

(19)



(11)

**EP 4 563 017 A1**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**04.06.2025 Bulletin 2025/23**

(51) International Patent Classification (IPC):  
**A24F 40/40** <sup>(2020.01)</sup> **A24F 40/20** <sup>(2020.01)</sup>

(21) Application number: **23213517.8**

(52) Cooperative Patent Classification (CPC):  
**A24F 40/40; A24F 40/20**

(22) Date of filing: **30.11.2023**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB  
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL  
NO PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA**  
Designated Validation States:  
**KH MA MD TN**

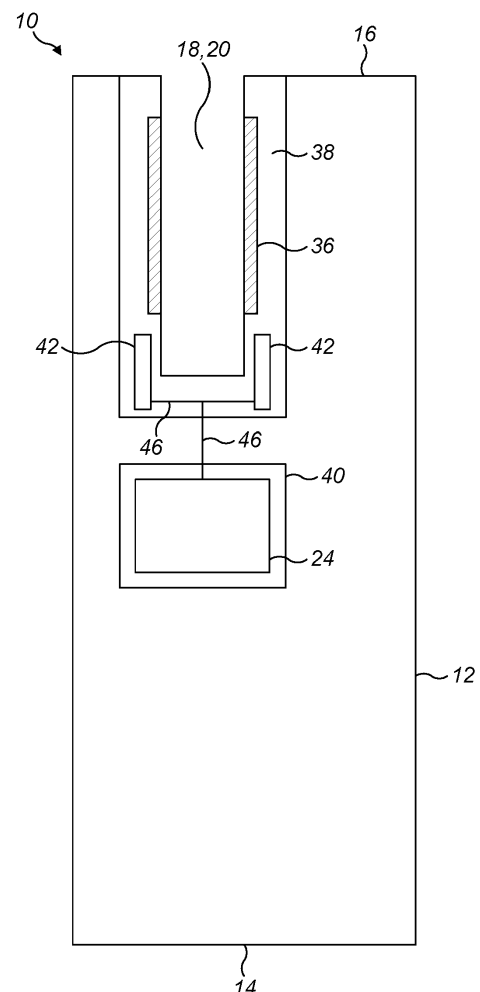
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**(54) AEROSOL GENERATING DEVICE**

(57) An aerosol generating device (10) is described. The aerosol generating device includes an outer housing (12). A heater (36) is located within the outer housing (12) and is adapted to heat aerosol generating material. A first air insulating space (38) is provided adjacent the heater (36). A separate second air insulating space (40) is provided within the outer housing (12). A solid-state energy storage device (42) is located in the first air insulating space (38). A control component (24) is located in the second air insulating space (40). The solid-state storage device (42) and the control component (24) are electrically connected by a flexible printed circuit board (46).

**FIG. 2****EP 4 563 017 A1**

## Description

### Technical Field

[0001] The present disclosure relates generally to an aerosol generating device, and in particular to a device that is configured to heat aerosol generating material to generate an aerosol for inhalation by a user. The present disclosure is particularly applicable to a portable (hand-held) aerosol generating device. The aerosol generating material may be part of an aerosol generating article that may be received in the device in use.

### Technical Background

[0002] Devices which heat, rather than burn, an aerosol generating material to produce an aerosol for inhalation have become popular with consumers in recent years. A commonly available reduced-risk or modified-risk device is the heated material aerosol generating device, or so-called heat-not-burn device. Devices of this type generate an aerosol or vapour by heating an aerosol generating material to a temperature typically in the range 150°C to 300°C. This temperature range is quite low compared to an ordinary cigarette. Heating the aerosol generating material to a temperature within this range, without burning or combusting the aerosol generating material, generates a vapour which typically cools and condenses to form an aerosol for inhalation by a user of the device.

[0003] It is known for such aerosol generating devices to include one or more air insulating spaces or layers of suitable insulating material as thermal insulation between the heater of the aerosol generating device and the outer housing or other heat-sensitive components such as energy storage devices or control components, for example. The air insulating spaces or insulating material takes up valuable space within the outer housing.

[0004] Solid-state energy storage devices (e.g., solid-state batteries) use solid electrodes and a solid electrolyte. Solid-state energy storage devices may typically tolerate higher external temperatures and have a higher thermal stability than conventional energy storage devices that use a liquid electrolyte instead of the solid electrolyte. The construction of solid-state energy storage devices may also allow them to act as thermal insulators.

### Summary of the Disclosure

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

- an outer housing (or main body);
- a heater located within the outer housing and adapted to heat aerosol generating material;
- a first air insulating space adjacent the heater;

a second air insulating space within the outer housing that is separate from the first insulating space; a solid-state energy storage device located in the first air insulating space; and a control component located in the second air insulating space.

[0006] The term "solid-state energy storage device" as used herein includes a semi-solid-state energy storage device that may use a combination of solid and liquid electrolyte (e.g., a gel-like electrolyte) and an all-solid-state energy storage device that may use only a solid electrolyte.

[0007] The aerosol generating device may further comprise a second energy storage device that may be the main power source for the aerosol generating device, e.g., it may have a larger energy storage capacity than the solid-state energy storage device. The second energy storage device may be a rechargeable Lithium-ion secondary battery, for example.

[0008] The solid-state energy storage device (e.g., a rechargeable solid-state battery) may have any suitable solid-state construction, e.g., with solid-state electrodes and a solid-state electrolyte or a combination of solid and liquid electrolyte. In one arrangement, the solid-state energy storage device is an all-solid-state energy storage device.

[0009] The solid-state energy storage device has high tolerance to the heat generated by the heater when heating the aerosol generating material. The solid-state energy storage device does not normally need to be thermally insulated from the heater, although in some cases, a small amount of insulating material may still be located between the heater and the solid-state energy storage device. Part of the volume of the air insulating space or insulating material that would normally be located between the heater and the outer housing in a known aerosol generating device may effectively be replaced by the solid-state energy storage device. This means that some of the thermal insulation within the outer housing of the aerosol generating device is replaced with additional energy storage capacity and the physical size and energy storage capacity of the second energy storage device may be reduced. This may result in a reduction in the overall size and weight of the aerosol generating device. Physically positioning the solid-state energy storage device close to the heater between the heater and the outer housing also means that the outer housing is at least partially thermally insulated from the heat generated by the heater by the solid-state energy storage device. The solid-state energy storage device may also thermally insulate other components that are located within the outer housing - i.e., where the solid-state energy storage device is positioned between the heater and the other components.

[0010] The heater may be adapted to heat aerosol generating material provided as part of an aerosol generating article. The aerosol generating article may be

adapted to be received in a heating chamber of the aerosol generating device. The heater may extend along one or more sides of the heating chamber or may extend substantially around the heating chamber so that it may heat the aerosol generating material when the aerosol generating article is received in the heating chamber.

**[0011]** The first air insulating space may be between the heater and the outer housing, e.g., positioned between the heater and a facing part of the outer housing such as a side wall and/or an end wall. The first air insulating space may extend along one or more sides of the heater or may extend substantially around the heater - i.e., so that it is located radially between the heater and a facing side part of the outer housing. The first air insulating space may be annular or cup-shaped, for example.

**[0012]** The solid-state energy storage device may also extend along one or more sides of the heater or may extend substantially around the heater.

**[0013]** The heater may be a resistive heater. The heater may be physically integrated with the solid-state energy storage device. The heater may be formed on a surface of the solid-state energy storage device, e.g., as one or more printed electrical tracks. The heater may also be formed as a separate component or layer and then physically integrated with the solid-state energy storage device. Using an integrated solid-state energy storage device and heater may provide structural benefits such as minimising the electrical contact between the components and simplify the assembly of the aerosol generating device, for example.

**[0014]** The solid-state energy storage device may comprise a plurality of solid-state energy storage device units (e.g., rechargeable solid-state battery units). The heater may comprise a plurality of heater units, each heater unit being physically integrated with a respective solid-state energy storage device unit. Each heater unit may be formed on a surface of a respective solid-state energy storage device unit, e.g., as one or more printed electrical tracks, or formed as a separate component or layer and then physically integrated with the respective solid-state energy storage device unit. Each heater unit may be a resistive heater unit. Each integrated heater unit/solid-state energy storage unit (or "assembly") may further comprise an optional air insulating space or air gaps between the heater unit and the solid-state energy storage device unit, which optional air insulating space may also incorporate one or more mechanical supports. Using one or more integrated assemblies may allow for more flexibility when positioning the solid-state energy storage device and the heater within the outer housing of the aerosol generating device.

**[0015]** The plurality of heater units (or assemblies) may be arranged to define a pair of planar heaters, which planar heaters may be arranged on opposite sides of a heating chamber and would be suitable for heating a flat-format aerosol generating article, for example. The plurality of heater units (or assemblies) may also be arranged

to define four or more planar heaters, which planar heaters may be arranged circumferentially around a heating chamber and would be suitable for heating a cylindrical or cuboid-shaped aerosol generating article, for example.

Each planar heater may comprise two or more heater units (or assemblies) arranged side-by-side or in an array, for example.

**[0016]** The aerosol generating device may further comprise a switching circuit adapted to configure how the plurality of solid-state energy storage device units are electrically connected to the heater depending on operating requirements during a discharging mode of the aerosol generating device. In particular, the switching circuit may be used to control how many of the solid-state energy storage device units are electrically connected together or are electrically disconnected, and whether they are electrically connected in series and/or parallel. The switching circuit may be part of the control component. The switching circuit may be a switch matrix, for example. In case of a low power demand, some of the solid-state energy storage devices units may be disconnected and in case of a high power demand all of the solid-state energy storage device units may be connected in parallel or in series-parallel, for example. For charging, it is preferred that all of the solid-state energy storage device units are electrically connected in parallel for voltage balancing and may be charged from an external power source by the same charging circuit (e.g., a battery charger integrated circuit (IC)) provided as part of the aerosol generating device.

