

PERSONAL SMOKING CESSATION DEVICE WITH AUTHENTICATION, ENCRYPTION, AND LOCK

BACKGROUND

1. Field of the Invention

[0001] The present application pertains to portable smoking cessation devices, in general, and to a modular portable smoking cessation device with authentication, encryption, and lock, in particular.

2. Background Art

[0002] Countless smokers have adopted some form of portable smoking cessation (PSC) device to promote cessation of tobacco product smoking. Typically, battery-operated PSC devices include a device body, a battery attached to the device body, and a reservoir of liquid, often flavored, that contains an active ingredient, such as nicotine. The reservoir also can be called a “pod” or cartridge, and the liquid can be known as “e-liquid” or “juice.” By inhaling through the PSC device, the e-liquid can be wicked into an electric firing chamber that produces a smoke-like vapor for inhalation. This activity can be called “vaping.”

[0003] Certain users of such devices may have no intention of ceasing to use tobacco or nicotine products, and the term “PSC device” as used herein is broad enough to cover device or components disclosed herein for vaping or inhalation of various chemicals whether or not the user intends to cease his or her behavior in the future.

[0004] Although vaping is less hazardous than tobacco smoking, recent events indicate that e-liquid material can be inauthentic, and PSC devices or their components can be counterfeited or modified, such that some users suffer pulmonary insults and even death. Furthermore, vaping has become widespread among the young, including high school and middle school children. Indeed, in a press conference on December 18, 2018, the United States Surgeon General, Jerome M. Adams officially declared the use of e-cigarettes among youth to be an “epidemic.” www.safetvandhealthmagazine.com/articles/17921-number-of-teens-vaping-hits-record-high-survey-shows (Jan. 10, 2019), accessed Oct. 17, 2019.

[0005] It has become a priority to prevent juveniles from purchasing PSC devices and from using imitation e-liquid materials. There can be difficulties even for age-appropriate users with current PSC devices. For example, the amount and characteristics of e-liquid used cannot be adequately controlled, if at all. Data pertaining to device and e-liquid use cannot be accurately

tracked and analyzed. Device and e-liquid counterfeiting is common. The device is unlikely to be intelligent, that is, it is difficult, if not impossible, to track e-liquid use and characteristics, as well as PSC device identification and operational data. Moreover, e-liquid leakage is common. Typically, the user needs to manually adjust various options. Also, vapor and e-liquid information cannot be collected, so the equipment cannot engage in intelligent analysis and operation. In addition, the structure of an e-liquid cartridge may allow for occasional e-liquid leakage from time to time. Moreover, the types of vapors and e-liquids can be complex complicated. Currently, e-liquids cannot be traced back to the source, cannot carry out batch management, and cannot provide accurate device and e-liquid usage information, including device statistics.

[0006] What is needed is a PSC device that makes difficult counterfeiting and illicit device use and can identify and use authentic e-liquid.

SUMMARY

[0007] The invention provides a personal smoking cessation (PSC) device which makes difficult counterfeiting and illicit device use, which can identify and use authentic e-liquid, which can be electronically locked by touching a contact, and which can provide data and feedback to the user regarding usage statistics.

[0008] The invention also provides a PSC device, including an e-liquid cartridge, an EEPROM disposed within the e-liquid cartridge, and a host body communicatively coupled to the EEPROM. The EEPROM within the e-liquid cartridge communicates with the host body. The EEPROM is a data encryption EEPROM, in which data to the EEPROM is encrypted, and data from the EEPROM is decrypted. The EEPROM is an authenticating EEPROM, in which a user is authenticated as an authorized user. In embodiments, the authenticating EEPROM is a multi-factor authenticating EEPROM, in which the user supplies a plurality of authenticating factors so that the user is authenticated as an authorized user. The PSC device includes a touch-sensitive electronic lock. In embodiments, the electronic lock is disposed within the host body. In embodiments, the electronic lock is coupled with a female USB connector. The electronic lock can be actuated by touching the female USB connector. The e-liquid cartridge is coupled to the host body with a first preselected electromechanical connector, which is a USB Type C electromechanical connector mechanically and electrically coupling the e-liquid cartridge with the host body. In embodiments, the host body further includes a radio transceiver configured to

exchange data with a communication device external to the PSC device. In embodiments, the host body is configured to receive a rechargeable battery, a replaceable battery, or a rechargeable, replaceable battery.

[0009] The invention further provides a Personal Smoking Cessation (PSC) device, which includes an e-liquid cartridge storing a preselected fluid to be vaporized and a vaporization element configured to vaporize the preselected fluid. Also included is an EEPROM within the e-liquid cartridge, in which the EEPROM has a universally unique identifier (UUID) stored therein, in which the EEPROM facilitates authentication of a user, the e-liquid cartridge, and the preselected fluid, and in which the EEPROM facilitates encryption of received data and decryption of transmitted data. The device additionally includes a host body with a first female USB-C electromechanical connector communicatively coupled to the EEPROM having a first male USB-C electromechanical connector. The first male and a first female USB-C electromechanical connectors form positive mechanical and electrical connections between the EEPROM and the host body. The host body exchanges data with the EEPROM. The host body includes an electronic lock. In embodiments, the electronic lock reversibly locks the EEPROM, and the electronic lock is operably coupled to a second female USB-C electromechanical connector. In embodiments, the PSC device further includes a Bluetooth radio transceiver coupled to the EEPROM, in which the Bluetooth radio transceiver communicates data between the PSC device and a second Bluetooth transceiver disposed in an external communication device.

[0010] These and other advantages of the present invention will be further understood and appreciated by those skilled in the art by reference to the following written specifications, claims and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In the FIGURES, which are not drawn to scale, like numerals refer to like features throughout the description. The following description is not to be taken in a limiting sense but is made merely for describing the general principles of the invention. Preferred embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

[0012] FIG. 1 is a perspective view of a personal smoking cessation (PSC) device, in accordance with teachings of the present invention;

[0013] FIG. 2 is an exploded view of the PSC device, in accordance with teachings of the present invention;

[0014] FIG. 3 is an exploded view of an e-liquid cartridge of the PSC device of FIG. 2, in accordance with teachings of the present invention;

[0015] FIG. 4 is an illustration of the PSC device assembly of FIG. 1, in accordance with teachings of the present invention;

[0016] FIG. 5 is an illustration of the PSC device assembly of FIG. 1 with PSC body viewed from above, in accordance with teachings of the present invention;

[0017] FIG. 6 is a longitudinal cross-section of the PSC device of FIG. 1 showing enlarged section, in accordance with teachings of the present invention;

