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(54) Title: AEROSOL GENERATING DEVICE FOR VAPING INTEGRATING MEANS FOR MAPPING AN ELECTRICAL FIELD OR ELECTRICAL POTENTIAL DISTRIBUTION ON AN EXTERNAL SURFACE OF THE DEVICE

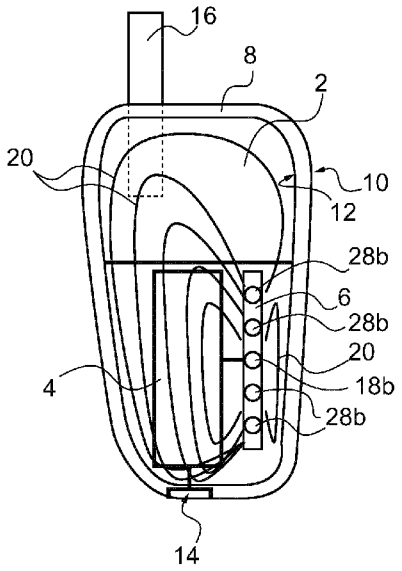

Fig. 1

(57) Abstract: The invention concerns an aerosol generating device for vaping comprising an outer case (8), an atomizer (2) to create an inhalable vapor, a battery (4) and a microcontroller (6), characterized in that at least a controlling part of an external surface (10) of the outer case is electrically resistive, and in that the device comprises: an generating unit (18b) generating an electric field (20) in the controlling part; a mapping unit (28b) establishing a time dependent map of the electric field or the electrical potential distribution in the controlling part; an analyzing unit to detect variations in the map representative of the presence and/or movements of a user's finger on the outer case controlling part, then to determine a specific interaction of the user with the controlling part, to compare the detected specific interaction with registered patterns associated with commands, and to send the corresponding command to the microcontroller.

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Title of the invention

Aerosol generating device for vaping integrating means for mapping an electrical field or electrical potential distribution on an external surface of the device

Field of the invention

The present disclosure relates to an aerosol generating device for vaping (hereafter also referred to as an e-vaping device), such as a heated tobacco device, which creates an inhalable vapor by heating though not burning a stick which contains tobacco or other substance(s) suitable for being converted into an inhalable vapor when heated.

Background of the invention

An aerosol generating device generally includes an outer case which accommodates: a microcontroller; a battery; an atomizer containing a chamber for receiving a vaporizable substance suitable to be heated to generate an inhalable vapor and an electrical heater powered by the battery and controlled by the microcontroller for heating the vaporizable substance by conduction, convection and/or radiation. The vaporizable substance may be a solid vaporizable material, such as a solid tobacco-containing stick, or an e-liquid. The present invention applies to both types of aerosol generating device.

Vaping experience depends on various parameters such as the maximum power delivered to the heater by the battery, the maximum temperature of the heater, the ramp-up (rise time to reach the desired maximum temperature), the inlet air flow, etc. These parameters may be set differently according to the substance to be vaporized and/or according to the user's mood and current wishes.

Thus it is desirable for the user to be able to control some of the functioning parameters of the e-vaping device. To this end, known e-vaping devices also include a user interface (human to machine interface) for bilateral communication with the microcontroller. This interface often includes lighting

indicators, such as lighting diodes, for indicating, for example, an On-state or an Off-state of the device, as well as a charge level of the battery. This interface also often includes a display screen for displaying, for example, a current value of a parameter, and at least two mechanical buttons, one "+" button and one "-" button to respectively enhance or reduce the value of the displayed parameter.

If they protrude from the outer case external surface, these mechanical buttons are likely to be torn off, whereas they may be uneasy to operate if they are slightly set back the outer case external surface to be protected by the outer case.

In order to avoid these drawbacks, it is known to replace any mechanical button of a user interface by a touch-sensitive button, by accommodating an electrical contact on the internal side of the outer case and applying an electric potential to this contact. This latter then forms one terminal of a capacitor (the outer case being made in a dielectric material at least in a small-sized area in front of the capacitor terminal). The user's finger applied on the external side of the outer case in front of the contact forms the other terminal of the capacitor and causes the discharge thereof. This discharge is next interpreted as the operation of the touch-sensitive button formed by the capacitor.

