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(54) **BIOMETRIC INTERLOCK FOR PERSONAL VAPORIZER**

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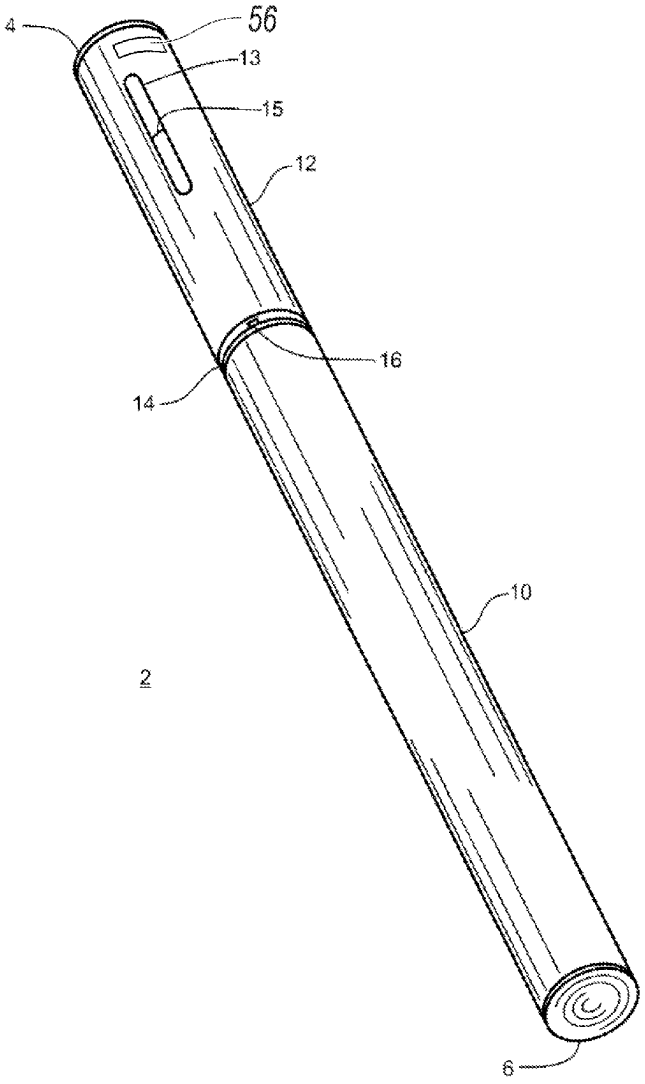
(57) **ABSTRACT**

The present disclosure describes systems, methods, and an apparatus for controlling access to a personal vaporizer. The system can include a personal vaporizer that includes a reservoir configured to hold a fluid to be vaporized, a puff sensor configured to detect airflow through the personal vaporizer and generate a puff signal, a heating element configured to atomize the fluid to be vaporized, and a first controller configured to receive the puff signal and deliver power to the heating element in response. The system can further include a biometric interlock that includes a biometric sensor configured to detect a lip print of a user, and a second controller configured to receive the lip print from the biometric sensor and determine that the lip print is an authorized lip print and in response enable the first controller to deliver power to the heating element.