[0018] FIG. 7 is a pictorial assembly of the body of the PSC device of FIG. 1, in accordance with teachings of the present invention;

[0019] FIG. 8 is a cutaway view of the PSC device of FIG. 1, in accordance with teachings of the present invention;

[0020] FIG. 9A is a cutaway obverse view of air flow in a PSC device, in accordance with teachings of the present invention;

[0021] FIG. 9B is an enlarged view of a portion of FIG. 9A, in accordance with teachings of the present invention;

[0022] FIG. 10 is a cutaway view of the reverse side of a PSC device, in accordance with teachings of the present invention;

[0023] FIG. 11 is an illustration of a PSC device in communication with a mobile device, in accordance with teachings of the present invention;

[0024] FIG. 12 is a bottom transverse view of a PSC device body including USB-C connector, in accordance with teachings of the present invention;

[0025] FIG. 13 is a longitudinal cross-section of a PSC device, in accordance with teachings of the present invention;

[0026] FIG. 14 is a front cutaway view of an e-liquid cartridge, in accordance with teachings of the present invention;

[0027] FIG. 15 is a schematic of several circuits of a PSC device, in accordance with teachings of the present invention;

[0028] FIG. 16A is a pinout illustration of a USB-C 24-pin connector, in accordance with teachings of the present invention;

[0029] FIG. 16B is a pinout illustration of a serial EEPROM, in accordance with teachings of the present invention; and

[0030] FIG. 17 is a pinout schematic of a Bluetooth® Low Energy System on a Chip (BLE-SOC), in accordance with teachings of the present invention.

[0031] Some embodiments are described in detail with reference to the related drawings. Additional embodiments, features, and/or advantages will become apparent from the ensuing description or may be learned by practicing the invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0032] The present embodiments provide a personal smoking cessation (PSC) device that employs authentication, encryption, or locking, or a combination, to make difficult counterfeiting and illicit use, and which can be finely controlled as to its operational behavior, and which can provide helpful usage statistics. At present, there is no e-liquid cartridge having built-in encryption or authentication device elements. The present invention can provide a meaningful solution to the counterfeit problem, and which can be controlled as to its operational behavior, and which can provide helpful usage statistics.

[0033] As used herein, identification is the claiming of an identity, whereas authentication is the act of verifying or proving the claimed identity. In authorization, a system entity or actor has been granted the right, permission, or capability to access a system resource. Encryption is the cryptographic transformation of data (called “plaintext”) into a form (called “ciphertext”) that conceals the data’s original meaning to prevent it from being known or used. If the transformation is reversible, the corresponding reversal process is called “decryption,” which is a transformation that restores encrypted data to its original state.

[0034] Referring to FIG. 1, an embodiment of PSC device 100 is shown, having mouth cover 110 and host body 120 coupled to mouth cover 110. PSC device 100 can verify, at a minimum, the genuineness of both the user and the e-liquid, by authentication. In embodiments in which PSC device 100 is used as an inhaler for controlled or prescription medications, PSC device 100 also may verify, for example, dosage, frequency of use, time of use, and physician’s prescription information. Data may be encrypted and stored in PSC device 100. In embodiments, if authentication fails, or if the user chooses, PSC device 100 can be temporarily disabled, e.g.,

reversibly locked. Data may be transferred bidirectionally with PSC device 100, including without limitation, operational data, usage data, and user demographic data. Data also may be transferred between PSC device 100 and an external communication device, such as a typical smartphone for example, using Bluetooth or other communication functionality, by using an application on the smartphone (not shown). The data in PSC device 100 can be encrypted to prevent unauthorized use of the data. Preferably PSC device 100 in Figure 1 is small enough to be held within the palm of a hand while in use so that it is easily hidden while being used and the user is not embarrassed or socially stigmatized, but PSC device 100 optionally may be any size.

[0035] Turning to FIG. 2, an exploded view of PSC device 200, obverse side, is illustrated. PSC device 200 can include mouth cover 210, e-liquid cartridge 220 coupled to mouth cover 210, cartridge connector 230 coupled to e-liquid cartridge 220, host body 240, air seal 235 between e-liquid cartridge and host body 240, work indicator light 245, host battery compartment 250, battery 260, motherboard 270, negative pressure switch 280 physically and electrically coupled to motherboard 270, upper host connector 290 coupled to motherboard 270, and lower host connector 295 coupled to motherboard 270.

[0036] Mouth cover 210 can be made of a molded rigid or semi-rigid food grade plastic, such as, without limitation, polypropylene (PP) or PCTG (Poly-Cyclohexylenedimethylene Terephthalate Glycol). PCTG is a food-grade thermoplastic glycol-modified terephthalate copolyester creating rigid or semi-rigid structures. PCTG has anti-corrosion, anti-leach properties, is recyclable and biodegradable, and does not emit the toxin bisphenol A (BPA). PCTG offers toughness, impact strength, and clarity. PP may be the safest of all plastics, and is a robust plastic that is heat resistant. Because of its high heat tolerance, PP is unlikely to leach even when exposed to warm or hot water and is approved for use with food and beverage storage. E-liquid cartridge 220 also can be made of, without limitation, PCTG. Cartridge connector 230 can be a USB type-C (USB-C) male connector, which can form an electromechanical connection with a corresponding female USB-C connector (not shown) in host body 240, can facilitate an exchange of data between e-liquid cartridge 220 and host body 240, and can provide electrical power to e-liquid cartridge 220. The mated USB-C connector also provides mechanical mating and stability with the USB-C junction.

