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[Continued on next page]

(54) Title: HEATING SMOKABLE MATERIAL

(57) Abstract: An apparatus configured to volatilize components of smokable material for inhalation, comprising a smokable material heating chamber and a heating material which is configured to be heated by the presence of a varying magnetic field, wherein the heating material is arranged to transfer heat energy to smokable material in the heating chamber to volatilize said components.

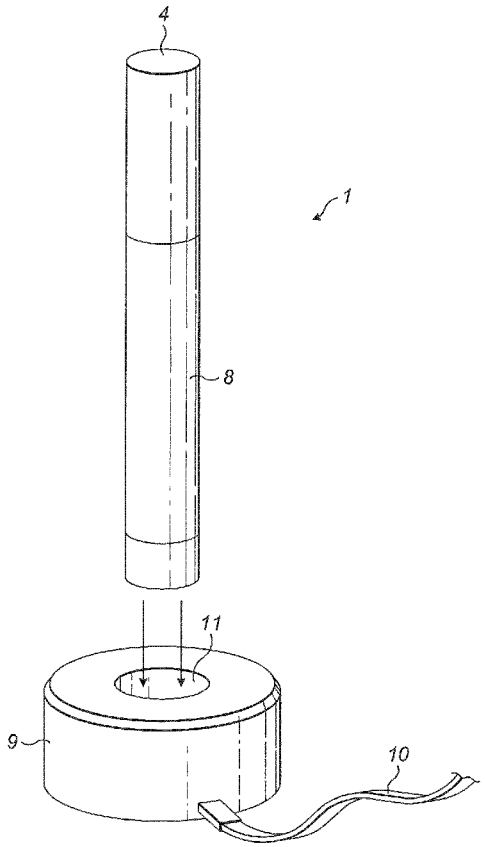

FIG. 2

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Heating smokable material

Field

The invention relates to heating smokable material in order to volatilize components of the smokable material.

Background

Smoking articles such as cigarettes and cigars burn tobacco during use to create tobacco smoke. Attempts have been made to provide alternatives to these smoking articles by creating products which release compounds without creating tobacco smoke. Examples of such products are so-called heat-not-burn products which release compounds by heating, but not burning, tobacco.

Summary

According to the invention, there is provided an apparatus configured to volatilize components of smokable material for inhalation, comprising:

a smokable material heating chamber; and

a heating material which is configured to be heated by the presence of a varying magnetic field, wherein the heating material is arranged to transfer heat energy to smokable material in the heating chamber to volatilize said components.

The heating material may be comprised in a heating member.

The heating member may comprise a base material in thermal contact with the heating material, the base material being configured to retain heat energy received from the heating material and to transfer the heat energy to smokable material in the heating chamber to volatilize said components.

The base material may be configured to transfer said heat energy to said smokable material over an extended period so as to raise and maintain a temperature of said smokable material at a volatilizing temperature for said extended period without simultaneous heating of the heating material by the varying magnetic field.

The heating material may comprise a plurality of pieces of heating material dispersed in the heating member with the base material.

The heating member may comprise an elongate member located adjacent the smokable material heating chamber.

The heating chamber may be located co-axially around the heating member.

The heating material may be located inside the smokable material heating chamber with the smokable material.

The heating material may comprise a plurality of pieces of heating material dispersed within the smokable material.

The heating material may comprise an electrically conductive material.

The heating material may be susceptible to eddy currents induced by the varying magnetic field in the material, the eddy currents causing the heating material to be resistively heated.

The apparatus may comprise a housing in which the heating chamber and heating material are contained and a varying magnetic field generator arranged to receive the housing during heating of the heating material.

The field generator may be arranged to releasably dock with the housing, thereby maintaining a stable position of the housing relative to the generator during heating.

The apparatus may comprise a mouthpiece in fluid communication with the heating chamber in order to allow volatilized components of the smokable material to be drawn through the mouthpiece by a user.

The heating material may be configured to heat the smokable material to a volatilizing temperature of between approximately 50°C and 250°C to volatilize said components.