Irrespective of the fact that a button is a mechanical or a touch-sensitive button, one may consider such a button on the outer case of an e-vaping device to be uneasy to operate because of its very small size compared with the size of a human finger.

Touch pads are also known. Such a touch-sensitive surface needs a grid of numerous conductors arranged under an insulating surface, which increase both the cost of the device and the risk of failure.

The invention aims to solve at least one of the above-mentioned problem, with a simple arrangement, cheap and easy to implement. In particular, the invention aims to provide an aerosol generating device having a new user interface, robust and easier to use. An objective of the invention is to provide a user interface for an

aerosol generating device for vaping that needs no moving parts and no visible features on the external surface of the device.

Summary of the invention

To this end, the invention proposes an aerosol generating device for vaping comprising an outer case which accommodates an atomizer for heating a vaporizable substance to create an inhalable vapor, a power source for powering the atomizer, a microcontroller supplied by the power source, with a controlling unit for controlling the atomizer, and a user interface enabling a user to send commands to the controlling unit.

The aerosol generating device for vaping according to the invention is characterized in that at least a part of an external surface of the outer case, referred to as the controlling part of the outer case, is made of an electrically resistive material, and in that the user interface comprises:

- an electric field-generating unit configured to generate an electric field in the controlling part of the outer case according to a reference map,

- a mapping unit configured to establish a time dependent map of the electric field or electrical potential distribution in the controlling part of the outer case,

- an analyzing unit configured to detect perturbations and/or variations over a time period in the map, representative of the presence and/or movements of a user's finger on the controlling part of the outer case, the analyzing unit being further configured to determine a specific interaction of the user with the controlling part of the outer case, to compare the detected specific interaction with registered patterns associated with corresponding commands and, if the detected specific interaction matches a registered pattern, to send the corresponding command to the controlling unit of the microcontroller..

The expression "electrically resistive" associated with the material constituting the controlling part of the outer case means that the material is neither a good conducting nor a good insulating material; its conductivity should be such

that the material is able to be permeated by electric fields for example by the application of an electric potential on two different points on its surface. This is not the case of a metallic material for example, because a very conductive medium tends to be equipotential.

For example, a suitable material may be a material having a surface resistivity comprised between 500 Ohms and 100M Ohms per square. Examples of materials that can be used are conducting plastics, such as the ABS (Acrylonitrile butadiene styrene) or a polycarbonate loaded with metallic or carbon-based particles. Any electrically insulating material that can be then coated with electrically conducting paint (by spray painting or printing) may also be used, as well as, in general, any solid material that can be made electrically insulating by covering it with a dielectric paint and subsequently painted with an electrically conducting paint.

As previously defined, according to the invention, at least a part of the outer case is made of an electrically conductive but resistive material and an electric field is generated and maintained in this part of the outer case, referred to as the controlling part. This generated electric field has a given shape or reference map. This electric field next can interact with the fingers and hands of the device user because human skin is partially electrically conducting. The presence of a human finger on the controlling part modifies the map of the electric field which permeates the controlling part. By measuring the electrical potential at various points on the controlling part of the outer case, it is possible to establish a map of the distribution of the electrical potential on the external surface of the controlling part. If this measurement is repeated many times every second, a time dependent map can be obtained. This map enables to monitor the interaction of the user's hands and fingers with the device itself and, consequently, to realize a kind of human to machine interface that needs no moving parts and no visible features on the surface of the device.

According to a possible feature of the invention, the electric field generating unit is configured to provide a voltage in the order of 1 to 10V DC or 1 to 10V AC with a frequency up to 500kHz.

According to a possible feature of the invention, the controlling part of the outer case extends along the entire external surface of the outer case. In other words, the whole outer case is rendered touch-sensitive and can be used as a human to machine interface.

