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(54) AEROSOL GENERATING SYSTEMS AND CARTRIDGES FOR USE IN AEROSOL GENERATING SYSTEMS

(57) An aerosol generating system 10 comprising a reservoir 22 having a reservoir chamber 24 for containing a liquid aerosol generating substrate, a vaporisation region 32, a vapour outlet channel 36a downstream of the vaporisation region 32, the vapour outlet channel 36a having an inner surface 44 defining a vapour outlet pathway 34 and an outer surface 52, and an insulation channel 48 surrounding at least a portion of the vapour outlet channel 36a, the insulation channel 48 having an inner surface 50 spaced from the outer surface 52 of the vapour outlet channel 36a.

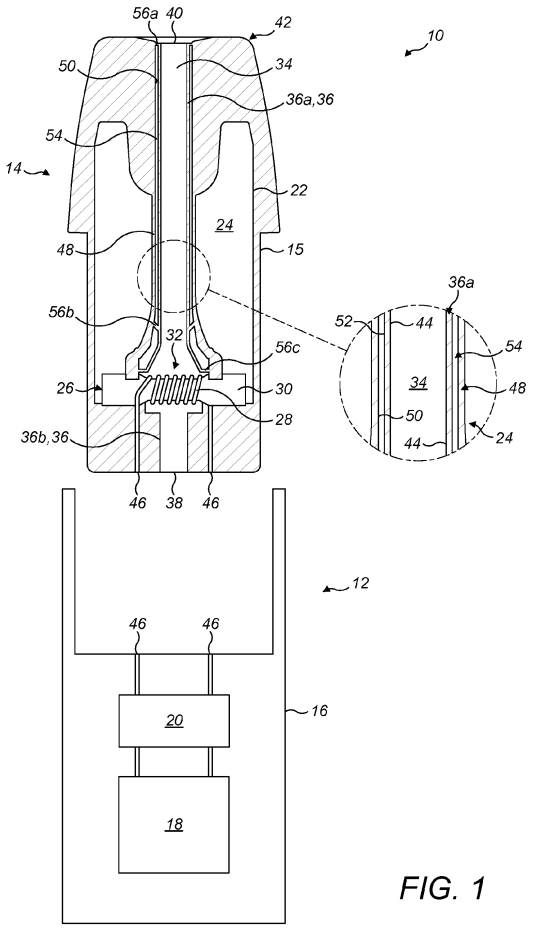

FIG. 1

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Description

Technical Field

[0001] The present invention relates generally to aerosol generating systems. The invention relates particularly, but not exclusively, to cartridges for aerosol generating systems that comprise a base part and a separable cartridge.

Technical Background

[0002] Aerosol generating systems, also commonly termed electronic cigarettes, are an alternative to conventional cigarettes. Instead of generating a combustion smoke, they vaporise a liquid aerosol generating substrate which can be inhaled by a user. The liquid typically comprises an aerosol generating substance, such as glycerine or propylene glycol, that creates the vapour when heated. Other common substances in the liquid are nicotine and various flavourings.

[0003] An aerosol generating system is a hand-held inhaler system, typically comprising a mouthpiece section, a reservoir configured to hold liquid aerosol generating substrate in a reservoir chamber, and a power supply unit. Vaporisation is achieved in a vaporisation region, such as a vaporisation chamber, by a vaporiser or heater unit which typically comprises a heating element in the form of a heating coil and a fluid transfer medium such as a wick. Vaporisation occurs when the heater heats the liquid in the wick until the liquid is transformed into vapour. The vapour is conveyed from the vaporisation region to an outlet in the mouthpiece section by means of a vapour outlet pathway.

[0004] 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.

[0005] Conventional cigarette smoke comprises nicotine as well as a multitude of other chemical compounds generated as the products of partial combustion and/or pyrolysis of the plant material. Electronic cigarettes on the other hand deliver primarily an aerosolised version of an initial starting e-liquid composition comprising nicotine and various food safe substances such as propylene glycol and glycerine, etc., but are also efficient in delivering a desired nicotine dose to the user. Electronic cigarettes need to deliver a satisfying amount of vapour for an optimum user experience whilst at the same time maximising energy efficiency.