**[0017]** The control component may further comprise a printed circuit board assembly (PCBA) with a printed circuit board (PCB) and one or more electronic components such as the above-mentioned battery charger IC, microcontroller unit (MCU) etc. The PCB of the PCBA may be a rigid PCB.

**[0018]** The solid-state energy storage device may be electrically connected to the control component (e.g., to the PCBA) by a flexible PCB (or flexible printed circuit (FPC)) that uses a flexible dielectric substrate or base material that may be bent or twisted without damaging the printed circuit. The flexible PCB therefore provides an electrical connection between the solid-state energy storage device, which is located in the first air insulating space, and the control component, which is located in the separate second air insulating space that is preferably spaced apart from the heater. In an alternative arrangement, the solid-state energy storage device and the control component may be electrically connected by one or more wires. The first and second air insulating spaces are preferably spaced apart within the outer housing of the aerosol generating device and the flexible PCB or the one or more wires extend through the outer housing to provide the electrical connection between the solid state energy storage device and the control component. The flexible PCB may also provide an electrical connection with the heater and/or with other components located within the outer housing such as one or more

temperature sensors, for example.

**[0019]** The flexible PCB may be single-sided with a conductive layer on one side of the flexible substrate or base layer, or double-sided with a first conductive layer on one side of the flexible substrate or base layer and a second conductive layer on the other side of the flexible substrate or base layer. The flexible PCB may be multi-layer with multiple conductive layers. The flexible PCB will typically also include one or more protective cover-layers (or cover layers) and adhesive layers.

**[0020]** Each conductive layer will define a pattern of conductive pathways or traces to which the one or more electronic components may be electrically connected, e.g., using solder.

**[0021]** Electrical connections to and between the conductive layer(s) may be facilitated by plated through holes or vias, for example.

**[0022]** The solid-state energy storage device may be mounted directly on the flexible PCB. For example, the terminals of the solid-state energy storage device may be soldered directly to one or more conductive layers of the flexible PCB.

**[0023]** The solid-state energy storage device may also be removably mounted to the flexible PCB. For example, the flexible PCB may comprise a mounting means such as one or more magnets that are adapted to removably or releasably mount the solid-state energy storage device in such a way that the terminals of the solid-state energy storage device are electrically connected to one or more conductive layers of the flexible PCB. Using such a mounting means may make it easier to assemble the aerosol generating device. It may also make it possible to remove the solid-state energy storage device if it is faulty or reaches the end of its normal operating lifetime.

**[0024]** The flexible PCB may comprise a first conductive layer on one side of the flexible substrate or base layer and a second conductive layer on the other side of the flexible substrate or base layer. The solid-state energy storage device may comprise a first terminal (e.g., a positive terminal) and a second terminal (e.g., a negative terminal). The first terminal may be electrically connected to the first conductive layer and the second terminal may be electrically connected to the second conductive layer.

**[0025]** One or more electronic components may be mounted directly on the flexible PCB. For example, the terminals of the one or more electronic components may be soldered directly to one or more conductive layers of the flexible PCB.

**[0026]** The solid-state energy storage device may be mounted on a first side of the flexible PCB and one or more electronic components may be mounted on a second side of the flexible PCB.

**[0027]** The solid-state energy storage device may comprise a plurality of solid-state energy storage device units. In one arrangement, the solid-state energy storage device units may be mounted on both sides of the flexible PCB. In another arrangement, the solid-state energy storage device units may be mounted only on one side

of the flexible PCB - i.e., no solid-state energy storage device units are mounted on the other side of the flexible PCB. The one or more electronic components may be mounted on both sides of the flexible PCB or only on one side of the flexible PCB. For example, one side of the flexible PCB may have only solid-state energy storage device units mounted to it and the other side may have only one or more electronic components mounted to it. In this arrangement, there are no electronic components mounted on the same side of the flexible PCB as the solid-state energy storage device units. The particular arrangement or positioning of solid-state energy storage device units and other electronic components may depend on the circumstances and the design of the aerosol generating device.

**[0028]** The aerosol generating device may further comprise a temperature sensor mounted directly on the flexible PCB and adapted to measure a temperature of the solid-state energy storage device. Mounting the temperature sensor on the flexible PCB may simplify the structure and assembly of the aerosol generating device.

**[0029]** The heater may be electrically connected to or mounted directly on the flexible PCB. The aerosol generating device may further comprise a temperature sensor adapted to measure a temperature of the heater. The temperature sensor may be mounted directly on the flexible PCB.

**[0030]** According to a second aspect of the present disclosure, there is provided an aerosol generating device comprising:

a plurality of solid-state energy storage device units (e.g., rechargeable solid-state battery units); and  
a plurality of heater units, each heater unit being physically integrated with a respective solid-state energy storage device unit to define an assembly.

**[0031]** Each heater unit may be formed on a surface of the respective solid-state energy storage device unit, e.g., as one or more printed electrical tracks.

**[0032]** The heater units may define a heater located within the outer housing adapted to heat aerosol generating material.

**[0033]** The assemblies may be located in a first air insulating space adjacent a heating chamber of the aerosol generating device. The heating chamber is adapted to receive an aerosol generating article with aerosol generating material. The first air insulating space may extend along one or more sides of the heating chamber or may extend substantially around the heating chamber. A control component may be located in a second air insulating space within the outer housing that is separate from the first air insulating space. The control component may be electrically connected to the solid-state energy storage device units by a flexible PCB.

**[0034]** Other features of the aerosol generating device may be as described above.

**[0035]** As briefly mentioned above, the aerosol gen-

erating material may form part of an aerosol generating article (or "consumable") and may be surrounded by a paper wrapper.

[0036] The aerosol generating article may be formed substantially in the shape of a stick, and may broadly resemble a cigarette, having a tubular region with an aerosol generating material or substrate arranged in a suitable manner. The aerosol generating article may also be formed as a flat-format article. The aerosol generating article may include a filter segment, for example comprising cellulose acetate fibres, at a proximal end of the aerosol generating article. The filter segment may constitute a mouthpiece filter and may be in coaxial alignment with the aerosol generating material. One or more vapour collection regions, cooling regions, and other structures may also be included in some designs. For example, the aerosol generating article may include at least one tubular segment upstream of the filter segment. The tubular segment may act as a vapour cooling region. The vapour cooling region may advantageously allow the heated vapour generated by heating the aerosol generating material to cool and condense to form an aerosol with suitable characteristics for inhalation by a user, for example through the filter segment.

[0037] The aerosol generating material may comprise any type of solid or semi-solid material. Example types of aerosol generating solids include powder, granules, pellets, shreds, strands, particles, gel, strips, loose leaves, cut filler, porous material, foam material or sheets. The aerosol generating material may comprise plant derived material and in particular, may comprise tobacco. It may advantageously comprise reconstituted tobacco, for example including tobacco and any one or more of cellulose fibres, tobacco stalk fibres and inorganic fillers.

[0038] The aerosol generating material may comprise an aerosol-former. Examples of aerosolformers include polyhydric alcohols and mixtures thereof such as glycerine or propylene glycol. Typically, the aerosol generating material may comprise an aerosol-former content of between approximately 5% and approximately 50% on a dry weight basis. In some embodiments, the aerosol generating material may comprise an aerosol-former content of between approximately 10% and approximately 20% on a dry weight basis, and possibly approximately 15% on a dry weight basis.

[0039] The aerosol generating device may be configured to heat the aerosol generating material or substrate, without burning the aerosol generating material, to volatilise at least one component of the aerosol generating material and thereby generate a heated vapour which cools and condenses to form an aerosol for inhalation by a user of the aerosol generating device. The volatile compounds released from the aerosol generating material may include nicotine or flavour compounds such as tobacco flavouring.

[0040] In general terms, a vapour is a substance in the gas phase at a temperature lower than its critical temperature, which means that the vapour may be con-

densed to a liquid by increasing its pressure without reducing the temperature, whereas an aerosol is a suspension of fine solid particles or liquid droplets, in air or another gas. It should, however, be noted that the terms 'aerosol' and 'vapour' may be used interchangeably in this specification, particularly with regard to the form of the inhalable medium that is generated for inhalation by a user.

[0041] The aerosol generating device is typically a hand-held, portable, device.

## Brief Description of the Drawings

### [0042]

Figure 1 is a diagrammatic cross-sectional view of an aerosol generating system comprising an aerosol generating device and an aerosol generating article ready to be positioned in a heating chamber of the aerosol generating device;

Figure 2 is a diagrammatic cross-sectional view of an aerosol generating device with first and second air insulating spaces;

Figures 3A to 3F are diagrammatic cross-section views of solid-state energy storage device units and electronic components mounted on a flexible printed circuit board;

Figure 4 is a diagrammatic cross-section view of an integrated solid-state battery unit and heater unit (or "assembly");

Figure 5 is a diagrammatic perspective view of the assembly of Figure 4;

Figure 6 is a diagrammatic perspective view of a first heater arrangement; and

Figure 7 is a diagrammatic perspective view of a second heater arrangement.

## Detailed Description of Embodiments

[0043] Embodiments of the present disclosure will now be described by way of example only and with reference to the accompanying drawings.

