US Patent & Trademark Office
Patent Public Search | Text View

United States Patent Application Publication 20250248449
Kind Code A1
Publication Date August 07, 2025
Inventor(s) HOLTZ; Arie et al.

HEATING ELEMENT AND HEATER ASSEMBLIES, CARTRIDGES, AND E-VAPOR DEVICES INCLUDING A HEATING ELEMENT

Abstract

In an example embodiment, a heater assembly for an electronic heating device includes a heating element and a support. The heating element includes a planar portion, a first lead, and a second lead. The planar portion includes a filament. The filament defines an air channel through the planar portion. The filament includes a plurality of curves. At least one of the curves has a tip thereon. At least one of the first lead portion, the second lead portion, or both the first lead portion and the second lead portion are generally coplanar with the planar portion of the heating element. The heating element is in contact with the support such that the tip of the at least one of the curves rests thereon.

Inventors: **HOLTZ; Arie (Jerusalem, IL), WEIGENSBERG; Isaac (Tekoa, IL)**

Applicant: **Altria Client Services LLC** (Richmond, VA)

Family ID: **66734791**

Assignee: **Altria Client Services LLC (Richmond, VA)**

Appl. No.: **19/185966**

Filed: **April 22, 2025**

Related U.S. Application Data

parent US continuation 18538706 20231213 parent-grant-document US 12290104 child US 19185966
parent US continuation 16273612 20190212 parent-grant-document US 11882878 child US 18538706
parent US continuation-in-part 15135930 20160422 parent-grant-document US 11083229 child US

16273612
us-provisional-application US 62151809 20150423

Publication Classification

Int. Cl.: **A24F40/46** (20200101); **A24F40/10** (20200101); **H05B3/06** (20060101); **H05B3/14** (20060101); **H05B3/16** (20060101); **H05B3/44** (20060101)

U.S. Cl.:

CPC **A24F40/46** (20200101); **H05B3/06** (20130101); **H05B3/141** (20130101); **H05B3/16** (20130101); **H05B3/44** (20130101); A24F40/10 (20200101); H05B2203/013 (20130101); H05B2203/021 (20130101)

Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of U.S. application Ser. No. 18/538,706, filed Dec. 13, 2023, which is a continuation of U.S. application Ser. No. 16/273,612, filed Feb. 12, 2019, which is a continuation-in-part of U.S. application Ser. No. 15/135,930, filed Apr. 22, 2016, which claims priority to U.S. provisional application No. 62/151,809 filed on Apr. 23, 2015, the entire contents of each of which are hereby incorporated by reference.

BACKGROUND
Field
[0002] At least some example embodiments relate generally to an electronic vaping (e-vaping or e-vapor) device.
Related Art
[0003] Electronic vaping devices are used to vaporize a pre-vapor formulation into a vapor. These electronic vaping devices may be referred to as e-vaping devices. E-vaping devices include a heater, which vaporizes the pre-vapor formulation to produce the vapor. The e-vaping device may include several e-vaping elements including a power source, a cartridge or e-vaping tank including the heater and a reservoir capable of holding the pre-vapor formulation.
SUMMARY
[0004] At least one example embodiment relates to a heater assembly.
[0005] In at least one example embodiment, a heater assembly comprises a heating element including a planar portion including a filament, the filament defining an air channel through the planar portion, the filament arranged so as to form a plurality of curves, each of the curves having a closed end and an open end, and at least one of the curves having a tip thereon, a first lead portion, and a second lead portion. At least one of the first lead portion, the second lead portion, or both the first lead portion and the second lead portion are generally coplanar with the planar portion of the heating element. The heater assembly also includes a support. The heating element is in contact with the support such that the tip of the at least one of the curves rests thereon.
[0006] In at least one example embodiment, at least one of the curves generally has a keyhole shape. In at least one example embodiment, at least one of the curves generally has an omega shape. In at least one example embodiment, at least one of the curves generally has a U-shape. In at least one example embodiment, the tip extends from the closed end of the at least one of the curves. In at least one example embodiment, the filament defines the air channel through a central area of the planar portion. In at least one example embodiment, the tip of the at least one of the curves

extends away from the air channel, and the open end of each of the curves is adjacent the air channel.
[0007] In at least one example embodiment, the filament includes stainless steel. In at least one example embodiment, the filament follows a circuitous path. A width of the filament varies along the circuitous path. In at least one example embodiment, a width of the filament gradually increases in a direction away from the air channel.
[0008] In at least one example embodiment, the first lead portion extends into the air channel and the second lead portion extends away from the air channel.
[0009] In at least one example embodiment, the first lead portion and the second lead portion extend away from the air channel. The support includes a support ring. In at least one example embodiment, the support ring is formed of one or more materials including polyetheretherketone. In at least one example embodiment, the support ring includes at least one electrical contact molded within the support ring. In at least one example embodiment, the tip has a generally trapezoidal shape. In at least one example embodiment, the tip has a generally rectangular shape. In at least one example embodiment, the tip has a generally triangular shape.
[0010] In at least one example embodiment, at least one of the first lead portion, the second lead portion, or both the first lead portion and the second lead portion having a generally spiral shape.
[0011] In at least one example embodiment, at least one of the first lead portion, the second lead portion, or both the first lead portion and the second lead portion having a generally L-shape.
[0012] At least one example embodiment relates to a cartridge for an e-vapor device.
[0013] In at least one example embodiment, a cartridge for an e-vapor device, comprises a housing, a reservoir in the housing, a transfer material adjacent a portion of the reservoir, and a heater assembly. The heater assembly includes a heating element and a support. The heating element includes a planar portion including a filament, the filament defining an air channel through the planar portion, the filament arranged so as to form a plurality of curves, each of the curves having a closed end and an open end, and at least one of the curves having a tip thereon, a first lead portion, and a second lead portion. At least one of the first lead portion, the second lead portion, or both the first lead portion and the second lead portion are generally coplanar with the planar portion of the heating element. The heating element is in contact with the support such that the tip of the at least one of the curves rests thereon.
[0014] In at least one example embodiment, the planar portion, the first lead portion, and the second lead portion are a unitary body.
[0015] In at least one example embodiment, the cartridge further comprise an inner tube within the housing. The inner tube defines an airway through the housing, and an outer surface of the inner tube and an inner surface of the housing at least partially define a portion of the reservoir.
[0016] In at least one example embodiment, the filament includes stainless steel. The filament follows a circuitous path. In at least one example embodiment, a width of the filament varies along the circuitous path. In at least one example embodiment, the width of the filament gradually increases in a direction away from the air channel. In at least one example embodiment, the first lead portion extends into the air channel and the second lead portion extends away from the air channel. In at least one example embodiment, the first lead portion and the second lead portion extend away from the air channel.
[0017] In at least one example embodiment, the support includes a support ring. The support ring is formed of one or more materials including polyetheretherketone. The support ring includes at least one electrical contact molded within the support ring.
[0018] In at least one example embodiment, the tip of the at least one of the curves has a generally trapezoidal shape. In at least one example embodiment, the tip of the at least one of the curves has a generally rectangular shape. In at least one example embodiment, the tip of the at least one of the curves has a generally triangular shape.
[0019] In at least one example embodiment, at least one of the first lead portion, the second lead