According to a possible feature of the invention, the electric field-generating unit includes two electrodes, hereafter referred to as generating electrodes, connected to the microcontroller and supplied by the power source, the two generating electrodes contacting an internal face of the outer case at two opposite points of the controlling part, the two generating electrodes being set at two different constant electrical potentials whereby an electric field is created on the external surface of the outer case between the two generating electrodes. For example, in case where the controlling part is the entire outer case, a first generating electrode is arranged in the vicinity of a top end of the outer case and a second generating electrode is arranged in the vicinity of a bottom end of the outer case; alternatively, a first generating electrode is arranged at a first side of the outer case whereas the second generating electrode is arranged at the other side of the outer case.

If needed, according to the geometry of the controlling part of the outer case, more than two generating electrodes may be provided.

According to a possible feature of the invention, each of the two (or more) generating electrodes includes a spring loaded pogo pin, the spring urging the pogo pin in contact with the internal face of the outer case.

According to a possible feature of the invention, the mapping unit includes a plurality of measuring points distributed on the controlling part of the outer case (such as to obtain the map of the electrical potential distribution on the controlling part), with, for each measuring point, a pair of electrical contacts or electrodes, and a measuring unit for frequently measuring the electrical potential difference between the two electrical contacts of each pair.

It is to be noted that a single measuring unit may be shared by a plurality of pairs (even by all the pairs) of measuring electrodes.

Besides, each pair of electrodes of the user interface may serve by turns as generating electrodes or measuring electrodes. For example, if the e-vaping device comprises five pairs of electrodes, the electrodes being numbered 1-10, a first round may be performed where electrodes 1-2 generate the electrical field while electrodes 3-10 measure in real time the electrical field in the controlling part. A second round may be performed with electrodes 3-4 generating the electric field and electrodes 1,2,5-10 measuring it.

Alternatively, a first pair of electrodes may be dedicated to the generation of the electric field while the other pairs of electrodes are dedicated to measuring for mapping.

In any case, an advantage of the invention compared with a known touch pad for example is that very few measuring pairs of electrodes or contacts need to be used (four pairs of electrodes are enough in most case) to perform electric field mapping on the controlling part of the outer case, even when the controlling part is the entire external surface of the whole outer case.

Brief description of the drawings

Other particularities and advantages of the invention will also emerge from the following description.

In the accompanying drawings, given by way of non-limiting examples:

- Figure 1 represents a front view of an aerosol generating device for vaping according to a first embodiment of the invention with a transparent outer case to show some of the internal members of the aerosol generating device,
- -Figure 2 represents a side view of the aerosol generating device for vaping of figure 1.
- Figure 3 illustrates an electric field appearing between two opposite electric charges on a resistive surface.
- Figure 4 illustrates the electric field appearing between two opposite electric charges on a resistive surface when a finger is further applied on the resistive surface between the two opposite charges.

Detailed Description

The aerosol generating device for vaping according to the invention, illustrated at fig. 1 and 2, comprises an atomizer 2 for heating a vaporizable substance to create an inhalable vapor, a power source such as a battery 4 for powering the atomizer 2, a microcontroller 6 with a controlling unit 60 for controlling the atomizer, and an outer case 8.

The microcontroller 6 may be in the form of a main printed circuit board (PCB) assembly. The microcontroller 6 is connected to the battery 4 and powered by the latter in a conventional way (here schematically represented by a connecting line). At its bottom end, the outer case 8 may include connecting means such as a USB (Universal Serial Bus) socket 14 for connecting the battery 4 to a charger (not shown) supplied with electricity by a suitable transformer.

The atomizer 2 is not detailed in the annexed figures. It may include a heating cylindrical cavity open at the top end of the atomizer for receiving a stick 16, and a heater surrounding the heating cavity for heating the stick 16 at a temperature suitable to vaporize a vaporizable substance embedded in the stick to create an inhalable vapor.

The embodiment of the invention illustrated at fig. 1 and 2 concerns an e-vaping device used with a vaporizable stick 16 also known as “consumable”. Such a consumable comprises a solid stick, that is to say a stick made of a solid vaporizable material which may include natural tobacco. It broadly looks like a conventional cigarette, having a tubular region with a vaporizable material arranged in a suitable manner. Filter, vapor collection and cooling regions and other structure may also be included in some designs. The top end of the stick forms a mouthpiece. An outer layer of paper or other flexible planar material such as foil may also be provided, for example to hold the solid vaporizable material in place, which further the resemblance to a conventional cigarette.

