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(54) Title: TOBACCO PRODUCT AND METHOD OF PRODUCING THE SAME

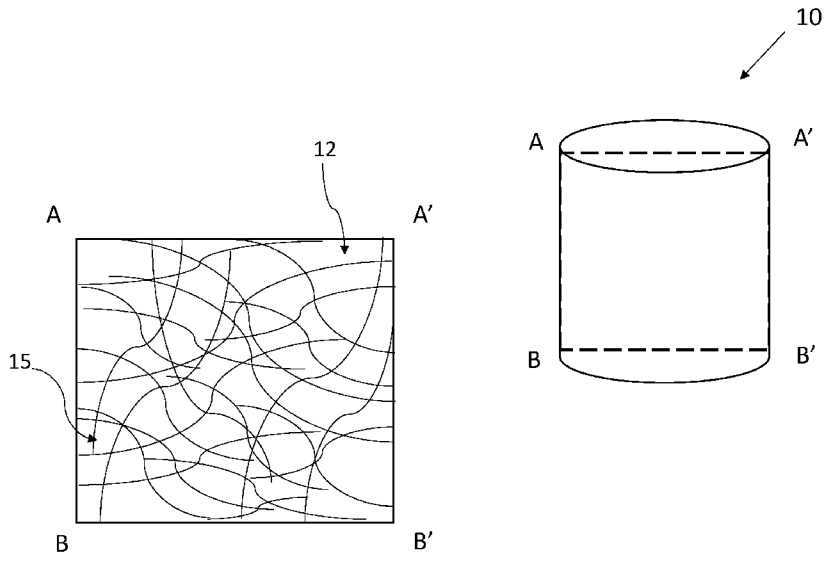

Figure 1

(57) Abstract: The disclosure relates to a tobacco unit of a heatable tobacco product for use with a heating device, which comprises a tobacco material, and a heat-transmitting material, integrally attached to the tobacco material, plastic net filter wherein the heat-transmitting material is adapted to form a plurality of heat transmitting paths for distributing heat from the heating device across the tobacco unit such that the tobacco material of the tobacco unit is homogenously heated. The disclosure also relates to a heatable tobacco product comprising the tobacco unit and a heating device for use with the heatable tobacco product.

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TOBACCO PRODUCT AND METHOD OF PRODUCING THE SAME

TECHNICAL FIELD

The present disclosure relates to a heatable tobacco product and a tobacco unit for use with the heatable tobacco product. The present disclosure also relates to a method for producing the tobacco unit.

BACKGROUND

The following discussion of the background is intended to facilitate understanding of the present disclosure. However, it should be appreciated that the discussion is not an acknowledgment or admission that any of the material referred to was published, known or a part of the common general knowledge in any jurisdiction as at the priority date of the application.

Heatable tobacco products (also known as heat-not-burn products) are tobacco products that produce a nicotine-containing aerosol/vapour by heating the tobacco products, which is then inhaled by a user. Since the tobacco does not burn, it is claimed that the level of harmful chemicals in the vapour are significantly reduced and hence 'second-hand smoke' can be mitigated. Further, little or no ash is produced from the heatable tobacco product, which provides additional benefits of being environmentally friendly.

Some existing heatable tobacco products make use of specifically designed tobacco sticks. Such tobacco sticks typically include a tobacco substrate (or an aerosol-generating substrate) formed primarily of tobacco-based material, while others use capsules or containers to contain tobacco for heating. In use, the tobacco sticks can be inserted in to a heating device which heats the tobacco via an electronically controlled heater. The heating device requires charging and the user draws on the mouthpiece at intervals to inhale volumes of the aerosol through the mouth, which is then taken into the body. The aerosols generated by heatable tobacco products contain the nicotine from tobacco, as well as other non-tobacco additives, and are often flavoured.

For most of the heatable tobacco products, the tobacco is heated up to a temperature that is lower than 600°C as in conventional cigarettes, for example, up to 350°C. Temperature control is critical for heatable tobacco products, to achieve a balance between taste experience and to avoid burning/combustion of the tobacco material. Within the tobacco plug/substrate, heat is transmitted from the heater/heating element to the tobacco material in contact with or in the vicinity of the heater/heating elements, further to other more remote parts of the tobacco substrate. A temperature profile is usually observed across the tobacco plug/substrate. It is desirable to provide a temperature profile as flat as possible across the tobacco plug/substrate, i.e. to have the different regions of the tobacco plug/substrate uniformly heated. To this end, the battery-powered heating systems of market available heatable tobacco products are often configured to simultaneously supply heat to and monitor the temperature of the tobacco plug/substrate of the coupled cigarette stick. Further, the heating system are adapted to heat the tobacco substrate evenly, for example, by means of using both an external heater to heat from the exterior of the tobacco substrate and an internal heater which is inserted into the tobacco substrate. This adds to the complexity of the heating system of the heatable tobacco products.

Apart from the heating system, cigarette sticks of heatable tobacco products are specifically designed with a different structure from that of conventional cigarettes. The cigarette sticks for heatable tobacco products can be made up from multiple elements that usually include a tobacco plug/substrate for generating the tobacco-infused vapour/aerosol, an aerosol-cooling segment for cooling generated aerosol, and several filter and support segments. The amount of tobacco material that such cigarette stick can accommodate is restricted by the multiple-elements designs, and can be a lot lower than in a conventional cigarette. It might be desirable to have more space in the cigarette sticks to contain tobacco material, in order to maximize user experience.

Further, the tobacco material, either in the form of cut/sliced tobacco leaves or in the form of reconstituted tobacco sheet, is often weak in mechanical strength and may

collapse, tear or break from extensive or heavy handling. In some cigarette stick designs, the reconstituted tobacco sheets need to be crimped or corrugated or textured for the purpose of enhancing the aerosol-generating efficiency, the process of which necessarily involves application of mechanical forces onto the tobacco sheets. Careful handling or deliberate machine modifications are often required during the process of forming the tobacco plug/substrate, because of the poor strength and often brittleness of the tobacco material.

There exists a need to develop a heatable tobacco product and particularly a tobacco substrate/unit for use in the heatable tobacco product that ameliorates the afore-mentioned drawbacks of existing heatable tobacco products at least in part.

SUMMARY

According to one aspect of the disclosure, there is provided a tobacco unit of a tobacco product for use with a heating device comprising:- a tobacco material, and a heat-transmitting material integrally attached to the tobacco material to form a single composite material, wherein the heat-transmitting material is adapted to form a plurality of heat transmitting paths for distributing heat across the tobacco unit such that the tobacco material of the tobacco unit is homogenously heated by the heating device.

In some embodiments, the heat-transmitting material comprises a plurality of heat-transmitting fibers, homogeneously dispersed in the tobacco material in random orientations.

In some embodiments, the heat-transmitting material comprises one or more heat-transmitting layers, each heat-transmitting layer being attached to the tobacco material on at least one surface.

In some embodiments, the heat-transmitting material comprises one or more of the following materials: - aluminium, copper, metallic alloys, graphite, conductive polymeric materials, any combinations thereof.

In some embodiments, the tobacco unit comprises a binder material for attaching the heat-transmitting material to the tobacco material.

In some embodiments, the tobacco unit further comprises one or more aerosol former materials.

In some embodiments, the weight percentage of the heat-transmitting material in the tobacco unit is in the range of 0.5% -10%.

In some embodiments, the length of the heat-transmitting fibers are in the range of 1 mm to 20 mm.

In some embodiments, the thickness of the one or more heat-transmitting layers are in the range of 0.05 mm to 1 mm.

According to another aspect of the disclosure, there is provided a heatable tobacco product for use with a heating device comprising: a tobacco unit at a first end of the heatable tobacco product, and one or more filter elements located downstream of the tobacco unit.

In some embodiments, the heatable tobacco product further comprises one or more tubular support elements.

In some embodiments, the one or more tubular support elements comprise one or more of the following: - an inner tube located at the immediate downstream of the tobacco unit; an outer tube located at the extreme downstream of the heatable tobacco product.

In some embodiments, the one or more filter elements comprise one or more materials from the following: - at least one metallic material; at least one natural or synthetic

fibrous material; at least one polymeric material; at least one resin material; and any combinations thereof.

In some embodiments, the one or more filter elements comprise one or more of the following materials: - natural plant fibers; natural animal fibers; carbonized plant fibers, carbonized animal fibers; synthetic polymer fibers; natural resin material; synthetic polymer resin; any combinations or derivatives thereof.

In some embodiments, the one or more filter elements comprises one or more of the following materials: - cotton; jute; hemp; bamboo fibers; bamboo charcoal fibers; wool; silk; nylon; polyester fibers; polyimide fibers; polylactic acid (PLA); polyethylene (PE); polyethylene terephthalate (PET); polyethylene ether ketones (PEEK); polypropylene (PP); polytetrafluoroethylene (PTFE); polyvinylchloride (PVC); cellulose acetate (CA), starch based polymers, liquid crystal polymer material (LCP); polyacrylonitrile (PAN); polysiloxane or silicone; natural or synthetic rubber; paper; paper yarn; paper net; cork; carbon; graphene; any combinations or derivatives thereof.

In some embodiments, the one or more materials forming the one or more filter elements are resistant to deformation or degradation when heated at temperatures of 180^{o}C and above.

In some embodiments, the one or more filter elements comprise one or more of the following types of filter: - fibrous tow filter, film filter, foil filter, mesh filter, fabric filter, fabric mesh filter, sheet filter, wrapped filament filter, spongy filter, laminated filter, wafer filter, honey-comb structure filter, extruded or moulded filter, paper filter, paper yarn filter, flat woven or braided filter, flat net filter. .

In some embodiments, the one or more filter elements comprise at least one net filter,

In some embodiments, the at least one net filter comprises a plurality of randomized aerosol paths.

In some embodiments, the one or more filter elements are formed from one or more natural materials obtained from one or more of the following plant parts: - leaf, bark, trunk, fruit, seed, stem, flower, pollen, branch, root, sap, pulp, resin bagasse, calyx of the respective flora, and any combinations thereof.

In some embodiments, the one or more filter elements are formed from one or more sliced materials.

In some embodiments, the one or more sliced materials are in one or more of the following forms:- a I-shape or straight cut, an H-shape, an N-shape, a Z-shape, a zig-zag or S-shape, any non-linear and non-symmetrical shapes.

In some embodiments, the one or more filter element comprises cellulose acetate (CA) in one or more of the following forms:- crushed or powder form, granule or pellet form, filament form, strip form, fibers or hardened fibers of any shape, threads, yarns, braided ropes, and flakes.

In some embodiments, the one or more filter elements comprise a granule-filled filter, wherein the granule-filled filter comprises one or more granulated materials encased in at least one filter material.

In some embodiments, at least one filter element is placed at the immediate downstream of the tobacco unit, the at least one filter element comprises a recess area for accommodating a part of the heating element protruding from the tobacco unit.

In some embodiments, the one or more filter elements comprise at least one aerosol channel to facilitate aerosol flow.

In some embodiments, the heatable tobacco product further comprises one or more overwraps circumscribing at least part of the heatable tobacco product.

In some embodiments, the one or more overwraps comprise one or more of the following materials: -natural plant fibers; natural animal fibers; carbonized plant fibers; carbonized animal fibers; synthetic polymer fibers.

In some embodiments, the one or more overwraps comprise one or more of the following materials: - jute; hemp; bamboo fibers; bamboo charcoal fibers; wool; silk; nylon; polyester fibers; polyimide fibers; polylactic acid (PLA); polyethylene (PE); polyethylene terephthalate (PET); polyethylene ether ketones (PEEK); polypropylene (PP); polytetrafluoroethylene (PTFE); polyvinylchloride (PVC), cellulose acetate (CA), starch based polymers, liquid crystal polymer material (LCP); polyacrylonitrile (PAN); polysiloxane or silicone; natural or synthetic rubber, cork, carbon, graphene, paper, paper yarn, paper net..

In some embodiments, the one or more overwraps comprise one or more of the following: woven fabric materials formed from any type of fibers; non-woven fabric materials formed from any type of fibers.

In some embodiments, the one or more overwraps further comprise one or more metallic foils.

In some embodiments, the one or more materials forming the one or more overwraps are resistant to deformation and degradation when heated at temperatures of 180^{o}C and above.

In some embodiments, at least two overwraps are laminated into one single sheet material.

In some embodiments, the one or more overwraps further comprise one or more heat insulating layers formed from one or more of the following materials:- heat insulation food grade glue; high temperature resistant film.

In some embodiments, the heatable tobacco product is adapted to be removably coupled to the heating device.

In some embodiments, the heatable tobacco product is integrally attached to the heating device.

In some embodiments, the heating device is configured to heat the tobacco unit of the heatable tobacco product at a set temperature under a constant power supply operational mode.

In some embodiments, the set temperature is in the range of between 280°C to 400°C.

In some embodiments, the heating device is further configured to heat the tobacco unit during one or more heating cycles, each heating cycle comprising a first heating period where the tobacco unit is heated at a first heating temperature, and a second heating period where the tobacco unit is heated at a lower second heating temperature.

In some embodiments, the heating device is configured to turn off electrical power of the heating element during the second heating period of each heating cycle under a power-saving operational mode.

In some embodiments, the heating device is further configured to control the operating temperature of the heating element to be in the range of between 280°C and 400°C.

In some embodiments, the one or more materials forming the one or more filter elements are odourless and non-toxic materials.

According to another aspect of the disclosure, there is provided a heating device to be used with a heatable tobacco product, the heating device comprising: - one or more heating elements arranged to produce and transmit heat to the heatable tobacco

product coupled to the heating device, and an electronic control unit for controlling the operation of the heating device.

In some embodiments, the heating device further comprises a switch arranged to selectively activate the heating device.

In some embodiments, the heating device further comprises a power source unit for supplying electrical power to the heating device.

In some embodiments, the switch comprises an insulating sheet adapted for putting the power source unit in an open electric circuit.

In some embodiments, the heating device is integrally attached to the heatable tobacco product.

In some embodiments, the heating device is removably attached to the heatable tobacco product.

In some embodiments, the heating device is configured to heat the tobacco unit of the heatable tobacco product at a set temperature under a constant power supply operational mode.

In some embodiments, the set temperature is in the range of between 280°C and 400°C.

In some embodiments, the heating device is further configured to heat the tobacco unit during one or more heating cycles, each heating cycle comprising a first heating period where the tobacco unit is heated at a first heating temperature, and a second heating period where the tobacco unit is heated at a lower second heating temperature.

In some embodiments, the heating device is configured to turn off electrical power of the heating element during the second heating period of each heating cycle under a power-saving operational mode.

In some embodiments, the heating device is further configured to control the operating temperature of the heating element to be between 200°C and 400°C.

In some embodiments, the one or more heating elements are arranged in one or more of the following configurations: - a coil, a straight or corrugated ribbon, a strip of wires, a needle, a plate, and/or any other three-dimensional shapes.

In accordance to another aspect of the disclosure, there is provided a method of producing a tobacco unit for use in a heatable tobacco product, the method comprising the steps of: - providing a homogenized tobacco material; preparing a solution containing at least a binding agent; preparing a plurality of heat-transmitting fibers; mixing a homogenized tobacco material, the heat-transmitting fibers and the solution to form a slurry; casting the slurry into a reconstituted tobacco material comprising heat-transmitting fibers homogeneously dispersed therein; forming the reconstituted material into a rod-like shape, further sized into a plurality of tobacco units for incorporating into the heatable tobacco product.

In some embodiments, the heat-transmitting fibers are formed from aluminium, copper, metallic alloys, graphite, conductive polymeric materials, or any combinations thereof.

In accordance to another aspect of the disclosure, there is provided another method of method of producing a tobacco unit, the method comprising the steps of: - providing a cast tobacco sheet material; providing a thin layer of heat-transmitting material; joining at least one cast tobacco sheet material and at least one heat-transmitting layer to form into a laminar sheet; forming the laminar sheet into a rod-like shape, further sized into a tobacco unit for incorporating into the heatable tobacco product.

In accordance to another aspect of the disclosure, there is provided another method of method of producing a tobacco unit, the method comprising the steps of: providing a heat-transmitting layer; preparing a homogenized tobacco material; depositing the homogenized tobacco material on at least one surface of the heat-transmitting layer with a binding agent to form a laminar sheet with at least one layer of tobacco material and at least one heat transmitting layer; forming the laminar sheet into a rod-like shape, further sized the tobacco unit for incorporating into the heatable tobacco product.

In some embodiments, the method comprises a further step of pressing the at least one tobacco sheet material and the at least one heat-transmitting layer to form a laminate.

In some embodiments, the heat-transmitting layer comprises thin foils of aluminium, copper, metallic alloys, graphite, conductive polymeric materials, or any combinations thereof.

Other aspects of the disclosure will be apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the disclosure in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments are described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates a cross-sectional view of a tobacco unit according to one embodiment;

Figure 2A and Figure 2B illustrate a cross-sectional view and the corresponding side view of a tobacco unit according to another embodiment;

Figure 2C illustrates another embodiment of a tobacco unit;

Figure 3A to 3O illustrate a heatable tobacco product according to various embodiments;

Figure 4 illustrates various embodiments of a sliced or cut material for forming a filter element;

Figure 5 and Figure 6 illustrate a heatable tobacco product comprising a filter element according to various embodiments;

Figure 7A and 7B illustrate a heatable tobacco product and a heating device in unassembled and assembled form according to one embodiment;

Figure 8 illustrates a heating device for use with the heatable tobacco product according to one embodiment;

Figure 9 to 13 illustrate a heating element of the heating device according to various embodiments;

Figure 14A and 14B illustrate a heatable tobacco product and a heating device in unassembled and assembled form according to another embodiment;

Figure 15 illustrates a laminate structure formed during a process of producing a tobacco unit according to various embodiments;

Figure 16A and 16B illustrate temperature profiles of a heating device, in a constant power supply operational mode and in a power-saving operational mode respectively; and

Figure 17 illustrates a temperature profile of a tobacco unit of a heatable tobacco product with respect to a heating profile of a coupled heating device in a power-saving operational mode.

Other arrangements are possible and it is appreciable that the accompanying drawings are not to be understood as superseding the generality of the preceding description of the disclosure.

DETAILED DESCRIPTION

Particular embodiments are described with reference to the accompany drawings. The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the present disclosure. Other definitions for selected terms used herein may be found within the detailed description of the disclosure and apply throughout the description. Additionally, unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one ordinary skilled in the art to which the present disclosure belongs. Where possible, the same reference numerals are used throughout the figures for clarity and consistency.

Throughout the specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Throughout the specification, unless the context requires otherwise, the word "include" or variations such as "includes" or "including", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Throughout the specification, unless the context requires otherwise, the word "have" or variations such as "has" or "having", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Throughout the specification, unless the context requires otherwise, the word "tobacco" will be understood to include products prepared from a part of the tobacco

plant, such as leaves, through the process of drying or curing, and further optional processes of aging, fermenting, flavouring etc., and to include any other products derived from any forms of tobacco leaves such as ground and reconstituted tobacco material.

Throughout the specification, unless stated otherwise, the term "heatable tobacco product" will be understood to include tobacco products containing a tobacco material to be heated, rather than combusted or burned as in conventional cigarettes. "Heatable tobacco product" may in some context be referred to as "heat-not-burn tobacco product" and in the description are used interchangeably. The tobacco material of a heatable tobacco product can be heated via an electrical power source functioning as a heating element at a temperature lower than the combustion point of the tobacco material and capable of producing vapors/aerosols containing nicotine and other chemicals suitable for consumption. It is appreciable that aerosol formation in a heatable tobacco product may be based on distillation and/or evaporation.

Throughout the specification, the term "fiber" "filament" "string" will be understood to depict a slender and substantially elongated shape.

Throughout the specification, the term "sheet" "layer" will be understood to depict a planar surface with a substantially higher length and/or width compared to thickness.

Throughout the specification, the term "homogenous", "even", "uniform" may be construed to depict a material including parts all of the same or substantially similar structure and characteristics, an arrangement of or a process involving multiple substances or components with little variation in form, manner or degree.

Throughout the specification, the term "downstream" is used to describe the relative positions of the different components or segments of a tobacco product in relation to the direction of the aerosol flow within the tobacco product, as a user draws on the tobacco product during normal consumption.

Throughout the specification, the term "paper", "paper material" is used to describe a material a material formed from a pulp containing cellulose fibers. Wood, rags, grasses and part of the plants or natural resources herein described such as straw, sugarcane bagasse, bamboo, flax, hemp, and jute may be a suitable source of cellulose fibers for forming the paper material.

Throughout the specification, where one material is "integrally attached" with another material, such integrally attachment between the materials may include embedding and mixing the materials in a fluid, aqueous or semi-aqueous state.

In an embodiment of the disclosure and with reference to Figure 1 and Figure 2A to Figure 2C, there is provided a tobacco unit 10 of a heatable tobacco product for use with a heating device. The tobacco unit 10 comprises a tobacco material 12 and a heat-transmitting material integrally attached to the tobacco material 12. The heat-transmitting material is adapted or configured to form a plurality of heat transmitting paths for distributing heat from the heating device 40 across the tobacco unit so that the tobacco material 12 of the tobacco unit 10 can be homogeneously heated by the heating device.

In various embodiments, the tobacco material 12 comprises tobacco as its major constituent, which releases a tobacco-flavoured vapor or aerosol when heated. The tobacco material includes, but are not limited to, cured/dried tobacco leaves/stems and reconstituted tobacco materials in any form. The tobacco material may comprise other additives such as non-tobacco fibers, aerosol-formers, humectants, plasticisers, flavourants, fillers, aqueous and non-aqueous solvents and any combinations thereof.

In various embodiments, the heat-transmitting material can include any material with a substantially good thermal conductivity, including, but not limited to, metallic materials such as silver, copper, gold, aluminium, iron, metallic alloys such as steel and bronze, graphene, and any other thermal conductive compounds with heat-conductive additives added thereto for conferring or enhancing the thermal conductivity, for example but not limited to, polymeric materials containing graphite,

aluminium nitride and boron nitride as conductive charges. Materials having similar range of thermal conductivity can be utilized alone or in combination.

The heat-transmitting material may be integrally attached or adhered or affixed to the tobacco material. The heat-transmitting material may be incorporated into the tobacco material during the process of producing the tobacco material, or joined with the tobacco material in a separate and further step. The tobacco unit 10 thus has an integral and composite structure formed from the tobacco material and the heat-transmitting material, and usually a binding agent for providing a substantially good binding strength between the two.

In various embodiments, suitable materials for use as binding agent(s) can include, but are not limited to: gums such as, for example, guar gum, xanthan gum, arabic gum and locust bean gum; cellulosic binders such as, for example, hydroxypropyl cellulose, carboxymethyl cellulose, hydroxyethyl cellulose, methyl cellulose and ethyl cellulose; polysaccharides such as, for example, starches, organic acids, such as alginic acid, conjugate base salts of organic acids, such as sodium-alginate, agar and pectins; and combinations thereof.

In some embodiments, the binding agent is a food-grade adhesive material, which is formulated with materials approved by the relevant food-safety regulatory authorities in respective countries. Examples of food-grade adhesive material include, but are not limited to, pectin and other hydrocolloid. Such food-grade adhesive material emits no or insignificant amount of harmful substances when heated, and may provide additional benefits of being bio-degradable and environmental-friendly. Further, the tobacco unit 10 according to this embodiment may be particularly desirable for use in heatable tobacco product 20, as the whole heatable tobacco product 20 may be disposed after use.

The heat-transmitting material within the tobacco unit 10 is arranged to form a plurality of heat-transmitting paths for receiving heat from the heating device 40 and for homogenously distributing the heat across the tobacco unit 10. The tobacco unit

10 exhibits enhanced thermal characteristics as compared with existing heatable tobacco product.

As mentioned in the background section of the disclosure, in existing heatable tobacco products, when a heating device is coupled to the heatable tobacco product, tobacco material in the vicinity of a heat source of the heating device receives heat from the heat source directly and thus is observed with a relatively higher temperature, as compared to the temperatures observed in the tobacco material located at a distance from the heat source. The closer the tobacco material is to the heat source, the higher is the temperature it experiences during heating. This can result in a sloped temperature gradient profile across tobacco unit 10, which is undesirable for heatable tobacco products as the tobacco material reacts very sensitively to different heating temperatures. Accordingly, heating devices used with existing heatable tobacco products are usually designed to incorporate additional electronic components for sensing and regulating temperature at different parts of the tobacco unit, and/or a specifically configured heating source arrangement for even heat distribution (for example, multiple internal and external heating elements located at different parts of the tobacco product). This may add to the complexity and costs of the system.

The tobacco unit 10 as described in the present application seeks to alleviate uneven temperature distribution and/or mitigate high temperature drops across the tobacco unit 10. The embedded heat-transmitting material is arranged such that a plurality of heat-transmitting paths are formed and dispersed evenly within the tobacco unit, each extending from one part of tobacco unit 10 to other parts. The embedded heat-transmitting material, and the heat-transmitting paths formed therefrom provide a means for heat to be transmitted/distributed to different parts of the tobacco unit 10 in a relatively fast and efficient manner. Advantageously, a homogeneous temperature distribution or a relatively flat temperature profile within the tobacco unit 10 can be achieved in a relatively shorter time after the heating device 40 is activated for heating. The tobacco material at any part of the tobacco unit 10 is heated at a substantially similar temperature level. Heat transfer within the tobacco unit 10 is

primarily via thermal conduction through the tobacco material 12 and the embedded heat-transmitting material, while some level of convective heating may also occur.

In various embodiments, the heat-transmitting material is in a relatively smaller amount compared to the tobacco-based material. In other words, the tobacco material 12 is the primary constituent of the tobacco unit 10, and the heat-transmitting material are provided in a significantly lower amount as compared to the tobacco material 12. The volume taken up by the heat-transmitting material in the tobacco unit 10 is also significantly lower as compared to the tobacco material 12.

In some embodiments, the tobacco unit 10 may contain about 1% to 20% of heat-transmitting material by weight. In some embodiments, the tobacco unit 10 contains about 1% to 10% of heat-transmitting material by weight. Advantageously, the tobacco unit 10 formed is a lightweight structure, and is relatively easy to transport, stored and disposed of. Further, the relatively lower amount of heat-transmitting material required for manufacturing can lower the material costs for manufacturing the tobacco unit 10.