[0037] Host body 240 can be a shell, made of sturdy material, such as plastic, metal, or a composite material. In embodiments, body 240 can be CNC aluminum. Body 240 can be

formed to provide battery compartment 250 and to receive motherboard 270. Battery compartment 250 can hold in place battery 260, which can be a rechargeable lithium-ion battery with a nominal voltage of about 3.7V and an energy capacity of about 550 mAh. A battery of another type and electrical characteristics also may be used, including battery 260, which may be rechargeable, replaceable, or both. Attached to battery compartment 250 can be motherboard 270. Motherboard 270 can hold operational components and connectors for PSC device 200, for example, negative pressure switch 280, upper body connector 290, and lower body connector 295. Negative pressure switch 280 can be an airflow sensor, which actuates heating in cartridge 220 when the negative pressure associated with a user's inhalation is reduced to a preset value. Upper body connector 290 can provide a secure mechanical receptacle for cartridge connector 230, as well as provide data exchange and electrical power between e-liquid cartridge 220 and motherboard 270. In embodiments, upper body connector 290 can be physically compatible with e-liquid cartridge connector 230 and may be a USB-C female connector. In use, the physical connection between connector 230 and mating connector 290 can positively and securely hold cartridge 220 in body 240. In addition, motherboard 270 may be electrically coupled to lower body connector 295. Lower body connector 295 may be a USB-C female connector for providing a streamlined physical appearance, while allowing communications with an external device, although a USB-C male connector also may be used. In general, data and electrical connections may exist between e-liquid cartridge 220 and lower body connector 295. Motherboard 270 may contain several operational circuits (not shown), which may perform specific functions to facilitate operation of PSC device 200, for example, without limitation, power adjustment, reverse polarity protection, earth leakage protection, intelligent power management, Bluetooth communication, e-liquid cartridge intelligent chip management, timing, temperature management, resistance adjustment, preheating, overheat prevention, touch detection, and PSC electronic lock. Motherboard 270 may be composed of a single layer or multiple layers or comprise multiple stacked boards. Electrically coupled to motherboard 270 may be work indicator light 245, a LED which provides a physical indication of the operational state of PSC device 200, for example, charge state and power status (on/off).

[0038] In FIG. 3, an exploded view of e-liquid cartridge 300 is shown. E-liquid cartridge 300 can be functionally like e-liquid cartridge 220 in FIG. 2. Cartridge 300 can include mouth cover 305, vapor passage 310 disposed through mouth cover 305, cartridge sealing cover 315, e-

liquid reservoir 320, vapor tube 325, heating element 330 which can be received by a distal portion of vapor tube 325, atomization chamber bracket 335 configured to keep vapor tube 325 physically stable, heating wire insulation 340, USB-C bracket cover 350, USB-C male connector 360, USB-C support 370, and EEPROM 375. EEPROM 375 can be a serial EEPROM.

[0039] Mouth cover 305 can be formed with vapor passage 310 therethrough, which allows vapor generated through the operation of heating element 330 to be received by an inhaling user. To prevent leakage of e-liquid from the top of e-liquid reservoir, cartridge sealing cover 315 can be securely fastened to the proximal end of reservoir 320. To allow for compact design, flue or vapor tube 325 can pass through reservoir 320 and be coupled to vapor passage 310 of mouth cover 305. At the distal end of vapor tube 325 can be an enlarged portion 380, which can be configured to receive heating element 330. As heating element 330 operates, e-liquid (not shown) from e-liquid reservoir 320 is vaporized and travels through vapor tube 325 to vapor passage 310. In embodiments, heating element 330 can be a hybrid ceramic heating element in which a ceramic support may be wrapped by Type 316 stainless steel.

[0040] Furthermore, heating element 330 may be a hybrid heating element, which can have organic cotton disposed within the coils of heating element 330. Atomization chamber bracket 335 can stabilize vapor tube 325 and heating element 330 when assembled. To mitigate the effects of heating on structures distal to atomization chamber 335, heating wire insulation 340 can be provided. In embodiments, insulation 340 can be a silica gel. Bracket cover 350 encloses atomization chamber bracket 335 to prevent leakage of e-liquid (not shown). Physically and electrically coupled to atomization chamber bracket 335 can be USB-C male connector 360. USB-C male connector 360 can be used to secure e-liquid cartridge 300 into a USB-C female connector in PSC device host body, as is depicted in FIG. 2. USB-C support 370 can provide mechanical stability to USB-C male connector 360 in e-liquid cartridge 300. Encrypted EEPROM data-based anti-counterfeiting technology, or a unique serial number, can be provided on a small PCB 375, or elsewhere, to virtually eliminate risk of counterfeiting via, for example, 128-bit encryption/decryption technology using the Advance Encryption Standard (AES) cryptography or other encryption technology.

[0041] EEPROM 375 can be used to store data regarding, for example, the characteristics of the cartridge, the content of the cartridge, smoking routines of the user, etc. In particular, a non-limiting list of data stored in EEPROM can include: cartridge content; cartridge brand; where

cartridge is made; brand flavor; content volume; maximum number of drags or puffs; main ingredient; co-ingredients (up to) 10; solvent used (up to 3 types); product batch number; content viscosity; whether preheating is needed; time delay for preheat; and heating coil type. Cartridge content indicates what the cartridge contains, including, for example, nicotine mixture, a CBD solution, a THC tincture, a cannabis wax, or a preselected medication. Cannabis wax is a form of hash oil concentrate created when a solvent is washed over marijuana plant material.

[0042] Cartridge brand indicates which brand of cartridge is being used, which itself provides information about the cartridge, its contents, and the context in which it is used. It can be important to know where the cartridge is made, for example, California or Colorado, etc., for quality control, for supply chain accountability, and for recall purposes. Brand flavor can be useful for identifying ingredients of a particular branded cartridge. Content volume describes how much content is in the cartridge. Typical values may be between about 0.5 ml to about 10 ml maximum volume. In view of the identified cartridge volume, a corresponding maximum number of drags is defined. When the maximum number of drags is reached, the cartridge locks and can no longer be used. In an embodiment, the cartridge is locked between about 350-800 drags, with a typical 1000 drag maximum. In an alternative embodiment, the total time length for vaporization may be used. In this instance, the total time of vaporization before the cartridge locks may be between about 150 seconds to about 2,000 seconds. This feature prevents the cartridge from being refilled, for example, with harmful ingredients, and resold on the black market, and removes the economic benefit of illicit or counterfeit trade. This feature also can be useful in situations in which the content is a controlled (e.g., THC) or potentially hazardous (e.g., nicotine) substance.

[0043] It is useful to know the main ingredient of the cartridge content, as well as co-ingredients of the content. Identified can be the ingredient or co-ingredient, its respective volume in milliliters, and the ratio of the co-ingredient mixture. In an embodiment, up to 10 co-ingredients can be identified, measured in milligrams. Up to 3 solvent types also can be stored. A solvent can be used for oily or waxy substances such as, THC and CBD ingredients. Product batch number identifies the particular batch of the product stored in the cartridge which, when accompanied by cartridge content and brand identification can specifically identify the production information of the cartridge. Batch number may be stored in a 32-byte value, producing roughly about 10^{77} unique batch number values. Content viscosity may be stored

as a percentage of a known value, for example, between about 0% to about 100%. Content viscosity can be useful to know, for example, for gauging and setting heating and preheating parameters. To that end, it is important to know whether preheating is desired for the content, and if so, the selected time delay and target preheat temperature and resistance values. In order to properly set the parameters needed for heating and preheating, it is necessary to know what type of heating coil is being used, for example, platinum, 316 stainless steel, nickel coated iron, etc. In the cartridge, behavioral data may be stored in the EEPROM, for example, each day may be separated into six (6), four (4) hour intervals, for mapping user behavior of drags and length of intake in each time interval. To accomplish this, the total number of drags in a predefined period are counted, and the total number of seconds of inhalation (in 0.1s increments) per drag on the cartridge are measured. The data stored maps user behavior of drags and length of intake in each time interval.

