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(54) **VAPOUR GENERATING UNIT**

(57) A vapour generating unit (34). The vapour generating unit (34) comprises a vaporisation device (36). The vaporisation device (36) comprises a positive temperature coefficient (PTC) heating element (38) configured to electrically couple to a power source (32) to receive a current flow and heat a vapour generating liquid to form an aerosol. The PTC heating element (38) comprises a porous PTC material having an electrical resistivity that varies based on temperature. In use, when the PTC heating element (38) is heated to a transition temperature, electrical resistivity of the porous PTC material increases to reduce current flow from the power source (32) to a level that limits further temperature increases of the PTC heating element (38). The PTC heating element (38) is arranged to hold and transfer a vapour generating liquid from a liquid store (22) by capillary action.

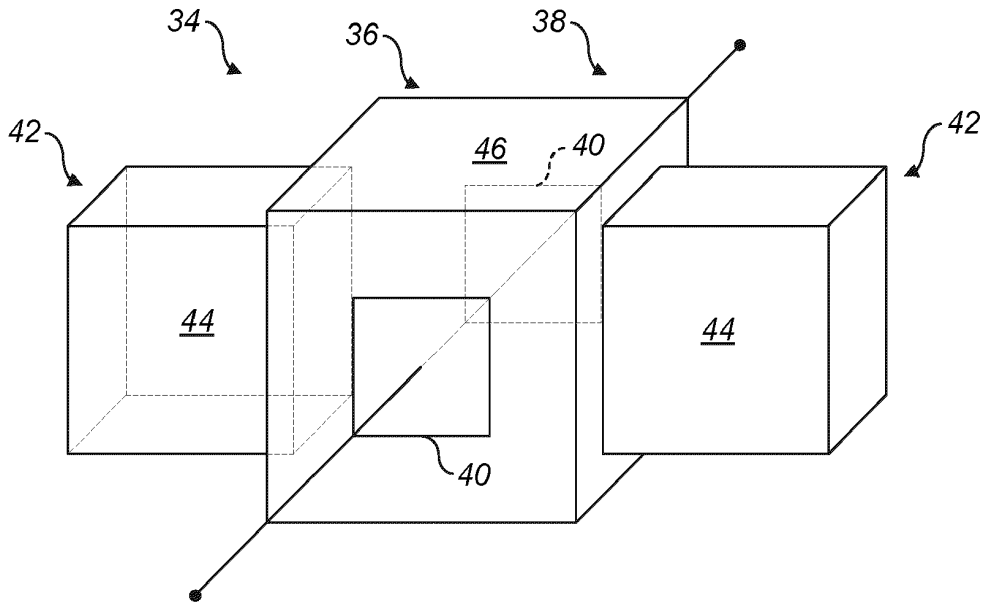

FIG. 2

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Description

Technical Field

[0001] The present disclosure relates generally to a vapour generating unit for a vapour generating device. The vapour generating device is configured to heat a vapour generating liquid to generate a vapour which cools and condenses to form an aerosol for inhalation by a user of the device.

Technical Background

[0002] The term vapour generating device (or more commonly electronic cigarette or e-cigarette) refers to a handheld electronic device that is intended to simulate the feeling or experience of smoking tobacco in a traditional cigarette. Electronic cigarettes work by causing a vapour generating liquid (or so called "e-liquid") to be heated by a vapor generating unit to generate a vapour that cools and condenses to form an aerosol which is then inhaled by the user.

[0003] Exceeding a required operating temperature of a vapour generating unit can lead to the formation of undesirable and potentially dangerous chemical by products.

[0004] There is, therefore, a need to provide vapor generating units which mitigate this drawback.

Summary of the Disclosure

[0005] According to a first aspect of the present disclosure, there is provided a vapour generating unit, the vapour generating unit comprising a vaporisation device, the vaporisation device comprising a positive temperature coefficient (PTC) heating element configured to electrically couple to a power source to receive a current flow and heat a vapour generating liquid to form an aerosol, wherein the PTC heating element comprises a porous PTC material having an electrical resistivity that varies based on temperature, wherein in use when the PTC heating element is heated to a transition temperature, electrical resistivity of the porous PTC material increases to reduce current flow from the power source to a level that limits further temperature increases of the PTC heating element, wherein the PTC heating element is arranged to hold and transfer a vapour generating liquid from a liquid store by capillary action.

