted through both the metalized foil core 608 and outer annular metallized foil 602. One or more ventilation holes 610 may be included in the outer annular metallized foil 602 and/or adsorbing matrix 604 for less than full flavor cigarettes.

[0060] Figures 7A and 7B show an example of a smoking article 700, constructed according to a further aspect of the invention, which includes multiple non-circular (e.g., cross-shaped) metallized foils 708 provided in an adsorbing matrix 704 of the filter portion of the smoking article 700. While not shown, an outer layer of metallized foil may also be included and wrapped around the adsorbing matrix 704. Ventilation holes 710 may be included in the outer metalized foil (not shown) and/or the adsorbing matrix 704 for less than full flavor smoking articles.

[0061] FIG. 8 is a diagram showing the filter temperature change as a function of puffs over time for a full flavor (FF) cigarette and a less than full flavor (LF) cigarette. In particular, FIG. 8 shows an example of maximum temperature change during a 2 second puff cycle, 28 second wait cycle, and a 50 ml syringe puff in a single port smoking machine (e.g., GPPC measuring apparatus 950, shown in FIG. 9B). The sampled FF cigarettes included 80 mm cigarettes of 134 mm H_2O pressure drop and 14 mg of tar. The sampled LF cigarettes included 100 mm cigarettes of 130 mm H_2O pressure drop.

[0062] Figure 8 separately shows the maximum temperature changes in the filter zones of (1) a full flavor cigarette with a metallized foil as compared to a control full flavor cigarette having no metallized foil and (2) a less than full flavor cigarette with a metallized foil compared to a control less than full flavor cigarette having no metallized foil. In the experiments, a thermocouple was placed 15 mm away from the cigarette mouth piece and the temperature was read during smoking. As seen in Figure 8, FF designates a graph of the inner filter temperature

difference between the full flavor cigarettes (i.e., having no ventilation holes) with and without a metallized foil. LF designates a graph of the inner filter temperature difference between less than full flavor cigarettes (i.e., having ventilation holes located 5 mm upstream from a thermocouple) with and without a metallized foil.

[0063] As seen in Figure 8, the full flavor cigarette having a metallized foil has higher inner filter temperatures than the control FF cigarette. The temperature differential increases within the sensitivity of the thermocouple, as the fire cone moves closer to the mouth piece.

[0064] The opposite behavior was exhibited in less than full flavor cigarettes having a metallized foil. As seen in Figure 8, the less than full flavor cigarette having a metallized foil has lower filter temperature than the control LF cigarette. Moreover, the relative inner filter temperature of the less than full flavor cigarette having a metallized foil decreases as the fire cone moves closer to the mouth piece during the smoking cycle. This is shown by the increasing negative temperature differential between the less than full flavor cigarette having a metallized foil and the control LF cigarette.

[0065] In the FF case the metallized foil acts as a heat shield so it contains the heat within the metallized foil measured zone. However, in the LF case two zones of different thermal characteristics are created. One of them is a warm zone which is located downstream of the ventilation holes which is warmed by the smoke stream, and the second, is a cool zone located upstream of the ventilation holes formed by the cooling of the air entering through the ventilation holes. Because the second zone is cooler than the first zone, heat moves from the hotter to the cooler zone therein, and acts as a heat sink and reduces the temperature of the warm smoke. So in the LF case, it was discovered that ventilated cigarettes that use metallized foil show an inner temperature gradient. Therefore, it has been determined that by controlling the

position, size, number and shapes of the ventilation holes and the size and material composition of the metallized foil, it is possible to control the filter temperature gradient.

[0066] Table II shows tar, nicotine, and carbon monoxide (TNCO) delivery in accordance with several examples illustrating principles of the invention.

Sample I.D.	Descriptor	Tar (mg/cigarette)	Nicotine (mg/cigarette)	CO (mg/cigarette)
Less than full flavor Non-mentholated				
6216	Control	9.18 +/- 0.51	0.78 +/- 0.05	11.1 +/- 0.59
6221	Invention Prototype	9.18 +/- 0.29	0.76 +/- 0.03	11.5 +/- 0.07
Less than full flavor Mentholated				
6218	Control	9.52+/-0.62	0.78 +/- 0.04	11.0 +/- 0.40
6222	Invention Prototype	9.48+/-0.32	0.76 +/- 0.02	11.6 +/- 0.49
Less than full flavor non-mentholated (50 % length foiled filter segment)				
7008	Control	10.65 +/- 0.25	1.03 +/- 0.04	13.8 +/- 0.44
7010	Invention Prototype	5.38 +/- 0.21	0.55 +/- 0.01	9.10 +/- 0.26
Full to less than full flavor comparison				
7004	Control	15.38 +/- 0.74	1.37 +/- 0.06	15.3 +/- 1.00
7007	Invention Prototype	10.73 +/- 8.82	0.98 +/- 0.09	13.8 +/- 0.72
Full flavor to less than full flavor (100 % length foiled filter segment)				
8335	Control	13.6 +/- 0.8	0.93 + /-0.03	15.9 +/- 0.7
8388	Invention Prototype	7.8 +/- 0.4	0.65 +/- 0.65	7.6 +/- 0.6

Table II. Delivery performance of this invention 100 mm mentholated and on mentholated cigarettes versus their controls

[0067] The methods described herein may be applied to less than full non-mentholated flavor cigarettes built with metallized foils. It has been found that less than full non-mentholated flavor cigarettes built with metallized foils are preferred more than twice non-foiled non-mentholated control cigarettes at essentially equivalent tar delivery. Specifically, a panel of twenty-eight non-menthol smokers evaluated two packs of each prototype and completed a questioner about their preference and perceived characteristics of the cigarettes. Preference was observed for metallized prototype which demonstrated statistical superiority in overall

satisfaction and liking of overall taste, strength of taste, strength of tobacco taste, and smoothness. Strong directional superiority was observed in liking of aftertaste and draw. The metallized prototype cigarette was statistically superior to the control in similarity to the usual brand smoked by the panel with both products perceived as better than the usual brand. The test product was so different from the control and liked significantly more by the panelists that when they smoked the control, it was rated much lower across most of the liking scores in comparison to previous tests. Figure 9 shows the preference results. The embodiment of the present invention was a cigarette having 9.2 mg of tar, 0.76 mg of Nicotine, and 12 mg CO per cigarette.