[0006] In some situations, liquid aerosol generating substrate can leak from an aerosol generating system. Such leakage is undesirable, and can be unpleasant for the user. Current systems typically leak through two mechanisms. Firstly, liquid aerosol generating substrate can leak from the reservoir via the wick into the inlet and outlets of the system, for example due to pressure difference and capillary force. Such leakage occurs mostly in storage and during transport. Secondly, during aerosol production vapour that is generated in the system can condense on the inner walls of the system, particularly in the vapour outlet pathway. After several cycles of use the condensed vapour can accumulate to a degree where drops of liquid leak out of the outlet. This second type of leakage is typically more short term, and occurs while the user uses the system. Currently, aerosol generating systems are not typically designed to mitigate leakage of this second type.

Summary

[0007] According to a first aspect of the invention we provide an aerosol generating system comprising:

a reservoir having a reservoir chamber for containing a liquid aerosol generating substrate;
a vaporisation region;
a vapour outlet channel downstream of the vaporisation region, the vapour outlet channel having an inner surface defining a vapour outlet pathway and an outer surface; and
an insulation channel surrounding at least a portion of the vapour outlet channel, the insulation channel having an inner surface spaced from the outer surface of the vapour outlet channel.

[0008] During use of an aerosol generating system, vapour produced in the vaporisation region is guided along a vapour outlet pathway via a vapour outlet channel toward a user's mouth. When the vapour contacts the inner surface of the vapour outlet channel it may condense when a saturation pressure point is reached. The onset of condensation can be delayed or prevented by increasing the temperature in order to raise the saturation pressure limit. However, increasing the temperature is not desirable in practice, as this would require additional energy to be input to the system.

[0009] As an alternative to increasing the temperature, the system described herein includes an insulation channel surrounding at least a portion of the vapour outlet channel. The insulation channel has an inner surface that is spaced from the outer surface of the vapour outlet channel, and hence is operable to restrict the thermal heat capacity of the parts of the system in thermal contact with the vapour. Condensation accumulation is thus reduced by reducing the convective heat transfer away from the vapour, because the parts of the system in thermal contact with the vapour are thermally isolated from the remainder of the system.

[0010] The outer surface of the vapour outlet channel may be spaced from the inner surface of the insulation channel by at least 0.1 mm. The outer surface of the vapour outlet channel may be spaced from the inner surface of the insulation channel by a distance in the range 0.1 mm-2mm, for example 0.2mm-1mm. Such a spacing provides a barrier to heat transfer between the vapour outlet channel and the insulation channel without significantly increasing the size of the system.

[0011] A space between the outer surface of the vapour outlet channel and the inner surface of the insulation channel may comprise a vacuum. Providing a vacuum between the vapour outlet channel and the insulation channel may improve the thermal isolation of the vapour outlet channel from the insulation channel in a compact and lightweight manner.

[0012] Alternatively, a space between the outer surface of the vapour outlet channel and the inner surface of the insulation channel may comprise an insulating gas, such as air. Such a system may have a simplified manufacture process as compared with a system comprising an evacuated space between the vapour outlet channel and the insulation channel, whilst still providing good thermal isolation.

[0013] The insulation channel may be disposed between the vapour outlet channel and the reservoir chamber. The thermal capacity of the reservoir may be high, particularly when the reservoir is full. Disposing the insulation channel between the vapour outlet channel and the reservoir chamber thus ensures that the vapour outlet channel is thermally isolated from a large potential heat sink.

[0014] The insulating channel may comprise a wall of the reservoir. Forming the insulation channel from a wall of the reservoir may allow for a simplified construction.

[0015] The vapour outlet channel and the insulation channel may extend through the reservoir, such that the reservoir chamber is disposed around the vapour outlet channel. Such an arrangement may result in a compact construction, whilst maintaining thermal isolation of the vapour outlet channel.