In one embodiment according to Figure 1, the heat-transmitting material comprises fibers or strings or filaments which are formed from a thermally conductive material. The heat-transmitting material, in the form of fibers or strings or filaments, is also referred to as heat-transmitting fibers 15. The heat-transmitting fibers are homogeneously dispersed throughout the tobacco material 12 and can be randomly oriented. Each heat-transmitting fiber 15 may form one or more intersections with one or more other heat-transmitting fibers 15. As such, an interconnected and grid-like structure is formed by the embedded and randomly dispersed heat-transmitting fibers 15, providing a plurality of heat-transmitting paths for transmitting heat from one part of the tobacco unit 10 to another part of the tobacco unit 10. A cross-sectional plane A-A'-B-B' of the tobacco unit 10 is selected to illustrate the arrangement of the heat-transmitting fibers 15 within the tobacco unit 10. As shown in Figure 1, two heat-transmitting fibers 15 not directly contacting each other can be abridged by one or more other heat-transmitting fibers 15. The interconnection of different heat-

transmitting fibers 15 provides for multiple heat-transmitting paths extending toward various directions within the tobacco unit 10. It is appreciable that the cross-sectional plane A-A'-B-B' is selected for illustration purpose and that cross-sectional planes of the tobacco unit 10 along other directions may comprises a similar arrangement of the heat-transmitting fibers 15, as the heat-transmitting fibers 15 are homogeneously distributed inside the tobacco unit 10.

In some embodiments, the heat-transmitting fibers 15 are aluminium fibers, or copper fibers, or combination of the two.

In some embodiments, the average length of the conductive fibers is 16mm. The length of the conductive fibers may be within the range of 1 mm to 20 mm.

In various embodiments, the heat-transmitting fibers can be incorporated into the tobacco material 12 during a reconstitution process, for example but not limited to, a paper making process for forming cast tobacco sheets.

In addition to providing the benefits of allowing the tobacco unit 10 to be evenly heated, the tobacco unit 10 with the embedded heat-transmitting fibers 15 is also advantageous in least the following aspects.

Tobacco material can be weak and susceptible to disintegration. Reconstituted tobacco material is relatively stronger that cured tobacco leaves, as additional components such as other cellulose fibers are usually added in the tobacco slurry during the reconstitution process. However, mechanical weakness of the tobacco material is still a key shortcoming in processing of tobacco products.

Due the inclusion of the heat-transmitting fibers 15 made of metallic or polymeric thermally conductive materials, the composite structure comprising both the tobacco material 12 and the heat-transmitting fibers 15 is more robust and durable. The product manufacturability is much improved and the structural integrity of the resultant tobacco unit 10 can be enhanced. In some embodiments wherein a cast

tobacco sheet is formed with aluminium and copper fibers added as the heat-transmitting material, the aluminium and copper fibers can effectively strengthen the tobacco sheet to withstand a load of 200N/m^2, which is an industry standard required for a machine to process the tobacco sheet for heat not burn products. In addition, as an additional advantage of the structural integrity of the resultant tobacco unit, stoppages and rejections due to manufacturing defect, for example breakage of tobacco sheets during production, may be reduced and/or minimized.

For heatable tobacco products in particular, a higher mechanical strength of the tobacco unit 10 may be desirable because some of the heating devices are configured such that one or more heating elements are penetrated into the tobacco unit 10 for heating the tobacco unit 10. Such heating element arrangement may cause the tobacco unit 10 to deform (e.g. bend) if the structure is not robust. Also, upon subsequent extraction of the heating elements, disintegration of the tobacco unit 10 may occur if the tobacco materials within the tobacco unit 10 are not well integrated. The present disclosure is advantageous in that the strengthened tobacco unit 10 can better resist any movement or disintegration of the tobacco unit 10 caused by the insertion and extraction of the heating elements.

In another embodiment according to Figure 2A and Figure 2B, the heat-transmitting material comprises one or more thin layers of thermally conductive material. The thin layer of thermally conductive material is also referred to as a heat-transmitting layer 17. The heat-transmitting layer 17 can be in the form of an aluminium foil, a copper foil, or a laminar sheet formed from any thermally conductive material.

In another embodiment shown in Figure 2C, the one or more heat-transmitting layers 17 may be formed via an interconnected configuration. At least one heat-transmitting layer 17 may have a sheet-like arrangement, a web-like arrangement, or a net-like arrangement. In some configurations, a heat-transmitting layer 17 may be connected to another heat-transmitting layer 17 in a helical spring-like configuration.

In some embodiments comprising a plurality of heat-transmitting layers 17, each heat transmitting layer may be arranged parallel with respect to other heat-transmitting layers 17.

It is appreciable that the interconnection between one or more heat-transmitting layers 17 may be arranged in a similar interconnected manner as the heat-transmitting fibers 15. In other words, one or more layers of the heat-transmitting layer 17 may be formed by the interconnection of heat-transmitting fibers 15.

In some embodiments, the tobacco material 12 are disposed and integrally formed on at least one side of each heat-transmitting layer 17. In some embodiments, the tobacco material 12 is integrally formed on both sides of the heat-transmitting layer 17.

In various embodiments, the tobacco unit 10 formed by the heat-transmitting material and the tobacco material 12 is a laminate structure comprising a plurality of alternating layers of the tobacco material 12 and the heat-transmitting material.

In some embodiments, the tobacco material 12 disposed on the heat-transmitting layer 17 may comprise granulated tobacco, homogeneously deposited onto the heat-transmitting layer 17 and adhered to the heat-transmitting layer 17 by using a binding agent or any suitable adhesive materials. In other embodiments, the tobacco material 12 comprises a reconstituted tobacco sheet joined together with the heat-transmitting layer 17 in a lamination process by heat, pressure, welding, and/or by applying a binding agent or other suitable adhesive materials.

In various embodiments, the thickness of the heat-transmitting layer 17 is between 0.05 mm to 1 mm.

An example of the tobacco unit 10 having the above-described multi-layer arrangement is illustrated in Figure 2A. On a cross-sectional plane A-A'-B-B' of the tobacco unit 10, the layers of the heat-transmitting material are extended along an axis, such as a longitudinal axis of the tobacco unit 10, and adjacent layers are spaced

apart with a substantially equal distance. At least one adjacent layer of heat-transmitting material 17 can be connected with another adjacent layer, along other planes. This can be achieved, for example, by rolling a single sheet of laminated tobacco and heat-transmitting material into a rod-like shape, or by aggregating or gathering multiple sheets of laminated tobacco and heat-transmitting material along the same direction into the tobacco unit 10. It is also possible to form one integral laminated structure comprising multiple layers of the tobacco and heat-transmitting material, which can be further sized into the rod-like shape of the tobacco unit 10.

In the embodiment shown in Figure 2A, at least one heat-transmitting layer 17 provide heat-transmitting paths primarily along the longitudinally direction of the tobacco unit 10. This embodiment is particularly suitable for use with a heating device, whereby the heat source of the heating device 40 is in contact with a surface, such as a bottom surface of the tobacco unit 10 to facilitate heat transfer.

It is appreciable that other arrangements of the heat-transmitting layers 17 may be conceived, according to the different configurations or placements of the heat source, such that heat-transmitting paths which are able to transmit heat from the heat source from an area of the tobacco unit 10 in contact with or in the vicinity of the heat source to other more remote areas of the tobacco unit 10. Similar to the embedded heat-transmitting fiber 15 arrangement shown in Figure 1, the heat-transmitting paths formed by the multiple heat-transmitting layers 17 are homogenously interspaced across the tobacco unit 10 or at least along one axis of the tobacco unit 10. This homogeneous placement of the heat-transmitting paths provides for the heat to be distributed evenly across the tobacco unit 10 in a fast and efficient manner.

This embodiment comprising heat-transmitting layer 17 may provide additional advantages. In a layered structure, heat transfer by the heat-transmitting material can be more efficient, because of the increased contact area between the tobacco material and the heat-transmitting material. Also, a more durable and robust tobacco unit 10 can be formed with such a layered structure. Compared to the embodiment with embedded heat-transmitting fibers 15 as shown in Figure 1, the tobacco unit 10

according to Figure 2A may have a further enhanced structural integrity provided by a "skeleton" formed by the one or more heat-transmitting layers 17. Lastly, the process of forming the laminate of tobacco and heat transmitting materials could be relatively easier and more flexible, details of which are illustrated further below.

It is appreciable that one or more heat-transmitting layers 17 may be connected to another heat-transmitting layer 17.

In accordance with another aspect of the disclosure, there is provided a heatable tobacco product 20 for use with a heating device. The heatable tobacco product 20 comprises a tobacco unit 10 with the heat-transmitting fiber 15 and/or heat-transmitting layers 17 as described, and one or more filter elements 24 located downstream of the tobacco unit 10. The heatable tobacco product 20 is also referred to as a heatable tobacco stick 20, which resembles the shape and form of a conventional cigarette stick. The one or more filter elements 24 may be included/incorporated in different product component configurations as will be elaborated with reference to Figures 3A to 3O.

Figures 3A to 3O, Figure 5 and Figure 6 illustrate examples and configurations of the heatable tobacco product 20 according to various embodiments. It is appreciable that Figures 3A, 3J-3M, 5 and 6 are two segment/component configuration, Figure 3B-3C and 3N-3O are three-component configurations, Figures 3D-3G are four-component configurations, Figure 3H-3I is a five-component configuration.

In various embodiments, the tobacco unit 10 is provided at a first end 21 of the heatable tobacco product 20. The one or more filter elements 24 are located downstream of the tobacco unit 10 and may be arranged coaxially with the tobacco unit 10 along a longitudinal axis of the heatable tobacco product 20. For example, the tobacco unit 10 and the one or more filter elements 24 may be arranged in a cylindrical form. The cylindrical tobacco unit 10 and the one or more cylindrical filter elements 24 may be aligned along a common axis and may adjoin each other at the base surfaces so as to assemble into the heatable tobacco product 20. Each filter

element 24 may comprise one or more types of filters and may be formed from or comprise any suitable filter material, or combinations of different filter materials. It is appreciable that different filter materials may be incorporated into the different types of filters to form a hybrid filter. In some embodiments, the filter elements 24 may contain a recess 57 which is a small void cut or introduced into the material by other methods.

In various embodiments, the one or more filter elements 24 can be formed from one or more natural materials obtained from various parts of different types of plants including, but not limited to, a leaf, bark, trunk, fruit, seed, stem, flower, pollen, branch, root, sap, pulp, resin bagasse, calyx of the respective plants.

In various embodiments, the one or more filter elements 24 can be formed from one or more of the following materials from different natural resources including, but not limited to, oak, maple, *Pandanus amaryllifolius* or screwpine, Daun Asam or tamarind, Roselle, sugarcane, lotus, Yucca, bamboo, reed, nypa fruticans, canna, mesquite, hickory, alder, *Tetrapanax papyrifer or* rice-paper plant or, *Broussonetia papyrifera* or paper mulberry, and any other plants, grasses, or flora; vegetables and fruits such as lemon, banana, grape, grapefruit, melon, pineapple, pomegranate, cucumber, durian, orange, cherry, apple, pear, mango, apricot, peach, any edible berry, fig, pumpkin, and nectarine; edible mushroom; lichen; coconut; coir; corn; corn husk; rice; glutinous rice; hazelnut; walnut; almond; peanut; pecan; any derivatives from the above natural resources. *Pandanus amaryllifolius* or screwpine is also referred to as Rampe.

The natural materials may undergo a preparatory treatment such as drying, steaming, curing, expanding, flattening, pre-cutting, heating, and carding. The pre-treated natural materials may then undergo further processes to be formed directly into a filter element 24 or formed into an intermediate material (for example, a paper sheet, a thread, a net, a fabric material, granules and etc.) for use in various types of filter elements 24 as described herein. For example, rice and/or glutinous rice may be

processed into thin sheets as an intermediate material to be incorporated into the filter element 24.

In some embodiments, the one or more filter elements 24 comprise one or more natural flavours derived or extracted from any suitable herbs, spices, any fragrant plants, and any aromatic food substances. The natural flavours may be derived from one or more of the following: vanilla, cinnamon, mint, abaca, hemp, cardamom, doringin or tarap tree leaf, tea, Rampe or *Pandanus amaryllifolius* or screwpine, coffee bean, cacao bean, butter, honey, ginger. For example, extracts distilled from or otherwise extracted from the leaves or flowers of screwpine plants may be used to add a sweet aroma to the one or more filter elements 24. The extract obtained from the flowers of screwpine plants is also known as Kewra.

In some embodiments, the one or more filter elements 24 comprise natural materials obtained from one or more herbs, spices, flowers or flowering plants including, but not limited to, Aconitum, African Daisy, Agapanthus, Alchemilla, Allium roseum, Alstroemeria, Alyssum, Amaranthus, Amaryllis, Anemone, Angelonia, Anthurium, Aquilegia, Argeratum, Aster, Astilbe, Astrantia, Aubretia, Baby's Breath, Bachelor's Button, Balloon Flower, Bee Balm Flower, Begonia, Bellflower, Bergenia, Black-Eyed Susan, Blanket Flower, Blazing Star, Bleeding Heart, Blue Star Flower, Bluebell, Blue-Eyed Grass, Bouvardia, Buddleja, Bush Morning Glory, Buttercup, Calendula officinalis, California Poppy, Calla Lily, Candytuft, Canna Lily, Cape Primrose, Cardinal Flower, Carnation, Celosia, Chrysanthemum, Clarkia, Clematis, Clove, Clover, Cockscomb, Columbine, Coneflower, Coral Bells, Coreopsis, Cosmos, Cotoneaster, Cranesbill Geranium, Creeping Phlox, Crocosmia, Crocus, Crown Imperial, Cuckoo Flower, Cyclamen, Daffodil, Dahlia, Daisy, Daphne, Day Lily, Delphinium, Desert Rose, Dianella, Dianthus, Diascia, Dichondra, Dietes, Dutch Iris, Echium, English Bluebell, Erica, Erigeron, Eustoma, Evening Primrose, Everlasting Daisy, Flannel Flower, Flax Flower or Linseed, Floss Flower, Forget Me Not, Forsythia, Foxglove, Frangipani or Plumeria, Freesia, French Marigold, Fuschia, Gaillardia or Blanket Flower, Gardenia, Gaura, Geranium, Gerbera, Giant Bellflower, Gladiolus, Goldenrod, Grape Hyacinth, Heartsease, Heather, Hebe or Showy

Speedwell, Helenium, Heliotrope, Hellebore, Hibiscus, Hollyhock, Honesty, Honeysuckle, Hosta, Hyacinth, Hydrangea, Hypericum, Ice Plant, Iceland Poppy, Ilex, Impatiens, Iris, Ixia, Ixora, Jaborosa, Jacob's Ladder, Jasmine, Jonquil, Kaffir Lily, Kalmia, Kangaroo Paw, Knautia macedonica, Kniphofia, Kolkwitzia, Lady's Slipper, Lantana, Lavender, Lechenaultia, Lilac, Lily of the Valley, Lily, Linaria, Lisianthus, Lobelia, Lotus, Love in the Mist, Lunaria, Lupin, Magnolia, Mallow, Maltese Cross, Mandevilla, Marguerite Daisy, Marigold, Matthiola, Mayflower, Meconopsis, Mexican Fireplant, Milkweed, Mimosa, Mina lobata, Monk's Hood, Moonflower, Morning Glory, Muscari, Narcissus, Nasturtiums, Nemesia, Nemophila, Nepeta, Nerine, Nierembergia, Nigella, Nolana, Orchid, Oriental Lily, Oriental Poppy, Ornamental Onion, Osteospermum, Ox Eye Daisy, Oyster Plant, Painted Daisy, Pansy or Violet Tricolor, Passion Flower, Peace Lily, Pelargonium, Penstemon, Peony, Persian Buttercup, Peruvian Lily, Petunia, Phlox, Pincushion Flower, Pink Lady's Slipper, Plume Celosia, Pointsettia, Polyanthus, Poppy Anemone, Portulaca grandiflora, Pot Marigold, Powder Puff, Primula, Purple Coneflower, Quaker Ladies, Queen Anne's Lace, Queen of the Meadow, Queen's Cup, Quince, Rain Lily, Ranunculus, Rock Rose, Rondeletia, Rose of Sharon or shrub althea, Rose, Rudbeckia, Salvia splendens, Saponaria, Scabiosa, Scaevola, Scented Geranium, Scilla, Sedum, Shasta Daisy, Silene, Snapdragon, Snowdrop, Snowflake, Speedwell, Starflower, Statice, Strawflower, Sun Drop, Sunflower, Sweet Pea, Syringa, Tea Rose or hybrid tea rose, Tiger Flower, Tiger Lily, Tithonia, Trachelium, Trillium, Triplet Lily, Tritonia crocata, Trollius, Tropaeolum, Trumpet Vine or Hummingbird Vine, Tuberose, Fever Root, Snapdragon Root, Tulip, Urn Plant, Ursinia, Uva Ursi, Verbena, Veronica incana, Viburnum, Vinca Minor, Viola wittrockiana, Viola, Violet, Virginia Creeper, Wallflower or Erysimum, Wandflower, Water Lily, Watsonia, Wax Plant or porcelainflower, Wedelia, Weigela, Whirling Butterflies, Wild Rose or Rosa acicularis, Wild Violet, Windflower, Winter Aconite, Winter Jasmine, Winterberry, Wishbone Flower, Wisteria, Woolly Violet, Xerophyllum, Xylobium, Xylosma, Xyris difformis, Yarrow, Yellow Archangel, Yellow Bell, Yellow-Eyed Grass, Yellowhorn, Zenobia, Zephyranthes, Zinnia.

Advantageously, the natural materials used for forming the filter element 24 impart a natural organic taste, aroma, flavour or smell onto the heatable tobacco product 20, and onto the aerosol generated by the heatable tobacco product 20 for user inhalation. Since the above materials are derived from natural sources, the filter element 24 made from the above natural materials is typically biodegradable and therefore may be environmentally friendly.

In some embodiments, the filter element 24 may be formed from a paper material. The filter element 24 formed from the paper material is referred to as a paper filter. In some embodiments, the paper material used for forming the paper filter may be a crimped or textured paper sheet, which is then gathered/combined together to form the filter element 24. In some embodiment the paper material may be in the form of paper yarn, which is bundled together, or processed in other ways (for example, braided or woven) into the filter element 24. The paper filter may be imparted with a natural flavour. The flavour may be imparted from the above-described natural materials in the formation of the paper filter or in the coating of the paper filter.

In some embodiments, the filter element 24 comprises sugarcane bagasse. The sugarcane bagasse can be formed into the filter element 24 directly or can be incorporated into other filter types to enhance filtration effect.

In some embodiments as shown in Figures 3A, 3C, 3D, 3E, 3F, 3H, 3I, 3K and 3N, the one or more filter elements 24 can include a net filter element 26 specially designed for the heatable tobacco product 20. The net filter element 26 may be formed from one or more of the following materials (which may be plastic or non-plastic): polylactic acid (PLA), Vectran™, polyethylene (PE), polypropylene (PP), polyvinylchloride (PVC), polyethylene terephthalate (PET), polyether ether ketone (PEEK), cellulose acetate (CA), Fluorinated ethylene propylene (FEP) plastic, Polyurethane (PUR) Plastic, Polytetrafluoroethylene (PTFE), Liquid Crystal Polymer (LCP), polyimide, polyacrylonitrile (PAN), polysiloxanes such as silicone, in the form of silicone oil, silicone grease, silicone rubber, silicone resin or silicone caulk, silicone as coating, laminate or mixed with other materials in this list; other polymer resins,

natural plant fibers such as jute, hemp and others, natural animal fibers such as silk, wool and others, carbonized natural plant fibers such as bamboo charcoal fiber and others, carbonized animal fibers, charcoal fibers, natural or synthetic rubber and its derivatives, carbon, graphite, liquid wood, starch made polymer, natural fibre, synthetic fibre, biodegradable fiber or non-biodegradable fiber, one or more composite or derivatives of the above mentioned materials, possible combinations of one or more of the above materials or/and other food grade non-toxic materials suitable as filter or any other material that can withstand temperatures of up to 180°C and above without considerable deformation or degradation.

In some embodiment, the net filter element 26 is formed from paper. The paper may be first processed into a paper yarn through various slicing and spinning processes. The paper yarn may be woven or braided to form the net filter element 26. . The paper yarn may also be woven or braided into a paper net as an intermediate material for forming the net filter element 26. The woven or braided paper net may be a flat net material, or may be in any other suitable shapes and forms. The net filter element 26 formed by weaving or braiding a paper yarn material is also referred to as a woven or braided paper filter.

The process of forming the net filter element 26 may include a step of gathering one or more net materials, and a further step of forming the gathered net materials into a filter element of a desired size and dimension. In some embodiments, the one or more net materials may be gathered into one or more elongate filter strands, which are then fed into a forming machine. As the net filter materials passes through the forming machine, the net filter may be compressed into a desired dimension, such as a diameter, and/or formed into a rod-like filter element or a continuous elongate filter body for further processing into the net filter element 26. The flexibility of the net material allows it to better conform to the shape of the inner channel of the tubular forming element, with minimal manufacturing variation. In some embodiments, other forming techniques may be used to form the net filter element 26 from the one or more net materials, for example, by rolling the one or more net materials into a rod-

like filter element or a continuous elongate filter body for further processing into the net filter element 26.

The resultant net filter element 26 may comprise a plurality of randomized aerosol paths or channels. The structure of the net filter element 26 provides for an enhanced filtration effect on the aerosol generated from the upstream tobacco unit 10. In some embodiments, as the aerosol is drawn through the net filter element 26, particulate elements in the aerosol which may give rise to undesirable taste can be filtered or blocked by the randomized aerosol paths or channels therein. At the same time, water vapour molecules with a relatively smaller molecule size are allowed to pass through the net filter element 26. This is different from the currently available cigarette filters, for example acetate tow filters, where the particulate elements in the aerosol can pass through relatively unhindered. Although the net filter element 26 may be arranged to block or filter particulate elements, the net filter element 26 does not filter vapor associated with or containing the tobacco flavour. The net filter 26 therefore provides the additional benefits of reducing the amount of particulate elements in the aerosol. In this manner, the level of harmful substances in the aerosol can be effectively controlled and the mouthfeel of tobacco-flavoured aerosol delivered to the user for inhalation is improved.

Further, the net filter element 26 provides a better aerosol delivery, in particular with a relatively lower pressure drop across the tobacco product 20. While aerosol is directed to flow through the net filter element 26, the net filter element 26 with the randomized aerosol channels also helps redirect or distribute heat from the aerosol across the net filter element 26. More specifically, the randomized aerosol channels can form a multitude of branching paths along which aerosol may travel. Some of the branching paths may connect two ends of the net filter element 26, which allow the aerosol from the upstream tobacco unit 10 to be drawn through the net filter element 26, and towards the mouth-end 22 of the heatable tobacco product 20. Some of the branching paths may terminate inside the net filter element 26 and may not connect to either end of the net filter element 26. These paths act as a heat sink, to transmit and redistribute heat away from the aerosol as it travels through the net filter element 26. The heatable

tobacco product 20, when incorporated with the net filter element 26, may provide for a desirable mouthfeel and improved user experience.

In some embodiments, the net filter element 26 may be shaped and dimensioned as a rod or a tube. In some embodiments, the net filter element 26 may be of a relatively small thickness, and may be a relatively flat/planar structure in the form of a thin layer, a disc, or a thin sheet. For example, the net filter element 26 may comprise one or more layers formed by braiding or weaving a plurality of fibers, thread, ropes, yarns, or filaments. The flat braided or woven net filter is similar to a membrane filter. The braiding or weaving process can be adapted and controlled to produce a net filter element 26 with a desired property. For example, the thickness and mesh density of such braided or woven net filter can be controlled by applying different braiding or weaving patterns and by controlling other parameters of the braiding/weaving process.

In some embodiments, a plurality of the flat braided or woven net filters are used in combination, and can be placed at different locations along the heatable tobacco product 20.

In various embodiments, the one or more filter elements 24 can also be any one of the following types of filter:- a fibrous tow filter, film filter, foil filter, mesh filter, fabric filter, fabric mesh filter, sheet filter, filament filter, spongy filter, laminated filter, wafer filter, honey-comb structure filter, extruded or moulded filter, paper filter, paper yarn filter, and any combinations and derivatives thereof. The different types of filters may comprise one or more filter materials that are sliced or shredded or cut. The sliced or shredded or cut filter materials can be gathered and wrapped to form the filter element 24.

In some embodiments, the one or more filter elements 24 can be made initially from one or more base fibers. The base fibers can be woven, braided, shaped or processed in other ways into the respective filter type. For example, an animal fiber such as silk can be processed into threads, and then woven or braided into a fabric filter or a net material for forming a net filter element 26 as described above.

In some embodiments, the filter type can include at least one of the following: bundled soft tube filter, bundled hollow tube filter, bundled yarn filter, bundled sheet filter or bundled strips filter. As a non-limiting example, a plurality of small stand-alone tubes, yarn, strips or sheets may be aligned along a longitudinal axis, after which they will be sliced or cut or shredded into smaller pieces and then immediately wrapped and sealed to form the cylindrical elongate filter element 24. It is appreciable that the aforementioned tubes can be non-hollow 1-2mm diameter tubes, hollow 1-2mm diameter tubes or a mixture of non-hollow and hollow tubes.

In various embodiments, the one or more materials forming the different types of filter elements 24 are resistant to high temperature, odourless and non-toxic.

In some embodiments, the one or more filter elements 24 may comprise a porous material such as a polymeric, plastics or paper foam.