[0044] Referring initially to Figure 1, there is shown diagrammatically an example of an aerosol generating system 1. The aerosol generating system 1 comprises an aerosol generating device 10 and an aerosol generating article 100 for use with the device 10. The aerosol generating device 10 comprises a main body 12 housing various components of the aerosol generating device 10. The main body 12 may have any shape that is sized to fit the components described in the various embodiments set out herein and to be comfortably held by a user unaided, in a single hand.

[0045] A first end 14 of the aerosol generating device 10, shown towards the bottom of Figure 1, is described for convenience as a distal, bottom, base or lower end of the aerosol generating device 10. A second end 16 of the aerosol generating device 10, shown towards the top of

Figure 1, is described as a proximal, top or upper end of the aerosol generating device 10. During use, the user typically orients the aerosol generating device 10 with the first end 14 downward and/or in a distal position with respect to the user's mouth and the second end 16 upward and/or in a proximate position with respect to the user's mouth.

**[0046]** The aerosol generating device 10 comprises a heating chamber 18 positioned in the main body 12. The heating chamber 18 defines an interior volume in the form of a cavity 20 having a substantially cylindrical cross-section for receiving an aerosol generating article 100. The heating chamber 18 has a longitudinal axis defining a longitudinal direction and is formed of a heat-resistant plastics material, such as polyether ether ketone (PEEK). The aerosol generating device 10 further comprises a main power source 22, for example one or more batteries which may be rechargeable, and a control component 24. The control component 24 may comprise one or more integrated circuits (ICs) and other electronic components. For example, an integrated circuit may comprise at least one of a microcontroller unit (MCU) and micro-processor unit (MPU). The control component 24 may comprise a printed circuit board assembly (PCBA) with a rigid printed circuit board (PCB) on which the one or more electronic components or ICs are mounted. In addition to the main power source 22, the aerosol generating device 10 also includes a solid-state battery 42 as a secondary power source.

**[0047]** The heating chamber 18 is open towards the second end 16 of the aerosol generating device 10. In other words, the heating chamber 18 has an open first end 26 towards the second end 16 of the aerosol generating device 10. The heating chamber 18 is typically held spaced apart from the inner surface of the main body 12 to minimise heat transfer to the main body 12.

**[0048]** The aerosol generating device 10 may optionally include a sliding cover 28 movable transversely between a closed position (shown in Figure 1) in which it covers the open first end 26 of the heating chamber 18 to prevent access to the heating chamber 18 and an open position (not shown) in which it exposes the open first end 26 of the heating chamber 18 to provide access to the heating chamber 18. The sliding cover 28 may be biased to the closed position in some embodiments.

**[0049]** The heating chamber 18, and specifically the cavity 20, is arranged to receive a correspondingly shaped generally cylindrical or rod-shaped aerosol generating article 100. Typically, the aerosol generating article 100 comprises a pre-packaged aerosol generating material or substrate 102. The aerosol generating article 100 is a disposable and replaceable article (also known as a "consumable") which may, for example, contain tobacco as the aerosol generating material 102. The aerosol generating article 100 has a proximal end 104 (or mouth end) and a distal end 106. The aerosol generating article 100 further comprises a mouthpiece segment 108 positioned downstream of the aerosol gener-

ating material 102. The aerosol generating material 102 and the mouthpiece segment 108 are arranged in coaxial alignment inside a wrapper 110 (e.g., a paper wrapper) to hold the components in position to form the rod-shaped aerosol generating article 100.

**[0050]** The mouthpiece segment 108 may comprise one or more of the following components (not shown in detail) arranged sequentially and in co-axial alignment in a downstream direction, in other words from the distal end 106 towards the proximal (mouth) end 104 of the aerosol generating article 100: a cooling segment, a centre hole segment and a filter segment. The cooling segment typically comprises a hollow paper tube having a thickness which is greater than the thickness of the wrapper 110. The centre hole segment may comprise a cured mixture containing cellulose acetate fibres and a plasticizer, and functions to increase the strength of the mouthpiece segment 108. The filter segment typically comprises cellulose acetate fibres and acts as a mouthpiece filter. As heated vapour flows from the aerosol generating material 102 towards the proximal (mouth) end 104 of the aerosol generating article 100, the vapour cools and condenses as it passes through the cooling segment and the centre hole segment to form an aerosol with suitable characteristics for inhalation by a user through the filter segment.

**[0051]** The heating chamber 18 has a side wall (or chamber wall) 30 extending between a base 32, located at a second end 34 of the heating chamber 18, and the open first end 26. The side wall 30 and the base 32 are connected to each other and may be integrally formed as a single piece. In the illustrated embodiment, the side wall 30 is tubular and, more specifically, cylindrical. The side wall 30 may be formed so that the cross-section of the heating chamber 18 is a perfect circle or an ellipse. In other embodiments, the side wall 30 may have other suitable shapes, such as a tube with an elliptical or polygonal cross section. In yet further embodiments, the side wall 30 may be tapered.

**[0052]** In the illustrated embodiment, the base 32 of the heating chamber 18 is closed, e.g., sealed or air-tight. That is, the heating chamber 18 is cup-shaped. This may ensure that air drawn from the open first end 26 is prevented by the base 32 from flowing out of the second end 34 and is instead guided through the aerosol generating material 102. It may also ensure that a user inserts the aerosol generating article 100 into the heating chamber 18 an intended distance and no further.

**[0053]** The device 10 includes a heater 36, which is configured to heat the aerosol generating material 102 when the aerosol generating article 100 is received in the heating chamber 18.

**[0054]** Figure 2 shows how the solid-state battery 42 is located in a cup-shaped first air insulating space 38 that substantially surrounds the heating chamber 18 and the heater 36. The control component 24 is located in a second air insulating space 40 that is spaced apart from the first air insulating space 38 within the main body 12.

The solid-state battery 42 is electrically connected to the control component 24 by a flexible PCB 46 that extends through the main body 12 between the first and second air insulating spaces 38, 40.

**[0055]** The solid-state battery 42 has high tolerance to high external temperatures such as those generated by the heater 36 when it is being used to heat the aerosol generating article 100. The solid-state battery 42 may therefore be located close to the heater 36 in the first air insulating space 38. This makes good use of the available space within the main body 12. Including a solid-state battery 42 provides additional energy storage capacity. As a result, the energy storage capacity of the main power source 22 may be reduced. This may mean that the physical size and weight of the main power source 22 may also be reduced, which may result in a smaller and/or lighter aerosol generating device 10. The solid-state battery 42 also acts as a thermal barrier between the heater 36 and the main body 12 and/or any other adjacent components of the aerosol generating device 10.

**[0056]** Referring now to Figures 3A to 3F, the solid-state battery 42 may comprise a plurality of solid-state battery units 44a, 44b and 44c, for example. The individual solid-state battery units 44a, 44b and 44c may be mounted directly on a flexible PCB 46 which is electrically connected to the rigid PCB of the PCBA of the control component 24. Although in Figures 3A to 3F the flexible PCB 46 is shown to be completely flat, it will be understood that in practice it may be bent or twisted so as to conform to a desired shape in use. The location of the various components - including the solid-state battery units 44a, 44b and 44c - that are mounted to the flexible PCB 46 must allow it to conform to that desired shape. Put another way, the mounted components should be positioned or spaced apart so that they do not interfere with or hinder the bending or flexing of the flexible PCB 46 within the main body 12 of the aerosol generating device 10.

**[0057]** In Figure 3A, a single-sided flexible PCB 46 includes a flexible dielectric substrate or base layer 48. A conductive layer 50 (e.g., a copper foil layer) is formed on one side of the flexible substrate or base layer 48. Although the conductive layer 50 is shown in Figure 3A as a solid layer, it will be readily understood that it defines a pattern of conductive pathways or traces. A protective coverlay 52 (e.g., a polyimide layer or film) is coated with a thermoset adhesive 54 and bonded to the conductive layer 50 with heat and pressure. A pattern of openings in the coverlay 52 exposes the conductive layer 50 in the areas where the one or more electronic components are to be electrically connected to the conductive layer 50. A second protective coverlay (not shown) may be bonded to the flexible substrate or base layer 48.

**[0058]** A pair of solid-state battery units 44a, 44b are mounted directly to the flexible PCB 46 as shown. In particular, each solid-state battery unit 44a, 44b includes a positive terminal 56 and a negative terminal 58. The positive terminal 56 of each solid-state battery unit 44a,

44b is electrically connected to a positive solid-state electrode (not shown) of the solid-state battery unit 44a, 44b. The negative terminal 58 of each solid-state battery unit 44a, 44b is electrically connected to a negative solid-state electrode (not shown) of the solid-state battery unit 44a, 44b. The positive and negative terminals 56, 58 of each solid-state battery unit 44a, 44b are soldered directly to the conductive pathways or traces defined by the conductive layer 50.

**[0059]** Other electronic components 60 are also mounted directly to the conductive layer 50 as shown. In particular, terminals of each electronic component 60 are soldered directly to the conductive pathways or traces defined by the conductive layer 50.

**[0060]** Although the structure shown in Figure 3A appears to be relatively simple, it would require a complicated pattern of conductive pathways or traces to be formed in the single conductive layer 50. For example, the conductive pathways would have to define a ground connection.

