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(54) **Inhalátor alkatrész**

INHALER COMPONENT

Description

The invention relates to an inhaler component for the formation of a vapour/air mixture and/or condensation aerosol by evaporation of a liquid material and, if appropriate, condensation of the vapour formed, comprising:

a housing;

an electrical heating element for evaporating a portion of the liquid material;

a wick with a capillary structure, which wick forms a composite structure with the heating element and automatically supplies the heating element with the liquid material;

a carrier plate, preferably a printed circuit board, which carries the composite structure and to which the heating element makes electrical contact;

a capillary gap which is at least partly formed by the carrier plate and which automatically supplies the composite structure with the liquid material by way of an end portion of the wick protruding into the capillary gap.

Definition of terms:

In the present patent application, the term "inhaler" refers to medical and non-medical inhalers. The term further relates to inhalers for administering pharmaceutical products and substances that are not declared as pharmaceutical products. The term also relates to smoking products and cigarette-substitute articles, such as those contained, for example, in the European Classification A24F47/00B, provided these are intended for administering to the user a vapour/air mixture and/or condensation aerosol. The term "inhaler" is also not intended to limit how the formed vapour/air mixture and/or condensation aerosol is supplied to the user or his body. The vapour/air mixture and/or condensation aerosol can be inhaled into the lungs or can also be supplied only to the oral cavity, without inhalation into the lungs.

A "capillary gap" refers to any gap that effectuates a transport of liquid solely on the basis of the capillary effect of its boundary walls. Wicks, coated wicks, or channels filled with wick material are not capillary gaps.

The use of the singular "composite structure" does not exclude the presence of multiple composite structures. The invention explicitly includes arrangements comprising multiple composite structures.

WO 2010/045671 (Helmut Buchberger) describes an inhaler component for the intermittent, inhalation- or draw-synchronous formation of a vapour/air mixture and/or condensation aerosol, comprising (figures 9-12 and figures 17-18) a housing 3, a chamber 21 disposed in the housing 3, an air inlet opening 26 for the supply of air from the surroundings into the chamber 21, an electrical heating element for evaporating a portion of a liquid material 16, wherein, in the chamber 21, the formed vapour mixes with the air supplied via the air inlet opening 26 and the vapour/air mixture and/or condensation aerosol forms. The inhaler component further comprises a wick with a capillary structure, which wick forms a planar composite structure 22 with the heating element and automatically supplies the heating element with the liquid material 16 again after evaporation. The planar composite structure 22 is supported with two end portions on two electrically conductive, plate-shaped contacts 23, to the surface of which the heating element simultaneously makes electrical contact. As an alternative, the plate-shaped contacts 23 can also be formed by printed circuit boards or a common printed circuit board. At least one heated portion of the planar composite structure 22 is contactlessly disposed in the chamber 21, and

the capillary structure of the wick is largely exposed in said portion, at least on one face 24 of the planar composite structure. The planar composite structure 22 or its wick protrudes with one end into a capillary gap 41, which itself is coupled or can be coupled via capillary action to a liquid container 4 containing the liquid material 16. The liquid container 4 comprises an openable closure element 18, which is still closed before use. The openable closure element 18 can be manually opened by a user, whereupon the liquid material 16 floods a reservoir 45 and wets the capillary gap 41. The capillary gap 41 draws the liquid material 16 out of the liquid container 4 or reservoir 45 and transports it to the composite structure 22. The capillary gap 41 is basically formed by one of the two plate-shaped contacts 23 and a top part 42 placed thereon in a planar manner by way of the two adjoining components or their surfaces forming boundary walls of the capillary gap 42. In addition, a ventilation channel 52 is formed in the plate-shaped contact 23, which channel connects the reservoir 45 or the liquid container 4 to the chamber 21. The ventilation channel 52 effectuates a pressure equalization by way of each portion of liquid material 16 that enters the capillary gap 41 being immediately replaced by a portion of air having the same volume.

Finally, a buffer storage 53 is integrated into the top part 42, which storage communicates with the capillary gap 41 and itself consists of capillaries, see figure 11 and figure 17. The buffer storage 53 is capable of receiving liquid material 16 from the capillary gap 41, storing it temporarily, and releasing it again to the capillary gap 41 as necessary. As a result, the inhaler components can also be operated in an upside-down position for use, i.e., the mouthpiece 5 points downward, at least for as long as liquid material 16 is available in the buffer storage 53. The buffer storage 53 consists of slits 54, which are arranged parallel to one another and which are formed in the top part 42. The slits 54 communicate via openings 55 with the capillary gap 41 on one side and, on the other side, with the chamber 21 via a ventilation gap 56. The capillary action of the slits 54 causes the liquid material 16 to flow out of the reservoir 45, via the capillary gap 41 and via the openings 55, into the slits 54, where it is temporarily stored and can be removed from the capillary gap 41 again as needed.

The design of the buffer storage 53 has proven to require a very large amount of space. In addition, the production of the fine slits 54, including the openings 55, formed in the top part 42 is relatively complex. Finally, it is disadvantageous that the openings 55 disrupt the capillary action of the capillary gap 41, because the openings 55 replace otherwise wettable wall portions of the capillary gap 41. In the worst case, the disruption of the capillary action can adversely affect the supply of the planar composite structure 22 with the liquid material 16.

The problem addressed by the invention is that of eliminating the above-described disadvantages of the arrangement known from the prior art. The problem addressed by the invention, in particular, is that of designing an inhaler component of the initially described type using structurally simple means in such a way that sufficient quantities of liquid material can be temporarily stored without taking up substantial additional installation space. In addition, the reliability of supplying the composite structure with the liquid material should be increased.

The problem is solved by the characterizing features of claim 1. According thereto, it is provided that both the front face and also the rear face of the carrier plate, at least in some areas, form boundary walls of the capillary gap. The supply of the composite structure with the liquid material therefore does not take place on only one face of the carrier plate, but on both faces. Capillary gaps or capillary-gap portions, which are delimited by the

carrier plate, are provided on both faces of the carrier plate. As a result, an additional capillary-gap volume can be created in a simple and installation-space saving manner, which volume functions simultaneously as a buffer. Another favourable effect is considered to be the redundancy of the liquid supply: if the supply in one capillary-gap portion fails, for whatever reason, the composite structure can therefore still be supplied with the liquid material at least via the capillary-gap portion located on the opposite face of the carrier plate.

In one refinement of the invention, it is provided that the edge of the carrier plate, at least in some areas, also forms a boundary wall of the capillary gap. The buffer volume can be further enlarged in this manner. It is particularly favourable when the capillary gap at least partially encloses the carrier plate. The enclosure has the effect that the capillary-gap portions on the front face and the rear face of the carrier plate communicate with one another via the edge of the carrier plate. Even if the capillary liquid flow were to be interrupted at multiple points of the capillary gap, there would be at least one alternative path for circumventing the affected points.

According to the invention, boundary walls of the capillary gap form over 50 percent of the surface of the carrier plate. Portions of the carrier plate protruding out of the housing are not taken into account in the calculation. As a result of utilizing a large surface area of the carrier-plate surface as a boundary wall of the capillary gap, the above-described effects related to the formation of an additional buffer volume and the increase in the reliability of supply can be maximized. Furthermore, the supply capacity, i.e., the maximum quantity of liquid material that can be transferred through the capillary gap per unit of time, can be increased.

It is particularly advantageous when the capillary gap is formed, at least in some areas, by the carrier plate and an adjacent wall of the housing. In this case, the capillary gap is formed, at least in some areas, solely by available components. Wall portions of the housing that are still present are utilized as boundary walls of the capillary gap. No additional installation space is utilized.

A preferred embodiment of the invention relates to an inhaler component with a liquid container which contains the liquid material and from which the capillary gap draws the liquid material, and it is provided that the capillary gap, at least in some areas, is formed by the carrier plate and an adjacent wall of the liquid container. The liquid container can either form an independent component or can be a part of the housing. In the latter case, the liquid container is formed by walls of the housing. Particularly favourable conditions result when the capillary gap communicates with the liquid material in the liquid container via a supply opening in the wall of the liquid container, by means of the wall of the liquid container forming a shoulder at the edge of the supply opening, on which shoulder the carrier plate abuts with its edge. As an alternative, it can also be provided that the carrier plate bears on the shoulder with its front face or rear face. Therefore, no additional aids are required for connecting the capillary gap to the liquid container. By means of the shoulder, a wall portion of the supply opening is lengthened toward the outside. Assuming that the participating surfaces can be well wetted by the liquid material, the effect results that a small quantity of liquid material is drawn out of the supply opening by the adhesion forces acting on the lengthened wall portion. The effect suffices to ensure that the liquid material also reaches and wets the carrier plate, which abuts the shoulder with its edge and bears on the shoulder with its front face or rear face. The capillary gap is therefore coupled to the liquid material in the liquid container and, driven by the capillary forces acting therein, can fill itself with the liquid material.

The invention also relates to an inhaler comprising an above-described inhaler component according to the invention. The inhaler component can therefore also be only a part, in particular a replaceable part, of an inhaler.

The invention is explained in greater detail with reference to an exemplary embodiment according to the drawings. In the drawings:

figure 1 shows different views of an inhaler according to the invention;

figure 2 shows the inhaler according to figure 1, comprising a reusable inhaler part and a replaceable inhaler component in the decoupled state;

figure 3a and figure 3b show different views of the replaceable inhaler components;

figure 4a, figure 4b, figure 4c, figure 4d, figure 4e, figure 4f, figure 4g show sectional views of the replaceable inhaler component along the line A-A in figure 3b in different installation states;

figure 5 shows an enlarged depiction of the detail a from figure 4a;

figure 6 shows an enlarged depiction of the detail b from figure 4b;

figure 7 shows a carrier plate designed as a multilayer printed circuit board;

figure 8 shows a sectional view of the replaceable inhaler component along the line B-B in figure 3b;

figure 9 shows an enlarged depiction of the detail c from figure 8;

figure 10 shows a cross-section of the replaceable inhaler component at the level of the supply opening;

figure 11 shows a cross-section of the replaceable inhaler component at the level of the composite structure;

figure 12 shows an alternative embodiment of the detail c (cf. figure 9).

Figure 1 shows an inhaler according to the invention, the shape and size of which are designed in such a way that the inhaler can be easily and comfortably handled by users. In terms of volume, the inhaler is only approximately half as large as a cigarette pack. The inhaler depicted by way of example basically consists of two parts, specifically an inhaler part 1 and an inhaler component 2.

The inhaler component 2 consists of a housing 3, which, on an end face, forms a tobacco pipe-like mouthpiece 4. The housing 3 is preferably produced from plastic. The inhaler component 2 contains a liquid material, which is electrically evaporated within the housing 3 and is converted into an inhalable vapour/air mixture and/or condensation aerosol. The formed vapour/air mixture and/or condensation aerosol is offered to the user via the mouthpiece 4. Any substances and preparations that evaporate largely residue-free under atmospheric conditions can be considered, in principle, as the liquid material. This condition is also already met when the particular substance or the particular preparation is present in diluted form, for example, dissolved in water and/or ethanol, and the solution evaporates without leaving a residue. As a result of a sufficiently high dilution in a highly volatile solvent such as water and/or ethanol, even otherwise poorly evaporable substances can meet the aforementioned condition, and a thermal decomposition of the liquid material can be avoided or substantially reduced. The aerosol particles generated by condensation have a mass median aerodynamic diameter (MMAD), as a rule, of less than 2µm and therefore also reach the alveoli. The inhaler according to the invention is suited, in particular, for administering systemically acting substances, in particular substances that exert their main effect in the central nervous system. One example thereof is nicotine, the boiling point of which is 246°C. The

nicotine-containing aerosol particles are deposited mainly in the bronchi and alveoli, where the active agent instantly enters the blood stream. A few seconds later, the nicotine, in a bundled concentration, reaches the brain, where it can exert the known effects.

The inhaler part 1 consists of a main housing 5, which is preferably also produced from plastic. The main housing 5 contains at least a battery 6 and an electrical circuit 7 (depicted in figure 1 using dashed lines), including a switch 7a. The battery 6 and the electrical circuit 7 provide the electrical energy required to evaporate the liquid material. The battery 6 preferably consists of a rechargeable battery, for example, type CGR18650K made by Panasonic, www.industrial.panasonic.com. This is a cylindrical lithium ion cell of size 18650 having a storage capacity of 1650mAh and a current loadability of up to 30A. Comparable cells are also mass-produced by other manufacturers, including Sony, Samsung, LG Chem.

As shown in figure 2, the inhaler part 1 and the inhaler component 2 in the specific exemplary embodiment are designed to be detachable from one another. This arrangement makes the inhaler part 1 reusable, which is useful, in principle, when one considers that, first, the inhaler part 1 does not come into contact with the liquid material, i.e., is not contaminated with the liquid material, and, second, said inhaler part contains components having a longer service life than the components of the inhaler component 2. After the liquid material has been used up, the inhaler component 2 is properly disposed of, in entirety, by the user, and is replaced by a new inhaler component 2. The inhaler component 2, therefore, is a replaceable disposable article. Proper disposal is indicated primarily when the liquid material contains pharmaceutical products or toxins such as nicotine. In principle, it would also be conceivable, of course, to design the inhaler part 1 and the inhaler component 2 as a single piece, i.e., to be inseparable from one another. This embodiment does not appear to be less economical, however, because, in this case, all the parts and components of the inhaler, i.e., the inhaler as a whole, is a disposable article for one-time use. It goes without saying that the present invention also includes this embodiment, wherein, in this case, the entire inhaler is considered to be the inhaler component.