In various embodiments, the one or more filter elements 24 may be formed from or comprise one or more of the following materials:- natural plant fibers including, but not limited to, cotton, jute, hemp, charcoal fibers such as bamboo charcoal fiber; natural animal fiber such as wool, silk, any other plant or animal fibers, and any carbonized plant fibers, carbonized animal fibers,; synthetic fibers including, but not limited to, nylon and Vectran™; fabric materials including, but not limited to, woven or non-woven fabric/cloth; plastic materials including, but not limited to, polylactic acid (PLA), polyethylene (PE), polyethylene terephthalate (PET), polyethylene ether ketones (PEEK), polypropylene (PP), polytetrafluoroethylene (PTFE) such as Teflon™, polyvinylchloride (PVC), cellulose acetate (CA), other starch based polymers, liquid crystal polymer material (LCP), and all other suitable plastic materials and plastic derivatives; resin materials including, but not limited to, polyimide, polyacrylonitrile (PAN), polysiloxanes such as silicone, in the form of silicone oil, silicone grease, silicone rubber, silicone resin or silicone caulk, silicone as coating, laminate or mixed with other materials in this list; and other polymer resins, natural or synthetic rubber and its derivatives; paper, cork and other similar materials;

and/or any combinations thereof. It is appreciable that the filter elements 24 can be formed from any suitable materials, not limiting to the materials listed herein. In various embodiments, the one or more filter elements 24 can be formed from any suitable materials that can withstand temperatures of up to 180°C and above without considerable deformation or degradation.

In various embodiments, the filter elements 24 further comprise a secondary filter material in any suitable form including, but not limited to, crushed or powder form, granule or pellet form, filament form, strip form, fibers or hardened fibers of any shape, yarns, braided ropes, and flakes. In some embodiments, a quantity of the secondary filter material in the form of granules or pellets may be encased in a specifically made container which is formed from or composed of one or more fibrous or porous materials and shaped into a granule-filled filter 28. A non-limiting example of the granule-filled filter 28 is shown in Figure 3O. The fibrous or porous encasing materials can be of the same material types as the filter elements 24.

The secondary filter material may be formed from any of the following materials:- plastic materials including, but not limited to, polylactic acid (PLA), polyethylene (PE), polyethylene terephthalate (PET), polyethylene ether ketones (PEEK), polypropylene (PP), polytetrafluoroethylene (PTFE) such as Teflon™, polyvinylchloride (PVC), cellulose acetate (CA), other starch based polymers, liquid crystal polymer material (LCP), polyacrylonitrile (PAN), polysiloxanes such as silicone, in the form of silicone oil, silicone grease, silicone rubber, silicone resin or silicone caulk, silicone as coating, laminate or mixed with other materials in this list, and all other suitable plastic materials and plastic derivatives; carbon, graphene, fiberglass; any combinations or derivatives thereof. It is appreciable that the filter elements 24 may comprise any suitable secondary filter materials, not limiting to the materials listed herein. In various embodiments, the secondary filter materials can be any suitable materials that can withstand temperatures of up to 180°C and above without considerable deformation or degradation.

In use, the tobacco-flavoured aerosol generated from the tobacco unit 10 upon being heated by the heating device 40 is drawn through the one or more filter elements 24. The one or more filter elements 24 are configured to facilitate the flow of the aerosol from the tobacco unit at the first end 21 through the tobacco heatable product 20, and ultimately to a second end 22 of the heatable tobacco product to be inhaled by the user. The second end 22, which is at the extreme downstream of the heatable tobacco product 20 and which, in use, is held to the mouth of a user, is also referred to as a mouth end 22. While passing through the one or more filter elements 24, any volatile and harmful substances (for example, specific constituents of the particulate phase including tar particles and tobacco dusts) within the aerosol stream may be reduced or removed through various filtration mechanisms such as adsorption and absorption.

In some embodiments, the one or more filter elements 24 may further comprise one or more additive materials capable of altering the volatile or semi-volatile constituents in the aerosol stream through chemical reaction.

In various embodiments, the filter element 24 can be an acetate tow filter comprising a bundle of acetate short fibers, the acetate tow filter may be used in a conventional cigarette. In various embodiments the filter element 24 can be other types of filters specially designed for heatable tobacco product 20. In some embodiments, the filter element 24 may be made of a charcoal material or may include certain amount of carbon compound. The carbon compound may be an active carbon component which can include a highly porous structure to provide for improved filtration efficiency.

In some embodiments, the filter element 24 comprises cellulose acetate (CA). The filter element 24 may be any type of filter (e.g. a yarn filter, a net filter, a tow filter, a disc filter and other filters as described above) formed from cellulose acetate (CA), or may comprise cellulose acetate (CA) as a secondary filter material. Non-limiting examples of filter element 24 comprising cellulose acetate (CA) are shown in Figure 5. The filter element 24 may comprise cellulose acetate (CA) in any suitable form including, but not limited to, flakes, granules, blocks, fibers, slices, sliced sheet material of any cut pattern (such as S-cut or wavy cut), ropes or bundles of ropes,

tubes of concentric circles, and tubes of various concentric shapes. Cellulose acetate (CA), which is derived primarily from purified wood pulp, can provide the benefits of being bio-degradable and being more environmentally friendly. It is appreciable that other suitable biodegradable synthetic plastic materials may also be used in the filter elements 24, for example in the filter elements 24 as shown in Figure 5.

In some embodiments, the filter element 24 comprises one or more internal aerosol channels or an internal profile which allows the aerosol to flow through the one or more filter elements 24 at a desired rate as the user draws on the mouth end 22 of the heatable tobacco product 20. In other words, the internal profile of the filter element 24 provides the benefit of facilitating the aerosol flow across the heatable tobacco product 20, and enhances the user experience. The filter element 24 with such an internal profile is also referred to as a channelled filter 27.

In some embodiments, the channelled filter 27 comprises a plurality of elongated segments, wherein at least one of the plurality of the elongated segments is configured to form an internal aerosol channel. In some embodiments, the plurality of elongated segments with at least one internal aerosol channel may be arranged to co-extend along the longitudinal axis of the channelled filter 27. Two non-limiting examples of the channelled filter 27 are illustrated in Figure 3L and 3M. As shown in Figure 3L, the channelled filter 27 is provided in the form of a hollow tube, comprising an internal aerosol channel extending along the longitudinal axis of the heatable tobacco product 20. As shown in Figure 3M, the channelled filter 27 comprises four elongated segments A, B, C and D, aligned with each other along the longitudinal axis of the heatable tobacco product 20. One or more of the four elongated segments A, B, C and D may comprise a hollow structure so as to form an internal aerosol channel for facilitating aerosol flow, and the other elongated segments may be formed from one or more suitable filter materials for providing the filtration functionality. The aerosol is drawn through the internal aerosol channel with a relatively lower resistance and correspondingly a relatively higher rate, as compared with a conventional filter without any internal aerosol channels, for example, a mono-filter. While the aerosol passes through the aerosol channels within the filter element 27, the physical and/or

chemical properties, for example, moisture content, nicotine level, phenol level in the aerosol, may be altered by the filter materials and by other active components of the filter element 27.

It is appreciable that the channelled filter 27 may be arranged in any suitable configurations and may comprise one or more channels of any suitable dimension, which may be calibrated or adjusted according to the desired aerosol flow rate in different product configurations. For example, the channelled filter 27 may comprise one or more internal aerosol channels spiralling around and extending substantially along the longitudinal axis of the heatable tobacco product, providing a longer pathway for the aerosol flow through the filter element 27 and thus achieving an enhanced filtration effect. The internal aerosol channel of the channelled filter 27 can be of any suitable geometric shape. As shown in Figure 3G, the channelled filter 27 placed at the mouth end 22 may comprise an internal channel in a circular shape, a rectangular shape, a triangular shape or a pentagram shape.

The channelled filter 27 may be formed using any suitable process, including but not limited to, injection moulding tube formation, extrusion tube formation, extrusion netting, knitted netting, mesh netting, gathered fibers with perforation, gathered fully strip cut or perforated cut, and/or any other extrusion form in axial direction.

In some embodiments, the filter element 24 may comprise about 25% of the total length of the heatable tobacco product 20.

In some embodiments, such as that shown in Figures 3B and Figures 3K to 3N, a net filter element 26 or a channelled filter 27 may replace a conventional tow filter. It is appreciable that one or more filter elements 24 of different types may be used in combination to supplement each other. For example, the net filter 26 and/or the channelled filter 27 may be used to in combination to supplement a conventional tow filter 24 as illustrated in Figure 3K.

It is appreciable that the filter element 24 of different types and configurations as described may also be modified for use in a traditional cigarette product. For example, the net filter element 26 with a relatively lower mesh density and correspondingly a relatively lower draw resistance may be produced from the same filter forming process as herein described. Such net filter element 26 may be more suitable for use in a traditional cigarette which requires a relatively lower draw resistance in the cigarette rod as compared to heatable tobacco product to facilitate burning or combustion of the tobacco material. Further, filter materials which can withstand a relatively higher temperature without degradation or deformation may be more suitable for forming filter elements which are intended to be used in the traditional cigarette products.

In various embodiments with reference to Figure 3B to 3I, the heatable tobacco product 20 further comprises one or more tubular support elements 30 located downstream of the tobacco unit 10. The tubular support element 30 may comprise at least one tube extrusion product with profile, which may be formed from injection moulding tube formation, extrusion tube formation, extrusion netting, knitted netting, mesh netting, gathered fibers with perforation, gathered fully strip cut or perforated cut, and/or any other extrusion form in axial direction.

Advantageously, the tubular support materials provides additional structural support for the heatable tobacco product 20. In some embodiments, the one or more tubular element 30 may be provided between the tobacco unit 10 and the filter between the tobacco unit 10 and one of the filter elements 24, and/or at the mouth end 22 of the heatable tobacco product 20, according to different product designs. The tubular support elements 30 may be formed from acetate with different bore diameter.

In various embodiments as shown in Figure 3, the tubular support element 30 may be formed from acetate with different bore dimeters. In some embodiments, the support element 30 can be an acetate or plastic tube 32 with a length of between 10mm to 20mm and a bore of about 2mm to 5mm in diameter. This acetate or plastic tube 32, also referred to as an inner tube 32, is placed at the immediate downstream of the tobacco unit 10, of which the primary function is to resist movement of downstream

elements when attaching the heatable tobacco product 20 to a coupled heating device. In use, it is also arranged to channel the aerosol stream generated from the tobacco unit 10 to the downstream elements including the filter elements 24 for modifying the aerosol stream to be more suitable for user inhalation.

In some embodiments as shown in Figure 3, a second acetate or plastic tube 34 with a length of about 5mm to 10mm and a bore of about 2mm to 5mm in diameter can be provided at the mouth end 22, that is, at the extreme downstream of the heatable tobacco product 20. The second acetate or plastic tube 34 can also be referred to as an outer tube 34. In addition to providing structural support, the second acetate or plastic tube 34 at the mouth-end 22 also acts as an aerosol outlet through which the tobacco-flavoured aerosol could be drawn out from the heatable tobacco stick 20 and inhaled by the user. Compared with the embodiments of Figures 3A to 3C, the various embodiments of Figures 3D comprises a second acetate or plastic tube 34 at the mouth end 22 and a correspondingly shorter mouth-end filter. Less amount of efforts are required from a user to draw out the aerosol from the heatable tobacco stick, because the overall drawing resistance of the heatable tobacco product 20 is reduced. In some embodiments, the length of the plastic tube 34 may be more than 10mm.

In the embodiments shown in Figures 3A to 3I, the tubular support elements 30, 32, 34 may be used in the various product configurations formed by extrusion, for example, may be used to improve the delivery of aerosol generated and/or improve the aesthetic look of the tobacco product 20.

The one or more tubular support elements 32, 34, 30 may aid in providing structural support. The one or more tubular elements 32, 34, 30 may be provided between the filter element 24 and the tobacco element 10, between two filter elements 24; and/or be positioned at the mouth end 22 of the heatable tobacco product 20, according to different product designs. In some embodiments, the one or more plastic tubular elements 30 may form one or more of the filter elements 24 or integrated with a filter element 24 to form one single component. For example, the tubular support element 30 of Figure 3B and the channelled filter 27 of Figure 3L and 3M may be adapted to

function both as an element for providing structural support and for filtering/modifying the aerosol to be suitable for inhalation.

In some embodiments, the tubular support element 30 may comprise one or more filter elements 24 placed inside the hollow portion of the tubular support element 30. The one or more filter elements 24 may be any type of filter made of any suitable natural or synthetic filter materials (e.g. a net filter, a charcoal-loaded filter, a tow filter or other types of filter as described above). The one or more filter elements 24 may be placed at any part of the hollow portion of the tubular support element 30. For example, as shown in Figure 6, the heatable tobacco product 20 comprises a tobacco unit 10 and a tubular support element 30 with a filter element 24 which may be placed near the tobacco unit 10, in the middle of the tubular support element 30 or near the mouth-end 22. The tubular support element 30 containing one or more filter elements 24 in the hollow portion is also referred to as a hybrid support-filter element. This hybrid support-filter element advantageously combines functionality of the tubular support element 30 and the filter element 24 in one single unit, and may provide additional benefits. Firstly, the pressure drop or resistance across the filter element 24 (or the tubular element 30 containing the filter element 24) is relatively low, because only part of the hollow portion of the tubular support element 30 is filled or occupied by the filter element 24. Also, as the aerosol generated from the tobacco unit 10 is directed to pass through the filter element 24 inside the tubular support element 24, the same or a comparable filtration effect can be achieved in this hybrid support-filter element despite less filter material used. It is appreciable that a lower manufacturing cost for the heatable tobacco product 24 may be achieved because of the reduced material costs. Further, no or minimal machine modification is required for combining the tubular support element 30 with the filter element 24.

In various embodiments, the tubular support elements 30, 32, 34 may be formed from one or more of the following materials:- metallic materials including, but not limited to, aluminium and copper which may be coated or uncoated, and may be provided in the form thin foils, or in various porous configurations; natural plant fibers including, but not limited to, cotton, jute, hemp, carbonized plant fiber such as bamboo charcoal

fiber, natural animal fiber such as wool, silk, any carbonized animal fibers, and charcoal fiber, synthetic fibers including, but not limited to, nylon and Vectran™; fabric materials including, but not limited to, woven cloth; plastic materials including, but not limited to, polylactic acid (PLA), polyethylene (PE), polyethylene terephthalate (PET), Polyethylene ether ketones (PEEK), polypropylene (PP), Polytetrafluoroethylene (PTFE) such as Teflon™, polyvinylchloride (PVC), cellulose acetate (CA), other starch based polymers, liquid crystal polymer material (LCP), and all other plastic materials and derivatives; resin materials including, but not limited to, polyimide, polyacrylonitrile (PAN), polysiloxanes such as silicone, in the form of silicone oil, silicone grease, silicone rubber, silicone resin or silicone caulk, silicone as coating, laminate or mixed with other materials in this list; and other polymer resins, natural or synthetic rubber and its derivatives; paper, cork and other similar materials; any combinations thereof. It is appreciable that the tubular support elements 30, 32, 34 can be formed from any suitable materials, not limiting to the materials listed herein. In various embodiments, the tubular support elements 24 can be formed from any suitable materials that can withstand temperatures of 180°C and above without considerable deformation or degradation.

In some embodiments, the filter element 24 and the tubular support element 30 may be made from a biodegradable polymeric material, for example, PAC or pro-oxidant additive containing plastic material. This provides for the heatable tobacco product 20 to decompose more easily after being disposed of, and thus provides a relatively environmentally friendly solution. In addition, some biodegradable materials may also remove or reduce hazardous substance in the aerosol stream.

In some embodiments, the one or more filter elements 24 and the tubular support element 30 may comprise one or more sliced or cut materials. The sliced or cut material may be in any suitable form including, but not limited to, slices of I-shape or straight cut, H-shape, N shape, Z-shape or zig-zag, s-shape, curves or waves, arc shape or any non-linear and non-symmetrical, or any random cuts, as shown in Figure 5. The sliced or cut material can be formed using any suitable cutting process, for example, using a die cut process. The sliced or cut materials may be folded or

processed in other way to provide a corrugated surface texture. The sliced or cut materials can be rolled up with wrinkled paper to form the filter element 24. The sliced or cut materials can also be formed into sheets, then rolled up to form multiple tubular elements or braided into multiple ropes, which are bundled together and wrapped to form into the filter element 24 or into the tubular support element 30.

In some embodiments, the one or more filter elements 24 and the tubular support element 30 may be formed from a sliced or cut paper material in any suitable form including, but not limited to, paper slices rolled up with wrinkled paper, bundles of small-diameter rolled paper, folded paper, die cut paper filter, paper string or paper rope. In some embodiments, the paper filter comprises paper slices and/or paper sheets wherein the individual slices can be of any shape i.e. a I-shape or straight cut, an H-shape, an N-shape or Z-shape or zig-zag an S-shape or curves, arcs or any non-linear and non-symmetrical shape or cut like a wave type as described above.

Advantageously, the one or more filter elements 24 and the tubular support element 30 formed by the sliced or cut material and more specifically sliced or cut paper material are light in weight. When used in the filter element 24, the sliced or cut material provides an improved filtration effect because the aerosol paths or channels within the filter element 24 are randomized due to the random cutting shapes of the individual slices and the surface textures of the sliced materials.

Advantageously, the tobacco unit 10 containing the embedded heat-transmitting fibers 15 or heat-transmitting layers 17 as provided in this disclosure allow more design flexibility of the heatable tobacco product 20. This is because the tobacco unit 10 is superior in both thermal conductivity and in mechanical properties over prior art solutions. Due to the enhanced mechanical properties, the tobacco unit 10 is less susceptible to disintegration or movement or distortion during manufacturing processes, and during handling by the users, especially during the process when the heatable tobacco stick is being attached or inserted onto the heating device. Further, a more robust tobacco unit 10 may eliminate the need of or lessen the reliance on using the tubular support element 30 for providing structural support to the heat stick. This

may simplify the heatable tobacco stick design and may also allow more space to accommodate tobacco material 12 or other components. Design flexibility is improved, manufacturing of the heatable tobacco product 20 may be done in an easier and more efficient manner and potentially at a lower cost.

In addition, the enhanced thermal properties of the tobacco unit 10 effected by the embedded heat-transmitting fibers 15 may remove or at least reduce the complexity of the heat generating and temperature control system of the heating device 40. The heat-transmitting paths formed by the thermally conductive fibers or thin layers allows the tobacco unit 10 to be heated more homogeneously, with less regard to the placement of the heating elements. More specifically, although certain parts of the tobacco unit 10 may receive heat from a heat source, the received heat may be transmitted and evenly distributed within the tobacco unit 10 via the heat-transmitting paths. As such, the placement or position of heating elements, when used with the heatable tobacco product 20 according to the present disclosure, may be less restricted or carries less significance on the heat distribution within the tobacco unit 10. Further, due to the improved heat-transmitting properties of the tobacco unit 10, the heatable tobacco product 20 of the present application may be heated at a relatively lower temperature to produce a tobacco-flavoured aerosol at a comparable aerosol generation rate compared to the existing heat-not-burn systems. Volatile and moisture content in the aerosol generated from the tobacco unit 10 may further be reduced. The temperature of the generated aerosol is also lowered, which reduces the reliance on using a specifically designed cooling segment in the heatable tobacco product.

In various embodiments, the tobacco unit 10, the one or more filter elements 24, and other elements such as the tubular support elements 30, 32, 34 may be circumscribed with one or more overwraps 33.

In some embodiments, the overwrap 33 may be formed from natural plant or animal fibers, formed into a single sheet by being woven into fabric or cloth or other technique. Natural fibers include, but not limited to, plant or carbonized plant fibers such as bamboo, jute, hemp, bamboo charcoal fibers and other charcoal fibers; animal

or carbonized animal fibers such as wool, silk; and any other plant or animal fiber carbonized or non-carbonized; and/or combinations thereof. The overwrap 33 may also be formed from or comprise of combinations of natural plant or animal fibers, formed into sheets by being woven or braided into fabric or cloth or other technique and laminated or pressed onto one or more sheets of natural plant or animal material or it can be any other material that can withstand temperatures of up to 180°C and above without considerable deformation or degradation.

In some embodiments, the overwrap 33 may be formed from a single sheet of plastic fiber or synthetic fiber woven or braided into or made into a sheet. The plastic materials can include but are not limited to such plastics as nylon and Vectran™, polyethylene (PE), polyethylene terephthalate (PET), polyethylene ether ketones (PEEK), polypropylene (PP), polytetrafluoroethylene (PTFE) such as Teflon™, polyvinylchloride (PVC), cellulose acetate (CA), other starch based polymers, liquid crystal polymer material (LCP) such as Vectra™ and Vectran™, polyacrylonitrile (PAN); polysiloxanes such as silicone, in the form of silicone oil, silicone grease, silicone rubber, silicone resin or silicone caulk, silicone as coating, laminate or mixed with other materials in this list; any other non-stick and/or non-toxic plastic types and derivatives. The overwrap 33 may also be formed from sheets of plastic fiber or synthetic fiber woven or braided into or made into a sheet and laminated or pressed onto one or more plastic fiber or synthetic plastic fiber sheet. The overwrap can be of any material that can withstand up to 180°C and above without significant deformation.

In some embodiments, the overwrap 33 may be formed from any one of the following:- natural plant fibers; natural animal fibers; carbonized plant fibers, carbonized animal fibers; synthetic polymer fibers; natural resin material; synthetic polymer resin; any combinations or derivatives thereof.

In some embodiments, the overwrap 33 may be formed from any one of the following:- cotton; jute; hemp; bamboo fibers; bamboo charcoal fibers; wool; silk; nylon; polyester fibers; polyimide fibers; polyethylene (PE); polyethylene

terephthalate (PET); polyethylene ether ketones (PEEK); polypropylene (PP); polytetrafluoroethylene (PTFE); polyvinylchloride (PVC), cellulose acetate (CA), starch based polymers, liquid crystal polymer material (LCP); polyacrylonitrile (PAN); polysiloxanes such as silicone, in the form of silicone oil, silicone grease, silicone rubber, silicone resin or silicone caulk, silicone as coating, laminate or mixed with other materials in this list; natural or synthetic rubber, cork, carbon, graphene, paper, paper yarn, paper net, woven and non-woven fabric materials made of one or more of the above materials, any combinations or derivatives thereof.

In some embodiments, the overwrap 33 may also be a combination of two or more of natural (plant or animal) material sheets and plastic material sheets, laminated or pressed onto one or more of each said material (natural or plastic). The materials for each would be the same as above or any other material that can withstand up to 180°C and above without significant deformation.

In other embodiments, the overwrap 33 may be a metallic sheet made of aluminium, copper or other metallic foils. The overwrap can also be a metal sheet laminated or pressed onto another metal sheet of the same material, another metallic material or can be any material able to withstand up to 180°C and above without significant deformation.

In other embodiments, the overwrap 33 may be a metallic sheet combined, laminated or pressed onto same natural or plastic materials stated previously or any material that can withstand up to 180°C and above without significant deformation.

In various embodiments, the one or more overwraps 33 may comprise one or more thin layers of suitable wrapping materials as described above, which provide for sufficient stiffness to facilitate the handling of the heatable tobacco product.

In various embodiments, the one or more overwraps 33 may be provided with one or more heat insulating layers or coatings 35. The heat insulating layer 35 may be formed using any suitable processes, for example, spraying, coating, laminating, or

any other thin-film application technologies, and that it may be applied before or after the application of any one or more layers of the wrapping materials. For example, a heat insulation food grade glue or other high temperature resistant films may be applied onto or attached onto any layer of wrapping material of the overwrap 33. Alternatively, the heat insulating layer 35 may form an innermost layer of the overwrap 33. For example, the heat insulation food grade glue or other high temperature resistant films may be applied onto or attached onto the surface of the various components of the heatable tobacco product 20, before applying the one or more layers of wrapping materials.

In various embodiments, the heat insulating layer 35 can be any material that can resist or withstand heat of at least 180°C and above during the operation of the heating device. Accordingly, the heatable tobacco product is advantageous in that heat transmitted to the outermost layer or the overwrap 33 of the heatable tobacco product 20 can be mitigated to prevent the hot feeling on the end user's hands and/or lips. User experience is improved. Further, the application of the heat insulating layer 35 of the overwrap 33 also minimize or reduce heat loss from the tobacco unit 10, saving electrical power for heating the tobacco unit 10.

In various embodiments, the length of the tobacco unit 10 of the heatable tobacco product 20 may be between about 10 mm and about 21 mm.

In various embodiments, the total length of the heatable tobacco product 20 may be between about 40 mm and about 53 mm.

In various embodiments, the heatable tobacco product 20 in a rod-like shape may have an average diameter of about 7.1mm without the overwrap 33, or an average diameter of about 7.2mm with the overwraps 33. In various embodiment, the different components including the tobacco unit 10, the filter element 24 and the tubular support element 30 have the same or a similar external diameter.

In some embodiments, the heatable tobacco product 20 is adapted to be removably coupled to the heating device 40. In use, the heatable tobacco product 20 is attached to the heating device 40 by the user. The user later removes the heatable tobacco product 20 from the heating device 40 after the tobacco is consumed. In some embodiments, the heating device 40 provides a recess or a cavity 57 for accommodating the heatable tobacco product 20. In some embodiments, one or more heating elements 48 of the heating device 40 are disposed in a configuration that receives, via insertion or other methods, the tobacco unit 10 of the heatable tobacco product 20. This heating device 40 can be a non-disposable type, which can be recharged and reused for multiple times.

In some embodiments, the heatable tobacco product 20 is integrally attached to the heating device 40. The one or more heating elements 48 of the heating device 40 are arranged to be in thermal contact with tobacco unit 10 of the heatable tobacco product 20. The heatable tobacco product 20 with the integrally attached heating device 40 is disposed of together after use, which provides a one-time use disposable type heatable tobacco product 20. The disposable type heatable tobacco product 20 can be manufactured at a relatively low cost and may be desirable for some users, for example travellers, who may find it inconvenient to carry a separate tobacco heating device 40 with them. In some embodiments, an exposing end of the tobacco unit 10 may be enclosed by the coupled tobacco heating device. Advantageously, the tobacco material 12 inside the tobacco unit 10 may be completely contained within the heatable tobacco product 20. Further, as the repetitive insertion and retraction of heating elements 48 can be avoided for such disposable type heatable tobacco product 20, there may be little or no risk of having any loose piece of the tobacco material 12 falling apart or out of the tobacco unit 10.