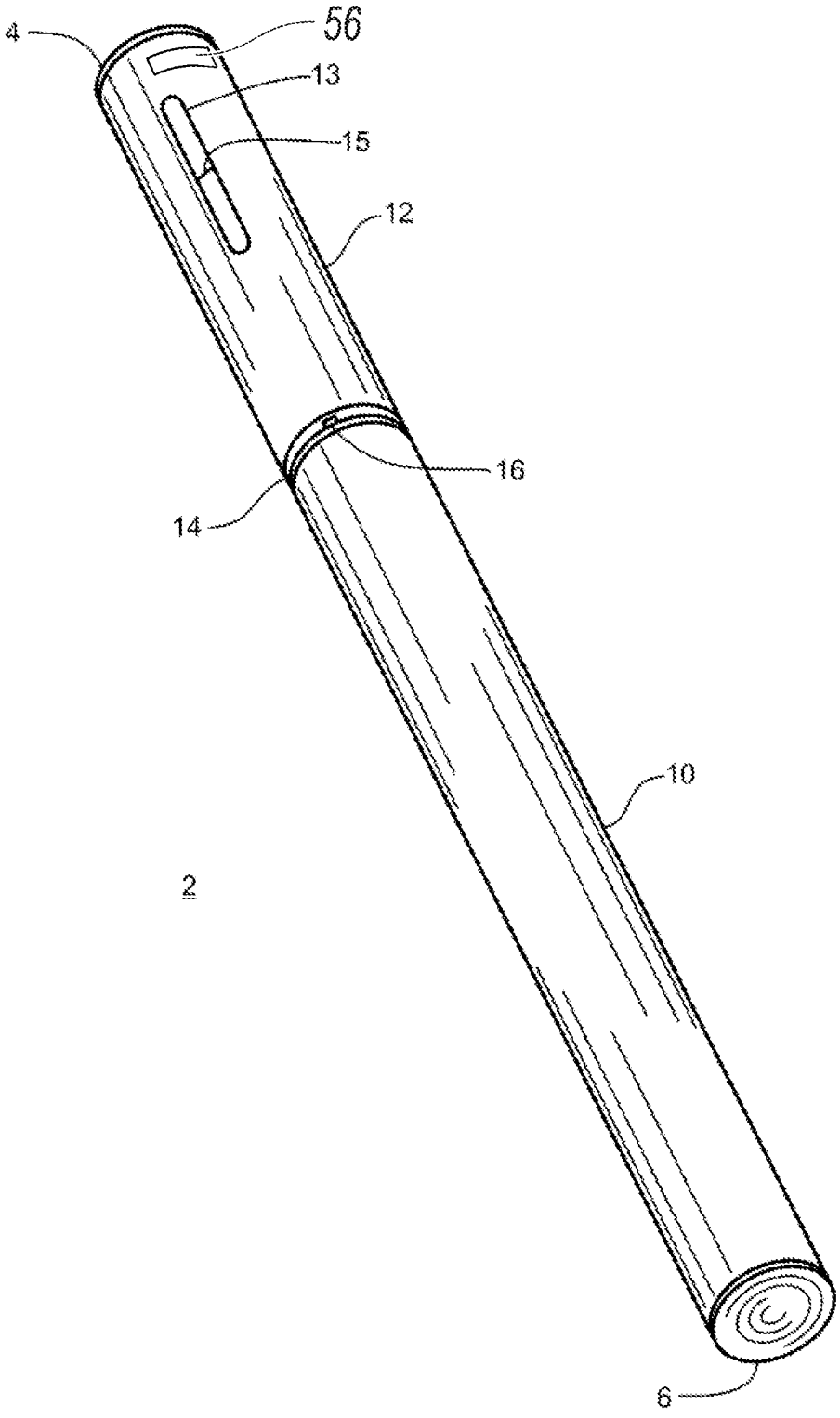


FIG. 1

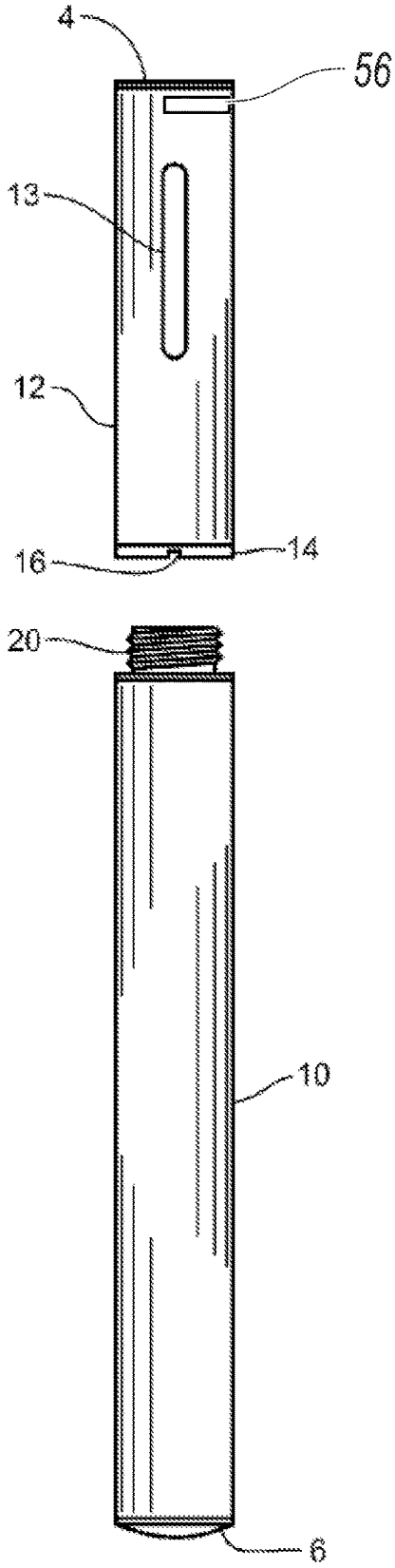


FIG. 2

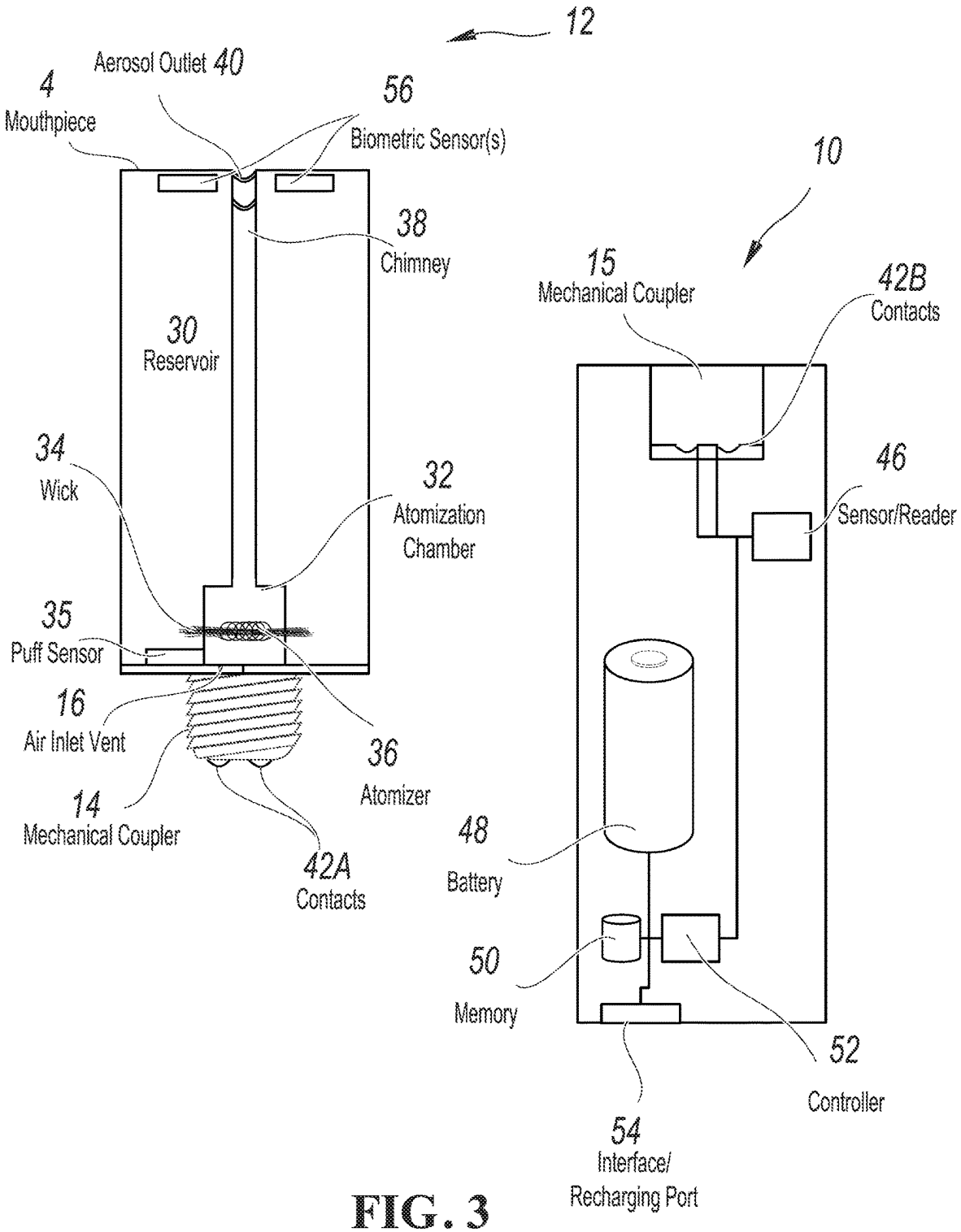

12
Aerosol Outlet 40
4
Mouthpiece
56
Biometric Sensor(s)
10
38
Chimney
15
Mechanical Coupler
42B
Contacts
30
Reservoir
34
Wick
32
Atomization Chamber
46
Sensor/Reader
35
Puff Sensor
16
Air Inlet Vent
36
Atomizer
14
Mechanical Coupler
42A
Contacts
48
Battery
50
Memory
52
Controller
54
Interface/ Recharging Port

