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(54) Titre : MATRICE DE CARTOMISEUR COMPRIMEE POUR UNE MEILLEURE DISTRIBUTION D'AROME
(54) Title: COMPRESSED CARTOMIZER MATRIX FOR IMPROVED FLAVOR DELIVERY

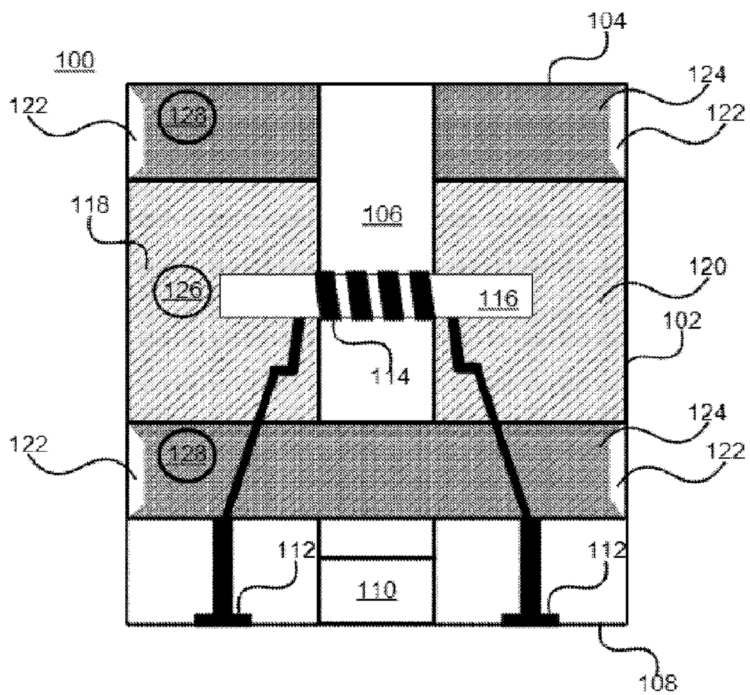


Fig. 7

(57) Abrégé/Abstract:
During the consumption of an atomizable liquid stored in a cartomizer matrix, in a vaporizer pod, flavor drop off has been noted to occur. To avoid or diminish flavor drop-off, a region of higher cartomizer matrix density is created away from a wick in the pod. The wick is placed in contact with a lower density section of the cartomizer matrix, facilitating delivery of the atomizable liquid to the wick. The higher density segment of the matrix is sized to hold a volume of atomizable liquid and prevent the delivery of this liquid to the wick, so that the liquid associated with flavor drop off is held away from the wick, preventing or diminishing the user experience of flavor drop off.

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**Abstract:**

During the consumption of an atomizable liquid stored in a cartomizer matrix, in a vaporizer pod, flavor drop off has been noted to occur. To avoid or diminish flavor drop-off, a region of higher cartomizer matrix density is created away from a wick in the pod. The wick is placed in contact with a lower density section of the cartomizer matrix, facilitating delivery of the atomizable liquid to the wick. The higher density segment of the matrix is sized to hold a volume of atomizable liquid and prevent the delivery of this liquid to the wick, so that the liquid associated with flavor drop off is held away from the wick, preventing or diminishing the user experience of flavor drop off.

# Compressed Cartomizer Matrix for Improved Flavor Delivery

## Cross Reference to Related Applications

[0001] This application claims the benefit of priority to US Patent Application Serial No. 17/482,243 filed on September 22, 2021 and entitled "Compressed Cartomizer Matrix for Improved Flavor Delivery", the contents of which are incorporated herein by reference.

## Technical Field

[0002] This application relates generally to a matrix for use in a cartomizer, and more particularly to a cartomizer under partial compression for use in conjunction with an electronic cigarette or vaporizer.

## Background

[0003] Electronic cigarettes and vaporizers are well regarded tools in smoking cessation. In some instances, these devices are also referred to as an electronic nicotine delivery system (ENDS). A nicotine based liquid solution, commonly referred to as e-liquid, often paired with a flavoring, is atomized in the ENDS for inhalation by a user. In some embodiments, e-liquid is stored in a cartridge or pod, which is a removable assembly having a reservoir from which the e-liquid is drawn towards a heating element by capillary action through a wick. In many such ENDS, the pod is removable, disposable, and is sold pre-filled.

[0004] In some ENDS, a refillable tank is provided, and a user can purchase a vaporizable solution with which to fill the tank. This refillable tank is often not removable, and is not intended for replacement. A fillable tank allows the user to control the fill level as desired. Disposable pods are typically designed to carry a fixed amount of vaporizable liquid, and are intended for disposal after consumption of the e-liquid. The ENDS cartridges, unlike the aforementioned tanks, are not typically designed to be refilled. Each cartridge stores a predefined quantity of e-liquid, often in the range of 0.5 to 3ml. In ENDS systems, the e-liquid is typically composed of a combination of any of vegetable glycerine, propylene glycol, nicotine and flavorings. In systems designed for the delivery of other compounds, different compositions may be used.



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[0005] In the manufacturing of the disposable cartridge, different techniques are used for different cartridge designs. Typically, the cartridge has a wick that allows e-liquid to be drawn from the e-liquid reservoir to an atomization chamber. In the atomization chamber, a heating element in communication with the wick is heated to encourage aerosolization of the e-liquid. The aerosolized e-liquid can be drawn through a defined air flow passage towards a user's mouth.

[0006] Figures 1A, 1B and 1C provide front, side and bottom views of an exemplary pod **50**. Pod **50** is composed of a reservoir **52** having an air flow passage **54**, and an end cap assembly **56** that is used to seal an open end of the reservoir **52**. End cap assembly has wick feed lines **58** which allow e-liquid stored in reservoir **52** to be provided to a wick (not shown in Figure 1). To ensure that e-liquid stored in reservoir **52** stays in the reservoir and does not seep or leak out, and to ensure that end cap assembly **56** remains in place after assembly, seals **60** can be used to ensure a more secure seating of the end cap assembly **56** in the reservoir **52**. In the illustrated embodiment, seals **60** may be implemented through the use of o-rings.

[0007] As noted above, pod **50** includes a wick that is heated to atomize the e-liquid. To provide power to the wick heater, electrical contacts **62** are placed at the bottom of the pod **50**. In the illustrated embodiment, the electrical contacts **62** are illustrated as circular. The particular shape of the electrical contacts **62** should be understood to not necessarily germane to the function of the pod **50**.

[0008] Because an ENDS device is intended to allow a user to draw or inhale as part of the nicotine delivery path, an air inlet **64** is provided on the bottom of pod **50**. Air inlet **64** allows air to flow into a pre-wick air path through end cap assembly **56**. The air flow path extends through an atomization chamber and then through post wick air flow passage **54**.

[0009] Sitting atop pod **52** is an optional mouthpiece **68**, shown in Figures 1A and 1B in cross section to allow a reader to see the structure of pod **50** in better detail. Mouthpiece **68** may attach to the pod **50** through the use of a detente and protrusion, or it may make use of a further seal not shown in the drawing. Within mouthpiece **68** are a pair of apertures that are shown as being off center from a central vertical axis of the pod **50**. These apertures allow for an airflow through the pod **50** to both entrain atomized e-liquid, and for delivery of this airflow to the user. Between the mouthpiece **68** and the top of the pod **50**, is an absorbent pad 66, typically made of cotton, and often annular in shape. This pad **66** is often referred to as a spitback pad, and is designed to absorb any large droplets of e-liquid that it encounters. This pad **66** may also serve to absorb e-liquid that condenses within the post wick airflow path **54** between uses.

[0010] Figure 2 illustrates a cross section taken along line A in Figure 1B. This cross section of the device is shown with a complete (non-sectioned) wick **66** and heater **68**. End cap assembly **56** resiliently mounts to an end of air flow passage **54** in a manner that allows air inlet **64** to form a complete air path through pod **50**. This connection allows airflow from air inlet **64** to connect to the post air flow path through passage **54** through atomization chamber **70**. Within atomization chamber **70** is both wick **66** and heater **68**. When power is applied to contacts **62**, the temperature of the heater increases and allows for the volatilization of e-liquid that is drawn across wick **66**.

[0011] Typically the heater **68** reaches temperatures well in excess of the vaporization temperature of the e-liquid. This allows for the rapid creation of a vapor bubble next to the heater **68**. As power continues to be applied the vapor bubble increases in size, and reduces the thickness of the bubble wall. At the point at which the vapor pressure exceeds the surface tension the bubble will burst and release a mix of the vapor and the e-liquid that formed the wall of the bubble. The e-liquid is released in the form of aerosolized particles and droplets of varying sizes. These particles are drawn into the air flow and into post wick air flow passage **54** and towards the user.

[0012] Figure 3 illustrates an alternate design for a pod **50**, having a reservoir **52** with a post wick airflow passage **54** and an end cap **56**. In place of O-ring style seals, a resilient top cap **78** can be affixed to the end cap **56** to provide a friction fit within reservoir **52**. Although no mouthpiece is illustrated, one could be affixed at what is illustrated as the bottom of the pod **50**. End Cap **56** and resilient top cap **78** define wick feedlines **58** that allow e-liquid to make contact with the wick **72**. Heater **74** is connected to electrical leads **62** to receive power so that e-liquid drawn across the wick **72** can be volatilized. Airflow can pass through pre-wick airflow passage **64** and enter into the atomization chamber **70**, where atomized e-liquid can be entrained and carried towards the user through post wick air flow passage **54**. Within the post wick airflow passage **54**, and provided as a feature within the top silicone **78** is a vortex generator **76**. Vortex generator **76** introduces turbulence into the airflow at the start of the post wick airflow passage **54** to encourage droplets above a threshold size to be directed into the wall of the post wick air flow passage **54**.

[0013] The above described pods make use of a reservoir designed to directly store e-liquid. To aid in the avoidance of leaks, seals are employed in addition to the design of an e-liquid that is sufficiently viscous to prevent leaks. This results in a slowed progression of e-liquid through the wick, which may result in reduced flavor generation during use. A less viscous e-liquid has traditionally been associated with increased flavor generation, but is also associated with increased difficulty in preventing leaks.

[0014] In place of a reservoir that directly stores e-liquid, a cartomizer can be described as a pod where the reservoir contains a matrix which is used to help in the storage and distribution of the e-liquid. There are a variety of different materials that can be used as the cartomizer matrix, each with a different set of benefits and detriments. In common implementations, the matrix can be implemented as a sponge, made of any number of different materials including cellulose, cotton, wool, hemp, linen, polymer-based materials such as nylon and other bulk materials, as a stack of woven sheets, or . In the example of the stack of woven sheets, cotton or other materials can be woven into cloth, the woven cloth can be cut to a desired size and shape, and then rolled, wrapped or otherwise shaped so that it can be placed within the cartomizer reservoir.

[0015] While there are a variety of different cartomizer fill materials, they all serve the same purpose, to provide a matrix to capture, hold and release e-liquid. In many cartomizers, the fill material provides a capillary structure within which the e-liquid is held and transported.

[0016] Figure 4A illustrates a perspective view of a cartomizer pod **80** having a reservoir **82**, a top **84** and a post wick airflow path **86**. Cut line A will be used in a subsequent Figure. Figure **4B** illustrates the base of cartomizer pod **80**. The end cap **88** of the cartomizer pod **80** has an entrance to pre-wick airflow **90** and a pair of electrical contacts **92**.