portion, or both the first lead portion and the second lead portion having a generally spiral shape. In at least one example embodiment, at least one of the first lead portion, the second lead portion, or both the first lead portion and the second lead portion having a generally L-shape.
[0020] In at least one example embodiment, the support is a generally cylindrical wall having a top edge, and the tip of the at least one of the curves rests on the top edge of the generally cylindrical wall. In at least one example embodiment, at least one of the curves generally has a keyhole shape. In at least one example embodiment, at least one of the curves generally has an omega shape. In at least one example embodiment, at least one of the curves generally has a U-shape. In at least one example embodiment, the tip extends from the closed end of the at least one of the curves. In at least one example embodiment, the tip has a generally pointed shape.
[0021] In at least one example embodiment, the heating element is in contact with the transfer material.
[0022] In at least one example embodiment, the tip of the at least one of the curves has a generally pointed shape.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0023] The various features and advantages of the non-limiting embodiments herein may become more apparent upon review of the detailed description in conjunction with the accompanying drawings. The accompanying drawings are merely provided for illustrative purposes and should not be interpreted to limit the scope of the claims. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted. For purposes of clarity, various dimensions of the drawings may have been exaggerated.
[0024] FIGS. **1**A-**1**C are perspective views of a heating element and portions of the heating element according to at least one example embodiment.
[0025] FIGS. **2**A and **2**B illustrate a heating element according to at least one example embodiment.
[0026] FIGS. **3**A and **3**B are perspective views of heating elements according to at least one example embodiment.
[0027] FIGS. **4**A and **4**B are cross-sectional views of an e-vapor device including a heating element according to an example embodiment.
[0028] FIGS. **5**A-**5**H illustrate elements of a cartridge of the e-vapor device in FIG. **4**.
[0029] FIG. **6** is a three-dimensional rendering of the cartridge shown in FIGS. **5**A and **5**B.
[0030] FIG. **7** is a perspective view of a heater assembly according to at least one example embodiment.
[0031] FIG. **8** is a partial cross-sectional view of a cartridge including the heater assembly of FIG. **7** according to at least one example embodiment.
[0032] FIG. **9** is a perspective view of a heating element for use in the cartridge of FIG. **8** according to at least one example embodiment.
[0033] FIG. **10** is a top view of a heater assembly including a heating element according to at least one example embodiment.
[0034] FIG. **11** is an exploded view of the heater assembly of FIG. **10** according to at least one example embodiment.
[0035] FIG. **12** is an exploded view of a cartridge including the heating element of FIG. **10** according to at least one example embodiment.
[0036] FIG. **13** is a perspective view of a heater assembly according to at least one example embodiment.
[0037] FIG. **14** is a perspective view of a heater assembly according to at least one example

embodiment.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

[0038] Some detailed example embodiments are disclosed herein. However, specific structural and functional details disclosed herein are merely representative for purposes of describing example embodiments. Example embodiments may, however, be embodied in many alternate forms and should not be construed as limited to only the embodiments set forth herein.

[0039] Accordingly, while example embodiments are capable of various modifications and alternative forms, embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that there is no intent to limit example embodiments to the particular forms disclosed, but to the contrary, example embodiments are to cover all modifications, equivalents, and alternatives falling within the scope of example embodiments. Like numbers refer to like elements throughout the description of the figures.

[0040] It should be understood that when an element or layer is referred to as being “on,” “connected to,” “coupled to,” or “covering” another element or layer, it may be directly on, connected to, coupled to, or covering the other element or layer or intervening elements or layers may be present. In contrast, when an element is referred to as being “directly on,” “directly connected to,” or “directly coupled to” another element or layer, there are no intervening elements or layers present. Like numbers refer to like elements throughout the specification. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

[0041] It should be understood that, although the terms first, second, third, etc. may be used herein to describe various elements, regions, layers and/or sections, these elements, regions, layers, and/or sections should not be limited by these terms. These terms are only used to distinguish one element, region, layer, or section from another region, layer, or section. Thus, a first element, region, layer, or section discussed below could be termed a second element, region, layer, or section without departing from the teachings of example embodiments.

[0042] Spatially relative terms (e.g., “beneath,” “below,” “lower,” “above,” “upper,” and the like) may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It should be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as “below” or “beneath” other elements or features would then be oriented “above” the other elements or features. Thus, the term “below” may encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0043] The terminology used herein is for the purpose of describing various embodiments only and is not intended to be limiting of example embodiments. As used herein, the singular forms “a,” “an,” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “includes,” “including,” “comprises,” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, and/or elements, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, and/or groups thereof.

[0044] Example embodiments are described herein with reference to cross-sectional illustrations that are schematic illustrations of idealized embodiments (and intermediate structures) of example embodiments. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, example embodiments should not be construed as limited to the shapes of regions illustrated herein but are to include deviations in shapes that result, for example, from manufacturing. Thus, the figures are schematic in nature and their shapes are not intended to illustrate the actual shape of a region of a device and are not intended to limit the scope of example embodiments.

