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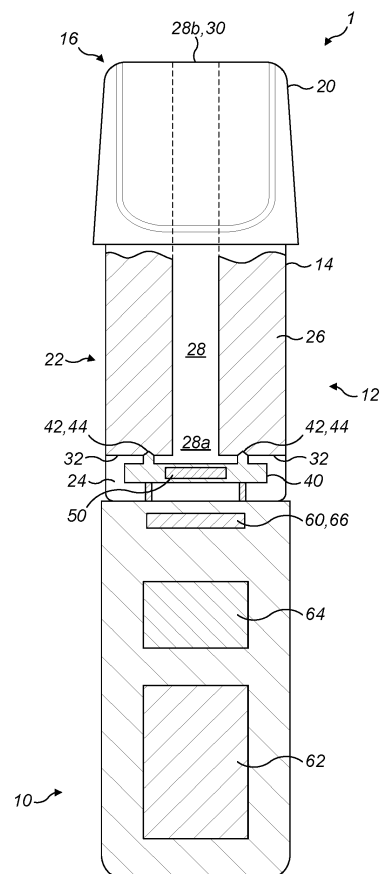
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(54) **AN AEROSOL GENERATING DEVICE AND AN AEROSOL GENERATING SYSTEM**

(57) An aerosol generating device (10) comprises: a liquid transfer element (40) including an opening portion (42) configured to open a cartridge (12) containing an aerosol generating liquid; and an inductively heatable susceptor (50) in contact with the liquid transfer element (40). The liquid transfer element (40) is configured to convey aerosol generating liquid from the opened cartridge (12) towards the inductively heatable susceptor (50). An aerosol generating system (1) is also described comprising the aerosol generating device (10) and a cartridge (12) containing an aerosol generating liquid releasably connected to the aerosol generating device (10).



**FIG. 2**

## Description

### Technical Field

[0001] The present disclosure relates generally to an aerosol generating device configured to heat an aerosol generating liquid to generate a vapour which cools and condenses to form an aerosol for inhalation by a user of the device. Embodiments of the present disclosure also relate to an aerosol generating system comprising an aerosol generating device and a cartridge configured to be used with the aerosol generating device.

### Technical Background

[0002] The term aerosol generating device or 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 heating an aerosol generating liquid 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". The vapour generating liquid usually comprises nicotine, propylene glycol, glycerine and flavourings.

[0003] Typical e-cigarette vaporizing units, i.e. systems or sub-systems for vaporizing the aerosol generating liquid, utilize a cotton wick and heating element to produce vapour from liquid stored in a capsule or tank. When a user operates the e-cigarette, liquid that has soaked into the wick is heated by the heating element, producing a vapour which cools and condenses to form an aerosol which may then be inhaled. To facilitate the ease of use of e-cigarettes, cartridges are often used. These cartridges are often configured as "cartomizers", which means an integrated component formed from a liquid store, a liquid transfer element (e.g. a wick) and a heater. Electrical connectors may also be provided to establish an electrical connection between the heating element and a power source. However, the complexity and numerous components of such cartridges are associated with drawbacks, such as complex and costly manufacturing and/or assembly processes.

[0004] In view of the above, it would be desirable to provide an aerosol generating device which allows the use of cartridges having a simplified structure such that the manufacturability and/or assembly of the cartridges can be improved.

### Summary of the Disclosure

[0005] According to a first aspect of the present disclosure, there is provided an aerosol generating device comprising:

a liquid transfer element including an opening portion configured to open a cartridge containing an aerosol

generating liquid; and  
an inductively heatable susceptor in contact with the liquid transfer element;  
wherein the liquid transfer element is configured to convey aerosol generating liquid from the opened cartridge towards the inductively heatable susceptor.

[0006] The aerosol generating device, and in particular the inductively heatable susceptor, is configured to heat the conveyed aerosol generating liquid to volatilise at least one component of the aerosol generating liquid and thereby generate a vapour which cools and condenses to form an aerosol for inhalation by a user of the aerosol generating device. The present disclosure is particularly applicable to a portable (hand-held) aerosol generating device.