But the invention is not limited to such a consumable. It may be used with any stick of vaporizable material, where the expression “vaporizable material”

designates any material that is vaporizable in air to form an aerosol. Vaporization is generally obtained by a temperature increase up to a temperature which corresponds to the boiling point of the vaporizable material, in particular a temperature up to 400°C, preferably up to 350°C. The vaporizable material may, for example, comprise or consist of tobacco derivatives, expanded tobacco, tobacco extract, homogenized tobacco, tobacco substitutes or any combinations thereof; it may also comprise or consist of an aerosol-generating liquid, gel or wax or the like.

The aerosol generating device according to the invention may thus be used not only with a stick made of solid vaporizable material(s), but also with a stick which includes liquid or gel or the like, the liquid or gel being for example retained in a solid matrix or contained in a pod forming the entire stick or forming a section of the stick (the stick may then comprise a combination of solid sections and of liquid or viscous sections in the form of pods filled with a liquid or viscous vaporizable material).

Moreover, the invention applies not only to an aerosol generating device for vaping configured to receive a solid stick of the kind that includes a mouthpiece or of the kind that resemble to a conventional cigarette as illustrated at fig. 1 and 2, but also to an aerosol generating device for vaping configured to receive a vaporizable stick in the form of a pod or capsule or tablet which is devoid of mouthpiece (in that second case, the aerosol generating device itself comprises a mouthpiece fixedly or removably attached to its outer case, at the top end thereof). In other embodiments, the heating cavity may be arranged to receive the vaporizable stick in other forms, such as loose tobacco or tobacco packaged in other ways.

In brief, the invention applies to any kind of aerosol generating devices for vaping, whatever the nature and structure of the vaporizable substance that can be used with the device.

According to the invention, the e-vaping device further includes an electric field-generating unit for generating an electric field on the external surface

10 of the outer case 8. The electric field generated follows a given reference map composed of lines 20.

In the illustrated embodiment, the whole outer case 8 is made of a single homogeneous resistive material. This is good for manufacturability. In principle, in such an embodiment, the whole outer case can be rendered touch sensitive, provided that the electric field-generating unit is configured to create an electric field on the entire external surface and the mapping unit is configured to establish a map of the electric field on the entire external surface of the outer case. In other words, in practice, if the outer case is made of a single homogeneous resistive material, the controlling part of the device may be the whole external surface of the outer case and the entire external surface 10 of the outer case 8 may be used to send commands to the controlling unit 60. Nevertheless, in practice, the location of the generating electrodes should make some areas more sensitive than others. So, in practice, even if the outer case is made of a single resistive material, it seems interesting to determine which are the most convenient areas for a user holding the device to apply one finger and move it according to predetermined (registered) patterns. The areas thus determined should constitute the “controlling part” of the outer case according to the invention. The positioning of the generating electrodes as well as the positioning of the measuring electrodes should be chosen according to the shape, extent and location of each area thus determined as constituting the controlling part of the outer case.

Alternatively, the outer case may comprise two or more areas made of different materials, including at least one area made of an electrically resistive material according to the invention, that is to say adapted to be permeated by an electric field created by the electric field-generating unit of the device. This or these resistive area(s) may constitute the controlling part of the outer case. In such an alternative embodiment, the other area(s) of the outer case may be made of a totally non-conductive material; by contrast, these other area(s) may be metallic or made

in any conductive material provided that the area(s) constituting the controlling part remain preferably electrically insulated from one another.

Fig.3 illustrates the electric field lines 24 which are generated by two opposite charges 22a, 22b on a planar resistive surface. Fig. 4 shows how the shape of the electric field lines 24 is modified by a fingerprint 26 of a human finger applying on the resistive surface between the two charges 22a, 22b. Drafting the map of the electric field gives the position and the extent of the human fingerprint 26 on the resistive surface.

This electric field-generating unit of the e-vaping device according to the invention may include two generating electrodes 18a, 18b powered by the microcontroller 6 and the battery 4 such as to be set and maintained at two different electrical potentials which do not vary in time. Thus, in the absence of perturbations such as the presence of a human finger touching the outer case, the electric field map should remain identical to the reference map. By contrast, when a user takes the device and/or interacts with the controlling part of the outer case, the electric field map varies.