[0045] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which example embodiments belong. It will be further understood that terms, including those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.
[0046] FIGS. **1**A-**1**C are perspective views of a heating element and portions of the heating element according to at least one example embodiment.
[0047] FIG. **1**A illustrates a heating element **10** for an e-vapor device. The heating element **10** includes a planar portion **20** having at least one filament **50**. The filament **50** may define an air channel **60** through the planar portion **20**. For example, the filament **50** defines the air channel **60** through a central area of the planar portion **20** (e.g., such that air flowing through the central area is unobstructed). The air channel **60** may have a substantially circular shape.
[0048] The planar portion **20** (with the filament **50**) may have a substantially flat or planar structure. Alternatively, a portion of the filament **50** may be punched in or punched out so as to change the flat structure into a three-dimensional structure. This may allow for the heating element **10** to heat additional surface area of a porous substrate of an e-vapor device. The structure of the filament **50** is described in further detail below with reference to FIGS. **1**B and **1**C.
[0049] The heating element **10** may include stainless steel or alloy thereof. Stainless steel (e.g., stainless steel 304) has a relatively high temperature coefficient, which allows for accurate temperature control of the filament **50**. Alternatively, the heating element **10** may include Nichrome (e.g., 80% nickel, 20% chromium) or other materials. Examples of other suitable electrically resistive materials for the heating element **10** include titanium, zirconium, tantalum, and metals from the platinum group. Examples of suitable metal alloys include stainless steel, nickel-, cobalt-, chromium-, aluminum-, titanium-, zirconium-, hafnium-, niobium-, molybdenum-, tantalum-, tungsten-, tin-, gallium-, manganese-, and iron-containing alloys, and super-alloys based on nickel, iron, cobalt, and stainless steel. For instance, the heating element **10** may include nickel aluminides, a material with a layer of alumina on the surface, iron aluminides, and other composite materials. The electrically resistive material may optionally be embedded in, encapsulated, or coated with an insulating material or vice-versa, depending on the kinetics of energy transfer and the external physicochemical properties required. In a non-limiting example embodiment, the heating element **10** may comprise at least one material selected from the group consisting of stainless steel, copper, copper alloys, nickel-chromium alloys, superalloys, and combinations thereof. In another non-limiting example embodiment, the heating element **10** includes iron-chromium alloys. A higher resistivity for the heating element **10** lowers the current draw or load on the power supply or battery of an e-vapor device.
[0050] Still referring to FIG. **1**A, the heating element **10** may include a first lead portion **30** and a second lead portion **40** extending away from the planar portion **20**. For example, the first lead portion **30** and the second lead portion **40** extend away from the planar portion **20** in a direction that is substantially perpendicular to the planar portion **20**. As shown in FIG. **1**A, the planar portion **20**, the first lead portion **30**, and the second lead portion **40** are a unitary body, which allows for efficient manufacturing of the heating element **10**. For example, the heating element **10** may be initially formed as a substantially flat element before first and second lead portions **30** and **40** are bent as shown in FIG. **1**A. Accordingly, the heating element **10** may be referred to as a single piece heating element. A tip **31** of the first lead portion **30** and a tip **41** of the second lead portion **40** may be bent or bendable in a direction that is parallel to the planar portion **20** (this bending is explicitly shown in FIGS. **2**B and **5**B, for example).
[0051] A height H**10** of the heating element **10** may be between 6.0 mm and 10 mm, for example, 8.5 mm. A width W**10** of the heating element **10** may be between 4.5 mm and 5 mm, for example, 4.72 mm. A width W**20** of the first lead portion **30** and the second lead portion **40** may be between

1.0 mm and 3.0 mm, for example, 1.9 mm. A length L**10** of the heating element **10** may be between 4.7 mm and 7.8 mm, for example, 7.4 mm. A thickness T**10** of the planar portion **20** may be between 0.05 mm and 0.30 mm, for example, 0.10 mm. The thickness T**10** may be uniform throughout the planar portion **20**, the first lead portion **30**, and the second lead portion **40**. However, example embodiments are not limited thereto. For example, the thickness of the planar portion **20** may be less than a thickness of the first lead portion **30** and the second lead portion **40**.

[0052] The first lead portion **30** and the second lead portion **40** may be substantially rectangular shaped and have step portions **33** and **35** at ends closest to the planar portion **20**. Step portions **35** may rest on a surface of a support for the heating element **10** while step portions **33** may provide a force that allows for the heating element **10** to be push fit into the support (see support **350** in FIGS. **5**A and **5**B, for example). Although two step portions **33** and **35** are shown, the first and second lead portions **30** and **40** may have one step portion or additional step portions as desired.

[0053] As illustrated in further detail by FIG. **1**B, the filament **50** may follow a circuitous or sinuous path **51** to define the air channel **60**. For example, the filament **50** may follow the circuitous path **51** such that the air channel **60** is substantially circular and has a diameter d**10** between 1.2 mm and 2.0 mm, for example, 1.6 mm. The filament **50** may have a diameter d**20** between 3.0 mm and 7.0 mm, for example, 4.1 mm. The filament **50** may be spaced apart from other sections of the planar portion **20** except at connection points **25** and **26**. As a result, the electrical connection between the first lead portion **30** and the second lead portion **40** is through the filament **50** (i.e., during operation, current must travel between lead portions **30** and **40** through filament **50** and parts of the planar portion **20** connected to the connection points **25** and **26**).

[0054] As illustrated in further detail by FIG. **1**C, the filament **50** includes a plurality of filament portions **70** that are substantially u-shaped. The plurality filament portions **70** change from one to the other at end sections **80** of each u-shape. As further illustrated by FIG. **1**C, a width of the filament **50** may vary along the circuitous path **51**. For example, as indicated by increasing widths W**30**, W**40**, and W**50**, the width of the filament **50** gradually increases in a direction away from the air channel **60**. A width W**30** may be between 0.05 mm and 0.30 mm, for example. A width W**40** may be between 0.05 mm and 1.0 mm, for example 0.16 mm. A width W**50** may be between 0.25 mm and 1.00 mm, for example, 0.65 mm. A length L**20** of each filament portion **70** may be between 0.5 mm and 3.5 mm, for example, 2.5 mm. It should be understood that a number of filament portions **70** may vary as desired. For example, the number of filament portions **70** may be between 3 and 25.

[0055] Spaces **110** between adjacent ones of the plurality of filament portions **70** may gradually increase in a direction away from the air channel **60**. For example, a width W**60** of the space **110** closest to the air channel **60** may less than a width W**70** of the space **110** furthest from the air channel **60**. In at least one example embodiment, a width W**60** and a width W**70** may be set so that a widest section of the spaces **110** at width W**70** occupies between 2° and 90°, for example, 8.3° of a 360° circle around the filament **50** (shown in FIG. **1**C by angle θ). The same dimensions may be set for widths W**75** and W**80** of spaces **111** between u-shaped portions of each filament portion **70**. However, example embodiments are not limited thereto, and the spaces **110** and the spaces **111** may have different dimensions as desired. A length L**30** between an end of space **111** that is furthest from the air channel **60** and a part of the u-shaped portion furthest away from the air channel **60** may be between 0.1 mm and 0.7 mm, for example, 0.3 mm.

