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(54) HEATING UNIT WITH INTUMESCENT MATERIAL INSULATION FOR AN AEROSOL-GENERATING DEVICE

(57) The present invention relates to a heating unit for an aerosol-generating article, the heating unit comprising a heating oven configured to heat an aerosol-forming substrate of an aerosol generating article when received within the heating oven; wherein the heating oven is thermally insulated by a layer of intumescent material.

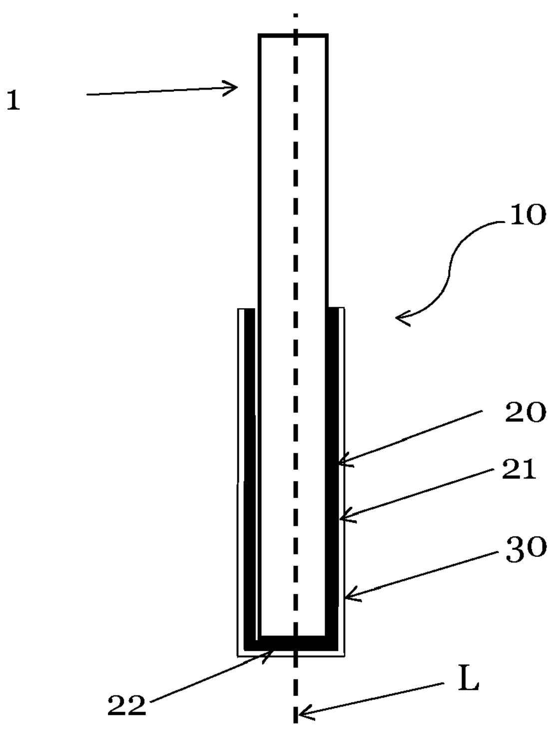

Fig. 1

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Description

Technical field

[0001] The present invention relates to a heating unit for an aerosol-generating device. The heating unit comprises a heating oven configured to heat an aerosol-generating article to generate an aerosol to be inhaled by a user. In particular, the present invention concerns such a heating oven which is thermally insulated by a layer of intumescent material. The invention further relates to a method of manufacturing such a heating unit, the use of a layer of intumescent material as a thermal insulant for such a heating unit and an aerosol-generating device and system.

Technical background

[0002] Aerosol-generating devices, in particular Electronic Nicotine Delivery Systems (known as ENDS) have become popular worldwide over the last decades. These devices are alternatives to traditional combustible tobacco products such as cigarettes.

[0003] Different types of aerosol-generating devices are currently available on the market, based on varying aerolisation technologies and aerosol-generating substrates. A particular subset of aerosol-generating devices is heated tobacco products, also known as "heat-not-burn" products and/or systems (HNB). These HNB systems can generate an inhalable aerosol from heating a tobacco containing substrate, usually in solid or pulverulent form. Such HNB systems require an electronic device comprising a heating unit to heat up a tobacco containing substrate instead of burning tobacco as performed in conventional cigarettes.

[0004] The above-mentioned heating units are usually provided with a heating cavity or oven, wherein an aerosol-generating article (or consumable) comprising tobacco, can be inserted. Subsequently, the tobacco of the consumable is heated until an aerosol is formed. The heating oven generates high temperatures between about 250 to 400°C, which contributes to a rapid formation of an aerosol that a user can inhale.

[0005] Heating ovens require significant thermal insulation to protect the surroundings of the heating unit and/or the aerosol-generating device from being heated and users to be harmed when holding the aerosol-generating device containing such heating oven in use. Furthermore, the space between the heating oven and its surroundings is typically limited, which makes the manufacture and assembly of the heating unit and its insulation means and/or of the aerosol-generating device difficult.

[0006] Conventional implementations of heating ovens in HNB devices fail to tackle these challenges or at least fail to tackle these challenges adequately. As an example, foam insulators are conventionally applied that require tapes for fixing and/or positioning the foam insulators accurately to insulate the heating ovens. Such conventional implementations can easily lead to a loss of insulation of the heating oven during ordinary use. In addition, it is difficult to insulate the heating oven's overall outer surface. Thus, thermal insulation cannot be ensured reliably, which also makes heating of an aerosol-generating article less effective. As another consequence, heating of the heating unit can occur, which is not intended. Furthermore, the process of manufacture and assembly of such conventional heating ovens is subject to space limitations. This often represents the bottleneck when it comes to correct positioning and attachment of wires around the heating oven. Thus, the process of manufacture and assembly of conventional heating ovens is impeded and cannot be automated easily. Rather, skilled labor is required and as a consequence, the process is time-consuming and costly.

[0007] Therefore, significant improvements are called for on such heating units and aerosol-generating devices comprising these heating units.

[0008] Against this background, an object of the present invention is to address one or more or all of the above-mentioned challenges. Particularly, it is an object of the present invention to provide an improved heating unit with a heating oven for an aerosol-generating article. The resulting heating oven will have enhanced thermal insulation, in particular at its surroundings. Accordingly, it is an object to prevent heat dissipation or heat loss to the surroundings of the heating oven. Additionally, it is an object to overcome space limitations associated with conventional heating units. Thus, a heating unit will be provided, which can be manufactured and assembled in a simpler way. Furthermore, the manufacture and assembly can be automated more easily than existing methods. Accordingly, it is also an object to facilitate an improved, costefficient and fast process of manufacture and assembly of such a heating unit.

[0009] These and other objects, which become apparent from the following description, are solved by the subject-matter of the independent claims. Preferred embodiments are subject of the dependent claims.

Summary of the invention

<u>General aspects</u>

[0010] A 1st embodiment of the invention is directed to a heating unit for an aerosol-generating article, the heating unit comprising: a heating oven configured to heat an aerosol-forming substrate of an aerosol-generating article when received within the heating oven; wherein the heating oven is thermally insulated by a layer of intumescent material.

[0011] The heating unit may be used in an aerosol-generating device to be held by a user. Thus, the aerosol-generating device may be a portable and/or a handheld aerosol-generating device that is comfortable for a user to hold. For instance, the aerosol-generating device may be held between the fingers and/ or in the palm of a single hand.

[0012] The heating unit may be configured to generate an aerosol for being inhaled by a user while a consumable, i.e. an aerosol-generating article is received (at least partially) within the heating oven.

[0013] An "aerosol-generating article" may also be referred to as a consumable or consumable article. Such an aerosol-generating article may comprise an aerosol-forming substrate, which can be heated to generate an aerosol and/or an inhalable vapor for the user.

[0014] The term "aerosol-forming substrate" is used to describe a substrate capable of releasing, upon heating, volatile compounds which can form an aerosol. The aerosol generated from the aerosol-forming substrates of the consumable may be visible or invisible and may include vapors, e.g. fine particles of substances, which are in a gaseous state. The aerosol generated may also comprise gases and liquid droplets of condensed vapors. The aerosol-forming substrate may be provided in a solid, gel-like, foamed or liquid form. In one example, the aerosol-forming substrate may be provided as a combination of the forms described herein. For instance, the aerosol-generating substrate may comprise tobacco in leaf or some other solid form such as reconstituted cast and/or crimped tobacco sheet. The tobacco may also be ground tobacco in particulate pulverulent form or in a foam or paste-like form.