According to the invention, there is provided a method of heating smokable material to volatilize components of the smokable material for inhalation, comprising:

generating a varying magnetic field;

using the varying magnetic field to induce an electrical current in a heating material and thereby heating the heating material;

transferring thermal energy from the heating material to the smokable material to heat the smokable material to a volatilizing temperature and thereby volatilize components of the smokable material.

According to the invention, there is provided a method of heating smokable material to volatilize components of the smokable material for inhalation, comprising:

inserting a housing containing heating material and smokable material into a device configured to generate a varying magnetic field;

generating the varying magnetic field in the device and thereby heating the heating material by causing an electrical current to be induced in the heating material;

transferring thermal energy from the heating material to the smokable material to heat the smokable material to a volatilizing temperature and thereby volatilize components of the smokable material.

There may also be provided an apparatus for performing the method, comprising:

a housing containing smokable material and a heating material; and

a device configured to generate a varying magnetic field.

For the purposes of example only, embodiments of the invention are described below with reference to the accompanying drawings, in which:

Brief description of the drawings

Figure 1 is a partially cut away illustration of an apparatus for providing volatilized components of heated smokable material for inhalation by a user, in which a heating member comprising an electrically conductive heating material is located adjacent a smokable material heating chamber;

figure 2 is a perspective illustration of an apparatus for providing volatilized components of heated smokable material for inhalation by a user, in which a housing of the apparatus is docked in a magnetic field generator for inducing eddy currents in a heating material;

figure 3 is a cross-sectional illustration of an apparatus for providing volatilized components of heated smokable material for inhalation by a user, in which an electrically conductive heating material is located with smokable material in a heating chamber; and

figure 4 is a perspective illustration of an apparatus for providing volatilized components of heated smokable material for inhalation by a user, in which a housing of the apparatus is docked in a magnetic field generator for inducing eddy currents in a heating material.

Detailed description

As used herein, the term 'smokable material' includes any material that provides volatilized components upon heating and includes any tobacco-containing material and may, for example, include one or more of tobacco, tobacco derivatives, expanded tobacco, reconstituted tobacco or tobacco substitutes.

An apparatus 1 for providing volatilized components of smokable material 2 for inhalation comprises a smokable material heating chamber 3 and a mouthpiece 4 which is fluidly connected with the heating chamber 3. The mouthpiece 4 may comprise a filter material such as cellulose acetate tow, which may be provided in the form of a wrapped plug. A user of the apparatus 1 can inhale the volatilized components from the mouthpiece 4 when the smokable material 2 is heated inside the heating chamber 3 to a temperature which is sufficient to volatilize the smokable material components.

As described more fully below, the smokable material 2 is heated by thermal transfer from a heating material 5 located in the proximity of the smokable material 2. The heating material 5 itself is resistively heated in an electromagnetic induction heating process.

More particularly, the heating material 5 comprises electrically conductive material of finite electrical resistance in which induced eddy currents cause resistive heating of the material 5 when the heating material 5 is placed in a varying magnetic field. An example of a suitable heating material 5 is Iron, although other electrically conductive materials could alternatively be used such as another electrically conductive metal or alloy. The heating material 5 is heated by the effects of electromagnetic induction to a temperature which is sufficient to volatilize components of the smokable material 2 in the heating chamber 3, such as nicotine and aromatic compounds, without burning the smokable material 2.

The heating material 5 may be located either inside the heating chamber 3 or in its close proximity. As explained below, an example is for the heating material 5 to be

located either directly adjacent the smokable material 2 or in a heating member 6 which is located directly adjacent the smokable material 2. The location of the heating material 5 is such that effective thermal transfer takes place between the heated heating material 5 and the smokable material 2 inside the heating chamber 3, thereby causing the smokable material 2 to be heated to a temperature which is sufficient to volatilize components of the smokable material 2 for inhalation through the mouthpiece 4.