[0044] Selected personal and usage data can be stored on the cartridge. Personal data can include, for example, user name, smoking history, and user age. The most recent 6 intervals (one day) can be stored on the cartridge. Each day for a total of 180 intervals (30 days) may be transferred to and stored on a memory device in the device body. In turn, this data can be transferred to and stored on a cloud. Usage data also may be collected and stored on the cloud, such as the number of drags per cartridge use, the average time length for drags, total number of drags, and the time interval for the drags. Transfer from cartridge to body may be accomplished by a USB-C connection between device and body, or by a short range wireless connection. Transfer from body to cloud may be accomplished by coupling a smartphone to the device body and transmitting the data from the body to the cloud via the smartphone. Alternatively, the body may contain a cellular or long range radio therein, which may use 4G, 5G, or 6G wireless capability to connect directly between body and the cloud. Data stored in the cloud which can be shared with a PSC device may include cartridge activation status, cartridge disable command, when set or disable only by batch at daily maximum count, and cartridge daily maximum setting. These three data currently are determined per batch of cartridges, but not for a single cartridge.

[0045] Data sampling can be initiated by the microphone, which can be a negative pressure sensor. For example, when a drag is initiated, a negative pressure is sensed by the microphone. When the microphone is activated continuously for more than 500 milliseconds, the count of the number of drags can be incremented by one and total time for drag can be incremented by the

length of the drag. This data can be written into firmware storage, as well as cartridge memory. Moreover, the number of seconds that the microphone is activated can be measured in 0.1 second intervals. Then, the total number of seconds of activation can be recorded and written in firmware storage as an updated total number of seconds, and also writes this data into cartridge memory. The data record can be separated by time slots of 6 intervals of 4 hours. Each interval may have an updated total number of drags, and total amount of time in 0.1 seconds resolution. A cartridge only may have the record of the most recent 6 intervals with the others being recorded in the device body. PSC device can record up to 180 time intervals of data, including the total time of drags counted and the time for each drag. Data can be stored when a cartridge is connected, and whenever a user interacts with the PSC device. In an embodiment, data can be transferred between the cartridge EEPROM memory and the body using the IIC (I2C) protocol.

[0046] FIGS. 4, 5, and 6 provide illustrations of the assembly of the PSC device 400, by a user. E-liquid cartridge 410 can be attached to body 420 by merely inserting e-liquid cartridge 410 into cavity 430 of body 420, and firmly seating the USB-C male connector 440 disposed in the distal part of the e-liquid cartridge into a corresponding USB-C female connector 450 disposed in body 420. The USB-C connection is generally physically secure so that e-liquid cartridge 410 remains seated in body 420 until removed by a user. In FIG. 5, upper body female USB-C connector is shown generally at the base of cavity 430 in body shell 420. To use a PSC device, one inserts male USB connector 440 of e-liquid cartridge 410 into upper body female USB-C connector. In FIG. 6, a cross-section of PSC device 400 provides an enlarged portion 600, which illustrates the physical connection of USB-C male connector 610 to upper body USB-C female connector 620. Although USB-C connector technology can be employed to communicate between e-liquid cartridge 410 and body 420, other connector technologies may be used, such as, without limitation, USB-A, USB-B, USB-mini B, and USB-micro B connectors; at least 5 spring-loaded connectors (pogo pins); Display port and mini-Display Port connectors; a Lightning connector; an optical connector; a Firewire connector; and modular jack connectors. Corresponding electrical protocols are USB 2.x, USB 3.x and USB 4, DisplayPort, Thunderbolt 3, and Lightning protocols. In some embodiments, in place of wired connectors, communication between e-liquid cartridge 410 and body 420 can be effected by a short-range wireless protocol including, without limitation, Near-Field Communication (NFC); High Frequency RFID (HF RFID); Bluetooth®, particularly Bluetooth® Low Energy (BLE); 6LoWPAN; Thread protocol;

Ultrawide bandwidth (UWB); WiGig™ (i.e., IEEE Std. 802.11ad); or other short-range low power wireless protocol. One of ordinary skill in the art would know which electrical protocol to pair with which connector technology.

[0047] In embodiments, host body 700 can be composed of internal assembly 710, which can be inserted and secured into body shell 760. Internal assembly 710 includes, inter alia, battery compartment 720, rechargeable battery 730, and motherboard 740, which is coupled to Bluetooth® radio module 750. IEEE 802.15.1 (or Bluetooth®) radio module 750 may be replaced by a radio module employing, without limitation, Bluetooth® Low Energy (BLE); Z-Wave; 6LoWPAN; Thread Protocol; Near-Field Communication (NFC) and HF RFID; IEEE Std. 802.15.4 (ZigBee®); IEEE Std. 802.15.6 (wireless body area network – WBAN) protocols; UWB; or WiGig™ (e.g., IEEE Std. 802.11ad), although other short-range communications protocols may be used.

[0048] FIG. 8 is a cut-away of PSC device 800, which further illustrates the internal structure of PSC device 800. Shown are e-liquid cartridge 810, battery 820, circuit board assembly 830 and seal ring 840. Seal ring 840 can be used to reduce air flow diminishment by providing a tight seal around e-liquid cartridge 810 and circuit board assembly 830. Airflow through PSC device 800 also is illustrated. When a user inhales on PSC device 800, airflow 850 enters through side air inlet 855 on the side of PSC device 800. Airflow 860 travels down through cartridge 810 to air inlet 865 of the bottom of the atomization bin, and then to negative pressure switch 875, which functionally may be a microphone. By sensing the air pressure change from user inhalation through negative pressure switch 875 disposed on the main PCB board, PSC device 800 is actuated. Airflow returns air to e-liquid cartridge 810, where a selected amount of e-liquid is vaporized and passed through vapor outlet 880. After PSC device 800 is actuated, data in e-liquid cartridge 810 will be read through PC board 870, and the control functions, for example, heating, will be performed according to e-liquid cartridge data (not shown). A user app (i.e., mobile phone software) corresponding to PSC device 800 can be employed to display the usage status, and which also can be uploaded to the user's mobile phone software for display via a link with the PSC device 800 once radio communication module 835 is connected and operating. Radio communication module 835 may be, but is not limited to, a Bluetooth® Low Energy (BLE) radio communication module, although radio communication modules for other types of short-range communications protocols may be used, including, without limitation, Near-

Field Communication (NFC); High Frequency RFID (HF RFID); “Classic” Bluetooth®; 6LoWPAN; Thread protocol; Ultrawide bandwidth (UWB); or WiGig™ (i.e., IEEE Std. 802.11ad).