[0007] According to a second aspect of the present disclosure, there is provided an aerosol generating system comprising an aerosol generating device according to the first aspect and a cartridge containing an aerosol generating liquid releasably connected to the aerosol generating device

[0008] By integrating both the liquid transfer element and the inductively heatable susceptor into the aerosol generating device, the number of components within the cartridge is reduced and, thus, the structure of the cartridge can be simplified and the cost reduced. Moreover, the liquid transfer element and the inductively heatable susceptor can be re-used with multiple cartridges, avoiding the need to discard and replace these components each time a depleted cartridge is replaced.

[0009] 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.

[0010] The opening portion may be configured to pierce the cartridge. The opening portion may include a tapered end. The opening portion may comprise a projection. The projection may be a piercing projection which may be configured to pierce the cartridge. The cartridge is readily pierced by the projection when the cartridge is connected to the aerosol generating device, thus allowing aerosol generating liquid to be conveyed by the liquid transfer element from the pierced cartridge towards the inductively heatable susceptor.

[0011] The projection may be hollow and/or may be formed of porous material. Such an arrangement ensures a reliable flow of aerosol generating liquid from the cartridge to the inductively heatable susceptor.

[0012] The inductively heatable susceptor may be encapsulated by the liquid transfer element. Heat is trans-

ferred efficiently from the encapsulated inductively heatable susceptor to the liquid transfer element, thus ensuring that the conveyed aerosol generating liquid is reliably heated and vaporised.

**[0013]** The liquid transfer element may be porous and may comprise a capillary material. The porous liquid transfer element contacts the aerosol generating liquid in the cartridge to enable absorption of the aerosol generating liquid by the capillary material, for example due to capillary action or wicking, and conveys the absorbed aerosol generating liquid to the inductively heatable susceptor where it is heated to form a vapour.

**[0014]** In an embodiment, the inductively heatable susceptor may be substantially planar. The substantially planar inductively heatable susceptor may extend in a transverse direction, perpendicular to a longitudinal axis of the aerosol generating device. An efficient transfer of heat from the inductively heatable susceptor to the liquid transfer element may be achieved with this arrangement.

**[0015]** In another embodiment, the inductively heatable susceptor may comprise a particulate susceptor material. The particulate susceptor material may be distributed throughout the liquid transfer element and may, for example, be distributed uniformly throughout the liquid transfer element. An efficient transfer of heat from the particulate susceptor material to the liquid transfer element and a uniform heating of the liquid transfer element may be achieved with this arrangement.

**[0016]** The aerosol generating device may include an electromagnetic field generator which may be positioned adjacent to the liquid transfer element for inductively heating the inductively heatable susceptor. A good electromagnetic coupling between the electromagnetic field generator and the inductively heatable susceptor is thereby achieved.

**[0017]** The electromagnetic field generator may comprise an induction coil and may, for example, comprise a planar induction coil. The planar induction coil may be a flat spiral coil. The flat spiral coil may extend in a plane substantially perpendicular to a longitudinal axis of the aerosol generating device. It may be advantageous to use a flat spiral coil in embodiments in which the inductively heatable susceptor is substantially planar, to ensure that a good electromagnetic coupling between the coil and susceptor is achieved. The induction coil may comprise a Litz wire or a Litz cable. It will, however, be understood that other materials could be used.

**[0018]** The liquid transfer element may comprise a substantially rigid porous material. The liquid transfer element may, for example, comprise a porous ceramic material. The liquid transfer element has the required level of structural rigidity to open the cartridge, for example by piercing a sealing element of the cartridge, and at the same time the required level of porosity to convey aerosol generating liquid from the cartridge to the inductively heatable susceptor.

**[0019]** The opening portion may be an integral part of the liquid transfer element. Manufacture of the liquid

transfer element is thereby simplified, because the opening portion can be formed during manufacture of the liquid transfer element. In an embodiment, the opening portion may be a projection formed integrally with the liquid transfer element, for example a porous ceramic projection or spike.

**[0020]** In an embodiment, the cartridge may comprise a sealing element. The sealing element may be pierceable and the opening portion, e.g. piercing projection, may be configured to pierce the sealing element. The sealing element may extend transversely across an opening of the cartridge to seal the opening. The sealing element may comprise a metal foil or an elastomeric sealing element, although it will be understood that any suitable material may be used to form the sealing element. The sealing element may help to preserve the aerosol generating liquid inside the cartridge prior to use and prevent unwanted leakage, thus improving the shelf-life of the cartridge. The sealing element is readily pierced by the projection when the cartridge is connected to the aerosol generating device, thus allowing aerosol generating liquid to be conveyed by the liquid transfer element from the pierced cartridge towards the inductively heatable susceptor.