The e-vaping device according to the invention comprises a mapping unit for mapping the electric field on the external surface 10 and an analyzing unit for detecting and analyzing the variations of the electric field map.

The mapping unit of the embodiment illustrated at fig. 1 and 2 includes four measuring pairs of measuring electrodes 28a, 28b, as well as a measuring module 30 for measuring the difference of electrical potential between the two measuring electrodes 28a, 28b of each pair. The mapping unit further includes a mapping module 32 for reconstructing the map of the electric field (or the electrical potential distribution) on the external surface 10, based on the measures of electrical potential given by the measuring electrodes 28a, 28b and the measuring module 30.

Each electrode 18a, 18b, 28a, 28b may be constituted by a spring loaded pogo pin arranged such as to contact the internal face 12 of the outer case at predetermined generating or measuring points.

The analysis of the map variations in time enables to identify the kind of interactions the user has with the controlling part of the outer case, that is to say the kind of movements the user's finger or hand drawn on the touch-sensitive part(s) of the external surface 10 of the outer case. To analyze the map variations, the e-vaping device comprises an analyzing unit, which may include an interpreting module 34 for interpreting the variations of the electrical field map such as to detect specific interactions from the user (that is to say specific movement of the user's finger on the controlling part).

The following specific interactions may be detected for example: the user simply holding the device in his hand (a perturbation in the map is detected but next the map does not show significant variations); tap or multiple tap gesture; sliding finger on one side of the outer case in a given direction, for example along the axial direction of the device, from bottom to top or inversely from top to bottom; drawing of an X on the front side of the device, etc.

The analyzing unit may further include a memory 36 where patterns of interactions are registered and where each registered pattern is associated with a command, and a comparing module 38 for comparing each previously detected specific interaction with the registered patterns.

When a detected specific interaction matches a registered pattern, it means that the corresponding command is requested by the user. The controlling unit 60 of the microcontroller then applies the command corresponding to the registered pattern identified.

The invention extends to all the alternative embodiments that are covered by the appended claims. By way of examples, the outer case may be comprised of different parts made of various material, and the touch-sensitive

controlling part may be limited to a part of the outer case (for example the front face); the position and number of generating electrodes may vary from that of the illustrated embodiment; likewise; the number of measuring electrodes is not limited to that of the illustrated embodiment.

List of references:

2 atomizer

4: battery

6: microcontroller

60: controlling unit

8: outer case

10: external face of the outer case

12: internal face of the outer case

14: USB socket

16: tobacco stick

18: generating electrodes

20: electric field lines

22a, 22b: opposite charges

24: electric field lines

26: human fingerprint

28a, 28b: measuring electrodes

30: measuring module

32: mapping module

34: interpreting module

36: memory

38: comparing module

CLAIMS

1. Aerosol generating device for vaping comprising an outer case (8) which accommodates an atomizer (2) for heating a vaporizable substance to create an inhalable vapor, a power source (4) for powering the atomizer, a microcontroller (6) supplied by the power source (4), with a controlling unit (60) for controlling the atomizer (2), and a user interface enabling a user to send commands to the controlling unit (60),

characterized in that at least a part of an external surface of the outer case, referred to as the controlling part of the outer case, is made of an electrically resistive material, and in that the user interface comprises:

- an electric field-generating unit (18a, 18b) configured to generate an electric field (20) in the controlling part of the outer case according to a reference map,

- a mapping unit (28a, 28b, 30, 32) configured to establish a time dependent map of the electric field or the electrical potential distribution in the controlling part of the outer case,

- an analyzing unit (34, 36, 38) configured to detect perturbations and/or variations over a time period in the map, representative of the presence and/or movements of a user's finger on the controlling part of the outer case, the analyzing unit being further configured to determine a specific interaction of the user with the controlling part of the outer case, to compare the detected specific interaction with registered patterns associated with corresponding commands and, if the detected specific interaction matches a registered pattern, to send the corresponding command to the controlling unit (60) of the microcontroller.