FIG. 3

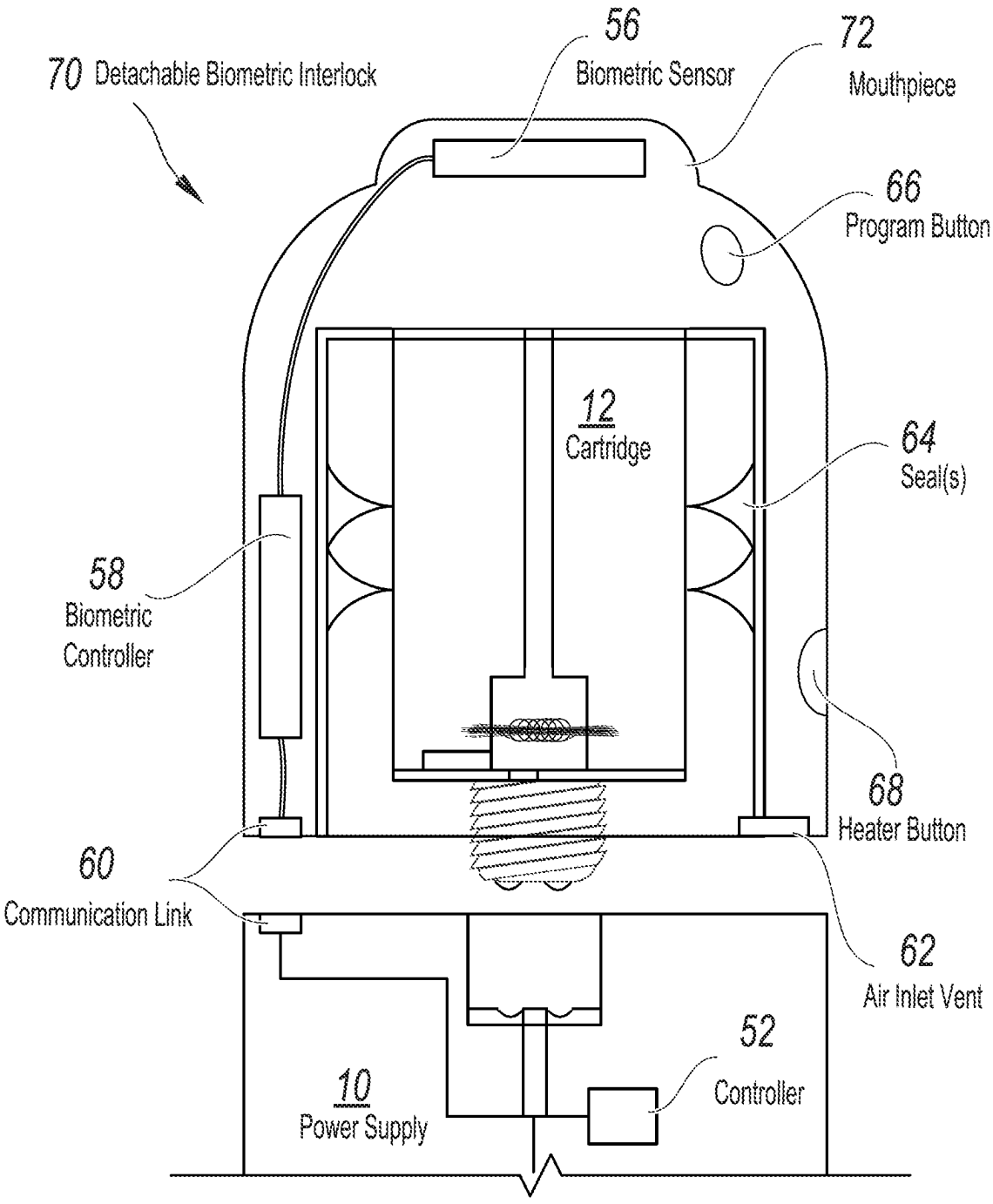

70 Detachable Biometric Interlock
56 Biometric Sensor
72 Mouthpiece
66 Program Button
12 Cartridge
64 Seal(s)
58 Biometric Controller
68 Heater Button
60 Communication Link
62 Air Inlet Vent
52 Controller
10 Power Supply

FIG. 4

BIOMETRIC INTERLOCK FOR PERSONAL VAPORIZER

BACKGROUND

[0001] Personal vaporizers provide an alternative to smoking techniques which involve combustion of organic matter and inhalation of the vapor. Instead, vaporizers atomize a substance (e.g., a nicotine substance or cannabis substance) using a heating element to simulate the combustion found in traditional cigarettes. Personal vaporizers often use removable/replaceable cartridges containing a substance for atomization. Different substances may require different heating profiles for improved vaporization.

SUMMARY

[0002] The present disclosure involves systems, methods, and an apparatus for controlling access to a personal vaporizer. The system can include a personal vaporizer that includes a reservoir configured to hold a fluid to be vaporized, a puff sensor configured to detect airflow through the personal vaporizer and generate a puff signal, a heating element configured to atomize the fluid to be vaporized, and a first controller configured to receive the puff signal and deliver power to the heating element in response. The system can further include a biometric interlock that includes a biometric sensor configured to detect a lip print of a user, and a second controller configured to receive the lip print from the biometric sensor and determine that the lip print is an authorized lip print and in response enable the first controller to deliver power to the heating element.

[0003] Implementations optionally include one or more of the following features.

[0004] In some instances, the second controller is configured to prevent the first controller from delivering power in response to determining that the lip print is an unauthorized lip print.

[0005] In some instances, the biometric interlock includes one or more seals that direct airflow through the personal vaporizer.

[0006] In some instances, the biometric interlock includes a battery configured to supply power to the second controller and the biometric sensor.

[0007] In some instances, the biometric sensor is an optical sensor.

[0008] In some instances, the biometric interlock includes a communication link with the personal vaporizer, and the second controller enables the first controller by sending a signal through the communication link.

[0009] In some instances, the biometric interlock includes a heater button that is configured to send a signal to the first controller using the communication link.

[0010] In some instances, the biometric interlock includes a program button that, when depressed, causes the second controller to record a lip print from the biometric sensor as the authorized lip print.

[0011] Implementations can further include a method for activating a personal vaporizer including sensing contact of a user on a lip sensor, scanning a lip print of the user with the lip sensor, and determining that the lip print is an authorized. In response to determining the lip print is authorized, a controller of the personal vaporizer is enabled to deliver power to a heating element of the personal vaporizer.

[0012] In some instances, the controller delivers power to the heating element in response to a puff signal generated by a puff sensor of the personal vaporizer.

[0013] In some instances, when it is determined that the lip print is not the authorized lip print, or there is no lip print, the controller is prevented from delivering power to the heating element.

[0014] In some instances, sensing contact of a user is performed with a capacitive sensor of the lip sensor.