As briefly referred to above, the heating material 5 may be comprised in a heating member 6 which is configured to transfer thermal energy from the heating material to smokable material 2 in the heating chamber 3. In addition to the heating material 5, the heating member 6 may comprise a base material 7 which is heat retentive and acts to release heat energy received from the heating material 5 over a relatively long period and thereby maintain the smokable material 2 at a volatilizing temperature for the duration of that period. An example is between approximately three and ten minutes, as discussed further below. The base material 7 may be an electrical insulator which, unlike the heating material 5, is not itself susceptible to induction of electrical eddy currents when placed in a varying magnetic field.

The base material 7 is in thermal contact with the heating material 5 so that, when the heating material 5 is heated by electromagnetic induction, thermal energy from the heating material 5 conducts into the base material 7 and causes it to heat up to the temperature of the heating material 5. The heat stored in the base material 7 then dissipates into the heating chamber 3 over an extended period so as to continuously heat the smokable material 2 therein and cause components of the smokable material 2 to be continuously volatilized for inhalation through the mouthpiece 4.

An example of a suitable base material 7 is a material with a high specific heat capacity, which may be higher than that of the heating material 5. An example is a specific heat capacity in the range of between approximately 1000 and 3500 J/kg.K, although other values may also be suitable. The material 7 may be a polymer, although other materials 7 could alternatively be used. An example of a suitable material 7 is HDPE or a Polycarbonate. As explained briefly above, the base material 7 is configured to store the heat energy received from the heating material 5 and to gradually dissipate the thermal energy from the heating material 5 over the extended period referred to above so as to heat the smokable material 2 to within a desired volatilizing temperature range and to maintain the temperature of the smokable material 2 in the desired volatilizing

temperature range until the extended period has elapsed. An example of a temperature range in which components of smokable material such as tobacco are volatilized is between approximately 50°C and approximately 250°C, such as between approximately 50°C and 150°C, between approximately 50°C and 120°C, between approximately 50°C and 100°C, between approximately 50°C and 80°C or between approximately 60°C and 70°C. Other ranges may also be suitable. The extended period may be approximately the same length as the period taken to smoke a conventional cigarette. An example period is between approximately four and eight minutes, such as approximately seven minutes.

The heating material 5 and base material 7 (if used) may optionally be placed in the varying magnetic field in between puffs in order to re-heat the heating material 5 before each puff.

The heating member 6 may extend along a longitudinal axis of the apparatus 1. The heating chamber 3 may also extend along a longitudinal axis of the apparatus 1 and may be located adjacent to the heating member 6. For example, the heating member 6 shown in figure 1 extends substantially along the central longitudinal axis of the apparatus 1 and the heating chamber 3 is located around its longitudinal surface. If the heating member 6 is substantially cylindrical, as shown in figure 1, then the longitudinal surface around which the heating chamber 3 extends is a circumferential surface of the heating member 6. In this type of configuration, the heating chamber 3 may comprise a co-axial layer around the heating member 6. This provides an annular space around the heating member 6 into which the smokable material 2 can be inserted for heating, as described below.

An alternative arrangement is for the positions of the heating chamber 3 and heating member 6 to be reversed, so that the heating chamber 3 is located along the central longitudinal axis of the apparatus 1 and the heating member 6 is located annularly around it as a co-axial layer.

As illustrated in figure 1, the heating material 5 may comprise a plurality of separate pieces of heating material 5 which are distributed throughout the base material 7 in the heating member 6. The substantially even distribution of the heating material 5 through the base material 7 provides even heating of the base material 7 when the heating material 5 is heated and therefore also provides even heating of the smokable

material 2 in the heating chamber 3. However, it will be appreciated that the use of a plurality of separate pieces of heating material 5 is not a requirement of the invention and that alternative configurations are equally possible for providing even heating of the base material 7 and/or smokable material 2.