[0068] The methods described herein may also be applied to less than full mentholated flavor cigarettes built with metallized foils. It has been found that these cigarettes are preferred more than three times the non-foiled control mentholated cigarettes. The panel in this experiment consisted of thirty menthol 80 mm cigarette smokers who evaluated 2 packs of each prototype and completed a similar questioner as the one described above. Statistical analysis of the questioners shows a significant preference difference between this invented prototype and the control. This difference is reflected in the overall satisfaction scores. The prototype showed significantly greater liking in "strength of taste" with strong directional superiority in liking of "overall taste"; it was found smoother and "closer to just about right" in "strength of taste", "strength of tobacco taste", and "draw." Figure 10 shows the preference results. The embodiment of the present invention in this study was characterized as having 9.5 mg of tar, 0.76 mg of Nicotine, and 12 mg CO per cigarette.

[0069] The examples above were for cigarettes that have equal tar delivery and with the present invention show improved taste. Surprisingly, it was also discovered that the present

invention can be used to achieve taste parity for cigarettes that have half the tar delivered than the control cigarette without the invention. Specifically, a panel of thirty traditional 100 mm cigarette smokers evaluated two packs of each prototype and completed a similar questioner as the one described above. The embodiment of the present invention in this study was characterized as having 5.4 mg of tar and 0.55 mg of Nicotine per cigarette. The control cigarette was characterized as having 10.7 mg of tar and 1.03 mg of Nicotine. Statistical analysis of the "liking" scores showed parity for the cigarettes.

[0070] Furthermore, with respect to improving the taste of a cigarette equipped with the invention described herein, an additional benefit is derived from the ability to reduce the overall tar delivery from a smoking article equipped with the invention described herein and achieve taste parity to a higher tar delivered from a cigarette not equipped with the invention described herein. The invention described herein has particular relevance in the ability to maintain the taste characteristics of a full flavor cigarette in a less than full flavor cigarette. As shown in Figure 11, laboratory results measuring the delivery of specific non-desirable gas phase components of the cigarette smoke demonstrate that the embodiments of the present invention do not affect the overall delivery of such non-desirable gas phase components.

[0071] Tables III and IV illustrate the ability to achieve taste parity or better between a mentholated cigarette comprising aspects of the invention described herein and a mentholated full flavor cigarette not equipped with aspects of the invention described herein. To evaluate the taste characteristics of the cigarettes, a panel of 29 menthol 100 mm cigarette smokers evaluated two packs of each prototype and completed a questionnaire about the sensory differences between a 15.4 mg/cigarette control and a 10.7 mg/cigarette comprising principles of the present invention. An analysis of variance (ANOVA) was carried out on the returned questionnaire

using a sequential monadic randomized block – 2 packs per product – home use. As Tables III and IV illustrate, smokers had a positive response to the cigarette implementing aspects of the present invention.

Table III

Variable	Control A cigarette 15 mg tar/cigarette	Control B cigarette 10.7 mg tar/cigarette	Invented cigarette 10.7 mg tar/cigarette	ANOVA Probability > F
Overall Liking (1-9) 1=Dislike, 9=Like Extremely	5.89a	5.55	6.06a	0.590
Overall Taste (1-7) 1=Extremely weak, 9=Like Extremely strong	4.53a	4.07a	4.38a	0.3356
Tobacco Taste (1-7) 1=Extremely weak, 9=Like Extremely strong	4.65a	4.03a	4.24a	0.162
Aftertaste (1-7) 1=Extremely weak, 9=Like Extremely strong	4.03a	4.03a	3.82a	0.810
Menthol Taste 1=Extremely weak, 9=Like Extremely strong	4.10a	3.31b	3.69a	0.062*
Smooth (1-7) 1=Extremely harsh, 9=Like Extremely smooth	4.65a	4.97a	5.10a	0.391
Draw (1-7) 1=Extremely easy, 9=Like Extremely hard	2.96a	3.07a	3.41a	0.173
Similarity to Usual Brand (1-7) 1=Not similar at all, 9=Like Extremely similar	3.76a	3.03a	4.00a	0.101

* 90 % confidence index level; ** 95 % confidence index level, if letter is different, then significant to the 95 % level (Dunnett's Method)

Table IV

	Smoker preferences		
Attributes	Control A cigarette 15.4 mg tar/cigarette	Control B cigarette 10.0 mg tar/cigarette	Invented cigarette 10.7 mg tar cigarette
Is robust and full-bodied	Yes	Yes	Yes
Has premium tobacco taste	Yes		Yes
Is soothing and easy to smoke		Yes	Yes
Smokes great all day	Yes	Yes	Yes
Has the fullest possible flavor	Yes		Yes
Is refreshing			Yes
Helps me enjoy life			Yes
Is mild and flavorful		Yes	Yes
Has pleasant menthol taste			Yes
Has right balance of menthol and tobacco taste		Yes	Yes
Tastes like a high quality brand	Yes	Yes	Yes

[0072] Table V illustrates the ability to achieve taste parity or better between a mentholated silver class cigarette comprising aspects of the invention described herein and a mentholated gold class cigarette not equipped with aspects of the invention described herein. To evaluate the taste characteristics of the cigarettes, a panel of 60 consumers evaluated two packs of each sample and completed a questionnaire about the sensory differences between a 14 mg/cigarette control and an 8 mg/cigarette comprising principles of the present invention. ANOVA analysis was carried out on the returned questionnaire using a sequential monadic randomized block – 2 packs per product – home use. As shown in Table V, smokers' opinions of the cigarette implementation aspects of the present invention were high.