The mechanical coupling between the replaceable inhaler component 2 and the reusable inhaler part 1 is implemented using plug-in tabs 8a and using guide projections 9a formed by the housing 3, which projections engage into corresponding plug-in sockets 8b and guide grooves 9b formed by the main housing 5 of the reusable inhaler part 1. The plug-in tabs 8a and plug-in sockets 8b are used simultaneously for introducing the electrical energy into the replaceable inhaler component 2 for evaporating the liquid material, as is shown in greater detail in the following.

Figure 3a and figure 3b show different views of the replaceable inhaler component 2. Figures 4-11 show further details of the inner design of the inhaler component 2. According thereto, the housing 3 of the inhaler component 2 has a substantially cuboid shape. Components that are essential to the formation of the vapour/air mixture and/or condensation aerosol are located in the interior of the cuboid housing 3. These include, in particular, the composite structures 10, which effectuate the evaporation of the liquid material. In the specific exemplary embodiment, six composite structures 10 are disposed next to one another, and the composite structures have a planar shape. The planar composite structures 10 each consist of a wick and an electrical heating element, which are connected to one another in a planar manner or are integrated in one another in a planar manner. The planar composite structures 10 can be formed, for example, of a metal foil and metal fabric layers sintered thereon. Instead of the metal fabric, open-pore metal foams can also be used. The open-pore

capillary structure of the fabric layers, which are sintered onto the metal foil, or of the metal foam forms the wick, and the electrical resistance of the metal forms the heating element. Suitable metallic resistance materials are, for example, stainless steels such as AISI 304 or AISI 316 and heat-conducting alloys, in particular NiCr alloys. The production of such planar composite structures 10 belongs to the prior art and is disclosed in detail, for example, in the previously cited WO 2010/045671 (Helmut Buchberger). It should be noted that the planar composite structures 10 do not necessarily have to be planar; they can also have a spatial curvature.

As best shown in figure 4b and figure 7, the planar composite structures 10 are supported with two end portions 10a, 10b on a carrier plate 11. The carrier plate 11 has a large recess 12, which is contactlessly bridged by the composite structures 10. In the specific example, the carrier plate 11 is designed as a printed circuit board, in particular, as a multilayer printed circuit board. All known printed circuit board materials, in particular the material types FR1 through FR5, are suitable, in principle, for use as the material for the printed circuit board 11. The planar composite structures 10 make electrical contact, in the area of the end portions 10a, 10b, to conductive tracks 13 of the printed circuit board 11. The conductive tracks 13 are depicted as black areas in figure 7. In the case of the above-described metal-foil composite structures, the electrical contacting is preferably implemented by means of a soldering on the foil side, after pretreatment with a suitable fluxing agent, if appropriate. Stainless steels of material qualities AISI 304 and AISI 316 can be easily soldered, for example, with a soldering concentrate having the trade name "50505 Nirosta" from the company Stannol GmbH, www.stannol.de. Alternatively, the electrical contacting can consist of an adhesive connection by means of an electrically conductive adhesive, for example, by means of a silver-filled epoxy adhesive. The planar composite structures 10 are mounted on and contacted to the printed circuit board 11 in a fully automated manner, wherein methods from the printed circuit board industry can be applied, which methods, moreover, are also suitable for mass production.

The printed circuit board 11 protrudes out of the housing 3 in the form of the aforementioned plug-in tabs 8a. The two plug-in tabs 8a are used for introducing the electrical energy into the inhaler component 2. The electrical energy is supplied to the composite structures 10 via the conductive tracks 13. According to figure 7, the conductive tracks 13 are disposed both on the front face 11a and also on the rear face 11b of the printed circuit board 11, wherein the front face 11a is the mounting side, i.e., the side to which the composite structures 10 make contact. Optionally, further conductive tracks can also be disposed in intermediate layers. According to the prior art, the individual conductive-track layers are advantageously interconnected by means of so-called plated through-holes. Furthermore, the current flow is depicted in figure 7. In the specific example, the composite structures 10 are interconnected in series in groups of three. As a result, the resultant heating resistance and, therefore, the heat output and evaporation rate can be influenced within certain limits. It can also be provided that the individual electrical resistances of the six composite structures 10 differ, by way of the thickness of the metal foil being varied accordingly, for example. As a result of this measure, the evaporation process can also be made dependent on the location, similar to the case of a cigarette.

A substantially plate-shaped top part 14, which preferably consists of plastic, is placed onto the front face 11a of the printed circuit board 11 (see figure 4c and figures 8-10). The top part 14 has a recess 15, which correlates with the recess 12 in the printed circuit board 11 with regard to its size and arrangement. In the simplest case, the top part 14 is supported directly on the end portions 10a, 10b of the planar composite structures 10. As a

result, the top part 14, in combination with the printed circuit board 11, forms a first capillary-gap portion 16a, the inner width or gap width of which substantially corresponds to the thickness of the planar composite structures 10 (see figure 9 and figure 11). The gap width typically amounts to 0.2mm. In figure 4f, the planar extension of the first capillary-gap portion 16a is depicted as a black area. The top part 14 is fastened on the printed circuit board 11 by means of an adhesive connection. The adhesive points are depicted as black areas in figure 4d. The printed circuit board 11 and the top part 14 are preferably joined outside of the housing 3, and are therefore a preassembled assembly.

The printed circuit board 11 is supported with its rear face 11b, at least in some areas, on a cuboid liquid container 18 containing the liquid material 17 (see figures 4a/4b, figures 8-9 and figure 11). The liquid container 18 or its walls 18a are formed by the housing 3. The printed circuit board 11 is not supported directly on the liquid-container wall 18a, however, but rather on spacers 19. The spacers 19 are formed partially by the liquid-container wall 18a and partially by other housing portions; they are depicted as black areas in figure 4a. In this manner, a second capillary-gap portion 16b is formed. The rear face 11b of the printed circuit board 11 and the adjacent liquid-container wall 18a form the boundary walls of this second capillary-gap portion 16b. In figure 4c, the planar extension of the second capillary-gap portion 16b is depicted as a black area. The gap width is defined by the height of the spacers 19 and is typically 0.3mm. The printed circuit board 11 is preferably fastened on the spacers 19 by means of an adhesive connection. The liquid container 18 is filled with the liquid material 17 at the plant at the end of the production process, preferably fully automatically through a small hole in the container wall 18a (not depicted) by means of a cannula and a metering unit. The hole is closed after the filling, for example, being heat sealed, and the entire inhaler component 2 is packaged in an air-tight manner.

The liquid container 18, at its lower end, comprises a slit-shaped supply opening 20 (see figures 5-6, figures 9-10). The second capillary-gap portion 16b receives all the liquid material 17 via this supply opening 20. The capillary coupling is established via a shoulder 21 formed by the liquid-container wall 18a. A wall portion of the supply opening 20 is lengthened toward the outside by the shoulder 21 (see figure 9). The adhesion forces acting on the lengthened wall portion cause a small quantity of liquid material 17 to emerge from the supply opening 20. The effect suffices for the liquid material 17 to also reach the printed circuit board 11, which abuts the shoulder 21 with its edge 11c (see figure 6 and figure 9). In an alternative embodiment, the printed circuit board 11 lies on the shoulder 21 with its rear face 11b (see figure 12). As soon as the liquid material 17 wets the rear face 11b of the printed circuit board 11, the second capillary-gap portion 16b can exert its suction effect and take up liquid material 17. The shoulder 21 bears against the housing 3 via a web 22 for reinforcement.

The slit-shaped supply opening 20 has an expansion approximately in the centre. The expansion forms a ventilation opening 23. The ventilation opening 23 communicates with a ventilation groove 24 formed in the printed circuit board 11 on the printed circuit board rear face 11b, which groove communicates, via the recess 12, with an inner space at atmospheric pressure. The ventilation opening 23 and the ventilation groove 24 effectuate a pressure equalization by way of each portion of liquid material 17 that is taken up by the second capillary-gap portion 16b being immediately replaced by a portion of air having the same volume.

As is best shown in figures 10 and 11, the first capillary-gap portion 16a and the second capillary-gap portion 16b are interconnected via a third capillary-gap portion 16c. The third capillary-gap portion 16c is formed by the printed-circuit board edge 11c and an adjacent housing wall 3a. The third capillary-gap portion 16c is

exactly defined by the plate-shaped top part 14 connected to the printed circuit board 11, which part adjoins the housing wall 3a and extends beyond the printed-circuit board edge 11c by a precisely defined extent. The extent corresponds to the gap width of the third capillary-gap section 16c and typically amounts to 0.3mm. The printed circuit board 11 and the plate-shaped top part 14, which, as mentioned above, form a preassembled assembly, must therefore be exactly joined.

The three capillary-gap portions 16a, 16b, 16c in combination form the capillary gap 16. The capillary gap 16 therefore consists of an extended, contiguous capillary-gap system, which partially encloses the printed circuit board 11. If the portions of the printed circuit board 11 protruding out of the housing 3, i.e., the plug-in tabs 8a, are left out of consideration, then, in the specific exemplary embodiment, boundary walls of the capillary gap 16 form substantially more than 50 percent of the surface of the printed circuit board. The resultant advantageous effects related to the temporary storage of the liquid material 17, and related to the reliability of supply and the supply capacity, were depicted above. A basic prerequisite for achieving these favourable effects is that the liquid material 17 wets all the surfaces that are acted upon to a good extent. In order to ensure this, the affected components - which, in this case, are the liquid container 18, the printed circuit board 11 including the composite structures 10, the top part 14, and at least parts of the housing 3 - must be hydrophilized in a suitable process before assembly. Suitable processes are hydrophilization in oxygen plasma and hydrophilization by means of plasma polymerization. Both of these processes are offered, for example, by the company Diener electronic GmbH u. Co. KG, www.plasma.de, within the scope of commission orders. The aforementioned company also offers customized planning and building of corresponding systems, which are also suitable for mass production. Before the mode of operation of the inhaler according to the invention is explained in greater detail, further components of the inhaler component 2 will be described in the following. Even if these components may not be directly relevant to the invention, the description thereof provides for a better understanding of the function of the entire inhaler component according to the invention, and for even further ensuring that the invention can be carried out: two open-pore, absorbent sponges 25a, 25b (see figure 4g and figure 11) are disposed between the top part 14 and the housing 3. The space between the sponges, together with the recess 15, forms a chamber 26 (cf. also figure 8), in which the actual formation of the vapour/air mixture and/or condensation aerosol takes place. The sponges 25a, 25b absorb, into their pores, condensate deposits formed from the vapour phase and prevent the formation of accumulations of condensate, which can move freely in the inhaler component 2 and which could adversely affect the function of the inhaler component. Such accumulations of condensate can also pose a problem in terms of hygiene, in particular if they enter the oral cavity of a user via the mouthpiece 4. The sponges 25a, 25b preferably consist of a fine-pored composite fiber. The company Filtrona Fibertec GmbH, www.filtronafibertec.com, specializes in the production of such composite fibers, wherein cellulose acetate fibers bonded by means of triacetin and also thermally bonded polyolefin fibers and polyester fibers are processed.

The sponges 25a, 25b are supported on angle sections 27a, 27b formed by a U-shaped carrier 27 (see figure 4g and figure 11). The carrier 27 is joined to the top part 14 by means of an adhesive connection. The carrier 27, including the angle sections 27a, 27b, preferably consists of a hydrophobic plastic. The hydrophobic material functions as a liquid barrier and ensures that no liquid material 17 can reach the sponges 25a, 25b as a result of capillary effects. A recess 28, which, together with the top part 14, forms an air nozzle 29, is formed in the leg

27c connecting the angle sections 27a, 27b, on the side facing the top part 14 (see figure 9 and figure 10). The air nozzle 29 serves to introduce ambient air into the chamber 26, which will be depicted in greater detail below. In order to ensure that accumulations of condensate do not block the air nozzle 29, it is recommended to cover the surface of the top part 14 with a thin hydrophobic adhesive strip in the area of the air nozzle 29 (not depicted).