[0056] A thickness T**20** of the filament portions **70** may be between 0.05 mm and 0.30 mm, for example, 0.10 mm.

[0057] Due to the above described structure, the filament **50** may generate a gradient of heat that is most intense near the air channel **60** and gradually dissipates in a direction away from the air channel **60**. It should be understood that an electrochemical etching process may be used to manufacture heating element **10** with the above described dimensions. Alternatively, the heating element **10** may be formed using a stamping process. It should also be understood that some parts of or the entire heating element **10** may be scaled up or down (e.g., scaled up 2.5 times larger than described above) depending on the desired implementation an e-vapor device.

[0058] FIGS. **2**A and **2**B illustrate a heating element according to at least one example embodiment. For example, FIG. **2**A is a top-view of a heating element **10′** before bending and FIG. **2**B is a perspective view of the heating element **10′** after bending.

[0059] As illustrated in FIGS. **2**A and **2**B, heating element **10′** is similar to the heating element **10** in FIGS. **1**A-**1**C, and includes a planar portion **20′**, a first lead portion **30′**, a second lead portion **40′**. However, heating element **10′** does not include an air channel **60** through the filament **50′**. The transition from FIG. **2**A to FIG. **2**B shows how the heating element **10′** in FIG. **2**A is bent along the dotted lines to form the heating element **10′** in FIG. **2**B with bent first and second lead portions **30′** and **40′** and bent tips **31′** and **41′**. It should be appreciated that tips **31** and **41** in FIG. **1** may be bent in the same manner as shown by tips **31′** and **41′** in FIG. **2**B.

[0060] FIGS. **3**A and **3**B are perspective views of heating elements according to at least one example embodiment.

[0061] FIG. **3**A is a perspective view of a dual heating element according to at least one example embodiment. The dual heating element **10″** may include two or more heating elements (e.g., two heating elements **10** from FIG. **1**) stacked on top of one another. The heating elements **10** may be electrically connected to one another via welding, soldering, or a pressure-based connection. If a porous substrate in fluid communication with a pre-vapor formulation is placed between the two heating elements **10**, the dual heating element **10″** may uniformly heat both sides of the porous substrate to create a high efficiency vapor production. A pre-vapor formulation is a material or combination of materials that may be transformed into a vapor. For example, the pre-vapor formulation may be a liquid, solid, and/or gel formulation including, but not limited to, water, beads, solvents, active ingredients, ethanol, plant extracts, natural or artificial flavors, and/or vapor formers such as glycerine and propylene glycol.

[0062] Although FIG. **3**A shows that the dual heating element **10″** may be formed from two heating or more elements **10**, it should be understood that the dual heating element **10″** may include two or more heating elements **10′** from FIGS. **2**A and **2**B, or one or more heating elements **10** and one or more heating elements **10′** stacked in a desired configuration.

[0063] FIG. **3**B is a perspective view of a heating element according to at least one example embodiment. FIG. **3**B illustrates a heating element **10‴** with a filament **50‴** that defines an opening **60‴**. The heating element **10‴** may have substantially the same dimensions as the heating element **10** from FIGS. **1**A-**1**C except that the filament **50‴** has filament portions **70‴** that have a substantially same width and substantially rounded ends throughout the circuitous or sinuous path.

[0064] FIGS. **4**A and **4**B are cross-sectional views of an e-vapor device including a heating element according to an example embodiment.

[0065] FIGS. **4**A and **4**B illustrate sections of an e-vapor device **200**. For example, the e-vapor device **200** may have a mouthpiece section **210**, a cartridge **220**, and a power supply section **230**. The mouthpiece section **210** may fit (e.g., pressure fit, or thread fit) onto the cartridge **220** in order to allow for an adult vaper to apply a negative pressure to the mouthpiece section **210** and draw vapor from e-vapor device. It should be understood that the mouthpiece **210** may be excluded from the configuration shown in FIGS. **4**A and **4**B or integrated with the cartridge **220** to reduce the number of parts. The cartridge **220** may include a heating element (e.g., one of the heating elements of FIGS. **1**A-**3**). The cartridge **220** may be replaceable. The cartridge **220** is described in more detail below with reference to FIGS. **5**A-**5**H, and **6**. The cartridge **220** and the power supply section **230** may be releasably connected (e.g., by a threading engagement). Alternatively, the cartridge **220** and the power supply section **230** may be in a unitary housing.

[0066] The power supply section **230** may be configured to selectively supply power to the heating element in the cartridge **220** via a battery **250**. The power supply section **230** may include an indicator **235**, control electronics **240**, battery **250**, air inlet **255**, conductive post **260**, and a connector **265**. The indicator **235** may be, for example, a light emitting diode (LED) located at one end of the power supply section **230**. The LED may flash different colors and/or different patterns to indicate different information about the e-vapor device **200**. For example, the LED may flash one color to indicate activation of the e-vapor device **200** and another color to indicate a battery level of the battery **250**. However, example embodiments are not limited thereto, and the LED may be used to indicate other information through various colors and patterns of flashes.

[0067] The battery **250** may selectively supply power to the indicator **235**, the control electronics **240**, and the heating element **10** (see FIGS. **5**A and **5**B). For example, the battery **250** may selectively supply power under a control of the control electronics **240**. The control electronics **240** may include control circuitry including a puff sensor for sensing a negative pressure applied by an adult vaper. The puff sensor is operable to sense an air pressure drop in the e-vapor device **200**, which causes the control electronics **240** to initiate the application of voltage from the battery **250** to the heating element **10**. For example, if the puff sensor indicates that an adult vaper is applying a negative pressure to the e-vapor device **200**, the control electronics **240** initiates a puff cycle by connecting the battery **250** to the heating element **10** to heat the heating element **10**, thereby vaporizing a pre-vapor formulation in a porous substrate in contact with the heating element **10**. Upon termination applying negative pressure by an adult vaper, the puff sensor ceases to sense the air pressure drop and the control electronics **240** disconnects the battery **250** from the heating element **10** to end the puff cycle.