2. Aerosol generating device according to claim 1, wherein the controlling part of the outer case (8) extends along the entire external surface (10) of the outer case.

3. Aerosol generating device according to claim 1 or 2, wherein the

electrically resistive of the controlling part is chosen among any material having a surface resistivity comprised between 500 Ohms and 100M Ohms per square, conducting plastics, ABS or a polycarbonates loaded with metallic or carbon-based particles, electrically insulating materials coated with electrically conducting paint, solid materials first covered with a dielectric paint and subsequently covered with an electrically conducting paint.

4. Aerosol generating device according to any one of claims 1 to 3, wherein the electric field-generating unit is configured to provide a voltage in the order of 1 to 10V DC or 1 to 10V AC with a frequency up to 500kHz.

5. Aerosol generating device according to any one of claims 1 to 4, wherein the electric field-generating unit includes two generating electrodes (18a, 18b) connected to the microcontroller (6) and supplied by the power source (4), the two generating electrodes contacting an internal face (12) of the outer case at two opposite points of the controlling part, the two generating electrodes being set at two different constant electrical potentials.

6. Aerosol generating device according to claim 5, wherein each of the generating electrodes includes a spring loaded pogo pin, the spring urging the pogo pin in contact with the internal face (12) of the outer case.

7. Aerosol generating device according to any one of claims 1 to 6, wherein the mapping unit includes a plurality of measuring points distributed on the controlling part of the outer case, with, for each measuring point, a pair of electrical contacts (28a, 28b), and a measuring unit (30) for frequently measuring the electrical potential difference between the two electrical contacts of each pair.