The supply of the inhaler component 2 with ambient air in order to form the vapour/air mixture and/or condensate aerosol is carried out via an intake snorkel 30 formed by the housing 3 (see figures 3a/3b and figure 8). The intake snorkel 30 is disposed on the side of the inhaler component 2 opposite the mouthpiece 4. This position provides the best protection against entry by rainwater. In the coupled state, the intake snorkel 30 of the inhaler component 2 protrude through a hole 31 formed in the main housing 5 of the inhaler part 1 (see figure 2). A flow throttle 32 is located in the intake snorkel 30. The flow throttle 32 has the purpose of generating a flow resistance that is similar to that of a cigarette, and so the user, during a draw, senses a drawing resistance that is similar to a draw on a cigarette. Specifically, at a flow rate of 1.05L/min, the flow resistance should be in the range of 8-16mbar and should have the most linear characteristic possible. The flow throttle 32 is required when the formed vapour/air mixture and/or condensation aerosol is supposed to be supplied as in the case of a cigarette, specifically as a draw into the oral cavity (draw volume: approximately 20-80mL), possibly followed by inhalation into the lungs. This mode of operation is recommended mainly when the liquid material 17 contains nicotine. The flow throttle 32 is omitted, however, when the inhaler is supposed to allow direct inhalation into the lungs in a single step, as is the case with most medical inhalers. The flow throttle 32 preferably consists of a composite fiber similar to a cigarette filter, wherein the density of the material must be tailored to the aforementioned flow characteristics. The material can also be obtained from the company Filtrona Fibertec GmbH, www.filtronafibertec.com.

The function of the inhaler is described in detail in the following: a user couples a new inhaler component 2 to the reusable inhaler part 1. The electrical circuit 7 registers the coupling and, if appropriate, triggers the execution of certain preparatory operations, for example, one or more evaporation cycles with the objective of supplying the composite structures 10 with fresh liquid material 17 and/or establishing stationary conditions. As soon as these operations have ended, the electrical circuit 7 signals, for example, via a light-emitting diode, that the inhaler is ready for operation. The user raises the mouthpiece 4 of the inhaler to the mouth and actuates the switch 7a. Simultaneously, he begins to draw on the mouthpiece 4. The underpressure generated as a result causes air to flow from the surroundings into the intake snorkel 30. After the air has passed through the flow throttle 32, the flow bends at a right angle (see arrows in figure 8 and figure 9) and enters a plenum chamber 33, where the air collects and is then steadily supplied to the slit-shaped air nozzle 29. The air flow is accelerated in the air nozzle 29 and enters the chamber 26 with a high muzzle velocity.

Actuating the switch 7a causes the circuit 7 to switch on the heater current. The heater current is preferably connected by means of a power MOSFET, wherein the supplied power can be adjusted to the particular requirements by means of a duty cycle. This adjustment can also be carried out by the user, within certain limits, via an interface, whereby the user is able to influence the amount of aerosol or smoke generated. The heater current is connected for a preset time period ("heating period"), which typically amounts to 1.0-1.8 seconds. The heater current is supplied to the composite structures 10 via the plug-in tabs 8a and the conductive tracks 13 of

the printed circuit board 11 and effectuates an instantaneous heating-up of the composite structures 10 and the liquid material 17 stored in the wicks, whereupon the liquid material 17 evaporates. The vapour is emitted into the chamber 26, where it mixes with the air flowing in through the air nozzle 29.

The arrangement and the dimensioning of the air nozzle 29 effectuate a steady and rapid flow over the composite structures 10. As a result, it is ensured that the vapour released by the composite structures 10 is in approximately the same mixing conditions on all sides, and the mixture of vapour and air is intimate. The air effectuates a cooling of the vapour, and so a condensation aerosol can also form, provided the evaporated liquid material 17 contains substances having a sufficiently low vapour pressure, so-called aerosol-forming substances. A typical example of such aerosol-forming substances is glycerol.

In the exemplary embodiment, the vapour/air mixture and/or condensation aerosol formed in the chamber 26 finally also flows through a cooler 34 before it is offered to the user, via the mouthpiece 4, for inhalation (see figure 4g and figure 8). The cooler 34 can consist, for example, of a porous filler material, a nonwoven fabric-like fiber material, or an open-cell foam material, through the pores of which formed vapour/air mixture and/or condensation aerosol flows. The cooler 34 can also be designed so as to have multiple stages, wherein the individual cooler stages have different properties. If the material to be evaporated contains nicotine, it can be advantageous to coat the cooler material of at least one cooler stage with a suitable absorbing agent, for example, with citric acid. The absorbing agent withdraws highly volatile nicotine fractions from the condensation aerosol flowing through, which fractions would otherwise deposit in the oral cavity and in the throat, which is neither pharmacokinetically or organoleptically desirable. Furthermore, aromatics such as menthol can be added to the cooler material.

Suitable nonwoven fabric-like fiber materials can be obtained, for example, from the company Freudenberg Vliesstoffe KG, www.freudenberg-filter.com. The material that is sold under the name Viledon® filter mats and consists of polyolefin fibers is produced to the customer's specifications, wherein the material properties can be tailored in such a way that the final product is as permeable as possible by the fine particles of the generated condensation aerosol. A suitable foam material can be obtained, for example, from the company Dunlop Equipment, www.dunlop-equipment.com. The aforementioned supplier offers Ni and NiCr foam under the product name Retimet® (grade 80) having a porosity of 90-95% and a pore diameter of approximately 300µm in a mat shape having thicknesses up to 15mm. Company representatives verbally reported that technology allows for the production of foams having even finer pores. The metal foams can also be additionally compressed by rollers. The mats can be further processed by laser cutting or wire eroding. Ni foam and, in particular, NiCr foam are characterized by high strength and by a high temperature resistance and oxidation resistance. These properties suggest that the relatively expensive metal foams should be recycled and reused at the end of the service life of the inhaler component 2. If the liquid material 17 contains nicotine, the inhaler component 2 should be given to the consumer, in principle, only in exchange for an appropriate deposit. In this manner, it is ensured that the greater part of the cooler 34, sponges 25a, 25b, and liquid container 18, which are contaminated with nicotine residue, are disposed of in an environmentally safe manner and, if appropriate, are recycled.

At the end of the heating period, the circuit 7 deactivates the switch 7a for a few seconds. The deactivation is displayed to the user, for example, by means of a light-emitting diode and is required so that the composite

structures 10 can cool down and the wicks can become saturated with the liquid material 17 again. The liquid transport is effectuated by the capillary action of the composite structures 10 and their wicks. The wicks suction the liquid material 17 out of the first capillary-gap portion 16a via the composite-structure end portions 10a, 10b (see figures 4b/4f and figure 11). The wicks are therefore infiltrated from two sides. The withdrawal of liquid material 17 from the first capillary-gap portion 16a induces a capillary pressure in the capillary gap 16, which pressure acts back into the liquid container 18. The capillary pressure causes liquid material 17 to flow out of the liquid container 18, via the slit-shaped supply opening 20, back into the second capillary-gap portion 16b (see arrows in figure 4a). From there, the liquid material 17 travels via the third capillary-gap portion 16c into the first capillary-gap portion 16a, where it finally replaces the quantity of liquid that was withdrawn. If disruptions in the capillary flow occur in the capillary-gap system 16 at one or more points, for whatever reason, an alternative path for circumventing the affected points will occur in most cases.

The quantity of liquid material 17 removed from the liquid container 18 is replaced by an equivalent quantity of air as a result of a pressure equalization. The pressure equalization takes place via the ventilation groove 24 and the ventilation opening 23. As soon as the composite structures 10 or wicks have been fully infiltrated with the liquid material 17 again, the inhaler is available for a new evaporation cycle.

In an upside-down position for use of the inhaler component 2, i.e., the mouthpiece 4 points downward, the capillary coupling between the capillary gap 16 and the liquid material 17 in the liquid container 18 is lost, because the air cushion 35, which is always present in the liquid container 18, constantly rises upward in every position as a result of the buoyancy, i.e., in the upside-down position for use, said air cushion comes to rest in the area of the supply opening 20. The inhaler can still be operated, however, at least for a certain number of draws or inhalations, because a sufficient quantity of liquid material 17 has been temporarily stored in the extended capillary-gap system 16. The wicks are not at risk of drying out unless all capillary-gap sections 16a, 16b, 16c are completely empty. At this point in time, at the latest, the inhaler component 2 must be rotated back into a normal position for use, so that the capillary gap 16 can fill with the liquid material 17 again, which process takes only a few seconds, however.

Finally, another nicotine-containing preparation of the liquid material 17, which was evaporated in prototypes, will be disclosed, by way of example (see table 1). The condensation aerosol that is formed and administered in this case was very similar to the smoke of a conventional cigarette with regard to the pharmacological, pharmacokinetic, and organoleptic effects. All the ingredients listed are also found in cigarette smoke.

Table 1:

Substance name	CAS number	Mass percentage
Water	7732-18-5	52.88
Ethanol	64-17-5	4.14
Glycerol (E422)	56-81-5	40.04
Nicotine	54-11-5	1.33
Lactic acid (E270)	50-21-5	0.33

Substance name	CAS number	Mass percentage
Succinic acid (E363)	110-15-6	0.33
Benzoic acid (E210)	65-85-0	0.24
Acetic acid (E260)	64-19-7	0.71
	Sum:	100.00

It should also be noted that the invention is not limited, of course, to one or more planar composite structures 10 according to the exemplary embodiment just described. Alternatively, the composite structures can also be designed so as to be linear or filamentary. Furthermore, the composite structures can be electrically interconnected in any manner. Finally, the invention also comprises devices, in which the liquid container 18 is disposed so as to be separable from the housing 3, so that the liquid container 18 can be replaced by a new liquid container as soon as it is empty.

List of reference numbers

1 reusable inhaler part

2 replaceable inhaler component

3 housing

3a housing wall

4 mouthpiece

5 main housing

6 battery

7 electrical circuit

7a switch

8a plug-in tabs

8b plug-in sockets

9a
guide projections

9b
guide grooves

10
planar composite structures

10a, 10b
end portions of the composite structures

11
carrier plate, printed circuit board, multilayer printed circuit board

11a
front face of the printed circuit board

11b
rear face of the printed circuit board

11c
edge of the printed circuit board

12
recess

13
conductive tracks

14
top part

15
recess

16
capillary gap, capillary-gap system

16a
first capillary-gap portion

16b
second capillary-gap portion

16c
third capillary-gap portion

17
liquid material

18
liquid container

18a
liquid-container wall

19

spacer

20

supply opening

21

shoulder

22

web

23

ventilation opening

24

ventilation groove

25a, 25b

open-pore, absorbent sponges

26

chamber

27

U-shaped carrier

27a, 27b

angle sections

27c

leg

28

recess

29

air nozzle

30

intake snorkel

31

hole

32

flow throttle

33

plenum chamber

34

cooler

35

air cushion

INHALÁTOR ALKATRÉSZ

SZABADALMI IGÉNYPONTOK

1. Inhalátor alkatrész gőz-levegő vagy/és kondenzációs aerosol képzésére folyékony anyag (17) elgőzölögtetésére, és adott esetben képződött gőz kondenzálására, amely tartalmaz:
   egy házat (3);
   egy elektromos fűtőelemet a folyékony anyag egy részének elgőzölögtetésére;
   egy kapilláris szerkezetű kanócot, ami a fűtőelemmel egy egységet (10) képez, és a fűtőelemet önállóan ellátja a folyékony anyaggal (17);
   egy hordozó lemezt (11), célszerűen vezetőlemezt, ami tartja az egységet (10), és amivel a fűtőelem elektromosan érintkezik;
   egy, legalább a hordozó lemez (11) egy részén kialakított kapilláris rést (16), ami az egységet (10) önállóan ellátja a folyékony anyaggal (17), ahol a kanóc vége benyúlik a kapilláris résbe (16);
   azzal jellemezve, hogy a hordozó lemeznek (11) mind az elülső oldala (11a), mind a hátulsó oldala (11b) legalább szakaszonként a kapilláris rés (16) határoló falait képezik.
2. Az 1. igénypont szerinti inhalátor alkatrész, **azzal jellemezve,** hogy a hordozó lemez pereme (11c) is legalább szakaszonként a kapilláris rés (16) határoló falait képezi.
3. A 2. igénypont szerinti inhalátor alkatrész, **azzal jellemezve,** hogy a hordozó lemez (11) a kapilláris rést (16) legalább részben körülveszi.
4. Az 1 – 3. igénypontok bármelyike szerinti inhalátor alkatrész, **azzal jellemezve,** hogy a hordozó lemez felületének 50%-nál nagyobb része a kapilláris rés (16) határoló falait képezi.
5. Az 1 – 4. igénypontok bármelyike szerinti inhalátor alkatrész, **azzal jellemezve,** hogy a kapilláris rést (16) legalább szakaszonként a hordozó lemez (11) és a ház (3) egy szomszédos fala (3a) képezi.
6. Az 1 – 5. igénypontok bármelyike szerinti inhalátor alkatrész, **azzal jellemezve,** hogy van egy, a folyékony anyagot (17) tartalmazó a folyadéktartály (18) egy szomszédos fala (18a) kiszívja, **azzal jellemezve,** hogy a kapilláris rést (16) legalább szakaszonként a hordozó lemez (11) és a folyadéktartály (18) egy szomszédos fala (18a) képezi.
7. A 6. igénypont szerinti inhalátor alkatrész, **azzal jellemezve,** hogy a kapilláris rés (16) a folyadéktartály (18) falában (18a) lévő tápnyíláson (20) keresztül van a folyadéktartályban (18) lévő folyékony anyaggal (17) kapcsolatban, ahol a folyadéktartály (18) fala (18a) a tápnyílás (20) peremén egy nyúlványt (21) képez, amin a hordozó lemez (11) peremével (11c) felütközik.
8. A 6. igénypont szerinti inhalátor alkatrész, **azzal jellemezve,** hogy a kapilláris rés (16) a folyadéktartály (18) falában (18a) lévő tápnyíláson (20) keresztül van a folyadéktartályban (18) lévő folyékony anyaggal (17) kapcsolatban, ahol a folyadéktartály (18) fala (18a) a tápnyílás (20) peremén egy nyúlványt (21) képez, amin a hordozó lemez (11) elülső vagy hátulsó oldalával (11a, 11b) felütközik.
9. Inhalátor, ami tartalmaz egy, az 1 – 8. igénypontok bármelyike szerinti inhalátor alkatrészt (2).