[0006] The electrical resistivity of the porous PTC material significantly changes at the transition temperature. Accordingly, the PTC heating element is temperature self-limiting; a sharp increase in resistance reduces current flow from the power source to a level that limits further temperature increases of the PTC heating element.

[0007] The PTC heating element therefore enables a device with intrinsic temperature control at or near a desired operating temperature of the device, which operating temperature substantially corresponds to the transition temperature. By utilizing a PTC heating element with intrinsic temperature control, overheating (e.g., burning) of the vapour generating liquid can be prevented, thereby avoiding formation of unwanted, and potentially dangerous, chemical by products. Accordingly, in use a required operating temperature can be maintained without the need for temperature sensors, electronic circuitry, or controllers.

[0008] In this arrangement the PTC heating element functions as a heater and is also arranged to hold and transfer a vapour generating liquid from the liquid store by capillary action. Combining these functions in a single element simplifies manufacture and assembly by reducing complexity and reduces cost and environmental impact.

[0009] The transition temperature may be from 160°C to 320°C. Preferably, the transition temperature may be from 180°C to 300°C. At these transition temperature ranges, evaporation is achieved without the generation of potentially harmful chemical species.

[0010] The electrical resistivity of the porous PTC material may increase by at least a factor of 100 beginning at the transition temperature and ending at a temperature of up to 10°C above the transition temperature.

[0011] The porous PTC material may comprise a porous PTC ceramic material. The porous PTC ceramic material may comprise a PTC oxide material. The PTC oxide material may comprise perovskite. Alternatively, the PTC oxide material may comprise a BaTiOs-based material. The $BaTiO_3$-based material may be doped with Pb. The Pb-doped $BaTiO_3$ material may comprise a protective coating. The $BaTiO_3$-based material may be La-doped $95BaTiO_3$-$5(Bi0.5Na0.5)TiO_3$ (BT-BNT) ceramic. Alternatively, the $BaTiO_3$-based material may be a quasi-BaTiO3-based ternary perovskite material. In other examples, the PTC oxide material may comprise a V_2O_3-based material.

[0012] Alternatively, the porous PTC material may comprise a PTC polymer composite.

[0013] According to a second aspect of the present disclosure, there is provided a cartridge for a vapour generating device, wherein the cartridge comprises a vapour generating unit according to any of the above paragraphs.

[0014] According to a third aspect of the present disclosure, there is provided a method comprising:

holding and transferring a vapour generating liquid from a liquid store by capillary action using a positive temperature coefficient (PTC) heating element of a vaporisation device comprised in a vapour generating unit;

heating, using the PTC heating element, the vapour generating liquid to form an aerosol, the PTC heating element being configured to electrically couple to a power source to receive a current flow to heat the vapour generating liquid, wherein the PTC heating

element comprises a porous PTC material having an electrical resistivity that varies based on temperature, wherein when the PTC heating element is heated to a transition temperature, electrical resistivity of the porous PTC material increases to reduce current flow from the power source to a level that limits further temperature increases of the PTC heating element; and

producing aerosol by the heating of the vapour generating liquid.

Brief Description of the Drawings

[0015]

Figure 1 is a diagrammatic view of a vapour generating system comprising a vapour generating device and a cartridge;

Figure 2 is a diagrammatic view of a vapour generating unit for a vapour generating system exemplified in Figure 1; and

Figure 3 is a diagrammatic cross-sectional view of a cartridge comprising the vapour generating unit of Figure 2.

Detailed Description of Embodiments

[0016] Embodiments of the present disclosure will now be described by way of example only and with reference to the accompanying drawings.

[0017] Referring initially to Figure 1 there is shown a vapour generating system 10. In the illustrated example, the vapour generating system 10 comprises a vapour generating device 12 and a cartridge 14 configured to be used with the vapour generating device 12.

[0018] The vapour generating device 12 may be elongate and have a substantially cylindrical shape which resembles a cigarette or cigar. Other shapes are, however, entirely within the scope of the present disclosure.