[0015] The details of these and other aspects and embodiments of the present disclosure are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the disclosure will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

[0016] FIG. **1** depicts a perspective view of an example implementation of a personal vaporizer.

[0017] FIG. **2** depicts a side view of an example personal vaporizer with a removable cartridge removed.

[0018] FIG. **3** illustrates a schematic diagram of some internal components of a personal vaporizer cartridge and power supply with an integrated biometric interlock.

[0019] FIG. **4** illustrates an example of personal vaporizer with detachable biometric interlock.

DETAILED DESCRIPTION

[0020] This disclosure describes a system and method of controlling user access to a personal vaporizer such as an electronic cigarette, a vape pen, vape kits, e-cig, or e-hookah, electronic nicotine delivery system. In some personal vaporizer implementations, a power supply portion operates a disposable cartridge portion. The cartridge includes a reservoir containing the substance to be vaporized, and a heating element. However, certain substances may be strictly regulated by governing authorities or otherwise be dangerous if consumed in too great a quantity. This disclosure describes a system and techniques for enhancing security of a personal vaporizer to ensure only authorized user have access by incorporating a biometric interlock that record a lip print of the user when they place their mouth on the personal vaporizer.

[0021] A biometric lip sensor can activate the device when the user places it in their mouth to take a drag or draw air through the personal vaporizer. Each individual has a unique lip print, similar to a fingerprint, that can be used to identify that individual. By requiring a positive lip print match, it becomes very difficult for an unauthorized person to use the personal vaporizer. Unlike a fingerprint sensor, or other biometric sensor, it is impractical for a person to use the lip sensor unless they're using the device. That is, to activate the device, the lip sensor, and thus device, must be placed into the user's mouth. This enhances security as an authorized user is not practically able to activate the device for an unauthorized user. For example, in a fingerprint implementation, an authorized user could hold the device while an unauthorized user inhales.

[0022] The biometric lip sensor can be incorporated into the cartridge, or can be a separate interlock component that fits over the cartridge. In implementations where the cartridge is refillable and reusable, an integrated biometric sensor may be preferred to minimize the overall number of separate components. In implementations where the car-

tridge is disposable, a separate biometric cap can fit over the disposable cartridge, and interface with the power supply independently of the cartridge.

[0023] Turning to the illustrated example implementation, FIG. **1** is a perspective view of a personal vaporizer. While illustrated in the form factor of an electronic cigarette, the concepts herein could be applied to other types of personal vaporizers such as e-hookahs, vape kits, vape pens, etc. The example personal vaporizer **2** includes a housing having a first elongated portion **10** and a second elongated portion **12**. The second elongated portion **12**, also referred to as the "cartridge" in certain illustrative implementations, includes a mouthpiece end **4**, which has an aerosol outlet (depicted in FIG. **3**) for drawing air through the cartridge **12**. The first elongated portion **10** and the second elongated portion **12** are removably joined together with a mechanical coupler **14**. One or more air inlet vents **16** are provided about the coupler **14** for allowing airflow into the cartridge **12** when the user draws air through the personal vaporizer **2**. The first elongated portion **10** includes a tip end **6**, which in the illustrative implementation, is fabricated from a translucent material enabling the transmission of light therethrough. Within the second elongated portion **12** is disposed a liquid reservoir (not fully shown). In some implementations, the liquid reservoir includes a clear or translucent window **13** to the exterior of the housing **12** for visually determining the liquid level **15** within the liquid reservoir.

[0024] In the illustrated example, a biometric sensor **56** is integrated into the housing of the cartridge **12**, which can be used to obtain a scan of the lips of a user in order to enable the use of the personal vaporizer **2** by a particular person.

[0025] FIG. **2** depicts a side view drawing, respectively, of a cartridge portion **12** and a power supply portion **10** of a personal vaporizer **2** according to an illustrative embodiment of the present invention. The mechanical coupler **14** can have two parts, one that is part of the cartridge portion **12** and one that is part of the power supply portion **10**, e.g., one part being female and configured to receive the other, male, part. The mechanical coupler can be, for example, threads, a lug/channel connector, a recessed magnetic connector or other suitable means for coupling the two portions of the personal vaporizer **2**. FIG. **2** shows the mechanical coupling **14** portion on the power supply portion **10** in the form of a threaded extension **20** of the housing that engages female threads of the mechanical coupler **14** portion on the cartridge portion **12**. In some implementations (as shown below and discussed with reference to in FIG. **3**), the cartridge **12** can include a threaded or male portion, which engages with female threads of the power supply portion **10**. In addition, an electrical connection can also be facilitated in the connection between the mechanical coupler **14** parts (as shown in more detail below with respect to FIG. **3**). The power supply portion **10** can include one or more circuits for controlling operations of the cartridge portion **12**. The circuits can be analog or digital and can include, for example, a microcontroller and various sensors to enable operation of the personal vaporizer **2**. In this example illustration, the cartridge portion **12** can thus be installed, uninstalled, and replaced as needed. The cartridge portion contains the liquid reservoir and window **13** provides the visual indication as to the liquid remaining.

[0026] FIG. **3** illustrates a schematic diagram of some internal components of a personal vaporizer cartridge **12** and power supply **10**.