[0049] FIG. 9A depicts a longitudinal section of the rear of PSC device 900 further describing air flow through PSC device 900. PSC device 900 can include PSC body 915 and PSC e-liquid cartridge 955. In turn, e-liquid cartridge 955 includes e-liquid reservoir 955, e-liquid storage bin 925, and operational compartment 920. Upon user inhalation on vapor outlet 945, air inlet 905 receives incoming airflow 910 and directs it to a negative pressure sensor (not shown), which can be functionally like negative pressure sensor 875 in FIG. 8. Upon sensing a preset pressure, the negative pressure sensor actuates the atomization components to cause vapor formation in atomization chamber 935. The formed vapor rises up flue 940 until the vapor exits vapor outlet 945 to the user. FIG. 9B is a portion of PSC device, including e-liquid storage bin 925. At times, vaporized e-liquid in e-liquid reservoir 955 may condense, leading to leakage from e-liquid reservoir 925. This leakage may penetrate operational compartment 920, which may damage elements therein. E-liquid storage bin 925 can be implemented beneath e-liquid reservoir 955 to mitigate such leakage by collecting the condensate in e-liquid storage bin inlet 960.

[0050] Turning to FIGS. 10 and 11, radio module 1025, which may be a Bluetooth® radio module, can be used to communicate between the user, typically using a multifunction mobile “smart” phone 1125, and PSC device 1100. Radio module 1025 can use, for example, Bluetooth® Low-Energy (BLE) protocol transmitter (not shown) using Bluetooth Low Energy protocol. BLE can maintain a similar communication range as standard Bluetooth radio or Bluetooth “Classic,” e.g., $\geq$ about 100 m. Power savings can be significant with BLE using 1% to 50% less power than Bluetooth Classic. In present embodiments, an ATB1103 Bluetooth® radio module 1025 is provided, although other modules with similar functionality may be used. ATB1103 is a product of Actions Technology, Shenzhen, CN. The ATB1103 is an ultra-low power, fully integrated, single-chip Bluetooth Low Energy microcontroller. It features a low-power physical layer, a link layer with a security engine, a host controller interface, and an ARM Cortex-M0 MCU to handle the upper layer protocol. The Bluetooth® Low Energy protocol is well-known to one of ordinary skill of the communications arts. The ATB110X family is an ultra-low power, fully integrated, single-chip Bluetooth Low Energy solution. It features a low-

power physical layer, a link layer with a security engine, a host controller interface and an ARM Cortex-M0 MCU to handle the upper layer protocol. ATB1103 supports the latest Bluetooth V4.2 version with LE packet length extension feature. Users can implement the application software on the embedded Cortex M0. Of course, other Bluetooth chipsets may be used to facilitate communication. In alternative embodiments, radio module 1025 can be without limitation, an NFC module, an RFID module, an UWB module, a 6LoWPAN module, a Thread protocol module, a WiGigTM module, or a module for another short-range low power wireless protocol.

[0051] It is desirable to prevent minors or unauthorized parties from using PSC device 1100. A user (not shown) can employ identification and authentication, in order to receive authorization to use PSC device 1100. Initially, the user registers by creating an account on-line through an external communication device such as, without limitation, PC or smartphone 1125, or other internet enabled device. During the registration process, the user supplies a unique ID (e.g., unique username, e-mail address, or 10-digit phone number) and a corresponding authenticating password. This information can be transmitted to host server 1175 during identification and activation, along with other information which may include the serial number of the PSC device 1100 or serial numbers/codes associated with e-cartridges 1120 that are in the possession of the user. Thus, the registered user and his or her e-cartridges 1120 will be associated with the PSC device 1100 and no one else will be able to use the PSC device 1100 or cartridges 1120. In this way, host activation ID authentication can effectively prevent the use of PSC device 1100 by minors. In addition, to ensure that the PSC device 1100 confirms the identity and age of the user, a photo identification may be required, which may be a government photo identification, including birthdate, among other things. This ID may be sent to a server. Acceptable forms of government photo identification include, for example, passports, Personal Identity Verification (PIV) cards, and drivers' licenses, Military ID, Permanent Resident Visa/Green Card, other Government-issued ID, etc. Government-issued ID is unlikely to be counterfeited. Multi-factor authentication also may be used. Multi-factor authentication is an authentication technique that requires users to provide multiple forms of identification when logging in. Each PSC device 1100 can have stored within it a unique, unalterable 128-bit identifier, serial number, or both, that can be associated with the credentials provided by a particular user, including username and password. The user may then be authenticated locally to

the mobile device by entering a PSC-related serial number, passcode or PIN, or by using mobile device-level biometrics to be able to use the stored credentials. An authorized user can be issued digital credentials that are stored securely on mobile device 1125. Mobile devices 1125 include without limitation, smart mobile phones, tablets, and smart watches. Once an account has been created and the credentials of the user have been approved, the user can be authorized to operate PSC device 1100. If a user is leaving the vicinity of their PSC device 1100, they can lock the device by tapping on the base of PSC device 1100, on the lower body USB-C connector. Alternately, PSC device 1100 may be programmed to affect a lock-out, for example, if the user has been away from their PSC device 1100 and a predetermined amount of time has elapsed without use, or if a user has made a predetermined number of failed authentication attempts. Mobile device 1125, properly authenticated, may be used to observe or change data stored in the EEPROM of device 1100, except for the unalterable, universally unique ID (UUID) also stored in the EEPROM. In addition, mobile device 1125 also may be associated with a serial number, which also may be used for multi-factor authentication.