**[0061]** Figure 3B shows a detail view of an alternative arrangement where the solid-state battery units are removably mounted to the flexible PCB 46. In particular, Figure 3B shows how one of the solid-state battery units 44b is removably mounted to the flexible PCB 46 by one or more magnets 62. Although only one magnet 62 is shown, it will be understood that two or more magnets may be spaced around each solid-state battery unit. Each magnet 62 may be provided on the coverlay 52 as shown in Figure 3B, for example, and may be positioned to magnetically attract and contact the facing underside of each solid-state battery unit. When the solid-state battery unit 44b is mounted to the flexible PCB 46, the positive and negative terminals 56, 58 are electrically connected to the conductive pathways or traces defined by the conductive layer 50. Using one or more magnets 62 to mount the solid-state battery unit 44b to the flexible PCB 46 may make it easier to assemble the device. It may also allow one or more of the solid-state battery units 44a, 44b to be removed and replaced if necessary. Other mounting means for removably mounting each solid-state battery unit 44a, 44b to the flexible PCB 46 may also be used.

**[0062]** In Figure 3C, a double-sided flexible PCB 46 includes a flexible dielectric substrate or base layer 48. A first conductive layer 50a (e.g., a first copper foil layer) is formed on one side of the flexible substrate or base layer 48 and a second conductive layer 50b (e.g., a second copper foil layer) is formed on the other side of the flexible substrate or base layer 48. Although the conductive layers 50a, 50b are shown in Figure 3C as solid layers, it will be readily understood that each defines a pattern of conductive pathways or traces. A first protective coverlay 52a (e.g., a first polyimide layer) is coated with a thermoset adhesive 54a and bonded to the first conductive layer 50a with heat and pressure. A second protective coverlay 52b (e.g., a second polyimide layer) is coated with a thermoset adhesive 54b and bonded to the second con-

ductive layer 50b with heat and pressure. A pattern of openings in the first coverlay 52a exposes the first conductive layer 50a in the areas where the one or more electronic components are to be electrically connected to the conductive layer.

**[0063]** A pair of solid-state battery units 44a, 44b are mounted directly to the flexible PCB 46 as shown. The positive terminal 56 of each solid-state battery unit 44a, 44b is soldered directly to the conductive pathways or traces defined by the first conductive layer 50a. The negative terminal 58 of each solid-state battery unit 44a, 44b is soldered directly to the conductive pathways or traces defined by the first conductive layer 50a but is also electrically connected to the conductive pathways or traces defined by the second conductive layer 50b by plated through holes or vias. This may simplify the pattern of conductive pathways or traces to be formed in the first conductive layer 50a, and also in the second conductive layer 50b. For example, the conductive pathways or traces formed in the second conductive layer 50b may define a ground connection for the mounted components.

**[0064]** In Figure 3C both of the solid-state battery units 44a, 44b and the other electronic components 60 are mounted on one side of the flexible PCB 46.

**[0065]** In Figures 3D to 3F components are mounted on both sides of the double-sided flexible PCB 46. In Figure 3D the pair of solid-state battery units 44a, 44b are mounted on one side of the flexible PCB 46. One or more first electronic components 60a are mounted on the same side of the flexible PCB 46 as the solid-state battery units 44a, 44b. One or more second electronic components 60b are mounted on the other side of the flexible PCB 46. More components may be mounted to the flexible PCB 46 if they are mounted on both sides. The solid-state battery units 44a, 44b may occupy a lot of the surface area of the flexible PCB 46 so it may be convenient to mount larger electronic components such as integrated circuits (ICs) on the other side of the flexible PCB 46.

**[0066]** In Figure 3E only the pair of solid-state battery units 44a, 44b are mounted on one side of the flexible PCB 46 and only one or more other electronic components 60 are mounted on the other side of the flexible PCB 46. In particular, there are no other electronic components mounted on the same side as the solid-state battery units 44a, 44b. This may be a particularly convenient structure, and may simplify the pattern of conductive pathways or traces to be formed in both of the first conductive layer 50a and the second conductive layer 50b.

**[0067]** In Figure 3F a pair of solid-state battery units 44a, 44b are mounted on one side of the flexible PCB 46 and a third solid-state battery unit 44c is mounted on the other side of the flexible PCB 46. In other words, solid-state battery units are mounted on both sides of the flexible PCB 46. One or more other electronic components 60a, 60b are also mounted on both sides of the flexible PCB 46 as shown. Such a structure may allow

additional solid-state battery units to be mounted to the flexible PCB, but it may also increase the complexity of the conductive pathways or traces defined by the conductive layers, for example.

**[0068]** One or more temperature sensors may be mounted directly on the flexible PCB 46, e.g., as one of the other electronic components described above. The temperature sensor(s) may be adapted to measure a temperature of the one or more of the solid-state battery units 44a, 44b and 44c or the heater 36. Each solid-state battery unit 44a, 44b, 44c may be associated with its own respective temperature sensor. The heater 36 may also be electrically connected to (or mounted directly on) the flexible PCB 46. Temperature measurements from each temperature sensor may be transmitted to the control component 24 through the flexible PCB 46 - e.g., directly to the PCBA of the control component.

**[0069]** Figures 4 and 5 show an assembly 66 with a solid-state battery unit 68 and an integrated heater unit 70. Electrically conductive heater tracks 72 are formed directly on surface of the solid-state battery unit 68. Optional air gaps 74 are provided between the main body of the solid-state battery unit 68 and the heater unit 70 and may incorporate mechanical supports 76. An insulation layer 78 may optionally be provided on the other outer surface of the solid-state battery unit 68. Such an assembly 66 may be mounted directly to the flexible PCB 46 in exactly the same way as the solid-state battery units 44a, 44b, 44c described above. The heater tracks 72 may also be electrically connected to the flexible PCB 46. In an alternative arrangement, the heater unit 70 may be formed separately and then physically integrated with the solid-state battery unit 68 - e.g., permanently fixed thereto.

**[0070]** Figure 6 shows how a plurality of the assemblies 66 shown in Figures 4 and 5 may be arranged to define a pair of planar heaters. More particularly, Figure 6 shows three assemblies 66a, 66b, 66c arranged side-by-side to define a first planar heater 80a and three assemblies 66d, 66e, 66f arranged side-by-side to define a second planar heater 80b. The first and second planar heaters 80a, 80b may be positioned on opposite sides of a heating chamber that is designed to receive a flat-format aerosol generating article (shown ghosted). The actual heating region of the first planar heater 80a faces towards a main surface of the flat-format aerosol generating article, and the actual heating region of the second planar heater 80b faces the opposite main surface of the flat-format aerosol generating article. Figure 7 shows how a plurality of the assemblies 66 shown in Figures 4 and 5 may be arranged to define four planar heaters. More particularly, Figure 7 shows assemblies 66a, 66b arranged side-by-side to define a first planar heater 82a, two assemblies 66c, 66d arranged side-by-side to define a second planar heater 82b, two assemblies 66e, 66f arranged side-by-side to define a third planar heater 82c, and two assemblies 66g, 66h arranged side-by-side to define a fourth planar heater 82d. The first, second, third and fourth



planar heaters 82a, 82b, ..., 82d may be positioned around a heating chamber that is designed to receive a cylindrical aerosol generating device (shown ghosted) or a cuboid-shaped aerosol generating article. The first, second, third and fourth planar heaters 82a, 82b, ..., 82d define a substantially tubular heater, for example. Each planar heater may have one assembly or any suitable number of assemblies arranged side-by-side depending on the size of the first air insulating space. Alternatively, at least one of the assemblies 60a, 60b, ..., 60d may form a curved shape before surrounding the cylindrical aerosol generating device.

**[0071]** The assemblies 66a, 66b, ..., 66h may be located in a first air insulating space (e.g., an air insulating space similar to the air insulating space 38 shown in Figure 2 that extends around the heating chamber 18, but without the separate heater 36 and the solid-state energy storage device 42). The assemblies 66a, 66b, ..., 66h may be electrically connected to the control component 24 by the flexible PCB 46. In particular, the solid-state battery units 68 of each assembly 66a, 66b, ..., 66h may be mounted directly to the flexible PCB 46 as described above. The integrated heater units 70 may also be electrically connected to the flexible PCB 46. Each heater unit 70 may receive power from its respective solid-state battery unit 68 and also from the main power source 22.

**[0072]** Solid-state battery units without an integrated heater unit (e.g., the solid-state battery units 44a, 44b etc. described above) may also be arranged in a similar way within the first air insulating space 38. That is, the solid-state battery units may be arranged side-by-side to define a pair of planar solid-state batteries or four or more planar solid-state batteries that may be arranged circumferentially around the heater 36. In this way, a plurality of solid-state battery units may be located in the first air insulating space 38. In some cases, the solid-state battery units may substantially fill the first air insulating space 38 to make full use of the available space within the main body 12 of the aerosol generating device 10 and to provide a more complete thermal barrier between the heater 36 and the main body 12 and/or any other components.

**[0073]** Although exemplary embodiments have been described in the preceding paragraphs, it should be understood that various modifications may be made to those embodiments without departing from the scope of the appended claims. Thus, the breadth and scope of the claims should not be limited to the above-described exemplary embodiments.

**[0074]** Any combination of the above-described features in all possible variations thereof is encompassed by the present disclosure unless otherwise indicated herein or otherwise clearly contradicted by context.

**[0075]** Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like, are to be construed in an inclusive as opposed to an exclusive or

exhaustive sense; that is to say, in the sense of "including, but not limited to".

