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(54) **HEATING ELEMENT FOR A VOLATILE LIQUID EMANATION DEVICE**

(57) The present invention describes a heating element (1) suitable for a volatile liquid emanation device, comprising a ring shaped resistive heater (2) comprising an upper side (3) and a lower side (4), both sides connected (3,4) to each other by an outer lateral surface (5); the heater (2) further comprising an axial through hole (6) for receiving a wick, the hole (6) extending from the upper side (3) to the lower side (4) defining an inner surface (7); at least two conductive terminals (8, 9), providing electrical contact to the resistive heater (2), wherein; wherein the two conductive terminals (8, 9) extend from the heater (2). The resistive heater (2) and the two conductive terminals (8, 9) form an integral component. The resistive heater (2) is covered with an electrically insulating layer (10), and the heating element (1) further comprises a supporting element (11.1, 11.2) able to hold the heater (2) inside it (11.1, 11.2).

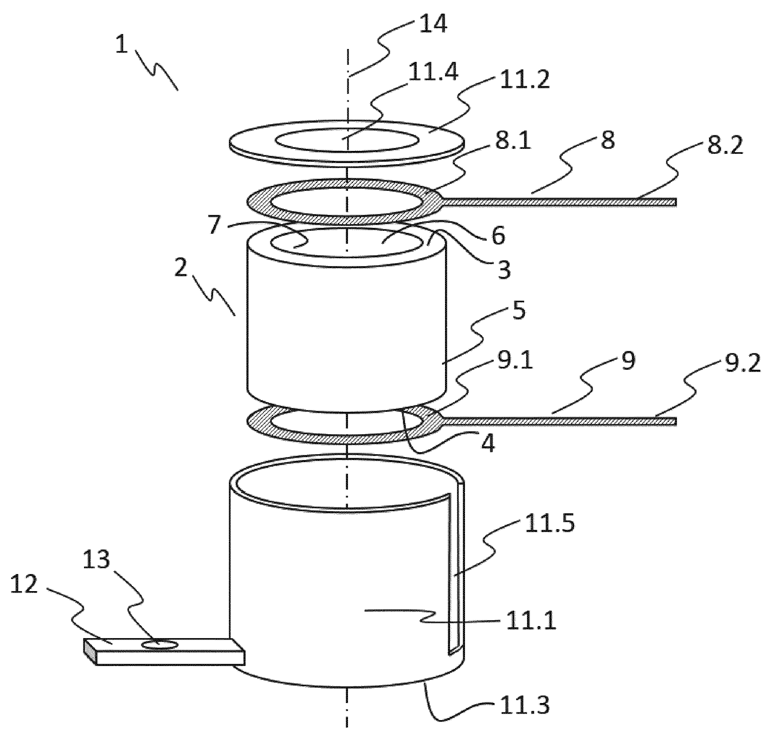

Fig. 1

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Description

[0001] The present invention concerns a heating element for a volatile liquid emanation device.

[0002] Devices for emanating materials are known, for example out of EP362397A1, which discloses a device with a bottle for containing material in liquid form, a heater and a wick for transporting the materials from the bottle to the wick. This device is attached to a power socket, and the heater works at a pre-defined power to emanate the materials into environment.

[0003] Such devices can emit many different kinds of materials, for instance insect repellents or perfumes.

[0004] A common heating element used in such devices comprises a resistive heater with a positive temperature coefficient PTC. An example of a typical heater used in such devices is described in EP0290159 A2. The PTC strongly increases its resistance with increasing temperature after a certain nominal value, thus self-regulating when connected to a power source. Typically, the PTCs are connected to the mains directly or via purely resistive elements such as a fuse. A switch may be provided as well.

[0005] Typical heating elements with PTC used for volatile emanation devices have a relatively high thermal resistance. Most of them require some metallic components to distribute the heat, and the supporting electrically insulating structure further increases the thermal resistance. Thus, it is difficult to change the temperature. That is also one of the reasons that PTCs are not used for precise temperature control.

[0006] The present invention aims to solve this problem with a heating element according to claim 1, and a device according to claim 15. The dependent claims concern further advancements of the invention. The present invention provides an improved heating element. Further, a device for emanating materials in the environment with improved temperature control can be made with an inventive heating element.

[0007] The invention concerns a heating element suitable for a volatile liquid emanation device, comprising a ring shaped resistive heater, and at least two conductive terminals. The ring shaped heater comprises an upper side and a lower side, both sides connected to each other by an outer lateral surface; the heater further comprises an axial through hole for receiving a wick, the axial through hole extending from the upper side to the lower side defining an inner surface. The at least two conductive terminals, are for providing electrical contact to the resistive heater, the two conductive terminals extend from the heater, preferably as wire leads. The ring shaped resistive heater and the two conductive terminals form an integral component. In a further development, most of, preferably the complete, electrically insulating layer has a thickness above 15 μm and below 1000 μm, preferably below 500 μm. The electrically insulating layer is preferably a coated layer. With coating, a very thin and defect free layer can be achieved thus enabling high electrical isolation while still having low impact on the thermal cycling time. Preferably, the resistive heater is free of other electrically insulating layers, especially on its inner surface, enabling short heat and cooling thermal cycling time. The heating element further comprises a supporting element able to hold the heater inside the supporting element, preferably for mechanically fixating the heater on an external part.

[0008] Integral means that they are a single piece, the conductive terminals are attached, preferentially mechanically, to the resistive heater. Preferably, the complete heating element, except for the part of the conductive terminals that are to be connected to external electrical source, is covered by the electrically insulating layer. The suitable coating can be used has good adherence, is preferably electrical insulating, and can sustain thermal cycling. Exemplary materials are epoxy for cycling up to 150 °C, and silicone-based, the last two can be used for cycling up to 200 °C or higher depending on exact chemistry and/or filler. Such coatings are commercially available.

Supporting element

[0009] The heating element according to the invention comprises a supporting element. The supporting element is preferably attached to the heater by attaching to, and further preferably enclosing, at least partially at least one of: the outer lateral surface, the lower side, and the upper side, of the resistive heater and leaving the axial through hole for the wick uncovered. It is preferred that the inner surface of the resistive heater, which is the surface at the axial through hole, is left uncovered, preferably completely free of supporting element. Thus, the sequence of layers from the heating element, starting from the resistive heater across the center, when empty of wick, is *resistive material / coating / air gap (through hole) / coating/resistive material.* This highly simplified construction gives the most efficient thermal transfer while maintaining an air gap towards a wick.