[0017] Figure 5 is a cross section view of cartomizer pod **80** taken along cut line Bin Figure 4A. Cartomizer pod **80** has a reservoir **82** defined by the sidewalls of the pod, along with the top wall **84**. An open base is sealed by an end cap **88** having a pre-wick air flow passage **90** and electrical contacts **92**. Within pod **80** is an air flow passage spanning from pre-wick airflow passage **90** to post wick air flow passage **86**. Within this structure is situated a wick **96** in contact with a heater 94 that is connected to electrical contacts **92**. A matrix **98** fills the reservoir defined within the pod **80**. As noted above, this reservoir can be used to store e-liquid. Ends of the wick **96** are in fluid contact with the matrix **98**. This allows e-liquid stored within the matrix **98** to be drawn across wick **96** so that it can be atomized through the heating of heater **94**. Where in the previously illustrated pod **50**, the e-liquid filled the reservoir **52** and was fed to the wick **72** using gravity, a less viscous e-liquid can be stored in matrix **98** and fed into wick **96** by capillary action. It should be understood that the capillary forces within matrix **98** are a function of both the matrix material, and the configuration of the void spaces between the matrix material. By ensuring that wick **96** has stronger capillary forces acting within it than the material within matrix **98**, the wick **96** can be fed e-liquid without strict reliance upon a gravity feed system.

[0018] Because the cartomizer matrix **98** holds the e-liquid within pod **80**, where the e-liquid was simply filling reservoir **52** in pod **50**, a less viscous e-liquid formulation can be employed. This allows for the e-liquid to be more rapidly drawn across the wick, aiding in the generation of atomized e-liquid that can be entrained within an airflow through pod **80**. Less viscous e-liquids are typically not relied upon in a pod without a cartomizer due to the propensity for leakage, which is reduced due to the presence of the cartomizer matrix.

[0019] Many cartomizers currently available are not in the format of a pod like cartomizer pod **80**, but instead are provided within single-use e-cigarettes that are designed to be disposed of after use. In many of these devices, the limiting factor for the use of the device is the non-rechargeable battery. When the battery is exhausted, the device no longer functions and the user can dispose of it. In a replaceable pod device, such as a device using pod **80**, the battery is typically re-chargeable, so the limiting factor in the lifespan of pod **80** is the e-liquid contained within it.

[0020] Figure 6 illustrates an alternate configuration of a cartomizer pod **80** of the existing art. Sidewall **82** and top wall **84**, and post wick airflow path **86** define an internal reservoir. The internal reservoir is sealed through the insertion of end cap **88** which includes a pre-wick airflow path **90** and electrical contacts **94**. Where the previously illustrated embodiments make use of a wick that is perpendicular to the axial orientation of the post wick airflow path **86**, in the embodiment of Figure 6, wick **96** is inline with the pre-wick airflow path **90** and the post wick airflow path **86**. In the illustrated embodiment, these features are all co-axial. Wick **96** has a hollow center that creates a vertical path through which an airflow can be drawn. Where in previous designs, the wick was surrounded by a heater, in this embodiment, the heater coil **90** is internal to the wick **96**, so that it can help atomize e-liquids into the airflow passing through the middle of the wick **96** from pre-wick airflow passage **90** and on to post wick airflow passage **86**. This configuration allows e-liquid to pass from the cartomizer matrix **98** into the wick **96** over a larger surface area. The location of the heater **94** inside the wick allows for the e-liquid to be atomized adjacent to the airflow within which it is to be entrained.

[0021] Many pod designs making use of a cartomizer matrix to store e-liquids are integrated within the vaping device. Because the pod is not replaceable, the device is treated as a disposable device, and in some devices, there is no mechanism to allow for recharging the battery. As such, the device is provided with enough e-liquid to exceed the ability of the battery to atomize e-liquid. One problem that has been observed relates to the delivery of flavor in the use of a vaping device using a cartomizer matrix. E-liquid is stored within the cartomizer matrix and drawn from the matrix across the wick towards the heater where it is atomized. It has been observed that there is a change in the flavor of the vapor produced by a vaping device over the life of the cartomizer. This phenomenon has been referred to as flavor drop off. Many users complain about the changing nature of the flavor in the generated vapor during the lifetime of a vaporizer using a cartomizer matrix. This is now a typical problem with a conventional pod that directly stores liquid within a reservoir. It should be understood by those skilled in the art that the role of a cartomizer matrix is to help store a less viscous e-liquid that would otherwise cause leakage if it were directly stored within a reservoir.

[0022] It should be understood that the cartomizer matrix is able to hold the less viscous e-liquid within the reservoir through the use of capillary forces that hold the e-liquid within the interstitial spaces of the cartomizer matrix. However, it should also be understood that the e-liquid is not a homogeneous solution, and instead is a combination of components, as noted above. Some of these components may be dissolved within the e-liquid while others may be in suspension. Although all the mechanics of the flavor drop off are not yet clear, it is understood that it does not appear to be associated with a change in the flavorants (such as a denaturing of the flavorant compounds), and instead is associated with the volatile flavorants being consumed in greater quantities early in the life of the cartomizer. This may be associated with migration of flavorants through the e-liquid stored within the reservoir. Although e-liquid may be referred to as being trapped within pockets within the cartomizer matrix, components within the e-liquid can still migrate within the e-liquid, and the e-liquid itself may migrate but only when replaced by other e-liquid. This migration may allow flavorants to migrate into the wick more rapidly than other components of the e-liquid. This results in the flavorants being consumed more quickly than other e-liquid components. As this continues the flavoring of the e-liquid varies over time, and can result in a drop off in the concentration of flavorants in the e-liquid being atomized. As the amount of e-liquid left within the cartomizer matrix decreases, it becomes less flavored, which results in a bad user experience.

[0023] It would therefore be beneficial to have a mechanism to provide a mechanism for improving the consistency in flavor delivery of e-liquid to the wick within a vaporizing system.

## Summary

[0024] It is an object of the aspects of the present invention to obviate or mitigate the problems of the above-discussed prior art.

[0025] In accordance with a first aspect of the present invention, there is provided a pod for storing an atomizable liquid. The pod has an airflow path defining a vertical axis, and a wick located within the pod. The pod comprises a cartomizer matrix having first and second sections. The cartomizer matrix is situated within the pod and stores the atomizable liquid for delivery to the wick. The first section of the cartomizer matrix stores the atomizable liquid with a first capillary force. It is aligned with a location of the wick within the pod. The second section of the cartomizer matrix stores the atomizable liquid with a second capillary force greater than the first capillary force, and is aligned to not overlap with the location of the wick within the pod.

[0026] In an embodiment of the first aspect, the second section of the cartomizer matrix has disjoint first and second parts located on opposite sides of the first section of the cartomizer matrix.

[0027] In another embodiment, the second section of the cartomizer matrix is made from the same material as the first section of the cartomizer matrix. Optionally, the second section of the cartomizer matrix is under greater radial compression than the first section of cartomizer matrix. In another embodiment, a compression member radially compresses the second section of the cartomizer matrix. In a further embodiment, the compression member is integrally formed within a sidewall of the pod. In another embodiment, the compression member is wrapped around the cartomizer matrix and applies a greater radial compression to the second section of the cartomizer matrix than to the first section of the cartomizer matrix.

[0028] In another embodiment, the second section of the cartomizer matrix is made from a different material as the first section of the cartomizer matrix.

[0029] In a further embodiment, the ratio of the volume of the first section of the cartomizer matrix to the second section of the cartomizer matrix is a function of the capillary sizes within the first and second sections of the cartomizer matrix. Optionally, the ratio is also a function of the carrying capacity of the first and second sections with respect to the atomizable liquid. In another embodiment, the second section is sized to store a volume of e-liquid determined in accordance with a determined volume of atomizable liquid associated with flavor drop off.

[0030] In some embodiments, the atomizable liquid is an e-liquid comprising at least one of vegetable glycerine, propylene glycol, nicotine and a flavoring. In some embodiments, the atomizable liquid is an e-liquid containing a cannabinoid.

[0031] In an embodiment the cartomizer matrix comprises at least one of cellulose, cotton, wool, hemp, linen, nylon and other polymer based materials. Optionally, the cartomizer matrix comprises a woven sheet of at least one of cellulose, cotton, wool, hemp, linen, nylon and other polymer based materials. In a further embodiment, the first and section sections of the cartomizer matrix comprise blown nylon filaments with different densities.

[0032] In another embodiment, the first section of the cartomizer matrix is comprises at least one of cellulose, cotton, wool, hemp, linen, nylon and other polymer based materials, and the second section of the cartomizer matrix is a different material than the first section of the cartomizer matrix.

**Brief Description of the Drawings**

[0033] Embodiments of the present invention will now be described in further detail by way of example only with reference to the accompanying figure in which:

Figure 1A is a front view of a prior art pod for use in an electronic nicotine delivery system;

Figure 1B is a side view of the pod of Figure 1A;

Figure 1C is a bottom view of the pod of Figure 1A;

Figure 2 is a cross section of the pod of Figures 1A and 1B along cut line A in Figure 1B;

Figure 3 is a cross section of an alternate pod design;

Figure 4A is a perspective view of a cartomizer pod;

Figure 4B is a bottom view of the pod of Figure 4A;

Figure 5 is a cross section view of the cartomizer pod of Figure 4A along cut line B;

Figure 6 is a cross section view of an alternate configuration for the cartomizer pod of Figure 4A cut along cut line B showing the use of a vertical heater coil;;

Figure 7 is a cross section view of a pod according to an embodiment of the present invention;

Figure 8 is a magnification of the cartomizer matrix in sections 126 and 128 of Figure 7;

Figure 9A is a cross section view of a cartomizer matrix according to an alternate embodiment of the present invention;

Figure 9B is a cross section view of a pod with the cartomizer matrix of Figure 9A;

Figure 10 is a cross section view of a cartomizer pod according to an embodiment of the present invention;

Figure 11 is a cross section view of a cartomizer pod according to an embodiment of the present invention; and

Figure 12 is a cross section view of a cartomizer pod according to an embodiment of the present invention.

[0034] In the above described figures like elements have been described with like numbers where possible.

## Detailed Description

[0035] In the instant description, and in the accompanying figures, reference to dimensions may be made. These dimensions are provided for the enablement of a single embodiment and should not be considered to be limiting or essential. Disclosure of numerical range should be understood to not be a reference to an absolute value unless otherwise indicated. Use of the terms about or substantively with regard to a number should be understood to be indicative of an acceptable variation of up to ±10% unless otherwise noted.

[0036] Although presented below in the context of use in an electronic nicotine delivery system such as an electronic cigarette (e-cig) or a vaporizer (vape) it should be understood that the scope of protection need not be limited to this space, and instead is delimited by the scope of the claims. Embodiments of the present invention are anticipated to be applicable in areas other than ENDS, including (but not limited to) other vaporizing applications. Furthermore, although discussions below specifically make reference to an e-liquid, it should be understood that other atomizable liquids can be used, including those carrying pharmaceutical compounds. Broadly speaking an e-liquid is typically composed of a combination of any of vegetable glycerine, propylene glycol, nicotine and flavorings. Other atomizable liquids may be used to carry compounds, such as cannabinoids, which may use different carriers. It should also be noted that although discussed in the context of a pod, it should be understood that a pod according to the disclosed embodiments does not necessarily have to be removable from the vaping device that it is associated with. Accordingly, a vaping device comprising a battery for storing electrical charge, a processor for regulating the application of charge to the pod, and the pod itself may be embodied as a single item, or the device and pod may be embodied as separate elements.

[0037] A cartomizer matrix for use in a vaping device is often formed from a material such as woven cotton, woven spun nylon, or a similar fabric structure, that is packed into a reservoir within the pod. In some embodiments, a woven material is rolled to create a cylindrical structure. This rolled cartomizer matrix is typically loaded with a wick assembly that includes a vertical airflow structure that provides both a post-wick airflow passage and an interface to a pre-wick airflow passage in the endcap. The amount of material used in the matrix is generally consistent from top to bottom, and is determined in accordance with an e-liquid storage capacity. The above referenced inconsistencies in the cartomizer matrix may be attributed to non-uniformities in the weave of the fabric among other factors. In other embodiments, a filament or thread, such as a nylon, can be heated and then blown into a mold so that it forms to a desired shape. Irregularities in the placement of filaments within the mold may result in small differences in the density of the cartomizer matrix.