[0068] The control electronics **240** may be between the indicator **235** and the battery **250** within the power supply section **230**. The connector **265** may facilitate a threaded connection to the cartridge **220**. For example, the threaded connection may be a combination of a conductive male threaded member on the connector **265** and a conductive or non-conductive female threaded receiver on the cartridge **220** (or vice versa). Alternatively, the threaded connection may be in a form of other suitable structures, such as a snug-fit, detent, clamp, and/or clasp arrangement. Although not explicitly shown, one terminal of the battery **250** is electrically connected to the conductive post **260** and the other terminal of the battery **250** is electrically connected to the connector **265** via the control electronics **240**.

[0069] The power supply section **230** may include an air inlet/outlet **255** at an end of the power supply section **230** nearest to the control electronics **240**. As shown by the arrows in in FIG. **4**B, when air is drawn through the mouthpiece **210**, air enters the tip of the e-vapor device **200** at air inlet/outlet **255**, travels past the control electronics **240** that includes the puff sensor through the spaces provided around the puff sensor (thereby detecting a negative pressure and activating the heating element **10**), and continues past the battery **250**. The air then goes through an opening in the axis of a conductive post **260** of the battery's **250** male connector, and straight into a conductive rivet engaged with the female connector of the cartridge **220** (see element **360** in FIGS. **5**A and **5**B). The air is then inundated with particles of vapor (produced by the heating of a porous substrate containing a pre-vapor formulation as a result of the activated heating element **10**) and exits through the mouthpiece section **210**. As shown by the return arrows in FIG. **4**B, excess vapor travels through the e-vapor device **200** and may be exhausted from the air inlet/outlet **255**.

[0070] Although FIGS. **4**A and **4**B shows one air inlet/outlet **255**, the e-vapor device **200** may include additional air inlets/outlets at other locations on the e-vapor device, for example, at or closer to a connection between the cartridge **220** and the power supply section **230**. This may allow for air intake at other locations of the e-vapor device **200**.

[0071] The battery **250** may be a Lithium-ion battery or one of its variants (e.g., a Lithium-ion polymer battery). The battery **250** may also be a Nickel-metal hydride battery, a Nickel cadmium battery, a Lithium-manganese battery, a Lithium-cobalt battery, or a fuel cell.

[0072] FIGS. **5**A-**5**H illustrate elements of a cartridge of the e-vapor device in FIG. **4**.

[0073] For example, FIG. **5**A is an exploded view of a cartridge of the e-vapor device shown in FIG. **4**. FIG. **5**B is a cross-sectional view of the cartridge in FIG. **5**A taken along line VB-VB′.

FIGS. **5**C-**5**H illustrate the details of various parts of the cartridge shown in FIGS. **5**A and **5**B.
[0074] FIGS. **5**A and **5**B illustrate that the cartridge **220** includes a housing **300**. The housing **300** may include a reservoir portion **310** and a connector portion **320**. The connector portion **320** is configured to connect the cartridge **220** to a power supply section (e.g., the power supply section **230** in FIG. **4**). With reference to FIGS. **5**A, **5**B, and **5**C, the connector portion **320** may be substantially hollow and have a substantially cylindrical shape. The connector portion **320** may include a female thread **321** for releasably engaging with a male thread of the connector **265** of power supply section **230** in FIG. **4**. The connector portion **320** may be made of, for example, a synthetic polymer or other material suitable for e-vapor devices such as solid plastic, and/or metal (e.g., stainless steel). An inner wall of the connector portion **320** may be conductive or non-conductive. The connector portion **320** may include substantially rectangular tabs (e.g., flexible tabs) **510** and **520** on opposing edges of the connector portion **320**. The tabs **510** and **520** provide a releasable snap fit connection to connection points **490** of the reservoir portion **310** (see FIG. **6**). A body **525** of the connector portion **320** may have a height H**20** of between 3.0 mm and 10.0 mm, for example, 4.70 mm. A diameter D**30** of the connector portion **320** may be between 8.5 mm and 9.5 mm, for example, 9.0 mm. The diameter D**30** may be larger or smaller depending on the application. For example, diameter D**30** may be the same as the diameter D**35** of the reservoir portion **310**. Alternatively, the connector portion **320** and the power supply section **230** may be fixed together (i.e., not releasable).
[0075] With reference to FIGS. **5**A, **5**B, and **5**D, the reservoir portion **310** is a storage portion configured to store a pre-vapor formulation in a cavity **311** of the reservoir portion **310**. Although not shown, the cavity **311** may include a pre-vapor formulation containing material (e.g., a material to draw the pre-vapor formulation via capillary action). The reservoir portion **310** may have a substantially cylindrical shape and be made of, for example, a synthetic polymer or other material suitable for e-vapor devices such as, glass, ceramic, and/or metal (e.g., stainless steel). The reservoir portion **310** may have a closed end, an open end, and a cylindrically shaped inner tube **315** may define an airway **600** that passes through a central area of the reservoir portion **310** from the closed end to the open end. The airway **600** may have a diameter of between 1.0 mm and 4.0 mm, for example, 1.60 mm. The reservoir portion **310** may have a height H**30** of between 15 mm and 60 mm, for example, 32.9 mm. The reservoir portion **310** may have a diameter D**35** of between 6.5 mm and 25 mm, for example, 9.0 mm. That is, the reservoir portion **310** and the connector portion **320** may have a same diameter. The reservoir portion **310** includes at least two connection points **490** (due to the symmetry of reservoir portion **310**, only one connection point **490** is shown in FIGS. **5**A and **5**D). Tabs **510** and **520** of the connector portion **320** may be releasably engaged with the at least two connection points **490** (see FIG. **6**).
[0076] With reference to FIGS. **5**A, **5**B, and **5**E, the reservoir portion **310** includes a porous substrate **400** in fluid communication with the cavity **311**. The porous substrate **400** may be substantially disc shaped and have a diameter of between 5.0 mm and 24 mm, for example, 8.0 mm. The porous substrate may have a thickness T**30** between 0.5 mm and 2.0 mm, for example, 1.0 mm. The porous substrate **400** may have a capacity to draw a pre-vapor formulation via capillary action as a result of the interstitial spacing between filaments of the porous substrate **400**. For example, the porous substrate **400** may be a ceramic material or other porous material capable of withstanding varying temperatures of the heating element **10** such as a ceramic, mineral fibrous material, metal (in a honeycomb or mesh structure), and glass fibers. A central area of the porous substrate **400** includes an opening **410** with a diameter D**40** between 1.0 mm and 4.0 mm, for example, 2.0 mm. The opening **410** may be aligned with the air channel **60** of the heating element **10** and with the airway **600** of the reservoir portion **310**.
[0077] With reference to FIGS. **5**A, **5**B, and **5**F, the reservoir portion **310** includes a gasket **420** configured to provide the fluid communication between the porous substrate **400** and the cavity **311**. The gasket **420** may include rubber or silicon, or some other material capable of preventing