In accordance to another aspect of the disclosure, there is provided a heating device 40 to be used with the heatable tobacco product 20, as shown in Figure 6, Figure 7 and Figure 13. It is appreciable that references to the heating device 40 described herein can include a reusable (non-disposable) heating device, a disposable (one-time use) heating device, or any other variants such as 2-time use, 3-time use etc. In the

embodiments where the heating device 40 is disposable, the heating device 40 may be integrally attached to the heatable tobacco product.

The heating device 40 comprises one or more heating elements 48, and an electronic control unit 49 for controlling the operation of the heating device 40. The heating element 48 is arranged to generate and transmit heat to the heatable tobacco product 20 coupled to the heating device 40. The electronic control unit 49 in electrical connection with the one or more heating elements 48 for controlling the operation of the heating device 40. The device is particularly suitable for use with the heatable tobacco product 20 of the present disclosure.

In some embodiments, the heating device 40 comprises a switch 46, which is arranged to selectively activate the heating device 40. In some embodiments, the heating device 40 comprises a power source unit 45 for supplying electrical power to the electronic components of the heating device 40.

In some embodiments, the power source unit 45 is a battery module 50 comprising one or more batteries of a suitable size and with a suitable terminal voltage. The battery module 50 is placed inside the heating device 40, and is adapted to be electrically connected to the one or more heating elements 48, the electronic control unit 49 and to the switch 46.

In some embodiments, the switch 46 includes a mechanical switch with mechanical lever for selectively connecting to and disconnecting from the electrical terminals of the power source unit 45 or the battery module 50.

In the embodiment illustrated in Figure 5, the switch 46 includes an insulating sheet 53 placed between two electrical contacts 52 of the power source unit 45, such that the power source unit 45 is being put in an open electric circuit and no electrical power is supplied to the electrical components of the heating device. In other words, the heating device 40 is in a default no-power state. In use, a user removes the insulating sheet 53 to power on the heating device 40. After removing the insulation

barrier between the two electrical contacts 52, a closed electric circuit is formed where the power source unit 45 operates to energize the heating element 48.

In various embodiments, the one or more heating elements 48 are operable to generate and dissipate heat when electric current flow through it. In other words, the electrical energy passing through the heating element 48 is converted into heat, which it radiates out to its vicinity or to a subject placed adjacent to it.

In various embodiments, the heating elements 48 of the heating device 40 can be formed from any suitable material which has a high melting point, is resistant to oxidization (even at high temperatures), resistant to expansion when heated, and has a reasonable constant electrical resistance. Suitable materials for forming the heating elements 48 comprise one or more of the following:-metallic materials including, but not limited to titanium, zirconium, tantalum and metals from the platinum group, suitable metal alloys, for example, stainless steel, nickel-, cobalt-, chromium-, aluminium- titanium- zirconium-, hafnium-, niobium-, molybdenum-, tantalum-, tungsten-, tin-, gallium-, manganese-, gold- and iron-containing alloys; ceramic materials, including, but not limited to doped ceramics, for example, doped silicon carbides, electrically conductive ceramics, for example, molybdenum disilicide; composite materials made of at least one ceramic material and at least one metallic material; carbon; graphite; high-temperature resistant plastic materials; and any combinations thereof.

In various embodiments, the heating element 48 can be in any suitable form, for example, a needle, a blade (planar or curved or profiled), a plate, a coil, a ribbon (straight or corrugated), and a strip of wire. Non-limiting examples of the heating element 48 are illustrated in Figure 5 to 12 respectively.

According to one embodiment as shown in Figure 4 and 5, the heating element 48 may be provided in a needle-like shape extending from a casing of the heating device. In use, the heating element 48 is disposed within or is penetrated into the tobacco unit 10 of the heatable tobacco product 20. Tobacco-flavoured aerosol is generated from

the tobacco material 12 of the heatable tobacco product 20 upon receiving heat from the heating element. Simultaneously, heat from the heating element 48 is distributed across the tobacco unit 10 by the embedded heat-transmitting material so that the tobacco material 12 within the tobacco unit 10 can be heated evenly.

In some embodiments, the heating element 48 may comprise one or more surfaces in contact with the tobacco material when disposed inside the tobacco unit 10. Non-limiting examples of the heating elements 48 are illustrated in Figure 9 to 13, whereby the heating elements 48 are configured in various shapes comprising one or more flat or curved surfaces. The heating elements 48 extend from a casing of the heating device 45 and are disposed inside the tobacco unit 10 when the heatable tobacco product 20 is mounted onto the heating device 45. As compared with the needle-like heating element of Figure 7A, 7B and Figure 8, the heating elements 48 as shown in Figure 9 to 13 have a relatively larger surface area. Advantageously, the contact area between the heating element 48 and the tobacco unit 10 of the heatable tobacco product 20, and thus the heating efficiency, is increased. This heating element arrangement also allows design flexibility, whereby the contact area between the heating element 48 and the tobacco unit 10 can be varied in different heating element configurations so as to achieve a desirable heating profile of the tobacco unit 10.

In some embodiments, the heating element 48 may comprise one or more flat surfaces. From a top view, the heating element 48 formed from the flat surfaces can be of a square or diamond shape, an L or V-shape, a W or M or 3 or E-shape, or an N or Z-shape as shown in Figure 8, an cross shape (such as X or "+" shape), an asterisk or star shape with a defined number of planes or points (e.g. with three to twenty-four planes or points) as shown in Figure 9. In some embodiments, the heating element 48 may comprise curved surfaces, which can be of any curvature or of any arc shape, for example, an S-shape, U or crescent or C-shape as shown in Figure 10.

In some embodiments, the heating element 48 may further comprise at least one hollow portion. From a top view, the at least one hollow portion can be of various shapes, such as a rectangular shape, a circular shape, or a pie shape, as shown in

Figure 11. The contact area between the tobacco unit 10 and the heating element 48 may be increased further as a result of the inclusion of the hollow portion in the heating element 48.

According to another embodiment as shown in Figure 12, the heating element 48 can also have one or more cut surfaces at an angle that modifies the shape of the heating element 48 to have one or more protruding tip portions. The one or more cut surfaces can comprise one or more planar cut surfaces and/or one or more curved cut surfaces of any curvature or arc shape. Advantageously, the heating element with the one or more protruding tip portions may facilitate insertion of the heating element 48 into the tobacco unit 10 of the heatable tobacco product 20.

In some embodiments, the heating element 48 can be disposed adjacent the tobacco unit 10 and can be arranged to be in contact with an exterior part of the tobacco unit 10 for transmitting heat to the tobacco unit 10. For example, according to the embodiment as shown in Figure 6, the heating element 48 may be shaped and dimensioned as a plate having a planar surface and is arranged to be in thermal contact or in thermal proximity with the tobacco unit at the first end 21 of the heatable tobacco product 20. For example, the plate-like heating element 48 can be placed adjacent and in contact with the exposed end of the tobacco unit 10, whereby the embedded heat-transmitting material of the tobacco unit 10 may be specifically arranged or oriented to allow heat to be transmitted from the exposed end of the tobacco unit 10 to the opposite end, so as to achieve a homogenous heat distribution within the tobacco unit 10.

The different shapes and configurations of the heating element 48 described above are non-limiting examples. It is appreciable that the heating element 48 may be in any suitable three-dimensional shapes, or comprise a combination of different three-dimensional shapes, and may be arranged in any suitable configurations. The heating device 40 may comprise one or more heating elements 48 placed at different locations with respect to the tobacco unit 10, such that the tobacco unit 10 can be heated according to a desirable heating profile and also in a relatively more efficient manner.

For example, the heating device 40 may comprise one needle-like heating element as shown in Figure 4 and one plate-like heating element as shown in Figure 14, and may further comprise one or more other heating elements in other suitable configurations.

In various embodiments, operation of the heating device 40 and the operating temperature of the heating element 48 may be digitally controlled by the electronic control unit 49. The electronic control unit 49 may be a temperature control printed circuit board or other types of temperature controllers. The operating temperature of the heating element 48 during the operation of the heating device 40 is referred to as a heating profile of the heating device 20. In various embodiments, one or more heating profiles of the heating device 20 corresponding to one or more operational modes of the heating device 20 may be pre-programed in the electronic control unit 49. The electronic control unit 49 may be further configured to put the heating device 20 in different operational modes, according to a pre-programmed temperature control algorithm and/or according to instructions received from a user, for example, via a control panel of the heating device 40.

In use, once the heating device 40 is powered on or activated by the user, the heating device 40 may first energize and increase the temperature of the heating element 48 from an initial temperature, which may be near room temperature, to a set (or predetermined) heating temperature. In various embodiments, the heating device 40 has a set temperature to achieve from a range of 280 to 400°C. This is applicable for both the disposable and non-disposable type heating device 40.

In some embodiments, the heating element 40 may be configured to supply heat to the tobacco unit 10 at a constant heating temperature, under a constant power supply mode of the heating device 40. For example, as depicted in Figure 16A, the heating element 40 is controlled to be heated up towards a set temperature ranging from 280 to 400°C and to maintain at the set temperature. This heating profile of the heating device 40 provides for the thermal energy to be transferred from the heating element 48 to the tobacco unit 10 at a constant rate, and thus allows aerosol to be generated

from the tobacco unit 10 throughout the usage duration. This is applicable for both the disposable and non-disposable type heating device 40.

In some embodiments, the heating element 40 may be controlled to supply heat to the tobacco unit 10 at a first heating temperature during a first heating period and at a second heating temperature during a second heating period, whereby the heating element 48 is controlled to repeat the first and second heating periods in an alternating sequence during the operation of the heating device 40. This heating profile with multiple heating cycles comprising the first and second heating periods may correspond to or used in a power-saving operational mode of the heating device 40. In some embodiments, the power source unit 45 may be set by the electronic control unit 49 to energize the heating element 48 at a pre-determined timer interval for multiple heating cycles. This is applicable for both the disposable and non-disposable heating device 40.

One non-limiting example of a heating profile of the heating device 40 under the power-saving mode is depicted in Figure 16B. The heating element 48 is controlled to operate at the set temperature during a first heating period (a), followed by a power-saving or a second heating period (b) wherein the operating temperature of the heating element is shown to move towards a lower temperature which is lower than the set temperature by 20-90%. The same heating cycle comprising the first and second heating periods (a, b, a', b'...) is then repeated until the smoking experience ends. This can be applicable for both the disposable and non-disposable heating device 40.

In some embodiments, the heating device 40 may be configured to detect a user taking a puff on the mouth end 22 of the heatable tobacco product 20, and to control the operation of the heating element 40 according to whether a puff is detected. In other words, the first heating period (a, a') and the second heating period (b, b') may be automatically triggered by detecting whether a puff is introduced into the system by the user. The heating device 40 may be configured to turn on the electrical power of the heating element 48 when a puff is detected, and to heat the tobacco unit up to and at the first heating temperature during the first heating period (a, a'...). An aerosol

stream is generated from the tobacco unit 10 and channelled to the mouth end 22 for user inhalation. This is applicable for both the disposable and non-disposable type heating device 40.

As heating device 40 detects that the puff has ended or no puff is introduced into the system, the heating element 48 is put into a power-off mode to save electrical power. Depending on the material and the configuration of the heating element 48 in different heating device designs and depending on the inter-puff durations of different users, the temperature of the heating element 48 can decrease from the set temperature by 20% to 90% during the power-saving periods (b, b'...). As a result, the tobacco unit 10 also cools down to a lower temperature. In various embodiments, the temperature of the tobacco unit 10 may decrease by 40% - 90% during the power-saving periods (b, b'...), as compared with the temperature of the tobacco unit during the period when it is heated at the set temperature (a, a'...). The power-saving heating profile is applicable for both the disposable and non-disposable type heat device 40.

Heating the tobacco unit 10 with alternating heating cycles or alternating power on-off cycles can be advantageous because the overall power consumption of the heating device 40 during the usage period is reduced, as compared with the constant power supply operational mode. The system is further advantageous in that the decrease in temperature of the tobacco unit 10 during the power-off period or the second heating cycles (b, b') is minimized because heat-transmitting fibers or foils within the tobacco unit 10 may absorb heat during the first heating cycles or the power-on cycles (a, a'...). Part of the absorbed heat is retained by the heat-transmitting material which slows down the temperature drop within the tobacco unit 10 during the second heating periods or the power-saving periods (b, b'...). Accordingly, the temperature profile of the tobacco unit 10 can be optimized in that:- at the initial 'ramp-up' stage, the heat-transmitting material allows the tobacco unit to be heated to the set heating temperature in a relatively short time period; during the power on cycles (a, a'...), the tobacco unit 10 can be homogenously heated at the set heating temperature; and during the power-off cycles (b, b'...), the embedded heat-transmitting materials in the tobacco unit 10 prevents a drastic temperature drop to occur in the tobacco unit which

will leads to a disrupted aerosol-generating process. A temperature curve of the tobacco unit 10 according to one embodiment is depicted in Figure 17, showing that the tobacco unit 10 remains at an elevated temperature, below the set temperature but above room temperature during the power-off periods (b, b'...).

In various embodiments, the electronic control unit 49 may be adapted to control the operating temperature of the heating element 48 within a predetermined range to achieve optimal heating. In some embodiments, the operating temperature of the heating element 48 is controlled to be within a range of 280 °C to 400 °C during the operation of the heating device 40. Within the pre-determined heating temperature range, the tobacco unit 10 is sufficiently heated to generate the tobacco-flavoured aerosol. At the same time, undesirable combustion of the tobacco material and generation of undesirable volatile compounds such as tar can be minimized.

In the present disclosure, the placement of the heating element 48 with respect to the tobacco unit is relatively more flexible and is less restricted by the requirement of having the tobacco unit 10 heated uniformly. This is because the heating-transmitting material within the tobacco unit 10 provides for the heat to be received from the heating element 48 and to be distributed across the tobacco unit 10 more efficiently. Further, temperature profile of the tobacco unit 10 can be controlled by the heating device 40 in a relatively easy manner. Particularly, the heat-transmitting material in the tobacco unit 10 allows the tobacco unit 10 to be heated to the target temperature within a relatively short time period and once heated to the target temperature, less variation or slower rate of change in the temperature profile of the tobacco unit 10 is observed.

In some embodiments, the heating device 40 is integrally attached to the heatable tobacco product 20, which is to be used with and disposed of together with the heat tobacco product. As described above, the assembly of the integrated heatable tobacco product 20 and heating device 40 is intended for one-time use and may provide convenience for some users.

In various embodiments, the heating device 40 comprises a plurality of air channels 56 adapted to allow air flowing through the heating device 40. Advantageously, heat from the electrical components of the heating device 40 can be dissipated out from the air channels 56. Also, more air is channelled through the heating device 40 to the tobacco unit 10 during the operation of the heating device 40 which may further enhance the aerosol-generation efficiency.

In accordance with another aspect of the disclosure, there is further provided a method or process of producing the tobacco unit 10 for use in a heatable tobacco product 20.

In some embodiments, heat-transmitting fibers 15 are incorporated into the tobacco material 12 during a process of producing a reconstituted tobacco material, where a homogenized tobacco material, a binder and other components are mixed together to form a slurry which is then cast into the desired shape/form. This can be a standard paper-making process commonly adopted by the tobacco industry for making the reconstituted tobacco.

The homogenised tobacco material can comprise a tobacco material which is granulated or grinded to a substantially small and homogenous particle size, and/or tobacco dusts/flakes being a waste material collected from the tobacco manufacturing process.

A solution is prepared containing at least a binding agent/binder dispersed in water. The binding agent can be for example but not limited to any of the gums or pectins, which is to ensure that the granulated tobacco remains substantially dispersed throughout the reconstituted tobacco sheet, and to assist in keeping the integrity of the resultant reconstituted tobacco material intact. In some embodiments, the binding agent are natural pectins, such as fruit, citrus or tobacco pectins; guar gums, such as hydroxyethyl guar and hydroxypropyl guar; locust bean gums, such as hydroxyethyl and hydroxypropyl locust bean gum; alginate; starches, such as modified or derived starches; celluloses, such as methyl, ethyl, ethylhydroxymethyl and carboxymethyl cellulose; tamarind gum; dextran; pullalon; konjac flour; xanthan gum and the like.

The heat-transmitting fibers 15 are prepared and sized according to a pre-determined dimension. The heat-transmitting fibers 15 may be prepared by using the standard fiber forming processes, for example, by extrusion or by electrospinning.

The prepared heat-transmitting fibers 15 and the homogenized tobacco material are mixed in the solution containing the binding agent to form into a slurry, which is then casted into a reconstituted material with a desired shape and form. In the resultant cast tobacco material, the heat-transmitting fibers 15 are homogeneously and randomly dispersed. In some embodiments, the heat-transmitting fibers 15 constitute 5% to 10% of the cast tobacco material by weight.

In some embodiments, the slurry is spread onto a surface or a continuous belt, whereby a cast tobacco sheet containing the homogenized tobacco material and the randomly dispersed heat-transmitting fibers 15 is formed after drying and curing.

In other embodiments, the heat-transmitting fibers 15 can also be incorporated into a wet layer of tobacco material formed from a slurry, prior to drying or curing the wet layer of tobacco material into a cast tobacco sheet material.

The cast tobacco sheet is then used to form into a rod-like shape and further sized into a tobacco unit 10 for incorporating into the heatable tobacco product 20. It is appreciable that the cast tobacco sheet may be formed into the rod-like tobacco unit 10 in different and flexible manners. In some embodiments, the cast tobacco sheet is rolled into a rod shape with a desired diameter. In some embodiments, the cast tobacco sheet are cut or sliced into multiple pieces, which are then gathered or aggregated into the rod-like tobacco unit 10. In other embodiments, the cast tobacco sheet is crimped, and/or pressed, or otherwise formed into the rod-like tobacco unit 10. In various embodiments, the result tobacco unit 10 are embedded with the homogenously and randomly distributed heat-transmitting fibers 15 interconnecting with one another to form multiple heat-transmitting paths for heat transmission and distribution, as having described in the present application.

It is appreciable that the slurry containing the tobacco material 12 and the heat-transmitting fibers 15 may be cast into any desired shapes, other than into a sheet-like form. For example, the process of making the tobacco unit may be simplified by casting the slurry directly into the rod-like tobacco unit 10.

In various embodiments, the heat-transmitting fibers 15 may be made from any materials having a substantially good thermal conductivity, including but not limited to aluminium, copper, metallic alloys, graphite, conductive polymeric materials, or any combinations thereof.

In some embodiments, the tobacco unit 10 is formed from a tobacco material 12 and heat-transmitting material in the form of thin layers, i.e. heat-transmitting layers 17.

In the process of forming the tobacco unit 10 with embedded heat-transmitting layers 17, a cast tobacco sheet and a heat-transmitting layer, for example, a thin metallic foil, may be first prepared. Cast tobacco sheets and metallic foils are easily obtainable materials, and can be produced from standard and known processes. Advantageously, the process of forming the tobacco unit 10 using this method can be substantially simplified.

One or more cast tobacco sheets and one or more metallic foil can be joined together in a lamination process. For better integrating the two materials, the lamination process may involve the application of heat, pressure, welding, and/or by applying a binding agent or other suitable adhesive materials.

In some embodiments, a heat-transmitting layer 17 such as a thin metallic foil can be provided first as a substrate material. A homogenized tobacco material, for example, in the form of granulated/grinded tobacco and tobacco dust/flake, is provided and is spread over the heat-transmitting surface, whereby a binding agent is applied for aggregating the homogenised tobacco material together and adhering/binding the tobacco material 12 on the heat-transmitting layer. As such, a laminate sheet

comprising a layer of the tobacco material 12 on the heat-transmitting layer 17 is formed, as shown in Figure 15. The process may involve the application of heat or pressure, which is to allow the tobacco material 12 to be more firmly attached to the heat-transmitting layer. It is appreciable that the process can be adapted to form a laminar sheet with multiple alternating layers of tobacco material 12 and heat-transmitting material.

In various embodiments, the heat-transmitting layers 17 may be made from any materials having a substantially good thermal conductivity, including but not limited to aluminium, copper, metallic alloys, graphite, conductive polymeric materials, or any combinations thereof.

In some embodiments, the heat-transmitting fibers can be incorporated into the tobacco material 12 via other processes, such as a rolling method. In particular, the rolling method may include the steps of mixing raw materials such as tobacco material 12, the binding agent(s), the additive(s), etc. The mixture may undergo a grinding step via a grinder to become a powder mix, referred to as a first mixture.

The first mixture may be further be mixed with other materials such as, but not limited to, cellulose fiber, water, polyethylene, glycol, VG, the heat transmitted fiber 15, other material within a nanotechnology mixer to form a second mixture. The resultant second mixture with the heat transmitted fiber 15 which may form a dough, undergoes a first set of lamination rollers to make laminated sheets and shredder. The resultant laminated sheets shredded may go through a second set of lamination rollers arranged in cross-direction with respect to the first lamination sheet direction. The resultant laminated sheet may then be dried before going through a rewinder to make a bobbin. The bobbin may next undergo the process of unwinding and perforations or cuts may be made on the resultant tobacco sheets.

In some embodiments, the resultant tobacco sheets may be rolled to form rod-like structures, and the rod-like structures may be cut into pieces.

The above is description of a tobacco product and method of making the same. It will be apparent that various other modifications and adaptations of the disclosure will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the disclosure. It is intended that all such modifications and adaptations come within the scope of the appended claims.

Further, it is to be appreciated that features from various embodiment(s), may be combined to form one or more additional embodiments.

Reference

10	tobacco unit
12	tobacco material
15	heat-transmitting fiber
17	heat-transmitting layer
20	heatable tobacco product
21	first end
22	second end
24	filter element
26	net filter
27	channelled filter
28	granule-filled filter
30	tubular support element
32	inner tube
33	overwrap
34	outer tube
35	heat insulating layer
40	heating device
45	power source unit
46	switch
48	heating element
49	electronic control unit
50	battery module
52	electrical contact
53	insulating sheet
56	air channel
57	recess

CLAIMS

1. A tobacco unit of a heatable (heat-not-burn) tobacco product comprising:
   - a tobacco material, and
   - a heat-transmitting material integrally attached to the tobacco material to form a single composite material,

   wherein the heat-transmitting material is adapted to form a plurality of heat transmitting paths for distributing heat across the tobacco unit such that the tobacco material of the tobacco unit is homogenously heated, and wherein the heat transmitting material comprises at least one of the following: - (i.) a plurality of heat-transmitting fibers homogeneously dispersed throughout the tobacco material, and (ii.) at least one heat-transmitting layer.

2. The tobacco unit according to claim 1, wherein the plurality of heat-transmitting fibers are homogeneously dispersed in the tobacco material in random orientations.

3. The tobacco unit according to claim 1 or 2, wherein the at least one heat-transmitting layer comprises a sheet-like arrangement, a web-like arrangement, or a net-like arrangement.

4. The tobacco unit according to claim 3, further comprises a plurality of heat-transmitting layers, wherein one of the plurality of heat-transmitting layers is connected to another of the plurality of heat-transmitting layer in a helical spring-like configuration.

5. The tobacco unit according to any one of the preceding claims, wherein the heat-transmitting material comprises one or more of the following materials: - aluminium, copper, metallic alloys, graphite, conductive polymeric materials, any combinations thereof.

6. The tobacco unit according to any one of the preceding claims further comprising one or more aerosol former materials.

7. The tobacco unit according to any one of the preceding claims, wherein the weight percentage of the heat-transmitting material in the tobacco unit is in the range of 0.5% -10%.

8. The tobacco unit according any one of claims 2, 5 to 7, wherein the length of the heat-transmitting fibers are in the range of 1 mm to 20 mm.

9. The tobacco unit according to any one of claims 3 to 7, wherein the thickness of the one or more heat-transmitting layers are in the range of 0.05 mm to 1 mm.

10. The tobacco unit according to any one of the preceding claims, wherein tobacco unit is configured to receive heat from a heating element directly coupled to the heatable tobacco product, and wherein the tobacco material is operable to be heated at a temperature lower than a combustion temperature of the tobacco material for generating an aerosol for inhalation.

11. A heatable tobacco product for use with a heating device comprising:

- a tobacco unit according to any one of claims 1 to 9 arranged at a first end of the heatable tobacco product, and
- one or more filter elements located downstream of the tobacco unit;

wherein the tobacco unit is adapted to be directly coupled to a heating element for heating at a temperature lower than a combustion temperature of the tobacco material for generating an aerosol for inhalation.

12. The heatable tobacco product according to claim 11, further comprising one or more tubular support elements.

13. The heatable tobacco product according to claim 12, wherein the one or more tubular support elements comprise one or more of the following: - an inner tube

located at the immediate downstream of the tobacco unit; an outer tube located at the extreme downstream of the heatable tobacco product.

14. The heatable tobacco product according to any one of claims 11 to 13, wherein the one or more filter elements comprise one or more materials from the following: at least one metallic material; at least one natural or synthetic fibrous material; at least one polymeric material; at least one resin material; and any combinations thereof.

15. The heatable tobacco product according to any one of claims 11 to 14, wherein the one or more filter elements comprise one or more of the following materials:- natural plant fibers; natural animal fibers; carbonized plant fibers, carbonized animal fibers; synthetic polymer fibers; natural resin material; synthetic polymer resin; any combinations or derivatives thereof.

16. The heatable tobacco product according to any one of claims 11 to 15, wherein the one or more filter elements comprises one or more of the following materials: - cotton; jute; hemp; bamboo fibers; bamboo charcoal fibers; wool; silk; nylon; polyester fibers; polyimide fibers; polylactic acid (PLA); polyethylene (PE); polyethylene terephthalate (PET); polyethylene ether ketones (PEEK); polypropylene (PP); polytetrafluoroethylene (PTFE); polyvinylchloride (PVC); cellulose acetate (CA), starch based polymers, liquid crystal polymer material (LCP); polyacrylonitrile (PAN); polysiloxane or silicone; natural or synthetic rubber; paper; paper yarn; paper net; cork; carbon; graphene; any combinations or derivatives thereof.

17. The heatable tobacco product according to any one of claims 14 to 16, wherein the one or more materials forming the one or more filter elements are resistant to deformation or degradation when heated at temperatures of 180^{o}C and above.