[0015] An "intumescent material" as used herein may also be referred to as a reactive material. The behavior of such a material maybe based on the principle of intumescence. In this sense, intumescence of a material may be understood such that the material expands upon exposure to increased or elevated temperatures, i.e. upon exposure to heat. Such an expansion upon elevated temperatures may be greater than merely as a result of the material's coefficient of thermal expansion. As an example, upon reaching a certain temperature (trigger temperature), an intumescent material may expand, hence swell, significantly. This may be caused by a chemical process initiated by heat. It is also possible that swelling occurs rapidly. Upon chemical reaction, a char may be generated. Thus, an intumescent material may also be referred to as a material that is "swelling while charring". Accordingly, the intumescent material may form an insulation, such as an insulating foam, when exposed to heat and/or elevated temperatures. Therefore, an intumescent material may provide for an improved thermal insulation. Another advantage of the intumescent material is that it provides a safe chemical profile with respect to handling and environment (e.g. it is halogen-free protection), which is appreciated by a user. The intumescent material as used herein may refer to a material that substantially remains in the expanded shape or state even when no longer exposed to heat (small variations may still be possible). The expansion of the intumescent material may also be understood such that the material's thickness and/or volume is increased and/or that the material's density is reduced.

[0016] The intumescent material may comprise any suitable material or materials that may swell as described above. Such a heat may be caused by the heating oven during ordinary use. By way of example, the intumescent material comprises an organic chemical compound. This may be starch or one or more pentaerythritols (or other types of polyalcohol). The intumescent material may also comprise an acid, such as ammonium polyphosphate. The intumescent material may also comprise a blowing agent such as melamine. Optionally, the intumescent material may comprise a binder, such as soy lecithin. As an example, a material comprising Toluene, Melamine and N-butyl acetate may be used (e.g. "char 22" or "char 22 pittura" by iris coatings s.r.1) as intumescent material.

[0017] With such substances, the mechanism of the intumescent material upon heating could be understood as follows: The acid source of the intumescent material may enhance charring of the carbon source upon heat. Subsequently, a gas that may be released from the blowing agent facilitates such charring to increase the material's thickness and/or volume.

[0018] It may also be possible that an agent for enhancing the formation of an insulating foam is added, such as chlorinated paraffins. In another example, a mixture of sodium silicate and graphite may be comprised by the intumescent material. In such an example a hard char foam may be generated when the material is exposed to elevated temperatures.

[0019] Such elevated temperatures may occur during use of the heating unit and/or the heating oven or before first use thereof, typically upon manufacturing of an aerosol-generating device comprising such heating unit.

[0020] The "layer" of intumescent material may be understood as a covering, film, wrapping or coating.

[0021] The heating oven is "thermally insulated", which means that less heat is transferred towards the surroundings of the heating unit (and/or heating oven) than inside the heating oven.

[0022] The above arrangement of the 1st embodiment has the advantage that the thermal insulation of the heating oven is improved. By the layer of intumescent material, thermal insulation of the heating oven is facilitated and simplified compared to conventional thermal insulation means. The intumescent material permits such thermal insulation in a more reliable, predictable and reproducible manner. Thereby, the overall heating efficiency of the heating unit is improved. This saves costs and power consumption during the lifecycle of the heating unit. Additionally, such an arrangement may improve battery duration. Furthermore, the heating unit's complexity can be reduced in comparison to conventional insulation means.

[0023] Another advantage is that the manufacturing of such a heating unit may be improved significantly. Providing a layer of intumescent material for thermally insulating the heating oven can be easily automated. Thus, manufacturing can be accelerated and errors or faults during such manufacturing can be eliminated. In particular, conventional means for insulation such as conventional foam insulators require additional tapes for accurately fixing and/or positioning the foam insulators. The inventors found a way to obviate the burden of managing such separate elements (foam and additional tapes). Thus, the layer of intumescent material provides a simplified solution for thermal insulation. In particular, there is no need any longer for dealing with different material expansions due to different thermal expansion coefficients of conventional materials. Accordingly, the proposed arrangement paves the way for cost-effective and fast manufacturing of the heating unit.

[0024] Additionally, the heating unit may provide an improved overall assembly of its parts. The intumescent material may swell, e.g. increase its thickness, after reaching an elevated temperature. This increases an installation space for assembly before reaching an elevated temperature. Thereby, assembly of different parts, such as wires and/or cables in proximity of the heating oven is enhanced. In addition, the core material volume (VMC) of the heating unit can be reduced (e.g. due to swelling, provision of a thin layer before reaching an elevated temperature may be sufficient), which reduces the costs of the heating unit's parts.

Function/ expansion of the layer of intumescent material

[0025] According to a 2nd embodiment, in the preceding embodiment, the layer of intumescent material is configured to be triggered when heated once to a trigger temperature.

[0026] The layer of intumescent material being triggered may be understood such that the intumescent material is activated. In this manner, chemical reactions may take place, which lead to expansion of the intumescent material and reduction of the density thereof. Thereby, a lightweight heating unit may be provided.

[0027] Heating "once" to a trigger temperature may be understood in such a manner that triggering of the intumescent material occurs when reaching the trigger temperature for the first time. Once the trigger temperature has been reached for a substantial time period, the volume of the layer of intumescent material may remain substantially constant over time, irrespective of further temperature variations of the intumescent material and its surroundings, such as the heating oven temperature.

[0028] This arrangement has the advantage that triggering, e.g. activation can be performed in a plannable, reliable, predictable and reproduceable manner.

[0029] According to a 3rd embodiment, in any one of the preceding embodiments, the trigger temperature is at least about 200°C.

[0030] The trigger temperature may also be greater than 200°C, depending on the intumescent material applied. For instance, it may be possible that the trigger temperature is at least 210°C, 220°C, 230°C or more. The skilled person understands that the trigger temperature depends on the intumescent material arranged on the heating oven.

[0031] According to a 4th embodiment, in any one of the 2nd or 3rd embodiments, the thermal resistance of the layer of intumescent material increases when the layer of intumescent material is triggered.

[0032] An increased thermal resistance may be understood as an increased capacity of the layer of intumescent material to reduce temperature across a thickness of the layer of intumescent material. From the perspective of physics, thermal resistance is a quantification of how difficult it is for heat to be transferred through a material from a first point to a second point, distinct and distant from the first point. Practically speaking, the effect of thermal resistance of a material is to dampen heat transfer within the material from the first point to the second point such that the temperature T2 at the second point is lower than the temperature Ti at the first point, i.e. T1>T2. In the context of the present invention, the thermal resistance of the layer of intumescent material may increase due to an increased thickness upon triggering the layer of intumescent material. It may also be possible that the thermal conductivity of the material reduces, due to chemical reactions upon triggering. This additionally improves thermal insulation.

[0033] According to a 5th embodiment, in any one of the 2nd to 4th embodiments, the layer of intumescent material has, before it is triggered, a thickness of at least 5 micrometers (μm), preferably at least 10 μm, more preferably at least 20 μm, most preferably at least 30 μm and/or a thickness of at most 60 μm, preferably at most 50 μm, more preferably at most 30 μm, most preferably at most 30 μm.

[0034] The above arrangement has the advantage that a relatively low thickness of the layer of intumescent material is provided to the heating oven initially, i.e. upon manufacturing thereof. Such a layer of low thickness eases the assembly of the heating unit within an aerosol-generating device and/or improving compactness of such aerosol-generating device.

[0035] Before the layer is triggered, its thickness should not be too small, to allow for sufficient thermal insulation after triggering. The inventors found that an optimal balance of these contradicting requirements can be ensured according to the 5th embodiment. In particular, such a layer's thickness is found to be sufficient to enable and participate on the advances of the swelling upon triggering to reach and improved, e.g. increased thermal insulation.

[0036] According to a 6th embodiment, in any one of the 2nd to 5th embodiments, when the layer of intumescent material is triggered, the thickness of the layer of intumescent material increases by a factor of at least 10, preferably at least 20, more preferably at least 40, even more preferably at least 60, further more preferably at least 80, most preferably by a factor of at least 100 and/or by a factor of at most 200, preferably at most 180, more preferably at most 160, even more preferably at most

140, further more preferably at most 120, most preferably by a factor of at most 100.