## 5 Claims

1. An aerosol generating device (10) comprising:

an outer housing (12);  
a heater (36) located within the outer housing (12) and adapted to heat aerosol generating material (102);  
a first air insulating space (38) adjacent the heater (36);  
a second air insulating space (40) within the outer housing (12) that is separate from the first insulating space (38);  
a solid-state energy storage device (42) located in the first air insulating space (38); and  
a control component (24) located in the second air insulating space (40).

2. An aerosol generating device (10) according to claim 1, wherein the heater is physically integrated with the solid-state energy storage device.

3. An aerosol generating device (10) according to claim 2, wherein the heater is formed on a surface of the solid-state energy storage device.

4. An aerosol generating device (10) according to any preceding claim, wherein the solid-state energy storage device (42) comprises a plurality of solid-state energy storage device units (44a, 44b, 44c; 68).

5. An aerosol generating device (10) according to claim 4, wherein the heater (36) comprises a plurality of heater units (70), each heater unit (70) being physically integrated with a respective solid-state energy storage device unit (68).

6. An aerosol generating device (10) according to claim 5, wherein the heater units (70) are arranged to define a pair of planar heaters (80a, 80b) or four or more planar heaters (82a, 82b, ..., 82d).

7. An aerosol generating device (10) according to any of claims 4 to 6, further comprising a switching circuit adapted to configure how the plurality of solid-state energy storage device units (44a, 44b, 44c; 68) are electrically connected to the heater (36) depending on operating requirements during a discharging mode of the aerosol generating device (10).

8. An aerosol generating device (10) according to any preceding claim, wherein the control component (24) is electrically connected to the solid-state energy storage device (42) by a flexible PCB (46).

9. An aerosol generating device (10) according to claim 8, wherein the solid-state energy storage device (42) is mounted directly on the flexible PCB (46).
10. An aerosol generating device (10) according to claim 9, wherein the flexible PCB (46) comprises a magnet (62) adapted to connect with the solid-state energy storage device. 5
11. An aerosol generating device (10) according to any of claims 8 to 10, wherein the solid-state energy storage device (42) is mounted directly to the flexible PCB (46) on a first side of the flexible PCB (46), and wherein one or more electronic components (60b) are mounted directly to the flexible PCB (46) on a second, opposite, side of the flexible PCB (46). 10 15
12. An aerosol generating device (10) according to claim 11, wherein the solid-state energy storage device (42) comprises a plurality of energy storage device units (44a, 44b, 44c), wherein the energy storage device units (44a, 44b, 44c) are only mounted directly to the flexible PCB (46) on the first side of the flexible PCB (46). 20 25
13. An aerosol generating device (10) according to claim 11 or claim 12, wherein the one or more electronic components (60; 60b) are only mounted directly to the flexible PCB (46) on the second side of the flexible PCB (46). 30
14. An aerosol generating device (10) according to any of claims 8 to 13, wherein the heater (36) is electrically connected to the flexible PCB (46). 35
15. An aerosol generating device (10) according to any of claims 8 to 14, further comprising a temperature sensor mounted directly on the flexible PCB (46) and adapted to measure a temperature of the solid-state energy storage device (42) and/or the heater (36). 40

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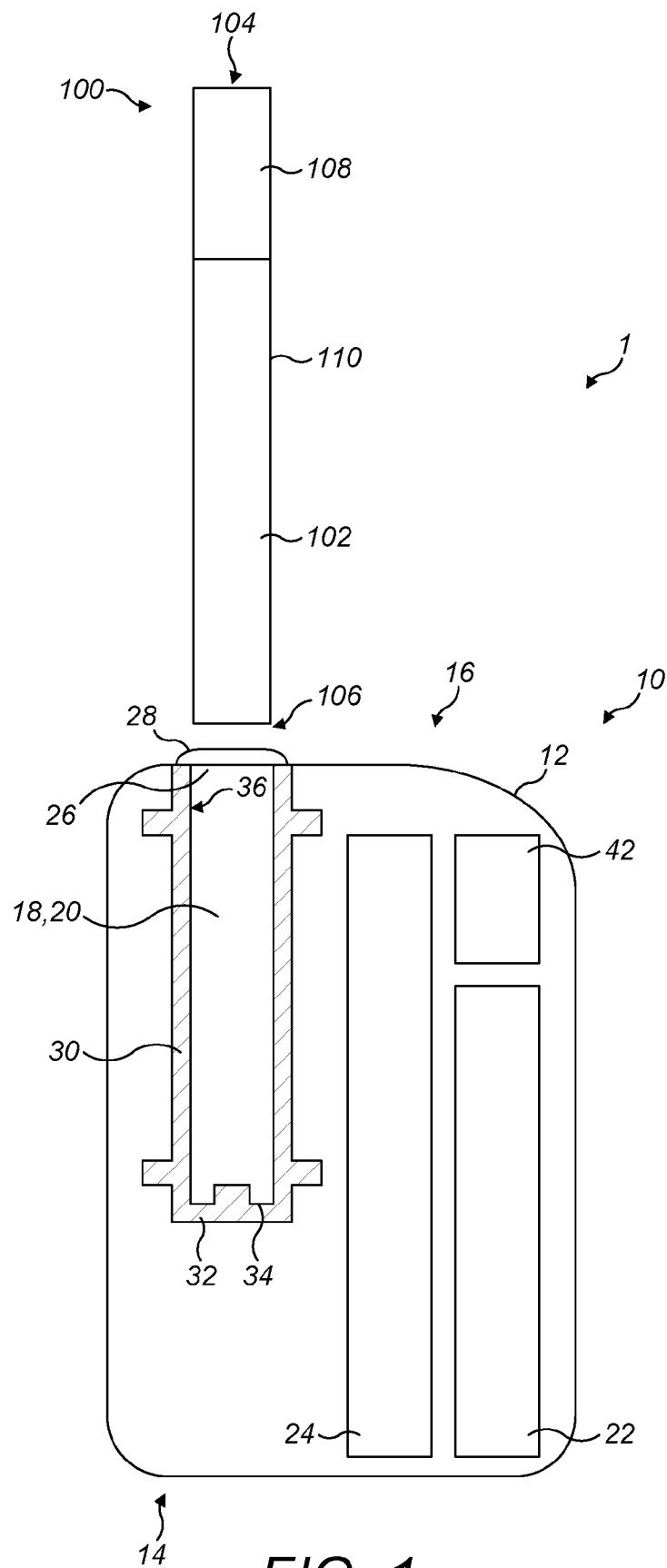