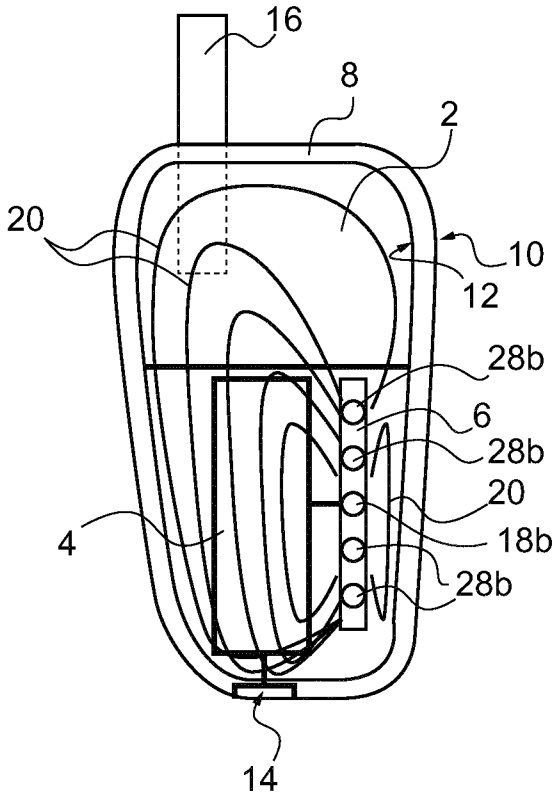

Fig. 1

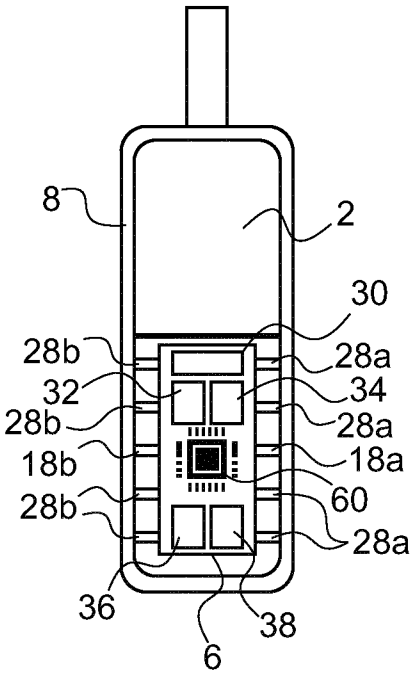

Fig. 2

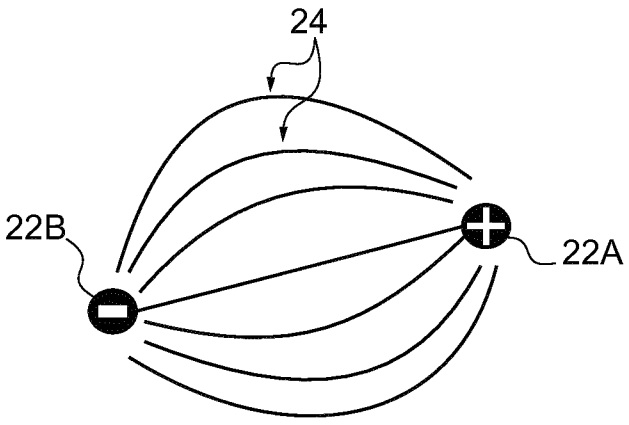

Fig. 3

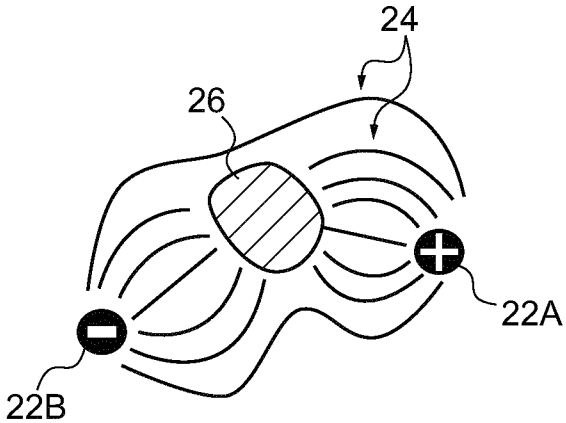

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2022/057474

A. CLASSIFICATION OF SUBJECT MATTER
INV. A24F40/60 A24F40/40 H03K17/96
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 H03K A61M

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.
Y	US 10 925 316 B2 (PHILIP MORRIS PRODUCTS SA [CH]) 23 February 2021 (2021-02-23) column 8, line 13 - column 9, line 54; figures 1-4	1-7
Y	WO 2005/043595 A2 (SOLECTRON CORP [US]; HOLLINGSWORTH TOMMY D [US]) 12 May 2005 (2005-05-12) page 4, paragraph 3 - page 7, paragraph 1; figures 1-3 page 2, paragraph 2	1-7
Y	US 2018/132528 A1 (SUR RAJESH [US] ET AL) 17 May 2018 (2018-05-17) paragraph [0069] - paragraph [0074]; figures 1,2	1-7

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
13 June 2022	22/06/2022

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Dobbs, Harvey

2

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2022/057474

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2012/319760 A1 (DEJEAN GERALD [US] ET AL) 20 December 2012 (2012-12-20) paragraph [0017] - paragraph [0022]; figure 1	1-7

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2022/057474

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 10925316 B2	23-02-2021	CA 2984049 A1	15-12-2016
		CN 107666837 A	06-02-2018
		EP 3307097 A1	18-04-2018
		JP 6924154 B2	25-08-2021
		JP 2018520663 A	02-08-2018
		KR 20180015622 A	13-02-2018
		RU 2017134778 A	04-04-2019
		US 2018160734 A1	14-06-2018
		WO 2016198266 A1	15-12-2016
WO 2005043595 A2	12-05-2005	US 2005088416 A1	28-04-2005
		WO 2005043595 A2	12-05-2005
US 2018132528 A1	17-05-2018	CA 3042623 A1	17-05-2018
		CN 109952038 A	28-06-2019
		EP 3537906 A1	18-09-2019
		EP 3799744 A1	07-04-2021
		ES 2858402 T3	30-09-2021
		JP 2019535264 A	12-12-2019
		KR 20190077091 A	02-07-2019
		PL 3537906 T3	14-06-2021
		RU 2019113793 A	14-12-2020
		US 2018132528 A1	17-05-2018
		WO 2018087740 A1	17-05-2018
US 2012319760 A1	20-12-2012	US 2012319760 A1	20-12-2012
		US 2014240164 A1	28-08-2014