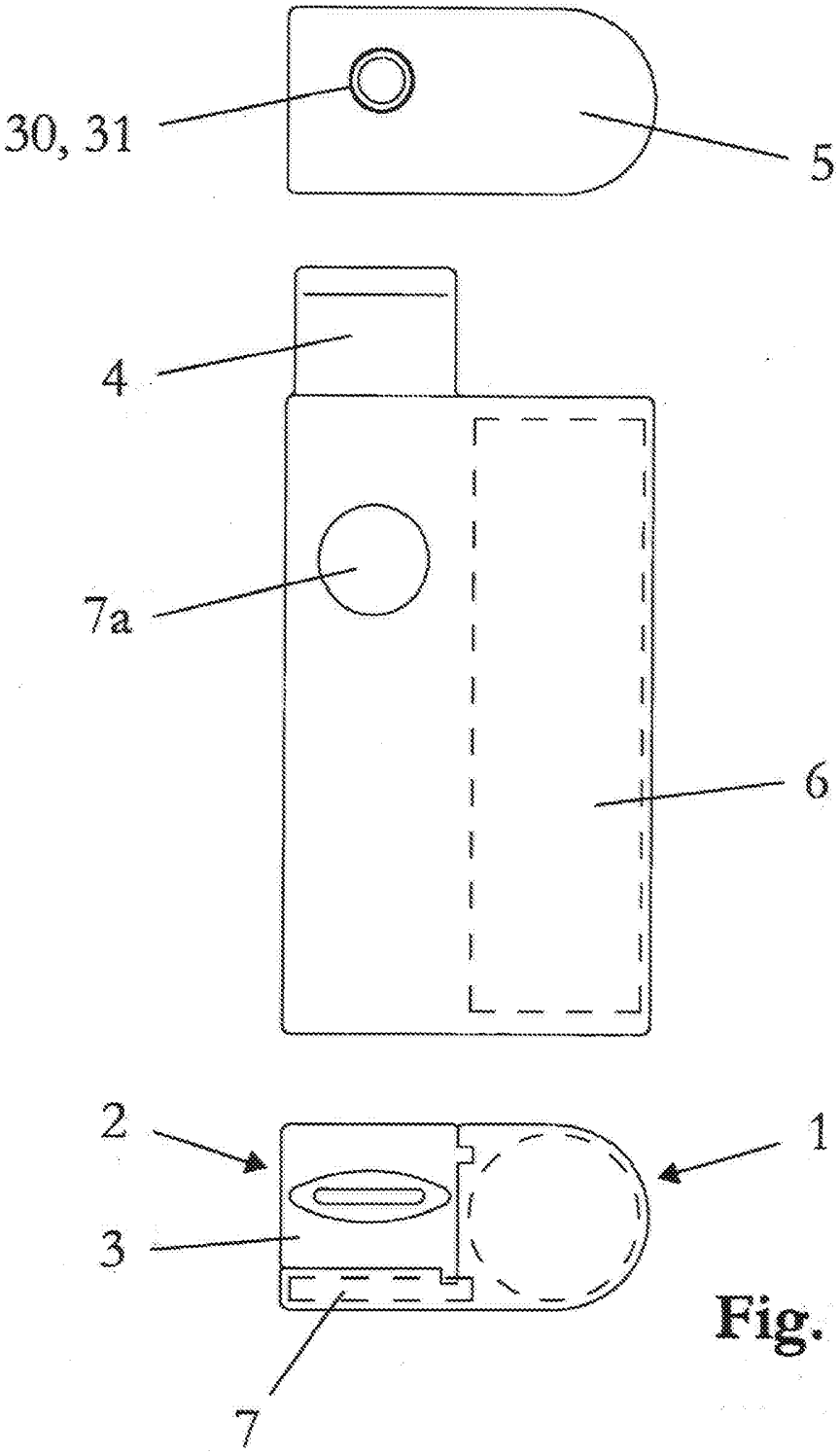


Fig. 1

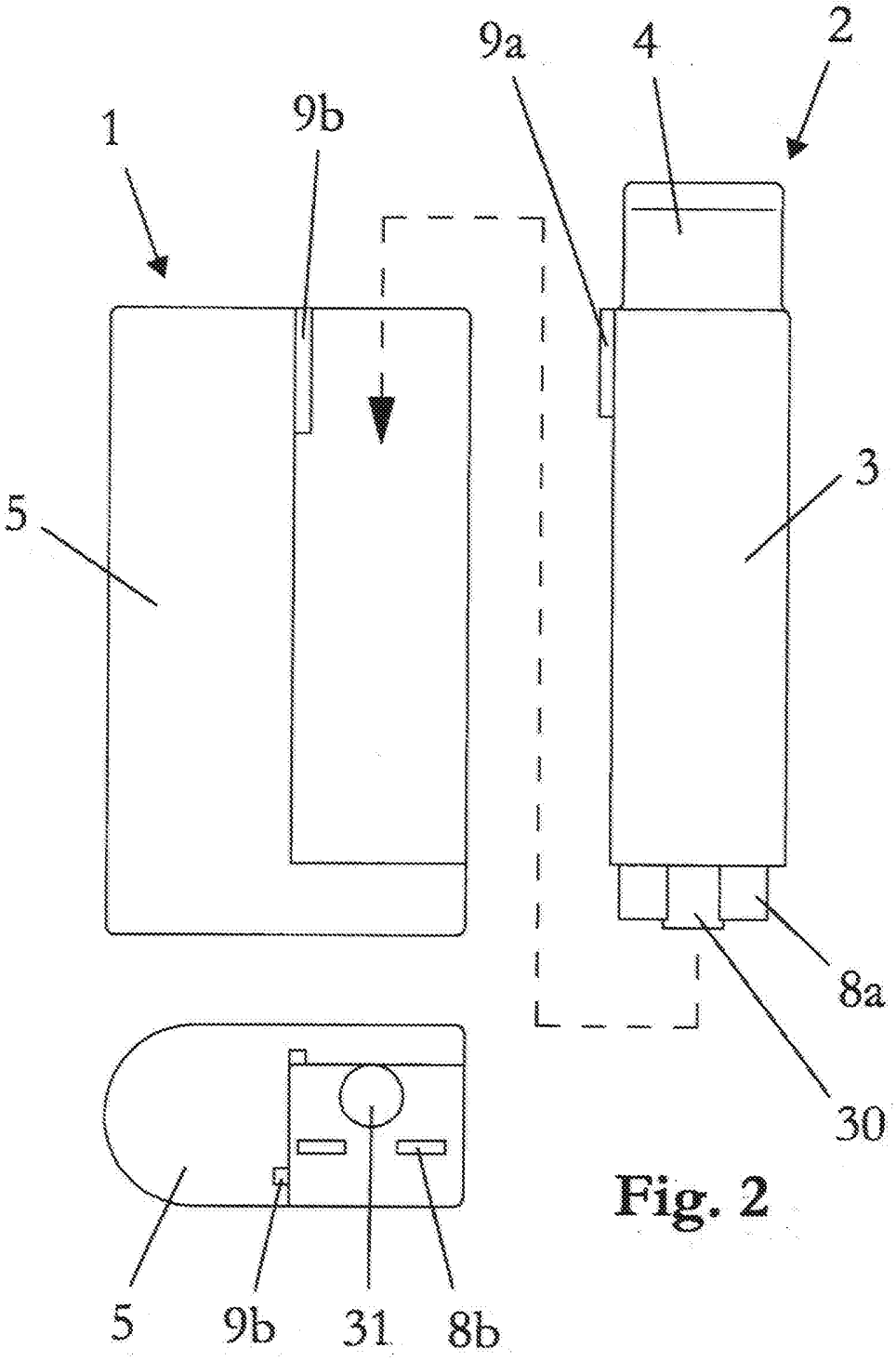


Fig. 2

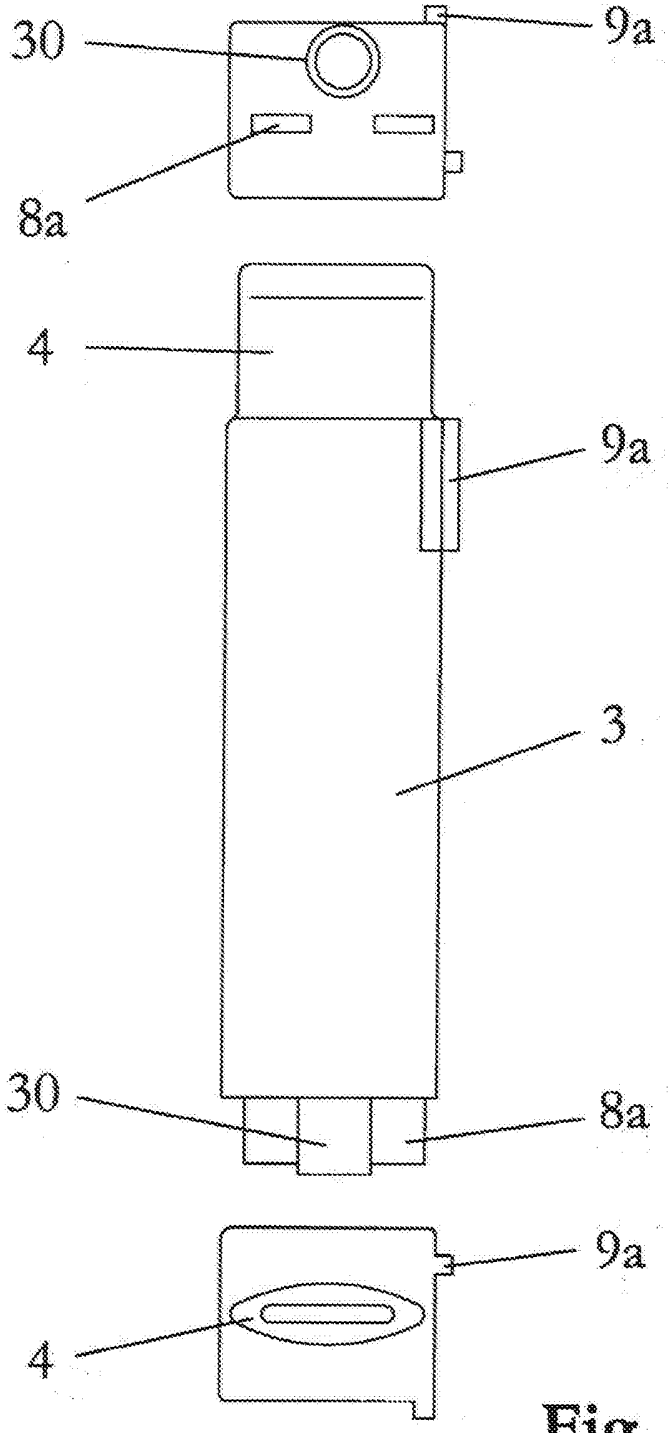
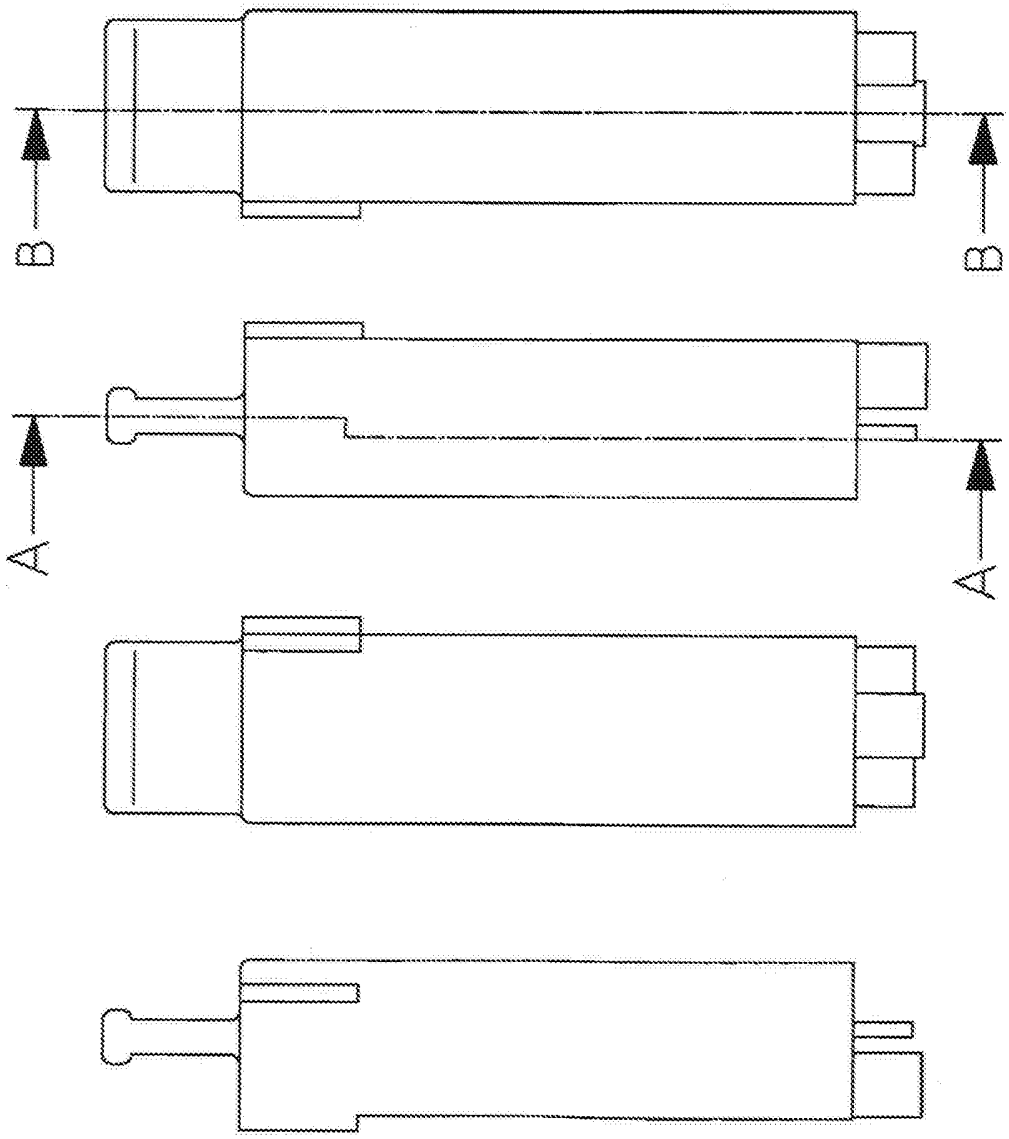