**[0021]** In an embodiment, the cartridge may comprise a valve and the opening portion may comprise a projection configured to open the valve. The valve ensures that the aerosol generating liquid is reliably contained in the cartridge and that unwanted leakage of the aerosol generating liquid is prevented. The opening portion provides for reliable and simple opening of the valve. The valve may also allow the cartridge to be refilled with aerosol generating liquid so that the cartridge can be re-used. The valve may comprise a duckbill valve which may be configured to open upon insertion of the projection into the valve. The valve may also be configured to close upon withdrawal of the projection from the valve.

**[0022]** The cartridge may further comprise a vaporization chamber for the inductively heatable susceptor, an air inlet communicating with the vaporization chamber, for example with an inlet of the vaporization chamber, and a vapour outlet channel in communication with an outlet of the vaporization chamber. The vapour generated in the vaporization chamber may cool and condense to form an aerosol as it flows along the vapour outlet channel, from the vaporization chamber towards an end of the vapour outlet channel. The end of the vapour outlet channel may comprise a mouthpiece.

**[0023]** The aerosol generating liquid may comprise polyhydric alcohols and mixtures thereof such as glycerine and/or propylene glycol. The aerosol generating liquid may contain nicotine and may, therefore, be designated a nicotine-containing liquid. The aerosol generating liquid may contain one or more additives, such as a flavouring.

**[0024]** The inductively heatable susceptor may comprise one or more, but not limited, of aluminium, iron, nickel, stainless steel, copper, and alloys thereof, e.g. Nickel Chromium or Nickel Copper. With the application

of an alternating electromagnetic field in its vicinity, for example generated by the electromagnetic field generator, the susceptor may generate heat due to eddy currents and magnetic hysteresis losses resulting in a conversion of energy from electromagnetic to heat.

**[0025]** The electromagnetic field generator may be arranged to operate in use with a fluctuating electromagnetic field having a magnetic flux density of between approximately 20mT and approximately 2.0T at the point of highest concentration.

**[0026]** The aerosol generating device may include a power source and may include circuitry. The power source and circuitry may be configured to operate at a high frequency. The power source and circuitry may be configured to operate at a frequency of between approximately 80 kHz and 500 kHz, possibly between approximately 150 kHz and 250 kHz, and possibly at approximately 200 kHz. The power source and circuitry could be configured to operate at a higher frequency, for example in the MHz range, depending on the type of inductively heatable susceptor that is used.

### Brief Description of the Drawings

#### **[0027]**

Figure 1 is a diagrammatic view of an aerosol generating system comprising an aerosol generating device and a cartridge configured to be releasably connected to the aerosol generating device;

Figure 2 is a diagrammatic view of the aerosol generating system shown in Figure 1, with the cartridge connected to the aerosol generating device; and

Figure 3 is a diagrammatic view from a first end of the aerosol generating device.

### Detailed Description of Embodiments

**[0028]** Embodiments of the present disclosure will now be described by way of example only and with reference to the accompanying drawings.

**[0029]** Referring initially to Figures 1 and 2, there is shown an aerosol generating device 10 according to the present disclosure. The aerosol generating device 10 is configured to be used with a cartridge 12 such that the aerosol generating device 10 and the cartridge 12 together form an aerosol generating system 1. In an embodiment, the cartridge 12 is releasably connectable to the aerosol generating device 10 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.

**[0030]** The cartridge 12 comprises a cartridge housing 14 having a proximal end 16 and a distal end 18. The proximal end 16 may constitute a mouthpiece end configured for being introduced directly into a user's mouth and may, therefore, also be designated as the mouth end 16. In the illustrated example, a mouthpiece cover 20 is

fitted to the proximal (mouth) end 16 and may be secured in position on the cartridge housing 14 by a snap-fit connection or glue. The cartridge 12 comprises a liquid storage portion 22 and a vaporization chamber 24. The liquid storage portion 22 comprises a reservoir (i.e., liquid store) 26 configured for containing therein an aerosol generating liquid, and a vapour outlet channel 28 having an outlet 28b at the proximal (mouth) end 16. The outlet 28b may constitute a mouthpiece 30 of the cartridge 12.