FIG. 1

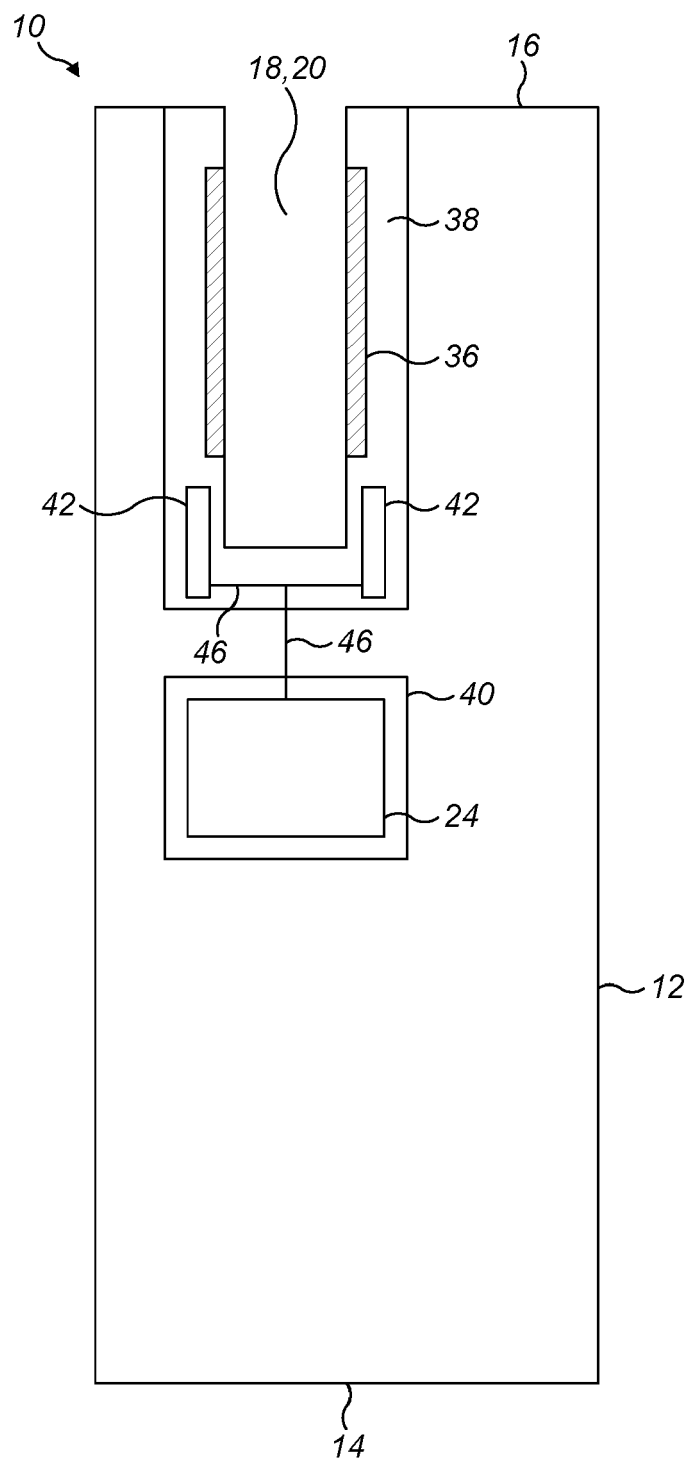


FIG. 2

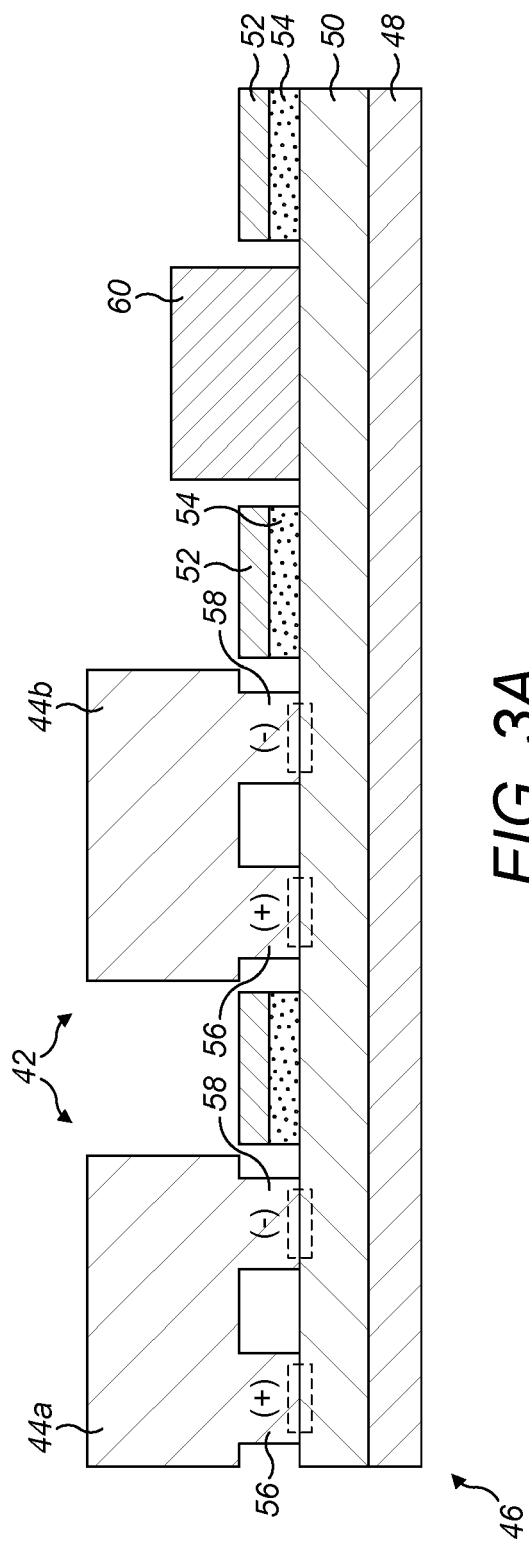


FIG. 3A

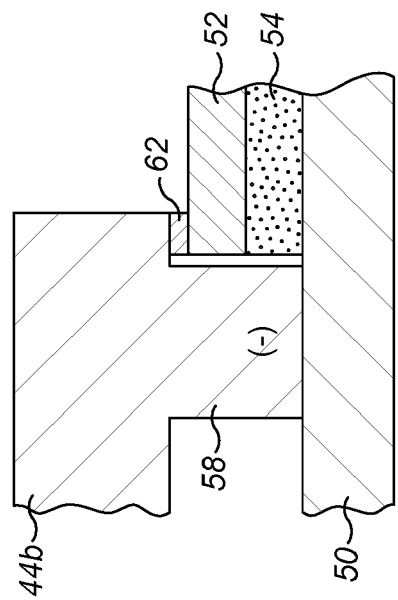