Table V

Variable	Control cigarette 14mg tar/cigarette	Invented cigarette 8 mg tar cigarette
Overall Liking 1=did not like at all, 9=greatest imaginable liking	5.5	5.6
Liking of Strength of Taste 1=did not like at all, 9=greatest imaginable liking	5.3	5.3
Just about right Strength of Taste 1=much too weak, 3=just about right, 5=much too strong	3.0 a b	2.8 b
Cooling Sensation 1=not like at all, 9=greatest cooling imaginable	5.2 a	5.9 b
Liking of Menthol Taste 1=did not like at all, 9=greatest imaginable liking	5.4	5.4
Just about Right Menthol Taste 1=much too weak, 3=just about right, 5=much too strong	2.8	2.9
Smooth 1= not smooth at all, 10=extremely smooth	5.5 a	5.9 b
Similarity to Usual Brand 1=Not similar at all, 9=Like Extremely similar	5.2	5.0

Different letters indicates significant differences at 90 % confidence index level

[0073] In addition, table VI illustrates the ability to achieve taste parity or better between a non-mentholated Gold class cigarette comprising aspects of the invention described herein and a non-mentholated Gold class cigarette not equipped with aspects of the invention described herein. To evaluate the taste characteristics, a panel of 28 Gold class non-menthol smokers

evaluated two packs of each sample and completed a questionnaire about the sensory differences between the cigarette comprising aspects of the present invention and a control at the same tar level. ANOVA analysis was carried out on the returned questionnaire using a sequential monadic randomized block – 2 packs per product – home use.

Table VI

Variable	Control cigarette 9.2 mg tar/cigarette	Invented cigarette 9.2 mg tar/cigarette	ANOVA Probability
Preference	29 %	57 %	
Overall Satisfaction (1-10) 1=Extremely Dissatisfied, 10=Extremely Satisfied	5.571	7.143	0.007 **
Overall Taste (1-10) 1=Disliked Extremely, 10=Like Extremely	5.393	6.929	0.002 **
Strength of Taste (1-10) 1=Disliked Extremely, 10=Like Extremely	5.393	7.036	0.046 **
Strength of Tobacco Taste (1-10) 1=Disliked Extremely, 10=Like Extremely	5.179	7.179	0.001 **
Aftertaste (1-10) 1=Extremely weak, 10=Like Extremely	5.357	6.714	0.075 ns
Smooth (1-10) 1=Not Smooth at all, 10=Extremely Smooth	5.929	7.357	0.042 **
Draw (1-10) 1=Disliked Extremely, 10=Like Extremely	6.321	7.607	0.062 ns
Strength of Taste JAR (1-5) 1=Too strong, 3=Just right, 5=Too weak	3.643	3.214	0.688 ns
Strength of Tobacco Taste JAR (1-5) 1=Too strong, 3=Just right, 5=Too weak	3.500	3.179	0.159 ns
Aftertaste JAR (1-5) 1=Too much, 3=Just right, 5=Too little	3.750	3.464	0.210 ns
Draw JAR (1-5) 1=Too easy, 3=Just right, 5=Too hard	2.964	3.071	0.436 ns
Similarity to Usual Brand (1-5) 1=Not similar at all, 5=Extremely similar	4.714	6.964	0.001 **
Overall Similarity to Usual Brand (1-5) 1=Better, 3=Same, 5=Worse	2.107	2.571	0.869 ns

** 95 % confidence index level, if letter is different, then significant to the 95 % level (Dunnett's Method)

[0074] According to the present invention, Kp was determined according to equation (1) based on Cp and Cg values measured using the method shown in Figure 12A and a gas and particulate phase component (GPPC) measuring apparatus 1250 shown in Figure 12B. The GPPC measuring apparatus 1250 comprises a holder 1222 and smoking and measuring machine 1228. The smoking and measuring machine 1228 comprises a smoker machine 1204 (shown in

Figure 12A) and a spectrometer (not shown) that may include a mass spectrometer 1206 (shown in Figure 12A) for measuring mass of gas and/or particulate phase components via spectrometry and a light spectrometer 1208 (shown in Figure 12A) for measuring, e.g., Tyndal Effect via light absorption spectroscopy.

[0075] Referring to Figures 12A and 12B, a cigarette 1202 is smoked by the smoking machine 1204 in the GPPC measuring apparatus 1250, and the resultant smoke stream may be substantially simultaneously sampled and measured by the smoking and measuring machine 1228 via mass spectrometry 1206 and light absorption spectroscopy 1208. According to this method, the cigarette 1202 may be held in position by the holder 1222, which may comprise a circular device containing three rubber diaphragms and a felt pad (not shown). In the smoking and measuring machine 1228, when a puff is taken by the smoking machine 1204, the smoke may be transferred through the holder 1222 into a light cell (not shown) in the light spectrometer 1208 where the smoke may interact with a light beam to produce a change in voltage associated with the smoke inside the light cell. The smoking and measuring machine 1228 may comprise a Cambridge pad (not shown) positioned behind the light cell to collect particulate materials and prevent particulate materials from entering a gas sampling region (not shown). In the smoking and measuring machine 1228, the gas phase components pass through the filter pad and travel into a gas sampling block (not shown) which may contain a pressure monitor (not shown) and a transfer line (not shown) connected to the mass spectrometer 1206. The mass spectrometer 1206 may monitor a pre-selected mass (mass-to-charge (m/z)).

[0076] Alternatively or in addition to enhancing taste characteristics of a smoking article by controlling the temperature, other methods may be used. For example, in some aspects, the saturation vapor pressure of the smoke produced during a smoking experience may be controlled

by adding to the tobacco column/filter material ingredients that reduce or increase the vapor pressure such as glycols, fragrances, salts, amorphous/crystalline balance of solid fragrances, hydrophilic polymers, hydrogels, etc. In some aspects, the average molecular weight of absorbing phases may be controlled by increasing or reducing the filter density and/or the filter material composition.

[0077] While the invention has been described in terms of exemplary embodiments, those skilled in the art will recognize that the invention can be practiced with modifications in the spirit and scope of the appended claims. These examples given above are merely illustrative and are not meant to be an exhaustive list of all possible designs, embodiments, applications or modifications of the invention.

WHAT IS CLAIMED:

1. A method of manufacturing a smoking article having enhanced taste characteristics, comprising:

selecting a heat adsorbing or reflecting material to apply to a filter of the smoking article, the heat adsorbing or reflecting material having one or more properties associated therewith; and

applying the heat adsorbing or reflecting material to the filter, the at least one heat adsorbing or reflecting materials being configured to control the inner temperature of the filter.