[0027] Cartridge **12** includes a reservoir **30** and an atomization chamber **32**. The atomization chamber **32** receives a primary substance in liquid form from the reservoir **30** via the wick **34**. The wick **34** can be a fibrous bundle that draws liquid via capillary action from the reservoir **30**. The wick **34** extends from the primary reservoir into the atomization chamber **32**. It can be formed of a heat-resistant wicking material, such as aramid, fluorocarbon, sulfide, melamine, polyimide, carbon, glass fibers, or any combination thereof. An atomizer **36** can be a resistive coil that generates heat when electrical current passes through it. The atomizer **36** can be supplied with electrical power from the power supply portion **10** of the personal vaporizer. The atomizer **36** is located proximal to the wick **34** (in the example illustrated in FIG. **3** it is wrapped around the wick **34**). Atomizer **36** heats the liquid carried from the primary reservoir **38** by the wick **34** and atomizes the primary substance which mixes with air in the atomization chamber to form an aerosol. One or more air inlet vents **16** near the bottom of the cartridge **12** allow airflow from the air inlet vent **16**, through the atomization chamber **32** and out the chimney **38**.

[0028] Chimney **38** provides a flow path from the air inlet vent **16**, through the atomization chamber **32**, and out the aerosol outlet **40** in the mouthpiece **4** portion of the cartridge **12**. Mechanical coupler **14**, illustrated as a threaded nipple, can include one or more electrical contacts **42**A, which are configured to mate with corresponding contacts **42**B on the power supply **10**. In some implementations, the mechanical coupler **14** can be another type of coupler (e.g., a snap fit, pin and groove, magnetic, etc.). These contacts **42**A can provide an electrical flow path from the battery **48**, via the controller **52**, through the atomizer **36**. In some implementations, contacts **42**A are a simple two pin system, with a positive and a common connection. In some implementations, contacts **42**A are more complex, and can include, for example, serial connections, dedicated transmit/receive connections, or other configurations. Cartridge **12** can include one or more puff sensors **35** which can be, for example, a microphone, or pressure sensor, that transmits a "puff" signal to the controller to enable the power supply **10** to activate the atomizer **36** when a user induces airflow through the cartridge **12**. In some implementations, sensor data is transmitted from the cartridge **12** to the power supply **10** wirelessly, e.g., using Bluetooth Low Energy, or ZigBee. In some implementations, sensor data (e.g., temperature data, puff data, or other information) is transmitted via contacts **42**A and **42**B.

[0029] In addition to a pressure or puff sensor **35**, one or more biometric sensors **56** can be included and integrated into the cartridge **12**. The biometric sensor **56** can be similar to a fingerprint sensor but designed to detect ridges and valleys in the user's lips. The biometric sensor **56** can include various types of sensors including optical, capacitive, ultrasonic sensors, or a combination thereof. Optical sensors which emit electromagnetic energy through a prism onto the lips, then collect reflected energy in a detector such as a charged coupled device (CCD) or complementary metal oxide semiconductor (CMOS) sensor. Capacitive devices can include an array of sensor pixels that measure capacitance variances between the ridges and valleys of the lip prints in. Capacitive sensors can be passive sensors that measure the dielectric constant of the lips (and their ridges and valleys) or active capacitive sensors. Active capacitive sensors may generate time varying electric fields in order to

observe impedance variances due to the lips of the user. In some implementations a combination of sensors is used, for example a capacitive array can be used to detect the presence of lips and activate an optical sensor, which records an image that is then correlated with the capacitive measurements to generate a three-dimensional structure of the lips.

[0030] Ultrasonic sensors can transmit high frequency sonic pulses toward the lips from a transducer. The sonic pulses reflect off the user's lips and are captured by a receiver or array of receivers, then a signal processing system identifies ridges and valleys in the lip based on changes to the reflected sonic pulses, such as doppler shift, and time delays.

[0031] Power supply **10** includes a complementary mechanical coupler **15** and complementary contacts **42**B which can receive and couple to mechanical coupler **14** and contacts **42**A, completing an electrical connection and enabling power transfer and communication between power supply **10** and cartridge **12**. In some implementations, the mechanical coupler **15** are threads that engage the threaded nipple of mechanical coupler **14** and physically support the cartridge **12**. A battery **48** supplies electrical power to power supply **10**, and can be rechargeable (e.g., via interface/charging port **54**).

[0032] A memory **50** can store instructions for controller **52**, and can be for example, a flash memory, or EEPROM, or other memory type. Memory **50** can represent a single memory or multiple memories. The memory **50** can include any memory or database module and can take the form of volatile or non-volatile memory including, without limitation, magnetic media, optical media, random access memory (RAM), read-only memory (ROM), removable media, or any other suitable component. In general, memory **50** stores operating instructions for controller **52**, and can include a database of cartridge types and settings. For example, memory **50** can store a database of operation settings, including heat intensity, duration, and frequency associated with a number of different cartridges. In some implementations, the controller **52** can periodically update this database by communicating with an external system via interface **54**. Interface **54** can be a serial interface such as a universal serial bus (USB) type A, C, micro or mini, or other connection. In some implementations, interface **54** serves a dual purpose of providing external communications to power supply **10**, as well as electrical power for recharging battery **48**.