[0010] The supporting element is preferably made of a thermoplastic material that is electrical insulator, preferably polymeric of the polyester type, such as polybutylene terephthalate. The thermoplastic is preferably reinforced, such as with 10 to 35% glass fibre, thus increasing its heat resistance. Preferably, the supporting element is treated with a flame retardant, e.g. with aluminium diethyl phosphinate.

[0011] In one preferred embodiment, at least a first part of the supporting element is mechanically engageable with at least one of the upper or lower sides of the resistive heater, in such a manner, that when engaged, the supporting element and the resistive heater have a pre-determined position. For instance, when the heater is a cylinder, the part of the supporting element can be cup shaped, and dimensioned so that the heater fits inside the cup shaped supporting element.

[0012] Additionally, the second part of the supporting element is configured to fit to the first part, preferably on the other side of the heater. In this case, the heater can be enclosed by the supporting element, between the first and the second part, while leaving the axial through hole for the wick uncovered, and further leaving the inner surface of the axial through hole area uncovered.

[0013] In a preferred embodiment, the support element for a cylindrical heater has a cylindrical shape with an inner diameter slightly larger than the heater, having spacers functioning to keep the heater in place within the support element. The lower and upper side of the resistive heater is covered by the support element, while leaving an opening for the passage of wick and flow of air, this opening being aligned, preferably coaxial, with the axial through hole in the resistive heater.

[0014] The support element is configured such that the at least two conductive terminals can extend from the resistive heater to the outer side of the support element, preferably by providing respective openings, such as a slot.

[0015] It is preferred that the support element comprises at least 1, preferably at least 2 attachment surfaces, each preferably as a radial extension; the extension being suitable to be secured to a housing via a fastening means such as, for example, a screw, a bolt, an elastic clip.

Resistive heater and terminals

[0016] Within the meaning of the present invention, the resistive heater also simply called heater, have the same meaning. The heating element is not the resistive heater; however, the heating element comprises the resistive heater.

[0017] The ring shaped resistive heater is preferably made of sintered material. The resistive heater according to the invention is preferably a PTC heater. Preferred materials are barium titanate based composites; these are preferred over lead titanate composites. Preferred is doped BaTi03, it can be doped, for instance with oxides of elements selected of the chemical group 3 or 5 (La, Y, Nb, Ta) or Sb. It is preferred that the PTC heater has a Curie temperature from 40 °C to 180 °C, preferably from 80° C to 150 °C. The Curie temperature, also known as transition temperature, is the temperature in that the PTC's resistance changes from decreasing to exponential rise with the increase of temperature.

[0018] It is highly preferred that the ring of the resistive heater has a closed perimeter, thus being gap free.

[0019] It is highly preferred that the two conductive terminals are arranged in such a position at the heater that when an electrical potential bias (voltage) is applied at the terminals, the respective current flows essentially through the complete ring. This current is in the operation mode as heater.

[0020] In a preferred mode of the invention, the two conductive terminals are placed on the upper and lower sides of the resistive heater, each of the conductive terminals having an annular conducting element providing electrical contact around the perimeter of the upper and lower sides. Thus, the electrical current, induced by application of electrical potential bias, flows from one conductive terminal from one side (upper or lower) through the heater to the other side (lower or upper respectively). The annular conducting element of each of the terminals has preferentially a closed perimeter.

[0021] In a slightly less preferred, mode of the invention, the conductive terminals are connected within the ring segment, and are angular spaced from each other at a smaller angle (<20°, preferably <15°) by an insulator (can be air) so that the current flows through the larger ring section when electrical potential bias is applied to the terminals. The insulator can be air, but is preferably a solid electrically insulating material. The solid material allows the resistive heater to have a closed perimeter.

[0022] In one optional mode of the invention, the conductive terminals are configured to accept electrical connectors. However, it is preferred that the at least two conductive terminals of the resistive heater extends outside of the electrically insulating layer as lead wires, these are preferably solderable. The solder may comprise tin. Preferably, the lead wires comprise, on the surface, a solderable material selected from: copper, nickel, tin, or mixtures thereof. The length of each wire is between 14 mm and 60 mm, preferably between 16 mm and 50 mm. With the present invention, the core temperature of the resistive material of the resistive heater is similar to the surface temperature. On conventional heaters, on the other hand, the resistive material is smaller and the heat is typically transported by metal parts, thus requiring higher core temperatures to achieve similar surface temperatures, or temperatures at a desired wick. Thus, typical PTC heaters are electrically connected to its power source via clamps, clips, or conductive paste. They are unappropriated for soldering because the solder breaks down over time due to the many heating and cooling cycles. The heating element according to the present invention provides lower temperatures at the conductive terminals. It was found that the temperature at the extremity of the terminals, that is away from the resistive heater, is sufficiently low that the terminals can be soldered and reliably kept soldered to the resistive heater, while the heater itself can achieve sufficient temperatures to evaporate conventional volatile materials from a wick at conventional rates. A further advantage is that the resistive heater does not require metal parts for heat conduction, thus facilitating recycling due to the lower amount of metal, which can be essentially limited to the conductive terminals.

[0023] In a preferred embodiment, the two conductive terminals are radially aligned, one closer to the upper side, the other closer to the lower side, the arrangement with the resistive heater and the two conductive terminals being symmetrical, meaning that the arrangement could be turned so that the upper side takes the place of the lower side, essentially without changes in mechanical and electrical characteristics. This symmetry facilitates soldering and fitting of the element inside a housing, due to less alignment requirements. The alignment of the conductive terminals enables the heater to be soldered to a vertical circuit board. The verticality is given in relation to the orientation of the wick, which is usually vertical (the reservoir with the liquid is at the bottom end of the wick).

[0024] Preferably, the axial through hole in the heater is cylindrical with a diameter (d) and a height (h). It is preferable that the hole has a height / diameter ration of: 0,65 > h/d < 2, further preferably 1 < h/d < 2. This ratio gives better emission rate. Without wanted to being bound by theory, it is believed that it has to do with enhanced convection.