2. The method of claim 1, wherein the heat adsorbing or reflecting material comprises a metallized foil material.

3. The method of claim 2 wherein the metallized foil material comprises one of aluminum, silver, copper or gold.

4. The method of claim 2 wherein the metallized foil material comprises a laminated material made of one or more of aluminum, silver, copper, or gold.

5. The method of claim 1, wherein applying the heat adsorbing or reflecting material comprises inserting the heat adsorbing or reflecting material into the body of the filter.

6. The method of claim 1, wherein applying the heat adsorbing or reflecting material comprises wrapping a filter absorbing matrix of the filter with the heat adsorbing or reflecting material.

7. The method of claim 6, wherein the smoking article comprises a less than full flavor smoking article, and wherein the method further comprises applying one or more ventilation holes to the filter.

8. The method of claim 1, wherein the one or more properties comprise at least one of a type of heat adsorbing or reflecting material, a surface roughness, or a mass.

9. The method of claim 1, wherein selecting the heat adsorbing or reflecting material to apply is based on at least one of the one or more properties.

10. The method of claim 1, wherein the smoking article comprises a full flavor smoking article, and wherein the applied heat adsorbing or reflecting material is configured to raise the inner temperature of the filter.

11. The method of claim 1, wherein the smoking article comprises a less than full flavor smoking article, and wherein the applied heat adsorbing or reflecting material is configured to lower the inner temperature of the filter.

12. The method of claim 11, further comprising:

determining at least one of a position, size, number and shape of one or more ventilation holes to be applied to the filter to control a temperature gradient of the filter.

13. The method of claim 11, further comprising:

determining at least one of a size and a material composition of the heat adsorbing or reflecting material to control a temperature gradient of the filter.

14. A smoking article, comprising:

a filter material that captures and substantially removes unwanted components in an aerosol; and

a foil that is configured to control temperature of the aerosol, so as to provide a full-bodied flavor to the aerosol.

15. The smoking article of claim 14, wherein a longitudinal length of the foil comprises at least 50% of a longitudinal length of the filter material.

16. The smoking article of claim 14, further comprising:

a hole provided in the foil to control a temperature of the aerosol.

17. The smoking article of claim 14, wherein the foil comprises an annular axial foil material.

18. The smoking article of claim 14, wherein the foil comprises:

aluminum; silver; copper; or gold.

19. The smoking article of claim 14, wherein the foil comprises a laminated material

made of one or more of:

aluminum; silver; copper or gold.

20. The smoking article of claim 14, wherein the foil is configured to decrease temperature of the aerosol.

21. A smoking article, comprising:

a filter material that captures and substantially removes unwanted components in an aerosol; and

a foil that is configured to control temperature of the aerosol, so as to provide a full-bodied flavor to the aerosol,

wherein:

a longitudinal length of the foil comprises at least 50% of a longitudinal length of the filter material;

the foil comprises a hole to control temperature of the filter material;

the foil comprises an annular axial foil made of at least one of aluminum, silver, copper, and gold.

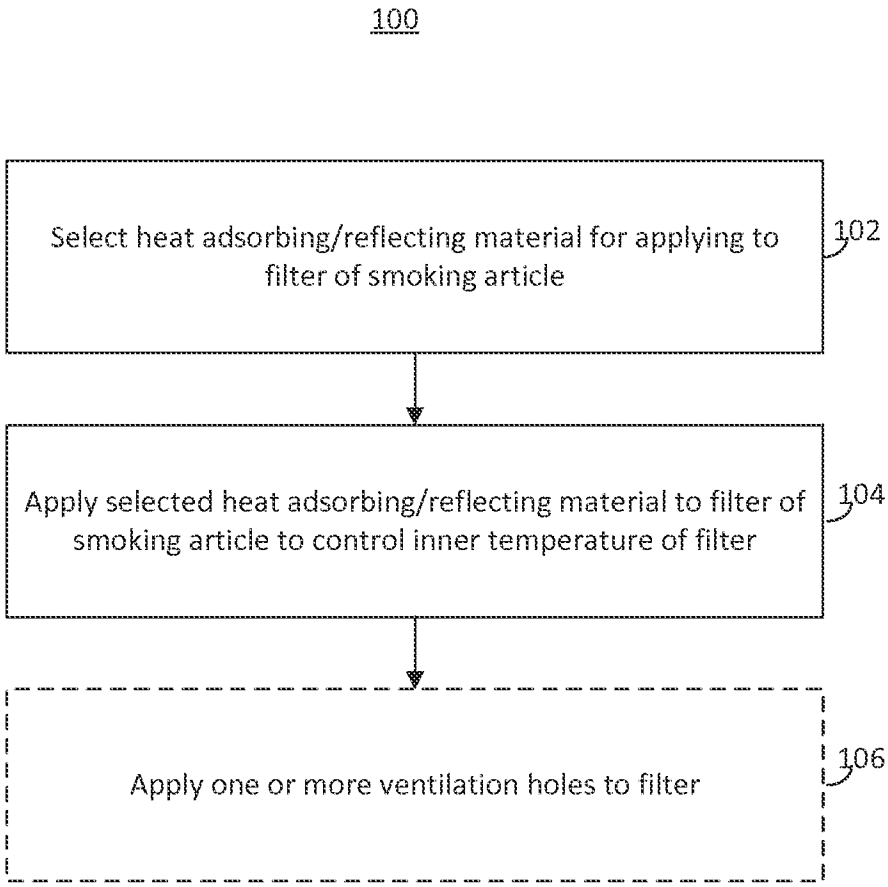
100
Select heat adsorbing/reflecting material for applying to filter of smoking article
102
Apply selected heat adsorbing/reflecting material to filter of smoking article to control inner temperature of filter
104
Apply one or more ventilation holes to filter
106