[0033] Controller **52** generally controls power supplied to the contacts **42**B and thus to atomizer **36**. In some implementations, controller **52** receives additional sensor inputs. For example, controller **52** can receive a signal corresponding to whether a cartridge is installed on power supply **10**, and if not, prevent power from being sent to contacts **52**B. In another example, controller **52** receives a "puff" signal from one or more sensors in cartridge **12** and uses the puff signal in addition to the cartridge type in order to determine how much power to supply to contacts **42**B.

[0034] The controller **52** can be enabled or disabled by operation of the biometric sensors **56**. When lips are detected at the biometric sensors **56**, they can perform a scan and generate a "lip print" that can be compared against a database of authorized lip prints. In some implementations, the memory **50** includes one or more authorized lip prints that can be pre-programmed or manually inserted into the memory. For example, when the user purchases a new vaporizer, the retailer can provide a one-time encryption key to allow the user to load their lip print into the memory **50**. In some implementations, the lip print can be recorded using the biometric sensor **56** in a first-time setup, and then additional lip prints or users must be added using a secure passcode or token via the interface **54**.

[0035] While illustrated as a single controller **52**, controller **52** can be multiple components, or in multiple locations. For example, circuitry for operating and controlling the biometric sensors **56** can be located in the cartridge **12**, while circuitry for operating and controlling the puff sensor **35** and atomizer **36** can be located in the power supply **10**. In general, the controller **52** is operable to interrupt power to the atomizer **36** unless and authorized lip print is detected by the biometric sensors **56**. In some implementations, the power supply **10** activates for a limited duration (e.g., 0.5 seconds, 1 second, 5 seconds, etc.) following a successful lip print detection and verification. Lip print verification can include generating a hash based on the detected lip print, and comparing it with a hash of a previously authorized lip print stored in memory **50**.

[0036] In some implementations, if an unauthorized lip print is detected the device can be temporarily or permanently disabled. For example, if five or more consecutive failed attempts are detected, the device can be disabled, requiring the owner to return to a retail provider to re-activate their device. In some implementations, the device is temporarily disabled (e.g., for 1 hour, 1 day, or 2 days, etc.).

[0037] The biometric sensor **56** can prevent device operation in a number of ways. For example, software in the controller **52** can simply not activate the atomizer **36** without the biometric sensor **56** providing an authorized lip print. In another example, a separate controller configured to operate the biometric sensors **56** can independently interrupt power to the atomizer **56**, using a switch or a transistor. In these implementations, the switch can default to an open position, isolating the atomizer **36**, until an authorized lip print is detected, at which point the switch closes, either for a predetermined period of time, or until the lip contact is no longer detected.

[0038] FIG. **4** illustrates an example of personal vaporizer with detachable biometric interlock **70**. The detachable biometric interlock **70** is shown in a cover or cap type format, that can magnetically or frictionally engage with the power supply **10** over the cartridge **12**. This configuration enables the use of low cost, disposable cartridges **12** while reusing more expensive and complex biometric components such as the biometric sensor **56** and controller **58**. The detachable biometric interlock **70** includes one or more seals **64**, a biometric sensor **56**, controller **58**, program button **66**, heater button **68**, air inlet vent **62**, communications link **60**, and a mouthpiece **72**.

[0039] The mouthpiece **72** forms an ergonomic shape for the user to place their lips on, and has a biometric sensor **56** integrated into its surface. The biometric sensor **56** can be an optical sensor, capacitive sensor, ultrasonic sensor, or combination thereof as discussed above with reference to FIG. **3**. Biometric sensor **56** is controlled by, or operated by a controller programmed to perform the operations described herein, namely biometric controller **58**. In some implementations, the biometric controller **58** includes its own power supply, such as a capacitor, battery and/or other power supply. In general, the biometric controller **58** includes suitable hardware and software for operating the biometric

sensor **56** to read lip prints, recording and storing authorized lip prints, determining if a read lip print is an authorized lip print, and if so, activating the personal vaporizer (e.g., by shutting a switch and/or otherwise enabling controller **52** to energize the heating element in cartridge **12**).

[0040] A communication link **60** can enable the biometric controller **58** to activate or deactivate the controller **52**, as well as receive power from the power supply **10**. In some implementations the communications link is a serial link (e.g., USB) or other digital link. In some implementations, the communication link **60** is an analog connection, and directly drives one or more circuits in the power supply **10** to activate or deactivate controller **52**. In some implementations the communications link **60** features a magnetic coupling with spring loaded or "pogo" pins to enable easy connection and disconnection. In some implementations communication link **60** is a wireless link, using near-field communications (NFC), radio-frequency ID (RFID) communications, and/or other wireless connections.