[0038] The e-liquid is stored within interstitial spaces within the matrix, such as the spaces between the threads in the woven matrix, the spaces between adjacent woven sheets, and to a limited extent the spaces between filaments within the threads. In embodiments in which the cartomizer matrix is a result of blowing filament into a mold, the interstitial spaces are a function of the volume of filament blown into the mold. The e-liquid is held within these spaces as a result of capillary forces. As e-liquid is drawn out of the matrix, there is a general equalizing force caused by the capillary forces in other areas of the matrix. It has also been observed that sections of the matrix with smaller capillary sizes (either because of the design



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of the substrate forming the matrix, or because of compression of the capillary matrix) exert a stronger capillary force on the e-liquid than sections with larger capillary sizes. Thus, although sections of cartomizer matrix with larger capillary sizes can hold more e-liquid, they will effectively surrender this e-liquid to sections of the cartomizer matrix with smaller capillary sizes (assuming that the section with smaller capillary sizes is not at its e-liquid carrying capacity).

[0039] This preferential e-liquid storage phenomenon can be used to address the e-liquid flavor drop off. If, for example, it is believed that flavor drop off, resulting from rapid consumption of the flavorant, becomes a noticeable phenomenon in the last 15% of the life of the cartomizer matrix pod, cartomizer matrix sections with smaller capillary sizes can be employed to act as e-liquid traps to prevent use of the last 15-20% of the e-liquid. A pod containing a cartomizer matrix may be advertised as storing a defined volume of liquid, it can then be filled with more liquid than advertised to ensure that the advertised volume is available for consumption. The retention of the intentional excess e-liquid allows for the flavorless (or flavor-reduced) e-liquid to be retained so that the user is not subjected to the worst effects of the flavor drop off. Embodiments of pods designed to provide this function will now be discussed with reference to the figures.

[0040] Figure 7 is a cross section of a cartomizer based pod **100** which has a reservoir defined by sidewall **102** and top wall **104**. Into this reservoir, cartomizer matrix **118** can be inserted, and the cartomizer matrix **118** can be sealed within the pod **100** through the insertion of end cap **108**. End cap **108** includes electrical contacts **112** and a pre-wick airflow passage **110**. Prior to insertion of cartomizer matrix **118** into the reservoir, an airflow channel and wick structure comprising wick **116**, heater **114**, ancillary wiring connecting heater **114** to electrodes **112** and an airflow passage linking pre-wick airflow passage **110** to the top of the pod and comprising post-wick airflow passage **106**, is inserted into the cartomizer matrix **118**.

[0041] In the prior art, consistent compression of the matrix **118** in both radial and axial directions results in a matrix that has a generally consistent degree of compression, and thus a generally consistent interstitial spacing between the fibers within the weave of the cartomizer matrix **118**. In the illustrated embodiment, controlled compression of the cartomizer matrix 118 is applied to create high compression sections **124** and low compression sections **120**. It should be understood that the terms high and low compression are only applied in comparison to the other sections of the cartomizer matrix **118**. Compression is controlled through the use of compression members **122** which effectively reduce the radius of the reservoir, causing increased compression of a cartomizer matrix **118** in the high compression sections.

[0042] As noted above, regions **124** in which the cartomizer matrix **118** is compressed demonstrate increased capillary force, and have a greater affinity for e-liquid storage. These compressed regions draw e-liquid to them with greater force than other areas, and are less likely to surrender their stored e-liquid to the regions **120** of the cartomizer matrix **118** that have lower capillary forces.

[0043] In Figure 7, a radially compressed region of the cartomizer matrix is formed through using a compression member implemented as bulge **122** in sidewall **102**. By decreasing the radial space within the pod **100**, bulge **122** creates a high compression section **124**within a consistently sized cartomizer matrix **118**. Regions **120** within the cartomizer matrix **118** where the compressive effects of bulge **122** are not present have reduced degree of compression in comparison to the region **124** adjacent to bulge **122**. It should be understood that the bulge **122** may take the form of a ridge encircling pod **100**, although in some embodiments this may differ. In the illustrated embodiment, a low compression region **120** is provided adjacent the wick **116** to allow for the e-liquid provided to the wick **116** to be preferentially drawn from this region. By ensuring that sufficient e-liquid is inserted into the cartomizer matrix to allow low compression region **120** to store approximately 80-85% of the e-liquid, it is possible to substantially sequester 15-20% of the e-liquid within the high compression sections **124**. This allows the low compression section **120** to house enough e-liquid accessible to the wick **116** so that it will be exhausted of usable e-liquid before flavor drop off is observed by the user. Those skilled in the art will appreciate that if a different e-liquid composition, or different cartomizer matrix composition is used, the 15-20% vs 80-85% e-liquid ratios can be varied if flavor drop off occurs at a different point. Most importantly, it should be understood that bulge **122** acts as a compression member to provide radial compression to a region of the cartomizer matrix **118**. The radial compression caused by a compression member is illustrated in Figure 8, with respect to two portions of the cartomizer matrix, portion **126** outside the radially compressed region and portion **128** which is inside the radially compression region.

[0044] In Figure 8, a magnification of callout **126** is illustrated to show one of the warp or the weft threads **130** in the first section **120** of cartomizer matrix **118**. The interstitial space

**132** illustrated in callout **126** is representative of the space between the threads in a given layer, and between the different layers of a woven material in a stackup of the cartomizer matrix **118**. The e-liquid is typically carried within the interstitial spacing, and is subjected to capillary forces that are associated with the distance between the threads **130**.

[0045] Callout **128**, shows a magnification of the second section **124** of the cartomizer matrix **118** which is subject to radial compression as a result of the compression member embodied by bulge **122**. The threads **134**, and the interstitial space **132** are both subjected to radial compression **136** caused by the narrower diameter of the interior of pod **100** as a result of the bulge **122**. This compression reduces both the lateral size of the threads **134** and the spacing **132** between them. This compression causes a reduction in the interstitial spacing **132**, both the spacing between the threads **134** and the spacing between filaments within the threads **134**. This compression may reduce the quantity of e-liquid held by the second section **122** of the cartomizer matrix **118**, but it also increases the capillary forces at play within the cartomizer matrix **118**. This increase in the capillary forces will reduce the likelihood of e-liquid being drawn away from the second section **122** by the first section **120** of cartomizer matrix **118**. This will create a hydrodynamic system in which e-liquid stored in the first section **120** preferentially flows to the second section **124**, where it can be drawn into wick **116**.

[0046] Figures 9A and 9B illustrate an embodiment of pod **100** that stores a first section **120** of the cartomizer matrix **118** under a lower compressive force than a second section **140** of the matrix **118**. Where previous embodiments of the pod **100** used a compression member, in the embodiment of Figure 9B, a different configuration of the cartomizer matrix **118** is used, as illustrated in Figure 9A. Where in other embodiments, and in the prior art, a cartomizer matrix is generally uniform in cross section, the cross section of matrix **118** illustrated in Figure 9A has sections with differing widths. A first section **120** is less wide than each of the second sections **140**. First section **120** can be adjusted in location to place it so that it will coincide with the placement of wick **116** within the assembled pod **100** as shown in Figure 9B. Second sections 140 are placed away from alignment with the wick so that they will sequester a quantity of e-liquid away from the wick 116.Because a larger quantity of the cartomizer matrix **118** is stored within the same width, second section **140** will be subject to higher radial compressive forces within pod **100**. This greater compression will result in higher capillary forces within second sections **140**, as demonstrated by the differences in callouts **126** and **128**, which were previously shown in Figure 8. Although pod **100** in Figure 9B is not shown as having a compression member, it is possible for a cartomizer matrix **118** as shown in Figure 9A to be used in conjunction with a compression member such as a bulge or ridge as previously shown.

[0047] Figure 10 illustrates a further embodiment of pod **100**. Although structurally similar to the description of pod **100** in Figure 9, in the embodiment of Figure 10, pod **100** makes use of a cartomizer matrix **150** composed of different materials. To obtain the different capillary sizes required for the first and second sections, instead of a radial compression, pod **100** makes use of a cartomizer **150** that has a first section made of a first material **152** and second sections made of a second material **154**. It should be understood that the first and second materials have different capillary sizes, even if made of the same underlying material. In one embodiment, material **152**, corresponding to the first section, may be made of an absorbent nylon, while material **154**, corresponding to the second section, may be made of a super absorbent nylon (or other super absorbent fiber). The different material structure provides for higher capillary forces in the second section without requiring compression of the matrix. In another embodiment, the two sections could be formed of first and second cellulose sponges, with the first cellulose sponge **152** having a larger pore structure than the second cellulose sponge **154**. This will result in more e-liquid being stored in the first section, but the e-liquid stored in the second sections being more tightly held. It should be understood that using different underlying materials for the first and second materials has also been considered, so that a cartomizer matrix **150** made up of a first material **152** such as cotton and a second material **154** such as a cellulose based sponge with smaller capillaries could be used. The smaller capillaries in the second material **154**, much like the compressed material in the above described embodiments, results in a greater capillary force that acts to hold the e-liquid. As a result, e-liquid within the first material **152** can be drawn into wick **116**, while the e-liquid within the second material **154** may be available for flavorant migration, but will be otherwise substantially sequestered. Second material **154** will preferentially store e-liquid within the cartomizer matrix **150**, and will allow the e-liquid within the first material **152** to be exhausted to aid in the pre-emption of flavor drop off.

[0048] In the above illustrations, a horizontally aligned wick is illustrated. Vertically oriented wicks allow for a replacement of some of the airflow path between the pre-wick airflow path and the post wick airflow path. This can provide for a large interface area between the wick and the cartomizer matrix, while minimizing the distance through the wick that the e-liquid has to traverse to before it is atomized so that it can be entrained within the airflow. Conventional vertical wicks demonstrate some desirable user experience characteristics including a desirable flavor and vapor delivery with a sufficiently high power delivered to the heater, but often have poor wicking characteristics that can result in negative user experiences. The application of high power to the heater to generate the desired flavor can burn the wick if the wick has not been able to draw in enough e-liquid. Although this is a problem also faced by horizontal wicks, it may be more pronounced with vertical wicks due to the higher power required by their heaters.

[0049] Figure 11 illustrates a pod **160** making use of a vertical wick **176**. Pod **160** has sidewalls **162** and a top wall **164**, and defines a post wick airflow passage **166**. The interior of pod **160** forms a reservoir. An end cap **168** having pre-wick airflow passage **170** and electrical contacts **172**, is sized to seal the reservoir within pod **160** created by the sidewalls **162** and top wall **164**. Connecting the prewick airflow passage **170** to the post wick airflow passage **166** is vertical wick **176**. As with conventional vertical wicks, vertical wick **176** is illustrated as a hollow cylinder of wick material, such as cotton, with an open central column. The vertical wick **176** houses a heater **174** that is connected to electrical leads **172**. The heater is at the interface of the vertical wick with its open central column. When activated, heater **174** will volatilize e-liquid drawn from cartomizer matrix **178** across wick **176**.

[0050] Within pod **160**, e-liquid will be preferentially drawn to the second section **180**of cartomizer matrix **178**, while the first cartomizer section 182 is used to hold a larger quantity of e-liquid under a lower capillary force. E-liquid is drawn from the first section **182** by wick **176** to replenish the wick **176** after each use. As e-liquid is consumed, there may be an exchange of liquid between the first cartomizer matrix section **182** and the second cartomizer matrix section **180**. In such an exchange, the second cartomizer section matix **180** will tend to keep the same amount of e-liquid, so this exchange is not typically associated with replenishing e-liquid within the first cartomizer section **182**. It should be noted however, that this exchange is typically, at least for the early part of the pod life, an exchange of fully flavored e-liquid from the second cartomizer matrix section for less flavored e-liquid from the first cartomizer section. Additionally, there may be a migration of flavorants within the e-liquid from high density locations within the second cartomizer matrix sections **182** to the less flavorant dense regions of e-liquid within the first cartomizer matrix section **180**. As e-liquid is consumed, it is drawn largely from the first section **182** of the cartomizer matrix **178**. The higher capillary forces within the second sections **180** will result in e-liquid being substantively sequestered within these sections of the cartomizer matrix **178** to allow for the pre-emption of flavor drop off.