FIG. 1

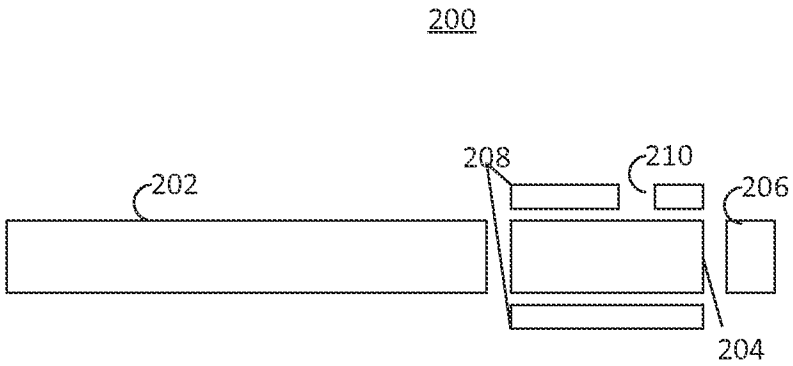

FIG. 2

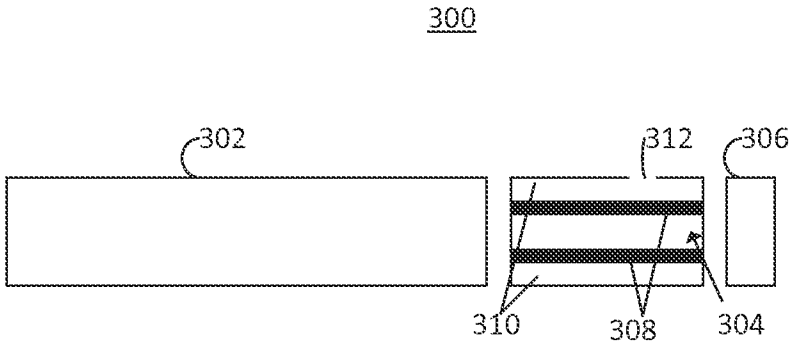

FIG. 3A

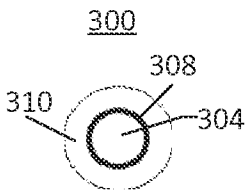

FIG. 3B

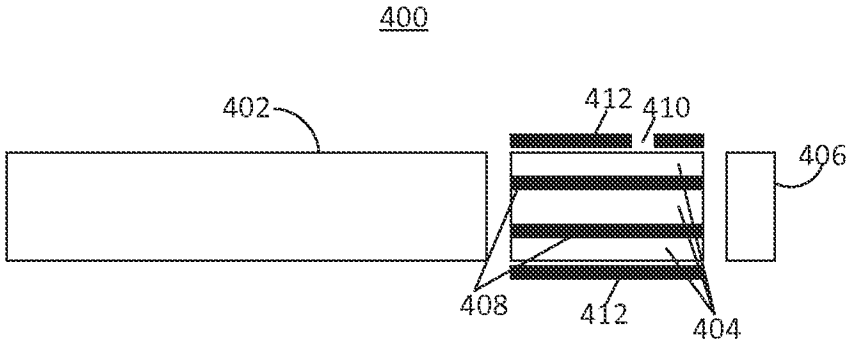

FIG. 4A

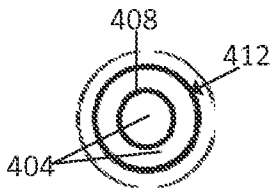

FIG. 4B

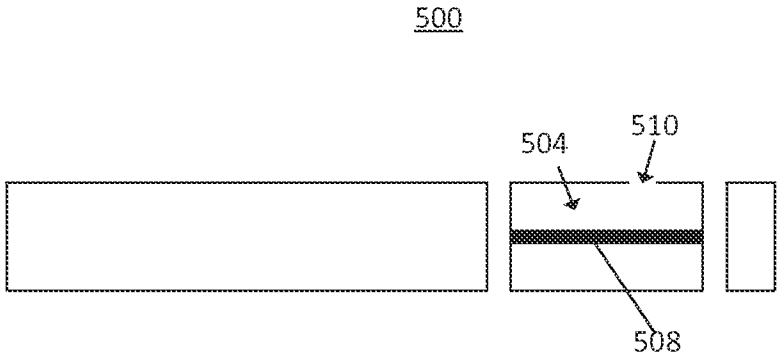

FIG. 5A

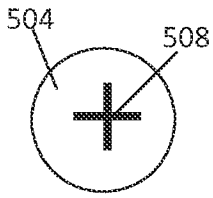

FIG. 5B

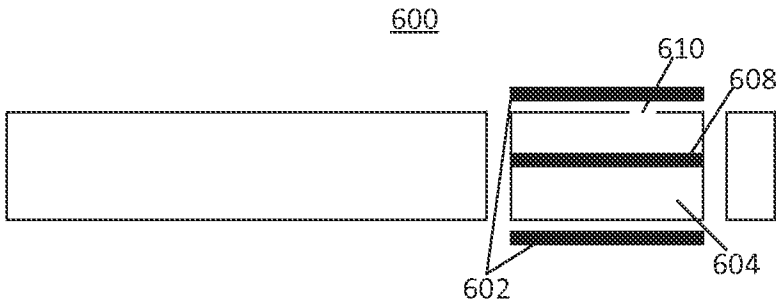

FIG. 6A

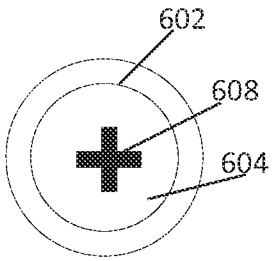