[0025] Due to the low thermal resistance of the heater, the circuit can be calibrated, especially in a quick manner, to operate in precise temperature ranges.

[0026] Another aim of the invention is to provide an improved volatile emanation device. The device comprises a heating element as described in the present invention and a circuit board comprising the circuit for controlling the heating element. The two conductive terminals of the heating element are soldered to the circuit board. An angle alpha which is the angle between the axis of the heater's hole and a plane that is coplanar with the circuit board, has an absolute value of < 35°, preferably the angle is smaller than 2° so that the circuit board and the axis are essentially parallel to each other. The circuit board's plane and the axis of the heater's hole are preferably parallel to each other. Such an inventive device provides improved temperature control possibilities, due to its faster thermal response. The conductive terminals' extension are preferably coplanar and soldered to the circuit board.

[0027] A volatile liquid emanation device according to the invention is a device configured to emanate materials in the environment, by heat evaporation. It preferably comprises a supply for materials; a heater according to the invention as emitter, for emitting the materials from the supply to surrounding environment, by application of power from a power supply. The emanation device preferably further comprises a housing.

Housing

[0028] The housing defines the overall shape of the device, with walls defining an interior. The housing may be comprised of any suitable housing material such as metal, plastic, glass or fiberboard, or combinations thereof, with blowmolded or injection-molded plastic being most preferred and practical housing materials of construction. It is important to note that the overall housing may be comprised of housing portions that are separately molded and later assembled to define the overall shape to the device, and which can provide for structural complexity inside and outside of the overall shell of the device. For example, housing portions may be screwed together, or fit together with plastic protrusions and holes, or sonically welded together to form the overall housing.

[0029] The shape of the housing may be cylindrical, or more box or block-like in shape, or may be some other practical and appealing overall shape, and may include various interior shelves, recesses and mounting surfaces for various interior components, along with contours, colors and exterior ornamentation for aesthetic reasons. Overall, the housing is essentially a container with walls that define an interior space in which various components of the present device (printed circuit board, etc.) may be placed and held. As mentioned, the configuration of the housing, and the placement of the components therein, may lead to various degrees of user accessibility for each of the particular components. The most preferred materials of construction for the housing of the present invention are polyethylene, polypropylene, polybutylene, polybutylene terephthalate, polystyrene, polycarbonate, polyvinyl chloride, and polyethylene terephthalate, or mixtures thereof, wherein the preferred plastic materials are blow-molded, injection blowmolded, injection molded, and/or thermoformed to create the various shapes of the housing portions. The housing may be created to appear opaque or transparent (in part or in whole) and may be constructed of any color (e.g., white or beige or some decorative color). Construction from injection-molded plastic allows for transparent/clear, transparent/colored, or opaque/colored plastic parts, further allowing wide variation of functionality and aesthetic appeal.

Main circuit

[0030] The invention also concerns a circuit board, also called main circuit board, for a device as described in the present invention; the board is preferably a printed circuit board (PCB). The board comprises, on it, an electronic circuit having functionally connected to it, at east:

- a connector for the emitter of materials;
- the operation mode adjusting means;
- the means for setting the transfer function.

[0031] Preferably, the main circuit board comprises a controlling unit (MCU), a memory circuit which can optionally an integrated circuit into the MCU chip, and an electronic communication interface. The electronic interface comprises at least one antenna, preferably directly on the cupper layer of the PCB. The electronic communication interface is preferably of the wireless type, being configured to transmit in a certain protocol, e.g. Wifi, BIE, Zigbee, Thread, IEEE 802.11 a/b/g/n, IEEE 802.15.4 MAC/PHY, IEEE Standard 802.15.4-2003, any Bluethooth 2,4Ghz ISM band. A part of the electronic communication interface can be integrated in the same circuit as the MCU.

[0032] In one preferred mode of the invention, the heater is powered by the mains, after a half of full wave rectifier, and is driven by a switching element such as a MOSFET, preferably in switching mode.

Panel

[0033] The device preferably comprises a panel, which further comprises a sign able to transmit information to a user. The panel further preferably comprises at least one button.

Light source for the indicia means

[0034] For example, the light source may be a one or more LED's (light emitting diodes). Non-limiting examples of preferred LED's include bicolor LED's, or dual 2-color LED assemblies, SMD LED's, micro LED's, 3-10 mm LED's, rectangular LED's, single color LED's, infrared LED's, right-angle LED's, blinking LED's, and the like. A preferred example is an RGB LED. The preferred LED may be chosen on the basis of: the particular events or status that requires signaling to the user, (for example, "ON", and/or "end-of-life" of the material). The electronics, (including printed circuit board (PCB) design, cost, compatibility of the LED with other electronic components, current/voltage requirements etc); and, the physical layout of the PCB, its size constraints, location and orientation within the housing of the device, (for example, orientation of the PCB may dictate the choice between a right-angle LED and a standard LED). Most preferred is to incorporate a suitable LED (such as a bicolor LED or an assembly of LED's) as the light source that may provide one color when the device is vaporizing volatile material (e.g., green, to signal that the device is running rather than off) and a second color to signal when the device is depleted of material (e.g., a red color, or a blinking color).

Environment

[0035] Environment corresponds to any defined space, whether open or enclosed by one or more surfaces, walls, ceilings, floors, or other solid or fictitious boundaries, which receives the evaporated material. For example, environment may correspond to a residential room (bedroom, bathroom, kitchen, etc.), commercial space (factory floor, office cubicles, etc.), automotive enclosure (car, truck, recreational vehicle), airline compartment, or any other space in which it is desirable to deliver a vapor.

[0036] For all necessary measurements it is considered that the measurements are done under constant room conditions (T=22°C, ambient pressure=1atm, Relative humidity = 50%). For heating, it is considered that the room is sufficiently large so that the heating of a PTC, small relative to the room, does not substantially influence the room's temperature. A sufficient volume in the environment, i.e. sufficiently large room, is considered as 28 cubic meter.

Material

[0037] The material is able to be delivered to the surrounding environment, so that its final form in the air is preferably: vapor, mist, gas, particulate suspension, or a mixture of any of these. Preferably, the material can be evaporated. The material has a composition. In one preferable embodiment of the invention, the material has an insecticide composition. In another preferred embodiment of the invention, the material has an air care composition. The term material for the purpose of this invention, refers to the material able to be dispensed, it will become clear when it is to be distinguished from the material of other components of the invention

[0038] In the present invention, evaporated material means the material delivered into the surrounding environment, so that its form in the environment is preferably: vapor, mist, gas, particulate suspension, or a mixture of any of these.