[0051] Although Figure 11 illustrates the use of a compression member **184** to create the radial compression of the second section **182**, it should be understood that the substantially similar effect could be accomplished through the use of a cartomizer matrix similar to matrix **118** shown in Figure 9B, with or without the use of the compression member **184** shown in Figure 11.

[0052] It should also be understood that while compression members, such as compression member **184**, or bulge **122** are illustrated as features within the pod and attached to the interior of the sidewall, this is one of a number of different possible embodiments. In some other embodiments, an insert into the reservoir may be used to provide a compression member located to create radial compression of the cartomizer matrix in the area surrounding the interface between the wick and the cartomizer matrix. In other embodiments a compression member may take the form of a resilient band wrapped around a cartomizer matrix before insertion into the pod reservoir. This compression member could be made from a resilient material such as silicone, and could be used to create radial compression of the cartomizer matrix to surround the interface between the cartomizer matrix and the wick. In embodiments where the reservoir is not directly accessible to a user, for example, where the vaping device has an integral pod, the compression members may be external to the pod but applying a radial compression to sections of the pod. Other embodiments may use different techniques to create zones with different capillary forces.

[0053] Figure 12 illustrates a cross section of an alternate embodiment of pod **160** in which the cartomizer **186** is formed from sections with different capillary properties. Where the structure of the overall pod **160** is similar to that of the pod illustrated in Figure 11, vertical wick **176** engages with a cartomizer **186** made of a first section **188** surrounded by a second section **190**.

[0054] To obtain the different capillary sizes required for the first and second sections, instead of a radial compression, pod **160** makes use of a cartomizer **186** that has a first section made of a first material **188** and a second section made of a second material **190**. It should be understood that the first and second materials have different capillary sizes, even if made of the same underlying material. In one embodiment, material **188**, corresponding to the first section, may be made of an absorbent nylon, while material **190**, corresponding to the second section, may be made of a super absorbent nylon (or other super absorbent fiber). The different material structure provides for higher capillary forces in the second section without requiring compression of the matrix. In another embodiment, the two sections could be formed of first and second cellulose sponges, with the first cellulose sponge **188** having a larger pore structure than the second cellulose sponge **190**. It should be understood that using different underlying materials for the first and second materials has also been considered, so that a cartomizer matrix **186** made up of a first material **188** such as cotton and a second material **190** such as a cellulose based sponge with smaller capillaries could be used. The smaller capillaries in the second material **190**, much like the compressed material in the above described embodiments, results in a greater capillary force that acts to hold the e-liquid. As a result, e-liquid will be substantially sequestered within the second material **190** so that as e-liquid is drawn from the first material **188** into wick **176** a portion of the e-liquid is effectively sequestered. Second material **190** will preferentially store e-liquid within the cartomizer matrix **186**, and will allow for substantial pre-emption of the flavor drop off by preventing the use of a portion of e-liquid stored within cartomizer matrix **186**.

[0055] As shown above, the differing capillary forces can be achieved through the use of sections in which different capillary forces may be a result of differing sizes of pores or interstitial spaces. These differing pore sizes or sizing of interstitial spaces can be a result of material selection or it could be the result of a radial compression applied to one of the sections. As shown above, radial compression can be achieved through the use of a compression feature that is built into the internal reservoir of the pod, or it can be achieved through the use of a separate element. Those skilled in the art will appreciate that a cartomizer matrix of a non-uniform width could also be used in a pod either with or without a compression feature. The radial compression allows for defined boundaries between the first and second sections. A cartomizer matrix made of two materials can also make use of radial compression as described above, though it may not be strictly necessary based on the selection of the different cartomizer materials.

[0056] In embodiments using a cartomizer matrix formed through a process of blowing threads, filaments or fibers into a mold, regions of different density may be produced through blowing more or less of the material into the mold in a given time interval, or through the use of differential heating of the material as it is being blown into the mold. This may allow for the creation of a matrix that has smaller interstitial spaces in some areas, and larger interstitial spaces in other areas. In such an embodiment, the pod **160** shown in Figure 12 can be integrally formed with different cartomizer sections having different capillary forces within the sections.

[0057] In the instant description, and in the accompanying figures, reference to dimensions may be made. These dimensions are provided for the enablement of a single embodiment and should not be considered to be limiting or essential.The sizes and dimensions provided in the drawings are provided for exemplary purposes and should not be considered limiting of the scope of the invention, which is defined solely in the claims.

CLAIMS

1. A pod for storing an atomizable liquid, the pod having an airflow path defining a vertical axis, and a wick located within the pod, the pod comprising:

a cartomizer matrix within the pod for storing the atomizable liquid for delivery to the wick, the cartomizer matrix comprising:

a first section of the cartomizer matrix, for storing the atomizable liquid with a first capillary force, the first section aligned with a location of the wick within the pod; and

a second section of the cartomizer matrix, for storing the atomizable liquid with a second capillary force greater than the first capillary force, the second section aligned to not overlap with the location of the wick within the pod.

2. The pod of claim 1 wherein the second section of the cartomizer matrix has disjoint first and second parts located on opposite sides of the first section of the cartomizer matrix.

3. The pod of any one of claims 1 and 2 wherein the second section of the cartomizer matrix is made from the same material as the first section of the cartomizer matrix.

4. The pod of claim 3 wherein the second section of the cartomizer matrix is under greater radial compression than the first section of cartomizer matrix.

5. The pod of claim 4 wherein a compression member radially compresses the second section of the cartomizer matrix.

6. The pod of claim 5 wherein the compression member is integrally formed within a sidewall of the pod.

7. The pod of any one of claims 5 and 6 wherein the compression member is wrapped around the cartomizer matrix and applies a greater radial compression to the second section of the cartomizer matrix than to the first section of the cartomizer matrix.

8. The pod of any one of claims 1 to 7 wherein the second section of the cartomizer matrix is made from a different material as the first section of the cartomizer matrix.



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9. The pod of any one of claims 1 to 8 wherein the ratio of the volume of the first section of the cartomizer matrix to the second section of the cartomizer matrix is a function of the capillary sizes within the first and second sections of the cartomizer matrix.

10. The pod of claim 9 wherein the ratio is also a function of the carrying capacity of the first and second sections with respect to the atomizable liquid.

11. The pod of claim 10 wherein the second section is sized to store a volume of atomizable liquid determined in accordance with a determined volume of atomizable liquid associated with flavor drop off.

11. The pod of any one of claims 1 to 10 wherein the atomizable liquid is an e-liquid comprising at least one of vegetable glycerine, propylene glycol, nicotine and a flavoring.

12. The pod of any one of claims 1 to 11 wherein the atomizable liquid is an e-liquid containing a cannabinoid.

13. The pod of any one of claims 1 to 12 wherein the cartomizer matrix comprises at least one of cellulose, cotton, wool, hemp, linen, nylon and other polymer based materials.

14. The pod of claim 13 wherein the cartomizer matrix comprises a woven sheet of at least one of cellulose, cotton, wool, hemp, linen, nylon and other polymer based materials.

15. The pod of any one of claims 1 to 14 wherein the first and section sections of the cartomizer matrix comprise blown nylon filaments with different densities.

16. The pod of any one of claims 1 to 15 wherein the first section of the cartomizer matrix is comprises at least one of cellulose, cotton, wool, hemp, linen, nylon and other polymer based materials, and the second section of the cartomizer matrix is a different material than the first section of the cartomizer matrix.



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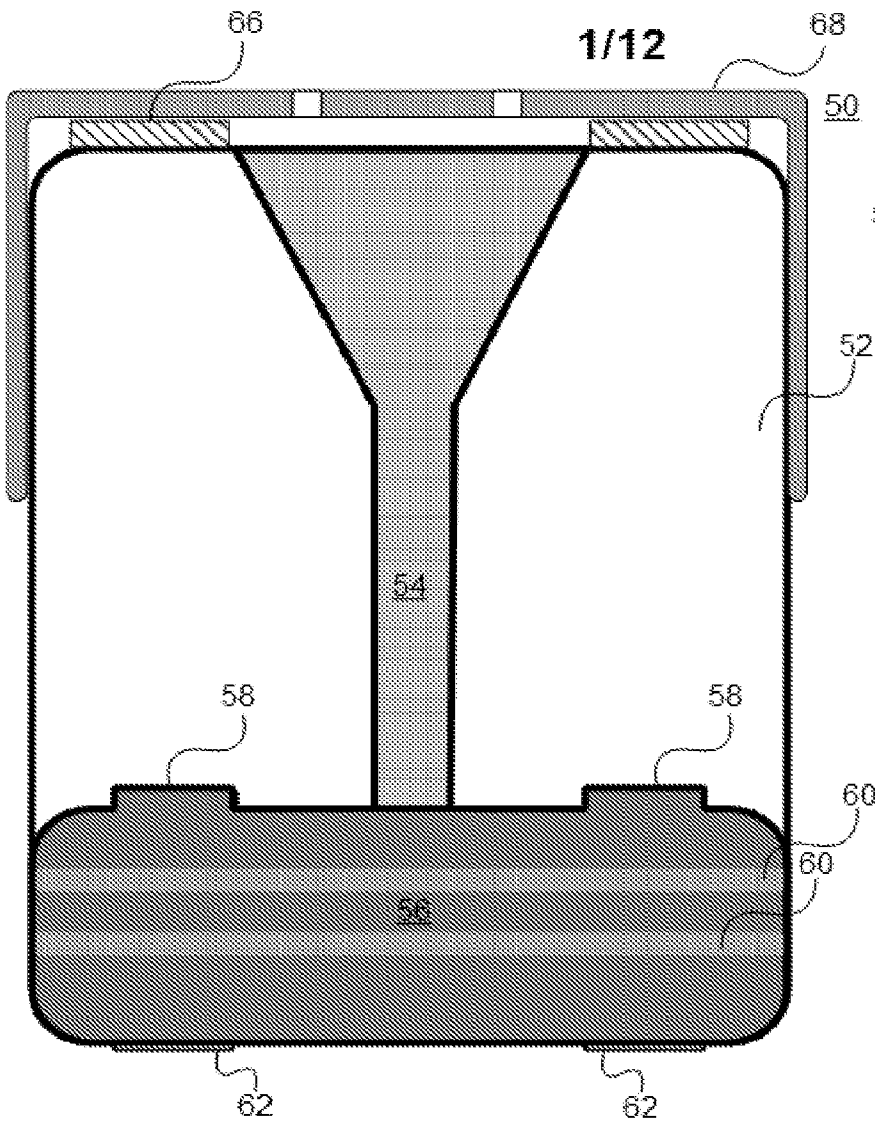


Fig. 1A (Prior Art)

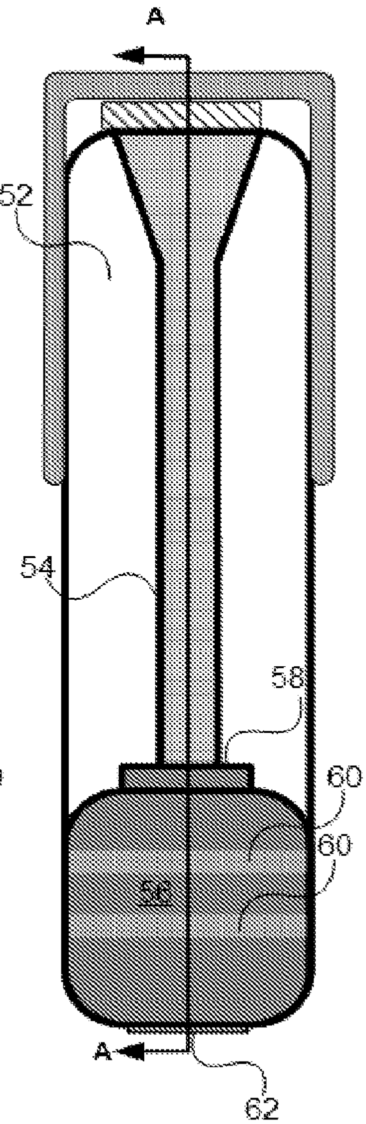


Fig. 1B
(Prior Art)