**[0031]** The aerosol generating liquid stored in the reservoir 26 may comprise an aerosol-forming substance such as propylene glycol and/or glycerol and may contain other substances such as nicotine and acids. The aerosol generating liquid may also comprise flavourings such as e.g. tobacco, menthol or fruit flavour. The reservoir 26 may extend generally between the proximal (mouth) end 16 and the distal end 18 and may surround, and coextend with, the vapour outlet channel 28.

**[0032]** The cartridge 12 can include a sealing element 32 at a distal end of the reservoir 26 to retain the aerosol generating liquid in the reservoir 26. The sealing element 32 extends transversely across an opening of the cartridge 12, and in the illustrated example comprises an annular sealing element 32 which seals a correspondingly shaped annular opening at a distal end of the reservoir 26. The sealing element 32 can comprise a metal foil or an elastomeric material, although it will be apparent to one of ordinary skill in the art that other materials could be used.

**[0033]** The aerosol generating device 10 comprises a liquid transfer element 40 and an inductively heatable susceptor 50 in contact with the liquid transfer element 40. The liquid transfer element 40 includes an opening portion 42 configured to open the cartridge 12 and release the aerosol generating liquid from the reservoir 26 when the cartridge 12 is connected to the aerosol generating device 10 as shown in Figure 2. In the illustrated example, the opening portion 42 comprises two or more transversely or circumferentially spaced piercing projections 44 which have tapered ends 46 configured to pierce the sealing element 32 when the cartridge 12 is moved towards, and connected to, the aerosol generating device 10 from the position shown in Figure 1 to the position shown in Figure 2.

**[0034]** The liquid transfer element 40 and the piercing projections 44 comprise a porous material and can be integrally formed as a single component. The porous material comprises a capillary material and may comprise a porous ceramic material. Aerosol generating liquid is absorbed into the porous material of the liquid transfer element 40 from the reservoir 26 via the porous piercing projections 44 and is conveyed, for example by a wicking action, towards the inductively heatable susceptor 50 so that the aerosol generating liquid can be heated and vaporized as discussed further below.

**[0035]** The piercing projections 44, and the liquid transfer element 40 more generally, comprise a substantially rigid porous material, for example a porous ceramic ma-

terial as mentioned above. The liquid transfer element 40 and the piercing projections 44 thus have the required level of structural rigidity to open the cartridge 12, for example by piercing the sealing element 32, so that aerosol generating liquid can be conveyed from the reservoir 26 towards the inductively heatable susceptor 50. The liquid transfer element 40 is positioned at, and may project from, a first end 10a of the aerosol generating device 10 and can be mounted on a support 48, for example comprising a material which is not inductively heated in the presence of an alternating electromagnetic field.

**[0036]** The liquid transfer element 40 can be an exchangeable part of the aerosol generating device 10 so that before or when dirty or clogged, it is exchanged by a clean or new liquid transfer element 40. For this, the support 48 may be attached to the aerosol generating device 10 in a detachable manner or not be attached at all. For example, the liquid transfer element 40 may be detached by the removal of the cartridge 12 from the aerosol generating device 10. In this case, when the cartridge 12 is removed, the liquid transfer element 40 remains attached to the pierced reservoir 26 of the cartridge 12. The attachment can be obtained by the piercing projections 44 and/or by distinct attachment members.

**[0037]** As best seen in Figures 1 to 3, the inductively heatable susceptor 50 is substantially planar and extends in a transverse direction, perpendicular to a longitudinal axis of the aerosol generating device 10. The inductively heatable susceptor 50 can be encapsulated by the liquid transfer element 40, but encapsulation is not strictly necessary provided that the inductively heatable susceptor 50 contacts the liquid transfer element 40 such that heat can be transferred from the inductively heatable susceptor 50 to the liquid transfer element 40. For example, a layered arrangement could be envisaged. Alternatively, the inductively heatable susceptor 50 could comprise a particulate susceptor material which is distributed throughout the liquid transfer element 40.

**[0038]** The aerosol generating device 10 comprises an electromagnetic field generator 60, a power source 62, and control circuitry 64 which may be configured to operate at high frequency. The power source 62 typically comprises one or more batteries which could, for example, be inductively rechargeable. The electromagnetic field generator 60 is positioned at the first end 10a of the aerosol generating device 10 adjacent to the inductively heatable susceptor 42. The electromagnetic field generator 60 includes a flat spiral induction coil 66 (see especially Figure 3) which extends in a plane substantially perpendicular to a longitudinal axis of the aerosol generating device 10 and which is positioned adjacent to the inductively heatable susceptor 50.