[0019] The term vapour generating device 12 (or more commonly electronic cigarette or e-cigarette) refers to a handheld electronic device that is intended to simulate the feeling or experience of smoking tobacco in a traditional cigarette. Electronic cigarettes work by causing a vapour generating liquid to be heated to generate a vapour that cools and condenses to form an aerosol which is then inhaled by the user. Accordingly, using e-cigarettes is also sometimes referred to as "vaping". Vapour generating liquid is sometimes referred to as e-liquid.

[0020] In general terms, a vapour is a substance in the gas phase at a temperature lower than its critical temperature, which means that the vapour can be condensed to a liquid by increasing its pressure without reducing the temperature, whereas an aerosol is a suspension of fine solid particles or liquid droplets, in air or another gas. It should, however, be noted that the terms 'aerosol' and 'vapour' may be used interchangeably in this specification, particularly with regard to the form of the inhalable medium that is generated for inhalation by a user.

[0021] The vapour generating liquid, i.e., liquid vaporizable material, may comprise polyhydric alcohols and mixtures thereof such as glycerine or propylene glycol. The vapour generating liquid may contain nicotine. The vapour generating liquid may also comprise flavourings such as tobacco, menthol or fruit flavour. In some examples, the vapour generating liquid has a low vegetable glycerine content and/or added water to reduce its boiling point.

[0022] The cartridge 14 comprises a housing 16 having a proximal end 18 and a distal end 20. The proximal end 18 may constitutes a mouthpiece, i.e., a mouthpiece end, configured for being introduced directly into a user's mouth and may, therefore, also be designated as the mouth end. The mouthpiece provides the ability for a user to easily inhale aerosol generated by the vapour generating device 12.

[0023] The cartridge 14 comprises a liquid store 22 for containing, i.e., for holding or storing, a vapour generating liquid. Accordingly, the liquid store 22 is configured for containing therein a vapour generating liquid.

[0024] The liquid store 22 may extend generally between the proximal (mouth) end 18 and the distal end 20. The cartridge 14 comprises a vapour outlet channel 24. The vapour outlet channel 24 is fluidly connected to the mouthpiece at the proximal end 18. In some examples, the liquid store 22 surrounds, and coextends with, the vapour outlet channel 24.

[0025] The vapour generating device 12 includes a controller 26. The vapour generating device 12 includes a user interface 28 for controlling the operation of the vapour generating device 12 via the controller 26 and/or for displaying information. In some examples, the user interface 28 may be comprised in a separate device such as a mobile device.

[0026] The controller 26 is configured to detect the initiation of use of the vapour generating device 12 in response to a user input, such as a button press to activate the vapour generating device 12, or in response to a detected airflow through the vapour generating device 12. As will be understood by one of ordinary skill in the art, an airflow through the vapour generating device 12 is indicative of a user inhalation or 'puff'. The vapour generating device 12 may, for example, include a puff detector (not shown), such as an airflow sensor, to detect an airflow through the vapour generating device 12.

[0027] The controller 26 includes electronic circuitry 30. The vapour generating device 12 includes a power source 32, such as a battery. The power source 32 and the electronic circuitry 30 may be configured to operate at a high frequency.

[0028] The cartridge 14 may be releasably connectable to the vapour generating device 12 by a releasable connection. The releasable connection can, for example, be a snap-fit connection or alternatively, a magnetic

connection, a threaded connection, or a bayonet connection. Accordingly, after the vapour generating liquid in the liquid store 22 of the cartridge 14 has been depleted, the cartridge 14 can be disconnected from the vapour generating device 12 and a replacement cartridge 14 can then be connected in its place, to allow further use of the vapour generating device 12. The cartridge 14 may be disposable. Alternatively, in some examples the cartridge 14 may be re-filled with vapour generating liquid so that the cartridge 14 can be re-used.

[0029] The cartridge 12 comprises a vapour generating unit 34. The vapour generating unit 34 comprises a vaporisation device 36.

[0030] The vaporisation device 36 comprises a positive temperature coefficient (PTC) heating element 38, i.e., a heater 38, configured to electrically couple to the power source 32 to receive a current flow and heat the vapour generating liquid to form an aerosol.

[0031] The PTC heating element 38 comprises a porous PTC material having an electrical resistivity that varies based on temperature.