Fig. 3a

Fig. 3b



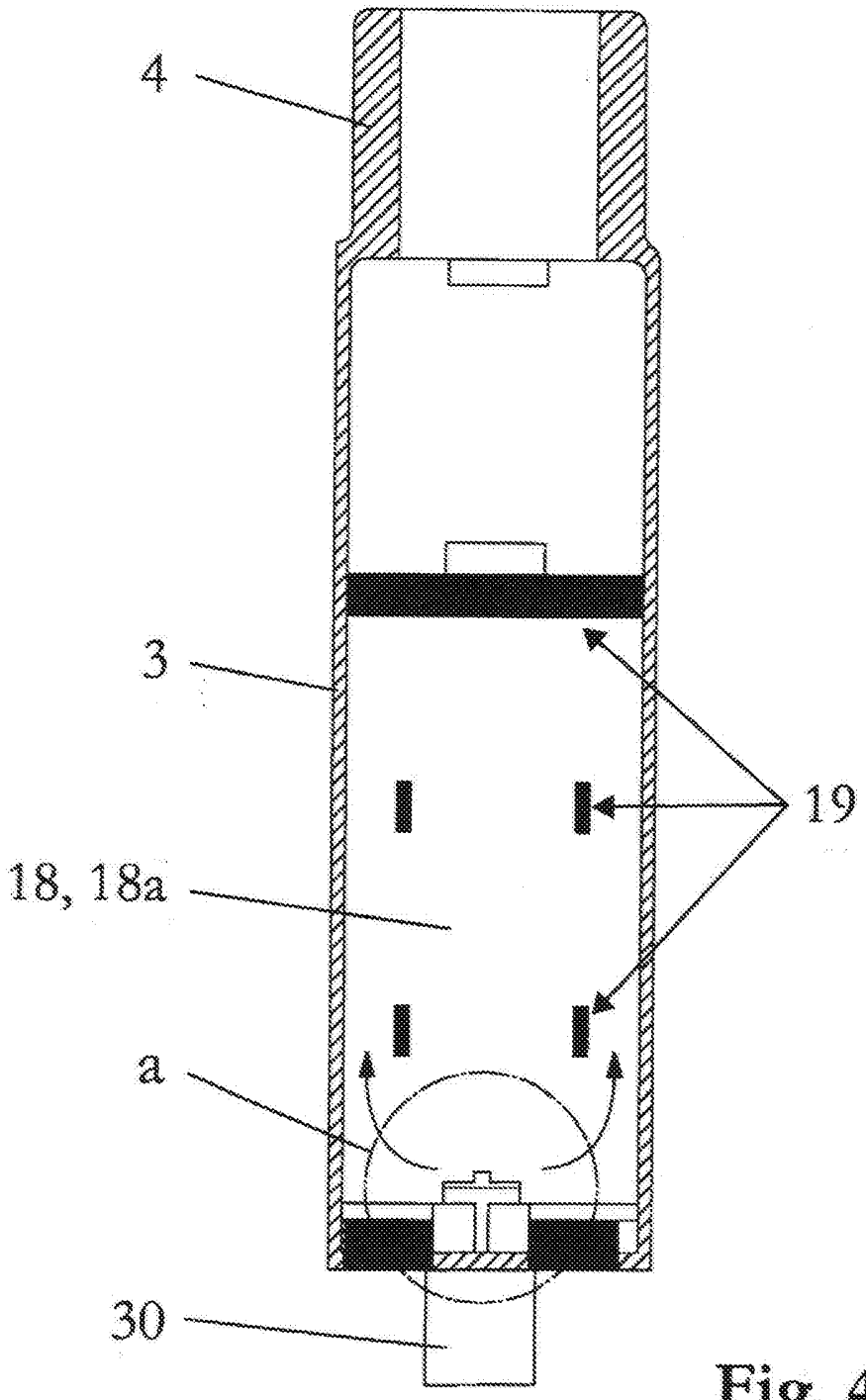


Fig. 4a

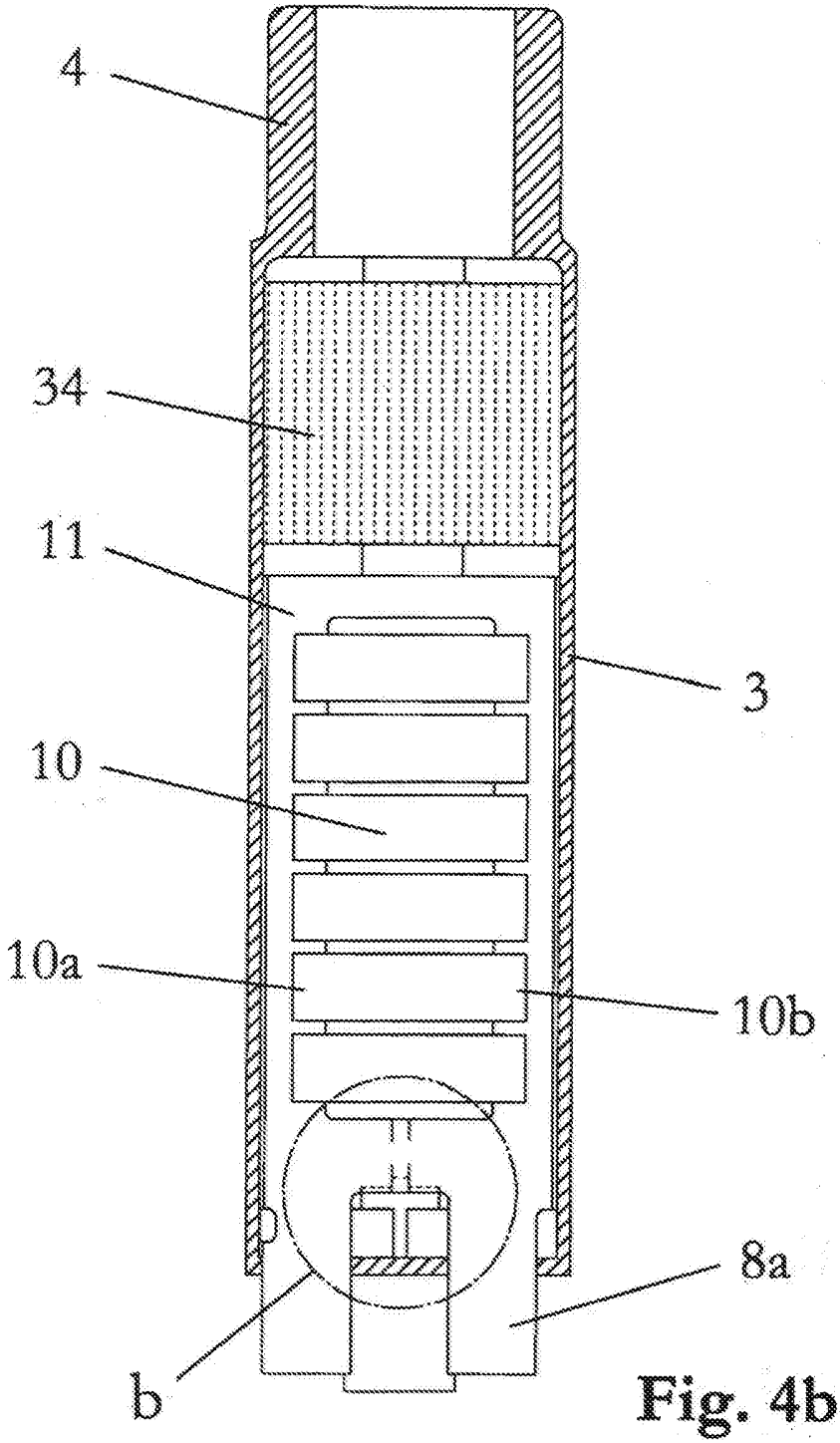


Fig. 4b

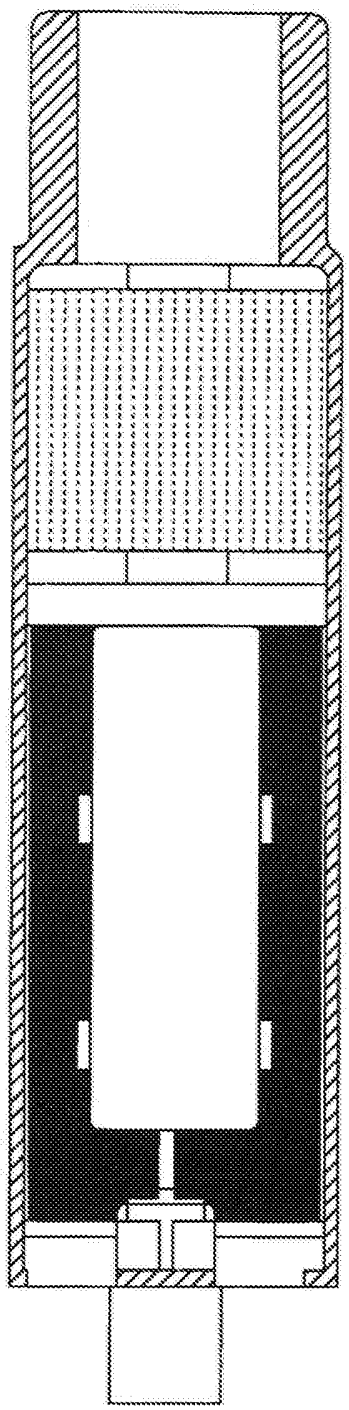


Fig. 4c

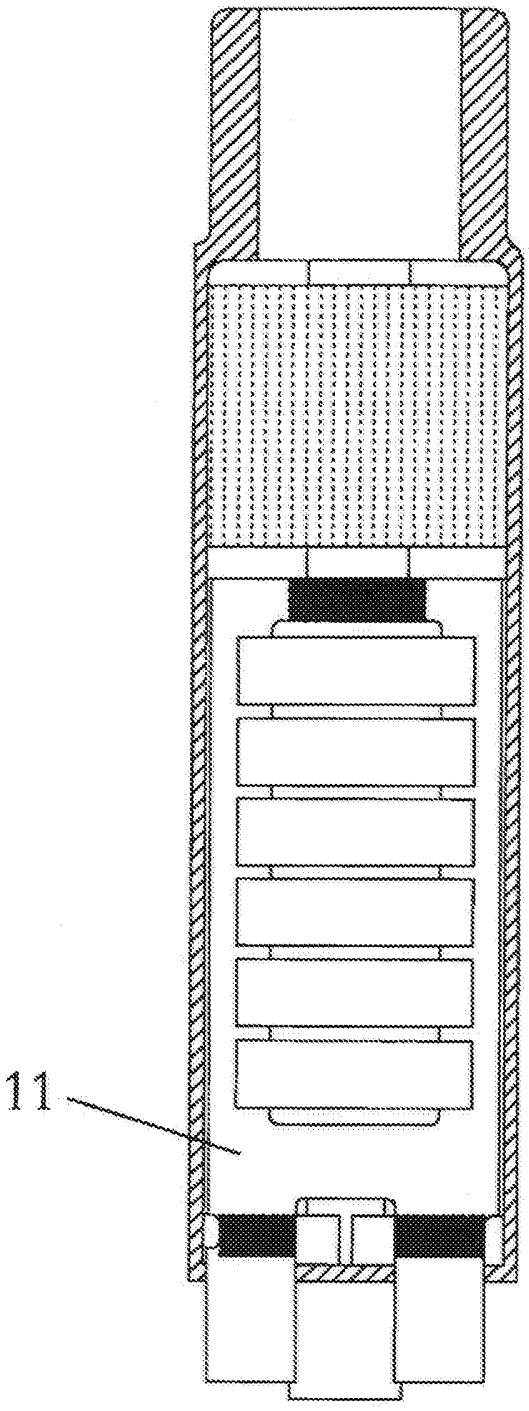