[0052] Through its registration with server 1175, PSC device 1100, is authorized only for a particular user. This may be particularly useful when the PSC dispenses prescription drugs. It may be used only after activation from user's smartphone 1125 or other smart device, or when "unlocked" by a successful series of taps on the lower body connector. Alternatively, a particular group of users may be authorized. Likewise the e-liquid cartridge 1120 also has a unique code or serial number, and may be authorized for use only with the particular PSC device 1100, through registration after purchasing, since smartphone 1125 or other smart device associated with PSC device 1100 will know what e-liquid cartridges 1120 are valid for PSC device 1100 through registration. Thus, PSC device 1100 alone or through communication with smartphone 1125 or other smart device, will only work with predetermined, registered e-liquid cartridges 1120. This prevents third party counterfeit or contraband e-liquid cartridges 1120 from working in PSC device 1100, since the third parties do not know the encryption algorithms used. PSC device 1100 security can prevent users from swapping e-liquid cartridges 1120 to others that may not be authorized (such as minors) or that may have physical issues with the e-liquid cartridges in question.

[0053] Moreover, circuit board 375 and motherboard 270 may contain sensors, memory, and variable circuits, connected to smartphone 1125 or other smart device wirelessly (such as

Bluetooth or cellular protocols) or by other means. Therefore, the user, through smartphone 1125 app, may control the wattage and time of atomization with the heating elements, thus controlling the amount of chemicals inhaled. Statistics such as overall usage, chemicals inhaled, trends (increasing or decreasing use) and other metrics may be shown on the smart phone or other smart device. E-liquid cartridge 1120 may also contain information indicating its manufacturer, the type of e-liquid it contains, and its current level, as well as other statistics, such as how often it has been used. Such sensor readings, statistics and other data may be uploaded to the cloud 1150 via connected smartphone 1125 or other smart device. Should a PSC device 1100 become lost or stolen, the user simply logs into their account and reports the device missing to the host server 1175. The next time an attempt is made to register device 1100 with host sever 1175, it may be deactivated and become non-functional. Thus, though registration of either or both the e-liquid cartridge 1120 and device 1100 body with central host server 1175, unauthorized use of e-cartridges 1120 and devices 1100 can be prevented. This will greatly improve the safety of devices 1100 and reduce knock-off, and potentially harmful, third party cartridges 1120.

[0054] Turning to FIG. 12, a locking mechanism for a PSC device is shown. On the PSC device base 1200, there can be a USB-C female connection 1225 that can assist with power control, data collection, and data exchange. In addition, connection 1225 can be coupled to a touch-sensitive circuit (FIG. 15, reference 1560) that, when touched a predetermined number of touches, shuts off and locks the corresponding PSC device. This convenience assists with preventing unauthorized operation of a PSC device by a user other than the owner of the PSC device. In embodiments, a user may lock their PSC device 1200 by applying, for example, five (5) touches to the edge of USB-C female contact 1225. USB-C female contact 1225 can be coupled, for example, to a capacitive touch-sensitive circuit (1560), which can bar or permit operation of PSC device 1200 when actuated. The touch-sensitive circuit (1560) can be adjusted to require fewer or more touches to activate and disable the lock.

[0055] In certain embodiments, such as for ODM distribution, a business-to-business buyer, which typically is not an end user, will pre-fill an e-liquid cartridge with e-liquid, seal the cartridges, and re-sell them as the buyer's brand. A suitable e-liquid may be, without limitation, nicotine, CBD oil, THC oil, or an oral respiratory inhalant, such as, without limitation, albuterol or a corticosteroid. Similarly, PSC device can be sold as an independent carrier brand to other

brand owners as a vaporizer and may be sold in a retail website, retail chain, online or in physical stores. E-liquid cartridge can be sold to authorized brands as ODM product. However, each e-liquid cartridge can be assigned an authorized ID code, which may be a unique identification (UID) or a universally unique identification (UUID) in advance for different customers. In embodiments, a unique 128-bit number can be assigned to respective e-liquid cartridge. Each e-liquid cartridge may require an authorized ID code to work with the particular PSC device.

[0056] FIG. 13 is a cross-section of complete PSC device 1300. Mouth cover 1305 can cover the proximal end 1310 of PSC device 1300 and can be mechanically coupled to flue 1315. Flue 1315 can be joined to atomization chamber 1320, in which e-liquid is absorbed by organic cotton 1325 into atomization chamber 1320. The wetted organic cotton can be surrounded by a coil-shaped hybrid ceramic heating coil 1395, and by heating to a preset temperature, e-liquid is atomized. PSC device 1300 can include body shell 1330 in which e-liquid cartridge 1310 and battery compartment 1335 are disposed. Battery 1340, which may be a 3.7V, 550 mAh rechargeable battery, provides energy for device management, security, data management, data transfer, communication, e-liquid atomization, and status lighting, among others. In this configuration, USB-C male connector 1345 is physically and communicatingly coupled with USB-C female connector 1355, and female connector 1360 is electrically and communicatingly coupled to USB-C female connector 1355. Air flows into PSC device 1300 through side inlet 1390 and flows out through mouth cover outlet 1305, forming circuit through air pressure sensor 1365, i.e., negative pressure transducer 1365.

[0057] By operation of air pressure sensor 1365, e-liquid atomization occurs in chamber 1320, and the selected vapor enters mouth cover 1305. Also disposed in host body shell 1330 can be main PCB 1365 and Bluetooth® PCB 1370. Main PCB 1370 contains functional elements to enhance the operation of PSC device 1300 including, without limitation, atomization, measuring of PSC temperature data, analyzing and controlling temperature, identification of e-liquid boiling points, power and charging management, and touch detection. Bluetooth® PCB chip 1375 supports and performs Bluetooth® functions to permit and facilitate Bluetooth®-based communications. A suitable Bluetooth® function chip may be an ATB1103 BLE SOC chip.

[0058] Alert and status indicator light 1380 can be provided to inform the user as to the energy level, power status, and device state of PSC device 1300. EEPROM 1385 is disposed in

e-liquid cartridge 1310 and communicates with a microcontroller unit (MCU) – not shown -- on the main PC Board 1370 to provide substantially constant power output.