[0032] In use, when the PTC heating element 38 is heated to a transition temperature, electrical resistivity of the porous PTC material increases to reduce current flow from the power source 32 to a level that limits further temperature increases of the PTC heating element 38.

[0033] The electrical resistivity of the porous PTC material significantly changes at the transition temperature. Accordingly, the PTC heating element 38 is temperature self-limiting; a sharp increase in resistance reduces current flow from the power source 32 to a level that limits further temperature increases of the PTC heating element 38.

[0034] The PTC heating element 38 therefore enables a device 12 with intrinsic temperature control at or near a desired operating temperature of the device 12, which operating temperature substantially corresponds to the transition temperature. By utilizing a PTC heating element 38 with intrinsic temperature control, overheating (e.g., burning) of the vapour generating liquid can be prevented, thereby avoiding formation of unwanted, and potentially dangerous, chemical by products. Accordingly, in use a required operating temperature can be maintained without the need for temperature sensors, electronic circuitry, or controllers. Temperature overshoot is therefore avoided which can otherwise lead to the formation of undesirable and potentially dangerous chemical by products.

[0035] The transition temperature may be understood as a critical temperature or switch temperature. The electrical resistivity of the porous PTC material can be increased by as much as several orders of magnitude within a temperature span of a few degrees. Accordingly, the transition temperature is the temperature at which electrical resistance starts to increase sharply.

[0036] In some examples, the electrical resistivity of the porous PTC material increases by at least a factor of 100 at the transition temperature. The electrical resistivity of the porous PTC material may increase by at least a factor of 100 beginning at the transition temperature and ending at a temperature of up to 10°C above the transition temperature.

[0037] In some examples, the transition temperature is from 160°C to 320°C. Preferably, the transition temperature is from 180°C to 300°C. At these transition temperature ranges, evaporation is achieved without the generation of potentially harmful chemical species.

[0038] Figure 2 shows a diagrammatic view of a vapour generating unit 34 according to examples of the disclosure. Figure 3 shows a cross-sectional view of a cartridge 14 comprising the vapour generating unit 34.

[0039] Referring to Figures 2 and 3, the PTC heating element 38 comprises a pair of electrical contacts 40 for electrical coupling to the power source 32. The pair of electrical contacts 40 are provided on a body 46 of the PTC heating element 38.

[0040] The PTC heating element 38 is arranged to hold and transfer a vapour generating liquid from the liquid store 22 by capillary action, i.e., by a wicking action. According, the PTC heating element 38 comprises a capillary material. The PTC heating element 38 thereby functions as both a heater and also a liquid transfer element (i.e., a wick). The PTC heating element 38 thereby provides a monolithic configuration in which wicking and heating functionalities are provided by a single element. Accordingly, a distinct and separate wick and heater (i.e., a heating wire) is not required.

[0041] As described above, in this arrangement the PTC heating element 38 functions as a heater and is also arranged to hold and transfer a vapour generating liquid from the liquid store 22 by capillary action (i.e., the PTC heating element 38 also functions as a liquid transfer element). Combining these functions in a single element simplifies manufacture and assembly by reducing complexity and reduces cost and environmental impact. A potential failure mechanism is also removed.

[0042] Furthermore, in examples of the disclosure there is efficient heat transfer between the PTC heating element 38 and the vapour generating liquid (i.e., e-liquid) held therein. This is crucial for the performance of the device 12 (i.e., e-cigarettes). This is achieved because the contact area between the PTC heating element 38 and e-liquid held therein is maximised leading to improved device efficiency and faster heat-up time. In conventional arrangements, the contact area between heater and e-liquid is limited, and the temperature will therefore rapidly drop away from the point of contact leading to reduced device efficiency and slower heat up time.

[0043] In some examples, the porous PTC material comprises a porous PTC ceramic material, such as a porous PTC ceramic wick. The porous PTC ceramic material may be applied from a liquid ink or paste containing nanometre or micrometre sized particles.

[0044] The porous PTC ceramic material may comprise a porous PTC composite ceramic material. In some

examples, the porous PTC ceramic material comprises a PTC oxide material, such as perovskite.