Fig. 4d

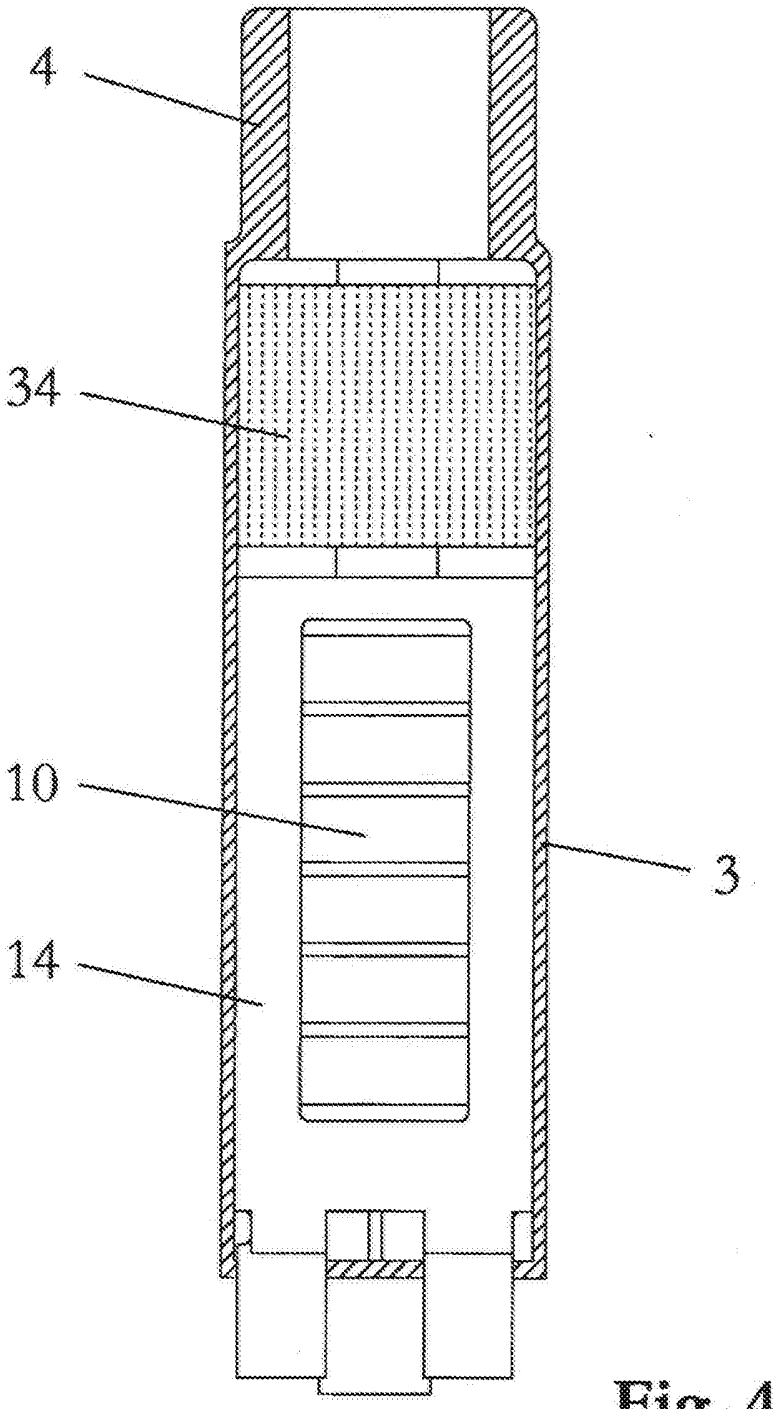


Fig. 4e

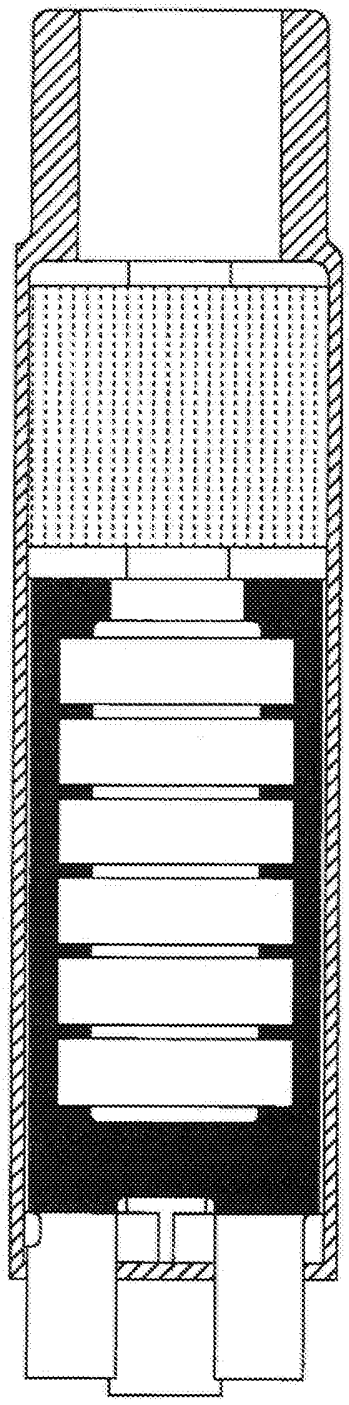


Fig. 4f

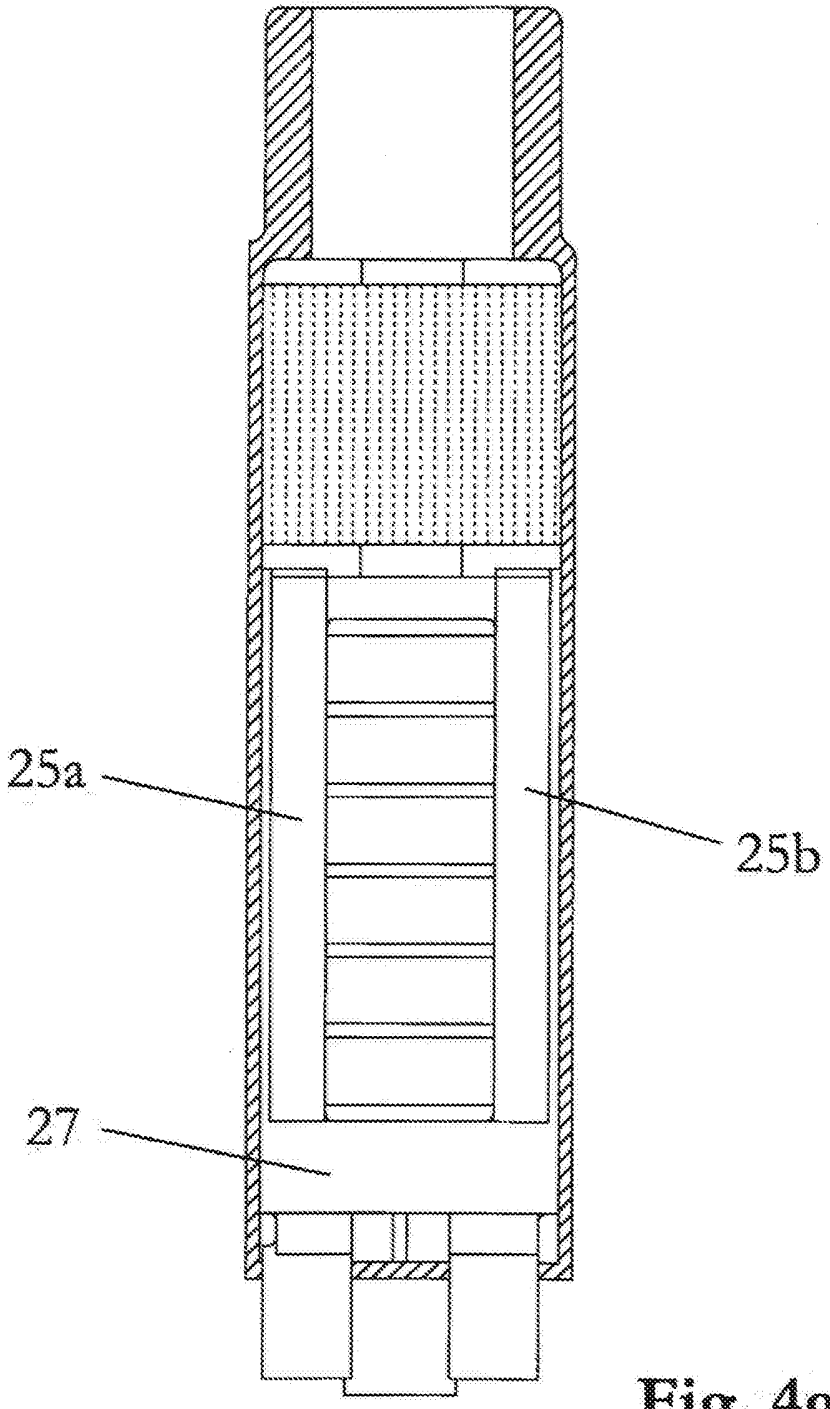


Fig. 4g

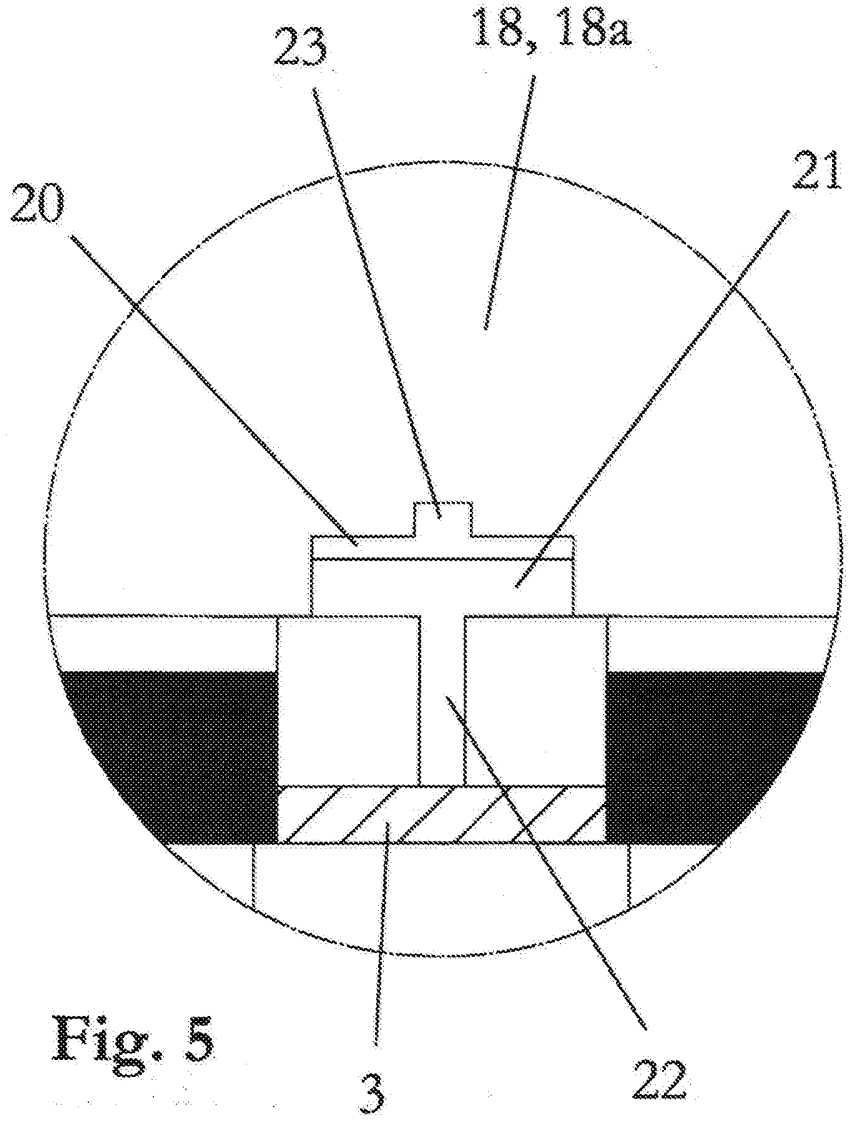


Fig. 5