[0037] The increase in the thickness of the layer of intumescent material, according to the above embodiment, may be measured under conditions in which there is substantially no physical prevention and/or limitation of the increase in thickness. The skilled person understands that in the event of a physical hindrance, obstruction and/or an obstacle, the increase in thickness may be less, e.g. the extent of the expansion may be limited. This may be the case if another part is in contact with and/or is pressed against the layer of intumescent material. Generally, this should not be the case according to the invention.

[0038] By way of example, an increase by a factor of 100 means that the thickness after triggering may be about 3 mm, if the thickness before triggering is 0.03 mm (3 mm / 0.03 mmm = 100). The above-mentioned factors of the increase in thickness significantly improve the thermal insulation of the heating oven. Thus, the overall heating efficiency of the heating unit is enhanced. An optimal balance should be struck between sufficient thermal insulation (high factors desired) and an acceptable expansion (lower factors desired) to facilitate positioning after triggering.

[0039] As an example, it may be possible that the layer of intumescent material is arranged around the heating oven, wherein the heating oven has a substantially cylindrical shape. In such a case, the thickness of the layer of intumescent material may be measured along a radial direction. Accordingly, the layer of intumescent material may expand radially by the factor specified in the 6th embodiment upon triggering.

[0040] According to a 7th embodiment, in the preceding embodiment, the layer of intumescent material substantially maintains the increased thickness even after the temperature of the intumescent material is reduced to between 25°C and 50°C, preferably to between 25°C and 30°C, most preferably to 25°C.

[0041] To "maintain" the increased thickness may be understood such that the thickness does not substantially vary, alter, change, or deviate. It should be understood that the increase of thickness usually occurs once the trigger temperature is reached (for the first time). Typically, a short period of time is required and may be sufficient for the layer of intumescent material to reach a certain increase in thickness. As an example, the short period of time may be in the ordner of magnitude of one or more seconds. In one example, the short period of time may be comparable with a heating time of the oven (e.g. the oven reaching a targeted temperature to provide for an aerosol for the user). After such triggering or activation, the temperature to which the layer of intumescent material is exposed has a substantially negligible effect on the thickness of the layer of intumescent material.

[0042] Preferably, there is no effect on the thickness of the layer of intumescent material after such triggering or activation, e.g. if the temperature is significantly reduced. For instance, if use of the heating unit is stopped, the temperature of the layer of intumescent material may cool down to about ambient temperature, e.g. about 20°C to 25°C. This may have no substantial effect on the layer's thickness. Furthermore, elevating the temperature of the layer of intumescent material again, to the trigger temperature or higher may not have an impact on its thickness.

[0043] The arrangement of the 7th embodiment improves manufacturing and assembling the heating unit. Maintaining the increased thickness of the layer of intumescent material provides the advantage that the spaces, areas and/or dimensions within the heating unit can be determined before the assembly more accurately. Such spaces, areas and/or dimensions can thereby be predicted in a more reliable and reproducible manner. As an example, knowing the space filled after and before triggering the layer of intumescent material allows to avoid unused space within the heating device. This provides for a more compact heating unit while guaranteeing excellent thermal insulation.

Arrangement/shape of the layer of intumescent material

[0044] According to an 8th embodiment, in any one of the preceding embodiments, the layer of intumescent material is arranged at an outer surface of the heating oven.

[0045] The outer surface of the heating oven may be understood as the surface opposite the surface that faces a consumable when it is received within the heating oven. In other words, the outer surface is substantially directed to the outside or surroundings of the heating oven. Thus, the outer surface of the heating oven faces other parts of the heating unit and aerosol-generating device containing such a heating unit/heating oven. Such other parts should not be heated, since they may be damaged. It also adversely affects the heating efficiency of the heating unit. Further, the outside of the heating unit and/or the outside of an aerosol-generating device comprising such a heating unit should not be heated, as this discomforts and impairs normal use by a user.

[0046] The arrangement of the layer of intumescent material at an outer surface of the heating oven means that at least part of the outer surface is covered by the layer. Thereby, the heating oven is thermally insulated, such that heat is substantially prevented from being transmitted to the remaining parts of the heating unit and/or the outside of the heating unit. This promotes heating efficiency and comfort for the user. By way of example, the layer of intumescent material being "arranged" at an outer surface of the heating oven can be understood in that the layer is applied, sprayed, dipped, coated or otherwise deposited on the heating oven. Preferably it is fixed on the heating oven.

[0047] According to a 9th embodiment, in any one of the preceding embodiments, a cross-section of the heating oven is U-shaped, and the layer of intumescent material is arranged at the outer side surface(s) and the outer bottom surface of the heating oven.

[0048] The cross-section of the heating oven may be viewed for instance with respect to a longitudinal axis of the heating oven. Typically, the longitudinal axis may be arranged substantially parallel to the direction of insertion of a consumable into the heating oven. The layer of intumescent material is arranged at the outer side surface(s) and the outer bottom surface of the heating oven to improve thermal insulation. In this manner, substantially the overall exterior of the heating oven may be thermally insulated. If the heating oven has a cylindrical shape, the outer side surface may also be referred to as the shell surface. Furthermore, the outer bottom surface may be referred to as a front face of the cylinder.

[0049] With such an arrangement, also the outer bottom surface of the heating oven can be easily insulated. Typically, the bottom surface is difficult to access during assembling the heating unit and may be a weak point in terms of thermal insulation. Conventional insulation means, such as (thick) foam insulators, fail to account for the challenging outer bottom surface. The inventors found a way to successfully overcome and encounter this issue. The provision of the layer of intumescent material on the outer bottom surface of the heating oven may not require more effort than the provision of the layer of intumescent material on the outer side surface(s). For instance, the manufacturing step of the layer of intumescent material on the outer bottom surface may be performed at the same time as the one on the outer side surface(s). Accordingly, the heating unit is eligible for a simplified and cost-effective manufacturing.

[0050] In addition, the overall thickness of the layer of intumescent material may be easily controlled and determined at the same time. This promotes an even thermal insulation of the heating unit. However, it may also be possible to provide parts of (an) outer surface(s) of the heating oven with a relatively thicker layer of intumescent material compared to other parts of (an) outer surface(s). In one example, it may be possible to arranged a further layer of intumescent material on one portion, e.g. one side of the oven. This could be beneficial it said one portion (e.g. one side) is closer to a surrounding part (e.g. a case or a thermally frigile or already warm component, thus requiring better insulation). This further enhances the control and predefinition of thermal insulation according to local heat deviations of the heating oven. This may be important if parts of (an) outer surface(s) of the heating oven become(s) hotter during ordinary use of the heating unit than other parts.

Further layers

[0051] According to a 10th embodiment, in any one of the preceding embodiments, a primer layer, preferably comprising epoxy or silicone, is arranged between an outer surface of the heating oven and the layer of intumescent material.

[0052] A primer layer may be understood as a layer that can at least partially interact with the layer of intumescent material. The primer layer aids at improving adhesion of the layer of intumescent material to the heating oven. It may be possible that the primer layer chemically reacts with the layer of intumescent material to further improve adhesion. In addition, it is possible that the outer surface of the heating oven is treated, e.g. by way of sandblasting, cleaning, laser scratching or plasma surface treatment. This can further enhance adhesion of the layer of intumescent material to the heating oven. As an example, the primer layer could be understood to be applied, sprayed, dipped, painted or otherwise put on the heating oven. Preferably it is fixed to the heating oven.