[0016] The vapour outlet channel may have one or more walls which are thin and/or which have a small volume relative to the volume of the vapour outlet pathway. For example, the wall(s) of the vapour outlet channel may have a thickness of less than 1mm, and preferably of less than 0.2mm, for example in the range 0.05mm-1mm, or 0.1mm-0.5mm. The inner surface of a channel having thin walls may rise to a temperature that is close to that of the vapour being conveyed within the channel more quickly that a channel with relatively thick walls. This may reduce the likelihood of vapour condensing on the inner surface of the channel, as vapour is more likely to condense on colder surfaces.

[0017] The vapour outlet channel may be formed from a material having a low thermal conductivity, such as thermoplastics. This may further reduce heat transfer away from the vapour.

[0018] The vapour outlet channel typically has a length extending between the vaporisation region and an aerosol outlet, and the insulation channel preferably surrounds the vapour outlet channel for substantially the entire length. This may improve the thermal isolation of the vapour outlet channel by maximising the surface area of the vapour outlet channel which is insulated.

[0019] The vapour outlet channel may be substantially cylindrical. The insulation channel may be substantially cylindrical. The vapour outlet channel and the insulation channel may be substantially coaxial. Such an arrangement is compact, with an even spacing between the insulation channel and the vapour outlet channel on all sides.

[0020] One or more mounting fillets may extend between the outer surface of the vapour outlet channel and the inner surface of the insulation channel. The fillets may operable to support the vapour outlet channel within the insulation channel, whilst providing only a small volume of material through which heat may be conducted away from the vapour outlet channel. Each of the one or more fillets may have a thickness of less than 1 mm, and preferably less than 0.2mm, for example a thickness in the range 0.05mm-1mm, such as 0.1mm-0.5mm.

[0021] In the context of this disclosure, an aerosol generating system may comprise an electronic cigarette, which may include a cartridge removably connected to a base part. The features described above may be included in the cartridge of the aerosol generating system, or in the base part of the system, or shared between the cartridge and the base part. Preferably the features described above in connection with the first aspect of the invention are included solely in a cartridge for an aerosol generating system.

[0022] Thus, according to a second aspect of the invention, we provide a cartridge for an aerosol generating system comprising:

a reservoir having a reservoir chamber for containing a liquid aerosol generating substrate;
a vaporisation region;
a vapour outlet channel downstream of the vaporisation region, the vapour outlet channel having an inner surface defining a vapour outlet pathway and an outer surface; and
an insulation channel surrounding at least a portion of the vapour outlet channel, the insulation channel having an inner surface spaced from the outer surface of the vapour outlet channel.

[0023] The cartridge may include any of the features discussed above with reference to the first aspect of the invention, in any combination that is not explicitly excluded.

[0024] As used herein, the term "electronic cigarette" may include an electronic cigarette configured to deliver an aerosol to a user, including an aerosol for inhalation/-vaping. An aerosol for inhalation/vaping may refer to an

aerosol with particle sizes of 0.01 to 20 μm. The particle size may be between approximately 0.015 μm and 20 μm. The electronic cigarette may be portable.

[0025] It is to be appreciated that the cartridge and/or the base part of the system may include any one or more components conventionally included in these parts of an aerosol generating system, as discussed in the description below.

[0026] The features set out above may be combined together in any combination that is not explicitly excluded, and also with features selected from the detailed description below.

Brief Description of the Drawings

[0027] There now follows a detailed description of the invention, by way of example only, with reference to the accompanying drawing, in which:

Figure 1 schematically shows an aerosol generating system including a base part and disposable cartridge.

Detailed Description

[0028] Figure 1 schematically shows one example of an aerosol generating system 10, such as an electronic cigarette. The aerosol generating device includes a base part 12 and a cartridge 14 (also referred to in the art as a "capsule" or "pod"). The cartridge 14 is removably connectable to the base part 12, and may be disposable. The base part 12 is thus the main body of the electronic cigarette and is generally re-usable.