FIG. 6B

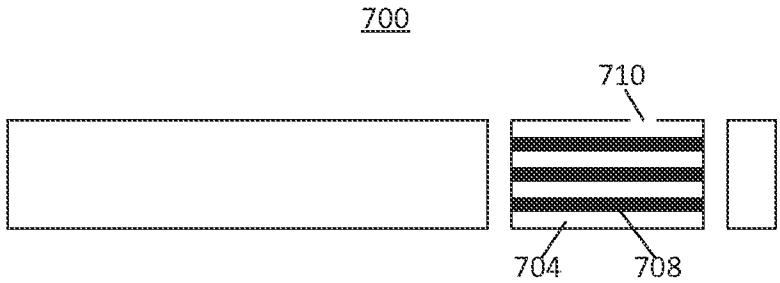

FIG. 7A

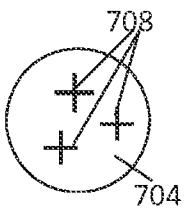

FIG. 7B

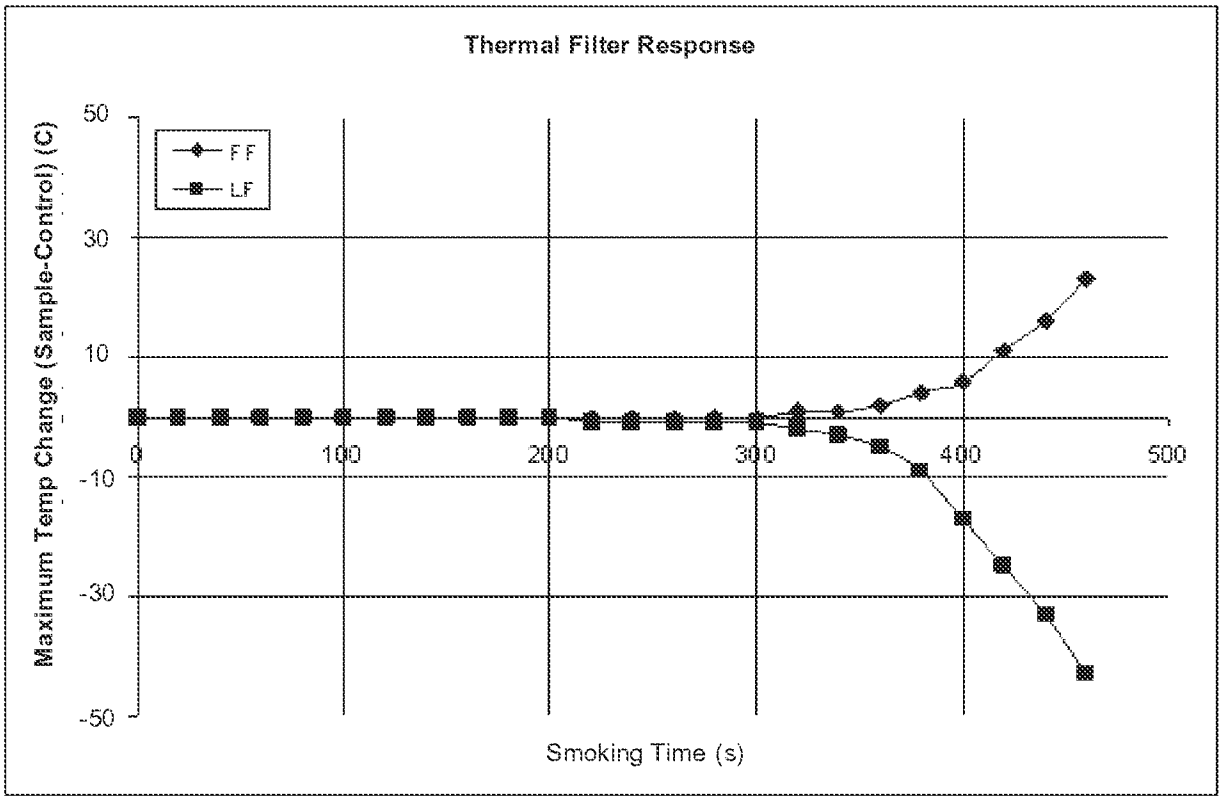
Thermal Filter Response
Maximum Temp Change (Sample-Control) (C)
50
30
10
-10
-30
-50
0
100
200
300
400
500
FF
LF
Smoking Time (s)

FIG. 8

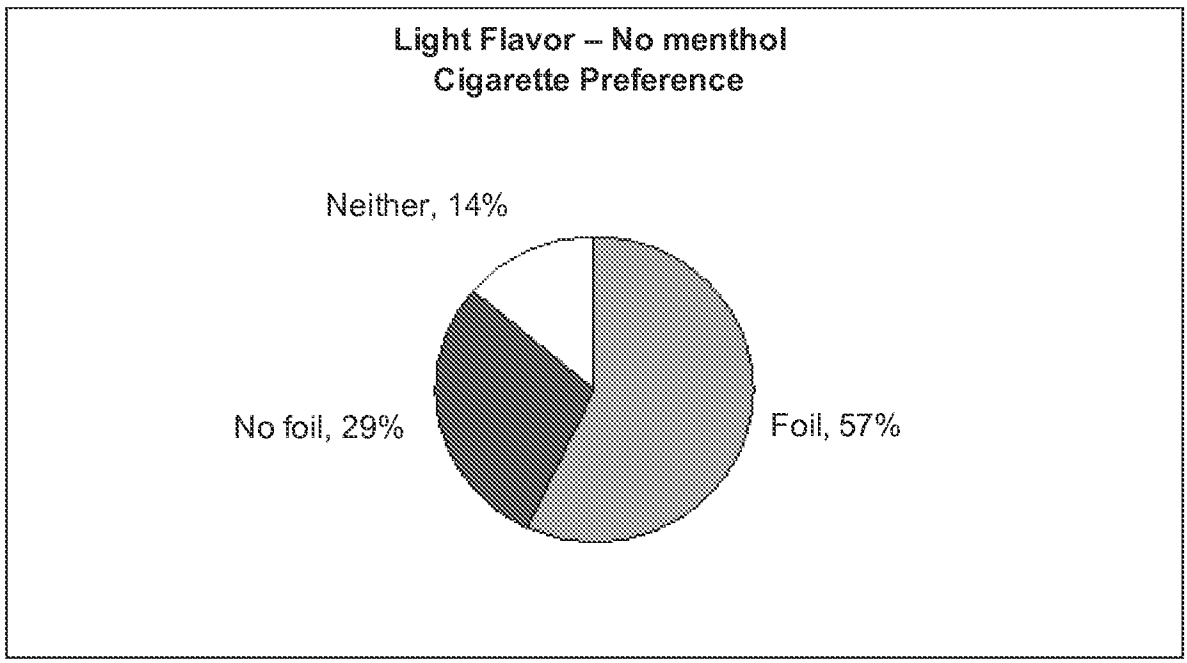
Light Flavor – No menthol
Cigarette Preference
Neither, 14%
No foil, 29%
Foil, 57%