FIG. 3B

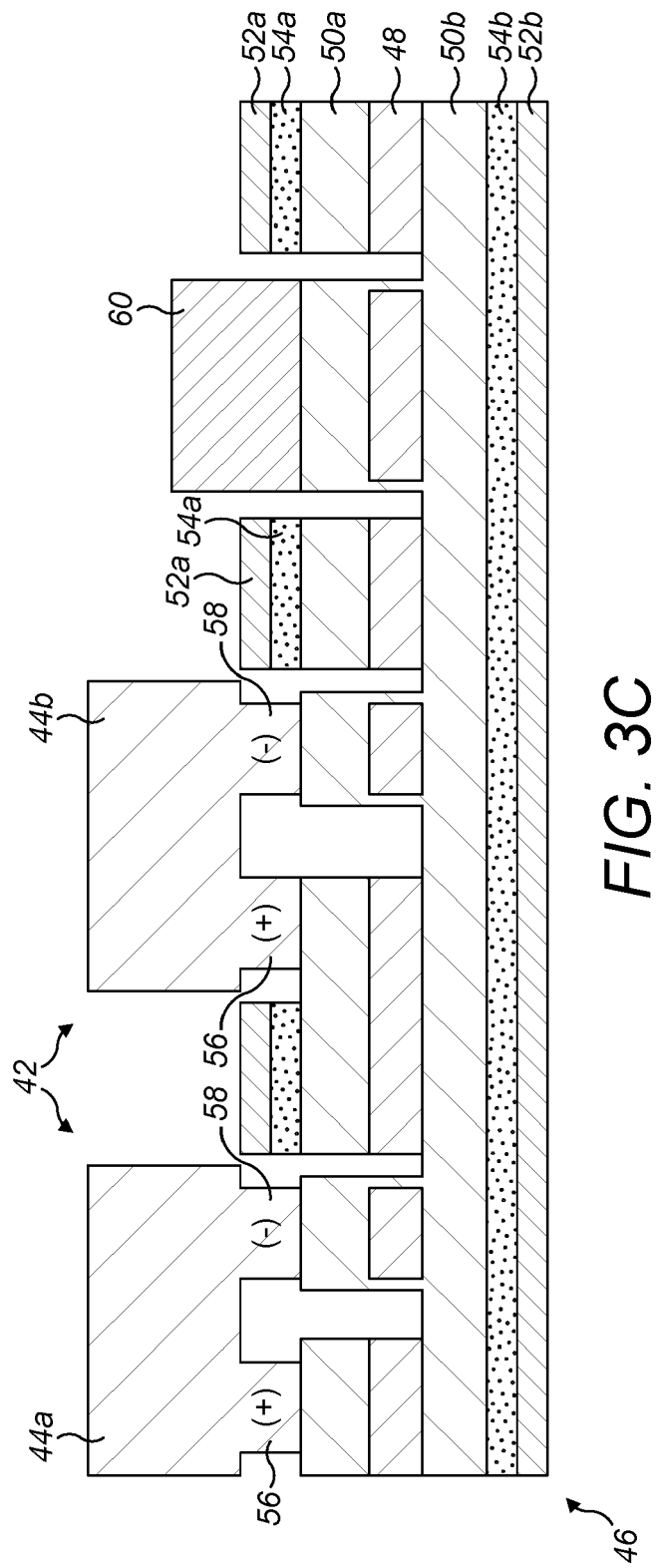


FIG. 3C

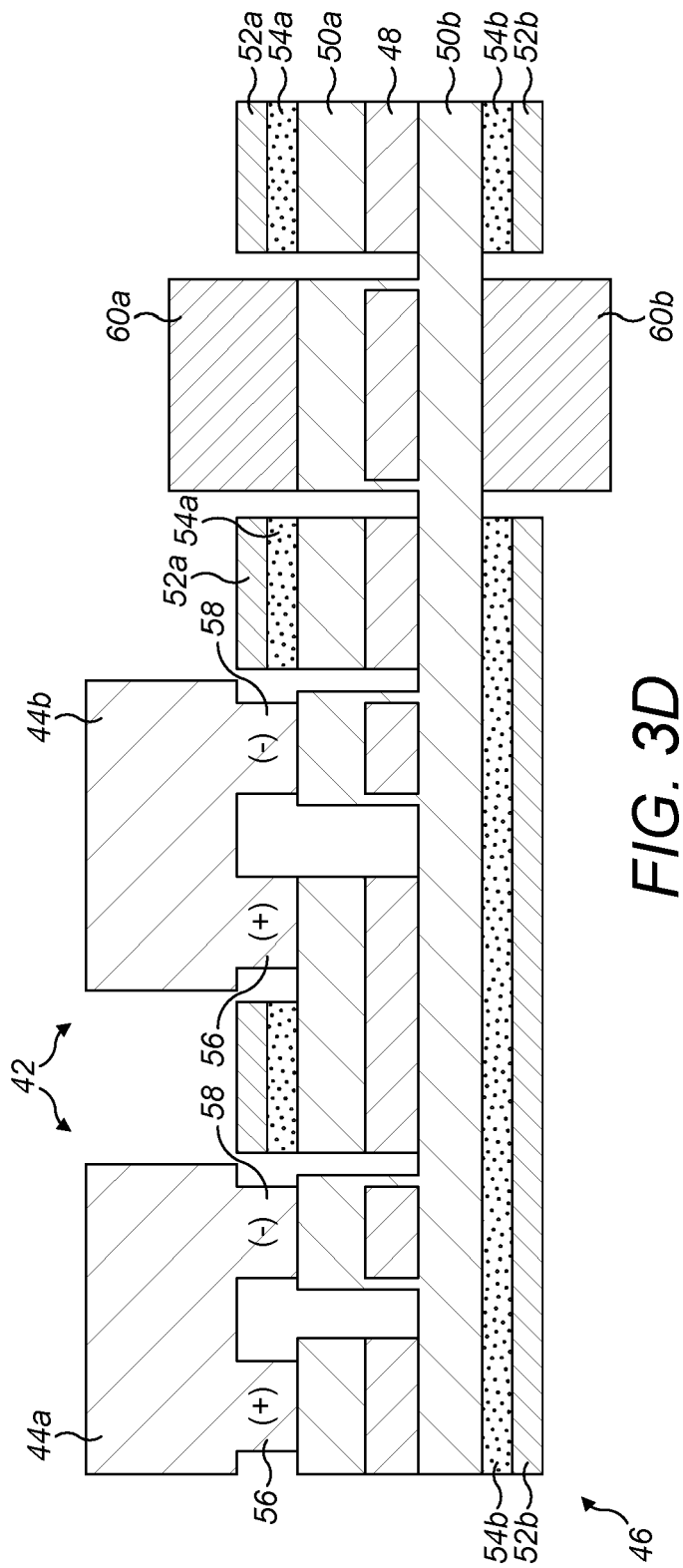
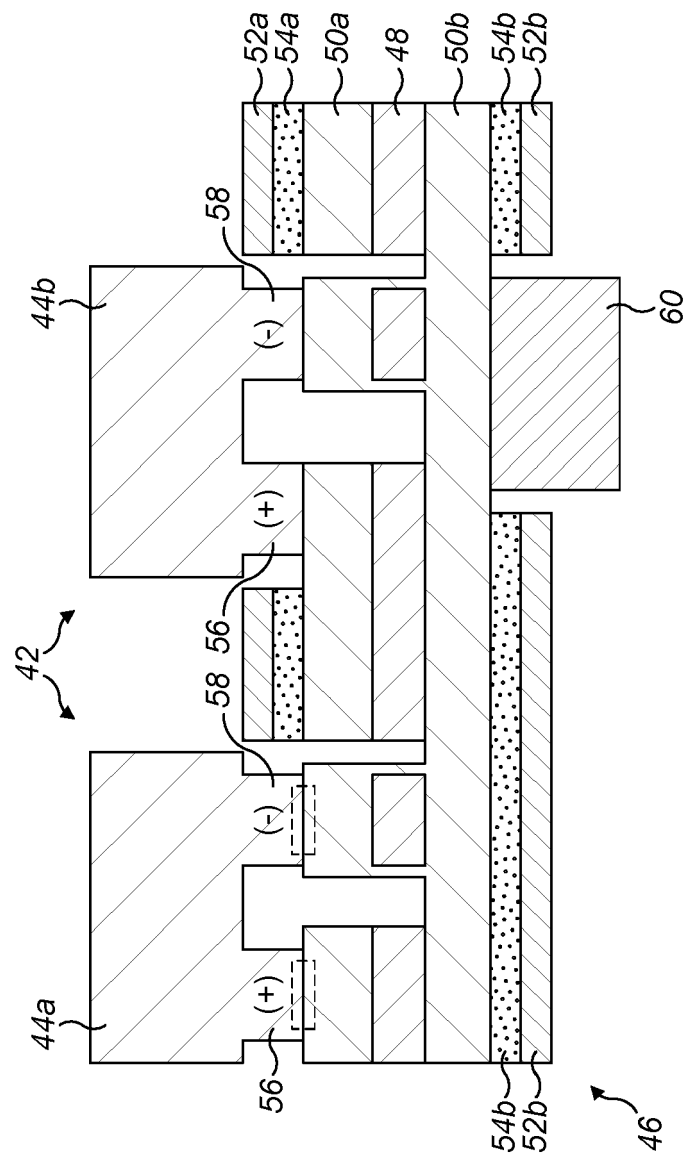