pre-vapor formulation in the cavity **311** from passing between the gasket **420** and walls of the reservoir portion **310** such as organic elastomers and/or inorganic elastomers. The gasket **420** may have a thickness T**40** between 1.0 mm and 3.0 mm, for example, 2.0 mm. The gasket **420** may have a diameter D**50** between 7.7 mm and 8.5 mm, for example, 8.1 mm. It should be understood that the diameter D**50** may vary from these values so long as the gasket **420** provides an effective seal in the reservoir **310**. A central area of the gasket **420** includes an opening **440** with a diameter D**53** between 2.6 mm and 2.8 mm, for example, 2.7 mm so that the gasket **420** fits around the airway **600**. The gasket **420** is configured to provide the fluid communication between the porous substrate **400** and the cavity **311** via at least one aperture **430** disposed adjacent to the opening **440**. According to at least one example embodiment, the gasket **420** includes two or more apertures **430** (e.g., four apertures) disposed in a diamond configuration on opposing sides of the opening **440**. The apertures **430** may be substantially circular in shape and have a diameter D**55** between 0.8 mm and 1.2 mm, for example, 1.0 mm. However, example embodiments are not limited to the shape and size of the apertures shown in FIG. **5**F and it should be understood that the apertures **430** may be of various sizes and shapes so long as the porous substrate **400** does not become oversaturated with pre-vapor formulation and leak from the e-vapor device **200**.

[0078] FIGS. **5**A and **5**B further illustrate that the cartridge **220** includes a heater assembly **330**. The heater assembly **330** includes a heating element **10**, a support **350**, and a conductive rivet **360**. The conductive rivet **360** may be optional. The heating element **10** may be, for example, one of the heating elements shown in FIGS. **1**A-**3**.

[0079] With reference to FIGS. **5**A, **5**B, and **5**G, the support **350** may support the heating element **10** and be disposed in the housing **300**. The support **350** may include silicon or some other material capable of withstanding varying temperatures of the heating element **10** such as organic elastomers and/or inorganic elastomers. The support **350** may have a substantially cylindrical shape and a diameter D**60** between 7.7 mm and 8.5 mm, for example, 8.1 mm. It should be understood that the diameter D**60** may vary from these values so long as the support **350** provides an effective seal in the reservoir **310**. A central area of an end surface of the support **350** includes a through hole **450** with a diameter D**65** between 1.7 mm and 2.1 mm, for example, 1.93 mm. It should be understood that the diameter D**65** may vary from these values so long as the support **35** provides an effective seal between an outer wall of the inner tube **315** and the gasket **420**. The support **350** may have a height H**40** between 3.0 mm and 8.0 mm, for example, 5.1 mm. The through hole **450** may be aligned with the air channel **60**, opening **410**, and airway **600**. If the conductive rivet **360** is not used, then the support **350** may include grooves along a lateral surface of the support **350** instead of the through hole **450**. Here, the grooves allow for the airflow formerly provided by the through hole **450** and electrical connection to the powers supply **250** is provided via direct connection with the tip **41**.

[0080] A first slot **460** and a second slot **470** may be on the end surface of the support **35** and disposed at opposing sides of the through hole **450**. The first slot **460** and the second slot **470** may have a shape and size that accommodates the first lead portion **30** and the second lead portion **40** of the heating element **10**. For example, as shown in FIG. **5**B, the slots **460** and **470** have substantially rectangular shapes so that the first lead portion **30** extends through first slot **460**, and the second lead portion **40** extends through the second slot **470**. As also shown in FIG. **5**B, the first lead portion **30** and the second lead portion **40** are bent in a direction that is substantially parallel to the planar portion **20** at tips **31** and **41**. Although tip **31** is shown in FIG. **5**B as not contacting a wall of the connector portion **320**, the tip **31** may extend to contact the wall of the connector portion **320** if desired. For example, if the inner wall of connector portion **320** is electrically conductive, the tip **31** may be extended to electrically connect to the inner wall of the connector portion **320** so that the first lead portion **30** is electrically connected to the connector portion **320**. As shown in FIG. **5**B, the support **350** may include a thin membrane **351** in the first and second slots **460** and **470**. The membrane **351** may be penetrated by the first and second lead portions **30** and **40** upon assembly and provide a seal at the penetration point. A thickness of the membrane **351** may be between 0.1 mm and 1.0 mm, for example, 0.3 mm.

[0081] Still referring to FIGS. **5**A, **5**B, and **5**G, the lateral surface of the support **350** may have a male thread engagement portion **530** for thread engagement with a female thread engagement of the reservoir portion **310**. Alternatively, the support **350** may push fit into the reservoir portion **310**. As another alternative, the support **350** may affixed to the reservoir portion **310** with ultrasonic welding. In yet another alternative, the support **350** and the reservoir portion **310** may have a bayonet connection. It should be appreciated that other connections between the support **350** and the reservoir portion **310** are within the scope of example embodiments. The support **350** may include at least two recesses **480** on opposing sides of the lateral surface of the support **350**. The recesses **480** may have a size, shape, and location that accommodate the tabs **510** and **520** of the connector portion **320**. As shown in FIG. **5**G, the recesses **480** have a substantially rectangular shape and extend from one end of the support **350** to a stop surface **485** to provide a tight fit with the tabs **510** and **520** (see FIG. **6** for connection between connector portion **320** and reservoir portion **310**).

