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(54) **SYSTEM FOR DEBOSSING A HEAT GENERATION MEMBER, A SMOKING ARTICLE INCLUDING THE DEBOSSED HEAT GENERATION MEMBER, AND A RELATED METHOD**

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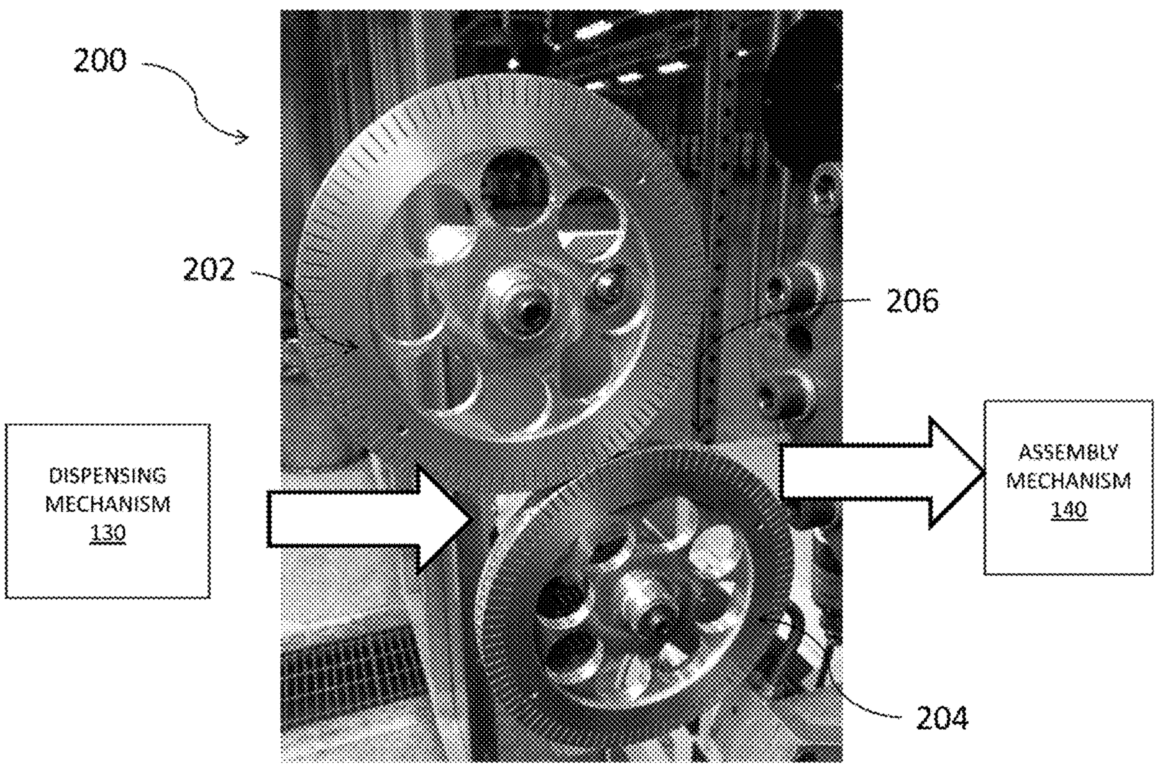
(57) **ABSTRACT**

A system for debossing a heat generation member of an elongate smoking article includes a dispensing mechanism configured to serially dispense a longitudinally-extending heat generation member along a machine direction, wherein the heat generation member has an outer surface and defines a longitudinal axis. The system further includes a debossing mechanism having a first die and an opposing second die each defining a longitudinally-extending channel, wherein the channels of the opposing first and second dies each include spaced-apart protrusions and are arranged to receive therebetween the longitudinally-extending heat generation member from the dispensing mechanism, and wherein the protrusions in the channels are configured to extend non-parallel to the channels and cooperatively interact with the heat generation member to deboss the outer surface thereof. An associated method and smoking article are also disclosed.



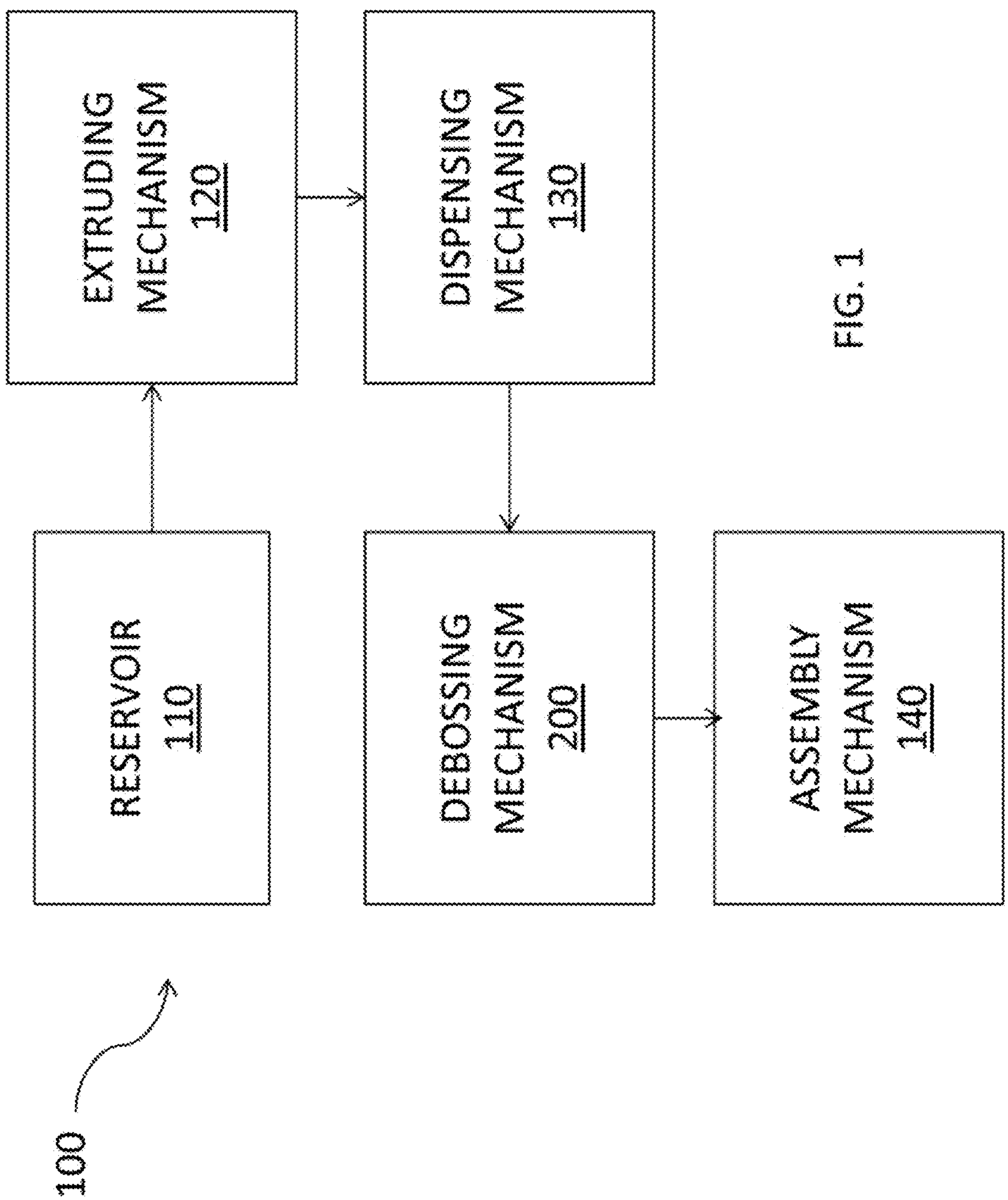
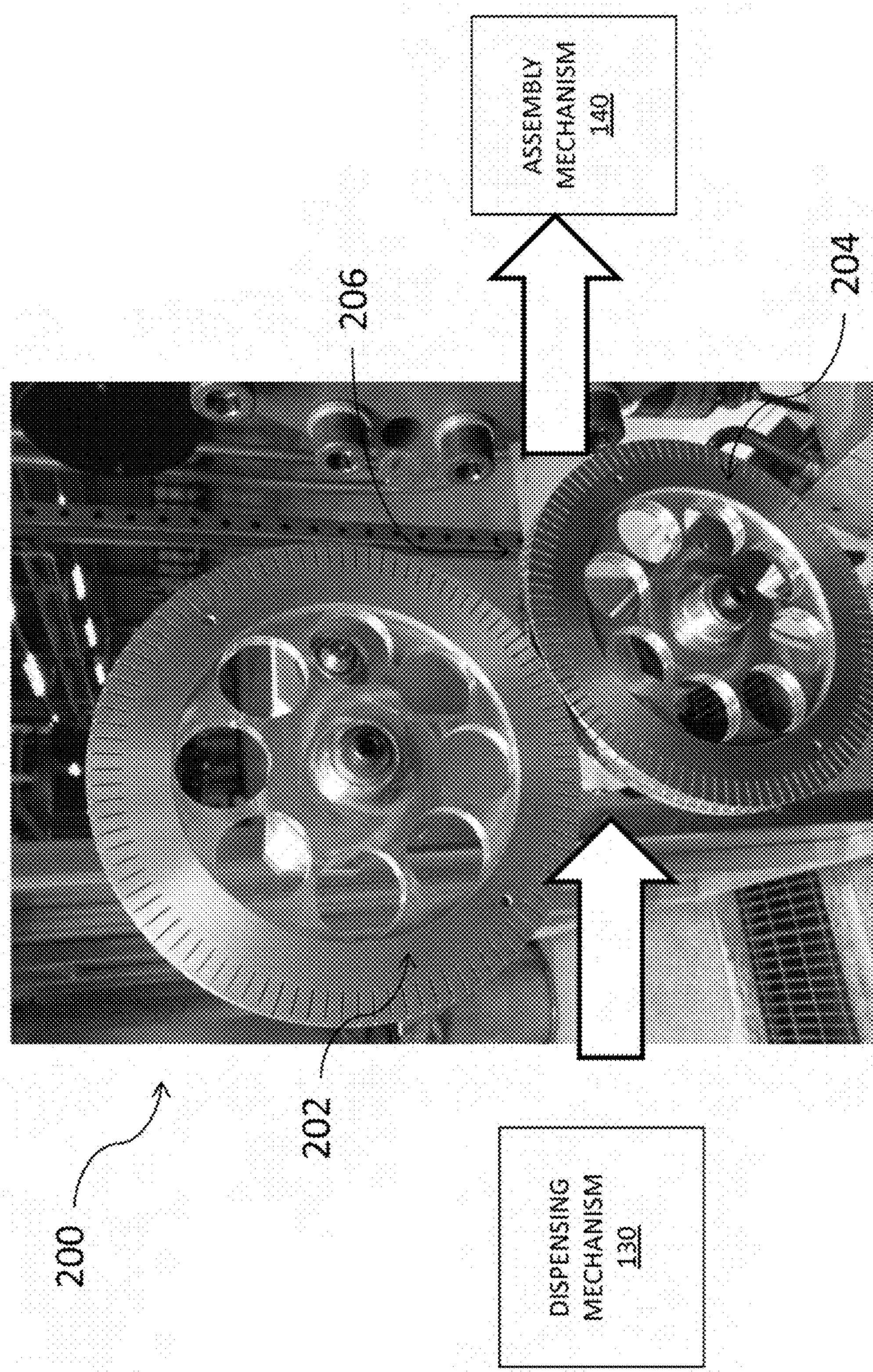