[0059] Turning to FIG. 14, an illustration of e-liquid cartridge 1400 is shown. Cartridge 1400 can include cartridge body 1465, which can be divided into three chambers: e-liquid reservoir 1470, e-liquid waste bin 1475, and operational compartment 1480. E-liquid reservoir 1470 can be formed to receive a preselected volume of e-liquid, for example, 1.0 ml. E-liquid waste bin 1475 is disposed to catch leakage from reservoir 1470, thereby preventing it from entering operational compartment 1480 or from leaking out to the user. The three chambers can be kept separate from each other by upper seal 1425 and lower seal 1435. However, if either seal 1425, 1435 leaks, e-liquid waste bin 1475 is disposed to catch a portion of the e-liquid and keep it from entering operational compartment 1480. Disposed within e-liquid reservoir 1465 can be e-liquid of the user's choice. Disposed between mouth cover 1405 and upper seal 1425 can be flue 1415 and atomization chamber 1420. During use, a user may put their lips on mouth cover 1405 and inhale, which starts a heater (not shown) to generate vapor within atomization chamber 1420. Upper seal 1425 may be composed of silicone to provide a seal that does not easily degrade with oils. During inhalation, vapor travels up flue 1415, out through mouth opening 1485, and into the user's lungs. If leakage does occur in reservoir 1465, the waste e-liquid will tend to collect in the middle chamber until the waste e-liquid reaches the top of vent 1430, at which time e-liquid may escape through vent 1430 and air hole 1455, which is connected to vent 1430. Air hole 1455 passes through operational chamber 1480 and vents to the outside. In this case, e-liquid waste can exit air hole 1455 without entering operational chamber 1480.

[0060] FIG. 15 includes schematic diagrams of operational electronic circuits that can be used in a PSC device. For example, microcontroller unit (MCU) 1510 can be a GF90F0320-Single-Chip-8051 Core-ADC Flash Chip MCU from Shenzhen Yuanjia Technology Co., Ltd., Guangdong, CN. The GF90F0320 is an enhanced 8-bit microcontroller developed in a high-speed, low-power CMOS process with FLASH program memory. It can be provided with a 128-bit unique chip ID, which can be used with the unique ID in the PSC EEPROM for encryption of EEPROM data. Rather than employing an EEPROM, other known methods of storing a serial number or authentication code may be used.

[0061] Synchronous buck circuit 1520 is a switch mode DC to DC electronic converter in which the output voltage can be transformed to level less than the input voltage, and thus, is a

voltage step-down device, and which can deliver high currents while minimizing power loss. Buck circuit 1520 can be used to provide a regulated DC voltage to MCU 1510 pin 14 from PWM signals from MCU 1510, pins 16-19.

[0062] USB-C cartridge interface 1530 such as, for example, upper body connector, which may be USB-C female connector in FIG. 5, element 450 or FIG. 15, element 1355, and can be used to provide mechanical, electrical, and bidirectional data support. Interface 1530 can communicate signals between, for example, MCU 1500 located in FIG. 13 on motherboard 1370 and EEPROM 1385, Bluetooth module 1375 or, through lower body USB connector 1360 to the “outside world.” External battery management circuits can be used to charge and monitor Li-Ion battery, such as battery 1340 in FIG. 13. An example of such a circuit can be charging management circuit 1540 in FIG. 15, which is a Songlang Micro 3A Synchronous Buck Lithium-Ion battery charger for 5V AC adapters from Shenzhen Junengxin Semiconductor Co., Ltd., Shenzhen, CN. Charging management circuit 1540 is a synchronous rectification buck circuit which can include a charge termination circuit, an automatic recharge and a 4.2V preset charge voltage with an accuracy of $\pm 1\%$. It integrates anti-backflow protection, output short-circuit protection, chip and battery temperature protection. When NSTDBY is activated a green light can be lit to show that charging is complete; conversely, when NCHRG is activated, a red light can be lit to show that charging is underway. Charging management circuit 1540 can be electrically coupled to the PSC battery (1340, FIG. 13) and to USB-C charging interface 1550. USB-C Charging Interface 1550 can be provided as an element of lower body connector (USB-C interface 1360, FIG. 13).

[0063] Electrically coupled to lower body connector (USB-C interface 1360, FIG. 13) and to charging interface 1550 can be USB-C Touch Detection circuit 1560. As indicated above, USB-C Touch Detection circuit 1560 can be physically and electrically coupled to lower body connector (USB-C interface 1360, FIG. 13), and be disposed at the base of the PSC device. In an exemplary implementation, Touch Detection circuit 1560 includes a PT2033C, which is a single channel touch detection chip provided by PingTeng Technology Co., Ltd., Hunan, CN. The chip has a built-in voltage regulator circuit to provide a stable voltage for the touch sensing circuit, and an internal integrated high-efficiency touch detection algorithm, so that the chip has a stable touch detection effect. In embodiments, the touch detection chip can be coupled to a female USB-C connector, and it is possible to touch the lower body connector USB-C Interface a preset

number of times to actuate the lock. For example, some implementations are configured to operate the lock by touching the lower body connector five (5) times. Moreover, Touch Detection Circuit 1560 can be coupled to MCU 1510 to allow Touch Detection Circuit 1560 to be turned on and off programmatically by MCU 1510. For example, if a PSC has not been used for a predetermined period or if authentication fails, Touch Detection Circuit 1560 can be turned off by MPU 1510 drawing VDD pin 1 (TCV) low. In a present embodiment, using Touch Detection Circuit 1560, five touches to the lower body connector (USB-C female connector exterior rim) may turn on the corresponding PSC device.

[0064] In FIG. 16A, USB-C connector 1600 can be a USB-C male connector, such as connector 1460, in FIG. 14. Connector 1600 can be used to convey data and commands to and from EEPROM 1650 (FIG. 16B). Connector 1600 can be like e-liquid cartridge connector seated securely within a USB-C connector, such as USB-C female connector 1355 in FIG. 13. Such a connection affirmatively secures cartridge to body, while providing a passage for data and power.

[0065] USB-C is an industry-standard connector for transmitting both data and power on a single cable. USB-C allows for a secure connection between the cartridge and the host body. In addition, a USB-C connector, typically female, may be used as an electronic lock for the host body. The USB-C connector can bidirectionally transfer power between host body printed circuit board (motherboard) and e-liquid cartridge printed circuit board. USB-C connectors are not the only type of physical connector that can be used. Although USB-C connector technology is employed herein, also suitable may be micro-USB, mini-USB, USB-A, USB-B, Lightning (Apple), DisplayPort, PCI-Express, Thunderbolt (Intel), at least 5 spring-loaded connectors (pogo pins), a Firewire (IEEE 1394) connector, and a modular jack connector (e.g., RJ11, RJ45, T568), among other possible wired connectors. A USB-C connector is capable of supporting popular high-bandwidth protocols such as, without limitation, USB 2.x, 3.x, and 4.x, Thunderbolt 3, Lightning, and DisplayPort protocols.

[0066] In some embodiments, a short-range wireless protocol may be used to communicate data between cartridge 410 and body 420 including, without limitation, Bluetooth®; Near-Field Communication (NFC); High Frequency RFID (HF RFID); Ultrawide bandwidth (UWB); or other short-range low-power wireless communication protocol. Such a

wireless communication link may be used to obviate a physical connection between cartridge 410 and body 420.