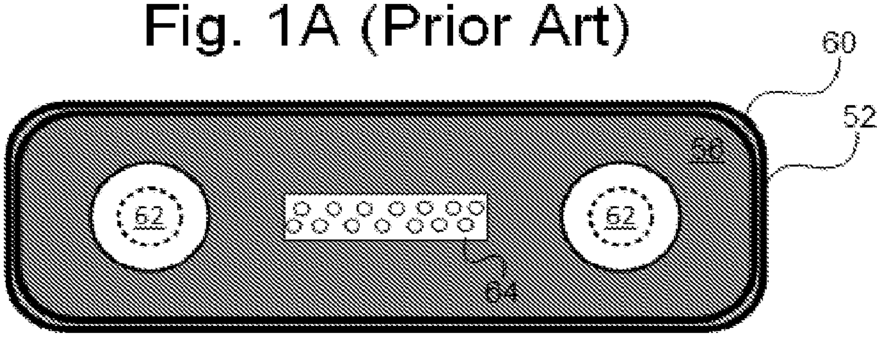


Fig. 1C (Prior Art)

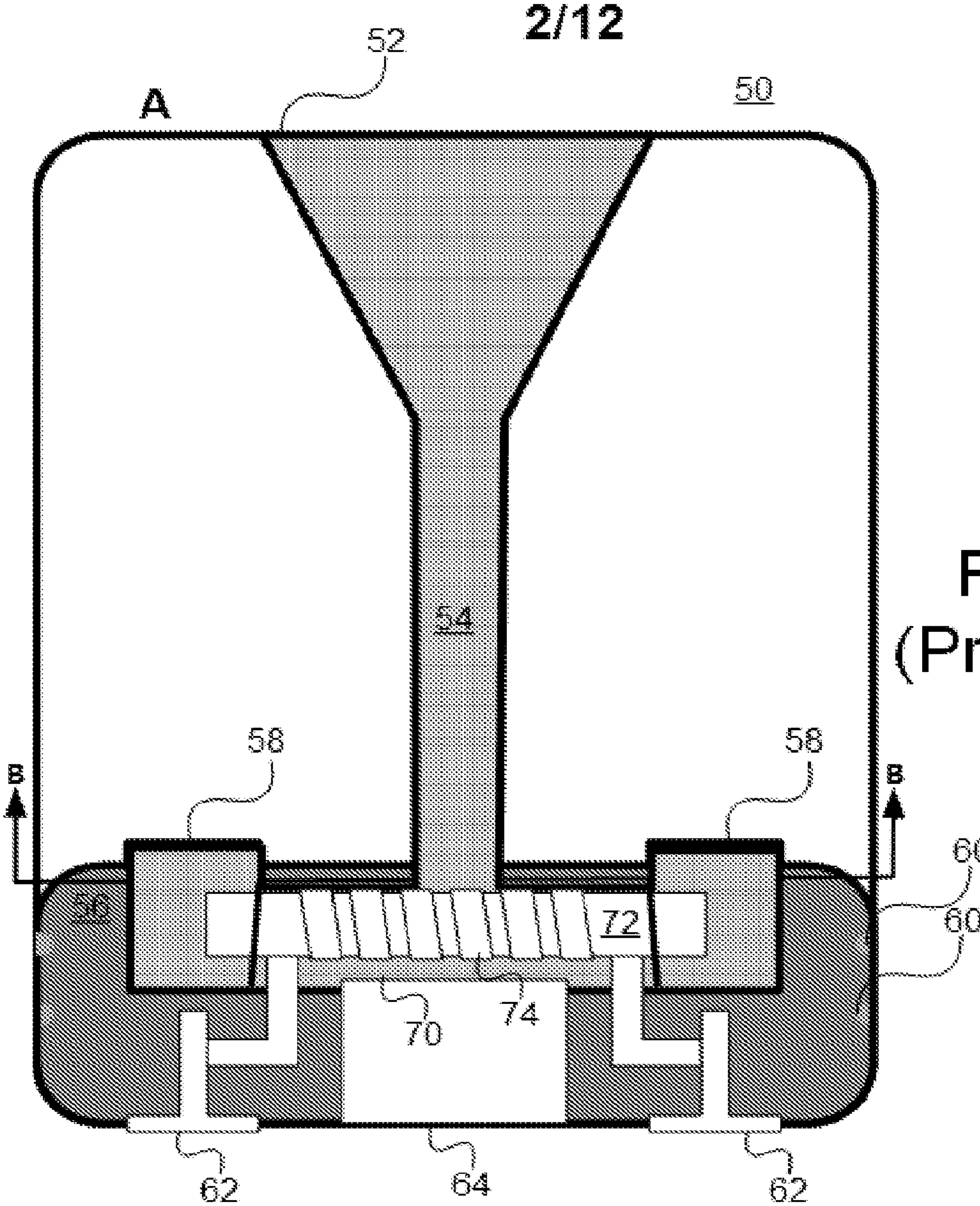


Fig. 2
(Prior Art)

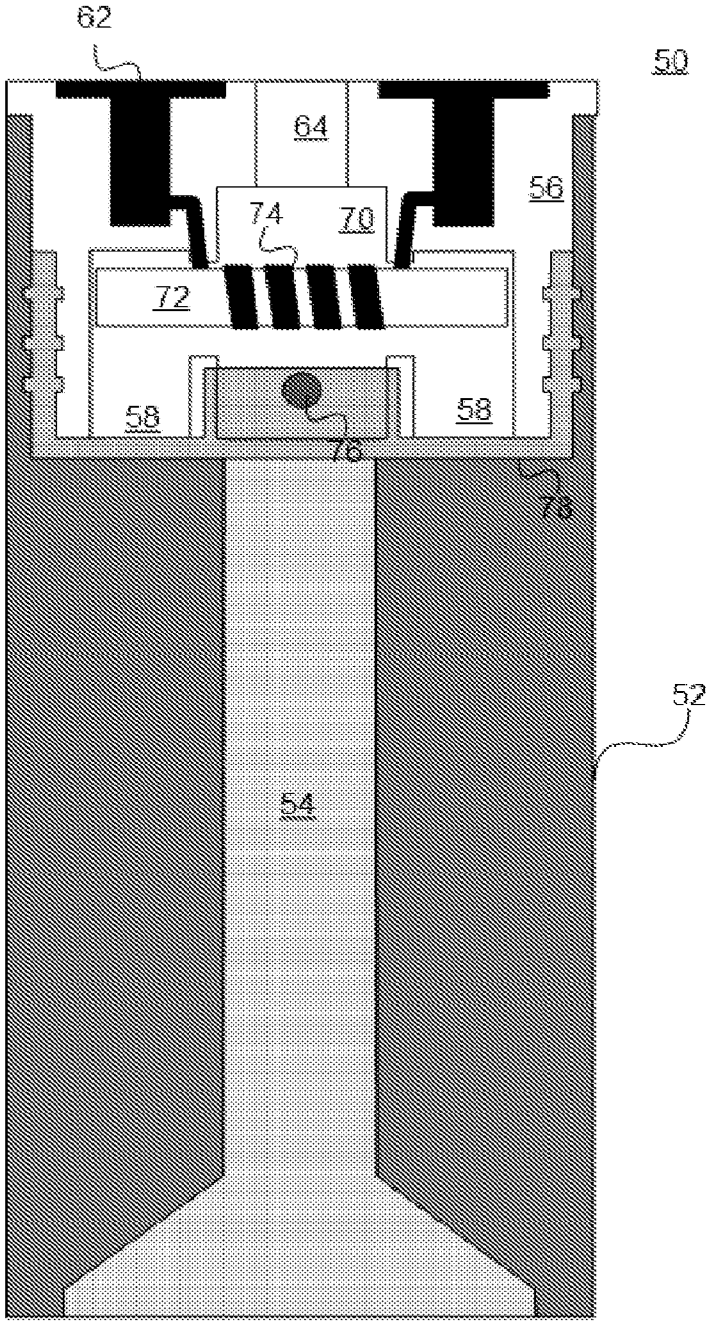


Fig. 3

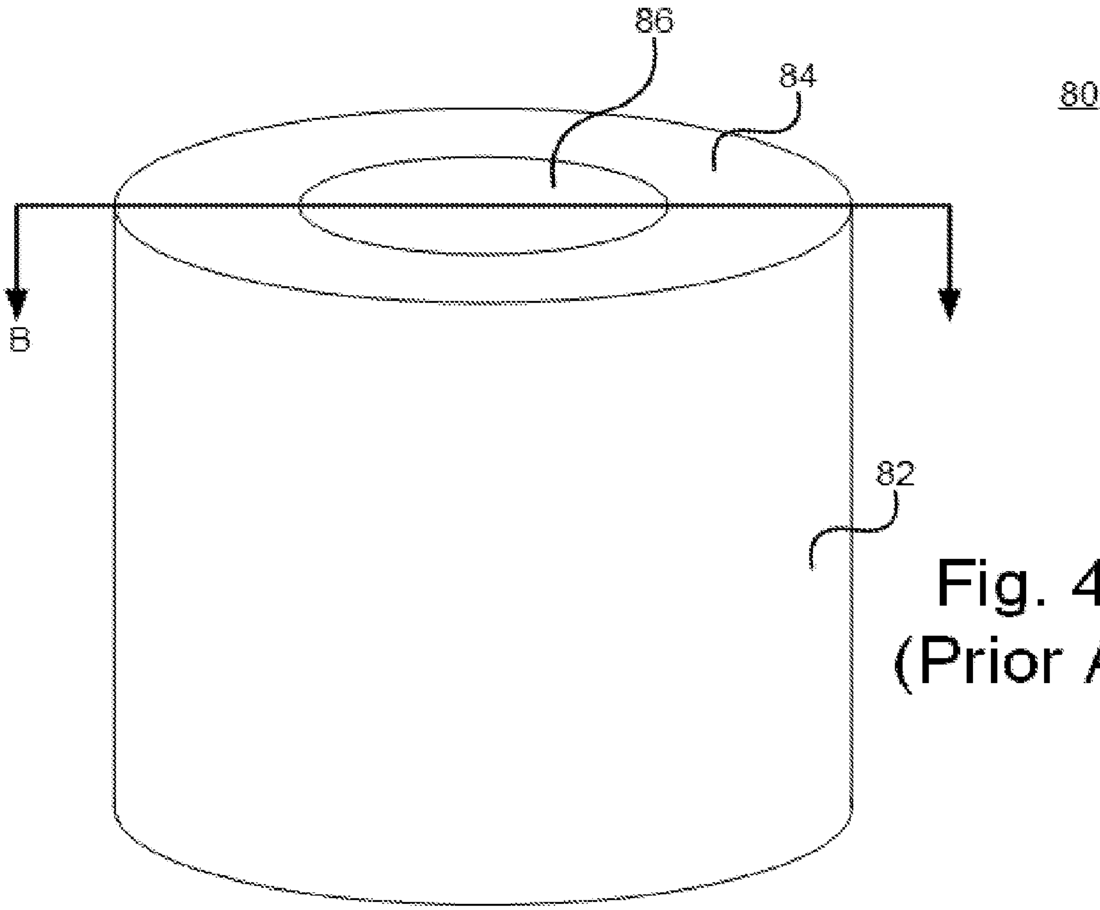


Fig. 4A
(Prior Art)