18. The heatable tobacco product according to any one of claims 11 to 17, wherein the one or more filter elements comprise one or more of the following types of filter: - fibrous tow filter, film filter, foil filter, mesh filter, fabric filter, fabric mesh filter, sheet filter, wrapped filament filter, spongy filter, laminated filter, wafer filter, honey-

comb structure filter, extruded or moulded filter, paper filter, paper yarn filter, flat woven or braided filter, flat net filter.

19. The heatable tobacco product according to any one of claims 11 to 18, wherein the one or more filter elements comprise at least one net filter.

20. The heatable tobacco product according to claim 19, wherein the at least one net filter comprises a plurality of randomized aerosol paths.

21. The heatable tobacco product according to any one of claims 11 to 20, wherein the one or more filter elements are formed from one or more natural materials obtained from one or more of the following plant parts: - leaf, bark, trunk, fruit, seed, stem, flower, pollen, branch, root, sap, pulp, resin bagasse, calyx of the respective flora.

22. The heatable tobacco product according to any one of claims 11 to 21, wherein the one or more filter elements are formed from one or more sliced materials.

23. The heatable tobacco product according to claim 22, wherein the one or more sliced materials are in one or more of the following forms:- a I-shape or straight cut, an H-shape, an N-shape, a Z-shape, a zig-zag or S-shape, any non-linear and non-symmetrical shapes.

24. The heatable tobacco product according to any one of claims 11 to 23, wherein the one or more filter element comprises cellulose acetate (CA) in one or more of the following forms:- crushed or powder form, granule or pellet form, filament form, strip form, fibers or hardened fibers of any shape, threads, yarns, braided ropes, and flakes.

25. The heatable tobacco product according to any one of claims 11 to 24, wherein the one or more filter elements comprise a granule-filled filter, wherein the granule-filled filter comprises one or more granulated materials encased in at least one filter material.

26. The heatable tobacco product according to any one of claims 11 to 25, wherein at least one filter element is placed at the immediate downstream of the tobacco unit, the at least one filter element comprises a recess area for accommodating a part of the heating element protruding from the tobacco unit.

27. The heatable tobacco product according to any one of claims 11 to 26, wherein the one or more filter elements comprise at least one aerosol channel to facilitate aerosol flow.

28. The heatable tobacco product according to any one of claims 11 to 27, further comprising one or more overwraps circumscribing at least part of the heatable tobacco product.

29. The heatable tobacco product according to claim 28, wherein the one or more overwraps comprise one or more of the following materials: -natural plant fibers; natural animal fibers; carbonized plant fibers; carbonized animal fibers; synthetic polymer fibers.

30. The heatable tobacco product according to claim 28, wherein the one or more overwraps comprise one or more of the following materials: - jute; hemp; bamboo fibers; bamboo charcoal fibers; wool; silk; nylon; polyester fibers; polyimide fibers; polylactic acid (PLA); polyethylene (PE); polyethylene terephthalate (PET); polyethylene ether ketones (PEEK); polypropylene (PP); polytetrafluoroethylene (PTFE); polyvinylchloride (PVC), cellulose acetate (CA), starch based polymers, liquid crystal polymer material (LCP); polyacrylonitrile (PAN); polysiloxane or silicone; natural or synthetic rubber, cork, carbon, graphene, paper, paper yarn, paper net..

31. The heatable tobacco product according to any one of claims 28 to 30, wherein the one or more overwraps comprise one or more of the following: woven fabric materials formed from any type of fibers; non-woven fabric materials formed from any type of fibers.

32. The heatable tobacco product according to any one of claim 28 to 31, wherein the one or more overwraps further comprise one or more metallic foils.

33. The heatable tobacco product according to any one of claims 29 to 32, wherein the one or more materials forming the one or more overwraps are resistant to deformation and degradation when heated at temperatures of 180°C and above.

34. The heatable tobacco product according to any one of claims 27 to 33, wherein at least two overwraps are laminated into one single sheet material.

35. The heatable tobacco product according to any one of claims 28 to 34, wherein the one or more overwraps further comprise one or more heat insulating layers formed from one or more of the following materials:- heat insulation food grade glue; high temperature resistant film.

36. The heatable tobacco product according to any one of claims 11 to 34, wherein the heatable tobacco product is integrally attached to the heating device.

37. The heatable tobacco product according to any one of claims 11 to 36, wherein the heating device is configured to heat the tobacco unit of the heatable tobacco product at a set temperature under a constant power supply operational mode.

38. The heatable tobacco product according to claim 37, wherein the set temperature is in the range of between 280°C to 400°C.

39. The heatable tobacco product according to any one of claims 11 to 38, wherein the heating device is further configured to heat the tobacco unit during one or more heating cycles, each heating cycle comprising a first heating period where the tobacco unit is heated at a first heating temperature, and a second heating period where the tobacco unit is heated at a lower second heating temperature.

40. The heatable tobacco product according to claim 39, wherein the heating device is configured to turn off electrical power of the heating element during the second heating period of each heating cycle under a power-saving operational mode.

41. The heating tobacco product according to any one of claims 10 to 40, wherein the heating device is further configured to control the operating temperature of the heating element to be in the range of between 280°C and 400°C.

42. The heatable tobacco product according to any one of claims 13 to 41, wherein the one or more materials forming the one or more filter elements are odourless and non-toxic materials.

43. A heating device to be used with a heatable tobacco product comprising:

- one or more heating elements arranged to produce and transmit heat to a heatable tobacco product coupled to the heating device, the heatable tobacco product comprising a tobacco unit according to any one of claims 1 to 9;, and
- an electronic control unit for controlling the operation of the heating device to provide heat to the heatable tobacco unit via the one or more heating elements directly coupled to the tobacco unit at a temperature lower than a combustion temperature of the tobacco material for generating an aerosol for inhalation.

44. The heating device according to claim 43 further comprising a switch arranged to selectively activate the heating device.

45. The heating device according to claim 43 or 44 further comprising a power source unit for supplying electrical power to the heating device.

46. The heating device according to any one of claims 43 to 45, wherein the switch comprises an insulating sheet adapted for putting the power source unit in an open electric circuit.

47. The heating device according to any one of claims 43 to 46, wherein the heating device is integrally attached to the heatable tobacco product.

48. The heating device according to any one of claims 43 to 46, wherein the heating device is removably attached to the heatable tobacco product.

49. The heating device according to any one of claims 43 to 48, wherein the heating device is configured to heat the tobacco unit of the heatable tobacco product at a set temperature under a constant power supply operational mode.

50. The heating device according to claim 49, wherein the set temperature is in the range of between 280°C and 400°C.

51. The heating device according to any one of claims 43 to 50, wherein the heating device is further configured to heat the tobacco unit during one or more heating cycles, each heating cycle comprising a first heating period where the tobacco unit is heated at a first heating temperature, and a second heating period where the tobacco unit is heated at a lower second heating temperature.

52. The heating device according to claim 51, wherein the heating device is configured to turn off electrical power of the heating element during the second heating period of each heating cycle under a power-saving operational mode.

53. The heating device according to any one of claims 43 to 52, wherein the heating device is further configured to control the operating temperature of the heating element to be between 200°C and 400°C.

54. The heating device according to any one of claims 43 to 53, wherein the one or more heating elements are arranged in one or more of the following configurations:- a coil, a straight or corrugated ribbon, a strip of wires, a needle, a plate, any other three-dimensional shapes.

55. A method of producing a tobacco unit according to claim 1 and 2 for use in a heatable tobacco product, the method comprising the steps of:

- providing a homogenized tobacco material,
- preparing a solution containing at least a binding agent,
- preparing a plurality of heat-transmitting fibers,
- mixing a homogenized tobacco material, the heat-transmitting fibers and the solution to form a slurry,
- casting the slurry into a reconstituted tobacco material comprising heat-transmitting fibers homogeneously dispersed therein,
- forming the reconstituted tobacco material into a rod-like shape, further sized into a plurality of tobacco units for incorporating into the heatable tobacco product,

wherein the tobacco unit is configured to receive heat from a heating element, and the heat-transmitting fibers are adapted to form a plurality of heat transmitting paths for distributing heat across the tobacco unit such that the tobacco material of the tobacco unit is homogeneously heated at a temperature below a combustion temperature of the tobacco material for generating an aerosol for inhalation.

56. The method according to claim 55, wherein the heat-transmitting fibers are formed from aluminium, copper, metallic alloys, graphite, conductive polymeric materials, or any combinations thereof.

57. A method of producing a tobacco unit according to claim 3, the method comprising the steps of:

- providing a cast tobacco sheet material,
- providing a thin layer of heat-transmitting material,
- joining at least one cast tobacco sheet material and at least one heat-transmitting layer to form into a laminar sheet,
- forming the laminar sheet into a rod-like shape, further sized into a tobacco unit for incorporating into the heatable tobacco product, wherein the tobacco unit is configured to receive heat from a heating element, and the at least one

heat-transmitting layer is adapted to form a plurality of heat transmitting paths for distributing heat across the tobacco unit such that the tobacco material of the tobacco unit is homogeneously heated at a temperature below a combustion temperature of the tobacco material for generating an aerosol for inhalation.

58. A method of producing a tobacco unit according to claim 3, the method comprising the steps of:

- providing a heat-transmitting layer,
- preparing a homogenized tobacco material,
- depositing the homogenized tobacco material on at least one surface of the heat-transmitting layer with a binding agent to form a laminar sheet with at least one layer of tobacco material and at least one heat transmitting layer,
- forming the laminar sheet into a rod-like shape, further sized into a tobacco unit for incorporating into the heatable tobacco product, wherein the tobacco unit is configured to receive heat from a heating element coupled to the heatable tobacco product, and the at least one heat-transmitting layer is adapted to form a plurality of heat transmitting paths for distributing heat across the tobacco unit such that the tobacco material of the tobacco unit is homogenously heated at a temperature below a combustion temperature of the tobacco material for generating an aerosol for inhalation.

59. The method according to claim 58 comprising a further step of pressing the at least one tobacco sheet material and the at least one heat-transmitting layer to form a laminate.

60. The method according to any one of claims 57 to 59, wherein the heat-transmitting layer comprises thin foils of aluminium, copper, metallic alloys, graphite, conductive polymeric materials, or any combinations thereof.

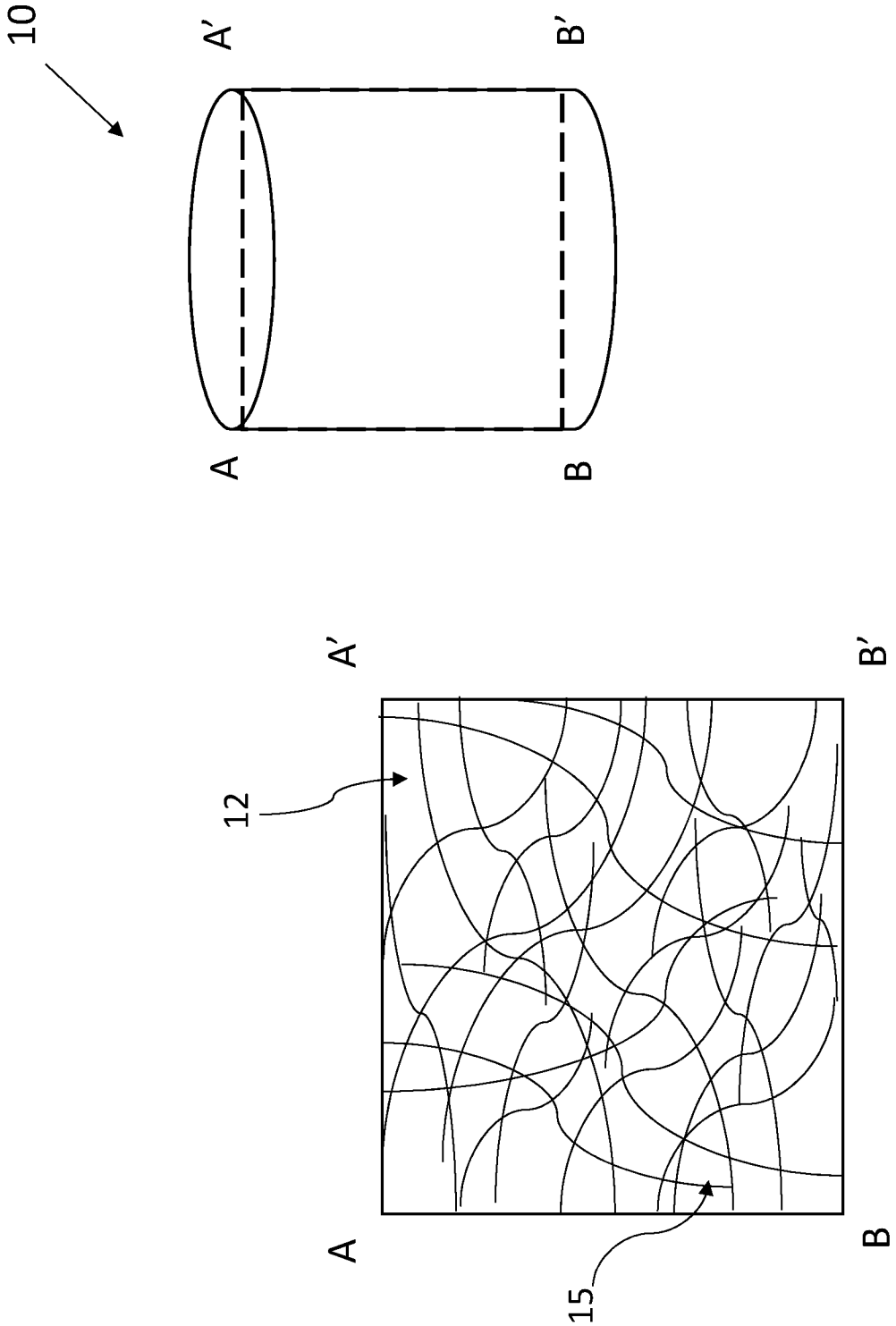


Figure 1

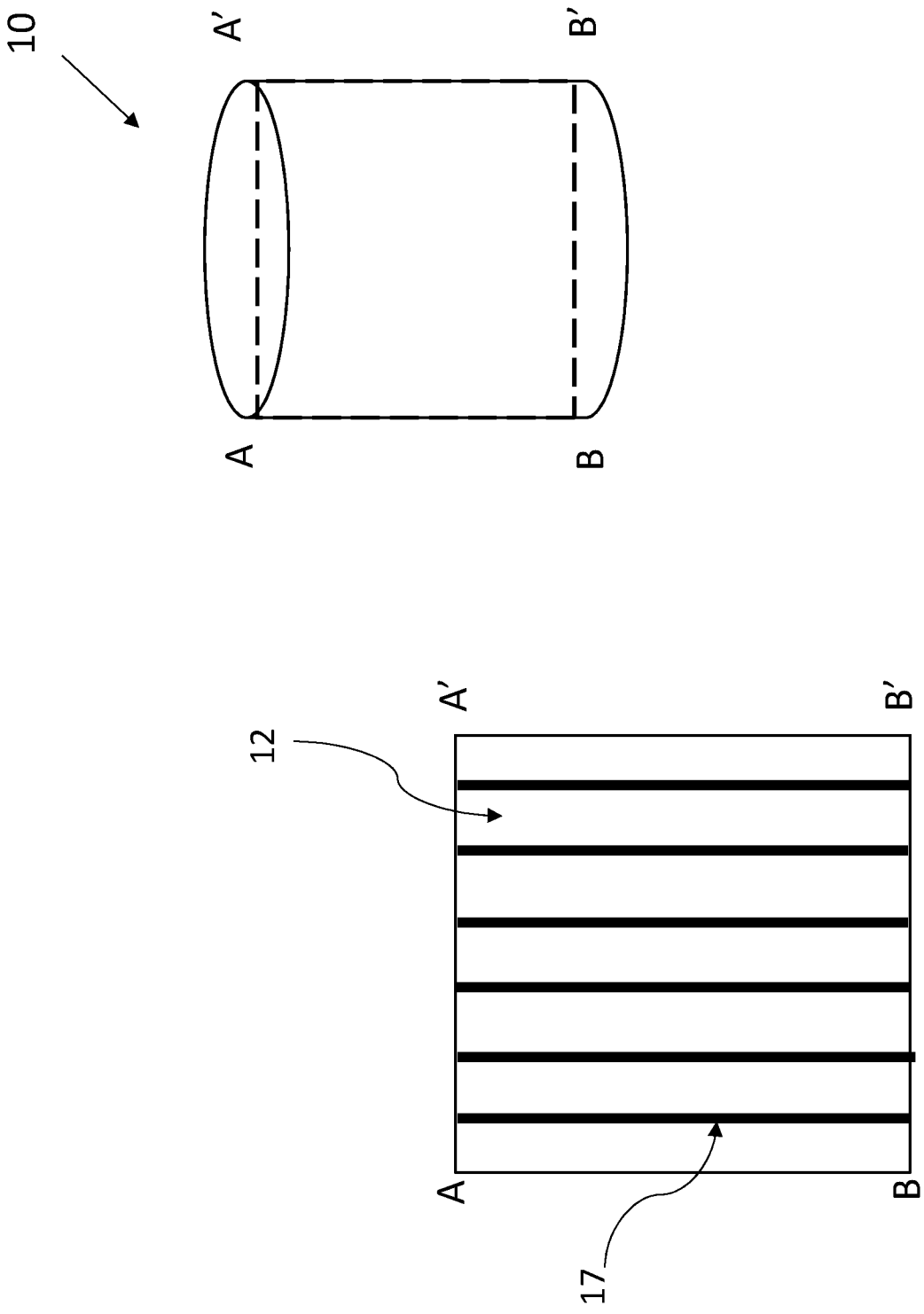


Figure 2A

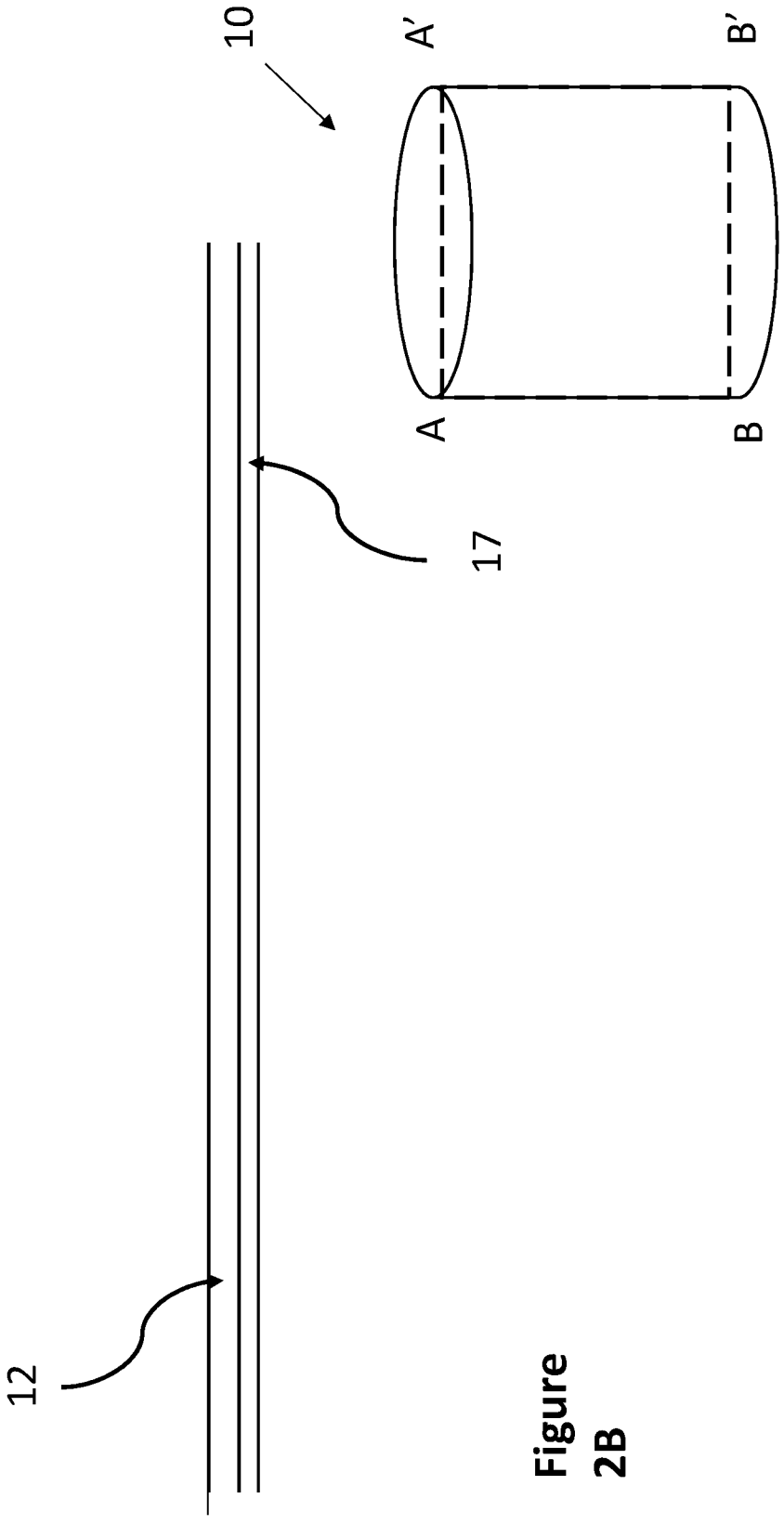
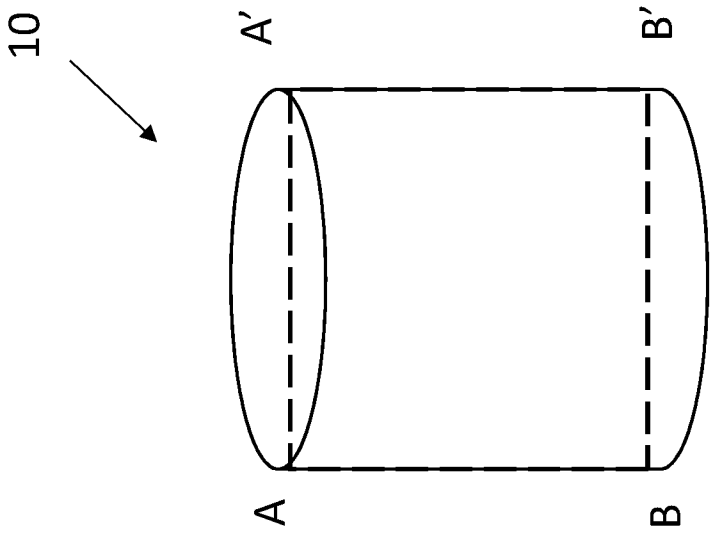