[0041] The air inlet vent **62** can allow air to pass into the lower portion of the detachable biometric interlock **70**, then into the cartridge **12** (e.g., via air inlet vent **16** as shown and described in FIG. **3**). As the user draws air through the mouthpiece **72**, it passes through air inlet vent **62**, into the lower portion of detachable biometric interlock **70**, where it is drawn through the cartridge **12**, into the user's mouth. One or more seals **64** provide a barrier to prevent or reduce air flow past the cartridge **12**. The seals **64** can be rubber, neoprene, or other compliant material that can compress or deform to fit around the cartridge **12**. As illustrated, detachable biometric interlock **70** includes a pair of ring seals **64** that operate as sleeve seals between the cartridge **12** and the interlock **70**. In some implementations, the seals **64** can be an O-ring or compression ring that seals against the top of the cartridge instead of the side. In some implementations, both are used. While two seals **64** are illustrated, a different number of seals is feasible. For example, a single seal, or no seal but instead tight tolerance between the interlock **70** and the cartridge **12** can be used. In another example, more seals (e.g., 3 or 5 or more) can be used.

[0042] Optionally, a heater button **68** can be included to allow the user to manually activate the heating element in the personal vaporizer. The heater button **68** can communicate with the power supply portion **10** via communications link **60** and allow the user to energize a vaporizer that doesn't automatically energize (e.g., doesn't include a puff sensor).

[0043] A program button **66** can be provided to allow the user to record their lip print as an authorized lip print. In some implementations, the program button **66** is a single use system, which allows the user to program their lips and then becomes non-functional following an initial programming. In some implementations, the program button **66** requires a device reset to be functional, or other security measures.

[0044] Although this disclosure has been described in terms of certain embodiments and generally associated methods, alterations and permutations of these embodiments and methods will be apparent to those skilled in the art. Accordingly, the above description of example embodiments does not define or constrain this disclosure. Other changes, substitutions, and alterations are also possible without departing from the spirit and scope of this disclosure.

1. A system comprising:

a personal vaporizer comprising:

a reservoir configured to hold a fluid to be vaporized;

a puff sensor configured to detect airflow through the personal vaporizer and generate a puff signal;

a heating element configured to atomize the fluid to be vaporized; and

a first controller configured to receive the puff signal and deliver power to the heating element in response to the puff signal; and

a biometric interlock comprising:

a biometric sensor configured to detect a lip print of a user; and

a second controller configured to receive the lip print from the biometric sensor and determine that the lip print is an authorized lip print and in response enable the first controller to deliver power to the heating element.

2. The system of claim **1**, wherein the second controller is configured to prevent the first controller from delivering power in response to determining that the lip print is an unauthorized lip print.

3. The system of claim **1**, wherein the biometric interlock comprises one or more seals that direct airflow through the personal vaporizer.

4. The system of claim **1**, wherein the biometric interlock comprises a battery configured to supply power to the second controller and the biometric sensor.

5. The system of claim **1**, wherein the biometric sensor is an optical sensor.

6. The system of claim **1**, wherein the biometric interlock comprises a communication link with the personal vaporizer, and wherein the second controller enables the first controller by sending a signal through the communication link.

7. The system of claim **6**, wherein the biometric interlock comprises a heater button, and wherein the heater button is configured to send a signal to the first controller using the communication link.

8. The system of claim **1**, wherein the biometric interlock comprises a program button that, when depressed, causes the second controller to record a lip print from the biometric sensor as the authorized lip print.

9. A method for activating a personal vaporizer comprising:

sensing contact of a user on a lip sensor;

scanning a lip print of the user with the lip sensor;

determining that the lip print is an authorized lip print and in response:

enabling a controller of the personal vaporizer to deliver power to a heating element of the personal vaporizer.

10. The method of claim **9**, wherein the controller delivers power to the heating element in response to a puff signal generated by a puff sensor of the personal vaporizer.

11. The method of claim **9**, comprising determining that the lip print is not the authorized lip print or there is no lip print and in response:

preventing the controller from delivering power to the heating element.

12. The method of claim **9**, wherein sensing contact of a user is performed with a capacitive sensor of the lip sensor.

13. The method of claim **12**, wherein scanning the lip print of the user is performed with the capacitive sensor and an optical sensor of the lip sensor.

14. A system comprising:

a biometric interlock comprising:

a biometric sensor configured to detect a lip print of a user; and

a controller configured to receive the lip print from the biometric sensor enable a personal vaporizer to atomize a fluid to be vaporized.

15. The system of claim **14**, wherein the biometric interlock is configured to be coupled to the personal vaporizer and at least partially enclose a cartridge of the personal vaporizer.

16. The system of claim **15**, wherein the biometric interlock comprises one or more seals that direct airflow through the personal vaporizer.

17. The system of claim **15**, wherein the biometric interlock comprises a communication link with the personal vaporizer, and wherein the controller enables the personal vaporizer by sending a signal through the communication link.

18. The system of claim **14**, wherein the biometric interlock magnetically couples with the personal vaporizer.

19. The system of claim **14**, wherein the controller is configured to and determine that the lip print is an authorized lip print based on a comparison with a stored lip print that is store in a memory of the personal vaporizer.

20. The system of claim **14**, wherein the biometric interlock comprises a battery configured to supply power to the controller and the biometric sensor.

* * * * *