[0039] The material in the reservoir for being delivered into the environment may be present from about 1 gram to about 50 grams. Depending on whether the composition is a fragrance or an insecticide or other air treatment mixture, the composition may contain anywhere from trace actives to 100% actives and may contain any number and amount of solvents and/or carriers, volatile or otherwise. For example, the device of the present invention may comprise a volatile material further consisting of only a single volatile chemical such as citronella. In another embodiment of the invention the volatile material may comprise only eucalyptus oil. The material may comprise anywhere from one or a few to up to many active materials dissolved or compounded with solvents and carriers that may or may not be volatile. Most preferred is to utilize volatile mixtures (comprising mixtures of actives and solvents together) wherein all of the components are volatile such that the reservoir will eventually empty of all visible contents after a predetermined use-up period referred to as the "end-of-life". Most preferred is to place from about 5 mL to about 45 mL of a liquid or gelled volatizable material within reservoir.

Material for insecticide

[0040] An insecticide composition according to the present invention may be a pesticide, an insecticide repellent, an insecticide killer, or combinations thereof. Insecticide compositions for use in the present invention are those of the type described in U.S. Pat. No. 4,663,315 to Hasegawa, et al., incorporated herein by reference. Hasegawa describes many useful volatile insecticidal compositions that will work well within the reservoir of the present invention. The preferred active ingredients of the compostion are pyrethroid compounds. Non limiting examples of suitable actives are: Allethrin, Bifenthrin, Cyfluthrin (dichlorovinyl derivative of pyrethrin), Cypermethrin (including the resolved isomer alpha-cypermethrin, dichlorovinyl derivative of pyrethrin), Cyphenothrin, Deltamethrin (dibromovinyl derivative of pyrethrin), Esfenvalerate, Etofenprox, Fenpropathrin, dichlorovinyl derivative of pyrethrin, Prallethrin,Resmethrin, Silafluofen, Sumithrin, tau-Fiuvalinate, Tefluthrin, Tetramethrin, Tralomethrin, Transfluthrin, Fenvalerate, Flucythrinate, Flumethrin, Imiprothrin, lambdaCyhalothrin, Metofluthrin, Permethrin. The composition may comprise one or more different active compounds.

Material for air care

[0041] For use as a fragrance-dispersing device, fragrance components of the volatizable material for the present invention may comprise one of more volatile organic compounds available from any of the now known, or hereafter established, perfumery suppliers, such as international Flavors and Fragrances (IFF) of New Jersey, Givaudan of New Jersey, Firmenich of New Jersey, etc. Many types of fragrances can be used in the present invention. Preferably the fragrance materials are volatile essential oils. The fragrances, however, may be synthetically derived substances (aldehydes, ketones, esters, etc.), naturally derived oils, or mixtures thereof. Naturally derived fragrance substances include, but are not limited to, musk, civet, ambergis, castoreum and like animal perfumes; abies oil, ajowan oil, almond oil, ambrette seed absolute, angelic root oil, anise oil, basil oil, bay oil, benzoin resinoid, bergamot oil, birch oil, bois de rose oil, broom abs., cajeput oil, cananga oil, capsicum oil, caraway oil, cardamon oil, carrot seed oil, cassia oil, cedar leaf, cedarwood oil, celery seed oil, cinnamon bark oil, citronella oil, clary sage oil, clove oil, cognac oil, coriander oil, cubeb oil, cumin oil, camphor oil, dill oil, estragon oil, eucalyptus oil, fennel sweet oil, galbanum res., garlic oil, geranium oil, ginger oil, grapefruit oil, hop oil, hyacinth abs., jasmin abs., juniper berry oil, labdanum res., lavander oil, laurel leaf oil, lavender oil, lemon oil, lemongrass oil, lime oil, lovage oil, mace oil, mandarin oil, mimosa abs., myrrh abs., mustard oil, narcissus abs., neroli bigarade oil, nutmeg oil, oakmoss abs., olibanum res., onion oil, opoponax res., orange oil, orange flower oil, origanum, orris concrete, pepper oil, peppermint oil, peru balsam, petitgrain oil, pine needle oil, rose abs., rose oil, rosemary oil, sandalwood oil, sage oil, spearmint oil, styrax oil, thyme oil, tolu balsam, tonka beans abs., tuberose abs., turpentine oil, vanilla beans abs., vetiver oil, violet leaf abs., ylang ylang oil and like vegetable oils, etc. Synthetic fragrance materials include but are not limited to pinene, limonene and like hydrocarbons; 3,3,5-trimethylcyclohexanol, linalool, geraniol, nerol, citronellol, menthol, borneol, bomeyl methoxy cyclohexanol, benzyl alcohol, anise alcohol, cinnamyl alcohol, (3-phenyl ethyl alcohol, cis-3-hexenol, terpineol and like alcohols; anethole, musk xylol, isoeugenol, methyl eugenol and like phenols; a-amylcinnamic aldehyde, anisaldehyde, n-butyl aldehyde, cumin aldehyde, cyclamen aldehyde, decanal, isobutyl aldehyde, hexyl aldehyde, heptyl aldehyde, n-nonyl aldehyde, nonadienol, citral, citronellal, hydroxycitronellal, benzaldehyde, methyl nonyl acetaldehyde, cinnamic aldehyde, dodecanol, a-hyxylcinnamic aldehyde, undecenal, heliotropin, vanillin, ethyl vanillin and like aldehydes; methyl amyl ketone, methyl (3-naphthyl ketone, methyl nonyl ketone, musk ketone, diacetyl, acetyl propionyl, acetyl butyryl, carvone, menthone, camphor, acetophenone, p-methyl acetophenone, ionone, methyl ionone and like ketones; amyl butyrolactone, diphenyl oxide, methyl phenyl glycidate, gamma.-nonyl lactone, coumarin, cineole, ethyl methyl phenyl glicydate and like lactones or oxides; methyl formate, isopropyl formate, linalyl formate, ethyl acetate, octyl acetate, methyl acetate, benzyl acetate, cinnamyl acetate, butyl propionate, isoamyl acetate, isopropyl isobutyrate, geranyl isovalerate, allyl capronate, butyl heptylate, octyl caprylate octyl, methyl heptynecarboxylate, methine octynecarboxylate, isoacyl caprylate, methyl laurate, ethyl myri state, methyl myri state, ethyl benzoate, benzyl benzoate, methylcarbinylphenyl acetate, isobutyl phenylacetate, methyl cinnamate, cinnamyl cinnamate, methyl salicylate, ethyl anisate, methyl anthranilate, ethyl pyruvate, ethyl a-butyl butylate, benzyl propionate, butyl acetate, butyl butyrate, p-tert-butylcyclohexyl acetate, cedryl acetate, citronellyl acetate, citronellyl formate, p-cresyl acetate, ethyl butyrate, ethyl caproate, ethyl cinnamate, ethyl phenylacetate, ethylene brassylate, geranyl acetate, geranyl formate, isoamyl salicylate, isoamyl isovalerate, isobomyl acetate, linalyl acetate, methyl anthranilate, methyl dihydrojasmonate, nopyl acetate, (3-phenylethyl acetate, trichloromethylphenyl carbonyl acetate, terpinyl acetate, vetiveryl acetate and like esters, and the like. Suitable fragrance mixtures may produce a number of overall fragrance type perceptions including but not limited to, fruity, musk, floral, herbaceous (including mint), and woody, or perceptions that are in-between (fruity-floral for example). Typically, these fragrance mixtures are compounded by mixing a variety of these active fragrance materials along with various solvents to adjust cost, evaporation rates, hedonics and intensity of perception. Well known in the fragrance industry is to dilute essential fragrance oil blends (natural and/or synthetic) with solvents such as ethanol, isopropanol, hydrocarbons, acetone, glycols, glycol ethers, water, and combinations thereof, and using solvent up to as much as 90% of the volatile fragrance composition. Thus, a preferred fragrance composition for use as the volatizable composition in the present invention is comprised of a mixture of many fragrance actives and volatile solvents, sometimes along with smaller amounts of emulsifiers, stabilizers, wetting agents and preservatives. More often than not, the compositions of the fragrance mixtures purchasable from the various fragrance supply houses remain proprietary.