[0053] If the primer layer is arranged as described in the 10th embodiment, the layer of intumescent material may not directly contact an outer surface of the heating oven. Rather, the layer of intumescent material may directly contact the primer layer. Nevertheless, the layer of intumescent material is arranged "at" an outer surface of the heating oven because it is arranged in close proximity to the surface and thermally insulates the heating oven, e.g. at the outer side surfaces and the outer bottom surface of the heating oven.

[0054] According to an 11th embodiment, in any one of the preceding embodiments, a top layer is arranged on top of the layer of intumescent material.

[0055] The top layer may be understood as a layer that is exposed to the exterior and/or surroundings of the heating oven. Thus, it is not located on the inner side of the heating oven, where a consumable may be received. The top layer may be referred to as the outermost layer of the heating oven. As an example, the top layer could be applied, sprayed, dipped, painted or otherwise put on the layer of intumescent material. Preferably it is fixed to the layer of intumescent material.

[0056] The top layer may aid in protecting the layer of intumescent material. For instance, the heating unit maybe exposed to or subject to environmental impacts such as humidity, dust and/or dirt. This may be the case if the heating unit is not used for a longer period of time. As an example, condensation of humidity in the air could take place, resulting in the formation of water droplets. Such droplets could adversely affect the functioning of the layer of intumescent material. This may apply before triggering, but also after triggering. Accordingly, the top layer can beneficially counteract any degradation of the layer of intumescent material.

Tube

[0057] According to a 12th embodiment, in any one of the preceding embodiments, the heating unit further comprises a tube that houses the heating oven and the layer of intumescent material.

[0058] A tube is a substantially hollow elongated part. The tube houses, e.g. encompasses or encloses the heating oven and the layer of intumescent material. The skilled person understands that it may also house the primer and/or top layer if these layers are applied. The tube may act as a container and/or reflector of infrared radiation. Thus, heat reaching the tube may be substantially reflected. This aids in keeping the outside of the heating unit cooler as compared to its inside and in particular as compared to the heating oven. Furthermore, this improves heating efficiency. The tube may also serve the purpose of holding the remaining parts of the heating unit together. Typically, the tube should not be heated. This may be achieved by the layer of intumescent material.

[0059] As an example, the tube may have a substantially cylindrical shape. This facilitates assembling the heating unit. E.g., the heating oven may be easily placed at least partially into the tube. Assembling is even further advanced if the heating oven is shaped so as to match the shape of the tube. For instance, the heating oven may also have a substantially cylindrical shape.

[0060] According to a 13th embodiment, in the preceding embodiment, a gap is provided between an outer surface of the heating oven and the tube.

[0061] The gap may be understood as a substantially empty space. This improves assembling of the heating unit because connecting the heating oven to other parts may be facilitated. As an example, electrical connection to a power supply is enhanced, because more space is obtained for wires and/or cables to be positioned appropriately. Such an approach may also be eligible for automation, which reduces production costs. In addition, such a gap eliminates errors during manufacturing. Overall, a more reliable heating unit can be provided.

[0062] The gap may be measured between the outer surface of the heating oven and the tube. Accordingly, the thickness of the primer layer, of the layer of intumescent material and of the top layer may not be decisive in measuring such a gap.

[0063] According to a 14th embodiment, in the preceding embodiment, the gap is at least 0.5 mm, preferably at least 1.0 mm, more preferably at least 1.5 mm, even more preferably at least 2.0 mm, most preferably at least 3.0 mm and/or at most 5 mm, preferably at most 4.5 mm, more preferably at most 4.0 mm, even more preferably at most 3.5 mm, most preferably at most 3.0 mm.

[0064] The size of the gap can depend on the desired installation space, the size of the consumable to be heated, the envisaged increased thickness of the triggered layer of intumescent material and/or the envisaged thermal insulation (which may be conflicting targets). The gap should not be too large, otherwise there could be empty space left after triggering, which leads to a less compact heating unit. The gap should not be too small and allow sufficient installation space. Accordingly, an optimal balance should be struck.

[0065] As an example, if the tube and the heating oven have a substantially cylindrical shape, the gap may be measured in a radial direction. Furthermore, the gap may be constant along the circumferential direction. In other cases, it may not be constant along the circumferential direction; e.g. the gap may not be circumferentially symmetrical or substantially non-symmetrical.

[0066] According to a 15th embodiment, in the 2nd embodiment and any one of the 13th or 14th embodiments, before the layer of intumescent material is triggered, the gap is filled with the layer of intumescent material by at most 10%, preferably at most 6%, more preferably at most 4%, even more preferably at most 2%, most preferably at most 1% and/or at least 0.1%, preferably at least 0.2%, more preferably at least 0.4%, even more preferably at least 0.6%, most preferably at least 1%.

[0067] The gap is filled with the layer of intumescent material by certain amounts, which means that the layer occupies part of the gap by certain amounts. Before triggering, such occupied space maybe small. This improves assembling. The occupied space may be dependent upon one or more of the above-mentioned conflicting targets, e.g. the envisaged increased thickness of the triggered layer of intumescent material (upon reaching the triggering temperature). An optimum balance is found to account for these conflicting targets.

[0068] Preferably, the filling of the gap is constant along a circumferential direction. It is, however, also possible that the gap is not constantly filled along a circumferential direction.

[0069] According to a 16th embodiment, in the 2nd embodiment and any one of the 13th to 15th embodiments, after the layer of intumescent material is triggered, the gap is filled with the layer of intumescent material by at least 60%, preferably at least 80%, more preferably at least 90%, even more preferably at least 94%, most preferably at least 96%.

[0070] Upon triggering, the layer of intumescent material increased its thickness. Thereby, the gap is filled to a large extent. This allows for a compact design of the heating unit. In addition, the installation space before triggering is beneficially reduced or completely occupied after triggering. This is advantageous, since after assembly, access to the outer surface of the heating oven may not be required. Instead, thermal insulation becomes important, which is also ensured by way of the increased thickness. Such filling of the gap also increases a structural integrity of the heating unit. In this manner, structural advantages are provided if external forces act upon the heating unit, e.g. when the device with the heating unit is dropped on a floor.

[0071] The gap may be filled to almost 100%. The extent to which the gap is filled could depend on the presence of the primer layer and the top layer and their respective thicknesses. Typically, their thickness may be small. The extent to which the gap is filled could also depend on other parts that may be located within the gap. For instance, one or more cables and/or wires may be located in the gap for providing an electrical connection to a power supply. It may be the case that the cables and/or wires are shifted radially towards the tube by the triggering. This could enhance durability, longevity or service life of these parts, because they are shifted away from the heating oven.

Method of manufacturing

[0072] A 17th embodiment of the invention is directed to a method of manufacturing a heating unit for an aerosol-generating article, the method comprising the steps of:

a) applying a layer of intumescent material on an outer surface of a heating oven configured to heat an aerosol-forming substrate of an aerosol-generating article when received within the heating oven;
b) heating the layer of intumescent material to a temperature of at least about 200°C to increase a thickness of the layer of intumescent material by a factor of at least 10, preferably at least 20, and at most preferably by a factor of at most 100.

[0073] The features and advantages as set forth above with respect to the heating unit according to any one of the 1st to the 16th embodiments mutually apply to the method of manufacturing such a heating unit for an aerosol-generating article. Thus, it is understood that features described with reference to the heating unit may also be used to describe the method. Likewise, the skilled person recognizes that features and advantages described with reference to the method of manufacturing are also applicable to the heating unit.

[0074] Method step a) may comprise that the heating oven is configured to heat an aerosol-forming substrate of an aerosol-generating article when received within the heating oven to generate an aerosol for being inhaled by a user while the aerosol-generating article is received within the heating oven. As an example, the heating unit may be used in an aerosol-generating device to be held by a user.