FIG. 9

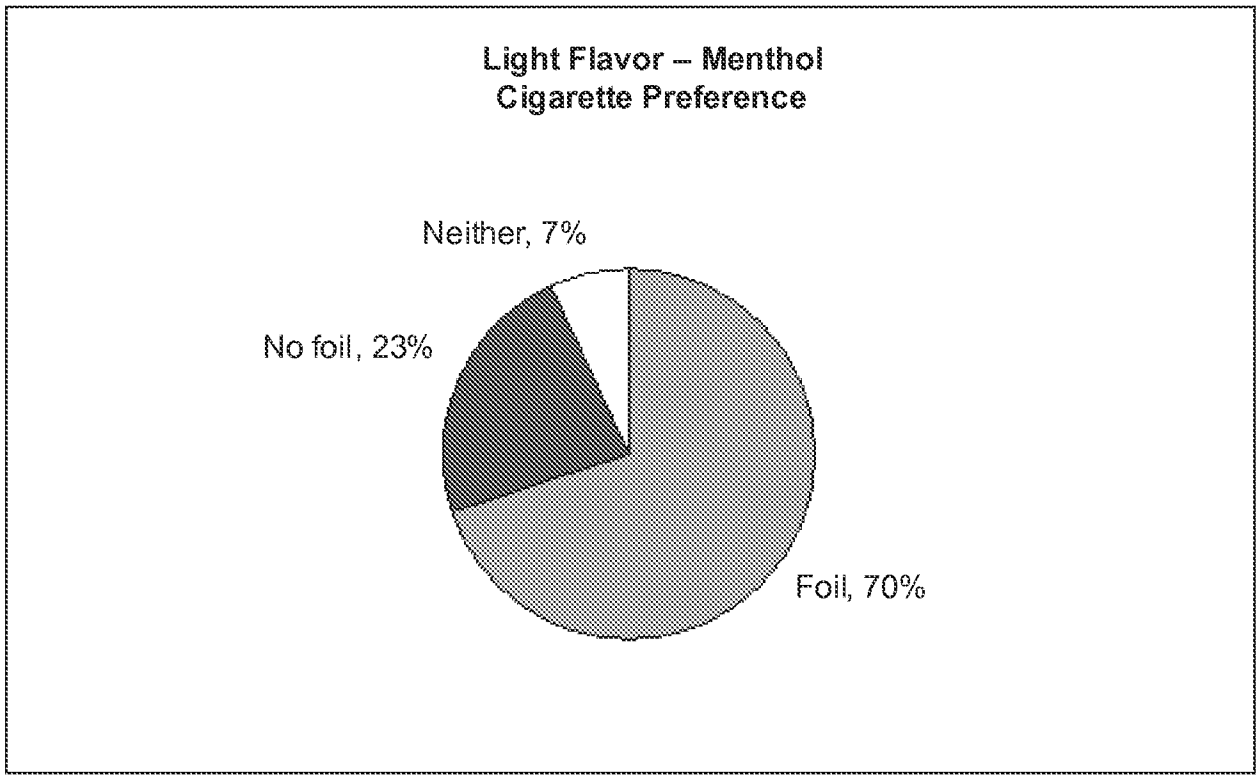
Light Flavor – Menthol
Cigarette Preference
Neither, 7%
No foil, 23%
Foil, 70%

FIG. 10

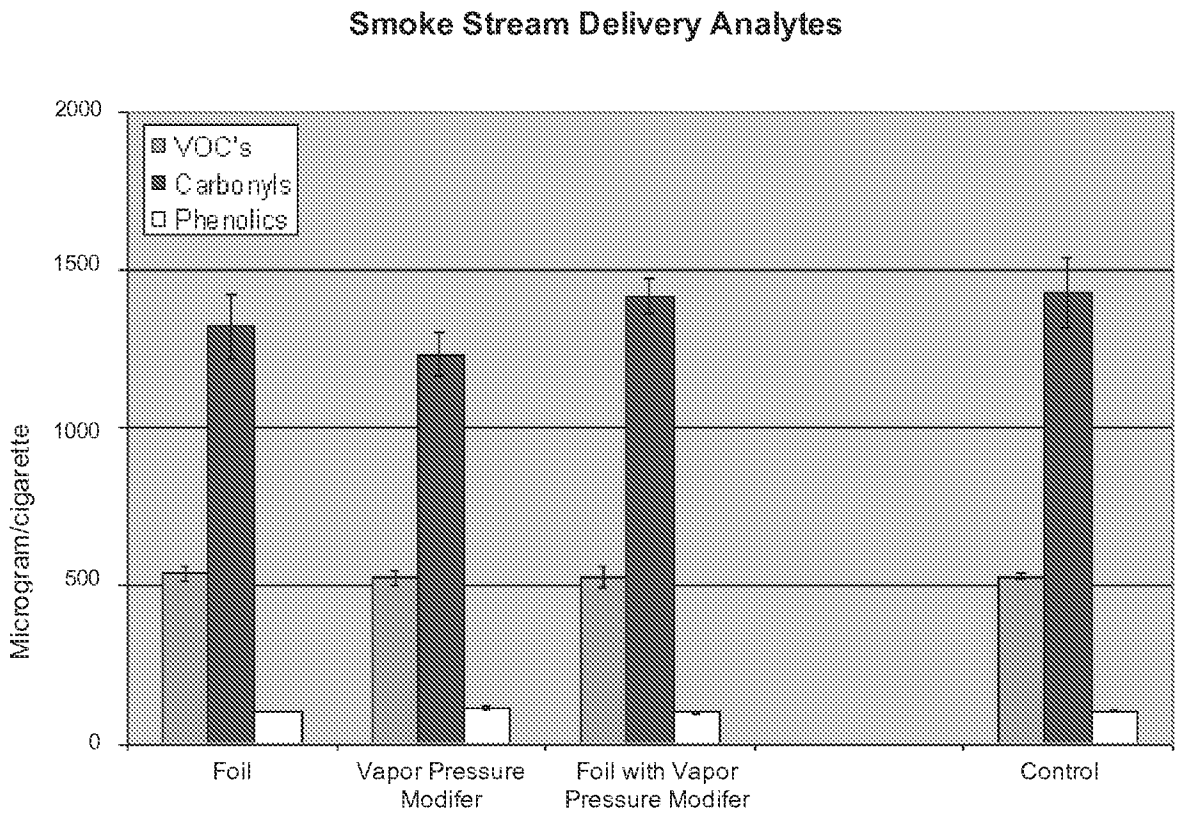
Smoke Stream Delivery Analytes
2000
1500
1000
500
0
Microgram/cigarette
VOC's
Carbonyls
Phenolics
Foil
Vapor Pressure Modifer
Foil with Vapor Pressure Modifer
Control