100
RESERVOIR 110
EXTRUDING MECHANISM 120
DISPENSING MECHANISM 130
DEBOSSING MECHANISM 200
ASSEMBLY MECHANISM 140

FIG. 1



200
202
206
204
ASSEMBLY MECHANISM 140
DISPENSING MECHANISM 130


FIG. 2A

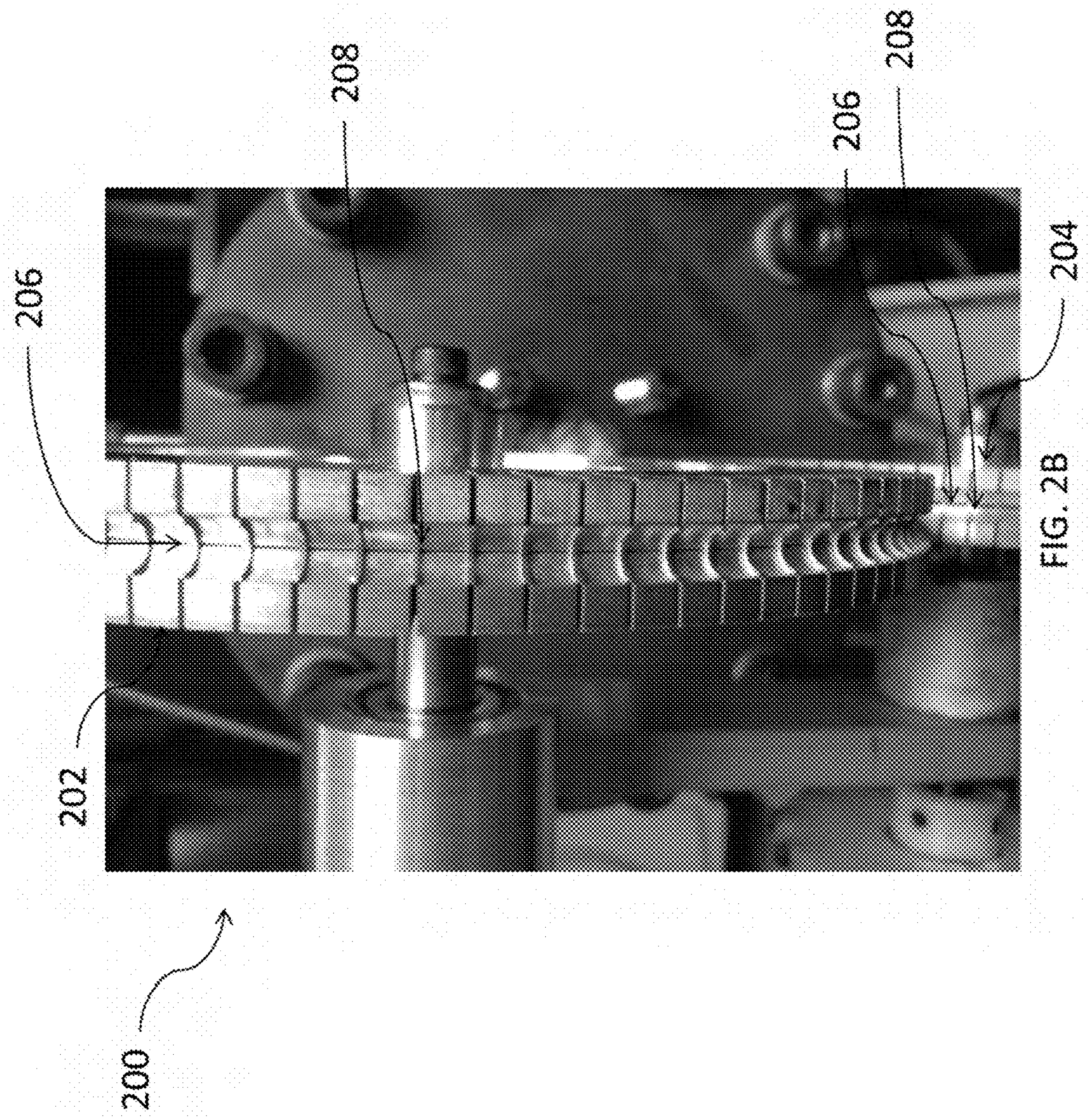



FIG. 2B

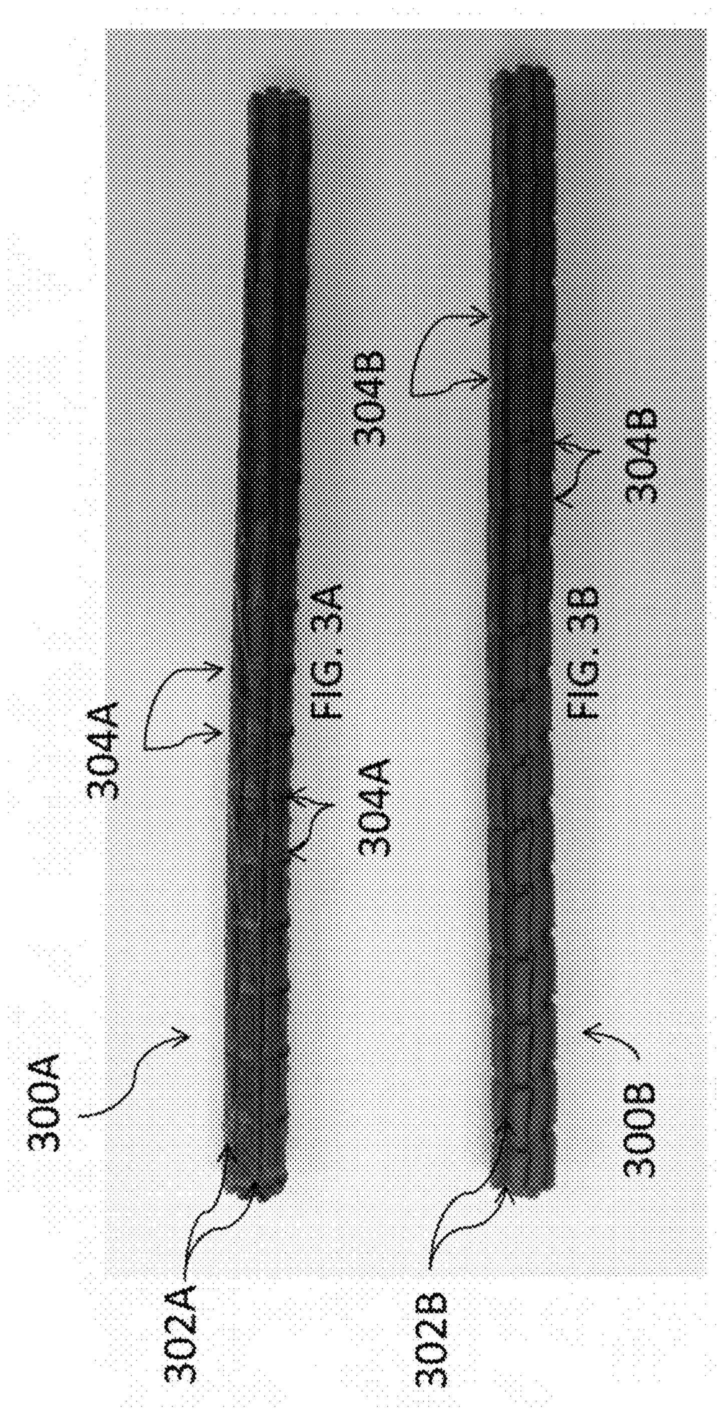



FIG. 3A

FIG. 3B

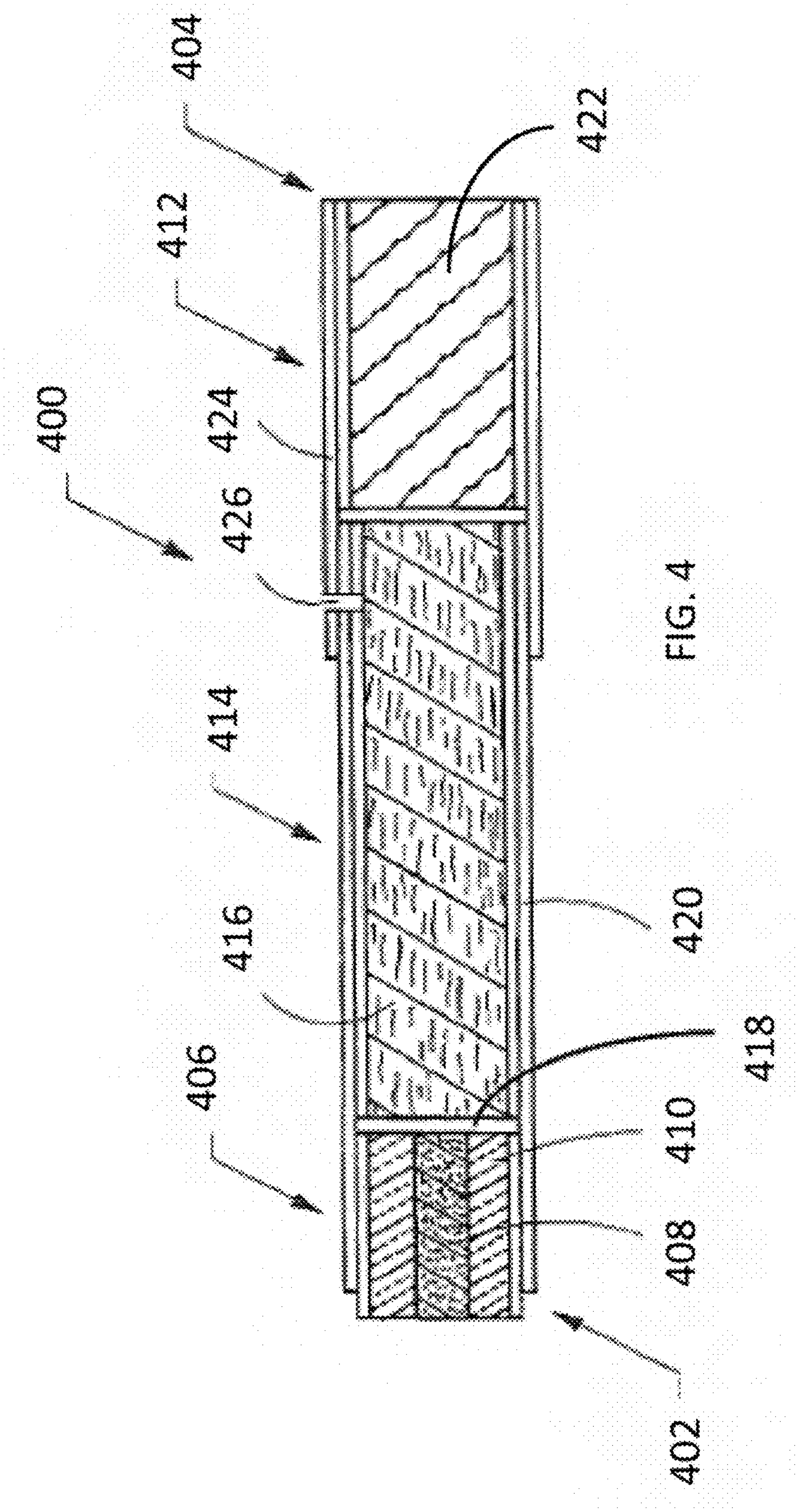



FIG. 4

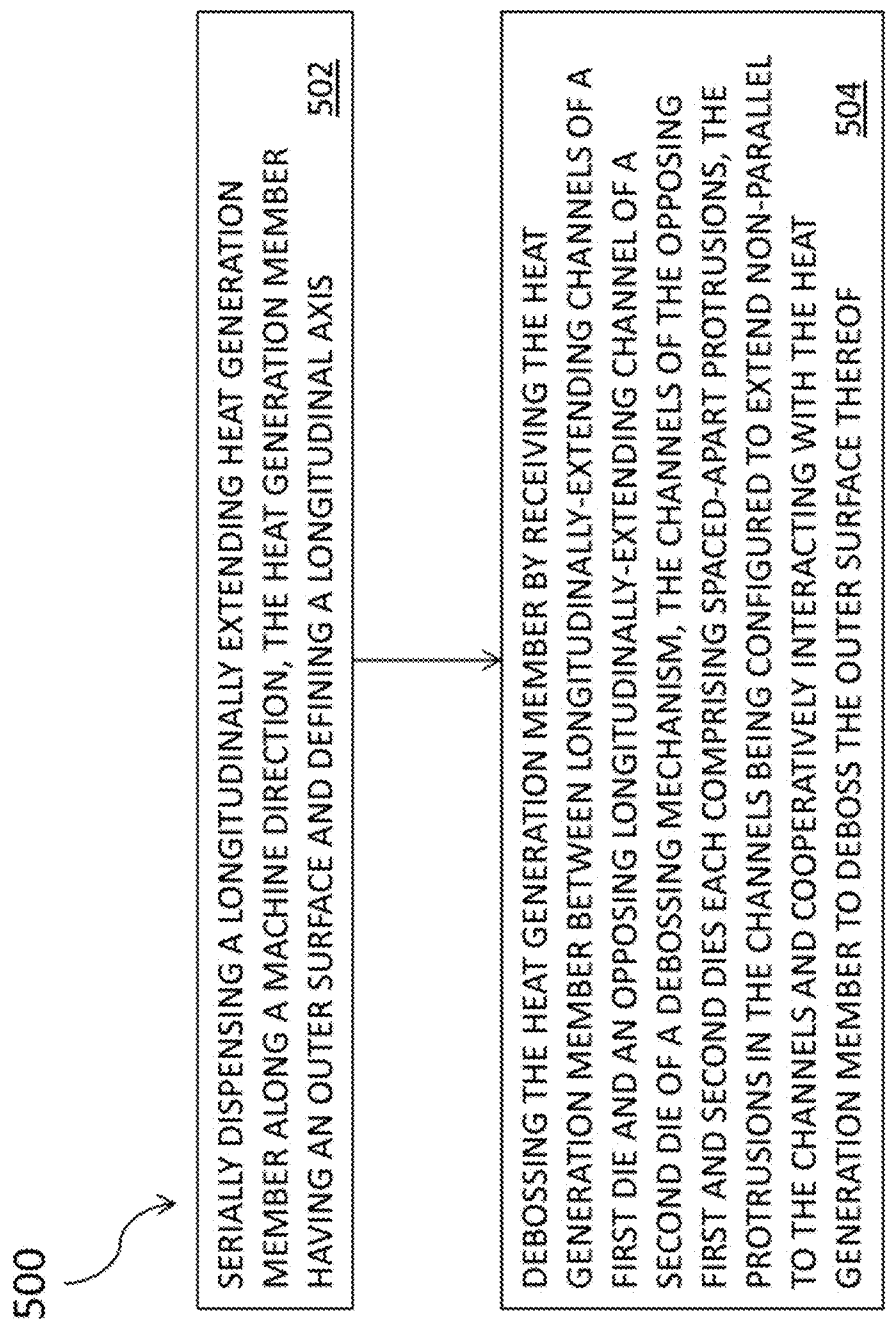

500
SERIALLY DISPENSING A LONGITUDINALLY EXTENDING HEAT GENERATION MEMBER ALONG A MACHINE DIRECTION, THE HEAT GENERATION MEMBER HAVING AN OUTER SURFACE AND DEFINING A LONGITUDINAL AXIS
502
DEBOSSING THE HEAT GENERATION MEMBER BY RECEIVING THE HEAT GENERATION MEMBER BETWEEN LONGITUDINALLY-EXTENDING CHANNELS OF A FIRST DIE AND AN OPPOSING LONGITUDINALLY-EXTENDING CHANNEL OF A SECOND DIE OF A DEBOSSING MECHANISM, THE CHANNELS OF THE OPPOSING FIRST AND SECOND DIES EACH COMPRISING SPACED-APART PROTRUSIONS, THE PROTRUSIONS IN THE CHANNELS BEING CONFIGURED TO EXTEND NON-PARALLEL TO THE CHANNELS AND COOPERATIVELY INTERACTING WITH THE HEAT GENERATION MEMBER TO DEBOSS THE OUTER SURFACE THEREOF
504