Another alternative arrangement is illustrated in figure 3, in which the heating material 5 resides within the smokable material 2 itself rather than within the heating member 6 described previously. As can be seen from figure 3, a plurality of pieces of the heating material 5 may be substantially evenly distributed throughout the smokable material 2 so as to provide even heating of the smokable material 2 across the chamber 3 when the heating material 5 is heated up by induced electrical currents. These individual pieces of heating material 5 may be surrounded by base material 7 so that the heating chamber 3 contains a plurality of heating members 6, each comprising heating material 5 and base material 7, distributed throughout the chamber 3. For example, the heating members 6 may be approximately spherical within an inner core of heating material 5 and an outer layer of base material 7.

The depth or otherwise transverse dimension of the heating chamber 3 may be between approximately 2mm and 10mm, such as approximately 5mm. This may or may not include the base material 5 if it is arranged as a co-axial core in the heating chamber, as discussed above. The length of the heating chamber 3 may be approximately equal to the length of a smokable material rod in a conventional cigarette. An example of a suitable length is between approximately 55mm and 60mm although other lengths could alternatively be used.

A housing 8 may contain components of the apparatus 1 such as the heating chamber 3, mouthpiece 4, heating material 5 and base material 7. In figures 1 and 2, the housing 8 is illustrated as being elongate with the mouthpiece 4 located at a first of its ends and the heating member 6 and heating chamber 3 extending along a longitudinal axis of the housing 8 through the interior region of the housing 8 from the housing's opposite second end. The housing 8 may, for example, be substantially tubular in shape, such as a pipe, with dimensions similar to those of a cigarette, cigar or cigarillo. The housing 8 may be formed of plastics, such as a suitable polymer material which is comfortable for a user of the apparatus 1 to hold during inhalation and general use.

The varying magnetic field which causes currents to be induced in the heating material 5 may be generated by a magnetic field generator 9, examples of which are illustrated in figures 2 and 4. The magnetic field generator 9 may comprise a power source 10, such as a suitable cell or battery, which provides electrical power for generating the varying magnetic field. The field generator 9 may alternatively be configured to receive electrical power from an external power supply, such as a mains power supply, personal computer or other external power source.

The field generator 9 may comprise an electrical coil in which a varying electrical current, such as an alternating current, is caused to flow to create a varying electromagnetic field such as a varying RF field in the vicinity of the generator 9. The varying magnetic flux created by the field generator 9 causes eddy currents to be induced in the heating material 5 when the heating material 5 is located in the vicinity of the generator 9. As described previously, these eddy currents in turn cause resistive heating to occur in the heating material 5 and can thus cause an increase in the temperature of the heating material 5.

The magnetic field generator 9 may be separate from the housing 8 in which the heating member 6, heating chamber 3 and smokable material 2 are located. In this case, the field generator 9 may be configured to structurally engage with the heating chamber housing 8 during heating of the heating material 5 so that the housing 8 and the apparatus components therein are held in a stable arrangement relative to the magnetic field source 9. For example, referring to figures 2 and 4, the magnetic field generator 9 may comprise a recess 11 into which the housing 8 can be inserted. An interior shape of the recess 11 may substantially match an exterior shape of an end region of the housing 8 so that the end region of the housing 8 can be docked and therefore physically secured inside the field generator 9.

The action of docking the housing 8 in the field generator 9 may trigger the generator 9 to generate the varying magnetic field and therefore begin the process of heating the heating material 5 to obtain volatilized smokable material components.

The field generator 9 may be located within a distance of approximately 5mm to 100mm of the heating material 5 when the generator 9 is in use, for example when the housing 8 is docked in the generator 9. This range is an example and other suitable distances outside of the range could alternatively be used.

As previously described, heat from the heating material 5 dissipates into the smokable material 2 in the heating chamber 3 and causes components of the smokable material 2 to be volatilized when the smokable material 2 reaches a volatilizing temperature. Optionally, the apparatus 1 may comprise a temperature sensor 12, for example comprising a thermocouple, which is configured to detect when the heating material 5, base material 7 and/or smokable material 2 in the heating chamber 3 has reached a predetermined volatilizing temperature. The temperature sensor 12 may comprise or communicate with an alarm, indicator light or some other suitable alerting unit, which is configured to alert a user that the volatilizing temperature has been reached and thus volatilized components of the smokable material 2 are available for inhalation.