Emission rate

[0042] The average emission rate Er_m over a period of use of at least 1 h, is preferably given by 3nL/s < Er_m

≤ 20 nL/s.

Reservoir

[0043] In the present invention, the reservoir is preferably a refill bottle comprises a plastic material that is compatible with the material to be emitted into the environment. It is understood that the reservoir comprises the material, unless specifically stated, such as *empty* reservoir. A cartridge or other equivalent container is also to be understood as refill bottle according to the invention. For example, refill bottle may be formed of polypropylene, barex and/or PET. However, in certain applications, it may be desirable for bottle to be formed of other bottle materials such as glass or the like. Preferably, bottle is suitably sized for use in connection with household use. In accordance with various aspects of the invention, bottle is preferably configured for receipt of between 25 to about 75 milliliters of liquid material. The weight and moment of the device of the present invention, inclusive of the reservoir bottle is preferably such that the center of gravity is appropriately positioned and the weight is less than that which would otherwise cause the device to be unstable in the electrical outlet.

Supply means

[0044] The device for emanating product has a supply means for supplying material to the emitter (heater). The supply means preferably comprises a mechanical attachment means (fitment) to which a reservoir, such as a refill bottle, can be attached. An example for the fitment is a suitable molded plastic collar that snaps over the opening of the refill bottle to adapt the reservoir opening to a smaller hole that accepts and seals around the wick. The fitment also provides a better sealing platform for a screw cap. Such a screw cap can then be used to seal the bottle and wick together (a so-called "witch hat" shaped cap that covers the exposed end of the wick and seals down around the neck fitment and the screw threads of the bottle). Such configurations for the reservoir, fitment, porous wick and screw cap assembly are well described in U.S. Patent Application Publications 2006/0022064 to Triplett, et al. and 2005/0191481 to He, et al., along with PCT Application Publication WO/2002030220 to He, et al, all incorporated herein in their entireties. In order to effect emanating of the material from the emitter of the present device, the wick is positioned in close proximity to the inventive heater. In this way, when the resistive heater is energized, the emitted heat will warm the saturated porous wick, vaporizing the material. To achieve the alignment of the reservoir such that its wick is placed into close proximity to the heater, a guidance device as that claimed in U.S. Pat. No. 6,104,867 to Stathakis, et al. may be readily employed within the design of the housing of the present invention.

Transport means

[0045] Preferably, the device comprises a transport means for allowing the transport of material from the supply means to the emitter. The transport means may extend into reservoir. In a preferred embodiment, the transport means is a wick that extends to the bottom of the reservoir, when in operational position, to ensure complete emptying. Suitable wick materials include cellulose fiber bundles, porous sintered plastic, wood, ceramics, graphite, and synthetic fiber bundles, and combinations of these materials, but as mentioned, the porous sintered plastic wicks are highly preferred.

[0046] Details of the inventions are shown in the Figures. Summary of the figures:

Fig.1 is a schematic view of a heating element according to the invention in exploded view.

Fig. 2 is a schematic view of a resistive heater as used in the invention.

Fig. 3 is a schematic view of a device according to the invention.

[0047] All figures are schematic representations; some elements may be exaggerated to better explain the invention. Particularly in Fig. 3 some elements (e.g. 16, 17) are shown in 2D while others are shown in perspective.