**[0039]** As will be understood by one of ordinary skill in the art, when the induction coil 66 is energised, an alternating and time-varying electromagnetic field is produced. This couples with the inductively heatable susceptor 50 and generates eddy currents and/or magnetic hysteresis losses in the inductively heatable susceptor

50 causing it to heat up. The heat is transferred from the inductively heatable susceptor 50 to the liquid transfer element 40, for example by conduction, radiation and convection, thereby heating the liquid transfer element 40.

**[0040]** In operation, when the cartridge 12 is connected to the aerosol generating device 10 as shown in Figure 2, the sealing element 32 is pierced by the piercing projections 44 and aerosol generating liquid is absorbed from the reservoir 26 by the porous liquid transfer element 40 and is conveyed towards the inductively heatable susceptor 50. When the aerosol generating device 10 is activated, the inductively heatable susceptor 50 is inductively heated by the electromagnetic field generator 60, and more specifically by the alternating electromagnetic field generated by the induction coil 66. The heat from the inductively heatable susceptor 50 is transferred to the absorbed aerosol generating liquid, resulting in the generation of a vapour which escapes from the liquid transfer element 40 into the vaporization chamber 24. The vapour then flows from the vaporization chamber 24, and into the vapour outlet channel 28 via an inlet 28a. As the vapour flows along the vapour outlet channel 28, it cools and condenses to form an aerosol that is inhaled by a user through the mouthpiece 30 formed by the outlet 28b. The vaporization of the aerosol generating liquid is facilitated by the addition of air from the surrounding environment through one or more air inlets (not shown) at the distal end 18 of the cartridge 12. The flow of air and/or vapour through the cartridge 12, i.e. from the one or more air inlets, through the vaporization chamber 24, along the vapour outlet channel 28, and out of the mouthpiece 30, is aided by negative pressure created by a user drawing air from the proximal (mouth) end 16 using the mouthpiece 30.

**[0041]** After the aerosol generating liquid in the cartridge 12 has been depleted, the cartridge 12 can be disconnected from the aerosol generating device 10 and a replacement cartridge 12 can then be connected in its place, to allow further use of the aerosol generating system 1 in the manner described above.

**[0042]** 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.

**[0043]** 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.

**[0044]** 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. An aerosol generating device (10) comprising:
 

a liquid transfer element (40) including an opening portion (42) configured to open a cartridge (12) containing an aerosol generating liquid; and an inductively heatable susceptor (50) in contact with the liquid transfer element (40); wherein the liquid transfer element (40) is configured to convey aerosol generating liquid from the opened cartridge (12) towards the inductively heatable susceptor (50).
2. An aerosol generating device according to claim 1, wherein the opening portion (42) comprises a projection (44).
3. An aerosol generating device according to claim 2, wherein the projection (44) is hollow and/or formed of porous material.
4. An aerosol generating device according to any preceding claim, wherein the opening portion (42) is configured to pierce the cartridge (12).
5. An aerosol generating device according to any preceding claim, wherein the opening portion (42) includes a tapered end (46).
6. An aerosol generating device according to any preceding claim, wherein the inductively heatable susceptor (50) is encapsulated by the liquid transfer element (40).
7. An aerosol generating device according to any preceding claim, wherein the inductively heatable susceptor (50) is substantially planar.
8. An aerosol generating device according to any preceding claim, wherein the aerosol generating device (10) includes an electromagnetic field generator (60) positioned adjacent to the liquid transfer element (40) for inductively heating the inductively heatable susceptor (50).
9. An aerosol generating device according to claim 8, wherein the electromagnetic field generator (60) comprises a planar induction coil (66).
10. An aerosol generating device according to claim 9, wherein the planar induction coil (66) is a flat spiral coil.
11. An aerosol generating device according to any preceding claim, wherein the liquid transfer element (40) comprises a substantially rigid porous material.
12. An aerosol generating device according to claim 11, wherein the liquid transfer element (40) comprises a porous ceramic material.
13. An aerosol generating system (1) comprising an aerosol generating device (10) according to any of the preceding claims and a cartridge (12) containing an aerosol generating liquid releasably connected to the aerosol generating device (10).
14. An aerosol generating system according to claim 13, wherein the cartridge (12) comprises a sealing element (32) and the opening portion (42) comprises a piercing projection (44) configured to pierce the sealing element (32).
15. An aerosol generating system according to claim 13, wherein the cartridge (12) comprises a valve and the opening portion (42) comprises a projection for opening the valve.