[0029] The base part 12 comprises a housing 16 accommodating therein a power supply unit in the form of a rechargeable battery 18. The aerosol generating device 10 further includes a controller 20, and may further include a user interface (not shown) for permitting a user to control the operation of the aerosol generating device 18 via the controller 20.

[0030] In the example shown in Figure 1, the cartridge 14 includes a liquid storage reservoir 22 defining a reservoir chamber 24 configured for containing therein a liquid to be vaporised. The liquid may comprise an aerosol-forming substance such as propylene glycol and/or glycerol and may contain other substances such as nicotine and acids. The liquid may also comprise flavourings such as e.g. tobacco, menthol or fruit flavour.

[0031] The cartridge 14 further includes a vaporising unit 26. In the example shown in Figure 1, the vaporising unit 26 comprises a heating element 28, such as a resistive heating wire, and a fluid transfer element 30, such as a ceramic or fibrous wick. The fluid transfer element 30 is located in fluid communication with the reservoir chamber 24, and is configured to draw vaporisable liquid from the reservoir chamber 24 towards the heating element 28 in a vaporisation zone 32. The vaporisation zone 32 is in fluid communication with a vapour outlet pathway 34.

[0032] A vapour transfer channel 36 extends from one or more air inlets 38 through and/or past the vaporisation zone 32, to one or more aerosol outlets 40 provided in a mouthpiece region 42 of the cartridge. The vapour transfer channel 36 includes a vapour outlet channel 36a, being the portion of the vapour transfer channel 36 which is downstream of the vaporisation zone 32, and a vapour inlet channel 36b, being the portion of the vapour transfer channel 36 which is upstream of the vaporisation zone 32. The vapour outlet channel 36a has an inner surface 44 defining the vapour outlet pathway 34. Similarly, the vapour inlet channel 36b has an inner surface defining an air inlet pathway. Together the air inlet pathway and the vapour outlet pathway 34 define an airflow path through the cartridge.

[0033] When the base part 12 is attached to the cartridge 14, power may be supplied to the vaporisation unit 26 from the battery 18 via heater contacts 46 to heat up liquid in the vaporisation zone 32 thereby generating a vapour. A user of the system may draw on the mouthpiece to encourage air to flow along the airflow path defined by the vapour transfer channel 36; that is, to encourage air to flow from the inlet 38, through the vaporisation zone 32, and towards the outlet 40. Vapour entrained in the airflow cools and condenses in the vapour outlet channel 36a to form an aerosol for inhalation by the user through the outlet 40.

[0034] Some condensation of the vapour is an inherent part of aerosol generation. Such condensation is not problematic when the resulting liquid droplets remain entrained in the airflow for inhalation by the user. However, condensation can be more problematic when it occurs on the inner surface 44 of the vapour outlet channel 36a. This is because condensed droplets can accumulate on the inner surface 44. Over time such condensed droplets may combine into droplets which are large enough to flow along the vapour outlet channel 36a. If the condensed liquid reaches the outlet 40 it may escape the cartridge. This can cause an unpleasant taste for the user and/or may result in liquid escaping onto other of the user's belongings.

[0035] Condensation of the vapour on the inner surface 44 of the vapour outlet channel 36a may be discouraged by minimising the temperature difference between the inner surface 44 of the vapour outlet channel 36a and the vapour. Put another way, condensation accumulation can be reduced by minimising the heat transfer away from the vapour. To this end, the system 10 shown in Figure 1, and in particular the cartridge 14 of the system, includes a further channel 48, referred to herein as an "insulation channel", surrounding at least a portion of the vapour outlet channel 36a. The insulation channel 48 has an inner surface 50 that is spaced from an outer surface 52 of the vapour outlet channel 36a. Thus a space or void 54 is defined surrounding the vapour outlet channel 36a. The inner surface 50 of the insulation channel is preferably spaced from the outer surface of the vapour outlet channel 36a by at least 0.1mm, for example by 0.2mm, or 0.3mm, or 0.4mm, or 0.5mm, or

more. In the example shown, the inner surface 50 of the insulation channel is spaced from the outer surface of the vapour outlet channel 36a by 0.2mm.