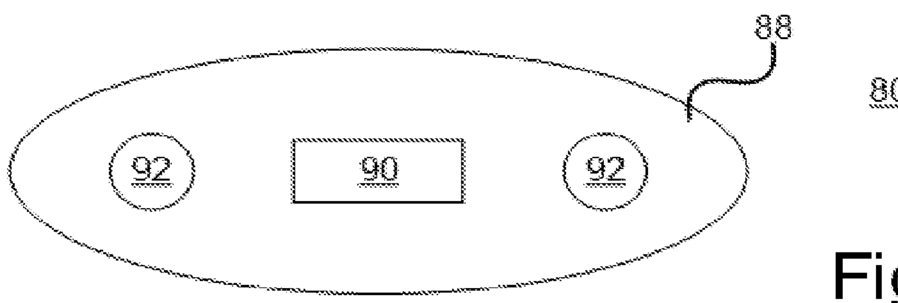


Fig. 4B
(Prior Art)

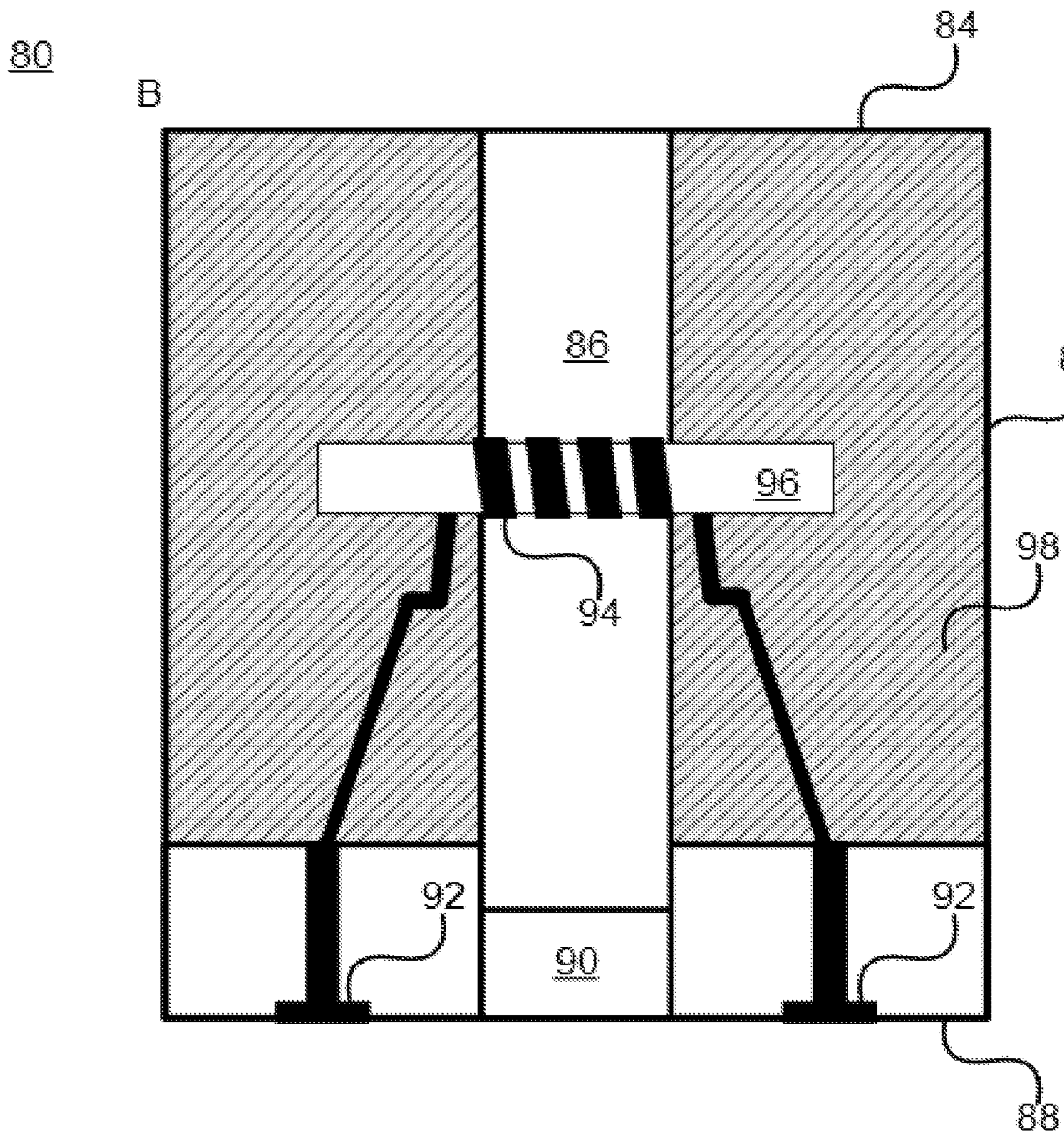


Fig. 5 (Prior Art)

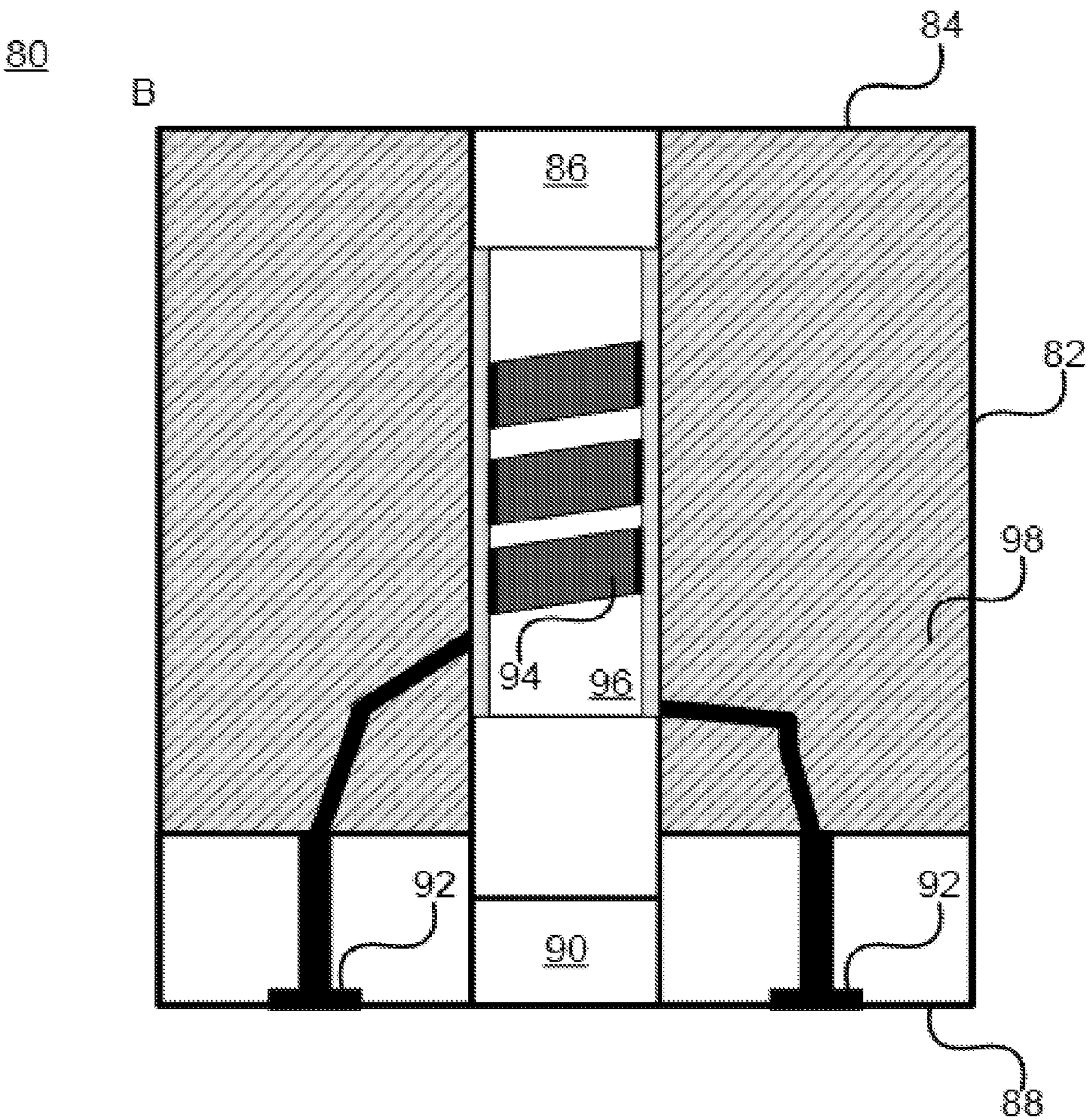


Fig. 6 (Prior Art)

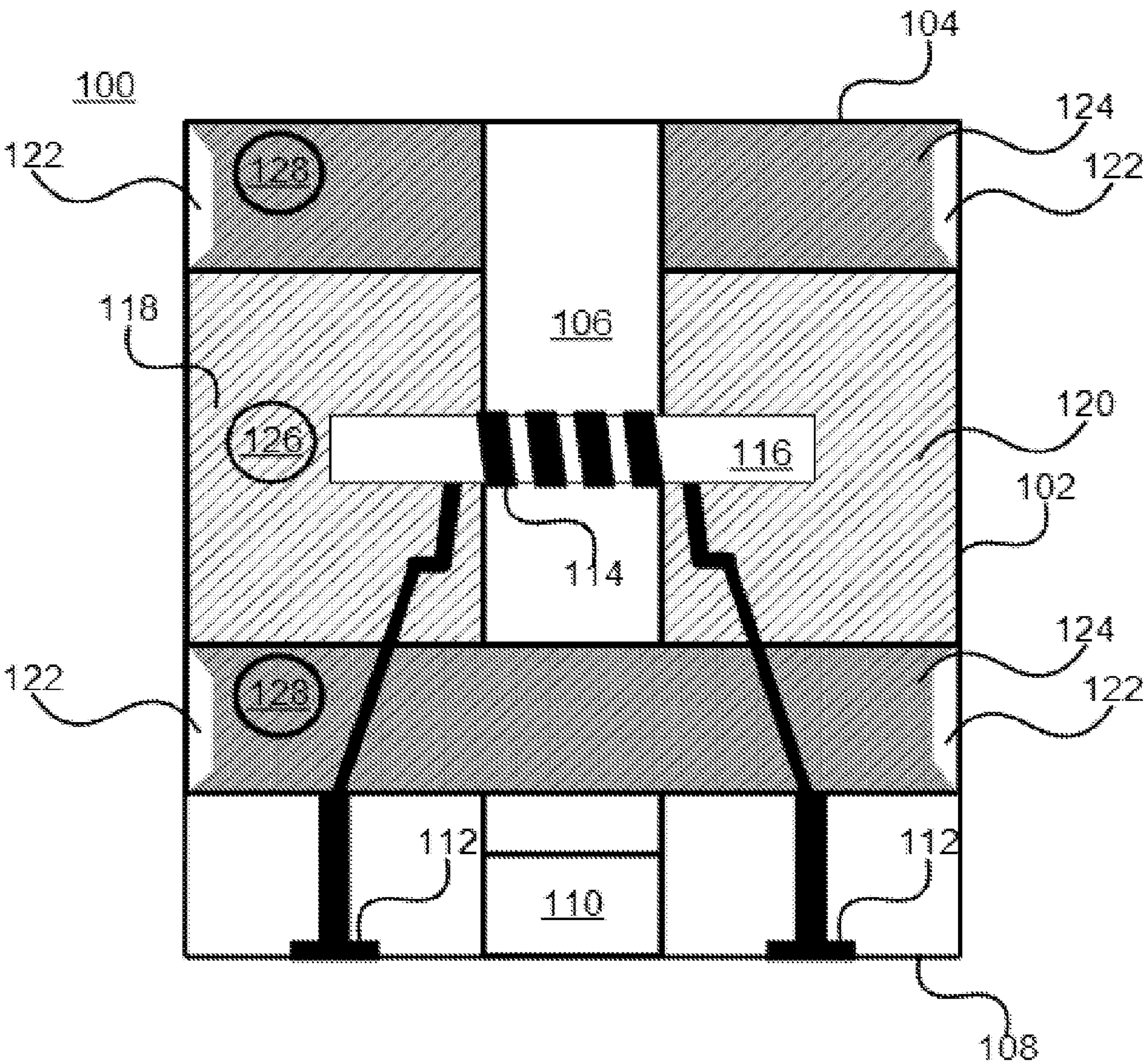
100
104
124
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Fig. 7