[0082] With reference to FIGS. **5**A, **5**B, and **5**H, the support **350** includes a conductive rivet **360** extending through the through hole **450**. The conductive rivet **360** may include metal or some other conductive material such as a brass coat with a nickel base and sliver plating. The conductive rivet **360** may include a substantially cylindrical body portion **361** and a substantially circular head portion **363** at one end of the body portion **363**. The body portion **361** may have a diameter D**70** between 1.77 mm and 2.17 mm, for example, 2.0 mm such that the conductive rivet **360** may push fit into the through hole **450** of the support **350**. Alternatively, the conductive rivet **360** may be welded or soldered to a tip **41** of the second lead portion **40**. The head portion **363** may have a diameter D**75** larger than diameter D**70**. Diameter D**75** may be between 2.5 mm and 4.5 mm, for example, 4.0 mm. The conductive rivet **360** may be substantially hollow. For example, an airway **365** may pass through a central area of conductive rivet **360**. The airway **365** may have a diameter D**77** between 1.2 mm and 1.7 mm, for example, 1.6 mm. A height H**50** from a top surface of the head portion **363** to an opposing end of the conductive rivet **360** may be between 4.0 mm and 7.1 mm, for example, 6.5 mm. A height H**55** from an end of the conductive rivet **360** to a bottom surface of the head portion **363** may be between 3.6 mm and 6.7 mm, for example, 6.1 mm.

[0083] An electrical connection of the heating element **10** to the battery **250** is described below with reference to FIGS. **4**A, **4**B, **5**A, **5**B, and **5**H. As shown in FIG. **5**B, the bottom surface of the head portion **363** is in electrical contact with a tip **41** of the second lead portion **40** while the top surface of the head portion **363** is in electrical contact with the conductive post **260** of the power supply section **230**. However, the head portion **363** is spaced apart from a tip **31** of the first lead portion **30** so as to be electrically isolated from the tip **31**. The tip **31** of the first lead portion **30** is electrically connected to connector **265** of the power supply section **230** upon engagement of the cartridge **220** and power supply section **230**. For example, the connector **265** may be a conductive male thread of the power supply section **230** that makes electrical contact with the tip **31** upon engagement with a female thread of the connector portion **320**. Alternatively, if an inner wall of connector portion **320** (e.g., the female thread) is electrically conductive, the tip **31** may be extended to electrically connect to the inner wall of the connector portion **320** so that the first lead portion **30** is electrically connected to the connector portion **320**. In this case, the conductive male thread of the connector **265** may be in electrical contact with tip **31** through the inner wall of the connector portion **320**.

[0084] As explained with reference to FIGS. **4**A and **4**B, when an adult vaper draws air through the mouthpiece **210**, the puff sensor in control electronics **240** is operable to sense an air pressure drop in the e-vapor device **200** to cause the control electronics **240** to initiate the application of voltage from the battery **250** to the heating element **10** via the above described electrical contacts between the conductive post **260**, the conductive rivet **360**, and the tip **41** and between the tip **31** and the connector **265**. It should be understood that the puff sensor acts as a switch that completes a closed loop circuit through the heating element **10** upon sensing the air pressure drop. The heating element **10** heats vapor drawn into the filament **50** from the porous substrate **400** to form vapor, which enters the adult vaper's mouth via air channel **60**, opening **410** and airway **600**.

[0085] Although not explicitly shown in FIGS. **5**A-**5**H, it should be understood that the support **350** may have alternative structures that allow air to pass through. For example, in addition to or an alternative to the location of the airway **365**, there may be other airways at the outer edge of the support **350** so that air is able to pass between the reservoir portion **310** and the support **350**. It should be further understood that the conductive rivet **360** may be eliminated. In this case, the connector **265** may be in electrical contact with the tip **41** without the conductive rivet **360** in between.

[0086] FIG. **6** is a three-dimensional rendering of the cartridge shown in FIGS. **5**A-**5**H.

[0087] FIG. **6** shows a completed cartridge **220** that is ready for connection to the mouthpiece **210** and/or connection to power supply section **230** in FIG. **4** via the female thread **321**. As illustrated in FIG. **6**, the heating element **10** may be spaced apart from the end surface of the support **350** with the aid of step portions **33** and/or **35** to provide efficient heat transfer to the porous substrate **400**.

[0088] FIG. **7** is a perspective view of a heater assembly according to at least one example embodiment.

[0089] In at least one example embodiment, as shown in FIG. **7**, the heating element **710** may generally include one or more features of the heating element of FIG. **1**A, and the first lead **730** and the second lead **740** are adjacent to one another, the filament **750** may include tip portions **700** that rest on a support **760**, and the support **760** includes a support ring. Further, the heater **710** may be formed of a thicker metal material, such as a stainless steel foil, instead of including the leads **730**, **740** that extend away from the planar portion **720** of the heating element **710**, which provide support to the heating element **710** (some example embodiments may include both a thicker metal material as well as leads **730**, **740** that extend away from the planar portion **720** of the heating element **710**). In at least one example embodiment, the support **760** may be formed of a substantially heat-resistant material, such as polyetheretherketone (PEEK), ceramic, and/or a ceramic-coated metal.

[0090] In at least one example embodiment, the filament **750** is arranged such that a plurality of curves are formed. Each of the at least one curves generally has a keyhole shape, an omega shape, a U-shape, or any combination of these. In other example embodiments, the at least one curve has a rectangular, square, and/or polygonal shape. In at least one example embodiment, the filament **750** defines an air channel **60** through a central area of the planar portion **720** of the heating element **710**. The tip portions **700** extend away from the air channel **60**, and the open end of each of the curves is adjacent the air channel **60**.

[0091] FIG. **8** is a partial cross-sectional view of a cartridge including the heater assembly of FIG. **7** according to at least one example embodiment.

[0092] In at least one example embodiment, as shown in FIG. **8**, a first contact **770** and a second contact **780** are overmolded in the support **760**, such that the first contact **770** is electrically isolated from the second contact **780**. The leads **730**, **740** of the heating element **710** may each be spot-welded or otherwise placed into contact with a respective one of the first contact **770** and the second contact **780**.

[0093] In at least one example embodiment, as shown in FIG. **8**, the heating element **710** may contact at least one transfer material **725**, such as the transfer material disclosed in application Ser. No. 15/729,895 filed Oct. 11, 2017, the entire content of which is incorporated herein by reference, and/or any other suitable transfer material. In some example embodiments, the heating element **710** may be spaced apart from the transfer material **725**, and a wick (not shown) may be placed between the transfer material **725** and the heating element **710**.

[0094] FIG. **9** is a perspective view of a heating element for use in the cartridge of FIG. **8** according to at least one example embodiment.

[0095] In at least one example embodiment, as shown in FIG. **9**, the heating element **910** is generally the same as in FIGS. **7-8**, except that one or more of the tip portions **900** that extend from the filament **950** are generally trapezoidal or rectangular in shape. The first lead **930** and the second lead **940** are generally L-shaped.