FIG. 5

# SYSTEM FOR DEBOSSING A HEAT GENERATION MEMBER, A SMOKING ARTICLE INCLUDING THE DEBOSSED HEAT GENERATION MEMBER, AND A RELATED METHOD

## BACKGROUND OF THE DISCLOSURE

### Field of the Disclosure

**[0001]** The present disclosure relates to products made or derived from tobacco, or that otherwise incorporate tobacco, and are intended for human consumption and, more particularly, to components and configurations of segmented-type smoking articles.

### Disclosure of Related Art

**[0002]** Popular smoking articles, such as cigarettes, have a substantially cylindrical rod-shaped structure and include a charge, roll or column of smokable material, such as shredded tobacco (e.g., in cut filler form), surrounded by a paper wrapper, thereby forming a so-called "smokable rod", "tobacco rod" or "cigarette rod." In some aspects, these popular types of cigarettes employ carbonaceous fuel elements have been 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). Additionally, a similar type of cigarette recently has been marketed in Japan by Japan Tobacco Inc. under the brand name "Steam Hot One." Furthermore, various types of smoking products incorporating carbonaceous fuel elements for heat generation and aerosol formation recently have been set forth in the patent literature. See, for example, the types of smoking products proposed in U.S. Pat. No. 7,836,897 to Borschke et al.; U.S. Pat. No. 8,469,035 to Banerjee et al., U.S. Pat. No. 8,616,217 to Tsuruizumi et al; U.S. Pat. No. 8,915,255 to Poget et al; and U.S. Pat. No. 8,464,726 to Sebastian et al.; US Pat. Pub. Nos. 2012/0042885 to Stone et al.; and 2013/0133675 to Shinozaki et al.; PCT WO No. 2012/0164077 to Gladden et al.; 2013/098380 to Raether et al.; 2013/098405 to Zuber et al.; 2013/098410 to Zuber et al.; 2013/104914 to Woodcock; 2013/120849 to Roudier et al.; 2013/120854 to Mironov; EP 1808087 to Baba et al. and EP 2550879 to Tsuruizumi et al.; which are incorporated by reference herein in their entirety. A historical perspective of technology related to various types of smoking products incorporating carbonaceous fuel elements for heat generation and aerosol formation may be found, for example, in the Background of US Pat. Pub. No. 2007/0215167 to Llewellyn Crooks et al., which is also incorporated herein by reference.

**[0003]** It would be highly desirable to provide smoking articles that demonstrate the ability to provide to a smoker many of the benefits and advantages of conventional cigarette smoking, without delivering considerable quantities of incomplete combustion and pyrolysis products. In conjunction with such desirable characteristics, it would also be desirable for a direct ignition smoking article to be readily ignited, and to remain ignited, while being used by the smoker.

## BRIEF SUMMARY OF THE DISCLOSURE

**[0004]** The above and other needs are met by aspects of the present disclosure which, in one aspect, provides a system for debossing a heat generation member of an elongate smoking article comprising a dispensing mechanism configured to serially dispense a longitudinally-extending heat generation member along a machine direction, the heat generation member having an outer surface and defining a longitudinal axis; and a debos sing mechanism comprising a first die and an opposing second die each defining a longitudinally-extending channel, the channels of the opposing first and second dies each comprising spaced-apart protrusions and being arranged to receive therebetween the longitudinally-extending heat generation member from the dispensing mechanism, the protrusions in the channels being configured to extend non-parallel to the channels and cooperatively interact with the heat generation member to deboss the outer surface thereof.

**[0005]** Another aspect of the present disclosure provides a smoking article comprising a mouth end portion disposed at a mouth end; a tobacco portion disposed between a lighting end and the mouth end portion; and an aerosol-generation system including an aerosol-generation portion disposed between the lighting end and the tobacco portion, the aerosol-generation system including a heat generation portion disposed at the lighting end, the heat generation portion comprising a longitudinally-extending heat generation member configured to be actuated by ignition of the lighting end, the heat generation member defining a plurality of spaced-apart depressions between opposed first and second ends thereof, each depression extending about a circumference of the outer surface thereof.

**[0006]** A further aspect of the present disclosure provides a method for debossing a heat generation member of an elongate smoking article comprising: serially dispensing a longitudinally-extending heat generation member along a machine direction, the heat generation member having an outer surface and defining a longitudinal axis; and debossing the heat generation member by directing the heat generation member between longitudinally-extending channels of a first die and an opposing longitudinally-extending channel of a second die of a debossing mechanism, the channels of the opposing first and second dies each comprising spaced-apart protrusions, the protrusions in the channels being configured to extend non-parallel to the channels and cooperatively interacting with the heat generation member to deboss the outer surface thereof.

**[0007]** Further features and advantages of the present disclosure are set forth in more detail in the following description.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0008]** Having thus described the disclosure in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein: FIG. **1** shows a representative system diagram of a system for debossing a heat generation member of an elongate smoking article;

**[0009]** FIGS. **2**A-**2**B show detailed views of a representative debossing mechanism for the system of FIG. **1**;

**[0010]** FIGS. **3**A-**3**B show two different representative heat generation members debossed by a debossing mechanism;

[0011] FIG. **4** shows a representative smoking article with a debossed heat generation member; and

[0012] FIG. **5** shows a method flow of a method for debossing a heat generation member of an elongate smoking article.

## DETAILED DESCRIPTION

[0013] The present disclosure now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all aspects of the disclosure are shown. Indeed, the disclosure may be embodied in many different forms and should not be construed as limited to the aspects set forth herein; rather, these aspects are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

[0014] Aspects and embodiments of the present disclosure relate, for example, to various smoking articles, and the arrangement of various components thereof. Example smoking article construction may include features disclosed in U.S. Pat. Nos. 8,464,726 and 9,486,013; both to Sebastian et al., which are incorporated herein by reference.

[0015] FIG. **1** illustrates a representative system **100** for producing a representative smoking article. In some aspects, the system **100** includes a reservoir **110**, an extruding mechanism **120**, a dispensing mechanism **130**, and an assembly mechanism **140**. In some example aspects, the system **100** is further configured to deboss the representative smoking article and includes a debossing mechanism **200**, described in detail in FIG. **2**.

[0016] In some example embodiments, the reservoir **110** is configured to retain a quantity of a substance and feed the quantity of the substance to the extruding mechanism **120**. The reservoir **110** is configured to feed the quantity of the substance in any number of ways depending on the characteristic of the substance retained therein. For example, where the reservoir **110** retains a substance for forming heat generation members therein, the reservoir **110** may gravitationally feed the substance for forming heat generation members to the extruding mechanism **120**. A controller (not shown) may be in communication with the reservoir **110** to control the timing of the substance fed to the extruding mechanism **120**.

[0017] The extruding mechanism **120** may be configured to receive the quantity of the substance from the reservoir **110** and may be configured to force (e.g., extrude) the substance through a die to thereby shape an outer circumference of an elongate member formed from the extruded quantity of the substance. The elongate member is then severed into a desired length to form individual monolithic elements. Each of the individual monolithic elements may be considered "heat generation members," though depending on the shape extruded from the extruding mechanism **120** other functionalities may be utilized, as well. Shapes such as, for example, rods and cubes can be formed by first extruding the material through a die having the desired cross-section (e.g., round or square) and then optionally severing the extruded material into desired lengths. Techniques and equipment for extruding tobacco-related materials are set forth in U.S. Pat. No. 3,098,492 to Wursburg; U.S. Pat. No. 4,874,000 to Tamol et al.; U.S. Pat. No. 4,880,018 to Graves et al.; U.S. Pat. No. 4,989,620 to Keritsis et al.; U.S. Pat. No. 5,072,744 to Luke et al.; U.S. Pat. No. 5,829,453 to White et al.; and U.S. Pat. No. 6,182,670 to White et al.; each of which is incorporated herein by reference in its entirety. Example extrusion equipment suitable for use includes food or gum extruders, or industrial pasta extruders such as Model TP 200/300 available from Emiliomiti, LLC of Italy. In some instances, a single machine may be capable of achieving multiple steps of the processes described herein, such as, for example, kneader systems available from Buss AG.