[0045] In other examples, the PTC oxide material comprises a $BaTiO_3$-based material, which may be a $BaTiO_3$-based material doped with Pb. In some examples, the Pb-doped $BaTiO_3$ material is coated with a protective layer, i.e., a protective coating, such as a layer of epoxy resin. Accordingly, in such examples the Pb-doped $BaTiO_3$ material comprises a protective coating. The protective coating can be applied by a liquid coating process. Alternatively, the protective coating can be applied by an atomic layer deposition (ALD) or molecular layer deposition (MLD) process.

[0046] The BaTiOs-based material may be doped with two or more donor materials. The $BaTiO_3$-based material may be characterised as La-doped $xBaTiO_3$-$(_{1-x})$(Biy-$Na_{1-y})TiO_3$ (BT-BNT) ceramic. The $BaTiO_3$-based material may be La-doped $95BaTiO_3$-5(Bi0.5Na0.5)TiO_3 (BT-BNT) ceramic, or a quasi-$BaTiO_3$-based ternary perovskite material.

[0047] In some examples, the PTC oxide material may comprises a V_2O_3-based material.

[0048] In other examples, the porous PTC material comprises a porous PTC polymer composite.

[0049] The cartridge 14 comprises a vaporisation chamber (not illustrated). The vaporisation chamber may be substantially cylindrical and centrally positioned in the cartridge 14. The vaporisation chamber is aligned with, and fluidly connected to, the vapour outlet channel 24. The vaporisation chamber may be disposed in the vapour outlet channel 24. The vaporisation chamber may be located in the vapour outlet channel 24. The vaporisation chamber provides a route which allows vapour generated by heating the vapour generating liquid to be transferred into the vapour outlet channel 24 where it cools and condenses to form an aerosol that can be inhaled by a user via the mouthpiece. The vapour generated in the vaporisation chamber cools and condenses to form an aerosol as it flows along the vapour outlet channel 24, from the vaporisation chamber towards an end of the vapour outlet channel 24. Efficient vapour generation is thereby assured. In particular, a continuous process is achieved in which vapour generating liquid from the liquid store 22 is continuously absorbed by the PTC heating element 38 and heated to generate a vapour in the vaporisation chamber.

[0050] The vaporisation of the vapour generating liquid is facilitated by the addition of air from the surrounding environment through the one or more air inlets (not illustrated). The flow of air and/or vapour may be aided by negative pressure created by a user drawing air through the mouthpiece.

[0051] In the illustrated example, the PTC heating element 38 comprises a liquid supply element 42 providing an outer surface 44 which is exposed to the inner space of the liquid store 22. The liquid supply element 42 transfers vapour generating liquid from the liquid store 22 to the body 46 of the PTC heating element 38 by capillary action. Vapour generating liquid is thereby absorbed into the PTC heating element 38 via the outer surface 44 and is conveyed, for example by a wicking action, to the body 46 so that it can be heated and vaporised producing a vapour which cools and condenses to form an aerosol which may then be inhaled.

[0052] An advantage of this arrangement is that it allows the delivery of liquid to the body 46 of the PTC heating element 38 to be carefully controlled whilst minimising heat transfer from the body 46 of the PTC heating element 38 to the vapour generating liquid in the liquid store 22.

[0053] In the example illustrated in Figures 2 and 3, the PTC heating element 38 comprises two such liquid supply elements 42.

[0054] In operation of the vapour generating system 10, vapour generating liquid is conveyed from the liquid store 22 to the PTC heating element 38 by capillary action. The vapour generating liquid is held and heated by the PTC heating element 38 resulting in the generation of a vapour. The vapour escapes from the PTC heating element 38 into the vaporisation chamber, and then flows from the vaporisation chamber along the vapour outlet channel 24 where it cools and condenses to form an aerosol that is inhaled by a user through the mouthpiece.

[0055] The vaporisation of the vapour generating liquid is facilitated by the addition of air flowing from the surrounding environment through the one or more air inlets into the vaporisation chamber. Air then flows from the vaporisation chamber along the vapour outlet channel 24 to the mouthpiece. Vapour generated is entrained in the air as it flows into the vaporisation chamber and along the vapour outlet channel 24 to the mouthpiece.

[0056] The flow of air and/or vapour through the cartridge 14, i.e., through the vaporisation chamber, along the vapour outlet channel 24, and out of the mouthpiece, is aided by negative pressure created by a user drawing air through the mouthpiece.