[0075] Method step b) may comprise that the thickness of the layer of intumescent material is increased by a factor of at least 40, preferably at least 60, even more preferably at least 80, most preferably by a factor of at least 100 and/or by a factor of at most 200, preferably at most 180, more preferably at most 160, even more preferably at most 140, further more preferably at most 120.

[0076] It may be appreciated that method step b) may occur during ordinary use of the heating unit and/or heating oven, e.g. during the first time of using it. However, it may also be possible to provide for such elevated temperatures before ordinary use by the user. In this case, elevated temperatures may be applied before a final product, such as an aerosol-generating device comprising a heating unit, is delivered to a user.

[0077] According to an 18th embodiment, in the method of the preceding embodiment, step a) comprises dipping and/or spinning the heating oven in a solution comprising intumescent material, or spraying a solution comprising intumescent material onto the heating oven.

[0078] Such an application of the intumescent material onto the heating oven makes the method of manufacturing more cost-effective. This may particularly be the case in comparison to conventional means of insulation, e.g. conventional foam insulators with additional tapes for proper fixation and/or positioning, which are cumbersome to implement. It may also be possible that step a) comprises applying, painting, brushing, taping or otherwise putting the intumescent material onto the heating oven. Preferably, dipping and spinning is performed. Thus, proper fixation and control of the thickness can be achieved.

[0079] The application of the intumescent material onto the heating oven may be performed in one single and quick manufacturing step. Such a single step could easily be automated, which makes it advantageous in terms of mass production.

Use of intumescent material as a thermal insulant

[0080] A 19th embodiment of the invention is directed to a use of a layer of intumescent material as a thermal insulant for a heating unit of an aerosol-generating device.

[0081] Intumescent materials have been used in the technical field of fire protection to increase safety of critical components in the heavy industry sectors such as to protect structural steel in buildings. Such applications proved to be successful to increase integrity of the steel in case of external fires.

[0082] In a pioneering way, the inventors found a way to make such technology possible in the sector of aerosol-generating devices.

Aerosol-generating device and system

[0083] A 20th embodiment of the invention is directed to an aerosol-generating device comprising: a heating unit according to any one of the 1st to 16th embodiments; and a power supply configured to provide a current to the heating unit, for generating an aerosol to be inhaled by a user. Advantageously, the heating unit may be of a resistive heating type, e.g. comprising a heating element arranged in contact with the heating oven walls to transfer heat thereto by conduction. The heating unit may also be of inductive type, e.g. comprising at least one inductor coil arranged circumferentially about the heating oven and configured to inductively heat a susceptor element contacting or formed by said heating oven walls or a susceptor element arranged in a consumable article inserted in the heating oven. The heating unit may also be a microwave heating unit comprising the heating oven as a consumable receiving cavity, a microwave radiation source, in particular a solid-state transistor based microwave source and an impedance matching unit to achieve impedance matching between a consumable article inserted into the heating oven and the microwave field generated from the microwave source.

[0084] A power supply may be any suitable power supply, for example a DC voltage source, such as a battery, e.g. a lithium iron phosphate battery. Alternatively, the power supply may be a Nickel cadmium battery, a Nickel-metal hydride battery, or a Lithium based battery, for example a Lithium-Cobalt, a Lithium-Iron-Phosphate, Lithium Titanate or a Lithium-Polymer battery. The power supply may be located within a part of the aerosol-generating device, or it may be another form of charge storage device such as a capacitor. The power supply may allow for recharging and may have a capacity that allows for storing enough energy for one or more, preferably a multitude of ordinary use cycles of the aerosol-generating device.

[0085] A 21st embodiment of the invention is directed to an aerosol-generating system comprising the aerosol-generating device according to the 20th embodiment and an aerosol-generating article comprising an aerosol-forming substrate.

Brief description of the figures

[0086] In the following, preferred embodiments are described, by way of example only. Reference is made to the following accompanying figures:

Fig. 1 illustrates a heating unit for an aerosol-generating article according to a first embodiment of the invention before triggering the layer of intumescent material, in a side cross-sectional view;

Fig. 2 illustrates a heating unit for an aerosol-generating article according to the first embodiment of the invention after triggering the layer of intumescent material, in a side cross-sectional view;

Fig. 3 illustrates a part of a heating oven and layers of a heating unit according to a second embodiment of the invention, in a side cross-sectional view;

Fig. 4 illustrates a heating unit for an aerosol-generating article according to a third embodiment of the invention before triggering the layer of intumescent material, in a side cross-sectional view;

Fig. 5 illustrates a heating unit for an aerosol-generating article according to the third embodiment of the invention after triggering the layer of intumescent material, in a side cross-sectional view;

Fig. 6 is a flowchart of a method of manufacturing a heating unit for an aerosol-generating article according to an embodiment of the invention; and

Fig. 7 illustrates an aerosol-generating device and an aerosol-generating system according to an embodiment of the invention.

Detailed description of the figures

[0087] In the following, the invention is described with reference to the accompanying figures in more detail. However, the present invention can also be used in other embodiments not explicitly disclosed hereafter. As detailed below, the embodiments are compatible with each other, and individual features of one embodiment may also be applied to another embodiment.

[0088] Throughout the following figures and specifications, the same reference numerals refer to the same elements, unless stated otherwise. The figures may not be drawn to scale, and the relative size, proportions, and depiction of elements in the figures may be exaggerated for the purpose of clarity, illustration, and convenience. The figures do not limit the scope of the claims but merely support the understanding of the invention.

[0089] Fig. 1 shows a heating unit 10 for an aerosol-generating article 1, the heating unit 10 comprising a heating oven 20, which is configured to heat an aerosol-forming substrate of an aerosol-generating article 1 when the aerosol-generating article 1 is received within the heating oven 20. The heating oven 20 is typically formed by a substantially tubular cup of metallic material such as aluminium or stainless steel. The heating oven 20 is thermally insulated by a layer of intumescent material 30. Although shown in this figure, the aerosol-generating article 1 is generally not part of the heating unit 10. Thus, the heating unit 10 may be provided as an individual piece, separate from the aerosol-generating article 1.

[0090] The intumescent material is a reactive material. Based on the principle of intumescence, the material expands upon exposure to increased or elevated temperatures (trigger temperature). Typically, such an expansion occurs at elevated temperatures of at least about 200°C. It can be recognized that the material expansion is greater than the mere material expansion attributable to its coefficient of thermal expansion. This maybe discernable upon looking at and/or examining the heating unit, e.g. when comparing the layer of intumescent material 30 at different temperatures, including the trigger temperature. The intumescent material can comprise a carbon source, such as a starch or one or more pentaerythritols (or other types of polyalcohol), an acid source, such as ammonium polyphosphate and a blowing agent such as melamine. Such substances may result in increasing the thickness of the layer of intumescent material 30 when triggered. Upon triggering, the acid source of the layer of intumescent material 30 can enhance charring of the carbon source. Then, a gas released from the blowing agent can increase such charring to increase the thickness and/or volume of the layer of intumescent material 30. This beneficially reduces the density of the intumescent material.

[0091] The layer of intumescent material 30 is arranged at an outer surface 21 of the heating oven 20, which is the surface opposite to the surface that faces an aerosol-generating article 1, if such an article 1 is received within the heating oven 20. In this manner, the outer surface 21 is substantially directed to the outside or surroundings of the heating oven 10. Accordingly, the outer surface 21 of the heating oven 20 can face other parts of the heating unit 10, e.g. other parts that should not be heated. Upon triggering, the layer of intumescent material 30 can provide for improved thermal insulation to the surroundings of the heating oven 10. This entails several advantages. For instance, this makes heating of the aerosol-generating article 1 more efficient and reduces power consumption, thereby increasing battery duration. Furthermore, the surroundings and the outside of the heating unit 10 are prevented from becoming unintentionally hot. This may not be wanted as a user may get in touch with these parts.