[0018] Representative heat generation members may comprise a generally cylindrical shape defining a longitudinal axis and having an outer surface. In some example aspects, the representative heat generation members may incorporate components including, for example, a combustible carbonaceous material. Carbonaceous materials generally include a carbon component having a high carbon content. Preferred carbonaceous materials are comprised predominately of carbon, typically have carbon contents of greater than about 60 percent, generally greater than about 70 percent, often greater than about 80 percent, and frequently greater than about 90 percent, on a dry weight basis. The carbonaceous materials may also include other non-carbon components including, for example, tobacco components, such as powdered tobaccos or tobacco extracts; flavoring agents; salts, such as sodium chloride, potassium chloride and sodium carbonate; heat stable graphite fibers; iron oxide powder; glass filaments; powdered calcium carbonate; alumina granules; ammonia sources, such as ammonia salts; and/or binding agents, such as guar gum, ammonium alginate and sodium alginate. A representative heat generation member may have a length of about 12 mm and an overall outside diameter of about 4.2 mm.

[0019] As such, in one example, each of the heat generation members is severed into a desired length from the material extruded from the extruding mechanism **120** through a die as a monolithic element of a carbonaceous material. Further, the die of the extruding mechanism **120** may be configured to extrude the elongate member such that a plurality of longitudinally-extending grooves is formed in the outer surface of the elongate member, wherein the grooves are spaced-apart about the circumference or outer surface thereof. When the individual heat generation members are severed from the continuously extruded material (monolithic extrudate), such that each heat generation member is its own monolithic element, the grooves also extend longitudinally between opposed first and second ends of each heat generation member, such that each of the heat generation members has a "fluted" cross-section. In this manner, each of the heat generation members defines between six and ten grooves equidistantly spaced apart about the circumference. In one preferred aspect, the heat generation member defines eight grooves equidistantly spaced apart about the circumference. In such aspects, the plurality of grooves may be provided in an even number such that the plurality of grooves includes a plurality of pairs of grooves, wherein the grooves in each pair are diametrically opposed to each other across the cross-section of the heat generation member. In this manner, the increased surface area, increased plurality of edges, and the even spacing and distribution of the grooves may facilitate more even heating/burning of the heat generation member (i.e., due to the configuration of the cross-section being substantially regular, even, and symmetrical, more consistency may be obtained in the ignition of and heat generated across the cross-sectional profile). Still other example embodiments of extruded heat generation members are described in U.S. Pat. No. 9,788,571 to Conner et al., which is incorporated herein by reference in its entirety.

**[0020]** In some other aspects, the heat generation members may include foamed carbon monoliths formed in a foam process. In still further embodiments, the heat generation members may be co-extruded with a layer of insulation, thereby reducing manufacturing time and expense. Still other embodiments of heat generation members may include those of the types described in U.S. Pat. No. 4,922,901 to Brooks et al. or U.S. Pat. App. Pub. No. 2009/0044818 to Takeuchi et al., each of which is incorporated herein by reference in its entirety. Where the heat generation members are not extruded and/or the extruding mechanism **120** is not used to form the heat generation members in the system **100**, the reservoir **110** is configured to retain a plurality of objects already-formed as heat generation members, and to feed the plurality of heat generation members directly to the dispensing mechanism **130**. The heat generation members may have a density that is greater than about 0.5 g/cm$^3$, often greater than about 0.7 g/cm$^3$, and frequently greater than about 1 g/cm$^3$, on a dry weight basis. See, for example, the types of heat generation elements, components, formulations and designs set forth in U.S. Pat. No. 5,551,451 to Riggs et al. and U.S. Pat. No. 7,836,897 to Borschke et al., which are incorporated herein by reference in their entirety. Particular aspects of heat generation members are described below with reference to FIGS. **3**A-**3**C.

**[0021]** The heat generation members as extruded by the extruding mechanism **120** or otherwise retained by the reservoir **110**, may be fed to the dispensing mechanism **130**. In some embodiments, the dispensing mechanism **130** is configured to receive each of the heat generation members and serially dispense each of the heat generation members along a machine direction. In some preferred embodiments, the dispensing mechanism **130** is configured to orient each of the heat generation members such that each of the heat generation members travels with its longitudinal axis oriented parallel to the machine direction. In this manner, the dispensing mechanism **130** may comprise a conveyor belt, a drum or wheel rotating about an axis perpendicular to the machine direction, a chute, and the like.

**[0022]** The dispensing mechanism **130** is configured to serially dispense each of the heat generation members to the debossing mechanism **200**. In some embodiments, and as illustrated in greater detail in FIGS. **2**A, **2**B, the debossing mechanism **200** is configured to receive the longitudinally-extending heat generation member from the dispensing mechanism **130** and deboss the outer surface thereof. As used herein, "deboss" is defined as the causing or forming of a depression on the outer surface of the heat generation member, such that the debossing mechanism is configured to form at least one depression in the outer surface of the heat generation member between the opposed first and second ends thereof.

**[0023]** More particularly and referring to FIGS. **2**A, **2**B, one example embodiment of the debossing mechanism generally illustrated in the system **100** is provided. As illustrated in FIG. **2**A, the example embodiment of the debos sing mechanism, generally referred to as **200**, comprises a first die **202** and an opposing second die **204**. The first die **202** and the opposing second die **204** may be comprised of stainless steel or other suitable material. The first and second dies **202**, **204** may comprise, for example, wheels, drums or the like having the outer circumferences thereof adjacently-disposed, and configured to rotate in opposite directions about an axis perpendicular to the machine direction. Each of the first die and the opposing second die may define a channel **206** extending about the outer circumference thereof (i.e., about the outer surface or circumference of the wheel, drum, or the like), and are thus considered "longitudinally-extending channels." The longitudinally-extending channels **206** of the opposing first and second dies **202**, **204** may be arranged to receive therebetween the longitudinally-extending heat generation member from the dispensing mechanism **130**. The first die **202** may rotate counterclockwise about its axis, while the second die **204** rotates clockwise about its axis in order to facilitate transport of the longitudinally-extending heat generation members along the machine direction. Alternatively, the first die **202** may rotate clockwise about its axis, while the second die **204** rotates counterclockwise about its axis in order to facilitate transport of the longitudinally-extending heat generation members opposite to the machine direction.

**[0024]** FIG. **2**B illustrates a detailed view of the longitudinally-extending channel **206** about the outer circumference of the first die **202** and the longitudinally-extending channel **206** about the outer circumference of the second die **204**. As illustrated in FIG. **2**B, and in some aspects, the channels **206** of the opposing first and second dies **202**, **204** each comprise spaced-apart protrusions **208**. The spaced-apart protrusions **208** are configured to cooperatively interact with the heat generation member to deboss the outer surface thereof and define a plurality of spaced-apart depressions between the opposed first and second ends of the heat generation member, where each depression extends about a circumference of the outer surface of the heat generation member (FIGS. **3**A-**3**B). In some aspects, the protrusions **208** are configured with a constant height and extend about the longitudinally-extending channels **206** in the cross-machine direction. However, in other aspects (not shown), the protrusions **208** may be provided as having a varying height and may extend in different manners about the longitudinally-extending channels **206** (i.e., generally not parallel to the machine direction) depending on the desired debossing of the heat generation member.

**[0025]** In some aspects, each of the protrusions **208** in the channels **206** of the debossing mechanism **200** is configured to deboss either a first hemicylindrical portion or an opposing second hemicylindrical portion of the outer surface of the heat generation member. More particularly, where the longitudinally-extending heat generation member is a cylindrical member received by the debos sing mechanism **200**, a first hemicylindrical portion of the heat generation member will be disposed in and will interact with the longitudinally-extending channel **206** of the first die **202**, while an opposing second hemicylindrical portion of the heat generation member will be disposed in and will interact with the longitudinally-extending channel **206** of the second die **204**. As such, the protrusions **208** in the channels **206** of the opposed first and second dies cooperatively interact with the heat generation member to form the plurality of spaced-apart depressions extending about either the first hemicylindrical portion or the opposing second hemicylindrical portion of the heat generation member.

**[0026]** FIGS. **3**A-**3**B illustrate two example heat generation members **300**A-**300**B that may be produced by the system **100** and may have a plurality of spaced-apart depressions extending about either the first hemicylindrical portion or the opposing second hemicylindrical portion thereof. Specifically, each of the heat generation members **300**A-**300**B may be extruded by the extruding mechanism **120**, dispensed by the dispensing mechanism **130**, and then debossed by the debossing mechanism **200** (e.g., debossing mechanism **200**, FIGS. **2**A, **2**B). As such, each of the heat generation members **300**A-**300**B include a plurality of grooves **302**A-**302**B spaced apart about the outer circumference and extending longitudinally between opposed first and second ends of the heat generation member (from the extruding mechanism **120**, e.g.) as well as a plurality of depressions **304**A-**304**B longitudinally spaced-apart between the opposed first and second ends of the heat generation member (from the debos sing mechanism **200**, e.g.). However, the heat generation members as contemplated herein need not include both the plurality of spaced-apart grooves and the plurality of spaced-apart depressions. For example, in some aspects, the heat generation members are only debossed such that only a plurality of spaced-apart depressions is defined in the outer surface. Accordingly, a surface area of the heat generation member is configured to be increased by at least the plurality of spaced-apart depressions, in addition to or instead of the plurality of spaced-apart grooves, exclusive of surface areas of the opposed first and second ends, over a surface area defined by an outer periphery of the heat generation member without the plurality of spaced-apart depressions or grooves (e.g., a cylinder).