[0048] Figures 1 and 2 show a heating element (1), comprising a ring shaped resistive heater (2). Fig.1 is the exploded view, in Figure 2 the assembled resistive heater is shown, without the supporting element. In Figure 2 the coated electrically insulating layer (10) is represented by the dashed line (10), this representation is exaggerated so that the thin coating can be shown. It preferably covers the complete heater (2) with connected terminals (8, 9), preferably leaving only the extremities (8.2, 9.2) of the terminals (8, 9) exposed. Now, focusing on Fig.1, the heater (2) comprises an upper side (3) and a lower side (4), both sides connected (3, 4) to each other by an outer lateral surface (5). The heater (2) further comprising an axial through hole (6) for receiving a wick, the axial through hole (6) extending from the upper side (3) to the lower side (4) defining an inner surface (7). The heating element (1) further comprises at least two conductive terminals (8, 9), providing electrical contact to the resistive heater (2), in the present figure, with the ring shaped contacting elements (8.1, 9.1) that are attached to the upper and lower surfaces (3, 4). An example of the attachment is shown in Fig.2, there the ring shaped contacting elements (8.1, 9.1) are mechanically secured to the heater by a suitable clamp (8.3). Other suitable means can be used. The two conductive terminals (8, 9) extend from the heater (2) preferably as wire leads (8.2, 9.2). The resistive heater (2) and the two conductive terminals (8, 9) form an integral component. The resistive heater (2) is preferably covered with an electrically insulating layer (10) of average thickness above 15 μm but below 1000 μm, preferably below 500 μm; and the insulating layer (10) is preferably a coated layer. It is preferred that the electrically insulating layer (10) gives further mechanical stability to the integral element. As shown in Fig.1, the heating element (1) further comprises a supporting element (11.1, 11.2) able to hold the heater (2) inside it (11.1, 11.2). As an example, the supporting element is comprised by two parts, namely the first part (11.1) and the second (11.2). In the present embodiment of Fig1. and Fig. 2, the wires (8, and 9) are coplanar, and when assembled, fit inside the slot (11.5) of the supporting means (11.1, 11.2). The second part (11.2) of the supporting element (11.1, 11.2) is configured to fit to the first part (11.1), preferably on the other side of the heater (2). In this case, the heater (2) can be enclosed by the supporting element (11.1, 11.2), between the first (11.1) and the second part (11.2), while leaving the axial through hole (6) for the wick uncovered, and further leaving the inner surface of the axial through hole (7) uncovered.

[0049] Figure 1 shows a further development of the invention, wherein the support (11.1, 11.2) comprises an attachment surface (12), as a radial extension of the support (11.1, 11.2), the extension (12) being suitable to be secured to a housing (16) via a fastening means (13) such as, for example, a screw (13).

[0050] Figure 3, shows a device for emanating materials in the environment. In this schematic representation of the invention, the device shows the heating element (1) as shown in the figures 1 and 2, in the assembled state. The device comprises a circuit board (16), which in turn comprises the circuit for controlling the heating element, e.g. switching elements such as transistors. The two conductive terminals (8, 9) of the heating element (1) are soldered to the circuit board (16) at respective positions (15.1, 15.2). The heater (2) is mechanically connected to the housing (16) by extension (12) and fastening means (17). While the supporting means (11.1, 11.2) could be integrally formed with the housing (16) it is preferred that these are separate parts, because they can be produced separately with materials that have different requirements, for instance, the supporting element (11.1, 11.2) must have a higher resistance to temperature. Figure 3 further shows, in schematically manner, the reservoir (21) containing the liquid material (21) to be emanated and a wick (19). The wick (19) and the reservoir (21) are also connectable to the housing (16) such that the wick (19) is aligned to the heater's hole (6) and the axis (14). The circuit board (15) is also mechanically fixed to the housing, for example by a fixation means (18).

[0051] Preferably the angle alpha which is the angle between the axis (14) of the heater's hole (6) and a plane that is coplanar with the circuit board (15), has an absolute value of < 35°, preferably the angle is smaller than 2° so that the circuit board (15) and the axis (14) are essentially parallel to each other. Fig.3 shows plane 15.3 (in cross section view) that is parallel to axis (14). In a variation, it is shown an alternative circuit board (15') which has an associated coplanar plane (15.3') that has an angle alpha with absolute value of approximately 20° with axis (14). Obviously, the shortest angle is used for measuring alpha.

Claims

1. Heating element (1) suitable for a volatile liquid emanation device, comprising a

   - ring shaped resistive heater (2) comprising an upper side (3) and a lower side (4), both sides connected (3,4) to each other by an outer lateral surface (5); the heater (2) further comprising an axial through hole (6) for receiving a wick, the hole (6) extending from the upper side (3) to the lower side (4) defining an inner surface (7);
   - at least two conductive terminals (8, 9), providing electrical contact to the resistive heater (2), wherein;
   - the two conductive terminals (8, 9) extend from the heater (2);

   characterized in that
   the resistive heater (2) and the two conductive terminals (8, 9) form an integral component;
   the resistive heater (2) is covered with an electrically insulating layer (10); and
   the heating element (1) further comprises a supporting element (11.1, 11.2) able to hold the heater (2) inside it (11.1, 11.2).

2. Heating element (1) according to claim 1, wherein the supporting element (11.1, 11.2) is attached to the heater (2) by enclosing at least partially at least one of the outer lateral surface (5), the lower side (4), and the upper side (3) of the resistive heater and leaving the axial through hole (6) for the wick uncovered, and further leaving the inner surface (7) of the axial through hole (6) uncovered, the inner surface (6) preferably being essentially free of supporting element (11., 11.2) except for optional small catches and/or place holders.

3. Heating element (1) according to claim 1, wherein the heater (2) has a closed perimeter.

4. Heating element (1) according to claim 1 or 2, wherein the two conductive terminals (8, 9) are configured and arranged in such a position at the heater that when an electrical potential bias is applied at the terminals (8, 9), the respective current flows essentially through the complete ring.

5. Heating element (1) according to claim 4, wherein, the conductive terminals (8, 9) are attached to the resistive heater (2) at the upper side (3) and lower

side (4), respectively, such that when a electrical potential bias is applied at the terminals, the respective current flows from one of the sides (3, 4) to the other (4,3).

6. Heating element (1) according to claim 5, wherein the conductive terminals part (8.1, 9.1) contacting the resistive heater (2) are arc shaped, preferably closed arc shaped forming a ring.

7. Heating element (1) according to claim 4, wherein, the conductive terminals (8,9) are connected within the ring segment, and are angular spaced from each other at a smaller angle (<20°, preferably <15°) by an insulator so that the current flows through the larger ring section when electrical potential bias is applied to the terminals.

8. Heating element (1) according to any of the previous claims, wherein the support (11.1, 11.2) comprises at least 1, preferably at least 2, attachment surfaces (12), each preferably as a radial extension, the extension (12) being suitable to be secured to a housing via a fastening means such as, for example, a screw, a bolt, an elastic clip.