[0036] It will be appreciated that the term "insulation channel" does not necessarily imply that the walls of the channel are formed from an insulating material (although they may be). Rather, an insulating effect is provided because the vapour outlet channel 36a downstream from the vapor generating unit 26 is embedded in a larger channel in such way that the outer surface 52 of the wall of the outlet channel 36a and the inner surface 50 of the insulation channel 48 are not in contact. This results in slower heat transfer from vapour into the rest of the cartridge and subsequentially the hot vapor is cooled down to the saturation (condensation) point at the walls with a slower rate, resulting in smaller accumulation of condensation during usage of the system.

[0037] In the example shown, the space 54 is evacuated, such that the insulation channel 48 encloses a region that is under vacuum. The vapour outlet channel 36a extends through the insulation channel 48, and thus is surrounded by the vacuum. Heat transfer away from the vapour outlet channel is thus reduced, since a vacuum is effective at reducing heat transfer via both conduction and convection. It will be appreciated that the space 54 could instead include an alternative insulator if preferred, such as an insulating gas (e.g. ambient air).

[0038] The insulation channel 48 is located between the vapour outlet channel 36a and the bulk of the thermal mass of the cartridge 14. In particular, the insulation channel 48 is located between the vapour outlet channel 36a and the reservoir chamber 24, and also between the vapour outlet channel 36a and the material forming a housing 15 of the cartridge. The insulation channel 48, and in particular the space 54 defined by the insulation channel 48 and surrounding the vapour outlet channel 36a, thus presents a barrier to heat transfer between the vapour outlet channel 36a and the remainder of the cartridge. The material forming the walls of the vapour outlet channel 36a may thus rise to a higher temperature more quickly, so reducing convective heat transfer away from a vapour flowing along the vapour outlet pathway 34.

[0039] This effect can be further promoted by ensuring that the material forming the walls of the vapour outlet channel is thin (for example less than 1 mm, and preferably less then 0.2mm). By minimising the thermal mass of the channel walls, heat transfer away from the vapour can be further reduced. Alternatively, or additionally, the walls of the vapour outlet channel may be formed from a material having a low thermal conductivity, such as thermoplastics. In the example shown the walls of the vapour outlet channel are approximately 0.2mm thick and formed of thermoplastics.

[0040] In the example shown in Figure 1, the vapour outlet channel 36a extends through the reservoir 22, such that the reservoir chamber 24 is disposed around the vapour outlet channel 36a. The insulation channel 48 is defined in part by a wall of the reservoir 22 and in part by the cartridge housing 15, so as to surround the vapour outlet channel 36a for substantially the entire length of the vapour outlet channel. The space 54 defined by the inner surface 50 of the insulation channel 48 thus surrounds the vapour outlet channel 36a for substantially the entire length of the vapour outlet channel 36a.

[0041] The vapour outlet channel 36a can take any appropriate shape, but in the example shown is substantially cylindrical. The insulation channel 48 is shaped so as to maintain a substantially even spacing between the insulation channel 48 and the vapour outlet channel 36a on all sides, and so in the example shown in Figure 1 is also substantially cylindrical, with the vapour outlet channel and the insulation channel being substantially coaxial. The reservoir chamber 24 extends around the insulation channer 48.

[0042] Any connections between the vapour outlet channel and the remainder of the cartridge are preferably well insulated, so as to reduce the transfer of heat towards the rest of the cartridge via the connections. This can be achieved either by forming the connections of an insulating material and/or by minimising the volume of the connections in order to minimize the "heat bridge" between the vapour outlet channel and the rest of the cartridge. In the example shown, the vapour outlet channel 36a is mounted within the insulation channel 48 using one or more fillets 56 extending between the outer surface 52 of the vapour outlet channel 36a and the inner surface 50 of the insulation channel 48. In particular, the example in Figure 1 includes three fillets, a proximal fillet 56a operable to support the vapour outlet channel 36a at or adjacent the outlet 40, a central fillet 56b operable to support a main body of the vapour outlet channel 36a, and a distal fillet 56c operable to support the vapour outlet channel 36a at or adjacent the vaporisation zone 32. Each of the one or more fillets may have a thickness of less than 1mm, and preferably less than 0.2mm, for example a thickness in the range 0.05mm-1mm, such as 0.1mm-0.5mm. In the example shown the fillets 56 have a thickness of approximately 0.2mm.