**[0027]** In FIG. **3**A, the heat generation member **300**A comprises a plurality of spaced-apart grooves **302**A spaced apart about the circumference thereof and extending longitudinally between opposed first and second ends of the heat generation member, as formed by the extruding mechanism **120**. The heat generation member **300**A also further comprises a plurality of longitudinally spaced-apart depressions **304**A that respectively extend about the first and second hemicylindrical portions and that are aligned with each other between the opposing hemicylindrical portions. In this manner, the longitudinally spaced-apart depressions **304**A extend continuously around the circumference of the outer surface of the heat generation member **300**A. In some aspects, the debossing mechanism **200** is configured to form the aligned, spaced-apart depressions by aligning the first die **202** and the opposing second die **204** such that the protrusions **208** in the channels **206** of the opposing dies **202**, **204** are aligned with one another. This may be accomplished by orienting or positioning the axes of each of the dies **202**, **204** so that opposing protrusions **208** are aligned in the machine direction.

**[0028]** In FIG. **3**B, the heat generation member **300**B comprises a plurality of spaced-apart grooves **302**B about the outer surface thereof and extending longitudinally between opposed first and second ends of the heat generation member, as formed by the extruding mechanism **120**. The heat generation member **300**B also further comprises a plurality of longitudinally spaced-apart depressions **304**B that extend about the first hemicylindrical portion thereof and are offset in the machine direction with regard to a plurality of longitudinally spaced-apart depressions that extend about the second hemicylindrical portion thereof. In some aspects, the debossing mechanism **200** is configured to form the offset, longitudinally spaced-apart depressions by aligning the first die **202** and the opposing second die **204** such that the protrusions **208** in the channel **206** of the first die **202** are offset in the machine direction with regard to the protrusions in the channel **206** of the second die **204**. This may be accomplished by orienting or positioning the axes of each of the dies **202**, **204** so that opposing protrusions **208** are offset in the machine direction.

**[0029]** Returning back to FIG. **1**, the debossing mechanism **200** is configured to deboss the outer surface of the heat generation members, wherein the debossed heat generation members may then be transported to an assembly mechanism **140**. The assembly mechanism **140** may be an apparatus or combination of several apparatuses configured to assemble the heat generation member with other components (e.g., filters, wrapping materials, substrates, etc.) in order to form an assembled smoking article. See, for example, the various representative types of smoking article components, as well as the various smoking article designs, formats, configurations and characteristics, that are set forth in Johnson, Development of Cigarette Components to Meet Industry Needs, 52$^{nd}$ T.S.R.C. (September, 1998); U.S. Pat. No. 5,101,839 to Jakob et al.; U.S. Pat. No. 5,159,944 to Arzonico et al.; U.S. Pat. No. 5,220,930 to Gentry; U.S. Pat. No. 6,779,530 to Kraker; U.S. Pat. No. 7,237,559 to Ashcraft et al., and U.S. Pat. No. 7,565,818 to Thomas et al.; and U.S. Pat. Appl. Pub. Nos. 2007/0246055 to Oglesby and 2005/0066986 to Nestor et al.; each of which is incorporated herein by reference in its entirety. Example assembly mechanism(s) for assembling each of the components into a representative smoking article, such as that disclosed herein, are disclosed in U.S. Pat. Appl. Pub. No. 2012/0120229 to Brantley et al., which is incorporated herein by reference in its entirety.

**[0030]** FIG. **4** illustrates a representative smoking article **400** assembled by the assembly mechanism **140** in system **100**. In some aspects, the smoking article **400** is generally in the form of a cigarette. The smoking article **400** has a rod-like or cylindrical shape, and includes a lighting end **402** and a mouth end **404**. At the lighting end **402** is positioned a longitudinally-extending, generally cylindrical, heat generation portion **406**. The heat generation portion **406** includes a longitudinally-extending heat generation member **408**, which may be circumscribed by insulation **410** and which may be coaxially encircled by wrapping material. The heat generation member **408** preferably is configured to be activated by ignition (direct ignition or indirect ignition) of the lighting end **402**. The smoking article **400** also includes a filter portion **412** located at the other end (mouth end **404**), and an aerosol-generating portion **414** (which may incorporate tobacco) that is located in between the heat generation and filter portions **406**, **412**.

**[0031]** The heat generation member **408** may define a plurality of spaced-apart depressions between opposed first and second ends thereof, each depression extending about a circumference of the outer surface thereof. In some aspects, each of the plurality of spaced-apart depressions extends about a first hemicylindrical portion or an opposing second hemicylindrical portion of the outer surface of the heat generation member **408**. Where other shapes of the heat generation member **408** are contemplated, each of the plurality of spaced-apart depressions may extend about a first longitudinally-extending half portion and an opposing longitudinally-extending second half portion of the heat generation member.

[0032] More particularly, in some aspects (e.g., **300**A, FIG. **3**A), the heat generation member **408** is configured such that the plurality of spaced-apart depressions extending about the first and second hemicylindrical portions are aligned with each other such that each of the longitudinally spaced-apart depressions extends continuously around the outer surface of the heat generation member. In other aspects (e.g., **300**B, FIG. **3**B), the heat generation member **408** is configured such that the plurality of longitudinally spaced-apart depressions extending about the first hemicylindrical portion are longitudinally offset along the heat generation member **408** with regard to the plurality of longitudinally spaced-apart depressions extending about the second hemicylindrical portion. In some additional aspects, the heat generation member **408** comprises a plurality of grooves spaced apart about the outer surface thereof and extending longitudinally between the opposed first and second ends thereof. In these instances, each of the plurality of depressions and/or the plurality of grooves may have a constant depth.

[0033] A representative layer of insulation **410** can comprise glass filaments or fibers. The insulation **410** can act as a jacket that assists in supporting, maintaining, and/or retaining the heat generation member **408** firmly in place within the smoking article **400**. The insulation **410** can be provided as a multi-layer component including an inner layer or mat of non-woven glass filaments, an intermediate layer of reconstituted tobacco paper, and an outer layer of non-woven glass filaments. These may be concentrically oriented or each overwrapping and/or circumscribing the heat generation member **408**. The insulation may additionally be configured such that drawn air and aerosol can pass readily therethrough. Examples of insulation materials, components of insulation assemblies, configurations of representative insulation assemblies within heat generation segments, wrapping materials for insulation assemblies, and manners and methods for producing those components and assemblies, are set forth in U.S. Pat. No. 4,807,809 to Pryor et al.; U.S. Pat. No. 4,893,637 to Hancock et al.; U.S. Pat. No. 4,938,238 to Barnes et al.; U.S. Pat. No. 5,027,836 to Shannon et al.; U.S. Pat. No. 5,065,776 to Lawson et al.; U.S. Pat. No. 5,105,838 to White et al.; U.S. Pat. No. 5,119,837 to Banerjee et al.; U.S. Pat. No. 5,247,947 to Clearman et al.; U.S. Pat. No. 5,303,720 to Banerjee et al.; U.S. Pat. No. 5,345,955 to Clearman et al.; U.S. Pat. No. 5,396,911 to Casey, III et al.; U.S. Pat. No. 5,546,965 to White; U.S. Pat. No. 5,727,571 to Meiring et al.; U.S. Pat. No. 5,902,431 to Wilkinson et al.; U.S. Pat. No. 5,944,025 to Cook et al.; U.S. Pat. No. 8,424,538 to Thomas et al.; and U.S. Pat. No. 8,464,726 to Sebastian et al.; which are incorporated herein by reference. Certain insulation assemblies have been incorporated within the types of cigarettes commercially marketed under the trade names "PREMIER" and "ECLIPSE" by R. J. Reynolds Tobacco Company, and as "STEAM HOT ONE" cigarette marketed by Japan Tobacco Inc.