Figure 2B



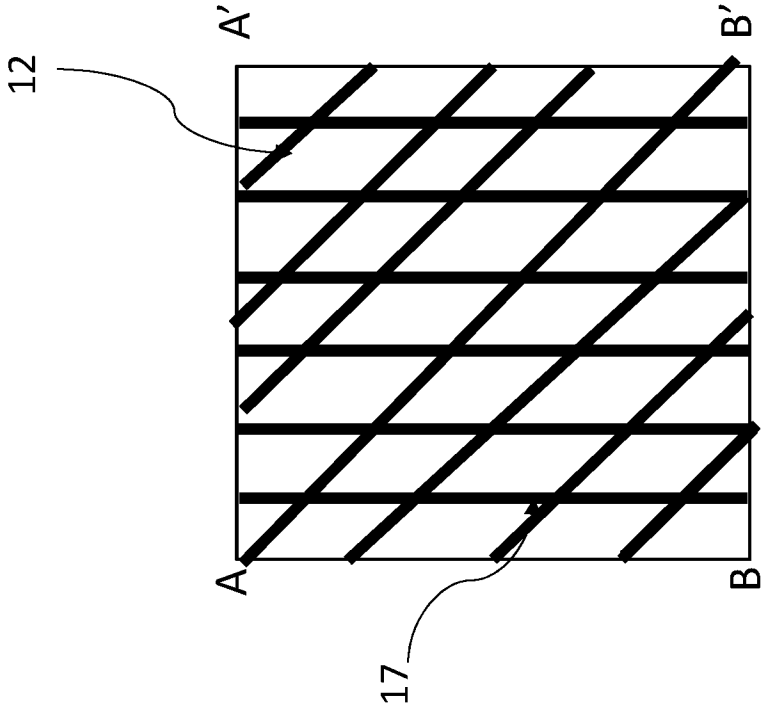


Figure 2C

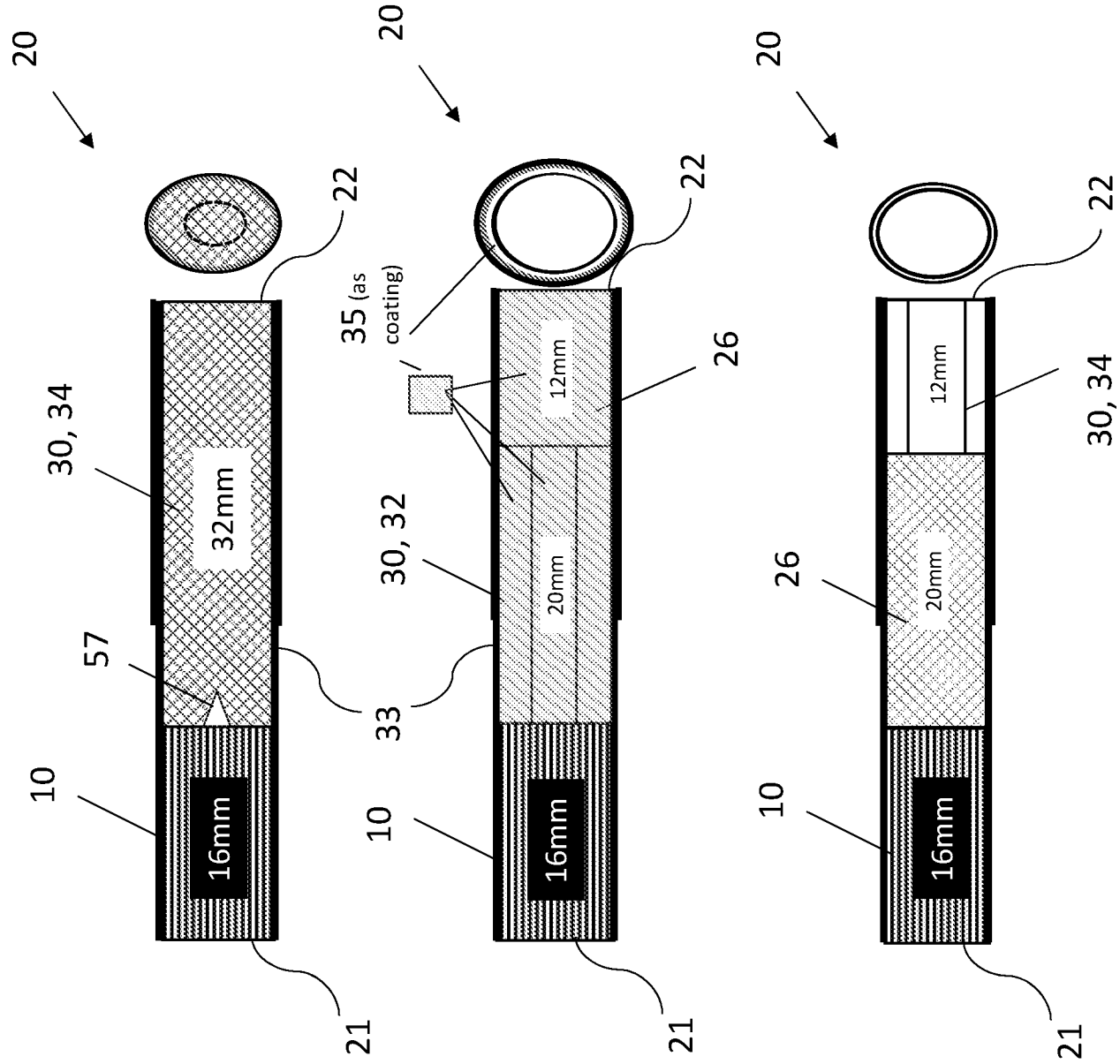


Figure 3A

Figure 3B

Figure 3C

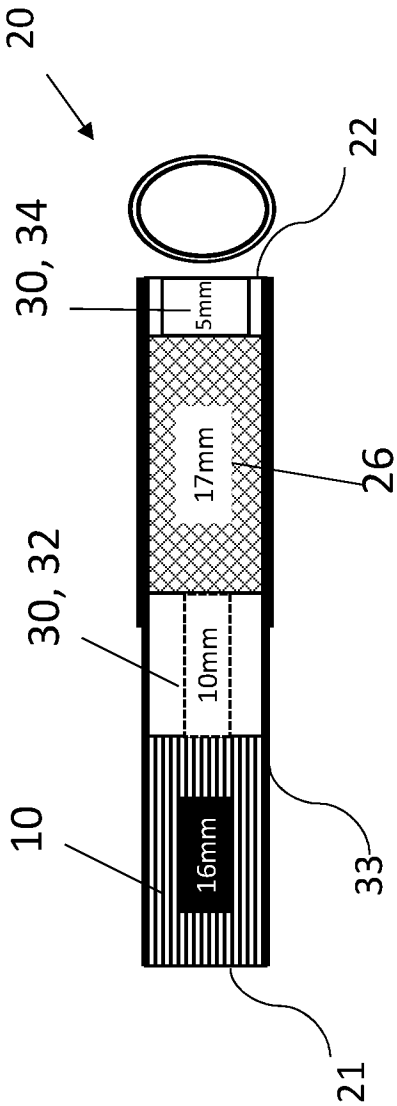


Figure 3D

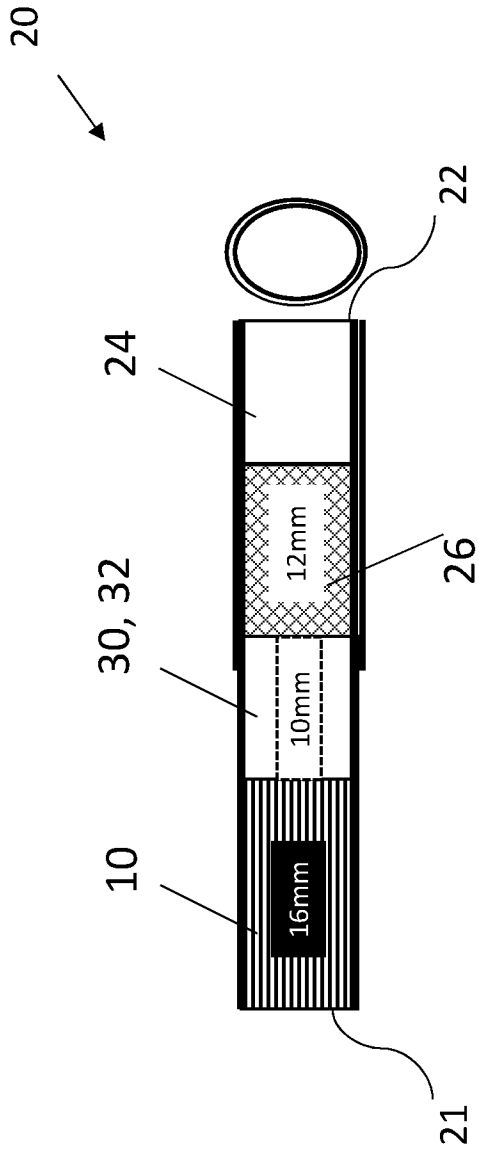


Figure 3E

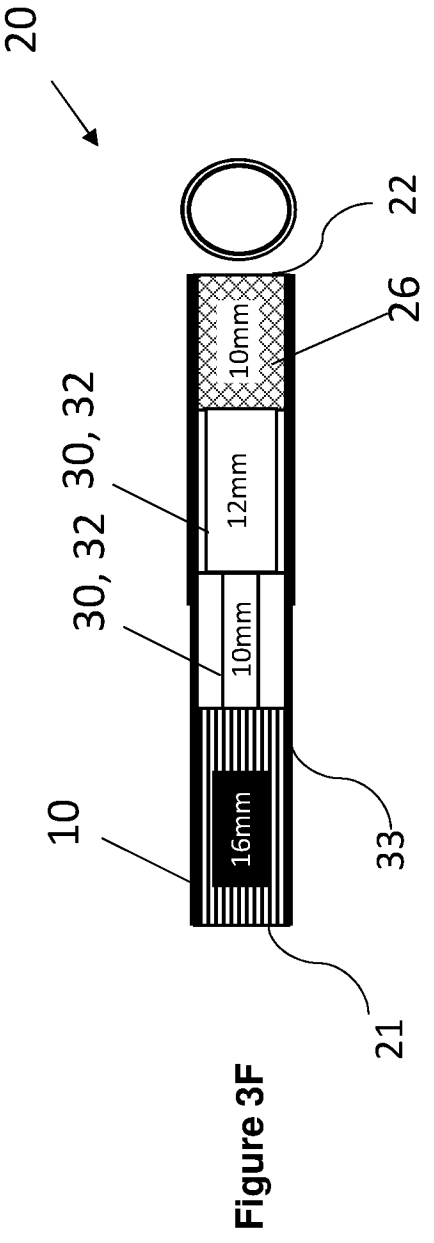


Figure 3F

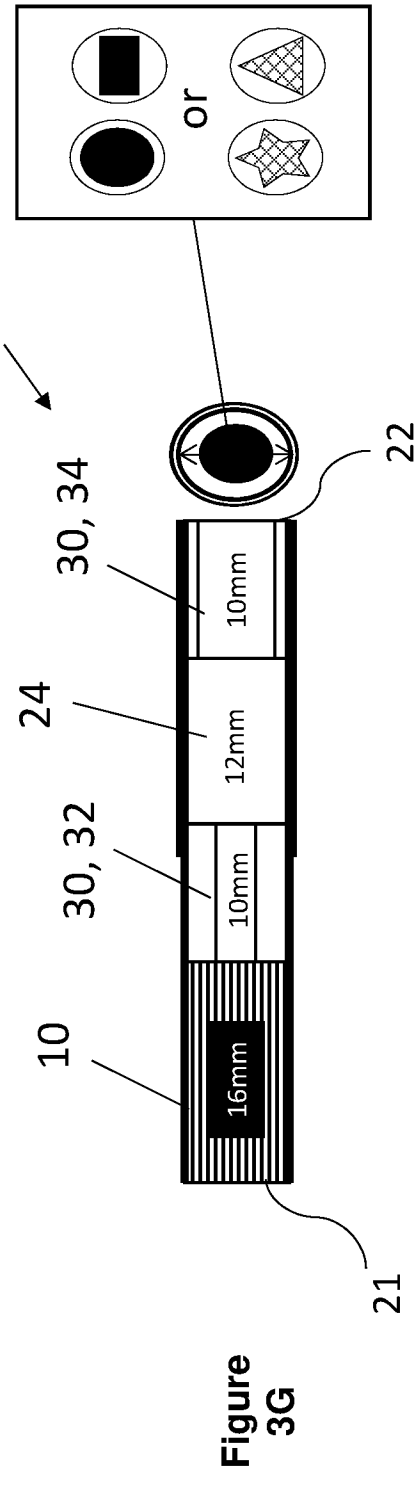


Figure 3G

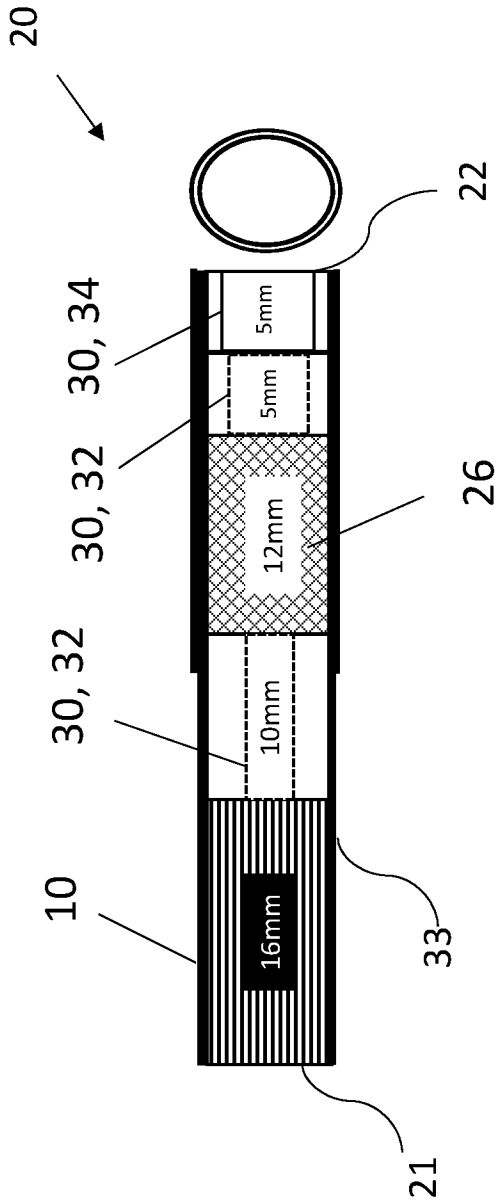


Figure 3H

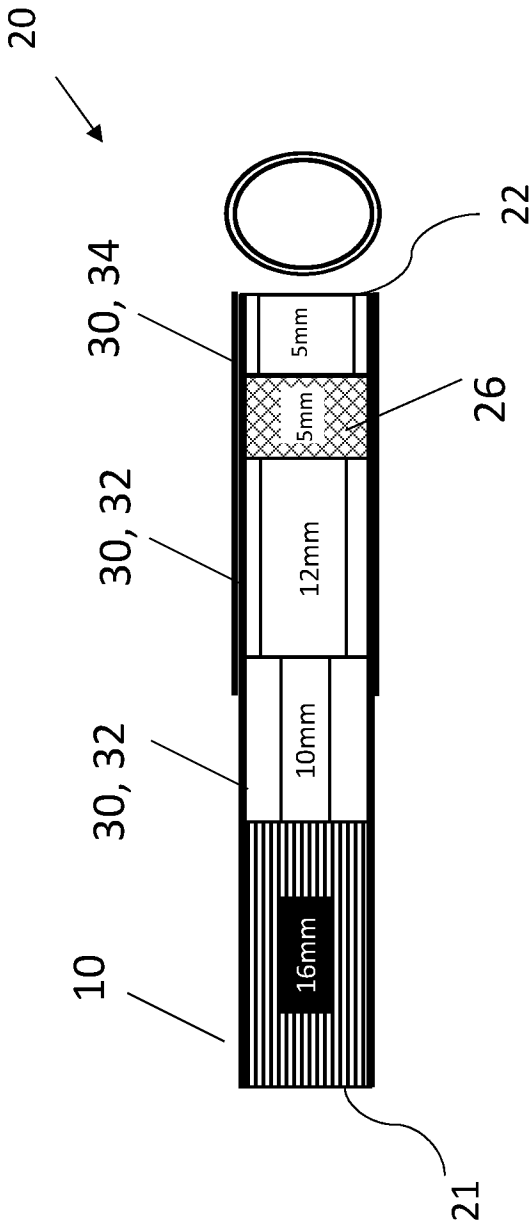
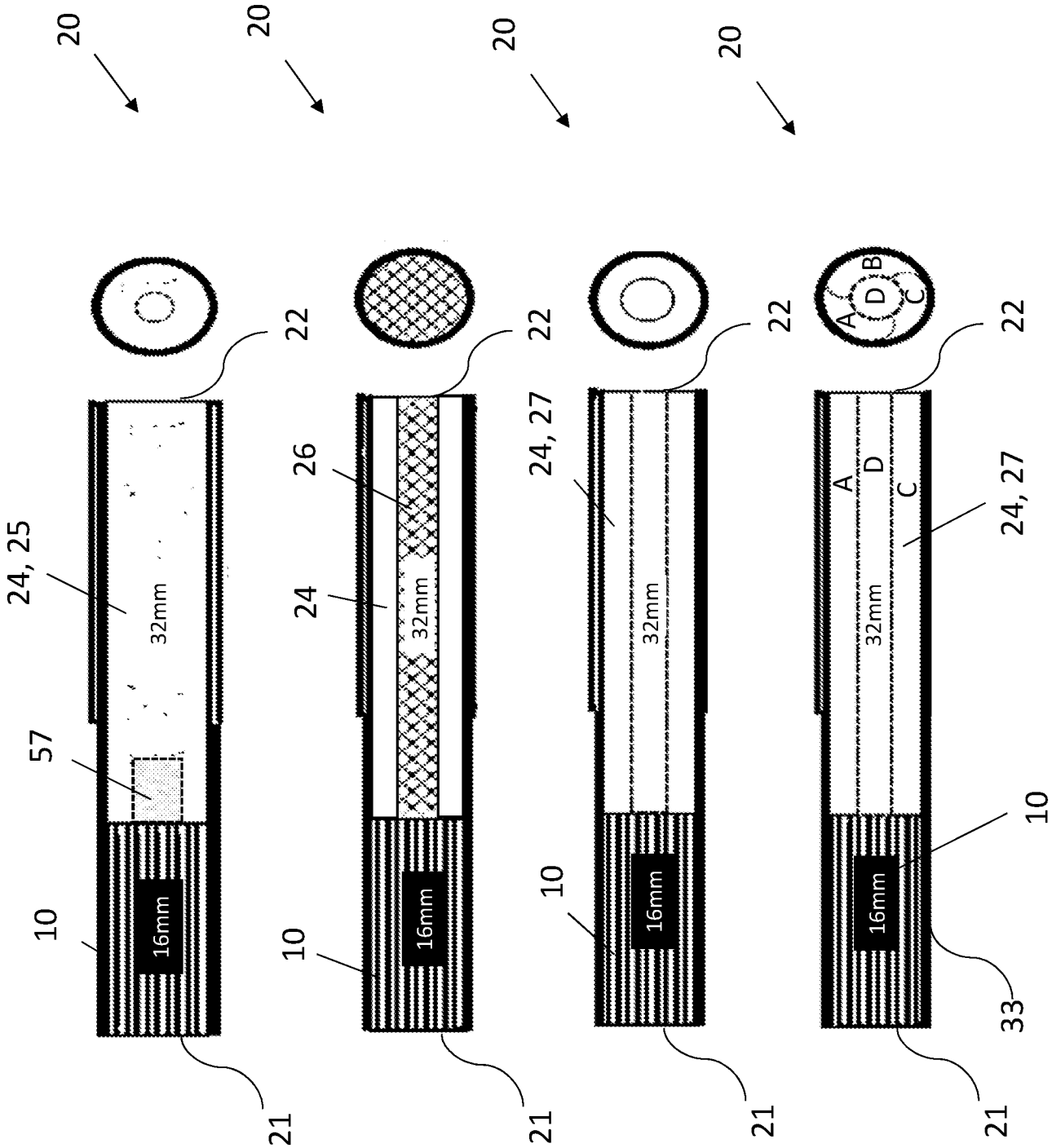


Figure 3I


20
22
24, 25
32mm
57
10
16mm
21
Figure 3J
20
22
26
24
32mm
10
16mm
21
Figure 3K
20
22
24, 27
32mm
10
16mm
21
Figure 3L
20
22
A
D
B
C
24, 27
32mm
10
16mm
33
21
Figure 3M

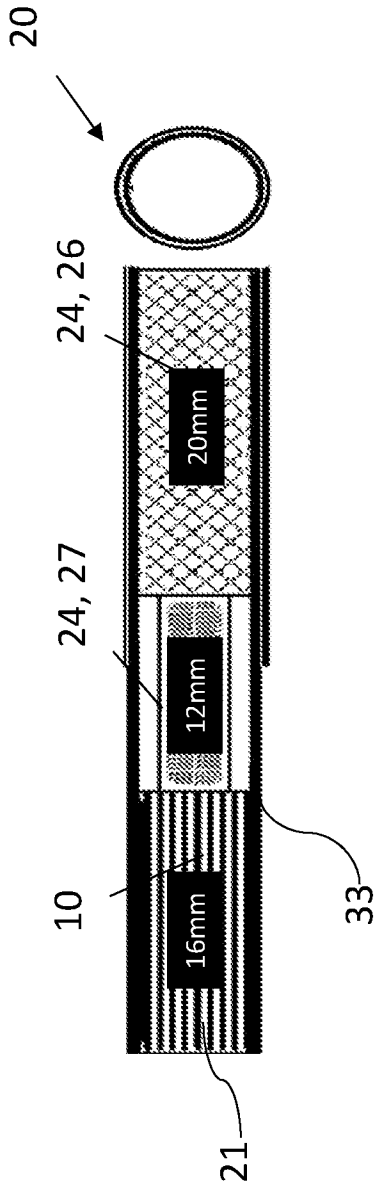


Figure 3N

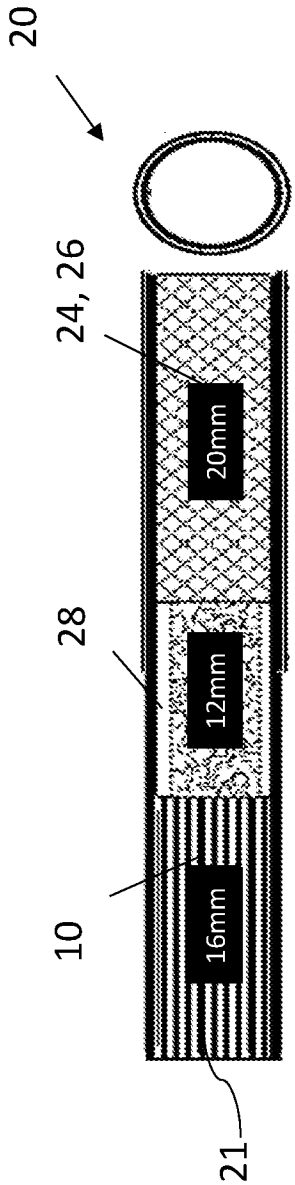


Figure 3O

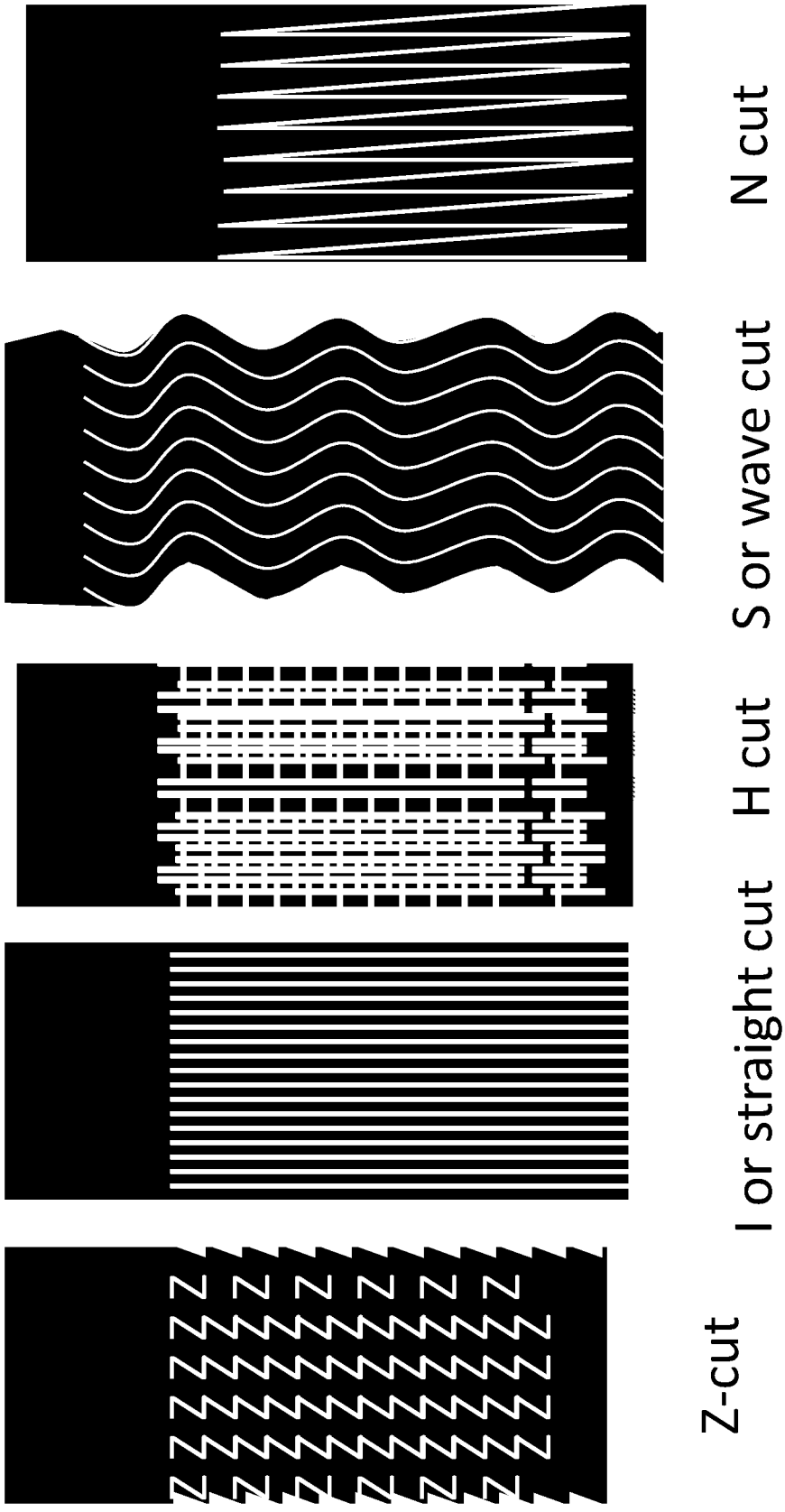


Figure 4

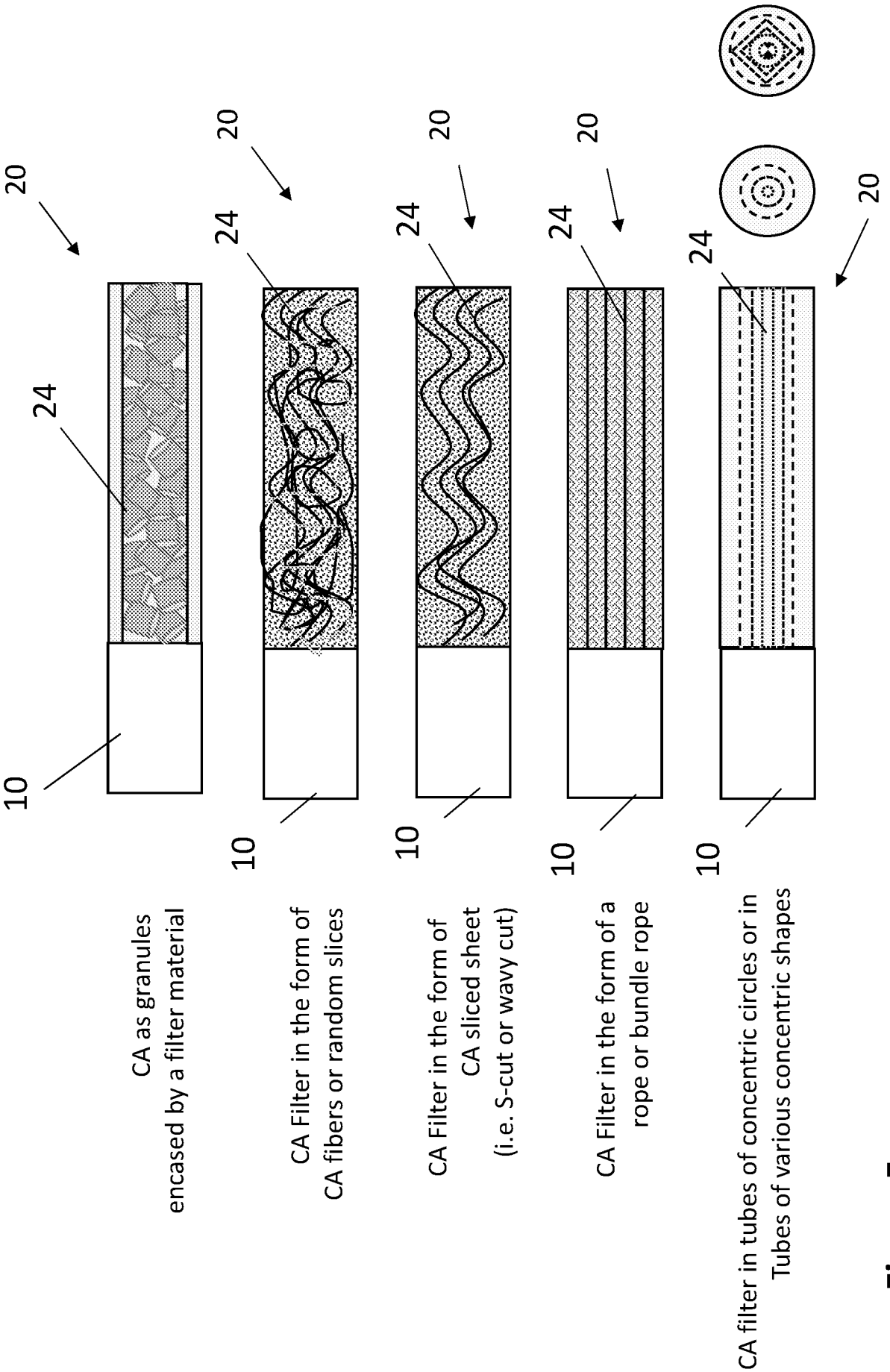

20
24
10
CA as granules
encased by a filter material
20
24
10
CA Filter in the form of
CA fibers or random slices
20
24
10
CA Filter in the form of
CA sliced sheet
(i.e. S-cut or wavy cut)
20
24
10
CA Filter in the form of a
rope or bundle rope
20
24
10
CA filter in tubes of concentric circles or in
Tubes of various concentric shapes