[0057] Examples of the disclosure also provide a cartridge 14 for a vapour generating device 12. The cartridge 14 comprises a vapour generating unit 34 as described above.

[0058] Examples of the disclosure also provide a method. The method comprises holding and transferring a vapour generating liquid from the liquid store 22 by capillary action using the positive temperature coefficient (PTC) heating element 38 described above. The method further comprises heating, using the PTC heating element 38, the vapour generating liquid to form an aerosol. The method further comprises producing aerosol by the heating of the vapour generating liquid.

[0059] The figures also illustrate a method of manufacturing a device 12, a cartridge 14, and a vapour generating unit 34 according to examples of the disclosure. The figures also illustrate a method of providing a system 10 according to examples of the disclosure.

[0060] Although exemplary embodiments have been described in the preceding paragraphs, it should be

understood that various modifications may be made to those embodiments without departing from the scope of the appended claims. Thus, the breadth and scope of the claims should not be limited to the above-described exemplary embodiments.

[0061] Any combination of the above-described features in all possible variations thereof is encompassed by the present disclosure unless otherwise indicated herein or otherwise clearly contradicted by context.

[0062] Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like, are to be construed in an inclusive as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

Claims

1. A vapour generating unit (34), the vapour generating unit (34) comprising a vaporisation device (36), the vaporisation device (36) comprising a positive temperature coefficient (PTC) heating element (38) configured to electrically couple to a power source (32) to receive a current flow and heat a vapour generating liquid to form an aerosol, wherein the PTC heating element (38) comprises a porous PTC material having an electrical resistivity that varies based on temperature, wherein in use when the PTC heating element (38) is heated to a transition temperature, electrical resistivity of the porous PTC material increases to reduce current flow from the power source (32) to a level that limits further temperature increases of the PTC heating element (38), wherein the PTC heating element (38) is arranged to hold and transfer a vapour generating liquid from a liquid store (22) by capillary action.

2. A vapour generating unit according to claim 1, wherein the transition temperature is from 160°C to 320°C.

3. A vapour generating unit according to claim 1 or 2, wherein the transition temperature is from 180°C to 300°C.

4. A vapour generating unit according to any of the preceding claims, wherein the electrical resistivity of the porous PTC material increases by at least a factor of 100 beginning at the transition temperature and ending at a temperature of up to 10°C above the transition temperature.

5. A vapour generating unit according to any of the preceding claims, wherein the porous PTC material comprises a porous PTC ceramic material.

6. A vapour generating unit according to claim 5, wherein the porous PTC ceramic material comprises a PTC oxide material.

7. A vapour generating unit according to claim 6, wherein the PTC oxide material comprises perovskite.

8. A vapour generating unit according to claim 6, wherein the PTC oxide material comprises a $BaTiO_3$-based material.

9. A vapour generating unit according to claim 8, wherein the $BaTiO_3$-based material is doped with Pb.

10. A vapour generating unit according to claim 8, wherein, the $BaTiO_3$-based material is La-doped $95BaTiO_3$-$5(Bi0.5Na0.5)TiO_3$ (BT-BNT) ceramic.

11. A vapour generating unit according to claim 8, wherein the $BaTiO_3$-based material is a quasi-$BaTiO_3$-based ternary perovskite material.

12. A vapour generating unit according to claim 6, wherein the PTC oxide material comprises a V_2O_3-based material.

13. A vapour generating unit according to any of claims 1 to 4, wherein the porous PTC material comprises a PTC polymer composite.

14. A cartridge (14) for a vapour generating device (12), wherein the cartridge (14) comprises a vapour generating unit (34) according to any of the preceding claims.

15. A method comprising:

holding and transferring a vapour generating liquid from a liquid store (22) by capillary action using a positive temperature coefficient (PTC) heating element (38) of a vaporisation device (36) comprised in a vapour generating unit (34);
heating, using the PTC heating element (38), the vapour generating liquid to form an aerosol, the PTC heating element (38) being configured to electrically couple to a power source (32) to receive a current flow to heat the vapour generating liquid, wherein the PTC heating element (38) comprises a porous PTC material having an electrical resistivity that varies based on temperature, wherein when the PTC heating element (38) is heated to a transition temperature, electrical resistivity of the porous PTC material increases to reduce current flow from the power source (32) to a level that limits further temperature increases of the PTC heating element (38); and
producing aerosol by the heating of the vapour

generating liquid.