[0096] FIG. **10** is a top view of a heater assembly including a heating element according to at least one example embodiment.

[0097] In at least one example embodiment, as shown in FIG. **10**, one or more features of the heating element **1010** are generally the same as in FIGS. **7-8**, and the first lead **1030** extends into the air channel **1060** and the second lead **1040** extends outwardly.

[0098] FIG. **11** is an exploded view of the heater assembly of FIG. **10** according to at least one example embodiment.

[0099] In at least one example embodiment, a support **1105** is a ring **1100** that may be formed of one or more of PEEK, ceramic, and/or a ceramic coated metal. The ring **1100** is sized and configured to mate with a base portion **1110** that is formed of an electrically conductive material. The base portion **1110** is generally cylindrical and includes at least one air channel **1115** defined in an outer surface **1120** of the base portion **1110**. The base portion **1110** also defines a passage **1130** extending through the base portion **1110** from a first end to a second end thereof. The base portion **1110** also includes a protrusion **1125** extending longitudinally from a top surface **1135** of the base portion **1110**. The second lead **1040** of the heating element **1010** contacts the protrusion **1125** to form a first electrical contact. An electrically insulating shell **1150** in the form of a ring is positioned at a second end **1155** of the base portion **1110**. The electrically insulating shell **1150** defines a hole **1160** therethrough. A post **1170** formed of an electrically conductive material extends through the hole **1160** and the passage **1130**. The post **1170** contacts the first lead **1030** to form a second electrical contact.

[0100] FIG. **12** is an exploded view of a cartridge including the heating element of FIG. **10** according to at least one example embodiment.

[0101] In at least one example embodiment, as shown in FIG. **12**, instead of the first lead **1030** and the second lead **1040** contacting the post **1170** and protrusion **1125**, the cartridge may include a support **1260** and two side-by-side electrically conductive posts **1220**, **1230**. The posts **1220**, **1230** are electrically insulated from each other, and may be molded into the support **1260** in some example embodiments. Moreover, the heating element **1010** may abut transfer material **725**, which may abut a gasket **1200** having weep holes **1210** therein. The gasket **1200** defines a portion of the reservoir, and pre-vapor formulation from the reservoir may flow through the weep holes **1210** in at least one example embodiment.

[0102] FIG. **13** is a perspective view of a heater assembly according to at least one example embodiment.

[0103] In at least one example embodiment, as shown in FIG. **13**, one or more features of the heating element **1310** are generally the same as in FIG. **11** and the first lead **1330** extends inwardly from the heating element **1310** and is not planar with the heating element **1310**, the second lead **1340** has a generally L-shape, the post **1170** is shorter than the post of FIG. **11**, and air channels **1300** are defined in sides of the support **1350**, such that air may flow between the support **1350** and an inner surface of a housing **300** of a cartridge **220**. In addition, a second electrical contact (not shown) may be overmolded in the support **1350**, such that the second lead **1340** contacts the second electrical contact when the heating element **1310** is placed on the support **1350**.

[0104] FIG. **14** is a perspective view of a heater assembly according to at least one example embodiment.

[0105] In at least one example embodiment, as shown in FIG. **13**, one or more features of the heating element **1410** are generally the same as in FIG. **11**, and the first contact **1430** has a generally spiral shape and the second lead **1430** has a generally L-shape. The tip portions **1450** of the heating element **1410** rest on a top surface of the support **1350**.

[0106] In other example embodiments, not shown, the heating element **10** may be reduced in size, such that tips of the heating element **10** are not supported by a support.

[0107] Example embodiments having thus been described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the intended spirit and scope of example embodiments, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. A heater assembly comprising: a heating element including, a planar portion including a filament, the filament arranged so as to form a plurality of curves, each of the plurality of curves including a closed end, an open end, and a tip of each of the curves extending from the closed end, a first lead portion, the first lead portion not planar with the planar portion of the heating element, and a second lead portion, the second lead portion coplanar with the planar portion of the heating element, the first lead portion and the second lead portion extending in opposite directions; and a support in contact with the heating element.

2. The heater assembly of claim 1, wherein at least one of the curves has a capital letter omega shape or a U-shape.

3. The heater assembly of claim 1, wherein the filament includes stainless steel.

4. The heater assembly of claim 1, wherein the filament follows a circuitous path.

5. The heater assembly of claim 4, wherein a width of the filament varies along the circuitous path.

6. The heater assembly of claim 1, wherein the filament defines a central area.

7. The heater assembly of claim 6, wherein a width of the filament gradually increases in a direction away from the central area.

8. The heater assembly of claim 7, wherein the first lead portion extends into the central area.

9. The heater assembly of claim 1, wherein at least one of the first lead portion, the second lead portion, or both the first lead portion and the second lead portion have a spiral shape or an L-shape.

10. The heater assembly of claim 1, wherein the support defines an air channel such that air flows between the support and a housing of a cartridge in which the heater assembly is received.

11. The heater assembly of claim 1, wherein the second lead portion contacts a second electrical contact when the heating element is placed on the support.

12. The heater assembly of claim 1, wherein the support includes a support ring.

13. The heater assembly of claim 1, wherein the support ring formed of one or more materials including polyetheretherketone.

14. The heater assembly of claim 7, wherein the support ring includes at least one electrical contact molded within the support ring.

15. A cartridge for an e-vapor device, comprising: a housing; a reservoir in the housing; a transfer material adjacent a portion of the reservoir; and a heater assembly including, a heating element including, a planar portion including a filament, the filament arranged so as to form a plurality of curves, each of the plurality of curves including a closed end, an open end, and a tip of each of the curves extending from the closed end, a first lead portion, the first lead portion not planar with the planar portion of the heating element, a second lead portion, the second lead portion coplanar with the planar portion of the heating element, the first lead portion and the second lead portion extending in opposite directions, and a support in contact with the heating element.

16. The heater assembly of claim 15, wherein the filament defines a central area.

17. The heater assembly of claim 16, wherein a width of the filament gradually increases in a direction away from the central area.

18. The heater assembly of claim 17, wherein the first lead portion extends into the central area.

19. The heater assembly of claim 15, wherein the support defines an air channel such that air flows

between the support and a housing of a cartridge in which the heater assembly is received.
20. The heater assembly of claim 15, wherein the second lead portion contacts a second electrical contact when the heating element is placed on the support.