FIG. 11

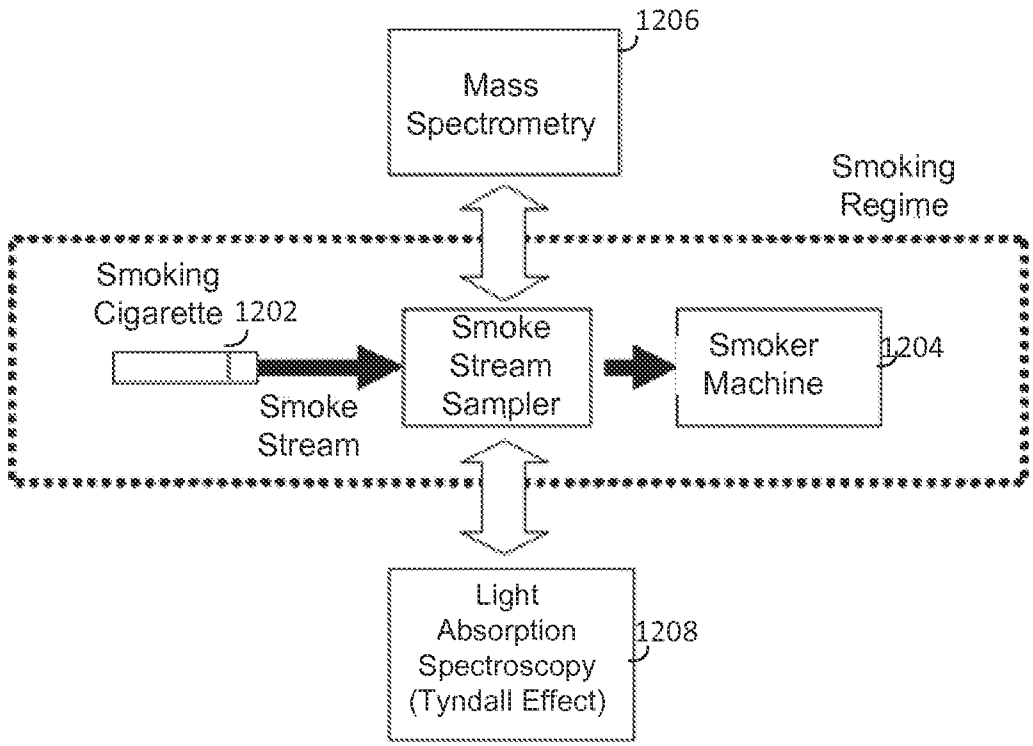

FIG. 12A

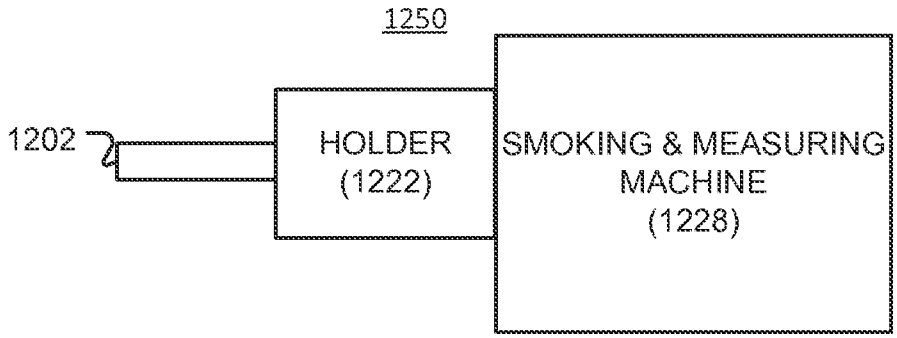

FIG. 12B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/041113

A. CLASSIFICATION OF SUBJECT MATTER

A24D 3/06(2006.01)i, A24D 3/02(2006.01)i, A24D 3/04(2006.01)i, A24D 1/00(2006.01)i

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)
A24D 3/06; A24D 1/02; A24D 1/00; A24B 15/00; A24D 3/02; A24D 3/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords:smoking article, foil, filter, heat adsorbing or reflecting meterial, flavor, control temperatur

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4991606 A (SERRANO, M. A. et al.) 12 February 1991 See claims 15-17, 21-22; column 3, lines 17-22; column 6, lines 7-16; column 6, line 68 - column 7, line 2; column 7, lines 39-45; figures 2, 5-8.	1-5,8-10,14-15,17-19
A		6-7,11-13,16,20-21
A	US 5097850 A (BRAUNSHTEYN, M. et al.) 24 March 1992 See abstract; claims 1, 4, 7.	1-21
A	US 5019122 A (CLEARMAN, J. F. et al.) 28 March 1991 See abstract; claims 1, 3.	1-21
A	US 6695924 B1 (DUBE, M. F. et al.) 24 February 2004 See abstract; claim 1; column 3, lines 3-9.	1-21
A	US 5261424 A (SPRINKEL, JR., F. M.) 16 November 1993 See abstract; claims 2, 30.	1-21

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of 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
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 September 2013 (03.09.2013)	**04 September 2013 (04.09.2013)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer
YANG In Su
Telephone No. +82-42-481-8131

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2013/041113

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 04991606 A	12/02/1991	CN 1019734 B	30/12/1992
		CN 1019734 C0	21/07/1989
		CN 1039710 A0	21/02/1990
		EP 0352109 A2	24/01/1990
		EP 0352109 A3	03/07/1991
		EP 0352109 B1	27/12/1995
		JP 02-084165 A	26/03/1990
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