[0034] Flame/burn retardant materials and additives useful in insulation may include silica, carbon, ceramic, metallic fibers and/or particles. When treating cellulosic or other fibers such as, for example, cotton, boric acid or various organophosphate compounds may provide desirable flame-retardant properties. In addition, various organic or metallic nanoparticles may confer a desired property of flame-retardancy, as may diammonium phosphate and/or other salts. Other useful materials may include organo-phosphorus compounds, borax, hydrated alumina, graphite, potassium tripolyphosphate, dipentaerythritol, pentaerythritol, and polyols. Others such as nitrogenous phosphonic acid salts, mono-ammonium phosphate, ammonium polyphosphate, ammonium bromide, ammonium chloride, ammonium borate, ethanolammonium borate, ammonium sulphamate, halogenated organic compounds, thio-urea, and antimony oxides may be used but are not preferred agents. In each embodiment of flame-retardant, burn-retardant, and/or scorch-retardant materials used in insulation, substrate material and other components (whether alone or in any combination with each other and/or other materials), the desirable properties most preferably are provided without undesirable off-gassing or melting-type behavior.

[0035] An insulation fabric preferably will have sufficient oxygen diffusion capability to sustain a smoking article such as a cigarette in a lit condition during a desired usage time. Accordingly the insulation fabric preferably will be porous by virtue of its construction. In knit, woven, or combined woven and knit constructions, the required porosity may be controlled by configuring the assembly machinery to leave sufficient (desirably sized) gaps between fibers to allow for oxygen diffusion into the heat source. For non-woven fabrics, which may not be porous enough to promote evenly sustained combustion, additional porosity may be achieved by perforations into the insulation by methods known in the art including, for example, hot or cold pin perforation, flame perforation, embossing, laser cutting, drilling, blade cutting, chemical perforation, punching, and other methods. The insulation may include non-glass material that is woven, knit, or a combination thereof, a foamed metal material, a foamed ceramic material, a foamed ceramic-metal composite, and any combination thereof.

[0036] In some embodiments, an inner layer of insulation may include a variety of glass or non-glass filaments or fibers that are woven, knit, or both woven and knit (such as, for example, so-called 3-D woven/knit hybrid mats). When woven, an inner layer may be formed as a woven mat or tube. A woven or knitted mat or tube can provide improved control of air flow with regard to evenness across the insulation layer (including as any thermal-related changes may occur to the layer). Those of skill in the art will appreciate that a woven, knit, or hybrid material may provide more regular and consistent air spaces/gaps between the filaments or fibers as compared to a non-woven material which is more likely to have irregularly closed and open spaces that may provide comparatively non-uniform and/or decreased air-flow. Various other insulation embodiments may be molded, extruded, foamed, or otherwise formed. Particular embodiments of insulation structures may include those described in U.S. Pat. Appl. Pub. No. 2012/0042885 to Stone et al., which is incorporated by reference herein in its entirety.

[0037] Preferably, both ends of the heat generation portion **406** are open to expose at least the heat generation member **408** and insulation **410** at the lighting end **402**. The heat generation member **408** and the surrounding insulation **410** can be configured so that the length of both materials is co-extensive (i.e., the ends of the insulation **410** are flush with the respective ends of the heat generation member **408**, and particularly at the downstream end of the heat generation portion **406**). Optionally, though not necessarily preferably, the insulation **410** may extend slightly beyond (e.g., from about 0.5 mm to about 2 mm beyond) either or both ends of the heat generation member **408**. Moreover, heat and/or heated air produced when the lighting end **402** is ignited during use of the smoking article **400** can readily pass through the heat generation portion **406** during draw by the smoker on the mouth end **404**.

**[0038]** The heat generation portion **406** preferably is positioned with one end disposed at the lighting end **402**, and is axially aligned in an end-to-end relationship with a downstream aerosol-generating portion **414**, preferably abutting one another, but with no barrier (other than open air-space) therebetween. The close proximity of the heat generation portion **406** to the lighting end **402** provides for direct ignition of the heat generation member **408** of the heat generation portion **406**.

**[0039]** A longitudinally-extending, cylindrical aerosol-generating portion **414** is located downstream from the heat generation portion **406**. The aerosol-generating portion **414** includes a substrate material **416** that, in turn, acts as a carrier for tobacco-related material (not shown). For example, the aerosol-generating portion **414** can include a reconstituted tobacco material that includes processing aids, flavoring agents, and glycerin. The foregoing components of the aerosol-generating portion **414** can be disposed within, and circumscribed by, a wrapping material. The wrapping material can be configured to facilitate the transfer of heat from the lighting end **402** of the smoking article **400** (e.g., from the heat generation portion **406**) to components of the aerosol-generating portion **414**. That is, the aerosol-generating portion **414** and the heat generation portion **406** can be configured in a heat exchange relationship with one another. The heat exchange relationship is such that sufficient heat from the heat generation member **408** is supplied to the aerosol-formation region to volatilize aerosol-forming material for aerosol formation. In some embodiments, the heat exchange relationship is achieved by positioning those portions in close proximity to one another. A heat exchange relationship also can be achieved by extending a heat conductive material from the vicinity of the heat generation member **408** into or around the region occupied by the aerosol-generating portion **414**. Particular embodiments of substrates may include those described below or those described in U.S. Pat. App. Pub. No. 2012/0042885 to Stone et al., which is incorporated by reference herein in its entirety.

**[0040]** In some preferred smoking articles, both ends of the aerosol-generating portion **414** are open to expose the substrate material thereof. Together, the heat generating portion **406** and the aerosol-generating portion **414** form an aerosol-generation system. Those portions can abut one another, or be positioned in a slightly spaced apart relationship, which may include a buffer region **418**. The outer cross-sectional shapes and dimensions of those portions, when viewed transversely to the longitudinal axis of the smoking article **400**, can be essentially identical to one another. The components of the aerosol-generation system preferably are attached to one another, and secured in place using an overwrap material **420**. For example, the overwrap material **420** can include a paper wrapping material or a laminated paper-type material that circumscribes each of at least a portion of the outer longitudinally-extending surface of the heat generation portion **406** and the aerosol-generating portion **414**. The inner surface of the overwrap material **420** may be secured to the outer surfaces of the components it circumscribes by a suitable adhesive.

**[0041]** The smoking article **400** preferably includes a suitable mouthpiece such as, for example, a filter portion **412**. The filter portion **412** preferably is positioned at the mouth end **404** of the cigarette rod adjacent to one end of the aerosol-generating portion **414**, such that the filter portion **412** and the aerosol-generating portion **414** are axially aligned in an end-to-end relationship, abutting one another but without any barrier therebetween. Preferably, the general cross-sectional shapes and dimensions of those portions **412**, **414** are essentially identical to one another when viewed transversely to the longitudinal axis of the smoking article. The filter portion **412** may include filter material **422** that is overwrapped along the longitudinally-extending surface thereof with circumscribing plug wrap material. In one example, the filter material **422** includes plasticized cellulose acetate tow, while in some examples the filter material may further include activated charcoal in an amount from about 20 mg to about 80 mg disposed as a discrete charge or dispersed throughout the acetate tow in a "Dalmatian type" filter. Both ends of the filter portion **412** preferably are open to permit the passage of aerosol therethrough. The aerosol-generating system preferably is attached to the filter portion **412** using tipping material **424**. The filter portion **412** may also include a crushable flavor capsule of the type described in U.S. Pat. No. 7,479,098 to Thomas et al. and U.S. Pat. No. 7,793,665 to Dube et al.; and U.S. Pat. No. 8,186,359 to Ademe et al., which are incorporated herein by reference in their entirety. The filter portion **412** may additionally or alternatively contain strands of tobacco containing material, such as described in U.S. Pat. No. 5,025,814, which is incorporated herein by reference in its entirety.

**[0042]** The smoking article **400** may include an air dilution provision, such as a series of perforations **426**, each of which may extend through the filter element tipping material **424** and plug wrap material in the manner shown, and/or which may extend to or into the substrate.

**[0043]** During use, the smoker lights the lighting end **402** of the smoking article **400** using a match or cigarette lighter, in a manner similar to the way that conventional smoking articles are lit, such that the heat generation member **408** at the lighting end **402** is ignited. The mouth end **404** of the smoking article **400** is placed in the lips of the smoker. Thermal decomposition products (e.g., components of tobacco smoke) generated by the aerosol generation system are drawn through the smoking article **400**, through the filter portion **412**, and into the mouth of the smoker. That is, when smoked, the smoking article yields visible mainstream aerosol that resembles the mainstream tobacco smoke of traditional cigarettes that burn tobacco cut filler.

**[0044]** Direct ignition actuates the heat generation member **408** of the heat generation portion **406** such that it preferably will be ignited or otherwise activated (e.g., begin to burn or smolder). The heat generation member **408** within the aerosol-generation system, once ignited, will provide heat to volatilize aerosol-forming material within the aerosol-generating portion **414** as a result of the heat exchange relationship between those two segments. Certain heat generation members will not experience volumetric decrease during activation, while others may degrade in a manner that reduces their volume. Preferably, the components of the aerosol-generating portion **414** do not experience thermal decomposition (e.g., charring or burning) to any significant degree. Volatilized components are entrained in the air that is drawn through the aerosol-generating region. The aerosol so formed will be drawn through the filter portion **412**, and into the mouth of the smoker.