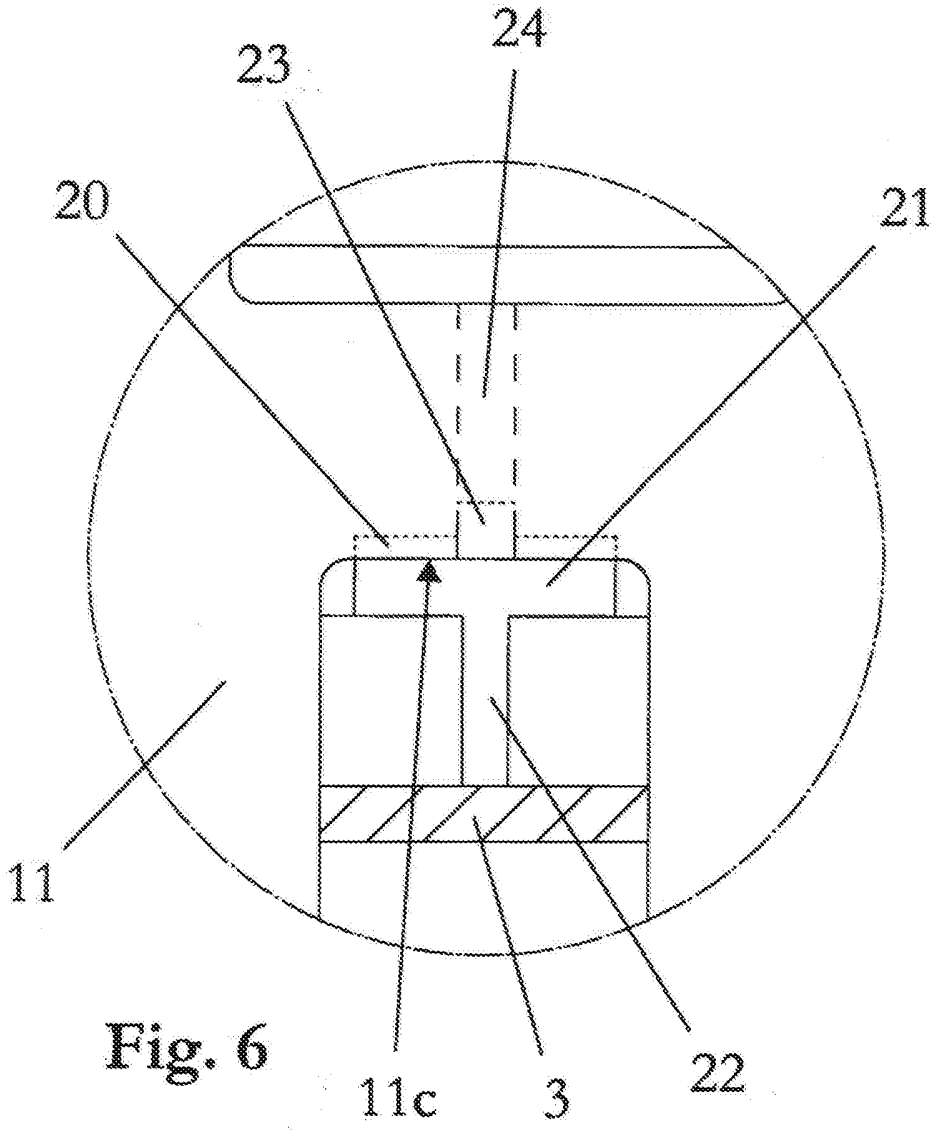


Fig. 6

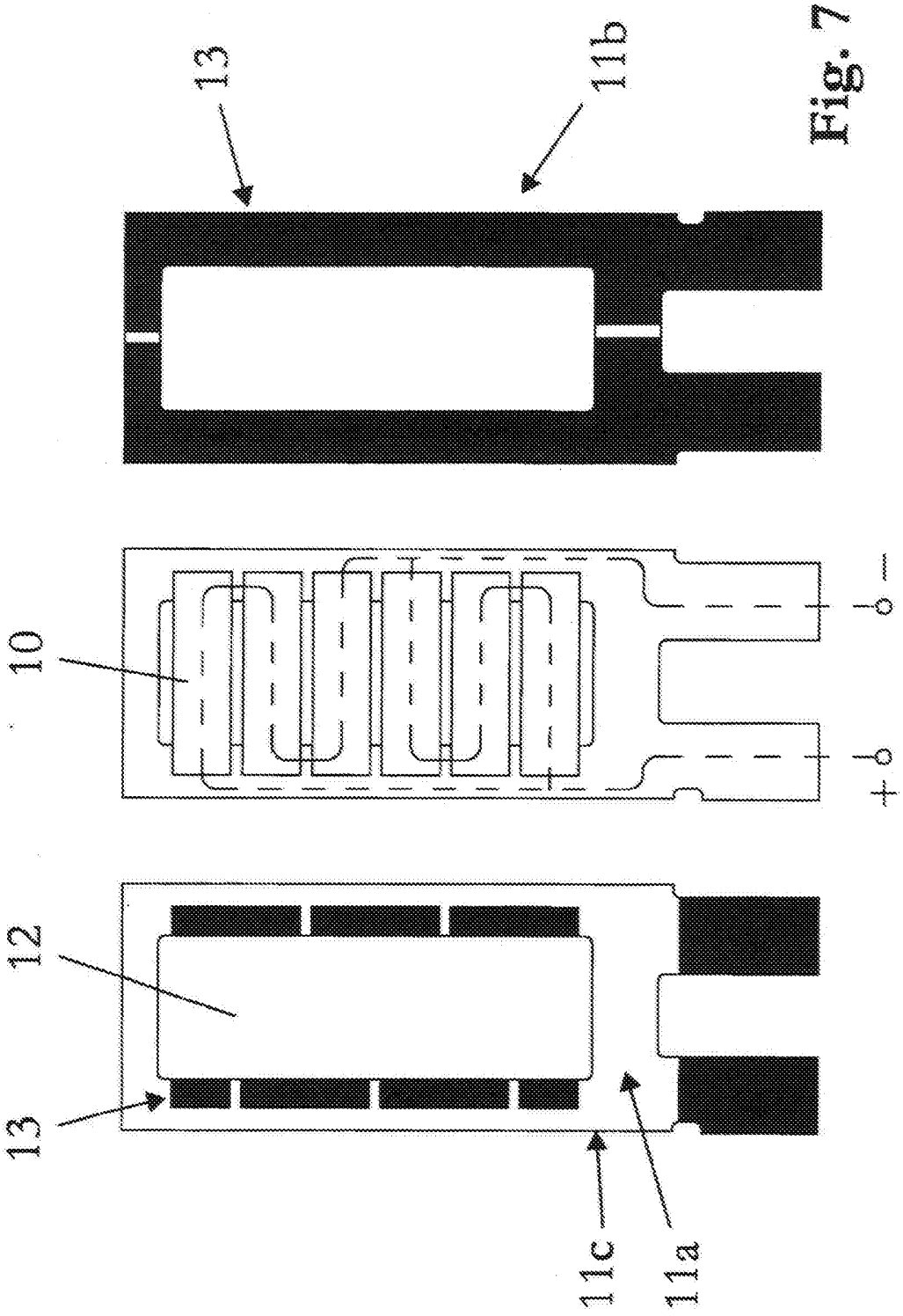


Fig. 7

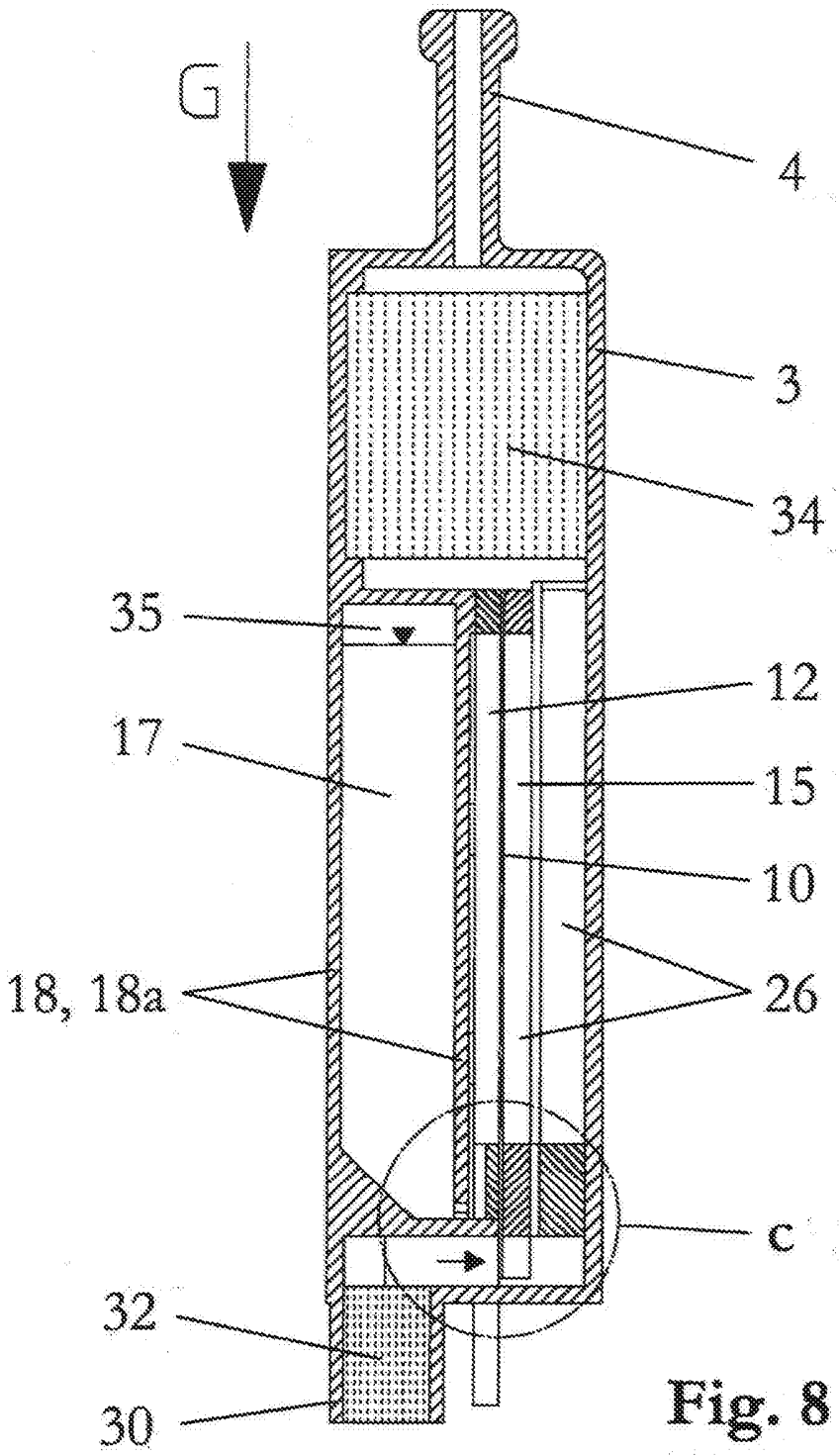


Fig. 8

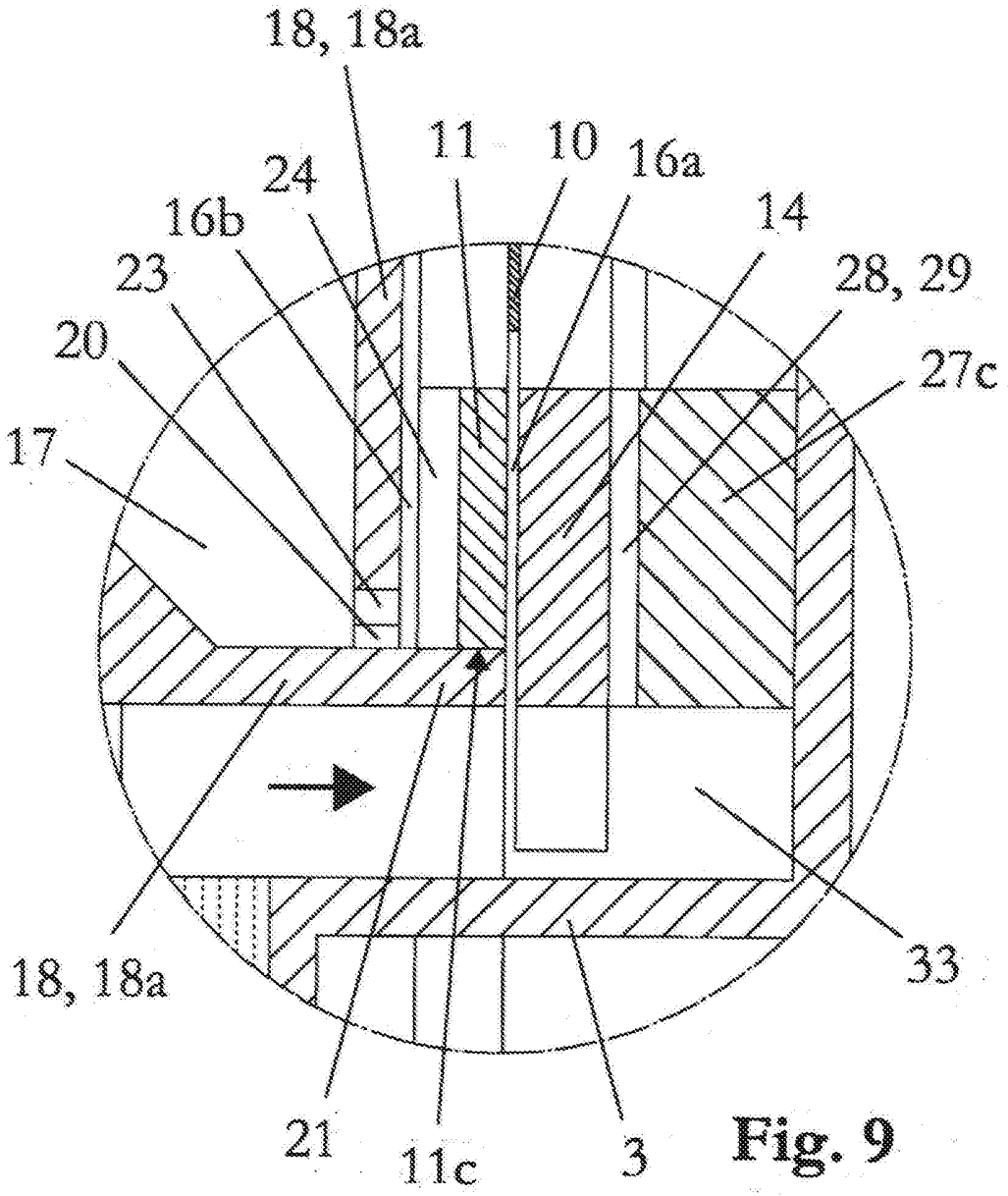


Fig. 9