[0043] Although the insulation channel above has been described in relation to an aerosol generating system comprising a liquid reservoir and a resistive heater it will be appreciated that this is not essential, and the insulation channel could be used in other types of aerosol generating systems which utilise a liquid aerosol forming substrate such as devices including an inductive heating system. Furthermore, the use of an insulation channel is not limited to a system of the type shown, and some or all components which are depicted herein as being included in the cartridge may alternatively be included in a base part of a device instead.

[0044] 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. 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.

Claims

1. An aerosol generating system (10) comprising:

a reservoir (22) having a reservoir chamber (24) for containing a liquid aerosol generating substrate;
a vaporisation region (32);
a vapour outlet channel (36a) downstream of the vaporisation region (32), the vapour outlet channel (36a) having an inner surface (44) defining a vapour outlet pathway (34) and an outer surface (52); and
an insulation channel (48) surrounding at least a portion of the vapour outlet channel (36a), the insulation channel (48) having an inner surface (50) spaced from the outer surface (52) of the vapour outlet channel (36a).

2. The aerosol generating system of claim 1, wherein the outer surface (52) of the vapour outlet channel (36a) is spaced from the inner surface (50) of the insulation channel (48) by at least 0.1mm.

3. The aerosol generating system of claim 1 or claim 2, wherein a space (54) between the outer surface (52) of the vapour outlet channel (36a) and the inner surface (50) of the insulation channel (48) comprises a vacuum.

4. The aerosol generating system of claim 1 or claim 2, wherein a space (54) between the outer surface (52) of the vapour outlet channel (36a) and the inner surface (50) of the insulation channel (48) comprises an insulating gas.

5. The aerosol generating system of any preceding claim, wherein the insulation channel (48) is disposed between the vapour outlet channel (36a) and the reservoir chamber (24) .

6. The aerosol generating system of any preceding claim, wherein the insulation channel (48) comprises a wall of the reservoir (22).

7. The aerosol generating system of any preceding claim, wherein the vapour outlet channel (36a) and the insulation channel (48) extend through the reservoir (22), such that the reservoir chamber (24) is disposed around the vapour outlet channel (36a).

8. The aerosol generating system of any preceding claim, wherein the vapour outlet channel (36a) has a wall thickness of less than 1mm, and preferably has a wall thickness of less than 0.2mm.

9. The aerosol generating system of any preceding claim, wherein the vapour outlet channel (36a) is formed from a material having a low thermal conductivity.

10. The aerosol generating system of any preceding claim, wherein the vapour outlet channel (36a) has a length extending between the vaporisation region (32) and an aerosol outlet (40), and the insulation channel (48) surrounds the vapour outlet channel (36a) for substantially the entire length.

11. The aerosol generating system of any preceding claim, wherein the vapour outlet channel (36a) is substantially cylindrical, and wherein the insulation channel (48) is substantially cylindrical and coaxial with the vapour outlet channel (36a).

12. The aerosol generating system of any preceding claim, wherein one or more fillets (56a, 56b, 56c) extends between the outer surface (52) of the vapour outlet channel (36a) and the inner surface of the insulation channel (48), the fillets being operable to support the vapour outlet channel (36a) within the insulation channel (48).

13. The aerosol generating system of claim 12, wherein each of the one or more fillets (56a, 56b, 56c) has a thickness of less than 1mm, and preferably less than 0.2mm.