[0092] In the embodiment of this figure, the heating oven 20 may be provided with a layer of intumescent material 30 by dipping and spinning. Thereby, a thickness 31 (not indicated in this figure) of the layer of intumescent material 30 can be controlled in a simplified manner. Such a processing can also be automated easily, which reduces manufacturing time and costs. The layer of intumescent material 30 has, before it is triggered, a thickness of at least about 5 μm (0.005 mm) to at most about 60 μm (0.06 mm). Preferably the thickness is about 30 μm.This has the advantage that a relatively low thickness of the layer of intumescent material is provided, which saves material costs. Another benefit attributable to this low thickness is that it supports assembling the heating unit 10. For instance, placement and positioning of wires and/or cables can be significantly simplified due to an increased installation space.

[0093] The embodiment of this figure can have a heating oven 20 which has a U-shaped cross-section. The cross-section of the heating oven 20 is shown in this figure as a cross-section along a longitudinal axis of the heating oven 20. Such longitudinal axis (indicated in this figure as a dashed line L) is arranged substantially parallel to the direction of insertion of an aerosol-generating article 1 into the heating oven 20.

[0094] The layer of intumescent material 30 is arranged at the outer side surface(s) 21 and the outer bottom surface 22 of the heating oven 20. The outer side surface(s) 21 and the outer bottom surface 22 of the heating oven 20 may be termed the (overall) outer surface 21 of the heating oven 20. Such an arrangement can improve thermal insulation, in particular around the overall outer surface 21 and exterior of the heating oven 20. As indicated in this figure, the heating oven 20 can have a cylindrical shape. Thus, the outer side surface 21 may be referred to as the shell surface of the cylinder and the outer bottom surface 22 may be referred to as a front face of the cylinder. A multitude of different shapes of the heating oven 20 are also possible and envisaged in the light of the present invention. In particular, the heating oven may exhibit a noncircular transversal cross-section perpendicularly to the longitudinal direction L. It may notably comprise at least two flat surfaces joined by arcuate sections, the flat surfaces offering compressing surfaces for improving heat transfer to an aerosol-generating consumable 1 when inserted in the heating oven 20.

[0095] Fig. 2 shows a heating unit 10 for an aerosol-generating article 1 according to the first embodiment of the invention after triggering the layer of intumescent material 30, in a side cross-sectional view. This embodiment corresponds to the embodiment shown in the previous figure. It can be seen, by way of the illustrating example, that the thickness 31 of the layer of intumescent material 30 is increased compared to the previous figure (indicated by a thick black line or thick black U-shape). Such an increase in thickness 31 may be in the range of a factor of at least 10 to a factor of at most 200 compared to the thickness 31 before triggering. As an example, the thickness 31 before triggering could be about 30 μm (0.03 mm) and the thickness 31 after triggering could be about 3 mm; thus, the thickness 31 is increased by a factor of 100.

[0096] It is particularly appreciated that also the outer bottom surface 22 is provided with an increased thickness 31 of the layer of intumescent material 30. Such an outer bottom surface 22 is typically difficult to access and to thermally insulate using conventional approaches for insulation. Thus, the illustrated embodiment significantly improves overall thermal insulation.

[0097] Once the layer of intumescent material 30 is triggered, it is appreciated that there is substantially no variation on the thickness 31 of the layer of intumescent material 30 afterwards. Thus, the thickness 31 is maintained or stays the same. This may even be so if the temperature of the intumescent material changes afterwards. However, in some cases the thickness 31 could vary slightly afterwards, which may be attributable to the coefficient of thermal expansion of the material. However, such an expansion may be low.

[0098] Fig. 3 shows part of a heating oven 20 and the layers 30, 40, 50 of a heating unit 10 (not shown completely in this figure) according to a second embodiment of the invention in a side cross-sectional view. This second embodiment is compatible with the previous embodiments and merely illustrates the arrangement of the layers 30, 40, 50. In comparison to the previous figures, this figure shows a part of the heating oven 20 which is rotated by about 90°.

[0099] A primer layer 40 is arranged between an outer surface 21 of the heating oven 20 and the layer of intumescent material 30. The primer layer 40 comprises epoxy or silicone and can (chemically) interact with the layer of intumescent material 30 to improve adhesion of the layer of intumescent material 30 on the heating oven 20. The primer layer 40 could be applied using a similar process as described with respect to the layer of intumescent material 30.

[0100] Furthermore, a top layer 50 is arranged on top of the layer of intumescent material 30. The top layer 50 is exposed to the exterior and/or surroundings of the heating oven 20, i.e. it faces away from an inner portion of the heating oven 20. To illustrate this, a dashed line is drawn in this figure, which may represent a central axis of the heating oven 20. The top layer 50 could be applied using a similar process as described with respect to the layer of intumescent material 30. The top layer 50 serves the purpose of protecting the layer of intumescent material 30 from environmental impacts. Such protection mutually applies and is mutually appreciated before and after triggering the layer of intumescent material 30. In particular, the top layer 50 can beneficially counteract any degradation of the layer of intumescent material 30. This improves longevity and integrity of the heating unit 10.

[0101] Although this figure shows all three layers, i.e. the primer layer 40, the layer of intumescent material 30 and top layer 50, it is understood that not all three layers are required. Rather, it is sufficient that the layer of intumescent material 30 is present, e.g. arranged on the outer side 21 of the heating oven 20. However, the additional arrangement of the primer layer 40 and the top layer 50 may aid in reaching the full potential of the advantageous effects of the layer of intumescent material 30 and its thermal insulation upon triggering.

[0102] Fig. 4 shows a heating unit 10 for an aerosol-generating article 1 according to a third embodiment of the invention before triggering the layer of intumescent material 30, in a side cross sectional view. This embodiment corresponds to the embodiment shown in Fig. 1.

[0103] In addition to the examples discussed above, the heating unit 10 of this figure comprises a tube 60, which houses the heating oven 20 and the layer of intumescent material 30. The tube 60 is a substantially hollow elongated part for enclosing the heating oven 20 and the layer of intumescent material 30. It is understood that it also houses the primer layer 40 and/or the top layer 50 if these layers are arranged on the heating oven 20 (as shown in the previous figure). The tube 60 acts as a container and/or reflector of infrared radiation. Thus, heat reaching the tube 60 may be reflected to keep the outside of the heating unit 10 cooler than its inside, and in particular than the heating oven 20. This additionally improves heating efficiency and increases user convenience.

[0104] As an example, a gap 61 can be provided between an outer surface 21 of the heating oven 20 and the tube 60. Such a gap 61 aids assembling the heating unit 10 because connecting the heating oven to other parts maybe facilitated and a space for installation is created. The gap 61 is at least 0.5 mm and may be at most 5 mm. Preferably the gap is about 3.0 mm. In this figure, the gap 61 may be constant along the circumferential direction. However, the gap 61 may also vary (in its width) along the circumferential direction. Before the layer of intumescent material 30 is triggered, the gap 61 is filled with the layer of intumescent material 30 by at most 10% and/or at least 0.1%, preferably it is filled by about 1%. This improves assembling significantly, since it is less prone to errors.

[0105] Fig. 5 shows a heating unit 10 for an aerosol-generating article 1 according to the third embodiment of the invention after triggering the layer of intumescent material 30, in a side cross sectional view. This embodiment corresponds to the embodiment shown in the previous figure.

[0106] Similar to Fig. 2 compared with Fig. 1, also this figure illustrates that the thickness 31 of the layer of intumescent material 30 is increased compared to the previous figure. Such an increase in thickness 31 may be of similar magnitude as previously described.