9. Heating element (1) according to any of the previous claims, wherein the two conductive terminals (8, 9) extend from the heater (2) in a direction parallel to heater's radius.

10. Heating element (1) according to claim 9, wherein the two conductive terminals (8, 9) extend radially from the heater (2).

11. Heating element (1) according to any of the claims 8 or 9, wherein the two conductive terminals (8, 9) are coplanar.

12. Heating element (1) according to any of the previous claims, wherein the conductive terminals (8, 9), especially their outer extremities (8.2, 9.1) are suitable to be soldered.

13. Heating element (1) according to any of the previous claims, wherein most of, preferably the complete, electrically insulating layer (10) has a thickness above 15 μm and below 1000 μm, preferably below 500 μm.

14. Heating element (1) according to any of the previous claims, wherein the electrically insulating layer (10) is a coated layer.

15. Device for emanating materials in the environment, comprising:

- a heating element according to any of the previous claims, the heating element comprising

  ◦ ring shaped resistive heater comprising an upper side and a lower side, both sides connected to each other by an outer lateral surface; the heater further comprising an axial through hole for receiving a wick, the hole extending from the upper side to the lower side defining an inner surface;
  ◦ at least two conductive terminals, providing electrical contact to the resistive heater, wherein;
  ◦ the two conductive terminals extend from the heater;

  wherein

  the ring shaped resistive heater and the two conductive terminals form an integral component; and
  the resistive heater is covered with an electrically insulating layer;
  the heating element further comprises a supporting element for mechanically fixating the heater on an external part; and

- a circuit board comprising the circuit for controlling the heating element,
characterized in that
the two conductive terminals of the heating element are soldered to the circuit board.

16. Device according to claim 13, wherein the angle alpha which is the angle between the axis (14) of the heater's hole (6) and a plane that is coplanar with the circuit board (15), has an absolute value of < 35°, preferably the angle is smaller than 2° so that the circuit board (15) and the axis (14) are essentially parallel to each other.