[0067] As illustrated in FIG. 16B, EEPROM 1650 is provided. EEPROM 1650 can be a serial, non-volatile storage device having 2 Kilobits (e.g., 256x8) of programmable memory elements. A Flash memory device also may be used. EEPROM 1650 can be used to prevent unauthorized use of a PSC device, to gather information about the PSC device, e-liquid use and preferences, and user data, and to provide a report of monitored PSC variables stored in EEPROM 1650. The programmable memory elements may be used to store operational data pertaining to operation and use of the PSC device, and the identity and demographics of the user. In embodiments, EEPROM 1650 may have an unalterable, pre-programmed unique ID, which may be a universally unique ID (UUID), e.g., a 128-bit identifier, stored therein and associated with an authorized user. EEPROM 1650 supports user authentication and avoids unauthorized use of a PSC device, e.g., by a minor or by anyone not able to verify their identity. If an unauthorized user attempts to use a PSC device, authentication fails, and the PSC device can be reversibly locked, prohibiting unauthorized use. A locked PSC may be unlocked by an authorized user. Of course, other well-known encryption/decryption or serial number reading techniques may be used as well,

[0068] In embodiments, EEPROM 1650 can include therein a preprogrammed, globally unique, unalterable 128-bit sequence that can identify essentially every e-liquid cartridge in existence (128-bit ID provides approximately 3.4×10^{38} identifiers). EEPROM 1650 can be used in conjunction with a microcontroller unit (MCU) (1510, FIG. 15), which may have an unalterable, globally unique preprogrammed 128-bit sequence therein to perform encryption and decryption of data stored in EEPROM 1650. An example of an EEPROM capable of providing a unique ID is FM24C16D 2-wire EEPROM with Unique ID and Security Sector. The FM24C16D can be provided by Shanghai Fudan Microelectronics Group Co., Ltd. of Shanghai, CN. The FM24C16D is internally organized with 128 pages of 16 bytes (128 bits) each and offers 16-byte Security Sectors which can be written and later permanently locked in READ ONLY mode. These registers may be used to store security and other important information separately from the main memory array. This EEPROM uses a separate memory block containing a factory preprogrammed, unalterable 128-bit Unique ID. Many variations of EEPROM encryption can be performed, for example, Advanced Encryption Standard (AES)

algorithm, which may be an AES dynamic transform encryption algorithm. Other suitable encryption/decryption algorithms may be used to achieve the desired ends. As an example, encrypted data resides in EEPROM and is read. Two keys are used: the dynamic EEPROM UUID key and the static MCU key. The respective keys can be combined to form a third key. AES encryption/decryption can be performed using the third key to reduce the likelihood that the data will be compromised. The third key is used by the MCU (microcontroller unit) to decrypt encrypted data, thereby converting the encrypted data into plaintext data. Conversely, as plaintext is received, the dynamic EEPROM UUID key and the “secret” static MCU key are retrieved and combined to form a third key. Note that the data encrypted onto EEPROM can only be decrypted by one particular MCU, which is the one embedded in the corresponding PSC device. Table 1 illustrates the encryption/decryption algorithm, which can be used with the present embodiments. The AES algorithm can be used for encrypting and decrypting the data using “KEY3,” i.e., a combination of KEY1 and KEY2. Table 1 illustrates the encryption/decryption algorithm, which can be used with the present embodiments.

[0069] TABLE 1

KEYS		
KEY1	0x12456789	EEPROM UUID Dynamic Key
KEY2	0x3ab9cdef	MCU UID Static Key
KEY3	0x4cff3578	KEY1+KEY2
ENCRYPTION		
DATA	1, 2, 3, 4, 5, 6, 7	Original data
PROCESS	ENCRYPT: 0x4cff3578	(AES: KEY3) Encryption algorithm
DATA	c, d, 3, f, 4, 8, b	Encrypted data
DECRYPTION		
DATA	c, d, 3, f, 4, 8, b	Encrypted data
PROCESS	DECRYPT: 0x4cff3578	(AES: KEY3) ⁻¹ Decryption algorithm
DATA	1, 2, 3, 4, 5, 6, 7	Original data

[0070] The notation (AES - KEY3)⁻¹ indicates the AES decryption algorithm, as used herein, with the notation representing an “inverse” type of AES operation.

[0071] Although many variations of EEPROM encryption can be performed, the present embodiments employ an advanced dynamic transform encryption algorithm. As an example, encrypted data resides in EEPROM and is read. Two keys are used: the dynamic EEPROM UUID key and the “secret” static MCU key. The respective keys are combined to form a third key. AES encryption/decryption can be performed using the third key to reduce the likelihood that the data will be compromised. The third key also may be used by the MCU to decrypt encrypted data, thereby converting the encrypted data into plaintext data. Conversely, as plaintext is received, the dynamic EEPROM UUID key and the “secret” static MCU key are retrieved and combined to form a third key. Note that the data encrypted onto EEPROM can only be decrypted by one particular MCU, which is embedded in a corresponding PSC device.

[0072] FIG. 17 is an illustration of an ATB1103 Bluetooth Low Energy System on a Chip (BLE SOC) radio 1700. BLE SOC radio 1700 can be exemplary of an integrated device which communicates between PSC device 1100 and smart phone 1125 via a short-range, low power, wireless protocol, here Bluetooth Low-Energy (BLE) protocol. However, BLE SOC radio 1700 also may be disposed, in addition, in cartridge 410 and in body 420 such that a wireless data connection, e.g., a BLE protocol connection, is provided between cartridge 410 and body 420 in lieu of a wired protocol. In such embodiments, cartridge 410 and body 420 may be coupled by way of magnets disposed proximately in each element 410, 420.

[0073] The examples used herein are intended merely to facilitate an understanding of ways in which the invention may be practiced and to further enable those of skill in the art to practice the embodiments of the invention. Accordingly, the examples and embodiments herein should not be construed as limiting the scope of the invention, which is defined solely by the appended claims and applicable law. Moreover, it is noted that like reference numerals represent similar parts throughout the several views of the drawings, although not every figure may repeat each feature that has been shown in another figure in order to not obscure certain features or overwhelm the figure with repetitive indicia. It is understood that the invention is not limited to the specific methodology, devices, apparatuses, materials, applications, etc., described herein, as these may vary. It is also to be understood that the terminology used herein is used for the purpose of describing embodiments only, and is not intended to limit the scope of the invention.