Additionally or alternatively, the apparatus 1 may comprise a timer 13 which is configured to measure the length of time that the heating material 5 has been exposed to the varying magnetic field and to cause the user to be alerted when a predetermined heating time, which is known to correspond to the volatilizing temperature being reached in the heating chamber 3, has elapsed. The timer 13 may be activated automatically by the apparatus 1 upon detecting or otherwise receiving information that the housing 8 has been docked in the magnetic field generator 9.

Once the heating material 5 has been heated to the predetermined volatilizing temperature, the housing 8 can be removed from the field generator 9 so that the heating material 5 no longer experiences any substantial resistive heating effect. The magnetic field generator 9 can be powered down at this stage. Optionally, the field generator 9 may be configured to automatically cease to generate the magnetic field when the predetermined volatilizing temperature has been reached and/or the predetermined heating period has elapsed.

Components of the smokable material 2 which have been volatized, or are subsequently volatized, by the heat released from the heated heating material 5 can be inhaled from the mouthpiece 4 without the field generator 9 being in the vicinity of the heating material 5. This allows a user of the apparatus 1 to inhale volatilized components from the mouthpiece 4 in a manner which is similar to how a user would inhale smokable material components from a smoking article such as a cigarette. The field generator 9 may, for example, be placed in a user's pocket for the extended period referred to above

whilst the user regularly inhales newly volatilized smokable material components from the mouthpiece 4 as the smokable material 2 continues to be heated.

In all configurations of the apparatus 1, the smokable material 2 may be provided in the form of a disposable smokable material cartridge or other smokable material consumable which can be inserted into, and removed from, the heating chamber 3 via a suitable opening in the housing 8. Therefore, a user of the apparatus 1 has the option to replace the smokable material 2 in order to obtain a different or improved inhalation experience, whilst re-using the housing 8, its internal apparatus components and the field generator 9. For example, the cartridge or other consumable may comprise a hollow smokable material tube which can be slid onto and off of an elongate heating member 6, such as the one shown in figure 1, or may comprise a substantially solid elongate core of smokable material 2 which can be slid into and out of a hollow centre of an elongate heating member 6. The cartridge may comprise a sleeve, for example formed of plastics, which contains the smokable material 2 and from which volatilized components of the smokable material can flow into the mouthpiece 4.

Alternatively, the housing 8 and its internal components, including the smokable material 2, may together form a disposable item which is intended to be discarded by a user after use.

As shown in figures 1 and 3, the housing 8 and/or the smokable material cartridge 2 may be provided with thermal insulation 14 to reduce heat losses from the smokable material 2 and the internal components of the housing 8 to the external atmosphere around the housing 8. The thermal insulation 14 may, for example, comprise vacuum insulation which is configured to insulate the apparatus 1 by providing an evacuated region between the heating chamber 3 and the external surface of the housing 8 to thereby substantially prevent heat losses by conduction and convection. The housing 8 and/or smokable material cartridge 2 may additionally or alternatively be provided with an infra-red reflective layer located between the smokable material 2 and the external surface of the housing 8 so as to prevent losses by thermal radiation. The reflective layer may optionally be provided on or in the thermal insulation layer 14.

The housing 8 may additionally or alternatively be thermally insulated by smokable material 2 located between the heating material 5 and the exterior of the housing 8.

The thermal insulation effect ensures that the external surface of the housing 8 is substantially not heated by the heating material 5 and therefore that the external surface of the housing 8 remains at a temperature which is comfortable for a user to grip the housing 8 during inhalation of volatilized components from the mouthpiece 4.

Optionally, the heating chamber 3 may be hermetically sealable so that volatilized components of the smokable material do not escape through the mouthpiece 4 undesirably. Inlet and outlet valves may be configured to seal the heating chamber 3 from the mouthpiece 4 and to only allow components which have been volatilized to leave the heating chamber 3 when a user draws on the mouthpiece 4. The apparatus 1 may include a puff sensor to trigger opening and closing of the valves at appropriate times. Alternatively, the valves may be caused to open automatically by the suction force generated by a user when he/she draws on the mouthpiece 4. A mechanical hinge may be used in the valves.