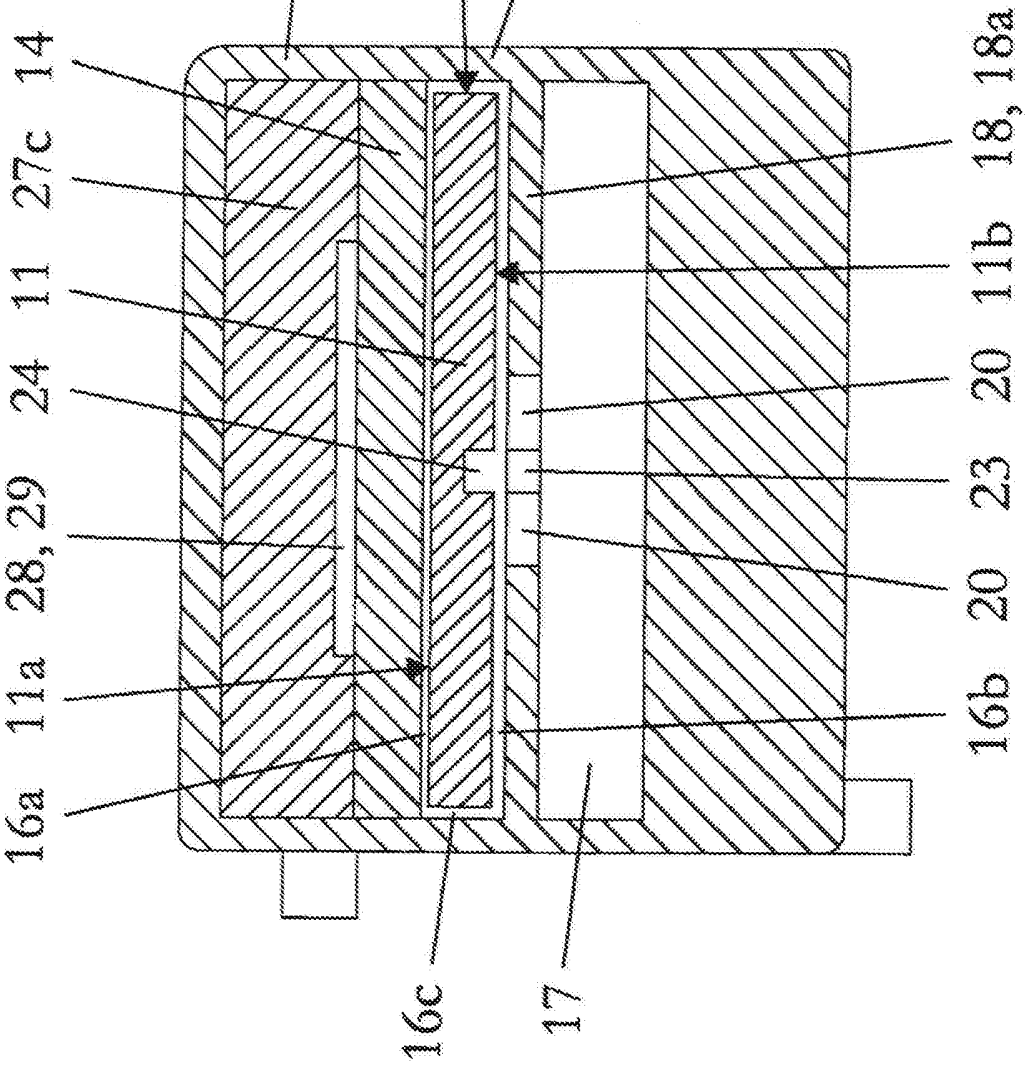


Fig. 10

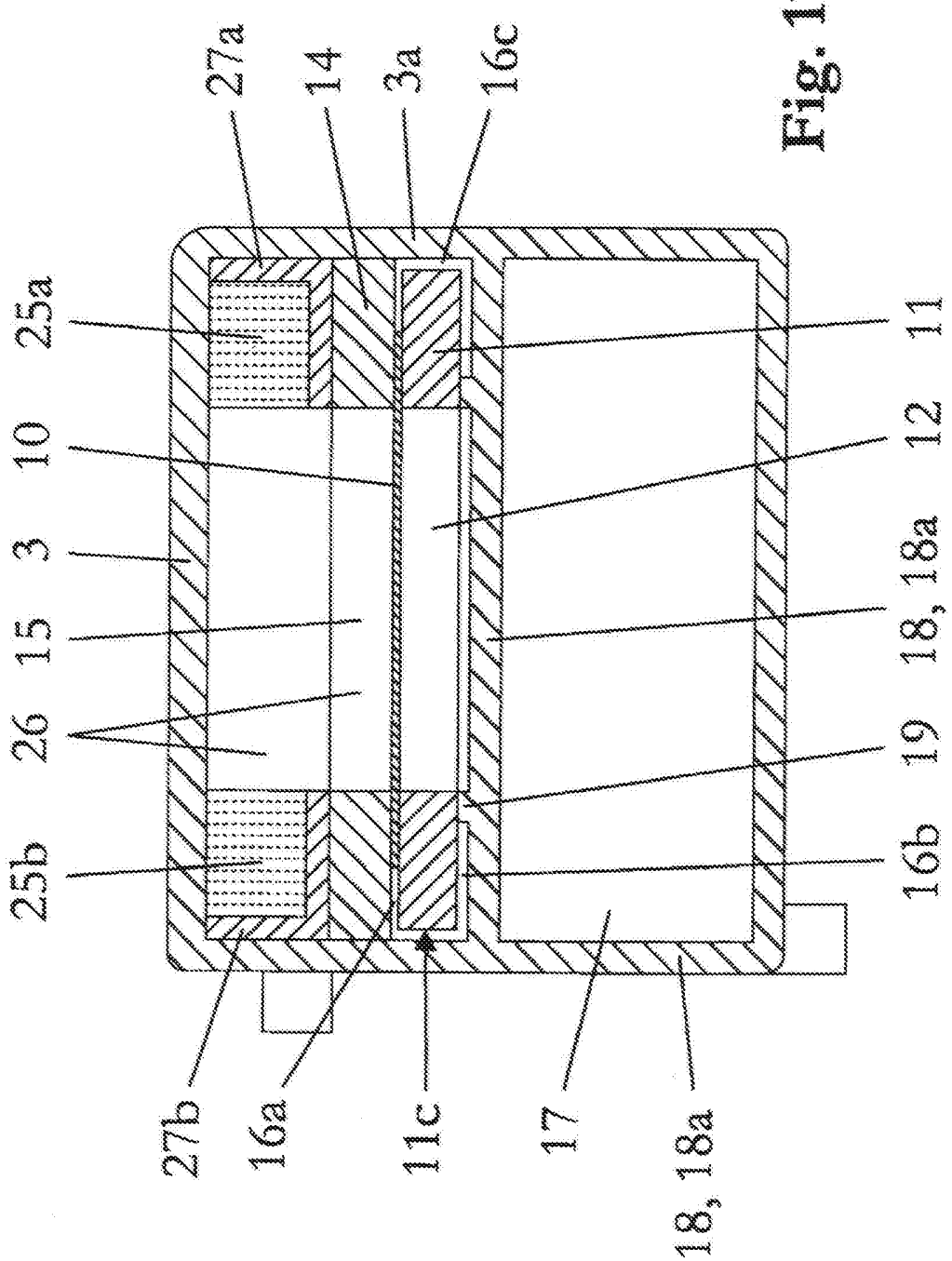

27a
14
3a
16c
25a
10
3
15
26
25b
11
12
18, 18a
19
16b
27b
16a
11c
17
18, 18a

Fig. 11

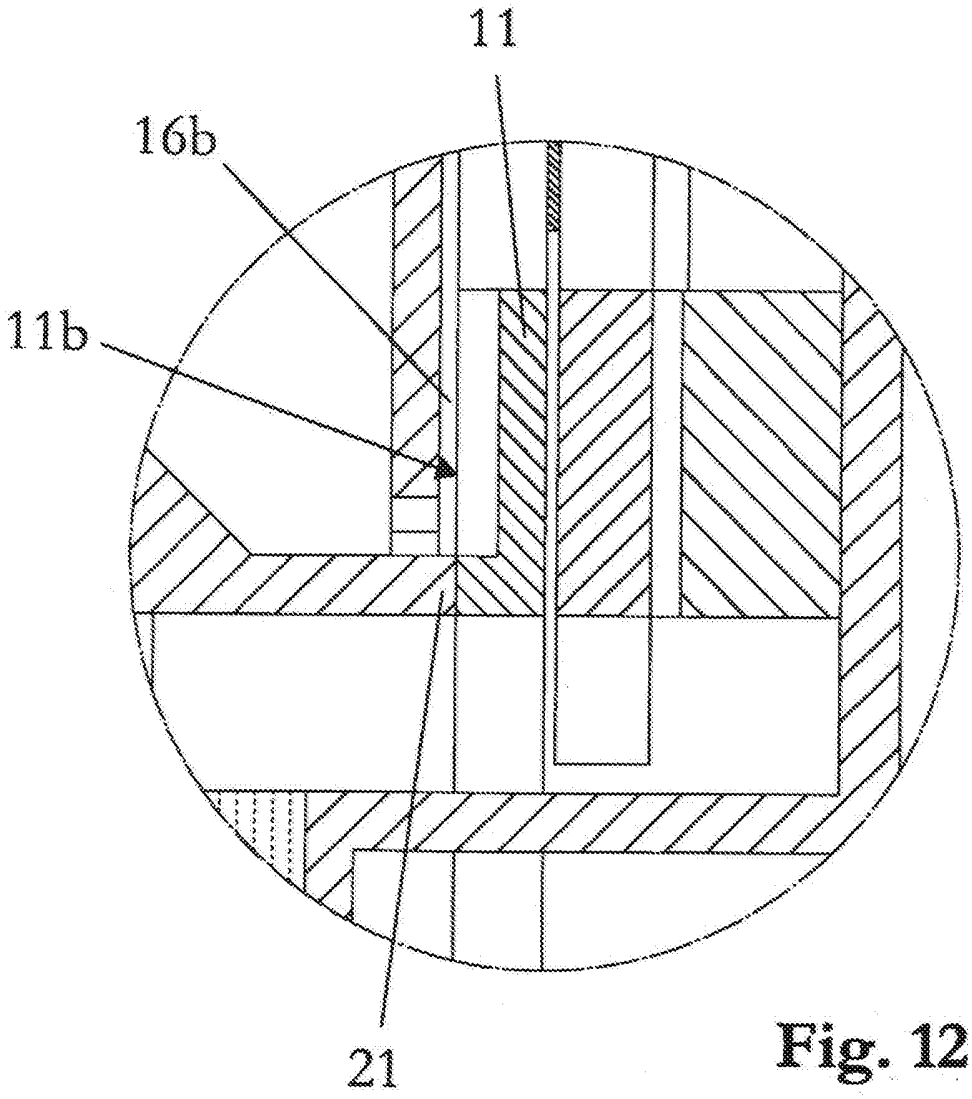


Fig. 12