[0107] After the layer of intumescent material 30 is triggered, the gap 61 is filled with the layer of intumescent material 30 by at least 60%, preferably at least 80%, more preferably at least 90%, even more preferably at least 94%, most preferably at least 96%. Due to the schematic nature of this figure, the exact amount of filling cannot be visually shown; however, it should be at least 60%. Such a filling facilitates a compact design of the heating unit 10 and reduces the installation space which is present before triggering and which may not be needed anymore after triggering (since the assembly has already been performed). In addition, thermal insulation is increased due to the increased thickness 31 of the layer of intumescent material 30.

[0108] Fig. 6 shows a flowchart of a method 300 of manufacturing a heating unit for an aerosol-generating article according to an embodiment of the invention.

[0109] Method 300 comprises the steps of: a) applying (310) a layer of intumescent material on an outer surface of a heating oven configured to heat an aerosol-forming substrate of an aerosol-generating article when received within the heating oven; and b) heating (320) the layer of intumescent material to a temperature of at least about 200°C to increase a thickness of the layer of intumescent material by a factor of at least 10, preferably at least 20, and at most preferably by a factor of at most 100.

[0110] Fig. 7 shows an aerosol-generating device 100 and an aerosol-generating system 200 according to an embodiment of the invention. The system 200 comprises an aerosol-generating device 100 and an aerosol-generating article 1 comprising an aerosol-forming substrate.

[0111] The aerosol-generating device 100 comprises a heating unit 10 according to any one of the previously described embodiments. Furthermore, the aerosol-generating device 100 comprises a power supply 101 configured to provide a current to the heating unit 10, preferably to the heating oven 20, for generating an aerosol to be inhaled by a user. The power supply 101 can be any suitable power supply 101, for example a DC voltage source.

[0112] In all of the above mentioned embodiments, the heating unit 10 is a portable or handheld heating unit 10.

The same applies to the aerosol-generating device 100, the aerosol-generating system 200 and the aerosol-generating article 1. It is appreciated that these parts are comfortable for a user to hold between the fingers, for instance between the fingers of a single hand.

[0113] The scope of protection is determined by the claims and is not limited by the embodiments disclosed in the above figures.

List of reference signs

[0114]

1	aerosol-generating article
10	heating unit
20	heating oven
21	outer surface of the heating oven
22	outer bottom surface of the heating oven
30	layer of intumescent material
31	thickness of the layer of intumescent material
40	primer layer
50	top layer
60	tube
61	gap
100	aerosol-generating device
101	power supply
200	aerosol-generating system
300	method
310	method step: applying
320	method step: heating
L	Longitudinal axis of the heating oven

Claims

1. A heating unit (10) for an aerosol-generating article (1), the heating unit (10) comprising:

   a heating oven (20) configured to heat an aerosol-forming substrate of an aerosol-generating article (1) when received within the heating oven (20);
   wherein the heating oven (20) is thermally insulated by a layer of intumescent material (30).

2. The heating unit (10) according to the preceding claim, wherein the layer of intumescent material (30) is configured to be triggered when heated once to a trigger temperature.

3. The heating unit (10) according to the preceding claim, wherein the trigger temperature is at least about 200°C.

4. The heating unit (10) according to any one of claims 2 or 3, wherein the layer of intumescent material (30) has, before it is triggered, a thickness (31) of at least 5 micrometers (μm), preferably at least 10 μm, more preferably at least 20 μm, most preferably at least 30 μm and/or a thickness (31) of at most 60 μm, preferably at most 50 μm, more preferably at most 30 μm, most preferably at most 30 μm.

5. The heating unit (10) according to any one of claims 2 to 4, wherein, when the layer of intumescent material (30) is triggered, the thickness (31) of the layer of intumescent material (30) increases by a factor of at least 10, preferably at least 20, more preferably at least 40, even more preferably at least 60, further more preferably at least 80, most preferably by a factor of at least 100 and/or by a factor of at most 200, preferably at most 180, more preferably at most 160, even more preferably at most 140, further more preferably at most 120, most preferably by a factor of at most 100.

6. The heating unit (10) according to any one of the preceding claims, wherein the layer of intumescent material (30) is arranged at an outer surface (21) of the heating oven (20).

7. The heating unit (10) according to any one of the preceding claims, wherein a cross-section of the heating oven (20) is U-shaped, and the layer of intumescent material (30) is arranged at the outer side surface(s) and the outer bottom surface (22) of the heating oven (20).

8. The heating unit (10) according to any one of the preceding claims, wherein a primer layer (40), preferably comprising epoxy or silicone, is arranged between an outer surface (21) of the heating oven (20) and the layer of intumescent material (30).

9. The heating unit (10) according to any one of the preceding claims, further comprising a tube (60) which houses the heating oven (20) and the layer of intumescent material (30).

10. The heating unit (10) according to the preceding claim, wherein a gap (61) is provided between an outer surface (21) of the heating oven (20) and the tube (60).

11. The heating unit (10) according to the preceding claim, wherein the gap (61) is at least 0.5 mm, preferably at least 1.0 mm, more preferably at least 1.5 mm, even more preferably at least 2.0 mm, most preferably at least 3.0 mm and/or at most 5 mm, preferably at most 4.5 mm, more preferably at most 4.0

mm, even more preferably at most 3.5 mm, most preferably at most 3.0 mm.

12. The heating unit (10) according to claim 2 and any one of claims 10 or 11, wherein, before the layer of intumescent material (30) is triggered, the gap (61) is filled with the layer of intumescent material (30) by at most 10%, preferably at most 6%, more preferably at most 4%, even more preferably at most 2%, most preferably at most 1% and/or at least 0.1%, preferably at least 0.2%, more preferably at least 0.4%, even more preferably at least 0.6%, most preferably at least 1%.

13. The heating unit (10) according to claim 2 and any one of claims 10 to 12, wherein after the layer of intumescent material (30) is triggered, the gap (61) is filled with the layer of intumescent material (30) by at least 60%, preferably at least 80%, more preferably at least 90%, even more preferably at least 94%, most preferably at least 96%.

14. A method (300) of manufacturing a heating unit (10) for an aerosol-generating article (1), the method comprising the steps of:

a) applying (310) a layer of intumescent material (30) on an outer surface of a heating oven (20) configured to heat an aerosol-forming substrate of an aerosol-generating article (1) when received within the heating oven (20);
b) heating (320) the layer of intumescent material (30) to a temperature of at least about 200°C to increase a thickness (31) of the layer of intumescent material (30) by a factor of at least 10, preferably at least 20, and at most preferably by a factor of at most 100.

15. Use of a layer of intumescent material (30) as a thermal insulant for a heating unit (10) of an aerosol-generating device (100).