The apparatus 1 may be manufactured by dispersing the heating material 5 within a suitable base material 7 and shaping the resulting product into a heating member 6. A housing 8 of the apparatus 1 may be formed by a plastics moulding technique to provide a substantially hollow interior region into which components of the apparatus 1 can be inserted. One or more layers of thermal insulation 14 may be provided on the interior or exterior of the wall of the housing 8 in order to reduce heat losses from the heating material 5 during use of the apparatus 1. As described previously, the heating member 6 may be secured along a longitudinal axis of the housing 8, such as the central axis, so as to leave a smokable material heating chamber 3 adjacent to it. The temperature sensor 12 and timer 13, along with the indicator light or other suitable alerting unit, are also secured in the housing 8 in an appropriate position. An example is between the heating chamber 3 and the mouthpiece 4, as shown in figure 1. The mouthpiece 4 is provided at one end of the housing 8 and a fluid channel is provided between the heating chamber 3 and the mouthpiece 4 to allow volatilized components of smokable material 2 to flow to the mouthpiece 4 for inhalation.

In order to address various issues and advance the art, the entirety of this disclosure shows by way of illustration various embodiments in which the claimed invention(s) may be practiced and provide for a superior apparatus and method. The advantages and features of the disclosure are of a representative sample of embodiments only, and are not exhaustive and/or exclusive. They are presented only to assist in understanding

and teach the claimed features. It is to be understood that advantages, embodiments, examples, functions, features, structures, and/or other aspects of the disclosure are not to be considered limitations on the disclosure as defined by the claims or limitations on equivalents to the claims, and that other embodiments may be utilised and modifications may be made without departing from the scope and/or spirit of the disclosure. Various embodiments may suitably comprise, consist of, or consist essentially of, various combinations of the disclosed elements, components, features, parts, steps, means, etc. In addition, the disclosure includes other inventions not presently claimed, but which may be claimed in future.

Claims

1. An apparatus configured to volatilize components of smokable material for inhalation, comprising:

a smokable material heating chamber; and

a heating material which is configured to be heated by the presence of a varying magnetic field, wherein the heating material is arranged to transfer heat energy to smokable material in the heating chamber to volatilize said components.

2. An apparatus according to claim 1, wherein the heating material is comprised in a heating member.

3. An apparatus according to claim 2, wherein the heating member comprises a base material in thermal contact with the heating material, the base material being configured to retain heat energy received from the heating material and to transfer the heat energy to smokable material in the heating chamber to volatilize said components.

4. An apparatus according to claim 3, wherein the base material is configured to transfer said heat energy to said smokable material over an extended period so as to raise and maintain a temperature of said smokable material at a volatilizing temperature for said extended period without simultaneous heating of the heating material by the varying magnetic field.

5. An apparatus according to claim 3 or 4, wherein the heating material comprises a plurality of pieces of heating material dispersed in the heating member with the base material.

6. An apparatus according to any of claims 2 to 5, wherein the heating member comprises an elongate member located adjacent the smokable material heating chamber.

7. An apparatus according to claim 6, wherein the heating chamber is located co-axially around the heating member.

8. An apparatus according to claim 1, wherein the heating material is located inside the smokable material heating chamber with the smokable material.

9. An apparatus according to claim 8, wherein the heating material comprises a plurality of pieces of heating material dispersed within the smokable material.

10. An apparatus according to any preceding claim, wherein the heating material comprises an electrically conductive material.

11. An apparatus according to any preceding claim, wherein the heating material is susceptible to eddy currents induced by the varying magnetic field in the material, the eddy currents causing the heating material to be resistively heated.

12. An apparatus according to any preceding claim, comprising a housing in which the heating chamber and heating material are contained and a varying magnetic field generator arranged to receive the housing during heating of the heating material.

13. An apparatus according to claim 12, wherein the field generator is arranged to releasably dock with the housing, thereby maintaining a stable position of the housing relative to the generator during heating.