**[0045]** FIG. **5** illustrates a method for debossing a heat generation member of an elongate smoking article, generally referred to as **500**. In a first step, **502**, a longitudinally-extending heat generation member is serially dispensed along a machine direction, the heat generation member having an outer surface and defining a longitudinal axis. In a second step, **504**, the heat generation member is debossed by being received between longitudinally-extending channels of opposing first and second dies of a debossing mechanism, wherein the channels of the opposing first and second dies each comprise spaced-apart protrusions along the channels, and wherein the protrusions in the channels are configured to extend non-parallel to the channels and to cooperatively interact with the heat generation member to deboss the outer surface thereof.

**[0046]** In some aspects, serially dispensing a longitudinally-extending heat generation member comprises extruding the heat generation member as a monolithic element of a carbonaceous material.

**[0047]** In some aspects, extruding the single carbonaceous material comprises forming a plurality of spaced-apart grooves in and about a circumference of the monolithic element, the grooves extending longitudinally between opposed first and second ends of the heat generation member.

**[0048]** In some aspects, debossing the heat generation member by receiving the heat generation member such that the protrusions in the channels of the debossing mechanism cooperatively interact with the heat generation member to deboss the outer surface thereof comprises defining a plurality of longitudinally spaced-apart, circumferentially-extending depressions between the opposed first and second ends of the heat generation member, each depression extending about a circumference of the outer surface of the heat generation member.

**[0049]** In some aspects, the method **500** further comprises aligning the first die and the opposing second die such that the protrusions in the channels of the dies are aligned with one another, the dies cooperatively interacting with the heat generation member to form the plurality of spaced-apart depressions, wherein the plurality of spaced-apart depressions extending about first and second hemicylindrical portions of the heat generation member are aligned with each other such that the spaced-apart depressions extend continuously around the outer surface of the heat generation member.

**[0050]** In some aspects, the method further comprises aligning the first die and the opposing second die such that the protrusions in the channel of the first die are offset in the machine direction with regard to the protrusions in the channel of the second die, the dies cooperatively interacting with the heat generation member to form the plurality of spaced-apart depressions, wherein the plurality of longitudinally spaced-apart depressions extending about a first hemicylindrical portion of the heat generation member are offset in the machine direction with regard to the plurality of longitudinally spaced-apart depressions extending about a second opposing hemicylindrical portion of the heat generation member.

**[0051]** Many modifications and other aspects of the disclosures set forth herein will come to mind to one skilled in the art to which these disclosures pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. For example, those of skill in the art will appreciate that embodiments not expressly illustrated or described herein may be practiced within the scope of the present disclosure, including that features described herein for different embodiments may be combined with each other and/or with currently-known or future-developed technologies while remaining within the scope of the claims presented here. Therefore, it is to be understood that the disclosures are not to be limited to the specific aspects disclosed and that equivalents, modifications, and other aspects are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

That which is claimed:

**1**. A system for debos sing a heat generation member of an elongate smoking article comprising:

a dispensing mechanism configured to serially dispense a longitudinally-extending heat generation member along a machine direction, the heat generation member having an outer surface and defining a longitudinal axis; and

a debossing mechanism comprising a first die and an opposing second die each defining a longitudinally-extending channel, the channels of the opposing first and second dies each comprising spaced-apart protrusions and being arranged to receive therebetween the longitudinally-extending heat generation member from the dispensing mechanism, the protrusions in the channels being configured to extend non-parallel to the channels and cooperatively interact with the heat generation member to deboss the outer surface thereof.

**2**. The system of claim **1**, further comprising an extruding mechanism configured to extrude the heat generation member as a monolithic element of a carbonaceous material.

**3**. The system of claim **2**, wherein the extruding mechanism is configured to form a plurality of spaced-apart grooves in the monolithic element, the grooves extending longitudinally between opposed first and second ends of the heat generation member.

**4**. The system of claim **3**, wherein the protrusions in the channels of the debos sing mechanism are configured to cooperatively interact with the heat generation member to deboss the outer surface thereof and define a plurality of spaced-apart depressions between the opposed first and second ends of the heat generation member, each depression extending about a circumference of the outer surface thereof.

**5**. The system of claim **4**, wherein each of the protrusions in the channels of the debos sing mechanism is configured to deboss either a first hemicylindrical portion or an opposing second hemicylindrical portion of the outer surface of the heat generation member to form the plurality of spaced-apart depressions extending about either the first hemicylindrical portion or the opposing second hemicylindrical portion.

**6**. The system of claim **5**, wherein the first die and the opposing second die are aligned such that the protrusions in the channels of each are aligned with one another so as to cooperatively interact with the heat generation member such that the formed plurality of spaced-apart depressions extending about the first and second hemicylindrical portions are aligned with each other, and such that the spaced-apart depressions extending continuously around the circumference of the outer surface of the heat generation member.

**7**. The system of claim **5**, wherein the first die and the opposing second die are aligned such that the protrusions in the channel of the first die are offset in the machine direction with regard to the protrusions in the channel of the second die, and wherein the first and second dies cooperatively interact with the heat generation member such that the formed plurality of spaced-apart depressions extending about the first hemicylindrical portion are offset in the machine direction with regard to the formed plurality of spaced-apart depressions extending about the second hemicylindrical portion.

**8**. A smoking article comprising:

a mouth end portion disposed at a mouth end;

a tobacco portion disposed between a lighting end and the mouth end portion; and

an aerosol-generation system including an aerosol-generation portion disposed between the lighting end and the tobacco portion, the aerosol-generation system including a heat generation portion disposed at the lighting end, the heat generation portion comprising a longitudinally-extending heat generation member configured to be actuated by ignition of the lighting end, the heat generation member defining a plurality of spaced-apart depressions between opposed first and second ends thereof, each depression extending about a circumference of the outer surface thereof.

**9**. The smoking article of claim **8**, wherein the heat generation member comprises a plurality of spaced-apart grooves extending longitudinally between the opposed first and second ends thereof.

**10**. The smoking article of claim **8**, wherein each of the plurality of spaced-apart depressions has a constant depth.

**11**. The smoking article of claim **8**, wherein each of the plurality of spaced-apart depressions extends about a first hemicylindrical portion or an opposing second hemicylindrical portion of the outer surface of the heat generation member.

**12**. The smoking article of claim **11**, wherein the plurality of spaced-apart depressions extending about the first and second hemicylindrical portions are aligned with each other such that the spaced-apart depressions extend continuously around the circumference of the outer surface of the heat generation member.

**13**. The smoking article of claim **11**, wherein the plurality of spaced-apart depressions extending about the first hemicylindrical portion are longitudinally offset along the heat generation member with regard to the plurality of spaced-apart depressions extending about the second hemicylindrical portion.

**14**. The smoking article of claim **8**, wherein the plurality of spaced-apart depressions are configured to increase a surface area of the heat generation member, exclusive of surface areas of the opposed first and second ends, over a surface area defined by an outer periphery of the heat generation member without the plurality of spaced-apart depressions.

**15**. A method for debos sing a heat generation member of an elongate smoking article comprising:

serially dispensing a longitudinally-extending heat generation member along a machine direction, the heat generation member having an outer surface and defining a longitudinal axis; and

debossing the heat generation member by receiving the heat generation member between longitudinally-extending channels of a first die and an opposing longitudinally-extending channel of a second die of a debos sing mechanism, the channels of the opposing first and second dies each comprising spaced-apart protrusions, the protrusions in the channels being configured to extend non-parallel to the channels and cooperatively interacting with the heat generation member to deboss the outer surface thereof.

**16**. The method of claim **15**, wherein serially dispensing a longitudinally-extending heat generation member comprises extruding the heat generation member as a monolithic element of a carbonaceous material.

**17**. The method of claim **16**, wherein extruding the single carbonaceous material comprises forming a plurality of spaced-apart grooves in the monolithic element, the grooves extending longitudinally between opposed first and second ends of the heat generation member.

**18**. The method of claim **17**, wherein receiving the heat generation member such that the protrusions in the channels of the debos sing mechanism cooperatively interact with the heat generation member to deboss the outer surface thereof comprises defining a plurality of spaced-apart depressions between the opposed first and second ends of the heat generation member, each depression extending about a circumference of the outer surface of the heat generation member.

**19**. The method of claim **18**, further comprising aligning the first die and the opposing second die such that the protrusions in the channels of each die are aligned with one another, the dies cooperatively interacting with the heat generation member to form the plurality of spaced-apart depressions, wherein the plurality of spaced-apart depressions extending about a first and second hemicylindrical portions are aligned with each other such that the spaced-apart depressions extend continuously around the circumference of the outer surface of the heat generation member.

**20**. The method of claim **18**, further comprising aligning the first die and the opposing second die such that the protrusions in the channel of the first die are offset in the machine direction with regard to the protrusions in the channel of the second die, the dies cooperatively interacting with the heat generation member to form the plurality of spaced-apart depressions such that the plurality of spaced-apart depressions extending about a first hemicylindrical portion are offset in the machine direction with regard to the plurality of spaced-apart depressions extending about a second opposing hemicylindrical portion.

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