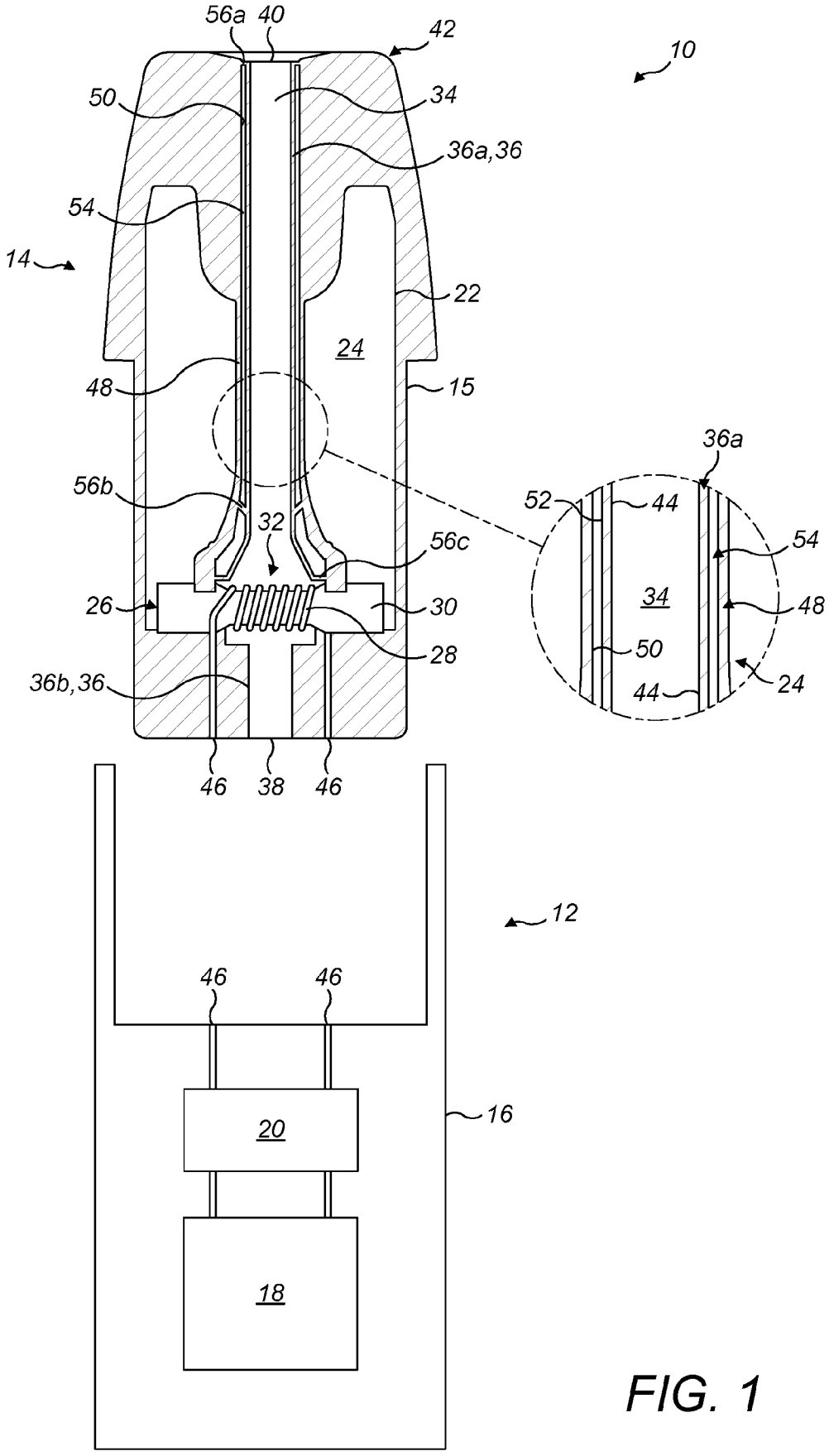
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FIG. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 7631

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A24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	20 February 2024	Kirchmayr, Katrin

CATEGORY OF CITED DOCUMENTS

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