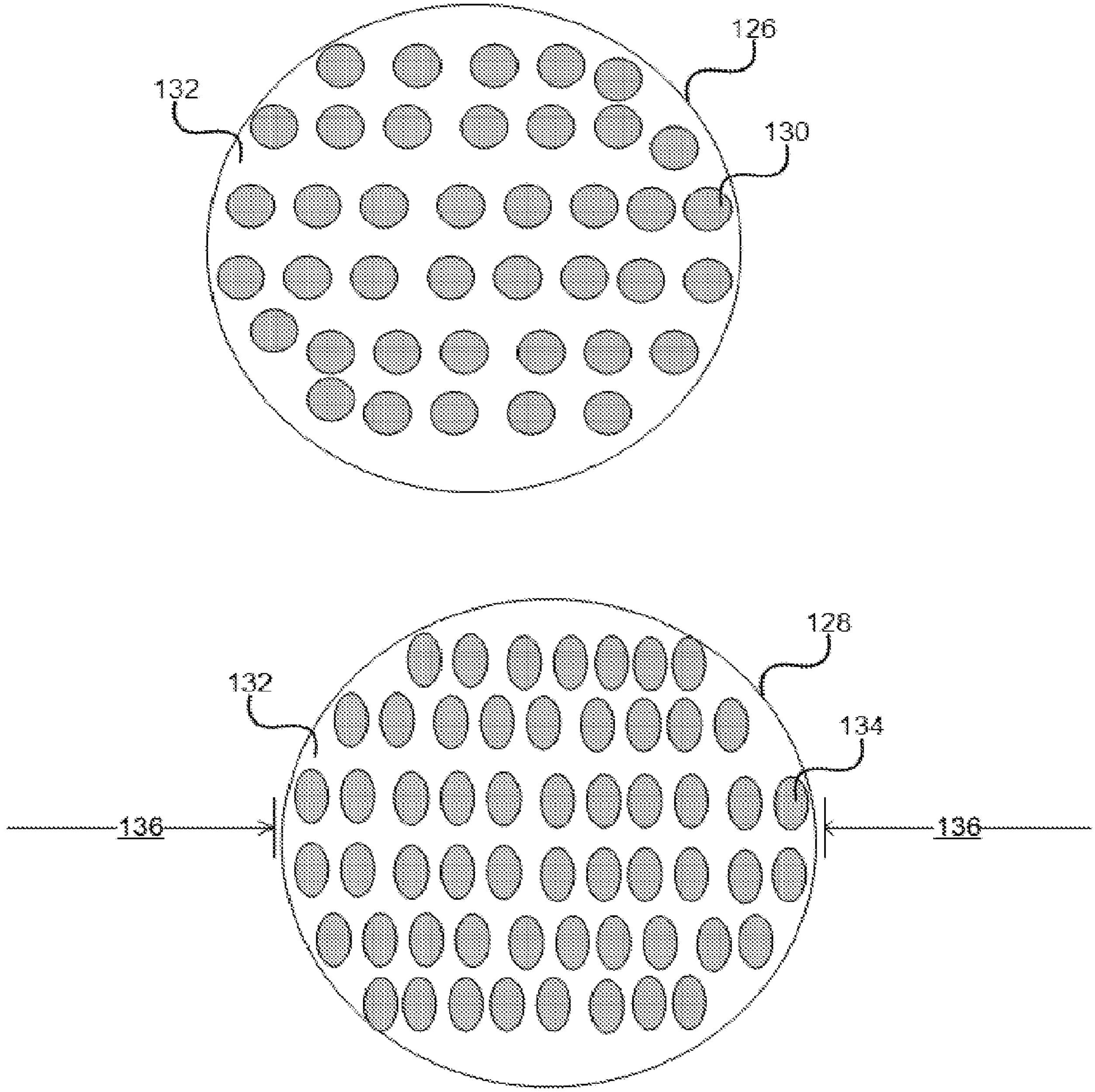
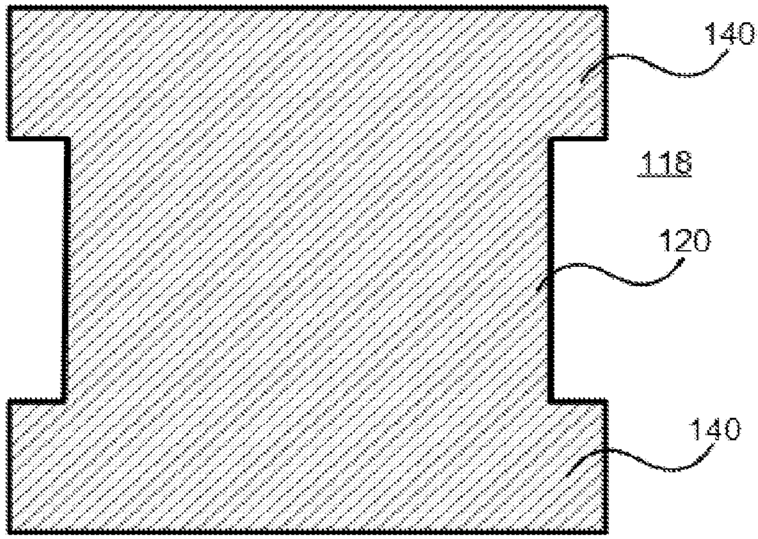



Fig. 8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118
120
140

Fig. 9A

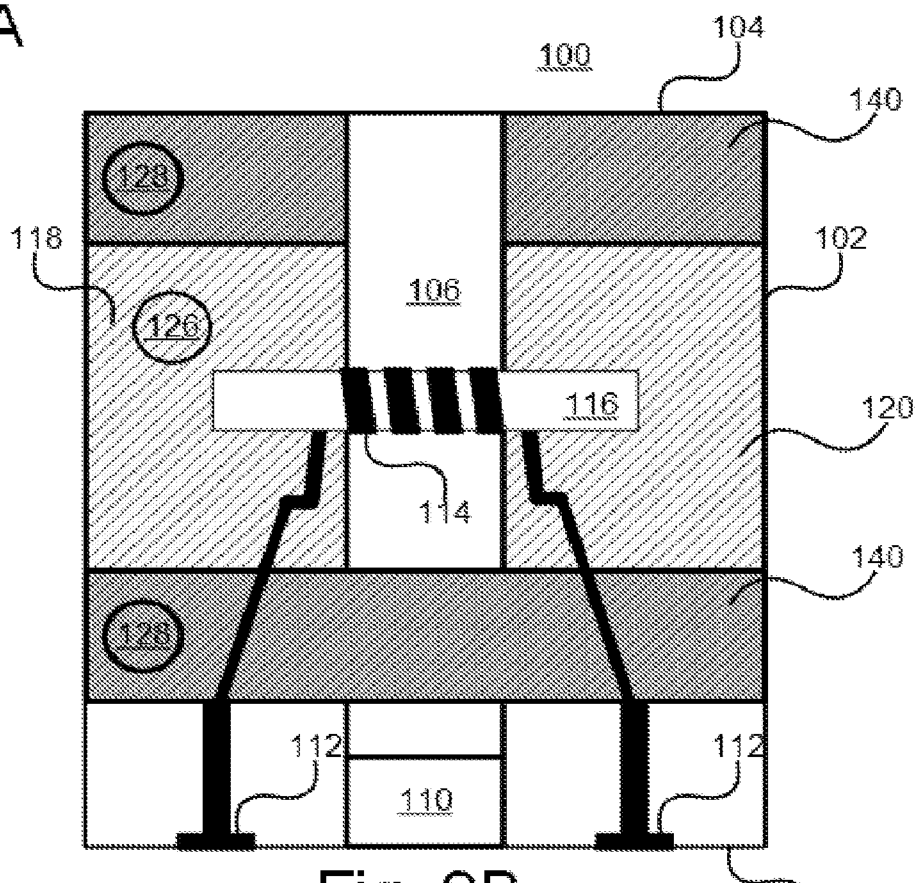
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Fig. 9B