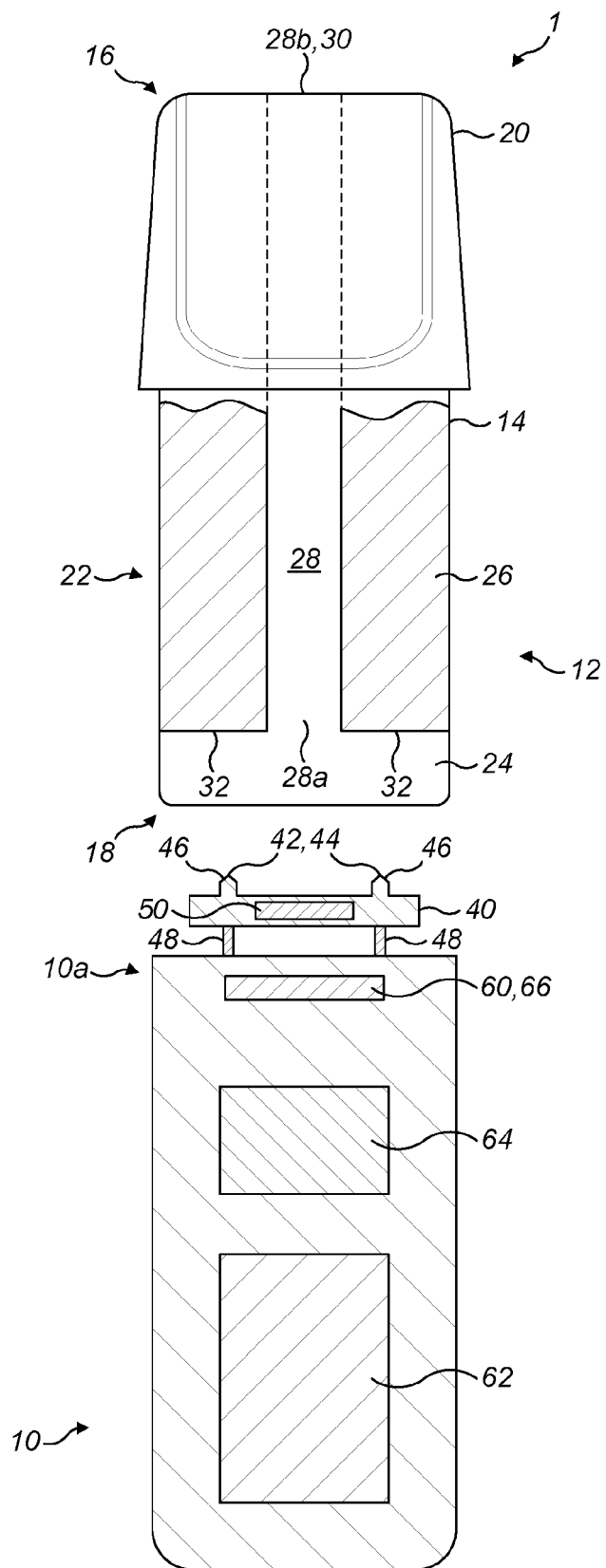


FIG. 1

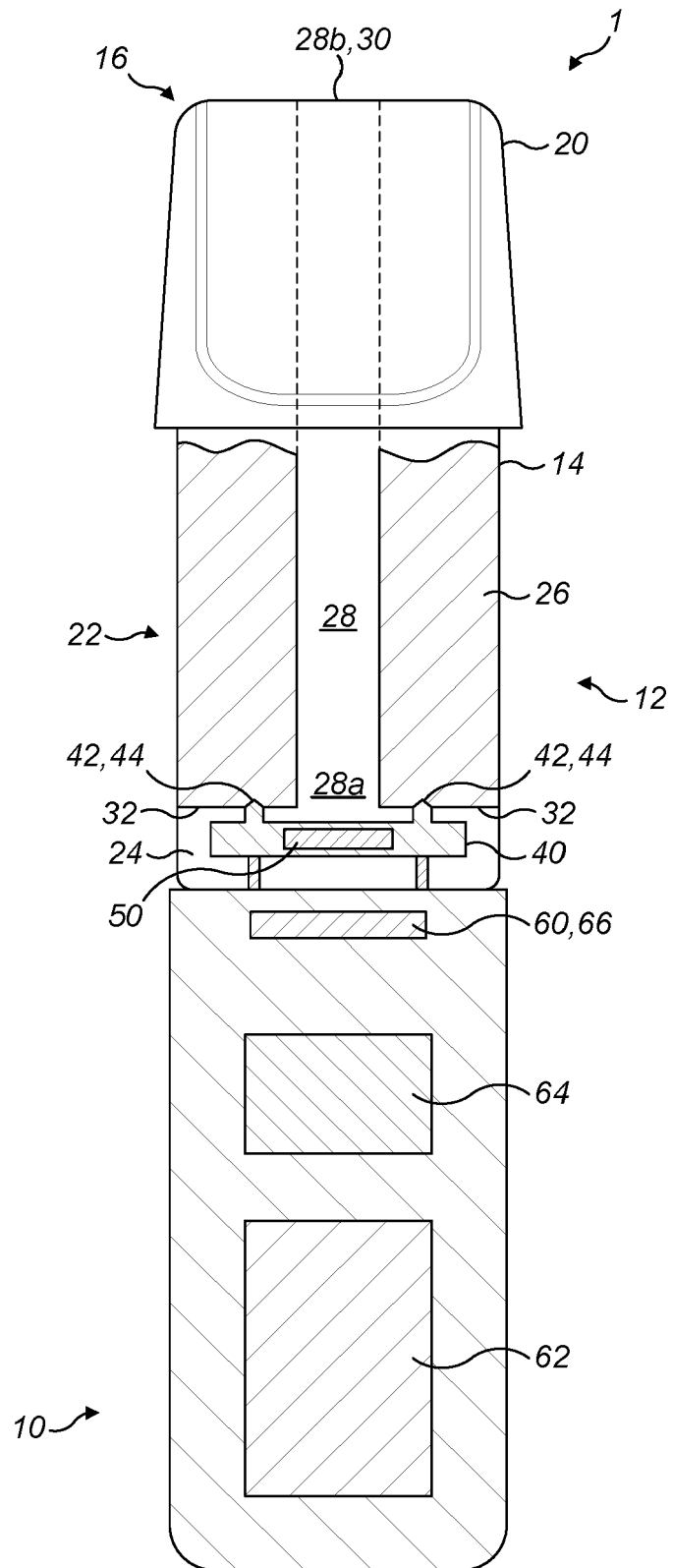
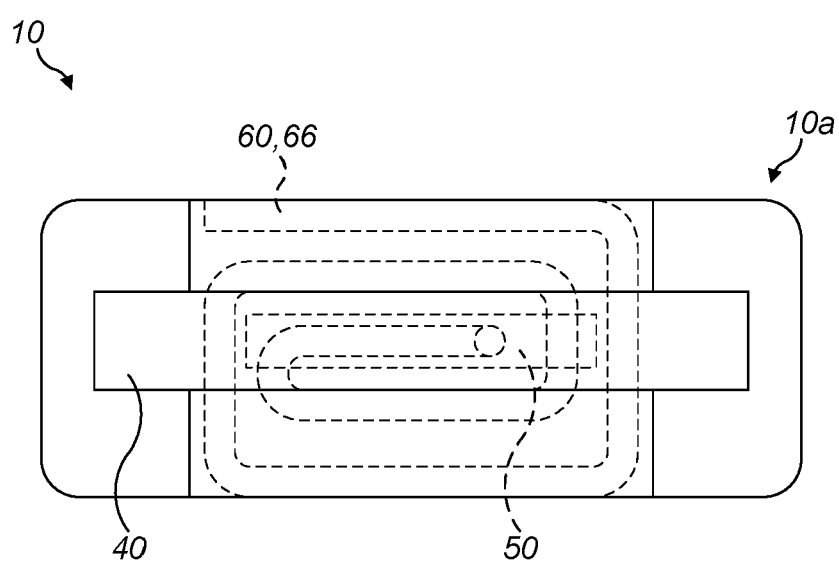


FIG. 2





**FIG. 3**



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Application Number  
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