FIG. 3D





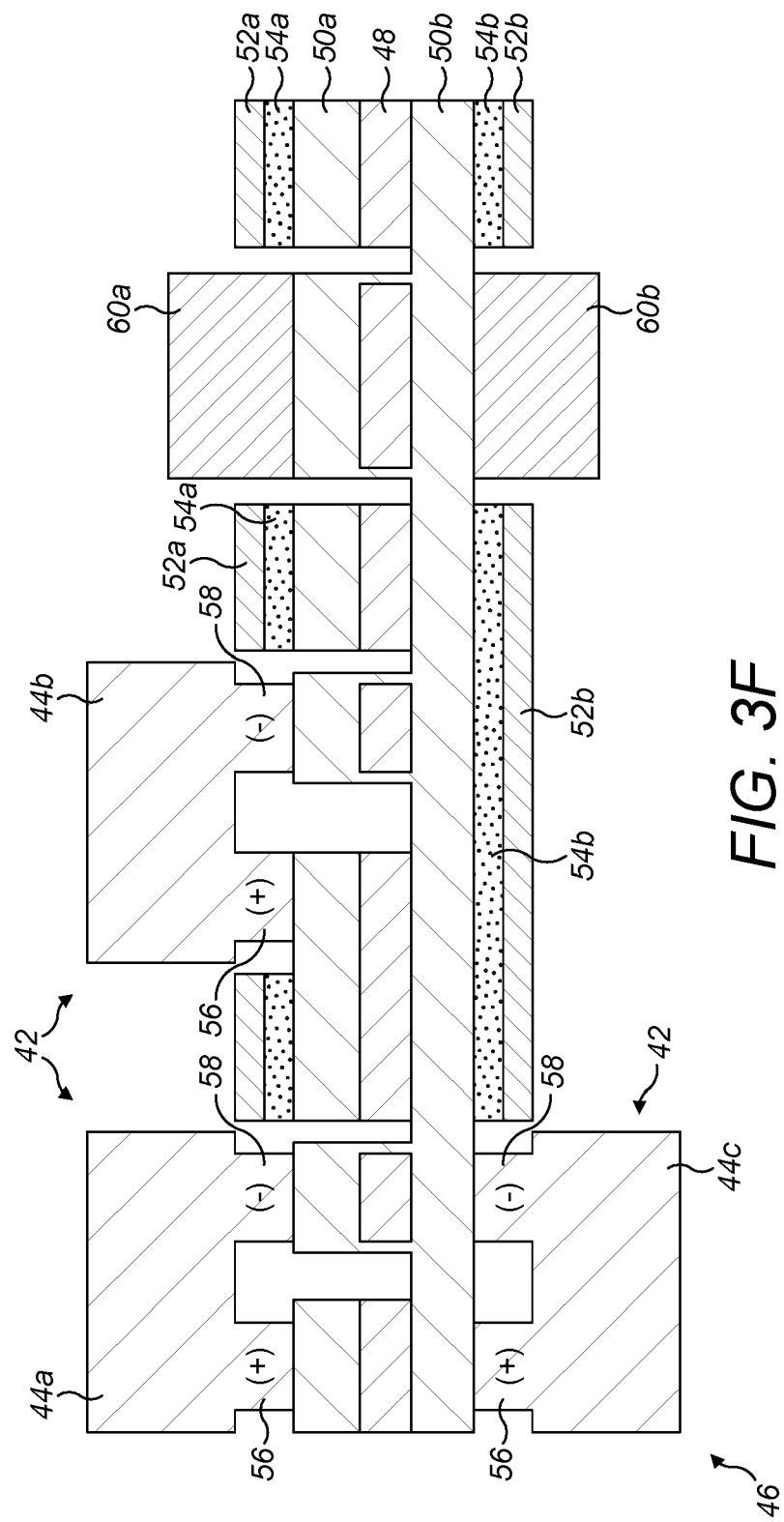


FIG. 3F

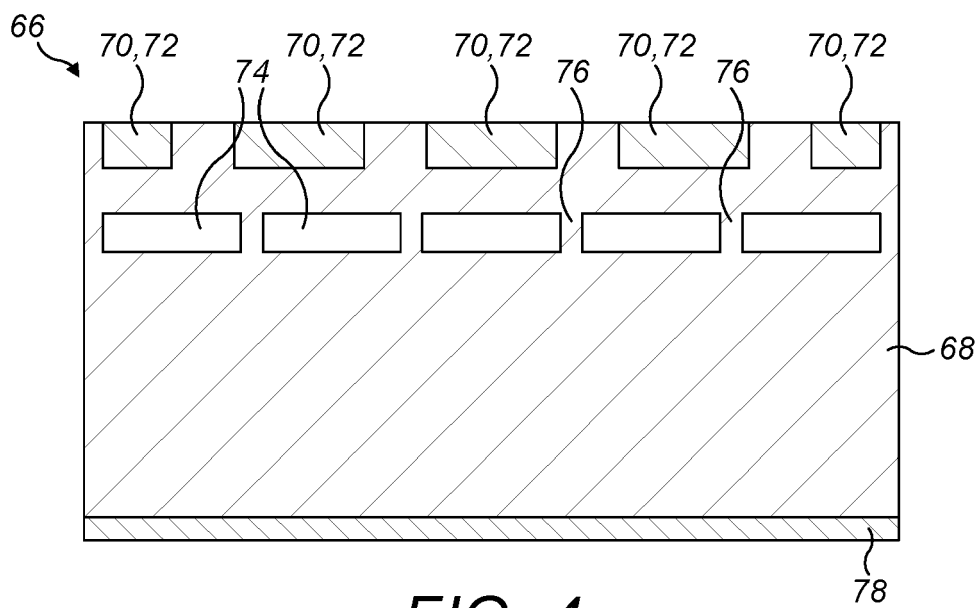


FIG. 4

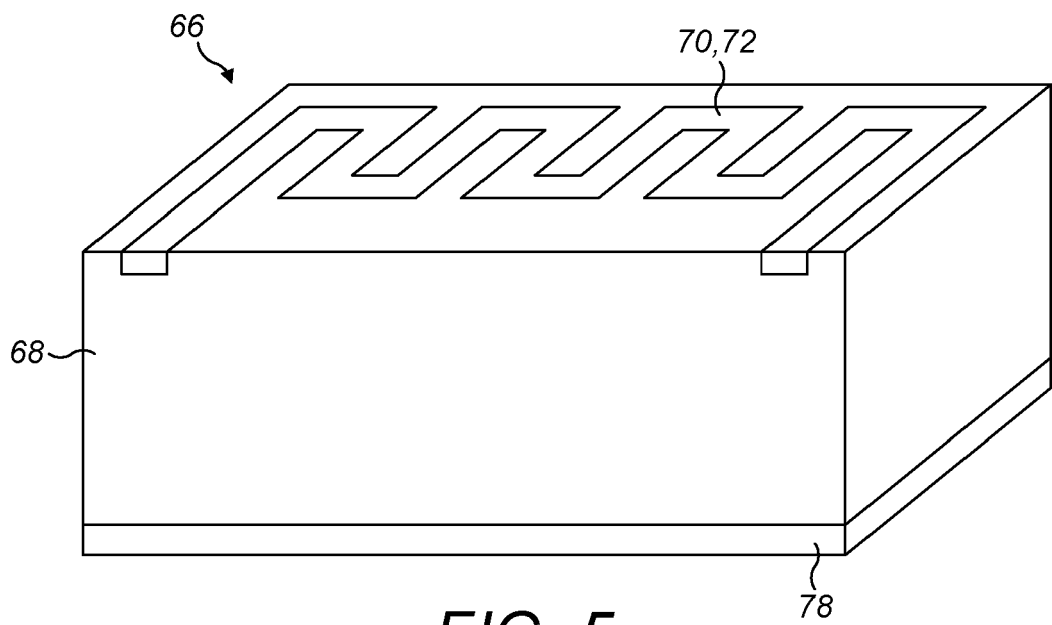


FIG. 5

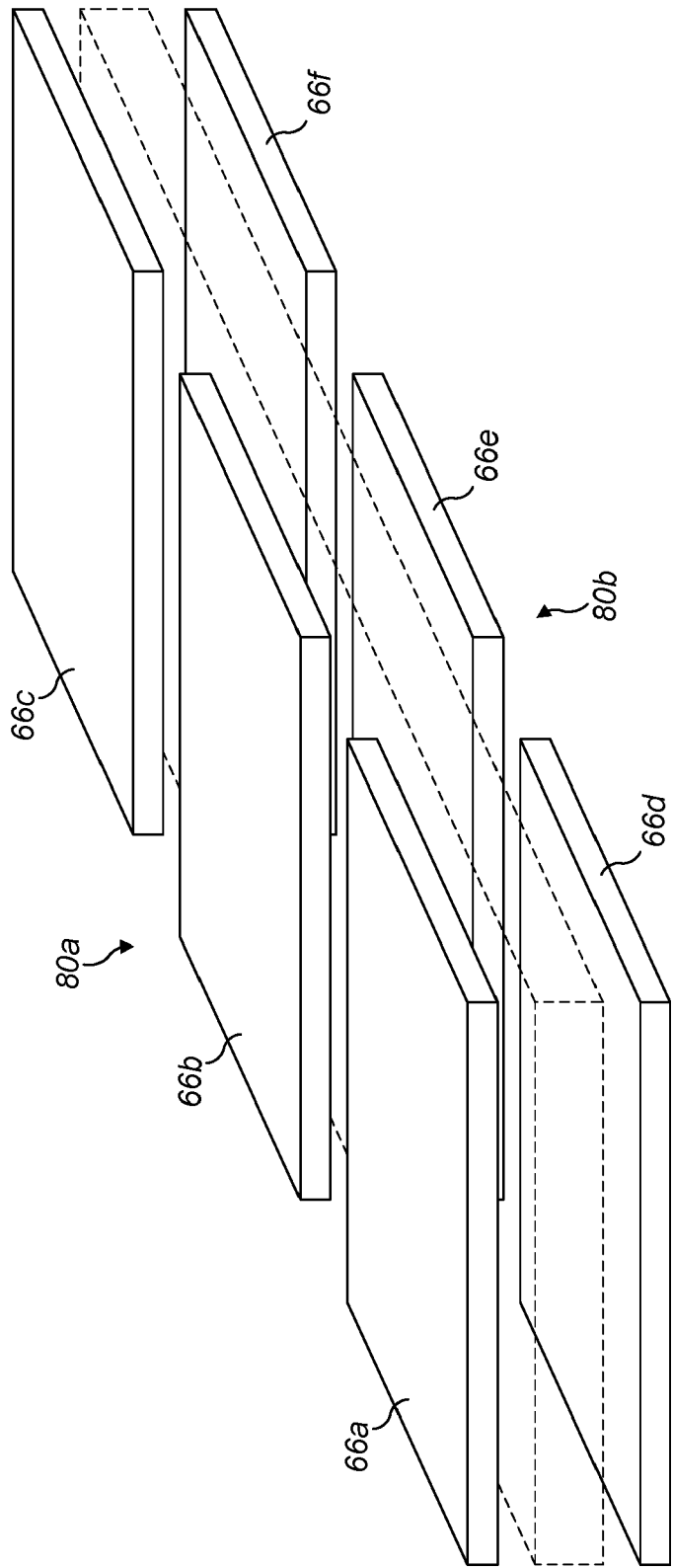
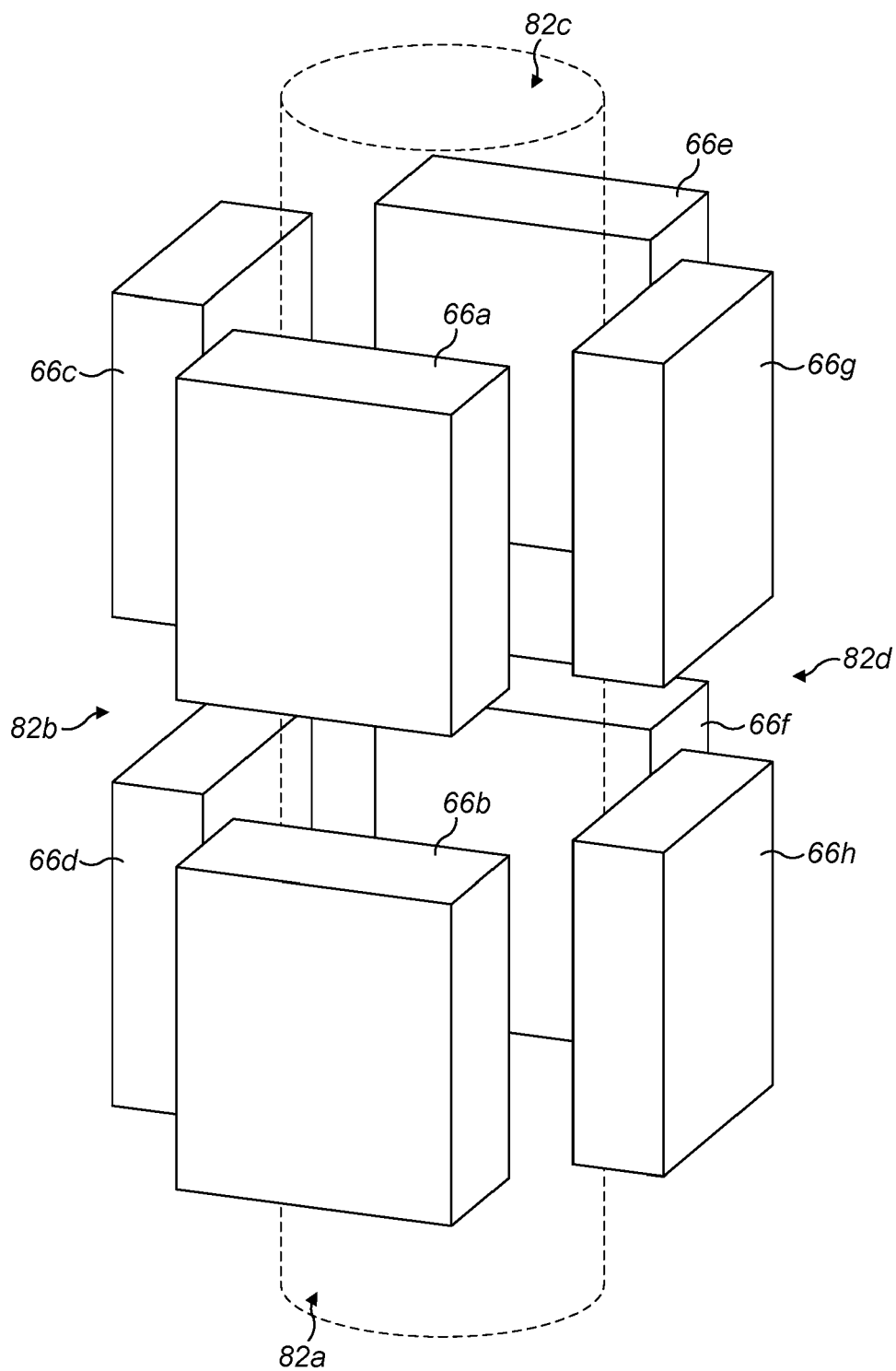


FIG. 6



**FIG. 7**



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Application Number

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