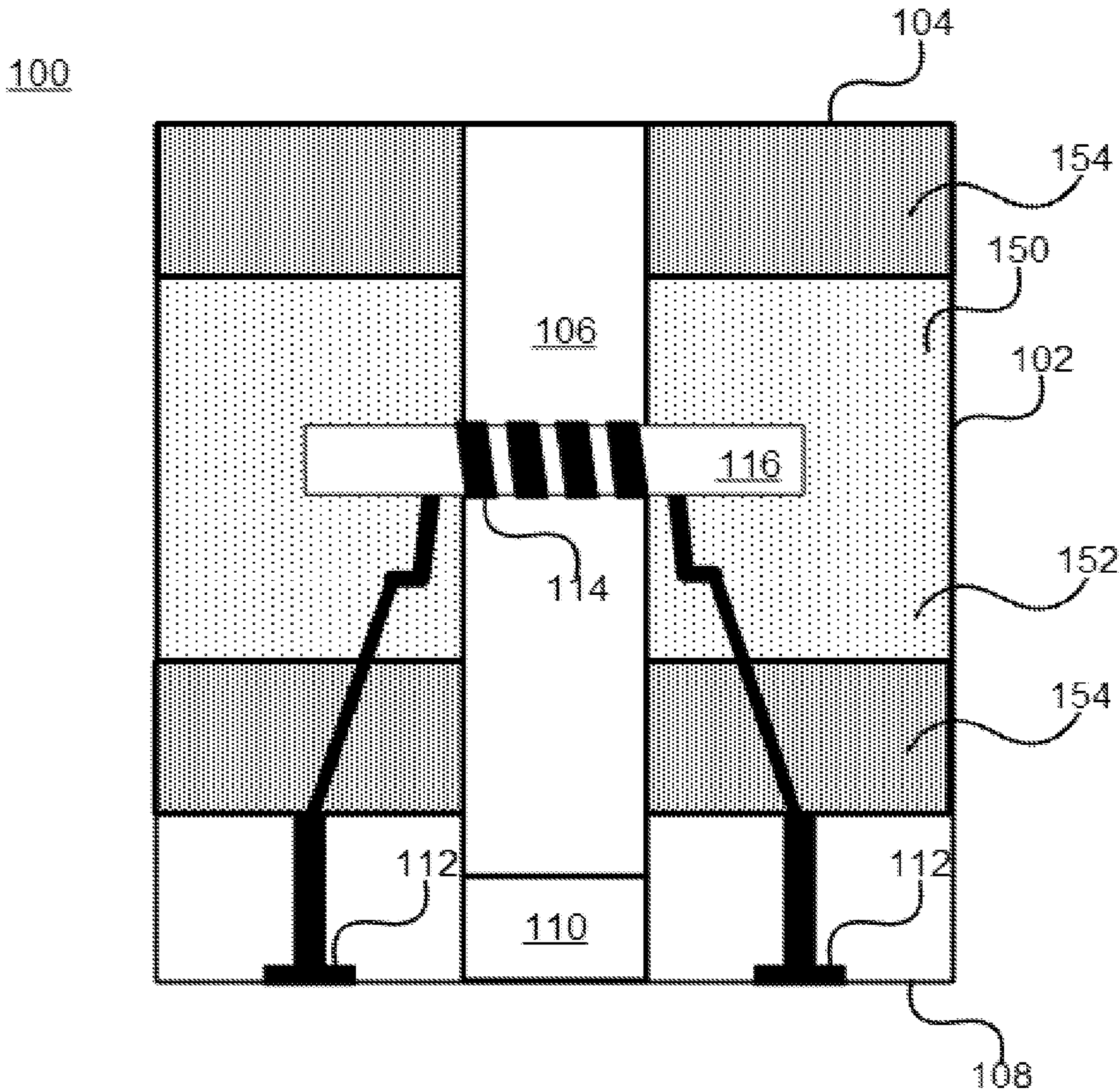


Fig. 10

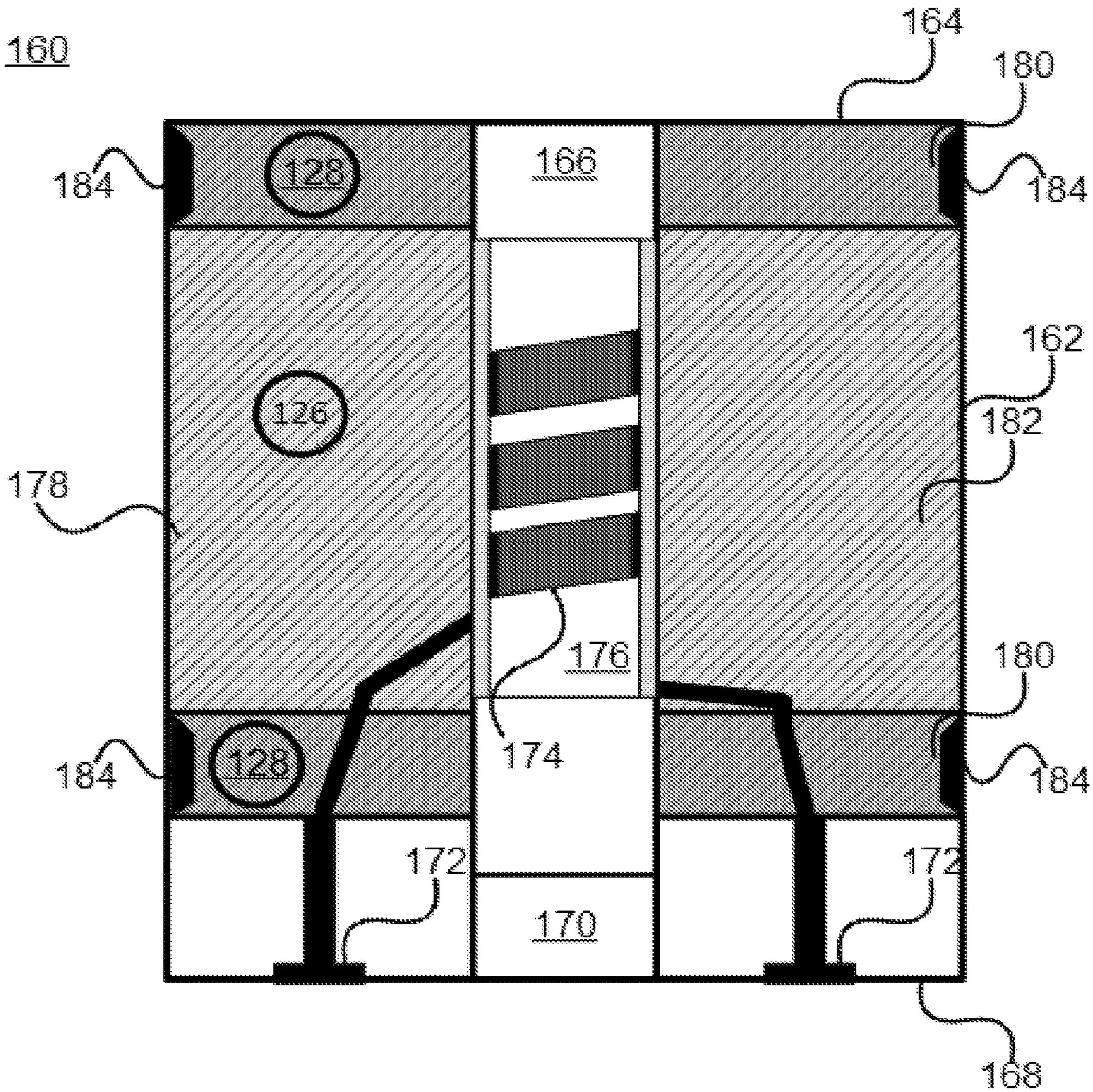
160
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Fig. 11

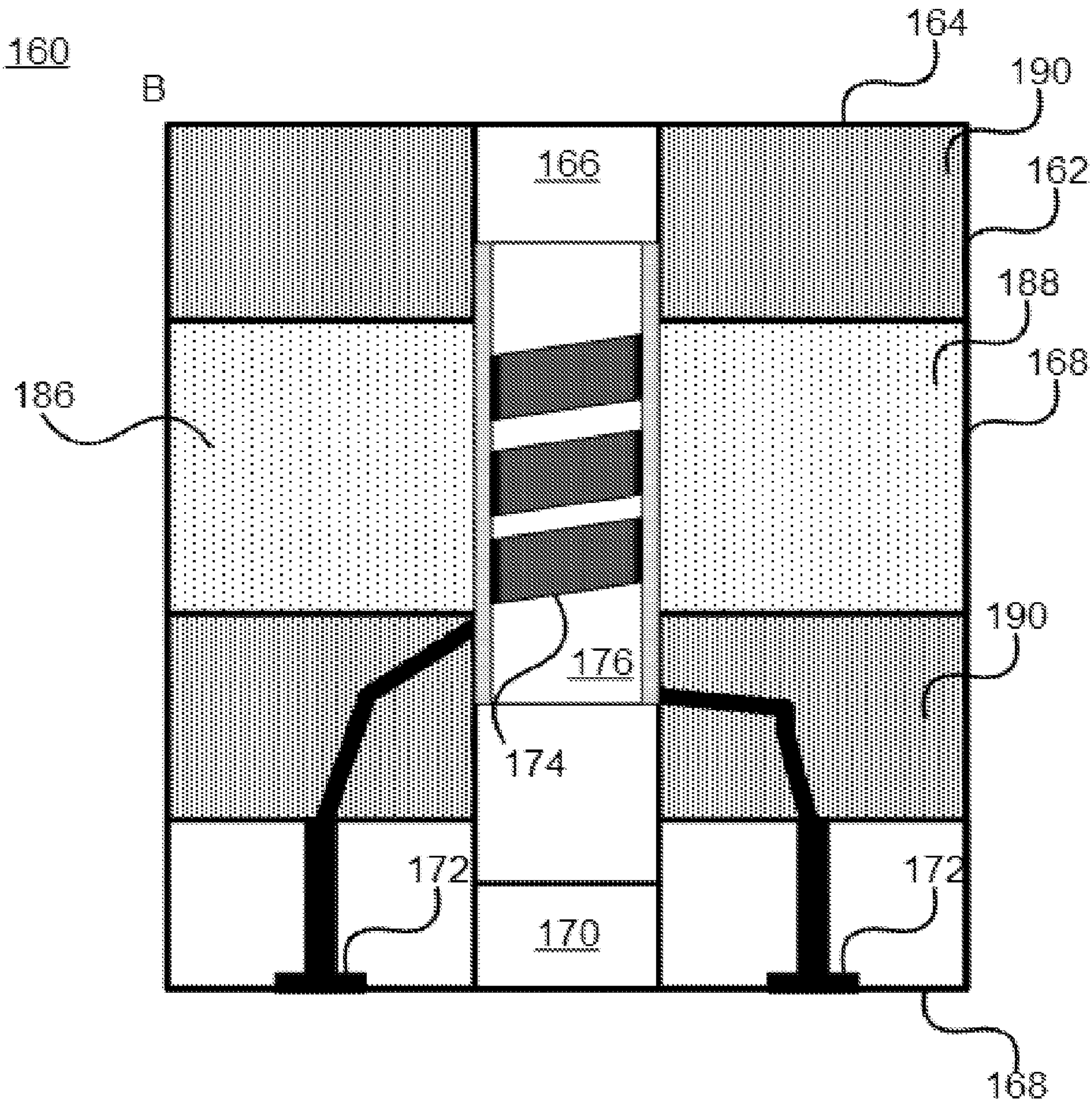


Fig. 12

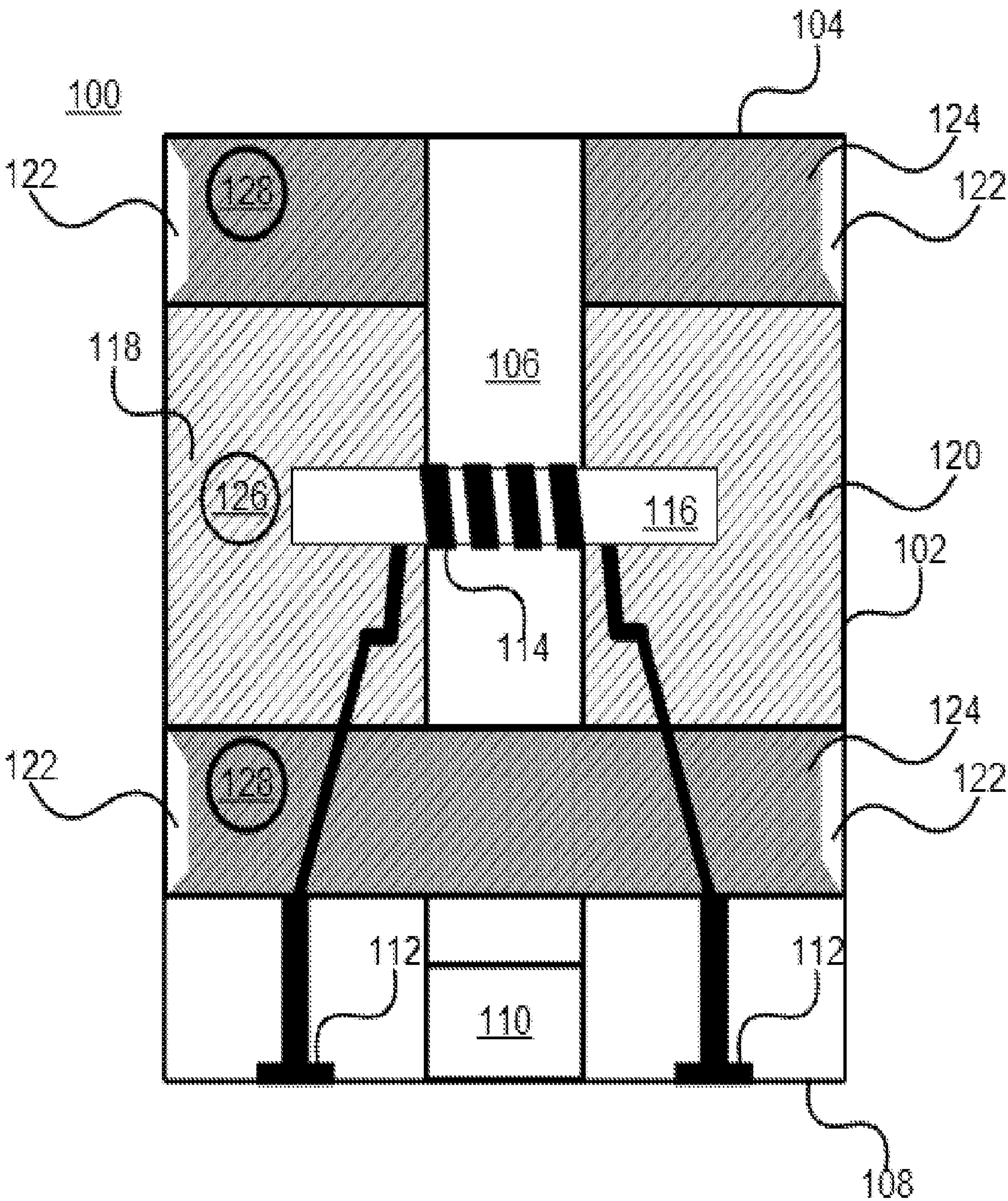


Fig. 7