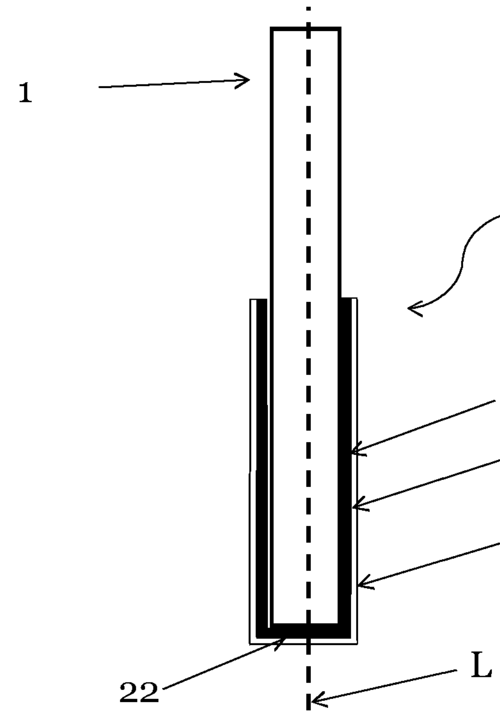

Fig. 1

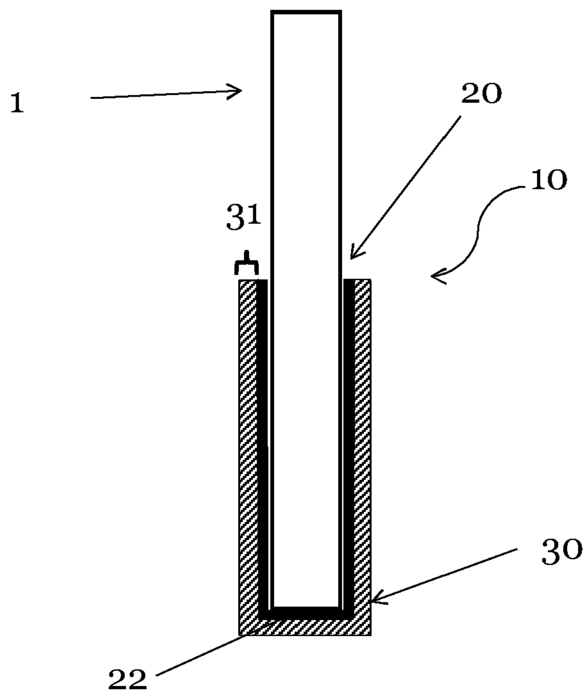

Fig. 2

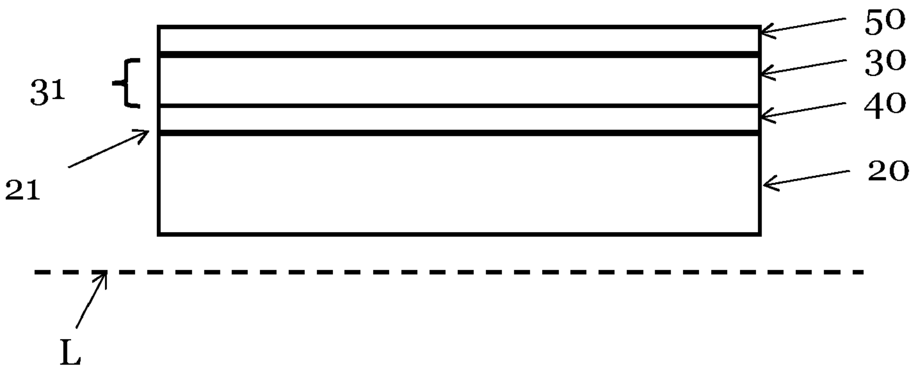

Fig. 3

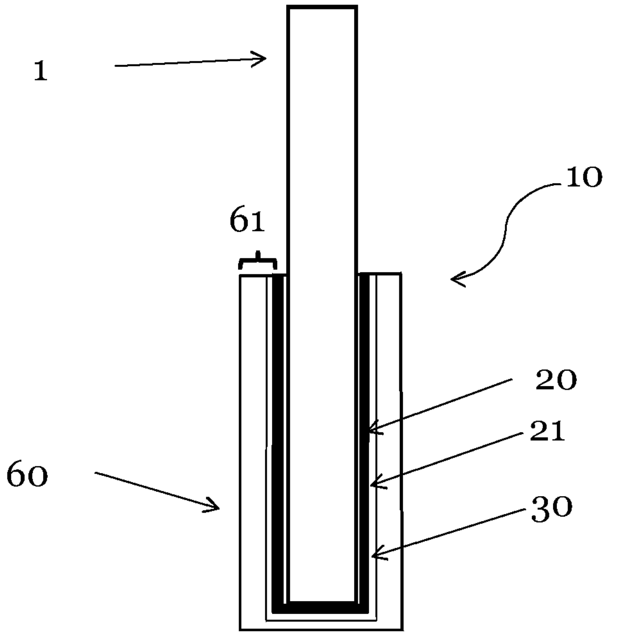

Fig. 4

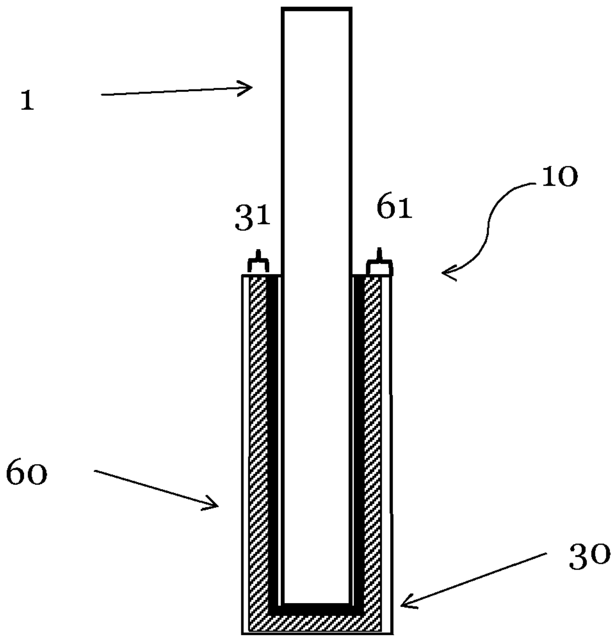

Fig. 5

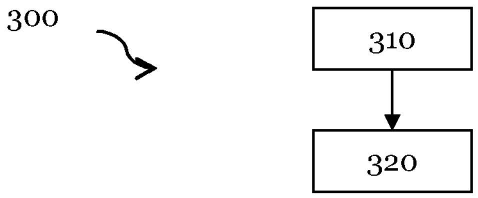

Fig. 6

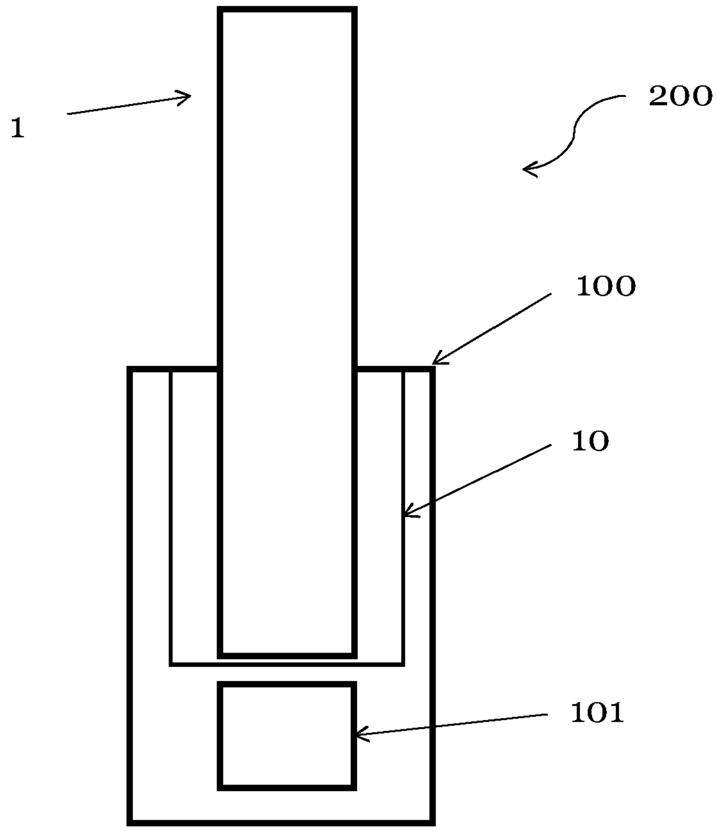

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 22 18 6386

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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CATEGORY OF CITED DOCUMENTS

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