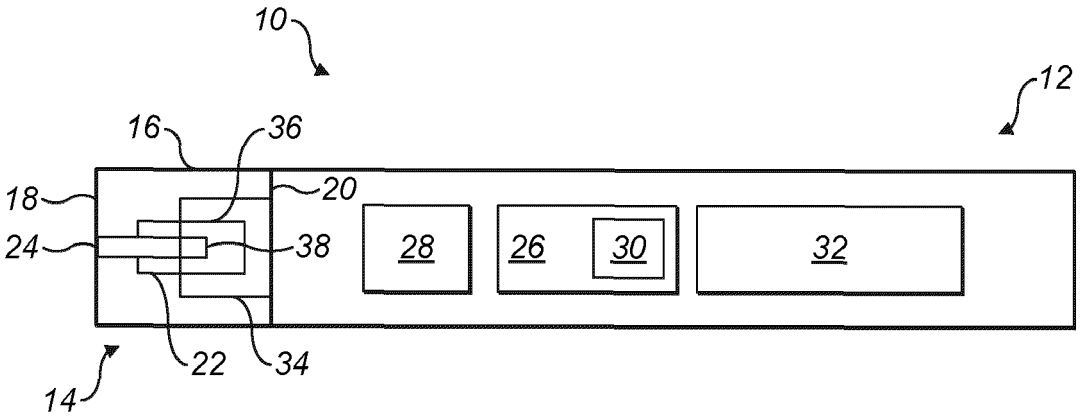

FIG. 1

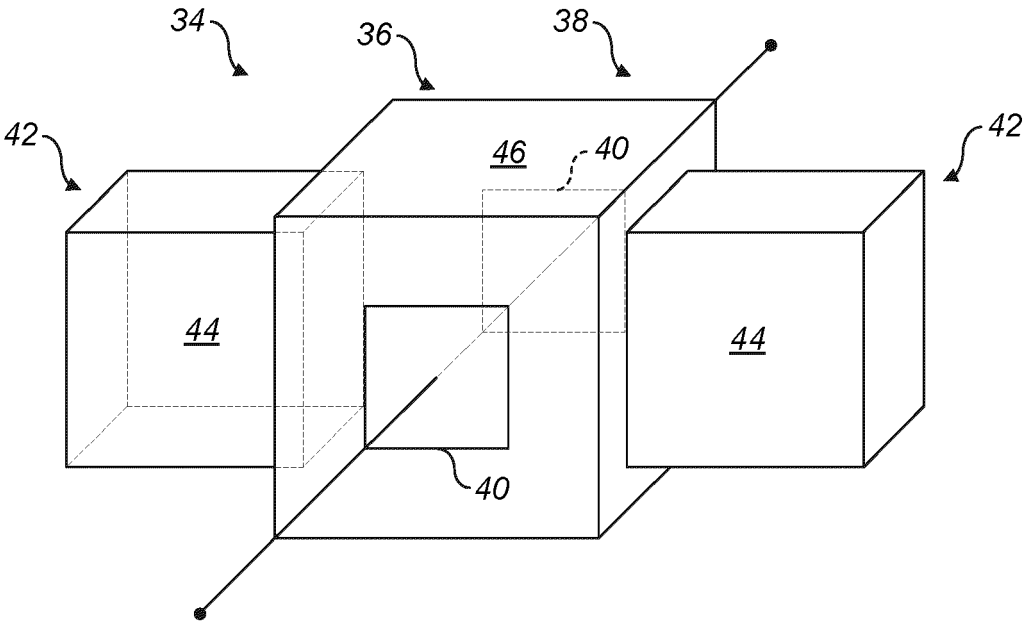
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FIG. 2