Figure 5

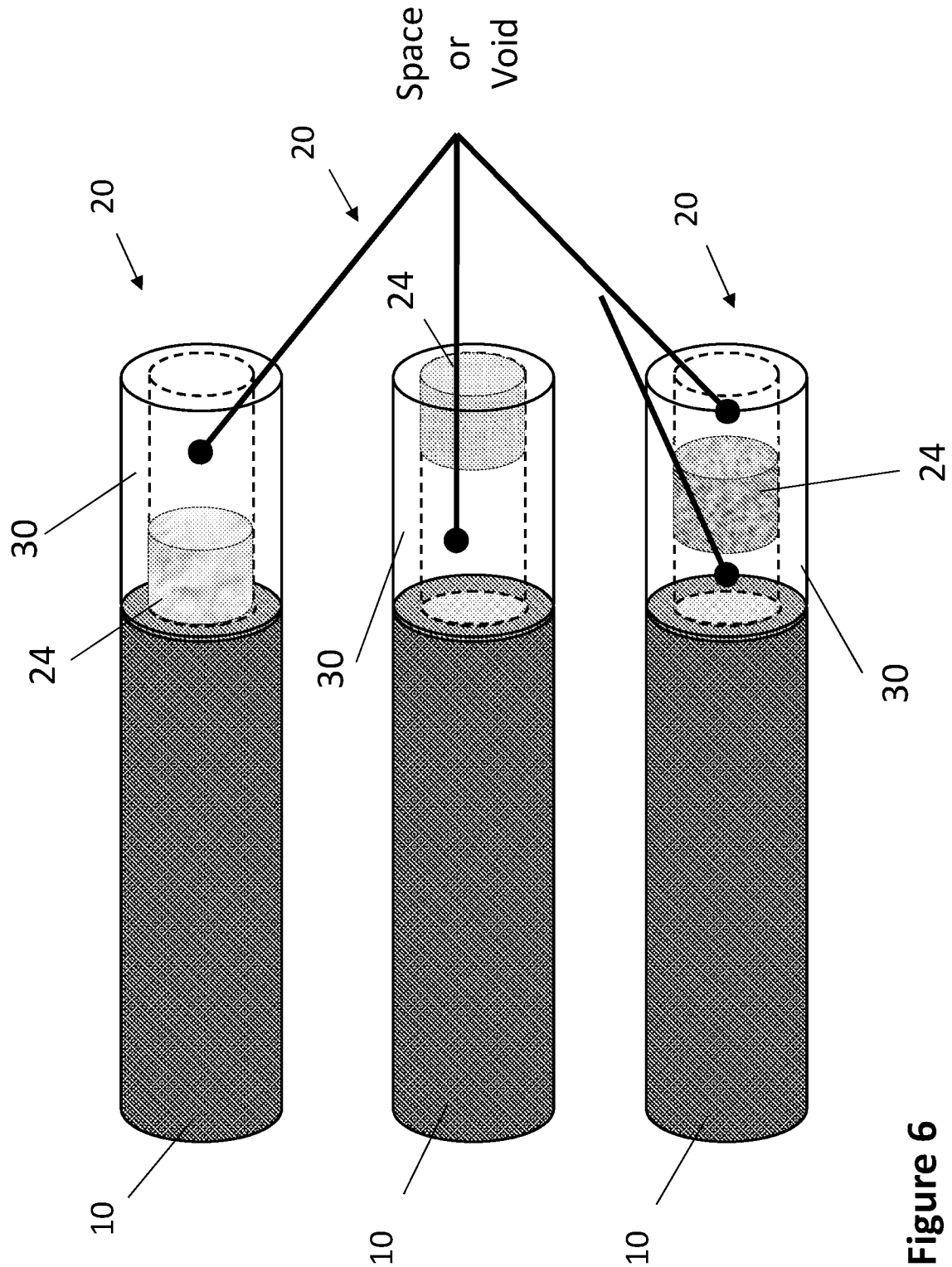


Figure 6

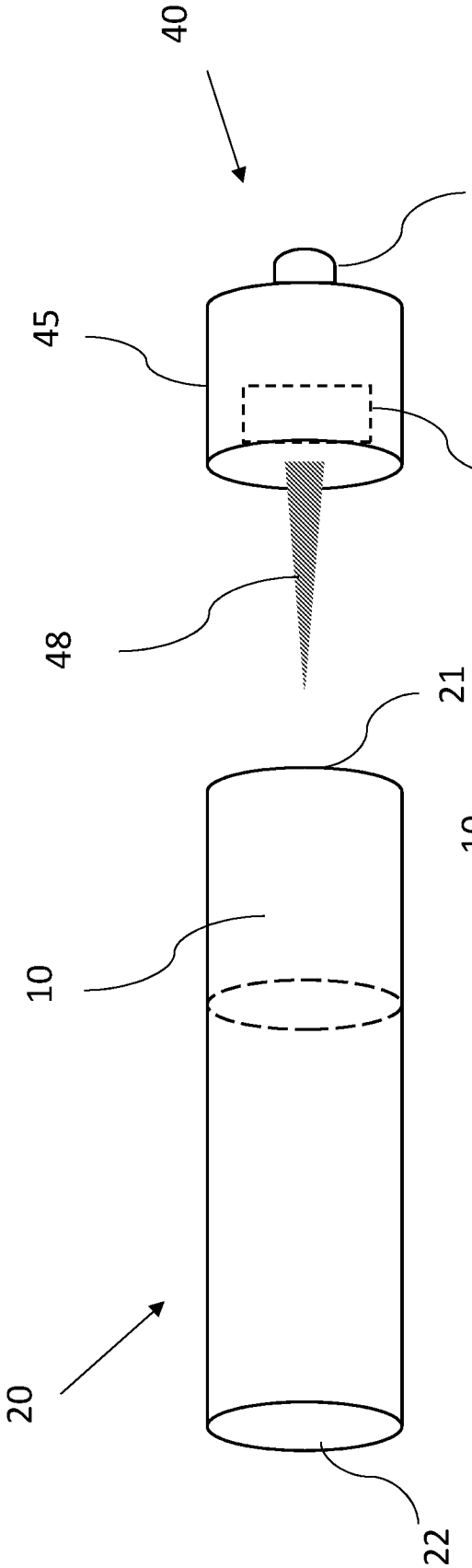


Figure 7A

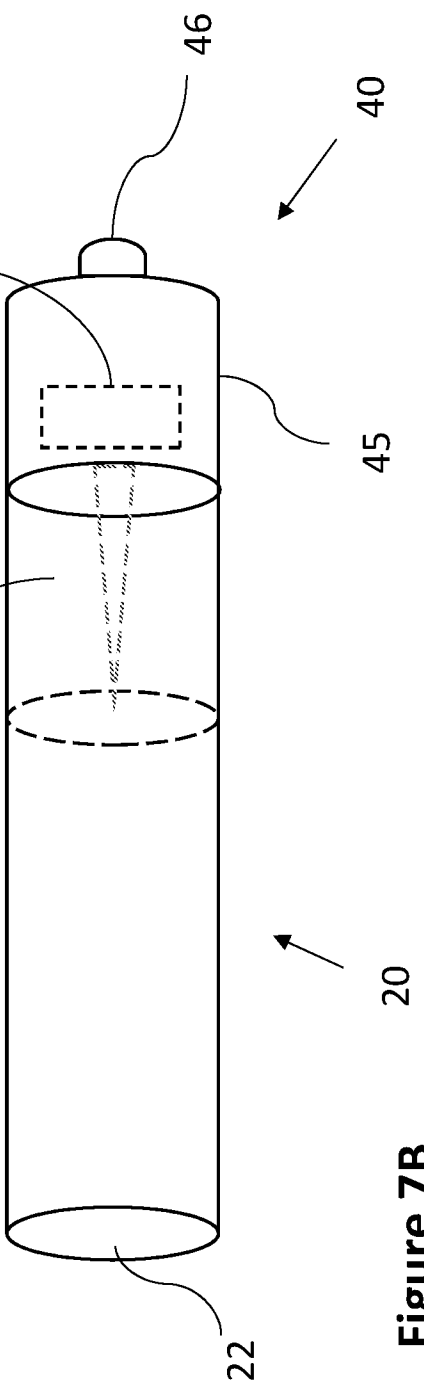


Figure 7B

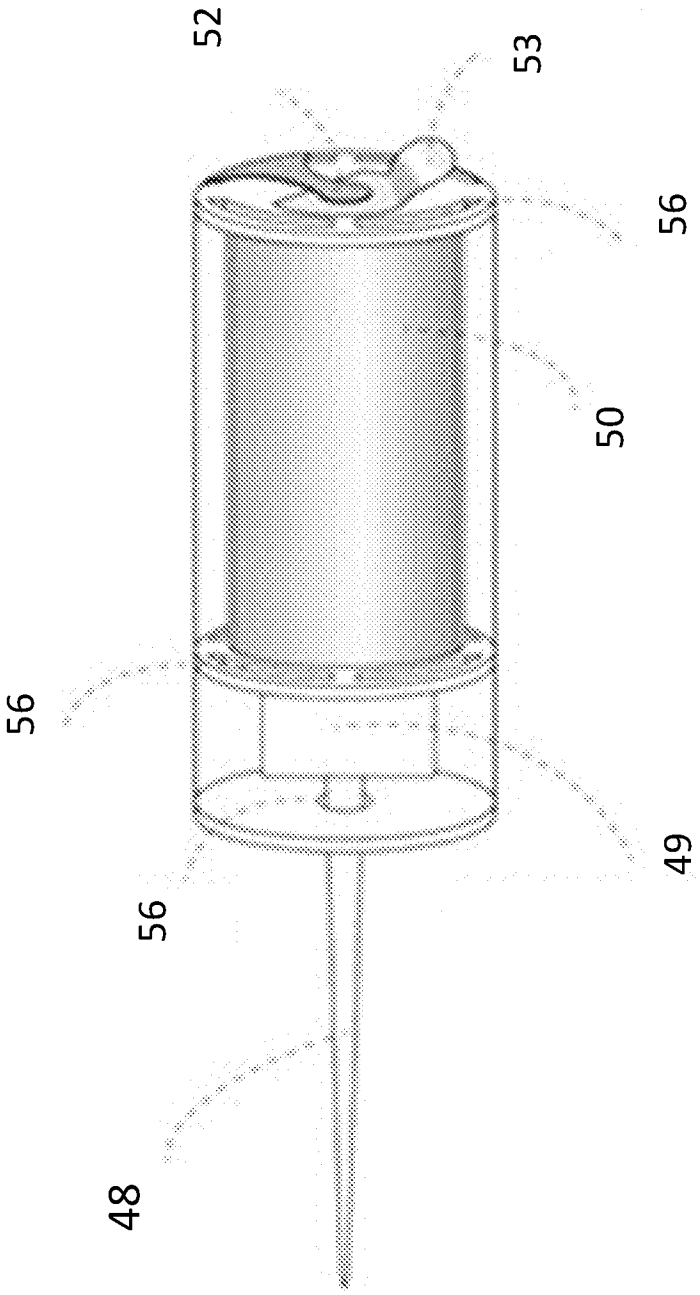


Figure 8

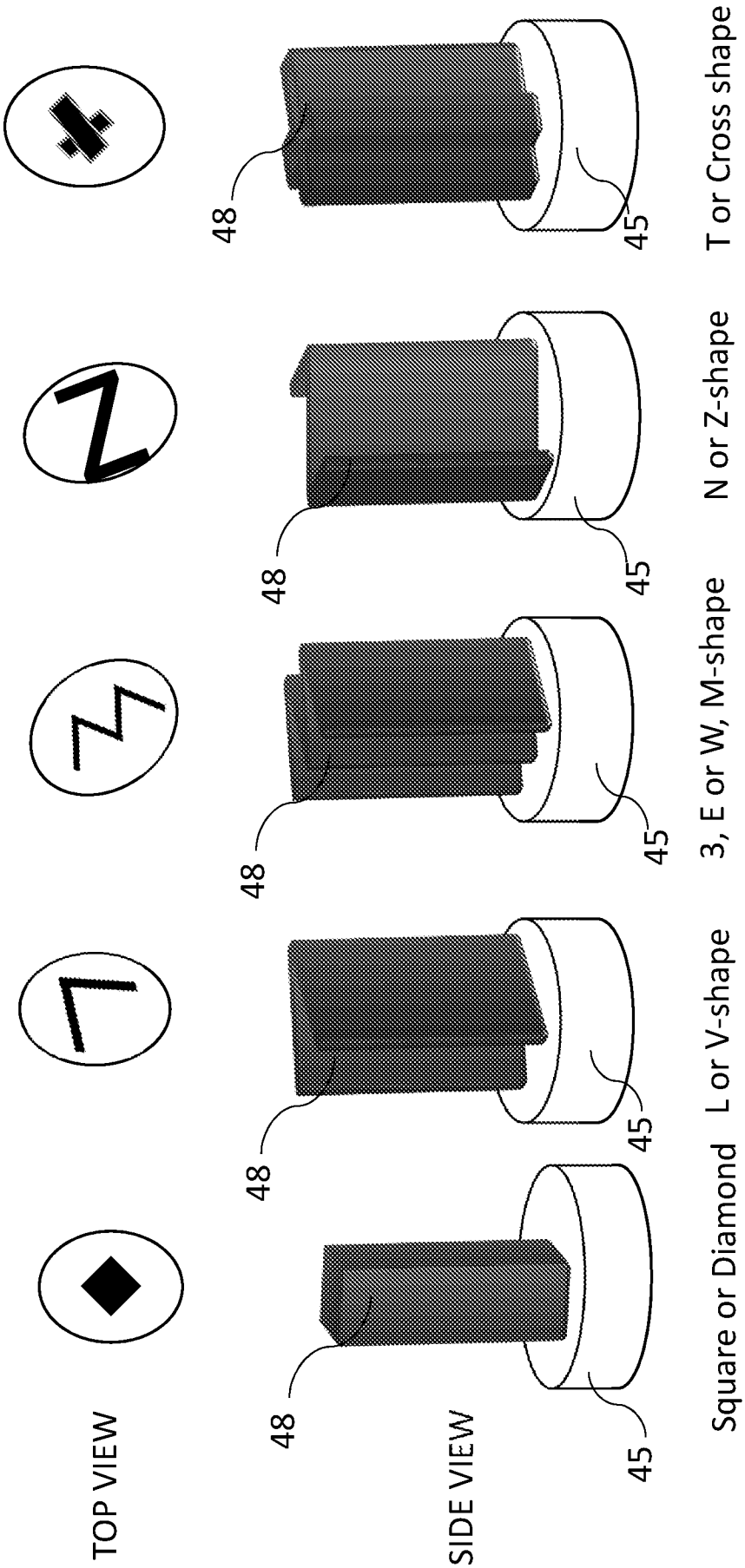

TOP VIEW
SIDE VIEW
48
45
Square or Diamond
L or V-shape
3, E or W, M-shape
N or Z-shape
T or Cross shape

Figure 9

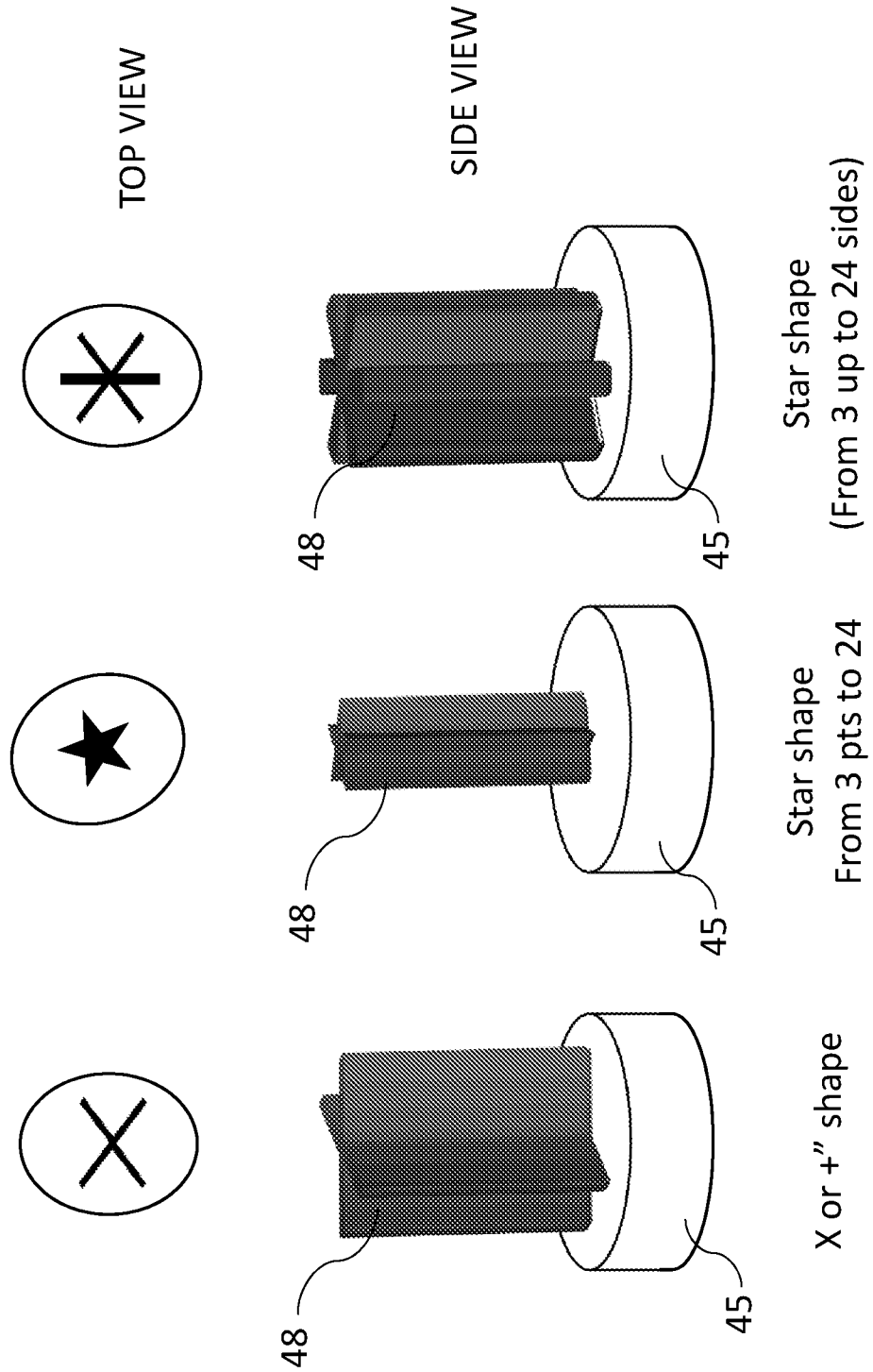

TOP VIEW
SIDE VIEW
48
45
Star shape
(From 3 up to 24 sides)
48
45
Star shape
From 3 pts to 24
points
48
45
X or +" shape

Figure 10

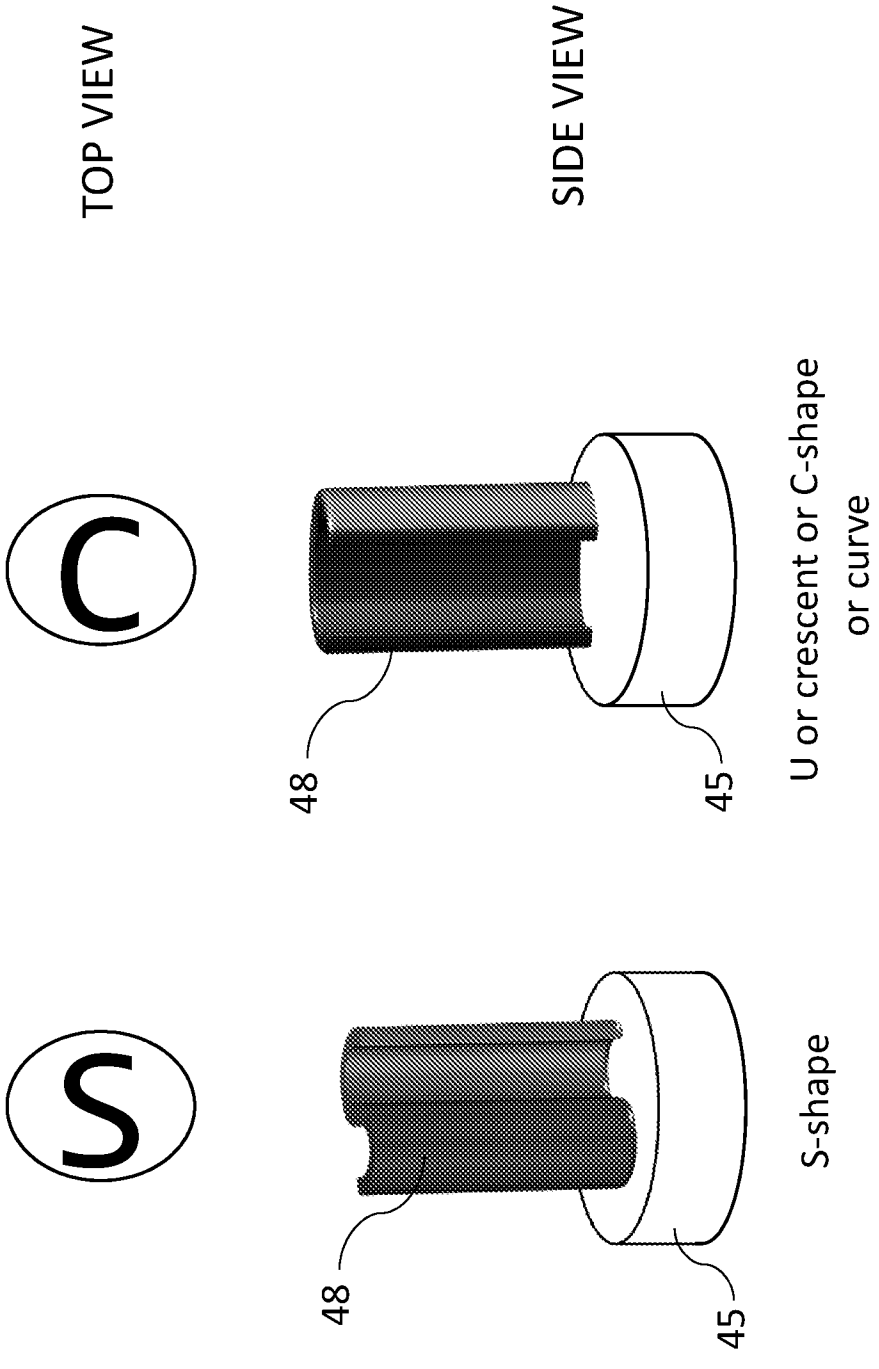

TOP VIEW
SIDE VIEW
C
48
45
U or crescent or C-shape or curve
S
48
45
S-shape

Figure 11

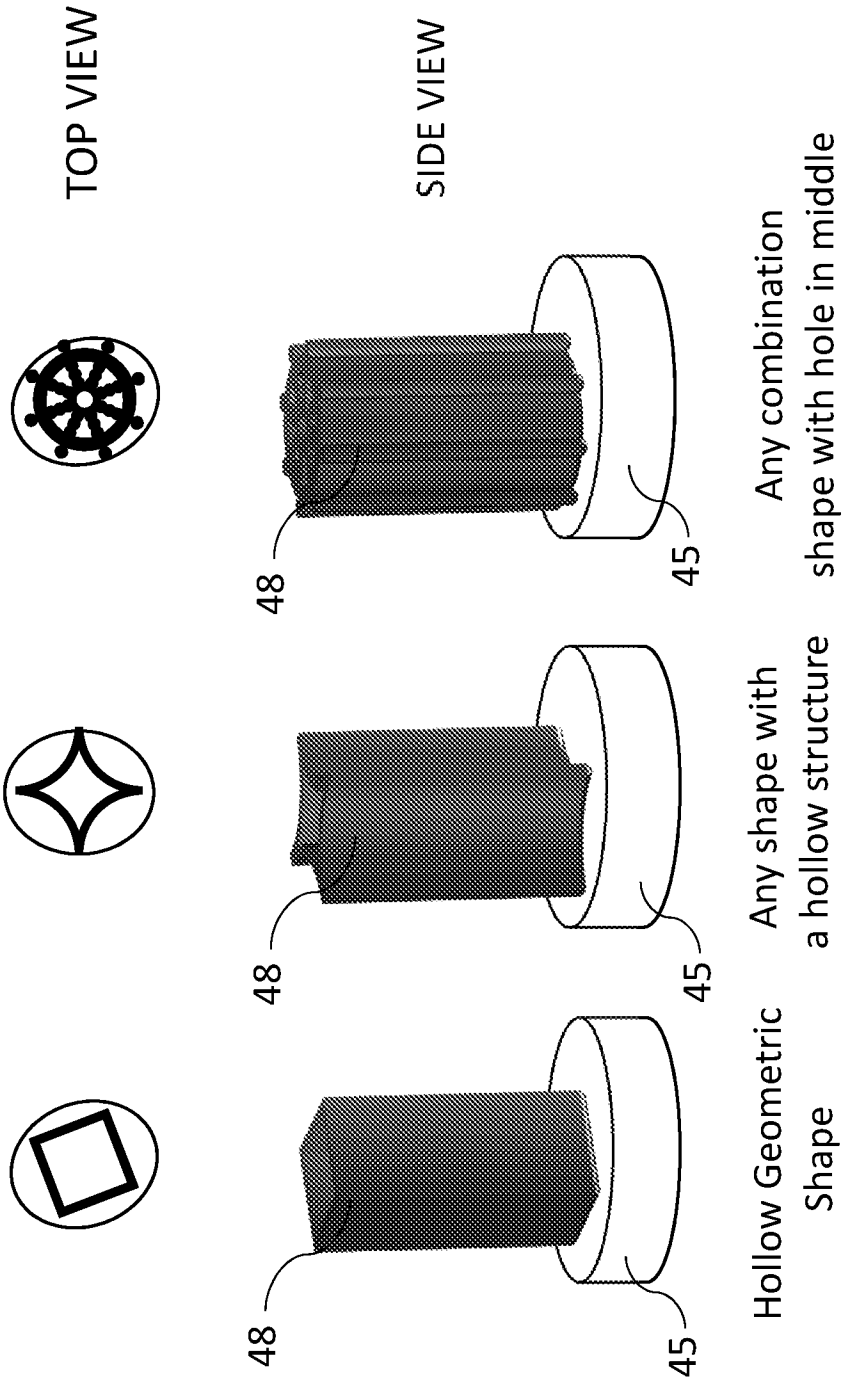

TOP VIEW
SIDE VIEW
48
45
Hollow Geometric Shape
Any shape with a hollow structure
Any combination shape with hole in middle