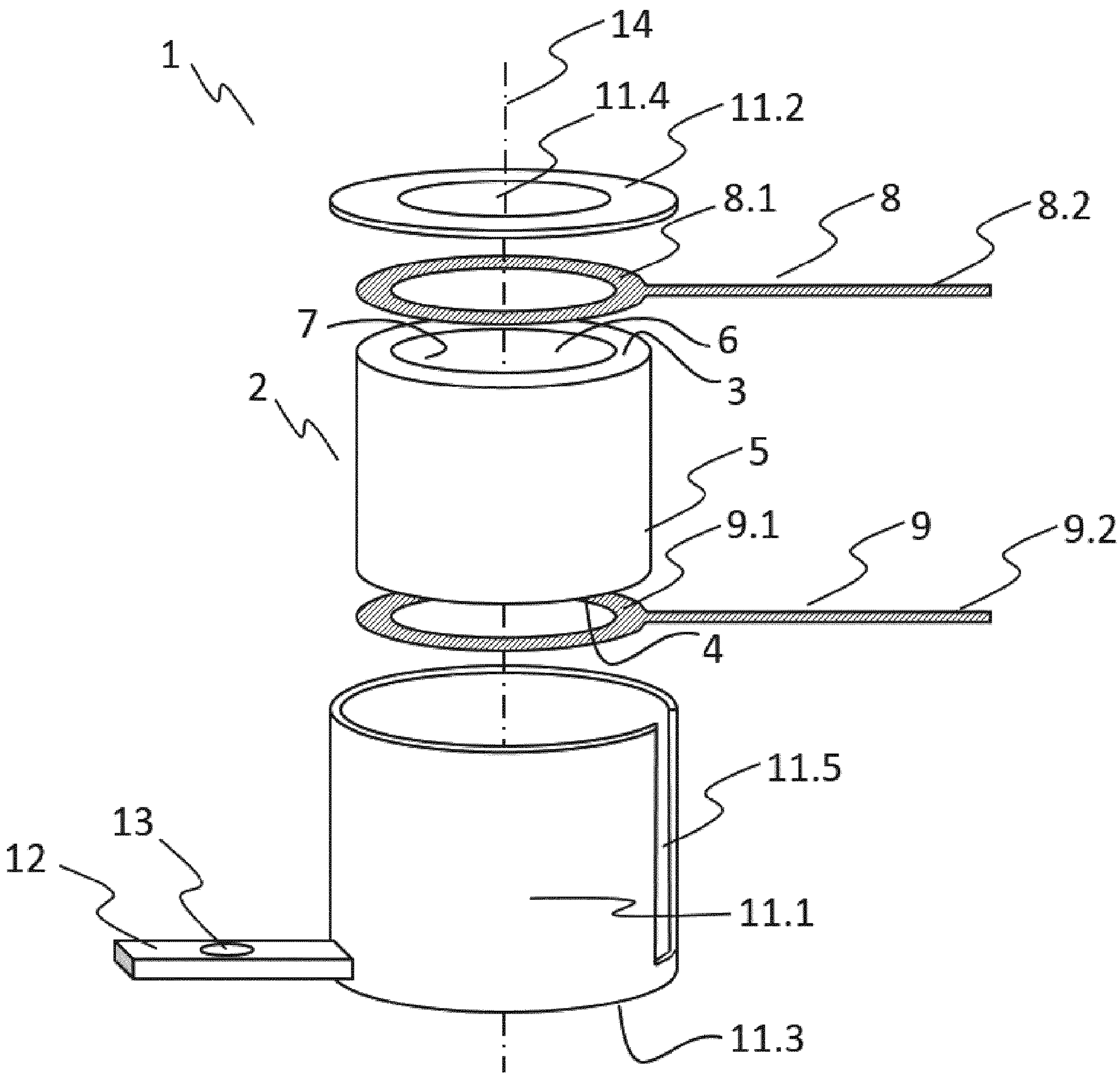


Fig. 1

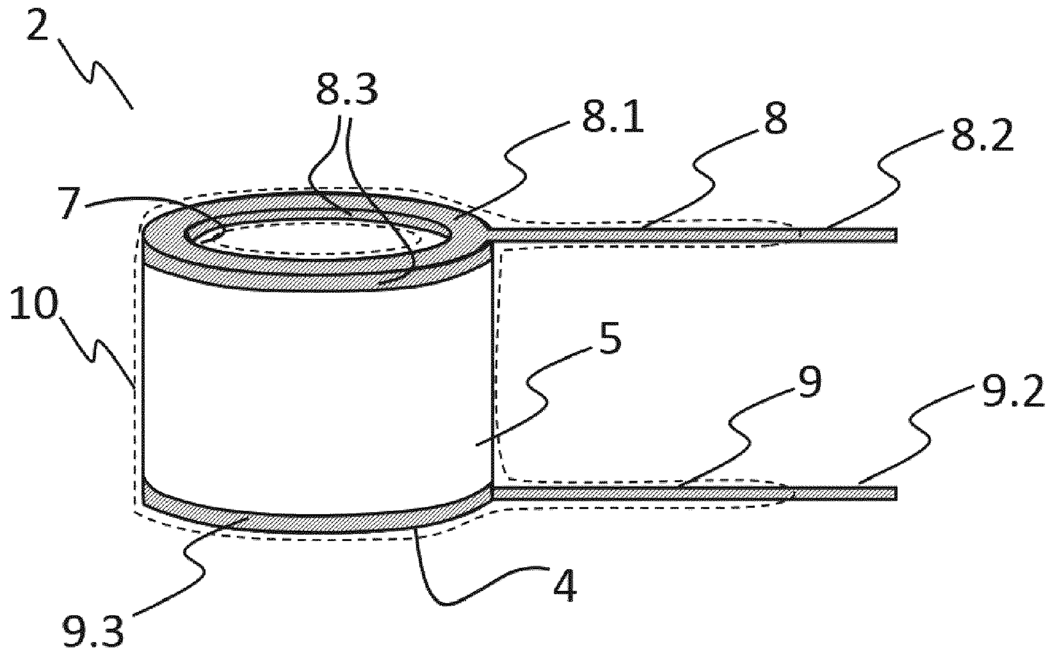
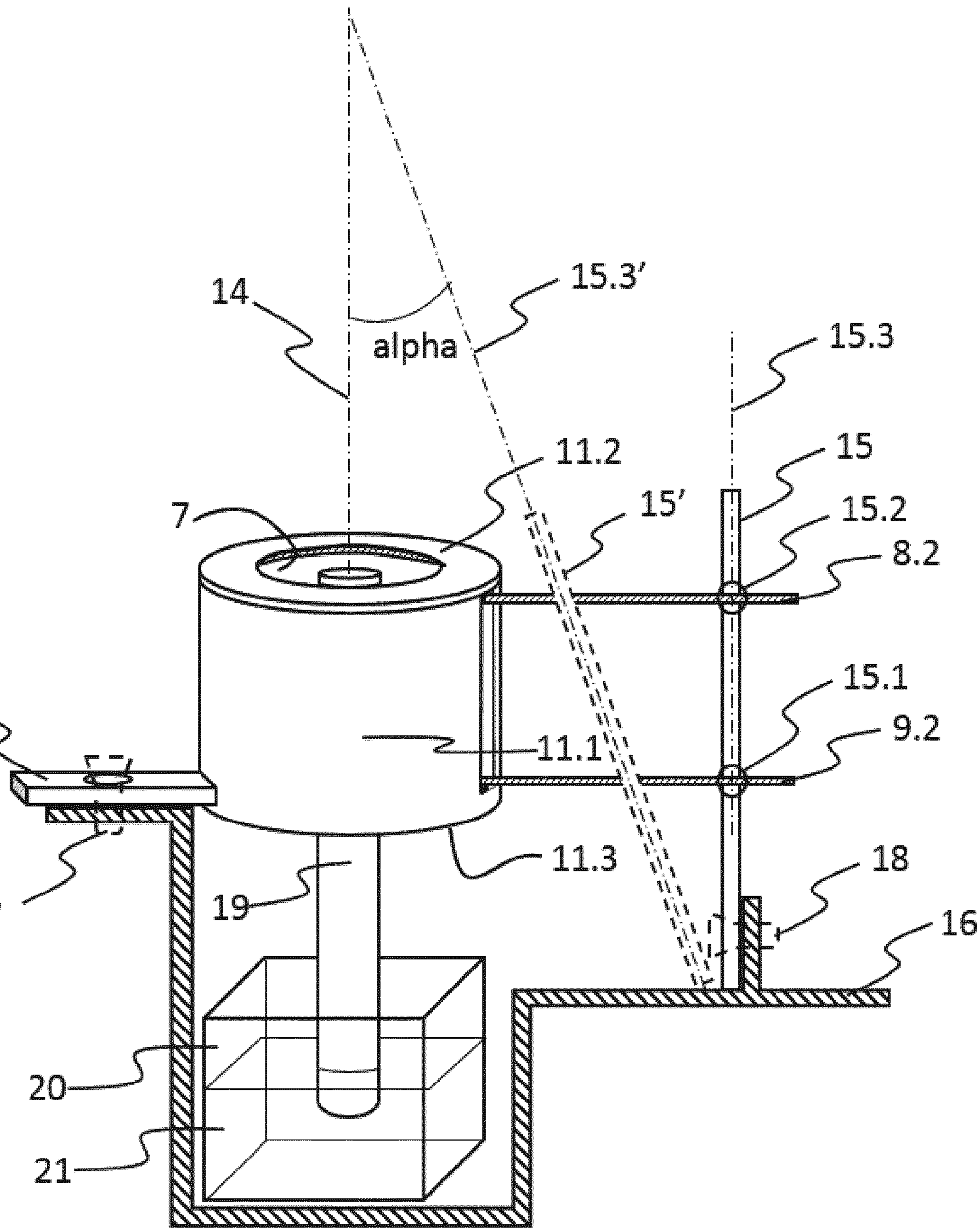


Fig. 2


14
alpha
15.3'
15.3
11.2
7
15'
15
15.2
8.2
15.1
12
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9.2
11.3
18
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16
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21

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 16 18 3452

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2014/037273 A1 (JAWORSKI THOMAS [US] ET AL) 6 February 2014 (2014-02-06) * paragraphs [0049] - [0053]; figures 5,9,10,13-16 * -----	1-16	INV. H05B3/00 H05B3/02 H05B3/06 H05B3/40 H05B3/42
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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	10 February 2017	Molenaar, Eelco

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