14. An apparatus according to any preceding claim, comprising a mouthpiece in fluid communication with the heating chamber in order to allow volatilized components of the smokable material to be drawn through the mouthpiece by a user.

15. An apparatus according to any preceding claim, wherein the heating material is configured to heat the smokable material to a volatilizing temperature of between approximately 50°C and 250°C to volatilize said components.

16. A method of heating smokable material to volatilize components of the smokable material for inhalation, comprising:

generating a varying magnetic field;

using the varying magnetic field to induce an electrical current in a heating material and thereby heating the heating material;

transferring thermal energy from the heating material to the smokable material to heat the smokable material to a volatilizing temperature and thereby volatilize components of the smokable material.

17. A method of heating smokable material to volatilize components of the smokable material for inhalation, comprising:

inserting a housing containing heating material and smokable material into a device configured to generate a varying magnetic field;

generating the varying magnetic field in the device and thereby heating the heating material by causing an electrical current to be induced in the heating material;

transferring thermal energy from the heating material to the smokable material to heat the smokable material to a volatilizing temperature and thereby volatilize components of the smokable material.

18. An apparatus for performing the method of claim 17, comprising:

a housing containing smokable material and a heating material; and

a device configured to generate a varying magnetic field.

19. An apparatus substantially as described herein, with reference to the accompanying figures 1 to 4.

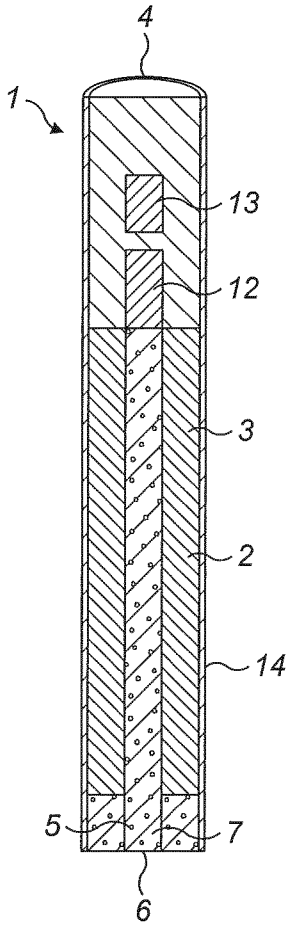

FIG. 1

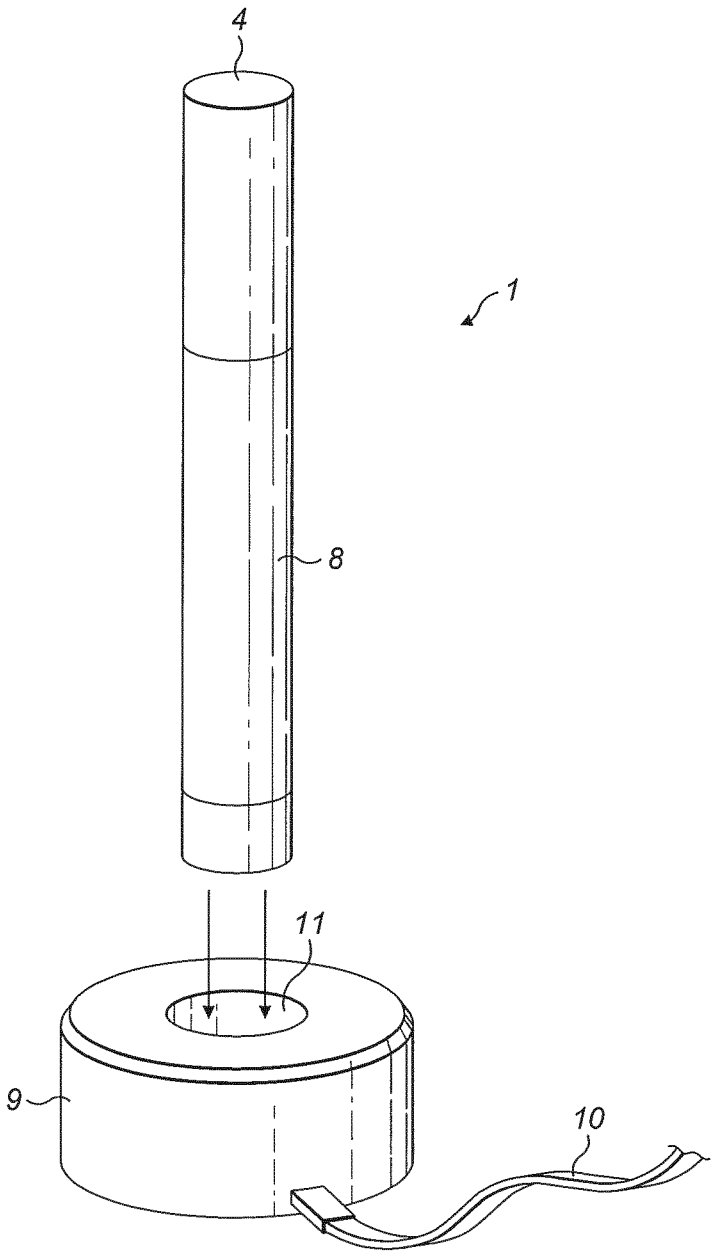

FIG. 2

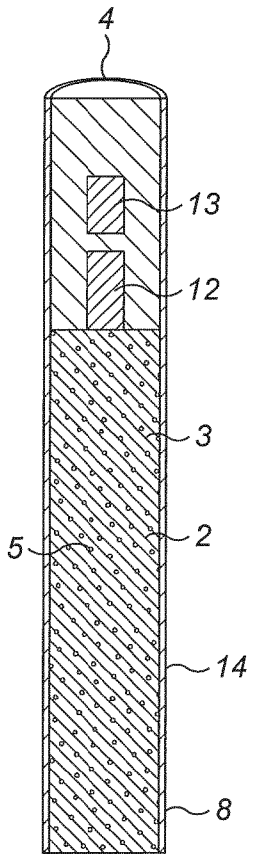

FIG. 3

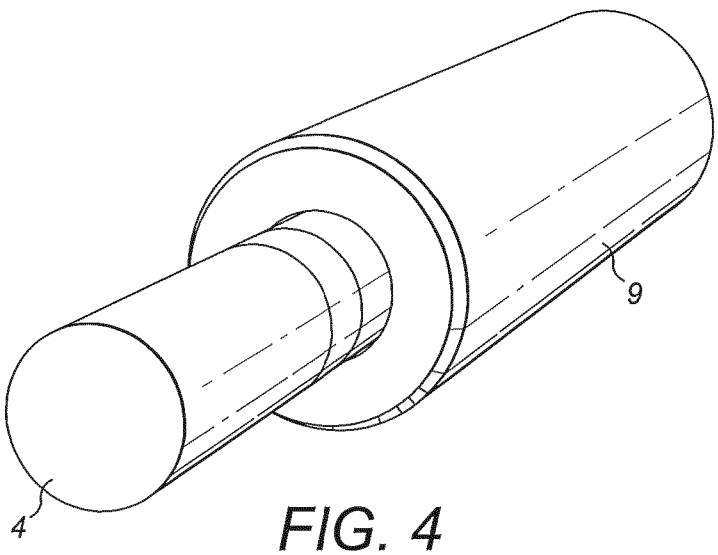

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/068797

A. CLASSIFICATION OF SUBJECT MATTER
INV. A24F47/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A24F

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 95/27411 A1 (PHILIP MORRIS PROD [US]) 19 October 1995 (1995-10-19) the whole document	1-19
X	US 5 649 554 A (SPRINKEL F MURPHY [US] ET AL) 22 July 1997 (1997-07-22) the whole document	1-19
X	EP 0 430 559 A2 (PHILIP MORRIS [US] PHILIP MORRIS PROD [US]) 5 June 1991 (1991-06-05) the whole document	1-19

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

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Information on patent family members

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