Figure 12

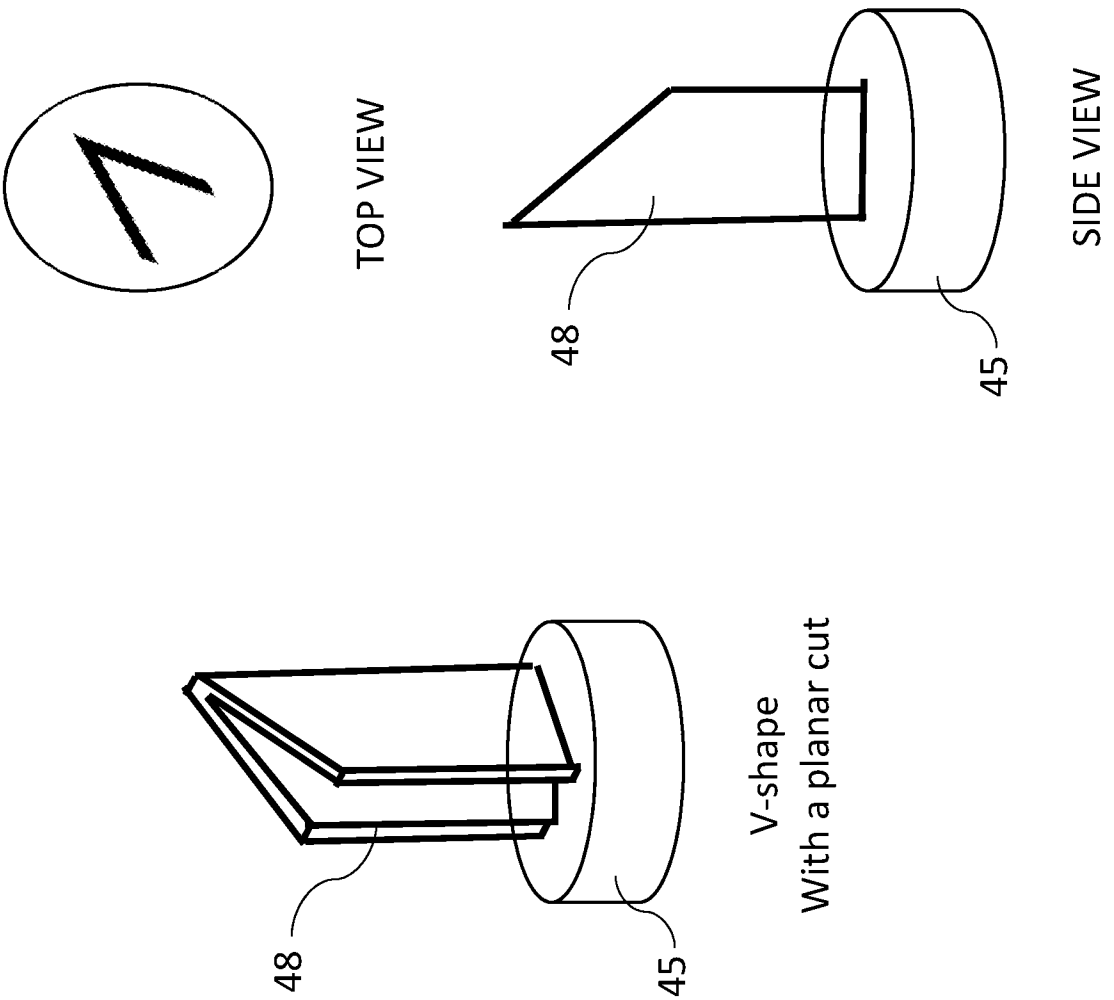


Figure 13

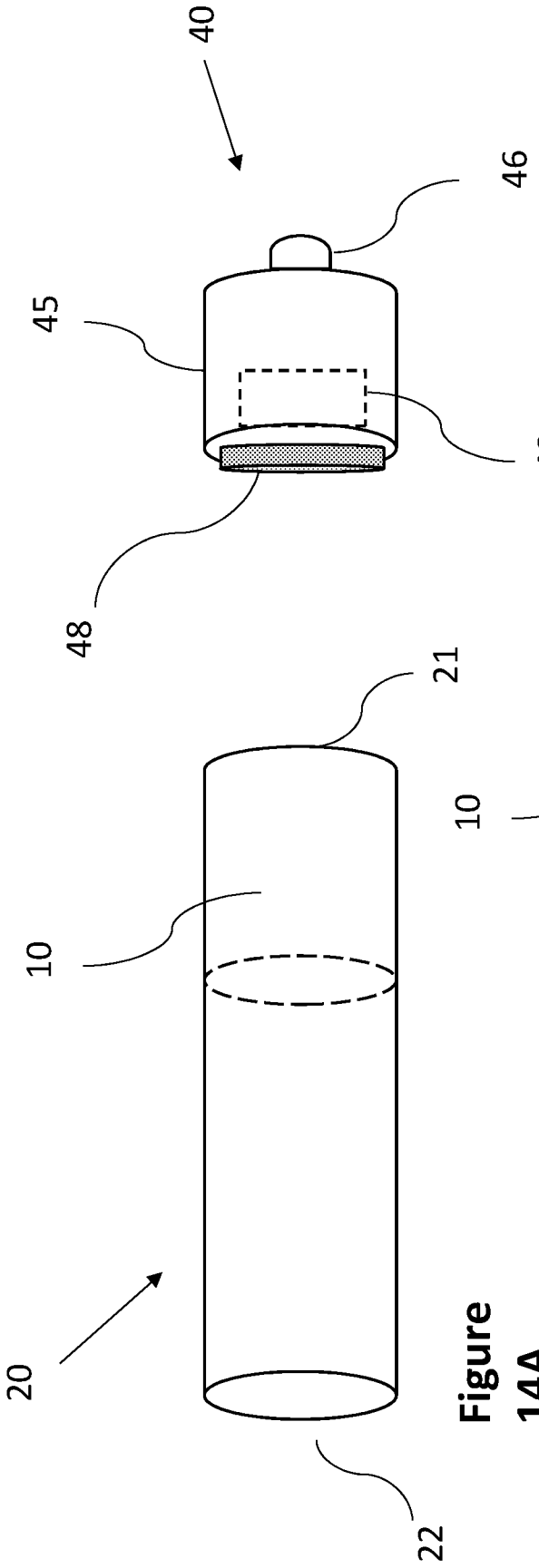


Figure 14A

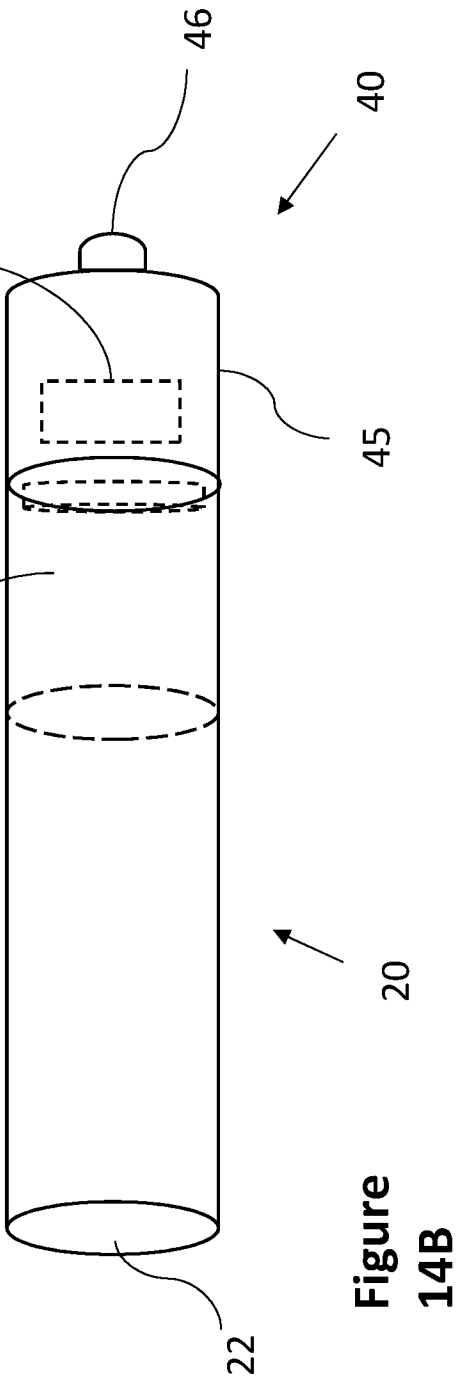


Figure 14B

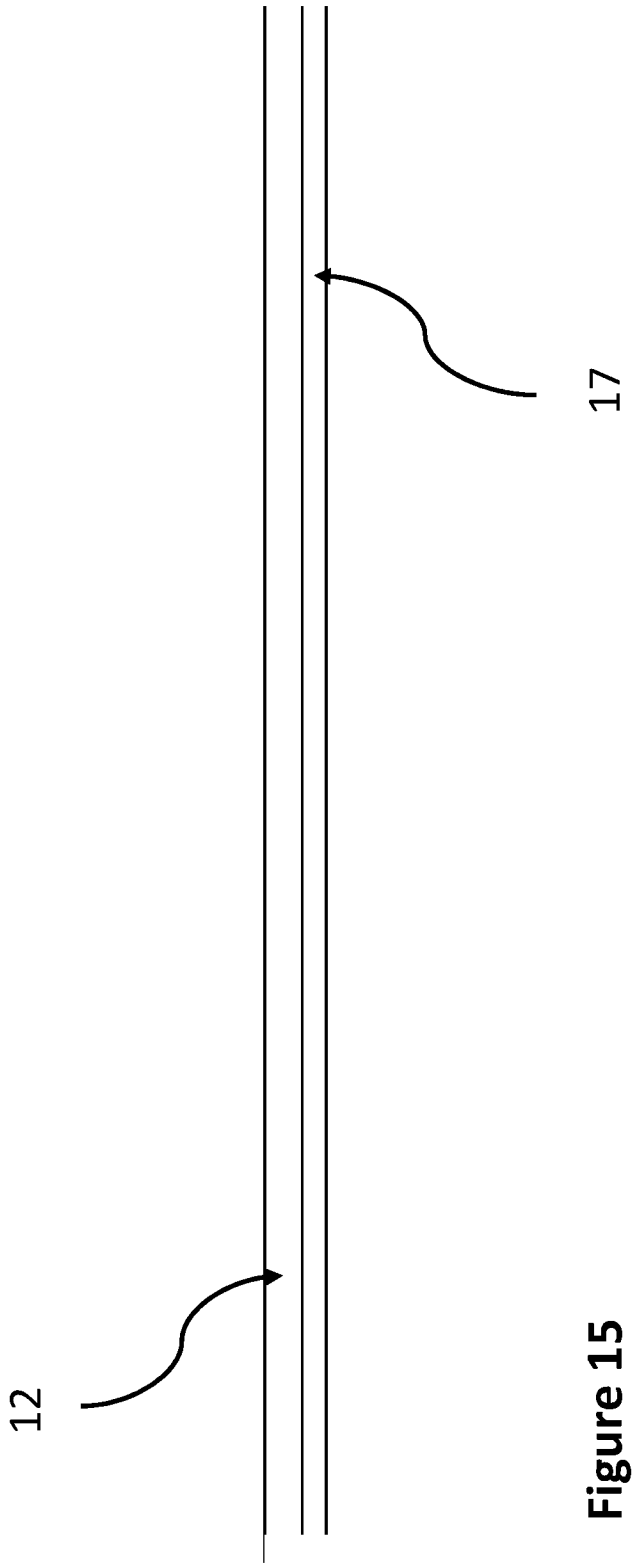


Figure 15

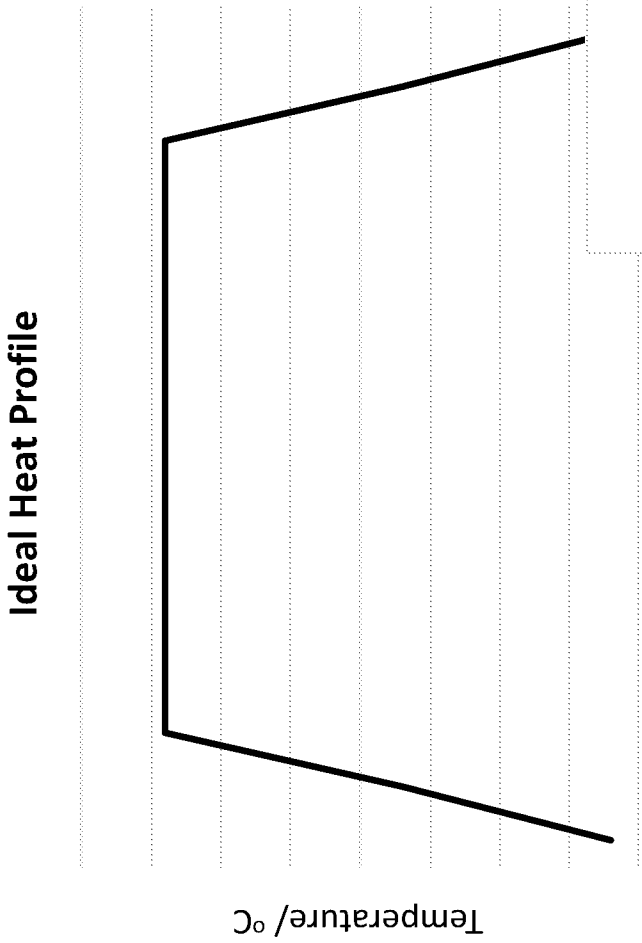


Figure 16A

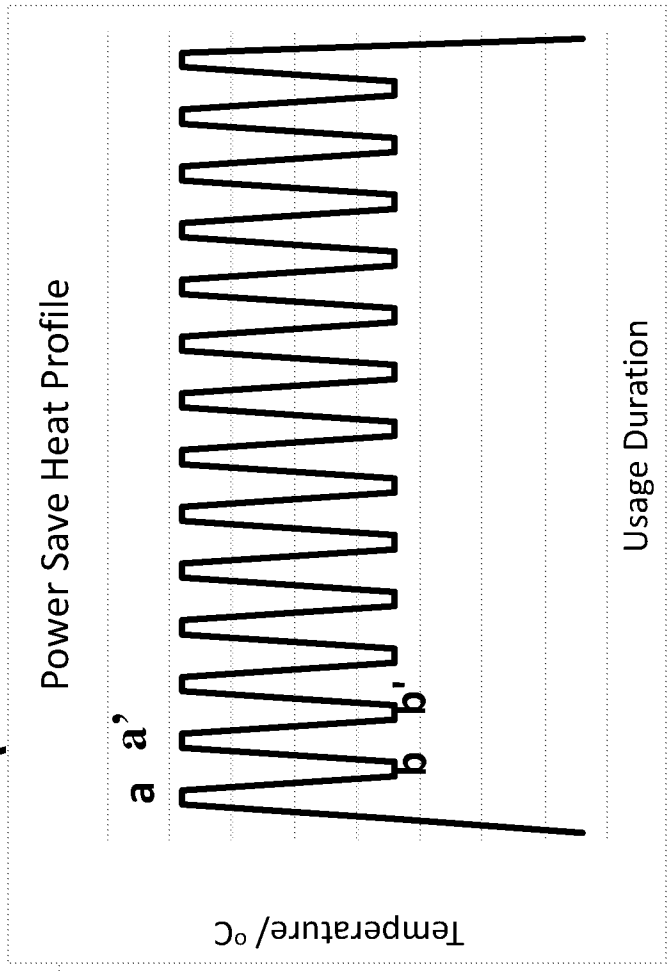


Figure 16B

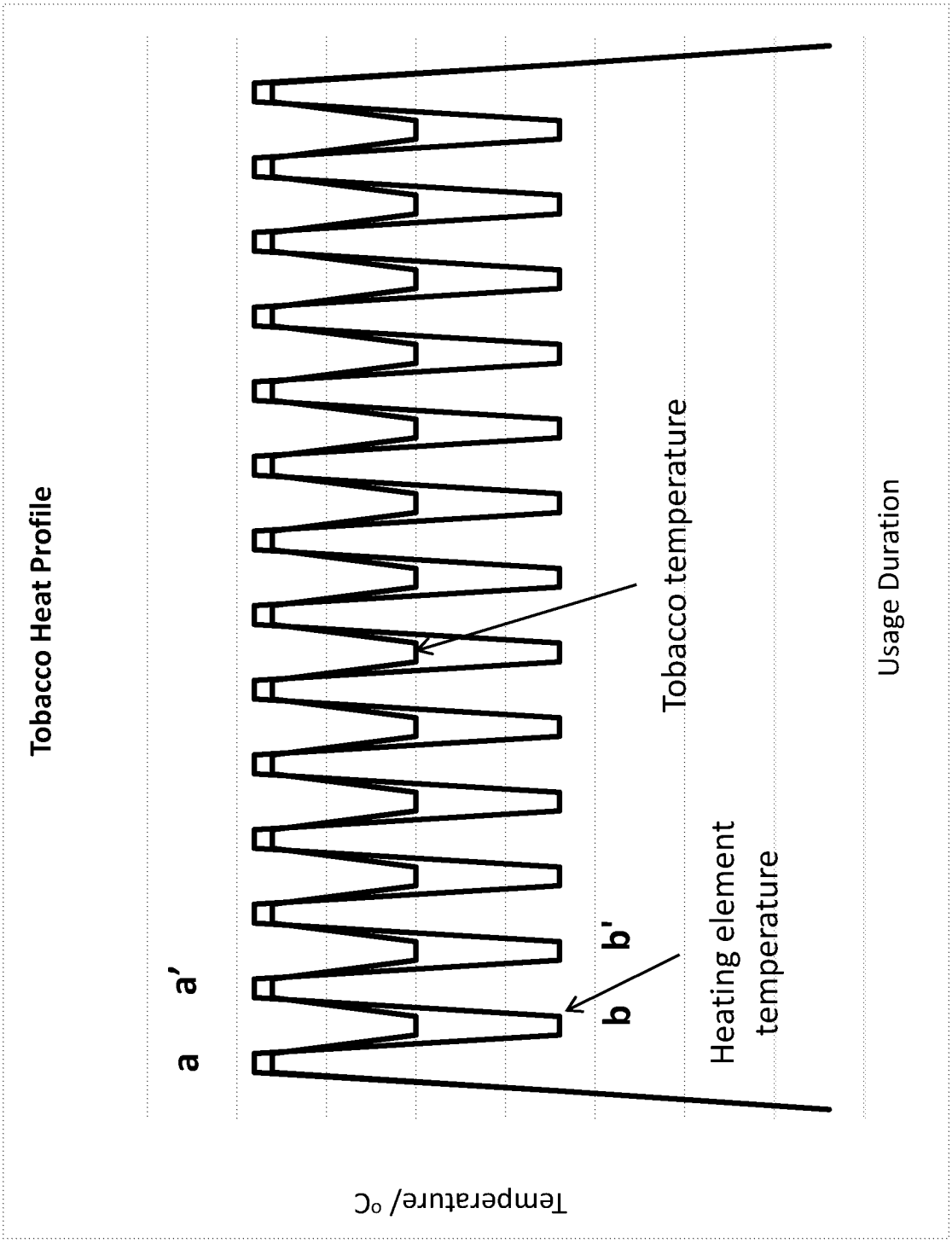

Tobacco Heat Profile
a
a'
b
b'
Tobacco temperature
Heating element temperature
Usage Duration
Temperature/ °C

Figure 17

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG2019/050643

A. CLASSIFICATION OF SUBJECT MATTER

A24B 3/00 (2006.01) ***A24D 1/08 (2006.01)*** ***H05B 1/00 (2006.01)*** *A24D 3/18 (2006.01)*

According to International Patent Classification (IPC)

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A24B 3/00; A24D; H05B 1/00

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

FAMPAT: Tobacco, heat-transmitting material, integral, homogenously heated, heating device, electronic control unit, removable, constant power, heating cycle, power-saving, 烟草, 传热, 整体, 均匀加热, 控制, 可拆开, 恒功率, 加热周期, 省电, and related terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/0258139 A1 (ONISHI M. ET AL.) 14 October 2010 Paragraphs [0004, 0007, 0034, 0039, 0041, 0046, 0048, 0049, 0053, 0054]; Figures 1A-C, 2F, 2H	1-42, 55-60
A	CN 107594634 A (WUHAN TENGNING NEW MATERIAL TECH CO LTD) 19 January 2018 Pages 3-5; Examples 4, 5; Figure 1 of the machine translation	1-42, 55-60
A	CN 206453230 U (CHINA TOBACCO GUANGDONG IND CO) 1 September 2017 Pages 2, 3, 7, 8; Figure 1 of the machine translation	1-42, 55-60
A	US 2017/0055582 A1 (BLANDINO T. P. ET AL.) 2 March 2017 Paragraphs [0019, 0054, 0061, 0078, 0102, 0104]; Figures 1, 2	1-42, 55-60
X	US 2017/0042250 A1 (TAKEUCHI M. ET AL.) 16 February 2017 Paragraphs [0001, 0036, 0043, 0048, 0070, 0109, 0113, 0186]; Figures 1, 2	43-54

☒ 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

"D" document cited by the applicant in the international application

"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 another citation or other special reason (as specified)

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

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

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

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

"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
10/03/2020 *(day/month/year)*	*27/03/2020* *(day/month/year)*

Name and mailing address of the ISA/SG

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2018/0042306 A1 (ATKINS A. ET AL.) 15 February 2018 Paragraphs [0003, 0025, 0039, 0053, 0076, 0083, 0088]; Figures 5, 9	43-54
X	US 2018/0070648 A1 (MONSEES J. ET AL.) 15 March 2018 Paragraphs [0062, 0154, 0175, 0214, 0277, 0279, 0282, 0293, 0305]; Figures 1, 2	43-54
X	US 2017/0188634 A1 (PLOJOUX J. ET AL.) 6 July 2017 Paragraphs [0016, 0026, 0033, 0042, 0067, 0071, 0075, 0079]; Figures 1, 5	43-54

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Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:

   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:

   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:

   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please refer to Supplemental Box (Continuation of Box No. III).

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

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PCT/SG2019/050643

Supplemental Box
(Continuation of Box No. III)

This International Searching Authority found multiple inventions in this international application, as follows:

Invention I: Claims 1-42 and 55-60 relate to a tobacco unit of a heatable tobacco product comprising: a tobacco material, and a heat-transmitting material integrally attached to the tobacco material to form a single composite material, wherein the tobacco unit is configured to receive heat from a heating element coupled to the heatable tobacco product, and the heat-transmitting material is adapted to form a plurality of heat transmitting paths for distributing heat across the tobacco unit such that the tobacco material of the tobacco unit is homogenously heated at a temperature lower than a combustion temperature of the tobacco material for generating an aerosol for inhalation.

Invention II: Claims 43-54 relate to a heating device to be used (*suitable for use*) with a heatable tobacco product, the heating device comprising: one or more heating elements arranged to produce and transmit heat to the a heatable tobacco product coupled to the heating device, the heatable tobacco product comprising a tobacco unit according to any one of claims 1 to 9; and an electronic control unit for controlling the operation of the heating device, wherein the tobacco unit is configured to receive heat from the one or more heating elements, and the heat-transmitting material of the tobacco unit is adapted to form a plurality of heat transmitting paths for distributing heat across the tobacco unit such that the tobacco material of the tobacco unit is homogenously heated at a temperature lower than a combustion temperature of the tobacco material for generating an aerosol for inhalation.

Please refer to **Box No. IV** of Written Opinion of The International Searching Authority (Form PCT/ISA/237) for detailed explanation.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SG2019/050643

Note: This Annex lists known patent family members relating to the patent documents cited in this International Search Report. This Authority is in no way liable for these particulars which are merely given for the purpose of information.

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		KR 20180036764 A	09/04/2018
		EP 3344078 A1	11/07/2018
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International application No.
PCT/SG2019/050643

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