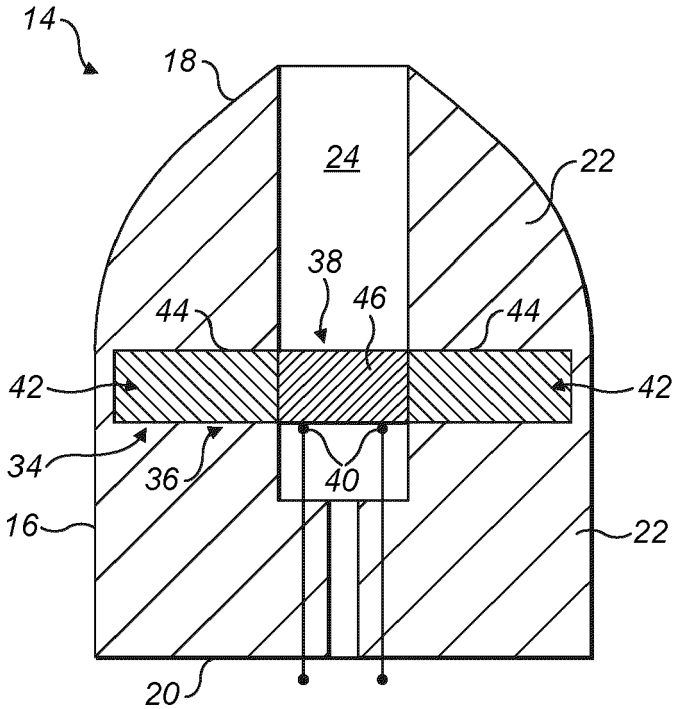
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FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 3526

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2023/057645 A1 (JIANG ZHENLONG [CN] ET AL) 23 February 2023 (2023-02-23) * paragraphs [0031], [0036], [0037], [0038]; figure 1 * -----	1-15	INV. H05B3/14 A24F40/10 A24F40/44 A24F40/46
X	WO 2022/106613 A1 (SCHOTT AG [DE]) 27 May 2022 (2022-05-27) * page 8, line 18 - line 26; claims 1,4; figure 3 * * page 27, line 24 - page 28, line 8 * -----	1-15	
X	WO 2022/106612 A1 (SCHOTT AG [DE]) 27 May 2022 (2022-05-27) * page 7, line 6 - line 10; claims 1,2; figure 3 * * page 11, line 14 - page 12, line 4 * -----	1-15	
X	US 2017/196273 A1 (QIU WEI-HUA [CN]) 13 July 2017 (2017-07-13) * paragraph [0085]; figures 4,5 * -----	1-15	
X	US 2021/084982 A1 (YILMAZ UGURHAN [GB] ET AL) 25 March 2021 (2021-03-25) * paragraph [0063]; figure 1 * -----	1-15	TECHNICAL FIELDS SEARCHED (IPC) H05B A24F H01G H01C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 November 2023	Gea Haupt, Martin

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 18 3526

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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21-11-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2023057645 A1	23-02-2023	EP 4136992 A1	22-02-2023
		US 2023057645 A1	23-02-2023
		WO 2021217292 A1	04-11-2021
WO 2022106613 A1	27-05-2022	CN 116530212 A	01-08-2023
		DE 102020130559 A1	19-05-2022
		EP 4248711 A1	27-09-2023
		US 2023284342 A1	07-09-2023
		WO 2022106613 A1	27-05-2022
WO 2022106612 A1	27-05-2022	CN 116458268 A	18-07-2023
		DE 102020130560 A1	19-05-2022
		EP 4248710 A1	27-09-2023
		US 2023338869 A1	26-10-2023
		WO 2022106612 A1	27-05-2022
US 2017196273 A1	13-07-2017	CN 104382239 A	04-03-2015
		US 2017196273 A1	13-07-2017
		WO 2016090951 A1	16-06-2016
US 2021084982 A1	25-03-2021	AU 2018379327 A1	18-06-2020
		BR 112020011423 A2	24-11-2020
		CA 3084865 A1	13-06-2019
		CN 111601522 A	28-08-2020
		EP 3720309 A1	14-10-2020
		IL 275035 A	30-07-2020
		JP 6989705 B2	05-01-2022
		JP 2021505128 A	18-02-2021
		KR 20200083576 A	08-07-2020
		RU 2738697 C1	15-12-2020
		US 2021084982 A1	25-03-2021
		WO 2019110669 A1	13-06-2019

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82